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OF

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1888.

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I hereby certify that copies of the Proceedings for 1888 have been presented at the meetings of the Academy as follows:—

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EDWARD J. NOLAN,
Recording Secretary.

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1838

PROCEEDINGS

OF THE

ACADEMY OF NATURAL SCIENCES

OF

PHILADELPHIA.

1888.

January 3, 1888.

The President, Dr. Joseph Leidy, in the chair.

Twenty-one members present.

The death of Andrew Garrett, a correspondent, was announced.

January 10.

The President, Dr. Joseph Leidy, in the chair.

Twenty-four persons present.

On a fossil of the Puma.—Prof. Leidy directed attention to a specimen recently sent to him for identification from Sparta, Illinois. It is the cranial portion of a skull of the Puma, *Felis concolor*, and was found under about thirty feet of earth, when digging in the bed of the Kaskaskia river, for a bridge pier. It accords with the corresponding part of recent animals, though presenting some slight differences from a number of skulls of our museum. The most striking difference is in the interparietal crest which is higher and of more uniform height and is especially higher in front. The narrow part of the cranial case is narrower and the forehead is more mesially depressed between the angular processes. Comparative measurements with two recent skulls of about the same size are as follows:

	Fossil	Recent	Recent
Length of interparietal crest	98	108	94mm
Height of interparietal crest	10–15	9–12	8–12
Height, on line of lower part of coronal suture	15	10	5
Breadth at narrow part of cranium	37	42	47
Breadth at centre of squamosals	74	75	75
Breadth at zygomata	150	150	145
Breadth at frontal angular processes	74	80	81
Breadth of narrow part of forehead	42	.52	44
Length of forehead to post-nasal depression	41	48	48
Height of inion from occipital foramen.	62	63	62

January 17.

Dr. A. E. Foote in the chair.

Eight persons present.

A paper entitled "Some new fossils from the Niagara Shales of Western New York" by Eugene N. S. Ringueberg M. D., was presented for publication.

January 24.

Mr. Geo. W. Tryon, Jr. in the chair.

Twenty persons present.

A paper entitled "The Distribution of the Color Marks of the Mammalia" by Harrison Allen M. D., was presented for publication.

The death of Wm. L. Mactier, a member, was announced.

On the relation of Sarracenia purpurea to Sarracenia variolaris.—Prof. W. P. Wilson remarked that *Sarracenia purpurea* produces two kinds of leaves. As the young plantlet first develops itself from the seed it forms a few leaves which differ widely from those which appear on the same plant a little later. The adult stage of these first leaves is from a twentieth to a tenth smaller than the adult stage of the second or later developed leaves. Generally only from five to ten of these first-leaves are produced.

After the second leaves begin to appear, then no more of the first form are grown by the plant.

In the ordinary leaves of *S. purpurea* it is well known that the hood surmounting the hollow leaf is erect and in no wise protects or covers its opening. In *S. variolaris* this is just the opposite—here the hood, a little above and back of the opening, makes a sharp bend forward and not only covers over the whole orifice but projects beyond it on all sides nearly ½ inch.

These first or seedling leaves of *S. purpurea* resemble in form not the later and adult leaves on the same plant, but those of *S. variolaris*. The hood is not erect but arches over the hollow leaf in precisely the same manner as in the adult leaves of *S. variolaris*.

There are also two forms of leaves in *S. variolaris*. In this plant, however, the differences are not so much a matter of shape as apparently of arrested development. The first leaves are very much like the adult form on the same plant only being from ten to twenty times smaller.

But the important fact remains to be stated:—the first leaves from each of these plants are perfect miniatures of each other. It would be next to impossible for an expert to separate them, should they happen to become mixed, and to accurately say which belonged to the one or which to the other of the two species.

The production of this first set of leaves by *S. purpurea* which so very closely resemble the ordinary leaves of *S. variolaris* had led him to believe that the species *purpurea* is a retrograde development from *variolaris*.

His belief in this is, however, not wholly based on the production of the early leaves, but rests upon several other important facts.

S. variolaris is a very highly specialized plant for the purpose of catching and digesting insects. Up and down the margin of the wing and around the mouth of the protected pitcher are numerous honey glands. In the interior is the smooth surface and also the hairy ones to prevent the escape of insects which have fed up to the top of the leaf and then fallen into this treacherous opening. These special adaptations are all present in *S. purpurea*, but the honey glands seldom secrete any nectar and are sometimes even rudimentary. Again the fluid found in *S. variolaris* contains a considerable quantity of a digestive ferment which acts directly upon the entrapped insects. This is not so in the fluid excreted by the leaves of *S. purpurea*. Only a trace of this ferment could be found after the most careful chemical search for it.

January 31.

Mr. Charles Morris in the chair.

Twenty-eight persons present.

Mimicry among Plants.—Prof. J. T. Rothrock remarked that among animals mimicry is usually related to the safety of the individual, or less frequently to the ease by which it may conceal itself and thus more readily capture its food. Whatever may be the cause of mimicry among plants, or by whatever governing forces one plant in the long run, may come to resemble another more or less remotely related to it, it is clear that neither of the causes which are associated with mimicry among animals can obtain in the vegetable kingdom.

These mimetic cases may conveniently be ranged under two heads.

1. Those in which we find the resemblances between plants in groups clearly distinct. The lower of these may sometimes well be called anticipating or prophetic types.

2. Those found between plants in the same natural family, where the descent within recent period, of one from the other, may reasonably be supported by all who admit the doctrine of evolution. This resemblance is of course often merely external, disappearing under even the slightest examination; as, for example, when one glances hastily at a specimen, particularly an herbarium specimen, of *Zygadenus elegans* Pursh, and then compares it with a narrow-leaved specimen of *Swertia perennis*. There are few who will not be struck with the likeness, yet the former is a well marked representation of the monocotyledonous group, and the other as evidently one of the dicotyledonous plant. It is somewhat startling to find along with marked points of distinction that there exist certain structural resemblances; thus one may well compare the unusual markings found on the bases of the perianth divisions in *Zygadenus* with the equally unusual gland found at the base of the petals in *Swertia*. There is in these resemblances nothing which can in any sense be called prophetic, because the relationship between the examples is quite too remote.

The case is, however, somewhat different when one compares the shape of some of the young liverwort with the prothallus of some ferns. Here the resemblance is often very marked and the line of relationship not so distant. It might almost be said that the permanent form of the liverwort clearly resembled the early, transient form of the fern.

Or, as another instance, compare the protonema of a moss before the shoot appears which is to develop into the erect aerial branch, with one of our filamentous algæ. Here again we have so marked a general resemblance that it may well enough be classed with the prophetic types.

The second group to which allusion has been made—those in which the resemblance is between related plants, may be fairly illustrated by the resemblance between *Nepeta Glechoma* and *Lamium amplexicaule*, especially when (as is often the case in *Nepeta*) the petioles are very much reduced in length.

Another unusual resemblance comes to mind. One may easily understand why the cup found about the base of the stigma in so many of the Lobeliaceae should be so exactly repeated in the allied order of Goodeniaceae. But how are we to explain its appearance in *Gaura* (one of the Onagraceae) which can hardly be regarded as closely related to either of the above orders. These resemblances and the questions growing out of them are to be further considered in a paper in course of preparation.

Messrs Lawrence J. Morris, Stewart Culin and Roberts Le Boutillier were elected members.

The following were ordered to be printed:—

A BIBLIOGRAPHIC AND SYNONYMIC CATALOGUE OF THE GENUS AURICULELLA, PFEIFFER.

BY W. D. HARTMAN, M. D.

Genus AURICULELLA, Dr. L. Pfeiffer.

A. amœna, Pfeiffer. **(Frickella.)** Proc. Zool, Soc. t. 30, p. 3, 1855.
Frickella amœna, Pfeiffer, Mal. Blätt. ii–1855, 166–1856.
Auriculella amœna, Gul. Proc. Zool. Soc. 91,–1873.
Sandwich Islands.

A. ambusta, Pease. Jour. Conch. 345, 1869. Proc. Zool. Soc. 649, 1869.
Sandwich Islands.

†**A. auricula,** Pfr. **(Partula.)** Fer. System, 66, No. 6.
Auriculella Auricula, Kust. t. 3, p. 14–16.
Auriculella Owaihiensis, Chem.
Tornatella Owaihiensis, Pfeiffer, 1842.
Partula Dumartroy, Souly.
Partula Auricula, Albers.
Achatinella Auricula, Pfeiffer, 1855.
Auricula Sinistrorsa, Chem. In Küst. t. 7, p. 14–16.
Bulimus Armatis, Migh. Proc. Bost. Soc. II, p. 19, 1845.
Tornatella Sinistrorsa, Pfr., Mon. Hel. viv; 652.
Hawai, Sandwich Islands.

†**A. brunnea,** Smith. Proc. Zool. Soc. t. 10, f. 23–1873.
Molokai, and Kauai.

†**A. Cerea,** Pfr. **(Achatinella.)** Proc. Zool. Soc. t. 20, f. 21–1855.
Achatinella Cerea, Pfr. Mall. Blätt,–1855.
Auriculella Cerea, Pse. Proc. Zool. Soc. 649–1869.
Sandwich Islands.

A. Chammissoi, Pfr. **(Achatinella.)** Proc. Zool. Soc. 98–1853.
Proc. Zool. Soc. Pfr. Mall. Blätt, 1855.
Auriculella Chammissoi, Pse. Proc. Zool. Soc. 649–1869.
Sandwich Islands.

A. Crassula, Smith. Proc. Zool. Soc. t. 10, f. 22–1873.
Makawao, East Maui.

†**A. diaphana,** Smith. Proc. Zool. Soc. t. 10, f. 25–1873.
Oahu.

†**A. expausa,** Pse. Proc. Zool. Soc. 649–1869. Jour. Conch. xvi. t. 14, f. 8.

Sandwich Islands.

A. jecunda, Smith. Nomen in Ann. Lyc. N. Y. x. 331–332–1873.

West Maui.

†**A. lurida,** Pfr. (**Achatinella.**) Mon. Hel. Viv. iii, 552.

Tornatellina Castanea, Pfr. Mon. Hel. Viv. iv, 570.
Balea Castanea, Adams.
Tornatella Castanea, Pfr. Mall. Blätt. 166–1856.
Auriculella lurida, Pfr. Nomen. Hel. Viv. 304–1881.

Sandwich Islands.

A. Obeliscus, Pfr. (**Achatinella.**) Mon. Hel. Viv. iii. 563.

Balea Newcombia, Pfr. Proc. Zool. Soc. 67–1852.
Temesia Newcombia, Bourg.
Auriculella Obeliscus, Pfr. Mall. Blätt, 166–1856.

Sandwich Islands.

A. patula, Smith. Proc. Zool. Soc. t. 10, f. 24–1873.

Sandwich Islands.

†**A. petetiana,** Pfr. (**Tornatellina.**) Mon. Hel. Viv. ii, 399.

Auriculella Petetiana, Pfr. Mall. Blätt, 4–1855.

Sandwich Islands.

A. perpusilla, Smith. Proc. Zool Soc. t. 10, f. 26–1873.

Sandwich Islands.

†**A. pulchra,** Pse. Jour. Conchyl. xvi, t. 14, f. 6–1869.

Sandwich Islands.

There is little difference between type examples of *S. pulchra*, Pse. and *A. auricula*, Fér.; the former are somewhat larger in size.

A. pusilla, Gld. (**Partula.**) Expd. Shells, t. 9, f. 90.

Achatinella pusilla, Pfr. Mall. Blätt, 166–1856.
Auriculella pusilla, Pfr. Nomen. Hel. Viv. 304–1881.

Matea Island.

A. solida, Gul. Nomen in Ann. Lyc. N. Y. x, 331–332–1873.

Kanailola, Oahu.

A. solidissima, Smith. Nomen in Ann. Lyc. N. Y. x. 331–332–1873.

Makawao, Oahu.

A. tenuis, Smith. Proc. Zool. Soc. t. 10, f. 27–1873.

Sandwich Islands.

A. triplicate, Pse. Jour. Conch. 346–1859.

Maui.

†**A. uniplicate,** Pse. Jour. Conchyl. xvi, t. 14, f. 7–1869.

Maui.

A BIBLIOGRAPHIC AND SYNONYMIC CATALOGUE OF THE GENUS ACHATINELLA,

BY W. D. HARTMAN, M. D.

The genus *Achatinella*,* embraces a group of small, beautiful and variously colored land shells, peculiar to the Sandwich Islands. Mr. Swainson first introduced the genus to the notice of naturalists in Brand's Journal, in 1828, and in 1831 the same author assigned it a position in the systematic arrangement of species, under the above name. Since that period many new species have been described by naturalists. Dr. L. Pfeiffer in the Malakozoölogische Blätter, and subsequently others have proposed sub-divisions for the numerous and diversified forms embraced by the genus. In some instances the lines of these sub-divisions are well-defined, while in others they are less marked. They have been generally adopted by conchologists, as they are found convenient for the arrangement of a collection. Mr. Thomas Bland says "the distinctions derived from the consideration of the form of the shells are arbitrary, and the limits are not well defined." His classification of the sub-divisions of the genus, is chiefly founded on the structure of the lingual dentition, "which indicates three groups, *a. Partulina* and *Achatinella* *b. Newcombia* and *Laminella*, and *c. Leptachatina;* judging from the shells alone, *Bulimella* and *Apex* belong to group *a*, while *Labiella* belongs to group *b* or *c* rather than to *a*." This arrangement is chiefly in accord with that of Dr. Pfeiffer and Mr. William H. Pease, for the details of which I must refer the reader to their several papers. I agree with Dr. Pfeiffer in eliminating *Carelia* and *Auriculella* as separate genera from *Achatinella*, and I also concur with Dr. Gulick in the opinion that *Frickella* should be added to *Auriculella*. I am also in accord with Mr. Lovell Reeve in the opinion that the small common shells for which Dr. Gould proposed the name of *Leptachatina*, should be removed from *Achatinella*, as they are more nearly allied to the Oleacinidæ than to the Bulimidæ, and they differ from *Achatinella* in being oviparous while the latter are viviparous. In consequence of the connection heretofore existing be-

* Although *Auriculella* possesses the same form of dentition as *Partula* and *Achatinella*, Dr. Pfeiffer has placed it in a separate genus, on conchological grounds, in which I concur. These minute shells, would seem to have no place in a serial arrangement of the genus *Achatinella*. Species marked † are in the author's collection.

tween *Achatinella* and *Leptachatina*, the latter has received especial attention in the preparation of this paper, and for the present it has been retained in the genus *Achatinella*. In analyzing the species of *Leptachatina* proposed by Dr. Gould, of which *L. acuminata* Gld. was designated as the type, they are found to be divisible into three groups. In the first may be placed the elongate or cylindrical and semi-transparent varieties, as *L. acuminata*, *striatula* and *cerealis* Gould, *gracilis* Pfeiffer, *tenebrosa* Pease, *terebralis* and *exilis* Gul., and *fusca* Newc. In the second, the short oval clear and polished varieties, as *cingula* Migh. *saccata* Hartm. *brevicula* Pse. and *nitida* Newc. And in the third, the larger inflated and more stout species, as *Hartmanii* Newc. *M. S. succincta*, *fumosa*, and *vitrea* Newc, *fusca* and *resinula* Gul. together with *corneola* and *pyramis* Pfr. The major part of the species are terrestrial in their habits, while a few are arboreal. In my examination of the Achatinellæ, I have also included the allied genus *Auriculella*. The generic name of *Achatinella* has been used by all authors previous to Dr. Pfeiffer's sub-division of the genus in Malakozoölogische Blätter in 1854 and 1856. Owing to several causes the species have been burthened with numerous synonyms, many of which have been herein omitted, to avoid a needless repetition of names. Their variability in form, age and color, has misled naturalists into the error of multiplying the species, and a change of environment Dr. Newcomb informs us, is known to so alter the appearance of some, as to cause them to be mistaken for distinct species. A change of environment and malnutrition materially modifies the growth of all animals, and nowhere is it more observable than in the molluscan fauna. The different appearance of depauperized or aberrant forms of shells is a prolific source of error, and often of embarrassment to the student of natural history, since corrections can only be made by the examination of types in scattered collections. Mr. Geo. W. Tryon Jr. in his recent books on conchology, has relegated to synonymy many shells heretofore considered of specific value, some of which are doubtless the result of environment or hybridization. In the early history of the genus *Achatinella*, naturalists in different parts of the world were engaged at the same time in describing the species, and some of the names then given have only been established by priority of publication. The application of boiling water to remove the animal, materially alters the color of the shell, changing a green or bright green to a dirty yellow; and the manufacture of species by scraping, has also been resorted to, to increase the number of commercial species.

Hybridization may have been a factor in the origin of some varieties as occurs in the allied genus *Partula*. The preservation of the species in the lower animals is due in a great measure to animal instinct, but where nearly allied species are thrown together, as often happens in the involuntary change of position of *Achatinella*, or the proximity of broods, as occurs with *Partula*, hybridization may take place. It is well known that embryonic young are priceless to the biologist, and since the tissue cells of species evolute from pre-existing germs and do not originate *de novo*, the shape of the embryonic or apical fold of each species of viviparous mollusk, should be the true index of a species, except in the case of hybrids, when it would take the form of one or the other of the parents, and would be farther distinguished in the adult, by the form, size and color of the predominating parent, a law always observable in hybrids.

Dr. Isaac Lea has always maintained the importance of the shape of the apical fold, for a correct determination of a species of *Unio*, I have said elsewhere, that viviparous hermaphrodite mollusca (being *cold blooded* animals) would probably more readily hybridize than *warm blooded*, which might in a measure account for the numerous forms and varieties of Unionidæ and Strepomatidæ in the rivers of the United States. The late Prof. Haldeman believed that hybrid Unios existed, and farther that individuals between *Melantho decisa* and *M. ponderosa* Say are often found, which look very much like hybrids of these species. It is well-known that fish, frogs and toads (which are cold blooded animals) hybridize, and recently some species of salmon have been successfully and profitably hybridized.

So far as known the food plants of the *Achatinella* have no influence in the coloration of the shell; those species possessing a black, dark or slate colored mantle, secrete a variegated shell, while others with a greenish, bluish, light yellow or flesh-colored mantle, secrete a shell with different shades of yellow. The varied and gorgeous tints of the shells of Achatinellæ, are probably owing to the action of light and oxygen on the secretions from the glands of the mantle; the striations and variations of color, are probably due to the chemical composition of a fluid from a different set of glands; hence the painting of the arboreal species is more bright and pleasing than that of the terrestrial, which are generally of uniform and somber hues. The surface of all the porphyroid and gaily painted species, exhibit under a glass, waved spiral striæ, similar to Partulæ. These lines commence at the termination of the first one-and-a-half whorls of the apex, which corresponds to their embryonic age. The apices of some of the *Amastra* are coarsely plicate, in this respectresembling *Laminella*. This is especially noticeable in the elongate species, as *A. magna, assimilis, biplicata, Huchinsonii, turritella* and some others which have been classed with *Laminella* by Dr. Pfeiffer; in others the plicæ of the apex are small wrinkles, and in *A. farcimen, reticulata, tristis, elliptica*, and some others, the apex is smooth and rounded, forming a sub-group of *Amastra*. A more constant character is found in the species of *Amastra* being *destitute of spiral striae*, differing in this respect from the porphyroid Achatinellæ. The *Amastra* being ground species and living beneath dead leaves and other debris, when the shells are deprived of the animal and are exposed to the atmosphere, the epidermis is more readily detached than in other Achatinellæ.

"The facts relating to the geographical distribution of *Achatinella*, and the development of so large a number of species within the limits of small areas, are very remarkable and interesting, and have presented problems bearing on the theories of evolution. Each island has its own peculiar species, and not only species, but its own peculiar types, or groups of species, of similar form. Again, on islands where there has been a full development of *Achatinella*, each principal mountain ridge and valley has its own peculiar species which are found nowhere else; *the species of each ridge or valley being often connected with those of the next—by intermediate varieties*. Another important fact observed in the distribution of the *Achatinella* is, that on a mountain chain with many culminating peaks, the tendency is to divergence of species, while on an individual mass of mountains concentrating towards a single culminating peak, the tendency is to a convergence of species." "The structure of the Hawaian Islands is volcanic; and in studying the distribution of shells over them, it is important to note the relative ages of the several islands. Geologically speaking, Kauai is the oldest; next in the series is Oahu; then Maui with the adjoining islands of Molokai and Lanai; and last comes Hawaii, in the southern portion of which volcanic fires are still raging."

"OAHU. The development of *Achatinella* on this island, both as regards number and variety of form and color, has been greater than on any other island of the group. Unlike most of the other islands which have individual mountain masses, Oahu has two true ranges or chains of mountains, a longer and a shorter one, with many independent culminating peaks. The aggregate length of the two ranges is 50 miles. The sides of these ranges, their entire length, are furrowed by deep valleys separating lofty ridges. These valleys and ridges are the home of *Achatinella*: each valley and ridge has its own distinct species which are connected with those of the next valley and ridge, by a multitude of intermediate varieties, presenting minute gradations of form and color. These two ranges of mountains have already furnished 227 distinct described species of *Achatinella*, the number of varieties has been estimated as high as 800 or 900. All these species and varieties, are found in an area of less than 120 square miles; and a considerable portion of the longer range remains yet to be explored. These species have all the various shapes from globose to conic, ovate and elongate-conical, and present almost every possible shade and variety of coloring, from pure white to jet black, and all the shades of green, rose, yellow, brown and ash; sometimes several of these colors are combined in one species, either in regular or irregular bands, or tessellated, marbled or zigzaged designs."

"WEST MAUI. On this part of Maui we have the converse of Oahu. Its individual mass of mountains, clustering around one common centre peak, 2000 feet higher than any part of Oahu, furnishes only 30 described species of *Achatinella*, each principal valley and ridge has its own peculiar species or varieties; but all the arboreal species can be referred to seven leading types, these differ much from the Oahu types, and do not present the same varieties of form or color. The prevailing colors are white and dark brown with all the intervening shades of either, plain or variously arranged in bands or zigzaged lines."

"EAST MAUI. The distribution of *Achatinella* on this part of Maui is not fully known. All its mountain gorges and ridges concentrate around the rim of the immense crater of Haleakala, a circumscribing bound of nearly thirty miles in extent. The almost impenetrable forest on the mountain slopes to the east and south of the crater comprising a belt of twenty miles long and six miles wide, remain unexplored, and its molluscan life is unknown. The woodlands on the north-west slope of the mountain facing West Maui furnish 29 described species of *Achatinella*; but they are the same or unmistakable counterparts of those found on West Maui. The narrow depression of land between East and West Maui has led many to infer that they were originally separate islands, this similarity of shell-types would seem to indicate that, if ever separate, they must have been united before the development of molluscan life; otherwise we should expect to find the types of East and West Maui differing as much from each other as do those of Maui and the contiguous islands of Molokai and Lanai."

"MOLOKAI. The distribution of *Achatinella* on this island presents some new features not observed on any other island. The island is forty miles long with a width of only seven miles, it is about one-third the size of Oahu, and like it has a mountain range extending nearly thirty miles through its length. The range is furrowed on each side by deep valleys. Some of these mountain gorges are very wide and cut deep into the narrow axis of the island. The larger ones have proved an effectual barrier to the migration of the shells. The island is thus divided into three natural sections, and each section retains its own peculiar species without intermingling with those of the next section." "Molokai furnishes 25 described species which are about equally divided between the three sections of the island, these shells exhibit more variety of form and color than those of Maui, and have peculiarities which separate them entirely from types of other islands."

"LANAI. This is the smallest and most arid of the shell producing islands. Its area is 100 square miles, of which probably not over one tenth is suited for the support of mollusks. The island is, however notable as the home of *A. magna* Adams, the largest shell of the whole *Achatinella* family. Specimens in our cabinet measure 1½ inches long, the whole number of species of *Achatinella* on Lanai is 13, and they exhibit peculiarities of type."

"KAUAI. This is the oldest and most verdant island of the group. It lies to the west of Oahu, and is separated from it by a channel wider than occurs between any of the other islands. Its extensive forests, luxuriant vegetation and moist climate render it peculiarly adapted for the abode of *Achatinella*; and one would naturally expect to find here a larger, and if possible, higher development of the family. But we are doomed to disappointment, the island yields no arboreal species, the shells are terrestrial, and those classed with *Achatinella* belong to the plainest forms of the *Amastra* and *Leptachatina* groups; 5 species to the former and 18 to the latter. Kauai, however, does furnish a very peculiar and interesting group of large terrestrial shells, remarkable for their elongate turretted form. The generic name of *Carelia* has been provided for the group;

it embraces some seven species. Specimens of *Carelia turricula* Migh. in my cabinet measure three inches long. This group has no place in the *Achatinella* family, as classed by M. Gulick. It lacks the peculiar spiral twist of the columella and other generic characters of that family; living specimens of *Carelia* are now very rare, but at some period in the history of Kauai they were exceedingly abundant. The alluvial deposits near the coast portions of the island, contain multitudes of these shells in a semi-fossil state, which have been washed from the mountains by the freshets of ages past. The small neighboring island of Nühau also has a single species of *Carelia* found in sand and mud deposits; no living specimens are found there now."

"HAWAII. This island embraces within its bounds two-thirds of the total area of the whole group. It is also supposed to be the most recently formed of the islands. The volcanic forces are still at work here. The extensive forests are as well adapted for the support of *Achatinella*, as those of any of the other islands, but it furnishes only a single arboreal species, and five terrestrial. The arboreal species is *A. physa;* it was first described by Dr. Newcomb in the Proceedings of the Zoological Society of London in 1853. In a subsequent number of the same Journal, Mr. Wm. H. Pease refers to this same shell as a "species rarely met with on the mountains of Hawaii." The centre of production is the Kohala range of mountains, notably the most ancient portion of the island; and it exists there now in unparalled abundance. During a recent visit to the locality in a few minutes I collected several hundred specimens, picking them from trees and low bushes as rapidly as one would gather huckleberries from a prolific field. The shell appears to be slowly migrating into the adjoining districts of Hamakua and Kona, and assuming new shapes and varieties of coloring. One of these varieties in our cabinet is almost worthy of assignment as a new species. The conchologist of a few centuries hence will no doubt be naming *Achatinella* from the different districts of Hawaii of manifold forms and gaudy colors, which have developed through the mysterious processses of evolution from the humble *A. physa* of the Kohala Mountains."

"The discovery of so large a number of land shells of the same genus within limited island areas was unprecedented, and at once induced the belief that the "completion of a collection of the genus had been sealed," this is a mistake. The homes of *Achatinella* are on rugged mountains, densely covered by vegetation and their sides furrowed by deep and almost inaccessible ravines and large districts on Oahu and East Maui which have never been visited by white men, remain yet to be explored. It will require years of research and study, before the number and exact distribution of the remaining species can be ascertained. It is also generally supposed that these shells are becoming extinct by the ravages of cattle through our forests. This is true in respect to a limited number of species on the island of Oahu whose habitats were the forests on the lowest range of hills. Some of these hills have been denuded of woods, not only by cattle, but the woodman's axe, and certain species are becoming rare. The favorite resorts of many species are the Ki (*Dracena terminalis*) and the Olona (*Boehmeria stipularis*) both excellent fodder plants. But in localities where these plants have been entirely destroyed by cattle, the shells have generally selected homes on other adjoining plants. The ravages particularly of wild cattle in our mountain forests are certainly to be deprecated, nevertheless by clearing the under brush they render the forests more accessible for the collection of known species; and by opening the paths to higher and more dense forests they facilitate the discovery of new species. The agencies now threatening the wholesale destruction of these little gems of the forest are the rats and mice, which have become very abundant in mountain forests, particularly where there are no cattle. Their ravages are not confined to the shells whose habitats are on the ground, but extend to those found on trees. It is not uncommon to find around the charnal cells of these noxious little animals hundreds of empty, mutilated shells. Notwithstanding these threatening agencies, the Achatinellæ are still quite abundant on Oahu and Molokai, where cattle have the widest range, though not so abundant as formerly on West Maui where the cattle ranges are somewhat limited and the mice enjoy greater immunity. In a recent excursion with a friend through a portion of the mountain forests between Ewa and Waialua on Oahu more than 3000 shells were collected in a few days embracing over fifty species of *Achatinella*, some of them new to science. In a similar trip around Molokai nearly 5000 were collected, embracing thirty species, some new."[1]

To Wesley Newcomb, M. D. more than to any author on *Achatinella*, we are indebted for a correct knowledge of the described species of this beautiful genus of shells. During a residence of nine

[1] Mr. D. D. Baldwin in Hawaian Almanac and Annual.

years in the Sandwich Islands he collected and reared large numbers of the different species and observed the numerous varieties from a common parentage. When in Europe in company with the late Dr. A. A. Gould he examined the types of Dr. L. Pfeiffer and others which enabled him to correct the synonymy of many doubtful species; all of which he has embodied in his Synopsis of the Genus, which entitles him to the designation of authority on *Achatinella* "par excellence."

For convenience of reference I have arranged the species alphabetically under the several sections, rather than in a connected series, as was attempted by Mr. Pease. The sections of Achatinellæ being more or less artificial, authors are not always in accord as to which certain species should be assigned. In the majority of instances, I have followed Dr. Pfeiffer or Mr. Pease in the distribution of the species among the sections, being guided in the main by authentic examples, or by figures and descriptions of authors; the sub-section Helicterina adopted by Mr. Pease from Baron Ferussac, has been supplanted by *Partulina*, the former having been preoccupied.

In the preparation of this paper I am indebted for aid to several friends. To Prof. A. Agassiz for the loan of the entire Pease collection of *Achatinella* together with all his duplicates amounting to near two bushels of examples, I have had in my possession several entire suites of Achatinellæ, kindly loaned to me by Prof. James Hall, Dr. Lea, Mrs. George Andrews and Mr. R. Ellsworth Call, by which I was enabled to identify types from authors hands. Recently, at the invitation of Dr. Newcomb I spent the greater part of two days in the examination of his collection of *Achatinella* made some years ago in the Sandwich Islands. My acknowledgements are also due him for assistance in the determination of many varieties. When in Europe in 1883 I purchased some of the species of Messrs Gulick and Smith from G. B. Sowerby Jr. Recently I have been favored by Mr. D. D. Baldwin of the island of Maui with written catalogues of the localities of the Achatinellæ of the Sandwich Islands, together with numerous examples of *Achatinella* and especially with specimens taken from the determined type examples of Mr. Gulick, in the Hawaian Museum. The geographical distribution of the Achatinellæ in those islands together with their habits, which has been embodied in this paper was expressly prepared by Mr. Baldwin for the Hawaian Almanac and Annual. I am also under obligations to Mr. Geo. W. Tryon Jr., for his uniform courtesy in aiding me in the examination of books and examples belonging to the Academy of Natural Sciences.

The following references have been abbreviated in the Catalogue:—Monographia Heliceorum viventium and Nomenclator Heliceorum viventium by Dr. L. Pfeiffer; Proceedings of the Zoological Society of London, containing the papers of Drs. Newcomb, Pfeiffer and Gulick; Proceedings of the Boston Society of Natural History, containing the papers of Drs. Gould and Mighels; Contributions to Conchology by C. B. Adams; Proceedings of the California Academy of Sciences; the American Journal of Conchology, containing the papers of Dr. Newcomb, and also the Journal de Conchyliologie, containing many of the papers of Mr. Wm. H. Pease.

Species marked † are in the author's collection.

The arrangement of the sub-groups of *Achatinella* herein adopted is as follows:—

A { *Partulina*, *Bulimella*, *Achatinellastrum*, *Eburnella*, *Apex*

B { *Perdicella*, *Newcombia*, *Labiella*, *Laminella*, *Amastra*, *Carinella*

C { *Leptachatina*

Section PARTULINA Dr. L. Pfeiffer.

P. aptycha, Pfr. **(Achatinella.)** Proc. Zool. Soc. tab. 30, f. 1–1855.
Newcombia aptycha, Pfr. Mall. Blätt. 165, 1856.
Helicter aptycha, Pse. Proc. Zool. Soc. 615–1869.
Perdicella aptycha, Pfr. Nomen. Hel. Viv. 315–1881.
Sandwich Islands.

†P. cinerosa, Pfr. **(Achatinella.)** Proc. Zool. Soc. tab. 30, f. 5,–1855.
(*Helicter perversa,* Pse.) Proc. Zool. Soc. 645–1869. (Non Swains.)
Sandwich Islands.

†P. compta, Pse. **(Partulina.)**
Partulina compta, Pse. Jour. Conchyl. xvii–1869.
Molokai.

†P. crassa, Newc. **(Achatinella.)** Proc. Zool. Soc. pl. 24, f. 71–1853.
Bulimella crassa, Pfr. Mall. Blätt. 124–1854, 163–1856.
Partulina crassa, Pse. Proc. Zool. Soc. 647–1869.
Lanai.

P. dolium, Pfr. (**Achatinella.**) Proc. Zool. Soc. tab. 30, f. 15–1853.

Bulimella dolium, Pfr. Mall. Blätt. 165–1856.

Partulina dolium, Pse. Proc. Zool. Soc. 647–1869.

Sandwich Islands.

†**P. dubia**, Newc. (**Achatinella.**) Proc. Zool. Soc. tab. 24, f. 65–1853.

Achatinella radiata, Pfr. Mall. Blätt. 116–1854. Non Gould.

Bulimella dubia, Pfr. Mall. Blätt. 162–1856.

Achatinellastrum dubium, Pse. Proc. Zool. Soc. 648–1869.

Partulina dubia, Pfr. Nom. Helic. Viv. 305–1881.

Maui.

P. Dwightii, Newc. (**Achatinella.**) Amer. Jour. Conch. ii, pl. 19, f. 9.

Partulina Dwightii, Pfr. Mall. Blätt. 162–1856.

Molokai.

†**P. Gouldii**, Newc. (**Achatinella.**) Proc. Zool. Soc. pl. 22, f. 1–1853.

Achatinella talpina, Gul. Ann. Lyc. N. Y. pl. 7, 138–1856.

Partulina Gouldii, Pfr. Mall. Blätt. 116–1854; 162–1856.

Waialuku Maui.

†**P. grisea**, Newc. (**Achatinella.**) Proc. Zool. Soc. pl. 24, f. 60–1853.

Achatinella dubia, Pfr. Var. β. 1854.

Partulina grisea, Pfr. Mall. Blätt. 117–1854.

Achatinellastrum grisea, Pse. Proc. Zool. Soc. 1869.

East Maui.

†**P. marmorata**, Gld. (**Achatinella.**) Proc. Bost. Soc. p. 200–1847. Expd. Shells tab. 7, f. 94.

†**Achatinella Adamsii**, Newc. Ann. Lyc. N. Y. 19–1853. Proc. Zool. Soc. pl. 22, f. 20–1853.

Achatinella induta, Gul. Ann. Lyc. N. Y. 207–1856.

†*Achatinella ustulata*, Gul. Ann. Lyc. N. Y. pl. 11, p. 37–1856, (reversed ex.)

Achatinella plumbea, Gul. Ann. Lyc. N. Y. pl. 11, f. 39, 1856.

Laminella marmorata, Pfr. Mall. Blätt. 126–1854.

Bulimella marmorata, Pfr. Mall. Blätt. 163–1854.

Bulimella marmorata, Pfr. Nomen. Helic. Viv. 306–1856.

Partulina marmorata, Pse. Proc. Zool. Soc. 647–1869.

Partulina perdix, Pfr. Mall. Blätt. 116–1854. (Non Rve.)

Haleakala Waialuku and Kula E. Maui.

Obs. The variable coloration of this species has been the source of its numerous synonymy.

P. morbida, Pfr. (**Achatinella.**) Mon. Helic. vi–167.

Helicter morbida, Pse. Proc. Zool. Soc. 645–1869.

Achatinellastrum morbida, Pfr. Nomen. Helic. Viv. 306–1881.

Sandwich Islands.

†**P. perdix**, Rve. (**Achatinella.**) Mon. tab. 6, f. 43a, 43b, 1850.

Achatinella pyramidalis, Gul. Ann. Lyc. N. Y. pl. 7, p. 32–1856.
Achatinella undosa, Gul. Ann. Lyc. N. Y. pl. 7, f. 33–1856.
Partulina perdix, Pfr. Mall. Blätt. 116–1854.=*marmorata*, Newc.
Partulina marmorata, Pse. Proc. Zool. Soc. 647–1869.

Lahaina and Kula, E. Maui.

Obs. Dr. Newcomb in his excellent synopsis of the genus *Achatinella*, has described the animal of *A. perdix* Pfr. which materially differs from that of *A. perdix* Rve.; they are doubtless specifically different.

†**P. proxima**, Pse. (**Partulina.**) Pl. f. 1–2.

Partulina proxima, Pse. Proc. Zool. Soc. 6–1862.
Bulimella proxina, Pfr. Nomen. Helic. Viv. 307–1881.

Molokai.

†**P. radiata**, Gld. (**Achatinella.**) Proc. Bost. Soc. 27–1845.

Partula radiata, Pfr. Mon. Helic. Viv. iii, 454.
Partula densilineata, Rve. Mon. Part. pl. 2, f. 9–1850.
Bulimus Gouldii, Pfr. Mon. Helic. Viv. ii, p. 74.
Achatinella dubia, Pfr. (Non. Newc.) Mall. Blätt. 116–1854.
Achatinella grisea, Pfr. (Non. Newc.) Mall. Blätt. 117–1854.
Achatinellastrum radiatum, Pse. Proc. Zool. Soc. 646–1869.
Partulina radiata, Pfr. Mall. Blätt. 162–1854.

Maui.

†**P. Redfieldii**, Newc. (**Achatinella.**) Proc. Zool. Soc. tab. 22, f. 5–1853.

Partulina Redfieldii, Pfr. Mall. Blätt. 115–1854.
Bulimella Redfieldii, Pfr. Mall. Blätt. 163–1856.

Molokai.

P. rufa, Newc. (**Achatinella.**) Proc. Zool. Soc. pl. 22, f. 3–1853.

Achatinellastrum rufa, Pfr. Mall. Blätt. 137–1854–164–1856.
Partulina rufa, Pse, Proc. Zool. Soc. 647–1869.

Molokai, E. Maui.

†**P. splendida**, Newc. (**Achatinella.**) Proc. Zool. Soc. tab. 22, f. 4–1853.

Achatinella Bayleana, Gul. Ann. Lyc. N. Y.; 202, pl. 7b, 31a. 31b–1858.
Partulina splendida, Pfr. Mall. Blätt. 115–1854, 162–1856.

Waialuku, Maui.

†**P. Tappaniaua**, C. B. Adams. (**Achatinella.**) Conch. Cont. 126–1850.

†*Achatinella eburnea*, Gul. Ann. Lyc. N. Y. 199, f. 28a, 28b, 1856.
†*Achatinella ampulla*, Gul. Ann. Lyc. N. Y. 200, f. 29, 1856.

†*Achatinella fasciata*, Gul. Ann. Lyc. N. Y. 201, f. 30, 1856.
Bulimella Tappaniana, Pse. Proc. Zool. Soc. 647–1869.

Maui.

†**P. tessalata**, Newc. (**Achatinella.**) Proc. Zool. Soc. t. 23, f. 28–1853.
Achatinella insignis, Mighls.? (Pfr.)
Partulina tessalata, Pfr. Mall. Blätt. 115–1854, 162–1856.

Molokai.

†**P. virgulata**, Mighl. (**Partula.**) Proc. Bost. Soc. 20–1845.
Bulimus Rohri, Pfr. Zeitsch. 1846.
Achatinella Rohri, Rve. Tab. 1, f. 3–1850.
Achatinella insignis, Pfr. (Newc.) In schedule. (Pfr. & Rve.)
Partulina Rohri, Pfr. Mall. Blätt. 114–1854, 162–1856.
Partulina virgulata, Pfr. Nomen. Helic. Viv. 305–1881.

Molokai.

Section BULIMELLA, Dr. L. Pfeiffer.

†**B. abbreviata**, Rve. (**Achatinella.**) Mon. pl. 3, f. 19, April 1850.
Achatinella clementina, Pfr. Proc. Zool. Soc. 205–1855.
Achatinella nivosa, Newc. Proc. Zool. Soc. pl. 12, f. 6–1853. (Manufactured.)
Bulimella abbreviata, Pfr. Mall. Blätt. 135–1854.
Achatinellastrum abbreviata, Pfr. Mall. Blätt. 164–1856.
Bulimella abbreviata,=*bacca*, Pse. Proc. Zool. Soc. 647–1869.

Palolo, Oahu.

B. bacca, Rve. (**Achatinella.**) Mon. pl. 6, f. 45.
Laminella bacca, Pfr. Mall. Blätt. 135–1854.
Achatinellastrum bacca, Pfr. Mall. Blätt. 164–1856.
Bulimella bacca, Pse. Proc. Zoöl. Soc. 647–1869.

Palolo, Oahu.

†**B. bulimoides**, Swains. (**Achatinella.**) Zool. Illus. ii, 450.
Achatinella bulimoides, Rve. Mon. t. 4, f. 28.
Achatinella obliqua, Gul. Ann. Lyc. N. Y. 245, f. 63, 1858.
Achatinella oömorpha, Gul. Ann. Lyc. N. Y. 246, f. 64, 1858.
Bulimella bulmoides, Pfr. Mall. Blätt. 119–1854, 162–1856.

Kahuna, Oahu.

†**B. Byronii**, Gray. (**Helix.**) Woods Index, Suppl. pl. 7, f. 30.
Achatinella melanostoma, Newc. Proc. Zool. Soc. pl. 22, f. 7,–1853.
Achatinella limbata, Gul. Ann. Lyc. N. Y. pl. 8, f. 70–1858.
Achatinella pulcherrima, Rve. (Non Swains.) Mon. pl. 3, f. 23.
Laminella Byronii, Pfr. Mall. Blätt. 136–1854.
Bulimella Byronii, Pse. Proc. Zool. Soc. 346–1869.

Ewa, Oahu.

†**B. decipiens**, Newc. (**Achatinella.**) Proc. Zool. Soc. pl. 24, f. 68–1863.

Achatinella planospira, Pfr. Proc. Zool. Soc. pl. 30, f. 8–1855.

†*Achatinella cuneus*, Pfr. Proc. Zool. Soc. 205, 1858. Sinistral.

†*Achatinella torrida*, Gul. Ann. Lyc. N. Y. pl. 8, f. 68–1858. Sinistral.

Achatinella corrugata, Gul. Ann. Lyc. N. Y. pl. 8, f. 66, 1858. (Short var.)

Achatinella scitula, Gul. Ann. Lyc. N. Y. pl. 8, f. 61. (Reversed smoothe var.)

Achatinella herbacea, Gul. Ann. Lyc. N. Y. pl. 8, f. 52. Var.

Bulimella viridans, Pfr. (Non Mighl.) Mall. Blätt. 121–1854, 163–1856.

Bulimella decipiens, Pse. Proc. Zool. Soc. 646–1869.

Bulimella decipiens, Pfr. Nomen. Helic. Viv. 306–1881.

Koolauloa, Oahu.

Obs. This is a species affected by environment. hence its protean forms.

†**B. elegans**, Newc. (**Achatinella.**) Proc. Zool. Soc. tab. 24, f. 57–1853.

(*Bulimella elegans*, Pfr. Mall. Blätt. 163–1856.

Hanula, Oahu.

B. faba, Pfr. (**Achatinella.**) Proc. Zool. Soc. 30–1859.

Bulimella faba, Pse. Proc. Zool. Soc. 646–1869.

Sandwich Islands.

B. Forbsiana, Pfr. (**Achatinella.**) Proc. Zool. Soc. pl. 30, f. 16–1855.

Bulimella Forbsiana, Pfr. Mall. Blätt. 163–1856.

Palolo Oahu.

†**B. glabia**, Newc. (**Achatinella.**) Proc. Zool. Soc. tab. 23, f. 23–1853.

Achatinella elegans, Pfr. (Non Newc.) Mon. Helic. iv–520.

Achatinella platystyla, Gul. Ann. Lyc. N. Y. Pl. 6, f. 25–1856.

Bulimella glabra, Pfr. Mall. Blätt. 124–1854.

Kawaiawa Oahu.

B. Hanleyana, Pfr. (**Achatinella.**) Proc. Zool. Soc. 202–1855.

Bulimella Hanleyana, Pfr. Mall. Blätt. 163–1856.

Bulimella Hanleyana, Pse. Proc. Zool. Soc. 646–1869.

B. Lehuiensis, Smith. (**Achatinellastrum.**) Proc. Zool. Soc. pl. 9, f. 8–1873.

Achatinellastrum Lehuiensis, Pfr. Nomen. Helic. Viv, 308–1881.

Lehui Oahu.

Obs. This shell may equal *Bulimella multicolor*, Pfr.

B. morbida, Pfr. (**Achatinella.**) Proc. Zool. Soc. 30–1859.

Helicter morbida, Pse. Proc. Zool. Soc. 649–1869.

Bulimella morbida, Pfr. Nomen. Helic. Viv. 306–1881.

Sandwich Islands.

†**B. multicolor**, Pfr. (**Achatinella.**) Proc. Zool. Soc. pl. 30, f. 11, Jan'y 1855.

Achatinella oviformis, Newc. Proc. Zool. Soc. 208, Nov. 1855.

Bulimella multicolor, Pfr. Mall. Blätt. 165–1856. *Oahu.*

†**B. multlineata**, Newc. (**Achatinella.**) Proc. Zool. Soc. pl. 22, f. 23–1853.

Helicter multilineata, Pse. Proc. Zool. Soc. 645–1869.

Achatinella monacha, Pfr. Proc. Zool. Soc. pl. 30, f. 9–1855, var.

Bulimella multilineata, Pfr. Mall. Blätt. 163–1856.

Kolaupoco Maui.

†**B. ovata**, Newc. (**Achatinella.**) Ann. Lyc. N. Y. 22–1853. Proc. Zool. Soc. tab. 22, f. 2–1853.

Achatinella Wheatleyi, Newc. Ms. Syn. Ann. Lyc. N. Y. 147–1855.

†*Achatinella candida*, Pfr. Proc. Zool. Soc. pl. 30, f. 4, 4a–1855.

†*Achatinella Frickii*, Pfr. Proc. Zool. Soc. pl. 30, f. 7, 1855. small var.

†*Achatinella vidua*, Pfr. Proc. Zool. Soc. pl. 30, f. 10–1855.

†*Achatinella rotunda*, Gul. Ann. Lyc. N. Y. 249, pl. 8, f. 67–1868.

Achatinella cervina, Gul. Ann. Lyc. N. Y. 241, pl. 8, f. 62–1868.

†*Achatinella spadicea*, Gul. Ann. Lyc. N. Y. 214, pl. 7, f. 65–1868.

Achatinella phaeozona, Gul. Ann. Lyc. N. Y. 214, pl. 7, f. 40, 1865, immature.

Achatinella lorata, Rve. Non Fér. Mon. pl. 1, f. 6.

Bulimella ovata, Pfr. Mall. Blätt. 119–1854, 163–1856.

Koolauloa Oahu.

Obs. This is a very variable species in size and coloration.

†**B. rosea**, Swains. (**Achatinella.**) Zool. Illus. ii, tab. 123. f. 1.

Bulimella rosea, Pfr. Mall. Blätt. 119–1854, 163–1856.

Obs. Recently I have received from Mr. D. D. Baldwin of Honolulu a small white variety with a yellow lip, see pl. I, fig. 4.

Waialua, Oahu.

†**B. rutila**, Newc. (**Achatinella.**) Proc. Zool. Soc. pl. 22, f. 21–1853.

Achatinella macrostoma, Pfr. Proc. Zool. Soc. pl. 30, f. 6–1855.

Achatinella viridans, Pfr. Mall. Blätt. 120–1854. Non Mighl.

Bulimella rutila, Pse. Proc. Zool. Soc. 646–1869.

Palolo and Niu, Oahu.

†**B. rugosa**, Newc. (**Achatinella.**) Proc. Zool. Soc. tab. 22, f. 22–1853.

Bulimella rugosa, Pfr. Mall. Blätt. 123–1854, 163–1856.

Ewa, Oahu.

B. solitaria, Newc. **(Achatinella.)** Proc. Zool. Soc. pl. 24, f. 60–1853.

Achatinellastrum solitaria, Pfr. Mall. Blätt. 163–1856.

Bulimella solitaria, Pse. Proc. Zool. Soc. 647–1869.

Palola, Oahu.

†B. sordida, Newc. **(Achatinella.)** Proc. Zool. Soc. pl. 23, f. 27–1853.

Achatinella Swainsonii, Pfr. Proc. Zool. Soc. pl. 30, f. 13–1855.

Bulimella sordida, Pfr. Mall. Blätt. 163–1856. *Lehui, Oahu.*

Obs. I have followed Dr. Newcomb in placing *Swainsonii* as a synonym of *sordida*, Dr. Pfeiffer in Nomen. Helic. Viv. gives it as a variety of *sordida*.

†B. Sowerbiana, Pfr. **(Achatinella.)** Proc. Zool. Soc. pl. 30, f. 14–1855.

†*Bulimella fuscobasis*, Smith. Proc. Zool. Soc. pl. 9, f. 15–1873.

Bulimella Sowerbiana, Pfr. Mall. Blätt. 163–1856. *Oahu.*

†B. subvirens, Newc. **(Achatinella.)** Proc. Zool. Soc. pl. 22, f. 21–1853.

Bulimella viridans, Pfr. Mall. Blätt. 163–1856. Non Mighls.

Bulimella subvirens, Pse. Proc. Zool. Soc. 646–1869.

Niu, Oahu.

†B. taeniolata, Pfr. **(Achatinella.)** Proc. Zool. Soc. 38–1846.

Achatinella rubiginosa, Newc. Proc. Zool. Soc. pl. 24, f. 59–1853.

Bulimella taeniolata, Pfr. Mall. Blätt. 124–1854, 163–1856.

Palolo, Oahu.

†B. terebra, Newc. **(Achatinella.)** Proc. Zool. Soc. pl. 23, f. 40–1853.

Achatinella attenuata, Pfr. Proc. Zool. Soc. pl. 30, f. 12–1855.

Achatinella lignaria, Gul. Ann. Lyc. N. Y. pl. 7, f. 35. (Var.)

Achatinella crocea, Gul. Ann. Lyc. N. Y. pl. 7, f. 36.

Bulimella attenuata, Pfr. Nom. Helic. Viv. 307–1881.

Bulimella terebra, Pse. Proc. Zool. Soc. 648–1869.

Waialuku, Maui.

Obs. I have followed Dr. Newcomb in referring Mr. Gulick's species to *terebra*, it varies in size and color; some are attenuate while others are large and inflated.

†B. viridans, Migh. **(Achatinella.)** Proc. Bost. Soc. Nat. Hist. Jan'y 1845.

Achatinella radiata, Pfr. Proc. Zool. Soc. Aug. 1845.

Achatinella cuneus, Pfr. Proc. Zool. Soc. 205–1855. Sinistral.

Achatinella rutila, Pfr. Var. β. Mall. Blätt. 1854. Non Newc.

Achatinella subvirens, Pfr. Var. β. (Non Newc.) Mall. Blätt. 1854.

Achatinella decipiens, Pfr. Var. β. (Non Newc.) Mall. Blätt. 1854.

Bulimella viridans, Pse. Proc. Zool. Soc. 646–1868.

Kouahuanui, Oahu.

Section ACHATINELLASTRUM, Dr. L. Pfeiffer.

†**A. adusta,** Rve. (**Achatinella**). Mon. tab. 4, f. 30–1850.

Achatinellastrum adusta, Pfr. Mall. Blätt. 138–1854.=164–1856. *Oahu.*

†**A. ampla,** Newc. (**Achatinella**). Proc. Zool. Soc. tab. 22, f. 19–1853.

Achatinellastrum ampla, Pfr. Mall. Blätt. 135–1854.–164–1856. *Kolau Oahu.*

†**A. bella,** Rve. (**Achatinella**). Mon. Tab. 3, f. 17–1850.

Achatinellastrum bella, Pfr. Mall. Blätt. 135–1854,–165–1856.

Achatinellastrum pulcherrimum, Pfr. Mon. Helic. B. ii, 237.?

Laminella bella, Rve.=*Polita*, Newc. Pse. Proc. Zool. Soc. 648–1869. *Molokai.*

†**A. bellulae,** Smith. (**Achatinellastrum**). Proc. Zool. Soc. t. 9, f. 8–1873. *Sandwich Islands.*

†**A. Buddii,** Newc. (**Achatinella**). Proc. Zool. Soc. Tab. 9, f. 8–1873.

Achatinella pexa, Gul. Ann. Lyc. N. Y. 196–pl. 6, f. 26–1856.

†*Achatinella plumata*, Gul. Ann. Lyc. N. Y. 217. pl. 7 f. 41–1856.

Achatinella papyracea, Gul. Ann. Lyc. N. Y. 207, pl. 8, f. 48, 1856.

Achatinella caesia, Gul. Ann. Lyc. N. Y. 234, pl. 8, f. 53, 1856. (Junior Ex.)

Laminella Buddii, Pfr. Mall. Blätt. 138–1854.

Achatinellastrum Buddii, Pfr. Mall. Blätt. 164–1856.

Achatinellastrum fuscozona, Smith. Proc. Zool. Soc. pl. 9–f. 9–1873. *Pololo Oahu.*

Obs. This species is very variable in texture and coloration.

†**A. castanea,** Rve. (**Achatinella**). Mon. Tab. 2, f. 24–1850.

Achatinellastrum castanea, Pfr. Mall. Blätt, 139–1854,–164–1856.

Achatinellastrum castanea, Rve.=*adusta*, Rve. (Pse). Proc. Zool. Soc. 646–1869. *Oahu.*

†**A. colorata,** Rve. (**Achatinella**). Mon. Tab. 3, f. 18–1850.

Achatinellastrum colorata, Pfr. Mall. Blätt. 134–1854.

Laminella colorata, Pfr. Mall. Blätt. 164–1856.

Laminella ustulata, Newc. M. S. (Pfr.) Mall. Blätt. 136–1854.

Bulimella colorata, Pse. Proc. Zool. Soc. 646–1869.

Achatinellastrum colorata, Pfr. Nomen. Helic. Viv. 308–1881. *Ahuimanu Oahu.*

†**A. concinna**, Newc. (**Achatinella**). Proc. Zool. Soc. Pl. 24, f. 79–1853.

Achatinellastrum concinna, Pfr. Mall. Blätt. 137–1854.–164 =1856.

Laminella concinna, Pse. Proc, Zool. Soc. 648–1869.

Lanai.

†**A. consanguinea**, Smith. (**Achatinella**). Proc. Zool. Soc. Pl. 9, f. 3–1873.

A. concolor, Smith. Proc. Zool. Soc. Pl. 9, f. 1–1873.

Ahuimanu Oahu.

Obs. These two species of Mr. Smith, are probably only varieties of *colorata*.

†**A. cucumis**, Gul. (**Achatinella**). Ann. Lyc. N. Y. pl. 7. f. 45–1858.

Achatinellastrum cucumis, Pse. Proc. Zool. Soc. 646–1869,

Kaliua Oahu.

A. formosum, Gul. (**Achatinella**). Ann. Lyc. N. Y. pl. 8. f. 55–1858.

Achatinellastrum formosum, Pse. Proc. Zool. Soc. 646–1869.

Oahu.

‡**A. fulgens**, Newc. (**Achatinella.**) Proc. Zool. Soc. pl. 22. f. 24–24a, 1853.

Achatinella diversa, Gul. Ann. Lyc. N. Y. 222–1858. (Junior Ex.)

‡*Achatinellastrum angusta*, Smith. Proc. Zool. Soc. 74, pl. 9, f. 7–1873.

Achatinellastrum fulgens, Pfr. Mall. Blätt. 137–1854, 164–1856.

Waialua, south east end of Oahu.

†**A. fuscolineata**, Smith. (**Achatinellastrum.**) Proc. Zool. Soc. 75, pl. 9, f. 2–2a–1873.

Achatinellastrum fuscolineatum, Pfr. Nomen. Helic. Viv, 307–1881.

Kaialua, Oahu.

Obs. A large quantity of duplicates of this species was contained in the collection of Wm. H. Pease. Mr. Smith designates *versipellis* Gul. as its nearest affinity, while Dr. Newcomb thinks it is one of the innumerable varieties of *vulpina* Fér.

†**A. fuscozona**, Smith. (**Achatinellastrum.**) Proc. Zool. Soc. pl. 9, f. 9–1873.

Makiki and Palolo, Oahu.

Obs. Judging from a suite of all ages, this may be a good species, although it approaches very near to *fuscolineata*, Smith.

†**A. germana**, Newc. (**Achatinella.**) Proc. Zool. Soc. pl. 24, f. 62–1863.

Achatinellastrum germana, Pfr. Mall. Blätt. 135–1854, 156–1856.

Bulimella germana, Pse. Proc. Zool. Soc. 649–1869.

Makawao, Maui.

†**A. Johnsoni**, Newc. (**Achatinella.**) Proc. Zool. Soc. pl. 23, f. 50–1853.

Achatinella aplustre, Newc. Proc. Zool. Soc. pl. 23, f. 51–1853.

Achatinellastrum Johnsoni, Pfr. Mall. Blätt. 134–1854.

Palolo Crater and Kolau, Oahu.

A. lilaceum, Pfr. (**Achatinella.**) Mon. Helic. Viv. vi 173.

Achatinellastrum lilaceum, Pfr. Nomen. Helic. Viv. 308, 1881.

Sandwich Islands.

†**A. ligatum**, Smith. (**Achatinellastrum.**) Proc. Zool. Soc. t. 9, f. 13–1873.

A. diluta, Smith. Proc. Zool. Soc. t. 9, f. 14–1873.

Waimula, Oahu.

Obs. Examples of the above in the Pease collection marked "new species" equal a dextral variety of *vulpina*, Fér.

†**A. Nattii**, Baldw. Nobis. (**Achatinellastrum.**) pl. I, f. 3.

Shell dextral, turbinate, spire half the length ; whorls 5, polished, the two last rapidly enlarged and inflated. Suture impressed, columella yellow, stout and twisted. Color bright gamboge yellow, with one white and three wide chestnut bands beneath the suture, the latter visible from within the aperture ; aperture round ovate, white, labium white, slightly thickened within, L. 16, D. 10, L, Ap 8, D. 5 mill.

Makawao, E. Maui.

Obs. This shell was found at the above locality by D. D. Baldwin, Esq. of Lahaina Maui, who has devoted much time and attention to the Achatinella of the Sandwich Islands. He has known of similar examples being found at the same locality. The shell is not quite mature, and at first sight has the facies of an *Apex*.

†**A. olivaceum**, Rve. (**Achatinella.**) Mon. tab. 3, f. 20–1850.

Achatinella prasinus, Rve. Mon. Tab. 4, f. 27.

Achatinellastrum olivaceum, Pfr. Mall. Blätt. 138–1854, 164–1856.

Sandwich Islands.

†**A. polita**, Newc. (**Achatinella.**) Proc. Zool. Soc. pl. 23, f. 37–1853.

Achatinellastrum polita, Pfr. Mall. Blätt, 134–1854, 164–1856.

Laminella polita, =*bella*, Pse. Proc. Zool. Soc. 648–1869.

Molokai.

Obs. *Polita* Newc. and *bella* Rve. are doubtless distinct.

†**A. productum**, Rve. (**Achatinella.**) Mon. tab. 2, f. 13–1850.

Achatinella venulata, Newc. Proc. Zool. Soc. pl. 23, f. 48–1853.

Achatinella hybrida, Newc. Proc. Zool. Soc. pl. 22, f. 52–1853.

Achatinella bilineata, Rve. Mon. Tab. 3, f. 22.

Achatinella Dunkeri, Cum. (Pfr.) Proc. Zool. Soc. 208–1855.
Achatinellastrum productum, Pfr. Mall. Blätt. 134–1854, 163—1856. *Kolau, Oahu.*

†**A. pulcherrimum**, Swains. (**Achatinella.**) Zool. Illus. pl. 123, f. 2.

Achatinella napus, Pfr. Proc. Zool. Soc. f. 19–1855.
Achatinella mahogani, Gul. Ann. Lyc. N. Y. f. 72–1858.
Laminella pulcherrima, Pfr. Mall. Blätt. 135–1854.
Achatinellastrum pulcherrima, Pfr. Mall. Blätt. 164–1856.
Ahonui, Oahu.

†**A. trilineatum**, Gul. (**Achatinella.**) Ann. Lyc. N. Y. pl. 7, f. 46–1858.

Achatinella zonata, Gul. Ann. Lyc. N. Y. pl. 8, f. 58–1858, (var.)
Achatinellastrum trilineatum, Pse. Proc. Zool. Soc. 646–1869.
Oahu.

†**A. versipellis**, Gul. (**Achatinella.**) Ann. Lyc. N. Y. vi, pl. 7, f. 44a, b.

Achatinellastrum versipellis, Pse. Proc. Zool. Soc. 646–1869.
Kailua, Oahu.

†**A. vulpinum**, Fér. (**Helix.**) Hist. Mol. tab. 155, f. 1.

Achatinella vulpina, Rve. Mon, Tab. 4, f. 29.
Achatinella livida, Pfr. Non Swains.
Achatinella Stewartii, Green. Maclur. Lyc. i, pl. 4, f. 1–2.
Achatinella Stewartii, Rve. Mon. tab, 4, f. 26,
Achatinella virens, Gul. Ann. Lyc. N. Y. vj, f. 47.
Achatinella varia, Gul. Ann. Lyc. N. Y. vj f. 43.
Achatinella crassidentata, Pfr. Proc. Zool. Soc. pl. 30, f. 23–1855.
Achatinellastrum tricolor, Smith. Proc. Zool. Soc. pl. 9, f. 6–1873.
Achatinellastrum ligatum, Smith. Proc. Zool. Soc. pl. 9, f. 12–13, 1873. (Dextral var?)
Achatinellastrum longispira, Smith. Proc. Zool Soc. pl. 9, f. 2–1873. (Var. *Stewartii.*)
Eburnella vulpina, Pfr. Mall. Blätt. 139–1854.
Achatinellastrum vulpinum, Pfr. Mall. Blätt. 139–1854.
Oahu.

A. zebra, Newc. (**Achatinella**). Ann. Lyc. N. Y. 142–1853.

Achatinellastrum zebra, Pfr. Nomen. Helic. Viv. 308–1881.
Laminella zebra, Pse. Proc. Zool. Soc. 648–1869.
East Maui.

Section EBURNELLA, Wm. H. Pease.

†**E. casta**, Newc. (**Achatinella**). Proc. Zool. Soc. tab. 22, f. 12–1853.

Achatinella dimorpha, Gul. Ann. Lyc. N. Y. pl. 8, f. 56–1858.

Achatinella juncea, Gul. Ann. Lyc. N. Y. pl. 7, f. 49–1858. (Dwarf.)

Achatinella cognata, Gul. Ann. Lyc. N. Y. pl. 7, f. 60–1858

Achatinellastrum casta, Pfr. Mall. Blätt. 138–1854,–164–1856.

Eburnella casta, Pse. Proc. Zool. Soc. 647–1869.

Ewa, Oahu.

Obs. I have followed Dr. Newcomb in assigning Mr. Gulick's species to *casta*, Mr. Gulick admits *E. dimopha* as a synonym, see Proc. Zool. Soc. 90–91–1873.

†**E. curta**, Newc. (**Achatinella**). Proc. Zool. Soc. tab. 23, f. 43–1853.

†*Achatinella delta*, Gul. Ann. Lyc. N. Y. 231, pl. 8, f. 50–1858.

Achatinella contracta, Gul. Ann. Lyc. N. Y. 237, pl. 8, f. 57, 1858.

†*Achatinellastrum rhodoraphe*, Smith. Proc. Zool. Soc. 74, pl. 9, f. 10–1873.

Eburnella pygmea Smith. Proc. Zool. Soc. 75, pl. 9, f. 11–1873.

Laminella curta, Pfr. Mall. Blätt. 139–1854.

Achatinellastrum curta, Pfr. Mall. Blätt. 164–1856.

Eburnella curta, Pse. Proc. Zool. Soc. 647–1869.

Waialua, Oahu.

Obs. In a large number of duplicates, contained in the collection of the late Wm. H. Pease, the above synonymy was illustrated.

†**E. livida**, Swains. (**Achatinella**). Zool. Illus. p. 108, f. 2.

†*Achatinella viridans*, Rve. Mon. Tab. 4, f. 25. (Non Migh.)

Achatinella Reevii, C. B, Adams. Conch. Cont. 128.

†*Achatinella Emersonii*, Newc. Proc. Zool. Soc. pl. 24, f. 74–1853.

Achatinella glauca, Gul. Ann. Lyc. N. Y. f. 47–1858.

Eburnella livida, Pse. Proc. Zool. Soc. 647–1869.

Kalaikoa and Waialua, Oahu.

Obs. About two quarts of duplicates, in the collection of Wm. H. Pease, exhibited considerable inosculation of the above so called species, *A. vulpina* Fer. which Dr. Pfeiffer places under *Eburnella* as a synonym of *livida* Swains, has no affinity therewith.

†**E. porcellana**, Newc. (**Achatinella**). Proc. Zool. Soc pl. 23, f. 27–1863.

Bulimella porcellana, Pfr. Mall. Blatt. 123–1854.

Eburnella porcellana Pse. Proc. Zool. Soc. 647–1869.

East Maui.

†**E. recta**, Newc. (**Achatinella**). Proc. Zool. Soc. pl. 22, f. 45–1853.

Laminella recta, Pfr. Mall. Blätt. 136–1854.
Achatinella nympha, Gul. Ann. Lyc. N. Y. 251, pl. 8, f. 9–1858.
Eburnella recta, Pse. Proc. Zool. Soc. 647–1869.

Waialua, Oahu.

E. saccata, Pfr. (**Achatinella**). Mon. Helic. vj.–175.

Eburnella saccata, Pse. Proc. Zool. Soc. 647–1869.

Sandwich Islands.

E. semicarinata, Newc. (**Achatinella**). Proc. Zool. Soc. pl. 24, f. 76–1853.

Bulimella semicarinata, Pfr. Mall. Blätt. 124–1854.
Eburnella semicarinata, Pfr. Nomen. Helic. Viv. 309–1881.

Lanai.

†**E. undulata**, Newc. (**Achatinella**). Bost. Jour. Nat. Hist. 218–1855. Amer. Jour. Conch. pl. 13, f. 15–1866.

Laminella curta, Pfr. Mall. Blätt. 139–1854.
Achatinellastrum curta, Pfr. Mall. Blätt. 164–1856.
Eburnella curta, Pse. Proc. Zool. Soc. 647–1869.

Waialua, Oahu.

Obs. I think this a variety of *E. curta*, Newc.

†**E. variabilis**, Newc. (**Achatinella**). Proc. Zool. Soc. pl. 24, f. 70–1853.

Achatinella fulva, Newc. Proc. Zool. Soc. 208–1855.
Achatinella lactea, Gul. Ann. Lyc. N. Y. pl. 6, f. 27–1856.
Bulimella variabilis, Pfr. Mall. Blätt. 124–1854.
Eburnella variabilis, Pse. Proc. Zool. Soc. 647–1869.

Lanai.

Section APEX, * **Albers.–1860.**

*The species of the Section Apex, are involved in almost inextricable confusion. Authors in many instances, have not given the localities of the species, and the great variability in size and color of many species, added to the many intermediate varieties, entails an almost endless task to separate them. To arrive at a certainty, the color of the animal and mantel must be observed, and local suites should be collected by which critical comparisons could be instituted. It is to be regretted, that species have been multiplied on slight grounds. In my endeavours to arrive at a correct synonymy, I may have erred by restricting the species within too narrow limits, which will be for future observers to correct. The Section Apex exhibits four prevailing types, as illustrated by the species ***turgida, mustellina, perversa*** and *Swiftii*, from which all others seem but modifications.

†**A. cestus**, Newc. (**Achatinella**). Proc. Zool. Soc. t. 22, f. 8–1853.

Bulimella cestus, Pfr. Mall. Blätt. 125–1854.
Helicter cestus, Pse. Proc. Zool. Soc. 645–1869.
Apex cestus. Pfr. Proc. Zool. Soc. 310.

Palolo, Oahu.

†**A. concavospira**, Pfr. Proc. Zool. Soc. 36–1859.

Laminella concavospira, Pse. Proc. Zool. Soc. 648–1869.
Achatinellastrum concavospira, Pse. Nomen. Hel. Viv. 307.
Sandwich Islands.

†**A. decora**, Fer. (**Helix**). Hist. Moll. t. 155, f. 5–7.

Achatinella decora, Gray.
Bulimus decorus, Beck, and Anton.
Achatinella vestita, Migh. Proc. Bost. Soc. 1845.
Achatinella lugubris, Pfr. Non. Rve.
Achatinella vittata, Pfr. Non. Rve.
Achatinella simulans, Pfr. Non. Rve.
Laminella decora, Pfr. Mall. Blätt. 140–1854.
Helicter decora, Pse. Proc. Zool. Soc. 645–1869.
Apex decora, Pfr. Nomen. Hel. Viv. 310.
Kaliakoa and Ahouin, Oahu.

†**A. flavida**, Gul. (**Apex**). Proc. Zool. Soc. pl. 10, f. 1–1873.

Apex tuberans, Gul. Proc. Zool. Soc. pl. 10, f. 3–1873.
Kaliakao, Ahouin and Waialua, Oahu.

Obs. This shell may=dextral *Swiftii* which often varies greatly in color.

†**A. Gulickii**, Smith. (**Apex**). Proc. Zool. Soc. pl. 9. f. 7–1873.

†*Apex albofasciata*, Smith. Proc. Zool. Soc. pl. 9, f. 29–1873.
†*Apex innotabilis*, Smith. Proc. Zool. Soc. pl. 9, f. 23–1873.
†*Apex neglectus*, Smith. Proc. Zool. Soc. pl. 9, f. 22–1873.
†*Apex coniformis*, Gul. Proc. Zool. Soc. pl. 9, f. 17–1873.
†*Apex versicolor*, Gul. Proc. Zool. Soc. pl. 9, f. 18–1873.
Kalikoa and Ahouin, Oahu.

Obs. About two quarts of the variety *albofasciata* was represented in the Pease collection. As I possess the other varieties, I can see no difference in them. Dr. Newcomb places the above with *perversa* of which he considers them only varieties.

†**A. lorata**, Fer. (**Helix**). Hist. Moll. t. 155, f. 9–10.

†*Achatinella pallida*, Nutt. Rves. Mon. pl. 1, f. 2a 2b.
Achatinella alba, Nutt. Jays Cat.
Helicteres loratus, Beck and Anton.
†*Achatinella ventrosa*, Pfr. Proc. Zool. Soc. 6–1855.
Achatinella nobilis, Pfr. Proc. Zool. Soc. 220–1855.
Achatinellastrum lorata, Pfr. Mall. Blätt, 134–1854.
Bulimella lorata, Pfr. Mall. Blätt, 163–1856.
Helicter lorata, Pse. Proc. Zool. Soc. 645–1869.
Sandwich Islands.

Obs. *Lorata* and *alba* represent the elongate varieties, and *ventrosa* with *nobilis* the short and inflated varieties.

†**A. lugubris**, Chem. (**Turbo.**) No. 2059–60, t. 8, f. 9–10.
Achatinella pica, Swains. Zool. Ill. pl. 99, f 1.
Monodonta seminigra, Lam. vii–37.
Bulimus seminigra, Menke. Syn. 26.
Helix apex-fulva, Dix, Voyage around the World, 1789.
Helix lugubris, Fér. Hist. Moll. t. 155, f. 8.
Helicter lugubris, Beck.
Achatina lugubris, Gray.
Achatinella lugubris, Pfr. 1841.
Achatinellastrum lugubris, Pfr. Mall. Blätt, 140–1854, 164–1856.
Helicter lugubris, Pse. Proc. Zool. Soc. 645–1869.
Apex lugubris. Pfr. Nomen. Hel. Viv. 310, 1881.
Apex bicolor, Gul. Mon. Hel. Viv. 529.
Apex polymorpha, Gul. Proc. Zool. Soc. t. 10, f. 5–1873.
Apex leucozonus, Gul. Proc. Zool. Soc. t. 10, f. 6–1873.
Oahu.

†**A. mustellina**, Migh. (**Achatinella.**) Pro. Bost. Soc. 21–1845, Rve. Mon. t. 3, f. 20–21a.
Bulimella mustellina, Pfr. Mall. Blätt, 125–1854, 163–1856.
Helicter mustellina, Pse. Proc. Zool. Soc. 645–1869.
Apex mustellina, Pfr. Nomen. Hel. Viv. 309.
Waianea, Oahu.

A. ovum, Pfr. (**Achatinella.**) Proc. Zool. Soc. 336–1856.
Helicter ovum, Pfr. Proc. Zool. Soc. 645–1869.
Apex ovum, Pfr. Nomen. Hel. Viv. 310.
Oahu.

†**A. perversa**, Swains. (**Achatinella.**) Zool. Ill. pl. 99, f. 2.
Achatinella concidens, Gul. Ann. Lyc. N. Y. pl. 8, f. 54.
Achatinella cinnamomea, Pfr. Proc. Zool. Soc. 22–1858.
Apex leucophea, Gul. Proc. Zool. Soc. pl. 9, f. 16–1873.
Helicter perversa, Pse.=*cinerosa*, Pfr. Proc. Zool. Soc. 645–1869.
Apex decora, Pfr. Var. Nomen. Hel. Viv. 310.
Waianea, Oahu.

Obs. Dr. Newcomb remarks, "there are several varieties of this species, one of which has a near affiinity to *decora* which has led to their having been confounded with each other."

†**A. pulchella**, Pfr. (**Achatinella.**) Proc. Zool. Soc. t. 30, f. 2–1855.
Helicter pulchella, Pse. Proc. Zool. Soc. 645–1869.
Apex pulchella, Pfr. Nomen. Hel. Viv. 310.
Sandwich Islands.

†**A. simulans**, Rve. (**Achatinella.**) Mon. pl. 2, f. 15.
Achatinella decora, Pfr. Mon. Hel. iv, 528. (Non Fér.)
Bulimella simulans, Pfr. Mall. Blätt, 125–1854, 163–1856.
Apex tumefactus, Gul. Proc. Zool. Soc. pl. 9, f. 20–1873.
Apex simulans, Pfr. Nomen. Hel. Viv. 310.
Wahiawa, Oahu.

†**A. Swiftii**, Newc. (**Achatinella.**) Proc. Zool. Soc. pl. 22, f. 9–1853.
Achatinella apicata, Newc. Proc. Zool. Soc. 210–1855.
Achatinella valida, Pfr. Proc. Zool. Soc. pl. 30, f. 54–1855.
Bulimella apicata, Pfr. Mall. Blätt, 125–1854.
Helieter Swiftii, Pse. Proc. Zool. Soc. 645–1869.
Apex Swiftii, Pfr. Nomen. Hel. Viv. 310.
Apex flavidus, Gul. Proc. Zool. Soc. pl. x, f. 1–1, a–1873.
Apex lilacea, Gul. Proc. Zool. Soc. pl. x, f. 4–1873.
Apex leucoraphe, Gul. Proc. Zool. Soc. pl. x. f. 2–1873.
Ewa, Oahu.

†**A. turgida**, Newc. (**Achatinella.**) Proc. Zool. Soc. pl. 22, f. 10–1853.
Achatinellastrum turgida, Pfr. Mall. Blätt, 138–1854, 164–1856.
Apex turgida, Pfr. Nomen. Hel. Viv. 310.
†*Apex turbiniformis*, Gul. Proc. Zool. Soc. pl. x, f. 7–1873.
Apex albospira, Gul. Proc. Zool. Soc. pl. x, f. 8–1873.
Ahouni, Oahu.

Obs. The two species of Mr. Gulick seem to be dextral varieties of *turgida*.

†**A. vittata**, Rve. (**Achatinella.**) Mon. No. 9, Mus. Cunning. (Newc.)
Achatinella decora, Pfr. Var. Non. Fér. Mon. Hel. iii–465.
Achatinella globosa, Pfr. Proc. Zool. Soc. pl. 30, f. 25–1855.
Helicter globosa, Pse. Proc. Zool. Soc. 645–1869.
Apex vittata, Rve. Nomen. Helic. Viv. 310.
Sandwich Islands.

Section PERDICELLA, Wm. H. Pease.

†**P. Helena**, Newc. (**Achatinella**). Proc. Zool. Soc. pl. 24, f. 63–1853.
Newcombia Helena, Pfr. Mall. Blätt. 117–1854.
Perdicella Helena, Pse. Proc. Zool. Soc. 648–1869.
Molokai.

†**P. Mauiensis**, Newc. (**Achatinella**). Proc. Zool. Soc. 207–1855. Amer. Jour. Conch. pl. 13, f. 16–1866.
Partulina Mauiensis, Gul. Proc. Zool. Soc. 91–1873.
Perdicella Mauiensis, Pfr. Nomen. Helic. Viv. 315–1881.
Maui.

P. minuscula, Pfr. (**Perdicella**). Mon. Helic. Viv. iv. 562.
Perdicella minuscula, Pse. Proc Zool. Soc. 648–1869.
Sandwich Islands.

†**P. ornata**, Newc. (**Achatinella**). Proc. Zool. Soc. pl. 24, f. 55–1853.
Newcombia ornata, Pfr. Mall. Blätt. 118–1854.–165–1856.
Perdicella ornata, Pse. Proc. Zool. Soc. 648–1869.
Maui.

P. zebrina, Pfr. (**Achatinella**). Proc. Zool. Soc. 202–1855.
Newcombia zebrina, Pfr. Mall. Blätt. 165–1856.
Perdicella zebrina, Pse. Proc. Zool. Soc. 648–1869.
Sandwich Islands.

Section **NEWCOMBIA**, Dr. L. Pfeiffer.

†**N. cinnamomea**, Pfr. (**Achatinella**). Proc. Zool. Soc. 22–1858.
Newcombia cinnamomea, Pfr. Mall. Blätt. 230–1853.
Molokai.

†**N. Cumingii**, Newc. (**Achatinella**). Proc. Zool. Soc. pl. 24, f. 59–1853.
Newcombia Cumingii, Pfr. Mall. Blätt. 118–1854.–165–1856.
Halea–Kala, Maui.

†**N. Newcombia**, Pfr. (**Bulimus**). Mall. Blatt. 119–1854.–165–1856.
Achatinella Pfeifferi, Newc. Proc. Zool. Soc. pl. 24, f. 58–1853.
Molokai.

†**N. plicata**, Migh. (**Achatinella**). Proc. Bost. Soct.–1848. Rve. Mon. pl. 6, f. 44.
Bulimus liratus, Pfr. Mon. Helic. Viv. ii, 235.
Newcombia liratus, Pfr. Mall. Blätt. 165–1856.
Molokai.

N. Philippiana, Pfr. (**Achatinella**). Mon. Helic. Viv. iv, 559.
Newcombia philippiana, Pfr. Nomen. Helic. Viv. 315–1881.
Sandwich Islands.

†**N. sulcata**, Pfr. (**Achatinella**). Proc. Zool. Soc. 22–1858.
Newcombia sulcata, Pse. Proc. Zool. Soc. 649–1869.

Section **LABIELLA**, Dr. L. Pfeiffer.

L. callosa, Pfr. (**Achatinella**). Mon. Helic. Viv. iv. 531.
Labiella callosa, Pse. Proc. Zool. Soc. 651–1869.
Oahu.

†**L. labiata**, Newc. (**Achatinella**). Proc. Zool. Soc. pl. 23, f. 33–1853.
Labiella dentata, Pfr. Proc. Zool. Soc. pl. 30, f. 27–1855.
Achatinella lagena, Gul. Ann. Lyc. N. Y. pl. 6, f. 3–1855. (=var.)

Labiella dentata, Pfr. Mall. Blätt. 142–163.–1856.

Lehui, Oahu.

L. pachystoma, Pse. (**Labiella**). Jour. Conch. xviij, 171–1869.

Kauai.

Section LAMINELLA, Dr. L. Pfeiffer.

†**L. Alexandria,** Newc. (**Achatinella.**) Cal. Nat. Hist. Soc. iii–182–1865.

Achatinella Alexandria, Newc. Amer. Jour. Conch. pl. 13, f. 14–1866.

Perdicella Alexandri, Pse. Proc. Zool. Soc. 648–1869.

Laminella Alexandri, Pfr. Nomen. Helic. Viv. 312–1881.

West Maui.

†**L. citrina,** Migh. MS. (**Achatinella.**)

Achatinella citrina, Rve. Mon. tab 5, fig. 33–1850.

Laminella citrina,=venusta, Pse. var. Proc. Zool. Soc. 648–1869.

Laminella citrina, Pfr. Nomen. Helic. Viv. 312–1881.

Oahu.

L. erecta, Pse. (**Laminella.**) Jour. Conch. xvij–174–1869.

Maui.

†**L. fusoidea,** Newc. (**Achatinella.**) Amer. Jour. Conch. ii, pl, 13, f. 8–1866.

Achatinellastrum fusoidea, Pfr. Nomen. Helic. Viv. 309.

Laminella fusoidea, Pse. Proc. Zool. Soc. 648–1869.

Maui.

†**L. gravida,** Fér. (**Helix.**) Hist. Moll. tab 155, f. 3.

Achatinella Dimondii, C. B. Adams. Conch. Cont. 126.

Laminella gravida, Pfr. Mall. Blätt, 126–1854, 164–1856.

Sandwich Islands.

L. luteola, Fér. (**Helix.**) Hist. Moll. tab 155, f. 12.

Bulimus luteolus, Pfr. Mon. Helic. ii, 234–1841.

Amastra turritella, Fér.=*luteola,* Fér. (Pse.) Proc. Zool. Soc. 650–1869.

Laminella luteola, Pfr. Nomen. Hel. Viv. 312–1881.

Sandwich Islands.

Obs. The small yellow shell figured by Férussac as *luteola,* has never been identified by conchologists.

L. Mighelsiana, Pfr. (**Achatinella.**) Proc. Zool. Soc. 231–1849.

Laminella Mighelsiana, Pfr. Mall. Blätt, 136–1854.

Achatinellastrum Mighelsiana, Pfr. Nomen. Helic. Viv. 308–1881.

Laminella Mighelsiana, Pse. Proc. Zool. Soc. 648–1869.

Molokai.

†**L. physa**, Newc. (**Achatinella.**) Pro. Bost. Soc. 218–1853. Proc. Zool. Soc. pl. 24, f. 64–1853. (Junior.) Amer. Jour. Conch. ii, pl. 13, f. 10 (adult).

Newcombia physa, Pfr. Mall. Blätt, 117–1854, 165–1856.
Laminella physa, Pse. Proc. Zool. Soc. 648–1869.

Hawai.

Obs. Mr. Pease observes, "this shell has no distinct allies" however he places it amongst the *Laminella* to which I assent. This is an instance which exhibits the difficulties in many of the attempts to classify these heterogeneous forms.

†**L. picta**, Mighl. (**Achatinella.**) Proc. Bost. Soc. January 1845.

Achatinella bulbosa, Gul. Ann. Lyc. N. Y. pl. 8, f. 71–1858.
Achatinella picta, Rve. Mon. tab 67, f. 28.
Laminella picta, Pse. Proc. Zool. Soc. 648–1869.

East Maui.

L. Remyi, Newc. (**Achatinella.**) Ann. Lyc. N. Y. 146–1855. Amer. Jour. Conch. pl. 13, f. 13–1866.

Laminella Remyi, Pfr. Mall. Blätt, 165–1856.

Lanai.

†**L. sanguinea**, Newc. (**Achatinella.**) Proc. Zool. Soc. pl. 22, f. 15–1853.

Achatinella Férussaci, Pfr. (var.) Mon. Helic. Viv. iv, 546.
Laminella Férussaci, Pfr. Mall. Blätt, 164–1856.
Laminella sanguinea, Pfr. Mall. Blätt, 156–1854,

Lehui, Oahu.

†**L. straminea**, Rve. (**Achatinella.**) Mon. pl. 5, f. 38.

Laminella straminea, Pfr. Mall. Blätt, 126–1854.

Sandwich Islands.

Obs. This shell in the collection of the Jardin des Plants, is labelled *A. gravida*, Fér. var.; it is certainly distinct from *gravida*.

†**L. subrostrata**, Pfr. (**Achatinella.**) Proc. Zool. Soc. p. 31–1839.

Labiella subrostrata, Pse. Proc. Zool. Soc. 651–1869.
Laminella subrostrata, Pfr. Nomen. Helic. Viv. 314–1881.

Oahu.

Obs. My examples of this species, obtained in London, and said to have been compared with the type, equals *albolabris* Newc. and is an *Amastra.*

L. tetrao, Newc. (**Achatinella.**) Amer. Jour. Conch. ii, pl. 13, f. 11–12–1866.

Laminella tetrao, Pfr. Nomen. Helic. Viv. 314–1881.

Lanai.

†**L. venusta**, Mighl. (**Achatinella.**) Proc. Bost. Soct. 21–1825.

Laminella venusta, Pfr. Mall. Blätt, 127–1854.
Laminella venusta,=*citrina*, Mighl. Pse. Proc. Zool. Soc. 648–1869.

West Molokai.

L. zebra, Newc. (**Achatinella.**) Ann. Lyc. N. Y. 142–1855.

Achatinellastrum zebra, Pfr. Nomen. Hel. Viv. 308.

Laminella zebra, Pse. Proc. Zool. Soc. 648–1869.

Maui.

Section AMASTRA, H. and A. Adams.

A. accincta, Gld. (**Achatina.**) Proc. Bost. Soc. 20–1845. Gld. Expd. Sh. tab. 7, f. 97.

Leptachatina accincta, Pse. Proc. Zool. Soc. 650–1869.

Amastra accincta, Pfr. Nomen. Hel. Viv. 31–1881.

Obs. The figure of this shell in Chemnitz, represents an *Amastra.*

Oahu.

†**A. affinis**, Newc. (**Achatinella.**) Proc. Zool. Soc. pl. 23, f. 35–1853,

†*Achatinella goniostoma*, Pfr. Proc. Zool. Soc. 203–1855.

Laminella affinis, Pfr. Mall. Blätt. 165–1856.

Amastra affinis, Pse. Proc. Zool. Soc. 650–1869.

†**A. albolabris**, Newc. (**Achatinella.**) Proc. Zool. Soc, pl. 24, f. 56–1853.

Achatinella nucleola, Rve. (Non Gld.) Mon. pl. 5, f. 39.

Laminella albolabris, Pfr. Mall. Blätt. 132–1854, 165–1856.

Labiella albolabris, Pse. Proc. Zool. Soc. 651–1869.

Oahu.

†**A. amicta**, Smith. (**Laminella.**) Proc. Zool. Soc. pl. 10, f. 20–1873.

Laminella amicta, Pfr. Nomen. Hel. Viv. 314–1881.

Sandwich Islands.

Obs. This shell may equal *A. petricola*, Newc.

†**A. Anthonyi**, Newc. (**Achatinella**). Proc. Cal. Nat. Hist. Soc. ii, p. 93–1860. Amer. Jour. Conch. ii, pl. 13, f. 2–1866.

Amastra Anthonyi, Pse. Proc. Zool. Soc. 649–1869.

Koloa.

A. assimilis, Newc. (**Achatinella..**) Proc. Zool. Soc. pl. 23, f. 53–1853.

Laminella assimilis, Pfr. Mall. Blätt. 129–1854.

Amastra assimilis, Pse. Proc. Zool. Soc. 650–1869.

Amastra conicospira, Smith. Proc. Zool. Soc. pl. 10, f. 10–1873.

East Maui.

Obs. Dr. Pfeiffer considers this species to be a small variety of *A. nubilosa*, Migh.

†**A. biplicata**, Newc. (**Achatinella.**) Proc. Zool. Soc. pl. 24, f. 75–1853.

Laminella biplicata, Pfr. Mall. Blätt. 128–1854, 165–1856.

Amastra biplicata, Pse. Var. *Deshaysii* Morelet, Proc. Zool Soc. 649–1869.

Lanai.

A. brevis, Pfr. (**Achatinella.**) Mon. Hel. Viv. iii, 558.

Laminella brevis, Pfr. Nomen. Hel. Viv. 315–1881.

Sandwich Islands.

†**A, crassilabrum**, Newc. (**Achatinella.**) Proc. Zool. Soc. pl. 23, f. 31–1853.

Labiella crassilabrum, Pse. Proc. Zool. Soc. 651–1869.

Laminella crassilabrum, Pfr. Mall. Blätt. 130–1854–165–1856.

Waianea, Oahu.

†**A. cylindrica**, Newc. (**Achatinella.**) Proc. Zool. Soc. pl. 22, f. 11–1853.

Laminella cylindrica, Pfr. Mall. Blätt. 164–1856.

Amastra cylindrica, Pse. Proc. Zool. Soc. 650–1869.

Waianea, Oahu.

A. conifera, Smith. (**Amastra.**) Proc. Zool. Soc. pl. 10, f. 11–1873.

Amastra conifera, Pfr. Nomen. Hel. Viv. 314–1881.

Kula, East Maui.

†**A. cornea**, Newc. (**Achatinella.**) Proc. Zool. Soc. pl. 23, f. 32–1853.

Laminella cornea, Pfr. Mall. Blätt. 132–1854, 165–1856.

Leptachatina cornea, Proc. Zool. Soc. 651–1869.

Sandwich Islands.

Obs. Dr. Newcomb pronounces this shell an *Amastra*, in which I concur.

†**A. ellipsoidea**, Gld. (**Achatinella.**) Proc. Bost. Soc. 200–1847. Exped. Sh. tab. 7, f. 96.

Achatinella decorticate, Gul. Proc. Zool. Soc. pl. 10, f. 14–1873.

Achatinella pupoidea, Newc. Proc. Zool. Soc. pl. 23, f. 42–1853.

Amastra ellipsoidea, Pfr. Nomen. Hel. Viv. 311–1881.

Maui.

†**A. elliptica**, Gul. (**Amastra.**) Proc. Zool. Soc. pl. 10, f. 15–1873.

Laminella elliptica, Pfr. Nomen. Hel. Viv. 313–1881.

Waianea, Oahu.

†**A. elongata**, Newc. (**Achatinella.**) Pl. I, f. 9, Ann. Lyc. N. Y. 26–1853.

Achatinella acuta, Newc. Proc. Zool. Soc. 142–1853.

Laminella acuta, Pfr. = *elongata*, Mall. Blätt. 127–1854, 165–1856.

Helicter Hutchinsonii, Pse. Proc. Zool. Soc. 7–1862.

Newcombia Hutchinsonii, Pse. Proc. Zool. Soc. 649–1869.

Amastra elongata, Pse. Proc. Zool. Soc. 649–1869.

Makawao, Maui.

Obs. Mr. Pease observes, this shell is the analogue of *Amastra obscura*, Newc.; like many other species of *Amastra*, it possesses the plicate apex of *Laminella*, but wants the spiral striæ, which is the best evidence that it belongs to the section *Amastra*.

†**A. farcimen**, Pfr. (**Achatinella.**) Pl. I, f. 5. Mon. Hel. Viv. iv, 552.

Laminella farcimen, Pfr. Nomen. Hel. Viv. 313–1881.

Amastra farcimen, Pse. Proc. Zool. Soc. 649–1869.

Maui.

†**A. flavescens**, Newc. (**Achatinella.**)Proc. Zool. Soc. pl. 24, f. 62–1853.

Achatinella tenuilabris, Gul. Proc. Zool. Soc. pl. 10, f. 16–1873.

Laminella flavescens, Pfr. Mall. Blätt. 130–1854, 165–1856.

Amastra flavescens, Pse. Proc. Zool. Soc. 650–1869.

Hawaii, (Baldwin.) *Wanoa, Oahu*, (Newcomb.)

Obs. A comparison of types exhibits *A. tenuilabris*, Gul.= *flavescens*, Newc. The latter in the collection of the Jardin des Plantes, is erroneously labelled *A. modesta*, C. B. Adams.

A. gigantea, Newc. (**Achatinella.**) Proc. Zool. Soc. pl. 20, f. 17–1853.

Laminella violacea, Pfr. Mall. Blätt. 141–1854.

Laminella gigantea, Pfr. Mall. Blätt. 140–1854.

Laminella gigantea, =*violacea*, var. Pse. Proc. Zool. Soc. 648–1869.

Amastra violacea, Pfr. Mall. Blätt. 164–1856.

Haleakala, Maui.

Obs. The only example of *gigantea* ever found is in the British Museum. It probably equals a large example of *A. violacea*, Newc.

†**A. humilis**, Newc. (**Achatinella.**) Ann. Lyc. N. Y. 143–1855. Amer. Jour. Conch. 211, pl. 13, f. 4–1866.

Laminella humilis, Pfr. Nomen. Hel. Viv. 313.

Amastra humilis, Pse. Proc. Zool. Soc. 649–1869.

Molokai.

†**A. intermedia**, Newc. (**Achatinella.**) Proc. Zool. Soc. pl. 22, f. 13–1853.

Laminella intermedia, Pfr. Mall. Blätt. 165–1856.

Amastra intermedia, Pse. Proc. Zool. Soc. 650–1869.

Wainoe, Oahu.

A. irregularis, Pfr. (**Achatinella.**) Mon. Hel. Viv. iv, 564.

Amastra irregularis, Pfr. Mall. Blätt. 164–1854.

Sandwich Islands.

A. inflata, Pfr. (**Achatinella.**) Mon. Hel. Viv. iv, 549.

Laminella inflata, Pfr, Nomen. Hel. Viv. 313.

Amastra inflata, Pse. Proc. Zool. Soc. 649–1869.

Sandwich Islands.

A. luctuosa, Pfr. (**Achatinella.**) Proc. Zool. Soc. 204–1855.

Sandwich Islands.

†**A. magna**, C. B. Adams. (**Achatinella.**) Conch. Cont. 125–1850.

Achatinella Baldwinii, Newc. Proc. Zool. Soc. pl. 24, f. 72–1853.
Achatinellastrum Baldwinii, Pfr. Mall. Blätt. 140–1854.
Amastra Baldwinii, Pfr. Mall. Blätt. 164–1856.
Laminella Grayana, Pfr. Proc. Zool. Soc. 204–1855. (Junior.)
Amastra magna, Pfr. Nomen. Hel. Viv. 311–1881.

Lanai.

Obs. Examples compared with *Grayana*, Pfr. in the British Museum, exhibit *Grayana* as the junior of *magna*. Numerous examples of all ages in the Pease collection, confirm the diagnosis.

A. malleata, Smith. (**Amastra.**) Proc. Zool. Soc. pl. 10, f. 18–1873.

Kula, East Maui.

†**A. Mastersii**, Newc. (**Achatinella.**) Proc. Zool. Soc. pl. 24, f. 67–1853.

A. rubens, var. Pfr. (non Gould.) Mon. Helic. iv, 552.
Laminella Mastersii, Pfr. Mall. Blätt. 129–1854.
Amastra Mastersii, Pse. Proc. Zool. Soc. 650–1869.

Maui.

†**A. melanosis**, Newc. (**Achatinella.**) Proc. Zool. Soc. pl. 23, f. 41–1853.

Laminella melanosis, Pfr. Mall. Blätt. 132–1854, 165–1856.
Amastra melanosis, Pse. Proc. Zool. Soc. 650–1869.

Hawai.

†**A. micans**, Pfr. (**Laminella.**) Pl. I, f. 10. Mon. Hel. Viv. vj, 179,

Amastra micans, Pse. Proc. Zool. Soc. 650–1869.

Sandwich Islands.

†**A. modesta**, C. B. Adams. (**Achatinella.**) Conch. Cont. 128–1850.

Laminella modesta, Pfr. Mall. Blätt. 129–1854, 165–1856.
Amastra modesta, Pse. Proc. Zool. Soc. 650–1869.

Molokai.

A. moesta, Newc. (**Achatinella.**) Proc. Zool. Soc. pl. 24, f. 77–1853.

Laminella moesta, Pfr. Mall. Blätt. 128–1854.
Newcombia obscura, Newc.=*moesta*, Pse. Proc. Zool. Soc. 649–1869.

Lanai.

†**A. mucronata**, Newc. (**Achatinella.**) Proc. Zool. Soc. pl. 23, f. 49–1853.

Laminella mucronata, Pfr. Mall. Blätt. 129–1854–165–1856.
Amastra mucronata, Pse. Proc. Zool. Soc. 650–1869.

Maui.

†**A. nigra**, Newc. (**Achatinella.**) Proc. Bost. Soc. 219–1855. Amer. Jour. Conch. ii, pl. 13, f. 3.

Amastra nigra, Pfr. Mall. Blätt. 164–1856.

Maui.

†**A. nigrolabris,** Smith. (**Amastra.**) Proc. Zool. Soc. pl. 10, f. 11–1873.

Laminella nigrolabris, Pfr. Nomen. Hel. Viv. 313–1881.

Wahiawa, Oahu.

†**A. nubilosa,** Migh. (**Achatinella.**) Proc. Bost. Soct. 20–1845.

A. nubilosa, Rve. Mon. pl. 1, f. 1–1850.

Laminella nubilosa, Pfr. Mall. Blätt. 129–1854, 165–1856.

Amastra nubilosa, Pse. Proc. Zool. Soc. 650–1869.

Molokai.

Obs. Dr. Newcomb says *nubilosa* comes from Molokai, while Mighels, Reeve, and Gould give Oahu as the locality. I have never seen a shell that equals in size Dr. Mighels' figure in Reeve's Monograph, and with Dr. Pfeiffer I incline to the opinion that it equals *assimilis*, var.

†**A. nucula,** Smith. (**Amastra.**) Proc. Zool. Soc. pl. 10, f. 19–1873.

Lanai.

†**A. nucleola,** Gld. (**Achatinella.**) Proc. Bost. Soc. 28–1845.

A. brevis, Pfr.? Proc. Zool. Soc, 1845.

Laminella nucleola, Pfr. Mall. Blätt. 142–1854, 165–1856.

Amastra nucleola, Pse. Proc. Zool. Soc. 649–1869.

Kavai.

†**A. obesa,** Newc. (**Achatinella.**) Ann. Lyc. N. Y. 24–1853. Proc. Zool. Soc. pl. 24, f. 39–1853.

Amastra obesa, Pfr. Mall. Blätt. 164–1856.

Amastra obesa, Pse. Proc. Zool. Soc. 649–1869.

Haleakala, Maui.

†**A. Peasii,** Smith. (**Amastra.**) Proc. Zool. Soc. pl. 10, f. 13–1873.

Laminella Peasii, Pfr. Nomenc. Hel. Viv. 313–1881.

Sandwich Islands.

†**A. petricola,** Newc. (**Achatinella.**) Amer. Jour. Conch. ii, pl. 13, f. 6.

Laminella petricola, Pfr. Mall. Blätt. 165–1856.

Amastra petricola, Pse. Proc. Zool. Soc. 650–1869.

Molokai.

†**A. porphyrea,** Newc. (**Achatinella.**) Proc. Zool. Soc. pl. 22, f. 16–1853.

A. grassa, Pfr. Proc. Zool. Soc. 204–1855. (Var.)

Laminella porphyrea, Pfr. Mall. Blätt. 130–1854–165–1856.

Amastra porphyrea, Pse. Proc. Zool. Soc. 650–1869.

Manoa, Oahu.

†**A. porphyrostoma.** Pse. (**Amastra.**) Pl. I. f. 6. Proc. Zool. Soc. 649–1869.

Amastra porphyrostoma, Pfr. Nomen. Hel. Viv. 311–1881.

Oahu.

Obs. This shell resembles examples of *A. farcimen*, Pfr. in Coll, Newcomb, from the Coll. Cuming.

†**A. pusilla**, Newc. (**Achatinella.**) Proc. Zool. Soc. pl. 23, f. 39–1853. Amer. Jour. Conch. ii, pl. x, iij, f. 5.

A. pulla, Pfr. Proc. Zool. Soc. 209–1855.
Laminella pusilla, Pfr. Nomen. Hel. Viv. 334.
Amastra pusilla, Pse. Proc. Zool. Soc. 650–1869.

Lanai.

†**A. reticulata**, Newc. (**Achatinella.**) Proc. Zool. Soc. pl. 24, f. 54–1853.

A. transversalis, Pfr. Proc. Zool. Soc. 204–1855.
A. conspersa, Pfr. Proc. Zool. Soc. pl. 30, f. 26–1853.
Achatinellastrum reticulata, Pfr. Mall. Blätt. 141–1854.
Amastra reticulata, Pfr. Mall. Blätt. 164–1856.
Amastra reticulata, Pse. Proc. Zool. Soc. 649–1869.

Waianoe, Oahu.

†**A. rubens**, Gld. (**Achatinella.**) Pro. Bost. Soc. 27–1845. Rve. Mon. pl. 6, f. 42b.

Laminella rubens, Pfr. Mall. Blätt. 129–1854–165–1856.
Amastra Mastersii, Pfr. (Non Newc.)
Amastra rubens, Pse. Proc. Zool. Soc. 650–1869.

Oahu.

†**A. rubida**, Gul. (**Amastra.**) Proc. Zool. Soc. pl. 10, f. 12–1873.

Laminella rubida, Pfr. Nomen. Hel. Viv. 313–1881.

Kahuku, Oahu

†**A. rudis**, Pfr. (**Achatinella.**) Proc. Zool. Soc. pl. 3, f. 17–1855.

A. chlorotica, Pfr. Proc. Zool. Soc. 205–1855.
A. albida, Pfr. Proc. Zool. Soc. 202–1855. (*Rudis* var. B.)
Laminella rudis, Pfr. Mall. Blätt. 165–156.

Oahu.

†**A. rustica**, Gul. (**Amastra.**) Proc. Zool. Soc. pl. 10, f. 17–1873.

Kula, East Maui.

Obs. This species may be only a variety of *variegata*, Pfr. Mr. Smith says *rustica* is allied to *confiera*, which latter may be another variety of *variegata*.

†**A. rugulosa**, Pse. (**Amastra.**) Jour. Conch. xvij 95–1870.

Kula, East Maui.

Obs. This shell is near *sphoerica*, but the latter is larger and more depressed than *rugulosa*.

†**A. sericea**, Pfr. (**Laminella.**) Mon. Hel. Viv. iv, 179.

Sandwich Islands.

†**A. spirozona**, Fér. (**Helix.**) Mon. tab. 155, f. 14–15.

A. boetica, Migh.
Laminella spirozona, Pfr. Mall. Blätt. 127–1854–156–1856.
Amastra spirozona, Pse. Proc. Zool. Soc. 650–1869.

Oahu.

A. sphoerica, Pse. **(Amastra.)** Jour. Conch. 1870. Jour. Conch. pl. 1, f. 5–5a–1876.

Lanai.

A. solida, Pse. **(Amastra.)** Jour. Conch. xviij 173–1869.

Oahu.

†**A. textilis,** Fér. **(Helix.)** Pl. I, f. 8. Tab. Syst. Animal Moll, p. 56, No. 436–1819.

A. ventulus, Rve. Mon. No. 31 (non Fér).
A. microstoma, Gld. Proc. Bost. Soc. 25–1845.
Laminella textilis, Pfr. Mall. Blätt. 126–142–1854–164–1856.
Amastra textilis, Pse. Proc. Zool. Soc. 649–1869.

Sandwich Islands.

†**A. tristis,** Fér. **Helix (Cochlogena).** Tab. Syst. Animal. Moll. p. 56, No. 435 1819.

Bulimus tristis, Pfr. Mon. Hel. Viv. ii, 240–1842.
A. fuliginosa, Gld. Proc. Bost. Soc. 28–1845.
Laminella tristis, Pfr. Mall. Blätt. 141–1854–164–1856.
Amastra tristis, Pse. Proc. Zool. Soc. 649–1869.

Palolo, Oahu.

†**A. turritella,** Fér. **(Helix.)** Hist. Moll. pl. 155, f. 13.

A. Oahuensis, Green. Mal. Lyc. 1827.
Laminella turritella, Pfr. Nomen. Hel. Viv. 313.
Amastra turritella, Pse. Proc. Zool. Soc. 650–1869.

Sandwich Islands.

†**A. umbilicata,** Pfr. **(Achatinella.)** Pl. I, f. 11. Proc. Zool. Soc. 205–1855.

Laminella petricola, Pfr. Var. Mall. Blätt. 165–1856.

Sandwich Islands.

Obs. When in London I had the good fortune to obtain this rare shell, for G. M. Sowerby Esq. Dr. Newcomb affirms it to be a good species, in which I concur.

†**A. uniplicata,** Nobis. **(Amastra.)** Pl. I, f. 7.

Shell dextral, solid, elongate oval, occasionally cylindrical, whorls 7, slightly rounded, the last somewhat inflated, suture impressed, longitudinally striate, aperture sub-oval, white; a single white elongate twisted plicæ within; outer lip acute, color of the shell a pale ochre-yellow, concealed by a black epidermis.

L 20. D 9. Aperture 28. D 4. mill. *Molokai.*

Obs. This shell is from a different island from *A. biplicata,* Newc. which it resembles, the latter possesses more coarse longitudinal striæ, and has a double plicæ within, and the aperture is red, while *uniplicata* has a single plicæ, and the aperture is white. The Pease collection contained a large number of duplicates marked "new species" by Mr. Pease.

†**A. variegata,** Pfr. (**Achatinella.**) Zeitsch. 90–1849.

A. variegata, Chem. Tab. 67, f. 14–15.
A. rubens, var. Rve. Mon. pl. 6, f. 42a.
A. decepta, C. B. Adams. Conch. Cont. 127–1850.
Laminella variegata, Pfr. Mall. Blätt. 128–1854–165–1866.
Amastra variegata, Pse. Proc. Zool. Soc. 650–1869.

Head of Boothes Valley, Oahu.

Obs. This is a very variable species and the name may embrace others herein enumerated as distinct species.

†**A. ventulus,** Fér. (**Helix**). Tab. Syst. Animal. Moll. p. 56, No. 437–1819. (Non Rve).

Achatinella melampoides, Pfr. Proc. Zool. Soc. 1851.
Amastra melampoides, Pfr. Nomen. Hel. viv, 311–1881.
Amastra ventulus, Pse. Proc. Zool. Soc. 648–1869.

Manoa, Oahu.

Section CARINELLA, Dr. L. Pfeiffer.

†**C. Kauaiensis,** Newc. (**Achatinella.**) Syn. Ann. Lyc. N. Y. pl. 13, f. 1–1860. Amer. Jour. Conch. ii, pl. 13, f. 1–1866.

Leptachatina Kauaiensis, Pse. Proc. Zool. Soc. 650–1869.
Carinella Kauaiensis, Pfr. Nomen. Hel. Viv. 312–1881.

Kauai.

†**C. obesa,** Newc. (**Achatinella.**) Proc. Zool. Soc. pl. 23, f. 59–1853.

A. obesa, var. *agglutinans*, Newc.
Amastra carinata, Gul. Proc. Zool. Soc. 83–1873.
Carinella carinata, Pfr. Nomen. Hel. Viv. 312.

East Maui.

Obs. Dr. Newcomb informs me that *agglutinans* and *carinata* are local varieties of *obesa*.

Section LEPTACHATINA, Dr. A. A. Gould.

†**L. acuminata,** Gld. (**Achatinella.**) Proc. Bost. Soc. 200–1848. Expd. Shells t. 7, f. 100.

Leptachatina acuminata, Pfr. Mall. Blätt. 154–1854, –166–1856.
Leptachatina acuminata, Pse. Proc. Zool. Soc. 650–1869.

Kauai.

†**L. antiqua,** Pse. (**Leptachatina.**). (Sub fossil.) Jour. Conch. t. 13, f. 6–1876.

Kauai.

†**L. balteata,** Pse. (**Leptachatina.**) Jour. Conch. t. 4, f. 4–1876.

Kauai.

†**L. brevicula,** Pse. (**Leptachatina.**) Jour. Conch. 169–1869.

Kauai.

†**L. cerealis**, Gld. (**Achatinella.**) Pl. I, f. 13. Proc. Bost. Soc. 201–1848.

Newcombia cerealis, Pfr. Mall. Blätt. 119–1854.

Amastra cerealis, Pfr. Mall. Blätt. 164–1856.

Leptachatina cerealis, Pfr. Mall. Blätt. 166–1856.

Waianea, Oahu.

†**L. cingula**, Migh. (**Achatinella.**) Pl. I, f. 14. Proc. Bost. Soc. 21–1845.

Achatinella dimidiata, Pfr. Proc. Zool. Soc. 205–1855.

Bulimus cingula. Chem., t. 67, f. 57.

Leptachatina cingula, Pfr. Mall. Blätt. 144–1854–166–1856.

Oahu.

Obs. *Achatinella dimidiata*, Pfr. equals *cingula*, Migh. in Coll. Newcomb, ex Auct. The figure of this shell in Chemnitz does not represent the species, but equals an *Amastra*.

L. clausiana, Migh. (**Bulimus.**) Proc. Bost. Soc. Nat. Hist. 20–1845.

Hawaii.

†**L. compacta**, Pse. (**Leptachatina.**) Jour. Conch. xviij–1869.

Labiella compacta, Pfr. Mon. Hel. Viv. viij 219.

Maui.

†**L. corneola**, Pfr. (**Achatinella.**) Proc. Zool. Soc. 90–1845.

Leptachatina corneola, Pfr. Mall. Blätt. 144–1854, 166–1856.

Labiella corneola, Pse. Proc. Zool. Soc. 651–1869.

Sandwich Islands.

†**L. coruscans**, Nobis. Pl. I, f. 16.

Shell dextral, ovate, very thin and polished, spire one third the length; apex obtuse, whorls 4½, rounded, the last one and a half inflated; suture impressed, aperture semi-ovate, with a very thin white lamellar tooth near the base; labium slightly thickened within and white, color amber.

L. 9. Diam 4½. L. apt. 3½. Diam. apt. 2½.

Molokai.

Obs. This shell was received from Mr. D. D. Baldwin, it has the outline of *L. brevicula*, Pse. but is much larger and more polished.

†**L. costulosa**, Pse. (**Leptachatina.**) Jour. Conch. xviij–90–1870, t. 3, f. 4–1876.

Kauai.

Obs. Near *L. striatula*, Gld.

L. cylindrata, Pse. (**Leptachatina.**) Jour. Conch. 1869.

Kauai.

L. exilis, Gul. (**Achatinella.**) Ann. Lyc. N. Y. vj t. 6 f. 15.

Leptachatina exilis, Pse. Proc. Zool. Soc. 651–1869.

Oahu.

L. extensa, Pse. (**Leptachatina.**) Proc. Zool. Soc. 651–1869. Jour. Conch. 1870.

Kauai.

†**L. fumosa**, Newc. (**Achatinella,**) Proc. Zool. Soc. t. 23, f. 28–1853

Leptachatina fumosa, Pfr. Mall. Blätt. 143–1854–166–1856.

Labiella fumosa, Pse. Proc. Zool. Soc. 651–1869.

Manoa, Oahu.

†. **L. fusca**, Newc. (**Achatinella.**) Proc. Zool. Soc. pl. 33, f. 44–1853.

Achatinella striatella, Gul. Ann. Lyc. N. Y. t. 6, f. 6–1856.

Achatinella petila, Gul. Ann. Lyc. N. Y. t. 6, f. 17–1856.

Laminella fusca, Pfr. Mall. Blätt. 165–1856.

Leptachatina fusca, Pse. Proc. Zool. Soc. 651–1869.

Manoa, Oahu.

L. fuscula, Gul. (**Achatinella.**) Ann. Lyc. N. Y. vj, f. 8.

Leptachatina fuscula, Pse. Proc. Zool. Soc. 651–1869.

Molokana, Oahu.

†**L. gracilis**, Pfr. (**Achatinella.**) Proc. Zool. Soc. pl. 30, f. 22–1855.

Achatinella elevata, Pfr. Proc. Zool. Soc. 209–1855.

Achatinella subula, Gul. Ann. Lyc. N. Y. vj, f. 19–1856.

Leptachatina elevata, Pfr. Mall. Blätt. 164–1856.

Achatinellastrum elevata, Pfr. Mall. Blätt. 164–1854.

Leptachatina gracilis, Pse. Proc. Zool. Soc. 651–1869.

Oahu.

L· glutinosa, Pfr. (**Achatinella.**) Proc. Zool. Soc. 204–1855.

Achatinella lachryma, Gul. Ann. Lyc. N. Y. pl. 6, f. 4–1858.

Achatinella glutinosa, Pfr. Mall. Blätt. 165–1856.

Leptachatina glutinosa, Pse. Proc. Zool. Soc. 651–1869.

Lehui, Oahu.

†**L. guttula**, Gld. (**Achatinella.**) Proc. Bost. Soc. 201–1845. Expd. Shells, t. 7, f. 98.

Leptachatina guttula, Pfr. Mall. Blätt. 144–1854–166–1856.

Achatinella gummea, Gul. Ann. Lyc. N. Y. vj pl. 6, f. 10.

Achatinella fragilis, Gul. Ann. Lyc. N. Y. vj pl. 6, f. 11.

East Maui.

†**L. grana**, Newc. (**Achatinella.**) Ann. Lyc. N. Y. vj 29–1853. Proc. Zool. Soc. pl. 23, f. 46–1853.

Achatinella granifera, Gul. Ann. Lyc. N. Y. pl. 6, f. 13–1858.

Achatinella vitriola, Gul. Ann. Lyc. N. Y. pl. 6, f. 23–1858.

Achatinella parvula, Gul. Ann. Lyc. N. Y. pl. 6, f. 24–1858.

Leptachatina grana, Pfr. Mall. Blätt. 144–1854, 166–1856.

East Maui.

†**L. Hartmani**, Newc. (**Leptachatina.**) Ms. Coll. Newcomb.
Achatinella extincta, Pfr. (sub fossil.) Proc. Zool. Soc. 204–1855.
Laminella extincta, Pfr. Mall. Blätt. 165–1856.
Leptachatina extincta, Pse. Proc. Zool. Soc. 651–1869.
Oahu.

Obs. Dr. Newcomb having recent examples of this shell, has changed the name, the former being a misnomer.

†**L. laevis**, Pse. (**Leptachinata.**) Jour. Conch. xviij–91–1870. 97, pl. 4, f. 6–1876.
Kauai.

†**L. lineolata**, Newc. (**Achatinella.**) Proc. Zool. Soc. t. 23, f. 29–1853.
Laminella lineolata; Pfr. Mall. Blätt. 128–1856.
Amastra lineolata, Pse. Proc. Zool. Soc. 650–1869.
Maui.

Obs. Examples of this shell from Dr. Newcomb, exhibits it as a *Leptachatina.*

S. lucida, Pse. (**Leptachatina.**) Proc. Zool. Soc. 651–1869.
Kauai.

†**L. margarita**, Pfr. (**Achatinella.**) Proc. Zool. Soc. 206–1855.
Achatinella granifera, Gul. Proc. Zool. Soc. 1873.
Leptachatina margarita, Pfr. Mall. Blätt. 166–1856.
Oahu.

†**L. nitida**, Newc. (**Achatinella.**) Proc. Zool. Soc. t. 23, f. 30–1853.
Achatinelia crystallina, Gul. Ann. Lyc. N. Y. vj pl. 6, f. 14.
Leptachatina nitida, Pfr. Mall. Blätt. 144–1854–166–1856.
Maui and Oahu.

†**L. obclavata**, Pfr. (**Achatinella.**) Mon. Hel. Viv. iv, 568.
Achatinella octogyrata, Gul. Ann. Lyc. N. Y. pl. 6, f. 18–1856.
Achatinella turrita. Gul. Ann. Lyc. N. Y. pl. 6, f 20–1856.
Leptachatina obclavata, Pfr. Mall. Blätt. 166–1856.
Oahu.

L. obtusa, Newc. (**Achatinella.**) Proc. Zool. Soc. 209–1855.
Leptachatina obtusa, Pfr. Mall. Blätt. 166–1856.
Sandwich Islands.

L. oryza, Pfr. (**Achatinella.**) Proc. Zool. Soc. 206–1855.
Achatinella tritacea, Gul. Ann. Lyc. N. Y. vj t. 6, f. 12.
Leptachatina oryza, Pfr. Mall. Blätt. 166–1856.
Oahu.

†**L. pyramis**,) Pfr. **Achatinella.**) Proc. Zool. Soc. 90–1845.
Achatinella pyramis, Rve. Mon. t. 6, f. 41–1850.
Achatinella leucocheila, Gul. Ann. Lyc. N. Y. vj t. 6, f. 1. (dwarf.)
Leptachatina pyramis, Pse. Proc. Zool. Soc. 651–1869.
Kauai.

L. resinula, Gul. (**Achatinella.**) Ann. Lyc. N. Y. Vj. t. 6, f. 2.

Leptachatina resinula, Pse. Proc. Zool. Soc. 651–1869.

Oahu.

L. saccula, Nobis. (**Leptachatina.**) pl. I, f. 15.

Shell dextral, ovate conic, thin and semi-pellucid, spire more than half the length. Whorls 6, slightly convex, the last inflated, suture well impressed, surface coarsely striate. Aperture roundly ovate, sub-umbilicate, columella white, with an oblong plicæ within; interior of labium white and slightly thickened; color pale green.

L 10. Diam. 6. L aft. 4. Diam. 2½ mill.

Hab. Sandwich Islands.

Obs. Three examples of this species were found amongst the duplicates of the Pease collection.

†**L. succinata**, Newc. (**Achatimella.**) Proc. Bost. Soc. 220–1855. Amer. Jour. Conch. ii, t. 13, f. 7.

Achatinella marginata, Gul. Ann. Lyc. N. Y. vj pl. 6, f. 7.

Labiella succincta, Pse. Proc. Zool. Soc. 651–1869.

Leptachatina succincta, Pfr. Mall. Blätt. 166–1856.

Wahai, Oahu.

L. saxitilus, Gul. (**Achatinella,**) Ann. Lyc. N. Y. vj. t. 6, f. 15.

Leptachatina saxitilus, Pse. Proc. Zool. Soc. 650–1869.

Oahu.

L. sculpta, Pfr. (**Achatina.**) Mon. Hel. Viv. iv, 609.

Leptachatina sculpta, Pse. Proc. Zool. Soc. 650–1869.

Oahu.

L. semicostata, Pfr. (**Achatinella.**) Mon. Hel. Viv. iv, 565.

Achatinella costulata, Gul. Ann. Lyc. N. Y. vj t. 6, f. 5.

Leptachatina semicostata, Pfr. Mall. Blätt. 166–1856.

Oahu.

Obs. Dr. Newcomb thinks it questionable if this species is not a synonym of *L. fusca*, Newc.

†**L. simplex**, Pse. (**Leptachatina.**) Jour. Conch. 1869–70.

Hawai.

Obs. Examples *L. nitida*, Newc. (coll. Newc.) and *L. simplex*, Pse. (coll. Pse.) are similar.

L. stiria, Gul. (**Achatinella.**) Ann. Lyc. N. Y. vj. t. 6, f. 22–1855.

Leptachatina stiria, Pfr. Nomen. Hel. Viv. 316–1881.

Oahu.

†**L. striatula**, Gld. (**Achatinella.**) Proc. Zool. Soc. 28, January 15–1845.

Achatinella clara, Pfr. Proc. Zool. Soc. August, 1845.

Leptachatina striatula, Pfr. Mall. Blätt. 143–1854, 166–1856.

Kauai.

†**L. tenuicostata,** Pse. (**Leptachatina.**) Jour. Conch. 170–1869.
Leptachatina tenuicostata, Pfr. Mall. Blätt. 166–1856.
Hawai.

†**L. tenebrosa,** Pse. (**Leptachatina.**) Jour. Conch. t. 3, f. 5–1876.
Kauai.

L. terebralis, Gul. (**Achatinella.**) Ann. Lyc. N. Y. vj t. 6, f. 21.
Leptachatina terebralis, Pse. Proc. Zool. Soc. 651–1869,
Oahu.

L. teres, Pfr. (**Achatinella.**) Proc. Zool. Soc. 206–1855.
Leptachatina teres, Pse. Proc. Zool. Soc. 651–1869.
Sandwich Islands.

†**L. turgidula,** Pse. (**Leptachatina.**) Jour. Conch. xviij–87–1870.
Labiella turgidula, Pse. Jour. Conch. xviij–167.
Leptachatina turgidula, Pse. Jour. Conch. 96–1876.
Kauai.

†**L. vitrea,** Newc. (**Achatinella.**) Proc. Zool. Soc. t. 23, f. 24–1853.
Achatinella fumida, Gul. Ann. Lyc. N. Y. vj t. 6, f. 9–1853. (Dwarf.)
Leptachatina vitrea, Pfr. Mall. Blätt. 144–1854–166–1856.
Labiella vitrea, Pse. Proc. Zool. Soc. 651–1869.
Manoah, Oahu.

Explanation of Plate I.

No. 1 *Partulina proxima,* Pse. Typical.
" 2 *Partulina proxima,* Pse. Variety.
" 3 *Achatinellastrum Nealii,* Bald. Nobis.
" 4 *Bulimella rosea,* Swains. Variety,
" 5 *Amastra farcimen,* Pfr. Typical.
" 6 *Amastra porphyrostoma,* Pse. Type.
" 7 *Amastra uniplicata,* Nobis. Type.
" 8 *Amastra textilis,* Fér. Typical,
" 9 *Amastra Huchinsonii,* Pse. Typical.
" 10 *Amastra micans,* Pfr. Typical.
" 11 *Amastra umbilicata,* Newc. Typical.
" 12 *Leptachatina Hartmanii,* Newc. Type.
" 13 *Leptachatina cerealis,* Gould. Type.
" 14 *Leptachatina cingula,* Mighls. Typical.
" 15 *Leptachatina saccula,* Nobis.
" 16 *Leptachatina coruscans,* Nobis.

FEBRUARY 7.

Mr. THOMAS MEEHAN, Vice-President, in the chair.

Twenty-four persons present.

The death of Geo. W. Tryon, Jr. on the 5th inst. having been announced the following minute was adopted:—

While this may not be the time to fully set forth the services which have been rendered to this Academy and to the scientific world by our departed member Geo. W. Tryon, Jr., yet it is fitting that the sad announcement of his death should be followed by immediate though brief expression of our sorrow.—Therefore be it

Resolved—That by the death of Mr. Tryon, the Academy of Natural Sciences of Philadelphia is bereft of one of its most faithful and useful workers—one whose devotion to the interests of the institution has been proven during nearly thirty years in varied and responsible positions of trust, by repeated and generous gifts, and above all, by untiring labor for its advancement; and whose earnestness and assiduity in his chosen field of study have been rewarded with a well-earned celebrity which will forever connect his name with the history and progress of conchological science.

Resolved—That we are enabled by our own knowledge of his kindly, helpful and endearing qualities to sympathize heartily with his family in their irreparable loss.

Dr. W. S. W. Ruschenberger was appointed to prepare a biographical notice of Mr. Tryon for publication in the Proceedings.

FEBRURY 13.

MEETING OF THE BOTANICAL SECTION.

The Director, Dr. W. S. W. RUSCHENBERGER, in the chair.

The death of Dr. Asa Gray, on January 30, was announced and the following minute which had been adopted by the Academy at the meeting held February 7, was read:—

The Academy of Natural Sciences of Philadelphia has learned with deep sorrow of the death of Professor Asa Gray of Cambridge, Massachusetts, who was elected a correspondent in 1836. In placing this record in our Proceedings we are unable to give adequate expression to our sense of the great loss which we, in common with the whole world of science, have sustained. A life extending to nearly four score years has been wholly devoted to scientific investigation, mainly in his chosen department of Botany, in which his labors and philosophic insight have been attended with results that do honor to him and to his country. In entering upon the study of the flora of his native land, he early realized the imperfect character of its existing literature and turned his attention to the examination of the original types of various authors as found in the herbaria of North America and Europe. His ultimate object seems to have been the production of a complete flora of North America, which, though he lived to see far advanced, he was not permitted to entirely finish.

In the course of his studies his far reaching mind found deep interest in the difficult questions pertaining to the geographical distribution of plants, and he was led to the discovery of the remarkable analogies between the flora of the Eastern United States and that of Eastern Asia. His reasoning upon this and kindred subjects prepared his mind to give respectful attention to the deductions made by Darwin, when they were first published, and though never a blind follower, he was one of the earliest scientists of our land to uphold the idea of progressive development, always maintaining its perfect harmony with theistic belief. Thus his labors in the botanical field have been utilized for the entire scientific world.

His interest in this Academy never abated; our library bears abundant evidence of his researches; our herbarium has been greatly enhanced in value by his studies of its types, and by his generous contributions; whilst his kind, genial and attractive presence at many of our meetings has endeared him to us all.—Therefore be it

Resolved—That this expression of our sorrow be communicated to his immediate family with the assurance of our deep sympathy with them in a loss which is so widely felt.

Resolved—That this record be entered in full upon our minutes and published in the Proceedings.

Mr. Redfield offered at the meeting of the Section, the following preamble and resolutions which were unanimously adopted:—

When in due course of nature a man eminent in his calling, conspicuous as a large minded citizen and remarkable for his private virtues is taken from us it is a duty which his colleagues owe, not only to the memory of the departed, but to themselves that they should recognize by public expression the value of so distinguished a life to the times in which it was cast:—Therefore be it resolved,—

1st. That in the death of Professor Asa Gray, the Botanical Section of the Academy of Natural Sciences of Philadelphia recognizes the removal of one who stood without a rival in his chosen field. The magnitude of his work, the industry and ability with which it was executed, the clearness of insight, the truthfulness and accuracy displayed in all that he undertook, have done more to elucidate the flora of North America, than the labors of any of his predecessors or cotemporaries.

2nd. That we desire here to record the fact, that as he was ever ready to aid his co-workers however humble, by his extensive knowledge, his removal is deplored as a loss to the whole scientific community.

3rd. That while his great intellectual attainments were combined with the charms of a pure life, a warm heart and a charitable disposition which gave a rare loveliness to his whole character,—there were also added an inflexible purpose, an unyielding devotion to duty, and an allegiance to all right principle.

4th. That we will cherish his memory, and endeavor to follow the spirit and purpose of his life in science, by fostering that fraternal feeling which he did so much to create among the botanists of our country.

5th. That while we trust that his removal hence is but the entrance upon a nobler field of action, we desire to offer to Mrs. Gray and to other relatives our most profound sympathy in their bereavement.

6th. That these resolutions be entered in full upon the minutes of the Section, be printed in the Proceedings of the Academy, and that a copy of them be transmitted to Mrs. Gray.

Mr. Wm. M. Canby in seconding the resolutions said:—

One of the most remarkable men of our country and, as a scientist, the best known and most esteemed abroad of any American of our day, has passed from among us. The early advantages of Asa Gray were not many. He was not a college-bred man in the ordinary acceptation of the term and his rise was due to his own genius and energy. It falls to me to-night to speak of him as a systematic botanist. It is difficult for our younger botanists to comprehend the low state of the science when Dr. Gray first became interested in it. Nothing of any moment had as yet been done except in systematic botany. True there had been good workers in this department, and the labors of Bartram and Marshall, of Walter and Michaux, of Muhlenberg and Elliott, of Schweinitz, Pursh, Nuttall and others, have always been highly esteemed. Many foreign botanists, from the time of Linnæus onward, had described American species. The labors of these had laid a *foundation* for North American botany. But many of the descriptions were in diverse and scattered publications and were often incomplete or faulty. The synonymy had become much confused. Vast regions now well known, were then terræ incognitæ. Even the flora of so near a district as the pine lands of New Jersey was almost unknown.

Nothing daunted, the young botanist, encouraged by the late Dr. Beck of Albany and yet more by his life-long friend and associate Dr. Torrey, gave up the practice of medicine and devoted his whole time to his favorite science. So far as I know he was the first American to fully do this. Almost at once the effect of his careful and excellent labor began to appear and much preliminary work was soon done. Dr. Torrey had seen the manifest need of a new and better "Flora of North America." Here was one who could not only assist him but take the main burden of the work; and soon the now classic "Torrey and Gray's Flora" began to appear. Any one familiar with this work must have noticed how rapidly the descriptions improved as the work went on, and what a vast amount of new material the collections of Nuttall, Fremont, James and other explorers of our western Territories brought into it. While the species were thus well studied and the new ones admirably described, the fullest and most generous credit was always given to the discoveries and labors of others. But collections of the plants of the great western regions, from public and private sources, began to come, in most embarrassing richness. It became evident that the further publishing of the "Flora" must be delayed until the floral wealth of the great interior could be better known. It was also necessary that the synonymy of the earlier described species should be settled. So, for a brief period, Dr. Gray studied these in European herbaria and gardens. Twice afterward he made similar studies with most important results. Soon after his return from his first visit abroad, came the call to Cambridge and his settlement at the Botanic Garden there. From this time onward he stood in the very front rank as a botanist. His energy and industry were unceasing, and his work, by no means confined to systematic botany or to the plants of our own country, went forward rapidly and well. Less than a year ago I was told by the Governor of the Fiji Islands that Dr. Gray's work upon the flora of those distant lands was still the foundation of their systematic botany. His researches into the flora of Japan and China are well known. Soon the "Manual of Botany" appeared with its excellent arrangement and its clear and accurate descriptions. Who can measure the influence of that work upon the botany of our country or the effect it has had to create and increase an interest in the science. At last, after an amount of well directed labor and research which could have been applied by no other man, and after very many "contributions" of new species and "monographs" of difficult and little known genera had come from his pen, the time seemed ripe for a real and comparatively complete "Flora of North America" to appear. We all know how two volumes of this were issued and, in a second edition, extended and improved; and how fondly we had hoped, knowing how unimpaired was his mental and physical vigor, that the whole might have been finished before death claimed him. This was not to be; but we can never be sufficiently thankful that so much which he alone could give was made free to all.

What estimate shall we place upon his work in this department of the science? None but the very highest would be just. To me it seems as if the systematic botany of our country owes nearly every thing to Dr. Gray. Much that he did not do personally was done under his eye or by his advice and approbation. He it was who brought order out of confusion and having made stable and secure the foundation of this branch of the science, erected thereon a noble edifice which his tireless energy well nigh completed.

But no man could have done this who was less richly gifted than Asa Gray, for he had that clear insight and prescience which is genius rather than talent. In him, with eminent ability to detect the relations of genera and species, were combined a rare faculty of conveying his own knowledge to others by felicitous and accurate description, and the conscientious truthfulness which would allow no work to be carelessly or incompletely done.

Would that it were my place also to bear testimony to his greatness of soul. But this I must leave to others,—only saying, what all will recognize as true, that in the death of Dr. Gray we have, in the largest sense, lost the *best* as well as the *greatest* of American botanists.

Prof. J. T. Rothrock then said:—

I desire here to speak of Asa Gray simply as a teacher, and shall not allude to his rich and rounded career in any other relation, except so far as may be required to bring out the teacher more fully. His work as a systematist will receive fuller and better consideration from others, than I could hope to give it.

Directly or indirectly almost all the botanical teachers and investigators of this country owed their training, or their inspiration to Professor Asa Gray. If they had not been directly trained under his eye, they were at least taught by those who had been, or had used the text-books prepared by him for the special purpose of diffusing a popular knowledge of botany. Two of his least pretentious books,—"How Plants Grow" and "How Plants Behave" are veritable missionaries which daily impart some worthy lesson to thousands of children all over the land. We can hardly think of a time when these books will cease to be read, or to be popular.

In each generation there are a few men to whom "the world owes its most notable impulses." One may well say that the life and labors of Charles Darwin illustrate this statement fully; and with equal propriety we may claim, that so far as our own country is concerned, the teaching and example of Asa Gray were no less noteworthy.

There comes a time in the history of almost every ambitious youth bent upon an intellectual life, when he is called upon to decide what *special* career he will select. His earliest ambition to become a master in the whole realm of knowledge is found to be worse than a dream. His first intention was to have devoted a year to one celebrated instructor and another year to a second, and so on, until he should lay the broad and solid foundation upon which his great learning and reputation might rest. I have known such ambitious students, and I have known them to become pupils of Professor Gray, with the full intention of leaving him at the end of a year or two, to seek instruction in another department of Science, from another teacher; but of that number, very few ever completed their proposed course of study. The charm of Professor Gray's manner, his kindness of heart, no less than the constantly widening views which unfolded under his instruction, wedded them to botany for life. Yet I never knew him to say, or even intimate, that one should elect *his* branch over another's. There have been students to whom botany was far from a favorite branch, but in less than six months, the great, warm-hearted teacher had won the pupil to himself and to botany forever. Had Asa Gray been a man of but medium attainments, his transparent and unselfish goodness would alone have made him a model teacher, whose example and whose memory a student must have revered to the end.

Yet of all this personal power which Gray the teacher wielded. not a trace was due to toleration of half done work. On the contrary if he had a characteristic which absolutely predominated, it was thoroughness. Not once in years did I ever know him to rest satisfied until he had obtained from a pupil the best results possible under the circumstances. From the outset he not only encouraged, but required a student to see, think and conclude for himself: often without aid from books and always without *unnecessary* aid from him. This may appear to many as harsh treatment, but systems of teaching can only be judged by their result, and in this light Professor Gray's method stands abundantly vindicated. How wretched the system of education which "crams" a lad with facts and leaves him unable to stand alone when beyond the authority of the preceptor. To the fullest extent Doctor Gray recognized this, and to prevent such a result insisted on mental discipline which left the student with a well-grounded confidence in his own powers. But on the other hand a student never could learn presumptuous trust from a teacher who had nothing of the kind himself. Those who received from Professor Gray the largest share of judicious "letting alone" were the ones disposed to hunt an easy solution to their problems. It was never enough to simply reach a result in work. His common custom was to question and cross question until there could be no doubt in the mind of either teacher or taught, that the result was fairly obtained. Often the conclusion of the student was treated as a thesis to be sustained.

Dr. Gray not seldom assigned to his advanced students, subjects for original investigation and of course required a written report, often for publication. Nothing shows more clearly his conscientiousness as a teacher than his strictness concerning these reports. It was not sufficient that the conclusions should be correct, but they must be stated in exactly the right way. An artistic turn of a sentence, making it graceful as well as logical, was in his eyes of the utmost importance. "There now, that is neatly stated," is an expression which yet rings in my ears. It was uttered by Doctor Gray, when at last I had succeeded in "putting a point" as he thought it should be. I had written my first scientific paper at least six times, and each time thought it was as well done as could be; certainly as well done as I was capable of doing it. But my critic was merciless. I mentally resolved each time, that I would not re-write it; but I did re-write it; and was obliged to continue doing so until he thought it might be allowed to pass. I can see now the benefit of all that criticism. It was the most helpful lesson I ever received in the art of stating things. How much easier it would have been for Professor Gray to have made a mere perfunctory criticism, and then allowed the paper to have gone, with the statement,—it will do, but it should have been better! The fact that he did not do so, however, is just the point that I desire to bring out in illustration of his conscientious discharge of duty. I have no doubt he sighed more over having to take time to re-read it, than I did over having to re-write it. But, though to him lost time, he was good enough to regard it as a duty, and as such he did it. His character as a teacher came out in the fact that he did not allow it to pass. It was this disregard of his own time when a duty to a student was apparent, which places him now so high in the esteem of scores of pupils.

During working hours Professor Gray would allow no talking for talk-sake, at least but for a moment. He would, however, volunteer a hint, to place a student on the track in a difficult problem, or if necessary he would cheerfully give an hour for the same purpose, though he would not reveal anything which it were better that the student should discover for himself.

So far as I am aware he never forgot or lost interest in any one whom he had instructed. This is certainly true of those who had spent any considerable period with him. Time and time again, have I known him to be on the watch for a chance to help a student make an honorable name. Is it strange then that all over the land there are those who have heart aches when it is remembered we shall see that loved teacher no more?

When a great, good leader has been taken it hardly alters the case that he went full of years and honor. We are even then not ready to spare him. We never would have been ready to spare Asa Gray.

Each year the aspect of a science changes and some new phase becomes the popular one: and this for the time being is apt to be regarded, as, if not the whole, then at least as the better or the major part of the science. It is simply the expression of an old human weakness, which tries to make a part appear greater than the whole of a thing. An individual of great force of character, may if he desires, impress his associates with an idea of the supreme importance of his particular, partial line of study. But after all we only discover the solid bulk of anything when it is viewed from all sides. This is intended to bear especially upon the fact that Professor Gray's teaching lay *mainly, but by no means exclusively* in the line of systematic botany. Just now there is a decided tendency to give more attention to morphological and physiological botany than ever before, which is right; and to *discourage* systematic botany, which is wrong. It is merely a temporary swing of the pendulum. Gravity will at length place all these lines of botanical thought, as they deserve to be, on an even plane. It should, however, be said that those who disparage the systematic side to which Doctor Gray leaned, and on which he mainly taught, have as a rule had so little training in it, that they fail to comprehend its full meaning. Even mere analysis of a plant may, nay must, if properly taught, indicate beside the name, those broader relationships which express, or suggest the lines of descent by which the plant has come down to us. If it is a grand study, and it surely is, to follow the development of the individual from the egg or cell to the adult condition, is it not a much grander and broader problem to follow the evolution of the species or the genus?

Further, it should be stated that Professor Gray's work and teaching was directly in the natural sequence of events. Above all, it is to be remembered that the most timely work is always the most valuable. The first, most pressing task in the botany of any country is to correctly name and arrange its plants. This is a pre-requisite condition upon which the record of all other botanical studies then, and the diffusion of all knowledge thence, must rest. It was to the completion of this great, this necessary work that Professor Gray was bending all his strength.

It is well, however, to come to the clear statement, that no one in America, and but very few in Europe were so fully and practically acquainted with the latest thought and latest observations in all departments of botany as was the subject of this sketch. He could discuss just as clearly the functions of chlorophyll, or the dual nature of lichens, or the relation of a plant to its environment, as he could the relation of one American species to another, or of an Eastern United States plant to one from far away Japan. Let it then be stated, that judged by the broadest standard, as a teacher, Asa Gray stood perfectly rounded in his knowledge. If any one can doubt this, let him but read the critical reviews which during the past twenty years Professor Gray has written for the American Journal of Science, and be convinced. Indeed the wide range of his exact knowledge was wonderful. But vast as were his attainments, and vast as was the sum of all that he has written, his strongest claim to a perpetual remembrance does not rest there. His was the task of starting a generation of teachers in the right direction. True, the times were ripe for the coming of Professor Gray; but how much more meagre the harvest would have been if he had not come! Certainly it could not have been what his care and culture have made it! It is a great thing to write a good book. It is a greater thing to write a clearer book for a country than had been produced before. But it was greatest of all, to take the young, ambitious naturalists of this growing and educationally immature country and teach them how to teach others, not only as to facts, but as to methods. The value of this labor passes comprehension, for its ultimate effects ever widening, reach far out into the future. Facts may be lost sight of, theories disproven, hypotheses rejected as insufficient, but men will henceforth never lose a key which unlocks realms of knowledge. Asa Gray's whole life as teacher and as investigator has been the model of a master key. Those who have his patience, his honesty, his genial faith in his associates will best unlock the secrets of our flora so long as any remain unrevealed.

Think of him in what relation we may, he stands out in strong light for inspection, the picture of a "manly man." Was he without fear? It was because he was without reproach. If to the last, his cheerfulness and mental buoyancy amazed even those who knew him best, it was because the elasticity of his love of God and man enabled him to reach beyond the limits which age usually imposes, clear into the sunlight of eternal youth.

Asa Gray has gone to his rest. We mourn his removal from our midst: but we are thankful for the honor he cast upon this land, throughout the length and breadth of which his name is revered. More than this, we his associates and pupils are especially grateful for the example of kindness and conscientious devotion which he has left us; as well as for the methods of study which he inculcated and so well illustrated in his own daily life and labor.

Prof. W. P. Wilson said:—

I wish to offer a few words on the relation sustained by Dr. Asa Gray to the various leading scientific societies and naturalists of the old world. I do this all the more gladly because like some others of our true scientific men he was known better abroad than in his own land. I do not wish to say that Dr. Gray was not *well* known at home, for he was. His series of text-books, eight in all, has introduced his name wherever botany is well taught, but had his celebrity in this country depended on his scientific papers and books not intended for the general reader, he might have been almost as unknown to the masses as Jeffiries Wyman, who wrote no text-books but made some very important additions to science and consequently was much better known in England and on the Continent than here. In this country, to the great majority of individuals who had seen or heard of Dr. Gray, his name was inseparably connected with the finest set of text books ever issued in the English language. Only a few botanists and friends knew of his incessant labor on original questions, and that the results of this work were frequently published in the proceedings of the different societies. It was this latter kind of work which rapidly gained for him abroad a great recognition.

While Dr. Gray in his early career labored incessantly at his chosen work, went on numerous collecting tours, prepared important papers on the Grasses and Sedges, gave lectures on botany in two or three schools and colleges, published several minor papers in different societies and made himself indispensable in the early work of the Flora of North America which Dr. Torrey had already begun—he was known only to a very limited circle at home.

This activity, accuracy and ability in botany had already made him through his collecting and papers quite a reputation abroad and had as early as 1836 secured for him membership in three foreign societies: The Royal Academy of Sciences of Stockholm in 1829, the Imperial Academy Naturæ Curiosorum, Warsaw, 1835, and the Royal Botanical Society of Regensburg (Ratisbon) 1836.

Dr. Gray's visits to Europe were in all six. He first went for botanical study in November 1838, returning in the November of the following year. The progress of the North American Flora required the study and comparison of the many collections which in earlier times had been sent over from America to the European herbaria.

In Glasgow he was the guest of Dr. W. J. Hooker. Among those whom he met in England at this time were George Bentham, Robt. Brown, Balfour, Lindley, Boott, Bauer, Lambert, Greville and a score of others. Upon finishing his work in England he went to the Continent pushing his undertaking with great vigor. In the course of his extended tour he visited Paris, Lyons, Vienna, Munich, Geneva, Halle, Berlin, Hamburg and other cities, and made the acquaintance of such men as Jussieu, Brongniart, Decaisne, Mirbel, Adrien, Gaudichaud, Gay, Delile, Duval, Endlicher, von Martius, Zuccarini, the De Candolles, Ehrenberg, Schlechtendal, Klotzsch, Kunth, Link, Lehmann and many more.

It will be seen that in this, his first visit to Europe, he made the acquaintance of many botanists already eminent, and others who like himself were later to become so. This was one of the most important years in his life. Acquaintances were made which were life-long; correspondences were opened and exchanges of plants and works begun which were alike helpful to all parties. It must be admitted that in America Dr. Gray had no equal, but in Europe there were many who were working on kindred problems and to whom he might turn for scientific companionship. Upon returning home he prosecuted the work on the "Flora" with his accustomed energy and by the spring of 1841 had issued the first 184 pages of Vol. II.

Passing over ten years of hard work in collecting, writing and teaching at Cambridge, we find him in June of 1850 in a sailing vessel for a second time on his way to Europe. His object now was a study of the plants of the Wilkes Exploring Expedition.

After travelling in Switzerland, working for a time in DeCandolle's herbarium at Geneva and visiting von Martius at Munich, he went with Mrs. Gray to the country place of Mr. George Bentham in Hertfordshire and spent two months there, going over in company with Mr. Bentham, the entire collection which had been sent out from America.

He next went to Sir Wm. Hooker's house at Kew, London, to study collections there.

A visit of six weeks to Paris with work in P. Barker Webb's herbarium and at the Jardin des Plantes was followed by nearly four months stay in London with study at the British Museum. Robert Brown was then living. For him Dr. Gray entertained the most profound respect, rating him as he ever after did, as one of the greatest of philosophical botanists.

In 1855 he made his third journey, visiting some of his old friends but remaining from home but six weeks. His fourth trip to England and the Continent was made in 1868. Between the years 1855, the date of the last visit, and 1868 much valuable work had been done. He had issued his "Structural and Morphological Botany" which had no rival in America, and no superior in Europe. It was a model of clearness and conciseness in its methods of treating the general morphology of the plant and especially that of the flower.

The "Manual" had been published and was already recognized as worthy a place by the side of Koch's German Flora. No higher praise could have been given to it. The two Manuals were regarded as models of clearness and brevity in description.

The work, also that on the Flora of North America, had been constantly carried on, besides the publication of various papers on botanical subjects, the most important of which was: "Relation of the Japanese Flora to that of North America." This had been a very remarkable piece of work, requiring close reasoning and comparison, all the more remarkable because the geological and palaeontological work on the fossil flora of the North by Heer had then not been done. The "Principles of Variation in Species" soon to be made known by Charles Darwin's "Origin of Species" was yet unpublished. Both of these works might have given great help toward the solution of the problem in hand. It is safe to say that this last work made him known to every active thinker in Europe.

What wonder is it then, that after the very successful issue of his valuable text-books, after many additions to the North American Flora and the publication of numerous papers including the last one mentioned on geographical distribution, this fourth visit abroad in 1868, should have been one continued ovation? Leaving home in September he spent this and the following autumn at Kew, hard at work. In the interim, visiting Paris, he renewed old acquaintances; worked with von Martius in Munich and with DeCandolle in Geneva, and visited various herbaria all over the Continent before returning to England.

Something of the high regard in which his scientific labors were held at this time may be gathered from the fact that when he sailed for home in 1869 he had been made a member of nearly every Royal Scientific Society in Europe.

He was in Europe twice after this; first in 1880, remaining about a year. He visited Paris, the Herbarium at Madrid, Spain, most of the Italian herbaria and then settled down at Kew for hard work, receiving plants for comparison from many of the German and other continental herbaria. Some time was, however, given to the visiting of old friends.

The last visit to Europe was made in April, 1887, returning in October of same year. A little work was done at Kew, and the Lamarck Herbarium at the Jardin des Plantes was carefully examined. Otherwise the time was devoted to pleasant travel and old friends. Returning in October, he had planned among other work the writing of his Recollections of European Botanists.

Dr. Gray was known both in England and on the continent not alone as a botanist, but as one of the ablest exponents of evolution. In the early times after the publication of the "Origin of Species" he was its most out-spoken defender in America. His articles at this time were often copied by the English journals. He did not accept the theory in its entirety. Many letters of Darwin's attest how fully the latter relied on his judgment and support—Darwin says in one of his letters to Dr. Gray "you never touch the subject without making it clearer," "I look at it as even more extraordinary that you never say a word or use an epithet which does not fully express my meaning," "others who perfectly understand my book, yet sometimes use expressions to which I demur." And again in the same letter he writes "I hope and almost believe that the time will come when you will go further, in believing a much larger amount of modification of species, than you did at first or do now."

When the history of the development theory is written no small part will be given to him whom we commemorate.

More than one continental botanist has had reason to venerate our teacher and leader in botany fully as much as Mr. Darwin. His criticism and kindly advice was freely given when asked and often proved invaluable.

Prof. THOMAS MEEHAN remarked that he desired to dwell somewhat more fully upon a trait of Dr. Gray's character which the previous speakers had touched only incidentally. The whole world of science owed a debt to Dr. Gray for his botanical labors; but he was not sure but the greater debt was due to his unpublished work, namely his kind helpfulness to other workers. Many had been made scientific students, many had even become eminent in usefulness, solely by the early encouragement received from Dr. Gray. If he might be-pardoned for referring to his own history, he would say that few have had better opportunity of knowing Dr. Gray in this respect than he himself. In 1857, at the instance of a friend he was led to open a correspondence with Dr. Gray upon the constant differences between the European and American forms of *Spiraea salicifolia.* Nothing could be kinder than the reply which urged him to continue his observations, saying that former authors had made the American form a distinct species under the name of *S. carpinifolia* and that Dr. Gray might probably adopt this name in the next edition of the Manual. The subsequent appearance of Darwin's "Origin of Species" so changed the hitherto prevailing idea of specific types that it is no wonder that it did not appear in the next edition under a distinct name. But the encouragement given to the obscure young man was not lost. It led to a closer observation of similar phenomena, and the paper on the relative characters of American and European species, which subsequently received the approval of Darwin, Mivart and others, was the result of the encouragement given in that letter. That and many subsequent papers were submitted to Dr. Gray before publication, and not presented without his approval; and it was not till later, after he had caught up with the whole literature of the subject, that he ventured to stand alone without the aid of his early friend and monitor.

Prof. Meehan then spoke of his long and frequent correspondence with Dr. Gray, growing out of his own editorial position. From month to month Dr. Gray would send his criticisms upon his editorial work. These were occasionally sharp and adverse, but always judicious, encouraging and kind, and Mr. Meehan cited many instances illustrative of this.

It was characteristic of Dr. Gray to give the same attention to the poorest and most obscure, as to the most prominent, if only he found them to be earnest searchers for truth. It had been said that he was hard to convince, but this was because he himself had taken so much pains to reach the truth. Nothing but positive evidence would lead him to set aside a conclusion at which he had arrived; but when once such evidence was produced, no one accepted it more readily or gracefully, and hence he was even more merciless in judging of his own work, than that of others. Of this readiness to reverse his own decisions, and do justice to others, Prof. Meehan gave many pleasant instances. Few men could have a warmer heart towards friends than Dr. Gray—but this did not lead him to ignore their faults, nor prevent him from expressing his views of them. Tender, loving and considerate as he always was, he could be caustic and severe when he believed the good of science demanded it. Once a very zealous collector to whom science was under many obligations, described and published a large number of plants, from imperfect material, with undue haste and without competent knowledge. Dr. Gray had to show that really there were very few new species among them, and in so doing his criticism was unusually severe. Mr. Meehan in writing to Dr. Gray ventured to remonstrate with him upon the severity which he had used. The reply was, "In my heart, I would have been more tender than you, but I cannot afford to be. I am, from my position before the world, a critic, and I cannot shrink from the duty which such a position imposes upon me. If you were in the position that I am, with a short life and a long task before you, and just as you thought the way was clear for progress, some one should dump cart loads of rubbish in your path, and you had to take off your coat, roll up your sleeves and spend weeks in digging that rubbish away before you could proceed, I should not suppose you would be a model of amiability."

In giving these recollections Prof. Meehan hoped that he should be pardoned for so much allusion to his own history, but it was because that history bore such full and rich testimony to the critical acumen, the kind judgment, the friendly aid and the warm and loving heart of the man as well as the scientist, whom we this evening commemorate.

Mr. Isaac C. Martindale then spoke of Professor Gray's encouragement to young students, and of his willingness always to aid them in their studies; this he was able to testify from his own experience, having been again and again assisted while engaged with perplexing botanical problems: he also spoke of the genial, kind and social disposition ever displayed, and which made the name of Professor Gray a household word in so many homes. He gave an interesting account of a botanical excursion to the mountains of North Carolina made in 1884 in company with this greatest of American botanists, referring to the readiness with which he recalled the names of all the plants met with during the journey, showing not only his perfect familiarity with the names of the species but also his most remarkable memory.

FEBRUARY 14.

The President, Dr. JOSEPH LEIDY, in the chair.

Twenty-two persons present.

On the resemblance of the primitive foraminifera and of ovarian Ova.—Prof. RYDER remarked that upon cutting sections of nearly mature ovarian ova with their investing membrane, zona radiata, in place, it was found that, in quite a number of cases, fine protoplasmic processes or pseudopods extended from the peripheral layer of protoplasm of the egg, through its capsule or zona and joined the cells of the granulosa or discus proligerus. This arrangement reminded one forcibly of the filamentous pseudopods extended from a Heliozoön or of the slender pseudopods extended through the perforations in the walls of the single chambers of *Globigerina*. This resemblance was all the more suggestive if one will compare a section of one of the chambers of a *Globigerina* made through the calcareous shell and its contained protoplasm with a similar section through the ovum of the Gar Pike, where the zona is formed of pillars of homogenous matter. Such prolongations of pseudopods through the investing zona radiata in the case of many species of animal forms, shows fairly well that this must be the principal means by which new matter is taken up from without and incorporated, as there is no direct extension of the vascular system into the egg, by which it can take up nutriment. It is thus seen that the early stages of the growing ovum, not only resemble some of the lower forms of Helizoa and *Foraminifera* as respects the grade of their morphological differentiation but also as to the mode in which they exhibit their nutritive or physiological activities. This resemblance is still further heightened if a form like *Orbulina* is compared with certain stages of the development of ova. It is thus seen that, in many cases, the ovarian germ, at least, passes through a stage which may be morphologically as well as physiologically compared with some of the lowest grades of the *Protozoa*.

Chaetopterus from Florida:—Prof. LEIDY directed attention to specimens which were collected in the trip of Prof. Heilprin and Mr. Willcox, at the mouth of the Manatee River. The species appears to be the *Chaetopterus pergamentaceus* of Cuvier, originally described from specimens from the West Indies. It is a remarkable form. It belongs to the Tubicolae or tube-living worms, but unlike most of these, is devoid of the numerous cephalic appendages, or tentacles and gills. The tube is membranous and laminated in structure and it has the appearance of parchment. The two tubes collected are 16 inches long by ¾ths of an inch in diameter, and tapering towards the ends. An incomplete worm, not well preserved on account of its delicacy, in its present condition is 9 inches long, and appears very narrow in comparison with the capacity of its tube. The anterior division of the body, about an inch long, is flattened, and about half as wide, but narrowing behind, and is composed of eight podal segments provided with dense bunches of lustrous, golden setae. The succeeding segment, long and narrow, is provided with a pair of wing-like appendages an inch long, and each furnished with two bundles of diverging setae. Then follow five long narrow segments with large membranous appendages, without setae. The terminal segments, of which 15 remain in the specimen, are furnished with pairs of long pointed appendages with bundles of setae.

FEBRUARY 21.

The President, Dr. LEIDY, in the chair.

Twenty-one persons present.

The following papers were presented for publication:—

"Researches upon the general physiology of Nerves and Muscles." By Henry C. Chapman M. D. and A. P. Brubacker M. D.

"Notes on an aquatic insect larva with jointed dorsal appendages." By Adele M. Fielde.

Necessity for Revising the Nomenclature of American Spiders.—Dr. McCOOK remarked that during the summer of 1887, while visiting the Zoological Library of the British Museum of Natural History, he gained information which may revolutionize, or at least compel a radical revision of the nomenclature of American spiders.

His interest in these animals being known by some of the zoologists in the room, his attention was called to a volume of unpublished figures of American spiders then in the library. These drawings were made by Mr. John Abbot, an Englishman settled in Savannah during the latter part of the eighteenth century. The figures were made as early as 1792. At least they bear that date. Mr. Abbot is well known to entomologists by his work upon lepidoptera, published in connection with Mr. Smith.[1] This book proved to be the volumes, long supposed to be lost, of original drawings from which Baron Walckenaer described the numerous species from Georgia which are found in his Natural History of Apterous Insects.[2]

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[1] "The Natural History of the rarer lepidopterous insects of Georgia. Including their systematic characters, the particulars of their several metamorphoses and the plants on which they feed. Collected from the observations of Mr. John Abbot, many years resident in that country, by James Edward Smith M. D. 2 Vol's, fol. London, 1797."

[2] Histoire Naturelle des Insectes. Aptères. Vols. I. and II. Suites a Buffon. 1837.

It was known, of course, from Walckenaer's introduction to his descriptions that he had purchased Abbot's[1] drawings of over five hundred species of spiders and other arachnids; that he also had the manuscript drawings made by Bosc of South Carolina spiders. But Americans seem to have been in ignorance of what had become of these drawings, and the fact that they were in the Zoological Library appears to have escaped the observation of the little circle of British students of araneads; at least the speaker could recall no reference made to them in current literature. It was not until the above incident that an American student was known to have a clew to the whereabouts of the valuable volume which the British Museum is so fortunate as to possess.[2] How the book happened to come into its present place, or in what manner it was procured from Baron Walckenaer or his executors, Dr. McCook was not able to say.

On the day when the discovery was made, he had engagements which prevented him giving more than an hour or two to the study of the figures, and as he was about to leave London, no further opportunity presented for making extended notes. However, he was able at once to recognize a number of species which have long and familiarly been known under the names published by Hentz. He took notes of a number of these species, principally among the orbweavers, a group with which he was at present particularly engaged. He also took the numbers under which the figures are listed by Abbot.

After returning to America Dr. McCook went over Walckenaer's descriptions, comparing them with his own notes, and found that there is no doubt at all as to the identity of these drawings with the original ones from which Walckenaer described his published species. The number of Abbot's figures as they appear in the manuscripts correspond with the numbers cited by Walckenaer in his references to the same. Moreover, Walckenaer's descriptions, viewed in the light of the speaker's recollection of the drawings, together with his own notes and identification on the spot, remove all doubt as to the identity of at least a considerable number of the species.

The importance of this discovery is seen in view of the following facts: Walckenaer published his descriptions of Georgia species in 1837; Professor Hentz, the father of American Araneology, made his publications in the Proceedings and Journal of the Boston Society of Natural History beginning with the year 1841, and continued until 1850. The latter have been gathered together and

[1] Walckenaer erroneously refers to the author as "Thomas" Abbot; his name is "John."

[2] The full title of the book is "Drawings of the Insects of Georgia in America by John Abbot of Savannah. Vol. XIV, 1792." Zoological Library of the British Museum of Natural History, London.

published in book form under the title of "The Spiders of the United States," edited by Edward Burgess and with notes by Mr. Emerton.[1]

Hentz had some previous papers of no very great consequence, and in 1835 he published a simple list of 125 species arranged under the genera to which he supposed that they belonged. This was in the Second Edition of Hitchcock's Report of the Geology of Massachusetts, (1835.) An examination of this list shows that it includes a number of the species which Walckenaer described in 1837 from the drawings of Abbot. So far then as the bare publication of these names is concerned Hentz has a priority of two years.

The question of priority involved is yet more complicated by the fact that the second volume of Walckenaer's work, containing many of the American species and all the orbweavers, bears a date whose integrity is seriously questioned. The title page gives "1837" as the year of publication, the same as that rightly borne by the first volume; but Dr. T. Thorell, who is one of the highest living authorities in Araneology, declares that this volume "did not come out till 1841."[2] This fact, however, does not seriously effect the points in issue, as only a few species of the Mygalidae were published by Hentz in 1841;[3] all the remaining species were published during and subsequent to 1842.

The attitude of American students of spider fauna toward Walckenaer's descriptions alluded to above has been something after the fashion of the famous Scotch verdict "not proven." In other words, in the absence of any types or specimens anywhere existing to which his descriptions might be referred; in the absence of the original drawings from which his descriptions were made, for none (or only one) of them were made from the specimens themselves; and in the absence of any knowledge as to whether those drawings anywhere existed, it was generally conceded, so far as there was any thought or action on the matter at all, that Walckenaer's descriptions must be considered as non-existent. The priority, therefore, of all the descriptions made by Hentz has been heretofore universally allowed, even though some of Walckenaer's descriptions are sufficiently clear to show without the aid of figures that he had in mind the same species covered under different names by Hentz. Dr. McCook believed that on the whole this decision was a righteous one, and that up to this date no claim could have been established in favor of Walckenaer's priority.

However, a question now arises which it is necessary to face and in some way settle. Does not the discovery of the original drawings in the Zoological Library of the British Museum put an entirely

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[1] Boston: Boston Society of Natural History, 1875.

[2] Thorell: "On European Spiders," Nova Acta Reg. Soc. Sci. Upsaliensis; Ser. 3rd, Vol. VII., p. 15, foot note. The text indicates that he knows "with certainty that such date was incorrectly given."

[3] *Mygale truncata*, *solstitialis*, *carolinensis*, *gracilis* and *unicolor*. See Proc. Bost. Soc. Nat. Hist. I, pp. 41–42.

new phase upon the matter? Shall we not be compelled, in view of the fact that there can now be no doubt of the identity of Walckenaer's species, to give the priority to him?

The very few American students of our spider fauna have become so familiar with many of Walckenaer's species under Hentz's names, that it will be difficult to throw those names out of mind. Moreover they have entered into all our literature up to this date, and there will be great confusion in making the corrections. Besides, it must be allowed that Hentz's names are better chosen then Walckenaer's. If Abbot, whose patient, long continued and intelligent labors deserve the real honor, could receive the credit of entitulation, one might, at least on the ground of sentiment, feel more reconciled to seeing the priority pass from Hentz; especially as Baron Walckenaer was often indifferent to the prior rights of fellow naturalists. But the laws of priority must be considered, and honesty and justice can give no room for considerations of convenience and sentiment.

Many of Walckenaer's descriptions may be considered as fairly good, and indeed they have all along been recognized as clearly covering some of Hentz's species. But when those descriptions are placed alongside of Abbot's drawings, from which they were made, all doubt is removed as to the identity. For the most part, Abbot's drawings are tolerably accurate, well finished, are colored after nature, and there was no difficulty at first sight in identifying a large number of our well known species, under the names published by Professor Hentz. It seems unfortunate that such good work should have remained so long unnoticed, and that credit for the same should have been so wholly lost to the author. It is at least some satisfaction to be able to render such justice and honor as this notice may bring, to one who barely escaped the distinction of being the father of American araneology by inability to publish or procure the publication of his faithful labors.

There are thus raised very delicate points as to the law of priority, concerning which Dr. McCook desired to obtain the judgment of his associates:—first, in view of the fact that Walckenaer's species were described not from the spiders themselves, but from the drawings of them made by another hand, can we be permitted to give priority to Hentz, whose descriptions were made from the animals themselves? Second, does the fact that two years previous to Walckenaer's descriptions, Hentz published the names of one hundred and twenty five species, many of which are identical with those of Abbot's drawings and Walckenaer's descriptions, entitle the American author to priority as to these species? Under ordinary circumstances it would perhaps be at once admitted that Hentz could have no claim, but in view of the special circumstances alluded to may there not be some departure from the strict construction of the *lex prioritatis*? The inconvenience of overthrowing Hentz's names would be a peculiar hardship to American araneologists, unless the original or a fac-simile of Abbot's Drawings could be obtained and made accessible on this side of the Atlantic. With the book in the British

Museum, there is no final court, before which to test the integrity of species, available for the bulk of American students. While Walckenaer's descriptions are generally intelligible with the drawings in hand, many are obscure without them. This is equally true of Hentz's descriptions; but then we have his figures to interpret the descriptions sufficiently well to enable us to identify the species.*

Dr. McCook presented a list of a few of the best known species, especially among the orb weavers, of those which were recognized by him as identical with the corresponding numbers in Abbot's drawings, and which, if Walckenaer's claim to priority be conceded, must hereafter be known under the names assigned by that naturalist. A reading of this brief list will give araneologists some idea of the serious labor that must be wrought by them before fixed and satisfactory results can be evolved from the confusion into which our existing nomenclature has been startled by the unexpected reappearance of Abbot's long lost manuscripts.

These species are here given in the following tabulated form. The first column shows the name given by Hentz. The second shows Walckenaer's names. The third column gives the names of the species as they must hereafter be known if Walckenaer's names are to be accepted.

TABLE OF REVISED NOMENCLATURE OF AMERICAN SPIDERS.

HENTZ.	WALCKENAER.	REVISED.
Epeira insularis	*Epeira conspicellata* [1]	*Epeira conspicellata.*
Epeira trivittata	*Epeira arabesca* [2]	*Epeira arabesca.*
"	*Epeira Pegnia* [3]	*Epeira arabesca.*
Epeira domiciliorum	*Epeira benjamina* [4]	*Epeira benjamina.*
Epeira parvula	*Epeira eustala* [5]	*Epeira eustala.*
Epeira thaddeus	*Epeira cepina* [6]	*Epeira thaddeus.*
Epeira verucosa	*Epeira arenata* [7]	*Verucosa arenata.*

*In the discussion which followed the remarks of Dr. McCook the opinion was expressed by Professors Leidy, Lewis and Dall that the earlier names should in all cases be adopted, no matter how much inconvenience might be entailed thereby, if the descriptions were recognizable. Prof. Heilprin held that such cases should be decided so as to cause the least embarrassment to naturalists and therefore the least detriment to Science.

1 Walck. Nat. Hist. Apteres. Vol. II, p. 58. 2 id p. 74. 3 id p. 80. 4 id p. 42.

5 id p. 37. This species, whose remarkable variations have attracted the attention of all who know it, is described by Walckenaer under several names, as it was by Hentz.

6 id p. 38. Walckenaer confounds *thaddeus* with *parvula* of which he makes it a variety. Hentz's name may therefore stand.

7 id p. 133.

Epeira stellata	*Plectana stellata* [8]	*Plectana stellata.*
"	*Epeira nobilis* [9]	
"	*Epeira cerasiae* [9]	
"	*Epeira iris* [10]	
Epeira riparia	*Epeira cophinaria* [11]	*Argiope cophinaria.*
Epeira fasciata	*Epeira argyraspides* [12]	*Argiope argyraspides.*
Epeira cancer	*Plectana ellipsoides* [13]	*Gasteracantha ellipsoides.*
Epeira rugosa	*Plectana gracilis* [14]	*Acrosoma gracilis.*
Epeira spinea	*Plectana sagittata* [15]	*Acrosoma sagittata.*
Epeira mitrata	*Plectana reduviana* [16]	*Acrosoma reduviana.*
Epeira caudata	*Epeira turbinata* [17]	*Cyrtophora turbinata.*
"	*Epeira glomosa* [18]	"
Tetragnatha grallator	*Tetragnatha fulva* [19]	*Tetragnatha fulva.*
Phyllyra riparia	*Uloborus Americanus*[20]	*Uloborus Americanus*

The numbers under which the species described by Walckenaer and listed in Abbot's figures are here given for the convenience of those who wish to refer to the originals. The reference numbers attached to them correspond with the reference numbers in the second column of the table and in the foot notes.

ABBOT'S MANUSCRIPT NUMBERS.—116, 121 [1]; 331, 346 [2]; 375, 389, 484 [3]; 126 [4]; 119, 120 [5]; 117 [6]; 181, 182, 183 [7]; 161 [9]; 166 [9]; 336, 341 [10]; 151 [11]; 156 [12]; 118 [13]; 47, 48 [14]; 50 [15]; 49 [16]; 79, 80 [17]; 77, 78 [18]; 211, 216, 221 [19]; 44 [20].

[8] id II, 171. This is probably the figure to which Hz. refers (Sp. U. S. p. 125) when he cites Bosc as authority for the name. The species which Walck. has named *nobilis*, *iris* and *cerasiae* all seem to me to be *stellata*, and it is odd that Walck. should have put them even into a different genus from *stellata* which is described in his "Tabl. des Araeides" p. 65, fig. 54. If this spider is to be placed in a genus other than *Epeira*, it might retain the now abandoned name of *Plectana*, which is here provisionally revived to receive it. Emerton gives the species to Hentz. ("New Eng. Epeiridae," p. 319).

[9] id p. 119. [10] id p. 120. [11] id p. 109. [12] id p. 110. [13] id p. 155.

[14] id p. 193. [15] id p. 174. [16] id p. 201. [17] id p. 140.

[18] id p. 144. This bears some likeness to my species *Cyrt. bifurca* and may prove to be the same.

[19] id p. 212. Abbott figures a number of Tetragnathas including what appears to be Emerton's *T. caudata* (*T. lacerta Wlk*); but a careful study will be required to determine which are simply variations. Hentz's *grallator* is probably the one here designated. Walckenaer's *Tetragnatha zorilla* (Aptr. II, p. 221 and Pl. 19, 2 B) which is figured from Abbot's mss., belongs to his own genus *Latrodectus* (*Lathrodectus*), and is Hentz's *Theridion verecundum* and *lineatum*. It is also the *Latrodectus formidabilis* and *L. variolus* of Walk. (Apt. Vol. I. p. 647, 648.). The name of this interesting spider will now be *Lathrodectus formidabilis* WALCK.

[20] id p. 212.

Cirolana feasting on the Edible Crab.—Prof. LEIDY stated that on last Saturday, having occasion to go to Beach Haven, N. J. during a leisure half hour stroll along shore, he noticed, here and there a dead crab, *Callinectes hastatus*, lying on the sand, near the last high tide mark. The crabs observed happened to be all females and they appeared to have died recently as some were quite fresh and showed no signs of decomposition. Others, broken open by removing the carapace, were found to have the body cavity swarming with a living isopod, the *Cirolana concharum*, which had preyed upon the organs and were variously colored by the food with which they were gorged. From a single crab there were taken 108 of the Cirolana ranging from 15 to 22 mm. in length by 5 to 7 mm. in breadth.

The isopod is grayish translucent above and whitish translucent beneath, and centrally variously colored, brown, black, red or yellow, from the food contents. The dorsal plates are minutely dotted, black or brown, in bands. The eyes are triangular with rounded angles, and black. The antennae are nearly double the length of the antennules. The mandibles are furnished with a strong, brown, tricuspid molar. The caudal plate or telson is triangular with a blunt, slightly emarginate apex and with a pair of spines each side of the latter. The isopod has been observed by Stimpson at Charleston, S. C. and by Harger at Vineyard Sound, Mass., but has not previously been reported from the coast of New Jersey. Three isolated specimens of the same were picked up on the shore of Beach Haven, the last summer.

On Bopyrus palaemoneticola.—Prof. Leidy also presented numerous specimens of the prawn, *Palaemonetes vulgaris*, infested with the parasite, *Bopyrus palaemoneticola*, obtained at Beach Haven, N. J. From about two quarts of the prawn, caught for fish-bait, upwards of fifty contained the Bopyrus.

FEBRUARY 28.

The President, Dr. LEIDY, in the chair.

Twenty-five persons present.

The death of James S. Mason, a member, was announced.

Note on Lepas fascicularis.—Prof. LEIDY remarked that while stopping at Beach Haven, N. J., the last summer he had observed that from time to time the debris thrown on shore would differ according to the direction of the wind. On one occasion a strong wind from the north east up a considerable quantity of material consisting of fragments of wood, grass, fucus, etc., to most of which was attached a profusion of goose-barnacles, *Lepas fascicularis*. Among the materials observed were apples and cranberries, which also had bundles of barnacles attached, and as the fruit was not decomposed, it apparently indicated a rapid development and growth of the animal. Portions of apples were exhibited with dense hemispherical groups of attached barnacles an inch and a half in diameter with the barnacles from 2 to 3 lines long, and several cranberries with bunches in which the barnacles are from 2 to 6 lines long.

Reputed Tape-worm in a Cucumber.—Prof. LEIDY stated that several years ago, his colleague in the University, Prof. Wm. Goodell, submitted to his examination a tape-worm, which he received from a correspondent, with the label "From the middle of a cucumber preserved in brine. S. E. Robinson, West Union, Iowa, May 29, 1876." The specimen appears to be complete and in its present condition, preserved in alcohol, is about eight inches long. The head is large, spheroid, provided with four, small, equi-distant hemispherical bothria, and surmounted by a prominent crown with a double circle of strong hooks. The neck is a slight constriction whence the body rapidly widens and again tapers behind. The anterior segments are transversely linear with a gradually increasing length and more acute and prominent lateral ends; the middle segments are about twice the breadth of the length and slightly companulate; and the posterior segments are proportionately longer and narrower. In the latter, the uterus is distended with eggs only at their anterior portion.

The hooks are partially lost on one side of the crown; and it is estimated that there were about 40 or more.

The head is ·875 mm. broad; the crown of hooks ·625 mm.; the neck ·8 mm.; at the middle of the body six segments together are 1 cm. long and 3·5 mm. wide; the terminal segments are about 4 mm. long and 2·5 mm. wide. The eggs measure from ·032 to ·036 mm.

While it cannot be admitted that the worm belonged to the cucumber, nor is it clear how it reached this position, it is a question as to the species. It bears a near resemblance to the *Taenia crassicollis* of the Cat, but is not more than half the size of this as it ordinarily occurs.

In comparison with a complete specimen of the latter, six inches in length in the contracted condition as preserved in alcohol, we find the following measurements.

	T. of the cucumber	*T. crassicollis.*
Breadth of head - - - -	·875 mm.	1·875 mm.
Breadth of crown of hooks -	·625 "	1· "
Breadth of neck - - - -	·8 "	1·25 "
Breadth of middle segments -	3·5 "	6 to 8 "
Length of middle segments -	1·66 "	1· "
Breadth of terminal segments -	2·5 "	3·5 "
Length of terminal segments -	4· "	5· "

Diamonds in Meteorites.—Professor CARVILL LEWIS exhibited a small fragment of a meteorite which had fallen in the district of Krasnoslobodsk, Government of Penza, Siberia, on September 4, 1886, and which he had obtained through the kindness of Mr. George F. Kunz. The specimen was of especial interest on account of the report (see *Nature*. Dec. 1, 1887. xxxvii, p. 110) that Professor Latchinof and Jerofief had detected in the insoluble residue small corpuscles having all the characters of diamonds.

The speaker had extracted from the fragment in his possession two small oval bodies with extremely high index of refraction and showing only slight traces of polarization, such as is common to many diamonds. They were colorless and transparent, resembling certain specimens of Brazilian "bort." Having been able to distinctly scratch a polished sapphire with portions of the meteorite, he was disposed to agree with Professor Latchinoff and Jerofief that these bodies were true diamonds. The olivine in this meteorite was also in the form of oval grains and had a deep yellow color and bright polarization. The rounded form of the olivine and the diamonds may have been due to corrosion of the igneous mass. This rounded form is very commonly shown by the olivines in basic eruptive rocks.

While diamonds have never before been found in meteorites, carbon has long been known in them in its graphitic or amorphous form. Recently Fletcher[1] has described under the name of Cliftonite a cubical form of carbon, somewhat harder than ordinary graphite, which he found in an Australian meteorite.

The important bearing of the present discovery upon the vexed question of the diamond is evident. The speaker had recently endeavored to show that the commonly received notion that itacolumite was the original matrix of the diamond is a mistake, and that diamonds really occur in, or in the neighborhood of, basic eruptive rocks.[2] The facts regarding the associations of the diamond in Africa, Borneo, New South Wales, California and elsewhere all point to peridotites or allied rocks as the matrix of the diamond. The similarity, both in structure and composition, of the diamond-bearing Kimberlite of South Africa to meteorites had been pointed out by the speaker previously, and he had, in view of this fact, suggested the search for diamonds in meteorites.

Ctenophores in Fresh Water:—Dr. BENJAMIN SHARP reported that he had observed in a fresh water pond at Sachecha, Nantucket, a great number of Ctenophores, in apparently good condition. This pond is occasionally opened to the sea to allow the escape of the perch that breed there is great numbers. The *Ctenophores* without doubt found their way into the pond at such time. As far as he could determine they were the common *Mnemiopsis Leidyi*, unchanged by their strange environment. They not only appeared perfectly healthy and active but were highly phosphorescent at night. He was not

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[1] Jour. Mineralog. Soc. vii, p. 121, 1887.

[2] Proc. Brit. Assoc. Adv. Science. Manchester, 1887. (See Geolog. Magazine, March. 1888.)

able to say whether they bred there or not, and until this is proven it is not possible to say that they have become perfectly adapted to the new condition of life. Many observers have noticed that Coelenterata move up rivers, but this is an interesting case, as the transition from the salt to the fresh water must have been very sudden. At the time of observation Dr. Sharp said that on drinking the water he could not notice the slightest trace of salt.

Messrs Henry A. Pilsbry and S. G. Morton Montgomery were elected members.

The following papers were ordered to be printed:—

THE DISTRIBUTION OF THE COLOR-MARKS OF THE MAMMALIA.[1]

BY HARRISON ALLEN, M. D.

The variations in the colors of the hair and the skin are of a character and importance which warrant a systematic study. I have ventured to formulate my impressions on this subject, and while departing in some degree from the directions of approach which zoologists have developed, I have not I trust, stated the case without due regard to the views of others on this perplexing phase of observation.

My main object has been to contemplate color marks as the result of nutritive processes controlled by recognized biological forces both in health and disease. I will not hesitate to treat of a perverted growth in the human subject as comparable to a normal growth in any member of the mammalian series.

Statements will be made respecting the distribution of colors of hair, (the superficial color, or rather the effect of the main color of the hair upon the eye being here intended) of the colors of pigment marks on the skin, of localized hypertrophies and atrophies, of vibrissæ, of pilose and naked warts, as though they were co-ordinates of equal value.

I have examined the museums at Philadelphia, New York, New-Haven and Washington. I have consulted the illustrations of works on Natural History and have made extended observations on the domesticated animals especially of dogs, horses, cattle, guinea-pigs and rabbits.

The conclusions drawn at this time have stood the test of repeated re-examinations and while they are not all susceptible of being held as rigid deductions from the premises, they present, I think, a group of tenets which may prove of interest to working zoologists.

The subject of distribution of the hair in the human subject has received attention from D. F. Eschricht[2] and C. A. Voigt.[3]

Both writers have taken the new-born child as a standard and have described the directions of the hair in two ways: first as it is

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[1] This paper is an elaboration of a portion of an essay which constituted the presidential address at the annual meeting of the American Society of Naturalists, December, 1887.

[2] Müller's Archiv. 1837, Vol. IV, 37.

[3] Denkschr. Wein. Akad. d. Wissenschaft. 1857, Vol. XII, III Abth. p. 1.

observed radiating from certain points, and second as it is seen to converge to certain points.

The following are the main points of radiation. The parietal bone, a short distance to the right of the obeleon, and the axilla. The parietal centres may be symmetrical.

The following are the main points of convergence. The head at the obeleon and directly above the auricle; the face at the inner end of the eyebrow, and at the root of the nose; the neck over the centre of the hyoid bone; the sternum at its upper third; the abdomen at the summit of the bladder; the under surface of the penis at the base; the nape of the neck on each side of the vertebral column; the trunk over the lower part of the coccyx; the side of the trunk; the arm at the insertion of the deltoid muscle; the elbow at the olecranon; the wrist at the head of the ulna; the ilium over the anterior superior process; the thigh at the lower end of the femoral artery; and the ham at the inner border.

It will be found in the course of the ensuing statements that the points of convergences are often found associated with the regions of markings which contrast with the ground-color. Thus the obeleon is the site of brown or black spots in the dog; in the same animal the tan-colored wart is found in black and tan dogs; the centre of the hyoid bone is also the centre of the gular white or gorget in many carnivorous and quadrumanous animals; the sternal point is often white in the horse and dog; the lower end of the back at the sacrum and coccyx is black or brown in ordinarily parti-colored dogs; the insertion of the deltoid is the lower end of the epaulette-region which is frequently of a contrasted color to that of the rest of the limb; the spot over the head of the ulna is in the line of the fringe of the fore-leg in the setter-dog and in some lemurs. The nape of the neck, the root of the nose, the summit of the bladder, the base of the penis, the olecranon, the anterior prominence of the ilium, the femoral point and the inner border of the ham are not found associated with color-marks. These cannot in turn be entirely separated according to Eschricht from being in the line of union of parts which unite late in the development of the foetus. A complicated disposition at the upper lip is held by the same writer to result from the union of the right and left halves at the median line. Some points, as for example the olecranon and the iliac process, answer to bony surfaces which are near the skin. The femoral point is also the region at which the long saphenous nerve pierces the fascia. The point on the side of the trunk is associated with the naked trunk surfaces of birds, and the colored area in *Indris brevicaudatus*. (See *infra*.)

In men who are notably hairy (the cases of universal hypertrichosis are not here included) the hair is chiefly developed on the breast and the anterior wall of the abdomen at its upper part,—on the region over the trapezius muscle near the scapula—and on the lower part of the loin and the shoulder. In a number of examinations I have made of hirsute men, I have never found the teeth defective unless a disposition to universal hypertrichosis was present. This disposition is shown (in addition to the dental defect) by great shagginess and looseness of contour of the eye-brows. They meet across the inter-orbital space and straggle off toward the temporal side of the forehead. The best marked of the naked places of the body in the hirsute men are the forehead, and the side of the trunk. Eschricht mentions having found but a single example of the trunk being naked at the side. His observations appear to have been made in Copenhagen and may perhaps exhibit a national peculiarity. In America I am sure such naked places are frequently seen. I can confirm Eshricht's statement that hirsute individuals usually have black hair, are of stalwart build and do not of necessity have strong beards or more than ordinary growths from the head.

An instructive analogy can be detected to exist between the naked surfaces on the sides of the trunk and the great lateral featherless spaces (apterylia) of most birds. Above I have invited attention to the fact that in *Indris brevicaudatus*[1] the side of the trunk possesses hair of a different color from that covering the ventre or the dorsum.

The literature of the subject of color-marks is scanty. The papers here given in abstract are of importance.

Th. Eimer[2] believes the striped forms of the mammalia antedated the spotted, and the retention of color obey phylogenetic laws. He traces the markings of *Viverra* through the varieties of the genus *Canis*. Faint traces of the transverse marks of *Hyena* can be detected in the wolf. The black spot at the root of the tail is mentioned as occurring in all dogs. The presence of a dorsal stripe is mentioned as being commonly present. In vertebrates generally the posterior parts of the body is more strongly marked than the anterior. This is evident in mammals though less marked than in the lower classes.

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[1] American Museum of Natural History at New York, No. 260.

[2] Zool. Anzeiger 1882, V. 685; 1883, 690.

The transverse body stripes are the highest form of development of a body-mark, and succeeds in phylogeny the series of dotted-marks. This order is the reverse of that suggested by Darwin. A paper by G. T. Rope[1] describes two varieties of coloring in the English form of the domestic cat viz: transverse stripes or rows of dots on a white ground and white markings of a more or less longitudinal direction on a black ground.

The following list includes the arrangement of the subject-matter of the present essay.

1. The "break" from the prevailing or ground color compared with the positions at which hair is retained in nearly hairless animals.
2. Brindles.
3. The regions in which color-marks are found regularly disposed. These are: the dorsal line of the trunk; the back of the neck; the the dorsi-facial line; the ventre and limbs; the ulnar border of the foreleg; the axilla and pudenda; the "collar;" the regions of the special senses; the sides of the body; the regions of nerve-endings; muscle-regions; regions which are rich in seba and moisture.
4. The effects of age.
5. Bilaterality.
6. Antero-posterior symmetry.

1. The "Break" from the ground Color, or prevalent Color, compared with the Positions at which Hair is retained in nearless hairless Animals.—When an animal of a single color changes (even in a slight degree) the uniformity of the tint, the new color will appear in an order definite enough for the variety, species, and sometimes for the family to which the animal belongs. A black, gray or chestnut colored dog when thus changing almost invariably has a white spot appear at one of the following localities: The tip of the tail,[2] the breast, the dorsal surfaces of the feet, and the tips of the ears. I have observed these changes in the New Foundland dog, the greyhound, the Irish setter and the collie. In the sunbear (*Ursus malayanus*) the prevailing black is relieved by a crescentic whitish-yellow spot on the breast. *Sarcophilus* when varying from its prevalent color exhibits a spot of white in the same region. Horses having white feet and a white

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[1] Zoologist, 1881, 353.

[2] According to Gervais the first white appears at the tip of the tail. G. T. Rope (Zoologist, 1881, 353) states that where only a very minute portion of white occurs, it is most likely to be found on the chest.

star on the breast while the remainder of the bodies are dark are objects of common observation. It cannot be an accidental circumstance that animals that are nearly hairless retain sparse clumps in the same localities. *Rhinoceros lasiotis* is hairless except at the tip of the tail, the dorsal surfaces of the feet and the tips of the ears. *Rhinoceros indicus* shows the same peculiarities to a less marked extent. In *Elephas* the tip of tail is similarly furnished. In the Mexican variety of the so-called hairless dog the same regions named in *Rhinoceros* are alone hairy. In another variety the breast is furnished with an abundant growth of hair. Men, who are more than usually hairy, yet who do not belong to the group of universal hypertrichosis, possess hair on the pectoral region, and are apt to have a sparse growth of hair at the upper margin of the auricle and a similar but separate line of hair along the posterior border, as well as a patch on the loin or near the coccyx in the median line of the trunk.

It may be said that the regions named tend to behave differently from the prevailing disposition in hair-nutrition. In breaking from a uniform color these regions present a contrasted color, and the same regions tend to retain hair which elsewhere for the most part is lost.

But it must be acknowledged that in animals which are for the most part hairless, clumps are seen which do not belong to the above category. These are discussed under other heads. See hair at junction of limbs to trunk, (p. 94) hairs on dorsal line (p. 89) hair at nerve ends. (p. 98)

2. Brindles.—In some animals the break from the prevalent color assumes another disposition of a widely spread character. I allude to the plan by which the entire pelt is covered by alternations of black with brown or chestnut: these embrace the "brindles." The wolf (*Canis lupus*) is often a brindle. Many varieties of dogs *e. g.* some of the mastiffs and bull dogs are brindles. It is often seen in the female of the domestic cat. The prevalent color remaining black the break is seen in dogs to take place to "tan" and to be localized to the feet to the supra-orbital hair clumps and to the hairy wart on the side of the face. The prevalent color being white, black spots are apt to have "tan" margins as is well seen in the fox terrier.

3. The regions in which Color-Marks are found regularly disposed.—I will now treat of the manner in which the color of a hue which is contrasted to the prevalent color is apt to occur along definite lines or regions of the body.

The Dorsal line of the Trunk. The line of the dorsal spines of the vertebral column (including the head as far as the parietal foramina,[1]) is one of the most instructive of these. The black line in the ass and the horse has especially received the attention of Darwin. Prof. Jno. Ryder[3] detected a dorsal arrangement of hairs in an embryo of the domesticated cat. It retains the same color in many carnivores. In the domestic cat two pairs of black stripes are often found on either side. In domesticated cattle these are supplanted by a white line. In piebald rats the stripe is commonly black.

Lemur collaris,[4] has a prevalent squirrel gray color, while the head is black and a black spot is seen at the root of the tail on the dorsal surface. In *Propithecus diadema*,[5] a conspicuous dorsal line is continuous with a black sacral region and tail. In *Lemur varius*[6] the same character of dorsal line is seen as in the foregoing animal but is not so marked. In the parti-colored *Indris brevicaudatus*[7] the region of the back of the sacrum is distinguished from the rest of the fur by being a uniform dull ochreous hue—a hue unlike that met with in any other region of the body. In *Propithecus verreauxi coquerelii*[8] the dorsum near the lower part of the thorax is marked by a dark spot, which is in contrast to the surrounding color. The sacrum and loin are of a dirty gray color. In animals which exhibit spots on the line which are in contrast to the prevalent color the retained colors may be looked upon as persistencies which for some reason have resisted the forces which have displaced the line itself. Such a view is in harmony with Darwin's statement[9] that dappled and spotted animals were originally striped. One of the numerous forms of *Lemur varius* exhibits a white circle at the base of the tail the prevalent color being light brown. This does not of necessity correlate with the dark sacral spot. But distinctive kinds of marking at the root of the tail in the dog are of the same signifi-

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[1] These are persistent in the human cranium near the sagittal suture a short distance in advance of the lamdoidal suture.

[2] Animals under Domestication pov.

[3] Proc. of Acad. of Nat. Sci. 1887, 56.

[4] American Museum of Natural History at New York.

[5] Ibid. No. 263.

[6] Ibid. No. 266.

[7] Ibid. No. 260.

[8] Ibid. No. 973.

[9] Animals under domestication I. p. 65.(Eng. Ed.)

cance as the sacral spot. In *Didelphys* a dark pigment ring encircles the base of the tail. In roan horses a white ring is occasionally found which also encircles the base of the tail.

In *Thylacinus*, *Felis manul*,[1] *Hyena striata*, *Myrmecobius*, and in some of the viverrine genera, the line is interrupted and a number of saddle marks are seen which are best marked posteriorly. In the dog when the black and tan colors are bred out, as in the English setter, the bull terrier and the fox terrier, the dorsal line is retained only at the sacrum and at the root of the tail. It often forms an irregular mark which may extend upon the flanks. In the "Chester reds," a variety of hog bred in Eastern Pennsylvania, black is persistently bred out, yet a small black spot is commonly found at the sacrum. In *Phoca fasciata* a broad white band crosses the trunk at the sacral region.

In *Cercopithecus diana*, the greater part of the dorsal region and all the sacral region are of a red color which extends downward upon the outer surface of the flank.

This disposition is seen in a number of the quadrumana. It appears to be repeated in many dogs (as already mentioned) in which a flank mark is continuous with the sacral spot. The mark may be homologous with the sacral saddle mark of *Thylacinus* and *Felis tigris*.

In a colony of piebald rats observed at the Zoological Garden, Philadelphia, the sacral region was black while the prevalent hue was white.

I will now attempt to explain the persistence of color marks at the region of the sacrum and the root of the tail, though the varieties of the colors themselves are not at present susceptible of demonstration.

In the range of human observation, L. Tait[2] records the frequent possession—nearly 45 per cent—of a pit, or "sacral dimple," over the sacral region in women.

A. Ecker[3] describes the frequent appearance of pits or depressions in the region of the coccyx, in the foetus and in new-born infants. The spot is associated with various pilose conditions. Max Bartels[4] describes a tail-like formation in man from the lower part of the same region. Virchow[5] finds the pilose spots co-ordinated with

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[1] A. Milne Edwards, Recherches sur les Mammiferes, Paris, 1868 to 1874. Pl. 31.

[2] Nature, 1878 XVIII, 481.

[3] Archiv. f. Anthropologie. 1880, XII, 129.

[4] Ibid, 1881, XIII, 1.

[5] Zeitschr f. Ethnologie 1875, VII 280.

occasional deformity of the sacral spinal processes and he arrives at the conclusion that the sacral pilosity is often connected with attempts at formation of spina bifida. Both Tait and Ecker connect the presence of the sacral depression with the formation of an exserted tail. I make the suggestion that the retention of white, black, tan or lemon colored patches at the sacral and lumbar region is an evidence in tailed quadrupeds of the great activity of nutritive processes between the superficies and deep-seated parts. It is but a step further, and a legitimate step I think, to connect the sacral pigment patches with the subject of sacral tumors which has been so ably elucidated by R. Middeldorpf.[1] This writer traces the congenital sacral tumors to retention-cysts of the neuro-enteric canal of the embryo, as defined by Kowalensky. The canal is the same as the post-anal gut of Balfour. It has been identified in Ascidians, *Amphioxus*, and in plagiostome and teleostean fishes. Should the retention of the pigment patch at the superficies of the region where such profound changes are seen to occur be proved to be associated with minor degrees of interference at the same region, it follows that in the individuals thus marked, minor changes in the sacral elements, and possibly in the condition of the lumbar swelling of the spinal cord, might be sought for.

The Back of the Neck.—The region of the back of the neck including the withers is well known to be often furnished with a mane of long or short hair. It is of interest to note that in a case of *trichosis circumscripta* recorded by Virchow[2] a distinct pilose growth lay over the region of the third and fourth cervical vertebræ.

As already remarked p. 88 the breast may be hairy in an animal which in other respects is nearly naked. It remains to mention the gnu in which form a pendant growth of hair from the same region is found associated with an animal having short hair—and a long tail furnished with a terminal brush.

The dorsi-facial Line.—The region of the head as far as that of the parietal foraminal belongs to the trunk while that in front is distinctive. A white median stripe is commonly found in the region last named in parti-colored dogs. In some varieties a spot of the prevalent color lies directly at the beginning of the trunkal region near the occiput which interrupts the dorsal white line, in the rare instances of its backward prolongation or may be enclosed by it. *Mephitis* may exhibit a white spot on the dorsum of the face especially

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[1] Virchow's Archiv 1885, 101, 37.

[2] Zeitsch f. Ethnologie VII, 279.

in the young. Horses commonly show a white mark, the "star," in the middle of the forehead between the eyes. In *Cercopithecus* a median white spot is often seen on the dorsum of the nose.

The Ventre and Limbs.—The hair of the under part of the trunk is in all animals less thick than that of the upper and is apt to be of a lighter shade of color. The color of the ventre is continuous with the inner sides of the limbs, and with the throat where it is apt to pass in Quadrumana to the crown. The account of the color-marks of the limbs cannot be disassociated from that of the trunk. The hair of the outer surfaces of the limbs extends to the sides and dorsum of the trunk and neck, while the inner surfaces extend to the ventre. "Stockings," by which term is meant patches of white color which pass entirely round the manus or pes above the palm or sole, are exceptions to the rule.

The feet of an animal are liable to be of the same color and this color to be black or a break from this color to a contrasted one (see p. 88). In the horse this is notably the case—a bay horse has black feet or exhibits a break from the black color to white. Both fore and hind feet of the Thibetan bear, *Ailuropus melanoleucus*, are black, the rest of the animal being white, with faint shades of brown. The fore foot in mammals is apt to a greater degree than is the case with the hind foot to retain the same color for the arm and the region of the scapula. This is remarkably well seen in *Ailuropus*, in which form the entire fore limb including the shoulder is black, while the hind limb and region of pelvis (excepting the foot) is white. The region of the scapula in many animals is distinctively patterned as is seen in the tiger (*Felis tigris*) and the leopard (*Felis pardus*). In the dog the prevalent color of the neck and the trunk is rarely continuous over the region of the scapula, which is usually of the contrasted color. The spots on the side of the trunk in white dogs appear to be arrested by the region of the scapula. A post-scapular spot of an opposed color is commonly seen in dogs.

P. Michelson[1] describes cases of *trichosis circumscripta* in which clumps were found above and below the region of the scapula but not upon it. I have often found similar clumps in hirsute men. In the horse and its allies the stripes when sparsely distributed are confined to the region of the scapula or lie in front of it. The region of the scapula is apt to be white in *Pecora*. The region of the shoulder, *i. e.* the region of the humero-scapular joint, is separately

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[1] Virchow's Archiv. 1883, Vol. C. 66.

marked in a number of diverse forms. In many bats a tuft of white color distinguishes this region. In the llama, camel and bison shaggy tufts of hair adorn it. *Cynocephalus hamadryas* exhibits on both shoulders conspicuous growths of hair which extend backward. In a specimen of *Colubus guerza*[1] the shoulder was found furnished with an epaulet of long white hair. In other examples of this species the epaulet extends backwards. B. Ornstein[2] describes an instance of *trichosis circumscripta*, in an adult man in which a clump of hair was found on both shoulders.

In Quadrumana the colors of the limbs are apt to be differently disposed from the arrangement in quadrupeds. In *Lemur catta* the colors are much like those in lower animals and in all varieties white stockings may be seen in the fore arm and leg. The inside of the limb is apt to be of a lighter color than the outer.

With this qualification I think I may say that the outer surface and anterior surface of the thigh to a point answering to the proximal third or fourth of the tibia is differently colored in Quadrumana from the leg and the foot. This is noticeable in *Indris brevicaudatus*[3] and *Propithecus verreauxi-coquereli*.[4]

The manus is commonly black in Quadrumana. In *Indris brevicaudatus*[5] the outer side of the arm is black, while the entire fore-arm is white.

In the figures of Audebert[6] the separate color marks of the limbs often correspond to the regions of manus, fore-arm, arm, pes, leg and thigh especially for the outer surfaces. From the well known artistic abilities of Audebert these figures may be accepted as authoritative.[7]

The ulnar Border of the Foreleg.—The ulnar border of the fore-leg often displays hypernutritive characters. The disposition is not confined to the mammalia. In this class the growth is most likely a survival of the natatorial form of foot and is at best an adaptative

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1 Am. Mus. No. 298.

2 Arch. f. Anthropologie 1886, 507.

3 Am. Mus. No. 260.

4 Ibid. No. 973.

5 Ibid. No 260.

6 L'Histoire Naturelle des Singes, des Makis, et des Galéopithéques, 1800.

7 C. F. Maynard (Quarterly Journ. Boston Zool. Soc., 1883, II, 18) states that in the variety of bear (*Ursus Americanus*) met with in Florida "brownish lines" are seen "starting from the point of each shoulder and extending down the legs on the inside." This disposition is certainly exceptional.

effort to extend a fold of skin from the sides of the limb. A skin-fold is demonstratable in *Menopoma* (where it is supplied by a branch of a nerve) as well as in *Emys* and its allies. It is the beginning of the hair-covered membrane in the flying squirrel (*Sciuropterus*) and in *Belideus*; it is enormously displayed in the bat.

The long fringe on the ulnar border of the fore-arm in the setter dog may be named as an example of its occurrence in a terrestrial mammal.

The fold corresponding to it is not so evident in the hind leg—where it would naturally be sought for on the inner border. The line of feathers seen in some varieties of the pigeon and of the domestic fowl on the outer border of the leg may be associated with a similar proclivity to that above named.

In a case of *trichosis circumscripta* recorded by B. Ornstein[1] in an adult male a growth of hairs was found on the ulnar border of the fore-arm of both sides.

In some species of Quadrumana the hair of the arm and the fore-arm inclines toward the elbow. Wallace[2] and Darwin[3] describe this arrangement in connection with the use made of it by the animal in shedding the water falling upon the flexed limb. That the hair in *Hylobates agilis* should be directed toward the wrist is evidently an aberrant arrangement if we are to follow the distribution of the lanugo as outlined by Eschricht and Voigt.

A marked instance of growth of the hair from ulnar border of the fore-arm and the corresponding border of the arm is met with in *Propithecus verreauxii-coquerelii*.[4] A long brilliant fringe of orange and white colors equals in width the arm at its greatest diameter.

The Axilla and Pudenda.—The presence of hair in the axilla and pudenda in man is not without interest in connection with the pilose regions of the newly born infant. It will be noticed that both Eschricht and Voigt separated the pudenda and the entire perineum from the rest of the body.

In *Lemur varius*[5] the prevalent color being a light brown the perineum is black. The axilla is often of the same color as the inside of the entire fore-leg in *Indris brevicaudatus*.[6]

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[1] Arch. f. Anthropologie, 1866, 507.

[2] On Natural Selection, 344.

[3] On Descent of Man. Am. Ed. I. 185.

[4] Am. Mus. No. 973.

[5] Ibid. No. 268.

[6] Ibid. No. 260.

It would appear that retention of hair at both junction of the fore and hind leg with the body is in someway connected with secretion and with retention of heat at these localities. (See p. 94.) The black stripe which is well defined in many examples of *Lemur varius* may extend as far as the patella or a little distal of that bone. In the case of the child exhibiting circumscribed trichosis reported by H. Ranke[1] a large pilose patch occurred at the front ot the patella and the upper part of the leg to its distal side. Two small patches were found in line with the front of the thigh.

The position of the pilose marks above mentioned can be consistently placed in the same category as the thigh marks in the lemurs.

The Collar.—The region of the head is distinguished in some of the more specialized mammals by a transverse band extending from the vertex down over or near the auricle (commonly in front of this appendage) and is variously dispersed on the neck. It is an interesting region since it affords some of the most striking superficial color-marks of the Quadrumana and is the probable precursor of the hair of the crown of the head and of the beard in man.

In the figures of Eschricht's and Voigt's papers on the lanugo already quoted, the outlines of the region of the color are clearly determined.

In many species of Quadrumana the region of the vertex of the head to near the occiput, the auricle, the region below the auricle and the throat and submaxillary regions are white. This disposition is conspicuous in *Hylobates lar.*[2] In *Colobus guereza*, the prevalent color being black, a white color is disposed as above and extends down the neck to the clavicle. In *Colobus vellerosus* the collar is white and includes the gular region. In *Cercopithecus diana*, the white collar is interrupted by black at the side; the chin is furnished with a white goatee. The prevalent color is a squirrel gray. In *Cebus hypoleucus* the collar is continuous down the neck and is continuous with the white scapular region and with the outside of the arm to a little below the elbow. The prevalent color is black.

In *Lemur varius*[3] the ears, retromaxillary region and the neck uniting the head lines, are white. In *Lemur albifrons*[4] a white band extends from the white crown over the head and thence to the neck.

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[1] Archiv. f. Anthropologie, 1883, 339, XIV.

[2] American Museum of Natural History, No. 953.

[3] Ibid. No. 266

[4] Ibid. No. 275.

In *Lemur catta*[1] the prevalent color being squirrel gray, the white color between the eyes unites with the color round the eyes and thence passes to the front of the neck. In another individual of the same species (No. 268) the crown remains black, while the rest of the collar is white. In *Phoca fasciata* a white band encircles the head and neck at the region of the auricle.

It will be seen from these examples that the color of the vertex which may be defined as the crown of the head, excepting the margin near the occiput, is often white; that this color tends to pass down over the region of the ear to the neck, where it may unite with the white of the ventre and embrace more or less of the arm. With the exception of *Phoca fasciata* I have not met with this color mark outside of the Quadrumana. Within the group last named the band appears to be homologous with the hair of the crown and the whiskers of the human subject. In the Saki the color is black in this region and inclines forward to the submandibular growth or the beard proper.

The abruptness of termination of the white patch on the crown as it approaches the occiput, appears to relate to the limitation of baldness of the human subject, and explains the common retention of hair at the line of the occiput. The occiput is under the control of the causes which maintain the body color as distinct from that of the rest of the head.

The Regions of the Special Senses—In addition to the dorsi-facial stripe in the carnivores and the "collar," the mammalian head displays a very noteworthy feature in the retention of a contrasting color to the prevalent one of the body, about the nostrils, the eyelids and the auricles. Such a style of coloration is typically represented in *Ailuropus melanoleucus*, in which form the body color is a dull white. According to Darwin[2] the Himalayan rabbit at birth is white, but in the course of a few months it gradually assumes dark eyes, nose, feet and tail. The circumpalpebral black is found in many animals when the ear is imperfectly pigmented, as in *Didelphys* and *Solenodon*. In *Nycticebus javanicus* the circle is brown. In *Nyctipithecus* and *Loris* the two circumpalpèbral circles unite in a median dorsal line. In *Nasua* the circle is white. In *Cercopithecus aethiops*, *C. collaris* and *C. fuliginosus* the eye-lids are white. In many dogs which are otherwise black or black and tan—a conspicuous black

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1 Am. Mus. Nat. Hist. 270.

2 Animals under Domestication I, 109.

patch surrounds one eye and includes one or both ears. Such are fox terriers, bull terriers and bull dogs. The two patches of circumpalpebral black may interrupt the dorsi-facial white stripe as is seen occasionally in the beagle.

Both the eyelids and the auricle may be included in the same patch of black as is seen in many dogs especially in pointers. The same is noticed in the Japanese dog. This disposition leads the observer to note that the same black patch may extend still farther backward and be found on the sides of the body. A typical example of such an arrangement is seen in *Myrmecophaga jubata*. In *Myrmecobius* the circle extends backward in a stripe. I have seen a similar stripe in the Scotch collie. In *Procyon* the patch is for the most part infra-orbital and extends backward to include the ear. In one of the many varieties of *Mephitis* the ear and auricle are included in a line of black, while the rest of the head is furnished with white longitudinal stripes; more commonly, however, the entire head is black except a jugal stripe which is white and extends down on the sides of the trunk but inclining toward the dorsum as in *Myrmecophaga*. When the auricle is black the tip may be furnished with a pencil of white hairs which suggest the reversion to the plan of coloration described on page 88.

The region of the nostrils or the muzzle is pigmented black in most mammals an exception being found in the Quadrumana as in *Semnopithecus nasalis*.

It is interesting to find that in the bull terrier the black may disappear in whole or in part from the muzzle.

The special organs containing as they do black pigment often appear to determine retention points of the same color at the periphery.

The breaks in the circumpalpebral color determine the disappearance of the color from the region in hairless animals excepting the brow where it is apparently caused by the presence at that point of the circumorbital wart. The eyebrow in man is in reality a stripe which tends to pass backward in obedience to the tendency of the stripe in animals generally.

But the direction taken by the eyebrow is not a guide to all the transitions in the form of the black about the eyes. A vertical black stripe extends from the eye to the mouth in the cheetah (*Cynælurus jubatus*). The same patch includes the lip in some New Foundland and pointer dogs.

The auricle and the hair growing from it need not be entirely black. The margin only is black in the hoary bat (*Atalapha cinerea*) and in *Didelphys*. The hair upon the auricle may be entirely white instead of black as in the North American badger (*Taxidea americana*). The base of the auricle may be alone covered with black hair as in the fox-terrier, or with tan as in the beagle.

The auricular black in the dog may include the skin of the side of the head for a variable distance and may cross the vertex and be in common with the corresponding patch of the opposite side. This arrangement interrupts the dorsi-facial white stripe. The appearance of black, tan or white spots on the vertex surrounded by patches of a contrasted color form "points" of breeding in some of the varieties of the dog.[1]

May it not be expected that a connection can be traced between the region of the obeleon and the pineal eye? Embryology teaches that the presence of various color marks of the skin appear before many of the more important deeper organs, and that the species to which an embryo belongs can be determined before the genus. The occasional reappearance in the dog of a patch of pigment at the spot at which an organ of special sense appeared in a remote ancestor, but which has no functional expression in the living descendant, is in harmony with many of the conclusions drawn from the data presented in this paper.

The Sides of the Body.—In *Pecora* the sides of the abdomen and chest are variously stripped and spotted when the body elsewhere, is differently marked. The young of the boar (*Sus scrofa*) is striped on the body. Lateral stripes are also seen in *Coelogenys*, and in *Tamias* and *Spermophilus*. Many varieties of domestic cattle show white spots extending up from the sides of the body from the ventre to variable distances.

Is it likely that the dorsal marks of the horse and carnivores, and the saddle marks of *Thyalcinus*, extending as they do downward are opposed in *Pecora*[2] by the disposition of ventral marks which extend upward?

Nerve-Endings.—The white stripes on the face in many South American bats, in *Lophiomys*, in *Taxidea*, and in some varieties of *Mephitis*, appear to be distinct from the simple contrast of color of

[1] In a recent exhibition of dogs in Philadelphia the vertex spot of the contrasted color was seen in the pointer, the Irish setter and the beagle each twice, in the spaniel and fox terrier each once.

[2] An exception is seen in *Antilope scriptus*, which has white saddle marks.

the black of the special organ above mentioned. In the tiger's marks, as seen on the muzzle, they are undoubtedly correlated to the distribution of the infra-orbital nerves. It is probable that similar patches of color, either black or white, are related to similar causes. Among them may be mentioned the black oral angle in *Felis onca*, the white lips of *Tapir pinchaque*, and the black lower lip in some varieties of the bull terrier and the fox terrier. In the ground hackie (*Tamias striata*) I have demonstrated that the main longitudinal body stripe answer to the terminal filaments of the intercostal nerves and to those nerves which are in serial homology with them.[1] I have found the spots on the fawn of the Virginian deer (*Cariacus virginianus*) answer to the places at which the cutaneous nerves pierce the fascia.

The papilla on the flexor aspect of the fore-arm which is seen in the domestic cat, the sciurmorph and myomorph rodents, and in some of the lemurs, is furnished with bristle-like hairs with the exception of the last named animals. It is supplied by a separate nerve in the domestic cat. The length of the hairs correlate with the length of the vibrissæ of the labial set, and are used (as I have observed in the common mouse) for cleansing the face and especially in combing the labial bristles. J. Bland Sutton[2] found a small bristle-bearing wart on the flexor surface of the the fore-arm in *Lemur catta*, *Chirogaleus coquerli* and *Hapalemur griseus*. No special pigment patches or hair clumps have been found associated with this papilla.

The so called "chestnut" of the fore-leg of the horse is probably homologous with this growth. Owing to the changes in the limb coincident with the reduction of the toes the growth assumes a more posterior position.

All warts and skin caruncles are best developed on the naked spaces at or near the margins of hairy surfaces. They are well seen on the margins of the regions of the whisker and the moustache in the human subject. They are found about the mandibles in the moose (*Alces canadensis*) and the hog. The same positions are seen occupied by warts in the bat where the face is sparsely haired. P. Michelson[3] found warts on the margins of the pilose patches in *trichosis circumscripta*.

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[1] Science 1887.

[2] Proc. Zool. Soc. Lond. 1887, 372.

[3] Virchow's Archiv. 1885, C, 66.

Animals which are uniformly furred carry occasional warts on the face—one of these is always supra-orbital and another is on the cheek, and forms in the dog the so-called "kiss mark." It is often separately marked by tan in the black and tan terrier, when it constitutes a "point" for the breeders of this animal.

Virchow[1] expresses the opinion that retention of lanugo upon the face may be confined to the distribution of the fifth pair of cranial nerves.

Muscle-Regions.—The stripes and spots on the limbs and the dapple-marks on the trunk, as well as some of the broader sheets of color, appear to be related to the intervals between muscle-masses or to the extent of skin-surfaces which corresponds to muscles.

The depression between the radial and digital extensors in the Felidæ is often marked by a black stripe. *Felis chaus* of India according to Sir W. Elliot[2] exhibits a brown bar on the inside of the arm. This writer assumes that the mark is distinctive of the East Indian species. I have seen a black mark in the same locality, in many examples of the varieties of the domestic cat in or near Philadelphia.

The black mark on the front of the thigh in lemurs (see p. 93) is limited distally to the region of the tibia at which the gracilis, semitendinosus and sartorius muscles are inserted. The region of the back which answers to the lower trapezius sheet is abruptly outlined in pure black, in contrast to the white color of the loin and of the lower distal region, in *Indris brevicaudatus*.[3] H. Ranke[4] reports a case of *trichosis circumscripta*, in which a patch was found in front of and below the right knee and a second over the front of the left knee. These marks may be held to be homologous with the distal ends of the black femoral stripe in *Indris brevicaudatus* as already stated above.

Regions which are rich in Seba and Moisture.—Eschricht[5] called attention to the fact of the early appearance of the sebaceous glands in connection with the development and distribution of the hair. While the presence of seba is found associated with hair-growth the fact that some clumps of hair are found in regions which are especially rich in the secretions poured from the skin, form a

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[1] Berliner Klin. Wochenschr. 1873, No. 29.

[2] Darwin, An. under Domestication. Eng. Ed. I. 44.

[3] Am. Mus. No. 260.

[4] Archiv. f. Anthropologie, 1883, taf. XIII.

[5] Müller's Archiv. 1837, 44.

separate group of the localities which show special disposition to retain abundance of hair. Such regions are illustrated by the hairy warts about gular pouches, by the hair of the axilla, of the pudenda and of the perineum.

The hair of the perineum is commonly distinctly colored in the dog and in some of the lemurs. The highly colored and vascular surfaces of the region of the perineum in the Cynopithecoids are probably created by the same cause.

The hair of the external auditory canal is associated with ceruminous glands. The coarse hair at the base of the nipple may be included in the same category.

I have found the wrinkles of the skin of the head of the wart-hog (*Phacochoerus aethyopicus*) correspond to the black stripes seen in the zebra (*Equus zebra*). I have no proof, however, that this marking is caused by influence of seba or of moisture.

The roof of the mouth being black in many mammals induces the observer of pigment patches to include this region under the heading of the distribution of color marks on the general integument. It is interesting to note that the efforts of breeders to run out the black from the integument will often result in the loss of pigment from the roof the mouth. That the oral surface is capable of yielding special outgrowths which are comparable to those of the skin is shown in *Balaena* and many rodents.

4. Effects of Age.—That the color marks of young animals frequently differ from the adult forms is a matter of common observation. The relations existing between the young of one species and the adult form of others have been often observed but need further elucidation. The white collar at the base of the neck in some dogs is seen in the young form only of the bear. The change in the Himalayan rabbit from white, to white with dark markings has been already noted.

The corresponding changes which take place in the animal in old age has received much less attention than it deserves. The few observations I have made confirm the statements made elsewhere respecting the orientation of pigment patches. Horses often become gray in the circumpalpebral regions before they change elsewhere. An Italian gray-hound, which I have observed for a number of years, displays as it advances in senility a dorsal white stripe, a white star on the breast, a circumpalpebral gray patch and white feet. In a word the fawn gray of adult life turns to white in the same regions (with the exception of the tip of the tail and the tip of the ear) that an animal is apt to break from its prevalent color. (See p. 88)

The loss of hair from the crown in man is the loss of the dorsal part of the "collar" of the Quadrumana as already mentioned on p. 95.

The growth of the hair from the tragus in man is more decided in middle life than at an earlier period and turns gray at a later period than the whisker.

5. Bilaterality. The study of color marks in connection with the law of asymmetry yields many attractive results. Prof. Wm. H. Brewer[1] found the white marks on the feet of horses more developed on the left than the right side. In *Nyctipithecus* I have found the left supra-orbital region white, and a white spot detected on the left cheek, while the remainder of the fur was gray. H. Ranke[2] describes a case of *trichosis circumscripta* in which a pilose patch was seen on the left cheek in advance of the region of the whisker but none corresponding to it on the right. The left arm, according to R. Hilbert,[3] may be alone pilose and a patch of icthyosis be confined to the shoulder of the same side. Dr. Henry H. Donaldson found as the result of many observations on the human subject in the south of Germany, the wart on the nasio-labial groove to be much more frequent on the left than the right side. He found a similar disposition in numbers of engraved portraits of distinguished men of all nationalities. I have frequently found the black circumpalpebral patch in the fox-terrier and the bull-terrier confined to the left side, or when the patches are found on both sides the left patch to be the larger. According to W. H. Flower[4] the color-marks of *Lycaon* are remarkable for being different on the two sides of the body. Prof. Brewer states[5] that in man the beard commonly turns gray first on the left side. It cannot be a coincidence that the left side in all the above instances shows the greatest disposition to variation. I have found a similar disposition to exist in the antlers of the Virginian deer.

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[1] Proc. Am. Assn. for Advancement of Science 1881, XXX, 246.

[2] Archiv. f. Anthropologie 1883, XIV, 339.

[3] Virchow's Archiv. 1885, XCIX, 569.

[4] Article "Mammalia" British Encyclopedia, IX edition.

[5] l. c. 249.

Naevus bearing abundant growths of hair has been found by J. Nevins Hyde[1] confined to the left side of the body in the form of three bands which followed in the direction of the intercostal nerves; a fourth band extended from the perineum to the scrotum and penis.

6. ANTERO–POSTERIOR ASYMMETRY.—The anterior half of the body may be disposed with reference to the color marks and the quantity or kind of hair, in a manner different from the posterior. This disposition is strikingly seen in many specimens of the tapir, the anterior part (with the exception of the lips which are white). being dark, while the posterior is white. In *Hystrix* the posterior half of the body alone bears the quills. In *Phascolarctos* the posterior half of the body is white. In *Hapale bicolor* a similar coloration is seen. In *Chrysochloris aurata* the posterior half only of the body justifies the name.

Concluding Remarks.—In reviewing the subject of the distribution of color marks in mammals it is evident that the causes of the arrangements are various, and do not admit of easy solution. The points which I have attempted to elucidate do not invalidate biological principles already established, while it must be acknowledged that some of them do not remain explained by these principles alone. That variations of deep lying structures will influence the periphery which over-lie them is a well established law. Illustrations are seen in the relations which exist between the true organs of generation and the skin coverings over them. It is but another application of the principle to find the sacral spot correlating to conditions of the neuro-enteric canal, and yet another in the skin about the nostril, the eye and the auricle remaining black because the true organs of olfaction, vision and audition also contain black pigment. The principle of antero-posterior symmetry—of bilateral symmetry and asymmetry are also illustrated.

The general contrasts of the color marks of the head as opposed to those of the body, which are so common in parti-colored animals, may be explained by the enormous influence which the brain must exert over the nutrition of the entire region. That nerve-endings can influence the color of the integument near them is abundantly proven. From the lateral line of teleostean fishes to the ground hackie is a long series in which the influence of nerve endings on the sides of the trunk can be associated with color marks. Sebaceous

[1] Chicago Med. Journ. and Examiner, Oct. 1877.

secretion and sweat conjoined with elevation of temperature appear to explain the retention of hair at the pudenda and axilla. Dr. Geo. Dimmick of Cambridge, Mass., has informed me that he has influenced the arrangement of color marks on the elytra of *Coccinella* by varying the temperature to which the insects had been subjected. According to H. Pryer[1] "temperature has a great evolutionary value in insects."

That margins of nutritive regions afford the conditions favorable to the appearance of warts agrees with what is known in a osseous system with respect to erostosis and absorption. In a growing cranial bone I have found its greatest thickness in the position of its centre of ossific deposit; in the adult bone the thickness is greatest at the margins. When sutures are well defined vascular activity is most marked along their lines. In atrophy an area of deficiency always occurs lying at a point somewhere between the centre of ossification and the borders of the bone.[2]

It is probably in obedience to the same law that in baldness a lock of hair commonly persists at the bregma and in the upper part of the metopic line. With respect to skin folds it must be said that the disposition is caused primarily by the position of the skeleton of the limbs to that of the trunk, head and neck. In *Rhinoceros* and *Armadillo* the folds answer pretty exactly to the divisions above named. But the folds on the side of the trunk between the limbs in *Armadillo* appear to be caused by muscular action if one can accept the conclusions drawn from the appearances seen in the instantaneous photographs of the hog as taken by Mr. Muybridge.[3]

If motion can originate skin folds it can also determine color-regions, and the category of the pigment patches in the intervals between muscle-masses and the limitation of color-areas to muscle sheets become practicable.[4]

The history of each mammalian embryo must present many phases of nutrition—especially of precocity and of retardation—which determine individuality. In a litter of two or more individuals the changes due to temperature, to motion, to rate of local blood inter-

[1] Trans. Ent. Soc. Lond. 1882, 489.

[2] Am. Journ. Med. Sci. 1870, 405.

[3] Photographs issued under the auspices of the University of Penna, series 673.

[4] It is a tempting subject for study to elucidate the distribution of skin diseases by the application of the same methods undertaken in this essay. The margins of the areas of the lanugo,—the course of distribution of nerves or of vessels, the influence of the bone lying in close juxtaposition to the skin, the

change must cause variations in the rates of growth in accession or repression of force which will call into activity one or more of the proclivities above named. The extreme variety of this individual experience doubtless explains the great difference seen in the ways that animals are colored.

The fact that coloration is limited, or that it is apt to be limited, to the points of convergence of Eschricht and Voigt would appear to be a tentative conclusion. The careful study of the peculiarities of the animals which are born naked would probably greatly strengthen it.

I will conclude by making the suggestion that the distribution of color-marks along the directions already indicated is a larger phase of the subject of evolution than is outlined by "mimeticism" and by "natural selection." I assume that *Ailuropus* does not, for the reason that it cannot, change the black feet, the black auricle and the black circum-ocular region for one in harmony with the ground color, notwithstanding the disadvantage to which the contrast between the black and white subjects him. I also assume that the breeders of the dog cannot run out the black from the skin over the sacrum and the root of the tail with the same ease he can determine many other colors. According to natural selection and domestication the various regions above named explain the frequent occurrence of colors which are of great use to the individual but they often meet with abrupt limitation owing to the influence of deep-lying restraining causes.

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occurrence of acne pustules or syphilitic papules in positions in which the marginal warts occasionally appear,—the retention of the hair near the bregma and at the occiput in instances of loss of hair other than from age, can be noted in studying the distribution of eruptions upon the skin and of naevi as well as of color marks. But the field of observation is difficult when the conditions are often so fleeting. The impressions of a single observer are not sufficient to secure definite conclusions: For information, including literature of this phase of the subject, the reader may refer to the experimental researches of A. Irsai and V. Babesin[1] upon the influence of the nervous system upon the pathological conditions of the skin, and to T. S. Dowse on the nervous affections of the skin and its appendages.[2]

[1] Vierteljahresschr. f. Dermatol. u. Syphil. 1882, IX, 433.

[2] Med. Press and Circular 1879, I, 499.

RESEARCHES UPON THE GENERAL PHYSIOLOGY OF NERVE AND MUSCLE.

BY Dr. HENRY C. CHAPMAN AND Dr. ALBERT. P. BRUBAKER.

No. 1.

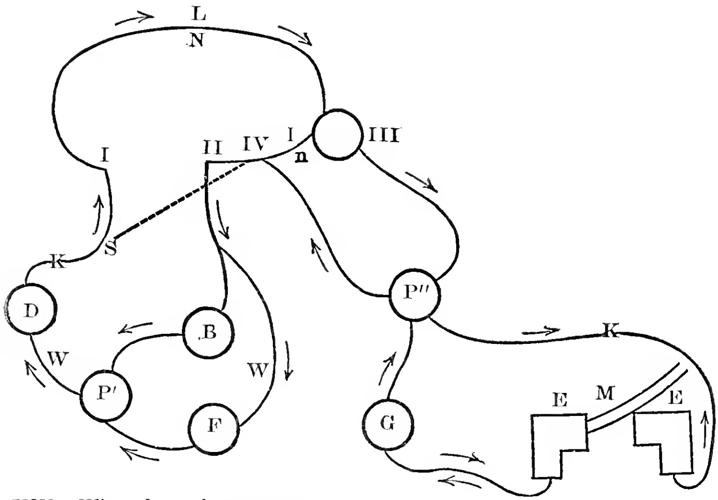
Electrical currents and Electro-motive force of Muscle and Nerve in frog. Whatever view may be entertained as to the nature of the electrical currents present in injured muscle or nerve, whether the same be regarded as pre-existing in the uninjured condition, or as being developed through injury, there can be no difference of opinion as to the fact that such currents exist, at least in the injured condition. In as much,. however, as so far known to the authors of this communication, all researches hitherto undertaken with the object of demonstrating the presence of electrical currents in muscle and nerve, and of more particularly determining the electro-motive force of the same, have been made by Prof. Du Bois Reymond it does not appear superfluous to bring before the attention of the Academy the results of some recent investigations made by the authors in the Laboratory of Jefferson Medical College upon large specimens of our our common frog, *Rana Catesbiana*. That the presence of electrical currents in nerve and muscle should have long escaped the notice of physiologists was doubtless due, not only to the imperfect forms of galvanometers formerly in use, but also to the fact of electrical currents being developed whenever two electrodes were placed in contact with organic tissues. With the construction of delicate galvanomters, like those of Wiedemann, and of non-polarizable electrodes, that is of electrodes that will convey or divert an electrical current present in a muscle or nerve to a galvanometer, without generating one, it became possible to demonstrate without cavil that injured muscle and nerve are seats of electro-motive force. The instruments made use of in obtaining the results tabulated below, were of the convenient form devised for this purpose by Prof. Du Bois Reymond,[1] to whom this branch of science is so much indebted, and consisted of a Wiedemann galvanometer with telescope and scale, a round compensator, mercurial keys and whippe and non-polarizable diverting cylinders and diverting vessels[2], the latter or non-polarizable electrodes being always

[1] Gesammelte Abhandlungen, Leipzig, 1875, Band I.

[2] A description of these instruments will be found in Chapman's Physiology 1887, Chap. XXXVIII.

applied to the equator and transverse section of the muscle and nerve respectively. The methods made use of by the authors in determining the electro-motive force of the gastrocnemius muscle and sciatic nerve of the frog as given in the synopsis below is essentially that of

SCHEME OF DETERMINATION OF ELECTRO-MOTIVE FORCE WITH ROUND COMPENSATOR.



IVII	Wire of round compensator.
N	Number of its divisions 1000.
L	Resistance offered by same.
S	Switcher.
K	Key.
D	Daniell Element.
W	Resistance offered by D IVII B P′ D and by IVII F P′ D.
P′	Whippe.
B	Coils.
F	Coils.
P′′	Commutator.
G	Galvanometer.
E	Electrodes.
M	Muscle or Nerve.
K	Key.
III	Wheel.
l	Fractional portion of wire of compensator.
n	Number of the division necessary to compensate.

Poggendorff with the difference that the round compensator was used instead of the long rheocord. This method[1] consists essentially in

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1 Du Bois Reymond, op. cit. S 257.
Archiv für anat. u. Phys. 1885 S. 381.

shunting off from the circuit of a standard element, a Daniell's cell for example, whose electro-motive force is known = 1·08 Volt, an amount of current sufficient to neutralize or compensate the current deflecting the magnet, the latter due to the electro-motive force of the muscle or nerve and which is to be determined. Thus, for example, let us suppose that the electrical current diverted by the non-polarizable cylinders or electrodes, Fig. 1 (E) from the nerve or muscle (M) to the galvanometer (G) be sufficient to deflect the magnet to an extent corresponding to 267 divisions of the scale. If now the compensator be moved so that the wheel III be opposite (n) for example, part of the current from the Daniell element will return through IVII F whence it came and part through III P″ to the muscle (M) and, being in the reverse direction to that of the current from and due to the muscle, the magnet will be slowly brought back from the the 267th division of the scale to zero, the wheel III then standing at (n), or the 820th division of the wire of the compensator, the latter (N) being divided into 1000 parts. Such being the case it is evident that the electro-motive force of the muscle or X is to that compensating it, or to (l), (the amount of the compensating force depending upon the resistance offered by the fractional portion of the wire L) as the electro-motive force of the Daniell element or (E) is to the whole resistance or W+L, or more briefly:—

$$X : l : : E : W+L$$

or

$$X = \frac{l}{W+L} \times E \ (1)$$

In as much, however, as the fractional portion of the wire (l) is to the number of its divisions or (n) as the whole wire (L) is to the number of its divisions N we shall have

$$l : n : : L : N$$

or

$$l = \frac{n\ L}{N}$$

If now this value of l be substituted in equation (1) we shall obtain

$$X = \frac{n}{N\left(1 + \frac{W}{L}\right)} \times E \ (2)$$

and it only remains, n and N being known, to determine the ratio of W to L to obtain the value of X or the electro-motive force of the muscle as a fractional portion of E, the latter being the electro-motive force of a Daniell element. To accomplish this let the circuit M G P″ IV III P″ K M and the circuit D K I, III, IV II F P′ D, be opened and the circuit D S IV II B P′ D offering a resistance W be closed, D being put in communication with IV by the switcher S, B being a coil of wire offering the same resistance as F and brought sufficiently near the galvanometer G to slightly affect it, the intensity of the current will then be equal to the ratio of E to W or $I = \frac{E}{W}$ or if we call J the number of the divisions of the scale corresponding to the deflection of the magnet, then $J = \frac{E}{W}$

Let now D be put in communication by means of the switcher S, with I, the beginning of the wire of the compensator, that is the current D K S I III IV II B P′ D be closed and offering a resistance W+L, L being the resistance offered by the wire I II of the compensator, the intensity of the current will then be equal to the ratio of E to W+L, that is $I = \frac{E}{W+L}$ or if we call J^1 the number of divisions corresponding to the deflection of the magnet, then $J^1 = \frac{E}{W+L}$

$$\text{or } \frac{J}{J^1} = \frac{\frac{E}{W}}{\frac{E}{W+L}} = \frac{W+L}{W} \quad \text{whence} \quad W\frac{J}{J^1} = W+L \text{ or}$$

$$\frac{W}{L} = \frac{1}{\frac{J-1}{J^1}} = \frac{J^1}{J-J^1}$$

If now this value of $\frac{W}{L}$ be substituted in equation (2) we will obtain

$$X = \frac{n}{N} \times \frac{J-J^1}{J} \times E \quad (3)$$

in which equation

X = the electro motive force of muscle.

n = the number of divisions of the graduated scale of the wire of the compensator necessary for compensation.

N = 1000; the number of divisions of the wire of the compensator.

J = Number of divisions of scale corresponding to deflection of magnet excluding the wire of the compensator.

J^1 = Number of divisions of scale corresponding to deflection of magnet including the wire of the compensator.

E = The electro motive force of the Daniell element.

Substituting the value of n and of J and J^1 obtained experimentally as described above and equation (3) becomes:—

$$X = \frac{820}{1000} \times \frac{90-81}{90} \times E$$

or

$$X = \frac{1}{12} E = 0{\cdot}0833 \text{ D.}$$

that is to say the electro motive force of the muscle or X that deflected the magnet to an extent corresponding to 267 dimensions of the scale is equal to 0·0833 of a Daniel element.

Finally it will be observed that the graduating of the compensator or the determining the amount of the fractional portion of the Daniell necessary to compensate the muscle current is accomplished immediately after compensating or before, since $\frac{J-J^1}{N\ J}$ from (3) $= \frac{1}{10000}$ of the Daniell, that is each division of the wire of the compensator at that moment switches off the $\frac{1}{10000}$th of a Daniell and as it required 820 such to compensate, $\frac{820}{10000} = \frac{1}{12}$ was the fractional portion of the Daniell element needed. It need hardly be added that in determining the electro-motive force of a nerve, we proceed in exactly the same way except that we make use of the diverting vessels as electrodes instead of diverting cylinders.

It may be mentioned incidentally that in all of the experiments performed in the above manner the telescope and scale were placed at a distance of 2·5, met (8 feet) from the galvanometer, the coils lay close up to the magnet, that the temperature of the laboratory was about 70° F. (38·9 C) the season January and February, the time of day noon. The following table gives the results synoptically arranged of 25 experiments performed upon the gastrocnemius of the frog and of 25 experiments upon the sciatic nerve of the same animal. Resuming, it will be observed that the average deflection of the magnet due to the electrical current of the muscle corresponded to 217 divisions of the scale, the electro-motive force causing the same the $\frac{1}{14}$th of a Daniell or 0·0696 D. a greater electro-motive force than that yet obtained, the same amounting according to Du Bois Reymond [1] to 0·035—0·075 D. the mean of which is 0·055D. It may be also mentioned incidentally in this connection that the electro-

[1] Op. cit. Band II, S. 243.

motive force of the semi-membranous muscle was found in several instances to amount to as much as the $\frac{1}{10}$th of a Daniell or 0·1 D. The deflection of the magnet due to the electrical current of the sciatic nerve corresponded on an average to 21 divisions of the scale, the electro-motive force giving rise to it to the $\frac{1}{50}$th of a Daniell or 0·0237 D. a result agreeing closely with that of Du Bois Reymond[1] viz:—0·022 D. In conclusion it is worthy of observation that the electro-motive of the muscle is more than three times as great as that of the nerve.

Synopsis of results of observations upon the electrical currents and electro-motive force of muscle and nerve in frog.

GASTROCNEMIUS MUSCLE.

Observation.	Magnetic Deflection.	Electro Motive Force.
1	186 div. of scale.	0·0625 D.
2	141 "	0·0666 "
3	155 "	0·0769 "
4	170 "	0·0714 "
5	190 "	0·0588 "
6	197 "	0·0666 "
7	165 "	0·0714 "
8	255 "	0·0714 "
9	217 "	0·0588 "
10	225 "	0·0588 "
11	191 "	0·0555 "
12	245 "	0·0769 "
13	225 "	0·0625 "
14	211 "	0·0769 "
15	270 "	0·0833 "
16	266 "	0·0625 "
17	216 "	0·0833 "
18	267 "	0·0833 "
19	266 "	0·0833 "
20	258 "	0·0833 "
21	207 "	0·0625 "
22	230 "	0.0588 "
23	200 "	0·0588 "
24	225 "	0·0714 "
25	260 "	0·0769 "
mean =	$\frac{5438}{25}$ = 217 div.	$\frac{1·7424}{25}$ = 0.0696 D.

[1]Op. cit. Band II, S. 250.

Sciatic Nerve.

Observation.	Magnetic Deflection.	Electro Motive Force.
1	25 div. of scale.	0·0277 D.
2	15 "	0·0212 "
3	19 "	0·0217 "
4	20 "	0·0222 "
5	30 "	0·0333 "
6	30 "	0·0333 "
7	27 "	0·0333 "
8	28 "	0·0333 "
9	19 "	0·0200 "
10	17 "	0·0208 "
11	19 "	0·0208 "
12	16 "	1·0180 "
13	17 "	0·0181 "
14	26 "	0·0256 "
15	23 "	0·0250 "
16	18 "	0·0185 "
17	19 "	0·0185 "
18	22 "	0·0185 "
19	27 "	0·0294 "
20	15 "	0·0181 "
21	18 "	0·0200 "
22	20 "	0·0250 "
23	19 "	0·0192 "
24	20 "	0·0263 "
25	24 "	0·0270 "
mean	$\frac{533}{25} = 21$	$\frac{0·5948}{25} = 0·0237$ D.

DESCRIPTIONS OF NEW SPECIES OF UNIONES FROM FLORIDA.

BY BERLIN HART WRIGHT, PENN YAN, N. Y.

Unio Fryanus. Plate II, fig. 1.

Shell elliptical, very smooth, very inequilateral, substance of the shell thin, inflated in the umbonial region, beaks projecting very slightly beyond the hinge line, ligament short, thin and light brown. Epidermis yellowish red and covered with bright green rays which are so thickly set upon the upper portion of the shell as to give that part, a bright green color: the young are of a bright shining green over the entire surface, the green being interrupted by heavy lines of growth of a light red color. Ligamental margin sub-angular before and slightly arched, posterior margin disposed to be slightly bi-angular and quite uniformly rounded above, anterior margin abruptly rounded; basal margin uniformly rounded; cardinal and lateral teeth double in the left and single in the right valves, the cardinal teeth short, oblique stout and crenulate, lateral teeth slightly and uniformly curved, dorsal cicatrices deep and slightly posterior to the cavity of the beak, anterior cicatrices slightly impressed and distinct. Nacre quite uniformly purplish.

Diameter .60. Length 1.00. Breadth, 1.75 inches.

Habitat. Lake Ashby, Volusia County, Florida.

Mus. Acad. Nat. Sciences. Phila. Newcomb Coll., Cornell Univ. National Museum.

Remarks. This species is highly polished, and the young are rich in lustrous rays. The strongest affinity is with *U. sparus* Lea. It approaches *U. fuscatus* Lea, but is thicker through the umbonial elevation, and the umbos are farther forward, and its valves thicker, heavier, and not so flat. The dorsal view shows it is enlarged anteriorly, while that of *fuscatus* is not so. It can not be mistaken for *U. perlucens* or *U. micans Lea.* Abundant on the muddy bottom of the outlet of Lake Ashby, Volusia Co. Fla.

Named for Mr. T. Marshall Fry, of Syracuse, N. Y. who is an enthusiastic collector and student of the Unionidæ.

Unio Websterii Plate II, fig. 2.

Shell oblong, inequilateral, considerably inflated, rounded at the sides, surface roughened by numerous obtuse irregular lines of growth, substance of the shell thin, ligamental margin moderately arcuate and rather short, posterior margin slightly biangular, ligamental area narrow, umbonial slope subangular, anterior margin projecting and uniformly rounded, basal margin slightly and uniformly curved. Epidermis reddish, interrupted by coarse, distant radiating lines of a blackish color. Greatest length near the middle of the shell, beaks eroded and ornamented with three to five radiating elevations. Umbos broad and rounded: nacre delicate flesh color to pink, usually clear, rarely mottled with waxy spots; cardinal teeth disposed to be double in both valves, slender, oblique, long and delicately crenulate, lateral teeth long and heavy, curved; cavity of the beak deep and rounded, cavity of the shell deep, and occasionally the surface is interrupted with undulating ridges near the anterior portion of the cavity; dorsal cicatrices forming a continuous line extending from the base of the posterior cardinal tooth backward for one half inch and directly under the edge of the roof to the beak cavity; anterior cicatrices small, the superior one undermining the anterior portion of the cardinal tooth, posterior cicatrices confluent.

Diameter 1½. Length 2.50. Breadth 4¼ inches.

Habitat. Lake Woodruff, Volusia Co. Florida.

Mus. Acad. Nat. Sciences. Newcomb Coll., Cornell Univ. National Museum.

Remarks. This is the largest Unio yet found in Florida waters. Its place is between *U. Savannahensis* Lea and *U. Mecklenburgensis* Lea. It is more inflated than the former, thinner, has more prominent and narrower beaks, higher and more rounded umbos, deeper and smaller anterior cicatrices and the teeth are lighter.

We are pleased to name this species after our botanical friend Mr. Buchard Webster of Lake Helen, Florida, who, with his father, often made our collecting trips more pleasant.

Unio Waltoni. Plate II. fig. 3.

Shell compressed on the posterior slope, transversely elongated, very inequilateral; valves rather thin, beaks not prominent and eroded; epidermis brownish black, apparently rayless, valves anteriorly rounded and oblique upward and sharply angled above, obtusely rounded behind; cardinal teeth nodulous, small, complex and serrated: lateral teeth lamellar and slightly curved upwards; nacre purple. Basal margin very much excurvated.

Diameter 1.00. Length 1.50. Breadth 4 inches.

Habitat. Lake Woodruff, Volusia Co., Florida,

Mus. Acad. Nat. Sci. Newcomb Coll. Nat. Mus.

Remarks. This species has the general form of *U. Emmonsii* Lea, and is more in affinity with that species, than with *U. Shepherdianus* Lea. The former is a much heavier species, and with coarse heavy teeth. *U. Shepherdianus* Lea, is deeply emarginate on its basal margin, and the sides of its valves are very much constricted obliquely from its projecting umbos down, while *U. Waltoni*, is very *convex* in its basal margin and its umbos *not* projecting, and its anterior end very obliquely rounded, instead of evenly rounded, and a *thin* shell. It can not be confounded with *U. perlatus*, Lea, though the obliquity of the anterior end is much alike in both. It is with much pleasure that we name this curious species, after Mr. John Walton, a zealous and working conchologist, and artist of Rochester N. Y.

Unio Dorei. Plate III, fig. 1.

Shell ovate, heavy; polished, rayless; epidermis reddish, with brownish colored elevations or growth-ridges; beaks blunt and massive, dorsal margin very broad, short and slightly arched; posterior margin quite straight; Umbonial angle sharp and supplemented by two parallel elevations which are more or less broken by undulations; basal margin slightly rounded, anterior margin truncate and angulated above; cardinal teeth with a tendency to being double in both valves, very massive, smoothish; lateral teeth very long, heavy and uniformly curved; nacre a rich salmon color; cavity of the beaks almost wanting: of the shell considerable. Named for Mr. H. E. Dore, and enthusiastic collector of mollusca of Portland Oregon.

Diameter 1.25. Length 1.6. Breadth 2.60 inches.

Habitat. Lake Monroe, Florida.

Mus. Acad. Sciences; Coll. B. H. Wright.

Remarks. The affinity of this species is with *U. Conasaugaensis* Lea, but the teeth differ, the umbos of the latter are not so broad and blunt, and are farther from the anterior end, and has a *white* nacre. There is much disparity between it and *U. Bucklyi Lea.*

Unio Averellii. Plate III, fig. 3.

Shell obovate, thin, fragile, slightly inflated, inequilateral, smooth, polished, interrupted by numerous green capillary rays arranged in fascicles which are narrowest at the anterior end of the shell, and broaden gradually until near the umbonial angle where they merge together, giving the posterior portion of the shell a dark green color; epidermis yellowish; beaks flattened, rather blunt, slightly and coarsely undulated; dorsal margin nearly straight; ligament short, horn colored, thin; anterior margin short and gracefully rounded; posterior margin bluntly rounded, basal margin with a tendency to emargination in old females; quite uniformly curved in males; greatest diameter near the middle of the ligament, greatest length at posterior end of dorsal line; cardinal teeth double in both valves, compressed, very oblique, crenulate, the anterior tooth in the right valve is much the smaller, as is the posterior one of the left valve; lateral teeth single in the right and double in the left valve, curved and slender; nacre light purple and spoted with a few dark-waxy spots; dorsal cicatrices two to four and in a diagonal row from the base of the anterior cardinal tooth across the centre of the cavity of the beak, anterior cicatrices distinct and well impressed.

Diameter .8. Length 1.2. Breadth 2⅛ inches.

Habitat. Lake Ashby, Volusia County, Florida.

Museum Acad. Nat. Sci. Phila. Newcomb Coll., Cornell Univ. Nat. Museum.

Remarks. This delicate species, is possibly related to *U. papyraceus* Gould. But Dr. Gould in his description of that species, says that "it resembles *Anodonta Couperiana* Lea, in shape, delicacy and even color."

But there is nothing in *U. Averellii* to remind one of *An. Couperiana* Lea. It has the outline of *U. occultus* Lea, but its affinity is with *U. rutilans* Lea, but differs in being very thin, almost paper-like, less blunt at each end, and without a depressed area at the anterior ligament. Named for Mr. Wm. D. Averell publisher of the Conchologist's Exchange, of Philadelphia, Pa.

Unio Nolani. Plate IV, fig. 1.

Shell wide, smooth, rather thick, beautifully polished throughout, and entirely covered with heavy greenish rays; epidermis yellowish and often olivaceous; dorsal margin arcuate, anterior margin gracefully and perfectly rounded, basal margin subemarginate, posterior margin uniformly rounded from the end of the ligament to the base with no tendency to biangulation; umbonial angle flatly rounded; umbonial slope flattened, depressed in the middle; beaks small, pointed, undulated, and rather prominent; cavity of the shell small; cardinal teeth heavy, erect, grooved, double in the left and single in the right valve; lateral teeth curved, heavy and much roughened; nacre beautiful pink and iridescent.

Diameter .9 Length 1.5. Breadth 3 inches.

Mus. Acad. Nat. Sciences. My own cabinet.

Habitat: A creek flowing into St. John's River, near Palatka, Fla.

Remarks. This beautiful shell was found by Mr. J. B. Upson several years ago. Its affinity is with *U. corneus* Lea, and with *U. Postellii* Lea. From the latter it differs in not having a striated and scaly epidermis, and in not having thick, but compressed cardinal teeth. The former has much heavier teeth, the groove of the lateral teeth being shorter and much farther from the cardinal teeth, and the beaks farther from the anterior end, and the post-ligamental area much more conspicuous. It can not be taken for *U. planilateris* Con. which has a stramineus epidermis.

We name this peculiar species for Dr. Edw. J. Nolan, Librarian to the Academy of Natural Sciences of Philadelphia.

Unio Hinkleyi. Plate IV, fig. 2.

Shell oblong, trapezoidal, attenuated and pointed behind, smooth, slightly inflated, and often flatish; rather thin, polished above. Epidermis black, thickly covered with brown, indistinct fine rays, visible with transmitted light. Posterior margin subemarginate, raised into a compressed wing. Anterior margin rounded and slightly oblique. Dorsal margin a slightly arched curve. Basal margin slightly convex. Umbonial slope raised and obtusely rounded. Cardinal teeth compressed, thin, very oblique and grooved, double in both valves. Lateral teeth very long, slender and undulating, nearly straight. Dorsal cicatrices four or more in one or two rows. Nacre pinkish, and iridescent. Umbonial region broad and blunt, very slightly projecting, but often *deep*.

Diameter 1.00. Length 1.50. Breadth 3.00.

Habitat. Lake Monroe, Florida.

Mus. Acad. Nat. Sciences. National Museum.

Remarks. In outline this species is similar to that of *U. declivis* Say, but its black epidermis, its pinkish or purplish nacre, readily distinguishes it from that species.

It is dedicated to Mr. A. A. Hinkley, of Dubois Illinois, an active collector of Unionidæ.

Unio Simpsoni. Plate V, fig. 1.

Shell oblong-ovate, pointed behind, and often very slightly uncinate below the point, inequilateral, remarkably smooth and polished. Valves *thin*, slightly inflated, and rarely with a few coarse, perpendicular, impressed grooves near the centre. Sometimes the valves are very flat. Ligamental margin higher behind, and straight or slightly arched. Posterior slope biangular below, straight or slightly emarginate, and raised into a distinct and angled carina, which is thin and compressed. Ligamental area often with several small plicæ. The posterior end is generally sharply compressed above and below, giving it a lance-shaped and ancipital appearance. Umbonial ridge depressed, narrow, and rounded. Anterior margin rounded and slightly oblique, basal margin convex. Epidermis yellowish-brown or olive colored, or even bright green, with slender green rays in uneven fascicles, or rayless and reddish-brown all over. Umbos very much flattened, and beaks very small and pointed, having a few concentric folds. Cavity of the beaks nearly obsolete. Dorsal cicatrices small and deep. Cardinal teeth oblique and very small. Lateral teeth long, thin, undulated and nearly straight. Nacre salmon or purple, or both mixed. Shell darker behind and at the base.

Diameter .75. Length 1.12. Breadth 2.30 inches.

Habitat. Lake Woodruff, Volusia Co., Florida.

Mus. Acad. Nat. Sciences. Cornell University. National Mus.

Remarks. The left beak is often shorter than the other. Its affinity is with *U. viridicatus* Lea, which has much larger cavities under the beaks, the lateral teeth coarser and not undulating and the anterior end not obliquely rounded, and is not rayed. It cannot be mistaken for *U. Jayanus* Lea. We have great pleasure in dedicating this species to Mr. Charles T. Simpson of Ogallala, Nebraska, who has done very much in studying the mollusca of Florida.

Unio Marshii. Plate V, fig. 2.

Shell somewhat narrow-elliptical, transverse, ventricose and very inequilateral, smooth, incremental lines close and slightly raised. Substance of the shell rather thin, and of very uniform thickness; swollen in the umbonial region; umbonial slope rounded; posterior slope compressed and rounded; dorsal margin nearly straight; anterior margin abruptly rounded; basal margin much excurvate and slightly constricted near the posterior extremity; posterior margin bluntly rounded and emarginate above; turned up, raised into a very small, depressed, and thin carina. Beaks blunt, broad, without concentric undulations but possessing three or four raised, radiating lines; epidermis remarkably thin, reddish brown below and greenish above, indistinctly and closely rayed over the anterior portion, and very dark or black on the posterior slope; nacre, a beautiful salmon varying to purple; cardinal teeth compressed, erect, striate, very oblique and disposed to be double in both valves; lateral teeth long, solid and curved; dorsal cicatrices four, well impressed and situated under the base of the anterior end of the lateral teeth which continue almost to the cardinal teeth.

Diameter 1.3. Length 2.00. Breadth $3\frac{3}{4}$ inches.

Habitat. Lake Woodruff, Volusia Co., Florida.

Mus. Acad. Nat. Sci. Phila. Coll. of Berlin H. Wright and Mr. W. A. Marsh, Aledo, Illinois.

Remarks. This species, though belonging to the Buckleyi group, has specific characters distinguishing it from *U. Buckleyi* Lea; the adult is very excurvate on the basal margin, has a very smooth and polished epidermis, filled with obscure rays, the anterior end being directed obliquely upwards, characters not pertaining to adult *U. Buckleyi.* The symmetry of the dorsal and basal curves is peculiar, being in this character like the same curves of *U. symmetricus* Lea. Its affinity is with *U. Buddianus* Lea, differing in the teeth and other characters. Dedicated to Mr. Wm. A. Marsh, of Aledo Illinois, an amateur of the Unionidae.

Unio Dallii. Plate VI, fig. 1.

Shell ovate, pointed and flattened behind, the point being directed downward, in an uncinate manner. Polished above, and lustreless below, valves not thick, thicker before, epidermis black, rayless, with numerous striæ of scaly plicæ below the umbonial region. Ligamental margin much arched, with an angle at each end. Posterior margin usually slightly and evenly convex. Basal margin emarginate near the posterior end, anterior margin nearly truncated, or abruptly rounded. Umbonial slope very depressed, obtuse and scarcely carinate, and the sides of the valves are decidedly flattened just forward of the umbonial slope. Greatest diameter in the middle of the shell. Umbos broad and flattened, obtuse, projecting, and very much eroded. Sides with numerous close coarse lines of growth. Nacre salmon or pink, varying to copper color, iridescent and usually with wax-colored spots, which often are confluent and cover the interior. Cavity of the shell, and of the beaks shallow. Lateral teeth long, heavy and much curved. Cardinal teeth coarse, deep, divergent. Anterior cicatrices distinct, the larger are deep. Posterior cicatrices confluent, well impressed. The type specimen is about two-thirds the full size.

Diameter 1.00. Length $1\frac{5}{8}$. Breadth $2\frac{1}{2}$ inches.

Habitat. Lake Beresford, Volusia Co., Florida.

Mus. Acad. Nat. Sciences. Newcomb Coll. National Museum.

Remarks. There is an affinity of this species with *U. venustus* Lea, but is more compressed behind and is larger. It has been largely distributed as *U. Buckleyi*, thus causing much confusion as to what the latter really is. *U. Buckleyi* Lea, is more pointed behind, not uncinate there nor emarginate on the basal margin. Its umbos are farther forward and less elevated. Its greatest diameter as well as greatest length, is just behind the beaks, while in *U. Dallii* the greatest length is through the summit of the umbos.

It is named for Mr. W. H. Dall of the Smithsonian Institution.

Unio Tryoni. Plate VI, fig. 2.

Shell wide, narrow-elliptical, compressed posteriorly, thin, polished above. Umbos slightly elevated, the beaks being close to the anterior end, and in the young undulated; epidermis brownish or grayish black, raised into numerous fine scaly striæ, roughish, rayless, or with some capillary obscure rays near the centre of the valves. Dorsal margin straight, posterior margin bluntly rounded or truncate, and triangular; often subemarginate above, basal margin slightly convex, anterior margin broadly rounded. Cardinal teeth of the left valve are long, erect and widely separated to receive the single wide tooth of the right valve. The anterior tooth is shorter and less pointed than the posterior one, and the latter is curved upward. Lateral teeth very long, rather slender and nearly straight. Nacre livid or light salmon colored and often with several dark-brown circular spots. Cavity of the beaks very shallow.

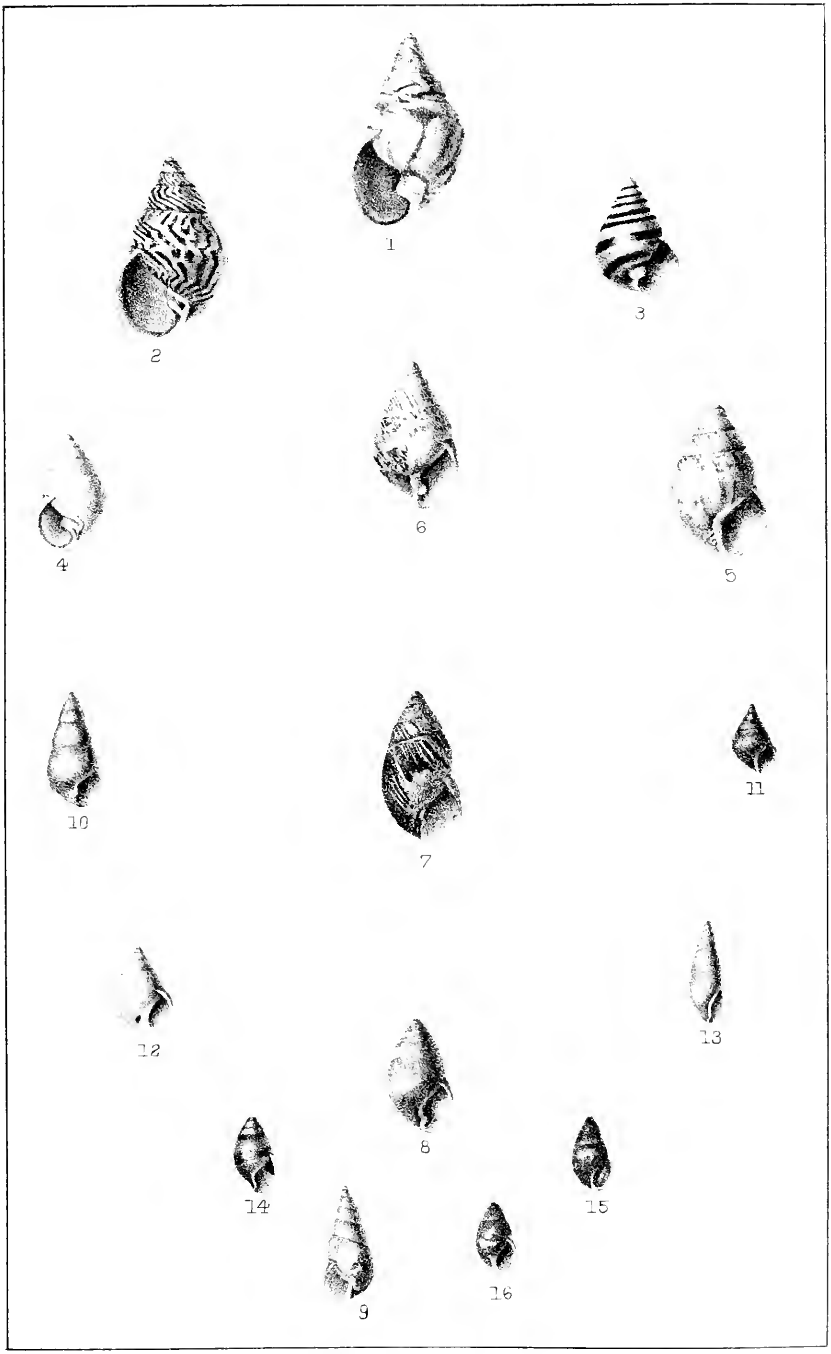
Diameter 1.25. Length 1.75. Breadth 4 inches.

Habitat. Lake Woodruff, Volusia Co., Florida, near De Leon Springs.

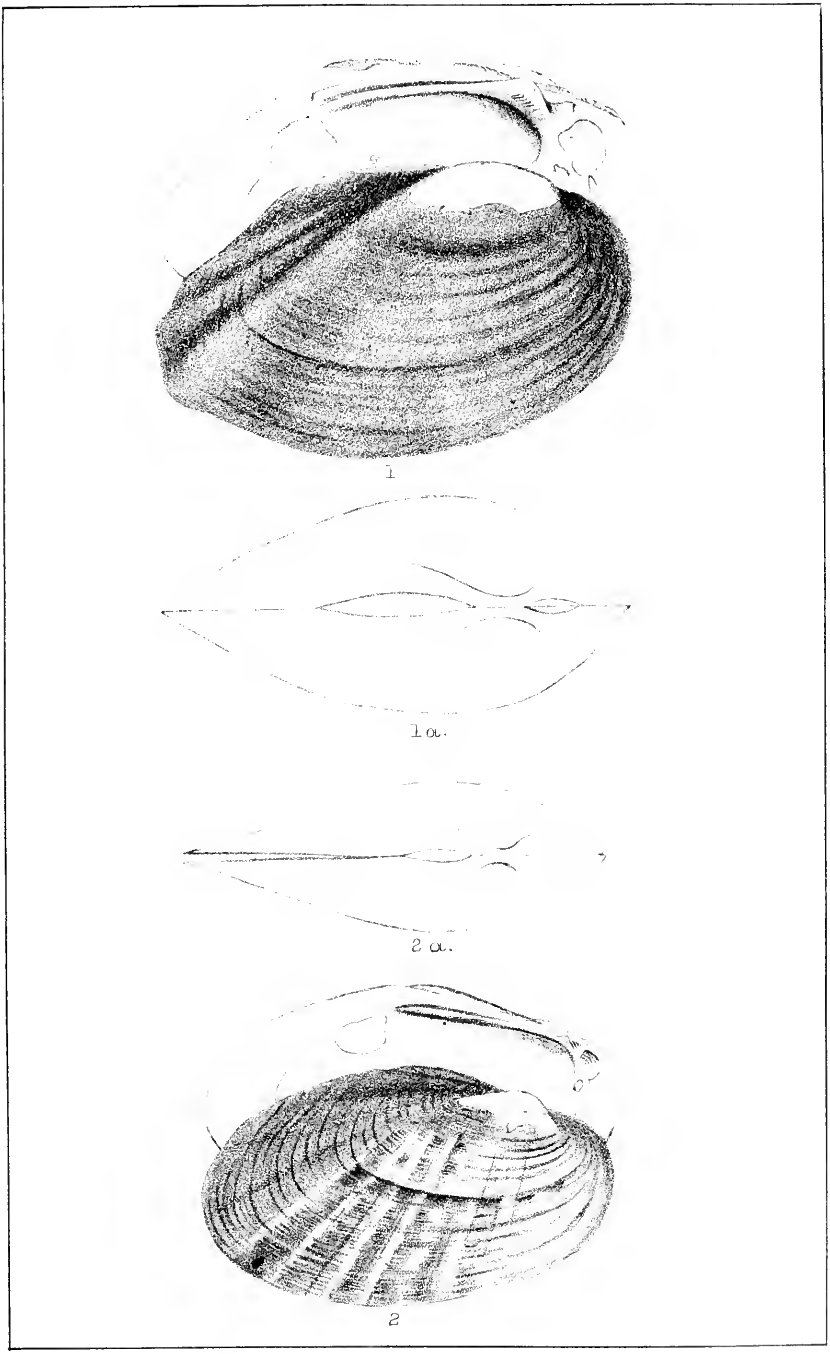
Mus. Acad. Nat. Sciences. Newcomb Collection. National Mus.

Remarks. This species is much thinner and lighter than *U. Ocmulgeensis* Lea, with which there is the affinity of outline. It is much narrower than *U. Buddianus* Lea, and its cardinal teeth are not oblique as in the latter. It is lighter, more rounded before and more attenuated behind, and has a much shorter hinge line. Some forms of it approach *U. Jayanus* Lea.

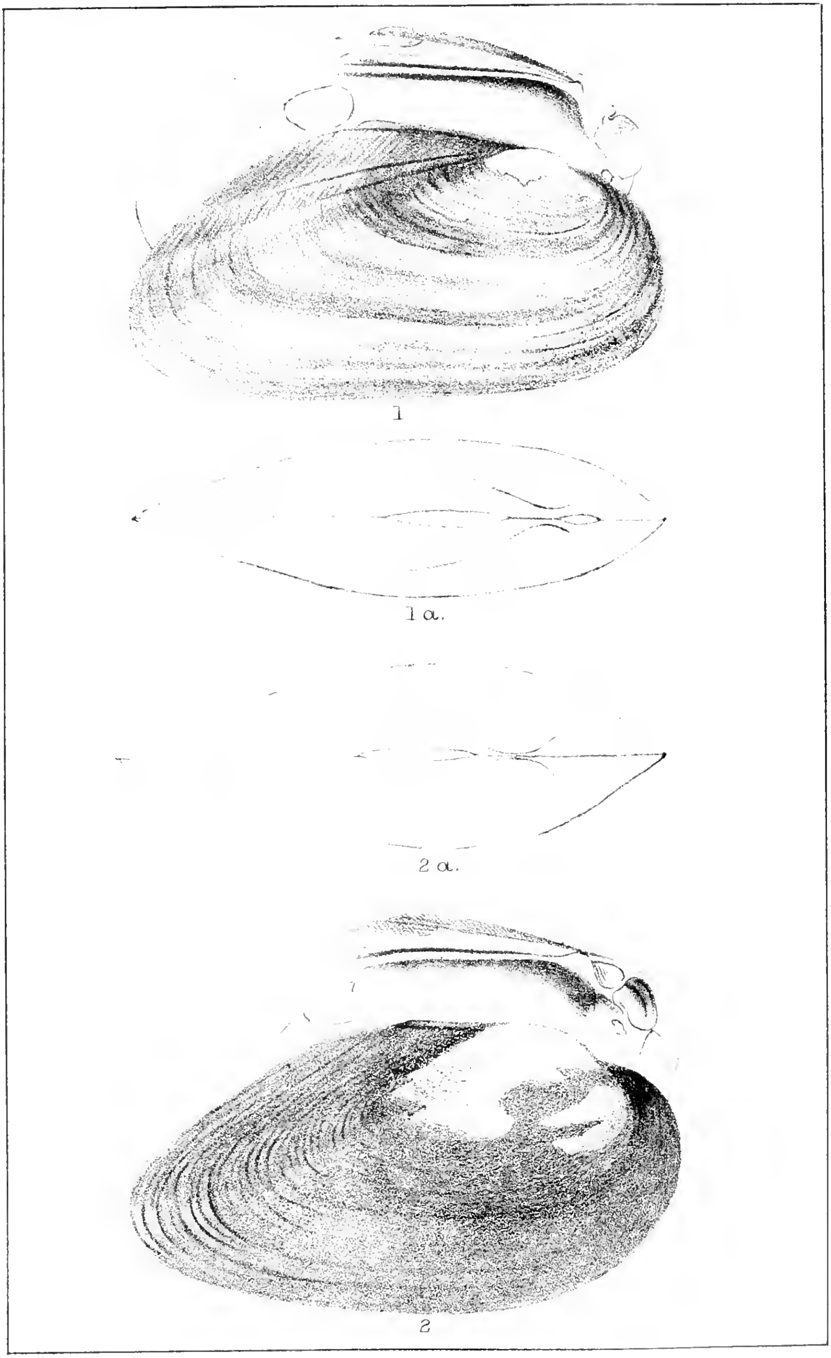
It gives us much pleasure to dedicate this species to the late Mr. George W. Tryon Jr., author of "Manual of Conchology" and other conchological works.



Hartman on Achatinella.



Wright on New Uniones.



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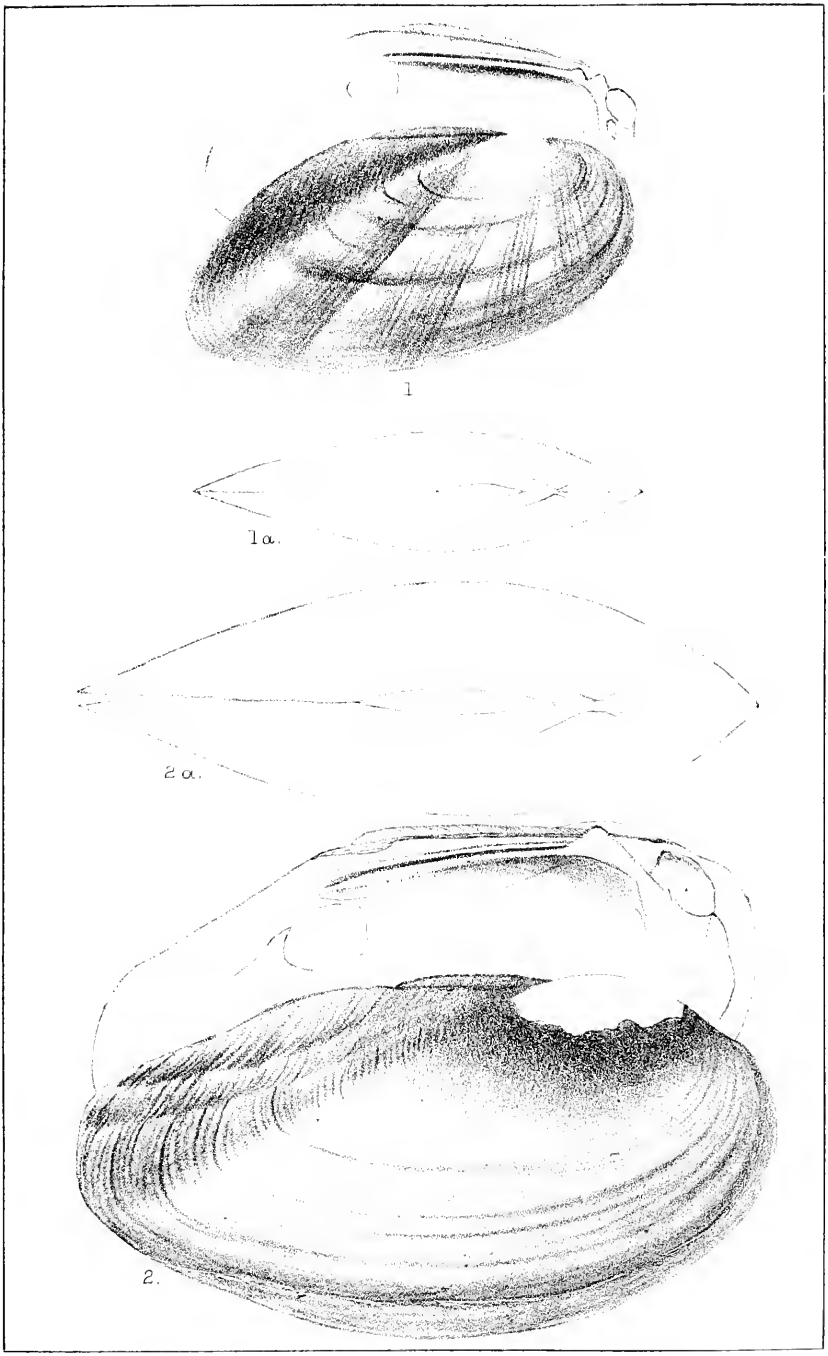

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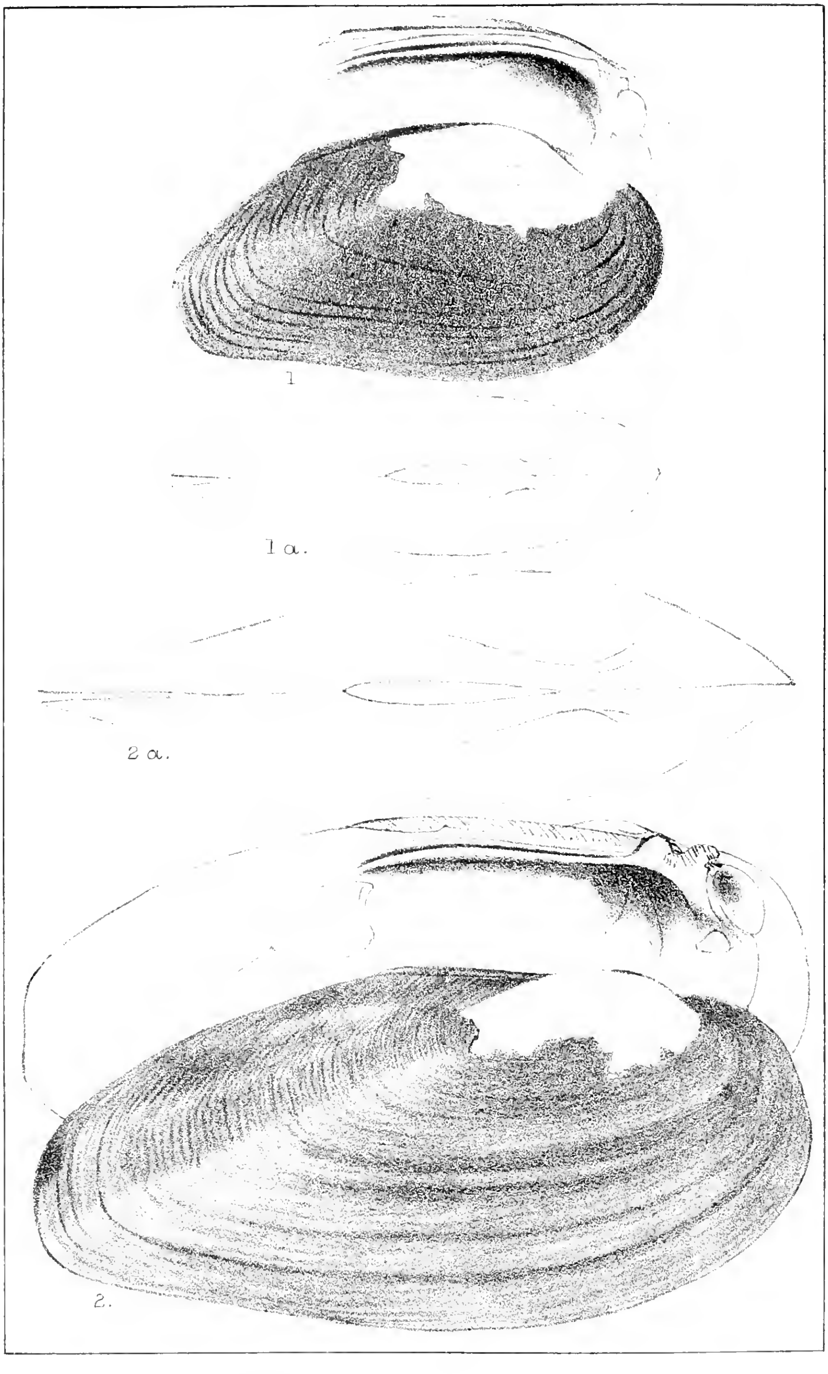


Wright on New Uniones.

MARCH 6.

Mr. THOMAS MEEHAN, Vice-President, in the chair.

Twenty-nine persons present.

Action of Hydrofluoric Acid on a Sphere of Quartz.—Dr. OTTO MEYER reported an experiment, which he had undertaken in connection with Mr. Sam'l. L. Penfield. A sphere of quartz was subjected to the action of hydrofluoric acid for more than two months. The acid dissolved the quartz, principally in the direction of the main axis and thus flattened the sphere. In the direction of the lateral axes the etching action proceeded with much less activity and at three places on the periphery the acid had not eaten away any of the material, but left the original surface of the sphere intact. These three places were situated at *one end* of each of the lateral axes, the result being a triangular disc. This experiment shows that a mineral may be soluble in a liquid in certain directions and on certain planes while at the same time insoluble in other directions and on other planes. Dr. Meyer exhibited the result, the object resembling a three cornered lens.—A more detailed account will be given elsewhere.

Remarks on the Phylogeny of the Lamellibranchiata.—DR. BENJAMIN SHARP brought forward some points regarding the classification of the Lamellibranchiata, and stated that in considering this group, a diversity of type was to be found that is equal to, if not greater than that found in any class of the animal kingdom, with the possible exception of the Hexipoda.

In examining the different forms, he pointed out two well marked extremes, *Ostrea* and *Aspergillum*. In the former as is well known, the two large unequal shells entirely cover the body, and they are closed by one large muscle, the adductor. The large and important organ, so common in the Lamellibranchiata generally, the foot, is entirely absent. The mantle edges are separated for nearly their whole extent, and there is no indication whatever of the mantle uniting to form a siphon.

In *Aspergillum*, on the other hand, the two shells are so diminutive, that they only cover an exceedingly small area of the animal's body, the siphon is enormously developed, and it is protected by a secretion of carbonate of lime, in which the shells are immovably embedded; the mantle is closed throughout its entire length, except at the anterior end, where there is a minute opening, and at the mouths of the two siphonal tubes.

His object in making the communication was to prove that these two very marked and different types of Lamellibranchiata arose from a common or what might be called a central type, and that a divergence from some cause set in, producing on one side the *Ostrea*, and on the other the *Aspergillum*.

As regards the whole class, he said there is no doubt, in his mind at least, that it is a degenerate one. Many anatomical and embryological facts, as well as their life habits, point to this, it being an acknowledged fact that fixed or stationary animals are as a rule degenerate. The loss of the head in all adult forms, the presence of eyes in the head area of some free swimming embryos, and their later total disappearence, are some facts that point unquestionably to the degenerate condition of the whole group.

As to the facts of geology pointing to this conclusion, he quoted from Prof. Heilprin's work on the "Distribution of Animals," p. 265. "Almost everywhere, the Cephalophora, or head-bearing mollusks, antedate by one full period the Acephala, or headless forms, which indisputably represent a lower grade of organism." By considering the group as degenerate, the conditions of the case are answered, for the Lamellibranchiata certainly came off from the Gastropoda, after the latter had become well established, as the anatomical and embryological facts show, and the geological evidence would seem to indicate this to be the case.

Assuming then, that the Lamellibranchiata have come off from the Gastropoda, Dr. Sharp then considered what was the form of the primitive type. It probably had a more or less developed foot, an organ that is present in all the Gastropoda, that it possessed gills on each side of the foot, that the mantle edges were separate and that two adductors were present of about equal size. This type has survived to the present day and, according to Lankaster (Art. Mollusca, Brit. Encl. p. 685), is represented by forms like *Nucula* and *Trigonia*. The former belongs to the family Arcidae (*Claus*) which is the oldest type that we know of, being found in the Silurian and Devonian. The shells of this family are equal; the adductor muscles of the same size, the mantle free, not being closed to form tubes like a siphon, foot well developed. The fulcrum of the shell is about equi-distant from the adductors. In following one branch from this toward *Ostrea*, it is found that one muscle, the anterior, gradually gets smaller, as is the case in *Mytilis*, and exceedingly small in *Pinna*, until in *Ostrea* but one muscle is present. From the fact that in this advance the animal becomes more and more fixed first by a secretion of the foot, the byssus, then by the shell itself, the foot gradually is less and less used as an organ of locomotion, until it entirely disappears in *Ostrea*. The retractor muscles of the foot, now practically useless organs, are however, still present.

The loss of one adductor muscle can probably be referred to mechanical causes. In studying the change of relation of the fulcrum to the adductors, he found that as the fulcrum moved forward (anteriorly) it increased the distance from the posterior, and lessened the the distance from the anterior muscle. As this took place, the muscle farthest from the fulcrum was always the larger, in fact it must of necessity be so, as more power was needed at this point, while the near one, from the fact that it does not require much power, diminishes in size. In *Pinna*, one muscle is very much, in fact four or five times, larger than the other; the smaller being close to the apex of the shell, in other words, close to the fulcrum.

As the fulcrum passes still farther forward, a point is soon reached when both muscles come in line with the fulcrum, the larger one in this case takes all the work from the smaller one, which from its now useless position degenerates to disappearance.

A proceedure from regular to irregular shell is to be seen in the fresh water forms. *Unio*, he held, is probably a fresh water *Mytilis*, which does not have any byssus present in the adult, but has one in the embryo. A form that closely resembles the oyster can be traced through *Aetheria* to *Muelleria*, the so-called fresh-water oyster. The later has both adductors in the embryo, but only one, like *Ostrea*, in the adult.

In passing now in the other direction, Dr. Sharp pointed out the stages connecting the central type to the extreme in *Aspergillum*.

In passing out from the central type, the Areas, the group known as the Syphonata appear, where besides the large foot, it is found that the aboral portion of the mantle has united at two or three points, forming one or two tubes. In some forms of *Lucina*, by the union of the mantle a single tube is formed, the so-called anal siphon, which corresponds to the superior one when two are present; through this passes the water outwards, the inflowing water passing in through the large space between the mantle edges, as in the asiphonated forms. In this form of *Lucina*, specialization has only determined the direction of the out-flowing current, which carries off the deoxygenated water and the exereta.

In *Cardium* the siphon is made up of two tubes; in other words, the ingoing and outgoing currents are now determined. The edges of the mantle commence to adhere, leaving room only for the protrusion of the foot. In *Venus* the arrangement is practically the same:—a well developed siphon, large wedge-like foot, which is a locomotor organ, a shell entirely covering the animal when it is closed and two well developed adductors, equal in size. The specialization in this line of development is in the direction of the siphon and closure of the mantle. *Mya* would represent a form, leading to *Solen*, here the siphon is large, the mantle more or less adherent, but the foot has degenerated to a useless organ and the form of the body still some what resembles *Venus*, the shell, however, gaping at the aboral or siphonal end.

In *Solen* the edges of the shells cannot be brought together, or they gape, as it is said. In this form the new type has become established, and the animal resembles a cylinder; the large siphon fills up the aboral or gaping portion of the shell, while the boring foot fills up the oral pole of the shell, the mantle being nearly closed between the foot and the siphonal openings.

The shells of *Macha* are small for the body, and the siphons are so large that they cannot in any way be drawn into the shell, a large portion of the mantle also is without the limits of the shell, so that the edges of the shell do not even touch in life.

In *Teredo*, no hinge teeth are present, nor is even a ligament formed, an organ that is present in all other Lamellibranchs, except the members of this family and the next one to be considered; besides this a new element is found, namely accessory shell pieces. The enormously developed siphon, is four or five times the size of the rest of the body. The mantle edges are firmly united except at the oral pole where the boring foot protrudes, and at the openings of the siphon. The true shells as well as the accessory pieces are movable, that is, not united with the calcareous secretion of the mantle.

In *Gastrochaena* the shells are very small, but still movable, the animal being enclosed in a calcareous shell, the secretion of the siphon. In *Clavagella*, a similar form, one shell is welded to the siphon shell, the right one only being free, and in the extreme form of *Aspergillum*, both shells are immovably fixed in the shelly tube that encloses the animal.

The fresh-water forms *Cyclas*, *Cyprina etc.*, are probably related to *Cardium* and have received their new forms by moving into fresh water.

In summing up, Dr. Sharp showed two branches in the Lamellibranchiata, one going off from a form related to *Arca* the other toward *Ostrea*, the fulcrum moving from a position between the two equally large adductors, toward the oral pole of the body. This brought the anterior adductor in a line with the fulcrum and posterior adductor, where, being of no use, it disappeared.

In the other direction, development is in the antero-posterior direction, the shell, however, not taking part in the growth until a form is reached where the shell is exceedingly small and the animal protected by a supplementary deposit of carbonate of lime.

MARCH 13.

Mr. CHARLES ROBERTS, in the chair.

Seven persons present.

MARCH 20.

The President, Dr. JOSEPH LEIDY, in the chair.

Habit of Cirolana concharum.—Prof. LEIDY said that he yesterday went to Atlantic City, in the expectation of finding interesting specimens cast ashore in the recent storm; but there proved to be nothing.

He picked up a few recently dead Lady-crabs, *Platyonichus ocellatus*, and found in them a number of the *Cirolana concharum*, feasting upon the flesh and other parts, as he had previously noticed them feeding on the edible crab. See page 80. From these observations it would appear to be the usual habit of the *Cirolana* to prey on dead crabs and probably other animals.

Parasites of the Striped Bass.—Prof. LEIDY exhibited numerous specimens of a minute crustacean parasite from the gills of the Striped Bass or Rock-fish, (*Labrax lineatus*), brought to our market. He said it is a common parasite and he had been familiar with it since 1851. It was described by the Danish naturalist, Dr. Henrik Kroyer, under the name ot *Ergasilus labricis*, obtained from the same fish at Baltimore. (Danske Naturh. Tids. 1863–4, 303, Tab. xi, fig. 2). Common as it seems to be Mr. R. Rathbun, in his published list of the parasitic Copepoda from American waters, says he had not observed it, (Proc. U. S. Nat. Mus. 1884, 483). The little crustacean lives suspended on the outer surfaces of the gills, where it is conspicuous, from the white color of its thorax and egg-pouches on the red color of the gills. The length of the parasite together with its egg-pouches is 2·125 mm; without the latter 1·25 mm.

Prof. Leidy further exhibited portions of two intestines of the same fish with numerous attached worms pertaining to *Echinorhynchus proteus*, which infested many fishes, both of fresh and salt water, of Europe. It is not only a frequent and abundant but a constant parasite of our Striped Bass. It ranges from 5 lines to an inch in length. The young ones are white; the older have the body yellow, bright orange, or brownish orange, with a white neck and proboscis, which together are one fourth the entire length. Diesing attributes to the proboscis 8 to 10 rows of hooks, but Dujardin gives double the number, and this accords with the condition observed in our specimens. The parasite lives in the large intestine with the proboscis and neck together embedded in the wall and the body suspended in the cavity. The proboscis and bulbous commencement of the neck together protrude externally and form on the outside of the intestine brown pyriform tumours, giving to the organ a peculiar tubercular appearance. The worms exhibit the following characters: Body widest at the commencement, where it is rounded and slightly constricted from the rest, which tapers to the posterior obtuse end. Proboscis cylindrical but expanded at the middle and base. Neck very long, bulbous at the commencement becoming narrow and cylindrical and a little dilated at the base; smooth throughout. Length of a large one 24 mm; proboscis and neck 6 mm; proboscis 1·25 mm long, 0·175 thick, 0·25 at middle expansion; bulb of the neck 1 mm, narrow part below 0·375 thick, at base 0·5 thick. Body at commencement 2 mm thick, near posterior end 1 mm thick.

MARCH 27.

The President, Dr. JOSEPH LEIDY, in the chair.

Twenty-five persons present.

A paper entitled "Notes on the Myology of Ursus maritimus," by Edw. A. Kelly, was presented for publication.

Trematodes of the Muskrat:—Prof. LEIDY stated that in the collection of the Academy there is a vial labelled "worms from the duodenum of the Muskrat." There are 25 worms, and in their present condition they are pale brown bordered by dark brown, and measure from 12 to 18 mm long by 1 to 1·5 mm broad. If not identical, they are closely allied to *Distomum echinatum*, which in the mature state lives in ducks and other water birds and in the larval state in fresh water snails. The Muskrat eats the latter so that it may likewise become infested in the same manner as the ducks and this would also seem to make it probable that the parasite is the same. Dujardin, Wedl, and others describe *D. echinatum* as having the fore-part of the body echinate, which is not the case with the Distome of the Muskrat, though in both the head is armed in the same manner and with the same number of spines. Its characters are as follow.

Body long, flattened, band-like, with the neck tapering and the tail obtusely rounded. Head reniform, with a coronet of strong straight spines, from 30 to 36. Ventral acetabulum much larger than the head, situated at the base of the neck a short distance behind the latter, spherical. Body of nearly uniform width. Oral acetabulum small; pharynx oval; intestines simple and narrow. Genital orifice immediately in advance of the ventral acetabulum; cirrus exsert to one side, curved and smooth; testes situated almost midway between the ventral acetabulum and tail; oviducts median behind the ventral acetabulum; ova oval, yellow; vitelline glands large and conspicuous, racemose, extending along the intestines from the ventral acetabulum to the end of the tail.

Head 0·5 to 0·6 broad; spines about 0·1 long by 0·02 thick; oral acetabulum 0·25; pharynx 0·3 long, 0·225 wide; ventral acetabulum 0·875 to 1·25 mm. Ova 0·1 long by 0·072 broad.

Since the above communication a collection of worms, from the small intestine of a Muskrat, has been received. Eighteen of the worms pertain to the supposed *Distomum echinatum*, and range from 18 to 25 mm long. In all, the fore part of the body to a short distance behind the ventral acetabulum is finely echinate, while the rest is smooth. Two other worms appear to belong to *Amphistomum subtriquetrum*, 12 and 15 mm long, a parasite previously observed only in the Beaver of Europe.

Entozoa of the Terrapin.—Prof. LEIDY stated that he had on one occasion examined eight of our much esteemed food Terrapins, to ascertain the character of their parasites. All were found to be infested with an Echinorhynchus, living in the small intestine and clinging by the thorny head to any part of the canal. The worms ranged from six to sixteen lines in length and in numbers from five to upwards of two hundred. The species is *Echinorhynchus hamulatus* originally described from several of our fresh water turtles. (See these Proceedings 1856, 48.)

In three of the Terrapins occurred a red thread worm, also living in the small intestine and associated with the former, and like them clinging, by their armed mouth, to the mucous membrane. The species is the *Cucullanus microcephalus*, the males up to nine lines, the females from twelve to sixteen lines. In one Terrapin there were eight, in a second over a hundred, and in the third upwards of several hundred. They extended all along the intestine but were most numerous at its upper part. The females are viviparous and contained living young.

In one Terrapin only, also in the intestine, there were two flukes, the *Amphistomum grande*, about half an inch long.

In the bladder of another Terrapin there was a single *Polystomum*, 3·5 mm long, probably *P. oblongum*, first described by Prof. Wright, of Toronto, from an individual obtained from the bladder of the Musk Turtle, *Aromochelys odoratus*.

In another Terrapin he had found four Polystomes of which three were in the throat and the other in the nose. These pertain to a different species from the former and may prove to be the *Polystomum ocellatum*, found in a similar position in the European Turtle, *Emys europaea*. At the genital outlet of *Polystomum* situated ventrally at the fore-part of the body, the cirrus is surrounded by a circle of hooks. In *P. integerrimum*, the species best known, and found in in Europe, living in the bladder of Frogs, the genital circle is composed of eight hooks. Prof. Wright ascribes sixteen hooks to the circle of *P. oblongum*, and this accords with the number in the Polystomum from the bladder of the Terrapin. In the other Polystomes of the latter he found the circle to be composed of thirty-two hooks. Siebold says there are forty hooks to the circle in *P. ocellatum*. Dr. Zeller figures the latter, from a sketch of Siebold, in which the caudal disk is represented as having two large hooks and eight small ones between the posterior pair of bothria. In the allied Polystomes of the Terrapin the number and arrangement of the hooks of the caudal disk is the same as represented in Prof. Wright's figure of *P. oblongum*. If then we have a correct record of the facts, the Polystome of the fauces of our terrapin may be regarded as another species which may be distinguished as follows:—

POLYSTOMUM CORONATUM. Body when elongated lanceolate. Caudal disk wider than the body, cordiform, with three pairs of bothria and with the body attached between the anterior two pairs; changeable in form to oblong, circular or quadrate; with three pairs of minute hooks between the anterior pair of the bothria and with a larger pair and two small pairs between the last pair of bothria. Genital aperture with a circular or a transverse oval coronet of thirty-two hooks of equal length. No eyes visible. Length elongated from 4 to 6 mm.; contracting to about half the length and widening proportionately.

Besides the foregoing there was found in the intestine of one of the Terrapins a little Distome, of 3 mm. length, which though mature he had not the leisure to examine. He also observed in the throat of one a number of little anguillula-like worms which he likewise did not examine.

In all the Terrapins the flesh, liver, and other parts than those above mentioned were entirely clear of parasites; therefore in preparing these animals for food it is easy to free them from the latter by rejecting the head, intestines and bladder; or if it is thought desirable to use the intestines they should be slit open and cleansed of the contents.

Prof. Leidy added that he had recently found in the collection of the Academy, a bottle labelled "alimentary worms in terrapin." These proved to be seven bot-larvæ like those described and exhibited at a former meeting. (See Proc. 1887, 393.)

Messrs Lancaster Thomas, John B. Deaver and Gerritt H. Weaver were elected members.

The following were ordered to be printed:—

NOTES ON AN AQUATIC INSECT, OR INSECT-LARVA, HAVING JOINTED DORSAL APPENDAGES.

BY ADELE M. FIELDE.

I have found here (at Swatow, China) in May and June, the temperature of the air being about 80° F., in still pools of fresh, living water, an insect or insect larva, having upon its back four longitudinal rows of jointed appendages, of nearly the same length as the body of the insect, and capable of being raised, lowered or bent, either by the insect or by external pressure. During this year and last year, I have found over a hundred specimens, varying from $\frac{1}{8}$ to $\frac{5}{8}$ of an inch in length. *Rotifera*, *Vorticella* and *Oscillatoria* with shreds of vegetable fibre, were attached upon and among the appendages. The color varies with the habitat, from pale green to black. As it slowly crawls upon water-plants, it resembles a minute porcupine; but it is discerned with difficulty, because of its similarity to its vegetable environment. I have caught my specimens in only one way—by taking from the pool, in which I hoped to find them, a quantity of the water and algæ, and keeping these in a basin till the staleness drove the insects to the sides of the vessel, where they escaped the sinking, decaying raft in which they had been concealed. Several of the larger specimens found have been kept alive for more than a month, in a soup plate in which the water was daily changed. They appeared to feed on microscopic objects, probably the heliozoans, rotifers and infusorians, which swarmed on the plate. They neither grew nor moulted within the month, and finally died, oppressed and perhaps suffocated by the diatoms that stood out like branches from all their appendages, making them look like moss. That these creatures moult in growing is proven by the exuviæ of varying size, found in the waters they naturally inhabit.

The head is flat, with a pair of large eyes, made up of clusters of six ocelli, projecting from the sides. The antennæ are short, six jointed, and just in front of the eyes. The biting mouth-parts are strong and horny. The three thoracic segments bear three pairs of six-jointed legs, ending in a long claw. All are used deftly in clearing the back from parasites. The second pair is double the length of the first pair, and the third pair a little longer than the second. The abdomen has nine segments, with the prominent vent on the ventral side of the posterior segments, which bears two sharp jointed styles, nearly as long as the body. The number of joints in the anal styles vary from 7 in an individual $\frac{1}{8}$ of an inch long to 11 in an individual $\frac{1}{4}$ of an inch long. The general shape of the body is cylindrical, tapering posteriorly, with the ventral surface flattened. All the segments, except the last, bear, on the dorsal half, four tapering, jointed tubes, containing branches of the trachea. The number of joints in each of these appendages vary from 12 to 17 in a specimen $\frac{1}{4}$ of an inch in length. In a specimen $\frac{1}{6}$ of an inch long there were 7 joints in each dorsal appendage. The main tracheal trunks run one on each side, between the proximal ends of the two rows of appendages, through which they send long, straight branches.

Plate VIII.

Fig. 1. The insect, or larva; actual length $\frac{1}{4}$ inch; anal style and dorsal appendages about $\frac{1}{4}$ inch; first pair of legs $\frac{7}{200}$ inch; second pair $\frac{14}{200}$ inch; third pair; $\frac{16}{200}$ inch.

" 2. Jointed dorsal appendage, showing the relative length of the joints; actual length $\frac{42}{200}$ inch; width of basal joint $\frac{3}{200}$ inch; number of joints, fourteen.

" 3. A joint highly magnified, showing the tracheal tube which runs to the distal extremity of the appendage.

" 4. Antenna, six jointed; total length $\frac{1}{80}$ inch.

" 5. Dorsal aspect of head; actual width $\frac{6}{200}$ inch.

" 6. Ventral aspect of head; actual length $\frac{5}{200}$ inch.

" 7. 8. 9. 10. Oral appendages, magnified.

" 11. One of the first pair of legs, actual length $\frac{7}{200}$ inch.

" 12. One of the second pair of legs: actual length $\frac{14}{200}$ inch.

" 13. Anal style, actual length $\frac{35}{200}$ inch, on specimen $\frac{3}{16}$ of an inch long.

SOME NEW SPECIES OF FOSSILS FROM THE NIAGARA SHALES OF WESTERN NEW YORK.

BY EUGENE N. S. RINGUEBERG M. D.

In the following descriptions of seven new species from this vicinity will be found representations from the three divisions of the Niagara Shale including three genera which I believe to be new to the Niagara of this State i. e. *Mariacrinus*, *Hyolithes*, and *Plumulites*. The specimens were all collected at Lockport and the types are in my collection.

Buthotrepis gregaria. (n. sp.) Pl. VII, fig. 1.

Plants small, gregarious, each separate plant growing in an irregularily radiating manner from a central point, commencing in several original trunks which rapidly branch out without any system or observable regularity, by bifurcations and lateral shoots. Diameter of the radiating fronds as spread out, from two to three and at times four c. m. It is however hard to get accurate measurement on account of the habit of this fucoid of growing in little clumps containing many individual plants, whose branches often interlace in a confusing manner. Its growth in different directions is rather irregular; sometimes one branch seems to out-grow all the rest, or again two opposite will spread out till the plant is twice as wide in one direction as in the other. The radiate arrangement, however, seems to be quite constant. Thickness of the branches averages about one millimeter.

This curious little fucoid is readily recognized by its radiate growth, which together with the size of the branches seems to be quite invariable—and also by its habit of growing in little clumps, occasionally specimens may be found which seem to grow upon the branches of some of the stouter fucoids; such as *Buthotrepis gracilis* var. *crassa*, Hall.

Found in the harder shale bands from the middle third of the shale at Lockport N. Y.

Inocaulis anastomotica (n. sp.) Pl. VII, fig. 2.

Frond flabelliform or possibly circular or cyathiform in the perfect state.

It is composed of large coarse branches, the principal ascending ones of which are from two to three millimeters in width, with smaller lateral branches and tips. Whole frond united by frequent anastomoses into an irregular network. The branches seem to anastomose as frequently by the growing towards each other of two adjacent branches; these unite whenever they chance to meet into a common branch, which grows upwards and bifurcates as before; as by the more slender diagonal connecting filaments.

By reason of this peculiar mode of growth no single branch can, as a rule, be traced for any considerable distance as maintaining its identity, for as it bifurcates each bifurcation is often met by that from the adjoining two branches and they, by uniting, form a single branch; at the outer margin the branches taper down and terminate in from two to more sharp points, or serrations.

Surface of the branches marked by strong, irregular longitudinal wrinkles, which at times seem to assume a semi-scabrous character. Margins of branches rarely present a slight serration or roughness; and in places where portions of the black corneous branches have scaled off the cast shows the obverse side to have the same character as the other.

The openings in the network are of various sizes and shapes but mostly oval or fusiform, no two being alike.

The type specimen presents about one third of the circumference of a circle and measures nine c. m. from the margin to as near the center as is preserved and which judging from the angle of radiation of the branches could not be more than one c. m. further.

There is some hesitancy in placing this species in this genus because all the forms which we are acquainted with are rather loosely branching with few if any anastomoses or reticulations. Still the character of the branches so closely resembles those belonging to this genus that I am constrained to place it here.

From the lower third of the shale at Lockport ranging as high as the Homocrinus band.

Only two fronds have been found in which the margin is preserved, and both seem to represent portions of a quite regular circle.

Dendrocrinus celsus (n. s. p.) Pl. VII, fig. 3.

Calyx elongate, cylindrical, slender, quite evenly tapering from the insertion of the brachials to the base which is of the same size as the last joint of the column.

Height to top of first radials seven millimeters. Width of base two millimeters. Width of top of calyx not quite six millimeters. Arms branched, without pinnules. Under-basals much higher than wide, slightly arched transversely giving the base of the calyx a moderately pentagonal form which is shared by a few of the upper joints of the column.

Basals long.

First radials wide and short with a deep horse-shoe shaped articular facets in the center of the upper margin which arches strongly outward to conform to this facet which is directed upward and outward for the reception of the brachials. These are about eleven in number before any bifurcation takes place. One ray is observed to bifurcate twice above this point. Only the anterior sides is as yet known.

Column round, long, thick in its lower portion where it is quinque-partite; it gradually tapers as it ascends till within a short distance below the calyx where it is less than half of its original thickness, and here its quinque-partite character disappears; and it continues of the same thickness for some distance till within four millimeters below the cup when it again commences to enlarge, finally becoming sub-pentagonal just before reaching the calyx. Length of column twenty centimeters—diameter near base about two and one half millimeters; at a short distance below calyx about one millimeter.

Radix tapering, inclined to one side and throwing off lateral rootlets from the under half; it has been traced for about two centimeters but evidently was somewhat longer.

This species is readily distinguished from *D. longidactylus* Hall, which is found in this group by the elongated calyx with its much higher basals and underbasals also by having about twice as many brachials before the first bifurcation takes place, and by having a sharper ridge in the first series; being there much like those above the first bifurcation in the former. The peculiar character and appearance of the brachials are almost sufficient to mark it as a *Dendrocrinus*.

The calyx was carefully scaled out of its matrix but unfortunately the posterior side was found to be so crushed in as not to admit of an accurate discription.

Mariacrinus warreni (n. sp.) Pl. VII, fig. 4.

Calyx inverted penta-pyramidal, irregularily expanding from the base to the second bifurcation of the radials, at which point it is, in the type specimen, thirteen millimeters high; angles sharp with strongly projecting, heavy, rounded carinae, the surface of which is crossed by well defined, and generally transverse, rugae.

Surface of the radial plates transversed by coarse radiating ridges of which there are four or five on both sides of the central elevation in each of the radials, surface between the ridges seems to be quite smooth, although so much difficulty was experienced in removing the adherent shale that this point could not be decided accurately. The interradial and inter-axillary plates have less prominent ridges ornamenting their surface.

Arms long, slender, of nearly equal diameter till near the tip, where they are very gradually tapering to a quite acute termination; surface smooth. Length about six centimeters, pinnules very delicate from five to seven millimeters long at the lower portion; rapidly shortening at the tip of the arm.

Column stout, as thick as the base of the calyx, at that point, from which it evenly tapers as far as it is preserved, which is about twelve centimeters, to one half its diameter at the calyx. Joints with rounded central projections, which are not quite so wide as the joint is long.

This species differs from *M. carleyi*, Hall, with which it agrees in the general size and contour of the calyx, principally in the surface ornamentation; it having a smoother surface and more numerous radiating ridges on the radial plates, and they are also thicker than in the former and the base is somewhat wider.

This specimen is from the upper third of the shale, and is associated on the same slab with the *Dendrocrinus* just described, its column lying across that of the former. This unique slab was found and presented to the author by W. H. Warren Esq. of Lockport, after whom the species is named.

Orthis acutiloba (n. sp.) Pl. VII, fig. 5.

Shell bilobate, obversely cordate in outline, apex semiacute. Both valves have a deep and sharp mesial depression thus forming an acute notch in the anterior margin. Hinge line very short, terminating in small sloping auricles which are scarcely noticeable when the shell is viewed from the ventral side.

A profile view shows the ventral side to be strongly convex with the beak of that valve projecting far beyond the other and somewhat outward, while the dorsal profile is sinuous, being slightly concave immediately behind the umbo and convex anteriorly. Length and breadth each five millimeters.

Dorsal valve with umbo but slightly projecting beyond the hinge line, outer profile having an S like or line of beauty curve, with the concavity at the apical end and the convexity anteriorly; inner or marginal profile regularly convex. Area small. Ventral valve strongly convex in profile, inner profile concave; area triangular, as high as wide, with the foramen occupying one-half of its width. Surface marked by strong radiating striations which seem to increase mostly by interstriation: they are from ten to twelve to fifteen in number on each lobe at the margin. These are crossed by lines of growth which vary in distance from each other and increase in definition as they approach the margin.

This little shell belongs to the same group of orthidean forms as *Orthis biloba* Lin. Pl. VII, fig. 6. and *O. varica* Con., and when first found was regarded as an example of the former, but upon comparison with some Wolcott, N. Y. specimens it was found to differ much more from that and *O. varica* than they do from each other. The principal points of specific distinction are the more elongate outline of the shell with longer and more pronounced lobes; a deeper anterior sinus, more acute rostrum and a greater disparity between the size and curvature of the two valves; and a hinge line which is comparatively only about one-half as long as that of the species under comparison. Only two perfect specimens have been found, but occasionally a single valve is seen imbedded in the shales of the middle and lower thirds at Lockport.

Not a single individual of *O. biloba* has fallen under my observation from this vicinity.

Hyolites subimbricatus, (n. sp.) Pl. VII, fig. 7.

Shell conical, sides regularly sloping from acute apex, aperture about half as wide as height of shell. Surface marked by very faint and closely arranged minute longitudinal striæ, which are crossed by irregular transverse striæ placed at various distances apart, with occasional stronger lines of growth which at times take on a slightly imbricating character.

On account of the partly flattened condition of the only example thus far secured, the exact angle of divergence of the sides from each other, and the outline of the aperture cannot be ascertained.

This species bears some resemblance to *H. columnaris* of Barrande, as figured by him, but the longitudinal striæ are very much finer and more closely arranged, so that they are hardly noticeable except under a lens, and the shell is not so tapering.

Plumulites gracilissimus, (n. sp.) Pl. VII, fig. 8.

Plate exceedingly frail and delicate. Phylliform base broad, evenly tapering to an acute apex, curved laterally, one margin slightly concave or nearly straight, the other quite convex; this latter side is considerably shorter than the other, thus giving an upward slope to the base towards this side. Surface ornamented by a median narrow ridge which follows the same general curve as the plate and tapers to a point at the apex. On the longer half of the plate, as divided by the median elevation, there is a secondary filiform ridge or striation subdividing that portion into two equal halves; it extends from the base upwards towards the apical end, finally becoming lost before reaching it.

These two longitudinal carinæ are crossed by twelve or more transverse lines which curve downwards in the centre from the two sides towards, and having the same contour as, the margin of the base; they are equi-distant and are placed about as far apart as the width of the central elevation. Length six millimeters.

This species approaches *P. minimus* Barr., in size, but is more elongate like *P. delicatus* Barr., from which it differs in having a narrower central elevation. Its fine lateral striation which again subdivides the longer lateral half is quite distinctive.

From the lower third of the shale at Lockport only separate plates have as yet been found.

Explanation of Plate VII.

Fig. 1. *Buthotrepis gregaria*, n. sp. One individual from the type slab.

Fig. 2. *Inocaulis anastomotica*, n. sp. Portion of the type frond.

a. Terminal of a branch from another portion of the frond enlarged.

Fig. 3. *Dendrocrinus celsus*, n. sp. Specimen with only a portion of the column represented.

a. Fusiform enlargement observed near the centre of the column.

b. Portion of column near root.

c. Root.

Fig. 4. *Mariacrinus warreni*, n. sp. Calyx with a portion of the column; the rest has been omitted, except:—

a. The portion at its termination showing its peculiar spiral ending.

Fig. 5. *Orthis acutiloba*, n. sp.

a. Ventral view enlarged three diameters.

c. Dorsal view enlarged three diameters.

d. Profile view enlarged three diameters.

Fig. 6. *Orthis biloba* Lin. Outline of a species from Walcott, N. Y. in my collection to show the difference in contour from *O. acutiloba*.

Fig. 7. *Hyolithis subimbricatus*, n. sp.

Fig. 8. *Plumulites gracilissimus*, n. sp.

a. Same enlarged three diameters.

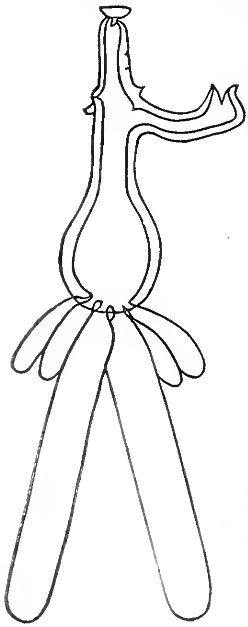
APRIL 3.

The President, Dr. JOSEPH LEIDY, in the chair.

Twenty-two persons present.

A paper entitled "Researches on the General Anatomy and Physiology of Nerves and Muscles, No. II." By Henry C. Chapman M. D. and Albert P. Brubacker, M. D. was presented for publication.

A Crustacean Parasite of the Red Snapper.—Prof. LEIDY remarked that in the examination of the fish called the Red Snapper, *Lutjanus Blackfordi*, brought to our market from Florida, he had observed a curious crustacean parasite adhering to the throat about the pharyngeal bones. It appears to be an undescribed species of *Anchorella*, which, from its having a bundle consisting of half a dozen posterior appendages, including a pair of large egg pouches, may be named A. FASCICULATA. The animal is milk white, though in the fresh condition the egg pouches are slightly reddish, and it is about half an inch long, including the latter. The body is pyriform with its long axis in the same line with the single suspensory arm, and with the head and neck curved outward and a little downward to one side. The head is bird-head-like in shape, with beak directed upward and furnished with two pairs of minute maxillipeds. The suspensory arm, or brachium, about as long as the head and neck together, is straight and is surmounted by a button, which is sessile and internally striated. At the base of the brachium on each side there is a minute papilla. The posterior appendages consist of two long cylindrical egg pouches and on each side two much shorter sausage-like pouches. The adjoining figure is an outline of the parasite magnified six diameters. Twenty-five were obtained from one fish. Measurements of a specimen are as follow: Length of body with brachium 2·5 mm; length of brachium 1·25; of head and neck 1·75; head 1· by 0·625; breadth of body 1·375; length of egg pouches 4·, thickness 0·625; length of short pouches 1·625 and 1·25. Clinging to the head of one of the females of the *Anchorella* was a minute male measuring 1·125 mm. in length. With the Anchorellæ was found a single specimen of *Caligus* which closely resembles



Anchorella fasciculata
(6 diam.)

the *C. nanus*, Kroyer, if it is not identical with it. It is 1·125 mm. long. The cephalothorax is about as wide as it is long 1·875 mm.; the first abdominal segment is obcordate 1·5 long and 1·25 wide; and the second long and narrow 1·375 long and 0·375 wide. The cephalic bothria 0·25 diameter.

APRIL 10.

Mr. USELMA C. SMITH, in the chair.

Nine persons present.

APRIL 17.

Mr. THOMAS MEEHAN, Vice-President, in the chair.

Twenty-nine persons present.

The following papers were presented for publication:—

"Distinctive Characters of Odontaspis littoralis." By Joseph Leidy, M. D.

"Parasitic Crustacea." By Joseph Leidy, M. D.

Note on Eleonorite from Sevier Co., Arkansas.—Prof. GEORGE A. KOENIG submitted his identification of Eleonorite. This species occurs in cavities of Dufrenite and likewise intimately interlaminated with it. It is of deep blood red color and gives a yellowish streak. The habitus is prismatic columnar, the prisms showing strong vitreous lustre and pleochroism—light yellow, in one direction, deep red brown in a direction at right angles. On the very scant material at the author's disposal, no planes are sufficiently developed to allow of an identification of the crystallographic characters. The specific gravity was found = 2·949. The crystals can be heated in a mattras to red heat without decrepitation, without change of color, lustre and shape, while yielding a strong condensation of water. Reactions for iron and phosphoric acids. The mineral is slowly dissolved in nitric acid, rapidly in hydrochloric acid. The iron is entirely *ferric*. The water is completely expelled at 250°C. Owing to the scantiness of the material, the analysis was made with only 54 mg. of the mineral.

This quantity yielded: water = 8 mg; $Mg^2 P^2 O^7$ = 26·3 mg. $Fe^2 O^3$ = 26·8 mg.; $Al^2 O^3$ = 2 mg. In percentage

$$\begin{aligned} H^2O &= 14{\cdot}81 \\ P^2O^5 &= 30{\cdot}93 \\ Fe^2O^3 &= 49{\cdot}60 \\ Al^2O^3 &= \underline{4{\cdot}50} \\ & 99{\cdot}84 \end{aligned}$$

This furnishes the ratio

$$P^2O^5 : (Fe, Al)^2O^3 : H^2O = 1 : 1{\cdot}625 : 3{\cdot}78$$
$$= 2 : 3{\cdot}23 : 7{\cdot}56$$
$$= 2 : 3 : 8$$

hence the formula $Fe^6P^4O^{19} + 8\ H^2O$. This is the formula established by A. Streng (Zeitschr. f. Kryst. and Min. Vol. 7, p. 398). Groth deduced from it the theoretical formula $Fe^3\ (HO)^3\ (PO^4)^2$. $2\frac{1}{2}\ H^2O$. (Tabell. Uebers. d. Mineral. Braunschweig 1882.) In view of the fact that the whole of the water escapes at 250°C. without change of color or structure, Groth's formula, assuming three molecules of hydroxyl, can not well be sustained. The water must be considered wholly as water of crystallization.

Eleonorite has heretofore been known but from one locality, the "Eleonore" iron mine near Giessen, in Germany. Some specimens are in Mr. C. S. Bement's collection, with which the author compared the mineral from this new locality. It was first announced by A. Nies in 1880 (Ber. d. Oberhess. Ges. fuer Natur. u. Heilk. No. 19.) and subsequently studied by A. Streng, who determined the symmetry as monosymmetric and established the formula given above.

April 24.

Mr. John H. Redfield, in the chair.

Twenty-nine persons present.

Samuel H. Friend, M. D. was elected a member.

The following were ordered to be printed:—

NOTES ON THE MYOLOGY OF URSUS MARITIMUS.

BY EDWIN A. KELLEY.

The subject of these notes was a young female polar bear, probably about three years old, which recently died at the Zoological Gardens in Philadelphia, and was received at the University through the courtesy of Mr. A. E. Brown, Superintendent of the gardens. The animal measured about four and a-half feet from nose to root of tail; it had been rather roughly skinned and eviscerated, so that little could be ascertained concerning the panniculus, abdominal and perineal muscles. My attention was given mainly to the limbs, and I have here mentioned only such muscles as seemed to present noteworthy characters.

NECK. *Splenius* commences in fascia at the second dorsal vertebra and its muscular area diverges from the middle line until at the point of insertion, on the lambdoidal ridge, it is over two inches distant from its fellow of the opposite side.

Trachelo-mastoid rises from the fourth cervical to the first dorsal vertebra, blends more or less with the splenius anteriorly and shows a tendinous inscription opposite the axis.

Complexus has a small separate slip from the fourth cervical, and behind that rises in common with the trachelo-mastoid to the first dorsal.

Transversalis cervicis inserts as usual into the last five cervicals and a *complexus tertius* runs from the second, third and fourth cervicals to the transverse process of the atlas.

Sterno-mastoid is a stout muscle which blends with its fellow for about a third of the way up the neck; at the level of the shoulder it divides into two bellies, a postero-internal one which continues to the mastoid process, and a more slender antero-external head which runs forward and outward, crossing obliquely the cleido-mastoid, and blends with the adjacent cephalo-humeral.

Cleido-mastoid has its usual relations, rising in common with the sterno-mastoid and diverging from it about the middle of the neck, to insert into the deep face of the cephalo-humeral at the shoulder; it is much more slender than the sterno-mastoid.

Omo-hyoid is a well developed ribbon about three quarters of an inch in width, which rises from the anterior border of the scapula, some distance back from the coracoid process, and follows a gently curved line to the basi-hyal bone.

Stylo-hyoid pursues its usual course transversely across the surface of the digastric, to insert into fascia, just anterior to the basi-hyal bone, being at that point over an inch in width. On the left side there was inserted in common with it, a muscular slip about $\frac{1}{8}$ in. wide, which ran outward *beneath* the digastric and finally was seen to rise in common with the latter; this little band was not present on the right side.

Shoulder and Arm. *Rhomboideus major* and *r. capitis* are united for half way up the neck; the former continues by fascia to the region of the atlas.

Cephalo-humeral as it proceeds towards the arm receives first the slip from the sterno-mastoid and then the insertion of the cleido-mastoid; it shows at the latter point no tendinous intersection and consequently the insertion of the muscle is the only indication of a distinction between trapezial and deltoid elements. Further down it blends with the pectoralis and scapular deltoid, and inserts on the lower half of the humerus, without showing any tendency to fuse with the brachialis anticus.

Acromio-trachelien, inserting on the metacromion, rises not only from the transverse process of the atlas, but also by a separate belly $1\frac{1}{2}$ in. long from the rectus anticus major.

Teres minor was stated by Professor Shepherd[1] to be indistinguishable from the infra-spinatus in his specimen of the American black bear. In the present subject this muscle was quite distinct, running more than half way back on the axillary border of the scapula; it inserted into the centre of the outer side of the great tuberosity, while the infra-spinatus ran about an an inch further on. I also found the muscle distinct in a young black bear, which I had the opportunity of examining.

The common tendon of *teres major* and *latissimus dorsi* shows very clearly up to its insertion the distinction between the two elements composing it.

Pectoralis. At first sight the superficial aspect of the pectoral seems to be formed by one unbroken muscular mass (*pectoralis major*) which rises along the entire length of the sternum, a distance of 13 inches, and behind this for several inches on the abdomen, where its inner border diverges somewhat from the middle line. From this extensive origin, its fibres converge toward the middle of the hu-

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[1] Myology of the American Black Bear. Jour. Anat. and Phys. Vol. XVIII, p. 108.

merus, and blending with the cephalo-humeral at a point $3\frac{1}{2}$ inches from the head of the humerus, are inserted in common with the latter on the outer lip of the bicipital groove for a distance of 4 inches. Beginning at a point 8 inches from the manubrium and 3 inches from the middle line of the sternum, its posterior border begins to be involuted, and this fold becoming deeper as it goes outward is finally inserted by an aponeurosis 2 inches wide, immediately beneath the superficial layer.

The posterior (" deep") division of the anterior thoracic nerve appearing at the anterior edge of this fold, runs backward over its superficial aspect to the line of folding and then turns forward on the deep surface of the main superficial mass, where it is finally lost.

Upon close inspection the posterior border of this mass is seen to be split off as a separate band, which is several inches wide at its origin, comprising most of the part rising from the abdominal muscles, but rapidly narrows as it passes outward until it is only about $\frac{3}{4}$ inch wide. This ventro-humeral slip is carried under with the fold just mentioned, forming at first its anterior edge; out toward the insertion, however, the widening fold extends itself between the ventro-humeral and the superficial pectoralis major, so that for a space its edge coincides with that of the former, and finally, the ventro-humeral, instead of forming the anterior border of the involution, comes to occupy the middle of its deep surface; the two blend and insert in common. The fold is thus seen to be complete without the ventro-humeral slip, though the latter appears to be an intrinsic part of it. The ventro-humeral and the main superficial mass (p. major) are quite distinct down to their origins, but the line between them is so obscure as to have escaped my notice at first.

The concavity of the involution shows a disposition to split off a number of narrow fasciculi. The outer edge of the posterior end of the ventro-humeral approaches closely to the latissimus dorsi, but there appears to be no connection between them. As, however, the skinning had been rather deep behind the axilla, there might have been connecting slips in that region which did not show in the specimen.

The distal end of the *pectoralis minor* (see below) lies immediately anterior to the involuted fold and in the same plane with it. The muscle rises from the sternal ends of the costal cartilages, from the second to the seventh inclusive, and pursuing an oblique course outward and forward, inserts by a thin aponeurosis which partly attaches to the outside of the great tuberosity and partly reaches the surface of the supra-spinatus muscle and the coracoid process. It is between this muscle and the involuted fold of the p. major that the deep anterior thoracic nerve issues.

Beneath the anterior portion of the pectoralis major and superficial to the p. minor, lie two muscular ribbons. The more anterior (*sterno-scapularis?*) rises for 1¼ inches on the manubrium and inserts, anteriorly by fascia and posteriorly by muscular fibres, into the great tuberosity and bicipital ridge for a distance of 3 inches. It thus increases in width outwards. The other band lies immediately posterior to this in the same plane, rising on the first three sternebræ; anteriorly it is quite distinct from the p. major, but its posterior border fuses more or less with the latter. Its anterior fibres have an independent insertion on the bicipital ridge, while posteriorly it inserts in common with the p. major and cephalo-humeral.

The diverse ideas concerning the homologies of the pectoral elements, and the consequent confusion of nomenclature are well-known. In the Carnivora, for instance, Cuvier[1] denies the existence of a pectoralis minor—though as remarked by Murie, the "Planches de Myologie" of Cuvier and Laurillard represent it as present; this opinion is supported by Meckel[2] and many recent investigators. Others who admit the presence of the muscle differ considerably in the element to which they apply the name. Wilder[3] believes the superficial backwardly directed layers to be the pectoralis major, and all of the deep forwardly directed bands, with apparently the exception of the most posterior ("xiphi-humeral") to be homologous with the human pectoralis minor. Owen[4] seems to consider that in the dog only the most anterior of these deep bands represents the p. minor, while Shepherd[5] applies the name to the muscle which has here been described as sterno-scapular.

The muscle which I have described as the pectoralis minor appears to me to be such, not only in the bear, but throughout the Carnivora, from its general position, from the usual continuation of its fascial insertion to the coracoid process, and from its relations to

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[1] Leçons d'Anat. Comp. Tome 1, p. 256.

[2] Syst. vergleich. Anat. Theil 3, pp. 490–1.

[3] The Pectoral Muscles of Mammalia. Proc. Am. As. Ad. Sci. 1873, p. 307. Also, Anatomical Technology, p. 235.

[4] Anat. Vert. Vol. III, p. 50.

[5] Loc. Cit. p. 105.

the two anterior thoracic nerves, which embrace and supply it much as in the human subject.

In most mammals there are behind the pectoralis minor, certain other muscular elements—"pectoralis quartus" "xiphi-sterno-humeral," "ventro-humeral," etc.—which have been the subject of much discussion. Wilder, as mentioned above, considers most of these as parts of the p. minor, but the most posterior slips he speaks of[1] as probably "differentiated portions of the main pectoral mass." In the Carnivora, Macalister[2] alludes to the "fourth pectoral or brachio-lateral part of the panniculus." As regards the Marsupialia, Cunningham[3] remarks: "There is a diversity of opinion regarding the character of the pectoralis quartus. Owen looks upon it as 'a dismemberment of the pectoralis major.' Humphrey and Macalister believe that it is in an 'intermediate piece of the superficial external muscular sheet between the pectoralis major and latissimus dorsi.' Its close connection in many cases with the panniculus carnosus would almost seem to indicate that it is merely a portion of this muscle. In *Cuscus*, indeed, it appeared to be simply the thickened lower margin of the panniculus, the connection between them is so intimate."

It appears to me almost unquestionable that, as implied in the above statement, the posterior slips of the more deeply inserting pectoral mass are phylogenetically different from the more anterior portion of the same layer. The opinions just quoted as to the derivation from panniculus or latissimus, may each of them be correct in different types, but the structure of the present specimen suggested to me an explanation, a development of the idea of Owen, which seems to be sustained by the series of Carnivora, and which would well explain the oblique position of these posterior elements.

According to this view, the structure in the polar bear would indicate that an originally simple and unsegmented pectoralis major muscle has gradually encroached backward upon the abdomen; that during this process its axillary border has become folded under and acquired a retrogressive attachment to the humerus beneath the parent mass; that finally, the entire posterior border of the muscle

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1 Loc. Cit.

2 Muscular Anatomy of the Civet and Tayra. Proc. Roy. Irish Acad. Vol. I, Ser. 2, p. 508.

3 Report on the Marsupialia. Challenger Rep. Zool. Vol. V, p. 8.

has become segmented off as a distinct band, which consequently forms the posterior boundary of the p. major and the anterior border of its involuted fold.

Such an explanation would derive probability from the mechanical relations of the parts. As the original pectoral mass travelled backward, and its posterior border came, as in this specimen, to lie more nearly in a longitudinal than in a transverse line, it would encroach more and more upon the axilla, that is, it would deepen the anterior axillary fold. As this fold began to project from the general contour of the body, there would be a tendency, especially during anterior extension of the arm, for it to be repressed by folding in, and the backward direction of this fold would be determined by the general curve of the integument. Such involutions of the posterior border of the pectoralis major occur in many mammals, and often, as in the human subject, in a form which makes it appear improbable that they can have been the result of fusion. This view is also favored in the present subject by the course of the deep anterior thoracic nerve, which, as mentioned above, runs completely around the concavity of the fold.

Through the kindness of Dr. Harrison Allen, I was enabled to examine the pectoral in a young *Ursus americanus*. In this specimen the first striking character was the much greater thickness and power of the entire mass. The concavity of the fold was partially obliterated by narrow fasciculi extending between its walls, but the type of the polar bear was still easily seen; the ventro-humeral slip was much stouter and separated from the rest of the muscle by a very distinct line. The p. minor was as in *U. maritimus*; of the two remaining divisions, the more posterior was so intimately fused with the p. major, as to be scarcely distinguishable. The fasciculi running from inside the fold to the sternum, began to give the idea of a separate muscle lying immediately behind the pectoralis minor, in the same plane. The thoracic nerve ran about as before.

In an alcoholic, probably new born, specimen of *Melursus libyus* in the collection of the Academy of Natural Sciences of Philadelphia, the modification of these parts had gone so far that they closely resembled the condition in the Cat, though still considerably simpler than in that animal. The most superficial division was a narrow ribbon (evidently the "first division of the pectoral" of Mivart,[1] or the cephalic "pecto-antebrachialis" of Wilder and Gage[2]) rising

[1] The Cat.

[2] Anatomical Technology.

from the manubrium and running obliquely outward and backward to blend with the cephalo-humeral and insert in common with it on the middle of the humerus. Beneath this and crossed obliquely by it was a large square mass ("ectopectoralis" of Wilder; "second division" of Mivart) which rose along somewhat less than the anterior half of the sternum and inserted into the proximal half of the humerus.

Upon reflecting this, three deep divisions were exposed. The most anterior, p. minor, rose on the middle third of the sternum, and inserted as in the bear; it would evidently correspond to that section in the cat, which is termed by Mivart the "third division," and by Wilder the "entopectoralis, div. cephalica." The next division, which immediately adjoined the last, rose along the remainder of the sternum and posterior costal cartilages and inserted by aponeurosis into the pectoral ridge of the humerus at the middle of the insertion of the "ectopectoral." It occupied the position of the "entopectoralis, div. caudalis" of Wilder and seems to correspond to the pectoralis quartus of Marsupials. The thoracic nerve, coming out behind the p. minor, ran backwards a short distance over the surface of this muscle and then dipped into its substance where it could be traced between two ill-defined laminæ almost to its posterior border. This muscle seems to be the realization of the tendency which was showing itself in the two other bears. The position of the mass, its partial separation into two laminæ, the relation to these of the thoracic nerve, and a certain greater obliquity of its antero-external than its antero-internal fibres, all appear to indicate that it is the representative of the involuted fold of the pectoralis major of the polar bear, which has been split off from the main mass and had its two layers nearly combined. According to the provisional hypothesis of Wilder this division would be part of the pectoralis minor, but the present comparisons indicate it rather to be an independent derivative of the pectoralis major.

The remaining slip, which was quite delicate, rose for a short distance along the linea alba and inserted beneath the last, which also received the insertion of the panniculus and a slip from the latissimus dorsi. I suppose it to be the ventro-humeral division of the two bears and to answer to the "xiphi-humeral" of the cat, which would then, according to this theory, owe its origin to the pectoralis major and not to the latissimus or panniculus.

The "entopectoralis, div. caudalis" in the cat is penetrated by the thoracic nerve in exactly the same manner as in this *Melursus*, and would of course be assigned the same origin.

Coraco-brachialis, as in the black bear, rises from the coracoid process and as it passes over the head of the humerus, divides into a deep belly (coraco-brachialis brevis), which inserts beneath the common tendon of the latissimus dorsi and teres major, and into a more superficial strand, which, opposite the latissimus tendon, further subdivides into a branch which joins the biceps (short head of biceps) and another which runs to the internal condyle and ridge (coraco-brachialis longus).

Triceps shows only three distinct heads. The outer humeral head has the form of a triangular prism, with a long sharp angle, which penetrates deeply between the scapular head and the humerus, and ends in a narrow plane truncation, which is closely applied through the whole length of the arm against a similar plane surface on the outer side of the inner humeral head. The two thus form an almost continuous mass.

Anconeus rises in a triangle whose apex is four inches above the condyles, and inserts on the entire width of the back of the olecranon and for 2½ inches on its outer side. It exhibits a splitting into two layers which are separate along its outer border and unite at about the axial line of the humerus.

Epitrochleo-anconeus small and narrow.

FORE-ARM. *Flexor carpi ulnaris.* The ulnar head is four inches long (distance from elbow to wrist being nine inches) and inserts by fascia on the outside of the humeral head. The ulnar nerve is visible between the heads for only about one inch from the elbow and then dips deeply between the humeral head and flexor profundus.

Flexor profundus rises by five heads, three from the internal condyle, one from the radius and one from the ulna.

Flexor sublimis rises from the internal condyle and proceeding down the arm as a very broad band, ends in four stout, flat tendons, which supply the four ulnar digits in the usual manner. Rising from its ulnar side is a fusiform accessory muscle, four inches long, which ends in a slender tendon that fuses near the metacarpo-phalangeal joint with the under surface of the sublimis tendon going to the 5th digit. Another accessory muscle rises from the most ulnar of the three condylar heads of the flexor profundus, 2½ in. from the wrist; its belly, 1 in. long, divides into two slender tendons, which fuse like the other with the inferior surface of the sublimis tendons of the 3rd and 4th digits. I have called the present muscle flexor sublimis because of the direct continuance of its tendons into the digits, the small accessory tendons seeming merely to insert upon the under surface of the broader tendons of the large muscle. In the cat, on the other hand, it is the accessory tendons which have a direct connection with the phalanges, and the tendons of the long condylar muscle, relatively more delicate and more intimately blended with the palmar fascia than in the bear, appear to insert upon the surface of the perforatus sheaths formed by the "accessory" muscles. Mivart hence calls the long muscle "palmaris longus," but in the numerous and often reciprocal variations existing in the palmaris longus, flexor sublimis and accessory flexor sublimis throughout the mammalian series, questions of homology would appear to be very uncertain.

Lumbricales four in number with their usual relations.

Supinator longus rises by two heads, one from the supinator ridge immediately above the extensor carpi radialis, and the other, which can be traced more than two-thirds of the way up the humerus, from out the substance of the brachialis anticus. The two unite before reaching the elbow, and the resultant belly runs down the fore-arm as a ribbon about $\frac{1}{2}$ in. wide, to insert by fascia on the lower end of the radius.

Supinator brevis reaches to within $1\frac{1}{2}$ in. of the distal end of the radius.

Extensor communis digitorum and *extensor minimi digiti* as in the cat or black bear.

Extensor indicis fused with *ex. secundi internodii pollicis.*

HAND. According to the "typical arrangement" of intrinsic muscles, so admirably presented by Cunningham, the elements in the hand are as follows:

In the right hand the palmar layer consisted of *adductor pollicis*, $\frac{5}{8}$in. wide, adductor indicis, $\frac{3}{8}$ in., *ad. annularis*, $\frac{1}{8}$ in., and *ad. minimus*, $\frac{5}{8}$ in. The adductor annularis was a very delicate slip and did not appear in the left hand. Adductor minimus divides before reaching the base of its digit into three portions, of which only one inserts into the digit; of the other two, the more radial ends in a long tendon, which runs toward the end of the digit to insert into the extensor tendon, and the ulnar turns directly backwards and inserts fleshily, also into the extensor system, opposite the end of the metacarpal.

The intermediate and dorsal layers are closely fused, as in Carnivora generally. The combined systems apparently send a *flexor brevis* head to the sesamoid and phalanx, on each side of each digit, but the exact homology of the long tendons which run back to the extensor system is, with the exception of abductor minimi digiti, not easily interpreted. These latter are two to every digit, one on each side, and as a rule, show no superiority in size or distinctness on either side; they are inserted into the extensor tendon near the end of the finger, and are commonly derived from that portion of the muscle which lies nearest the bone, so that they wind around the palmar surface of the flexor brevis in their course. Which represent interossei and which do not, is not plain.

In the pollex, the long tendon of the radial side inserts partly on the base of the proximal phalanx, and partly continues as a cord, which quickly changes to yellow elastic tissue and inserts into the distal phalanx as a *retractor ligament*, in common with the main extensor tendon. On the ulnar side the corresponding band seems to contract no tendinous union with the proximal phalanx, but continues directly to the distal as the elastic retractor ligament—very suggestive facts, especially as most of the "long tendons" in the other fingers terminate in the extensor system just at the point where the retractor ligaments commence, while in the foot as mentioned below, several of them are more or less continuous with the retractors.

In the minimus the place of the ulnar long tendon is taken by the *abductor mimimi digiti*, which rises from the pisiform bone and acquiring scarcely any union with the phalanx, inserts into the tendon of the extensor minimi digiti. The long tendon on the radial side is more delicate than usual.

The flexor brevis pollicis and the outer flexor muscle of the 3rd, each derive, in the left hand at least, a small head of origin from the adductor mass.

HIP AND LEG. Of the proximal muscles, only a few show points worthy of mention.

Gluteus maximus sends both of its divisions to the great trochanter, there being no continuation by fascia down the thigh.

Gemellus anterior remains distinct from the tendon of the obturator internus, and inserts separately into the anterior border of the great trochanter in common with the pyriformis. The posterior gemellus, however, joins the obturator tendon, and is quite distinct from the anterior.

Semi-membranosus, as usual, sends its tibial tendon under the internal lateral ligament, which, in position, is mainly continuous with the peroneus quinti digiti.

Extensor longus digitorum exhibits more surface on the front of the leg than the tibialis anticus, which latter extends under it as a thin sheet. The tendon of origin of the extensor perforates the capsule of the knee joint to rise in front of the outer condyle of the femur.

Peroneus longus rises partly on the fibula, partly on the tibia, extending its origin under the ex. longus digitorum.

Plantaris rises as usual from the external femoral condyle in common with the gastrocnemius, but contracts no union with that muscle on its way down the leg. In passing over the heel into the foot, it is much less firmly tied to the calcaneum than is the case in the cat.

Soleus rises almost entirely from the tibia.

Gastrocnemius. The inner head rises from a pit behind the internal condyle of the femur, extending up under the insertion of the semi-membranosus, and showing no sesamoid bone. The outer head has its origin in common with the plantaris from the femur and sesamoid above the external condyle, sending also a delicate tendinous band, $\frac{1}{8}$ in. wide, over the sesamoid to the patella.

These two heads extend about half way to the heel and then run out into a common thin aponeurosis, which is joined $2\frac{1}{2}$ in. above the heel by the narrow tendon of the biceps, and then thickening itself, receives the soleus, as already stated; on the inner side it becomes especially thick, forming a distinct cord, which near the heel crosses the tendo Achillis to the outer side.

In dissecting these muscles I was impressed with the smallness of the gastrocnemius in the bear as compared with that in the digitigrade Carnivora, and was reminded that I had been much more struck by the same circumstance about a year ago, while dissecting the limbs of the Indian Elephant, in which animal, as is well known, the gastrocnemius is of singularly slight dimensions. The physiological reason for such a relation in these two plantigrade animals, where the heel does not have to be kept off the ground by a continuous muscular exertion, is evident, and I regret that no comparative weights of the masses in the elephant were preserved.

I, however, selected a slightly built cat from a number preserved in alcohol at the Biological Laboratory of the University of Pennsylvania, and with it made comparisons in weight with the bear.

The leg in each case was disarticulated at the knee and ankle, and the crus thus obtained cleared from fascia and the extrinsic ham-string muscles. The test was perhaps not entirely fair, as the cat was probably older in proportion than the bear, but it was quite a spare specimen and cannot have much increased the proper difference.

The results were as follows:

Ursus maritimus.

Entire crus	29 oz. or	100 %
Gastrocnemial system (gast., solens, and plantaris)	10 " "	34·4 %
Gastrocnemius	4 " "	13·8 %
Soleus	3 " "	10·3 %
Plantaris	3 " "	10·3 %

Felis domestica.

Crus	46·5 grams, or	100 %
Gastrocnemial system	18·5 " "	39·8 %
Gastrocnemius	12·3 " "	26·5 %
Soleus	2·2 " "	4·7 %
Plantaris	4·0 " "	8·6 %

A large muscular cat gave 43·5 % for the gastrocnemial system and 28·5 % for the gastrocnemius, so the difference is not great. In the above examples, it will also be seen that in the bear the gastrocnemius constitutes 40 % of its own system, while in the cat it is 66·5 %.

FOOT. *Extensor brevis digitorum* divides into three muscular bellies, of which the outer one sends a tendon to the outer side of the 4th digit, the next divides into two tendons which supply the inner side of the 4th and the outer side of the 3rd, and the third similarly divides to supply the outer side of the 2nd and the hallux. As usual, the peroneus quinti digiti takes the place of the short extensor in the 5th digit.

Flexor brevis slips to the index and medius come from a muscular belly, but on the outer side, the muscle has degenerated into a broad thick aponeurosis, so that the tendons to the 4th and 5th do not run back into muscle, but are continuous through this fibrous mass with the plantaris tendon.

Accessorius rises on the posterior and external edges of the calcaneum and inserts on the deep flexor tendon formed by the union of flexor longus digitorum and flexor longus hallucis. Its muscular fibres are restricted to the side of the foot, all that portion on the sole being tendinous.

Lumbricales four, as usual; the one inserting in the fifth digit rises from the 4th deep tendon.

Rising from the 5th deep flexor tendon, beside the lumbricals, is a similar but somewhat longer belly, which blends with the 5th flexor brevis tendon. This seems to correspond to what Mivart describes as "accessorius" in the third and fourth digits of the cat.[1] The cat, however, has a distinct accessorius similar to the one in the present specimen.

In the plantar layer of adductores we have *adductor hallucis, ad. indicis,* and *ad. minimi digiti,* which rise in common from the bases of the 2nd and 3rd metatarsals and are united for a third of the way out towards the phalanges. The adductor minimi digiti soon divides into two heads, of which the outer inserts into the inner side of the distal end of the 5th metatarsal, constituting the *opponens minimi digiti.* The other head again divides into two slips, of which the more distal becomes the normal adductor, while the more proximal runs around to blend with the extensor system at the metatarso-phalangeal joint.

The intermediate and dorsal systems are fused, as in the hand, and terminate in a similar manner. Flexor brevis slips appear to be given to each side ot each digit; the *flexor brevis hallucis* rises by a number of small heads from the cuneiform and ligaments at the base of the hallux.

In the dorsal system there is a slender *abductor ossis metatarsi minimi digiti,* from the postero-external part of the plantar surface of the calcaneum to the tuberosity at the root of the 5th metatarsal, and a stout *abductor minimi digiti,* which was much cut on both sides by the skinning.

The "long tendons" described in the hand appear on both sides of each digit except the 1st and 5th. There is none on the outer side of the 5th, its place being taken by the regular abductor, and there appeared to be no representative on the tibial side of the hallux in either foot, though the mutilation of that region in the skinning might have destroyed it. That on the fibular side of the hallux in-

[1] I have recently seen a cat which lacked the connecting muscles in the third and fourth digits and possessed one on the fifth, thus repeating the structure shown here in the polar bear.

serts partly into the proximal phalanx, sending also a few fibres to the extensor tendon at that point, and partly continues as a yellow elastic cord to form the retractor ligament of that side.

The relation of these long tendons to the retractor ligaments was also more or less evident in the other digits, especially in the 4th of one foot. On the outer side of that digit the long tendon, after giving a slip to the extensor system at the metatarso-phalangeal joint, ran on to join the extensor tendon near its insertion, but before doing this gave off a broad band which blended with the entire width of the normal retractor ligament of that side. On the inner side the long tendon joined the extensor, but some fibres immediately left it again to become elastic and form the dorsal border of the retractor ligament.

RESEARCHES UPON THE GENERAL PHYSIOLOGY OF NERVE AND MUSCLE.

BY Dr. HENRY C. CHAPMAN AND Dr. ALBERT P. BRUBAKER.

No. 2.

Resistance offered by Nerve and Muscle to the passage of an Electrical Current. It was shown by the authors in a previous communication made to the Academy, No. 1, that both muscle and nerve are the seats of electro-motive force amounting in the case of muscle to the 0·0696, of nerve to the 0·0237 of a Daniell, capable of deflecting the magnet of a Wiedemann galvanometer as indicated by the scale to an extent of 217 and 21 divisions respectively. Now since the current after passing from the muscle or nerve to and through the galvanometer, in returning to the point from which it started, must pass through the muscle or nerve, it becomes a matter of importance as well as of interest to determine the resistance offered by the latter which must be overcome by the muscle and nerve current as the internal resistance of the battery must be overcome in order that the electrical circuit may be completed. The method made use of by the authors in determining the resistance offered by muscle, nerve etc. to the passage of an electrical current is that known as the Wheatstone bridge method, a brief account of which is indispensable to the proper understanding of the apparatus to be presently described and by which the results to be communicated were obtained. To illustrate the theory of the Wheatstone bridge let us suppose that a current from a Daniell element D enters the wire A B Fig. 1 at A, the wire being graduated into 1000 parts and along which the slider S can be moved; such being the case if the slider be pushed along the wire close up to A, then of the current entering at A, part returns through the galvanometer G and part returns through A S B to the Daniell element whence it came.

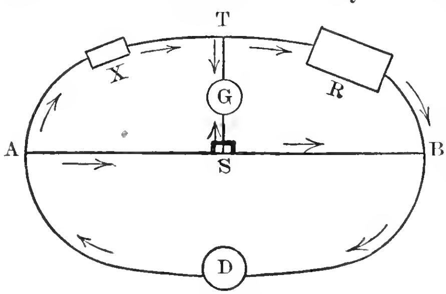


Fig. I.

Suppose, however, that the slider be pushed from B only as far as S, then the current entering at A will divide into two branch currents passing respectively to S and X. The one branch current on reaching S will subdivide again into two currents one of which will return through S B to the Daniell element the other passing into the galvanometer G and deflecting the needle to the left for example, supposing it to be unopposed by the current which we shall see passes into the galvanometer G in the opposite direction from T. The other branch current on passing through X, the muscle or nerve whose resistance is to be determined, on reaching T will similarly divide into two currents, one of which passing through the resistance box R will return through B to the Daniell element; the other passing into the galvanometer will deflect the needle to the right supposing it to be unopposed by that passing into the galvanometer G from S in the opposite direction. The resistance box just referred to, Fig. 2, is so called on account of its offering a resistance to the passage of an electrical current the amount of resistance offered being determined by the number of plugs out. Let us suppose for example, the slider being at B, that we make the resistance box offer a resistance of 100 ohms (1) by taking out the plug numbered 100, Fig. 2 a, the effect of this will be that of the current which would otherwise return through R to the Daniell, part now passes into the galvanometer and deflects the needle to the right. Let now, however, the slider be moved from B to S, that is to exactly the middle of the wire or to its 500th division, it will be observed that the needle of the galvanometer G is deflected back to zero, proving that of the current which, when the slider was at B, returned to the Daniell element, part now passes into the galvanometer G opposite in direction to that passing in the galvanometer from T, but with an equal electro-motive force since the needle of the galvanometer is brought to zero. Let us suppose in order to illustrate graphically the relation of the forces involved in

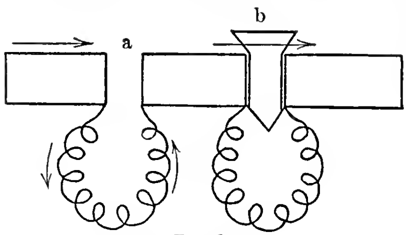


FIG. 2.

An ohm is the resistence offered by a copper wire 1 mm. in diameter and 46·25 mm. in length.

the preceding experiment that the vertical line A E Fig. 3 represents the electro-motive force of the current as it enters A Fig. 1 from the Daniell and that the horizontal line A S B Fig. 3 represents the resistance offered by the wire A S B Fig. 1, S representing in Fig. 3 the point where the current passes into the galvanometer from S in Fig. 1, S G in Fig. 3 will then represent the electro-motive force of the current at the point S. It need hardly be added that S G must be shorter than A E since the electro-motive force at S is necessarily less than at A, the electro-motive force diminishing gradually from A to B. Similarily A E Fig. 4 representing the electro-motive force at A Fig 1, let A T B represent the resistance offered by A X R B Fig. 1 to the passage of the current. The line A T B Fig. 4 being shorter than the line A S B, the resistance being greater, the electro-motive force will be diminished more suddenly and the point T where the current from T Fig. 1 passes into the galvanometer will consequently be nearer A, and T G Fig. 4, will then represent the electro-motive force at that point and being equal to the electro-motive force at S Fig. 3 it must be equal to S G. But if S G be equal to T G, which must necessarily be the case since they represent the electro-motive forces through whose equal and opposed effects the galvanometer needle remains at zero, it follows that A T : T B : : A S : S B or what is the same thing that X : R : : A S : S B (1). Substituting in (1) the values of R, A S, S B as experimentally determined and we obtain X : 100 : : 500 : 500 or X = 100 ohms. That is to say that X the nerve or muscle offers a resistance to the passage of an electrical current that is equal to 100 ohms. In deter-

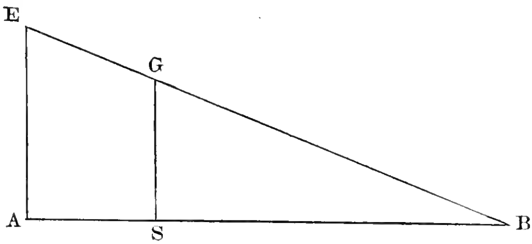


Fig. 3.

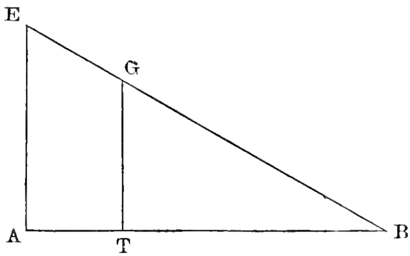


Fig. 4.

mining the resistance offered by muscle and nerve to a current of electricity as in the case of the determination of the electro-motive force of the same, the authors made use however of the round compensator Fig. 5 with Christiani's modification, that is with the addition of the binding screw O, a much more reliable and convenient instrument than the long rheocord. The relations existing between the resistance to be determined or X and that of the resistance box R and the portions of the wire A S S B on either side of the wheel S are, however, precisely the same as in the case of the long rheocord since in both cases the ratio obtains of X : R : : A S : S B as may be at once seen by a comparison of Figs. 5 and 1.

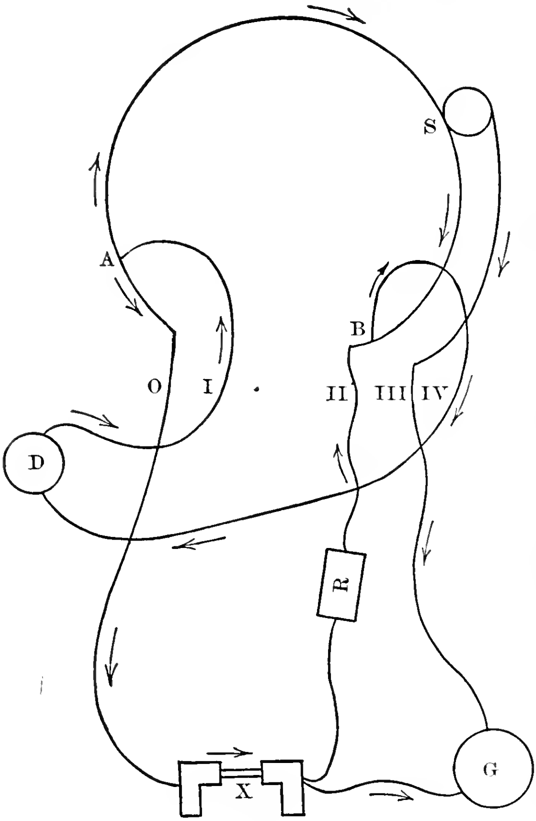


Fig. 5.

In order that the amount of muscular and nervous tissue used in the different experiments should be the same the authors made use of the method employed by Hermann (1) of enclosing the tissue between two plates (in the present instance of ebonite instead of glass) to the four corners of one of which were cemented pegs so that when the other plate rested on the latter a definite space was included. It would have been desirable if practicable that the same amount of nerve had been used as muscle but on account of the scarcity of frogs, the season being winter and the great number of sciatic nerves that would have been required to have filled up the space, amounting in the case of the muscle to 2 cent. in length and breadth and 1 mm in thickness, a smaller space was made use of in the case of nerve, namely of 2 cent. in length 1 cent. in breadth and 0·5 mm in thickness. It will be observed from the tabulated results given below of the resistance offered by muscle and nerve to the passage of an electrical current, that the resistance varied with the amount of the resistance offered by that of the resistance box. At first sight it might appear that such variations vitiated entirely the result. It must be borne in mind, however, that the polarization due to the passage of the current through the tissue offers a resistance as well as the tissue itself and that this polarization varies with the current, the latter varying in turn according to the resistance box. Such being the case the variations in the resistance offered by the same amount of tissue according as the resistance of the resistance box is modified, may be attributed to the polarization set up in the tissue. It may be mentioned incidentally in this connection that in the absence of a round compensator the resistance of muscle, nerve etc. can be determined, though not so conveniently or accurately, by means of that form of resistance box in which the latter is provided with the Wheatstone bridge arrangement as represented in Fig. 6 and

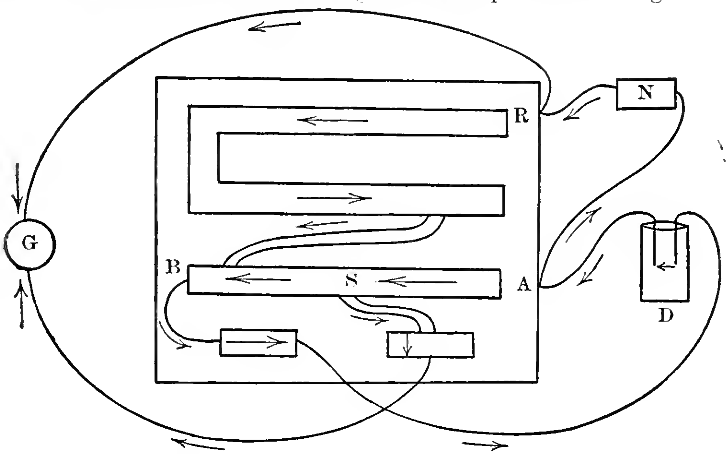


Fig. 6.

which was made use of by the authors with the view of comparing the results as obtained by it and by the compensator. After what has been said as to the general theory of determining resistance it will be

[1] Pflugers Archiv. B and V.

seen that by this particular method the proportion of X : R : : AS : S B obtains as when the round compensator is used, the only difference being that in making at once A S = S B, the value of X is inferred from that of R. In conclusion it may be pointed out that while the resistance offered by the human body to the passage of an electrical current is very great in a state of health, it appears to be diminished in a state of disease, notably in Graves disease, indeed so much so as to constitute an important diagnostic symptom of that condition.

Tabulated results of resistance offered by muscle and nerve of a frog to a current of electricity.

MUSCLE.

Sartorius, length and breadth 2 cent. thickness 1 millim. Resistance of 70 ohms offered by pads including shields in each case deducted from result.

Formula for experiments X : R : : A S : S B, X = Resistance [in ohms.

1st Series		
Longitudinally	X : 2000 : : 478 : 512, X =	1836
Longitudinally	X : 4000 : : 318 : 682, X =	1795
Longitudinally	X : 5000 : : 271 : 729, X =	1788
Mean		1806
Transversely	X : 2000 : : 857 : 143, X =	11916
Transversely	X : 10000 : : 540 : 460, X =	11670
Mean		11793
2nd Series of experiments.		
Longitudinally	X : 2000 : : 515 : 485, X =	2053
Longitudinally	X : 4000 : : 334 : 666, X =	1936
Longitudinally	X : 5000 : : 290 : 710, X =	1972
Mean		1987
Transversely	X : 2000 : : 890 : 110, X =	16111
Transversely	X : 5000 : : 730 : 270, X =	13448
Mean		14779

Ratio of mean longitudinal to transverse resistance as shown by 1st series of experiments 1 to 6·5.

Ratio of longitudinal resistance to that of mercury taken as unity 2006000 to 1, of transverse resistance 13103000 to 1.

Nerve.

Sciatic, length 2 cent. breadth 1 cent. thickness 0·5 mm. Resistance of 47 ohms offered by pads etc. deducted from result.

Formula of experiments X : R : : A S : S B, X = Resistance [in ohms.

1st Series

Longitudinally	X : 2000 : : 840 : 160, X =	10453
Longitudinally	X : 4000 : : 735 : 265, X =	11047
Longitudinally	X : 5000 : : 690 : 310, X =	11082
Mean		10860
Transversely	X : 2000 : : 880 : 120, X =	14619
Transversely	X : 4000 : : 785 : 215, X =	14557
Transversely	X : 5000 : : 745 : 255, X =	14160
Mean		14445

2nd Series of experiments.

Longitudinally	X : 2000 : : 845 : 155, X =	10856
Longitudinally	X : 4000 : : 725 : 275, X =	10498
Longitudinally	X : 5000 : : 680 : 320, X =	10578
Mean		10644
Transversely	X : 2000 : : 860 : 140, X =	12251
Transversely	X : 4000 : : 740 : 260, X =	11038
Transversely	X : 5000 : : 685 : 315, X =	11156
Mean		11481

Ratio of mean longitudinal to transverse resistance as shown by 1st series of experiments 1 to 3.

Ratio of longitudinal resistance to that of mercury taken as unity 12066000 to 1 of transverse resistance 32099000 to 1.

It will be observed that the ratio of the longitudinal to the transverse resistance in nerve as well as the ratio of both the longitudinal and transverse resistance in nerve as compared with mercury taken as unity differ from the same ratios obtaining in muscle. It must be borne in mind, however, that this difference is due to some extent at least to the amount of nerve tissue used, being less than that of muscle.

DISTINCTIVE CHARACTERS OF ODONTASPIS LITTORALIS.

BY JOSEPH LEIDY, M. D.

In the collection of the Academy is a shark, 8½ feet long, which was caught some years ago at Beesley's Point, New Jersey. I was present when the shark was caught, and helped to land it and prepare the skin and jaws for preservation. Attached to the shark were a number of lernean parasites, subsequently to be described. Recently, wishing to know the exact name of the shark, I determined it to be the *Odontaspis littoralis*, but found its distinctive characters rather vaguely indicated by authorities. The shark is not uncommon on our coast; and is commonly called the "man-eater." In color it is iron grey above, paler at the sides and dusky white beneath. In the form, relative position of the fins, and other external characters, it clearly accords with the figure 1, of plate 36, of Storer's Fishes of Massachusetts, referred to *Carcharias griseus* of Ayres. In the figure the branchial clefts are represented as being placed well in advance of the pectoral fin, as in our specimen, and not close to the latter as indicated by Müller and Henle in the figure of *Odontaspis taurus.*

Dr. Abbott (Proc. 1861, 400), in describing our specimen named it *Odontaspis americanus* and gives the dental characters as follows:—"Teeth with a single toothlet on either side, but occasionally *one* wanting. Upper and lower first tooth smaller than the adjoining teeth; then follow above two very long teeth; then another pair of somewhat smaller teeth; then two somewhat increase in length; then the remainder gradually decrease. In the lower jaw the teeth gradually decrease from the first pair."

Prof. Gill, in a Synopsis of the Eastern American Sharks, (Proc. 1864, 260,) names the same species *Eugomphodus littoralis*, and gives as its synonyms *Squalus americanus*, *littoralis* and *macrodus* of Mitchell; *Carcharias littoralis*, Dekay; *C. griseus*, Ayres; *Eugomphodus griseus*, Gill; and *Odontaspis americanus*, Abbott. He says that *Eugomphodus* is distinguished from *Carcharias* (Raf.), *Triglochis* or *Odontaspis* "by the *simple* first and fourth teeth of the upper jaw, as well as the first of the lower."

Günther, in the Catalogue of Fishes in the British Museum, names the same shark *Odontaspis americanus*, and includes the other names above given as synonymous, to which is added the *Odontaspis taurus* of Müller and Henle. He gives as characters of the dentition, "upper first tooth not smaller than the second; one or two small teeth between the upper third and fourth long teeth; large teeth with a single small cusp on each side. As localities, he gives the Atlantic and South Pacific.

Jordan and Gilbert, in the Synopsis of the Fishes of North America, for *Odontaspis littoralis*, also include all the other names mentioned as synonymous except the *O. taurus*. As distinctive characters they adopt the diagnosis of *Eugomphodus* of Gill—"first and fourth teeth of the upper jaw and first of the lower simple, without basal cusps." Müller and Henle gives as characters of *Odontaspis taurus* "upper first tooth smaller; then follow two very long teeth; then one or two smaller ones; then again large ones from which they gradually decrease. The lower teeth gradually decrease from the second."

Besides the specimen of *Odontaspis littoralis* from Beesley's Point, we have at command half a dozen sets of jaws of the same species. Of these one is from Nantucket, and another from Townsend's Inlet, N. J.; the others have no locality marked. In all the essential characters of the dentition are alike; but they do not accord with those which have been given as distinctive of the species. The number of teeth varies according as there are a few or more of the rudimentary ones at the ends of the series, but this is a difference of no diagnostic value as a like variation occurs on the two sides of the same jaw. In all our specimens, without exception, the teeth are provided with a pair of denticles; none being simple as intimated by Gill, and by Gilbert and Jordan, in the diagnosis of *Eugomphodus*. The anterior teeth in general are long, narrow, and sigmoid, and their denticles are curved. The more posterior, lateral and larger teeth are shorter than the former and proportionately wider, and have also shorter and wider denticles. In different specimens they exhibit a variable disposition to the production of a second smaller denticle. In five of the sets of jaws in which the teeth are well displayed throughout, we find the following range of numbers:

$$\frac{19—17}{18—18},\quad \frac{19—22}{18—17},\quad \frac{20—18}{18—14},\quad \frac{22—23}{19—19},\quad \frac{24—24}{22—24}.$$

The distinctive dental characters are as follows:—In the upper jaw, three large teeth, of which the first and third are nearly equal and the second is slightly larger; fourth tooth very small, about one third the size of the former; then follows a considerable hiatus; fifth to the seventh teeth nearly equal and smaller than the third tooth; the remaining teeth successively decreasing. In the under jaw the first tooth is small, about one-half the size of the next, which is the largest; and then the others successively decrease.

Müller and Henle, Abbott, and Günther intimate that in *Odontaspis*, in the upper dental series, there are one or two small teeth after the third large tooth. In none of our specimens are there two small teeth in this position, but after the single small tooth there is a hiatus, in different jaws ranging from a third to more than half an inch, which presents no trace of a tooth. This hiatus is unusual in the dental series of sharks; and it perhaps gave rise to the inference and consequent assertion that it is normally occupied by a second small tooth. In the figure of the dentition of *Odontaspis taurus* as given by Müller and Henle, notwithstanding their statement, a single small tooth appears after the upper third large tooth, in accordance with what we observe in *O. littoralis*. In *O. taurus*, the first tooth in both jaws is represented as being nearly equal and about a third less than the adjoining teeth; and the upper third and lower second teeth appear as the largest of the series.

PARASITIC CRUSTACEA.

BY JOSEPH LEIDY, M. D.

Attached to the Shark, *Odontaspis littoralis*, caught at Beesley's Point, N. J., above indicated, on each side of the mouth, hanging from the upper lip, were a number of lernean parasites, and these were thickly covered with a hydroid parasite. The lernean appears to be an undescribed species, and may therefore be distinguished by the following name and characters.

Lerneonema procera.

Animal pale yellowish. Head horizontal, semi-oval, convex above, with three, short, blunt occipital tubercles, fore part convex, excavated beneath and enclosing the mouth, antennæ and maxillipeds; neck long, linear, cylindrical; body short, fusiform, and truncated behind; tail longer than the body, linear, cylindrical. Egg pouches, long, linear, cylindrical. Length 70 mm.; including egg pouches 90 mm. Head 3 mm. long; neck 30 to 45 mm. long, 0·375 thick; body 10 to 12 mm. long, 1·75 thick; tail 12 to 15 mm. long, 0·5 thick. Egg pouches 20 mm. long, 0·25 thick.

The hydromedusarium appears to belong to *Eucope parasitica*, found in the same manner, by A. Agassiz, on a lernean of *Orthagoriscus mola*. Some of the stems rise from the creeping root from 5 to 8 millimeters, with short branches, two or three ringed. The polyp-cups are 0·375 mm. long by 0·25 wide. The stems are 0·1 mm. thick, and the alternate lateral branches about 0·2 long.

From the fin of a Shark, also caught at Beesley's Point., but the name not ascertained, there was obtained a single specimen of a lernean, which nearly resembles the *Perrisopus dentatus*, of Steenstrup and Lütken. It is 5 mm. long. The cephalothorax is a little smaller than the abdominal segment, and between them are three pairs of dorsal lobes which completely cover the space. The egg pouches are linear and 0·25 mm. thick.

May 1.

The President, Dr. Leidy, in the chair.

Twenty-six persons present.

Parasites of the Rock Fish.—Dr. Leidy stated that he recently had examined the gills and entrails of a Rock-fish, *Labrax lineatus*, weighing 20 pounds, on which he made the following remarks. The gills were swarming with the little crustacean parasite *Ergasilus labracis.* In many of these the thorax and egg-sacs were opaque milk-white, but in most of them the latter were more translucent and of a blue color. This difference is due to the devolopment of the embryos, within which there appears blue pigment.

Attached to the gills there were three opaque milk-white flukeworms and a fourth of the same kind was embedded in the muscular coat of the pharynx. These appear to pertain to an undescribed species, and may therefore be distinguished by the following name and description:—

Distomum galactosomum. Opaque milk-white, depressed, spatulate, narrowest in advance, obtusely rounded at both extremities, dorsally convex, ventrally flat. Head rounded truncate or transversely oval discoid, with prominent margin, unarmed; neck short, slightly widening to the ventral acetabulum, which is sessile, larger than the oral acetabulum, and with its orifice appearing triangular; posterior part of the body elliptical, in movement expanding and becoming thinner and translucent, and concave beneath with the opaque white intestine on each side shining through. At rest about 6 mm. long by 2 mm. wide; elongating to 12 mm. by 2·5 mm. wide posteriorly, and 1 mm. at the base of the neck.

After being killed in dilute alcohol, the specimens remained of spatulate shape, 6 to 8 mm. long, 2 mm. wide behind. The oral acetabulum 0·625 broad; the ventral acetabulum situated 1·375 mm. back of the summit of the head, was 0·875 broad.

When the animal was in motion and expanded the posterior portion of the body to such an extent as to render it translucent, the intestine on each side became especially conspicuous through its white opacity. The intestines extended directly from the minute pharynx to the caudal extremity, more or less tortuous according to the degree of elongation or shortening of the animal. They are widest back of the ventral acetabulum and are sacculated. In the expanded condition of the body, by transmitted light, it exhibited a minutely reticular appearance, the lines of the rete being more opaque white and apparently according with a capillary net communicating laterally with the vessels proceeding from the caudal vesicle. The opaque white appearance of the body seems to be due to the presence of granules of calcium carbonate, for the application of acetic acid caused their disappearance with the evolution of bubbles of gas, and the body became more uniformly translucent, without however affecting the white opacity of the intestines. The generative apparatus appears to be undeveloped, as no distinct organs were observable. At the middle of the posterior portion of the body, in the usual position of the testes, there appeared a single clearer spot, and in advance of it a clearer streak. The character of these he had not determined.

Many worms, the *Echinorhynchus proteus*, clung to the interior of the intestine its whole length, but they were not so numerous as, nor larger than, they are commonly found to be in smaller individuals of the same fish.

Of two other large Rock-fish examined, weighing each about a dozen pounds, one was free of parasites of all kinds, and in the other there were only a few of the little crustacean, *Ergasilus*, adhering to the gills; and within the abdominal cavity, adherent to the stomach, closely coiled and encysted, a dozen nematoid worms, the *Agamonema capsularia*, a common parasite of the shad and herring. Neither of the fish contained a single Echinorhynchus, a remarkable circumstance, for he had never before examined a Rock-fish without finding this parasite present.

Louse of the Pelican.—PROF. LEIDY remarked that the admirable monograph of E. Piaget, "Les Pediculines," a large work with supplement, in 3 quarto volumes, illustrated, and published in Leyden from 1880 to 1885, presented to night, had reminded him that he had formerly made a communication to the Academy on an insect of the kind, which was remarkable on account of its living in the pouch of the Pelican. A brief description of the louse, under the name of *Menopon perale* is given in the Proceedings 1878, p. 100. Mr. Piaget describes two species of Menopon from Pelicans, *M. titan*, living on *Pelicanus onocrotalus* and *M. consanguineum*, which he observes appears by preference to infest the interior of the great pouch of *P. erythrorhynchus*. He remarks of the latter that it probably has some relation with *Menopon perale*, and regrets the insufficient description of this species for comparison. Prof. Leidy continued that M. Piaget's figures of *Menopon titan* and *M. consanguineum* appear so nearly alike and resemble so closely *M. perale* that from his own judgment, he would have regarded them as all of one species. In 1878 he had prepared a more detailed description with figures of *Menopon perale*, intended for publication in one of the government reports, but as it was not called for, it was forgotten until he was reminded of it by the appearance of the great work of M. Piaget. *Menopon perale* was named from specimens submitted to him by Prof. Wyman, who obtained it from the pouch of *Pelicanus trachyrhynchus*, in Florida, and others obtained by Dr. E. Coues, from the same bird, on the Red River, near Pembina, Dakota. Dr. Coues in his "Birds of the North West," U. S. Geol. Surv. 1874, 587, says of the White Pelican: "I took a female in very poor flesh, with worn, harsh, plumage, which was attributable to a disease of the pouch. On the inside of this organ were fastened in patches, great numbers of a louse, which produced an induration, ulceration, and finally perforation of the membrane."

The characters of *Menopon perale* as drawn from his original manuscript are as follow: Head wider than long, transverse reniform, pale brown with a darker patch and a crescentoid black spot between the clypeus and temple, fringed in front with short hairs, with a longer tuft at the posterior lateral lobe, and a row of eight along the posterior concave border. Antennæ concealed beneath the head, with the terminal joint largest and oval. Maxillary palpi cylindrical, reaching to the lateral border of the head, four-jointed. Mandibles strong, deeply two-toothed, black. Eyes two, close together on each side at the lateral border of the head. Prothorax narrower than the head, rounded hexagonal in outline and produced laterally in a strong conical point, pale brown above with a darker band crossing the middle and darker at the lateral borders, smooth. Metathorax as wide as the head, bell-shaped in outline, with lateral rounded angles; crossed by a row of hairs. Limbs well produced; anterior femora short and robust; the posterior two nearly twice as long as the former and darker brown in color. Tibiæ with a spur at the distal extremity. Tarsus with an ovate appendage at the proximal extremity, and a single hair at the distal extremity. Ungues strong, black. Abdomen long elliptical, nearly twice the length of the head and thorax and widest at the fourth segment. Segments of nearly equal length, the last one mammiliform, all with a wide chestnut brown band, and a row of short hairs emanating from clear circular bases. Last segment with an additional tuft of hairs on each side.

Entire length $2\frac{1}{4}$ lines; color translucent whitish and transversely striped with chestnut brown. Smaller individuals paler in color with narrower stripes of brown.

In an individual 4·75 mm. long, the head was 0·75 long and 1 mm. broad; the prothorax 0·55 long and 0·825 broad; the metathorax 0·625 long and 1 mm. broad; the abdomen 2·875 long and 1·25 m. broad.

Attached singly or in groups up to fifteen or more between the folds of the lining membrane of the pouch of *Pelicanus trachyrhynchus*.

The President was authorized to execute on behalf of the Academy an acceptance of a Deed of Trust, by which Mrs. Emma W. Hayden conveys to the Society in trust the sum of $2500.00, to be known as the Hayden Memorial Geological Fund, in commemoration of her husband the late Prof. Ferdinand V. Hayden M. D., LL.D.

According to the terms of the deed, a bronze medal and the balance of the interest arising from the fund are to be awarded annually for the best publication, exploration, discovery or research in the sciences of geology and paleontology, or in such particular branches thereof as may be designated. The award and all matters connected therewith are to be determined by a committee to be selected in an appropriate manner by the Academy.

MAY 8.

The President, Dr. LEIDY, in the chair.

Eighteen members present.

The following papers were presented for publication :—

"On the formation of rock-salt beds and mother-liquor salts." By Dr. Carl Ochsenius.

"Description of a new species of Ocinebra." By John Ford.

Parasites of the Pickerel.—Dr. LEIDY remarked that among the numerous parasites which are mentioned as infesting the Pike, *Esox lucius*, of Europe, no *Tænia* is indicated. In the Pickerel, *Esox reticulatus* brought to our market, a species of the latter appears to be common. In two fishes he found half a dozen, in the intestine and stomach; and in another a single individual two feet in length. It resembles closely the *Tænia amblopltitis*, noticed in the Rock Bass, *Ambloplitis rupestris* (Proc, 1887, 23) and may be the same. Distinguishing it with the name of TAENIA LEPTOSOMA, its characters are as follow: Body long, and thin, and at the fore-part thread-like. Head unarmed, without rostellum, with four equidistant hemispherical bothria ; neck very short or none ; anterior segments transversely linear, many times wider than long ; posterior segments gradually becoming proportionately longer and quadrate and barrel shaped ; genital apertures marginal, alternating irregularly. Ova spherical.

Length from six to nine and twenty six inches, shortening to one-half or less ; breadth to 2 and 2·5 mm. Head 0·25 to 0·5 mm. broad ; bothria 0·125 to 0·175 mm. Anterior segments an inch from the head 0·175 mm. long by 1 mm. broad ; posterior segments 0·5 to 0·75 mm. long by 2 to 2·5 mm. broad. Ova 0·028 to 0·032 mm. in diameter.

A single slender *Scolex* associated with the longest *Tænia* was 4 mm. long by 0·25 wide, but elongated to 8 mm. by 0·1 wide. The head was of the same form as that of the *Tænia*. After being in alcohol, the head of the *Scolex* was 0·225 mm. wide with the bothria 0·1 mm. in diameter. The posterior part of the body exhibited traces of segmentation, with the segments 0·075 mm. long by 0·25 wide.

Upper Tertiary Invertebrates from West side of Chesapeake Bay.—Dr. OTTO MEYER made some remarks on Upper Tertiary invertebrates. Dr. Benjamin Sharp had given him for examination a specimen of *Balanus concavus* Bronn, which had been collected by Dr. J. Alban Kite, on the west side of Chesapeake Bay. The Balanus has a diameter of two inches. Its tergum has a long spur as in the specimens of *Balanus concavus* from the English Crag; the parietes, however, are smooth, while the Crag specimens are ribbed. The scutum is less elaborately sculptured than a scutum of the same species from Yorktown Va. in his collection.

The inside of this Balanus was filled with sand containing shells etc. From this sand he had picked out the following species.

GASTROPODA.

Crucibulum costatum Morton,
Crepidula fornicata Lam.,
Natica sp.
Caecum trachea Montagu,
= *C. annulatum* Emmons,
= *C. pulchellum* Stimpson,
Nassa trivittata Say,
Trochus lens H. C. Lea, sp.,
Adcorbis concava H. C. Lea, sp.,
Cerithiopsis terebralis Adams,
= *C. clavulus* H. C. Lea, sp.
Eulima eborea Conr.,
Urosalpinx cinereus Say,
Pleurotoma marylandica Conr.?
Tornatella ovoides Conr.

LAMELLIBRANCHIATA.

Pecten eboreus Conr.,
Lucina crenulata Conr.,
Venus cortinaria Rogers,
Corbula cuneata Say,
Cardium sp.,
Mactra sp.,
Aligena laevis H. C. Lea,
Aligena Sharpi n. sp.

BALANIDAE.

Balanus concavus Bronn.

OSTRACODA.

Cythere sp.

FORAMINIFERA.

(Determined by Mr. A. Woodward.)

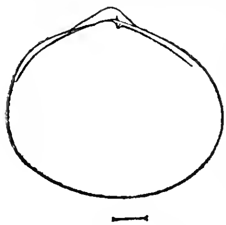
Miliolina seminulum Linn. sp.,
Polymorphina compressa d'Orbigny,
Gaudryina pupoides d'Orbigny.

These determinations were made partly from fossil specimens in Dr. Meyer's collection, partly from recent species in the collection of the Academy and he is obliged to the Conservator of the Conchological Department of the Academy, Mr. H. A. Pilsbry, for giving him the opportunity to compare them with the recent forms. The names are not intended to be the final ones, for most species of shells have not only been described as recent forms but they have frequently had other names as fossils given them, and sometimes quite a number of names, and it will be a very great task to determine the final synonymy of the tertiary and recent species.

In two cases only did he try to give synonyms and definite names. The species of *Cæcum* of which he found nearly a dozen specimens, agrees with a specimen of *Cæcum annulatum* Emmons, in the collection of the Academy, which species has been described from the Tertiary of North Carolina. He was unable to distinguish the form specifically from specimens of *Cæcum pulchellum* Stimpson, from the Atlantic coast of America, and considers specimens of *Cæcum trachea* Mont., from the Atlantic coast of Europe as belonging to the same species.

Cerithiopsis clavulus H. C. Lea, sp., of which species he found a specimen with smooth embryonic whorls in material from Yorktown, Va., agrees with the recent *Cerithiopsis terebralis* Adams, from the Atlantic coast, Florida specimens of which show three and a half smooth embryonic whorls. If the nucleus of *Cerithiopsis terebralis* should agree with the nucleus of the European *Cerithiopsis trilineata* Phil., the two species would be identical and the name of Philippi would have the priority.

ALIGENA SHARPI, n. sp. Convex, subrotund, somewhat oblong, posterior margin slightly truncated. Beak small. Hinge with one small cardinal tooth. Ligament internal in a shallow sulcation, running from the beak past the dorsal margin obliquely posteriorly and interiorly. Anterior muscular impression much elongated; posterior muscular impression oval. Pallial line apparently entire. Surface with irregular prominent striæ of growth.



Only the figured specimen was found.

The genus *Aligena* is not mentioned in the Manuals of Conchology of Tryon and of Fischer. It was founded by H. C. Lea (Trans. Amer. Philos. Soc. (2) vol. IX, p. 238.) in 1843, and was defined by him in the following way:—"Shell equivalve? subequilateral, closed posteriorly and anteriorly; hinge with one cardinal tooth and a long shallow sulcation under the beaks. The cardinal tooth is in general rather small. The sulcus appears to have received the ligament. It commences at the beak and runs obliquely past the dorsal margin into the cavity under the beak."

The two species of H. C. Lea have been placed by the authors after him, in the genus *Kellia.* In accordance with it Dr. Meyer has (at another place) enumerated *Kellia laevis* H. C. Lea, among the fossils which occur at Yorktown Va. But an examination of recent species of *Kellia*, especially of *Kellia suborbicularis* Mont., made him believe that these Miocene shells should not be placed in this genus.

The two species *Aligena leavis* H. C. Lea, and *Aligena striata* H. C. Lea, do not differ in shape from each other and are probably identical. *A. Sharpi*, however, differs from them greatly in shape, being more rounded and more inflated.

May 15.

Rev. H. C. McCook, D. D., Vice-President, in the chair.

Eighteen persons present.

The deaths were announced of Caleb Cope, a member, on the 12th, inst. and Dr. Gerhard Vom Rath, a correspondent, April 23.

A paper entitled "Notes on new species of Orb-weaving Spiders." By Rev. Henry C. McCook was presented for publication.

Notes on the Relations of Structure and Function to Color Changes in Spiders.—Rev. Dr. Henry C. McCook submitted the following remarks on color changes in spiders, which he wished to be understood as in part, at least, tentative. They were intended to evoke suggestions and helpful information from members of the Academy and others, rather than to present final conclusions on a most interesting subject.

I. On the Relation of Structure to Color he observed that:—

1 The color of young spiders is almost without exception light yellow, or green, whitish or livid, tints that blend very well with the prevailing greens of foliage, young twigs and the grays of bark of trees, of rocks and soil. This is due largely to the fact that the tissues are at that time translucent, allowing a free play of light through them. The effect is also, probably, caused by the absence of food in the alimentary tract and lack of distribution of nutriment throughout the system.

As young spiders advance in age the color deepens, which is caused no doubt by gradual hardening of the tissues, thus making them more opaque. Up to this period no food has been taken, hence the absence of food alone is not sufficient to account for the light colors of the first stages after exode. Yellows and browns in various tints occur at this period, and in some cases, not generally he believed, color patterns which are characteristic of the various species in adult life begin to appear with more or less distinctness, or at least suggestively. It is not until sedentary spiderlings have established themselves upon their own webs, and so to speak, have set up housekeeping for themselves, that the characteristic colors of the species begin to appear with any positive degree of distinctness.

2 As the spiders further advance in age and make their successive moults, various color changes may be noted. Immediately after moulting the color is always lighter, which is probably due to the fact that the harder skin, just cast off, prevented the passage of light through the tissues. The new skin is probably thinner, and more translucent. Dr. McCook believed that moulting produces changes in color patterns of a very decided kind, at least in certain species. Apparently some organic change occurs which is the cause of this phenomenon.

3 In old age the color changes are very decided in almost all species. In some, as *Eperia trifolium* and *Epeira thaddeus*, the changes give added brilliancy to the color at certain parts of the body. Some of the color changes of *trifolium* are very beautiful and the same is true of *thaddeus*.

But advanced age, as a rule, makes the colors darker. Orange and brown then have a ruddier hue; yellows darken into orange and brown. Sometimes the yellow patterns are entirely lost, and the spider becomes very dark, almost black. There is a grizzled appearance about the animal in this stage which reminds one of the corresponding condition of man and lower vertebrate animals. These last named changes are manifest in the spider after the final deposit of eggs.

4 In gravid females the changes of color are often very decided. Some of the bright colors upon *trifolium* and *thaddeus* are doubtless due to this condition. Most spiders during gestation have a lighter color, which may be the result of mechanical changes in structure. The skin becomes distended and more transparent, the pigment is thereby distributed, and thus centres of color are broken up and the color matter diffused. Not only the skin, but other parts of the abdomen are distended during gestation, and this distension produces changes in the color of the animal by modifying in some way the various secretions from the liver and other organs.

5 The little pits or dark spots upon the dorsum of the abdomen which mark the attachment of the muscles within, appeared to him to be centres for aggregation of coloring material. At least the dorsal patterns seem to be grouped in some regular way around these muscular attachments. Thus the action of the muscles on the skin and chitinous shell or walls serves to compel certain aggregations along the lines of use, that form these colors and patterns. It might be important in this connection to consider what is the ordinary effect of muscular action upon the distribution of pigment in the human system or with vertebrate animals?*

The color rings or annuli around the joints of the limbs of spiders may also be produced by action of the muscles. It is noticeable that the tendency of these darker and more vivid colors is towards the ends of the joints, as though by the outward action of the muscles the pigment were forced mechanically or otherwise attracted toward these points.

In the cephalthorax may be noted the same tendency of color to group itself around the points of muscular attachment, particularly

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* After the remarks here recorded, Dr. Nolan, the Secretary, called attention to the fact that he then had in hand for publication a paper by Dr. Harrison Allen, on "The Distribution of the Color Marks of the Mammalia." This paper has now appeared, and is a most valuable and interesting one. (See Proceed. Acad. Nat. Sci. Phila., 1888, pp. 85–105). The following sentence is quoted therefrom as bearing upon the above suggestion: "The stripes and spots on the limbs and the dapple-marks on the trunk, as well as some of the broader sheets of color, appear to be related to the intervals between the muscle-masses or to the extent of skin surfaces which correspond to muscles." p. 100.

the central depression. Dr. McCook added that, as far as he knew, no araneologist had suggested the theory of muscular attachment and action as effecting color distribution, and he did not wish his opinion for the present to be considered as fixed; but he thought the theory probable, at least.

II. On the Relation of Environment and Habit to Color Changes, it was observed:

1 Spiders that live upon plants as a rule have colors that are harmonious with the prevailing greens and yellows, and admixtures thereof, of branches, leaves and flowers.

2 Spiders that nest in stables, houses, on fences etc., ordinarily have dusky colors, harmonious with the environment. Examples, *Theridion vulgare, Agalena nævia, Tegenaria medicinalis* (*Durhami*) etc. However, the speaker did not find that any great difference in color is observable in the above species when they are found nesting in foliage, as is often the case, at least with *Agalena* and *Theridion*. It might be said, perhaps, that there is a slight tendency to darker and a more uniform color when the spiders are found in the first named locations.

3 Ground spiders (the Lycosids etc.) generally have colors of neutral grays that blend well either with the soil, with rocks or with stalks of grass etc., especially when the latter are somewhat dry.* Lycosids found in the neighborhood of streams do not seem to be especially influenced by the natural color of water; but *Dolomedes sexpunctatus*, which is so constantly found on the water, frequently has a tint like that of the stream itself.

4 Saltigrades follow the rule of the Lycosids as to color. Their colors harmonize well with the surface of rocks, trunks of trees etc., upon which they habitually seek their prey. They are also sufficiently harmonized with the color of leaves and the ground.

The metallic green on the fangs of some Saltigrades seems almost like a green leaf-ambush to the body of the creature as it is observed stalking its prey. This suggests the strategy most familiar from its association with the lines of Shakespeare:

> "Macbeth shall never vanquished be, until
> Great Birnamwood to the Dunsinane hill
> Shall come against him."

Of course this suggestion is fanciful; but of what use to the creature can such a provision be if it serves not as an aid in securing its prey or protecting it against enemies? One might almost be justified for asking: can there possibly be anything in the above idea?

5 Are the brightest colored spiders, which one would suppose naturally to be most exposed to enemies like birds, and raiding ichneumon-flies and mud-dauber wasps, commonly protected by their industry? Dr. McCook cited a few examples as bearing upon this

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* It is a fact that the darker colors of most spiders are found contemporaneously with the autumn changes of the foliage to a duskier hue, but the two facts are probably due to the same cause, viz., the advancement of decay and the changes which result from this last named stage of vitality.

inquiry. *Argiope riparia* and *fasciata* have protective wings of retitelarian lines thrown out on each side of their nets, which protect the exterior of their bodies; and a thick shield-like sheeting which protects the underside of the body. These spiders are highly colored and conspicuous by size; they dwell in shrubs, bushes, grasses, low trees, and commonly are stationed in the centre of their round webs, having no domicile or tent to which they retire.

The very bright colored spiders *Epeira insularis* and *trifolium*, do not hang habitually in the centre of their webs, but live in leafy tents and their habitat is among shrubs and trees. *Insularis* inclines to groves etc., much more strongly than *trifolium*. *Epeira thaddeus* has the same habit.

Per contra, *Eperia strix*, which is not a bright colored spider, by any means, is one of the most secretive orb-weavers in its habits, dwelling in a domicile of rolled leaves, shrinking away into cavities and holes, under bark etc., and only occupying its snare during the night.

Epeira domiciliorum and *cinerea* (*Harrisonæ*) are also spiders of rather inconspicuous colors, and both of them screen themselves in tents, though *domiciliorum*, at least, not so habitually as *insularis* and *trifolium*.

Epeira labyrinthea and *triaranea* are among the most strongly protected by industry, having besides their orb and thick retitelarian snare, a dome-shaped silken tent as a domicile, and *labryinthea* in addition a dry leaf as shelter above her body or tent. These spiders are strongly marked as to their patterns but do not have the bright hues which characterize *Argiope*, *Epeira insularis* and others.

Meta hortorum is one of the most brilliantly colored of our indiginous spiders. Although its colors harmonize, particularly its green and metallic silver, with its leafy surroundings, it rests beneath its horizontal orb, and has straggling, pyramidal, retitelarian lines beneath it. It dwells mostly in wooded places, at least in this neighborhood. *Epeira gibberosa* is also a bright colored spider. It dwells beneath a sort of hammock or stretcher of lines woven between the edges of a leaf. It is thus very well protected.

Our three indiginous species of *Acrosoma*, *rugosa*, *spinea* and *mitrata* are all, particularly the first two, well marked spiders. They are protected, *mitrata* least conspicuously, by spinous processes, (if such can be called protections). They live in the centre of their orbs as a rule, and their webs are most frequently found stretched between the trunks of young trees, in openings of groves, woods, and like spots.

Gasteracantha, with its strongly developed spines has very much the same habit as our indiginous *Acrosoma*, but the spines appear to be wanting in the young of this genus, the very age, one would think, at which they are most needed. However, the young of *Gasteracantha*, at least with numerous specimens sent from the Pacific coast, are almost black in color, a feature which may certainly be regarded as protective if bright colors best invite the observation of enemies.

On the whole, the conclusion seems justified that many spiders that appear to be more exposed to enemies by reason of bright colors or greater size, have developed, or at least possess, special variations in industry and habits that in some degree are protective. But there are a number of apparent exceptions which require more careful study before any general deduction can be warranted.

May 22.

Mr. J. H. Redfield, in the chair.

Twenty-one persons present.

May 29.

Mr. J. H. Redfield, in the chair.

Eleven persons present.

The following papers were presented for publication:

"Description of a new species of Etheostoma (*E. longimana*)." By David Starr Jordan.

"On the generic name of the Tunny." By David Starr Jordan.

June 5.

Mr. Thomas Meehan, Vice-President, in the chair.

Twenty-four persons present.

On an Insect-Larva Habitation.—A communication was read from Miss Adele M. Fielde stating that during June of last year there were found near her house at Swatow, China, two specimens of an insect larva-habitation, of a sort that she had not seen there before, during a residence of a dozen years. The one was attached to an exotic oak-leaved geranium, the other was crawling upon a path under a *Pinus sinensis*. The first, some days later, gave issue to a small brown moth. She opened the second and found the occupant to be three-fourths of an inch in length, and black, with white specks on the head and thorax. It had three pairs of short legs, ten abdominal segments, and biting mouth-parts. Its house was builded from small dry stalks of plants, cut evenly and laid side by side in a spiral of expanding whorls, the larger coils overlapping the smaller at the lower edge, showing the lower ends of the straws. The colors varied from pale green to dark brown, and were laid in such a way as to indicate that one straw had been used up before another was sought for the building. There were a hundred and twenty pieces in the structure, the lower small end being open as well as the upper. The house was lined with a brown silk cocoon, upon which the straws were very tightly and evenly cemented.

Hoping to see the method in which the creature worked, she removed from the upper portion of the truncate inverted cone, half a whorl of its straws, put the larva back, closed its house, put it under a wire screen, on a plate of tender rose leaves, and stuck through the screen several dry, small stalks of grass. The active and shy larva would never emerge from its domicile when she was looking at it, but she managed to surprise it at its work so many times as to make sure of its method. The holes made in the rose leaves indicated that they furnished food for the worker. The dry straw was drawn into such a position that its end could be laid upon the house, and cemented, with silken lining, into its place at the upper, enlarging end of the spiral layers. When laid and fastened, the lower end being exactly in line with previously laid stalks, the upper end was made by biting off the straw in the line of the upper edge of the structure. Thirteen new straws were thus laid on to replace what she had violently removed, and, after two weeks of active life under the wire screen, the larva closed the upper aperture (its front door and place of egress) by fastening it with a veil of silk, to the top of the screen, from which it hung suspended. She did not perceive that it had ever voluntarily departed from its house, though its head and thorax often projected beyond its front door. By the small lower aperture refuse was cast out. This specimen died without having reached its metamorphosis.

JUNE 12.

Rev. HENRY C. MCCOOK, D. D., Vice-President, in the chair.

Fifteen persons present.

JUNE 19.

Mr. CHARLES MORRIS, in the chair.

Thirteen persons present.

The following papers were presented for publication :—

"Observations on the Female Generative Apparatus of Hyæna crocuta." By Henry C. Chapman M. D.

"A new Fossil Spider, Eoatypus Woodwardii." By Rev. Henry C. McCook, D. D.

The deaths were announced of S. Fisher Corlies and Rachel L. Bodley, M. D., members, on the 13th and 15th inst. respectively.

JUNE 26.

Rev. HENRY C. McCOOK, D. D., Vice-President, in the chair.

Forty persons present.

A paper entitled "Nesting habits of the American Purseweb Spider." By Rev. Henry C. McCook, D. D., was presented for publication.

The death of Dr. J. L. Ludlow, a member, on the 21st. inst. was announced.

Mr. Wm. W. Jefferis was elected a member of the Council, to fill the vacancy caused by the death of Mr. S. Fisher Corlies.

Mr. Benjamin P. Wilson was elected a member.

Mr. John Donnell Smith of Baltimore was elected a correspondent.

The following were ordered to be printed:—

DESCRIPTION OF A NEW SPECIES OF ETHEOSTOMA (E. LONGIMANA) FROM JAMES RIVER, VIRGINIA.

BY DAVID STARR JORDAN.

Subgenus **IMOSTOMA**, Jordan.

Head 4 in length to base of caudal: depth 5. D. IX or X,—12 or 13. A. II, 8; scales 6–43–7. Type No. 24619. Mus. Comp. Zool.; 8 specimens, the largest 2½ inches long.

Body moderately elongate, not much compressed; head rather long, somewhat blunt anteriorly, convex above the eyes, profile of the snout steep and nearly straight; premaxillaries protractile; lower jaw included; maxillaries reaching front of orbit, about as long as eye which is 4 in head, and about as long as snout; teeth rather strong; gill membranes very slightly connected; cheeks nearly or quite naked; opercles with some scales.

Lateral line complete; scales rather large; nape naked; belly naked anteriorly, with ordinary scales posteriorly. Pectorals extremely long, reaching front of anal, about 1½ times as long as head; ventrals long, but not reaching tips of pectorals. Dorsal spines high, the longest 1⅓ in head; soft dorsal very high, $1\frac{1}{10}$ in head; anal rather large, but smaller than soft dorsal; anal spines small, the first longest; caudal subtruncate.

Color in spirits, olivaceous; traces of about 5 dark cross-shades which extend on the dorsal fin; fins nearly plain, the spinous dorsal somewhat mottled; snout and suborbital with some dusky; a dark spot at base of caudal.

The types of this interesting species were taken by Professor Baird, about 1855, in a tributary of the James River, Virginia. They were found by me in the Museum of Comparative Zoology, bearing the Mss. name (from Professor Agassiz or Prof. Putnam,) of *Cottogaster longimanus.*

ON THE GENERIC NAME OF THE TUNNY.

BY DAVID STARR JORDAN.

In the first edition of the Règne Animal, 1817, pp. 313, 314, the generic names, *Thynnus* and *Orcynus*, were proposed for the Tunnies. The former name was given to the short-finned tunnies, type *Scomber thynnus* L., and the latter to the species with long, ribbon-shaped pectorals, type *Scomber germo* Lac.=*Scomber alatunga* (*alalonga*) Gmelin.

It has been generally agreed that these two groups are generically identical. Many European writers have continued to use the name *Thynnus* for both, although this name was much earlier preempted, by Fabricius, for a genus of Insects.

The name *Orcynus* is however also preoccupied having been proposed by Rafinesque in 1815, in his worthless "Analyse de la Nature," as a substitute for *Scombroides* Lacépède.

According to current rules of nomenclature, the group of Tunnies is left without a tenable generic name. I therefore propose the name *Albacora*, for the group of which *Scomber thynnus* is the type, this species being with others, widely known as *Albacore*. The subgenus or genus distinguished by the elongate pectorals may be called *Germo*, its types being *Sc. alalonga* Gmelin.

ON THE FORMATION OF ROCK-SALT BEDS AND MOTHER-LIQUOR SALTS.

BY DR. CARL OCHSENIUS.

As is well known that ocean-water, from which all primitive rock-salt masses have been formed, contains on the average 3½ % fixed *i. e.* saline constituents, of which 2½ % is sodium chloride, the remainder consisting of magnesium compounds, calcium sulphate, potassium chloride, sodium bromide and small quantities of boron, iodine and lithium salts, as well as traces of every other element, of which indeed there exists one or the other compound, soluble in water and much more so in salt-water.

The open sea precipitates no salt, but in bays partially cut off from it, a deposition can take place under certain circumstances, in such a way that gypsum forms the base, and anhydrite the uppermost layer of the salt deposit; this is plainly seen in every large rock-salt bed. In considering the mode of formation of such deposits we are met on all sides by three questions, which hitherto have remained somewhat inexplicable:—1st the absence of fossils in the salt, whilst the neighbouring rocks often contain them well preserved and in abundance, 2nd the small quantities of easily soluble magnesium and potassium salts, though they were contained in the sea-water, and 3rd the replacement of these latter by one of the most insoluble constituents, viz. sulphate of lime in the form of a cap of anhydrite, the so-called *Anhydrithut.* These facts can, however, be explained, if we take a hydrographical element, viz. the bar, into account in the process of formation. When a nearly horizontally running bar cuts off a bay from the sea, so that only as much sea-water runs in over it as is compensated by evaporation from the surface of the lagoon, and the so partially separated portion receives no large additions of fresh—, *i. e.* rain or running water a deposition of salt takes place in the way to be described.

In such a bay the following phenomena may be observed:—The sea-water running in evaporates, and by the amount of salt it adds, the solid constituents of the bay are continually increased. The upper sheets of water, warmed by the sun, sink as they get specifically heavier from the larger amount of salt, and in the course of time, a vertical circulation setting in, the whole aqueous contents become enriched in saline matter and rise in temperature.[1] The greater part of the deliquescent magnesium salts however remains in the upper layers, while chloride of sodium is found preponderating below. As the saltness increases, organisms pcssessing free locomotive power, are compelled to seek a new habitat and make their escape into the open sea against the currents and waves sweeping over the bar; those without free movement die off and generally leave only indistinct remains in the strata, which are next deposited. The formation of the latter commences with the precipitation of oxide of iron and carbonate of lime, as soon as the concentration has proceeded so far as to double the amount of saline matter in the lagoon and then ceases until the solution contains five times as much salts, when a second layer of carbonate of lime settles, this being brought about by a double decomposition between the soda and gypsum held in solution in producing calcium carbonate and sodium sulphate. At the same time gypsum begins to deposit and constitutes the basis proper. As soon as the saline solution has increased its weight of salts eleven times, its specific gravity reaches 1·22 and the precipitation of chloride of sodium begins in the form of the well know foliated crystalline masses, accompanied by some calcium sulphate etc., added from the sea-water running in.

Though generally speaking the sediments follow in reverse order of their solubilities, as Usiglio [2] has shown in his exhaustive experiments, it often happens that small quantities of easily soluble salts are mechanically included in the others; thus magnesium sulphate is frequently found contaminating rock-salt, and especially there, where clayey mud washed in, and was deposited at the same time. Then again some substances, only scantily represented in sea-water, remain longer in solution than we should be led to expect from labo-

[1] By this interchange of heat downwards the constant temperature of 14C°. to a depth of 4000 meters in the Mediterranean can be accounted for, the high barrier at the Straits of Gibraltar cutting this sea off from the Atlantic; westwards of the entrance to the Mediterranean on the other hand, we find extending to the same depth, an icy temperature of 0° to 40°. Accordingly deep sea currents rich in chloride of sodium flow from the Mediterranean into the Atlantic as well as the Black Sea, and are compensated by return surface currents. As a result of this circulation, the surface water of the Mediterranean is rich in magnesium salts, whilst the Black Sea, analogous to the Baltic, does not contain ocean water diluted with fresh water as one might at first be led to expect from the great influx of river-water, but shows a preponderating amount of sodium chloride.

[2] Ann. Chim. et Phys. 27, 172.

ratory experiments. This is especially the case with borates, magnesium borate in particular, as well as with silica and titanic acid. As the depositing process continues, the greater part of the deliquescent salts remains dissolved in the upper layers and constitutes the mother-liquors (*Mutterlaugen*), which contain, along with sodium chloride, the potassium and magnesium compounds etc. We have then in the mother-liquors above the rock-salt, approximately arranged in order of solubility: sulphate of magnesium, chloride of potassium, chloride of magnesium, borates, bromides, lithium salts, an iodine compound probably magnesium iodide, and calcium chloride. In the course of the continued growth of the rock-salt beds and likewise of the mother-liquors, the latter attain the level of the bar and commence flowing out seawards directly over it, as soon as their specific gravity can overcome the current of the inflowing sea-water. After this stage is reached, ordinary sea-water can only have access through the upper portion of the bar-mouth, the lower part being occupied by the outgoing mother-liquors.

At this point the last stage of the process begins viz., the deposition of the uppermost bed of sulphate of calcium in the form of the *Anhydrithut*. Portions of the concentrated mother-liquors get mixed with surface-water washed in, and this, from the increased amount of the hygroscopic chlorides of magnesium and calcium, lessens the superficial evaporation of the bay, and hence the influx of sea water diminishes gradually. The sulphate of lime in the sea-water that has flown in, is now precipitated, the other salts mixing with the mother-liquors and flowing out with them over the bar. As the gypsum falls through the concentrated mother-liquors, its water of combination gets abstracted, and a seam of anhydrite is by degrees deposited. Sometimes a compound is formed of gypsum with the sulphates of magnesium and potassium (the latter by double decomposition of sulphate of magnesium and chloride of potassium) viz., polyhalite, a mineral occurring in the upper strata of many salt deposits. The bay meanwhile assumes the character of a bitter-lake and influences the surrounding shores, the organisms inhabiting the littoral waters dying off, and the neighboring rock disintegrating to dust, which is blown into the lake, forming the material for the salt-clay; this offers a good explanation for the increased thickness of salt-clay seams often observed in the upper layers of salt deposits.

A regular succession of these briefly described phenomena will rarely be found in nature. Every alteration in height of the bar, resulting from storms and other disturbances, naturally affects the precipitations about to take place, by accelerating or retarding them, or even redissolving some of the layers already *in situ*. In some cases where the *Anhydrithut* was never formed, the bar not having retained its original height long enough, the salt-clay plays the part of protecting covering; however, even under these circumstances the resulting series of deposits are so characterised as to point clearly to their mode of origin.

Salt beds deposited from aqueous solutions under the above-named conditions, are found in all geological epochs as far back as the Archæan rocks; this is shown by the super-position of Silurian strata to the salt in Salt Range in India. The existence of primitive salt beds points conclusively to the presence of shores, *i. e., terra firma,* at the time of formation. At the present day the first of the above stated agents is found in operation in several localities on the East coast of the Caspian, especially in the great bay of Adschi Darja, whose narrow mouth, Karaboghaz ("black abyss"), is partially cut off from the Caspian by a bar. The bay is one of the saltiest of this inland sea, and receives no supplies of water at all from the land, only its evaporation being balanced by a corresponding influx of sea-water. Under these circumstances no animal can live in the Adschi Darja waters, and the bottom is covered with a layer of salt of unknown thickness; in a specimen of this deposit dredged up by Abich, the latter found gypsum intermixed with rock-salt. C. Schmidt* in 1876, found no trace of potassium in the salt bed of Karaboghaz. On the other hand the water contained in 100 parts:—

8·33 sodium chloride
1·00 potassium chloride
12·94 magnesium chloride
·02 magnesium bromide
6·19 magnesium sulphate, etc.,

in all 28·50 per cent. of salts; this composition is nearly identical with that found by Usiglio in mother-liquors, when they give off no more water at the ordinary temperature. Similar conditions have been noticed at Tjuk-Karagan, Mertwy-Kultuk and Karassee, Krasnorvodosk, etc. The Caspian then gives up its chloride of sodium to the salt-pans on its east coast and in return receives only mother-liquors, accounting for the character of the water in the principal basin, which contains less salt than the ocean, but much more magne-

* J. Roth, Chem. Geol. I, 467.

sium compounds, and hence causes a degeneration in the marine fauna and flora on the East coast. The Oxus (Amu Darja), which two centuries ago poured its waters into Adschi Darja prevented a deposition of salt there, but since sand-storms have diverted this stream into the Aral, the change of the Caspian into a bitter-lake has been accelerated by the formation of sand-bars along the East-coast bays, which are converted into salt-pans.

The above description of the processes now being carried out on the East coast of the Caspian will suffice to illustrate the origin of all rock-salt deposits, from the Silurian down to the present era, and further, the occurrence in each of gypsum, as basis and the Anhydrite-cap with salt-clay as cover. Fossils are hardly ever present, and mother-liquor salts rarely in large amounts.

To go back to the time when the first signs of the anhydrite-cap make their appearance, we find that an increase in altitude of the bar, sufficient to cut off the influx of sea-water, causes the mother-liquors to stagnate and under favorable conditions of temperature to solidify. Such a process has taken place in the Egeln-Stassfurt basin, and in some other localities of the old North-German Permian salt-sea. The potassium and magnesium salts, together with boron and bromine compounds, have crystallized out and been exceptionally well protected against re-solution by a clay seam impermeable to water. There are to be seen lying on a rock-salt bed many hundred yards thick, consecutive zones of carnallite, kieserite and polyhalite; the latter generally encloses the sulphate of lime, which was still contained in the waters of the bay at the time of the closing in by the bar, magnesium sulphate occurs especially in the second, and in the zone of carnallite are found the chlorides of magnesium and potassium, borates and magnesium calcium bromide (brom-carnallite). Calcium chloride is also met with in certain minerals, such as tachhydrite etc., and in some cases undergoes in presence of magnesium sulphate a double decomposition, calcium sulphate and magnesium chloride being formed.

The total quantity of chloride of magnesium occurring in the Stassfurt beds does not correspond to the normal amount; portions of this substance must have made their exit over the bar with the lithium and iodine salts, or have been absorbed by the upper beds (N. B. lithium is found in the salt-clays above, but not iodine) or were carried away in solution later on. Hence the succession of mother-liquor salts in Stassfurt is not quite complete; on the other hand the saltpetre fields of Tarapacá and Atacama in Chile, now resting on lower levels to those of the original salt-pans, afford an example of an entire series of beds. In the reopening of the bar in the Stassfurt basin, the process of salt deposition came again into operation above the stratum of clay protecting the mother-liquor or *Abraum*-salts; this is proved by the occurrence of an upper salt bed, with anhydrite-cap etc.

The lowest division of the whole series there, though the name does not correspond very well, is known as the *Anhydritregion*, or zone of anhydrite, on account of thin parallel bands of sulphate of lime transversing it at regular intervals; they are called annual rings (Fahresringe), but cannot be explained by the direct influence of the seasons, *e. g.* in winter, because they are not found in other salt deposits, which have been formed under similar climatic conditions. It is more probable that a process, similar to that in the deposition of the second lot of calcium carbonate of Usiglio, has taken place in their formation. Some agent or other, related to that, which caused the conversion of gypsum and soda into carbonate of lime and sulphate of soda, must also have been at work here. Most likely the decomposition took place at first gradually, whereas towards the end it was rapid, from which can be explained the "rings" being ramified below and level above. Local peculiarities may also have been the cause, for instance, periodic supplies of water coming from the land, but it was certainly not of a purely climatic nature. This might be a probable explanation for the exceptional case of Stassfurt deposits, where the mother-liquors were dried up above the salt beds proper and not afterwards removed by external agencies.

As the process of filling up of a salt-pan with gypsum, rock-salt, anhydrite and salt-clay has proceeded so far that the anhydrite-cap reaches the height of the bar, the latter deposit naturally retains cavities and irregularities in its surface, occupied by fluid residues of mother-liquors. These residues must often have been pretty considerable, and they represent a most importänt geological agency; for rock-salt formations can only occur on the sea-coast, and it is here that volcanic action has its sway, so that we often find the neptunistic and volcanic forces cooperating. Through displacement in the beds, the residual mother-liquors are set free and flow to lower levels, where on reaching an impervious stratum they collect and form a salt-lake; or if brought to the surface again appear as brine and mineral springs more or less removed from the original source.

During their flow or collection the sulphates often separate from the chlorides; borates, once precipitated, remain so, and give rise to *suffioni*; carbonic acid decomposes saline solutions more or less, but chloride of sodium is scarcely ever entirely absent, and boron, iodine, bromine and lithium are represented by traces. On account of this remarkable action of carbonic acid on mother-liquor salts, the minerals accompanying trona thermonatrite etc., must be principally sodium compounds, (chloride, sulphate, borate, silicate etc.) the carbonates of calcium and magnesium being separated out as fairly insoluble precipitates. The carbonates of the alkalis decompose silicates of lime in the rocks around forming carbonate of lime and silicates of sodium and potassium as intermediate products, which easily undergo decomposition, silica thereby being separated out in the hydrated state: allowed to remain in contact with animal detritus, saltpetre is produced; magnesium chloride and sulphate convert limestone into dolomite and certain silicates to serpentine; the sulphates of magnesium and lime also are often decomposed by certain organisms, giving rise to sulphuretted-hydrogen and a separation of sulphur; lastly magnesium chloride dissolves all metallic compounds, and even gold, hence mother-liquors with or without the aid of water impregnated with carbonic acid, must have played a great part in the deposition of most of our ores, by dissolving out the metals contained in the different rocks around and concentrating the same in cavities of various kinds.

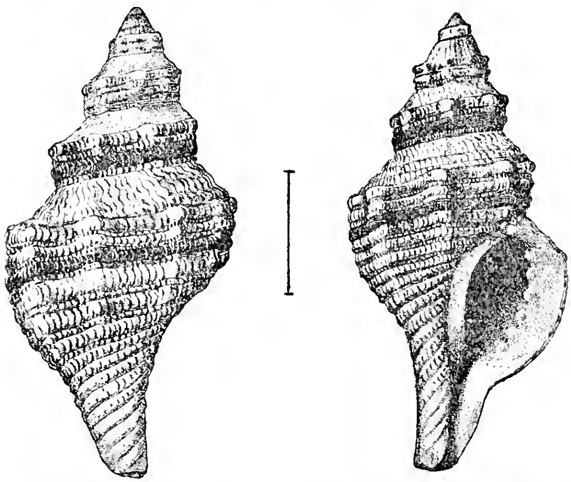
As the bituminous matter contained in brine-springs doubtless is a product of decomposition of organic substances met by the mother-liquors on their way, so the origin of petroleum, which is always intimately connected with salt districts, can be accounted for by the sudden destructive action of an overflow of mother-liquors over a rich marine fauna and flora, the accompanying mud serving to shut off access of air from the cadaverous remains, and the presence of some chloride of aluminum enabling the formation of all the representatives of the hydrocarbon series from the small particles of anthracite occurring in lodes, to the masses of volatile hydrocarbons of the vast oil districts. In short, in most littoral districts of past and present oceans, from the depths of our mines to the summits of the mountains, which ocean-water has not reached, but where mother-liquor residues have been transported, do we find tangible proofs of the remarkable effects of which mother-liquors have been the primary cause.

DESCRIPTION OF A NEW SPECIES OF OCINEBRA.

BY JOHN FORD.

Ocinebra Michaeli, Ford.

Shell fusiform, rather slender, turreted, light gray, with a narrow median brown band; whorls 5, convex, shouldered above, the upper ones carinate; sculptured with numerous rather coarse revolving lirations, the interstices with riblets bearing crowded festooned lamellæ of growth, which are also prominent below the sutures; longitudinally prominently plicate, with about seven folds to each whorl; aperture oval, white within, angular above; anterior canal quite long, open, straight; outer lip thickened within, bearing six small tubercles; columella nearly straight; with a whitish callus



projecting slightly at beginning of canal. Length of shell 16, diam. 8 mill. Length of aperture 9 mill. Hab., Cayucos, San Luis Obispo Co., California. Differs from *O. interfossa* Cpr., in having open canal. *O. subangulata* Stearns, is somewhat related, but is much longer, ess angulated, aperture more rounded and without the internal tubercles shown by *O. Michaeli.* So far as can be learned, this small, but distinct species, has been found only by Mr. Geo. W. Michael, Jr., after whom it is deservedly named; the gentleman being not only an efficient collector, but a careful student of science also. About forty specimens have been secured alive by him at the locality mentioned, which is the only one known at present.

OBSERVATIONS ON THE FEMALE GENERATIVE APPARATUS OF HYÆNA CROCUTA.

BY HENRY C. CHAPMAN, M. D.

The Hyæna, as well known, was regarded by many of the ancients as being a hermaphrodite. Thus Aelian[1] observes "if you see a male hyæna one year the next year you will see a female, if now truly a female, afterwards a male, for it partakes of both sexes," while according to Pliny[2] "the vulgar believe that the hyæna is of both natures and are on alternate years male and female, and bring forth without a male." The same opinion appears also to prevail to a considerable extent even at the present day among the natives and settlers in South Africa. Like many other popular opinions and superstitions the view of the sexes being united in the same individual in the hyæna is based to a certain extent upon fact, as in one species at least, the *Hyæna crocuta*, or spotted hyæna, the male and female individuals resemble each other so closely that naturalists as well as animal dealers and showmen find it impossible, without dissection, to distinguish one sex from the other. Such being the case it might naturally have been supposed that the attention of anatomists would long since have been called to the consideration of the generative apparatus in *Hyæna crocuta*, especially as in the other two species and *Hyæna striata*, *Hyæna brunnea*, the disposition of the generative apparatus is normal. It is only, however, within recent years that it was shown by Prof. Watson of Manchester, England, that in the female of *Hyæna crocuta* the uterus passes directly without an intervening vagina into the urethra to form a uro-genital canal which, perforating the clitoris, offers a passage-way, not only for the urine but also for the foetus. Such a disposition would naturally suggest without dissection the idea of the animal being a hermaphrodite—especially as not only are the vulva and vagina entirely absent, (Plates IX and X), but there are present in addition to the large and well developed clitoris two projections below the anus simulating a condition

[1] Hyaenam si videas uno quidem anno marem altero videbis foeminam, si verò nunc foeminam, postea marem, utruisque enim sexas particeps est. Claudii Aeliani, De Animalium natura. Ludguni, 1616, Lib. 1, Cap. xxv.

[2] Hyænis utraqua esse natura et altenus annis mares alteris foemias fieri, parere sine mare vulgus credit. C. Plinii Secundi Naturalis Historiæ. Venetiis 1559, Lib. viii, Cap. xxx.

of the scrotum, obtaining in many of the carnivora. As my dissection of the female generative apparatus of *Hyæna crocuta* that recently died at the Philadelphia Zoological Garden agrees in every respect[1] with that of Prof. Watson, and as the description of the parts given by that anatomist is excellent, my dwelling further upon the same in detail apart from confirmation, would be superfluous. I will limit myself therefore, rather to the consideration of how such an extraordinary disposition of generative apparatus might be brought about and to pointing out its significance in the determination of the homologous parts of the male and female generative organs of the mammalia generally. It is well known that at an extremely early period of intra-uterine life, about six weeks, for example, in the case of the human embryo, (Plate XI, fig. 2.) the sex is undistinguishable, ovaries or testicles are undeveloped, the Mullerian and Wolffian ducts, bladder and rectum terminate in a common receptacle or cloaca, while no external generative organs are observable. As the development of the mammal advances, however, the rectum and bladder separate and open by distinct openings, the anus and urethra, the cloacal condition being retained through life only in *Ornithorynchus* and *Echidna*, the Wolffian ducts become the vasa deferentia, the Mullerian ducts atrophying, supposing the individual to become a male or the Wolffian ducts atrophying and the Mullerian ducts become transformed into Fallopian tubes, uterus and vagina, supposing the individual to become a female, the two bodies up to this moment, indifferent functionally, becoming testicles or ovaries respectively—the testicles usually in time descending into a scrotum, the urethra passing through the penis. It is well known that in the female of certain shrews, moles and lemurs and, as recently observed by the author in the South American hare, *Capromys pilorides*, (Plate XI, fig. 1.) the urethra passes through the clitoris as through the penis in the male of these animals. The fact of the clitoris being traversed by the urethra in the of female *Hyæna crocuta* is, therefore, not such an uncommon condition as at first sight it might appear and confirms the view held by morphologists of the clitoris being the homologue of the penis. Indeed the clitoris only differs from the penis in being smaller and in the fact that the labia minora do not unite underneath the urethra in the middle line to form what would correspond

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[1] It need hardly be mentioned that the contracted kidney and dilated ureter, the latter due to impacted calculi, observable in my dissection, are pathological conditions.

to the skin on the under surface of the penis. It has already been mentioned that an early stage in the development of the mammalian embryo the rectum, bladder, Mullerian ducts (the latter in the female becoming the vagina and uterus) pass into the cloaca, and that as development advances the rectum separates from the cloaca, opening by the anus. With a still further advance in development the uterus separates from the uro-genital canal and opens by a distinct canal, the vagina, the bladder opening through the urethra. While such is the normal order of development of the female generative apparatus in the mammalia, it may be readily conceived that, should the development be arrested at the stage in which the uterus and the bladder still pass together into a uro-genital sinus and should the latter traverse the clitoris in the same manner as the urethra does in the case of *Capromys* etc., a disposition precisely similar to that found by Prof. Watson and the author, in the female of *Hyæna crocuta* would result. If the above view be admitted, then the peculiar arrangement of the female generative apparatus in *Hyæna crocuta* may be regarded as due to an arrest of development. One of the most remarkable peculiarities of the female generative apparatus of *Hyæna crocuta*, to which we have hitherto only incidentally alluded, is the entire absence of a vagina, the uterus passing directly into the urogenital canal in which respect the animal differs from all other mammalia, except perhaps the elephant. In the latter animal in both the Indian and African species, as observed by the author[1] a long and capacious urogenital canal leads into the bladder on the one hand and on the other into a cavity which the author regarded either as corresponding to a vagina or to the neck of the uterus, this cavity leading in turn into the body of the uterus. Should the latter view be accepted, that is if the cavity in question be regarded morphologically as uterine, then the vagina would be absent in the elephant, as it is without doubt in the hyæna. In conclusion it may be mentioned that the fact of the vagina being undoubtedly absent in *Hyæna crocuta* and probably also in the elephant settles definitely, at least for these animals, the question as to whether the utriculus or sinus pocularis of the male should be regarded as the homologue of the uterus or the vagina of the female, since if the vagina be absent in the female hyæna and elephant the utriculus of the male of these animals must necessarily be homologous with the uterus of the female.

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[1] On the Placenta and female generative apparatus of the Elephant. Journal of Acad. of Nat. Sci. of Philad., n. s. VIII p. 413.

JULY 3.

Mr. THOMAS MEEHAN, Vice-President, in the chair.

Ten persons present.

Note on Mazapilite, a new species.—Prof. GEO. A. KOENIG announced the occurrence of this mineral at Zacatecas, Mexico, in the mineral district of Mazapil. The crystals are well developed in all directions. They are of orthorhombic symmetry exhibiting a flat prism in combination with a brachy dome and a pyramid. The color is deep brown red, nearly black, but transparent at the edges. The hardness is nearly 7, its streak greenish yellow. The specific gravity 3·567. In closed tube a white crystalline sublimate is produced ($As^2 O^3$) and water, while the powder turns dark brown. B. B. fuses at 3 to a black globule. On charcoal the odor of arsenic is observed. With borax only iron reaction. Easily soluble in in warm HCl. A preliminary analysis proves the mineral to be a *calcium ferric arsenite.* The structural formula must be made the subject of a more thorough investigation, which the speaker proposes to carry out in the fall. This mineral is the first representative of the class of pure arsenites in nature and is therefore of marked interest. For the material the author is indebted to the indefatigable zeal of Dr. F. A. Foote, who is now in Mexico.

The following was ordered to be printed:—

DESCRIPTIVE NOTES OF NEW AMERICAN SPECIES OF ORB-WEAVING SPIDERS.

BY HENRY C. MCCOOK, D. D.

Epeira gemma. n. sp.

1. (Fig. 1.) This is one of the largest orbweavers of the Pacific coast, and is found from San Diego northward as far as Victoria, British Columbia. The species varies a good deal in size and markings, but the largest adult female (a gravid specimen) measures over 20 mm. in length. The abdomen is 15·5 mm. long; the base of the abdomen is crowned with two large conical processes. The markings upon the abdomen are as follows: The forepart which rises quite abruptly from the cephalothorax is of a blackish brown color, interspersed at irregular periods with yellow spots. Along the median line extends a narrow band of yellow, upon which are placed two angular or lance head markings, the first of which is placed about the middle of the basal part, and the second near the crest. This band continues more or less regularly along the dorsum to the apex. About the middle of the dorsum is a shield-shaped figure with scolloped edges, blackish brown in color for the most part, though interrupted by yellow lines of a herring-bone pattern. A narrow yellow border encompasses the shield. The color of the abdomen is yellow, and this color extends to the posterior half of the abdominal processes, the anterior half of the same being darkish brown. Dark brown waving and interrupted lines extend along the sides, and between these are small round spots, which are distributed laterally along the sides with more or less regularity. A brownish band extends along the ventral part of the abdomen from the spinnerets to the epigynum, bordered on either side by a yellowish band and with two short parallel yellowish longitudinal lines drawn equidistant between these two.

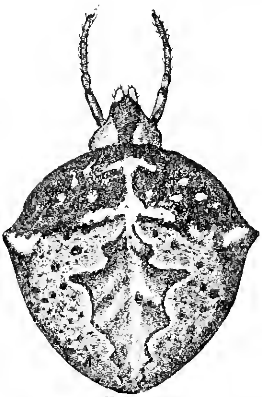

Fig. 1.
Epeira gemma, female, × 2.

The epigynum is comparatively small, and between and slightly bent over the dark lateral lobes is a short flat flap; it is thickened on the edges and viewed from the front, the tip is somewhat hooded. (See fig. 2.) A broad central patch marks the sternum, and the tongue and mandibles are tipped with yellow.

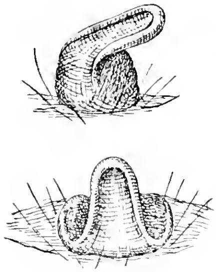

FIG. 2.
Ep. gemma. Epigynum lower figure, view from apex; upper figure, side view.

The cephalothorax is about 5 mm. long; is rather small as compared with the immense abdomen, and is marked with two broad yellowish bands extending along the sides and broadening over the dorsum. The head is a brownish color. The legs are marked strongly with annuli.

Their respective lengths are as follows: 1st pair, 23 mm.; 2d pair, 21·25 mm.; 3d pair, 14·75 mm.; 4th pair, 21·25 mm. The spider makes a large circular web of the usual character of the group of Angulata, to which it belongs, and rests in a nest of rolled leaves or dome shaped rubbish placed on the upper side of its snare. The cocoon is a round flossy ball of a darkish yellow color, about three-fourths of an inch in diameter. A number of cocoons sent to me by Mrs. C. K. Smith from San Diego, California, were found during the month of April to contain well developed young spiders. These spiders are of a quite uniform light yellow color, with a brown, well marked shield-shaped figure upon the dorsum of the abdomen, which is without the conical prominences that characterize the adult. Several of these cocoons were hung in an arbor upon the 1st of May, and the spiderlings immediately issued therefrom in great numbers, following the usual habit of their kind to ascend for a considerable distance, and then gather in small clumps or balls closely packed together. It is noticable that the spiders from the various cocoons mingled together without any hostility, climbed together the various bridge lines which immediately issued from the spinnerets, and snugged together in balled groups under the leaves, as though they all belonged to one brood. The month being cold and very rainy, they remained thus clustered throughout the entire month, and were not fully dispersed until the first week in June.

Specimens received from Mrs. Rosa Smith Eigenmann, and Mr. Charles R. Orcutt.

Epeira bicentennaria, n. sp.

2. (Fig. 3.) In the summer of 1882 I found in north-western Ohio and in the Alleghany mountains of Pennsylvania, specimens of a species apparently new, which I named *Epeira bicentennaria*.

This spider I described in a verbal communication to the Academy of Natural Sciences of Philadelphia. The specimens were found in nests of rolled leaves, after the manner of *Epeira insularis* and kindred spiders, and were attached by a taut trapline to the centre of its adjoining snare. The specimens then obtained were not mature and on the appearance of Mr. Emerton's descriptions of New England Epeiroids I concluded that my species was identical with his *Epeira silvatica*, which it greatly resembles in external form. Subsequently, I received a number of adult specimens from Professor Peckham of Milwaukee, Wisconsin, collected by him in that state, and thereafter, (1886) I myself collected a number of the same species in the Adirondack mountains of New York, in the neighborhood of the Saranac lakes and elsewhere.

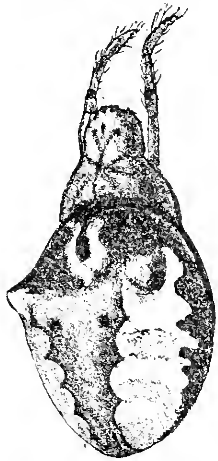

FIG. 3 Epeira bicentennaria, female, × 3.

A study of these led me to conclude that these examples differ from *E. silvatica*. The species is 15 mm. in length; is distinguished by two processes on either side of the dorsum of the abdomen at the base. The markings are not unlike those of *Epeira silvatica*, but the epigynum of the female, differs from that organ as represented by Emerton.* This is shown by a comparison of Fig. 4, with Fig. 5. This appears to indicate a specific, or at least, a varietal difference between the two animals. According to Emerton in adult females of *silvatica* "the under side of the abdomen is dark brown without markings;" but the adults of *bicentennaria* have a yellow lunette on each side of the venter below the gills, and a yellow circular patch on each side of the median line, both at the middle and at the spinnerets. The abdomen is somewhat triangular in shape. The breadth at the base is a little less than the length; the color is a yellowish gray with brownish markings. On the basal part is a yellow mark, often assuming the shape of a lyre

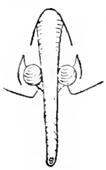

FIG. 4. Epigynum of Epeira silvatica

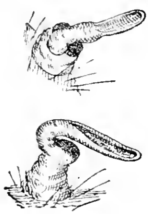

FIG. 5. Epigynum of E. bicentennaria, lower figure side view; upper, view from the front above.

* See Emerton, "New England Spiders of the Family Epeiridae." Trans, Conn. Acad. Vol. vi 1884, Pl. xxxv, fig. 6.

or the letter "U." A shield-shaped figure with scolloped edges occupies the middle of the dorsum. On each side is a broad, light undulating band, with five or six foliæ of unequal length. See fig. 3.

The cephalothorax is 5 mm. long; is smooth and marked by brownish bands along the sides and middle. The legs are strongly annulated with brown rings about the joints and also in the middle of the thigh, tibia and metatarsus. Length: 1st pair, 22·5 mm.; 2nd pair, 21·75 mm.; 3rd pair, 16 mm.; 4th pair, 20·5 mm.

Epeira vertebrata, n. sp.

3. A number of specimens of both sexes and various ages of this spider have been received from Mrs. Rosa Smith Eigenmann, San Diego, California, at which point the species seems to be abundant, and indeed is distributed to some extent northward along the Pacific coast. The specimens include two forms, which are very distinct in their shades and coloring, one form being darker than the other, so dark indeed, that some examples seem quite black.

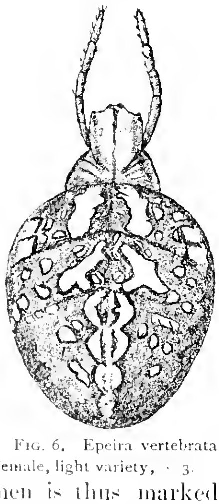

FIG. 6. Epeira vertebrata Female, light variety, × 3.

Female. (Fig. 6.) Length of body, abdomen, 11 mm.; cephalothorax 4·5 mm. The abdomen is of a yellowish brown color; a V-shaped whitish figure opening posteriorly, extends from the cephalothorax to the crest of the abdomen. The margins of this figure are broad and irregular. A series of irregular white spots extends across the base and around the sides which are marked by three rather regular rows of black spots. The V-shaped figure is followed by a shorter similar figure, and this again by three circular patches of diminishing size, the whole series terminating near the apex with a triangular patch. The whole median line of the abdomen from cephalothorax to abdomen is thus marked by this series of distinct figures which are broken through the centre and along the line by a scolloped band of yellowish brown color. At regular intervals on each side of these vertebræ-like median markings, are circular and triangular patches of a whitish yellow color. The outlines of the whitish patches are marked by strong lines of rosy brown hue. The abdomen is strongly reticulated and the whole appearance is very beautiful. Underneath the abdomen, between the spinnerets and the epigynum are three broken patches of whitish yellow color, enclosing a dark brown band.

The epigynum is marked by a hooked process or finger, hollowed like a spoon at the tip. On the anterior side, the stem or base of the finger rises from a white circular cushion that extends beyond the body. The end of the process is black, slightly tipped with yellow, and the base is yellowish brown in color. (See Fig. 7.) The sternum is shield-shaped, of a blackish brown color, with a broad yellow lance-head figure in the middle. Slight processes on either side of this band mark the points at which the legs are inserted. The cephalothorax is a yellowish brown color, marked by bands of brown on either side, and a narrow band along the median line to the summit of the caput. The head is a very little depressed and narrows towards the face. The palps and legs are of the same color as the cephalothorax; the legs somewhat darker, and with dark brown rings at the ends of the joints. Length, 1st pair, 23·5 mm.; 2nd pair, 21·25 mm.; 3rd pair, 14·5 mm.; 4th pair, 23.5 mm.

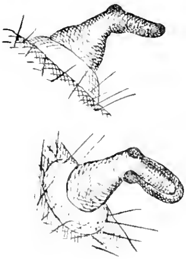

FIG. 7 Epigynum of Ep vertebrata.

Male: length of abdomen 7 mm.; cephalothorax, 4·75 mm.

The male differs very little in length, and in the general character of the markings from the female. The herring-bone or vertebrate figures along the median line of the abdomen are commonly more closely united than in the female. The waving marks along the side are less broken and of a duller color. The general color of the abdomen is gray, with the central markings of a whitish yellow. The abdomen and legs are a yellowish brown color. The cephalothorax is broad, the caput narrowing towards the face: the central band of lighter color quite broad. Length of legs, 1st pair 24·5 mm.; 2nd pair, 21·75 mm.; 3rd pair, 13·5 mm.; 4th pair, 20·5 mm. The tibia of the second pair of legs is slightly curved, and is armed on the lower and inside part with strong rows of thick black spines.

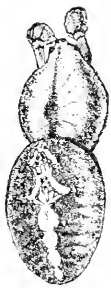

FIG. 9. Epeira vertebrata, male. 3.

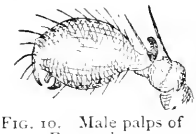

FIG. 10. Male palps of E. vertebrata.

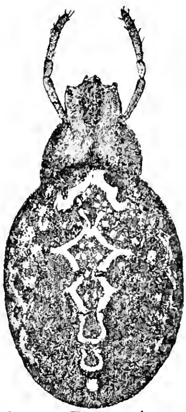

FIG. 8. Ep. vertebrata. Female, dark variety × 3.

The dark variety of this species resembles in the markings of the abdomen the lighter variety. the abdomen, however, in the specimens possessed by me, appears to be of a more uniform oval shape throughout. The colors of the abdomen are black, with yellow markings. On either side are two broad broken bands of circular and irregular waving figures, which meet in front and at the apex. The cephalothorax and the legs are of a dark reddish brown or even blackish. The bands on the cephalothorax are also quite black, as are the tips of the palps.

This may be the normal color of the female after depositing the cocoon, but I have so many specimens that are marked in this way, that it seems well to note the difference. (See Fig. 8.) (*Ep. vertebrata*, var. *pullus*.)

Epeira balaustina, n. sp.

4. I have three female specimens of this beautiful spider, one of which I collected in Florida; another was sent by Mr. C. A. Townsend, from Swan Island, Caribbean Sea, and a third was sent to me by the late Mr. William M. Gabb, from Santo Domingo.

The spiders differ little in size, and measure in length 15 mm. The abdomen is of a slightly triangular shape, in this respect approximating *Epeira domiciliorum*. The abdomen is a bright yellow color, somewhat mottled upon the sides and around the ventre with a darker shade of yellow or yellowish brown. The markings are a quadruple series of lines drawn from the pits that indicate the muscular attachments, longitudinally, to the apex. The spinnerets, legs, sternum and cephalothorax are of a bright orange, except where the abdomen overhangs the latter, which is yellow.

The palps are a lighter shade inclined to yellow. The legs are without distinct annuli, except the Florida specimen, which has a broad black ring around the upper part of the thighs of the first, second and fourth pairs of legs. The cephalothorax and abdomen are covered with white hairs, and the leg armature is of the same color, and rather weak and sparse.

The epigynum consists of a short flap, tri-lobed at the tip, which is slightly separated from a thicker flap of similar shape, but which consists apparently of three folds. Viewed from the side the epigynum presents somewhat the appearance of the thumb of a human hand clasped over the closed fingers; the thumb representing the posterior flap and the knuckles the folds and rugosities of the thick anterior one.

Epeira parvula. Var. **conchlea.**

5. There are few spiders that present such striking variation in markings upon the dorsum of the abdomen as *Epeira parvula*. It is a curious problem, which remains yet to be solved, what causes this variety. It is probably due in some degree to those changes which in certain species are evidently effected by the various moultings which spiders undergo. But that this cannot be the sole cause is shown by the fact that the varied markings appear even among mature specimens, particularly of the females. In a quite large collection received from Wisconsin, through Prof. Peckham, and from California through Mrs. Rosa Smith Eigenmann, I observed a number of individuals upon whom a further and even more striking change was manifest.

The abdomen of *Epeira parvula* is triangular shaped upon the dorsum, and the apical part, instead of rounding into an oval, ends perpendicularly; that is to say, is a straight wall from the spinnerets to the top. In the variety alluded to, which I have named *Epeira conchlea,* the terminal part of the dorsum of the abdomen assumes the shape of a caudal process, resembling that which is characteristic of the tailed spider, *Cyclosa caudata*. (See Fig. 6, a.) This peculiarity I have traced in about a dozen species, and in some much more decidedly than in others. In other respects the specimens appear to be nearly identical with *Epeira parvula*. The epigynum is in form the same, although larger, the finger being very broad at the base, and rapidly terminating in a point that is slightly curled. In front of the base is a tri-lobed black corneous flap. (Fig. 6, e.)

Fig. 6, a.

Fig. 6, e.

The body length is about 7 mm. The maxillae are broader or as broad as long and subtriangular at the tip.

Habitat, Wisconsin, California.

A NEW FOSSIL SPIDER, EOATYPUS WOODWARDII.

BY HENRY C. McCOOK, D. D.

While visiting the British Museum of Natural History at South Kensington, London, in the summer of 1887, I was permitted to examine some fossil insects and fossil spiders therein contained, under the kind direction of Dr. Henry Woodward, the Keeper of the Geological Department. Among the aranead fossils I observed one which appeared to me to be new to science, and closely related to the genus *Atypus*. The fossil is a tolerably well preserved impression, taken from the Eocene Tertiary at Garnet Bay, Isle of Wight.

After my return to America, Dr. Woodward sent me casts both in wax and plaster, from which the appended description has been made. These impressions somewhat shook the view which I was at first inclined to take as to the systematic place of the specimen. But on the whole, I am inclined to adhere, though with some qualification, to my original judgment.

The only hesitation that an araneologist would feel in placing the species would be as to whether it belongs with the Saltigrades or jumping spiders, among the Attidæ perhaps, or with the Territelariæ among the Atypinæ. Those who have examined fossils of insects and other small arthropods, especially of the order Araneæ, will understand the difficulty in determining with absolute accuracy their generic and specific rank, and will, therefore, not be surprised at this hesitation concerning the above named specimen.

The shape of the cephalothorax to some extent, especially as viewed from the original fossil in the British Museum, and more particularly the character of the falces as noted in a side view of the specimen shown at Fig. 1, indicate that the fossil may belong to the family Atypinae and be closely related to *Atypus*. The name *Eoatypus Woodwardii* is therefore suggested for the species. If this inference is correct, we may possibly have in this new fossil the distant progenitor of the present British species of Atypus, *Atypus piceus*.

ORDER ARANEAE.

FAMILY ATYPINAE.

EOATYPUS, Nov. Gen.

Eoatypus Woodwardii.

The total length of body, including mandibles is, 8 mm.; length of abdomen 4 mm; length of cephalothorax 3 mm.; of mandibles

1 m.; width of abdomen at the base 3·5 mm.; width of abdomen at the apex 1·75; width of the cephalothorax at the caput 2·25; width of cephalothorax from margin to margin across the middle 3·5 mm.; length of palps 2 mm. Both palps are represented by rather thin lines, showing slight marks of joints, and on one palp is a suggestion of a terminal bulb which might indicate it to be a young male.

The caput and median part of the cephalothorax as viewed from the cast, are well elevated and defined; the cephalothorax narrows towards the abdomen. But in the original impression in the rock

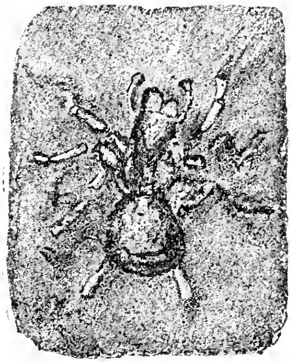

FIG. 1. Eoatypus Woodwardii, x 4.

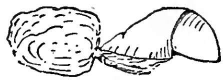

FIG. 2. Eoatypus Woodwardii x 4 Outline side view of body.

and less distinctly on the casts, there appear outlines on either side of the margin of the cephalothorax, as though by pressure those parts had been flattened, and only the caput and a part of the dorsum of the cephalothorax along the median line had withstood the pressure and had been pushed upward into the matrix by the same. These outlines are visible, but not as distinct in the plaster cast. It is at this point that one experiences difficulty in determining whether the specimen is related to *Attus* or *Atypus*. If the broader marginal markings are impressions of the original cephalothorax, the inference would be that the spider represented by this fossil belonged to the Atypinae. That such is the case, I am strongly inclined to believe, both on the ground just named, and the characteristics of the mandibles, as well as the general facies of the impression and cast. (See Fig. 1.*) In the absence of the characteristic eyes and long, jointed superior spinners it would be impossible to relegate the specimen to the genus *Atypus* with absolute authority.

* This figure has been drawn from the cast and compared carefully with one kindly made for me in the Geological Department of the British Museum, and furnished by the Keeper, Dr. Woodward,

Neither would one be warranted to characterize a new genus by the absence of eyes and spinners, since these organs were doubtless present but have simply failed to impress themselves upon the matrix. I have, therefore, felt compelled, on the one hand to propose a new generic place for this fossil, and on the other, to present no sharply defined generic characteristics. Indeed, it must be admitted that besides expressing the general facies of the fossil, as above described, the generic value of the name *Eoatypus* consists largely in assigning the specimen rank as a fossil spider.

On one side, portions of all the four legs are preserved, the first three showing the articulations at the trochanter, femur and patella. The second leg shows also the patella entire, indicating the articulation with the metatarsus. On the other side a portion of the femur of the first leg is shown with the patella and its articulations. Both hind legs are represented by the apical parts of the femora.

The horizon from which this new fossil was obtained is that from which most European fossil spiders have been taken, viz., the Eocene Tertiary. It is also that from which have come our American aranead fossils as recently studied by Mr. S. H. Scudder from specimens collected at Florissant, Colorado.

NESTING HABITS OF THE AMERICAN PURSEWEB SPIDER.[1]

BY REV. HENRY C. MCCOOK D. D.

Genus **ATYPUS.**

Atypus Abbotii (Walck).

1792.	*Purse Web Spider* Abbot.	Mss. drawings of Georgia Insects, Vol. xiv, Pl. 8, No. 36, Zool. Lib. Brit. Mus. Nat. Hist.
1837.	*Sphodros Abbotii* Walk.	His. Nat. des Ins. Apt. Vol. i, p. 247.
1842.	*Atypus niger* Hentz.	Jour. Bost. Soc. Nat. Hist. Vol. iv, p. 224, p. 2, viii.
1875.	*Atypus niger* Hentz.	Spid. of the U. S. p. 19, Pl. ii, fig. 1.

During a visit to Florida in April 1886, I had the pleasure of observing in natural site for the first time the nests of Abbot's Atypus, an aranead heretofore known as the black Atypus, or *Atypus niger* of Hentz. I had possessed for a number of years specimens of the long tubes in which this creature dwells [2] concerning which I only knew that they were reported as being spun along the outside of the trunks of trees.

I. GEOGRAPHICAL DISTRIBUTION.

The field of observation was on the plantation of Dr. William Wittfeld,[3] at the lower part of Merrit's Island, which is situated between the Indian and Banana Rivers, a few miles south of Cape Canaveral. A large number of specimens were collected, some of which are submitted for inspection. The species is distributed widely throughout the state of Florida, is found in Georgia, and probably in the Southern Atlantic States.

The female of this Atypus has not heretofore been described, although it has recently come to light that it was known and figured nearly a century ago by Mr. John Abbot, an Englishman settled in Savannah, Georgia, during the latter part of the last century [4]

[1] The substance of this paper was given as a verbal communication before the last meeting (1887) of the British Association for the Advancement of Science, at Manchester, England.

[2] I had Floridian examples of the nest from Professor Riley the Entomologist of the Agriculture Bureau; and also from Dr. George Marx of Washington.

[3] Fairyland, Georgiana, Brevard Co. Fla.

[4] See the author's paper in Proc. Acad. Nat. Sci. Phila. 1888, p. 74, on Necessity for Revising the Nomenclature of American Orbweaving Spiders.

Among Mr. Abbot's figures is one of this Atypus which he quite happily describes as "the purse web spider", (a popular name which I cordially adopt), and makes a brief and correct note of its habits. "This singular species," he says, "makes a web like a money purse to the roots of large trees in the hammocks or swamps, five or six inches out of the ground, fastened to the tree, and the other end in the ground about the same depth or deeper. To the bottom of that part in the ground the spider retreats. I imagine they come out and seek their food by night as I never observed one out of its web. In November their young ones in vast numbers cover the abdomen of the female and the abdomen then appears very much shrunk. The male is the smallest, but has the longest nippers. Taken in March and is not common."[1]

Fig. 1. Atypus Abbotii.

The description of Hentz[2] was made from a single specimen, a male, found in June on newly turned soil at Northampton, Mass. Mr. William Holden reports it as collected in Ohio.[3] The spider ought therefore to be found in the Middle and Atlantic States of America, but I have never been so fortunate as to see it therein, and have never heard of any one who happened upon it. It probably is not abundant, or its nesting habits must be greatly modified by change of latitude; otherwise one would suppose that its very conspicuous nest would not have escaped notice. Or, may we suppose that it is disappearing, perhaps has disappeared before the progress of human civilization?

II. DESCRIPTION OF THE NESTS.

The Florida nests are silken tubes of various lengths and sizes, ranging from ten inches long and three-fourths inch in diameter, to minute silken pipes a few inches long, and about one-eighth inch in diameter. Externally most of them present a dark, weather beaten appearance and are covered with more or less sand. Inside, the silk is white and clean. The texture of the material of which the nest is spun is quite close, resembling a rough-finished bit of silk cloth.

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[1] Manuscript Drawings of the insects of Georgia in America by John Abbot of Savannah. Vol. xiv, 1792. Zoological Library of the British Museum of Natural History.

[2] Spiders of the United States, p. 19. Plate ii., fig. 1. Hentz knew nothing of the habits of his species.

[3] Id. Emerson's note.

These tubes are found attached to the trunks of trees, along which they extend upwards for various distances according to their size; the size being evidently determined by the age of the occupant. The young spiders have very small tubes. The adults occupy large tubes. The nests are fastened to the bark of the trees at several points by white threads. They are often open at the top, that is, there is no designed closure like a lid or door; but for the most part the top edge of the tube drops in or folds over, making an accidental closure. Beneath the surface of the ground the tubes extend into the sandy soil around the root of the tree for various distances, sometimes equalling the length above the surface, and in one or two cases even exceeding it.

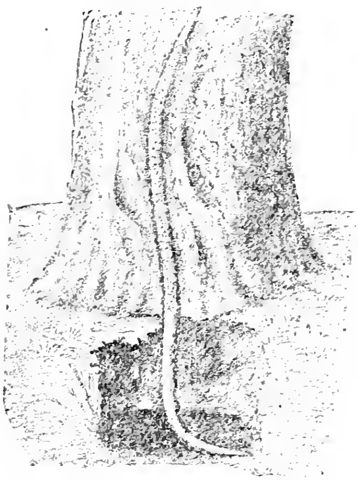

FIG. 2. Purseweb Spider's Nest: with under-surface part exposed by removing the sand

The spider seems to have no preference for any special tree against which to spin its tubes. The palmetto was frequently chosen, and I counted as many as thirteen tubes, great and small, long and short, extending around a large portion of the base of one palmetto trunk. Some of these may have been the nests of a brood the individuals of which had established themselves in close neighborhood. Very frequently these tubes were found attached to small trees or bushes. When the trunks of the saplings have a slanting position, as occasionally happens by reason of external pressure of some kind, the tube generally drops straight down to the ground, forming an angle with the point of attachment instead of hugging the bark of the plant. Most of the tubes which I followed beneath the surface terminated in a point or had a club-shaped terminus; but in one case at least the tube broadened out into an irregular chamber with two short branches constructed like the main stem.

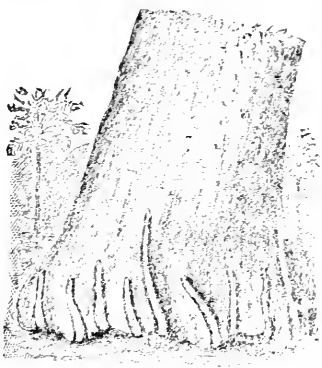

FIG. 3. Colony of Purseweb spider's nest on a palmetto tree.

III. USE AND MANNER OF SPINNING THE TUBULAR NEST.

Immense numbers of these nests were found throughout the woods on the grounds of Dr. Wittfeld. Spiders when found within the tubes were usually clinging to the inside, a short distance from the top, or were found in the same position underneath the soil. The most persistent observation at various hours, night and day, failed to uncover any of the spider's habits as to capture of prey, the mode of building the tube, or the uses of the tube in the life economy of the creature. I have no doubt, however, that in the uses of its peculiar web the Purseweb spider will be found to resemble closely her British congener, *Atypus piceus.* According to Mr. Fredrick Enock,[1] this aranead captures the insects that crawl upon the outer surface of her tube by striking them through the silk from the inside, and when they are thus secured cutting a vent in the tissue large enough to drag the prey through into the tube. This is a most curious and interesting habit, the existence of which was established with tolerable certainty by Mr Enock by various observations and experiments. I may venture to repeat the substance of one of these.

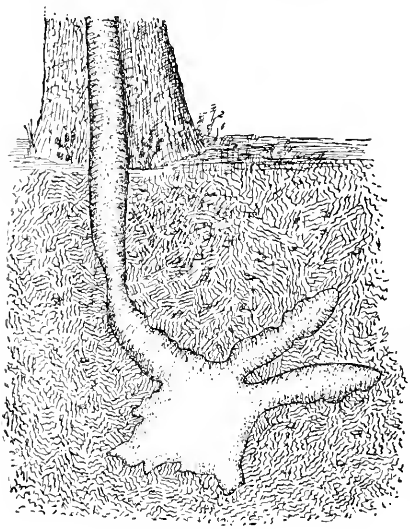

FIG. 4. An underground terminus or den, with branches.

A large blow fly was held by its wings and permitted to crawl upon a bank until it walked upon one of the tubes of Atypus. The spider ascended a little distance and returned. The head of the fly was then rubbed against the tube a number of times, the tube meanwhile becoming imperceptably distended, indicating the spider's approach. After a moment's pause the fangs were thrust through the fly, followed by a crunching sound as the spider closed and almost crossed the top fangs around its prey. The observer released his hold upon the fly, and immediately the left hand fang was withdrawn just into the tube which was torn, and the fang refixed into the fly. The right fang was then withdrawn and quickly seized the

[1] The Life History of Atypus piceus Sulz., by Fredc. Enock. The Transactions of the Entomological Society of London, 1885, p. 389.

fly through the opening, and after several tugs the insect was pulled within the tube, and the spider backed downward holding its prey fast in its falces, leaving a rent a quarter inch long by three-sixteenth inch wide. After an interval of three minutes the spider cautiously reascended the tube to the opening, and taking hold of the ragged edges of the rent, drew them towards each other until they almost touched. She then backed a little and turned her abdomen so that the spinners approximated the united edges. Then by a number of zigzag movements with the spinners across the juncture, she completely closed the rent, and when it was neatly repaired returned apparently to feed upon her prey. The next morning the rent was covered with sand so carefully that Mr. Enock could scarcely detect where it had been. When the spider was satisfied with food, it would draw in the tube in a determined manner, and would retain her hold in this position sometimes for several hours.

1. *A time-measure of the spinning-work.*—Being foiled by the persistent secretiveness of this spider in natural sites, I captured several specimens and placed them within glass jars in order to observe their behavior under these artificial conditions. Some important facts resulted, particularly as to the mode of constructing the tubular nests. The bottom of each jar was filled with sand, and a stick inserted within, in order to give a natural position for the establishment of a nest if the spider should be inclined to weave one. One individual, after long continued exploration of its quarters, at last established itself at the foot of the standing stick and began to burrow a little hole. I was compelled to leave at this point, and did not return to my room until evening, after twelve hours absence. During this time a vertical tube of white silk one and one-fourth inch long and about the thickness of the spider had been spun along the side of the stick. The outside of the tube was sparsely covered over with particles of sand which of course had been brought from below.

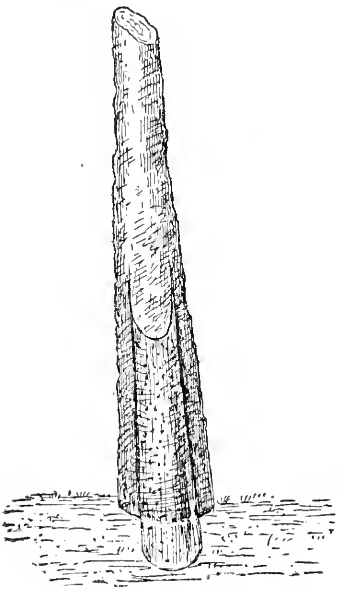

Fig. 5. First section of Purseweb spider's tubular nest.

A unit for measuring the time required to construct a tube was also obtained. The inch and a quarter tubing was built within twelve hours, although of course it cannot be determined how much of this time was actually consumed in spinning work, probably not more than two hours. It is at least evident that a length of two inches or more a day is quite within the spinning capacity of Atypus.

2. *The Foundation Frame and mode of Spinning the Exterior Tube.*—Another specimen gave a very satisfactory clew to the entire mode of constructing a tube. It first took its position at the foot of the stick in the centre of the jar and wove a small lateral tube extending partly around the base. (See fig. 7.) At 9 o'clock in the evening this tube was pierced at the top, and the creature began to erect a vertical tube along the surface of the stick. The mode of proceeding was substantially as follows: Single threads were attached to the stick about two inches above the surface. These threads were stretched downward and over a lateral space about the width of the tube to be spun, extending to the little opening which had been made in the tube at the base of the stick. The lines were repeated and over laid until at last they acquired considerable consistency of texture. At the top terminus they were attached to the stick or to one another. At the bottom the point of attachment was a little distance from the surface of the stick so that most of the lines had a slanting position. Their appearance might be compared to that of a number of poles leaned against a tree. The structure thus gradually assumed a skeleton tubular form which was increased by the pressure of the spider against the lines as it moved back and forward within them upon the surface of the stick. When the scaffolding was completely overspun the section appeared as a close silken tube.

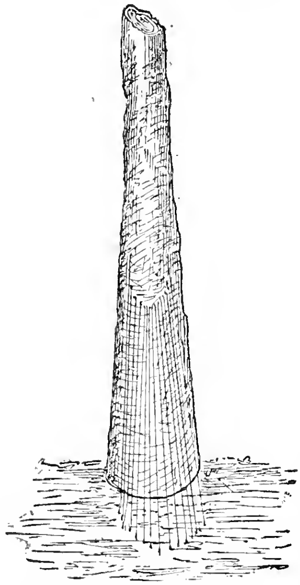

Fig. 6. Purseweb Spider. Foundation lines of frame for a tube.

3. *Mode of Spinning under ground.*—A third specimen enabled me to determine the manner in which this rough frame was completed so as to give it the close texture of the tubes found in Nature. This specimen had excavated a tunnel against the inner surface of the

glass jar. Its movements were thus entirely open to observation. Along this subterranean way or tunnel the spider strung fine threads covering the bottom, the side and the top, forming a frame quite resembling the foundation scaffolding used in spinning the vertical tube. (See fig. 6). It then proceeded to thicken these lines in the following manner. The bottom parts were overspun by emitting from the long inferior spinnerets numerous fine threads which were beaten down against the surface by dropping the spinnerets, and were spread around by a lateral movement of the abdomen, which of course carried with it the spinnerets and the threads issuing therefrom. The animal's motion reminded one of a plasterer using his trowel to spread mortar rather than a weaver spinning cloth. The space covered by these movements having been sufficiently thickened, the spider proceeded to another spot and went through the same process. When it came to thickening the upper portion of its tube it turned its abdomen upward resting its body upon the dorsum of the cephalothorax. In other words the creature laid upon its back. Its abdomen was well turned over so that in this position the spider was almost in the form of a semicircle. The pressure of the abdomen upwards forced the lines at the point of impact into a little bay, the concavity of which was thickened over with threads spun from the spinnerets which were managed in the way already described. That is, the spinnerets were moved back and forward, and the out spun threads were beaten upwards into the lines already formed.

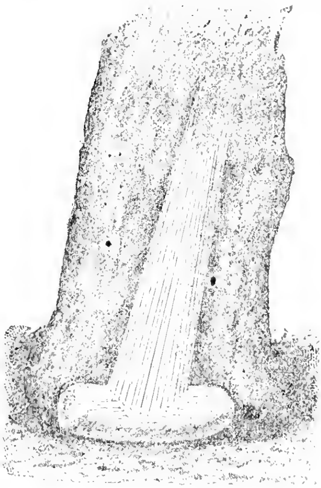
Fig. 7. Purseweb Spider's tube. Section after frame is overspun.

This procedure very closely resembles the manner of spinning which I have often observed in *Mygale Hentzii* the large tarantula of our southwestern States. This mode of thickening over the foundation lines of the tube also closely resembles the behavior of orbweaving and other spiders when constructing the thick padding which surrounds their eggs, forming their eggsacs or cocoons. I have seen it notably in the case of Lycosa. It is without doubt the way in which the trap-door spider of California (*Cteniza Californica,*) spins the silken lining of her well known and much admired trap-door nest.

4. *The Nesting Tube Spun in Sections.*—It was further determined with reasonable certainty that the spider builds its tube in sections. A letter from Miss Anna Wittfeld, after I returned from Florida, informed me that the spiders had spun complete tubes within the jars which I had left under her care. The question was at once raised, were these tubes completed by adding to the section which had already been observed? From correspondence with Miss Wittfeld the information was obtained that the tubes had been finished as I had conjectured, by adding to the portions previously formed. We may, therefore conclude first, (1) that the mode of constructing these tubes is for the first time fully determined; second, (2) that the original section, of greater or less length as the case may be, is spun in the manner now determined and described; and third, (3) that additional sections, of probably about the same length, are added thereto according to the fancy or necessity of the builder, and constructed in the same manner as the preceeding one. It is thus within the power of Atypus to lengthen out her tube and extend along the trunk to any desirable height, the web surface available as a snare for taking food. Thus, also, as she ascends along her arboreal hunting ground she carries with her the protecting walls of her tubular home, which is truly her castle.

A large number of tubes was collected, and these I cut open with the view of determining whether any trace of this mode of spinning by sections had been left in the form of seams or joints; but nothing of the sort was found. The points of juncture were so skilfully covered over that they differed in no respect from the texture of other portions of the tube. The silk on the inside, however, was of beautiful smooth white color, decidedly in contrast with the appearance of the outside. In many specimens examined the upper extremity of the tube was made of perfectly white silk which apparently had been quite recently spun, showing an addition to the tube either for the purpose of repairing and strengthening, or else of extending the old nest. This observation upon the nests spun in natural site quite harmonizes with the conclusion reached from the action of Atypus in confinement.[1]

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[1] For an account of the English *Atypus piceus* making a new nest as observed by Rev. O. Pickard-Cambridge, See Annals and Mag. of Natural History, Vol. viii., p. 241, 1876.

5. *Doors.*—An examination of the numerous nests shows that openings are usually but not always left at the top of the tube. These openings are placed indifferently beneath, at the side and above. When the spider is not near the upper portion of its tube, the silk naturally collapses, and the opening is not apparent. However, it must be remembered that a very slight stroke of the mandibles would open the tube at any part and give the spider egress. So also a few movements of the spinnerets would close the aperture. Moreover, if we accept the conclusion that the mode of capturing prey is the same as that of *Atypus piceus* (as above described) there appears to be no special need for a door for the main necessity of life, since the spider has little or no occasion ever to go outside her own tower or cave.

IV. SANDING THE OUTSIDE OF THE TUBE.

It has been stated that one of the individuals put under observation, after having spun her snare, covered it more or less thickly with grains of sand. It was thus indicated that the sanded condition of the tubes found in natural positions is the result of purpose on the part of the builder. What purpose does it serve? Many spiders of various families are in the habit of protecting their cocoons or eggsacs by covering them with mud, with particles of soil, with bits of decayed wood and bark scraped or broken off, with various minute chippage, and even with the debris of insects' wings, heads, legs etc., captured for food. In this behavior the purpose is obviously to protect the enclosed eggs from hurtful weather changes and various enemies, cheifly the parasitizing ichneumon-fly, *Pezomachus.*

The use of the sand deliberately placed upon the outside of the nest of Atypus is not so obvious, although it perhaps serves to toughen it, and possibly protects its inmate from the assaults of certain enemies as yet unknown. In natural site the sand and weathering give the tubes almost the exact appearance of the outside of the tree along which it is placed. In a large proportion of my specimens the sand was intermingled with brown wood-dust from decayed bark and the dark colored vegetable mold which was heaped around the base of the trunk, and into which the spiders had excavated.

It has been conjectured that this is an example of so called mimicry. Some observations made by Mr. Frederick Enock on the habits of *Atypus piceus*, the British congener of our Florida species, raise a doubt upon this supposition, at least indicate another solution. The mode of constructing the tube as observed by Mr. Enock is substantially that which I have above described as practiced by our Purseweb Atypus. After the completion of her tube Piceus was seen to take a load of sand between its falces, every grain of which it deftly guided with its fangs, literally pushing the grains through the side of the tube. Having exhausted its supply it reversed its position, returned to the bottom, and repeated the action of gathering and distributing the sand. At the end of an hour and a half it had completely covered the silken tube with sand, every grain of which it had brought up from the surface of the ground, thrust it through the silken tube from the inside, and afterwards, as the occasion required, smoothed over the rent with newly extruded silk. The next morning a small quantity of sand had been forced out at the top of the tube, showing that the industrious creature had continued its labor during the night; and this, indeed, was prolonged during the greater part of the day. The following night it had lengthened the aerial portion of the tube and covered it with sand.[1] We may perhaps, conclude from these facts that the spider had apparently simply endeavored to save itself the labor of carrying sand to the top of its tube, by pushing it through the rent sides, a method which would be naturally suggested by its custom of opening the tube to take in its prey.

Mr. Moggridge attributed this sanding of the exterior to a protective purpose, and alludes to the fact that while tubes of *Atypus piceus* found on sandy banks were covered with sand, a nest taken at Troyes, France, in a mossy site, had moss and plant fibres woven upon it.[2] But as the spider in such environment would be compelled to clear away particles of moss, root fibres etc., in extending the nest over the surface and through the close standing stems, there appears to be no reason why it might not treat this chippage precisely as it did the sand in Mr. Enock's examples. No doubt these spiders, as well as our Purseweb, while in the act of deporting the sand excavated from beneath, frequently leave grains attached to the inside of the tube. Indeed, it would be difficult to prevent this, as the sand readily entangles with the silken fibres; but as such a rough coating would be unpleasant to the creature in its frequent passing to and fro, it would overspin all these inside droppings. Indeed, in this very fact we may see a sufficient reason for the

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[1] The Life History of Atypus piceus, page 397.

[2] Harvesting Ants and Trap-Door Spider. Supplement. p. 188.

habit of getting the sand out at a point nearer the ground than the top of the tube. On the contrary the particles dumped from the top or through slits in the side, and which also readily entangle within the silk strands as they fall, are permitted to remain inasmuch as they are not inconvenient. The idea of a protective purpose cannot, however, be wholly excluded; for it is found that in repairing the rents made in the tube in order to draw in the stricken prey, the new material spun over the rent is quite invariably sanded. This indicates a deliberate intention.

On the whole, in view of the above facts, and reasoning from them by analogy it appears that (1) much of the sand and bark-dust which covers the outside of the nests of Atypus is an incidental result of the act of excavation; (2) that, however, the spider does at times deliberately add to this coating; (3) that the purpose of this act is probably protective at least in the way of strengthening the tube; (4) that there is no positive proof that protective mimicry has any part in the habit; yet (5) as a matter of fact this exterior coating does better adapt the tube as a snare both to decoy insects to a light and enable them to travel upon it.

V. MATERNITY HABITS.

Much remains to be determined of the life-history of the Purseweb spider, but we may venture the prediction that in many points it will be found to differ little from the habits of its British congener as described by various observers. We know from Abbot's note above cited that the young, like the offspring of Lycosids, domicile upon the back of the mother after they are hatched. The cocoon containing the eggs is of course retained within the purseweb, and probably in that portion which is beneath the surface of the ground. *Atypus piceus* suspends her egg-cocoon in a pretty hammock of silk an inch long, attached to the top and bottom of the pouch.[1] The number of eggs within the cocoon of Piceus is from one hundred to one hundred and fifty. They are deposited in midsummer, July or early August, and the young issue from the cocoon about the latter part of September. They remain with their mother in the maternal nest during the winter, and Mr. Enock found the female and her young together March 31st, and again as late as April 5th. About

[1] See Mr. Enock's paper, p. 392. See also a good figure representing the same habit in Mr. Simon's paper, Annals Entomological Society of France, 5th Series, tom. 3, 1874, plate 4; also "Spiders of Dorset", Rev. O. P. Cambridge, page xxxiii, Introduction.

the last named dates the younglings make their exode, and after being dispersed in the manner usual to spiderlings, proceed to make tiny tubes which are miniatures of the parent nest. As the development of spider life in Great Britain is later than in the United States the tubelets of the young of Abbot's Atypus may be looked for in the early autumn. Some of the Florida specimens which I collected in April within their tubes, I judge to be members of the preceding autumn broods.

VI. ORIGIN AND RELATIONS OF THE TUBEWEAVING HABIT.

The tube-making faculty appears to be, as far as secondary causes are concerned, the natural result of the instinct of self-protection. It is perhaps most natural that the lower animals should seek to protect themselves within barriers formed by their body secretions, as is the case among the larvæ of many insects. The restless movements of the body characteristic of these creatures, conjoined with the instinct to cover themselves up, to protect themselves from unfavorable weather changes and from the approach of enemies, may be a sufficient natural explanation of the origin of the tube-making habit. Thus the silk moth larva while secreting silk from the glands which open on the under lip, moves backward and forward continually distributing its secretions, and at the same time by the motion of its body limits them to the borders of the space around which it moves. In the same way the social caterpillars have learned to shut themselves within their well known tent, which presents so largely the appearance of a designed structure, but which, in its origin, at least, may have been quite as much the result of accident, the silken secretion simply hardening around the limits of the space through which the restless creatures move, and which by their motions they keep free from threads. In like manner the larva of the ant, at the moment when Nature brings upon it the sense of the great change from its larval to its pupal estate, moves backward and forward within a narrow space secreting its delicate silk, which by its movements is pushed from direct contact with its body, and hardens into the little case or pouch in which itself at last is encompassed. Thus, in an entirely natural way, we may suppose that the Great Over-Force while planning and directing, preserving and governing all creatures and all their actions, has developed the interesting habit of spinning tubes or cylinders as a protection to the body.

Among the spider fauna this habit is particularly prominent. It does not exist as with insects in a larval estate, but in the perfect animal, the only one, with possibly one exception,[1] of which we have knowledge, the tube-making instinct of insects being confined to the larval period. This habit, which characterizes the larvæ of insects is carried forward to the perfect animal among the Araneæ. The habit of protecting themselves by tubular spinning work in one form or another exists among some species of every section or tribe of the spiders.

Among the Orbweavers we have such examples as *Epeira strix*, which spins a tough silken cylinder, open at one end. Within this she makes her home, and holds a connection with her round snare by means of a thread. This tube is spun within cavities of various sorts, and often within a curled leaf. The habit is again illustrated among the Orbweavers by the beautiful silken domes or tents with or without a leafy covering, such as are formed by the Insular spider, *Epeira insularis* or the Shamrock spider, *Epeira trifolium.*

Among the Retitelariæ or Lineweavers we have such examples as the pretty tubular tent of *Theridium zelotyppum* which I have found swinging among pine leaves in the Adirondack forests containing the mother and young. The Saltigrades or Vaulting spiders spin thick silken tubes within which they shelter themselves during summer and winter, and in which also they bestow their egg-sacs. The Laterigrades I have found sheltered underneath a little tubular tent, guarding their cocoons, although the tube making habit seems to be least decided among these of all the aranead families. The Tubeweavers, of course, as their name implies, have a strong tendency in this direction. Indeed, some remarkable examples of tubular nests may be found among them, as in the case of our Medicinal spider (*Tegenaria medicinalis*), and the funnel-shaped snare of the Speckled tubeweaver (*Agalena nævia*), which is one of the most common spiders of America.

The nest of this Agalena is a tube, oftentimes of considerable length, which broadens out from the top-opening into a sheeted snare that is spread over surrounding surfaces, and is usually guyed or supported by lines reaching upward. It may be seen extending within little cavities and openings, insect burrows, gopher holes and the like, and in some cases I have thought that I have seen indica-

[1] Psocus. See my "Note on a Web-spinning Neuropterous Insect, Psocus sexpunctatus." Proceed. Acad. Nat. Sci. of Philadelphia 1883, pp. 278–9.

tions that the occupant had assisted in accommodating her spinning work to her usurped quarters by widening and deepening the hole. At all events, the snare when seen in such sites presents a very striking appearance of having been a work of design, both in the burrow and in the inter-spun tube, precisely as in the case of the Tunnelweavers. *Agalena* has one remarkable physical characteristic in common with Atypus and other Theraphosids, namely, the long jointed spinnerets which are used so actively in spinning her characteristic tube.

When we come to the two remaining tribes, the Lycosids and Tunnelweavers, (Territelariæ) we see this habit possessing special developments, and here also we see it associated with the burrowing habit which is such a marked characteristic of many of the higher animals and even of man himself.

The nest of *Cyrtauchenius elongatus* as described by M. Eugene Simon closely resembles that of *Agalena nævia* in the character of the tube alone; but this tube is enclosed within a deep cylindrical burrow, and is prolonged upward for about three inches above the surface of the ground, and enlarged into a funnel-shape, so that it becomes from two to three inches across at the orifice. This aerial portion is snow white, and at once attracts the eye even from a considerable distance; the nests, rising up amid sparse grass which serves to support but not conceal them, present the appearance of scattered white fungi. *Cyrtauchenius* belongs to the Territelariæ, and appears to be nearly related to *Atypus* and *Nemesia*. Mr. Moggridge classifies its nest among those of the trap-door spiders, characterizing it as the funnel-shaped nest.[1]

The nest of Cyrtauchenius even more closely resembles that of certain Lycosids found in the United States; for example, *Lycosa tigrina*[2] is quite abundant in the Atlantic States of America. It constructs a nest which answers closely to Simon's description of Crytauchenius, the only exception being that the portion of the nest above ground quite invariably forms an oblique angle with the tunnel within the ground, and the burrow is not lined with spinning work below the mouth. The aerial portion of this spider's nest is sometimes formed into a beautiful vestibule above the mouth of the burrow, and as the winter season advances is occasionally shielded

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[1] Harvesting Ants and Trap-Door Spiders, Supplement p. 190. Mr. Moggridge gives a diagramatic figure of this Spider's nest from the description of M. Simon. See pl. 13, p. 183.

[2] Tarentula tigrina McCook. Proceed. Am. Entom. Soc. 1879, p. xi.

with a sort of swinging door. Hentz says that one winter he found a burrow of a *Lycosa* (species not named) supplied with a lid, and he thinks it probable that all Lycosids close the orifice of their holes for hibernation.[1] I may say here that probably all burrowing Lycosids close the openings of their nests as the cold season approaches, and it is possible that the same habit will be found to prevail as a protection against heavy rains even in the summer and autumn. Mrs. Mary Treat says that certain Lycosids thus shut themselves in just before moulting, and remain so until quite recovered from the after debility[2].

Another interesting Lycosid tubemaker is the turret spider.[3] This creature constructs above the surface of the ground to the height of one or two inches a little tower which is in form an irregular pentagon, and is composed of bits of straw, stalks of grass etc. It is quite like the old fashioned mud-chimneys which I have often seen attached to the gables of log cabins in the far west.[4] Unlike the surface nest of Tigrina, the tower of Arenicola is invariably built in the line of the burrow, the whole forming a straight perpendicular tube. We have thus established, through the nest of *Cyrtauchenius*, a very close connection between the nesting habits of the Lycosids and that of the Territelariæ.

In the case of *Atypus sulzeri*, as it is seen in England and described by its first observer, Mr. Joshua Brown, the nest assumes the shape of a pendant inflated tube, covered with particles of sand, closed at the top, extending nine inches more or less above the silk-lined burrow of like depth, and attached to surrounding foliage. In this form it cannot differ largely from that of our Purseweb spider except that the former is stayed among the grass-stalks and the latter is fastened to the tree trunks. It would be interesting and perhaps highly suggestive were Abbot's Atypus to be domiciled in a grassy site away from trees, to note its behavior. Would it make a nest quite like that of the English Atypus?[5]

[1] Spiders U. S. p. 25.

[2] "My Garden Pets," p. 82.

[3] *Lycosa arenicola*, Scudder. Psyche. Vol. II, p. 2, 1887.

[4] McCook, "Tenants of an Old Farm," figs. 44, 45, p. 131–5.

[5] Efforts to pursue my studies of the Purseweb spider were prevented by the loss of the living specimens sent me by Miss Wittfeld from Florida. We exhausted our ingenuity in providing protection for packages sent through the mail, but not a spider lived. Evidently the species is more sensitive to such confinement than many others. I regret to record that since writing this note, the young lady here mentioned has died. Her keen and intelligent interest in insect life are well known and were highly appreciated not only by myself but by others entomologists.

The nests of the same spider[1] according to other observers have the projecting part trailed along the ground or surface growth of grass or moss. Thus the tube differs from that of the Purseweb Atypus simply in that it is spun horizontally along the surface instead of being attached in a perpendicular position to a tree. M. Eugene Simon says that *Atypus piceus* conceals herself in dry localities, partly underground; sometimes in woods, principally the plantations of evergreens. Its retreat is altogether hidden, sometimes by the stones, at other times by the moss, so that it is necessary to search with care and over large spaces in order to discover it. This Atypus burrows obliquely a deep tunnel of 15 to 20 centimetres of the size of its body. It constructs part of its tube quite straight and of a tissue very thick, of which the upper part is longer than that within the subterranean gallery. It is continued horizontally upon the soil and terminates in a tapering closed point. Near its lower extremity, the tube presents a large expansion where it dilates into the form of a chamber quite spacious, within which the spider dwells. It is at the entrance of the contraction that it suspends by a few threads the cocoon containing its eggs. Simon presents a drawing in site of the nest of Atypus,[2] and a good figure of a collected specimen is given by Moggridge.[3]

These comparative results suggest a very interesting analogy between the spinning industry of the two aranead tribes, the Citigradæ and Territelariæ, which I venture to present in diagrammatic outlines at Fig. 8 and 9. The first figure in the cut (Fig. 8, 1) represents the simple burrow of the Mygalidæ, which, in many species and especially our own American tarantula, is a tubular hole in the ground without any silken tube or lining. This quite corresponds with the unlined tubular burrow which is the typical nest of the Citigrades as represented by most cf the Lycosids (Fig. 9, 1.) The second figure of the series (Fig. 8) shows the silken tubular nest of the Atypinæ, as represented by the American and European species considered in this paper. Here we have the ground burrow

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[1] Note on Atypus sulzeri, Mr. Edward Newman, Linnean Society. See also Zoologist, Vol. xiv., 1856. p. 5021. See also Moggridge, Trap-Door Spiders, p. 185.

[2] Annals Entomological Soc. of France, 5th Series, Tome 3, 1873, Plate 4.

[3] Harvesting Ants and Trap Door Spiders, Supplement, p. 183, Pl. xiii.

of Mygale with the addition of a silken lining[1] which also is carried above the surface and attached to trees (*a*) or to the adjacent herbage either in a straight tube (*b*) or a curved one (*c*).

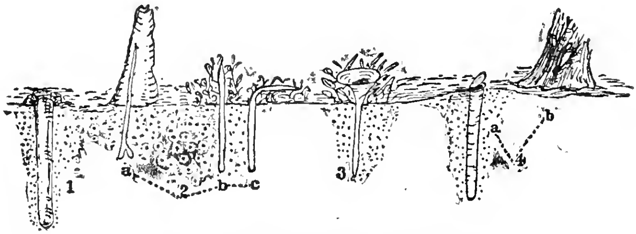

FIG. 8. Nesting Industry of the Territelariæ.
1. Mygale. 2. Atypus a, A. Abbotii, b, c, A. piceus. 3. Cyrtauchenius. Cteniza and Nemesia.

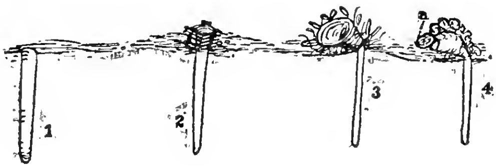

FIG. 9. Nesting Industry of the Citigradæ.
1. Lycosa. 2. L. arenicola. 3, 4. L. tigrina.

Turning to the corresponding number in the Citigrade series (Fig. 9, 2) we see the burrow slightly silk lined at the mouth, and carried upward above the surface where it is supported by a rude turret. The silken tube is, however, open and is rudimentary as compared with that of Atypus.

The third members of the two series show a yet closer likeness in in the nest forms viz., that of *Cyrtauchenius* (Fig. 8, 3) and that of *Lycosa tigrina* (Fig. 9, 3). The last named spider by that form of surface nest described above (Fig. 9, 4), shows us a rude suggestion of the trap-door spider's nest which, whether spun within a ground burrow (Fig. 8, 4, *a*), or within the ridges of bark upon a tree (4, *b*) as with certain Mexican species, has attracted the admiration not only of naturalists but of all observers. It is curious to note, by the way, the tendency of these accomplished nest builders to domicile upon a tree like their American tribal associates, the Purseweb spiders.

[1] Some of the large creatures known generally as the Mygalidæ or tarantulas I have no doubt silk line their burrows. We might therefore add to this series another and intermediate form of nest between Mygale (1) and Atypus (2) as here given.

From this comparison these conclusions and inferences appear: First, (1) Tunnelweavers and Citigrades have several well marked common characteristics in their nesting industry that suggest a close relation in spinning economy. Second, (2) the two tribes furnish examples of nests that may be arranged in series of advanced industrial skill, from a simple burrow to the highly specialized nest of the Trap-door spider on one side and, on the other, to the rude door or lid of Tigrina's silk-lined vestibule. Third (3), the most perfect manifestation of nesting industry is found with the Tunnelweavers, who are more dependent upon spinning-work for sustenance (and probably protection) than the Citigrades. Fourth (4), there appears to be some, although no very marked relation between the animal organization and the quality of the spinning work of the two tribes. The greatest development in size, as well as in spinning function, has been reached among the Tunnelweavers; but most araneologists would consider the Lycosids the more highly organized spiders. Moreover, the Tunnelweavers are provided with long, jointed superior spinners (lacking in Lycosids) specially adapted for weaving their more perfect nests.

Finally, as the result of a comparative study of the nesting industry of all the spider fauna, we may conclude that there is one germinal or typical form of nest among all the tribes, which form is the tube. Around this common and rudimentary form, which has been shown to be the one most natural to all animals possessing the spinning function, the greatly varied and widely divergent nests of spiders,—whether known as domiciles, dens, tents, tunnels, or caves,—may be grouped in series of more or less modified forms.

JULY 10.

Mr. THOMAS MEEHAN, Vice-President, in the chair.

Eleven persons present.

The following papers were presented for publication:—

"On the Fauna of the Lower Coal Measures of Central Iowa." By Charles R. Keyes.

"Descriptions of two new Fossils from the Devonian of Iowa." By Charles R. Keyes.

The death of Edwin L. Reakirt, a member was announced.

JULY 24.

Mr. ISAAC C. MARTINDALE in the chair.

Nine persons present.

A paper entitled "New Species of Shells from the New Hebrides and Sandwich Islands." By W. D. Hartman M. D. was presented for publication.

The death of Henry Carvill Lewis, Professor of Mineralogy in the Academy, was announced.

JULY 31.

Mr. CHARLES ROBERTS in the chair.

Thirteen persons present.

The following were ordered to be published:—

ON THE FAUNA OF THE LOWER COAL MEASURES OF CENTRAL IOWA.

BY CHARLES R. KEYES.

The carboniferous rocks of the region in the immediate vicinity of Des Moines have, until quite lately, yielded only fragmentary remains of fossils. Recent investigations, however, have disclosed a rich fauna embracing, as hereafter enumerated, more than 35 genera and nearly 60 species, the majority of them in a most perfect state of preservation. In Iowa the lower coal measures present, lithologically, a marked contrast with both the under-(subcarboniferous) and the over-lying (middle and upper coal measures) strata which are pre-eminently calcareous, while the lower coal measures are characterized by an almost total absence of the calcareous divisions, which are represented only by a few thin bands of impure limestone, local in distribution. A section of the rocks at Des Moines presents:

Drift	20	feet.
Löss	15	"
Middle coal measures	40	"
Lower coal measures	160	"
St. Louis limestone (not exposed in Polk county.)		

The superficial deposits have been quite thoroughly studied by McGee and Call,[1] but the palæozoic rocks have in Polk county received but a passing notice. Though economically of far greater importance than any other formation in the state, the lower coal measures have received comparatively little geologic attention; and the two attempts at an exhaustive and detailed survey of this formation in Iowa, and a correlation of the different coal horizons was unfortunately rendered abortive by circumstances entirely beyond the control of those engaged in the study of the Des Moines valley region. In Iowa the lower coal measures probably have a maximum thickness of more than two hundred feet, but notwithstanding the fact that at Des Moines the entire formation underlies the city, which is situated just at the eastern border of the middle coal measures, this maximum is nowhere, in Polk county, attained. The base of the middle coal measures as characterized by Mr. St. John[2] and as is clearly shown in several localities in the immediate vicinity of Des Moines, is composed of variegated clays and shales,

[1] *Vide* Am. Jour. Sci., vol. xxiv, Sept. 1882.

[2] White's Geol. Iowa, vol. I, p. 272.

with one or two intercalated bands of impure nodular limestone. These variegated shales have a thickness of forty or more feet, and are easily recognizable at numerous exposures in the bluffs of the vicinity by the thin limestone bands, which within the city limits have yielded twenty or more species of fossils. There are also included in the middle coal measures some local depositions of micaceous sandstone, usually soft, and unfit even for the roughest masonry; some of it, however, is concretionary and quite durable. Formerly these portions were quarried for local use, but of late no attempt has been made for its utilization. At the southern extremity of Capital Hill this sandstone reaches a thickness of more than twenty-five feet. A short distance north of the city a sandstone having a thickness of twelve feet caps the bluff, and forms a high mural escarpment along the south side of the Des Moines river. Although the Des Moines and Racoon rivers have, in Polk county, corraded their channels through the upper strata, the lower coal measures are fully represented from the underlying St. Louis limestone[1]—the nearest exposure of which is about thirty miles below Des Moines—to the superimposing variegated shales just mentioned. This formation as represented in this vicinity is composed almost entirely of clays and shales, with a few thin layers of soft sandstone, and at least three workable beds of coal. The relative positions of the latter are shown in the following sections at the Giant Coal Mine where the fossil forms hereafter mentioned were chiefly collected:

Drift clay and carbonaceous shales	56	feet
Coal No. 1,	4	"
Shales, etc.	$20\frac{1}{2}$	"
Coal No. 2,	$4\frac{1}{2}$	"
Shales, lower layers fossiliferous.	35	"
Coal No. 3	$4\frac{1}{2}$ to 6	"

To the southwest, from Capital Hill, the distance between coals No. 2 and No. 3 appears to increase, and the latter vein attains a thickness in some places of seven feet. The coal measures of Iowa have a general dip to the south and west. To the northeast from Des Moines, the coal veins appear to thin out and finally are wanting, as shown in the accompanying sections; the first at Altoona,

[1] *Vide* White on the Unconformability of the coal measures upon the older rocks, etc. Geology of Iowa, Vol. I, p. 225 *et seq.*

nine miles from Des Moines, and the second three miles north of Mitchellville, or sixteen miles from Des Moines.

Drift and carbonaceous clays	110 feet.
Shale	60 "
Sandstone	15 "
Coal	$1\frac{1}{2}$ "
Shale	15 "
Coal	4 "

A boring near Mitchellville at the eastern border of Polk county shows an almost entire absence of coal.

Drift	64 feet.
Blue and black shales with a thin band of limestone and one of sandstone	$17\frac{1}{2}$ "
Impure coal	$1\frac{1}{6}$ "
Gray, black, blue and sandy shales with two layers of sandstone	$141\frac{1}{2}$ "
Limestone, with marly partings	$39\frac{1}{2}$ "

Coals No. 2 and especially No. 3, are the most profitably worked and furnish nearly all the coal mined in the county. Immediately overlying, and thus forming the roof of, coal No. 3 is a soft black clayey shale often slaty in places, highly fossiliferous and containing much iron pyrites in the form of crystals and nodules; many cubes of the former being over an inch along the edges, and the latter often containing shells of mollusca. The shell substance of the fossils from these shales, aside from those contained in the pyritiferous nodules, is replaced more or less completely by pyrite. In some specimens the replacement is complete; in others only a thin film of pyrite covers the shell, leaving the interior of the shell substance with the original calcareous constituents; between the two extremes all degrees of replacement by pyrite occur. In a few instances—*Lophophyllum*, fish-teeth and the remains of crinoids—no replacement has taken place. These fossiliferous shales are, upon exposure to the weather, easily and speedily disintegrated into a fine black clay, and the iron pyrite contained quickly decomposes; thus rendering it extremely difficult to obtain good specimens of fossils, unless the shales are examined immediately upon being taken from the mines. This fact may account, in part, for the apparent rarity of fossils from the lower coal measures of Central Iowa, as all traces of fossil remains are quickly obliterated after the shales have been disturbed.

Independent of its biological and geological relations, the fauna of the lower coal measures of Des Moines is of considerable interest in its bearing upon the geographical distribution during carboniferous times of certain species; and also on account of the close similarity in many respects, of this and the fauna of the lower coal measures of eastern Illinois, particularly that of the superimposing black shales of the "Danville" coal, or coal "No. 7" of the general Illinois section. Stratigraphically the relations of these two fossiliferous shales to the principal coal-beds are the same—each forming the roof of the most extensive coal stratum in their respective localities; lithologically the two shales are apparently identical.

CŒLENTERATA.

Lophophyllum proliferum McChesney.

Cyathaxonia prolifera McChesney, 1860. Disc. New Palæo. Fos. p. 60.

Cyathaxonia sp?. Geinitz, 1866. Carb. und Dyas in Nebraska, pp. 65, 66, tab. v, figs. 3–4.

Lophophyllum proliferum Meek, 1872. U. S. Geol. Surv. of Nebraska, p. 144.

This species though a characteristic, and usually one of the most abundant, fossils of the coal measures is extremely rare in the lower coal measures of central Iowa; however, it is not to be expected that the remains of cœlenterates would occur very abundantly in bituminous shales.

Rhombopora lepidodendroides Meek.

Rhombopora lepidodendroides Meek, 1872. U. S. Geol. Sur. of Nebraska, p. 144.

Rhombopora lepidodendroides White, 1875. Expl. and Sur. W. 100 merid. Vol. IV, pt. 1, p. 99.

From the lower coal measures but a single specimen of this species has been collected. In a thin band of limestone of the middle coal measures about one hundred feet higher than the horizon from which this specimen was found, this species occurs quite abundantly.

ECHINODERMATA.

Eupachycrinus (sp.?).

The only remains of echinoderms as yet discovered in the black shales are a few stem joints and a brachial plate which evidently belong to one of the coal measure species of this genus.

BRYOZOA.

Synocladia biserialis Swallow.

Synocladia biserialis Swallow, 1858. Trans. St Louis Acad. Sci., Vol. I, p. 179.

Synocladia virgulacea Geinitz, 1866. Carb. und Dyas in Nebraska, p. 70.

The only bryozoan remains from the black shales consist of a few well preserved specimens of this species. From the investigations of Meek and Ethridge it would appear that Prout's genus *Setopora* is synonymous with *Synocladia*, and according to the former writer *S. cestriensis* from the Chester limestone is very closely allied to, if not identical with, *S. biserialis*. This would give *Synocladia biserialis* a much more extensive vertical range than has hitherto been supposed.

BRACHIOPODA.

Lingula umbonata Cox.

Lingula umbonata Cox, 1857. Geol. Surv. Ky., Vol. III, p. 576, pl. x, fig. 4.

Lingula umbonata White, 1884. 13 Ann. rep. Geol. Ind., pt. II, p. 120, pl. xxv, fig. 14.

The specimens from Des Moines are somewhat larger than the one originally figured by Cox (*loc. cit.*), and like that are broader posteriorly to the mid-length than anteriorly. The posterior margin is broadly rounded instead of being obtusely angular as it is often said to be, and as is shown in some figures of this species. None of the specimens under consideration are, therefore, so prominently subangular on the posterior margin, and broader anteriorly to the mid-length as those shown in the figures of Meek and Worthen[1] of a form which they call *L. mytiloides* Sowerby, while specimens of Sowerby's species figured by Ethridge[2] have the posterior margin even more sharply rounded or obtusely angular. No opportunity has been offered for directly comparing the American with the European forms and consequently their exact specific relations have not been sufficiently considered.

Discina nitida Phillips.

Orbicula nitida Phillips, 1836. Geol. Yorks., II, p. 221, pl. xi, figs. 10–13.

Discina nitida Meek and Worthen, 1873. Geol. Ill., Vol. V, p. 572, pl. xxv, fig. 1.

This species is common at the Polk county coal mine but has not as yet been discovered elsewhere in the county. The specimens

[1] Geol. Illinois, Vol. V, p. xxv, figs. 2a, 2b, 2c.

[2] Proc. Nat. His. Soc. Glasgow, Vol. IV, pl. v, fig. 3.

collected are, on the average, smaller than those from other localities. Meek and Worthen regard *D. missouriensis* Shumard a synonym of this species.

Productus nanus Meek and Worthen.

Productus nanus Meek and Worthen, 1860. Proc. Acad. Nat. Sci. Phila., p. 450.

Productus nanus Meek and Worthen, 1866. Geol. Ill., Vol. II, p. 320, pl. xxvi, figs. 4a, 4b, 4c, 4d.

This species was described from the lower coal measures of Jefferson county, and inasmuch as the St. Louis limestone is exposed in many of the creeks of that locality, its horizon is near the base of the coal measures; the horizon at Des Moines from which the specimens under consideration were obtained is somewhat higher. Though quite rare it will doubtless be found in other localities in the Des Moines valley. It is associated with *P. muricatus* N. and P. to which it presents differences that are both characteristic and constant. The almost total absence of spines in this species forms a marked contrast with the congeneric species of the same locality.

Productus cora D'Orbigny.

Productus cora d'Orbigny, 1842. Voyage dans l'Amerique Meridionale.

Productus prattenianus Norwood, 1854. Jour. Acad. Nat. Sci. Phila., Vol. III, p. 17.

Productus æquicostatus Shumard, 1855. Geol. Rep. Missouri, p. 201, pl. C, fig. 10.

Productus flemingi Geinitz, 1866. Carb. und Dyas in Nebraska, p. 52, tab. iv, figs. 1, 2, 3, 4.

Productus cora White, 1884. Ind. Geol. Rept. for 1883, p. 126, pl. xxvi, figs. 1, 2, 3.

A single specimen from the Polk County coal mine. This species was originally described from South America; but with the exception of Owen[1] and Marcou,[2] American paleontologists have until quite recently adopted for this form Norwood's name of *P. prattenianus*. A *Productus* collected from the Kinderhook in the vicinity of Burlington, and from the same horizon in Marshall county, unquestionably belongs to this species; if, however, this is the form described by White[3] as *P. lævicostus*, the latter is certainly synonymous

[1] Geol. Rep. Iowa, Wisconsin and Minnesota, 1852.

[2] Geology of North America, 1858.

[3] Boston Jour. Nat. His., Vol. VII, p. 230, 1860.

with *P. cora;* the vertical range of which would extend downward to the base of the subcarboniferous.

Productus muricatus Norwood and Pratten.

Productus muricatus Norwood and Pratten, 1854. Jour. Acad. Nat. Sci. Phila., Vol. III, p. 14, pl. i, fig. 8.

Productus muricatus White, 1875. Exp. and Sur. w. 100 merid. vol. IV, pt. I, p. 120, pl. viii, fig. 4.

In the geology of Yorkshire, (p. 214, pl. viii, fig. 3) Phillips in 1836 described *Producta muricata:* but the description is very brief and his figure would indicate that he had in hand a specimen of less than average size of *P. costatus* described by Sowerby nine years before. In Iowa, Dr. White found Norwood and Pratten's *P. muricatus*, most characteristic of the middle coal measures; the recent discoveries, however, show that it is the most abundant brachiopod of the lower coal measures in the region around Des Moines, yet the average size is somewhat less than that of the same species from the calcareous strata of the middle coal measures of the same locality. Both Davidson and Meek regard *P. muricatus* N. and P. identical with *P. longispinus* of Sowerby. Throughout Iowa at least, *P. muricatus* N. and P. presents characteristics that are remarkably constant; and when associated with *P. longispinus* no hesitancy whatever would be entertained in separating the two forms. The species of *Productus* described have been numerous, as is attested by an extensive and remarkable synonymy, which is only too apparent to those who have given the subject careful attention. The wide geographical distribution of some species, and the extensive vertical range of others, together with the concomitant differences of environment at the time when the species were living, readily accounts for the extreme variations presented. Inattention to this important factor has often led to the basis of species upon superficial characters which are relatively unimportant as classificatory criteria, and the confusion arising therefrom has rendered the study of this group extremely unsatisfactory.

Chonetes mesoloba Norwood and Pratten.

Chonetes mesoloba Norwood and Pratten, 1854. Jour. Acad. Nat. Sci. Phila., Vol. III, p. 27.

Chonetes mesoloba White, 1875. Expl. and Surveys w. 100 merid., Vol. IV, p. 123, pl. ix, fig. 7a.

This species is one of the most abundant of the brachiopods occurring in the bituminous shales of this locality. The average width of fifty specimens is nine millimeters, much below normal; specimens very much larger occur in other horizons. Here it is generally perfectly preserved in all its details; the mesial fold is more sharply defined, and the depressions on each side of the fold relatively deeper than is usual with this species. The depauperate condition of this, and in fact of all the brachiopods from the same horizon, is suggestive of an environment, at the time these animals lived, that was extremely unfavorable to the full development, and to the attainment of a normal size that would be rendered possible by a more congenial habitat.

Chonetes lævis nov. sp. (Plate XII, figs. 3a, 3b.)

Shell small; much wider than long; transversely semi-elliptical; the cardinal line as long as the greatest width of the shell, or often slightly extended beyond the lateral margins. Ventral valve convex, with no indication of a mesial sinus; beak not prominent; cardinal area rather narrow but well defined centrally, becoming linear toward the extremities; foramen moderately wide; cardinal margin bearing from four to seven oblique spines on each side of the beak. Dorsal valve flat or very slightly concave; with no mesial fold. Surface of both valves apparently perfectly smooth; but under a magnifier it is seen to be marked by numerous fine concentric striæ, and more prominent, often somewhat imbricated, lines of growth; these are sometimes crossed by fine nearly obsolete radiating striæ.

Length 7 mm.; breadth 12 mm.

This species is found in the superimposing black shales of coal No. 3 at Des Moines; and is associated with *Chonetes mesoloba*, *Productus muricatus*, and the minute gasterpods hereafter mentioned. The glabrate character, and the absence of a mesial fold and sinus, as is constant in all eight of the specimens found, forms a marked contrast with the associated congeneric forms, in which the radiating striæ are unusually sharp and well defined; and also with the other carboniferous forms of the same genus. This species is closely allied to, and perhaps identical with, the form described by Geinitz[1] as *Chonetes glabra*; but this name, however, was preoccupied by Hall in 1857, for a species from the Upper Helderburg.

[1] Carbonformation und Dyas in Nebraska, 1866, p. 60.

Streptorhynchus crenistria Phillips.

Spirifera crenistria Phillips, 1836. Geol. Yorks., II, p. 216, pl. ix, fig. 6.

Orthisina crassa Meek and Hayden, 1858. Proc. Acad. Nat. Sci. Phila., p. 260.

Orthis robusta Hall, 1858. Geol. Iowa, vol. I, pt. II, p. 713.

Orthis lasallensis McChesney, 1860. New Palæo. Foss., p. 32.

Orthis richmondi McChesney, 1860. New Palæo. Foss., p. 32.

Hemipronites crassus Meek and Hayden, 1864. Palæ. Upper Missouri, p. 26.

Orthis crenistria Geinitz, 1866. Carb. und Dyas in Nebraska, p. 46.

Hemipronites crassus McChesney, 1867. Trans. Chicago Acad. Sci., p. 28.

Hemipronites crassus Meek and Worthen, 1873. Geol. Ill., vol. V, p. 570.

At the Pioneer mine several moderately larger specimens have been obtained. This species has been more generally known as *Hemipronites crassus* M. and H. It is a common and characteristic fossil of the coal measures throughout Iowa and the contiguous states, and presents many varietal phases. Hall's *Orthis robusta* described from this state is unquestionably identical with this species. There is also associated with the Des Moines specimens a smaller form, about five millimeters in width, which appears to differ very materially from any forms of *S. crenistria* examined.

Spirifera camerata Morton.

Spirifer cameratus Morton, 1836. Am. Jour. Sci., vol. XXIX, p. 150.

Spirifer cameratus Meek and Worthen, 1873. Geol. Ill., vol. V, p. 573.

Though a most abundant and characteristic species of the coal measures of the west, this species is represented in the Des Moines collections by only two specimens, one fairly good though somewhat crushed, and the other fragmentary, yet they exhibit distinctly the peculiar fasciculated costæ, as in the typical specimens.

Spirifera lineata Martin.

Spirifer lineatus Martin, 1809. Petrif. Derb. Coal Meas.

Spirifer perplexa McChesney, 1860. New Palæ. Foss.

Spirifera lineata White, 1884. Geol. Rep. Ind. for 1883, p. 133.

Pioneer mine; six or eight specimens were obtained, associated with *Athyris subtilita*.

Spirifera rockymontana Marcou.

Spirifer rockymontanus Marcou, 1858. Geol. N. A., p. 50.
Spirifer opimus Hall, 1858. Geol. Iowa, vol. I, pt. II, p. 711.
Spirifer subventricosus McChesney, 1860. Disc. New Palae. Fos. p. 44.

Pioneer mine: three specimens. This and *S. opimus* Hall are unquestionably synonymous; and though both names were proposed the same year, Marcou's has priority as has been shown by White (*Vide* under *Retzia mormoni*). McChesney in 1860 described this form as *Spirifer subventricosus*, but in the revision of his first paper he makes his species synonymous with Hall's *S. opimus*.

Spiriferina kentuckensis Shumard.

Spirifer kentuckensis Shumard, 1855. Geol. Sur. Missouri, p. 203.
Spiriferina kentuckensis Meek, 1872. U. S. Geol. Sur. Neb., p. 185.

Pioneer mine; two specimens. This species is quite common in the calcareous strata of the middle coal measures of the same locality.

Athyris subtilita Hall.

Terebratula subtilita Hall, 1852. Stans. Exp. Gt. Salt Lake, p. 409.
Athyris subtilita Newberry, 1861. Ives Exped. Colorado River, p. 126.

Not common; in fact, brachiopods are comparatively rare in the lower coal measures of the region under consideration, and with two exceptions the species are represented by few examples. In the limestones of the middle coal measures this species is quite abundant, and often attains a large size. As is well known it has a wide geographical and vertical distribution, being found from the Appalachian to the Rocky Mountain regions; it also occurs in the subcarboniferous of Europe and India. In all probability several species described from the subcarboniferous of this country will prove synonymous with this form. In North America its vertical range would then extend from the subcarboniferous through the coal measures into the permian.

Retzia mormoni Marcou.

Terebratula mormonii Marcou, 1858. Geology N. A., p. 51.
Retzia punctilifera Shumard, 1858. Trans. St. Louis Acad. Sci., vol. I, p. 220.
Retzia mormonii Meek and Hayden, 1859. Proc. Acad. Nat. Sci. Phila., p. 27.

This species is represented by two specimens, one of which is somewhat crushed. There appears to be satisfactory evidence that Marcou's name has priority. Dr. White says in a foot note on p. 125, volume IV, of Explorations and Surveys west of the 100th meridian :

" *Orthis pecosi*, *Retzia mormoni*, *Rhynchonella uta*, *R. rockymontana*, and *Spirifer rockymontana* were published by Marcou in his Geology of North America. I have obtained satisfactory evidence that the work was published as early as March 1, 1858. Vol. XV, of the Bulletin de la Société Géologique de France contains a statement that a copy of the book was sent to that society on April 20, 1858. In the same year Shumard and Swallow published a paper containing descriptions of the three first named species, under other names, in the transactions of the St. Louis Academy of Sciences, but that publication was not made until about the first of June. In December of the same year, Hall published in the Geological Report of Iowa, *Spirifera rockymontana* as *S. opimus;* and in 1860, McChesney published *R. rockymontana* as *R. etoniæformis.* It thus appears clear that Marcou is entitled to priority of all five of the names given above, as stated in the synonymy heading the descriptions of those species in this report."

LAMELLIBRANCHIATA.

Myalina swallovi McChesney.

Myalina swallovi McChesney, 1860. New. Palæ. Foss., p. 57.

Myalina swallovi Meek and Worthen, 1866. Geol. Ill., II, p. 341.

Giant mine: not common; some of those obtained are in an excellent state of preservation.

Aviculopecten coxanus Meek and Worthen.

Aviculopecten coxanus Meek and Worthen, 1860. Proc. Acad. Nat. Sci. Phila., p. 453.

Aviculopecten coxanus Meek and Worthen, 1866. Geology Ill., vol. II, p. 326.

Of this little species six good specimens have been obtained at the Pioneer mine; none of them are larger than that figured by Meek and Worthen (loc. cit).

Aviculopecten neglectus Geinitz.

Pecten neglectus Geinitz, 1866. Carb. und Dyas in Nebraska, p. 33.

Aviculopecten neglectus Meek and Worthen, 1873. Geol. Ill., vol. V, p. 589.

The specimens referred to this species are somewhat larger than either of those figured by Geinitz, or Meek and Worthen, but otherwise correspond in every particular. It is without ornamentation excepting concentric lines of growth and the folds or wrinkles of the ear.

Nuculana bellistriata Stevens.

Leda bellistriata Stevens, 1858. Am. Jour. Sci., 2nd series, vol. XXV, p. 261.

Nuculana bellistriata White, 1884. Geol. Rep. Ind. for 1883, p. 146.

At Des Moines this species is not common; but in the black shales overlying the workable coal seams at Van Meter in Dallas county it is very abundant, often being found in "nests" closely packed together.

Nucula parva McChesney.

Nucula parva McChesney, 1860. Disc. New Palæ. Foss., p. 54.

Nucula parva Meek and Worthen, 1873. Geol. Ill., vol. V, p. 589.

Giant mine; quite rare. Owing to its small size it might easily escape notice and this fact may partly account for the apparent rarity of this species.

Nucula ventricosa Hall.

Nucula ventricosa Hall, 1858. Geol. Iowa, vol. I, pt. ii, p. 716.

Nucula ventricosa White, 1884. Geol. Rep. Ind. for 1883, p. 146.

Many of the specimens collected exhibit the internal characters of the shell—the characteristic and well defined muscular impressions, and the small prominent teeth along the hinge line.

Schizodus (sp. und.)

This genus is represented by casts which occur in nodules of iron pyrites, but the specific characters have not as yet been made out.

Clinopistha radiata Hall.

Edmondia? radiata Hall, 1858. Geol. Iowa, vol. I, p. 716.

Clinopistha radiata Meek and Worthen, 1870. Proc. Acad. Nat. Sci. Phila., p. 44.

Some of the Des Moines specimens exhibit no radiating striæ whatever, though the concentric lines of growth are often quite conspicuous. Inasmuch as the smooth forms and those having distinct radiating striæ, and between the two extremes every degree of gradation occur associated, it is questionable whether the variety *lævis* M. and W. can be considered as having even the value of a variety; but is to be regarded rather as an individual and not a varietal difference.

Solenomya soleniformis Cox.

Solenomya soleniformis Cox, 1857. Geol. Sur. Kentucky, vol. III, p. 573.

At the Giant mine the form which is here referred to the species described in the Kentucky Geological report, vol. III, p. 573, is not common; it is considerably larger than that figured by Cox, but otherwise corresponds in all other observable particulars. It is by far the largest lamellibranch yet found at Des Moines, but the shell is very thin and easily detached from the matrix.

GASTEROPODA.

Dentalium meekianum Geinitz.

Dentalium meekianum Geinitz, 1866. Carb. und Dyas in Nebraska, p. 13.

Dentalium meekianum? Meek and Worthen, 1873. Geol. Ill., vol. V, p. 590.

This species is represented by numerous specimens, but none of them having both extremities perfectly preserved. The ornamentation in some of the specimens is well preserved, in others it is obsolete, and a few are perfectly glabrate.

Dentalium annulostriatum Meek and Worthen.

Dentalium? annulostriatum Meek and Worthen, 1870. Proc. Acad. Nat. Sci. Phila., p. 45.

Dentalium? annulostriatum Meek and Worthen, 1873. Geol. Ill., vol. V, p. 589.

This species is represented by six specimens; in four of these the characteristic annular costæ are very prominent and the furrows separating the costæ are correspondingly quite deep.

Bellerophon percarinatus Conrad.

Bellerophon percarinatus Conrad, 1842. Jour. Acad. Nat. Sci. Phila., vol. VIII.

Bellerophon percarinatus Meek, 1872. U. S. Geol. Sur. Nebraska, p. 227.

Rather common and in a fine state of preservation. It is associated with the two other congeneric species here mentioned.

Bellerophon monfortianus Norwood and Pratten.

Bellerophon monfortianus Norwood and Pratten, 1855. Jour. Acad. Nat. Sci. Phila., vol. III, p. 74.

Bellerophon monfortianus Geinitz, 1866. Carb. und Dyas in Nebraska, p. 8.

Giant mine; a highly ornamented species, but not as common as its associated congeners.

Bellerophon urii Fleming.

Bellerophon urii Fleming, 1828. Brit. Anim., p. 338.

Bellerophon urii Keferst, 1834. Naturg. des Erdk., II, p. 430.

B. urii Phillips, 1836. Geol. Yorks., II, p. 31, pl. 17, figs. 11–12.

B. atlantoides d'Orbigny, 1840. Monog. des Céphalop. Cryptodibr., pl. 4, figs. 14–19.

B. urii Phillips, 1841, Palæ. Foss. Cornwall, etc., p. 106, pl. xl, fig. 199.

B. urii d'Arch. et de Vern, 1842. Geol. Trans., (2), vol. VI, pt. ii, p. 386.

B. urii Fleming et Portlock, 1843. Rep. on the Geol. of the County of Lond., p. 400, pl. XXIX, fig. 9.

B. d'Orbignyi Portlock, 1843. Rep. Geol. Lond., p. 401, pl. XXIX, fig. 12.

B. (Euphemus) urii McCoy, 1844. Syn. Carb. Fos. Ireland, p. 26.

B. urii de Koninck, 1844. Descriptions des Animaux Fossiles (de Belgique), p. 356, pl. XXX, fig. 4.

B. urii J. Morris, 1854. Cat. Brit. Fossils, p. 288.

B. urii Norwood and Pratten, 1854. Jour. Acad. Nat. Sci. Phila., vol. III, p. 75, pl. IX, fig. 6.

B. urii McCoy, 1855. Brit. Palæ. Foss., p. 555.

B. carbonarius Cox, 1857. Palæont. Rep. Ky. Geol. Sur., vol. III, p. 562.

B. blaneyanus McChesney, 1860. New Palæ. Foss., p. 60.

B. urii F. Römer, 1863. Zeitschr. d. d. geol. Ges., vol. XV, p. 582, taf. XV, f. 4.

B. carbonarius Geinitz, 1866. Carb. und Dyas in Nebraska, p. 6, tab. i, fig. 8.

B. blaneyanus McChesney, 1867. Trans. Chicago Acad. Sci., vol. I, p. 45, pl. ii, fig. 5.

B. urii Armstrong, 1871. Trans. Geol. Soc. Glasgow, vol. III, supp. p. 61.

B. carbonarius Meek, 1872. U. S. Geol. Sur. Nebraska, p. 224, pl. iv, fig. 16; et pl. xi, fig. 11.

B. urii de Koninck, 1873. Recherches sur les Animaux Fossiles, p. 98, pl. iv, fig. 2.

B. carbonarius White, 1884. Geol. and Nat. His. Sur. Indiana, 13 rep., p. 158, pl. xxxiii, figs. 6, 7, 8.

Abundant at the Giant mine. The shell is of medium size; subglobose; dorsum broadly rounded. Umbilici closed. Aperture transversely semilunate, but not expanding more rapidly than the uniform increase in the size of the volutions; inner lip but slightly developed; outer lip thickened and rounded towards the umbilici, but becoming very attenuated towards the middle; its medial sinus rather broad, rounded and not very deep. Medial band obscure on the costate portion of the shell, but on the terminal half of the body whorl more or less distinct and in some specimens bordered on each side by a low, narrow, yet well defined, ridge. Surface except the last half of the outer whorl ornamented with from fifteen to thirty or more sharp, simple, nearly parallel costæ. Terminal half of body whorl smooth, except along the medial portion which is often marked by lines of growth, and sometimes by the low ridges, to which reference has already been made.

The form considered here under the name of *Bellerophon urii* is the one usually designated by American palæontologists as *B. carbonarius* Cox. A careful comparison of the descriptions and figures of the various writers on this group of Gasteropoda, and a large series of specimens fails to furnish any valid reason for separating specifically the American from the European form described by Fleming in 1828 as *Bellerophon urii*. Norwood and Pratten referred Cox's specimens to *B. urii;* but Cox in 1857 made it the type of a species which he called *B. carbonarius,* distinguishing it from the European form by the slight lateral expansion of the mouth and particularly by the less number of revolving costæ, which in *B. carbonarius* were said to vary from nineteen to twenty-five, while according to de Koninck *B. urii* had from thirty-six to thirty-eight. Though de Koninck does make this latter statement in his earlier[1] work, his later Recherches[2] state that the number varies from twenty-two to thirty. McChesney in the description of his *B. blaneyanus* seems also to have made the chief distinctive character between his

[1] Descriptions des Animaux Fossiles, p. 356. (1844.)

[2] Recherches sur les Animaux Fossiles, p. 98. (1873).

species and the European form the possession by the former of only sixteen costæ, or about half the number ascribed to *B. urii* by de Koninck.

Pleurotomaria brazoensis Shumard.

Pleurotomaria brazoensis Shumard, 1860. Trans. St. Louis Acad. Sci., vol. I, p. 624.

Pleurotomaria brazoensis? Meek and Worthen, 1866. Geol. Ill., vol. II, p. 354.

The specimens of this species collected do not present much variation. The two peripheral carinæ are nearly equal and between them is located the concave band of the sinus. The whorls are ornamented by sixteen or seventeen strong filiform lines—nine below the lower carina, upon which there are two filiform lines; three above the upper carina upon which there are two and sometimes three lines; and a single line on the sinal band. Crossing the revolving lines are numerous prominent, equidistant transverse lines which give to the whole ornamentation a peculiarly yet regularly cancellated appearance; between, and parallel to, these transverse raised striæ are also from three to six microscopic, yet sharp and distinct raised striæ. Meek and Worthen refer with a query to Shumard's species a form from Macoupin county, Illinois, having about twenty-five revolving lines (twelve of which occupy the lower side of the body-whorl) instead of thirteen or fourteen as ascribed by Shumard to this species. Shumard says: "surface of volutions ornamented with from thirteen to fourteen rather strong filiform striæ which are crossed by sharp transverse striæ;" if by this he intends to convey the idea that this is the entire number of lines including those on the under side of the body whorl, Meek and Worthen remark that they "should scarcely entertain a doubt in regard to our [their] shell being a distinct species, since it uniformly has about double that number of revolving striæ on the last whorl." In this and some other groups of gasteropods much classificatory importance appears to have been attached to the number of revolving costæ; and sometimes a variation of three or four in the number has been almost the only basis for specific distinction. After a critical examination of a large series of different species presenting these characters, the question has arisen relative to the value of the number of costæ as a classificatory criterion. In some gasteropodous groups it has, within certain limits of course, small value; its exact importance in *Pleurotomaria* and some allied genera has not as yet been satisfactorily made out, but it is certain, however, that in some groups at least, it does not possess specifically such an important classificatory value as has been generally supposed.

Pleurotomaria modesta nov. sp. (Plate XII, figs. 2a, 2b.)

Shell small, sublenticular, spire greatly depressed, volutions six, obliquely flattened above; body whorl very large, rapidly increasing in size, sharply angular on the periphery, flattened or very slightly concave above, prominently rounded below, suture line linear; spiral band very narrow almost linear, very slightly impressed and occupying a position just above the peripheral angle; on the spire the band is obscured by a single series of conspicuous nodes; aperture subquadrate, or subrhombic; umbilical region slightly impressed, but not perforated; surface glabrate; under a glass exhibiting fine lines of growth; the last whorl with a series of small transverse folds, or wrinkles, toward the tuberculated margin; each fold apparently originating at a node and extending about one-half or two-thirds the distance to the periphery.

Twenty or more specimens of this beautiful little species have been obtained from the black superimposing shales of coal No. 3. It approaches more closely than to any other the form described by Cox as *P. depressa* and may eventually prove identical with that form. *P. depressa*, however, was preoccupied by Phillips in 1836; and this name was also used by de Koninck and by Passy.

Pleurotomaria grayvillensis Norwood and Pratten.

Pleurotomaria grayvillensis Norwood and Pratten, 1855. Jour. Acad. Nat. Sci. Phila., vol. III, p. 75.

Pleurotomaria grayvillensis Geinitz, 1866. Carb. und Dyas in Nebraska, p. 9.

Shell rather small, conical subovate, longer than wide; spire moderately elevated; whorls five to seven, obliquely flattened above. Body whorl large, rapidly increasing in size, rounded below; biangular around the periphery, both angles being visible on the spire. Aperture subrhombic; outer margin sharp. Columella extended below. Surface ornamented by from twenty-five to forty revolving lines, of which twenty or more occupy the inferior surface of the body whorl; some of the lines are much more prominent than others, and there is a more or less regular alternation of the more prominent ones with less prominent raised striæ; these are crossed by numerous somewhat regular lines of growth, giving a more or less tuberculate appearance, which is most conspicuous toward the suture. The number of raised revolving lines appears to vary with the size of the specimens, and the maximum given is for the largest specimens collected. This species was originally described from Pasey county, Indiana, and Grayville, Illinois.

Pleurotomaria carbonaria Norwood and Pratten.

Pleurotomaria carbonaria Norwood and Pratten, 1855. Jour. Acad. Nat. Sci. Phila., (2), vol. III, p. 76.

This is by far the largest gasteropod yet discovered at Des Moines, and the test, as compared with that of the associated species, is extremely thick and heavy. A closely allied species has been described from the coal measures at Newport, Indiana, as *P. newportensis* White. According to Dr. White it differs from *P. carbonaria* in having "its revolving band ample and raised instead of concave, with revolving lines within it, as in that species; and also in having its aperture subcircular instead of semicircular."

Macrocheilus humilis, nov. sp. (Plate XII, fig. 1.)

Shell very small, short, subfusiform, or elongate-subovate; spire prominent, forming one-third or more of the entire length of the shell; volutions about six, increasing moderately in size, slightly convex. Test rather thin. Columellar fold distinctly visible within the aperture, which is subelliptical; callosity clearly defined but not conspicuous; outer lip thin, sharp. Suture well-defined but not deeply impressed. Surface smooth, but under a glass exhibiting lines of growth. Length 6 mm.; width 3·5 mm.

This little species is from the superimposing black shales of coal No. 3, at the Giant mine; and is found associated with the numerous other small gasteropods mentioned hereafter.

Macrocheilus gracilis Cox.

Macrocheilus gracilis Cox, 1857. Geol. Sur. Kentucky, vol. III, p. 570.

The roof shale of coal No. 3, has furnished a good series of this species, representing all stages of development up to those fifteen millimetres in length. The smaller specimens are less ventricose and have the spire proportionally higher than in the older ones, which approach nearer the form described as *M. ventricosus* Hall, and there is therefore reason to believe that the two species will eventually prove identical. Cox states in his description that his species was most likely a young shell. White[1] considers *Soleniscus*

[1] Geol. Ind., Rep. for 1883, p. 155.

(*Macrocheilus*) *brevis* White, described in the supplement to vol. III, of the Expl. and Surv. west of the 100 merid. synonymous with *M. ventricosus* Hall.

Macrocheilus newberryi Stevens.

Loxonema newberryi Stevens, 1858. Am. Jour. Sci., (2), vol. XXV, p. 259.

Macrocheilus newberryi Hall, 1858. Geol. Iowa., vol. I, p. 719.

The specimens collected at Des Moines present considerable variation: some are typical *M. newberryi*, from which others gradate into forms more nearly approaching that described by Hall from Alpine Dam as *M. fusiformis;* hence their identity is not improbable. This is also in corroboration with the suggestion of Dr. White in the Indiana geological report for 1883 that "with full collections at hand, it will be difficult to clearly define the specific characters between *M. newberryi*, *M. planus* and *M. fusiformis*."

Orthonema conica Meek and Worthen.

Orthonema conica Meek and Worthen, 1866. Proc. Acad. Nat. Sci. Phila., p. 270.

Orthonema conica Meek and Worthen, 1873. Geology Ill., vol. V, p. 390.

This species is represented by only two specimens, both somewhat smaller than those figured by Meek and Worthen.

Actæonia minuta Stevens.

Loxonema minuta Stevens, 1858. Am. Jour. Sci., (2), vol. XXV, p. 260.

Actæonia minuta Meek and Worthen, 1873. Geol. Ill., vol. V, p. 594.

This is one of the most abundant of the small gasteropods occurring in the bituminous shales overlying coal No. 3.

Aclisina minuta Stevens.

Aclis minuta Stevens, 1858. Am. Jour. Sci., (2), vol. XXV, p. 259.

Common; associated with *A. robusta*, compared with which it is much more slender, and the spire possesses three or four more volutions.

Aclisina robusta Stevens.

Aclis robusta Stevens, 1858. Am. Jour. Sci., (2), vol. XXV, p. 259.

Aclis robusta Meek and Worthen, 1873. Geol. Ill., vol. V, p. 596.

Abundant. This and the preceding species were described by Stevens under *Aclis,* but in 1881 de Koninck established the genus *Aclisina* which now includes the four American carboniferous species originally described under the former genus.

Streptacis whitfieldi Meek.

Streptacis whitfieldi Meek, 1871. Proc. Acad. Nat. Sci. Phila., p. 173.

Streptacis whitfieldi Meek and Worthen, 1873. Geol. Ill., vol. V, p. 596.

This species is very rare, and is found associated with the four preceding species.

Anomphalus rotulus Meek and Worthen.

Anomphalus rotulus Meek and Worthen, 1866. Proc. Acad. Nat. Sci. Phila., p. 268.

Anomphalus rotulus Meek and Worthen, 1873. Geol. Ill., vol. V, p. 597.

One of the most abundant species occurring in superimposing shales of coal No. 3. In some of the specimens there is a tendency to become angular around the periphery toward the terminus of the body-whorl.

Euomphalus rugosus Hall.

Euomphalus rugosus Hall, 1858. Geol. Iowa, vol. I, p. 722.

Straparollus (Euomphalus) subrugosus Meek and Worthen, 1873. Geol. Ill., vol. V, p. 607.

Euomphalus rugosus White, 1884. 13th Rep. Geol. Indiana, p. 161.

This species is quite common.

Euomphalus pernodosus Meek and Worthen.

Straparollus (Euomphalus) pernodosus Meek and Worthen, 1870. Proc. Acad. Nat. Sci. Phila., p. 45.

Straparollus (Euomphalus) pernodosus Meek and Worthen, 1873. Geol. Ill., vol. V, p. 604.

But a single specimen of this large *Euomphalus* has been found at Des Moines.

CEPHALOPODA.

Orthoceras rushensis McChesney.

Orthoceras rushensis McChesney, 1860. New Palæ. Fossils, p. 68.
Orthoceras rushensis White, 1884. Geol. Report Ind. for 1883, p. 164.

Specimens of this, and perhaps other species, often occur quite abundantly. The specific characters of the described species of this genus are so obscure that all attempts to separate many of the so-called species prove futile. A careful comparison of the carboniferous forms will doubtless lead to a considerable increase in the synonymy of this group, and a reduction of the number of species to four or five.

Orthoceras (sp. und.)

A single specimen from the Pioneer mine; it is nearly 50 cm. in length and has a diameter at the larger extremity of about 5 cm. It is by far the largest specimen of this genus yet observed in the carboniferous rocks of Iowa.

Nautilus lasallensis Meek and Worthen.

Nautilus lasallensis Meek and Worthen, 1866. Proc. Acad. Nat. Sci. Phila., p. 261.
Nautilus lasallensis Meek and Worthen, 1873. Geol. Ill., vol. V, p. 610.

Quite common at the Giant mine; but few of the specimens are in a very good state of preservation.

Nautilus occidentalis Swallow.

Nautilus occidentalis Swallow, 1858. Trans. St. Louis Acad. Sci., vol. I, p. 196.
Nautilus quadrangularis McChesney, 1860. Disc. New. Palæ. Foss., p. 65.
Nautilus nodocarinatus McChesney, 1860. Disc. New Palæ. Fos., p. 66.
Nautilus biserialis Hall, 1860. Geol. Iowa, Supp., p. 92.
Nautilus occidentalis McChesney, 1867. Trans. Chicago Acad. Sci., p. 57.

Only a single specimen has thus far been found at Des Moines.

Nautilus winslovi Meek and Worthen.

Nautilus (*Temnocheilus*) *winslovi* Meek and Worthen, 1870. Proc. Acad. Nat. Sci. Phila., p. 50.

Nautilus (Temnocheilus) winslovi Meek and Worthen, 1873. Geol. Ill., vol. V, p. 609.

Nautilus winslovi White, 1884. Geol. Ind., Rept. for 1883, p. 165.

Not common, and usually fragmentary.

CRUSTACEA.

Cythere nebracensis Geinitz. ?

Cythere nebracensis Geinitz, 1866. Carb. und Dyas in Nebraska, p. 2.

It is with some doubt that the form from Des Moines is referred to Geinitz's species; it is much smaller than that which he described, and also differs in other particulars. A dozen or more good specimens were collected at the Pioneer mine where they were associated with *Synocladia biserialis*. This and a trilobite are the only crustacean remains thus far discovered in the carboniferous strata at Des Moines. The remains of articulates in the lower coal measures of Iowa are exceedingly rare, and the only hitherto known specimens of this group are more or less fragmentary remains of a single genus of trilobites. Prior to this, ostracoid crustaceans have been collected in Iowa in the upper and middle coal measures, and now is recorded their presence in the strata of the lower coal measures of the state.

Phillipsia (sp. ?)

Of the trilobites only a single pygidium of a *Phillipsia* has been collected, and this at the Pioneer mine.

VERTEBRATA.

Petrodus occidentalis Newberry and Worthen.

Petrodus occidentalis Newberry and Worthen, 1866. Geol. Ill. vol. III, p. 70.

From the Pioneer mine have been collected nearly all the remains of fishes that have been found in the carboniferous strata of this region. It is with some little doubt that the dermal tubercles that are here referred to this species really belong to it. The base is subquadrate in outline; and the thin abruptly sharpened edge is broader than in the one figured by Newberry and Worthen; the ridges extending downward towards the obtuse angles of the base are much more prominent than the others, which do not extend to the top of the crown. There has also been collected at this mine the fin spines of two species; one about two centimeters, and the other four centimeters in length; the former is the more common and in a very perfect state of preservation.

Diplodus sp. ?

From the superimposing shales of coal No. 3 at the Giant mine. The specific characters of the teeth collected have not been satisfactorily made out. They are evidently not far removed from *D. amplicatus* M. and Worthen, but the denticles are larger, more slender and much longer than in that species.

Synoptical Table of Genera and Species.

Cœlenterata	Polypi	genera	1	species	1
Echinodermata	Crinoidea		1		1
Vermes	Brachiopoda		9		14
	Bryozoa		1		1
Mollusca	Lamellibranchiata		7		9
	Gasteropoda		10		20
	Cephalopoda		2		5
Crustacea			2		2
Vertebrata			2		2

Summing up the predominant faunal features as presented in the accompanying synoptical table, it appears (1) that in those groups having an optimum habitat marine there was not only a fewness of species but also an extreme paucity of individuals; (2) that brachiopods though well represented in both genera and species were in fact not as proportionately abundant as might be expected when it is remembered that this type of life had now nearly reached its greatest expansion and culmination, and (3) that the fauna was predominately molluscan—nearly two-thirds of the entire number of species.

The Cœlenterata, Bryozoa and Echinodermata form indeed a very inconspicuous proportion of this local fauna, only three or four specifically distinguishable traces of each group being obtained. Though the Brachiopoda are represented by fourteen species, included in nine genera, they were with three exceptions of comparatively rare occurrence—*Productus muricatus*, *Chonetes mesoloba* and *Discina nitida* only being abundant. The brachiopods are also all depauperate, attesting conditions at the time that they lived extremely unfavorable to their full development and to the attainment of a normal size that under more congenial circumstances would have been rendered possible. Molluscan life, while the black shales forming the roof of coal No. 3 were being laid down, flourished luxuriantly, especially the gasteropods which in number of species composed more than one-third of the entire fauna. Not only did they exceed in species but they far outnumbered all others in individuals, and while as a rule they were small and some of them even minute their great numbers made up, in great part at least, for the conspicuity of larger but few forms. Though the majority of the forms of this group are small it is not a depauperation as among the brachiopods, as is shown by the average size of the individuals of each species being normal, and in some instances even considerably above. Some of the species are also of interest because of their recognition for the first time within the limits of the state, and thus to a considerable extent their known geographical range is increased. Others of the species enumerated are now known to have a wide geographical distribution which is suggestive of a somewhat extended vertical range. Among recent mollusca and especially land forms a wide geographical distribution, as has been remarked by Binney, appears to be indicative of a high antiquity for the group. The corroborative evidence is abundant: a notable instance is the living *Zonites*, four or more species of which are circumpolar in their distribution; and the genus—even a subgenus *Conulus* to which one of these living forms belongs—ranges back to the carboniferous, while the genus *Pupa* is represented in the carboniferous by four species. Cephalopods are not abundant in the region under consideration and are represented by only two genera and five species, yet a *Nautilus* attained a diameter of twenty centimetres, and an *Orthoceras* was fifty centimetres in length with a diameter at the larger extremity of five centimetres. Of the lamellibranchs the majority are small, though two of them are comparatively large, attaining a length of nearly ten centimetres, yet having an extremely thin and fragile shell. One of the specimens collected is of especial significance as exhibiting in all its details the internal features of the shell—the characteristic well-defined muscular scars and the edentulous hinge margin; in fact, so closely does it resemble in these characters, the general form and external appearance, a modern *Anodonta* that it is difficult to see how it can be generically separated from it; and should further investigation prove that the specimens under consideration really belong to that genus, it would be of unusual interest in its bearing upon the distribution of freshwater or non-marine mollusca during geologic times. The modern *Unio* and allied genera certainly have both a wide geographical and geological distribution, as is shown by the rich discoveries of *Union-*

idæ in the Mesozoic strata of the west: and the genus *Anodonta* is, if the opinion of Hall is adhered to, represented in the Devonian by two species, but that these two forms really belong to *Anodonta* is still questioned. Dawson has described several allied forms from the carboniferous of Nova Scotia; their family position is as yet also unsettled. With these considerations in view, the evidence thus far obtained points to a high antiquity for this group of bivalves which now is so abundantly represented in all our streams and ponds. As will be noted Crustaceans are represented by a species of *Cythere;* and a trilobite of which a single pygidium only has been discovered. Vertebrates are rare also, a few fish spines about two centimetres in length, and several teeth, and dermal tubercles are the only remains of this class found.

DESCRIPTIONS OF TWO NEW FOSSILS FROM THE DEVONIAN OF IOWA.

BY CHARLES R. KEYES.

Conocardium altum nov. sp. (Plate XII, figs. 4a and 4b.)

Shell of medium size, subtrigonal, anterior view broadly cordate. Anterior end truncate, with a forward slope from the umbones to the lower anterior sharply rounded extremity. Dorsal margin behind the beaks slightly curved, with the edges of the valves incurved, while in front of the beaks it is produced forward into a more or less prominent alate extension; basal margin crenate within; posterior extremity at the hinge line decidedly angular. Beaks rather prominent, gibbous, incurved. Hiatus lanceolate; occupying about two-thirds of the lower posterior margin. Surface marked by simple, regular, radiating costæ, about forty in number, twenty-five of which occupy that portion of the shell behind the umbonal slope; the umbonal slope is broad, bordered on each side by a prominent costa which gives it a decided biangular appearance; the costæ are crossed by numerous fine, crowded concentric lines; and a few larger somewhat imbricated lines of growth.

Length 24 mm.; breadth 21 mm.; height 20 mm.

Horizon and locality. Limestones of the Hamiltonian at Iowa City, Iowa.

This species somewhat resembles certain forms of *C. trigonale* of Hall, but the very broad strongly biangular umbonal slope readily distinguishes it from that species. It also approaches some congeneric forms from the Devonian of Europe, especially certain species from the western part of France, recently described by M. Œhlert[1]

Cyrtoceras opimum nov. sp. (Plate XII, fig. 5.)

Shell rather large, strongly curved, gradually expanding toward the outer chamber, but enlarging more rapidly transversely than in the opposite direction; transverse section broadly elliptical, slightly flattened on the ventral side. Distance between the septa about one-fifth or one-sixth the transverse diameter.

Horizon and locality. Hamiltonian of Johnson county, Iowa.

This is a large and robust species from the Iowa Devonian, having a length along the dorsum of probably forty or forty-five centimetres, and a transverse measurement of eighteen or twenty

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[1] Étude sur quelques Fossiles Dévoniens de l'ouest de la France.

centimetres; dorso-ventral diameter of outer chamber nearly six centimetres. It has been found at various exposures of Hamiltonian limestone in Johnson and the contiguous counties. It appears to be closely related to certain species from the Niagarian of the western states.

Explanation of Plate XII.

Fig. 1. *Macrocheilus humilis* n. s. .... page ....
Enlarged about 5 diameters.

Fig. 2. *Pleurotomaria modesta* n. s. ....
2a. View from above, × 2.
2b. Profile, × 2.

Fig. 3. *Chonetes lævis* n. s. ....
3a. An average sized specimen, × 2.
3b. Longitudinal section, × 2.

Fig. 4. *Conocardium altum* n. s. ....
4a. Lateral view.
4b. Dorsal outline.

Fig. 5. *Cyrtoceras opimum* n. s. ....
Reduced to $\frac{2}{3}$ natural size.

August 7.

Mr. Thomas Meehan, Vice-President, in the chair.

Twelve persons present.

August 14.

Mr. Chas. H. Pennypacker in the chair.

Six persons present.

August 21.

Dr. A. E. Foote in the chair.

Seven persons present.

August 28.

Mr. Isaac C. Martindale in the chair.

Ten persons present.

Mr. John Shallcross was elected a member.

September 4.

Mr. Thomas Meehan, Vice-President, in the chair.

Fourteen persons present.

September 11.

Dr. J. B. Brinton in the chair.

Seven persons present.

The following was ordered to be printed:—

NEW SPECIES OF SHELLS FROM THE NEW HEBRIDES AND SANDWICH ISLANDS.

BY W. D. HARTMAN, M. D.

Partula auraniana, Nobis. Pl. XIII, fig. 1.

Shell dextral, ovate, solid, smooth, spire short, one-fourth the length, whorls 5, rounded, body whorl large, suture deeply impressed, spiral striæ numerous and very fine; umbilicus slightly compressed, aperture somewhat oblique, lip white expanded and slightly concave, peritreme not connected by callus, shell pale horn color, spire in most examples denuded of epidermis, presenting a white appearance.

L. 16. Diam. 10. L. apt. 8. Diam. 5 mill.

Hab. Aura Island in the Malo Pass, Santo Espirito group New Hebrides. A common species.

Obs. Received from E. L. Layard, Esq., H. B. M. Consul at New Caledonia.

Partula carnicolor, Nobis. Pl. XIII, fig. 2.

Shell dextral, ovate elongate, spire attenuate, acute, more than half the length, whorls 5, rounded, suture impressed, spiral striæ very fine; umbilicus compressed, aperture ovate, slightly oblique, columella wide at base. Lip white, expanded and slightly concave, shell a pale flesh color, with wide darker striæ running obliquely through it.

L. 26. Diam. 10. L. apt. 20. Diam. apt. 5 mill.

Hab. Aura Island, with the preceding species.

Obs. I am indebted to Mr. Layard for this rare species. It has the general facies of *P. Caledonica*, but wants the very oblique semi-quadrate aperture of that species.

Partula fraterna, Nobis. Pl. XIII, fig. 3.

Shell dextral, conic, solid; spire half the length, convexly conical; whorls 5, rounded, suture well impressed, surface smooth and shining, umbilicus compressed. Aperture ovate, subvertical, labium moderately expanded and slightly concave; columella wide at base, color reddish brown, lighter at the suture, with darker striæ running obliquely through the shell; apex light purple.

L. 21. Diam 11. L. apt. 8. Diam. apt. 5 mill.

Hab. Aura Island, with the preceding species, E. L. Layard, Esq.

Obs. A shorter and more stout shell than the *P. carnicolor*, from the same island.

Partula albescens, Nobis. Pl. XIII, fig. 4.

Shell dextral, ovate elongate, spire acute, regularly tapering, equal to one half the length, whorls 5, rounded. Suture impressed, body whorl somewhat inflated, spiral striæ numerous, regular and very fine, umbilicus open, aperture ovate, oblique, peritreme connected by a thin callus, columella wide at base, lip white, expanded, and concave, color a clear white and translucent.

L. 25. Diam. 13. L. apt. 8. Diam. apt. 5.

Hab. Aura and Satova Islands, N. Hebrides, E. L. Layard, Esq.

Obs. A pretty species, resembling *Partula alabastrina* Pfr. from Figii Isles, except that it is larger and the spire is more acute.

Trochomorpha rubens, Nobis. Pl. XIII, figs. 5, 5a, 5b.

Shell sub-lenticular, translucent, convex above, whorls 5, acutely carinate, compressed, planulate, lightly striate beneath the suture, which is margined by the acute carina, base convex, with very fine transverse striæ, umbilicus large, perspective one fifth the diameter of the shell, aperture oblique, diagonal, peritreme simple, except near the base, color reddish brown, with a darker revolving line at the periphery, visible within the aperture, and extending to the apex.

H. 5. Diam. 15. H. apt. 2½. Diam. apt. 6 mill.

Hab. Aura Islands, N. Hebrides.

Obs. Mr. Layard observes, "this shell has a general range throughout the N. Hebrides," it differs from all others with which I am acquainted. *T. planorbis* is thinner, more translucent, and more depressed, with a wider umbilicus exhibiting the whorls to the apex.

Helicina Layardi, Nobis. Pl. XIII, figs. 6, 6a.

Shell dextral, orbiculate, thin, spire convex, whorls 4, compressed, the first one and a half foveate, with thin indistinct elevated spiral striæ, the remainder transversely and finely striate, suture distinct, umbilical region covered by an elevated vitreous callosity which is foveate, aperture triangularly lunate, peristome slightly revolute, moderately thickened, emarginate at base, color pale lemon yellow, with two blood-red bands, one above, the other beneath the periphery, and visible within the aperture.

H. 4½. Diam. 7. H. apt. 3½. Diam. apt. 2 mill.

Hab. Aura Islands, New Hebrides, E. L. Layard.

Obs. Resembles *H. primeana* Gass. from New Caledonia.

Amastra simularis, Nobis. Pl. XIII, fig. 7,

Shell dextral, ovate conic, whorls 5½, slightly rounded, body whorl somewhat inflated, two thirds the length, the first one and a half composed of slightly curved plicæ, suture lightly impressed, epiderm-is dark brown with black zig-zagged lines and linear striæ, body whorl a dark red color beneath the epidermis, aperture semi-ovate, dark red, columella straight, with a white twisted plait near the base.

L. 15. W. 7. L. apt. 6. Diam. apt. 3 mill.

Molokai.

Obs. Received from D. D. Baldwin, Esq., and so called from its size and resemblance to *A. mucronata* Newc.

Melania abberans Brot ms. Nobis. Plate XIII, figs. 8, 8a.

Shell solid, elongate, the last one fourth of the spire, rapidly tapering to the acute apex, whorls 16 or more, horn color, with numerous longitudinal plicæ over the whole surface, which are decussated by transverse lines giving it a granulated appearance, the base of the plicæ of the last whorl, are spinous, which are sometimes absent. The surface of the shell between the plicæ is smooth; base spirally striate; aperture rounded ovate, white within; a heavy callus deposit on the columella, which is incurved and twisted, opercle with the polar point near the base.

Length, 44 mill.

Hab. Vati, New Hebrides.

Obs. I have received a number of examples of this shell, from Mr. E. L. Layard, under the name of *Pirenopsis costata;* Dr. Brot informs me it is a true Melania in which I concur. It is nearly related to *Mel. fastigiella,* Reeve. Mons. Marie, a dealer in Paris, sent it to Dr. Brot, some years ago, for identification, and he gave it the provisional name of *abberans;* these were obtained by Mons. Rossitie in the New Hebrides. It is now described and figured for the first time.

SEPTEMBER 18.

Mr. CHARLES MORRIS in the chair.

Fourteen persons present.

A paper entitled "The Palatal Rugæ in Man," by Harrison Allen M. D., was presented for publication.

SEPTEMBER 25.

Dr. J. B. BRINTON in the chair.

Nine persons present.

The following was ordered to be printed:—

THE PALATAL RUGÆ IN MAN.

BY HARRISON ALLEN, M. D.

The structures of the body which are the most constant and those which are the most variable have alike an interest to the biologist and to the physician. When constant they present characters which may be employed in classification, and when variable they are accepted as delicate tests for the activity of the nutritive and developmental processes. I propose in the connections last named to study the folds or rugæ of the hard palate as they are seen in the human subject after the period of infancy, especially in subjects who have reported to me for the treatment of chronic nasal catarrh. A group of minor structures is here met with which can be presented in a systematic manner notwithstanding the wide range of variation they exhibit.

What variations from the type met with in the lower animals are seen in man? How do these variations in turn associate themselves with morbid states? With what structures do these variations correlate? What forces are at work to produce in man results so different from those seen in the animals related to him?

I will attempt to answer these questions. I will also give among related appearances those which may have a clinical significance.

In the main it may be said that the rugæ of the lower animals form a constant series. But instances of irregularity can be given. They are much broken up in the posterior part of the palate of the hog. A slight asymmetry often exists in the horse; and instead of being in opposite, may be in alternate series. For a full discussion of the subject with literature, especially for the description of the human rugæ in the embryo and infant, see Carl Gegenbaur, Morpholog. Jahrbuch, IV, 673.

The following embraces a brief description of the rugæ in man and a list of names which will be employed in this paper.

Two kinds of rugæ are recognized, the longitudinal and the transverse. The *longitudinal* lie in the median line and answer to the line of union between the right and left maxillæ and premaxillæ; the *transverse* lie across the palate and are composed of a right and left set.

The longitudinal kind is divided into two parts, viz.: the *raphé,* or the seam-like line which occupies the middle of the palate at the maxillæ, and the *incisive pad* which is an elliptical or pear-shaped body which answers to the position of the incisive foramen.

The raphé is ordinarily composed of two parts, one of which represents the median line and the other is deflected from it to the left at the posterior free end. (See figs. 2, 4, 7.)

The rugæ extend back no farther than the first molar tooth. The region answers to an imaginary plane which bisect the infra-orbital foramina. The rugæ are composed of papules which are arranged in series, an arrangement which is most evident in the posterior folds. The folds are smallest where the membranes are the thinnest and are the largest where they are the thickest.

As a rule the incisive pad is in line with the raphé, but it may be deflected (see fig. 3) or continued forwards between the central incisors (see fig. 5). Occasionally the anterior end can be seen from the front lying in the interval between the teeth named. It may persist in the aged long after the loss of the incisors. When the deflection is decided it enters into the causation of *torus palatinus*.[1]

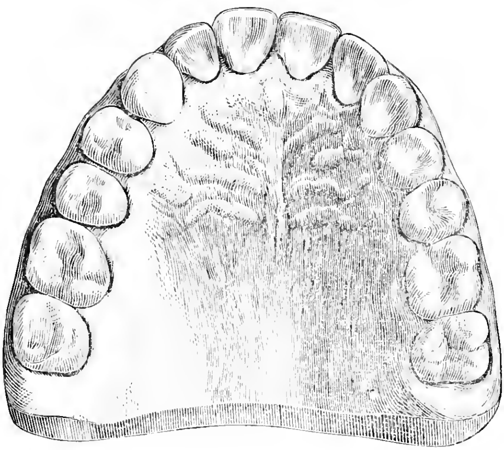

FIGURE I.
The arch is wide and moderately arched. The rugæ as a rule are entire,—the exceptions being both first post-sutural rugæ—and the last post-sutural on the left side. The neck folds are conspicuous.

The largest transverse fold lies between the canine teeth or between them and the first bicuspid and answers to the suture between the maxilla and the premaxilla. It will receive here the name of

[1] For reference to *torus palatinus* see W. Sommer, Virchow's Archiv. 1883, vol. 94, 21.

the *sutural ruga.* The sutural ruga is the widest of any in the entire series. It is usually inclined somewhat backward, but never forward. A deep sulcus is often seen at the base of the sutural fold anteriorily.

The sutural fold divides the hard palate into two parts, the pre-sutural and the post-sutural. The pre-sutural space thus answers to the premaxilla and has but one ruga[1] (see fig. 2). The post-sutural space has four to seven rugæ and are named in order from before backward the first, second, third, fourth, etc. Of these folds the third is the best developed. As a rule the first and the second are the least so and are represented usually by small nodules, or by groups of papules, at the outer portion of the vault. They are often aborted. The fifth, sixth, and seventh are also often aborted or represented by faintly expressed broken sinuate lines. The presutural portion of the vault is nearly flat and is of a special use in presenting a firm surface for the tip of the tongue to press against in mastication and in speech. The post-sutural space is concave with an abrupt declivity forwards. The alveolar processes of the molar range and the declivity named bound the true palatal vault. It presents extraordinary varieties, no two subjects being in all respects the same.

The pre-sutural rugæ were found in an examination of 90 examples of hard palates, present on the right side alone in 11, on the left side alone in 1, on both sides, 17, absent in 50, doubtful in 11. Occasionally a system of minute raised folds extends from the raphé outward in the spaces between the rugæ.

The roof of the mouth at the region of the incisors and the bicuspids is distinguished from that of the molars by the presence of folds of gum-tissue placed at the necks of the teeth. These may receive the names of the *neck-folds.* They indicate a disposition of the mucous membrane to be in excess at the parts where the palate is the narrowest. They often entirely occupy the pre-sutural space. The rugæ as a whole, are the best developed in the regions where the neck-folds are found.

Each palatal ruga is divided into a median and a lateral part. The median part, as a rule, is crescentic in outline with the convexity directed forwards. The lateral is directed forwards. Taken together the last named folds are arranged in vertical series, (i. e. with the main axes of the crowns of the teeth) and are either separated by

[1] Some of the figures show neck-folds which must not be confounded with rugæ.

intervals of equal size or are clustered at the alveolar border opposite the bicuspids.

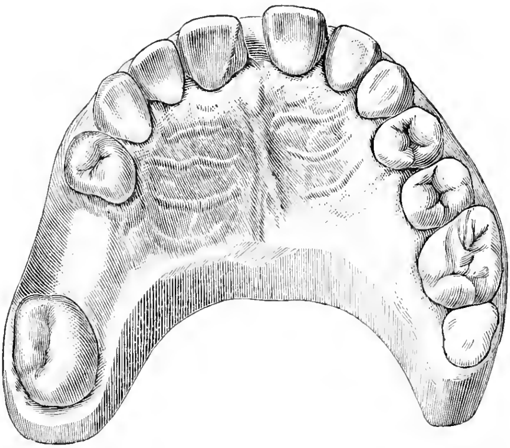

FIGURE 2.
The arch is flat and wide, the rugæ entire; no hyperostosis is present; moderate lateral concresence is seen on the left side.

When the two parts, (the median and the lateral) are contiguous the rugæ may be said to be *entire*. But when they are separated by intervals more or less appreciable they may be said to be *broken*. In palates of a moderate curvature *i. e.* midway between the flat and the high vaults, the folds may be evenly disposed and be without break on one side while they are irregular and broken on the other. The left side is commonly the most developed, a feature which the rugæ exhibit in common with the mandible, the left ramus of which is commonly the larger.

An elliptical exostosis which is often met with on the roof of the mouth is almost always larger on the left side. The left sutural ruga (see fig. 3) is generally prolonged back farther than is the right. A similar disposition is seen in the first post-sutural ruga but to a less degree. The post-sutural rugæ especially on the right side (see fig. 9) may extend obliquely forward. The third is commonly so placed, but the fourth, fifth and even the second may illustrate this disposition (see fig. 8). As opposed to exostosis the term *hyperostosis* will be employed to denote the general excess of bone deposition along the line of the intermaxillary suture. It is a common form of hypertrophy in the Anglo-American and one which has a distinct clinical significance (see fig. 5).

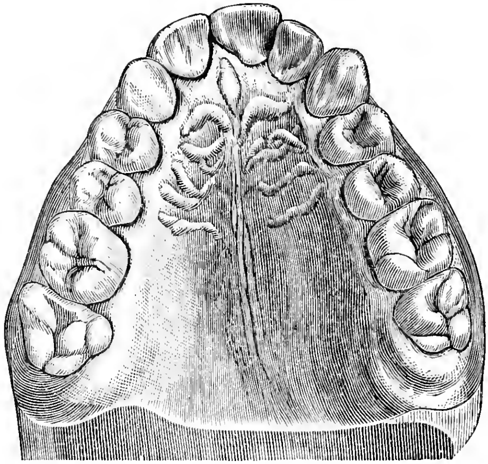

FIGURE 3.

The palate is moderately high arched. The lateral elements are elongated. The median elements are either two faint to be apparent or are absent.

The right lateral incisor is absent and the incisive pad shows an inclination to the side of defect. The left sutural fold is directed backward at the raphé.

The union of the right sutural and post-sutural rugæ so as to present a fork-like figure, the arms of the fork projecting outwards, is frequently seen.

The incisive pad, the raphé and the two sutural rugæ in rare instances may coalesce and give rise to a conspicuous cruciform figure.

The vertically placed lateral ends of the rugæ are by far the most constant of any parts of the series. They are especially well developed in high narrow vaults.[1]

The course of the posterior palatine vessels and nerves serve as a guide to interesting conditions of the hard palate.

The mucous membrane is pale where it overlies tissues which are not in contact with the bone. The interval between the raphé and

[1] In the horse the roof of the mouth is very vascular. In *Mephitis* the pre-sutural portion appears to be in a similar condition. The exact limitation of this part of the roof is of interest and, so far as it goes, supports the position taken that the rugæ are naturally divided into a pre-sutural and a post sutural set.

the sides of the vault is marked by a whitish surface which yields to pressure. In some individuals this motion can be traced as far forward as the first post-sutural fold. The tract is best developed when the roof is normally formed. With a flat arch and a median exostosis present, the track is small. With rugæ well shown, but broken, the place of the interruption occurs across the track. The pale tracks appear to be entirely absent in high, acute arches. An association of the track and the color marking of the hard palate can also be detected, The high-arched palates are uniformly of a red color, while the flat arches are red only along the median line and at the region of the gum. A test exists here for the rate of blood vessel activity of the palatine structures and, by inference, of the rates of development of the maxilla.

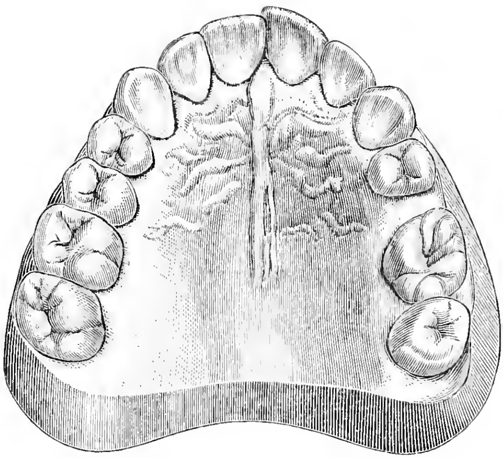

FIGURE 4.

The palate is normal in curvature. The incisive pad and raphé are continuous. The sutural folds are entire, the left fold extending farther up along the raphé than does the right. Median concresence is seen on the left side.

VARIATIONS OF THE RUGÆ.

At the risk of repeating some of the facts of the preceding description it is proposed to discuss under this head the principal variations of the rugæ. They will be included under the following propositions:

I. The rugæ of the left side tend to be the better developed (see figs. 3, 4, 5, 6, 7, 8,).

II. The rugæ of high laterally compressed as well as the wide, flat vaults are apt to be entire. (See fig. 8.)

III. The rugæ of vaults whose median suture has become the seat of general hyperostosis are always broken. (See. fig. 5.)

I. Not only is the group of rugæ on the left side more prominent than on the right, but the distance from the median line to the canine tooth is greater on the left than on the right side. The pre-sutural space is slightly the more prominent on the left. The left sutural rugæ is apt to be inclined backward as it approaches the median line to a point beyond that reached by the right. The right side exhibits a forked sutural ruga, and a larger first post-sutural fold than is seen on the left (see p. 261). The obliquely placed last post-sutural fold is as peculiar to the right side as the deflected sutural is to the left.

II. The rugæ of the high compressed vaults not only tend to remain unbroken but are well developed. The membranes are thick, cushiony and vascular. The incisors are thrown forward, since they cannot be accommodated in the narrow space between the canines, or the teeth last named remain out of the arch.

The skeleton is slight and the tonsils large if not hypertrophied.

The hard palate with a wide, flat arch is associated with thin rugæ whose intervals are wide (see figs. 2 and 9). The sutural rugæ tend to be deflected less than in the other types. A hyperostosis is common.

III. The form of the wide arch which is modified by the hyperostosis of the median structures of the palate is an illustration of the disposition of the bones where they unite one to another by suture to exhibit excess of nutrition.[1]

The raphé is exaggerated, a median bony ridge extends along its line, the pre-sutural region is occupied by thick membranes and prominent neck-folds. The left sutural ruga is apt to incline backward at the median line. The right sutural fold is united with the third near the raphé. This group is frequently met with in subjects of nasal catarrh.

The rugæ of man as compared with those of the lower animals.

A generally accepted method of study embraces the variations of human structures and those of the lower animals in which these "variations" are constant.

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[1] See a paper by the writer, Am. Journ. of the American Sciences, 1870, 405.

Most variations in human anatomy are said to be reversions. While this method is a most valuable one it has a limited use when applied to the study of the rugæ, excepting in the instance of the broken rugæ, and even here the comparison is not exact.

The human rugæ derive their peculiarity from two causes: *First*, the divergence from the median line of the dental arches as they are traced from before backward; this is much greater in man than it is in the lower animals. Out of 96 examples of dental arches examined by me 58 were found to be deflected more on the left than on the right (see figs. 3, 4, 5, 6, 9,), 21 deflected more on the right than the left, (see figs. 1, 2) while 17 only were symmetrical. If, as I have assumed, the folds in part at least are the result of compression it follows that abrupt and varying deviations of the boundaries of the palate must greatly disturb the harmonious development of its rugæ.

The deviations of the curves of the vault especially when interrupted by a disposition to hyperostosis must also be a disturbing influence. In 90 examples of palates the hyperostosis itself was found in 51. This is certainly a remarkably high proportion and when it is remembered that the specimens were from the mouths of patients who were suffering from chronic nasal catarrh, the association is suggestive of a relation between coincident causes.

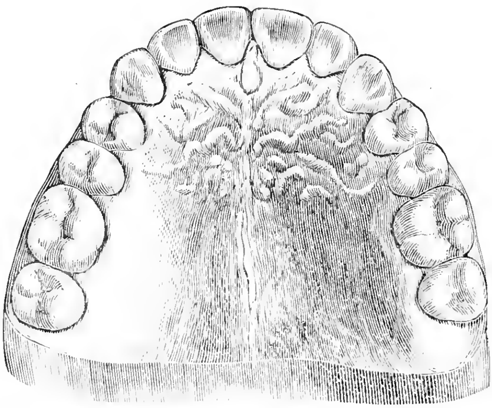

FIGURE 5.

The arch is wide. The raphé lies on a conspicuous ridge which forms a hyperostosis. The rugæ are irregular, while some in advance are long and entire, others are converted into clusters of coarse papillæ.

Again, in 90 examinations the sides of the vaults along the range of the bicuspids and molars was in 27 instances, both right and left, nearly vertical, in 47 both sides inclined moderately outward, 3 had right side vertical and left inclined, 4 had the left side vertical and right inclined, and in 9 the inclination was undetermined.

Second, the extraordinary modifications in the proportions of the face. The face stunted as it is in its anteroposterior dimensions compensates for this defect in a great tendency to downward growth. The premaxilla is enormously thickened as it enters into the composition of the mouth; the sides of the vault including the alveolar processes are greatly elongated; and the sutural line of the maxillæ tends to become hyperostosed in the region of the rugæ or a separate exostosis forms back of it on the free surface of the palate. It has been seen how the presence of the hyperostosis modifies the shapes of the rugæ. The firm suture between the premaxilla and the maxilla determines the greater size of the ruga which answers to it. The sides of the vault drag the lateral part of the rugæ of the post-sutural set from a horizontal to a vertical and forward position. The median hyperostosis breaks the rugæ into parts,—a condition never seen so far as I know in any quadruped. The changes are in illustration of the well known law that peripheral structures are conformable to the deeper lying tissues with which they are in correlation.

One of the most conspicuous appearances in the human rugæ is the approach of two or three folds towards one another either at the median or lateral ends. It is most marked in children in the lateral ends (where they are clustered toward the deciduous canines and molars) and in the adults at the median ends anteriorly.

The third and fourth rugæ of the right side have marked special dispositions to incline forward and inward, often cutting off the first and second folds or causing them to disappear. The convergence may go so far as to effect union between the different folds. Especially is this the case between the sutural fold and the third on the right side, by means of which the forked appearance is seen (see fig. 8). In some examples the sutural fold is united with the third behind, and with the pre-sutural in front.

In 90 specimens examined I found the lateral ends of the left rugæ convergent in 19; the lateral ends of those of the right side in 10; and on both sides in 11.

In the same number of specimens I found the median ends convergent in the left side in 6, on the right side in 4, and on both sides in 5.

The rugæ may be convergent on one side and transverse on the other. It is thus seen that the disposition of the rugæ to form little clusters is noticeable.

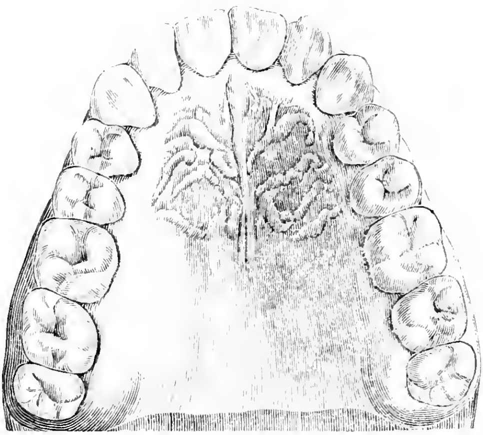

FIGURE 6.

The palate is wide but with deep recesses from a moderately high arch back of the sutural rugæ. The lateral elements on the left are regular and elongated; those on the right are unusually irregular, and first and second post-suturals very oblique. The median elements on both sides are strangely disturbed. Median concresence exists on both sides.

The inclination for the third, fourth and fifth rugæ on the right side to incline forward is especially marked.

In 90 specimens I found the right rugæ thus inclined in 33, the left only in 2 while in both right and left, 16. In the whole number the inclination of the third rugae is the rule. The disposition is marked in palates with hyperostosis.

The median half of each ruga may incline independently of the lateral, but the inclined fold is, as a rule, entire. The degree of inclination is variable but it may be expected to be so great that the sutural and post-sutural folds may unite.

The approach of the rugæ one to another their entire length is much less frequently seen than the foregoing. The sutural, the third and the fourth post-suturals may be coalescent. In 90 examples this was noted on the right side 9 times, on the left 6 and on both 2.

The union of the sutural and pre-sutural I have seen but once. It was symmetrical.

The folds may be contiguous only. In 90 examples I found the arrangement on the right side 3 times, on the left 1, and for both 5.

It is probable that some forces create the variations above noted, which are distinct from those already named. They are evidently often out of harmony with one another,–the right side exhibiting their effects oftener than the left. Sometimes they are operating on the ends of the folds, sometimes in their entire length of the median halves. That they are correlative with morbid phenomena is undoubted (see p. 269). For the clumping of the rugæ their entire length is often found in atrophic foetid catarrh, and in the senile state. But it may be so by coincidence. No data exists which covers the entire range of appearances. Certainly nothing comparable to such dispositions are seen in the lower animals.

The term *concresence* is an exact and convenient term to use in describing this class of modification of the rugæ.

The common abortion of the first and second post-sutural rugae is not the least instructive of the changes affected by concresence.

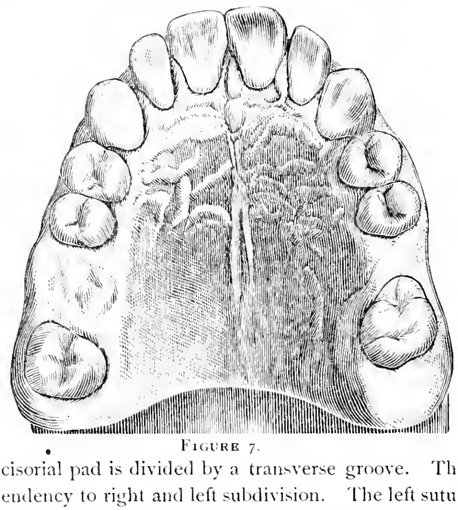

FIGURE 7.

The incisorial pad is divided by a transverse groove. The raphé shows a tendency to right and left subdivision. The left sutural ruga is deflected backward along the raphé. The post-sutural rugae are irregular. A small pre-sutural ruga is evident. The right post-sutural rugae tend to be oblique, especially in their displaced median elements. Median and lateral concresence is shown on the right side.

The deflection of the left sutural fold backward along the raphé is probably also an example of concresence. But for some reason it does not tend to unite with the post-sutural.

Of 90 examples I found the left sutural ruga thus deflected in 49 instances, the right, in 3 instances only, and on both right and left, 5 instances. In all the other examples the fold was transverse. In deflection it must be noted that the ruga after reaching the raphé is thence abruptly turned so as to be parallel with that structure. Both the right and the left fold may be inclined back before approaching the raphé or may not reach it at all.

The forms of the rugæ are never pathological as I venture to define that term. The question to what extent variations of structure may be said to be pathological is no longer a novel one. The fact that the forces operating in the economy often antagonize is generally accepted. Upon this antagonism the approach to symmetry as seen in the paired structures alone depends. In the plastron of a turtle (*Chrysemys picta*) in my possession, the plates exhibit a constant disposition for those of the right side to crowd and minimize those of the left. The same disposition for one side to gain ascendency is seen in all paired structures which form by their growth inward a median suture or raphé. If such minor variations were to be called pathological every living creature would be an epitome of morbid anatomy. Anatomical variation I assume to be a better term for such deviations unless the structures are hurtful to the individual or at least tend to be so. A pathological condition is one in which the final effect is to create distress or to excite lesion. Prof. Alpheus Hyatt has described certain distorted shells found by him as constituting pathological species. Are not such species degraded, or reverted rather than pathological forms? The comparison sometimes made between the horn of the rhinoceros and the epidermic hypertrophies which appear upon the surface of man and some of the lower animals, is based upon the conception that the outgrowths are in both instances of the same nature,—that they are both pathological and differ only in the single feature that the rhinoceros by the law of selection has utilized a horn which happened to appear at a convenient locality. To my mind the structure is not pathological unless it expresses perverted function or interferes with a function; not only this but that it interferes in an abrupt, obstructive manner. If it does not so appear but in such guise as to encourage the animal to use it; the organ should be named an anatomical variation.

The word pathology is an anachronism in a system of biology. It originated at the hands of observers who had imperfect conceptions (if indeed they may be said to have any at all) on the general physiological laws operating in all the tissue changes of the body. What was once "morbid" is now natural. If the word is to be retained by naturalists, it should have a strictly medical application —the one originally designed for it by practical men.

THE CORRELATION BETWEEN THE RUGÆ AND THE INTERIOR OF THE NOSE.

I have met with ten examples in which the left side of the nose was smaller than the right and in which the same side of the hard palate was also the smaller. Care must be taken to distinguish the common variety of narrowing of the nose by a deflection of the septum from the much rarer form or reduction of the chambers in all directions.

In six cases the right side of the nasal chamber was the larger and a corresponding increase in size of the right half of the palate was detected.

But the association between palatal and nasal conditions is by no means uniform and at the same time I cannot conclude that the cases brought forward in evidence were coincidences. I have studies of individual cases in which not only was harmony present between the proportions of the nose and the hard palate but between these structures and the cranium as well.

It may be said that, in a manner, the law of symmetry is not without exemplifications in the harmonies of the arrangement of the sides of the hard palate, with the nasal chambers and with the corresponding side of the head but that this exemplification is subject to so many exceptions by the operation of minor disturbing factors as to be rarely present.

In examples of hyperostosis of the inter-maxillery suture the inferior turbinated bones are high and apparently compressed. This condition is often associated with imperfect development of the vomer at the choana. The same peculiarity is found in high V–shaped vaults.

A well defined group of subjects exhibit intumescent states of the membranes of the premaxillary portion of the nasal chamber, a rounded nodule projecting from the floor of the vestibule, a prominent anterior end of the inferior turbinated bone, and a tumid state of the membrane covering the septum. While such pronounced morbid appearances are seen in the front of the chamber the remainder of the nasal surface is perfectly healthy. Coincident with these peculiarities of the nose the roof of the mouth is distinguished by a small incisive pad and coalescence of the sutural and the third post-sutural folds. The tonsils are moderately enlarged.

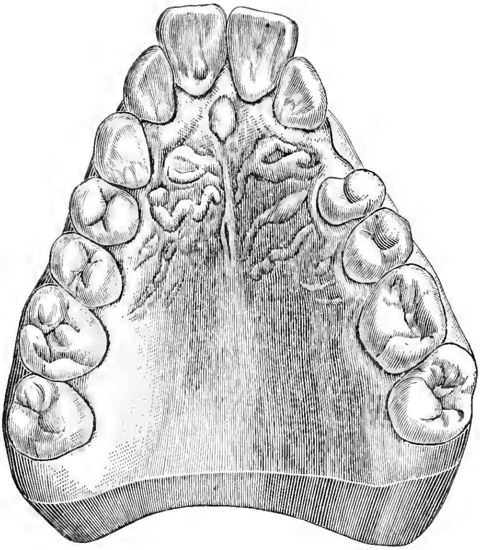

FIGURE 8.

The arch is narrow and high, the pre maxillary portions being thrown forward. Hence the space between the sutural rugæ and the incisorial pad and all the parts in advance of the sutural rugæ are exceptionally open. The third post rugæ is confluent with the sutural on both sides. The pre sutural rugæ are absent.

THE RELATION BETWEEN THE RUGÆ AND THE TEETH.

The relation existing between the rugæ and the teeth is not as important as would at first sight appear. For the pre-maxilla it may be said that no influence is exerted by the incisor teeth over the pre-sutural rugæ. The sutural ruga is directly opposite the canine teeth, the first post-sutural, directly between the canine and the first bicuspid, the second ruga opposite the bicuspid, etc. In the Proceedings of the Acad. of Nat. Sci. of Phila. p. 310, 1882, I proposed a system of naming of the parts in accordance with these facts. But it is less satisfactory than the one used in this paper.

Nevertheless the following statements would confirm the position assumed that some connection between the rugæ and the teeth must be accepted to exist.

The axis of the incisive pad when deflected from that of the median line is inclined toward the side which is minimized by the non-appearance or extraction of one of the incisor teeth of the permanent set, by the eruption of a tooth on the buccal or labial side of its arch, or by some third related cause (see fig. 3).

In one adult subject whose palatal vault exhibited straight, regular, unbroken rugæ on the right side retained on the left all the rugæ broken and parts of two entering into the composition of the pre-sutural and the sutural. The left side was narrower than the right. It is not likely that the irregularity of the rugæ on the left side was independent of the fact that the lateral incisor and the second bicuspid were absent from the upper jaw, and that the second bicuspid on the same side of the lower jaw was also absent, its place being taken by the second milk molar which had never been changed from the time of its eruption and was in all respects a normal, healthy tooth. The left side of the face was slightly smaller than the right.

In a girl of twelve years the rugæ were normal on the left but on the right the sutural fold was forked and the remaining folds broken. On the left side the left second bicuspid tooth was absent, while on the right both teeth were in position.

It is always of importance to remember that the mouths of children in whom the deciduous canines and molars are yet in position at a time when the permanent incisors and the first permanent molar have been erupted, that the rugæ exhibit a disposition to approach one another toward these teeth. Is it possible that the change from the infantile arrangement where the folds are entire, regular and symmetrical to that of the older child, where the acquired variations take place, is due either to the retention of the deciduous canines and molars, or to the retardation in development of the permanent bicuspid teeth?

The region of these teeth is an exceedingly active one within the maxilla since the germs of the permanent canine and of the bicuspids are well advanced to completion. At the same time the peripheral structures are not changing in correspondence. Hence an element of disturbance is created.

Clinical applications.

It is evident that if, as has been claimed, the rugæ are modified by nutritive and developmental processes they will have clinical significance also. The application will be especially evident in the manner in which the rugæ are aborted by protusion of the premaxillary elements, and of the hyperostosis of the structures at the raphé. When the vault is flat—the rugæ tending to be symmetrical though feebly developed,—a condition is present which is often found associated with chronic nasal catarrh of the atrophic type. If the arch is wide the sides of the palate and the alveolar processes

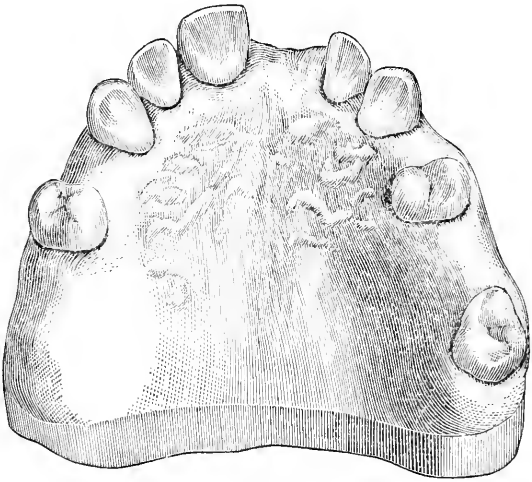

FIGURE 9.

The hard palate is without neck-folds, is of low arch and is wide. The raphé is nearly obliterated. The rugæ are broken. The lateral half of the third post-sutural fold extends obliquely forward and is in line with one of the median elements (probably of the second). No similar disposition is seen on the left. Lateral concresence is seen on the left side.

are not well developed, the rugæ are gathered in a clump upon an anterior declivity of low inclination, the turbinal scrolls are small, and the membranes nonerectile. The teeth in such individuals are large especially the incisors, the patient is predisposed to premature recession of the gums from about the necks of the teeth and to suppurative affections of their roots.[1]

The Incisive Pad. The pad is often of a bluish red color when the palate elsewhere is of a pale hue. At other times the pad is of pink color and the base surrounded by a deep blue line. Thus the pad may be congested either in whole or in part while the rest of

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[1] For the connection between atrophic catarrh and premature recession of the gum see a paper by the author in Dental Cosmos, 1885, xxvii, 329.

the hard palate be entirely free. In a man fifty six years of age from whom I had removed a number of polypi the pad was the seat of soreness and pain for a week after the operation. It constituted the only annoyance which followed upon an operation of exceptional extent. In children who have been operated upon for deflected septum the necks of the teeth are surrounded by a purplish red line as long as the plug is worn in the nose.

Absence of Rugæ. The rugæ may disappear by pressure from within, as from a nævus or a fibrous tumor, and from without, as from the pressure from a plate for artificial teeth. The absorption of the alveolar process after the extraction of teeth, as a rule, induce the absorption of the rugæ, but occasionally the rugæ persist and are found lying directly across the position of the former dental arch.

Medico-Legal Value of the Rugæ. The persistence of the rugæ after death leads to the conclusion that they may afford valuable signs by which the body can be identified, for during the processes of decomposition the mucous membrane of the hard palate is among the last to be lost. When the positions of the rugæ are recorded (as in the event of a patient having been recently under the care of a dentist and the impression of the rugæ having been taken in plaster,) it is certainly true that the folds could be used in connection with the teeth, or even in the absence of these organs, in identifying the subject.

Congenital Syphilis. In congenital syphilis I have often observed that while the roof of the mouth especially at the anterior part was of a deep red color from inflammation that the rugæ were milk white. The folds become swollen and painful in acute inflammation of the roof of the mouth and infiltrated in cases of prolonged suppuration from the alveolar processes.

In the diagnosis of syphilis this appearance is of importance. While the characters of the teeth as caused by scarlet fever may be much the same as those produced by syphilis yet in the sequelæ of the disease first named the hard palate yields no characters. In syphilis more or less congestion if not inflammation appears to be constantly present.

The study presented in the foregoing pages is based entirely upon examinations made upon living subjects. Forms of mouths which occurred to me as interesting were selected and casts of the rugæ and teeth taken in plaster with great care.[1] The material therefore is not of the average. It is based upon the hard palate of individuals known to have some disease associated with disturbed states of secretion of the nasal chambers.

In order that the study should have a more extended application it was thought to be desirable before any exact clinical conclusion could be drawn that a study of similar extent be based on material known to be derived from entirely healthy individuals.

To make such examinations I visited the State Eastern Penitentiary in this city and by the courtesy of Dr. W. D. Robinson, the physician of the Institution, was enabled to stuby the mouths and nasal chambers of the inmates. In this way ninety examinations were recorded.

In no instance was hyperostosis present in the form spoken of in the foregoing pages. Nor was a single case of hyperostosis of the roof of the mouth back of the region of the rugæ seen. In a word no form of rugæ was detected which was broken by the descent of the median structures.

In twenty-two examples the raphé was sufficiently prominent to form a slight fullness which could be felt by the finger. The remaining fifty-eight examples were perfectly smooth.

The rugæ were very commonly of the form exhibited in Figs. 1 or 2 with a disposition for the folds to be concrescent at their outer ends. The examples of the left sutural rugæ deflected along the line of the raphé, were but six in number; moderate degree of asymmetry of the sides of the roof in seven; concresence of the right sutural and post-sutural as to form a fork-like figure in but three.

It is evident that the variations of the arrangement of the rugæ were within a much narrower range than in the ninety cases from subjects from other sources.

The roof of the mouth presented no narrowing of the vault with compression as seen in Fig. 8, and no flat wide palate as seen in Fig. 9. Thus the extremes of variation—viz., of the high narrrow vault and the low, wide vault were absent. But one instance of a moderately compressed vault was seen and in this example the pre-maxillæ were not thrown forward.

[1] I desire in this connection to acknowledge my indebtedness to many of my friends especially to Dr. L. Ashley Faught, Dr. E. C. Kirk and Dr. J. M. McGrath. Dr. J. W. White and Dr. W. Storer How of the S. S. White Dental Mfg. Co,, also greatly aided me in the investigation.

Respecting the presence of catarrhal affections in the cases it is necessary to say that not a single man among the entire number examined had complained to Dr. Robinson of any of the symptoms of these diseases. I detected small quantities of secretion in the nasal pharynx in fifteen instances. I cannot admit that this circumstance had any significance in the absence of any of the usual appearances of the membranes.

The teeth and nasal chambers were also examined but nothing found which is of special mention.

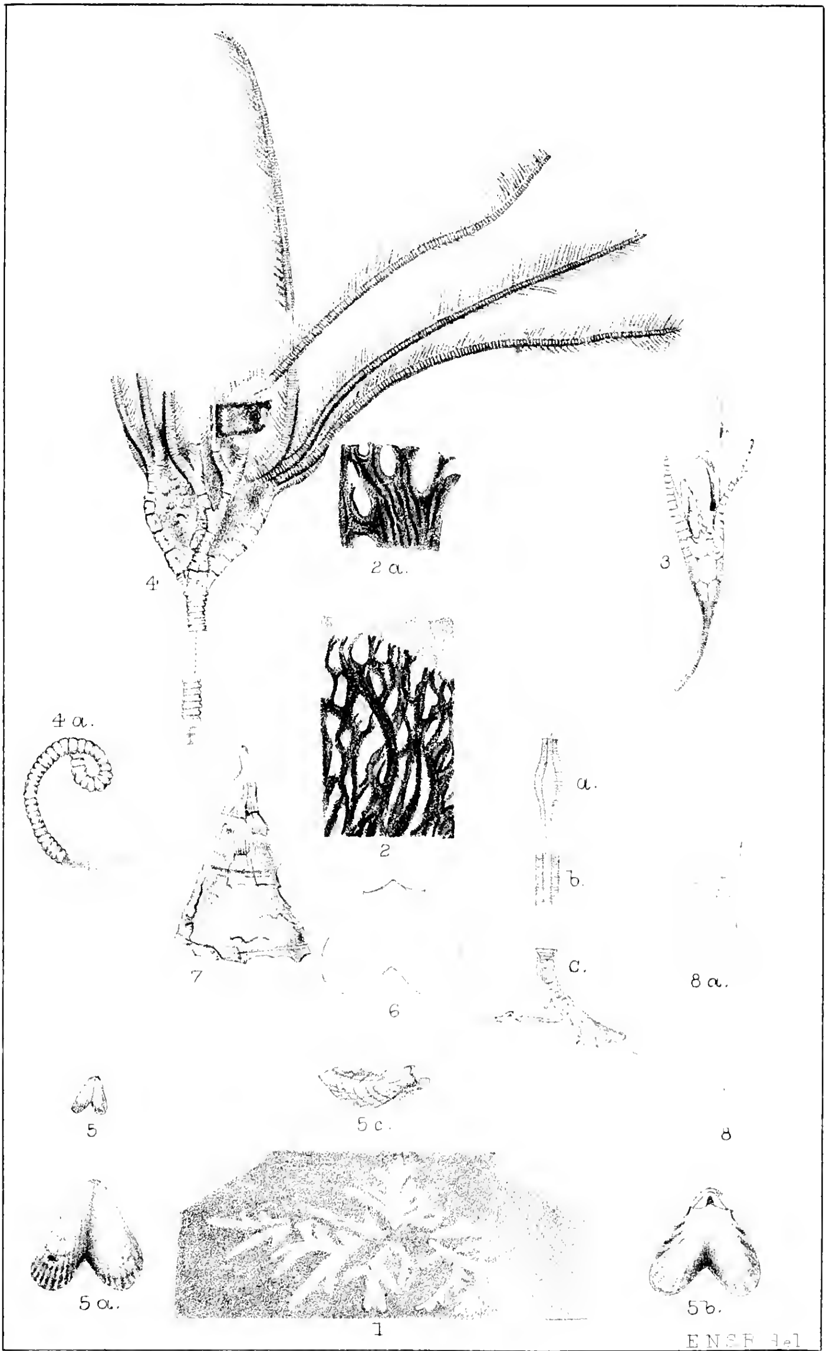
Conclusions. The following conclusions may be drawn from the statements made in the paper.

(1) That the range of variation in the roof of the mouth and its folds is greater in subjects of nasal catarrh than in those who are free from this disease.

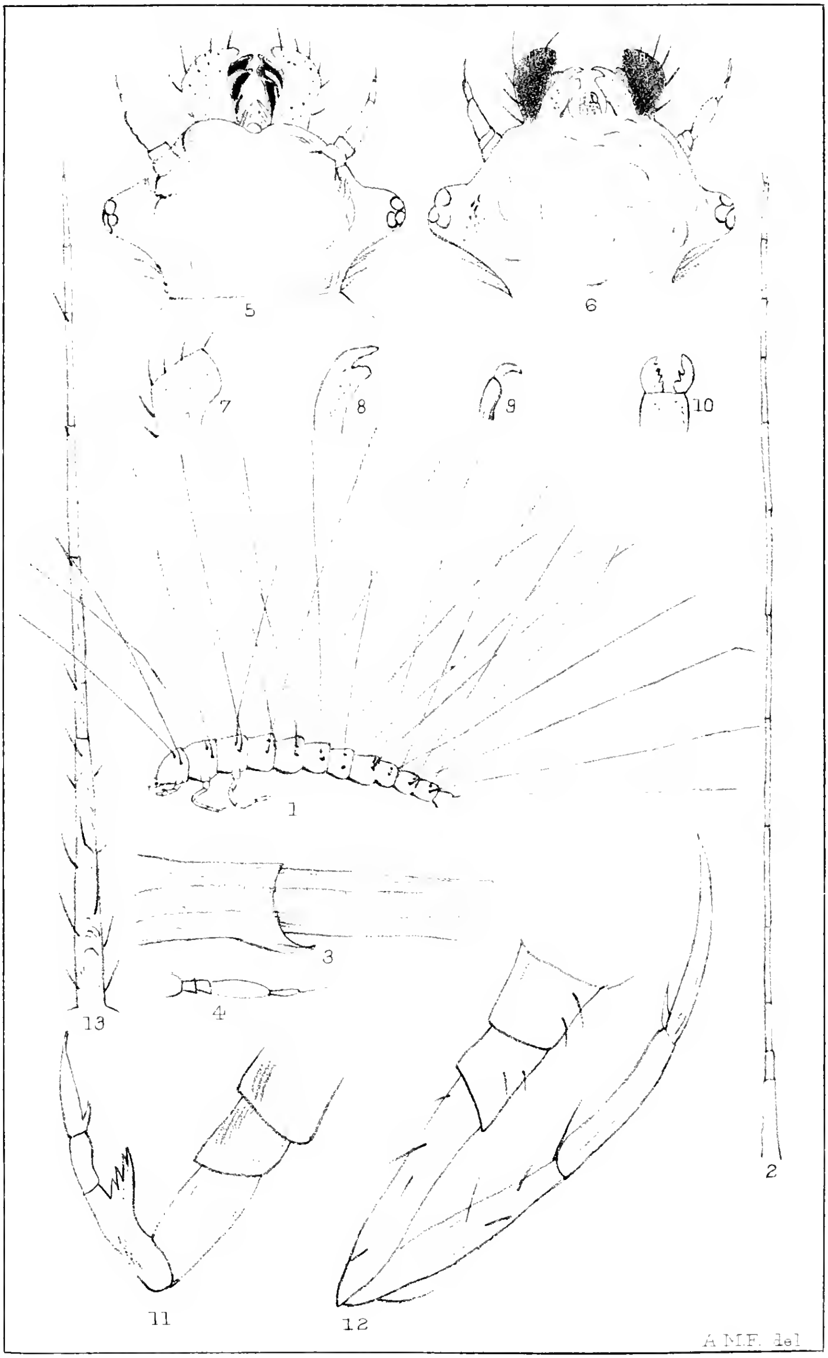
(2) That the variations of the rugæ are different on the two sides of the roof.

(3) That excess of development of the pre-maxilla and the horizontal plate of the maxilla, especially at the anterior portion, constitutes a condition which is found in about fifty per cent. of cases of chronic nasal catarrh.

(4) That chronic nasal catarrh is found associated with so many phases of asymmetry of the rugæ of the hard palate and the dental arches that the disease should be studied as a morbid action which is based upon morphological elements and not alone upon climatic conditions.



Ringueberg, Fossils from Niagara Shale.



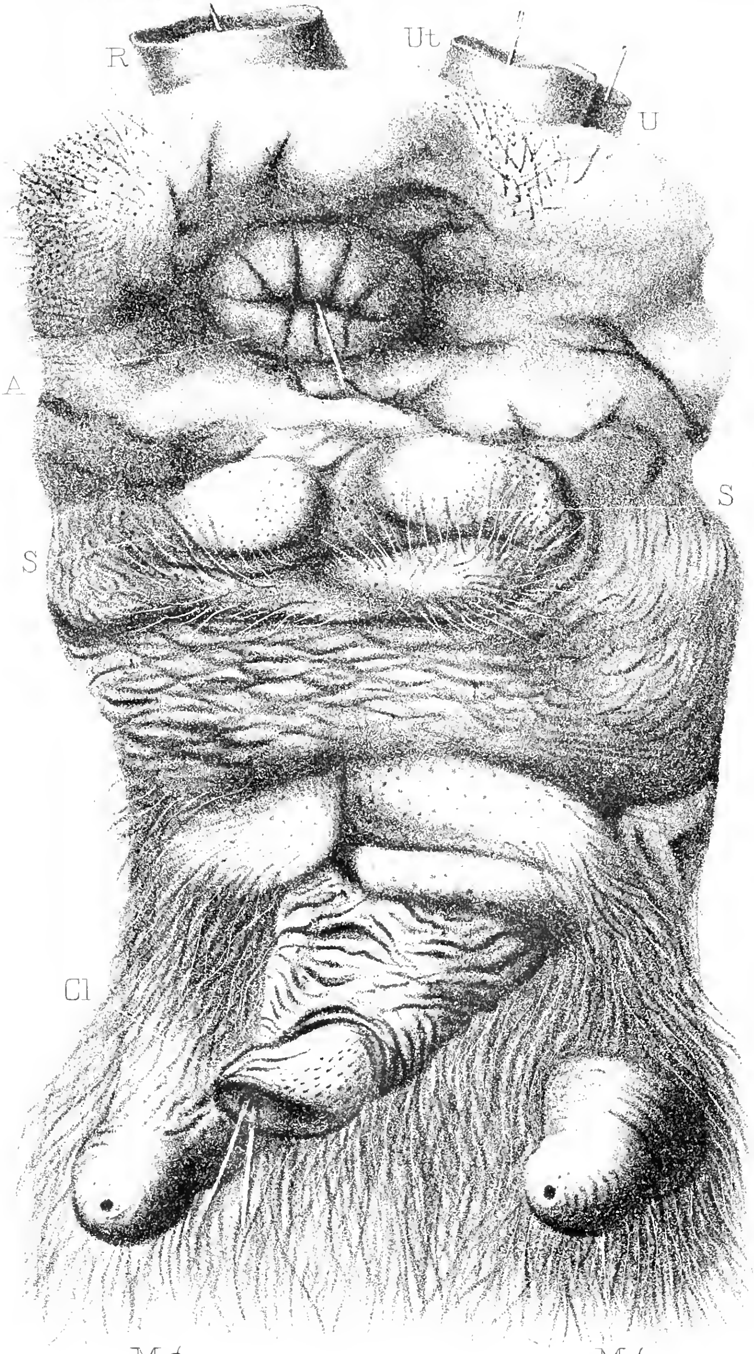
A. M. Fielde on Aquatic Larva.

Explanation of Plates IX, X, XI.

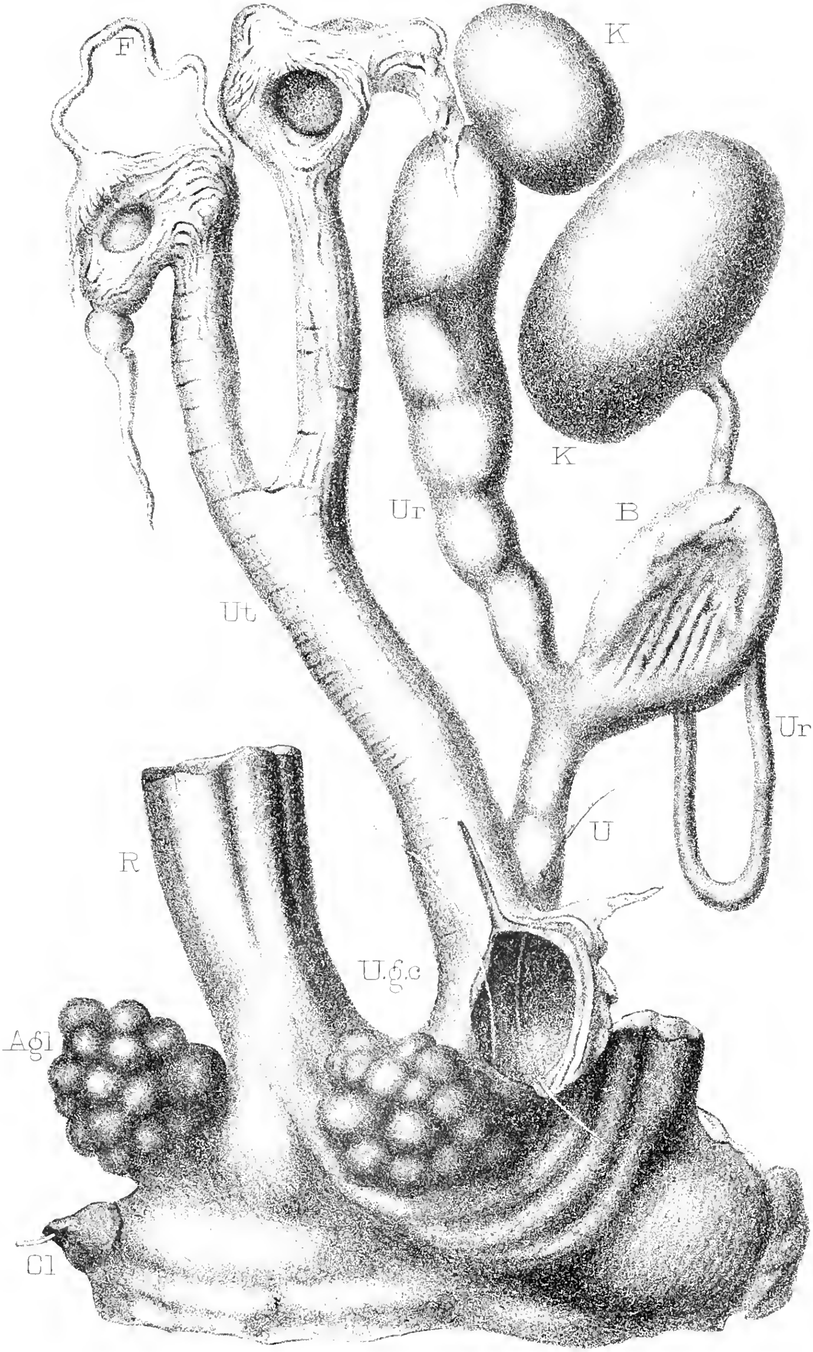
The lettering is the same on all the figures.

A.	Anus.
Agl.	Anal Glands.
B.	Bladder.
Cl.	Clitoris.
F.	Fallopian Tube.
k.	Kidney.
m.	Müllerian Ducts.
MG.	Mammary Glands.
o.	Ovary.
R.	Rectum.
S.	Scrotal Pouches.
Sr.	Supra-renal Capsules.
t.	Testicle.
U.	Urethra.
Ugc.	Urogenital Canal.
Ur.	Ureter.
Ut.	Uterus.
V.	Vagina.
W.	Wollfian Ducts.

Corrections. Page 189, line 19, omit "and."
Note, line 3 from bottom for "altenus" read "alternis," for "alteris" read "alternis," for "foemias" read "foeminas."



Chapman on Hyaena &c.



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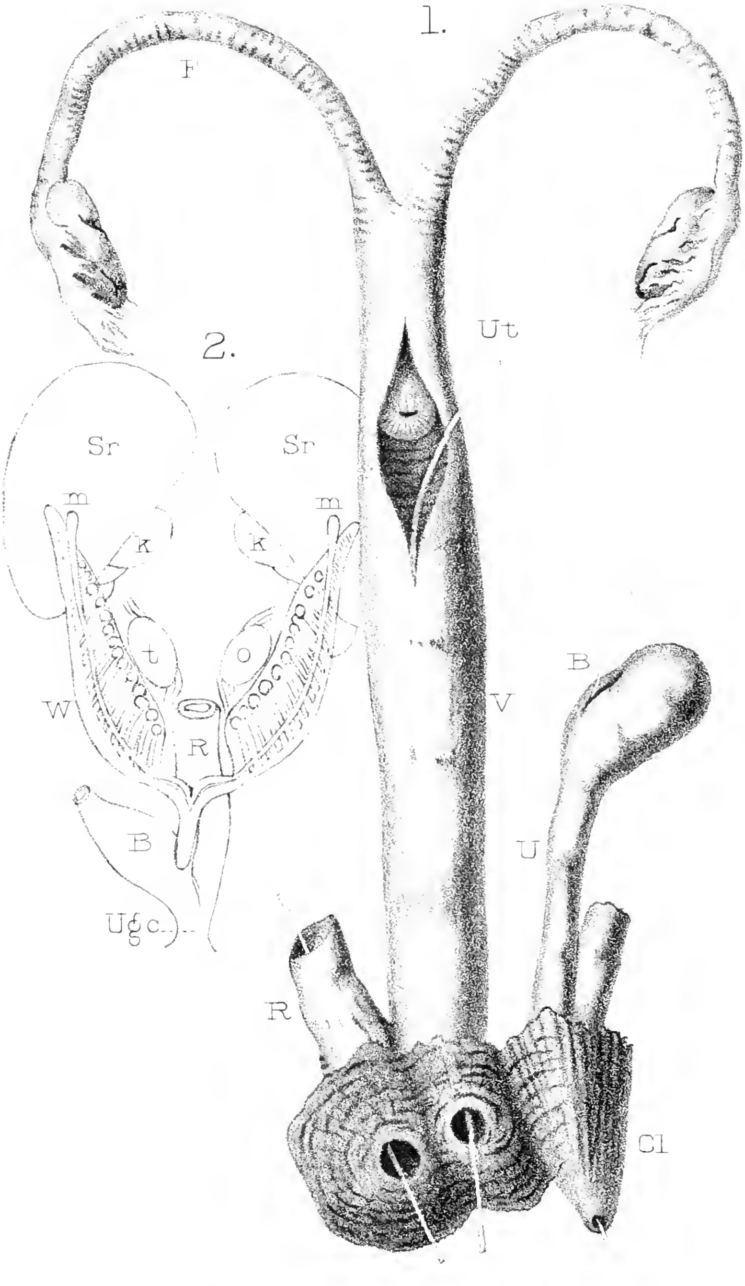

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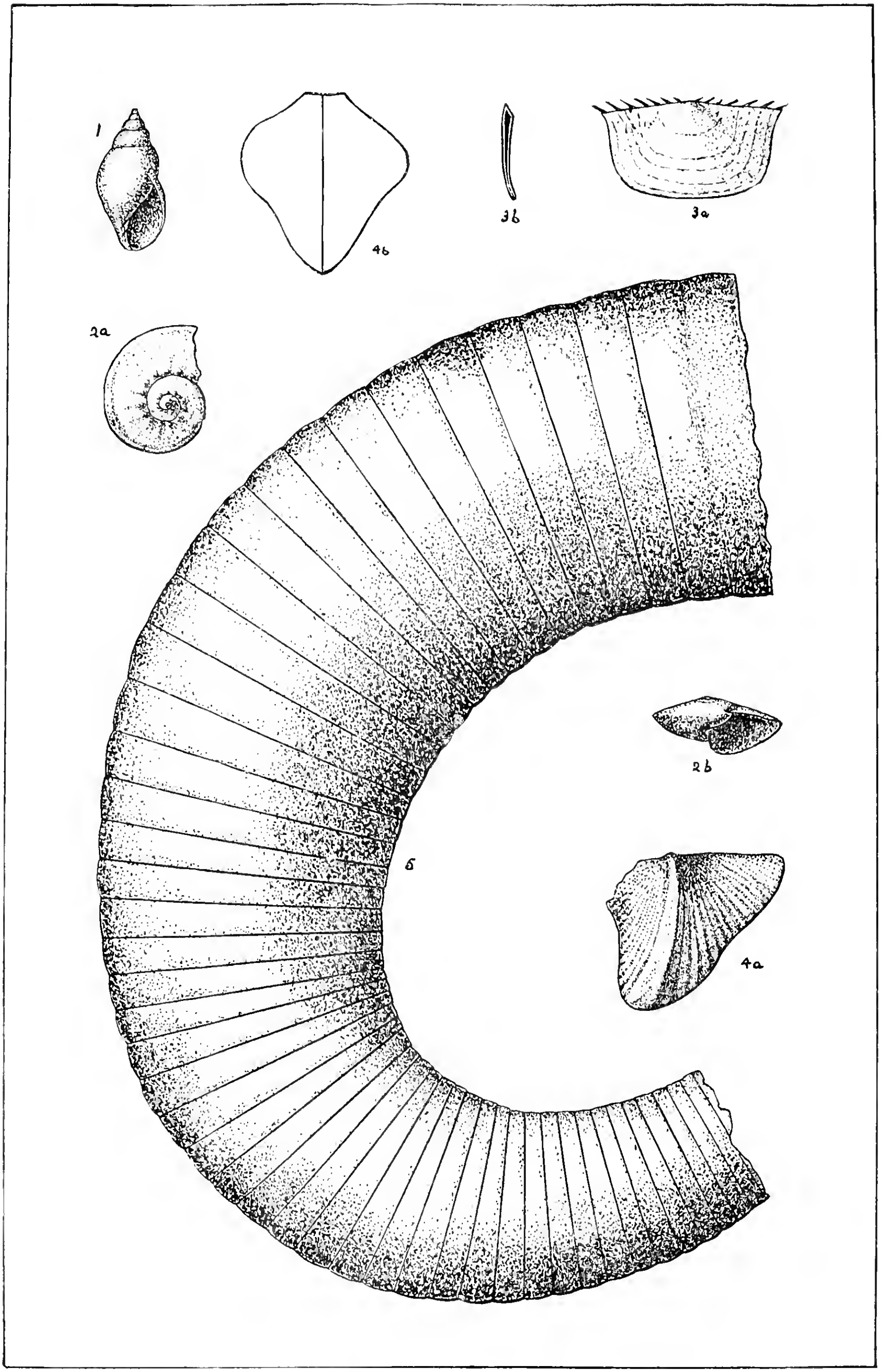

KEYES, ON IOWA FOSSILS.

Geo. W. Tryon Jr.

OCTOBER 2.

The President, Dr. JOSEPH LEIDY, in the chair.

Fifteen persons present.

Megalonyx Jeffersonii.—Prof. LEIDY exhibited an ungual phalanx of *Megalonyx Jeffersonii*, submitted to his examination by Prof. J. E. Todd, of Tabor, Indiana, who informed him that it was found in a sand bed, below the drift, in Mills Co., Iowa.

Anomalies of the human skull.—Prof. LEIDY exhibited the right half of a skull, from France, in the maxilla of which, besides the usual number of incisors, the canine and premolars, there is a series of four molars, of which the last one is about half the size of the others. In the same skull the fore part of the middle turbinal is inflated and forms a large sinus forming part with the anterior ethmoidal sinuses.

Further, in the same specimen the venous portion of the jugular foramen is nearly obsolete, and its inner portion forms a distinct foramen for the inferior petrosal sinus. The descending portion of the groove for the lateral sinus, about the eighth of an inch wide, ends in a large mastoid foramen.

OCTOBER 9.

Mr. JOHN H. REDFIELD in the chair.

Eighteen persons present.

A paper entitled "Contributions to the Natural History of the Bermuda Islands," by Angelo Heilprin, was presented for publication.

The following, received through the Botanical Section, was ordered to be printed:—

CONTRIBUTIONS TO THE LIFE HISTORIES OF PLANTS, NO. II.

BY THOMAS MEEHAN.

The leading facts, given in these papers, have been communicated verbally during the year 1888 to the Academy of Natural Sciences of Philadelphia or its Botanical Section. In preparing them for publication, it was believed they might add to the interest of the meeting of the American Association for the Advancement of Science at Cleveland, if read there prior to a full publication here. This statement is necessary to explain the somewhat controversial manner, intended to excite debate, in which the facts are presented. The remarks of those who discussed the papers, are briefly given in the *Botanical Gazette*, for September 1888.

Some new facts in the life History of Yucca.—In the extremely fascinating subject of the relation of insects to flowers no plant possesses a greater interest than the *Yucca*. It is assumed that insects' visits are arranged for cross-fertilization, and this again on the assumption that cross-fertilization must in some way, be a great benefit to the species or to the race. This conclusion is a fair one. Some good has been found from cross-fertilization, and some flowers seem only to produce seed when cross–fertilized,–but in *Yucca* we have the anomaly of a floral structure so arranged that it can scarcely pollinate itself or in any way receive pollen except by artificial aid and yet that arrangement results, in so far as we can see, simply from the use of its own pollen. There is in *Yucca* a more wonderful relation between the insect and the flower fertilized than possibly in any other case. Professor Riley, to whom the great credit of this wonderful discovery is mainly if not wholly due, has well expressed this intimate relation in the insects name *Pronuba yuccasella*, and yet it is evident to those who observe closely the working of this wonderful arrangement, that it has no relation to cross-fertilization, but results in self-fertilization. In most cases, as clearly shown by the observations of Prof. Riley, the pistil receives through the medium of the insect the pollen' from its own flower, or at best the pollen from the flowers on the same or adjacent plants; which is equally self-fertilization. Just why this plant should be put to all this trouble to get results through an agent, with no other result than it would obtain if it did the work itself, is surely a problem worthy of any endeavor to solve. Mankind has servants and slaves, and even small insects, drone bees, and other creatures live in indolence by the sweat of other brows. There are many parallels between plants and animals. Is *Yucca* to be a case of absolute servitude on the part of the insect, from sheer indolence on the part of the Yucca to do its own work? It seems to me we shall not be able to draw the veil from this great mystery till we make continuous and careful observations of all the facts in its history, and place them on record for comparison with those which others may make.

Prof. Riley once made the remarkable statement that he had seen the Yucca Moth collect pollen, and thrust it down the tube of the stigma, as if it knew that some such process was necessary to insure fertilization. Dr. Engelmann had found in the Yuccas he examined, that the apex of the pistil was not stigmatic,—the receptive portion was low down in the tube. The two observations, taken together, gave color to the supposed object of the insect. I have shown, (see Proceedings of the Meetings at Cincinnatti, Saratoga and Buffalo,) that pollen applied to the apex in *Y. angustifolia*, and protected by gauze from the insect, resulted in seed just as well as when the work was done by an insect. The tubular character noted by Dr. Engelmann cannot therefore be a constant one; and we shall have to admit that the reasoning of the insect which led it to thrust the pollen down the tube in the other species, leads it to perceive there is no tube in *Y. angustifolia*, and that the application of pollen to the bare apex is sufficient in this species.

Up to this season I had never been able to detect the insect behave in the plants around my house, as Professor Riley saw them behave; but I have always conceded that he is too careful and too close an observer to have been mistaken in such an observation. The record of the act of the insect thrusting its tongue down the stigmatic tube, from so accurate a naturalist, needs no confirmation from any one, however one may be allowed to hold his judgment in suspense as to the object of the insect in such behavior; not then as confirming Prof. Riley, but as part of my observations of this year, I desire to say that I have recently seen an insect at the same task. It worked its proboscis up and down the tube of the pistil, much as a sportsman would load his gun.

I find, in this region *Yucca filamentosa* commenced to bloom this year about the end of June. Some plants will bloom a full week, or occasionally ten days before others, though years ago, all the plants under my notice came from root cuttings of one stock and not from seed. The flowers begin to expand an hour before sun-down, assuming a campanulate form by dark. By sunrise the next morning they are closed, and they remain closed till an hour before sun-set when they again expand, and go through another day as before. But at the third evening's expansion they become almost rotate, closing again the next morning but only to wither and fall away. The flower opens and fades within three days.

During the first week or ten days of the flowering period, an enormous amount of moisture exudes from every part of the flower. It trickles down the outer surface of the perianths, collecting in drops at the apices of the lobes, sometimes almost covering the leaves with spots where the drops have fallen and indicating a somewhat gummy character. The pistil is completely covered with minute bullæ, from which the same kind of liquid exudes. It is not a sweet liquid, indeed differs from pure water only in having a very slight trace of bitterness. The moths become very active just after sunset, traveling up and down rapidly over the moistened stigma, my idea being that they were feeding on the moisture, and that this probability also included the case of the one noted above as thrusting its proboscis down the tube of the stigma. But the insect's motions are so rapid that in the twilight I could not feel absolutely sure of the objects for which they were laboring so hard.[1]

The most interesting part of my observations comes in here. When about half the blossoms on the huge panicle had matured, the production of moisture ceased. On the evening of the eighth of July I could find no trace of an exudation of moisture, nor was there during the whole remainder of the flowering period. Strange to say my friends whose attention was called to this sudden cessation of a watery overflow all suggested, "did you note any peculiar condition of the atmosphere?" I call attention to this here because it is so common in reasoning on similar phenomena to say the atmosphere was so-and-so *therefore* this or that resulted. It is the bane of exact philosophical deductions that such hasty assumptions are common. We may with more propriety remember that in trees and plants generally a large amount of moisture is stored in the tissue

[1] This paper was read at the Cleveland meeting of the American Association for the Advancement of Science, where Prof. Riley was present and it is due to this eminent naturalist to say that he insisted on his former view that the sole object of the insect in working down the pistil, was to ensure the fertilization of the flower.

during winter, apparantly ready for the enormous draft on the storage basins which the sudden burst of masses of young foliage must entail in spring. All know how maples and other trees bleed on the slightest wound before the bursting of the leaf,—and how completely destitute of moisture the tissue seems a short time afterwards. All bleeding ceases as the young leaf has fully expanded. Will not the same necessity exist for a provision of moisture for the enormous number of juicy succulent flowers the Yucca has suddenly to produce? May there not be enough and to spare in the earlier period, with none to waste towards the last? These suggestions are all useful as clews to further discoveries. The danger in science is that we rest satisfied with plausibilities, and mistake them for facts.

My object is to show that the much discussed *Yucca* is yet a comparatively unexplored field; and that its unknown life-history yet promises to be one of the most interesting subjects the teleologist can possibly give his attention to.

A study of the Hydrangea in relation to cross-fertilization.—That many flowers are arranged for cross-fertilization needs no argument to sustain it, nor is it less certain that some flowers can only be fertilized through the aid of wind or insects. Sprengel, it is well known in the early part of the present century, placed this beyond doubt. The great question is not, do plants generally cross-fertilize, but why do they do it? Mr. Darwin's great work in this connection has been to prove that plants abhor in and in breeding, that the struggle for life is necessarily the chief object of existence, and that cross-fertilization tends to make the race stronger and better fitted to engage in this struggle than close breeding would do. The results of many of Mr. Darwin's experiments sustain his views, as do those of many others; but to my mind just as large a number do not sustain them. Mr. Darwin himself has candidly stated that continuous self-fertilization does not in the least impair the fertility of the race. Mere negative vigor is the leading advantage he finds in crossed plants. (Cross and Self-fertilization, Chap. IX, p. 327.)

It is not my object now to controvert the views of Mr. Darwin, or or of his numerous followers. My view of one object of nature in cross fertilization is to aid in production of variety. I have shown ever since discussion grew warm on these subjects, that variation is essential to the present order of things,—that nature, to be consistent with herself, must provide for variations if for no other purpose than to make variety. I now propose to show by some studies in

Hydrangea, that the variations in the species are of the most contradictory character taken from the stand-point of benefits in the struggle for life; while they are entirely consistent with my view of variation for variety's sake. Our garden Hydrangea from Japan, *Hydrangea hortensis*[1] has the ray florets sterile, or rather it is the lateral florets of the compound cyme, that give the enlarged sepals, and fail to perfect the gynœcium. The terminal florets are fertile. In *H. quercifolia*, all the lateral florets are fertile, and it is only the terminal one that has petaloid sepals and is barren. Will any one assert that these exactly opposite conditions can have any bearing whatever as aids in a struggle for life? Suppose we say that the attractive sepals are given to these species for the purpose of attracting insects, and thus aiding cross-fertilization. With this view we examine the American species *H. arborescens*, and we find barely an attempt to make these enlarged petaloid sepals. There are small ones on a few terminals and this is all. It has made out certainly as well in the great struggle as either of its two brethren. But is it a fact that the showy sepals are given to the plant to attract insects? There is neither pollen nor nectar in the male flowers of *H. hortensis*. They conceal the terminal hermaphrodites, and it is scarcely probable many insects, if any, visit the flowers. In the other two, many insects visit the flowers—so far as my observations go, as many visit the *H. arborescens* without the attractive sepals, as the *H. quercifolia* that makes such a show of them.

Turning to the minute fertile flowers on these two species, we are struck by the immense number of stamens and the enormous number of pollen grains one of these racemose cymes gives us. I estimated the number of stamens on one of *H. quercifolia* at 13,000; shaken over a sheet of dark paper it completely whitens it. It can be carried by the wind everywhere, why should it develop pelatoid sepals to attract insects? Both species have the odor of Hawthorn, but in addition *H. quercifolia* has an enormous yield of nectar, which is apparently not abundant in *H. arborescens*. In spite of all the attractions, the petaloid sepals, the abundance of pollen, the delightful fragrance, the super-abundance of nectar, and the actual visits of numerous insects, the flowers are self-fertilizing. The outer row of five stamens mature pollen simultaneously with the expansion of the petals, which falls at once on the receptive stigmas, some hours after the inner

[1] Franchet and Savatier, insist that Smith's name of *H. hortensis*, has priority over *H. Hortensia*.

series mature, and ensures that self-fertilization which the pollen from the first series may possibly have missed. The only possible aid insects can give is in self-fertilization.

It is broadly asserted that we owe to the existence of insects the various forms and colors of flowers with their grateful odors and sweet secretions. Here we have illustrations of the most dissimilar and contradictory variations in a single genus, variations which cover all the leading points called for by the insect-adaptationists, and so far as any argument in common use goes, could have occurred with as much reason if not a single insect ever existed. The facts are absolutely inexplicable on any theory of the survival of the fittest in the struggle for life,—but on my view of the absolute necessity of variation for its own sake, the explanation seems simple enough.

Variation is inseparable from even the closest in-and-in breeding. We are as fully justified in saying that nature abhors a perpetuity of form as that she abhors in-and-in breeding, and we can just as earnestly claim cross-fertilization as an agent in bringing about variation for the sake of variety, as for the reasons usually given, and which we find we cannot apply with consistency in so many cases.

That cross-fertilization aids variation, we may well believe is a sufficient reason for its existence,—without assuming that it has no other office to perform.

On the forms of Lonicera Japonica; with notes on the origin of the forms.—The well-known honeysuckle of our gardens, *Lonicera Japonica* Thunberg, gives three forms of this in general cultivation, supposed to be distinct species. One, known as *L. Halleana*, introduced into America about a quarter of a century ago, I take to be the plant so intended by the author of the original name. It is the plant figured in *Botanical Register*, plate 70. Another is *L. brachybotrya* Asa Gray, a well-known form, preferring to creep and root in the ground, to climbing. The third has been long in cultivation as "Chinese woodbine," a favorite for its rosy, sweet flowers, and is the *L. flexuosa* of Loddiges. All the characters given by the authors of the several names, can be found in different stages and conditions of the same plant. The segments of the corolla in *L. flexuosa* are somewhat narrower than in the other two; and it has a rosy purple tint in the stems, leaves and flowers. The leaves in *L. brachybotrya* are shining, and the hair, being a little shorter, makes the plant seem different. The flowers in all three turn yellow soon after they open.

On account of this change, the plant is known as "Silver and Gold" in Japan.

The flowers open towards evening. At the expansion of the corolla, the stamens and pistil are of equal length. The flower is proterogynous. In the morning the stigmas will adhere, if brought together by their viscid secretions; but the anthers do not disperse pollen till later. The expanded flower remains white or rosy-tinted all the day after opening, and turns yellow the second day, fading the third. The tube of the corolla is about an inch long. On the evening of expansion it contains no honeyed secretion. In the morning the production of nectar is coeval with the bursting of the anther cells, by noon the sweet liquid has risen up the tube for about one-third its length. It continues to flow after the change to yellow; and by evening, the tube is full for half its length, or half an inch. When the flower wholly fades, the sweet secretion, which gives the name of honeysuckle to the family is still there. Amid all these points of uniformity, there are differences in productiveness. The form known as *L. brachybotrya* is abundantly fertile: in occasional instances only do the others bear fruit. This is worth noting. Plants twining on trellises, under exactly the same conditions, vary remarkably in their reproductive powers. Such observations have been made before on other plants, and are the facts regarded as puzzling. Mr. Darwin says:—"They make me believe that some individuals of a species differ from others in their sexual affinities (to use the term employed by Gaertner) like closely allied species of the same genus." (*Cross and Self-fertilization*, Chap. vi, p. 209.)

As the expression "sexual affinity" does not explain anything, and as these three honeysuckles are such very distinct individuals as to have been regarded as distinct species of the same genus, they suggested themselves as offering excellent opportunities for observation as to the influence of anything that could be understood as being in the nature of environment that might account for the origin of their several forms; and especially what part the visits of insects might have had in developing the general form of the whole flower. In the honeysuckle, the tube of the flower attracts prominent attention. The large amount of nectar it contains, gives the name of honeysuckle to the family as already noted, and one cannot help referring to the accepted explanation of the origin of tubular forms. "It may be admitted as almost certain that some structures, such as . . . . a long tubular corolla have been developed in order that certain kinds of insects alone should obtain the nectar." (*Cross-and Self-fertilization, Chap. x, p.* 382.) The honey-bee visits all these forms freely. The honey nearly fills the tube, and bees have no difficulty in collecting freely. It can scarcely be believed that the plant made an effort to exclude short tongued visitors, and that the long tube was the result of that effort, and then secreted so much nectar as to nearly fill the tube by which the short tongued insects could get as much as before the effort was made.

Nor must we lose sight of the supposed objects for which insect visitors are to be encouraged, namely, cross-fertilization.

In order to make no mistake in our conclusions, it is proper to note here, that modern literature has misconceived the whole idea of cross-fertilization. There cannot possibly be any physiological benefit from one flower crossing another on the same plant; but this is about all that is involved in much that is written in connection with the visits of insects. Yet Darwin takes especial pains to explain that this is not cross-fertilization. He says: "cross fertilization always means a cross between distinct plants raised from seeds" (p. 10). Even distinct plants, unless under distinct conditions scarcely constitute crossings in his mind. "The mere act of crossing two distinct plants, which are in some degree inter-related, and which have long been subject to the same conditions does little good" (p. 61). Referring to Compositæ (p. 173) he notes that the florets were "self-fertilized" though with different florets from the same head. On p. 345 he declares "pollen from the same plant is equally injurious or nearly so, as from the same flowers." And, after all, it is difficult to tell what Mr. Darwin really means by "injurious," for the most of his experiments, when in his mind resulting beneficially, referred to vegetative luxuriance, in many little related to those greater vital questions on which the good of the race depends. He distinctly states (p. 327) "there is therefore, no evidence at present, that the fertility of plants goes on diminishing in successive self-fertilized generations, although, there is some rather weak evidence that this does occur with respect to height and growth." Still it is clearly his idea, and evidently the proper one, that the cross-fertilization can only be fairly entertained when the physiological conditions vary in the individuals crossed. Though the honeysuckles referred to are all from cuttings from the one individual in each case introduced, yet being three distinct ones from seed originally, there might be a chance for cross-fertilization when three kinds grew altogether, as in those under my observation.

But I found that the bees, and other short-tongued visiting insects, could not, in any way, aid in fertilizing the flower, when gathering nectar. In these forms, the stamens and pistil are curved upward, so that anthers and stigma are far above the lower lip, on which the insect alights. If any insects aid in cross-fertilization, it must be the pollen-gathering bees, and others; but this will render the speculation in connection with the development of nectar, and the prolongation of the tube in favor of certain classes, of no value, especially in connection with the fact noted, that the short-tongued insects can get the liquid in spite of the prolonged tube.

It is usual, when similar instances in other plants have been noted, to weaken the force of the lessons they teach, by objecting, that many things "may have happened." In this case, it would be urged, that there might be some insects in the native country of these honeysuckles, that we have not here where the plant is introduced; but this would not change the fact, that whatever they may be, they would still be divided into long-tongued and short-tongued classes; and that some bees gather honey only, while others are devoted to collecting pollen; nor would it ignore the fact that the stamens and style are out of the reach of the short-tongued class. It "may be" also urged that after the tube had been lengthened to exclude the short-tongued insect, the plant had subsequently, under excessive excitation from the long-tongued visitors, overdone its work, and supplied more nectar than it had originally given; and then, among the "may be's" often indulged in, is that of a "continuation of effort after the reasons therefor have ceased to exist," and the "progress of development towards a new stage of self-interest."

No one could rationally deny that in the functions of plants, self-interest largely enters. Nor can it be successfully controverted that flower are often wholly dependent on insects for their fertilization. The point I have for some years contended for is, that we need not necessarily be forced to assume that every variation in a plant, or every function in its life-work, is for its special interest. It seems to me absolutely essential to the present order of things, that variety, for mere varieties' sake, should exist quite independently of any other consideration. This may involve the necessity of changing the term "adaptation" to "design" in many cases. At any rate, I am unable to see a reason for the special form and arrangement of parts in the honeysuckle flower, that will accord with prevalent speculations, and am constrained to to believe the plant has been forced to assume them for *variety's sake.*

October 16.

Rev. H. C. McCook, D. D., Vice-President, in the chair.

Twenty-two persons present.

The following papers were presented for publication:—

"Additional Notes on the Structure and Classification of the Mesozoic Mammalia." By Henry Fairchild Osborn.

"On the Helicoid Land Mollusks of Bermuda." By H. A. Pilsbry.

October 23.

Mr. Charles Morris in the chair.

Twenty-nine persons present.

The following papers were presented for publication:—

"Crotalocrinus. Its Structure and Zoological Position." By Charles Wachsmuth and Frank Springer.

"On a New Species of Starfish of the genus Pteraster." By J. E. Ives.

October 30.

The President, Dr. Joseph Leidy, in the chair.

Fifty persons present.

The following papers were presented for publications:—

"Discovery of the Ventral Structure of Taxocrinus and Haplocrinus and consequent modifications in the Classification of the Crinoidea." By Charles Wachsmuth and Frank Springer.

"Observations on the Development of the Skull in Neotoma fuscipes, a contribution to the Morphology of the Rodentia." By R. W. Shufeldt.

The following were ordered to be printed:—

ON THE HELICOID LAND MOLLUSCS OF BERMUDA.

BY H. A. PILSBRY.

Through the courtesy of Professor Angelo Heilprin I have been enabled to study the Bermudan land shells, collected by the party conducted by him during the past summer. Among them were examples of all the Helicoid species which have been repôrted by previous observers from the island, some containing the living animal. The species, with the exception of a number of artificially introduced European shells, are mostly forms well-known from various West Indian localities; such as *Helix cereolus* var. *microdonta* Desh., *H. vortex* Pfr. and others; but besides these, there are a number of shells peculiar to Bermuda; and these last have furnished material for the following notes.

The helicoid species confined to Bermuda are as follows: *H. bermudensis* Pfr., *H. nelsoni* Bld., *H. reiniana* Pfr., *H. circumfirmata* Redf., *H. discrepans* Pfr. As to the systematic position of these forms there has been considerable difference of opinion among authors: the first, *H. bermudensis*, has been placed in *Caracolus* by Von Martens, in *Hyalina* by Clessin, in *Zonites* by Bland; *H. reiniana* has been considered a *Patula* by Pfeifler, Clessin, Tryon and Fischer; and *H. circumfirmata* and *discrepans* have been placed in *Microphysa* by Von Martens and Binney, in *Hyalosagda* by Clessin Tryon and others.

Thus it will be seen that these species have been distributed into several genera in two distinct families. Upon examining the soft parts, however, I find that all have essentially the same organization and without doubt belong to the same genus.

Dr. O. Boettger proposed in 1884, for the Lower Miocene fossil *Helix imbricata* Braun, and the *H. bermudensis* Pfr. the name of *Pœcilozonites*. He gave no diagnosis of the new group, but assigned it a position between the typical palæarctic *Zonites* and the American groups *Zonyalina* and *Moreletia*, a position which the anatomical characters prove to be erroneous.[1]

1 " * * * Endlich sei noch einer nahen Verwandten der Hocheimer untermiocäner *Helix imbricata* Al. Braun gedacht, die Sandberger bekanntlich zu *Trochomorpha* (*Discus*) gestellt hat. Ich gebe die Aehnlichkeit zu; aber zur Section Videna H. u A. Adams, Discus Alb., möchte ich die betreffende fossile Art nur ungern stellen, da alle mir bekannten lebenden Arten dieser Gruppe zum mindester einer verdichter basalrand, der oft recht erheblich Helix-artig umgeschlagen

By error, the genus was quoted "Poecilozonites *Sandberger*," in the Zoölogical Record for 1884, and this error was repeated by Tryon[1] who gives the first diagnosis of the group published, giving *H. bermudensis* as the type and only species. We may, then, consider the *H. bermudensis* Pfr., the type species of the genus. Whether the *H. imbricata* Braun be associated with the Bermudan shells or not is a point still to be settled. The superficial resemblance is marked; but as the history of the species of *Pœcilozonites* teaches us, "systematizing" helicoid land mollusks by the shells alone is the merest guess-work.

The fact that the fossil species which Dr. Boettger proposes to unite with the Bermudan form is from the Lower Miocene formation of Germany, is in itself no great objection to the view that they are congeneric; for no fact is better established in malaco-geography than the close affinity existing between the European Tertiary land mollusca and those now inhabiting the West Indies.[2] To explain this relationship existing between two regions separated by the whole expanse of the Atlantic, various theories have been offered. One of the most plausible is that which bridges the Atlantic by an ancient (Eocene, Early and Middle Miocene) continent—an *Atlantis*.

ist (wie z. B. bei *Tr. merziana* Pfr.) besitzen. Viel näher liegt daher wohl der vergleich der *Helix imbricata* mit der etwas kleineren, mit zwei braunen bändern gezierten *Hyalinia bermudensis* Pfr. von den Bermudas, deren Uebereinstimmung in allen wesentlichen charackteren bei directem Vergleich sofort in die Argen springen dürfte. Freilich kommen wir hier fast von dem Regen in die Traute, da die systematische stellung dieser lebenden Art selbst noch in hohen Grad unsicher ist, was ihr Autor durch ein vorgesetzes '?' sehr richtig selbst schon angedeutet hat. Bei *Hyalinia* kann sie unmöglich bleiben. Da sie meiner Ansicht nach auch nicht in die indische, indo malayische und polynesische gattung *Trochomorpha* passt, so dürfte eine eigene Gruppe für *Hyal. Bermudensis* und *Helix imbricata* zu errichten sein, für welche ich den Namen *Poecilozonites* vorschlage, und die ich am liebsten zwischen die ächten paläarktischen *Zonites* und die tropisch amerikanischen Gruppen *Mordetia* und *Zonyalina* vorläufig als section in der Gattung *Zonites* Montf. einreihen möchte, bis die Anatomie der lebenden Art eine mehr gesicherte Stellung im System an die Hand geben wird." O. Boettger in *Neues Jahrbuch für Mineralogie, Geologie u. Palaeontologie*, 1884. ii Bd., s. 139.

[1] Manual of Conchology, 2d, series, iii, p. 19, 95.

[2] This affinity although doubtless very great, has been considerably exaggerated. There is, for instance, no warrant for referring European tertiary species to the exclusively New World genera *Pleurocera*, *Anculosa*, *Tulotoma*, *Mesodon*, *Carinifex*, *Melantho*, and others. There seems to have been no infusion of European Tertiary types into the North American snail fauna east of the Californian region. This fauna is truly autochthonous.

This view has been advocated by the well-known conchologist Dr. W. Kobelt[1] and by others.

But although this theory explains many anomalies in the distribution of molluscs, I must freely confess that the objections to it seem to me almost insurmountable. The recent work of the Challenger, Blake, and other deep-sea explorations, all tend to confirm the view held by Guyot, Dana, Agassiz and others, that the great oceanic basins, practically as they exist to-day, are of great antiquity; and render the existence of a former Atlantic continent with any considerable Western extension, highly improbable.

A view more in accordance with the facts with which we are at present acquainted, seems to me to be the following: It is a well ascertained truth that until toward the close of the Miocene, large portions of Nothern Africa as well as Europe were submerged; and it appears probable that the westward flowing Equatorial current of the Indian Ocean extended across northern Africa, and united with the Atlantic northern equatorial current, which now flows westward from northern Africa, through the Antilles into the Gulf of Mexico. This current would afford a means of transport not only for the free swimming embryos of marine molluscs, (and there are not a few forms both of gasteropods and pelecypods, common to the Mediterranean and Gulf Provinces,) but also, through the agency of floating materials, trees, etc., swept from rivers, land mollusks may have been transported across the Atlantic, just as they have been carried by the Gulf Stream from the West Indies to the outlying island of Bermuda,[2] a distance of over 700 miles.

A further development of the same idea explains certain peculiarities in the distribution of species common to the Pacific and the Gulf of Mexico. The presence of Miocene and Pliocene deposits render it certain that there was communication between the Gulf and the Pacific across the isthmus of Panama as late as the Pliocene. And a portion of the equatorial current probably swept directly through to the Pacific. Thus it is likely that those forms common to both sides of the isthmus, will prove to be of Atlantic origin, and to have been distributed westward.

The indigenous Bermudan mollusc-fauna, marine as well as terrestrial, has undoubtedly been derived wholly from the West Indies.

[1] Nachrichtsblatt d. deutschen Malak. Gesell., 1887, p. 147.

[2] See Darwin, Origin of Species, 6th ed., p. 353. Also a paper by Mr. C. T. Simpson, On the Distribution of Land and Fresh-water Shells in the Tropics, Conch. Ex. ii, p. 37, 50.

And since the island is typically oceanic, "a solitary peak rising abruptly from a base only 120 miles in diameter" surrounded on all sides by between 2500 and 3000 fathoms depth, we have an indication here that land mollusks of many families, *Helicidæ*, *Zonitidæ*, *Succinidæ*, *Pupidæ*, *Helicinidæ*, even *Vaginulidæ*, (for a large undescribed species of *Vaginulus* exists upon the island) may be transported very great distances by sea, by, in all probability, the agencies mentioned above.

The considerable divergence existing between the various species of the Zonitoid genus peculiar to Bermuda, *Poecilozonites*, indicates that the island is of considerable antiquity.

We may define the genus as follows:

POECILOZONITES.

Generic characters: Shell helicoid, subtrochiform, depressed conic, or subdiscoidal, perforate or umbilicate, obliquely striate, ornamented with radiating zigzag flammules or spiral bands of chestnut color on a lighter ground; whorls numerous (7–10) very slowly widening; body whorl more or less flattened or compressed below the usually carinate periphery, not descending anteriorly; aperture more or less irregularly lunate; peristome simple, the columellar margin slightly expanded and thickened with a white callus which encircles the pillar within. Animal similar in form to *Helix;* foot narrow, short posteriorly, scarcely reaching behind the shell, without longitudinal furrows above its margin or caudal mucous pore; orifice of genitalia on the right side of neck, near, but not under the mantle; mantle margin simple; jaw like that of *Limax*, very thin, arcuate, with a broad blunt median projection anteriorly; radula with tricuspid central teeth having quadrate basal plates, the central cusps projecting beyond the anterior margins of the basal plates, the side cusps rather short, with well reflexed cutting points; lateral teeth similar but asymmetrical, lacking the inner cusps; marginal teeth aculeate, with simple thorn-shaped cusps and oval basal plates.

It will be seen by the above definition that the genus cannot be included in any of the groups with which its species have been associated by authors; the Zonitoid dentition at once removing it from the *Helicidæ*, and the absence of a caudal mucous pore, the more anterior position of the orifice of the genitalia and the coloration of the shell, separating it from *Zonites* and its subgenera.

The relationship of the species of *Poecilozonites* to one another is shown by the similarity of the radulæ and jaws, and of the external characters of the animal; and in the shells, which at first glance seem to be a heterogeneous assemblage, by the callus which coats the columella, the compression of the whorl below the periphery, and especially by the color-pattern, which is the same in all the species, consisting of zigzag flammules radiating from the sutures. In *P. bermudensis* the flammules coalesce into continuous bands above and below the periphery in the adult; but an examination of young specimens reveals the same pattern that is found in *P. circumfirmata*, *P. reiniana*, etc. The internal spiral lamella of *P. circumfirmata* would incline one at first to separate it from the other species; but it is scarcely of generic importance, in view of the fact that in all other characters the species is very similar to *P. bermudensis*, etc.

The following analysis shows the inter-relations of the various species:

A. Base of shell with a revolving lamina within *circumfirmatus, discrepans.*

B. Base of shell without lamina.

- *a.* Aperture rounded below; umbilicus wide *reinianus.*
- *b.* Aperture angulate below; umbilicus narrow *bermudensis, nelsoni.*

Poecilozonites bermudensis Pfr. (pl. xvii. figs. E. C.)

The typical species is a form of about twenty-five mill. diameter, solid, coarsely irregularly striate and acutely carinate at the periphery; a broad chestnut band usually encircles the shell above the periphery, and another below it: but these are sometimes absent; the inner whorls of the spire usually retain traces of the original color-pattern of radiating flames, and the base in young examples, is radiately streaked (pl. xvii. fig. E). The base is convex, and not indented around the narrow and deep umbilicus, but is angulated at its margin; the parietal wall is generally covered by a shining white layer with which the interior of the shell is lined. Reeve, Tryon and other authors have figured the shell of this species.

The jaw is like that of *P. circumfirmata*.

The radula (pl. xvii. fig. C) is rather long. The central teeth have basal plates almost as broad as long, the median cusps projecting below their lower margins, with well-developed cutting points, the side cusps short, attaining about the middle of the basal plate, and directed outward; the lateral teeth are similar, but lack inner cusps; they are about eight in number, and are followed by about four transition teeth; the marginals number about fifty on either side, and their cusps become more slender toward the outer edge, and the basal plates shorter. A central with five adjacent lateral teeth, and a group of transition teeth with a true marginal tooth are shown in the figure.

Helix albella of Chemnitz, (not of Linnæus), and *H. ochroleuca* of Pfeiffer, (not Ferussac) are, I believe, synonymous with this species. The former is placed in *Euryceratera* in Pfeiffer's *Nomenclator*, and the latter has been compared to *Pachystyla rufozonata*, a form somewhat similar in characters of the shell, but belonging, of course, to a distinct group.

Poecilozonites nelsoni Bland. (pl. xvii, figs. J, K, L).

A fossil form, differing from *bermudensis* in the much greater size, greater number of whorls, more convex base, coarser striation, impressed sutures, and especially in the peculiarly prominent dome-shaped upper whorls. These are, indeed, so closely coiled as to resemble a specimen of *P. circumfirmata*. The coloration, imperfectly shown in several specimens before me, is that of *bermudensis*; and whilst its affinities are with the latter species, I regard it as a divergent branch, rather than as an ancestor of that form.

As has been observed in other cases of species approaching extinction, and probably subject to some decided and unfavorable change in environment, (in this case, perhaps, due to the comparatively recent subsidence and partial submergence of the island[1]) the shell exhibits great mutations and distortions of form; sometimes the spire is elevated conical, sometimes much depressed; frequently the planes of the upper and lower volutions are not parallel, and the spire consequently is canted to one side. The species is remarkably large, solid and roughly sculptured for a Zonitoid.

Poecilozonites reinianus Pfr. (pl. xvii, figs. I).

This heretofore unfigured species is discoidal in form, widely umbilicate, the umbilicus about one-third the diameter of the base, exhibiting all the whorls; the apical whorl is smooth and whitish; the following whorls are quite convex, with deep sutures, brownish, very prettily zigzagly flammulate with chestnut color, like many of the species of *Patula*. The body-whorl in adult examples is round-

[1] See Challenger Report, Narrative, vol. i, p. 138.

ed; the base concave around the umbilicus, and the general aspect that of *Patula*.

The jaw is like that of *circumfirmata*.

The radula (pl. xvii, fig. D) is similar to that of *bermudensis* except in the following points: the cusps are larger, with much more widely reflexed cutting points; the perfect lateral teeth are seven on either side; the change to marginals is quite abrupt, as there are but two real transition teeth; the marginals number about sixteen on each side, the inner six or seven of about equal size, the outer ones rapidly decreasing toward the edge. The basal plates are longer than in the other species. A central tooth with two adjacent laterals and one marginal are shown in the figure.

Poecilozonites circumfirmatus Redfield. (pl. xvii, figs. F).

A form with much the appearance of *Hyalosagda*, a group with which it has been classed by some authors. It is a delicate subtranslucent yellowish brown shell, marked with brown streaks, spots and flammules; the whorls are separated by moderately impressed sutures; the apex is like that of *reiniana*; the last whorl is more or less angulate around the periphery, rather flattened below the angle, then convex, indented around the narrow deeply perforating umbilicus; there is a white calcareous deposit around the columella, inside, as in the other species, and an acute white lamella which revolves within the base near to the periphery, a character which none of the preceding species possess. The variation in form is very great—specimens more elevated than my figure F being not infrequent, and these are connected by examples more and more depressed (fig. G) with the flattened lenticular form called by Pfeiffer *H. discrepans*. This extremely depressed variety, now figured for the first time, (Pl. xvii, fig. H.) cannot be considered specifically distinct from the *P. circumfirmata*.

Jaw (pl xvii, fig. B) transparent, very thin, arcuate, with blunt extremities and a wide obtuse median projection below.

Radula (pl. xvii, fig. A) as described for *P. bermudensis*, but with only seven laterals, two or three transition teeth, and about twenty-eight marginals. The marginals have longer basal plates than in *P. bermudensis*.

ADDITIONAL OBSERVATIONS UPON THE STRUCTURE AND CLASSIFICATION OF THE MESOZOIC MAMMALIA.

BY HENRY FAIRFIELD OSBORN.

In connection with a visit to the recent Geological Congress in London the writer reviewed the British Museum collection of Mesozoic Mammals which formed the principal basis of a recently published Memoir[1] and examined also the valuable specimens at Oxford, Bath and York which had previously been studied merely from the descriptions and figures of Professor Owen and others. Also the *Neoplagiaulax* specimens in the collection of Dr. Lemoine at Rheims. There are two undescribed specimens in the Oxford Museum and since the writer worked upon the collection in the British Museum, (in 1886), many of the Purbeck fossils have been much more fully exposed by the further removal of the matrix. Important features have been brought to light, not visible previously, which lead to a revision of some of the conclusions which were reached upon the evidence then at hand. Greater familiarity with the minute Mesozoic types of molars sharpens the powers of observation and one is more apt to discover new points when on the lookout for them. Thus many inconspicuous but important features were noticed which formerly escaped attention. Some of these, such for example as the identity of *Amblotherium* and *Stylodon*, had been already anticipated, but others, such as the tritubercular molars of *Amphitherium* were entirely unexpected.

The following notes are in abstract from a Postscript to the Memoir, which is in preparation, and are not to be considered as final.

AMPHILESTES.

Besides Professor Owen's type, which is preserved in the York Museum,[2] there are two specimens belonging to this genus at Oxford. In the type, it is somewhat difficult to determine the number of the teeth, as described by Owen, since the incisor and canine alveoli are indistinct, but the Oxford specimens show that there were but *six* molars instead of seven as conjectured in Lydekker's Catalogue, Part V. p. 271, and adopted by myself, (op. cit., p. 193). In fact, one well preserved specimen, a right ramus seen upon the outer surface, shows but five molars. If this specimen be adult, as seems improbable, it may represent a new genus transitional between

[1] "The Structure and Classification of the Mesozoic Mammalia." Journ. of the Acad. of Nat. Sciences of Philadelphia. vol. ix, no. 2, July 1888.

[2] I am indebted to Mr. Plattnauer, the Curator of this Museum, for the opportunity of freely examining this specimen.

Amphilestes with six molars and *Triconodon* with four. The second specimen, a left ramus also seen upon the outer surface, has three premolars *in situ* and the space for a fourth, (pm_1); in front of this is a deeper alveolus, probably for the canine, preceded by the alveoli of at least three incisors, so that the lower dental formula may now be given with considerable certainty as follows:

$$i.\ ?_3,\ c_1,\ p_4,\ m_6.$$

The canine is not preserved. The premolars as viewed upon the outer surface have prominent cingules but not the true basal cusps seen in *Triconodon*. The outer face of the molars is entirely devoid of a cingulum. None of the specimens give any evidence that the angle is distinct, but indicate that the lower border rises to the level of the condyle precisely as in *Phascolotherium*, *Spalacotherium* and *Triconodon*. This strengthens the writer's reference of these genera to one family as opposed to the views of Marsh and Lydekker; nevertheless, as shown below, *Spalacotherium* is a more specialized type than the others.

PHASCOLOTHERIUM.

Besides the type in the British Museum there is a beautifully preserved specimen belonging to this genus in the Oxford Museum and through the kindness of Mr. James Parker of Oxford the writer had an opportunity of examining a third specimen in his private collection. The latter, which has been figured in Phillips' "Geology of Oxford," is remarkable for the extension of the coronoid beyond the vertical line of the condyle. The Oxford Museum specimen[1] contains only the four posterior molars, probably m_4—m_7 with the fangs of m_2 and m_3. It may however be readily distinguished from the *Amphilestes* specimens by the stout cones and by the fact that the internal cingulum rises in two points upon the inner faces of the molars instead of in a single point beneath the protocone; also by the stout character of the jaw.

A renewed study of the molar teeth in the type specimen shows that all the post-canine teeth present the characters of molars in some respects. The *first* tooth behind the canine has a main cusp like that of the posterior molars and an internal cingulum horizontal and rising in two points instead of showing the sweep downwards and backwards which is so characteristic of premolar cingula. The accessory cusps are either covered with matrix or broken off. The *second* tooth has a fractured cingulum so that one cannot determine

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[1] The cast of this specimen in the Natural History Museum (M. 2300) has been mistakenly referred to *Amphilestes* by Lydekker, op. cit., p. 272, on the ground of "the small development of the accessory fore-and-aft cusps." The basal cusps of the molars are quite as prominent as in the type.

whether the anterior cusp is a cingule or a true paracone. The posterior cusp or metacone is prominent and distinct as in the premolars of *Triconodon*. The chief interest lies in the main cusp which is loftier and more pointed than the protocone of the *third* tooth which in turn has all the characteristics of a molar. This is an important point which has been overlooked previously, since it appears to indicate an available line of division in the functional adaptation of the series, *i. e.* a line between premolar and molariform teeth. If such a division be confirmed by further examination of the first and second teeth, it will lessen the gap between *Amphilestes* and this genus and remove what has been considered an entirely exceptional feature, viz. a type with no premolariform teeth. The mandibular formula may then be provisionally written thus: i_4, c_1, p_2, m_5.

The crowns of this front pair of teeth have never been correctly represented. The writer's figure (op. cit., Pl. 8, fig. 3) is incorrect in restoring the cingulum of the second tooth and the basal cusps of the first tooth. In this Buckland's figure was followed, believing it probable that the jaw was in better condition when he figured it than now, for the last molar was then present. Another error in the drawing is the high position of the dental foramen, to which Professor Marsh kindly directed attention.

AMPHITYLUS.[1]

In the type of this genus at Oxford the teeth are so fractured that it is impossible to form any idea of their full structure. There is some doubt whether the dental formula, i_4, c_1, p_4, m_7, as generally given, is correct; one cannot be positive, for the 4th and 5th postcanine teeth are much mutilated; the characters of the condyle and angle, however, separate this specimen clearly from *Amphilestes*. At the time this genus was proposed the writer supposed we had in No. 36822 (Brit. Mus. Coll.) a ramus showing the outer face of the *Amphitherium* molars, but this proves to have been a mistake. The crowns of the last three molars in *Amphitylus* show a prominent posterior or third cusp, of which there is no evidence upon the molars of *Amphitherium*, as seen upon the inner face. The penultimate and ante-penultimate molars also retain this third cusp. The fourth, fifth and sixth molars counting from the last, show the trifid division of the crown characteristic of the triconodont type, then follow the two mutilated teeth with bifid crowns which may represent either premolars or molars. Thus the formula may read either

[1] Proc. Acad. Nat. Sc. Phila. June 21, 1887.

i_4, c_1, p_5, m_6, or p_4, m_7, as given by Lydekker and adopted by the writer. Owen's formula, p_6, m_6, includes the canine in the premolar series.

PERAMUS.

We are fortunately able to greatly increase our knowledge of this genus. Upon uncovering the anterior molars of the type specimen of *Leptocladus*, an antero-internal cusp came into view, leading to the discovery that the latter genus is identical with *Peramus*, and still more interesting is the fact that the type specimen of *Spalacotherium minus*, (Owen) presents the much desired internal view of the *Peramus* molars. A third specimen confirms the facts derived from the second and shows that altogether there are six or, possibly, seven specimens in the British Museum collection which should be referred to this genus, giving us nearly all the characters of the mandibular dentition. These are:

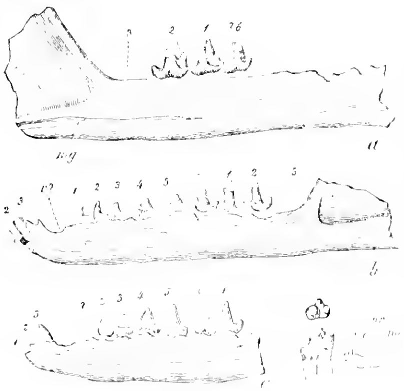

Fig. 1.

a. *Peramus* (*Spalacotherium*) *minus* Owen. Internal view of left mandibular ramus. *b.* *P.* (*Leptocladus*) *dubius* Owen. External view of left mandibular ramus. *c.* *P. tenuirostris* Owen. Outer face of anterior portion of left ramus. Also, Second Molar of *Amphitherium Prevostii* Owen, internal view. Also, Second molar of *P. minus*, enlarged from fig. 1 *a* above; internal view. *pr*, protoconid. *pa*, paraconid. *me*, metaconid. *hy*, hypoconid. *mg*, mylohyoid groove. Much enlarged.

The type, No. 47742, also No's, 47744, 47754, 47743. All except the last, portions of the left mandibular ramus seen upon the outer face. Referred by Owen to *Peramus* and so adopted by Lydekker (op. cit., p. 277.)

To which should be added:

No. 47,739, the type of *Leptocladus dubius*, (Owen, op. cit., p. 53, Pl. III, fig. 4; Osborn, op. cit., p. 239, Pl. 9, fig. 10; Lydekker, op. cit., p. 291.) A left mandibular ramus seen upon the outer surface.

No. 47,751, the type of *Spalacotherium minus*. (Owen, op. cit., p. 28, Pl. I, fig. 39.) A left ramus seen upon the inner face.[1]

The heel upon the molars of *S. minus* and the antero-internal cusp upon the antepenultimate molar of *Leptocladus* suggested a

[1] Also possibly, No 47799, referred by Lydekker to *Spalacotherium minus*, op. cit., p. 294.

further examination which developed the fact that all the specimens of the above list agree in the following particulars: 1. In evidence of the presence of three incisors. (No's 47744, 47739, 47743). 2, In evidence, direct and indirect, of the presence of six *premolariform* teeth, (No's 47743, 47739, 47742). 3, In evidence of the presence of but three molariform teeth. 4, In the fact that the mylohyoid groove does not terminate at the dental canal but extends back beneath the lower border of the pterygoid fossa, (No's 47751, 47754). All the specimens which do not directly bear upon these four features of agreement support them indirectly, or at least present no negative evidence.

The formula, pm_6, m_3, is very exceptional, and Mr. Oldfield Thomas, who kindly examined these specimens and discussed the dentition with the writer, suggested a different division of the series. In No. 47739 the third and fourth premolars present lower crowns than the succeeding tooth, fig. 1 *b*, but this is apparently because the tips are not fully exposed. And as we have at present no other data than the mere form of the teeth, it seems that we are bound to take the dentition as it stands, exceptional as it is, and divide it provisionally as follows:

$$i_3, c_1, p_6, m_3.$$

The almost invariable presence of four premolars among the Mesozoic and recent mammals is a very difficult fact to explain. This genus and apparently *Amphitherium* are among the few exceptions. Why was the line drawn exactly to include five teeth behind the incisor series, the first of these developing into a canine?

In describing *Peramus* (op. cit., p. 263), the writer questioned the reference of the anterior portion of the jaw, (No. 47743) to it on several grounds, but now considers this less doubtful, as the single incisor preserved is very similar to that in No. 47744., and both differ from those of *Stylodon*, the only other type which this specimen resembles. The last premolar has a heel very similar to that of the molars. The molars, fig. 1 a, are very similar to those of some of the eocene Creodonta, presenting the primitive *tubercular-sectorial* type. Among the Jurassic Mammals, they apparently approach most closely the molars of *Amphitherium*.

AMPHITHERIUM.

A comparison of the three specimens belonging to this genus, two in the Oxford collection, and the one previously studied in the

British Museum, has enabled the writer to determine fully the structure of the molars and premolars and to correct a previous error.

In examining the first and second molars of the type specimen under a strong lens, an external cusp was detected directly between the internal pair, a discovery of great interest, since, in connection with the last genus, it adds two important types to the trituberculur series. This external cusp is probably the one referred to by Owen, (op. cit., p. 14) in describing the penultimate molar of the second specimen of *Amphitherium*.[1] He speaks of the latter tooth as the posterior molar, but one can detect the tips of a molar behind this, just breaking through the jaw.

The molar of *Amphitherium* is thus apparently similar to that of *Peramus* with the exception that the external cusp, in the type species at least, is less lofty. This observation led to a reëxamination of the jaw in the British Museum, No. 36822. This unquestionably belongs to *Amphitherium*, as previously determined, (Osborn, op. cit., p. 192, fig. 2.; Lydekker, op. cit., p. 374), but presents the inner face of the right ramus instead of the outer face of the left ramus as previously described. This is proved by the double internal cusps, by the cingulum upon the premolar, and by the faint mylohyoid groove, near the lower border, which was previously overlooked. The individual is much smaller and younger than the two Oxford types, which are nearly of the same size, and the tips of the para- and metacones are entirely unworn.[2]

In the Memoir, the formula of *Amphitherium* was doubtfully given as pm_4, m_6, (following Lydekker). An examination of the Oxford types shows that Prof. Owen was more nearly correct in putting it, pm_6, m_6. If we deduct the foremost bifanged tooth which he naturally reckoned with the premolar series, but which is probably the canine, we have c_1, pm_5, m_6. In the second Oxford specimen there are undoubted traces of three premolars in front of

[1] "The posterior molar shows a middle internal and part of a larger external cusp" This observation shows the keenness of the observer, for the molar referred to is in a very fractured condition.

[2] The teeth in the Stonesfield Slate specimens are much more brittle than those in the Purbeck series, but it would be well to run the risk of injuring one of these molars to expose the external cone.

the two complete ones. In front of these, Prof. Owen describes sockets for a bifanged tooth, (the canine), and for four single incisor fangs.

PERALESTES.

A reëxamination of the superior molars in the type maxilla of this genus reveals an inconspicuous but important feature in the crown which escaped Professor Owen's notice as well as the writer's. That is, the presence of a low transverse crest connecting the antero-internal and antero-external cusps. This puts the functional adaptation of the *Peralestes* molar in a different light from that described in the Memoir, since it shows that this molar is *subtrenchant.* A close examination of the anterior faces of these crests, moreover, yields some evidences of wear by the crown of an inferior molar. These crowns are placed somewhat obliquely, but when the jaw is tilted so that the teeth can be viewed directly upon end, they are seen to have a triangular section, with the base with its lesser cusps directed outwards, and the main cone directed inwards, precisely as in the primitive tritubercular crown. When viewed in this way, this pattern at once suggests that of the *Spalacotherium* lower molars, which consists of a triangle reversing the above, *i. e.* with the main cone external and the base internal. Mr. Lydekker was the first to reach this conclusion as to the probable identity of these two genera but upon different grounds,[1] and the writer has hitherto held quite an opposite opinion,[2] which is now withdrawn.

The premolar formula of *Peralestes* is somewhat uncertain and the molars agree in number and size with those of *Spalacotherium.* At present, however, the evidence for the union of these genera is hardly sufficient to justify more than the placing of *Peralestes* in brackets with the above genus.

STYLACODONTIDAE.

After all the systematic work which has been done upon the genera embraced in this family, there are none in greater confusion as to no-

[1] "The true molars (of *Peralestes*) agree so closely in structure with those of *Chrysochloris* that there is every probability that the specimen belongs to *Spalacotherium tricuspidens*" op. cit., p. 294: In the writer's opinion, the molars of *Chrysochloris* bear only a remote resemblance to those of *Spalacotherium.*

[2] "A review of Mr. Lydekker's Arrangement of the Mesozoic Mammalia." American Naturalist, March, 1888, p. 235, "The molars of this genus are widely different from those of *Spalacotherium* etc."

menclature. As the writer anticipated after examining Prof. Marsh's *Dryolestes*, (Am. Naturalist, March 1888, p. 234 and Memoir, p. 236.) the genera *Amblotherium* and *Achyrodon* prove upon further examination and exposure of the crowns to belong to the *Stylodon* type.

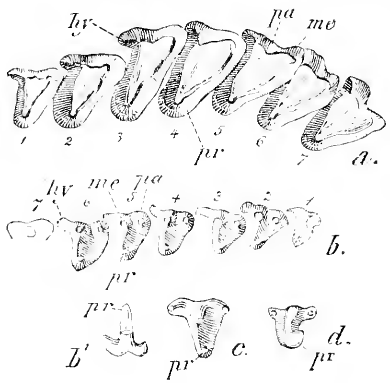

Fig 2

a, Kurtodon. Superior molar series of the left maxilla, viewed upon the wearing surface. *b, Amblotherium soricinum*, inferior molar series, viewed from above. *b'* *A.* (*Peraspalax*) *talpoides.* A lower molar viewed upon the internal face. *c.* The same. A lower molar viewed from above. *d, Achyrodon nanus.* A lower molar viewed from above. Much enlarged. Abbreviations as in fig. 1.

It further appears that Mr. Lydekker was correct in placing *Peraspalax* with *Amblotherium* (op. cit., p. 275), although he did not recognize the trituberculate character of the crown with the styloid external cone and two internal cusps and heel. The writer was in error, first in describing the external cusp of the molars of this genus (*Peraspalax*) as separated by a valley from the internal cusps, for there proves to be a distinct transverse crest; probably also, second, in associating this jaw with the *Peralestes* maxilla, (op. cit., p. 233).

It is now evident that the molars of Professor Owen's types of *Amblotherium soricinum* (Mes. Mamm., 1871 p. 29) of *A. mustelula* (ibid., p. 31.), of *Phascolestes longirostris* (ibid., p. 35.), of *Achyrodon nanus* (ibid., p. 37.), of *A. pusillus* (ibid., p. 39.), of *Peraspalax talpoides* (ibid., p. 40.), all present substantially the same crowns, (see Fig. 2). It is also probable, but not actually demonstrated, that *Stylodon pusillus* (Geol. Mag., 1866, p. 199.) and *S. robustus* (ibid. have the same molar pattern. Professor Marsh has further applied a series of generic and specific names to the closely allied American genera. Altogether it will prove a difficult matter to clear up the synonomy of these numerous species and will require a close examination and revision of all the material available.

It is singular, in view of the probable similarity of many of these species, that all the specimens referred to *Stylodon*, because exposing the external face, possess but seven molars, with one possible exception, while three of the specimens shown upon the inner face have eight molars. As derived from a study of Professor Marsh's collection, the basis of distinction between these genera will depend: 1, upon the number of the teeth in the adult condition; 2, upon the presence of a heel, which is apparently wanting in *Asthenodon*; 3, upon the presence of one or of two transverse crests connecting the external with the pair of internal cones.

The name *Stylodon* is preoccupied, but *Amblotherium* has the precedence of *Stylacodon*, (Marsh) and *A. soricinum* can probably be retained for the larger species with seven molars, thus embracing *S. robustus* with which it agrees closely in measurement. *Phascolestes* would then embrace the species with eight molars. But these questions can only be finally determined by a careful revision of all the material.

It now seems probable that the type maxilla of *Kurtodon* (No. 47755.) fig. 2 *a*, should be placed somewhere in this series, as held by Owen and not represent a distinct family as maintained by the writer. Since the original study and figuring of the molars, the matrix has been extensively removed, so that the outer faces of the crowns are exposed and show a low antero-internal cusp near the base of the crown; this cusp is very important because it is apparently homologous with the postero-internal cusp of the *Amblotherium* lower molar. Further, as Mr. Lydekker has pointed out (op. cit., p. 291) the block No. 47786 (*S. pusillus?*) contains upper molars of a very similar pattern associated with lower teeth, resembling those of *Stylodon*. It is freely admitted that the views before expressed by the writer are not sustained by this additional evidence, although as to the more definite question, it is not as yet evident with which of these jaws the *Kurtodon* maxilla should be placed. The question will be settled by the exposure and study of the crowns of the numerous specimens referred to *Stylodon*. The *Kurtodon* crowns are unlike those of *Amblotherium soricinum* or of *Achyrodon* since the summit is much broader and the wearing surface, instead of being trenchant, is grinding, as previously described, (op. cit., p. 109).

Summary.

The principle features of the present contribution are the following: 1, Additional characters of *Amphilestes* and the probable determination of the premolar-molar formula. 2, Additional characters of *Phascolotherium*, suggesting a division between molars and premolars. 3, A review of the *Amphitylus* dentition. 4, The union of *Leptocladus dubius* and *Spalacotherium minus* with *Peramus*, and determination of the mandibular dentition of the latter genus. The molars are tritubercular. 5, The discovery also of apparently tritubercular molars in *Amphitherium* and probable determination of the premolar-molar formula, (confirming Owen's views). 6, Confirming Lydekker's suggestion of the probable union of *Peralestes* with *Spalacotherium*, and of *Peraspalax* with *Amblotherium*. 7, The probable union of *Peraspalax*, *Amblotherium*, *Achyrodon*, *Phascolestes*, *Stylodon* and *Kurtodon*, into two or three genera with a substantially similar molar structure. 8, The correction of the writer's former views as to the family separation of the *Peralestidæ* and probably of the *Kurtodontidæ*.

The general result of the renewed and more extended study of these mammals has thus been, first to reduce the number of genera and eliminate two of the families proposed in the Memoir; second, by the discovery of the molar structure of *Amphitherium* and *Peramus*, to substantially reduce the number of molar types among the English genera to two, viz.: the *triconodont* in *Amphilestes*, *Phascolotherium*, *Triconodon* and probably *Amphitylus*, and the *tritubercular* in all the remaining genera.

This latter result is of great interest in its bearing upon the theory that the molar teeth of all the mammalia have either passed through the tritubercular stage or have been arrested at one of the steps in tooth development leading to this stage.

CONTRIBUTIONS TO THE NATURAL HISTORY OF THE BERMUDA ISLANDS.

BY PROF. ANGELO HEILPRIN.

The following notes on the zoology of a group of islands but little known to the naturalist are based on personal observations, and on collections made during a brief sojourn on the islands during the past summer, in company with a class of students from the Academy of Natural Sciences. But little systematic work, other than that in the departments of ornithology, ichthyology, and botany, had hitherto been done in this remarkably interesting, and typically oceanic, island group, and it was thought that a more critical survey might bring out facts of general interest to the zoological student, and throw some additional light upon the intricate subject of zoogeography. In the results obtained I have not been disappointed. The exuberance of animal life has yielded much that has proved to be new to the systematist, while certain remarkable peculiarities in the distribution of a number of well-known types of animals open up vistas in geographical distribution which appear to me at present to recede into darkness, and, perhaps, tend to draw only more closely the veil over this mysterious subject.

Much of my time was devoted to an examination of geological features, and, indeed, the special object of the journey was to ascertain, in the light of more recent inquiry, what evidence could be obtained from the Bermudas bearing upon the question of the growth and development of coral islands. The substance of my observations in this field will be presented in a future paper. Only a portion of the zoological results is here published, inasmuch as additional material in certain departments, intended to fill in gaps in the inquiry, has been promised by local collectors.

The specimens noted or described in the following pages were mainly obtained through dredgings, which were carried on as well in the outer water as in the smaller interior sounds and lagoons. As might have been anticipated the greatest profusion of animal life was found on the edge of the growing reef itself, the shoals surrounding the cluster of rocks on the northern barrier known as the North Rock. The wealth of forms occurring here almost transcends belief; unfortunately, the combination of limited time at our command and the state of the weather prevented more than a cursory examination of this locality, which is made comfortable for collecting and wading during a partial exposure above water of some three hours. All the dredgings were confined to depths within 16 fathoms, which also represents the greatest sounding made by us in the lagoons.

ACTINOZOA.

The true stone corals of the Bermudas are comprised, as far as we now know, in some twenty-five species, the greater number of which are represented by identical forms in the Bahaman or West Indian seas, The genera thus far indicated are *Oculina*, *Mycedium*, *Astræa*, *Siderastræa*, *Porites*, *Isophyllia*, *Mæandrina*, and *Diploria*. The genus *Madrepora*, one of the commonest of the Bahaman and Floridian corals, appears to be absent. On the south and east side of the island group the outer margin of the growing reef, largely covered by a serpuline and vermetus growth, approaches to within a few hundred feet of the shore, where it breaks the inflowing surf into a white crest. Within the line of these breakers the depth of water is in places as much as ten or twelve fathoms. The brain coral (*Diploria*) and various gorgonians develop here in great profusion, the huge yellow masses of the former appearing almost everywhere at depths of from ten to twenty feet. Vast growths of millepore also cover the shallower bottoms, presenting in the ensemble a wonderful garden of animal development. This profusion of coral growth is, however, surpassed on the north side, where the reef recedes to a distance of some eight or nine miles from the island- shores, enclosing an extensive body of water whose depth is in general about eight or ten fathoms, and more rarely twelve fathoms. Much the same coral growth is indicated here as on the south side, the large brain corals preponderating by their masses. While, probably, the greatest profusion of animal life is really met with on the actual edge of the growing reef, this does not appear to be the case with the corals themselves. At any rate, I was unable to satisfy myself that there was any marked difference to be observed between the marginal growth and that which extends gradually backward from the margin into deep water. Indeed, as far as the brain-corals themselves are concerned, it appeared to me that their largest masses were to be found some distance within the bounding reef, and consquently beyond the breaking action of the surf. This condition is again shown in the comparatively quiet and sheltered waters of Castle Harbor, where portions of the platform-bottom may be said to constitute one almost connected mosaic of huge Diplorias. In so far, therefore, the Bermudas differ from the greater number of coral islands, in which, as is commonly stated, there is a marked deficiency in the coral growth within the bounding area, and an equally marked luxuriance on the crest and outer slope of the reef.

In most places the largest corals do not come nearer than a foot or two feet of the surface of the water, the massive brain-corals rarely appearing in water of less depth than five or six feet. But in the shallows off the North Rock we found *Porites astræoides* almost at the surface in low water, and just off the entrance to Harrington Sound, on the north shore, *Siderastræa galaxea* was covered by only about two inches of water. The borders of Harrington Sound are largely overgrown with species of *Isophyllia*, which likewise approach to within a short distance of the surface. In the greater depths of the Sound we found only Oculina, down to ten fathoms, the dredge-net being frequently caught and reversed by their ramose stems; beyond ten fathoms the dredge usually came up empty.

The following species were obtained by us:

Mycedium fragile, Dana.

Two specimens. North Rock?

Oculina diffusa, Lamk.

Harrington Sound.

Oculina varicosa, Lesueur.

Harrington Sound.

Oculina pallens, Ehrenberg.

Harrington Sound.

I feel satisfied that this species is identical with the preceding, the same stock bearing what might be considered to be typical representatives of both forms.

The amount of variation in the disposition of the calyces, as well as in their individual shape, is very great in this genus, and I am by no means sure that two or three of the other forms of *Oculina* here enumerated represent anything more than varietal modifications. Pourtalès, in his illustrations of the corals of the Florida reefs (Mem. Mus. Comp. Zoology, VII, plates I and II) correctly refers, it seems to me, both types to a single species (*A. varicosa.*)

Oculina speciosa. Edwards and Haime.

Harrington Sound.

Oculina recta. Quelch.

One specimen, from Harrington Sound, which agrees in the special characters of the species from St. Thomas (Quelch. Challenger

Reports, Zoology, XVI, p. 51.) The species does not appear to have been hitherto observed in the Bermudian waters.

Oculina coronalis, Quelch.

Harrington Sound. First described from the Bermudas (Challenger Reports, Zoology, XVI, p. 49.)

Quelch, in his report on the reef-building corals of the Challenger (*op. cit.*, pp. 9 and 49), enumerates as an additional member of the Bermudian fauna the *Oculina Bermudiana* of Duchassaing and Michelotti. I have been unable to find anything in the description or figures furnished by these authors (*Supplément au Mémoire sur les Coralliaires des Antilles*, p. 162, pl. IX, figs. 1, 2—*Memorie della Reale Accad. Scienze di Torino*, Ser. Sec., XXIII, 1866) to distinguish their species from *Oculina speciosa*, nor does it appear to me to be distinct. The characters upon which the form is separated are exceedingly trivial, and well within the amount of variability which is presented by individual specimens of nearly all the species of Oculina. I further believe that *O. coronalis*, and possibly also *O. recta*, will have to be united with *O. speciosa*.

Isophyllia australis? Edwards and Haime.

Three specimens from the North Rock, doubtfully identified with this species.

Isophyllia fragilis? Dana.

I am unable to satisfy myself as to the positive existence of this species in Bermuda, although Quelch refers to a single specimen having been obtained there by the Challenger party. This authority doubtfully refers one of the forms figured by Pourtalès (*op. cit.*, pl. VII, fig. 3) as *I. dipsacea* to Dana's species, but from an examination of a number of Bermudian specimens which agree absolutely with Pourtalès's figure I am fairly convinced that this identification is incorrect. The specimens do certainly not agree sufficiently with Dana's description, and if they are not the types of a distinct species, then they represent probably only a certain phase of development of *I. dipsacea*, as in indicated by Pourtalès.

Isophyllia dipsacea, Dana.

Three specimens, from Castle Harbor.

Isophyllia strigosa, Duchassaing and Michelotti.

A number of specimens, from Harrington Sound, which agree with the description of this species. I am doubtful as to the species being distinct from *Isophyllia dipsacea;* possibly, however, some of the varieties (so-called) of the latter species figured by Pourtalès are really members of this species. Its principal distinguishing characters appear to be the thinner and more irregular septa, and the terminal cleft that indents or separates the septa of opposing calyces where they cross the common wall. It also presents a more bristling appearance than *I. dipsacea*.

Isophyllia Guadeloupensis, Pourtalès.

One specimen. This appears to be a good species, although by Quelch it is referred to *Isophyllia strigosa*.

In addition to these forms Quelch enumerates *Isophyllia* (*Symphyllia*) *marginata*, *I. cylindrica*, and *I. Knoxi*, all of Duchassaing and Michelotti, as having been obtained at the Bermudas, but I have failed to detect any specimens among our collections which can be confidently referred to these species. On the other hand, I find one or two forms which I have not yet been able to identify with any described forms.

Siderastræa galaxea, Ellis and Solander.

Abundant on the shoals of Gallows Island, near the mouth of Flatts Inlet, where the colonies come to within about two inches of the surface; also on the borders of Harrington Sound.

Porites clavaria, Lamk.

Two specimens, dredged in Harrington Sound.

Porites astræoides, Lamk.

We found this species very abundantly along the outer reef, especially on the flats of the North Rock, where it is the dominant form of coral. The species appears to have been overlooked by the Challenger party, and indeed, the only reference that I have been able to find indicating the occurrence of this common West Indian form among the Bermudas is contained in Mr. Rathbun's list of the species of Porites in the United States National Museum (Proc. U. S. National Museum, 1887, p. 354).

Mæandrina labyrinthica, Ellis and Solander.

Three specimens, from the North Rock.

Mæandrina strigosa, Dana.

This form is represented by large, sub-globose specimens, one of which, obtained through purchase, and probably from Castle Harbor, has an exceedingly attenuated base of attachment. The corallum is thus openly turbinate, or even pediculate, and exhibits in regularly scalariform outline the successive stages of outward development.

Diploria cerebriformis, Lamk.

This species is exceedingly abundant in the shoals lying to the leeward of the marginal reef, where its huge hemispherical or reniform masses of bright orange, measuring as much as four or five feet in diameter, can be distinctly seen through the transparent waters at depths of from six to fifteen or twenty feet. I cannot say how much further down the species extends. It is equally abundant in Castle Harbor, where it is largely instrumental in building out the shore-platform which, at a moderate distance from the shore, descends vertically into deeper water. When attached by a contracted base, the brain-coral may be readily removed from its moorings; but where the base is largely co-extensive with the under-surface of the corallum the difficulties of removal are very great, necessitating much undercutting with a chisel. The largest specimen obtained by us measured about 28 inches acrcss; our efforts to dislodge a specimen about four feet in diameter proved unsuccessful.

Diploria Stokesi, Edwards and Haime.

We obtained a number of specimens of this species in Castle Harbor and through presentation; for the latter my thanks are due to Miss A. Peniston, of Penistons. The habitat of the species, as far as I am aware, had not hitherto been noted. Edwards and Haime in their description of the species (*Hist. Nat. des Coralliaires*, II, p. 403, pl. D, fig. 3) state "*Patrie inconnue.*" I believe it may be assumed that this species is the form described and figured by Knorr as *Madrepora labyrinthiformis* (*Deliciæ Naturæ Selectæ*, I, p. 18, Pl. A 4, fig. 1). In our collections we have a closely related, and possibly identical species, which assumes a ring form, and in which the peculiar calycular hollows of *D. Stokesi* run out into parallel transverse grooves on the inner side of the ring.

ALCYONARIA.

The gorgonians are abundant in the waters inside of the bounding reef, whence nearly all our specimens were obtained. A few were nipped up on the south side of Castle Harbor, and at the passage way conducting from the north into that body of water.

Rhipidogorgia flabellum, Valenciennes.

The purple variety of this species is abundant more particularly in the northern waters, both near the outer reef and on the shallows known as Devonshire Flats. We failed to obtain any of the yellow forms, and I am not positive that this variety has ever been found at the Bermudas.

Gorgonia (Plexaura) purpurea, Pallas.

Gorgonia (Plexaura) flexuosa, Lamouroux.

This species, of which we obtained several specimens, is, I believe, without doubt the *Gorgonia anguiculus* of Dana (U. S. Exploring Expedition, Zoophytes, p. 668). It is referred to under Lamouroux's name as a member of the Bermudian fauna in Dana's "Corals and Coral Islands," p. 114, 1872.

Gorgonia (Plexaura) homomalla, Esper.

Gorgonia (Plexaura) multicauda, Lam.

(*Gorgonia crassa*, Ellis and Solander.)

(*G. vermiculata*, Edwards and Haime.)

The exact limitations and synonymy of this species are difficult to make out, but as far as my studies have permitted me to analyze the forms above indicated from the rather insufficient or deficient descriptions that have been furnished by their authors, they appear to represent an identical form. As such as I have accordingly referred them in this list.

Gorgonia (Plexaura) dichotoma, Esper.

A single specimen, measuring about a foot and three-quarters in height, with the main stems somewhat over a half-inch in diameter.

Gorgonia (Eunicea) pseudo-antipathes, Lam.

One much branched specimen, and another, slightly differing, which appears to belong to the same species.

Pterogorgia acerosa, (?) Pallas.

A single specimen of a large Pterogorgia, entirely stripped of cœnenchyma, and measuring about two and a-half feet in height, was obtained through purchase at the Crawl. The axial skeleton is yellowish, or of the color of earth. The terete branches are much more broadly spreading than in *P. setosa*, and unite into a common basal stalk which is upwards of two inches in thickness. The pinnules are very numerous, exceedingly slender, and pendulous, giving to the whole organism the decided appearance of a weeping-willow.

I have not been able to satisfy myself as to the exact affinities of this species. It appears to differ broadly from the common purple sea-feather of the West Indies, and does not have the depressed branches which are assumed for Esper's *Pterogorgia acerosa.* It is, however, with little doubt one of the forms that are included by Pallas in his *Gorgonia acerosa* (*Quercus marina Theophrasti*), and may be the one that is referred to by Milne-Edwards as *Pterogorgia Sloanei.*

Of the species of gorgonians above enumerated Dana indicates *Rhipidogorgia flabellum, Gorgonia flexuosa, G. homomalla,* and *G. crassa* as coming from the Bermudas ("Corals and Coral Islands," p. 114). I find no mention in any more recent work of the occurence there of either *Gorgonia pseudo–antipathes* or *G. dichotoma.* On the other hand, we failed to obtain the *Pterogorgia Americana* mentioned by Dana.

ZOANTHIDÆ.

Of the zoanthoid forms of actinians we collected three species, *Palythoa* (*Corticifera*) *glareola*, Lesueur, *P. ocellata*, Ellis and Solander, and a species of *Zoantha*, closely related to *Z. sociata*, but possibly new. The first of these species was found in large encrusting masses at the North Rock, partially exposed at low water. The glary white or yellowish crusts were nearly half an inch in thickness. *Palythoa ocellata* also occurs, but more sparingly, at the same locality; on the western exposure of Gallows Island, at the entrance to Flatts Inlet, it was much more abundant, forming large patches in association with *Siderastræa galaxea.* The species of Zoantha was sparingly developed off Gallows Island, but in one or more rock-hollows in Tucker's Town Bay, Castle Harbor, the bright green colonies of this beautiful polyp were plentiful.

ECHINODERMATA.

HOLOTHURIA.

The animals of this order are in places excessively abundant; indeed, excepting the corals, they may be said to constitute the most distinctive feature of the fauna of the sand bottoms. Where other forms are apparently entirely absent, the black masses of the great Stichopus stand out in prominent relief over the white bottom. Motionless, seemingly, during the greater part of their existence, these singular creatures present the appearance of big black blotches on the sand, of which they consume, whether for nourishment or otherwise, vast quantities. All the individuals that were opened had their intestinal canal, or more properly, their entire digestive tracts, completely choked with calcareous particles.

The following are the species of holothurians observed by us, only one of which, I believe, had hitherto been noted from the Bermudas:

Holothuria Floridana, Pourtalès. (**Holothuria atra**, Jäger.) Pl. 14, figs. 6, 6a, 7, 7a.

I identify with this species five small individuals of an olive-green color which were obtained in Castle Harbor, and which in a general way agree with the description of the species given by Pourtalès (Proc. American Assoc., 1851, p. 12). Unfortunately, no figure accompanies the description, and that part which pertains to the calcareous bodies embodied in the skin is too vague to permit of specific determination. Selenka (*Zeitschrift für wissenschaftliche Zoologie*, xvii, p. 324, 1867) has supplemented the original description with further details of structure and with illustrations of the spicules, which practically leave no doubt in my mind that the Bermudian forms, even though differing somewhat from the type described by Pourtalès, are really that species. I have examined the spicular bodies of all the individuals, and find that they exhibit considerable variation (Pl. 14, figs. 6, 6*a*, 7, 7*a*). This is especially noticeable in the form of the stools. I really doubt if very much dependence can be placed upon these bodies as furnishing characters for specific distinction. I also find a certain amount of variation in the number of tentacles. Thus, while four of the individuals have the normal number of tentacles, 20, one has only 10, although in all other essentials of structure it agrees with the remaining four. The dorsal surface is distinctly papillate. The elongated yellowish pedicels of the ventral surface are irregularly distributed, as stated by Selenka, and I could not determine any strictly linear disposition such as in indicated by Pourtalès.

The largest specimen measures about two and a half inches.

Semper, Ludwig, and Lampert (*Die Seewalzen*, Semper's *Reisen im Archipel der Philippinen*, 1885, p. 86) identify this species with the *Holothuria atra* of Jäger (1833), whose range is made to be practically cosmopolitan—extending from the Radack Archipelago and the Sandwich Islands to Adelaide, Zanzibar, the Red Sea, and the

West Indies—but on this point I can offer no satisfactory evidence, never having had an opportunity to examine authentic specimens of Jäger's species.

Holothuria captiva, Ludwig. (Pl. 14, figs. 4, 4a)

Two individuals, agreeing with the species described by Ludwig from the Barbados.

Holothuria abbreviata, n. sp. (Pl. 14, figs. 5, 8, 8a.)

Among the smaller forms of holothurians is one which in many of its characters agrees most closely with Ludwig's *H. captiva*, but yet differs to such an extent as to compel me to recognize it as a distinct species. Indeed, by many systematists it would probably be made the type of a distinct sub-genus or genus. The distinguishing peculiarity is the abrupt truncation of the body, which carries the vent on the dorsal surface, immediately about the extremital border. In the single specimen before me I could determine only 17 tentacles, with as many tentacular vesicles, and but a single Polian body. A large Cuvierian bundle is present. The pedicels are arranged ventrally in three more or less distinct rows. Color olive green. Length about two inches.

The stools, buttons, and fenestrated plates of the pedicels are figured on plate 14. It will be seen that in general they bear a close resemblance to those of *Holothuria captiva*, but the rounded summits of the stools serve readily to distinguish them from the somewhat similar, but more strictly castellated, bodies of the other species.

SEMPERIA.

Semperia Bermudensis, n. sp. (Pl. 14, figs. 2, 2a, 3.)

Body cylindrical, spindle-shaped, tapering almost equally to both extremities. Tentacles 10, of which 4 are shorter than the remaining 6; pedicels crowded, arranged in five broad rows, and scattered over the interambulacral areas; two genital bundles, with very numerous non-divided, and greatly elongated filaments; two Polian vesicles; two long respiratory trees. Color greyish white, minutely speckled with brown; five narrow longitudinal brown bands separating the ambulacral areas. Length about 3½ inches.

Calcareous bodies consisting of baskets, knotted and smooth buttons, and perforated more or less circular disks; pedicels with fenestrated plates. Calcareous ring with long back processes for the attachment of the powerful retracted muscles.

One specimen, from the north shore about a half-mile west of Flatts Village.

I first mistook this species for the *Semperia* (*Colochirus*) *gemmata* of Pourtalès (Proc. Amer. Assoc., 1851, p. 11), described from Sullivan's Island, coast of South Carolina, but the more exact descriptions and figures of that species given by Selenka and Lampert convince me that it is quite distinct. Both species are of a greyish-white color, but no mention is made by either of the authors above quoted of the existence in the Carolinian form of the five longitudinal brown bands which extend over the entire length of the Bermudian species. Apart from this, *Semperia Bermudensis* differs in the disposition of the tentacles, the greater number of Polian vesicles, and the character of the spicular buttons, which are in the greater number of instances strongly knotted. The posterior processes of the calcareous ring appear also to be much more elongated.

From *Semperia* (*Cucumaria*) *punctata*, described by Ludwig from the Barbados (*Arbeiten aus dem zoolog. zootom. Instituts in Würzburg*, ii, 1875, p. 82) the species differs, apart from the general scheme of coloring—tentacles as well as body—in the different disposition of the tentacles (9 equal in *S. punctata*. according to Ludwig), the smaller number of Polian vesicles (5 in *S. punctata*), and in the much greater number of filaments composing the genital bundles. The vent does not appear to have been rayed.

Ludwig states that there are in his species no calcareous eeth about the anal aperture, whereas Lampert just as positively asserts that they are present (Semper, *Philippinen*, 1885, p. 152). None such were detected in the Bermudian form.

STICHOPUS.

Stichopus diaboli, n. sp. (Pl. 15, Figs. 1, 1a, 1b, 2.)

Body stout, more or less quadrangular, flattened ventrally, and bearing two rows of prominent marginal, wart-like, tubercles; sometimes two additional rows of minor tubercles are noticeable on the lateral margins of the dorsum. Tentacles 20, unequal. Dorsal papillæ scattered, not prominent, leaving the surface nearly smooth. Pedicels and papillæ on ventral surface arranged in three broad bands, which are more or less distinct for the entire length of the body, but most distinct near the extremities; numerous in each transverse row.

The body-cavity is largely occupied by the greatly developed, and finely dissected, respiratory apparatus, and by the loops of the variously branched genital organs, which are disposed in two great bundles. Tentacular vesicles present. Two Polian vesicles. Calcareous ring with long back processes.

Calcareous bodies in the form of stools very numerous (Pl. 15, fig. 16.) C–shaped bodies very scanty, and possibly in some cases entirely wanting.

Color black, somewhat more intensely so on the dorsal surface, becoming Vandyke brown or chocolate in alcohol.

Length, about one foot; width of corresponding animal about three inches.

Abundant over the sandy floor of the entrance to Harrington Sound, opposite Flatts Village, in Harrington Sound, and in Castle Harbor, whence it was obtained in several of our dredgings.

I have little doubt that this species is the dark-brown form which is referred to by Théel as having been obtained by the officers of the Challenger at the Bermudas, and which is doubtfully referred by that authority to Semper's *Stichopus Haytiensis* (Report on the Holothuroidea, Challenger Reports, Zoology, XIV, p. 162.) But a single specimen appears to have been obtained, which when examined was too deformed to permit of positive specific determination. I cannot agree with Théel's determination. Apart from the differences which Théel himself points out, is the great diffierence in coloring. Semper (*Reisen, Philippinen, Holothurien*, 1868, p. 75) states that his species is dark chocolate-brown, blotched with yellow spots, which form five longitudinal bands, corresponding to the interradii. No such coloration is visible in our species, although probably we observed as many as a hundred individuals, all of which were uniformly black. Semper's description of the coloring of *Stichopus Haytiensis* is restated by Lampert.

Stichopus xanthomela, n. sp. (Pl. 14, fig. 1; Pl. 15, fig. 3.)

Body stout, flattened ventrally, and bearing on the basal margin two rows (one row on each side, as in the preceding species) of prominent wart-like processes. Tentacles 18, unequal, whitish or gray, edged with brown., Dorsal papillæ fairly prominent, scattered. Pedicels on ventral surface crowded, arranged in three longitudinal series, five to eight, or more, in each transverse row.

Body-cavity, as in the preceding, largely occupied by the respiraatory tree and the double genital bundle, the filamental processes of the latter much finer than in *S. diaboli*. Tentacular vesicles present. One (?) Polian vesicle.

Calcareous bodies, in the form of stools (Pl. 15, fig. 3), very numerous. C–shaped bodies scarce, in the form of broadly-opened calipers. Ground-color reddish-yellow, irregularly blotched with black or very dark brown. The spots on the ventral surface more or less coalescent in the median line, forming there a broad longitudinal band, or entirely united to form a uniformly dark-colored base; on the back, united into two irregularly ramifying or wandering bands.

Length of longest specimen about ten inches; width about two and a-half or three inches.

The same habitat as that of the preceding species, although apparently much less abundant.

I strongly suspect that this is the form which Théel, in his report on the Challenger holothurians (*loc. cit.*, p. 159), identifies with *Stichopus Möbii* (Semper), one specimen of which, "rather deformed and compressed" when examined by Théel, was obtained at the Bermudas. I assume the identity in this case, as well as in that of the preceding species, on the ground that the two species here described are the characteristic forms of the archipelago, and it is barely possible that they could have escaped the attention of the Challenger people. But the identification with Semper's species appears to me to be erroneous. The resemblance to *Stichopus Möbii* appears to rest almost wholly upon the form of the spicules, which are largely similar in many very distinct forms of *Stichopus*, and in a general scheme of coloring. But Semper distinctly states (*Holothurien*, *loc. cit.*, p. 246) that the characteristic spots are almost wholly wanting on the ventral surface, and no mention is made of their occurrence there by Lampert, in his revision of the species of the genus (*op. cit.*, p. 108.) Moreover, Semper affirms that the body is devoid of wart-like tubercles, whereas such are quite prominent in the Bermudian form, although not as prominent as in *Stichopus diaboli*. Théel, however, makes no mention of the occurrence of tubercles in his single specimen, but probably through contraction in alcohol their existence had been effaced. The number of pedicels in each transverse row seems also to be much more numerous in the Bermudian species than in *Stichopus Möbii*.

Another apparently related form is *Stichopus errans* of Ludwig (*Arbeiten zoolog. zootom. Inst.*, *Würzburg*, 1875, p. 97), described from a specimen in the Hamburg Museum, reputed to have come from the Barbados. But in this species there appear likewise to be no lateral tubercles, nor is the coloring like that of our species, although in this regard there may be considerable variation. The number of tentacles is stated by Ludwig to be 19, and their color yellow. The form from the Barbados which is somewhat doubtfully referred by Théel (*loc. cit.*, p. 191) to Ludwig's *S. errans* would seem to be more nearly related to the Bermudian species.

ASTEROIDEA.

We obtained but a single species of star-fish on the Bermudian coast. This is the *Asterias Atlantica* of Verrill, a form which had already been previously noted from the Bermudas (Trans. Conn. Acad. Sciences, i, p. 368), and whose range extends to the Abrolhos Reef, Brazil. With very few exceptions the rays were either six or eight in number, and of the total number of individuals examined I believe that not over two had five arms. The species exhibits a marked want of constancy in ornamentation and coloring, the dorsal spines being in some cases acute, while in others they are terminated by a minute bead; again, while the maculation is brown in some individuals, in others it is blue, or of both colors combined.

Asterias Atlantica, Verrill.

Common in the entrance to Harrington Sound, opposite Flatts Village—under stones; dredged in Harrington Sound.

Ophidiaster Guildingii, Gray.

This species, which was first described from St. Thomas, is apparently a member of the Bermudian fauna. A single specimen, marked as having been collected by Mr. Janney in the Bermudas, is in the possession of the Academy of Natural Sciences.

OPHIUROIDEA.

Six species of ophiurians were obtained in our dredgings and under rock shelters, the greater number of which, as far as I am aware, had not hitherto been reported from the Bermudas. For a critical examination and review of the species I am indebted mainly to my assistant, Mr. J. E. Ives, who has made a careful study of all the species in the collections of the Academy of Natural Sciences. From an examination of many of these forms I feel satisfied that too much dependence should not be placed upon the constancy in minute details of either the form or relative size of the arm plates and their appendages, nor upon an exact scheme of coloration. These characters, and others that may be added, which have been drawn in very close limits by Mr. Lyman in his several memoirs, vary materially within the limits of the same individual, and render the discrimination of species which have been most "elaborately" defined as to exact lengths and breadths of the arm-shields and oval plates, the precise form and number of the arm spines, etc., a matter of almost hopeless possibility.

Ophiocoma crassispina, Say.

One specimen, taken at low water from the North Rock, which agrees perfectly with the species described by Say from the coast of Florida (Journ. Acad. Nat. Sci., Phila. v, p. 147). This species is generally considered to be identical with the *Ophiocoma* (*Ophiura*) *echinata* of Lamarck, but I am disposed to consider this identification erroneous, unless, indeed, several distinct forms, as has been averred by Müller and Troschel (*System der Asteriden*, 1842, p. 98), were included by Lamarck in his species. Two distinct forms, closely related to each other, certainly do occur in the West Indies, one of which, with more blunt arm spines, is clearly Say's species, while the other, with more elongated arm spines, and much less stoutly developed uppermost spine, more nearly corresponds to the general type of Lamarck's species.

Ophiocoma pumila, Lütken.

A fragmentary specimen; exact locality unknown. This species had been recorded by the Challenger from Bermuda.

Ophiostigma isacantha, Say.

Two very young specimens, dredged in Harrington Sound.

Ophiactis Krebsii, Lütken.

O. Mülleri, Lütken?

Two very young specimens, dredged on the north shore between Bailey's Bay and Shelly Bay, which manifestly belong to one or the other of the above species, although partaking of the characters of both. They agree with *O. Krebsii* in having a lobe to the outer edge of some of the upper arm plates, and in the banded character of the arms, while they differ from that species in having but four arm spines. In this respect they agree with *O. Mülleri*. Possibly the two species are only varieties of the same form.

Ophionereis reticulata, Lütken.

Very abundant at low tide in the rock shelters of Shelly Bay: also under stones at the entrance to Harrington Sound.

Ophiomyxa flaccida, Lütken.

One specimen, dredged in Bailey's Bay.

ECHINOIDEA.

The number of species of echinoids observed by us is six, of which five had already previously been ascribed to the archipelago; *Cidaris tribuloides*, as far as I am aware, had not hitherto been collected—at any rate I have been unable to find any mention of its occurrence there. One species, *Mellita sexforis*, we did not ourselves collect, the specimens in our possession having been kindly donated to us by local collectors.

Cidaris tribuloides, Bl.

Fairly abundant among the coral shelters of the North Rock.

Diadema setosa, Gray.

This species, one of the gems among sea-urchins, is exceedingly abundant in the flats about the North Rock, where, in magnificent contrast to the wealth of color by which it is surrounded, its ebony-black masses stand out in prominent relief from the coral shelters which it inhabits. All the individuals occupied recesses in the coral growth, which they had by some means probably managed to keep open. It seems hardly likely that they should have crept into these shelters after they had been already formed, and that the association is one of mere selection. It is a noteworthy fact that while most of the animal forms inhabiting this portion of the growing reef were brilliantly colored, harmonizing with, and shielding, one another by their party tints of red, yellow, purple, and green, these urchins were alone conspicuous by the absence of any such protective cloak; but just in their case no protective guise in the form of coloring would be needed, inasmuch as these animals are abundantly able to shield themselves by means of their extremely attenuated spines.

This species is also abundant in the moderately deep water that lies within the reef border.

Hipponoë esculenta, Leske.

North Rock, and the deeper water within the growing reef.

Echinometra subangularis, Leske.

Several specimens from the flats about the North Rock. There is a certain amount of variation in the coloration of the spines, which ranges from olive or sea-green to purple.

Toxopneustes variegatus, Lamk.

We found this species very abundantly in Harrington Sound, where it rarely escaped being hauled up in our dredge. It seems to frequent the calcareous bottom to a depth of 10–12 fathoms, or even more. Probably the species is equally abundant elsewhere.

Mellita sexforis, Agassiz.

As before remarked, we did not ourselves obtain any specimens of this species. It is said to be abundant along the calcareous bottoms of some of the inlets, as, for example, opposite Flatts Village.

CRUSTACEA.

For the following notes on the Crustacea I am principally indebted to Mr. Witmer Stone, one of my assistants on the trip, who has made a careful study of all our specimens, as well as of the allied and identical species contained in the collections of the Academy of Natural Sciences. In the case of in any way doubtful forms I have personally satisfied myself as to the determinations, and particularly in cases where the geographical range appeared to indicate possible or probable error. The occurrence in the Bermudas of a number of what had hitherto been considered to be distinctively Pacific or Old World types, as for example, *Palemonella tenuipes* (Sooloo Sea), *Palemon affinis* (Pacific), *Penæus velutinus* (Pacific)—may be considered positive, even though it be opposed to the common facts of zoogeography. But this anomaly in distribution is again repeated among the mollusca, as will be seen in the enumeration of species in a future paper.

The total number of species here enumerated is not very large, but yet it is considerably in excess of the number published in any previous paper, probably one-half of the species being now for the first time credited to the Bermudas. The species of some of the remaining groups—the Isopoda, Amphipoda—still await analysis and determination.

BRACHYURA.

Microphrys bicornutus, Latr.

Three females and one male, collected on the beach at the entrance to Harrington Sound.

Mithraculus hirsutipes, Kingsley.

Two males and one small female, which agree in every way with the description of the species given by Kingsley (Proc. Bost. Soc. Nat. Hist., 20, p. 147), except in the number of teeth on the fingers, a character which appears to be very variable. The three individuals differ in this respect among themselves.

Actæa setigera, Milne-Edwards.

One male dredged off Shelly Bay. The individual differs from the description given by Milne-Edwards (*Nouv. Arch. du Mus. d'Hist. Nat.*, i, p. 271, pl. xviii, fig. 2) in having the color of the outside ot the hands red, instead of black. It however agrees precisely with specimens attributed to Milne-Edwards' species in the collections of the Academy, and labeled as coming from the Florida reefs. The species has also been recorded fiom Cuba.

Panopæus Herbstii, var. **serrata**, De Saussen.

Numerous small specimens, both male and female, from under stones on the beach of St. George's Causeway, and at the mouth of Harrington Sound. The specimens vary greatly in color, some being very light, others dark brown, while a few are reddish; otherwise they are identical in structure.

The species, described in the *Hist. Nat. du Mexique et des Antilles* (*Crustac.*, p. 16, pl. 1, fig. 7), had previously been recorded from the Bermudas.

Lobopilumnis Agassizii, Stimpson.

One small male, agreeing well with Stimpson's description (Bull. Mus. Comp. Zool., ii, p. 142) except in that it lacks the subhepatic spine. Recorded from Bermuda and Florida.

Neptunus hastatus, L.

(*N. dicanthus.*)

Two small males.

Geocarcinus lateralis, Frem.

Numerous large specimens, from the banks and fields near the south shore. We found them specially abundant near the locality known as Spanish Mark or the Chequer Board, and again not far from Peniston Pond. The burrows in places extend diagonally three or four feet, or even more, beneath the surface, and the animals, rapidly retreating into these, are frequently difficult of capture.

This is, doubtless, the species that is referred to by Willemoës Suhm in the Challenger narrative as *Gecarcinus lateralis*, and is apparently the *G. lagostoma* (?) described by Miers in the systematic portion of the Challenger Reports (Zoology, XVII, p. 218), in so far as this description applies to the single Bermuda specimen.

Nautilograpsus minutus, L.

One small specimen dredged off Shelly Bay.

Grapsus maculatus, Catesby.

One large female, and numerous empty shells from Harris's Bay, south shore.

Pachygrapsus transversus, Gibbes.

Numerous specimens, including ovigerous females; very abundant on the rocks about the mouth of Harrington Sound, and also on the Pigeon Rocks, Bailey's Bay.

Recorded from Florida, West Indies, Australia.

Cyclograpsus integer, Milne-Edwards.

One small female. Species recorded from Brazil and Florida.

Goniopsis cruentatus, Latr.

One female, from the mangrove swamp of Hungary Bay, south shore. Although the species was very abundant at this locality we only succeeded in catching a single individual. The mangrove crab, or "mangrove climber" as the animal is sometimes called, burrows among the thickets of mangrove stems and roots, up which it not infrequently climbs to a height of several feet. The great similarity existing between its coloring and that of the bright and partially withered leaves of the mangrove, especially in the shades of yellow and red, renders the animal difficult of detection, and often at a distance of only a few feet, buried among the fallen leaves, these agile creatures escaped observation, even when attentively sought after. We have here one of the most remarkable instances of protective coloring, or semi-mimicry, with which I am acquainted.

Sesarme cinerea, Bosc.

Numerous specimens, from the beach of Flatts Village. The species was seen almost everywhere scampering over the rocks.

Calappa fiammea, Herbst.

A single male individual obtained through purchase. Species previously recorded from the Bermudas.

ANOMURA.

Petrolisthes armata, Gibbes.

Five specimens, obtained on the beach of Flatts Village, appear to be identical with the form described under this name from Florida, (Proc. Amer. Assoc., 1850, p. 190.)

Cenobita Diogenes, Latr.

A number of living specimens obtained at Wistowe, opposite Flatts Village, and kindly presented to us by Miss Edith Allen, daughter of the American Consul. Most of the animals are still living (October), and apparently flourishing, three months after their capture. The shells occupied by the largest individuals are those of *Natica catenoides.*

Calcinus obscurus, Stimpson.

Several specimens obtained on the beach of Flatts Village.

Clibenarius (Pagurus) tricolor, Gibbes.

Numerous on the beach of Flatts Village and at the St. George's Causeway; under stones, etc.

MACRURA.

Palinurus Americanus, Lamk.

We observed a number of specimens of the large Bermuda crayfish, but unfortunately obtained none. I am unable, therefore, to state positively if the species is correctly referred, but in all probability it is the same as the common West Indian form.

Scyllarus sculptus, Milne-Edwards.

One specimen, purchased at the Crawl, which agrees with Milne-Edwards' description (*Hist. Nat. des Crust.*, ii, p. 283) and Lamarck's illustration in the *Encyclopédie,* pl. 320. The locality of the original specimen appears to have been unknown, nor have I been able to obtain data regarding this species from any of the later writers, by many of whom it is entirely ignored.

Alpheus avarus, Fabr.

(*A. Edwardsii,* Audouin.)

(*A. Bermudensis*, Spence Bate.)

A series of some twenty specimens collected at the same locality shows considerable variety of form. The smaller specimens are evidently the *A. Bermudensis* of the Challenger Reports, while the larger ones, agreeing with these in the structure of the head, etc., more nearly approximate in the configuration of the hand *A. avarus* and *A. Edwardsii,* the former a common Old World species, and the latter, a species described from the Cape Verde Islands. Our series contains what might be considered undoubted representatives of all three (so-called) species, showing all the gradations that unite or separate the forms from one another. Hence, I am constrained to look upon them as mere varietal forms of a single species, the *Alpheus avarus* of Fabricius. The older the specimens, the more deeply grooved is in most cases the hand.

Alpheus minus, Say.

A number of species taken from sponges and tunicates collected in Harrington Sound. All the individuals were of small size, measuring rather less than an inch in length, although the females were abundantly provided with eggs.

Alpheus formosus, Gibbes.

One specimen (dredged) which agrees well with Gibbes' description (Proc. Amer. Assoc., 1850, p. 196), and seems to indicate that the species is distinct from *Alpheus minus*, with which it is united by Kingsley. The specimen is larger than any of the individuals of *A. minus*, and is also differently colored, although appearing identical in alcohol.

Palæmonella tenuipes, Dana.

Several specimens dredged off Shelly Bay, which agree perfectly with the species described by Dana from the Sooloo Sea (U. S. Exploring Expedition, Crustacea, p. 582). The remarkable distribution here indicated induced me to make a very careful examination of the Bermudian species, which has left no doubt in my mind as to the identity of the forms from the antipodal region of the earth's surface. The only other known species of Palæmonella, *P. orientalis* (Dana), is likewise an inhabitant of the Sooloo Sea (Dana, *op. cit.*; Spence Bate, Challenger Reports, Zoology, XXIV, p. 786).

Palæmon affinis, Milne-Edwards.

Numerous specimens from shallow water, Castle Harbor. All are exactly like one another, except in the number of teeth on the beak, which may be 8 above and 4 below, or in the relations of 8–3, 7–3, 9–3, and 9–4. This character is manifestly a very variable one, and, therefore, of little or no value from a classificatory point of view. The specimens agree well with the descriptions and figures of *A. affinis*, although that species has hitherto been recorded, as far as I am aware, only from the Pacific (obtained by Dana off New Zealand) The species is near to the Eurafrican *P. squilla*, but yet sufficiently distinct to permit of ready recognition as only an allied form.

It is remarkable, in view of the distribution and the number of specimens that we obtained of this species, and the position of the island group, that we should have failed to obtain any individuals of the common form of the eastern United States, *Palæmon vulgaris*. Whether the species is entirely absent or not I cannot of course say, but it is surprising that it should not have been observed by us.

Penæus velutinus, Dana.

One specimen, which agrees with the figure and description of the species obtained by Dana off the Sandwich Islands (U. S. Exploring Expedition, Crustacea, p. 604), and which was subsequently collected by the Challenger party at various points in the Pacific, and between Australia and New Guinea (Challenger Reports, Zoology, XXIV, p. 253). This species, as well as all the immediately related forms, has, as far as I know, been found thus far only in the Pacific. The case is, therefore, another example of remarkable geographical distribution.

STOMATOPODA.

Gonodactylus chiragra, Latr.

One specimen from the beach of Flatts Village.

MOLLUSCA.

The enumeration of species of molluscous animals is left for a future paper, as our collections, large as they are, are doubtless in great part deficient. Through the kind energies of local collectors I hope to supplement at an early day the material obtained by us, and to present, as nearly as is possible, a full list of the species inhabiting the Bermudian waters. We ourselves collected some 110 or 120 marine species, which is largely in excess of the number that has thus far been chronicled in any list of Bermudian species, but the examination of private collections in the islands satisfies me that there must be an additional 30 or 40 species, or more, that are common to the island group.

It is a well-known fact that the Bermudian molluscan fauna is distinctly, and it might be said, overwhelmingly Antillean in character, by far the greater number of species being found in the Bahaman and West Indian Seas, or along some part of the coast of Florida. The practically total absence of species of the Eastern United States which are not found in the Floridian waters is astonishing, and shows how insuperable is the barrier which the waters of the Atlantic, and of the Gulf Stream particularly, offer to a free migration or dispersion of the species. This, again, appears the more remarkable in the light of certain anomalies of distribution which a critical examination of the species reveals, and which had already in many cases been noted as a characteristic of the West Indian fauna. Thus, of the various species of Triton, *Triton chlorostoma* and *T. tuberosus* are members of the Mauritian fauna, and *Triton cynocephalus* and *T. pileare* of the fauna of the Philippines; *Ranella cruentata* crops up in the variety *R. rhodostoma*, from Mauritius. Again, *Epidromus concinnus*, from the Philippines, is represented in our collections by a number of individuals which are absolutely undistinguishable, both in shell ornamentation and color-markings, from the Pacific specimens, although they differ somewhat from the closely related *E. Swifti*, from Antigua. A number of other forms, common to the west coast of Africa and to the southern waters of Europe, also occur. Among a number of American west coast species which, I believe, have not hitherto been recorded from the Atlantic may be mentioned *Chama exogyra* and *Tellina Gouldii*, both from the Californian coast. In the case of both of these forms I have very carefully satisfied myself as to absolute identity. *Arca solida* from the west coast does not appear to differ measurably from *A. Adamsii*, a West Indian form which has its representative in the Bermudian fauna.

The following notes on new species are given in advance of the publication of the full list.

CEPHALOPODA.

Cuttle-fishes are said to be abundant in the Bermudian waters, but we were not very successful in our search after these animals. Two moderately large octopods, which we could only see, but not obtain, may possibly be the common West Indian *Octopus vulgaris*, or one of the forms that have been separated off from it as a distinct species. We made considerable efforts to capture one of these, but all our attempts to dislodge the creature from its hold upon the interior of a rock crevice were unavailing. The following species was obtained beneath a stone on the beach of Flatts Village.

Octopus chromatus, n. sp. (Pl. 16, fig. 1.)

Body spheroidal, somewhat acuminate behind, and impressed, but not furrowed, ventrally; mantle opening extending about one-half around the circumference of the body, and terminating some distance below and back of the eyes. The head not much narrower than the body; eyes not conspicuous, with a wart above each; funnel largely free, reaching about half way to the base of the web, which is about as long as the body and head combined.

Arms longest as 1. 3. 2. 4, although possibly the second pair outmeasured the third pair previous to contraction; slender, very tapering, and exceedingly attenuated toward the apex; suckers fairly large, closely placed, and in regular zigzag alternation from the base, contracting with a quadrangular outline.

Body granulated posteriorly, and to a less extent in the region of the neck. Color milky, closely blotched or speckled with ochre, giving a yellowish appearance, and sprinkled with brown.

Length of specimen about nine or ten inches.

The only form with which I can closely compare this species is the *Octopus Bermudensis* of Hoyle (Challenger Reports, Zoology, XVI, p. 94, Pl. II, fig. 5), which is described from a single young specimen, measuring, including the arms, not more than two and a-half or three inches. It differs from this form in the extremely tapering and attenuated arms, their relative lengths (1. 3. 2. 4 instead 1. 2. 3. 4), and in the disposition of the acetabula, which are in zigzag alternation from first almost to last; the body is also in part granulated, and the siphon, instead of being attached for nearly its full length, is largely free.

I should have hesitated perhaps in describing this as a new species, distinct from *O. Bermudensis*, and preferred supposing that the characters indicated by Hoyle were not very clearly marked, or that they possibly represented only the immature form, but Hoyle distinctly states that while his specimen is probably immature, the characters are so well marked as to safely permit of their recognition as typical of a new species (*op. cit.*, p. 95).

GASTEROPODA.

Aplysia æquorea, n. sp. (Pl. 16, figs. 2, 2a, 2b).

Body broadly oval, with a moderately elongated neck; tentacles cylindrical, slit at the extremity; buccal lobes broad, infolded; mouth between fairly developed lips; aperture to opercular cavity on a slightly raised papilla.

Color drab or greenish; exterior surface with thin black annulations and irregular markings, which are few and scattered; the inside of the mantle-lobes, as well as the cover to the opercular cavity, almost free of blotches.

Shell narrowly-elongate, somewhat oblique, and calcareously lined; longitudinally radiated, and transversely finely striated.

Length of animal about four and a-half inches.

A single specimen, found in shallow water on the south side of Castle Harbor, opposite Tucker's Town.

The nearest ally of this species is probably the *Aplysia ocellata* of D'Orbigny, from the Canary Islands, or the common *A. dactylomela*, from the eastern Atlantic, of which the former is by some authors considered to be only a local variety (Rochebrune, *Nouvelles Archives du Muséum*, 1881, p. 264). From both of these forms, apart from other characters, it differs in the absence of the heavy ocellation, and from *A. dactylomela* in lacking the purple lining on the mantle margins. From *A. ocellata*, again, it is clearly marked off by the non-maculated surface of the interior of the mantle lobes and of the opercular covering. The shell in the Bermudian form is comparatively narrower than in any other large species of *Aplysia* with which I am acquainted, and wholly different in outline from that of either of the two species above referred to. I have fully satisfied myself on this point through an examination not only of the figures furnished by Rang and D'Orbigny, but of actual specimens.

Dobson, in a communication made before the Linnæan Society of London (Journ. Linn. Soc., Zoology, xv, p. 159, *et seq.*, 1881), identifies a specimen of *Aplysia* from the Bermudas with the *A. dactylomela*, and describes the color as being "a rich drab, marked all over with circles and streaks of velvet black, the latter most abundant on the mantle covering the shell and on the lateral swimming lobes. The shell agrees in all respects with that of *A. dactylomela* as figured by Rang, and the only difference observable is that the margins of the swimming lobes are not tinged with violet. This might be accounted for by supposing that such a fugitive color had disappeared in the alcohol, but the captor does not remember to have seen it in the living animal." This may be the true *A. dactylomela* or *A. ocellata*, but it is, doubtless, distinct from the species above described. I am confirmed in this supposition by the examination of a specimen recently collected by Prof. Dolley in the Bahamas, and which has been placed in my hands through the kindness of Prof. Leidy. This Bahaman form has the massive ocellation and blotching distinctive of *A. ocellata* or *A. dactylomela*, and further agrees with these two species (or varieties) in the form of the shell. The stellate opening to the opercular cavity appears to be destitute of a papilla. This is the form, probably, that Mr. Dobson received through Surgeon R. Vacy Ash.

Deshayes described some years ago an Aplysia, ocellated and of a yellowish color, from Guadeloupe (*Journal de Conchyliologie*, 2d. ser., ii, p. 140) under the name of *Aplysia Schrammii*, but the species is so imperfectly characterized that it is almost impossible to determine its exact relationships.

Chromodoris zebra, n. sp. (Pl. 16, figs. 3, 3a.)

Animal of the form typical of the genus; head portion considerably extended and expanded in motion; caudal portion moderately elongated; base flattened; mantle beaded immediately over the tail.

Color bright blue above, variously lined and streaked with light yellow; on the dorsal surface the yellow markings are disposed in longitudinal wavy or nearly straight lines, one or more specially prominent lines along the dorso-lateral border. Sides of animal irregularly reticulated or angulated with yellow markings; under surface pale blue, bordered with faint yellow.

Rhinophores deep indigo or black, the rhinophoral aperture bordered with yellow; gills 12 or 13, black, bordered with yellow, and carrying blue cilia; under surface of head blue, with yellow spots.

Length, when expanded, three and a-half inches.

Three specimens, dredged in about ten fathoms on the north side of Harrington Sound. I dissected one of these and found that the stomach is lodged entirely within the mass of the liver. The alimentary canal is sharply deflected forward (dorsally) beyond the buccal or œsophageal tracts, and is caught up in a nerve ring proceeding from the supra-œsophageal ganglia.

This species appears to be third or fourth of the genus found in the western Atlantic. It differs clearly from the *C. picturata* of Mörch (*C. Mörchii*, Bergh, *Mus. Godef.*, part xiv) and *C. gonatophora* of Bergh, two West Indian species. In the scheme of coloring the species appears to be nearest to *Doris pulcherrima* of Cantraine (*Malacologie Méditerranéenne*, p. 57, Pl. 3, fig. 6, = *D. Villafranca?* of Risso), from which, however, it differs in a number of details, such as the number of gills, etc.

Onchidium (Onchidiella) trans-Atlanticum, n. sp. (Pl. 16, figs. 4, 4a.)

Body convex, smoke color or dark olive; lighter, dirty or greyish green on the under surface; pedal disk considerably more than one-third the width of base, yellowish green; mouth margin papillose, bunchy; under surface obscurely or obsoletely tuberculose; dorsal surface closely verrucose, with finer granules interspersed between the warts.

Anal aperture immediately beyond the extremity of foot, inframarginal to a raised border; respiratory orifice between the anal pore and the apex of body.

Length about three-quarters of an inch.

About a dozen specimens, found in a rock hollow on the north shore just beyond Wistowe, near Flatts Village, at an elevation of about two feet above the water.

This is, as far as I am aware, the only species of *Onchidium* that has thus far been recorded from the western Atlantic. Its occurrence is, therefore, of considerable interest as bearing upon the subject of geographical distribution. Nearly all the species of the genus are confined to the Eurafrican and Indo-Pacific waters, although one species is known from Arctic America, one from the Californian coast, and one from the west coast of South America (Bergh, in Semper's *Reisen im Archipel d. Philippinen*, Land Mollusks, VI).

The Bermudian species appear to be most nearly related to *O. Carpenteri*, from the Californian coast, but differs from it in color. The positions of the anal and respiratory apertures differ from what is indicated by Stearns (Proc. Acad. Nat. Sci., Phila., 1878) to exist in the west American form, although agreeing with the determinations made by Bergh for manifestly the same species.

NOVEMBER 6.

The President, Dr. JOS. LEIDY, in the chair.

Forty-nine persons present.

NOVEMBER 13.

Mr. CHARLES MORRIS in the chair.

Thirty-six persons present.

A paper entitled "Contributions to the Life History of Plants, No. III." By Thomas Meehan, was presented for publication.

NOVEMBER 20.

Rev. HENRY C. MCCOOK D. D., Vice-President, in the chair.

Twenty-four persons present.

The President was directed to convey to Mrs Clara Jessup Bloomfield Moore the thanks of the Academy for her gift of Five Thousand Dollars as an addition to the fund endowed by her father, the late Augustus E. Jessup.

NOVEMBER 27.

The President Dr. JOS. LEIDY, in the chair.

Thirty-four persons present.

Dr. W. S. W. Ruschenberger read his biographical notice of the late Geo. W. Tryon Jr. prepared at the request of the Academy.

Remarks on the fauna of Beach Haven, N. J.—Prof. LEIDY stated that he had spent the last two summers at Beach Haven, on which he made the following remarks: The place, a summer resort, is situated on the island of Long Branch, a sand bar but a few feet above the ocean level, 22 miles long and little more than half a mile wide, off the New Jersey coast, from which it is separated by Little Egg Harbor and Barnegat Bays. The island consists of the ocean beach, flanked by long low sand hills and meadows extending to the bays. It is treeless, but produces frequent patches of wax-myrtle, *Myrica cerifera*. While the variety of marine animal life in the vicinity is comparatively small, a few forms adapted to the special localities are abundant. The ocean beach consisting mainly of fine silicious sand without pebbles, between tides, swarms with the mole crab, *Hippa talpoidea*, and the little mollusk, *Donax fossor*. Above tides, the beach oft-times is lively with sand-fleas, among which are conspicuous the *Talorchestia macrophthalma*, and less commonly the *T. longicornis*. Still higher extending to the sand-hills, the sand-crab, *Ocypoda arenaria*, is frequent. The mud of the bays and sounds swarms with the scavenger snail, *Ilyanassa obsoleta*, while the meadows abound with the marsh snail, *Melampus bidentatus*. The borders of the meadows are thickly planted with the horse-mussel, *Modiola plicatula*, or are honey-combed by the fidler crab, *Gelasimus pulgilator*. The bays supply the market with abundance of the oyster, which is extensively cultivated for the purpose. The clam, *Venus mercenaria*, also occurs in the greatest abundance, and is constantly gathered for the market. The squirt-clam, *Mya arenaria*, is likewise supplied from mud flats of the bays. The edible crab, *Callinectes hastatus*, often occurs in the bays in great numbers. The previous summer, the bottom appeared to swarm with them, but the last summer they were less numerous, in consequence, as the fishermen report, of great numbers having been destroyed by the severe cold of last winter. In a visit to Beach Haven, in February, I observed many recently dead crabs thrown up on the ocean beach, and feasted on by multitudes of the isopod crustacean, *Cirolana concharum*.

The previous summer also, the lady-crab, *Platyonichus ocellatus*, was frequent on the ocean beach near low tide, but during last summer was almost absent. It probably, also suffered from the cold of last winter, for in February, at Atlantic City, I found a number recently dead, and likewise feasted on by the *Cirolana*.

In the bays the spider crab, *Libinia canaliculata*, the shrimp, *Palaemonetes vulgaris*, and the hermit crab, *Pagurus longicarpus*, are in abundance, and the *P. pollicaris* is not infrequent. The shrimp is infested to a wonderful degree with a parasitic crustacean *Bopyrus palaemoneticola*. The horse-shoe crab, *Limulus polyphemus* also occasionally occurs on the ocean beach.

The sand of Beach Haven is remarkably sonorous; when scraped in walking, it emits a sound like that produced by sliding a rubber shoe on the pavement.

The condition of the ocean beach varies with the direction of the winds and violence of the waves. Mostly, it is remarkably uniform and free from organic debris, and is composed of fine, white quartz sand without pebbles, and with streaks and patches of black sand, which from its greater specific gravity is incessantly sifted from the white sand by the winds and waves. On one occasion, during the prevalence for several days, of a strong north-east wind, the beach above high tide was covered with a broad stratum of black sand from a fourth to an inch thick, over which the white sand was blown like columns of smoke and accumulated at the base of the sand hills where it looked by contrast like snow drifts. The organic debris cast ashore mostly consists of materials carried out from the bays, commonly, masses of eel-grass, *Zostera marina*, and bunches of bladder-wrack, *Fucus vesiculosus;* the latter often attached to a horse mussel, on which the plant grew. Frequently attached to the plants are various animals, especially *Bugula turrita, Obelia commissuralis, Perophora viridis, Lepas fascicularis,* etc. Occasionally there are thrown ashore a live beach-clam, *Mactra solidissima,* a dead shell of the same with attached branches of *Sertularia argentea,* the collar-like sand egg-cases of *Natica* and the chaplet ones of *Fulgur.* In the experience of two summers medusae were rarely wafted ashore, and these were in fragments and pertained to *Cyanea arctica* and apparently *Aurelia flavidula.*

Goose barnacles, *Lepus fascicularis* occasionally are not infrequent; and more rarely *L. anatifera,* attached to fragments of timber, is thrown on the sands. High up on the beach, at the base of the sand-hills and often extending into the valleys between them are multitudes of bleaching shells, the remains of occasional severe storms. Most of the shells are those of the beach clam, *Mactra solidissima,* which, everywhere on the open coast of New Jersey, appears to be the most common lamellibranch, except the little *Donax fossor.* The younger shells of the Mactra are often observed along shore, with a circular hole through the umbo, made by Natica. Some years since, at Atlantic City, I observed a number of beach clams, in the sand between tides, which were in possession of *Natica heros* in the act of boring the shell.

Among the occasional shells on the beach, fragments of large ones of *Pholas costata* are not infrequent, and yet an experienced clam catcher, who is familiar with the ordinary animals of the locality informed me that he had never found a living one.

My friend Joseph Willcox and I made several attempts at dredging in Little Egg Harbor, but with very little result of interest. Near the mouth of the bay, we drew up great quantities of *Mytilus edulis,* less than half grown, accompanied by many star-fishes, *Asterias arenicola.* In some positions we took numerous dead shells of the oyster and clam, *Venus mercenaria,* preyed upon by the sulphur colored boring sponge, *Cliona sulphurea.* This, after drilling and tunneling the shells in all directions, continues to grow into masses from the size of one's fist to that of the head, in which condition it is known to the clam-catchers as the "bay pumpkin." The skeleton of this sponge is constructed of calcareous pin-like spicules. It also attacks and preys on the shell of the living oyster, but appears not to do so on the living clam. The sedentary habit of the former, no doubt, facilitates its attacks. The shells of the oyster and clam, *Venus,* bored in a sieve-like manner, and freed from the sponge, are frequently thrown on the ocean beach, and with them rarely the shell of a Mactra bored in the same manner, but I could not ascertain whether the Cliona lived on the shore of the open ocean.

Another sponge frequently observed growing on living oysters and on dead shells of the same and of the clam, *Venus,* is called by the catchers the "red beard," *Microciona prolifera.* It is bright vermilion color when alive, but brown when dead, and masses of it in the latter condition are often found on the ocean beach. It is a silicious sponge and does not prey on the shells of mollusks.

From an oyster bed we took up some young oysters, an inch to two inches long, with the shell perforated by the "drill," *Urosalpinx cinerea*. The perforation, made in the vicinity of the adductor muscle, about admits an ordinary bristle. An oyster catcher, James R. Gale informed us that the "drill" was introduced into the locality, with spat brought from the coast of Virginia. With the Urosalpinx we took another snail, *Anachis similis*, which Mr. Gale assured us was more destructive, as a borer, to young oysters than the former. Another snail which we took, the *Eupleura caudata*, Mr. Gale says has the same habit.

Attached to oysters were also found a great profusion of the polyzoon *Vesicularia dichotoma*.

Of the mollusca of the vicinity of Beach Haven I observed the following:

GASTERPODA.

Ilyanassa obsoleta.	Exceedingly abundant.
Melampus bidentatus.	Exceedingly abundant.
Fulgur carica.	
Fulgur canaliculata.	
Natica heros.	
Natica duplicata.	
Urosalpinx cinerea.	
Eupleura caudata.	
Anachis similis.	
Bittium nigrum.	
Crepidula fornicata.	
Crepidula convexa.	
Crepidula plana.	

LAMELLIBRANCHIATA.

Mactra solidissima.	Exceedingly abundant.
Donax fossor.	Exceedingly abundant.
Venus mercenaria.	Exceedingly abundant.
Mya arenaria.	Abundant.
Solen americanus.	Common.
Tagellus gibbus.	
Ceronia deaurata.	One dead specimen.
Cochlodesma earum.	
Thracia leana.	One dead specimen.
Cyclocardia borealis.	One dead specimen.
Astarte undata.	
Astarte castanea.	
Petricola pholadiformis.	
Pholas truncata.	
Pholas costata.	
Cyclas dentata.	

Scapharca transversa.	
Arca pexata.	Common.
Arca transversa.	
Mytilus edulis.	Abundant.
Modiola plicatula.	Exceedingly abundant.
Pecten irradians.	Common.
Anomia glabra.	Abundant.
Ostrea virginiana.	Exceedingly abundant.
Teredo navalis.	

Of Crustacea the following were observed:

Callinectes hastatus.
Platyonichus ocellatus.
Cancer irroratus.
Ocypoda arenaria.
Gelasimus pugnax.
Gelasimus pugilator.
Libinia canaliculata.
Panopeus Sayi.
Pinnotheres ostreum.
Eupagurus pollicaris.
Eupagurus longicarpus.
Hippa talpoidea.
Gebia affinis.
Palaemonetes vulgaris.
Orchestia palustris.
Orchestia agilis.
Talorchestia longirostris.
Talorchestia macrophthalma.
Gammarus ornatus.
Unciola irrorata.
Caprella geometrica.
Erichsonia attenuata.
Cirolana concharum.
Bopyrus palaemoneticola.
Livonica ovalis.
Lepas fascicularis.
Lepas anatifera.
Limulus polyphemus.

The Turret Spider on Coffin's Beach.—Dr. HENRY C. McCOOK remarked that he had spent July and August, 1888, at Annisquam, Mass., a port of Cape Ann at the mouth of the Squam river where it enters into Ipswich Bay. The eastern shore of the bay opposite Annisquam consists in part of a stretch of sand hills, known as Coffin's beach. The sand is of a beautiful white color and is massed at places in elevations of considerable height, constituting what is known as the "sand hill," or "the dunes." The fragrant bay bush grows in clumps along the edges and summits of these irregular sand elevations, and this is intermingled with patches of tough grass.

At his first visit to this beach he discovered several burrows of *Lycosa arenicola* Scudder,[1] popularly known as the Turret spider.[2] Subsequently he explored the field and found numbers of these Lycosids domiciled in the sand and spread very generally over the dunes. They came down very close to the high water mark. Thirteen burrows were found quite near together, seven in a circle of six feet in diameter. Most of these burrows were about half an inch in diameter. Two were located within twelve inches, and several others within two feet of the edge of the sandy ridge which marks the point of highest tide. The tubes vary in size and depth. Some are scarcely larger than a quill, some, indeed, not much larger than a good big darning needle. These were occupied by young spiders. The adult spiders occupy burrows in the sand about twelve inches or less in depth; the younglings make holes four inches deep or less.

In digging for spiders Dr McCook began to remove the sand ten inches or more from the opening of the burrow. Thus the dry sand immediately surrounding dropped away into the excavation, leaving the silken tube which lined the burrow adhering to the grass stalk or twig which he had inserted within it. The burrows proved to be silk-lined for a space of from four to seven inches, the lining however, being of a very thin texture, not like the tough silken tube with which the Trap-door spider lines her nest, or which the Purseweb spider erects along the trunks of trees. Below that point the burrow enters into the sand unlined. The top of the sand is quite dry, but the bottom part, wherein the lower portions of the burrows are made, was invariably found to be damp, and of course closely packed, so that it was not very liable to fall into the excavation. A little circular ridge of sand ordinarily surrounds the opening of the burrow, but he saw in no instance anything like the tower of straws and sticks which this spider builds in the meadows and fields of New Jersey, Pennsylvania and other points where it has been observed. The drifting of the sand before the wind seemed to have little or no effect upon the burrows which were always found quite open and free around the mouth. Heavy rains which fell during the season had no appreciable effect upon the burrows or their inmates although the tubes must often have been filled with water.

The spiders captured were all of a light hue as compared with the same specimens found in our vicinity. Specimens almost identical with these were found by Dr. Joseph Leidy in the sand at Beach Haven, New Jersey; and this pale coloring appears in all other littoral specimens examined. The influence of environment, manifest in the lighter coloring of this spider, was also seen in a grasshopper or locust which is quite abundant on Coffin's beach. It is almost as white as

[1] Psyche, vol. II, p. 2, 1877.

[2] Emerton ("New England Spiders of the Family Lycosidæ" Trans. Conn. Acad. vol. vi, 1885) describes the species as *Lycosa nidifex* Marx, for what reason he does not state. Scudder made the spider known in 1877; Dr. Marx gave his description in the "American Naturalist" May 1881. The priority is undoubtedly with Scudder's name.

the sand over which it was found hopping. These grasshoppers probably furnish food for the spiders, but the only remains of animal food found within the burrows were those of a large brownish beetle, several specimens of which were picked up on the beach.

Among the other denizens of the beach are ants of a small species whose nests are well nigh numberless. They are made in the sand, but it seemed that the little creatures must have considerable difficulty in preserving their galleries and rooms from continual destruction by the caving in of the incoherent particles. However, they do manage it, although in digging to find the character of their galleries the speaker could not so manipulate the sand as to prevent it from tumbling into the formicaries and thus hindering him from studying of the interior. He did not know what the ants feed upon, although he found some of them engaged at the carcass of one of the brown beetles above alluded to, and no doubt the flotsam of the sea thrown upon the beach affords them abundant material for food. He made a number of visits to these sand dunes both by day and night, prolonging his stay to a late hour in the evening in order to discover something of the outdoor habits of the colony of Turret spiders, but succeeded in learning very little that is new.

A lady artist who with some companions was sketching upon the beach, (for Annisquam is a favorite field for painters,) informed Dr. McCook that about dusk a large spider was seen moving over the sand towards the water. Supposing this to be one of the above colony the question at once arose, do they come down from the dunes to the wide flat stretch of beach, that is covered at flood and that is uncovered at ebbtide, in order to prey upon the sea life that may be left at the retiring of the waters? Two afternoons and nights were spent from five until nine and ten P. M. endeavoring to solve this problem, but without any results. He then tried another method. Visiting the beach in day-time he captured a couple of mature spiders; placed them upon a smooth stretch of clean sand and permitted them, and when necessary compelled them by prodding, to move over the surface. They left upon the sand a peculiar track which is here roughly represented by two sections taken from different parts of the trail. Having made a careful sketch of these foot prints he returned early next morning and made a careful examination of the beach for a considerable distance along the shore.

Many tracks of various kinds of creatures, including such insects as beetles and grasshoppers, and also of some small vertebrate animals, were found.

But by far the greatest number were tracks which corresponded precisely with those made on the previous day by the captured Arenicolas. Multitudes of these were seen upon the sand covering the surface and slopes of the hills and extending to the very border of the surf line. They traversed the ground which had been covered by the tide, but which for a considerable distance is there exposed at the ebb. These foot-prints could be traced everywhere as issuing from and returning to the burrows which he had marked by flagging the grass stalks in their neighborhood. It was thus demonstrated, in this indirect way, that the narrative of his artist friend was correct, and that the Turret spiders do issue from their burrows during the night and perhaps at other periods and traverse the sandy flats, no doubt in search of prey. One half grown spider was captured while wandering on the flat.

These spider tracks were in themselves an interesting study, and Dr. McCook expressed regret that he did not sketch a longer consecutive series. The motion of the feet was so rapid that he could not determine the order in which they were placed down, nor identify the mark made by any particular foot. The scratch in the figures he thought might have been made by the spinnerets at the apex of the abdomen trailing in the sand.

Dr. Charles S. Dolley had observed similar tracks upon the sandy beach of Lake Ontario, near Rochester, which were made by the same spiders that dwell in that vicinity. He had found the spiders sheltered under the drift on the very edge of the shore whither they had doubtless gone in pursuit of prey or to drink.

Messrs Auguste Sallé of Paris, Louis Bedel of Paris and Dr. David Sharp of Wilmington, England were elected correspondents.

The following were ordered to be printed:—

DISCOVERY OF THE VENTRAL STRUCTURE OF TAXOCRINUS AND HAPLOCRINUS, AND CONSEQUENT MODIFICATIONS IN THE CLASSIFICATION OF THE CRINOIDEA.

BY CHARLES WACHSMUTH AND FRANK SPRINGER.

Since the publication of our paper "on the Summit Plates of Blastoids, Crinoids and Cystids, and their Morphological Relations,"[1] we have made several important discoveries bearing on this subject, which have materially modified some of the views expressed therein, as well as at some places in the Revision of the Palæocrinoidea.

Hitherto we have recognized in the summit of the Palæocrinoids a central plate, surrounded by four large proximals and two smaller ones, with anal plates interposed between them. In our earlier writings we regarded the two small proximals as representing posteriorly a fifth plate; but these, as we have explained (Revision Pt. III, p. 47), are really the two posterior radial dome plates, pushed in by the anal structures, the three other radial dome plates being placed at the re-entering angles of the four larger proximals. This was clearly pointed out on Pl. VII, in figures 2, 3, 4, 5, 6, 8, 9, 10, and on Plate VIII, figs. 1, 3, in which the plates formerly considered as the smaller proximals were marked as actinal radials, and designated by the letters "x r." In fig. 7, Pl. VII, they correspond to, and probably are, the first or inner covering pieces of the ambulacra. After discovering that these plates are situated radially and not interradially, we met with frequent difficulty in identifying the two smaller proximals, and mistook for them some of the plates which we now clearly see are anal pieces. In some cases, and especially in very complicated forms, we observed intercalated between the proximals, touching the central piece, certain plates which we regarded as the representatives of the first and second radials of the dorsal cup, absent in the vault of simpler forms; while we considered those underneath which the bifurcation of the ambulacra takes place—being the radial dome plates in the simpler forms—as the representatives of the third or axillary radials.

From the internal structure we found that the radiation of the ambulacra was from underneath the central plate, in a similiar manner as the ambulacra from beneath the five orals in the Neocrinoidea,

[1] Proc. Acad. Nat. Sci. Philadelphia, March, 1887.

and it was this, principally, that led us to the supposition that the central plate, and this only, represented in the vault of the Palæocrinoids the five orals collectively, and that the four large and two smaller proximals were interradial vault plates, corresponding to the interradials of the abactinal side (Rev. III., pp. 44–59). The latter was contrary to the views originally expressed by us (Rev. II, pp. 15 and 16), when we supposed that "the six proximals surrounding the central plate represented the basals or genitals." The great objection to this interpretation was that it involved a homology between six plates and five, and we were so greatly impressed with the force of it, that we were afterwards led to consider these plates as interradials, as to which on the dorsal side a division of the posterior interradial into two plates by the interposition of an anal plate is a frequent occurrence in Palæocrinoids. It seemed to us therefore very natural that a similar division of the posterior plate should be found on the ventral side.

Dr. P. Herbert Carpenter, like ourselves, recognized a central plate and six proximals, but he regarded the former as the actinal representative of the dorso-central or terminal plate of the column in the Pentacrinoid larva, and established for it the term "oro-central," as a distinct element in the vault of the Palæocrinoids, unpresented in other Echinoderms. He adopted the theory that the surrounding six proximals are the homologues of the basals, and as such are the oral plates—he considering that the posterior one was divided by anal plates into two. His views on this subject are fully set forth in the Challenger Report on the Stalked Crinoids, pages 158 to 184, and the same interpretation of the plates in question was reasserted by Etheridge and Carpenter in the Catalogue of the Blastoidea in the Geological Department of the British Museum, pages 66 to 75.

Although this conception of the morphological relations of the proximals agreed with the ideas we originally entertained, as before mentioned, we found ourselves unable to reconcile it with the difficulty arising out of a homology of six plates which surround but do not cover the oral center, with a set of five closed oral plates which cover the mouth. This objection did not exist as to the central plate which covers the oral center, and it seemed to us, therefore, more reasonable to regard that plate, though undivided, as the representative of the five orals, than to consider it an entirely new element in Echinoderm morphology, which the so-called "oro-central" of Carpenter certainly was. Our theory of the relations of the summit plates, in conformity with these ideas, was discussed in the Revision of the Palaeocrinoidea, Part. III, pages 44 to 59, and afterward in greater detail in our paper on the Summit Plates, above referred to.

Another consideration which strongly influenced us in adopting this view was the supposed presence of a central plate in *Haplocrinus*, to which considerable importance was attached both by Carpenter and ourselves in our discussions of the oral question, though leading us to very different conclusions. On page 56, Revision, III, we said: "A far less objectionable interpretation of the central plate than that given by Carpenter would be to regard it as a posterior oral. In this case the orals would be represented by five plates, and not by six; the anus would be placed outside the oral ring, and the radial dome plates would occupy the same position toward the orals as the calyx radials toward the basals. But it would place the mouth underneath the posterior oral, and it offers no explanation of the central piece in *Haplocrinus*."

This theory seemed to us at that time very plausible, and we should have advocated it, if it had not been for the central plate in *Haplocrinus*, which we discovered, as we supposed, in a specimen of *H. mespiliformis*, our observation being verified by Carpenter, to whom we sent the specimen for examination, (Challenger Report, page 158).

When we took up a year ago, the investigation of the Larviformia, the group to which *Haplocrinus* belongs, we had before us the original specimens of *H. clio* from New York, and found ourselves unable to discover any suture between the so-called central plate, and the posterior vault plate, and we began to suspect there was something wrong about the central plate. During a visit of one of the writers to Europe in the winter of 1887–8, he procured in the Eifel mountains a very large series of good specimens of *H. mespiliformis*, with a view to ascertaining if possible the real fact about the central plate, and also the anal opening which was fully as great a mystery. These specimens at once disclosed the fact that the "central plate" is a myth, and that what had before been taken for it was simply a more or less tongue-like or polygonal prolongation of the posterior plate, sometimes surmounted by a small node—the "knopf" of Goldfuss. We had mistaken a fracture in our original specimen for a suture on the posterior side, and have seen another in which a similar mistake might have been made if one had that specimen alone. The real structure of the vault of *Haplocrinus* is as follows: The five triangular plates composing the ventral pyramid meet in the center by sutures which are often difficult to see. The posterior plate is the largest, and projects in between the two postero-lateral ones, completely separating them, and interlocking with the antero-lateral plates by a variety of plans, from a simple zigzag suture to a triangular or dovetailed insertion, or a long slender tongue extending into the latter plates, which are cut away to fit it (Pl. XVIII, figs. 6b and 6c). This projection stands sometimes at a lower level than the other part of the plate and the adjoining plates, leaving a depression in the center which is sometimes partially occupied by a small node. In other cases a high ridge runs from the posterior plate over the central space, branching to the two antero-lateral plates (Pl. XVIII, fig. 6b). It thus appears that the whole ventral surface in *Haplocrinus* is covered by five large plates which meet in the center as in *Allagecrinus*.

The anal opening in *Haplocrinus* has not heretofore been correctly identified, but it has been generally claimed to be located at the suture between two radials and the posterior vault plate. In the Revision III, pp. 157 and 162, we alluded to a small pore we had observed in one specimen of *H. mespiliformis*, the position of which is indicated in fig. 1, on Pl. V, of that work. We afterward became satisfied that this pore was due to chemical action, or some imperfection in the test and was not organic, as subsequent examination of a very large number of specimens of the same species, better preserved, failed to disclose any opening in that position. After we discovered that the so-called central plate was nothing but a prolongation of the posterior vault plate, it became easy to distinguish that plate in the specimens, and we began a careful search upon that side, from the radials up, for the anal opening. We soon found a small, scar-like opening or pit, with a slightly thickened and well defined rim, situated just within the upper angle of the triangular depression on the posterior plate (Pl. XVIII, fig. 6a). A similar structure was observed in a large number of specimens, varying in form from that above described to a small tubercle in which no opening could be detected. It was always in the same position, and we have been unable, after the closest examination, to discover anything like it upon either of the other four plates in any of the specimens. We ground down a number of specimens on the posterior side, and in every one found that this was an actual opening, piercing the plate, in a similar manner, and in the same position as the anal opening pierces the deltoid in *Orophocrinus*, and we could not find on these ground specimens, any indications of another opening lower down. These facts led us to the conclusion that the above described opening must be the anus, and that it was probably closed by minute pieces as in *Orophocrinus*. We think it quite probable that the tubercular elevation which appears in several of the specimens, may represent the closed condition, the plates being too small to be distinguishable, especially in fossils whose preservation is so peculiar that the suture lines between the large vault plates are often invisible.[1]

So long as the central plate in *Haplocrinus* was recognized, we saw good reason to believe in the existence of a similar plate in other groups of the Palæocrinoidea, especially as a plate similarly situated over the center of radiation was so conspicuous a feature in the vault of many different genera. But after it became evident that no such plate in fact existed in *Haplocrinus* and allied forms, the idea recurred to us that the plate, so apparently central in many Platycrinidae and Actinocrinidae, might after all be the posterior oral, pushed inward to a central position by anal structures, which we had formerly suggested. With the objection arising out of the supposed condition of *Haplocrinus* removed, this interpretation seemed to us to be one of the greatest force, more likely than any other to answer the conditions of a valid homology, and to obviate the principal objections urged by Carpenter and ourselves, respectively, to other theories.

Upon comparing the summit plates of the Platycrinidae and Actinocrinidae, it will be seen that the so-called central plate is always inserted between the four large proximals, so that in most cases it occupies, more or less, the center of figure, being enclosed on the posterior side by anal plates, and abutting against them. In *Dorycrinus* (Pl. XVIII, fig. 2), an enormous development of the central plate is shown. In *Agaricocrinus* (Pl. XVIII, fig. 3), the four proximals have been separated from it by the intercalation of other

[1] Upon our communicating to Dr Carpenter several months ago our observations upon *Haplocrinus* as above set forth, he informed us that Prof. Beyrich, of Berlin, had independently discovered the same facts, both as to the construction of the ventral pyramid, and the location of the opening which we consider to be the anus, and that Beyrich also regards this as the anal opening, while he (Carpenter) thinks it an open question whether it be the anus or a water pore, in which latter case the anus would remain undiscovered.

plates; while in the later *Talarocrinus* (Pl. XVIII, fig. 7) they seem to have disappeared entirely, leaving only the central plate, from which the covering plates to the ambulacra pass directly out. In forms like *Batocrinus* (fig. 5), and *Eretmocrinus* (fig. 10), where there is a strong, nearly central anal tube, we find the central plate resting against, and forming the base of the tube, and the four proximals pushed far over to the anterior side, and greatly displaced.

In some forms of *Platycrinus* the central position of the posterior plate is well marked (Rev. III. Pl., VII, figs, 5, 6, 7, 8, and Pl. VIII, fig 6), varying somewhat in degree. Some recently acquired specimens of this genus exhibit most clearly a transition from a centrally located plate surrounded by proximals and anals, characteristic of the foregoing figures, to a set of five nearly equal plates, occupying the center of figure in the vault, and from whose five re-entering angles the ambulacra pass out to the arms, as shown by the beautiful specimen in fig. 15, (and also by figs. 4, 8, and 9).

In all these cases it will be observed that the posterior plate is inserted between the four proximals to a greater or less extent, separating the postero-lateral ones, so that the five plates meet in the vault in a manner substantially similar to the five plates composing the ventral pyramid of *Haplocrinus.* No one who is acquainted with the structure of palaeozoic crinoids will doubt that the five unsymmetrically arranged plates in the vault of *Dorycrinus*, *Batocrinus*, etc, are structurally identical with the five nearly equal plates centrally located in the specimens of *Platycrinus* above mentioned. And it will be seen at once that all the disturbance observable in different degrees in these various forms was primarily caused by the anal structures, which pushed the plates—especially the posterior one—out of their primitive position. Regarding these five plates as the orals, it will be found that the five radial-dome-plates lie within the re-entering angles all around, and that the two rings of plates thus correspond exactly in their relative position with the basals and radials upon the dorsal side in the Crinoidea, and the genitals and oculars in the Echini.

The above interpretation of the plates meets with no serious difficulty from a morphological point of view. The only objections occuring to us that might be urged against it are: 1. that the mouth would be situated beneath the posterior oral; and 2. that some species of *Talarocrinus* and *Dichocrinus* have in the summit in place of five orals a single very large plate, from underneath which the ambulacra pass out to the rays. The first of these objections, which was raised by us already in Revision III, p. 56, is readily explained if we suppose that the posterior oral was pushed inward over the mouth by the plates connected with the anus, and that this became a constant character in palaeontological time. The presence of a single large central plate in *Talarocrinus*, etc, may be accounted for by resorption of the four anterior orals, the posterior plate actually performing the functions of all. It might also be possible that this large plate in these forms represents the whole oral pyramid, five plates coalesced, in a similar manner as the basals in some instances at the dorsal side.

These considerations were quite sufficient to convince us that the five orals of Neocrinoids were represented in the Palaeocrinoids by both the central plate and four large proximals taken together; thus in a large measure reconciling the conflicting views of Carpenter and ourselves upon this question—the orals being found at last to consist of a portion of the proximals which he has claimed, with the addition of the central plate which we have contended for. This rational result, as often happens in such cases, adopts what was sound, and rejects the errors in the views of both parties.

The evidence which we had obtained was entirely satisfactory to us, and we were prepared upon the foregoing facts to announce our final conclusion, as above stated, when we made a most unexpected discovery, which in our judgment not only settles the oral question in conformity with these views beyond all controversy, but bears so strongly upon questions of classification, that it may justly be regarded as one of the most important discoveries ever made in palaeozoic crinoids.

In the Ichthyocrinidae the ventral structure has been hitherto almost totally unknown. Some small plates had been seen on the ventral side in a few instances, apparently belonging to a plated integument, but not in a condition to afford much information, and its real nature has been a matter of conjecture and theory. We have been of the opinion that it was a vault, covering a subtegminal mouth and ambulacra, but pliant, yielding to motion in the calyx and arms; while Carpenter believed that it was a disk paved by plates as in some of the Neocrinoidea. It was evidently of the most fragile construction, and this, together with the fact that in this family the arms are generally found closely folded and firmly impacted over the vault, was strongly against the probability of ever finding the ventral covering in place. We had seen, however, in some specimens of *Taxocrinus* from the Kinderhook beds at Le Grand, Iowa, that there was an integument of some kind taking the form of pouches along the ventral side of the rays, and this induced a faint hope, in view of the unusually fine preservation of the fossils at that locality, that something more might eventually be found out about it.

On the 9th of August last, we made an excursion to Le Grand, for the purpose of obtaining some needed material for our work on the Crinoids of North America now in progress. Upon arriving at the station we met Mr. George Cull, the agent of the Chicago and Northwestern Railway, to whom we were already indebted for many favors. While exhibiting to us some interesting fossils collected by him in that vicinity, he produced a specimen of *Taxocrinus* with the greater part of the rays broken off. We saw at once that it had the ventral covering preserved in place, though largely imbedded in a matrix of exceedingly fine calcareous mud. Upon being informed that the specimen possessed especial value as throwing light upon important scientific questions, he presented it to us, with the remark: "I will donate it to Science." For the valuable assistance he thereby afforded us he has our grateful thanks, and in this we are sure that every naturalist who is interested in the morphological study of Echinoderms will join us.

Although we saw at once that there was an integument of very small pieces, with covered ambulacral furrows running toward some large plates in the center, it was not until we had with great labor, and the most delicate manipulation, cleaned the specimen from the fine adherent matrix, that we discovered the extraordinary fact that it has *an external mouth, surrounded by five parted oral plates, with the ambulacra converging to it and passing in between the orals.*

The specimen belongs to a species which we have described and figured for the 8th volume of the Illinois Geological Survey, now in press, as *Taxocrinus intermedius.* It represents a form of *Taxocrinus* in which there is a strong tendency toward the free and spreading rays of *Onychocrinus,* to which genus, indeed, we were for some time inclined to refer it. Several specimens of it have been found before, but all of them had the arms closely folded, and were more or less flattened by pressure. This individual, exceptionally, was deposited with the rays well extended and without any flattening, leaving the ventral side in an almost natural position. Most of the rays are broken off a little above the first bifurcation, so that the whole structure is plainly visible, and, except in one or two places, is in the most perfect condition (Pl. XVIII. figs. 1^{c} and 1^{e}).

The ventral surface is covered by an integument of very small, irregular plates, attached to some larger plates within the dorsal cup, and the marginal plates along the free rays, forming in connection with the latter along the rays pouches or sacs which extend far up along the arms, being traced in other specimens to the second and third bifurcation. Along the median radial portions of this integument rest the ambulacra, which pass from the middle of the disk to the rays, following their bifurcations. There are two rows of subambulacral pieces, transversely elongate and alternately arranged, forming the floor of the groove. The groove is bordered by side pieces, and roofed over by two rows of interlocking covering plates, which seem to have been moveable, as they are open in several places in the specimen,—indeed they appear to be mostly in that condition. The anterior ambulacrum is perfect, with the covering pieces in place, and slightly gaping. In the right antero-lateral ambulacrum the covering plates and side pieces have slipped off from the subambulacral plates, and lie interradially to the left of them, but are otherwise not much disturbed. In the other three ambulacra the covering pieces for the most part are gone, leaving only the floor with the subambulacral plates in position. The plates covering the interpalmar areas are also well shown in the specimen at three sides; at the two others the integument is not intact, and the plates lie scattered upon the surface. When one sees the exceedingly frail character of this covering, he may well wonder at the exceptional good fortune by which it is preserved in this specimen, and will not expect to find it soon again.

The central region is occupied by five rounded or very obtusely polygonal plates, interradially disposed, rather elliptic in outline. The two antero-lateral plates are tolerably good-sized, and the postero-lateral ones slightly smaller. All four of them have a considerable thickness, extending downward below the level of the ambulacra, and also rising somewhat above it. The posterior plate is nearly three times as large as any of the others, and almost twice as long as wide, extending well in between the two postero-lateral plates.

The relative positions of these plates are exactly like those of the five plates at the summit of the forms of *Platycrinus* illustrated on

Plate XVIII, figs, 4, 8, 9, 10, 15, except that they do not meet in the center, but leave a slightly excentric, obtusely pentagonal oral opening, transversely elongated, its longest side next to the posterior oral plate. Into this opening, which is deep, and contains at the bottom some dark-colored substance, converge the ambulacra, their lips turning downward at the five corners. They enter between the five plates, touching them, and completely separating the visible portions of those plates from each other. Whether there is any lateral projection beneath the ambulacra, by which they come in contact again, cannot be seen, but from the form of the exposed portions we should think not.

That the five plates around the center, although somewhat unequal in size, represent the five orals of the recent genera *Rhizocrinus*, *Hyocrinus*, and *Holopus*, and that the integument of small pieces is a disk and not a vault, nobody will deny after seeing the specimen. And a comparison of the parts in *Taxocrinus* with the summit plates in *Platycrinus*, *Actinocrinus*, etc, leaves no room for doubt that these are likewise orals. In the posterior interradius (Pl. XVIII, fig. 1, c), there is a small lateral appendage or proboscis composed of a row of rounded quadrangular plates gradually tapering upward. This appendage is supported by a small anal plate, which rests upon the right upper corner of the posterior basal and the right posterior radial, both of which are somewhat indented to receive it. The appendage seems to be attached by its inner side to the integument, and there are to the right of it, within the posterior interradius three small tapering ridges composed of very small plates, which look like branches from it; upon close inspection, however, they are seen to be folds in the perisome, into which they are incorporated at their upper ends, in a similar manner as the row of larger plates. At the upper end of the appendage there are a great many minute pieces closely packed together, and we think it probable there was an opening at this point. In the two other specimens (Pl. XVIII, figs. 1*b*, and 1*d*), the structure is more clearly shown. Neither of them has supplementary ridges or folds, and it is plainly seen that the large plates composing the proboscis are bordered by numerous small pieces, by means of which they are connected with, or incorporated into the perisome. The upper end of the appendage is rounded off, and stands well out from the perisome, but we have been unable to ascertain from the specimens whether it is perforated by a canal, or solid as in the remarkable recent genus *Thaumatocrinus*, which in the structure of its posterior side bears a striking resemblance to the form under consideration. From all that we can see on our three specimens, and some examples of *Onychocrinus exsculptus*, in which a similar set of plates and parts of the perisome are preserved, we do not believe that there was a second appendage in the disk as in *Thaumatocrinus*, but think that the row of large plates supported the anus. The shape of the visible portions of the disk varies in the three specimens, and it is evident that the whole perisome was pliant and could be expanded or contracted.

A similar integument has been found between the rays in *Taxocrinus robustus* W. and Sp. from the same locality, a new *Taxocrinus* from the St. Louis limestone, and in *Onychocrinus asteriaeformis* from the Burlington limestone. In a specimen of *Onychocrinus diversus* lying on the ventral side, and from which we removed the basal and some of the radial plates, giving an inner view from below, we can see in two rays the alternating subambulacral plates converging near the center, but not the orals nor any part of the perisome. In one of *Onychocrinus exsculptus* we find remnants of the perisome and traces of the oral plates, however not in position. The last two specimens are those mentioned by us in Revision Pt. I, p. 32, on one of which we based our statement (Rev. I, p. 54), under *Onychocrinus*, that "in the median portion of the vault there are six rather thin but large apical dome plates", which we were afterwards inclined to modify, as we could not make out satisfactorily the arrangement of the plates (Rev III. pp 20, and 67). In several specimens of the last named species we have seen the anal appendage, with the integument extending either way to the rays, and the same thing was long ago observed by Meek and Worthen (Geol. Rep. Illinois., Vol. III, p. 494.).

It is thus evident that the ventral covering of *Taxocrinus* consisted of perisomic plates with external mouth and food grooves, and five oral plates, surrounding the mouth and separated by the ambulacra. We have now very little doubt that the structure thus discovered is substantially that of the Ichthyocrinidae generally, and that the ventral side of the calyx in this family is morphologically in the condition of *Thaumatocrinus*, and similar to that of *Hyocrinus* and *Rhizocrinus*.

Although we have heretofore entertained a different opinion, we yield most cheerfully to the proofs, and we are heartily glad to be the means of bringing to light one substantial fact to take the place of theories, even though some of our own views suffer in consequence. We also take pleasure in bearing this testimony to the soundness of Dr. P. H. Carpenter's views as to the nature of the ventral covering in the Ichthyocrinidae. He always considered that this family represented an approximation to the Neocrinoids, and that the integument was comparable to a disk and not to a vault.[1]

This discovery is also a confirmation of the opinion always insisted upon by us, as a conclusion necessarily following from the structure of the calyx and arms, that the ventral covering of the Ichthyocrinidae was pliable, yielding to motion in the calyx and arms, and emphasizes the distinction between this group and other Palaeozoic Crinoids based on the summit structure, as pointed out by us at the beginning of our writings (Rev. I, p. 5), although, we admit, to a higher degree than we ever anticipated.

Recurring now to the orals, it is easy enough to understand from the structure of *Taxocrinus* how a set of five equal plates, symmetrically disposed over the mouth as in the larva of *Antedon*, could be so altered by the presence of anal structures, as to bring the mouth beneath the posterior plate. It is readily conceivable, that by the encroachment of the anal plate, the posterior oral was pushed to a central position, and remained permanently in that condition. The transition from five unequal to five equal orals through such forms as *Platycrinus* (Pl. XVIII, fig. 15), seems also quite apparent. The fact that the covering plates of the ambulacra in our specimen rest against the lateral edges of the orals, is contrary to the observations heretofore made among recent crinoids in which orals have been observed. In all of them the ambulacra pass in at their outer margins, and the plates are parted so as to form open slits. In the Camarata the orals remain closed, and the ambulacra,—when exposed at all,—with their food grooves closed, enter the vault on or before approaching the orals.

We therefore consider the evidence entirely conclusive that the homologues of the five oral plates of the young *Antedon* and the adult *Holopus*, *Hyocrinus*, *Rhizocrinus* and *Thaumatocrinus* are to be found in the so-called central plate and four large proximals in all Camarata in which these are developed—the two smaller proximals, heretofore considered as the equivalent of a fifth, being anal plates.

The question now naturally arises, what are the morphological

[1] Challenger Report on the Stalked Crinoids, pp. 42, 181 and 182, and elsewhere.

relations of the ventral plates in *Haplocrinus*, in view of the discovery that it has no central plate? Those plates meet in the center, and cover the mouth substantially in a similar manner as the five orals in *Platycrinus*; being, however, more alike in form and size, and more regular in their arrangement. They also closely resemble the five orals of the Pentacrinoid larva of *Antedon*, but, unlike them, are suturally connected with one another as well as with the radials. The plates also occupy the position of the five interradials of *Cyathocrinus* and the deltoids of the Blastoidea; resting like the latter upon the limbs or upper extensions of the radials.

We have heretofore contended, against the views of Carpenter and others, that the ventral plates of *Haplocrinus* are interradials and not orals, believing the latter to be represented by the "central plate," which we took to be the homologue of the so-called central plate of Actinocrinidae and Platycrinidae.

It would seem to follow naturally that with the elimination of the central plate from the question, the chief objections to considering the five summit plates as orals, which impressed us so strongly before, would now be removed. A serious morphological difficulty, however, is still found in the position of the opening which we suppose to be the anus. This, as we have already described, penetrates the middle portion of one of the vault plates—a structure not found in any other known Crinoid, either in the adult or larval state. The position is the same as that of the anus in the deltoid of the Blastoid genus *Orophocrinus*, which complicates the case still more.

It is further a fact that in the lowest Silurian Camarata interradials are more profusely represented than among Carboniferous forms, frequently extending over the whole ventral surface of the calyx, while the orals apparently are unrepresented. From this it would seem to follow that if *Haplocrinus* represented a larval form of the Palaeocrinoidea, the plates in question could not be orals, or the structure would appear to be at variance with the palaeontological development of the group.

For these difficulties we are unable at present to offer any explanation, but nevertheless we admit that there are very strong reasons for regarding those plates as orals. They present a striking resemblance to the five plates composing the unopened oral pyramid of the Pentacrinoid larva before its separation from the radials by perisome, and there are unquestionably very strong grounds for considering *Haplocrinus* and allied genera as larval forms. Taking into consideration all the facts as now disclosed, and especially the non-existence of a central plate, we must admit the weight of the evidence is in favor of the supposition that the plates covering the ventral surface in *Haplocrinus*, and *Allagecrinus* are orals, and that these orals are permanently closed in the Haplocrinidae without the assistance of interradial plates. In accepting this as probably the correct interpretation of those plates, we now recognize also in *Symbathocrinus* and *Pisocrinus* five large orals as covering the greater part if not all of the ventral surface, more or less similar to those of *Haplocrinus*, though with a very different anal arrangement in *Symbathocrinus*, and probably also in *Pisocrinus*.

A still broader question remains to be considered, viz: the effect of the late discoveries upon the classification of the Crinoidea, generally. In proposing the Palaeocrinoidea as a distinct order of the Crinoids, we considered the presence of a subtegminal mouth, and the closed state of the food-grooves, as the most important characters by which they were distinguished from Mezozoic and more recent forms. But it is evident that since the discovery of an open mouth in the Palaeozoic genus *Taxocrinus*, we can no longer by this means separate the earlier from the later crinoids. Carpenter did not agree with us as to the importance of the subtegminal mouth, and he proposed to separate the Palaeocrinoids from the Neocrinoids principally upon other features which he discussed in detail in the Challenger Report on the Stalked Crinoids, pages 149–155. A slight examination will show that all these other characters meet with so frequent and important exceptions in both groups, that it is not safe to depend upon them.

According to Carpenter, in the Neocrinoidea underbasals are represented rarely, in the Palaeocrinoidea frequently (Challenger Report, p. 149). Several years ago we discovered that there is a regular alternation in the arrangement of the successive parts of crinoids below the radials, which furnishes a most important guide for distinguishing between monocyclic and dicyclic crinoids, by the structure of the column and cirri. It was stated on page 7 of the Revision, Part III,—with a most unfortunate transposition of terms in printing, which we corrected on page 294,—and which may be graphically expressed by the following sketch:—

		Dicyclic.	*Monocyclic.*
1.	Basals.	Interradial.	Interradial.
2.	Underbasals.	Radial.	
3.	*Column.*[1] Exterior angels of.	Interradial.	Radial.
	Column. Sections of.	Interradial.	Radial.
4.	*Column.* Sutures.	Radial.	Interradial.
	Column. Sides.	Radial.	Interradial.
	Column. Cirri when present.	Radial.	Interradial.
	Column. Axial canal.	Radial.	Interradial.

We have found this rule to be without exception among palæozoic crinoids, and upon the strength of this, and an examination of the column of such Neocrinoids accessible to us as possessed an angular column, or cirri, we came to the conclusion, as stated in the Revision III, p. 8, that "probably many Neocrinoids either possess small underbasals, or these were present in their larval form." We became more and more of the opinion that the Neocrinoids, for the most part, were built on the plan of dicyclic crinoids, and we again stated (Rev III, p. 71), that "all Neocrinoidea, or at least the most of them, in their larval state may have possessed rudimentary underbasals, hidden by the column." On pages 294–299, we discussed this question more at length, and stated our conclusion to be (p. 298) that "either the rules which meet with no exceptions among Palaeocrinoidea, as far as we know, do not hold good for the Neocrinoidea, or the genera to which we alluded, and which are built otherwise upon the plan of dicyclic crinoids, really possessed rudimentary underbasals during life, as *Extracrinus* and certain species of *Millericrinus*, or that perhaps underbasals were present in their larva. The ventral surface

[1] Our observations respecting the column were naturally restricted to species in which the stem and axial canal are angular, and in alluding to the sections and sutures of the column we refer to species with a pentapartite stem. In cases in which only basals are visible, and the angles of the stem are interradial, underbasals invariably are present beneath the column.

of the centro-dorsal in some species of *Antedon* is almost identical with that of the top stem joint of *Millericrinus;* the plate is also interradial (Pl. 6, fig. 11), and rests, as in the Apiocrinidae, against the outer face of the basals, not within the basal ring. It is similar in other Comatulae, in all of which the centro-dorsal is interradial, and upon this, mainly, we base the opinion that perhaps also the Comatulae in their early larva had rudimentary underbasals. That these plates if present were not observed, is not surprising, as they may have been very minute, and been covered entirely by the column."

So strongly were we impressed with the conviction that the Comatulae were dicyclic crinoids, that we urged European investigators to make a fresh search for the underbasals in the larva, notwithstanding that no trace of them had been found by Wyville Thomson, the two Carpenter, Götte and others, who had extensively studied the embryology of *Antedon.*

It was therefore with no little satisfaction that we received the information in July 1887 that the underbasals, whose existence we had thus predicated upon palaeontological evidence, had actually been discovered in the early larva of *Antedon rosacea.* This important discovery was made by Mr. H. Bury, who announced it at the Manchester Meeting of the British Association in 1887. Mr. Bury's paper giving the full details of his investigations, has not yet appeared, although understood to be in press. The results, however, are stated by Carpenter[1] as follows: "while this paper was in press an important discovery was announced by Mr. H. Bury at the Manchester Meeting of the British Association. He has found the underbasals in the ciliated larva of *Antedon rosacea*; but they soon fuse with the top stem joint (centro-dorsal), and all trace of them is lost when the cirri appear. This is a very striking confirmation of the views of Messrs. Wachsmuth and Springer, whose palaeontological studies had led them to express the belief that the underbasals might be present in the early larva of Comatulae."

Upon the same grounds, we think, we may safely postulate a dicyclic base in the extensive families of Apiocrinidae and Pentacrinidae, and all other Neocrinoid families in which the so-called centro-dorsal or top stem joint is described as forming an integral part of the calyx as in the Comatulae, and whose stem, when angular, is

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[1] Notes on Echinoderm Morphology, No. XI, Quart. Journ. Microscop. Sci., Vol. XXVIII, New. Ser. p. 311.

directed interradially. In two species of *Millericrinus* rudimentary underbasals have already been found by De Loriol,[1] and in both of them the plates in question are attached to the top stem joint.

From these facts we may fairly say that the dicyclic plan prevails far more generally among Neocrinoidea than among Palaeocrinoidea.

It is very interesting to note, in this connection, that the underbasals in many of the Ichthyocrinidae are of an exceedingly rudimentary nature. In *Ichthyocrinus* they are scarcely ever seen at all, being usually visible only on the interior of the dorsal cup, In *Taxocrinus* they are always hidden by the column, and sometimes visible only within the calyx, which led Schultze to call them "cryptobasalia." In *Forbesiocrinus* and *Onychocrinus* they are nearly always concealed by the column, and furthermore in some cases they seem to be fused with the upper joint of the column, for they separate from the basals and remain attached to the column when the latter is broken off. It is therefore a suggestive fact that in *Millericrinus polydactylus* and *M. Orbignyi*, the two species in which De Loriol discovered underbasals, these were in a precisely similar way separated from the basals and firmly attached to the column.

Another distinction relied on by Carpenter is that in Neocrinoids "by far the greater number of genera have five equal and similar basals, with five equal and similar radials resting upon them." He excepts *Hyocrinus*, which has three basals, and *Holopus* and *Eudesicrinus* in which the radials are not symmetrical; and he adds: "but this want of symmetry is not due to the intercalation of any anal plates as in nearly all Palaeocrinoids." He therefore admits a certain amount of asymmetry in Neocrinoids, so long as not due to anal plates, though he elsewhere attaches some importance to a similar irregularity in some Palaeocrinoids, when confined to basals and radials only, and not in any way connected with anal plates, as for example *Eucalyptocrinus*.[2]

Another point characteristic of the later crinoids brought out by Carpenter is that "the articular facets of the first radials occupy the whole width of their distal faces, so that the lowest parts of the rays, whether divided or not, are of nearly the same width as the radial plates which bear them (Chall. Rep. p. 155). Exceptions to this are found in *Hyocrinus, Plicatocrinus* and *Marsupites*. It is true that

[1] Paleont. Franc., Vol. XI, Crinoides Pts. 110 and 116.

[2] Challenger Report, p. 151.

in the Palaeocrinoids there are many families in which the articular facet of the first radial simply occupies the middle of its distal edge; but this is not the case with the Ichthyocrinidea, the most of the Poteriocrinidae, Cupressocrinidæ, and Symbathocrinidae.

The main point, upon which Etheridge and Carpenter,[1] and afterwards Carpenter alone,[2] distinguished the two groups was stated to be the regularly pentamerous symmetry of the calyx in Neocrinoids contrasted with the asymmetry of the Palaeocrinoids, in which "the pentamerous symmetry of the calyx[3] is almost always disturbed by a greater or less modification of the plates on the anal side." From this Carpenter was obliged to except the genus *Thaumatocrinus*, as to the Neocrinoidea, which has well developed anal plates.

A far greater number of exceptions are found in the Palaeocrinoidea, among the Camarata as well as the Inadunata and Articulata. Among the first may be mentioned *Dolatocrinus*, *Stereocrinus*, *Centrocrinus*, *Technocrinus*, *Corymbocrinus*, *Eucalyptocrinus* and *Callicrinus*, in which the anal interradius cannot be distinguished in the dorsal cup from the four others; *Lyriocrinus*, *Ripidocrinus*, *Thylacocrinus*, *Rhodocrinus*, and *Gilbertsocrinus*, in which it is rarely distinct; and *Briarocrinus* whose irregularity is not caused by anal plates. Among the Inadunata there are *Codiacrinus*, *Lecythiocrinus*, *Stemmatocrinus* and *Erisocrinus*, in none of which the usual anal plate is known to exist. Among the Articulata, we note *Ichthyocrinus* and *Nipterocrinus* as being in a similar condition as *Briarocrinus*. In some of the above genera, however, there is an irregularity in the basals; yet this is not due to anal plates, but to a coalescence of two or more of the plates, a variation which is also found in the recent genus *Rhizocrinus*, and among the underbasals in the *Antedon* larva.

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1 "On Allagecrinus, Ann. and Mag. Nat. Hist., Apr. 1881, pp. 295 and 296.

2 Challenger Report on Stalked Crinoids, p. 150.

3 It must be observed that the term "calyx" was used by Dr. Carpenter in the Challenger Report, and by us at that time, to designate the part of the test below the arm bases. Finding more and more the necessity of having a more stable terminology, which would be applicable to the Crinoids generally, we have agreed with Dr. Carpenter upon the following terms, which will be used by both of us hereafter for descriptive purposes, viz:—

Crinoid minus the stem = *Crown*.

Crinoid minus stem and arms = *Calyx*.

All parts of the calyx below the arm bases = *Dorsal cup*.

The ventral perisome with mouth and ambulacra = *Disk*.

All parts covering the disk = *Vault*.

In alluding to the symmetry or asymmetry of the calyx, we must consider only the arrangement of the plates in the dorsal cup, as the ventral covering in all crinoids, whether composed of vault or disk, is more or less disturbed by the anus.

We do not regard it as a good distinctive character that in the later crinoids the basals are generally pierced by interradial canals or grooves in connection with the chambered organ, when not a vestige of them is seen in *Marsupites*, and similar grooves are found in *Cutillocrinus*, *Mycocrinus*, *Crotalocrinus* and many Fistulata. Nor do we think it of much importance that in some palaeozoic forms the first division of the rays does not take place upon the third radial, or that in one or two cases the first radials themselves are axillary, when among Neocrinoids *Metacrinus*, as well as *Plicatocrinus*, form exceptions to this rule.

Another of Carpenter's distinctions is that in the Neocrinoidea with the exception of *Thaumatocrinus*, the primary radials are in contact with one another by the entire length of their sides; but the fact is that there are also among the Palaeocrinoidea a number of genera, both of the Ichthyocrinidae and Inadunata, in which a similar structure is found.

Now to the presence of interradials, a character upon which we placed so much importance as separating the older from the later crinoids. We held that interradials were present in all groups of the Palaeocrinoidea, but among the Neocrinoidea only in *Thaumatocrinus*. This applies very well to the Camarata and perhaps to all Fistulata, but it is possible that among the latter, in certain Carboniferous genera, especially within the Poteriocrinidae, their interradials became resorbed. Interradials are also absent in the Larviformia, if we regard their large ventral plates as orals. We also doubt if the so-called interradials of the Ichthyocrinidae are the homologues of the interradials in the Camarata, but rather regard them as comparable with the unevenly distributed, interradially disposed plates, which occur in some of the Apiocrinidae, and which we take to be perisomic.

The so-called interradials of the Apiocrinidae, which occur only in a few species, vary among individuals and are irregular in their arrangement. According to De Loriol[1] they are represented variously by one or three plates in the lower row, even in the same species. Owing to this irregularity they have been regarded by us as "enor-

[1] Paleont. Francaise, 1st Serie Anim. invertebr., Crinoides, p. 272.

mously developed perisomic plates" (Revision, Pt III, p. 63), and not as true interradials, although they present a more rigid appearance than perisomic plates generally have. Our views have been strengthened by De Loriol's important discovery of the plates covering the ventral surface in *Apiocrinus roissyanus.*[1] According to his description the space between the rays, from the first or the first two interradial pieces up, are occupied by transverse series of two or three small, somewhat regular plates, which gradually lose their regularity, and at the top of the third radial become for the most part entirely irregular and unequal. They differ in their form and arrangement in every one of the interradial spaces, and pass into a conical "ventral sac," which rises to the top of about the ninth brachial piece. The plates composing this ventral covering are equally irregular, and, though tolerably strong, are not absolutely rigid. De Loriol considers them as constituting a pliable integument, and not a solid vault like that of *Actinocrinus*, but in the specimen the central portion was not preserved and he could not discover the condition of the mouth, nor could he find traces of the ambulacra. In the same paper, on page 14, De Loriol also describes a specimen of *Apiocrinus magnificus*, in which the interradial spaces between the third radials, and up to the first brachial piece, are occupied by numerous irregular plates, dissimilar in the different spaces. He considers these interradial plates, in both species as belonging to the "ventral sac," which was capable, in his opinion, of contraction or expansion.

A similar irregularity in the interradials exists among the Ichthyocrinidae. In *Ichthyocrinus* interradials and interaxillaries are generally wanting, but in the one species in which they have been found their arrangement seems to be rather uniform in the different spaces. In *Forbesiocrinus*, which also has interradials, we frequently find two plates in the first row at the azygous side, in other cases but one. In *Taxocrinus*, when the rays are close together, there are sometimes no interradials at all, or, when there are more than one, the first is followed by one or two smaller plates. In *Taxocrinus Thiemei*, the type specimen has neither interradials nor interaxillaries, while other specimens in our collection, not otherwise distinguishable, have one to three interradials. In *Taxocrinus interscapularis* (Iowa Geol. Rep. 1858, Vol. I., Pt II, Pl. 1, fig. 3), we find a single plate inter-

[1] Note sur Quelques Echinodermes Fossils des Environs de la Rochelle. 1887. p. 11.

calated opposite the second and third radials and an interaxillary between the second secondary radials. In *Onychocrinus*, and those forms of *Taxocrinus* which resemble it in the expansion of the rays, like *T. intermedius*, there is frequently a large first interradial, succeeded by a variable number of smaller ones; while in other cases (Pl. XVIII, figs. 1 a, b, c) the lower plates themselves are quite irregular, following the curvature of the rays. They are connected with their fellows in the same interradius by the plates of the disk, which are attached to their inner edges. In both these genera the structure of the posterior interradius resembles that of the recent genus *Thaumatocrinus* in having a succession of anal plates forming a lateral proboscis-like projection, connected for more or less of its length with the perisome. *Lecanocrinus*, *Pycnosaccus*, *Cyrtidocrinus* and *Mespilocrinus* have an azygous and anal plate, but as a rule no interradials. *Lecanocrinus macropetalus* of New York has no interradial plates; while a specimen from Sweden, which agrees with the genus otherwise, has at each side one large interradial. *Calpiocrinus*[1] has an azygous plate passing well down between the basals toward the underbasals, and from one to four interradials in the same species. *Sagenocrinus*[2] has a remarkable azygous plate in line with the basals—the sixth parabasal of Angelin—and some variability in the other interradial spaces, although on the whole it is a rather symmetrical form.

The irregularity in the arrangement of the interradials, so frequently found in this group, their presence between the higher radials, and absence upon the first primary radials in species, and even among individuals of the same species, has always presented to us a difficulty in classifying the Ichthyocrinidae with the Palaeocrinoids.

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[1] *Calpiocrinus* is not the aberrant genus which we supposed from Angelin's figures (Rev. I, p. 30, 38). A good series of specimens from Dudley, not otherwise distinguishable from *C. fimbriatus* and *C. heterodactylus*,—which are probably synonymous—shows that it has the usual calyx plates of the family—three underbasals and five basals. In a specimen of *C. ovatus*, the underbasals are concealed by the column, and it is probable that this is the case in most of the Swedish specimens, and that in some instances the peculiar azygous plate, in line with the basals, has led to a misconception of the latter plates.

[2] Examination of the specimens leaves little doubt that *Sagenocrinus* belongs to the Ichthyocrinidae. We noted its resemblance to *Taxocrinus* (Rev. II, p. 202), and it always appeared to us out of place in the family Rhodocrinidae, which is greatly improved by its removal. Our generic diagnosis, made entirely from the figures and insufficient descriptions, is defective and incorrect in some particulars, and will be improved hereafter, as the genus has been discovered in America.

The interradials in the Apiocrinidae, extending up between the rays, connecting with, and forming a part of the ventral covering, find a close parallel in those of many of the Ichthyocrinidae, and since the discovery of a disk and open mouth in *Taxocrinus*, we have not the slightest doubt, that these plates represent the same elements in both groups, forming in both of them parts of the disk, and that perhaps the same is the case with the interradials and interaxillaries of *Uintacrinus*, which in many respects resemble those of the Ichthyocrinidae.

The subtegminal mouth, which we supposed to be the best character of the Palaeocrinidea, proves to be subject to exceptions fully as great as the others. Our recent discoveries show that in some palaeozoic crinoids, and probably in the Ichthyocrinidae generally, the mouth is exposed, and there is no vault aside of the orals; and we are not certain but that we may find other exceptions among the later Poteriocrinidae and Encrinidae. We now know that there are no additional elements in the oral system of palaeozoic crinoids, but that the mouth opens out in a very similar manner by the parting of the orals as in the larva of recent forms, and this leads us to put less faith than before in the condition of the mouth as a character for the subdivision of the Crinoidea. For these may well be different stages in the development of the mouth, represented in palaeontological time, and we need not be surprised to find at some time a Silurian Ichthyocrinoid with the orals closed, or a Haplocrinoid with the orals parted.

From this review of the principal characters relied upon to distinguish the earlier from the later crinoids, it will be apparent that the exceptions are so numerous as to leave nothing stable or definite on which to base such important primary divisions, and we are again confronted with the problem of rectifying the classification of the Crinoidea, or proposing a new one. It is true that many of these exceptions are due to differences which tend to separate the Ichthyocrinidae from the Palaeocrinoids, and unite them with the Neocrinoids; and it might be the simplest, as well as the least radical change, to modify the definition of the Neocrinoidea so as to admit the Ichthyocrinidae, which would thus fall exactly into that place among them, for which Carpenter was always obliged to make an exception in favor of Thaumatocrinus. In so doing, however, we would be bringing together some of the earliest and latest forms, which would render the name Neocrinoidea wholly inappropriate.

The two groups would be separated chiefly upon the condition of the mouth, and the name "Stomatocrinoidea," which we proposed in 1879 (Revision I, p. 22), might be revived. The greatest objection to this plan, however, lies in the possibility, as before mentioned, of finding an Ichthyocrinoid with closed mouth, or a Haplocrinoid with parted orals, which would upset the whole arrangement.

To attempt to modify the definition of the Palaeocrinoidea so as to admit forms with an external mouth, is in our opinion entirely out of the question, and would simply increase the difficulties now encountered, because there could not be pointed out a single reliable character by which the two groups could be distinguished.

After considering the question in all its new aspects, as presented by the facts recently brought to light, it is our best judgment, that all attempts to subdivide the Crinoidea by separating the palaeozoic from the mesozoic and later forms as natural divisions, will have to be abandoned, and some mode of separation sought for, entirely independent of geological age. In that case, the names Palaeocrinoidea and Neocrinoidea—unless in the sense of mere conventional terms for designating the palaeozoic and later crinoids—will have to be laid aside.

To this end we think that four well defined groups can be distinguished as independent primary divisions of the Crinoidea, viz:

1. Camarata.

2. Inadunata, including the branches Larviformia and Fistulata.

3. Articulata,[1] including the Ichthyocrinidae, and possibly *Uintacrinus* and *Thaumatocrinus*.

4. A fourth division to include the most of the mesozoic and recent crinoids, for which the name Canaliculata[2] might be very appropriately adopted. These divisions will be suborders or orders, depending upon the rank which may be ultimately assigned to the Crinoidea—a question we think still open for discussion. In the definition of them many classificatory criteria, such as the condition of the mouth, the presence or absence of interradials, the relative proportions of the actinal and abactinal regions in the calyx, which

[1] The Crotalocrinidae, which we formerly assigned to the Articulata, have been found to belong to the Camarata, as we have shown at length in another paper.

[2] This name was proposed by Prof. E. J. Chapman in a paper entitled "A classification of Crinoids," Toronto, 1874, to include the genera *Pentacrinus, Antedon, Encrinus, Eugeniacrinus, Apiocrinus, Bourgueticrinus*, and *Rhizocrinus.*

when applied to the older and later crinoids seem to lose much of their significance, will form strong and distinctive characters. Palaeozoic and recent crinoids may, if necessary, be brought together in the same group, according to their zoölogical characters, free from embarrassment arising from restrictions as to geological age.

The Camarata, Inadunata and Articulata would be defined, as to their most general characteristics, substantially as we have already defined them in the Revision of the Palaeocrinoidea, with some modifications as to the ventral structure in the Inadunata and Articulata, to conform to recent discoveries.

We are strongly of the opinion that the recent genera *Holopus*, *Bathycrinus* and *Hyocrinus* might very properly be arranged under the Larviformia. All three are monocyclic, and like the Haplocrinidae and Symbathocrinidae retain through life large oral plates. But while the orals in these two families are closed and rest directly upon the radials, in the above named recent forms they are parted, and separated from the radials by a narrow band of perisome, which, we strongly suspect, was also the case in the Gasterocomidae. The aberrant genus *Thaumatocrinus* might be referred to the Articulata, with which, for the most part, it agrees in the asymmetry of the calyx and the construction of the azygous side. *Uintacrinus* will very likely fall into the same group; while the Encrinidae will probably find a resting place among the Fistulata, and perhaps also *Marsupites*.

The removal of these genera would leave the Canaliculata as a very compact, well defined group. It would contain only crinoids which are dicyclic, or built upon the dicyclic plan, and in which the underbasals are anchylosed to the top-stem-joint, the two together forming the centro-dorsal. All of them would be free from any disturbance by anal plates, and the basals in all of them, so far as known, would be perforated by interradial canals or furrows in connection with the chambered organ.

The disposition of the later crinoids, as herein indicated, is merely suggestive, as we prefer to leave their arrangement to Dr. P. H. Carpenter, who has made them a special study.

We shall not at present undertake more than to submit for the consideration of our fellow naturalists the conclusions to which we have been led by the evidence of recent discoveries, leaving to a future occasion the framing of detailed definitions of the divisions we have proposed in case they should meet with favor. A consensus of opinion on this subject is much to be desired, and would greatly facilitate future studies.

From an interchange of notes with Dr. Carpenter we understand that we are now in substantial agreement upon the oral question, but he will shortly state his own views at length in a paper now in preparation. Should the views herein set forth contribute toward the establishment of a sound classification, we shall consider that our long controversy with Dr. Carpenter, both in print and by letter, has borne good fruit, and we shall waste no regrets over the fact that in some points the result has proved that he was right and we were wrong.

We give herewith a corrected diagnosis of the family Ichthyocrinidae to conform to the ventral structure as we now know it.

Family ICHTHYOCRINIDAE.

Test pliable. Symmetry of the calyx irregular and usually disturbed by anal plates. Base dicyclic. Underbasals three, unequal, rarely visible beyond the column; the smaller one directed toward the right postero-lateral radial,[1] frequently anchylosed to the upper stem joint. Primary radials perforate; variable in number among species and individuals from two upward; either abutting laterally, or separated by one or more plates. Radials and arm joints united by muscles and ligaments; line of union more or less undulating, frequently with patelloid projections from the proximal margins of the plates; articular surface usually occupying the whole distal face of the first and succeeding radials. Arms uniserial, apparently without pinnules. Interradials irregular in form, size and arrangement, sometimes entirely wanting in species in which they are usually present; their lateral faces provided with deep ligamentous fossae. Posterior interradius with or without anal plates; the latter, when present, frequently associated with an azygous plate. Disk, so far as known, paved with irregular perisomic plates, and larger plates between the rays. The center of the disk occupied by five unequal orals surrounding the mouth. Mouth exposed, at least in the later forms. Food grooves lined by moveable covering pieces. Column large, decreasing in size rapidly near the calyx. *Geological Position:* Palaeozoic. From the Lower Silurian to the Upper Coal Measures.

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[1] In the Revision, Pt. III., Pl., VI, fig. 23, we represented the underbasals of *Ichthyocrinus* incorrectly as directed anteriorly. We have since examined numerous specimens of various genera, and find the small underbasals located, as above stated, in all of them.

Explanation of Plate XVIII.

Fig. 1. *Taxocrinus intermedius* W. and Sp.

1[a] Specimen showing the irregularly arranged interradial plates and pouches along the free rays; 1[b] posterior view of the same specimen, showing the lateral proboscis, and the perisomic plates; 1[c] posterior side of another specimen, showing the proboscis and folds in the perisome; 1[d] the proboscis and ventral perisome in another specimen; 1[e] ventral view of the same specimen as 1[c], showing the ventral perisome, the ambulacra, mouth and parted orals.

Fig. 2. Vault of *Dorycrinus mississippiensis* with an extremely large posterior oral.

Fig. 3. Vault of *Agaricocrinus Wortheni*. The orals very irregular and separated by small accessory pieces.

Fig. 4. Vault of *Platycrinus discoideus* with more regularly arranged oral plates.

Fig. 5. Vault of *Batocrinus clypeatus*, the orals pushed over to the anterior side by the subcentral anal tube.

Fig. 6[a] *Haplocrinus mespiliformis*, posterior aspect, showing the position of the anal opening; 6[b] showing the 5 large anal plates, and the tongue-like projection of the posterior oral; 6[c] another specimen, showing the "knopf" of Goldfuss at the upper end of the posterior oral, and the proximal arm joints.

Fig. 7. Vault of a new species of *Talarocrinus*, with a single large plate in the center.

Fig. 8. Vault of *Platycrinus Yandelli*, the posterior oral pushed out of place by the proboscis.

Fig. 9. Vault of *Platycrinus americanus* with more regular orals.

Fig. 10. Vault of *Eretmocrinus coronatus*. The orals very much displaced by the proboscis.

Fig. 11. Vault of *Rhodocrinus Whitei*, apparently without oral plates.

Fig. 12. Vault of a new *Rhodocrinus* from New Mexico, like the preceding species apparently without orals.

Fig. 13. Oral plates of *Amphoracrinus quadrispinus.*

Fig. 14. Inner floor of the orals of a *Pisocrinus* from Indiana.

Fig. 15. Vault of a young *Platycrinus symmetricus* W. and Sp., with almost uniform orals.

(All specimens in the collection of Wachsmuth and Springer)

CROTALOCRINUS: ITS STRUCTURE AND ZOOLOGICAL POSITION.

BY CHARLES WACHSMUTH AND FRANK SPRINGER.

The type of Crinoids that has been described under the name *Crotalocrinus*, is one of the most extraordinary yet brought to light from palæozoic rocks. Its net-formed radial appendages, so widely different from those of any other known Echinoderm, and resembling rather the fronds of a Bryozoan than the arms of a Crinoid, have long made it a puzzle to naturalists, and the efforts of all writers up to the present time—ourselves included—have contributed but little toward any satisfactory determination of its systematic relations. Though so highly differentiated in its structure, the genus is confined to the upper Silurian, so far as known. It has been found in the island of Gothland, Sweden, where it was first noticed by Hisinger in 1828, and afterwards described by him as a *Cyathocrinus* in 1837. It was also found at Dudley, England by Parkinson in 1808, who called it the *Turban* or *Shropshire Encrinite*; and it was redescribed by J. S. Miller in 1821, as *Cyathocrinus rugosus*. No trace of it has ever been discovered at any other locality. Good specimens are rare and difficult to obtain, so that the facilities for its study, outside of the countries where it occurs, have hitherto been practically *nil*.

The arm structure was not understood until 1854, when Johannes Müller figured and described under the name *Anthocrinus Loveni* the principal Swedish species, although Austin had established the genus *Crotalocrinus* in 1843, for the English form, without figure and with a very meagre description. Angelin's elaborate work on the Swedish Crinoids in 1878, contained numerous beautiful figures of apparently perfect specimens, and seemed to give the most ample illustrations of every part elucidating the structure of this curious fossil. Upon these descriptions and figures, and without any opportunity to study even a single specimen, we prepared our description of the genus, and discussions relating to it, as they appeared in Part III of our Revision of the Palæocrinoidea.

Not long after the publication of this work, we found reason to believe that our interpretation of the structure and affinities of *Crotalocrinus* was erroneous, and that much of what we had written on the subject was altogether worthless. During a visit of one of us to Europe last winter, he had an opportunity of examining the best known English specimens, in the British Museum and other collections, and by considerable effort succeeded in obtaining some excellent material for more detailed study, both from England and Sweden. Besides this we have enjoyed the unexpected privilege of studying a number of the original specimens used by Angelin. For this we are indebted to Dr. Gustav Lindström, Curator of the Palæontological Department of the National Museum at Stockholm, who on being informed of our perplexity regarding this genus, upon his own motion, sent us these and other specimens, with liberty to study them at our leisure; and also furnished us most important information in the way of drawings and observations upon other specimens. It was an act of thoughtful kindness for which we find it difficult to adequately express our gratitude, and if this paper shall be found to be of any value to our fellow naturalists, it will be in a very large measure due to the facilities thus generously afforded us.

In the Revision of the Palæocrinoidea, Part III, pp. 140–143, we referred *Crotalocrinus* and *Enallocrinus* to the Articulata, and at various places (pp. 18, 19, 56, 64, 65) based some of our arguments as to the character of this suborder upon the supposed structure of these two genera. On pages 18 and 19 of Part III, we stated that "In the Crotalocrinidae, which include *Crotalocrinus* and *Enallocrinus*, the whole ventral surface, in what appear to be the best preserved specimens, is composed of strong, convex plates, without definite arrangement. In these specimens there is no central plate, nor proximals, nor traces of ambulacra (Icon. Crin. Suec., Pl. VII, fig. 3a; Pl. VIII, figs. 6, 7, and Pl. XXV, fig. 2.); there are, however, other figures of Angelin, apparently of a closely allied species (ibid. Pl., XVII, fig. 3a), in which the plates paving the ventral surface are much more delicate, and consist of a central plate, large proximals, and several rows of covering pieces, without the intervention of either anambulacral or interradial plates. It would be difficult, with the utmost stretch of our imagination, to recognize in the former figures either proximals or central piece, which, as admitted by Carpenter, are present in all these crinoids, and we think there can be little doubt that the two sets of figures represent different parts of the animal, the one the disk, the other the vault, and that the one covered the other. A similar opinion was evidently entertained by Zittel (Handb. d. Palaeont. I, p. 357), who stated that *Crotalocrinus* possessed five 'grosse Oralplatten, bald unter der Decke, bald äusserlich sichtbar.' According to our interpretation, the calyx of the Crotalocrinidae extends ventrally to the oral pole, and the ambulacra, central piece, and proximals are subtegminal, covered by interradial plates, which extend out to the lower rows of covering plates and side pieces (Icon. Crin. Suec., Pl. VIII, fig. 6, and Pl. XXV, fig. 2). A similar condition probably prevailed in the Ichthyocrinidae, with which the Crotalocrinidae have close affinities."

As our reference of these genera to the Articulata was based exclusively upon the figures, especially those of Angelin, it will be well to examine them now in the light of the knowledge we have since obtained. The only figure of those quoted that gives the vault structure correctly, is fig. 3a, on Plate XVII. It shows very plainly four large proximals and a large plate toward the posterior side, which, according to the terminology we then employed, we regarded as a central plate. The proximals are elongate-nail-shaped, and two of them touch the incurved ends of the upper faces of the first radials, while two others abut against a small interradial plate, and the larger posterior plate against small plates around the anus. Within the re-entering angles, between every two of the large plates, there are several series of small pieces ramifying toward the arm openings and laterally connected. Dr. Lindström has sent us a very carefully prepared drawing of a specimen which he thinks is the original of the above mentioned figure. This is reproduced by us on Pl. XX, fig. 4. The structure appears substantially the same, but the details are better defined in this figure than in the former, showing that the proximals touch the first radial only at one side, while at the other sides one, two, or three small interradial plates are interposed. Within the five re-entering angles formed by the five orals (central plate and four large proximals),* rest five comparatively large radial-dome-plates, which are followed by several rows of small alternating pieces. That the latter are covering plates which were continued along the arms is well shown in both figures.

A totally different structure was exhibited by figs. 6 and 7, Pl. VIII, of *Crotalocrinus pulcher*, and by fig. 3*a*, Pl. VII, and fig. 2 Pl. XXV, of *Enallocrinus scriptus*, all purporting to show the plates of the ventral side completely. In all of these figures the arrange-

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* The so-called "proximals" and "central plate," as we have shown elsewhere, are now regarded by us as representing the five oral plates, the central plate being the posterior oral, modified and displaced by anal structures.

ment of the plates covering the visceral cavity is extremely irregular, scarcely any two plates being alike. There is neither a central plate, nor anything that might be compared with the four large proximals, and no plates corresponding to, or which might be identified as covering plates until the region of the arms is reached. In Pl. VIII, fig. 6, the plates appear ornamented by small nodes up to the second bifurcation of the ray, and a similar ornamentation covers the anal structure, of which portions are visible. This ornamentation is so marked, and gives to this part of the figure such a totally different aspect from the higher branches of the rays, in which it is entirely absent, that we regarded it as a vault, from underneath which the covering plates emerged. The whole figure gives one the impression that it was made from a very perfect specimen, in which the minutest details of structure were exceptionally well preserved. The other figure–7–on the same plate exhibits a similar vault, but with less elaboration of ornament and surface details. Covering plates are here visible only upon the parts which extend beyond the limits of the calyx, nor is there any trace of proximals or central plate.

Figure 3*a*, of Pl. VII, which is said to represent "*pars perisomatis ventralis*" of *Enallocrinus scriptus,* shows a complete uninterrupted covering of the whole ventral surface of the calyx and portions of the rays. As in the other figures, the plates are wholly wanting in definite arrangement, no summit plates can be discovered, and the covering pieces, as before, begin at the periphery of the calyx.

Another figure of the same species, apparently from a most beautifully perfect specimen, to judge from the drawing, is given on Pl. XXV, fig. 2. It is stated in the explanation of the plate to be the same specimen as fig. 1, seen from above, and there is no reference to any imperfection or restoration. It appears to show all the plates of the ventral covering from the center of the summit to a long distance out upon the arms. In this figure, as in the preceding, there is a complete absence of any regular plan of arrangement among the plates forming the ventral part of the calyx. It would be impossible by any degree of imagination, to identify among them anything like summit plates or covering pieces, the latter commencing beyond the limits of the calyx. The plates are generally represented as nodose, and those toward the middle as the largest, but beyond this there is nothing in the figure to distinguish any of them.

It was upon the information derived from these figures that we based our conclusion—hasty as it may have been—that there were two integuments in these genera, one above the other; one representing the perisome containing the ambulacra, the other a vault of irregular pieces, and to some degree pliable.

We could not see how two such totally different structures as those shown by Pl. XVII, fig. 3*a*, and Pl. VIII, fig. 6, could represent the same elements in one and the same genus, and we therefore adopted the idea of a double covering as the only solution we could find, although after considerable hesitation, feeling that such an arrangement was quite anomalous, and without a parallel elsewhere. We were also influenced in no small degree by the fact that Prof. Zittel, who had the opportunity to see the Swedish collections, interpreted the structures in a similar way.[1]

We could not, of course, imagine that such magnificent figures as are represented in Angelin's work[2] in the absence of any explanation to that effect, could be wholly imaginary as to the most important parts of the structures illustrated. The fact is, however, as we now know, that all these important figures are to a large extent fictitious; that the middle portions of them, where the summit plates and covering pieces of the vault should have been found, were not shown in the specimens at all, but were filled in by the artist according to his own notion of their probable structure.

The only specimen in the National Museum at Stockholm which shows any part of the vault structure of *Crotalocrinus*, aside from the original of fig. 3*a*, Pl. XVII, has been sent to us for examination. It is evidently the original from which fig. 7, Pl. VIII was composed; for Dr. Lindström informs us that there is no other which can be regarded as the type of that figure. It shows the lanceolate areas and covering plates along the arms beyond the calyx very well, but

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1 Handb. d. Pal. Vol. i, p. 357.

2 It is but justice to the distinguished Swedish palæontologist to remark that his work on the Crinoids of Sweden was not complete at the time of his death. His descriptions seem to be rather preliminary notes made for his own use, preparatory to a more detailed study. These were collected after his death and published, together with twenty-nine plates illustrating them, under the direction of the Royal Academy of Sciences of Sweden. It is not strange under such circumstances there should be errors, and in pointing out some of them in this paper we have no intention of discrediting a work which has been of great service to palæontology by bringing to notice one of the most magnificent crinoidal faunae ever discovered.

the middle is entirely broken away, leaving, however, partially in place a few plates around the anal opening. There is nothing in the specimen from which the form and arrangement of the summit plates could be even inferred.

Of fig. 3*a*, Pl. VII, Dr. Lindström writes: "The figure is not correct. The central plates are totally wanting, as in *all* specimens of *Enallocrinus* I have seen, and there are no vestiges left to infer its true nature. There can be no satisfactory drawing made of it."

Among the specimens sent us from Stockholm was one labeled "VII 3," which we suppose to be one of the originals from which Angelin's Pl. VII, fig. 3*a*, was in part deduced. We have figured it to illustrate our description of *Enallocrinus* (Pl. XX, figs. 6*a*,*b*), and we learn that there are no other specimens of *Enallocrinus* which show any more of the summit than this.

As to fig. 2, Pl. XXV, Dr. Lindström writes: "I cannot conceive how such a drawing could have been executed out of it. The upper side is so badly preserved that no good figure can be taken."

The original of the splendid figure 6, Pl. VIII—*Crotalocrinus pulcher*—which was from the Marklinean Museum at Upsala, cannot be found, and we are therefore unable to give any particulars about it. We have not the least doubt, however, that this figure, which is stated to be enlarged (how much, we do not know), is even a greater fiction than the others. In our own specimen of *C. pulcher* from Sweden (Pl. XIX, figs. 1*a*, *b*, *c*), we succeeded in exposing enough of the summit, while cleaning around the ventral tube, to show that it is composed of covering pieces, interradials and summit plates, just like the Cambridge specimen (Pl. XIX, fig. 3).

These four figures, thus shown to be to a large extent incorrect and misleading, were the ones on which we entirely relied in the statement above quoted from Part III of the Revision. That statement was critized by Dr. P. Herbert Carpenter in a paper "On the structure of Crotalocrinus," in which he asserts, that "in their [our] statement that 'there is no central piece, nor proximals, nor traces of ambulacra' in the figures of *Crotalocrinus pulcher* and *Enallocrinus scriptus*, they appear to me to be seriously in error."[1]

It must be observed first, that in this portion of the paragraph quoted, we were speaking solely of the vault proper, and not of the rays and arms beyond the limits of the calyx. We distinctly refer to the existence of "covering plates and side pieces to which

[1] Ann. and Mag. Nat. Hist., 1886, p. 339.

the interradials extend" (p. 19), and on page 143, in our diagnosis of the *Crotalocrinidae*, we stated: "Ambulacral furrow deep, ramifying with the arm branches, covered by alternating plates, and bordered by side pieces." The ambulacra and covering pieces over them, *in the arms*, which those figures all show, were therefore clearly recognized by us always.

It is worthy of note, however, that Carpenter, while pronouncing us "seriously in error" in saying that there is no central piece, nor proximals, nor traces of ambulacra in the figures of Angelin above referred to, does not undertake to point out the presence or location of either one of those elements upon the figures in question, although he expresses on p. 403 his belief "that the small covering plates of *Crotalocrinus rugosus* are the representatives in a smaller crinoid* 'of the large rigid plates' shown in figures 6 and 7, * * * * while I shall also continue to believe, until the contrary is demonstrated, that the central plate and proximals are among the irregular pieces occupying the oral pole in the originals of these two figures." Neither does he inform us that the figures themselves are totally incorrect and fanciful, although at that time fresh from an examination of the type specimens at Stockholm.

Carpenter says (*op cit.* p. 399) that "while the summit plates are clear and well defined in some species and genera, there are other closely allied forms, in which these plates are almost or entirely undistinguishable among the large number of plates to be found in the vault. I will only mention one instance in illustration of this statement, viz. *Cyathocrinus iowensis* and *C. multibrachiatus*, both of which are figured by Wachsmuth and Springer (Revision Part. III, p. 65, Pl. IV, fig. 6, and Pl. V, fig. 7), the former with, the latter without any distinct summit plates."

These two figures, as the explanation shows, represent specimens in which the summit plates were in an imperfect condition, indicating a process of resorption or modification going on, and were expressly given for the purpose of illustrating this fact. The summit plates, as we stated on page 49 (Rev. Pt. III), "are in their arrangement, as a rule, very regular, and only disturbed by the anal tube." We stated further on the same page that the apparent disturbance in some species with a large number of arms was due to a misconception of the plates. It is true that in some forms the summit plates are not so readily distinguished as in others, and there are some genera,

* *C. rugosus* appears generally to be a much larger species than *C. pulcher*.

mostly Silurian, of different families, in which the vault is composed of an integument of innumerable minute pieces in which they are undistinguishable, and, in our opinion, do not exist. But we know of no other case of a vault composed of well defined and even ornamented plates, in which in the same genus there was a total absence of plan of arrangement in one species, and well defined summit plates and covering pieces in another. It seemed to us impossible that the summit plates and ambulacra, which were so distinct and conspicuous in the one specimen, should be entirely absent in another species of the same genus; and the only solution of the mystery which we could arrive at, was that in the latter they must be subtegminal, and that the covering of irregular pieces, shown in the four figures above quoted, was broken away in the specimen which exhibited the summit plates.*

As we have said before, we had no opportunity to study the Crotalocrinidae from actual specimens when we prepared the Revision. It required but a single glance at the specimens from Dudley and Gothland coming under our observation lately, to show us that our conception of the structure and relations of *Crotalocrinus*, and its congener, was completely erroneous, and that our views respecting the subtegminal summit plates and double covering are without foundation in the facts. We now renounce them altogether, and all conclusions or arguments based upon the supposed existence of these structures are hereby withdrawn. The same inspection of specimens that disclosed to us our error, revealed with equal clearness the real nature of those plates, and left not the least necessity for inferring the existence of summit plates among the irregularly arranged vaults of Angelin's restorations.

While it is of course unpleasant to be obliged thus to correct descriptions and repair arguments upon which we have laid considerable stress, we regret it in this case the less, because the result at which we have arrived regarding the systematic position of *Crotalocrinus* and *Enallocrinus*, confirms in a most satisfactory manner the validity of the great groups which we have recognized as subdividing

* The references to these figures in Part III of the Revision were unfortunately mixed up in the printing. They should be corrected as follows: on page 64, 7th line from bottom, for "Pl. 6," read "*Pl. 8*," and for "figs. 15 and 25," read *figs. 2 and 15*;" and in the 6th line from bottom, for "Pl. 13," read "*Pl. 8.*" On p. 65, 6th line from top, for "Pl 6," read "*Pl. 8.*" We also misunderstood Angelin's fig. 15, Pl. 25, and Joh. Müllers' fig. 10, Pl. 8, and our references to them should therefore be ignored.

the palæozoic crinoids, and proves that, while the groups themselves are entirely correct, our error consisted simply in a wrong understanding of the family, which led us to assign it to a group to which it does not belong.

Let us now proceed to ascertain to what group *Crotalocrinus* should be assigned.

We established the suborder Articulata to include the group defined by us under the family name Ichthyocrinidae with the addition of *Crotalocrinus* and *Enallocrinus*, (Revision III, p. 140). It is clear from what we now know of their structure, that the two latter cannot remain among the Articulata as that suborder has been defined by us.*

There is no doubt that *Crotalocrinus* possesses some characters belonging to each of the three groups which we introduced in the third part of the Revision. It resembles the Articulata in the peculiar articulation of the arms. In the arrangement of some of its calyx plates it bears a very close relation to the Inadunata, especially *Cyathocrinus*, to which genus J. S. Miller referred it. Like that it has three rings of plates, the upper one including a single anal plate. A casual glance at the structures succeeding these would lead one to think them somewhat similar to the unconnected rays of the Inadunata, but a more careful study will show that they are constructed upon the same principle as the same parts in some groups of the Camarata. They are actually neither true radials nor free arm plates, but, as in the Platycrinidae, represent a transition between them. As in *Platycrinus* there are but two primary radials, the upper one a small triangular axillary, to both sides of which the secondary radials are attached, resting both against its sloping sides and upon the first radial. They are overlaid by the tertiary radials, of which the lower ones often, in a similar way, rest upon the secondary radials and the first primary.

All these plates, in a most peculiar and unique manner, are solidly fitted together with each other and the first primary radial, and have at their ventral face a wide, deep, diverging groove, arched by strong, rigid covering plates, with a large tubular cavity underneath, which in reality forms a part of the cavity of the calyx, like in the free radial appendages in some forms of the Platycrinidae and Actino-

* The actual discovery by us of the disk of *Taxocrinus* with an external mouth, which we have elsewhere described, has settled all debate as to the summit structure of the Ichthyocrinidae.

crinidae. The mode of insertion of the higher radials upon the first primary is similar to that found in *Pterotocrinus* (Pl. XIX, fig. 6), and *Marsupiocrinus* (Pl, XIX, fig. 7, and also Angelin's Pl. XXII, figs. 1, and 28, Pl. XXVII, fig. 4), and is upon the very same principle that prevails in the Platycrinidae generally.

A further striking resemblance to the Platycrinidae is to be observed in the structure of the vault. We give for comparison figures of three of the most perfect vaults of *Crotalocrinus* ever found. Fig. 4, on Pl. XIX is from the Swedish specimen already described as the original of Angelin's Pl. XVII, fig. 3a. Fig. 3 is from a specimen formerly in the Fletcher collection at Dudley, but now belonging to Cambridge University. It differs somewhat from the others in the form of the four smaller orals, which are nearly equilateral instead of clavate, and in having a few more interradials. Fig. 2b is from a Dudley specimen in our own collection. We can see enough of the vault in our specimen of *C. pulcher* from Gothland to show that it is built upon the same plan as in the three specimens of *C. rugosus* illustrated, but it cannot be exposed sufficiently to afford a good figure without mutilating the specimen more than is justifiable.

Taking all these facts together, the vault of *Crotalocrinus* seems to have been composed of well developed oral plates (four proximals and a central), large interradials, several anal plates, with anus in form of a subcentral opening or a tube, and covering plates. The latter are solidly inserted in the vault *between* the other plates, so as to form a part of the wall, contrary to the Inadunata, in which the covering plates, and the ambulacra generally, rest *upon the edges* of the other vault plates.

Taking now for comparison the vault of *Marsupiocrinus tennessensis* (Pl. XIX, fig. 7), we find the same arrangement of orals; the same solid covering pieces incorporated into, and forming part of the vault, originating at the re-entering angles of the five orals, and passing outward to the arm bases; we also find a system of interradial and anal plates substantially like that of the Cambridge specimen of *Crotalocrinus* (Pl. XX, fig. 3). Indeed, if we had the vaults alone of these two specimens under examination, it would not be a very easy matter to point out why they might not belong to the same generic type. Certainly no one can look at the two figures, and not be entirely convinced that they represent the same plan of summit structure. And if we then compare the parts above the first radials in the two forms, there cannot be the slightest doubt that they belong to the same group, and that that group is the Camarata. It might indeed be fairly said that the calyx of *Crotalocrinus*, in all that determines its subordinal rank, is nothing more than a dicyclic *Marsupiocrinus*. The mode of union of the plates in the dorsal cup is also somewhat similar in the two genera. There are in both of them along the suture lines small conical pits, which penetrate a short distance inward but do not pass through the test (Pl. XIX, fig. 5); the inner half of the apposed faces is peculiarly striated, indicating a sort of syzygial union. On the other hand, the vast multiplication of arms, with their lateral connection into a net-work, constitutes a wide differentiation of this type from any other group of the Camarata, and is without a parallel among crinoids generally. But this is a character which does not affect the fundamental plan of structure, which unites it unquestionably with the Camarata.

Another very remarkable character of this family is the perforation of the higher radials and arm joints by a dorsal or axial canal, which in the higher radials is very large, ramifying to the arms, and in *Crotalocrinus* extends to their extremities. The canals of each ray unite into one on the inner surface of the first radials, and pass downward toward the base. This perforation, and the fact that the arm joints are united also by muscles instead of ligaments only, distinguishes the family sharply from all other Camarata. It was this mainly that led us to place them among the Articulata not knowing the solid structure of the vault. The arms in this group must have possessed a high degree of flexibility, being found sometimes closely folded together lengthwise, often spread out horizontally—even dropping over the calyx—and sometimes compactly inrolled for a considerable distance from the ends, as shown in our figure (Pl. XIX, fig. 1*a*).

There is one point in *Crotalocrinus* which is not clear to us, and on which our specimens do not seem to throw much light. Johannes Müller[1] gives the following description of the ventral structure of the arms. "Dieser Canal [speaking of the ventral furrow along the the arm joints] ist querüber von kleinen Plättchen verdeckt, welche meist alternirend in einander greifen. Zu den Seiten stehen auf der Volarseite der Glieder, die Ambulacra einfassend, äusserst zarte Pinnulae oder schmale Saumplättchen, von denen mehrere (3–4) auf die Länge eines Gliedes kommen. Diese Pinnulae sind unge-

[1] Ueber den Bau der Echinod. Abh. Berl. Akad. d. Wissensch. 1853, p. 189.

gliedert, nur an der Basis scheint sich zuweilen ein Stückchen abzusetzen. Die Höhe der Pinnulae gleicht am breiteren Theil der Hand der Dicke der Glieder."

In the specimens which we have examined, the small alternating plates which cover the ventral furrow are very plainly seen, but we find no trace of the so-called "pinnules or saumplättchen," which were figured and described by Müller and Angelin. It is evident that the alternating *inner* plates, covering the ventral furrow, are the "*saumplättchen*" or covering pieces, and not the *outer* ones along the lateral margins of the furrow, which, if they exist at all, probably are ad-ambulacral plates; they cannot be pinnules in the ordinary sense, for there are, according to Müller, 3 to 4 to each arm-joint. In one of our specimens (Pl, XIX, figs. 1*a*, *b*), high up along the arms, the covering plates are perfectly seen in place, and there appear at their sides in some places, along the margin of the furrows, what seem like serrated edges, several to a joint, and it may be that Müller and Angelin took these edges, which rise somewhat above the level of the covering plates, for pinnules. If these are the structures figured by Müller and Angelin (Bau. d. Echinod. Pl. VIII, figs. 7 and 8; and Icon. Crin. Suec., Pl. XXV, figs. 19, 19a), then the projecting parts are mostly broken away in our specimens, and in all others we have seen.

The arms of the species named by Müller *Anthocrinus Loveni*—but which Angelin considered to be a synonym of *Crotalocrinus pulcher*—were described by him as resembling the five leaves of a flower, which when spread out would not connect, but when closed were folded up, and overlapped each other. It is possible that this is the case in that species, and in fact his cross-section (*Op. cit.* Pl. VIII, fig. 4) clearly indicates it. But we have had before us three specimens from Sweden and one from England, considered to be *C. rugosus*, all having the arms completely spread, in some cases bending downward, and in these the arms are certainly in lateral contact, not only within the rays, but continuously all around. Also the cross-section of the arms of this species, given in Murchison's Siluria (3rd Ed. p. 247, fig. 4a), shows the continuous connection of the arms, and how they fold in upon themselves when closed. The specimen figured in Pl. XX, fig. 4, which, in our opinion, is not *C. rugosus* but an undescribed species, represents a form in which the rays may have been disconnected as in *C. pulcher*. It differs widely from both species in the first radials, which are excavated and have large, limb-like projections, deeply incurved between the bases of the rays. This form which occurs also at Dudley, associated with *C. rugosus*, is usually labeled as such in collections.

The reticulate arm structure, which distinguishes *Crotalocrinus* from all other crinoids, is its most interesting character. The arms are deeper (from the dorsal to the ventral side) than they are wide, they extend to a great length, and bifurcate just often enough, and at such intervals in *C. rugosus*, to fill up the spaces necessary to form a complete circle with the arms in lateral contact out to the periphery, and the number of branches in the adult specimen, when perfect must have been enormous. In our specimen of *C. rugosus* (Pl. XIX, fig. 1), at the height of the fifteenth joint, there are forty rami to each ray, and this is not more than one third their full length, so that the number of ultimate divisions would amount in this specimen to at least five or six hundred. The joints at the same height are of the same length, and the sutures are in the same line all around, so that they form regular concentric circles. Each joint has two lateral projections given off from the middle part of each side, which meet with those of adjacent branches, forming points of union by which the arms are connected throughout, but leaving open spaces or meshes which produce the reticulate appearance. The arms of *Enallocrinus* resemble those of *Crotalocrinus* in their mode of bifurcation and extraordinary length, but are not connected laterally except for a few of the lower joints. They have, however, frequently, if not always, lateral projections along the joints on each side, and hence possess the cross-shaped arm joints of *Crotalocrinus* (Pl. XIX, fig. $6\frac{c,d}{}$). The sutures between the joints are also in the same line, and do not alternate as we formerly supposed.

The mode of insertion of the higher radials upon the first radial is very peculiar, and has not hitherto been understood. We might have still remained in ignorance about it, had it not been for the fortunate discovery among our Dudley specimens of an isolated first radial with the succeeding radials attached, so that we could see them from all sides (Pl. XX, fig. 4). By the aid of this, and a very interesting, much weathered specimen, loaned us by Dr. Lindström, we are enabled to describe and illustrate the position of these parts quite satisfactorily. The plates from the second radial up are of considerable size, but they are not always visible on the dorsal side. In *C. pulcher* they are plain enough (Pl. XX, fig. 1), but in *C. rugosus* they often appear as mere points or thin edges

(Pl. XX, fig. 2^a). The other ends emerge upon the ventral side, where they present a considerable surface, containing a large ambulacral groove. In order to attain this position, the plates, which are wedge-shaped, bend inward and upward until their opposite ends stand nearly at right angles to each other, and the arms at their origin pass out in a horizontal position. This can be seen in fig. 2^c Pl. XIX, which represents a vertical section, giving a side view of the same succession of plates as is shown dorsally by fig. 2^a, and ventrally by fig. 2^b on the same plate. The successive pieces are numbered in each figure to correspond, and by comparing them, and remembering that they present three different views of the same elements, we think there will be no difficulty in understanding them. We cannot see the least evidence of mobility of these plates until they become free from the first radial, and thus attain the rank of arm plates. Whenever the arms are found folded up, the bending from a horizontal to a vertical position takes place in the lower arm plates, and not in the higher radials. The lanceolate areas, which are such a conspicuous feature of the ventral surface, and extend from the second axillary to the fifth or sixth bifurcations, are formed by a great thickening along the outer edges of the marginal plates of two adjacent rays, and therefore consist of two rows of arm plates, respectively radials, decreasing in width in their upward arrangement.

The anus is excentric, and in *C. pulcher* takes the form of a large tube, while in all authentic specimens of *C. rugosus* it seems to be a simple opening. The form and position of the tube have been wrongly described by us. Angelin's beautiful looking figure, purporting to show it to its full length (Icon. Crin. Suec., Pl. XVII, fig. 1), originating at the edge of the calyx, and lying outside the arms, proves to be an ideal figure, based upon the erroneous interpretation of some fragmentary pieces. Our specimen (Pl. XX, fig. 1^b) shows the base of the tube very well, but not its full length. To judge from the fragments, shown by Angelin's Pl. XXV, figs. 8—13, it must have been of considerable length in some specimens. It seems to have been somewhat more highly organized than the anal tube of the Camarata generally, and to approach the ventral sac of the Fistulata. The actual length has not been observed, but from the manner in which the large cavity within tapers in different specimens, we have no doubt that the opening is at the upper end, and represents a true anal tube, whatever other function it may have possessed. Nothing is known of the anal opening of *Enallocrinus.*

We give herewith new definitions of the Crotalocrinidae and their two genera *Crotalocrinus* and *Enallocrinus,* to take the place of those given by us in the Revision, Part III, p. 143, and pp. 147—152, and we request all who may be using the Revision to substitute them at once.

We now direct attention to another point of considerable interest which has been developed by this investigation. A very perplexing figure was given by Angelin (Pl. XVII, fig. 2b), and a somewhat similar one by Murchison (Siluria, 3rd Ed., p. 247, fig. 5), which show certain extensions apparently from the inner rim of the first radials, and which superficially resemble the so-called "consolidating apparatus" of *Cupressocrinus.* A closer examination of Angelin's figure shows these extensions to be composed of small plates; both figures, however, are misleading, for our specimens show that the plates forming those extensions do not rest against the inner edges of the first radials as represented, but upon their upper faces, as correctly shown in Angelin's Pl. XVII, fig. 2a. They are nothing but the exposed ventral surfaces of the second primary and succeeding radials, the elevations being the projecting margins along the ambulacral grooves. Neither do they extend so far inward as would seem from Angelin's figure, they project inward only for a short distance, and form underneath a surface of attachment for certain organs hereafter described.

Müller described and figured correctly (*Op. cit.* p. 189, Pl. VIII, fig. 5), the inward curvature of the plates, but we cannot agree with him in his statement that by means of this curvature a roofing is formed over the periphery of the calyx. This is not confirmed by the specimens, in which the calyx is covered by summit plates, interradials, etc., and the grooves around the periphery are roofed over by solid covering plates—leaving only the lateral margins exposed—in connection with, and forming part of the calicular cavity. The structure is clearly seen in our fig. 1a, Pl. XIX, in which the grooves are shown open except in one ray, where the covering plates are restored from the same part in another specimen.

Another figure of Angelin (Tab. VII., fig. 7a) gives an inner view—that is, from below; not "*superne visus,*" as erroneously stated in the explanation of the plate—of a specimen of *C. pulcher* of which he speaks as showing the so-called "consolidating apparatus."

Carpenter in his paper on Crotalocrinus[1] explains that "the calyx is broken across near the level of the top of the basals, so that the internal faces of the radials and the following plates are exposed to view, with the remarkable striations upon them, which were regarded by Angelin as corresponding to the consolidating apparatus of *Cupressocrinus*," and he proceeds: "It is possible that, like this structure, they may represent an uneven surface for the attachment of muscles and ligaments, but whatever else they may be, the striæ are certainly not hydrospire slits, as supposed by Wachsmuth and Springer in 1879 * * * *. But in any case they will no longer be able to refer to this family as Palæocrinoids which 'probably have hydrospires within the calyx,' and to use this supposed fact as an illustration of their theory that Blastoids, Cystids and Crinoids are so closely linked together that they are not entitled to rank as Classes of Echinoderms equivalent to the Urchins and Starfishes."

We have been able to study the organs in question in our specimen from Gothland (Pl. XIX, fig. 1), and in two of those used by Angelin, loaned to us from the National Museum of Stockholm, in all of which they are very well shown. They are totally different structures from the so-called consolidating apparatus of *Cupressocrinus*, which we regard as muscle plates for the attachment of muscles and ligaments to move its huge arms. The muscle plates of *Cupressocrinus* are appendages of the first radials, and form part of the upper surface of the vault, similar to the muscle plates of *Symbathocrinus*, in which we know from direct observation that they constitute parts of the vault, only the central space being closed by additional plates. In both genera those plates are apposed by corresponding faces upon the first brachials, and there is no roof or covering of any kind above them, they being necessarily external if they served for places of muscular attachment to move the arms. The case is totally different in *Crotalocrinus* in which the parts in question are roofed over by very solid covering plates, leaving little more than the faces forming the lanceolate areas exposed. Angelin applies the name "consolidating apparatus" not only to the overhanging margins of the radials, but also to the lamellæ underneath, to which Carpenter refers as "remarkable striations," possibly for "the attachment of muscles and ligaments." These so-called striations consist of parallel lamellose walls or partitions, located in regular sets within chambers or recesses, which underlie partly

[1] Op. cit, p. 406.

the overhanging margins of the higher radials constituting the lanceolate areas, partly the outermost interradial, and are limited on either side by the inward extensions of the second and succeeding radials. There are two sets of these lamellæ to each interradius, those of adjacent rays meeting laterally and entering the same chamber where they are closely connected; while those of the same ray stand at an angle from each other, and are apparently disconnected except by a mere point. Each set is composed of five to seven folded lamellæ, with continuous walls forming loops at each end. They stand upright, and seem to be attached at their lower ends to the inner surface of the first radials, and those in the same ray come together by their upper ends at a small angle under the small triangular second radial, where it projects farthest inward. The upper ends are further attached along the inner walls of the higher radials and the outer interradials, underneath which the two adjacent sets meet by parallel plates and form a close connection. The arrangement at the anal side is not clearly shown in any of the specimens. In *Enallocrinus* we have not been able to discover anything of the lamellæ, but we had for examination but a solitary specimen showing the interior of the calyx. There are seen, however, the same chambered spaces in which they might rest, and we have little doubt they existed in that genus also. Their position and structure in *Crotalocrinus rugosus* are shown in our figures 1[a] and 1[b] on Plate XIX.

From our description it must be clear that these laminated structures do not possess any of the characteristics of muscle-plates. Their position in paired sets is interradial; they are completely internal, and have no visible connection with the arms, nor do they present any surface for the attachment of muscles or ligaments; but on the contrary are very frail structures, having in some places little partitions connecting the walls, and giving the whole a somewhat porous appearance. On the other hand if we compare them with the hydrospires in the Blastoid genus *Orophocrinus*, one cannot help being struck with the resemblance in form, position and arrangement. We will not assert unqualifiedly that they are hydrospires, but we are very confident that they are not muscle-plates, nor anything of that nature, and if they are not of the same character as the similar organs in *Orophocrinus*, which have been universally considered to be hydrospires, then we must acknowledge ourselves completely at a loss for anything in echinoderm morphology with which to compare them. There is nothing else like them in any known crinoid. If they are hydrospires, then they certainly do afford a strong illustration of the close alliance between Blastoids, Cystids and Crinoids. If they are not hydrospires, we should like to know what they are.

Enallocrinus is evidently very closely allied to *Crotalocrinus*. The genus occurs at Dudley, England, whence we obtained specimens showing the arms better than the Swedish ones, but nevertheless our material for the study of this type was by no means so satisfactory as that of *Crotalocrinus*. The English specimens are all more or less crushed, and do not throw much light on the structure of the calyx.

Angelin's figures purporting to show the vault are imaginary, as we have before shown. The only specimen in the Stockholm Museum showing any part of the ventral covering has been sent to us for examination, and we give two views of it (Pl. XX, figs $5^{\underline{a,b}}$). It is somewhat abnormal, two of the rays being grown together in such a way as to modify the arrangement of some of the plates. It is one of the specimens from which it is supposed Angelin's figure 3a, Pl. VII was constructed. The insertion of the higher radials upon the first radials is upon the same plan as in *Crotalocrinus*, especially the species shown by Angelin's Pl. XVII, fig. 3a, and our Pl. XX, fig. 4, and from this, and what little we can see of the ventral covering in the specimen above alluded to, we conclude that the vault must have been constructed substantially like that of *Crotalocrinus*.

We figure a flattened specimen from Dudley (Pl. XX, fig. $6^{\underline{a}}$), which shows the arrangement and bifurcations of the arms, but not by any means to their full length. We have another set of arms which seem to have their filiform extremities nearly complete, and from this we should infer that the specimen we have figured shows but little over half the length of the arms. Figs. $6^{\underline{c}}$ and $6^{\underline{d}}$ illustrate the projections from the sides of the joints, in the same specimen. We consider them important characters, perhaps representing the projections on the arms of *Crotalocrinus*, and indicating a tendency toward the reticulate arm structure, which is the only well marked distinction between the two genera.

The specimen represented by Angelin's Pl. XV, figs. 1, 1a, and 2, as *Enallocrinus assulosus*, and which Dr. Lindström assures us is correctly figured, represents in the reduced lateral connection of the arm bases, and the presence of small interradials on the dorsal side, a considerable departure from the typical form of the genus. It is inconsistent with the generic definition of Angelin, who described it as having "*interradialia nulla*." It is a variation in the direction of the English form of *Marsupiocrinus*—*M. coelatus*—(Pl. XX, fig. 7), which differs in its dorsal interradials from *M. tennesseensis* in almost the same way.

Crotalocrinus and *Enallocrinus* form a good family, which is connected through *Marsupiocrinus*[1] with the other Camarata.

Suborder CAMARATA.

Family CROTALOCRINIDAE.

Base dicyclic, symmetry bilateral. Calyx throughout composed of rigid plates. Dorsal cup constructed almost exclusively of underbasals, basals, the first radials, and a small anal plate. Higher radials up to the third or fourth order irregularly wedge-shaped, their sharp ends directed outwards or sometimes hidden from view, their larger ends, which curve upwards, grooved for the ambulacra. The plates rest partly upon the first radials, partly against the radials of the preceding order, being with the former, and with one another. and laterally with those of adjoining rays, firmly united by suture. Arms capable of great mobility; uniserial; long; dividing into very numerous branches, which are free, or connected laterally by tissues so as to form a net-work around the calyx, either continuous, or limited to the rays and forming five reticulate leaf-like arms. The arm branches are perforated by large axial canals, which penetrate also the higher radials.

Ventral surface of calyx flat, composed of five unequal orals—the posterior one the larger—five radial dome plates, one or more interradials, and several series of covering pieces which take the rigid form of vault plates.

Column large, round; central cavity extremely large.

CROTALOCRINUS Austin.

1842. Austin, Ann. and Mag. Nat. Hist., Ser. 1, Vol. X, p. 109.
1843. Austin, ibid., Ser. 1, Vol. XI, p. 198.
1848. Morris, Cat. Brit. Fos. (Ed. 1), p. 50; (Ed. 2), p. 75.

[1] It is an interesting fact as showing the keen perception of that veteran English naturalist, that Th. Austin in 1843 (Ann. and Mag. Nat. Hist. Ser., II, Vol. XI, p. 198) referred *C. rugosus* to the Marsupiocrinidae, a family named, but not defined by him.

1854. Salter, apud Murchison, Siluria, (Ed. 2), p. 219; (Ed. 3), p. 247, figs. 4, 5, 6, 7.
1855. McCoy, Brit. Pal. Foss., p. 54.
1873. Salter, Cat. Mus. Cambr., p. 123.
1878. Angelin, Icon. Crin. Suec., p. 26, Pl. 7, Pl. 8, Pl. 17, Pl. 25.
1879. Zittel, Handb. d. Palæont., I., p. 356, fig. 244.
1882. De Loriol, Pal. de France, tome 11, Crin., p. 51.
1886. Wachsmuth and Springer, Rev. Palæocr., Pt. III., p. 165.
1886. P. H. Carpenter, Ann. and Mag. Nat. Hist. for November, p. 397.

Syn. *Cyathocrinus*, 1821, J. S. Miller, Nat. Hist. Crin., p. 89, with plate; *Anthocrinus*, 1853, Joh. Müller, Abh. Akad. Berlin, pp. 188–192, Pl. 8;
1855. Roemer, Lethæa. Geogn. (Ausg. III), p. 255.
1855. Quenstedt, Handb. d. Petref., IV, p. 943, Pl. 75.
1857. Pictet, Traité. de Paleont., IV, p. 312, Pl. 100.
1860. Bronn, Klassen. d. Thierreichs., (Actinozoa), Pl. 27.
1862. Dujardin and Hupé, Hist. Nat. Zooph. Echinod., p. 117.

GENERIC DIAGNOSIS.

When the arms are closed the crinoid resembles an elongate bud with folded leaves; when these are spread, it is wheel shaped, with five lanceolate areas between the bases of the rays. Calyx subglobose, flattened above.

Underbasals 5, large, pentangular, of uniform size. Basals 5, very large, extending three fourths the height of the calyx, all hexagonal except the posterior one, which is higher and has the upper angle truncated for the reception of a comparatively small, quadrangular anal plate, which rests between the first radials.

First radials much wider than high, their distal faces thickened, either concave or straight, and occupied by small, shallow depressions for the reception of the second and higher radials, which to the third or fourth order rest partly upon this plate. The second radial occupies a very small space at the middle of the first, where it appears as a small, trigonal bifurcating plate, sometimes scarcely visible dorsally. From its dorsal or outer side to its ventral side, the plate is very long and slender, bent upwards almost to a right angle, so as to bring the face opposite to that exposed dorsally into a horizontal position, and on a level with the vault. The secondary radials rest against the sloping faces of the second primary, and upon the first; they are bifurcating plates, and as such support immediately the tertiary radials, which in *C. rugosus*, sometimes together with the first plate of the fourth order, rest partly upon the first radial. All of these plates, in various ways, are firmly attached to the first radial, and united suturally with one another, and all of them, by curving upwards and inwards, extend from the dorsal to the ventral surface of the calyx, forming as such a sort of transition between true radials and arm plates, in a similar manner as the higher radials of the Platycrinidae, which they resemble in their arrangement. The plates are wedge-form, thinning out toward the dorsal cup, where they are seen as mere points or lines, or one or more of them are invisible altogether. Their larger upper faces, which are exposed ventrally, are deeply grooved for the reception of the ambulacra, and, when the covering plates are in position are only partly exposed. The plates above the fourth order are not in contact with the first radials, and may be regarded as true árm-plates, which they resemble in form and in point of mobility.

The arms are long and branch frequently; they are connected laterally by points of attachment from near the middle of each joint, with open spaces between them, forming together a sort of network around the calyx with innumerable elongate meshes. In *C. rugosus* the network is continuous around the calyx, but in *C. pulcher* the rays are separated, and form five broad reticulate leaves, which, when closed over the calyx, overlap each other, contrary to the case of *C. rugosus* in which the undivided network is closely plicated and folded. The lower plates of the rays, to the third or fourth order, are immovably connected among each other and with the first radials; but higher up in the rays, where the plates are no longer in contact with the first radials, an articulation by strong muscles and fossæ takes the place of suture. The arm joints, owing to their lateral projections, have the form of a cross with short arms: they are long flat on the dorsal surface, laterally compressed, with straight sides, and deeply grooved on the ventral surface for the reception of the ambulacra.

The ambulacral furrows are arched by covering pieces, 3 to 4 to each side of the arm joint, alternately arranged. The arm joints are disposed in regular dichotomizing longitudinal rows, as well as in regular concentric transverse rows, the points of union occupying the same line all around. Each arm plate is pierced with a very large dorsal canal, and the bifurcating ones with two, which meet in the middle of the plate; they ramify to the ends of the arms, and all converge into one in the second radials, thence passing downward along the inner surface of the first radials toward the basals. The bifurcations near the calyx are unequal, the sloping faces of the axillaries next the outer margins of the rays being considerably wider than the inner ones, and the plates which they support are as large in proportion. This continues on to about the sixth axillary, above which the bifurcations gradually become regular, and the outer plates attain the same width as the inner ones. By this peculiar arrangement there appear, when the arms are spread, along the outer plates of adjacent rays, five well marked lanceolate areas, to the top of which the rays remain in lateral contact. The bifurcations along the arms are extremely numerous, and take place at various intervals, sufficient to fill up the full segments of the circle when the arms are extended; they taper but slightly, are very long, and become thread-like at the ends.

The higher radials from the first primary up project inwards, beyond the periphery of the calyx; the second projects the farthest, and the plates of the second order slope away from it, as also those of the third. The latter form the proximal ends of the lanceolate areas whose overhanging margins, together with the outermost interradial, form a roof, under which are located five large recesses or chambers, interradial in position, each of which is occupied by two sets of laminated structures, in form and arrangement closely resembling the hydrospires of the Blastoid genus *Orophocrinus*. Each set apparently is composed of five to seven folded lamellae with continuous walls and loops at each end; they stand upright, face laterally the inner walls of the overhanging primary radials, their upper ends attached to the inner floor of the outer interradial, being thus completely covered by vault structures.

Vault flat, on a level with the spreading arms; composed of five oral plates (the so-called central plate and the four large proximals). The posterior oral (central plate) is large, somewhat elongate, its anterior end resting between the truncate faces of the four others, the posterior end againt small anal plates. The four small orals vary from elongate-clavate (Pl. XX, figs 2^{b} and 4) to almost regularly hexagonal (Pl. XX, fig. 3). Outside the orals, and alternating with them, are five somewhat irregular radial plates, which are axillary, giving off two sets of covering pieces, two rows of plates to each set, all in lateral contact; they are heavy, convex plates, a little wider than high, alternately arranged, and solidly inserted into the vault.

Between the covering plates, and abutting against the four smaller orals, are two or more interradials, the inner ones the larger. Between the radial-dome-plates, and against the large posterior oral, are numerous small anal plates which embrace the anus, and of which the outer ones face the anal plate of the dorsal cup. The anus is excentric, and its form varies among species, being either extended into a tube, or placed at the top of a small protuberance. The tube apparently reached considerable length, and seems to have been composed of several rows of transverse pieces longitudinally arranged, with a large octagonal cavity.

Column very large; terminating in numerous rootlets. Canal large, round.

Geological Position, etc. Upper Silurian of England and Sweden.

List of Species:—

1840. *Crotalocrinus pulcher* Hisinger, (*Cyathocrinus pulcher*), Leth. Suec., Supp. II., p. 6, Pl. XXXIX, figs. 5 a. b.–1878, Angelin, Iconogr. Crin. Suec., p. 26, Pl. VII, figs. 5—7 a, b; Pl. VIII, figs. 1—9a; Pl. XVII, figs. 1, 1a—d; Pl. XXV, figs. 8—20.—1879, Zittel, Handb. d. Palaeont., Vol. I, p. 357, figs. 2, 4, 4 a—e.—1886, W. and Sp., Revision Palæocr., Pt. III, p. 150.

Syn. *Anthocrinus Loveni* Joh. Müller, 1853, Abh. d. Berl. Akad. d. Wissensch., p. 192, Pl. VIII, figs. 1—11.—Pictet, 1857, Traité de. Paléont., Vol. IV, Pl. c, figs. 8 a, b, c.—Dujardin and Hupé., Hist. nat. Zooph. Echinod., p. 117.—Quenstedt, 1885, Handb. d. Petrefactenk., IV, p. 943, Pl. 15, fig. 4.
Upper Silurian, Gothland, Sweden, and Dudley, Eng.

1821. *Crotalocrinus rugosus* Miller, (*Cyathocrinus rugosus*), Nat. Hist. Crin., p. 89., with plate.—1837, Hisinger, (*Cyathocrinus rugosus*), Leth. Suec., p. 89, Tab XXV, fig. 3; also Anteckn, Heft IV, p. 217, Pl. VII, fig. 3.—1839, Phillips (*Cyathocrinus rugosus*), Murchison's Silur. System, p. 672, Pl. 18, fig. 1.—1843, Austin, Ann. and Mag. Nat. Hist., Ser. 1, Vol. XI, p. 198.—1843, Morris, Cat. Brit. Foss., (Ed. I), p. 50.—1850, D'Orbigny, (*Cyathocrinus rugosus*), Prodr. d. Paléont., Vol. I, p. 46.—1854, Salter, apud Murchison, Siluria, (Ed. 2), p. 219, (Ed. III, p. 247), figs. 4—7, and Pl. 13, fig. 3.—1855, McCoy, Brit. Pal. Foss., p. 55.—1873, Salter, Cat. Mus. Cambr., p. 123.—1878, Angelin, Icon. Crin. Suec., p. 26, Pl. VII, fig. 4; Pl. XVII, figs. 8, 8a. (not figs. 3, 3a, b).—1879, Zittel, Handb. d. Palæont., I., p. 357, fig. 244.—1885, Quenstedt, (*Cyathocrinus rugosus*), Handb. d. Petrefactenk., IV, p. 943, fig. 349.—1886. W. and Sp., Rev. Palæocr., Pt. III, p. 150.

Upper Silurian. Gothland, Sweden and Dudley, Eng.

1878. *Crotalocrinus superbus* Angelin, Iconogr. Crin. Suec., p. 26, Pl. XVII, figs. 2, 2a, b.—1886, W. and Sp., Rev. Palæocr., Pt. III, p. 150.

Upper Silurian. Gothland, Sweden.

Crotalocrinus (undescribed species). Pl. III, fig. 4 (Referred by Angelin, Pl. XVII, figs. 3, 3a, b, to *C. rugosus*).

Upper Silurian. Gothland, Sweden and Dudley, Eng.

ENALLOCRINUS D'Orbigny.

1850. D'Orbigny, Prodr. d. Pal., 1., p. 46; Cours. élém., II, p. 142.
1854. Salter, apud Murchison, Siluria, (3rd Ed.), p. 247.
1857. Pictet, Traité d. Pal., IV., p. 320.
1862. Dujardin and Hupé, Hist. nat. Zooph. Echin., p. 134.
1878. Angelin, Icon. Crin. Suec., p. 25.
1879. Zittel, Handb. d. Pal., I., p. 356.
1886. Wachsmuth and Springer, Rev. Palæocr., Pt. III, p. 150.

Syn. *Apiocrinites* (Hisinger) in part;
Millericrinus (D'Orbigny) in part; *Anthocrinus* (Quenstedt) in part.

Generic Diagnosis.—Calyx similar in form and construction to that of *Crotalocrinus*; interradials sometimes appearing dorsally. Arms not reticulate.

First radials wide, their distal faces usually occupied by a deep lunate excavation in which the second primary and one or two higher radials rest; sometimes, however, truncate. Second primary and higher radials inserted and connected as in *Crotalocrinus*, curving upward and appearing on the ventral side in a similar way. Rays completely disconnected from the first radials up, and the arms becoming free variously between the first to the fourth bifurcation. Second radials perforated by a large axial canal which passes downward; it ramifies within the higher radials, and passes into the arms, but apparently does not extend to their full length.

Arms uniserial, very long, tapering little, bifurcating at lengthening intervals toward the upper parts into very numerous equal branches, the ultimate divisions being extremely attenuate; the arms capable of being spread out horizontally. Arm joints shorter than in *Crotalocrinus*, with parallel sutures; those of adjacent branches opposite each other not alternating. Toward the upper ends of the arm joints there are more or less conspicuous transverse projections —one from each side of the joint—which are more prominent and elongate at the ventral side. They border the arm furrow, and give to the arm, when viewed from the side, a pectinate appearance, which is more strongly marked toward the distal ends of the arms (Pl. XX, figs $6^{b,c}$). Ambulacral furrows shallow, with covering plates arranged in the usual way.[1]

Vault apparently similar to that of *Crotalocrinus*; median part unknown; ambulacra toward the periphery roofed over by convex alternating pieces having the form of vault plates, which pass out over the arms. Anal opening unknown.

Column round, very large, with short joints and thin walls; canal round and of extremely large size.

Geological Position, etc. Upper Silurian of Sweden and England.

List of Species:—

1878. *Enallocrinus assulosus* Angelin, Icon. Crin. Suec., p. 26, Pl. XV, figs. 1—4. Upper Silurian, Gothland, Sweden.

1828. *E. scriptus* Hisinger (*Cyathocrinites?*), Anteckn IV, p. 217; Pl. V, fig. 9; Pl. VII, fig. 1.—1831. (*Apiocrinites* (?) *scriptus*), Anteckn V, p. 123, Esquisse d'un tableau des Petref. de la Suède, p. 23.—1837. Leth. Suec., p. 89, Pl. XXV, figs. 1 and 2.—D'Orbigny, 1840 (*Millericrinus scriptus*), Hist. Nat. Crin., p. 94, Pl. XVI, fig. 29.—1850. Prodr. d. Pal., I, p. 46.—Angelin, 1878, Icon. Crin. Suec., p. 25, Pl. VII, figs. 1—3a; Pl. IX, figs. 18 and 19; Pl. XXV, figs. 1—7; Pl. XXVII, figs. 17—20a.

Syn.—*Enallocrinus punctatus* Hisinger, Leth. Suec., p. 89.—*Millericrinus punctatus* D'Orbigny, Hist. Nat. Crin., p. 94, Pl. XVI, fig. 30.—*Enallocrinus punctatus* Salter, apud Murchison, Siluria, (Ed. 2), p. 218.—*Anthocrinus scriptus* and *A. punctatus*, Quenstedt, Handb. d. Petref., IV, p. 944, Pl. 75, figs. 6, 7.

Upper Silurian. Gothland, Sweden and Dudley England.

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[1] We have observed these projections on the arms only in the English specimens. We give it as a generic character, as we think it likely the Swedish ones will show it also when sufficiently well preserved; and because we consider it of some importance, as representing the projections on the arms of *Crotalocrinus* by which these were connected, and thus exhibiting a tendency toward the reticulate structure.

EXPLANATION OF PLATES.

PLATE XIX.

Fig. 1a. *Crotalocrinus rugosus.* Ventral aspect of a large specimen from Sweden, showing the inner floor of the calyx, the lanceolate areas, and the outstretched arms with their deep ventral grooves, and in places their covering pieces; the tips of the arms coiled up so as to expose their dorsal face. The covering pieces at the lower right hand corner restored from another specimen.

(Collection of Wachsmuth and Springer.)

Fig. 1b. Oblique view of a portion of the same specimen, showing the lamellae beneath the overhanging margins of the higher radials.

Fig. 1c. Ventral view of a portion of the arms enlarged.

Figs. 2a. b. c. Diagramatic figures showing the arrangement of the higher radials in *Crotalocrinus rugosus*; 2a. the dorsal side; 2b. the ventral side; 2c. a vertical section through the dotted line in 2b.. The numbers refer to the same plates in all three figures, i. e. 1^1 and 1^2 to the first and second primary radials, 2^1 to the secondary radials, 3^1 and 3^2 to the tertiary radials, 4^1 and 4^2 to the quaternary radials; the succeeding plates are brachials.

Fig. 3. Ventral aspect of the same species from a specimen in the National Museum of Stockholm, showing the rigid covering plates around the margin of the calyx.

Fig. 4. A portion of a first primary radial of the same species with the higher radials in place resting upon it.

(Collection of Wachsmuth and Springer.)

Fig. 5. Enlarged view showing the markings on the lower face of a first radial of the same species.

Fig. 6. Radials and lower arm plates in *Pterotocrinus.*

Fig. 7. The radials and lower arm joints in *Marsupiocrinus tennesseensis.*

PLATE XX.

Fig. 1a. *Crotalocrinus pulcher.* Anterior view of a specimen with arms from Gothland, Sweden.

(Collection of Wachsmuth and Springer.)

Fig. 1[b] Posterior view of the same specimen, showing the base of the proboscis.

Fig. 2[a] Calyx of a small specimen of *Crotalocrinus rugosus* from Dudley, England.
(Collection of Wachsmuth and Springer.)

Fig. 2[b] Ventral aspect of the same specimen.

Fig. 3. Ventral aspect of *Crotalocrinus* sp.?
(Drawn from a gutta percha cast. Original in the Museum at Cambridge, England.)

Fig. 4. *Crotalocrinus* sp. und., from Sweden. Ventral view, from a fine drawing by Mr. G. Liljevall. (Original in the National Museum at Stockholm).

Fig. 5[a] *Enallocrinus scriptus.* Posterior view of a specimen from Sweden in the National Museum at Stockholm. 5[b] ventral view of same specimen, showing portions of the covering plates in some places; the middle of the vault broken away.

Fig. 6[a] *Enallocrinus scriptus.* Anterior view of a nearly complete specimen from Dudley, England (Collection of Wachsmuth and Springer), 6[b] transverse section of column of same specimen, showing the large central canal; 6[c] enlarged side view of a portion of the arm, showing the pectinated projections; 6[d] Dorsal view of same.

CONTRIBUTIONS TO THE LIFE HISTORIES OF PLANTS. No. III.

BY THOMAS MEEHAN.

Smilacina bifolia. Observing in a large tract of *Smilacina bifolia* that the leaves were for the most part at a very light angle, indeed almost vertical, it seemed to afford a good opportunity to test a prevalent idea that, in such cases, the stomata are nearly equal in numbers on each surface of the leaf. Dr. J. B. Brinton kindly made a careful microscopical examination of some leaves I furnished him with, but he found no difference in this respect to leaves with a purely horizontal direction. On a small section, of which he hands me a drawing, there was only one stoma on the upper surface, while there were fifteen on the under surface.

Dichogamy and its significance. Dichogamy has reference to the relative period of maturity of stamen and pistil. When the stamens are in the advance the flowers are said to be proterandrous; when the pistil is mature before the stamens, the flower is proterogynous. Usually the term is employed in connection with hermaphrodite flowers. But as it is a mere question of the time required for the development of the sexual organs necessary to the perfecting of a complete individual, it is obvious that we may extend the term so as to include monœcious and diœcious plants.

The law under which the separate sexual organs are retarded in their growth in some instances and accelerated in others, cannot but have supreme importance in the study of vegetable biology. If we can trace the working of this law in the hermaphrodite flower to the extent of acceleration or retardation for but a single day, we can easily get to understand how some plants may come to have the maturity of these organs days apart, and to finally divide into monoecious or dioecious classes.

Among the contributions I have made to botanical science, few impress me with more importance than the determination of the fact that a degree or measure of heat capable of exciting the male organs to growth, may yet be wholly inadequate to start growth in the female (see *Proceedings of the Academy of Natural Sciences* 1885, *p.* 117.)

I observed that the aments of walnuts, hazel-nuts and similar plants were often perfected weeks and occasionally months before the female flowers were in conditon to receive pollen, and that it was only in seasons when the stamens and pistils matured simultaneously, that large crops of nuts followed. I had overlooked at that time, the fact that something similar had been placed on record before. In the *Transactions of the Horticultural Society of London*, vol. v, 1824, is a paper by Rev. George Swayne, showing that the filbert crop in Kent fails two years out of five; that some seasons the catkins mature before the female flowers open, and at others not till afterwards, and that failure to produce a crop results from the absence of pollen at the period when the female flower is in receptive condition. All I can, therefore, claim as original is the formula that varying measures of heat influence variously the separate sexes,—the smaller measure influencing the male, while the female still continues to rest.

Since my observations were made on the hazel, I have extended them to other plants. It has long been known that in many of the Central States coniferous trees that produce seeds abundantly farther north, rarely have one perfect seed in those regions. I know this is so in the vicinity of Philadelphia. The Norway spruce may produce cones by the cart-load, with not an ounce of seed in the lot. Since the observations above cited I find that the male flowers mature long before the female, and affords a satisfactory reason for the failure. Further north, where winter does not coquette with spring as here, they remain in rest equally, and advance together. In their gregarious, forest condition, no doubt the extent of surface conduces to an equilibrial condition of climate not surrounding isolated trees in a cultivated state.

In brief, I may enumerate a number of coniferæ, alders, walnuts, chestnuts, oaks, hickories and the hazel-nut as among those that I carefully watched for the few years past, noting a wide range of difference each season between the times of maturing of the male and female flowers. The season of 1887–8, I noticed was favorable to a simultaneous maturity of the sexes. I exhibited specimens in the spring of 1888, to the Botanical Section of the Academy, and had no difficulty in predicating on the fact of simultaneity an abundant harvest of nuts, which has been fully realized. I have since been observing the working of this principle in elms and maples—hermaphrodite plants; the species under observation being *Ulmus americana*, and *Acer dasycarpum*. The trees of the former were comparatively young, but had flowered the first three years without perfecting more than a seed here and there. I had no difficulty in perceiving in these elms and maples in the spring of 1887, that the pollen had been dispersed weeks before the pistil was mature. The past season (1888) examination showed the anthers bursting simultaneously with the receptive conditions. There was an abundant crop of seeds. The maple is usually inclined to diœcism. Although the flowers may seem perfect, the stamens in some fertile flowers never proceed beyond anthers that give no pollen, while in other cases perfect stamens with filaments and fertile anthers are produced, when the gynœcium seems unable to fulfil its functions. But the elm, at least here, seems a full hermaphrodite, yet only this season of three successive ones, had it full hermaphrodite functions. In the two first it was so very proterandrous as to be barren. It was not proterandrous this year, though I cannot say it was proterogynous. It was, in fact as well as in name, hermaphrodite.

Surely I am warranted in presenting the formula, that varying measures of temperature variously affect the separate sexual organs, and that the dichogamy has its origin in this simple circumstance.

It is interesting to note how near we may get to a great truth without actually perceiving it till long afterwards. In 1868, I announced, through the Proceedings of the Academy, my discovery that *Mitchella repens* was not merely heterostyled but practically dioecious. I had subsequently found a white-berried variety which bore berries freely when surrounded by its companions, but I never had one during the many years it was under culture in my garden. Up to that time and subsequently, the course of these phenomena was obscure. Mr. Darwin, in *Forms of Flowers* (Chap. VII), observes: "But according to Mr. Meehan *Mitchella* itself is dioecious in some districts. * * * Should these statements be confirmed, *Mitchella* will be proved to be heterostyled in one district and dioecious in another." With our present light we can readily see how this may easily be.

Now what is the significance of dichogamy? The general view at the present time is substantially the same as given in the work above quoted. There Darwin expresses it in these words: "Various hermaphrodite plants have become heterostyled, and now exist under two or three forms; and we may confidently believe that this has been effected in order that cross-fertilization should be assured."

With the new light I have thrown on the origin of dichogamy, I am sure the great Darwin would be ready to modify this view. It cannot have the significance we all thought it had at that time.

We now see that a plant may find itself in a climate or in surroundings favorable to an early development of stamens; in another case in a locality or country where the reverse will prevail. Dichogamy will then vary. We also know that heredity plays a part in fixing a constantly recurring local tendency, so that a plant having acquired a tendency to proterandy or it may be to proterogyny, would continue to carry the habit long after the superinducing causes had passed away. Plants remaining for ages in a locality where the conditions would be favorable to a wide difference between simultaneity, would probably become in time monœcious or diœcious, and all this, as we see, from no particular assurance that cross-fertilization would thereby be affected.

In trying to reach generalizations of this character, we should not, however, forget that in nature, things seldom follow from a single cause, but from the operation of united forces. In this connection I have shown, (see Proceedings of the *American Association for the Advancement of Science, Salem*, and subsequent meetings,) that sex itself is largely influenced by the amount of nutrition available when the primordial cell is fertilized. If sex itself may be influenced by nutrition, the subsequent growth of its representative organs may still further be influenced, which would introduce into the consideration an additional element aside from temperature alone.

I have my own postulate as to the significance of dichogamy. I rest here by the simple proposition that whatever its significance, it arises from no effort innate to the plant itself, but from an outside force that can have little interest in cross-fertilization.

(It is proper to say that an abstract of this paper was read before the *American Association for the Advancement of Science*, at Cleveland. See *Botanical Gazette* for September 1888.)

Trientalis Americana, Pursh. There can be but little doubt that *Trientalis Americana* grew freely over what is now the city and county of Philadelphia. It is still found in adjoining counties, and here and there are old botanists who remember having collected it on the confines of the county; but it is not included in Barton's Flora, now over 60 years old,—nor in Darrach's Catalogue, or any published list so far as I know. In an old chestnut wood at Chestnut Hill, my brother Joseph detected a small patch this summer, that has evidently been there for ages, but overlooked,—and this suggests some thoughts on its habits and past geographical record of general interest.

I have collected this plant in its various forms over widely separated portions of the American continent,—Canada, the Alleghanies, California and Alaska,—and though holding its own wherever found, it does not show evidences of the extension that must have characterized it in the past, when, with no remarkably specialized organs favoring distribution, it managed to travel in its various forms—as *T. Europæa*, *T. Americana* and *T. Arctica*—over the whole north of Europe and across the American continent to Behring's Straits. So far as I have seen in the localities named, the plants seem to produce seeds, though not abundantly; but there are no evidences of seedlings. In the Chestnut Hill location, the only tract on which the plant is found is but a few hundred square feet, yet though unnoted, it must have been confined to this limited area for at least a hundred years, or perhaps for many centuries. The piece of wood is a favorite botanical hunting ground. I myself have wandered through it for over a quarter of a century, and the early Philadelphia botanists—sharp-eyed as they were—would surely have seen it here if at all common in those times. It is worth while considering how so great a wanderer in remote ages should have acquired such remarkable stay-at-home habits in recent times. Some conditions favorable to distribution must surely have existed, which have disappeared in modern ages. What can these changes be?

So far as persistency is concerned I note a fact, not recorded anywhere, that the plant is stoloniferous, bearing a small tuber at the end of a slender thread, which reproduces the plant next year, the whole of the previous years' plants, except these little tubers, dying away. In this way the plant, through its progeny, can be a traveler at the rate of two or three inches a year. It is remarkable that this character is not noted by systematic authors, for the specimens in the herbarium of the Academy taken at various times during the flowering period, from different parts of the world, exhibit traces of the little tubers at the ends of stolons that have evidently been passed over for true roots. It is hardly to be supposed that the plants have wandered wholly by the aid of these little tubers, valuable as they must be for persistency when once a foot-hold has been obtained. We are forced to the conclusion that at some former period it received much more aid from seed and seedlings than it receives in modern times.

As we are often aided in the study of the geographical wanderings of plants, a list is appended of comparatively local plants, found in companionship with *Trientalis* on the 3rd of June.

Allium Canadense	*Pogonia verticillata*
Amelanchier Botryapium	*Polemonium reptans*
Cypripedium pubescens	*Pyrola elliptica*
Hypoxys erecta	*Pyrus arbutifolia*
Mediola Virginica	*Viburnum acerifolium*
Mitchella repens	*Viola pubescens*
Goodyera pubescens	*Veratrum viride*
Osmunda spectabilis	*Aspidium cristatum.*
Oxalis violacea	

On the glands in some Caryophyllaceous flowers. It cannot be said that the existence of glands near the base of the common chickweed and its allies, has been wholly overlooked, but they are seldom referred to, and no attempt has been made to read their significance.

In regard to the chick-weed, *Stellaria media*, Withering notes in the *British Flora* (p. 547) "stamens glandular at the base." Dr. Bromfield notes of a closely related species, *Stellaria uliginosa*, "stamens 10, those alternating with the petals inserted on shortish, flattened glands; near, but not close to the base of the germen; being, in fact, above the latter and at the top of the conical enlargement of the calyx below the sepals" (*Flora Vectensis* 71). At p. 75, the same author notes of *Arenaria serpyllifolia* "stamens 5 to 10, those alternating with the sepals placed on a projecting glandular base, five shorter, having apparently abortive anthers." Of *Honckenya peloides*, both Torrey and Gray and Withering note the ten glands alternating with the stamens; and Hooker remarks of *Cherleria sedoides* that it has glands inside the five stamens.

Examining with a pocket lens, some flowers of the chickweed, between two and three o'clock in the afternoon early in May, I noticed the glands had secreted an enormous amount of liquid. The little globules were nearly as large as ordinary pin heads. It did not occur to me, at that time, that the period of the day had anything to do with the phenomena, but I was led to examine other allied species of plants the next day. I did not detect any, and I particularly examined *Cerastium viscosum* and had about concluded that the existence of prominent glands and a free exudation of liquid was peculiar to the chickweed, when, examining about the same time of day as in the former case, I found the exudation as abundant in the *Cerastium* also. Profiting by this hint, and examining at this time of day all species coming under my notice, I can say that glands exist in *Cerastium viscosum*, *C. arvense*, *Arenaria serpyllifolia*, *Stellaria longifolia*, *S. media;* I could not find the glands in *Stellaria pubera*.

It is well known that in Caryophyllaceæ generally, there are usually ten stamens, in two series,—the outer alternate with the petals,—the inner five alternate with the outer, and opposite the petals. There are often less by abortion, in which case it is the members of the inner series that disappear. No glands are between the stamens of the inner series. There are never but five, and these alternate with outer stamens. The outer series mature the anthers a day before the inner series mature them (except, I believe, in *S pubera*) ; but the liquid exudation occurs with the maturity of the anthers of the first series.

The liquid (in the chickweed) has a slightly sweet taste, and is very viscid, as a little taken out with the point of a pen-knife and rubbed between finger and thumb, testifies.

The five outer stamens in *Arenaria serpyllifolia* bend inwards, and the abundantly polliniferous anthers rest on the apex of the stigmas, completely covering the stigmas with own-pollen. The inner ones turn outwardly, resting on the petals or nearly so, and seem to have anthers wholly destitute of pollen. In *Cerastium viscosum*, the pollen matures before the pistils. At the time the pollen scatters, the fasicle of pistils are keeping close company. Soon afterwards they diverge, push themselves up among the pollen-clothed stamens, and are certainly self-fertilized in most, if not absolutely in all cases.

Examining the chickweed as it grew over a very large tract of waste ground, and soon after noon, when with a close naked-eye observation the comparatively large globules can be seen glistening in the sun,—one can scarcely neglect asking nature the chief object of this enormous production of sweet liquid,—for the collective quantity from these millions of flowers may be truly styled enormous. It has been asserted that nectar is given to flowers to attract insects for the purpose of cross-fertilization, and many observations confirm the deduction in numerons instances. Certainly the nectar attracts and as certainly the visits often result in fertilization—sometimes by the flowers' own pollen, oftener by the pollen from flowers on the same or neighboring plants, and occasionally from flowers from plants under different conditions, the true Darwinian idea of cross-fertilization. But I could see no bees visiting the chickweed for this banquet of nectar set before them. As the flowers are arranged for self-fertilization, there could be no assistance to the flowers in this work even did bees visit them. If insects came, in no way does it appear they could be of any advantage. Because I did not see any bees using the nectar during warm days following the first observations, it does not follow that they never resort to it. Bees go to those flowers where their hard task is the easiest. I have often seen them collecting pollen from chickweed, when a few warm early spring days attracted them from the hive, but at soon as the male catkins of the willow mature, with their very abundant crop of pollen, they leave the chickweed, and indeed most other flowers, while the willow pollen lasts.

Later on, about the middle of May, I found nectar-collecting honey bees working freely on *Cerastium viscosum*. It is never safe to say bees or other insects do not visit certain flowers. It depends largely on the supply of material. When abundant they evidently have preferences, and let the more difficult tasks alone.

BIOGRAPHICAL NOTICE OF GEORGE W. TRYON, Jr.

BY W. S. W. RUSCHENBERGER, M. D.

. . . . . . "for, go at night or noon,
A friend, whene'er he dies, has died too soon,
And, once we hear the hopeless *He is dead*,
So far as flesh hath knowledge, all is said."

James Russell Lowell—Agassiz.

The Academy of Natural Sciences of Philadelphia requested me, February 7th, 1888, to prepare a biographical notice of the late George W. Tryon, Jr. for publication in its *Proceedings*. He died February 5. The suddenness of the event shocked all his personal and many of his merely scientific friends, far and near. One (Mr. C. E. Beddome), who is in every sense qualified to justly appraise his worth, said to me in a note, dated Tasmania, April 4, not very long since received,—"I have respected him as one of the grandest conchologists of the day. I feel that I have lost my most valued correspondent; but what must be the loss of your academy and the conchological world. His great work 'Manual of Conchology,' not yet finished, will be the grandest monument that could be erected to his memory."

Eminence, fairly acquired by a toiler on any path of learning or scientific research, wins admiration, especially from those moving forward on the same quest, whether in his neighborhood or in places widely remote; and after he dies, they become more or less curious about his origin and career. Some are pleased to seek causes of his success in the circumstances of his life, assuming that social environment sways the formation of character, just as physical conditions surrounding certain organisms are supposed to influence their development. Students of this class ask where the eminent man was born and raised and trained, as well as what notable features characterized the locality where he grew to be distinguished among his associates. Those of another sort, who confide almost entirely in the doctrines of heredity, are disposed to ascribe the notable qualities of a contemporary to his parents and their ancestors, thus failing to recognize in him any merit wholly and clearly his own. They seem to forget that uncommon intellectual force, mental capability is not always traceable to heredity or to environment in any considerable extent. All the great heroes of science and literature did not have scientific ancestors or scientific environment. The genius of neither Franklin nor Shakespeare was an inheritance.

George Washington Tryon Jr. the eldest son of Edward K. Tryon and his wife, *née* Adeline Savitd, was born May 20, 1838, on Green street between Front and Newmarket streets, then in the district of the Northern Liberties. The place of his birth is about twelve or fifteen hundred yards, to the northward and eastward of the State House of Philadelphia,—Independence Hall. The locality was never a fashionable quarter of the city. It abounds in alleys and courts of small tenements, having small windows glazed with eight by ten inch panes, and roofs of cedar shingles, as may be seen to-day. A substantial, industrious people, most of them engaged in mechanical pursuits, inhabited the neighborhood, the alleys and streets of which were the play-grounds of their many children. It is now as it was fifty years ago, only the signs of age in some spots are probably more apparent.

George Washington Tryon, a gunsmith, had trained his son, Edward K. Tryon in the manufacture and trade in fire-arms and sportmen's accoutrements, a business which he had established and conducted successfully during a quarter of a century or more. He retired in 1837, leaving his son in possession of the establishment.

George W. Tryon Jr. at an early age manifested a retiring, cheerful and considerate disposition. His interest in the sports and games of boys was not sufficient to divert him from books. When about seven years old he began to collect specimens of natural history. The taste was encouraged by giving him a room at home in which to display them to members of a society of infant naturalists which he formed. From the start, shells received most of his attention.

The observant and reflective character of the child's mind is notable. He early discovered that a nomenclature was necessary to satisfactorily arrange even a small collection of specimens. He invented one. He named shells according to their shapes or colors, as the round shell, the white shell; one of such irregular form as puzzled him to designate he called the funny shell. The habit of gathering specimens of natural history begun without method in infancy, and more and more systematized as his experience and observation matured, was life-long. His first and predominant love for shells increased with his years and made him an industrious votary of conchology.

He was taught the rudiments of learning at home. After he had passed through one or two private schools for children, it was determined that he should receive academic instruction in the Friends' Central School, because it was regarded to be the best available. It was then in Race between Fourth and Fifth streets, and now is at the S. W. corner of Race and Fifteenth streets.

He became a pupil of the institution in October 1850, and continued till his school days ended, June 1853. During the almost three years here his attention was given only to English studies and drawing. The transfer of the family residence, in 1852, to Pittville, one of the purlieus of Germantown, five or six miles from the business centre of Philadelphia, did not interrupt his regular attendance at school, nor hinder the growth of his museum. The family returned to, and was permanently established in the city, in 1869.

Very soon after leaving the Friends' Central School he employed tutors in the city and studied French, German, and Music until he had acquired knowledge enough, to write and speak the languages sufficiently well for practical purposes, and to understand the principles of musical composition. About this time with some of his young friends he formed a musical society or club. Their performances enlivened the evenings at their country homes.

His interest in books created in him a desire to be an author. His first effort in this direction was a history of the United States finished when he was twelve years old, but not printed. A few years later he announced that literary and scientific work would be his permanent occupation. But, at the earnest request of his parents, he relinquished the project, for a time, and engaged in mercantile work in his father's establishment. At the age of nineteen, 1857, he was given a share in the business, and on the retirement of his father in 1864, he became the principal of the firm, and so continued till 1868, when he retired with a modest income, sufficient in his estimation to justify indulgence in unrestrained pursuit of science and letters.

He found relaxation from business cares in music. Though not a notably skilful player on any instrument, he was acquainted with the science of music.

He wrote a comic opera in three acts, entitled, Amy Cassonet or the Elopement, which was acted at the Amateur Drawing Room, and published; but it was in no sense successful. The copyright is dated 1875.

He sought to spread a love of music among the people and to elevate their taste. With this in view he joined in the management of the Germania Orchestra for a season. It was a failure. His partner disappeared, and Mr. Tryon had to supply pecuniary deficiencies.

In connection with a musical-publication firm—Lee and Walker,—he edited and published, prior to 1873, librettos of fifty-two standard and popular operas. During 1874 and 1875, he revised and edited the sheet-music publications of Lee and Walker, and in the same years edited The Amateur; a monthly magazine of music and literature. He also arranged a series of operatic songs which were published, in 1875, under the title of Operatic Gems. In 1884, he published "Sacred Songs for Choir and Home Circles, a Collection of Solos, Concerted Pieces, Hymns, etc.," the music of which consisted largely of selections from the scores of the more popular operas.

Mr. Tryon was a warm admirer of the fine arts, and occasionally amused himself with painting.

Music and the fine arts were secondary occupations; they never diverted him from the pursuit of natural history.

He was elected a member of the Academy of Natural Sciences of Philadelphia, June 1859. From that time till the end of his life no one did more to promote the interests of the institution. His services were many and important. The society is largely indebted to Mr. Tryon for the edifice which it now occupies. On his motion, November 14th, 1865, a committee was formed "to devise methods for advancing the prosperity and efficiency of the academy, by the erection of a building" etc. He was appointed chairman of the committee. The measures recommended by it were adopted. The election of a Board of Trustees of the Building Fund followed, Jan. 11, 1867. Mr. Tryon was appointed Secretary and held the office till he died, twenty-one years. He was a member of the building committee. No one labored more assiduously in every way to promote the completion of the enterprise which he had started. He gave $3000 to the building fund; and his generosity enabled the Conchological Section of the Academy to give to it as much more.

Mr. Tryon was elected a Curator of the academy, January, 1869, and resigned July, 1876. Under his direction and personal attention the numerous collections of the museum were safely transferred, in January 1876, from the old, and arranged in the new building. This arduous task was admirably performed.

At his instigation the Conchological Section of the Academy of Natural Sciences was founded, December 26, 1866. He was a constituent member, and its Conservator from December, 1875, thirteen years. His skill in conchology is manifest in the admirable arrangement and classification; and his incessant carefulness, in the excellent condition of the collections which were under his official charge. According to the annual report of the Section, December 1887, they consisted of 189,150 specimens, contained in 51,327 trays each with an appropriate label. This enormous collection, and an almost complete conchological library of 954 volumes, besides 455 pamphlets, bound in 26 volumes, all accessible under one roof, render the facilities of study of the subject in the academy unsurpassed.

April 9, 1867, he made a special deposit of more than ten thousand species of shells and more than a hundred jars of specimens, chiefly of naked mollusks, in alcohol, gathered during his life-long devotion to the subject, on condition that none should be loaned. They were appropriately intercalated with the academy's collection. The duplicates were sold, by his direction, and the proceeds of sales covered into the treasury of the Conchological Section. It is notable that he did not stipulate that this very large contribution—the largest private collection in this country—should be kept separate from the rest of the museum and designated by his name, which is a usual condition attached to donations of private natural-history cabinets to public museums. It was his opinion that it is unwise to accept cabinets on such terms, because it must result sooner or later, in encumbering the museum with the care of numberless and useless duplicates, for which space cannot be easily afforded.

The records show that Mr. Tryon contributed valuable specimens to the museum every year during the remainder of his life.

He gave, May 7, 1867, 119 volumes and 56 pamphlets on conchology to the library.

The first number of the American Journal of Conchology, of which Mr. Tryon was the editor and proprietor, was issued, February 1865. Seven volumes were published, the last number in May, 1872. After the institution of the Conchological Section of the Academy it was issued, nominally, by the publication committee of the Section, of which Mr. Tryon was chairman, but he was still the editor. The third and subsequent volumes contain summaries of the proceedings of the Section at its stated meetings.

To the Proceedings of the Academy of Natural Sciences, and to the American Journal of Conchology Mr. Tryon contributed sixty-four papers, between 1861 and 1873, inclusive, a list of which is appended.

In conjunction with Mr. Wm. G. Binney, in 1864, Mr. Tryon edited the complete writings of C. S. Rafinesque on recent and fossil conchology. In 1866, he published A Monograph on the terrestrial mollusca of the United States; in 1870, A Monograph of the Fresh-water univalve mollusca of the United States; in 1873, American Marine Conchology, and A Monograph on the Streptomatidæ (American Melanians) of North America. This work was prepared at the instance of the Smithsonian Institution, and published in its Miscellaneous Collections, in December. It was a result of several years' study. The manuscript was completed in 1865, and laid aside. At the end of seven or eight years, he again took up the subject, which he regarded as "one of the most interesting and difficult branches of American Conchology," and found himself "inclined to question many of the conclusions" which he had reached. In the preface of the work he says:—"A more enlarged acquaintance with fresh-water shells convinces me that a much greater reduction of the number of species than I have attempted must eventually be made; but until the prolific waters of the Southern States have been systematically explored, and a great collection of specimens obtained, which shall represent every portion of those streams and include as many transitional forms as can be procured, a definite monograph of our Melanians cannot be written."

More conclusive evidence of Mr. Tryon's habitual devotion to accuracy in all his work than is contained in the history of the preparation of this monograph is not required.

Mr. Tryon, for the sake of relaxation, left Philadelphia, May 1874, and returned September 19. During an absence of four months, he visited England, Holland, Belgium, Germany, France, Switzerland, Italy.

In a series of letters he wrote good-humored, cheerful sketches of his impressions of people and places at which he halted on his way. They were published in the Amateur; a monthly magazine of Music and Literature.

He visited England and the continent of Europe again in 1877. His route included Liverpool, London, Paris, Marseilles, and thence along the coast of the Mediterranean to Nice, San Remo, Genoa, Pisa, Rome, Naples, Sorrento: returning through Venice, Florence, Turin, Geneva, Chamouni, Berne, Mayence; the Rhine, Cologne, Brussels, Antwerp and back to London, Liverpool and home, in the autumn.

Now, naturally imbued with the love of truth exclusively for the truth's sake; possessed of the true methods of scientific inquiry, and equipped with the results of his life-long home studies of the mollusca, as well as of his observations in the European museums and cabinets, Mr. Tryon devised the plan of his greatest work—Manual of Conchology—and promptly began its execution.

The plan embraced four series of volumes. The first series of eleven or twelve volumes is devoted to the marine univalves; the second, of six or seven, to the terrestrial mollusca; the third, of four or five, to the marine bivalves, and the fourth, of four or five volumes, to the fluviatile genera.

The Manual of Conchology, completed according to the author's plan, will consist of from twenty-one to twenty-nine octavo volumes, all fully illustrated.

The scope of this great work is described in the "advertisement" or preface of the first number, which was finished and ready for publication in the last week of December, 1878. Mr. Tryon says, the Manual "will include, in systematic order, the diagnoses of all the genera and higher divisions of the mollusca, both recent and fossil, and the descriptions and figures of all the recent species; together with the main features of their anatomy and physiology, their embryology and development, their relations to man and other animals, and their geological and geographical distribution."

The numbers of the first series were issued quarterly. Volume IX was completed December 1887. The nine volumes include 3125 pages of text, illustrated by 680 plates of 12,055 figures.

The first number of the second series—terrestrial mollusca—was distributed January 1885, and thereafter quarterly to the close of Vol. III, December 1887. The three volumes contain 942 pages of text, illustrated by 187 plates of 6,434 figures.

Conscious that he probably might not live to complete his enterprise, but without foreboding, Mr. Tryon interested Mr. H. A. Pilsbry in it. To him he freely imparted his purposes and views in connection with it, so that he might continue the publication, should it become necessary. Mr. Pilsbry, who had the unreserved confidence of the author, has succeeded him in his office and will edit the work according to the plan. It will be published by the Conchological Section of the Academy, of which Mr. Pilsbry is the Conservator.

Mr. Tryon published the first volume of Structural and Systematic Conchology, in 1882; the second, in 1883, and the third and last volume, in 1884. The three volumes contain 1195 octavo pages of text, illustrated by 140 plates of 3,087 figures.

During the last ten years of his life, Mr. Tryon wrote 5262 octavo pages on conchology, illustrated by 1007 plates of 21,576 figures. To the labor of composition the business cares of publication were added: he was the publisher of his own works.

Until his admission into the Friends' Central School, October 1850, whatever religious impressions he may have imbibed in childhood, if any, came from the Sunday School and the example and teaching of his parents who were Lutherans. After leaving school, June 1853, he became interested in the Society of Friends and regularly attended its meetings during several years. For reasons, no doubt conclusive and satisfactory to himself, he left the meetings of the Friends, and, from about the year 1876, he was usually present at the stated services of the First Unitarian Church of Philadelphia. When it was proposed, about 1883, to construct a new building for the church Mr. Tryon was chosen one of its trustees. The work interested him. He gave very generously ($1000) in aid of its completion. He was long chairman of the Society's committee on music, and, until his death, was prominent among those who, in various ways, actively promoted the interests of the church.

He was not, however, rigidly sectarian. Knowing that there is difference on every question that interests men, his natural spirit of tolerance swayed his views and conduct relatively to those holding opinions opposite to his own.

He printed for private circulation, a pamphlet entitled, *Church and Stage*, with the motto, *Fiat justitia, ruat cœlum*. It contains twelve octavo pages, and is dated March 15, 1880.

The object of the paper is to uphold the drama as a proper means of popular instruction in spite of its general condemnation by clergymen.

After stating substantially that, in western Europe as well as in ancient Greece, the stage is the off-spring of the ceremonies of public worship—that the mystery play, which followed the liturgical drama, was the first form of the serious national stage in England, France, Italy, Spain and Germany,[1] he contends that in as much as the theatre has originated independently and exists under many types of civilization—Chinese, Japanese, Indian, Greek, Roman and modern European—and the influence of the Christian Church exerted against it through so many centuries has failed to extirpate it, the institution is likely to continuously thrive. Therefore, instead of persistently denouncing the stage, it would be more politic to kindly endeavor to point out and eliminate from it all acting that is, in any degree, detrimental to morality.

His manner of treating the subject may be seen in the following quotations:

"The first charge is, 'that dramas are frequently immoral stories, abounding in covert or open indecencies of language or action—sometimes actually blasphemous.' We appeal to any regular theatre goer whether his experience does not partially confirm this. Even those who frequent dramatic representations with the intention of encouraging only meritorious and unobjectionable plays, occasionally through ignorance of the matter of some new drama, or misled by uncandid notices of the press, find themselves 'assisting' at representations, quite bad enough to destroy their faith in the theatre. Our own experience, however, and we believe that it will be borne out by the experience of every play-goer who has not depraved instincts, is that plays are usually entirely innocent, and those of a serious character are intended to and do inculcate good morals and right living, that they teach man's whole duty with, (no words are more expressive), dramatic force; that is to say, they make an impression such as can never be made by either reading or lecture; for, to the power of trained declamation is added the verisimilitude of scenery and action. The eye as well as the ear receives and transmits the lesson to the brain and heart. No sermon can be so effectual for good, simply preached from the pulpit as when it is embodied in appropriate action:—that brings it home to us in all its reality; it is no longer a mere abstraction.

The play's the thing
Wherein I'll catch the conscience of the king.

"Such is a good play, better than the best sermon, not only more powerful but more far-reaching in its beneficent mission.

"Then if we take up the clerical charge once more, and agree that the amount of evil done by conveying this indecency or blas-

[1] *See* Harper's Magazine, Dec. 1888, p. 62.

phemy through the vividness of dramatic portrayal is incalcuable; that it familiarizes the auditors with wrong thinking, speaking and doing, and thus lowers the moral tone of the community,' on the other hand, a good play, by parity of reasoning, should have an equally incalculable good influence, and we believe that it has. The vast majority of men [who] are not attracted towards the church, find themselves unable to comprehend its methods, endure its limitations, or perhaps appreciate its motives—and for these, else left without moral instruction, the play yields along with its human interests and entertainment, its realistic teaching by example as well as precept.

"Nay more, the clergyman who objects to the representation of the prayer scene in 'Hamlet,' does not hesitate to read the passage, or to hear it read, perhaps by the very actor who is accustomed to play the part, and who will throw into it all the emotion and all the action that the lecture platform permits him. He will even listen to this recital in the opera house probably, and without alarming his conscience 'because it is not a dramatic performance, but only a recital.'

"Thus, to be consistent, it seems that we must at least tolerate upon the stage, that which we approve in the library or lecture room. But this point is not yet exhausted: there are various conceptions of morality perhaps, and that of the churchman is not necessarily the highest. No one will deny that among theatre-goers are to be found persons who are as cultivated in religion, morals and manners, as tender of conscience, as responsive to the call of duty as any of the abstainers. Is it not rather illiberal then to assume that these persons only visit the theatre because they, in this particular, disregard the voice of conscience? Again, the lower classes of mankind, who frequent the sensational second-class play, who read the equally sensational second-class 'weekly;' are they to be frowned down on account of the vulgarity of their amusements? The uncultured cannot become educated christian people at a bound: generations of refining influences are required to effect the transformation. For these men and women in process of enlightenment, with yet unformed, or badly formed tastes, the theatre is a civilizing agent of far greater power than it is for their betters.

"It may be taken for granted that actors as well as audiences are susceptible to the moral or immoral lessons of the drama, and if, as we assert, the vast majority of plays exert great, though unobtrusive moral influence, then so far as their profession may be supposed to affect their conduct we should expect to find actors respectable and worthy the acquaintance of the pure and noble. But, it will be said, there is abundant evidence that at least many actors are dissolute people, that they live low, vagabond lives, are indecent in language and conduct, drunkards, gamesters, irreligious. The evidence, alas! *is* abundant, and if it could be proven that the proportion of actors who are disreputable is larger than in other professions, we might accept the fact as some evidence of the cause assigned for it; but it is notorious that in all public professions lapses from rectitude are numerous.

"A word in conclusion concerning those who, whilst despising the stage and its associations, yet avail themselves of its fruits. They owe their best music to its inspiration; their best choir singers there received their education; their minister is himself indebted to it, either directly or indirectly, for the force and grace of style and declamation which render him so impressive. Without the stage you would not be possessed of Shakespeare—whose single influence for good has certainly far outweighed all the evil which the theatre has ever done mankind. Those who while discountenancing the theatre, read Shakespeare or hear him read; who listen with delight to the operatic overture or aria; who hang entranced upon the eloquence of the rostrum, are meanly, (I had almost written dishonestly) enjoying the fruits of an institution which they condemn."

Whether Mr. Tryon's championship of the stage be acceptable or not, few persons will fail to perceive in it his philantrophic disposition and love of justice, as well as the degree of his inclination to render homage to the Muses.

To those who would withhold all such matters from a biographical account of a scientist as not pertinent, and to those whose hostility to the theatre is relentless, the above citations may seem too long; but they may be excused. They prove that his mental scope took in very much more than the truths of natural science; that the comparatively inferior and ignorant classes of society had his sympathy, and that he was ready to help improve their mental and moral level. Thus, they indicate a feature of his character not portrayed elsewhere in his writings. None will deny that a feature partly or wholly left out obscures or spoils the likeness, even in a finished painting of a friend.

Mr. Tryon was notably cautious and conservative in scientific work. The personal reputation incident to success he did not appreciate very highly, nor regard to be among the objects of scientific research. Just as a private in the ranks, forgetful of all the labor and perhaps blood he has contributed towards it, delights in the glory of his regiment, wholly unmindful of the personal distinction he may have fairly earned for himself, so Mr. Tryon toiled to promote the welfare and fame of the academy, within the bounds of which he seemed to have merged his scientific aspirations. Few have been like him in this respect; but his example may have followers. Natural modesty, an almost reclusive disposition made him reluctant to hold office. He often refused to permit friends to nominate him for prominent positions in the society, and was apparently indifferent to the honor of membership in other associations. He did not care to publish that he was a corresponding member of the California Academy of Natural Sciences, from December 1862; of the Boston Society of Natural History, from March 1864; of the Royal Society of Tasmania. from June 1886, nor of any other in which his name had been enrolled.

Mr. Tryon's good sense and unselfish nature; his cheerful, unpretentious deportment at all times, won for him affectionate respect and enduring friendships. Because he was punctual, prompt and efficient in doing, within the limits of official duty, whatever concerned the interests of the academy, he deserved and had the unreserved confidence of all.

The quantity and quality of work done during his happy career are perennial vouchers of his unremitting industry and varied ability. It is doubted whether a collegiate training and the Master's degree would have facilitated his progress and enabled him to acquit himself better in any sense. A genius for discovering his own deficiencies, and then filling them by opportune self-help, was a practical substitute for an Alma Mater.

Mr. Tryon's abiding desire to increase our knowledge of conchology, which he has done so much to advance, is manifest in his last will and testament, dated March 18th, 1886.

He bequeathed to the Conchological Section of the Academy certain real estate to be a source of a permanent trust fund, the income from which is to be applied to augment the Conservator's salary, to increase the collection of shells, as well as to other purposes, at the discretion of the Section. All profits which may be derived from his conchological works and from his conchological publication business are to be added to the fund.

This provision, in connection with the present vast collections and an almost perfect library, goes far towards establishing in the United States the centre of conchology at the Academy of Natural Sciences of Philadelphia.

Mr. Tryon was methodical in all his ways, and unswervingly firm of purpose. He always did what he believed to be right in face of all opposition; but he tranquilly considered argument against his opinions, and gracefully yielded them whenever he could not answer it. He passed much of his time in the academy at work among its collections and books. For health's sake he appropriated time for daily exercise in the open air, without much regard to the state of the weather. On Saturday, January 28, 1888, while the temperature, ranged between 12° and 17° F. and the wind was blowing freshly from the north-west, he walked briskly in an easterly direction more than a mile, and returning faced the wind. Paroxysms of difficult breathing forced him to stop many seconds, and several times. On reaching home he was much depressed physically; his circulation was abnormally slow and weak, but he soon rallied and seemed to be surely recovering. In the course of two or three days a kind of roseola, to which he had been liable at times since an attack of scarlet fever in childhood, appeared, and towards the last became hemorrhagic. He died February 5, the eighth day after his cold walk.

His father, a brother and a sister survive him. His mother died December 23, 1869. He was a bachelor. As far as known he was at no time inclined to change his celibate condition.

Accepting a definition that poetry is merely the blossom and bloom of human knowledge, Mr. Tryon was Laureate of the kingdom of the mollusca. He well knew all its inhabitants—they were thousands—and characterized every typical one in descriptive lines—full of knowledge but without poetic cadence or poetic measure of any kind. But his whole attention was not given to those mollusks. He had eyes for all natural objects. He was fond of flowers, had studied botany successfully, and learned to botanize. In the summer it was his custom to take long walks in the country. On reaching home from those walks he was almost sure to be laden with flowers and grasses, gathered by the way, some for study in connection with his herbarium, which was large, and others to bedeck certain rooms in the house. And now and then a mineralogist was surprised to hear him talk so knowingly about minerals. Indeed, his acquaintance with natural history, generally, was sufficiently intimate to make the title of naturalist appropriate to him. His knowledge of nature and natural things was a pure accomplishment, in no sense associated with his bread-wining work while he was the successful man of business.

This imperfect sketch of an eminent benefactor of the academy is fittingly closed with the following tributary stanzas, written by his friend, our fellow member, Mr. John Ford, Feb. 15, 1888.

In memoriam.

As falls the oak, mature and strong in limb,
  A giant 'mong its fellows tall and grand,—
So fell the peer of those whom Science crowns,
  Th' immortal Tryon, type of noblest men.

Not human hearts alone do feel the blow
  That struck him down in life's meridian,—
The leafy woods, the vales, and quiet streams
  Where Nature's gems he sought, alike are grieved.

E'en Neptune mourns the loss of one who knew
  His sea-born children all by sight and name;
And from their games the Tritons sadly turn
  To breathe a requiem through horns of pearl.

His form is gone, but deathless evermore
  On pages manifold his thoughts remain;
And there, like ripened fruits, they wait the hands
  Of all who would their charming flavor prove.

Though well we know the victor's fadeless crown
  His brow adorns, and that he dwells in peace,
Yet do our hearts, remembering the past,
  Still long to meet him face to face again.

List of Papers and Books written by George W. Tryon Jr.

On the mollusca of Harper's Ferry, Va. Proc. Acad. Nat. Sc. Philad. 1861, pp. 396–399.

Synopsis of the recent species of Gastrochænidæ, a family of acephalous mollusca. Proc. Acad. Nat. Sc. Philad. 1861, pp. 465–494.

On the classification and synonymy of the recent species of Pholadidæ. Proc. Acad. Nat. Sc. Philad. 1862, pp. 191–220.

Description of a new genus, (Diplothyra) and species of Pholadidæ, (Dactylina Chilöensis.) Proc. Acad. Nat. Sc. Philad. 1862, pp. 449–450.

Notes on American Fresh Water Shells, with descriptions of two new species (Vivipara Texana, Amnicola depressa.). Proc. Acad. Nat. Sc. Philad. 1862, pp. 451–453.

Monograph of the family Teredidæ. Proc. Acad. Nat. Sc. Philad. 1862, pp. 453–482.

Contributions towards a monography of the order of Pholadacea, with descriptions of new species. Proc. Acad. Nat. Sc. Philad. 1863, pp. 143–146.

Descriptions of two new species of Fresh Water mollusca, from Panama, (Planorbis Fieldii, Amnicola Panamensis,). Proc. Acad. Nat. Sc. Philad. 1863, p. 146.

Description of a new Exotic Melania, (M. Helenæ.). Proc. Acad. Nat. Sc. Philad. 1863, pp. 146–147.

Descriptions of new species of Fresh Water Mollusca, belonging to the families Amnicolidæ, Valvatidæ, and Limnæidæ, inhabiting California. Proc. Acad. Nat. Sc. Philad. 1863, pp. 147–150.

Description of a new species Pleurocera (P. plicatum.). Proc. Acad. Nat. Sc. Philad. 1863, pp. 279–280.

Description of a new species of Teredo, (T. Thomsonii) from New Bedford, Mass. Proc. Acad. Nat. Sc. Philad. 1863, pp. 280–281.

Descriptions of two new species of Mexican Land-Shells, (Helix Rémondi, Cyclotus Cooperi.). Proc. Acad. Nat. Sc. Philad. 1863, p. 281.

Synonymy of the species of Strepomatidæ, a family of Fluviatile Mollusca, inhabiting North America. Proc. Acad. Nat. Sc. Philad. 1863, pp. 306–322.

Synonomy of the species of Strepomatidæ, a family of Fluviatile Mollusca inhabiting North America. Proc. Acad. Nat. Sc. Philad. 1864, pp. 24–48, 92–104; 1865, pp. 19–36.

Description of two new species of Strepomatidæ; Goniobasis Haldemani, Pleurocera Conradi. Amer. Journ. Conchol. I, 1865, p. 38.

Descriptions of new species of Pholadidæ. Amer. Journ. Conchol. I, 1865, pp. 39–40.

Observations of the new genus Io. Amer. Journ. Conchol. I, 1865, pp. 41–44.

Catalogue of mollusca, collected by Prof. D. S. Sheldon, at Davenport, Iowa. Amer. Journ. Conchol. I, 1865, pp. 68–70.

Observations on the family Strepomatidæ. Amer. Journ. Conchol. I, 1865, pp. 97–135.

Catalogue of the species of Physa, inhabiting the United States. Amer. Journ. Conchol. I, 1865, pp. 165–173.

Descriptions of new species of Melania. Amer. Journ. Conchol. I, 1865, pp. 216–218.

Descriptions of new species of Amnicola, Pomatiopsis, Somatogyrus, Gabbia, Hydrobia, and Rissoa. Amer. Journ. Conchol. i, 1865, pp. 219–222.

Descriptions of New Species of North American Limnæidæ. Amer. Journ. Conchol. i, 1865, p. 223–231.

Review of the Goniobases of Oregon and California. Amer. Journ. Conchol. i, 1865, pp. 236–246.

Catalogue of the species of Limnæa inhabiting the United States. Amer. Journ. Conchol. i, 1865, pp. 207–258.

Description of a new species of Mercenaria; (M. fulgurans,) Amer. Journ. Conchol. i, 1865, p. 297.

Monograph of the family Strepomatidæ. Amer. Journ. Conchol. i, 1865, pp. 299–341; ii, 1866, pp. 14–52, 115–133.

An abnormal specimen of Planorbis bicarinatus. Amer. Journ. Conchol. ii, 1866, p. 3.

Descriptions of new fresh-water shells of the United States. Amer. Journ. Conchol. ii, 1866, pp. 4–7.

Descriptions of new exotic fresh-water Mollusca. Amer. Journ. Conchol. ii, 1866, pp. 8–11.

Description of a new species of Rissoa; R. exilis. Amer. Journ. Conchol. ii, 1866, p. 12.

Note on Mr. Pease's species of Polynesian Phaneropneumona. Amer. Journ. Conchol. ii, 1866, p. 82.

Description of a new species of Vivipara; V. Waltonii. Amer. Journ. Conchol. ii, 1866, pp. 108–110.

Descriptions of new Fluviatile Mollusca. Amer. Journ. Conchol. ii, 1866, pp. 111–113.

Observations on an abnormal specimen of Physa gyrina. Amer. Journ. Conchol. ii, 1866, p. 114.

Note on the lingual dentition of the Strepomatidæ. Amer. Journ. Conchol. ii, 1866, pp. 134–135.

Monograph of the terrestrial mollusca of the United States. Amer. Journ. Conchol. II, 1866, pp. 218–277, 306–327; iv, 1869, pp. 5–22.

Description of a new species Columna; C. Leai. Amer. Journ. Conchol. ii, 1866, pp. 297–298.

Descriptions of new species of Melaniidæ and Melanopsidæ. Amer. Jour. Conchol. ii, 1866, pp. 299–301.

Description of a new species of Septifer; S. Trautwineana. Amer. Journ. Conchol. ii, 1866, p. 301.

Description of a new species of Helix; H. Bridgesi. Amer. Journ. Conchol. ii, 1866, p. 303.

On the terrestrial Mollusca of the Guano Island of Navassa. Amer. Journ. Conchol. ii, 1866, pp. 304–305.

Notes on Mollusca collected by Dr. F. V. Hayden in Nebraska. Amer. Journ. Conchol. iv, 1869, pp. 150–151.

Catalogue of the families Saxicavidæ, Myidæ, and Corbulidæ. Amer. Journ. Conchol. iv, 1869, (Append.), pp. 59–68.

Catalogue of the family Tellinidæ. Amer. Journ. Conchol. iv, 1869, (Append.), pp. 72–126.

Descriptions of new species of terrestrial Mollusca from Andaman Islands, Indian Archipelago. Amer. Jour. Conchol. v, 1870, pp. 100–111.

Descriptions of new species of marine bivalve mollusca in the collection of the Academy of Natural Sciences of Philadelphia. Amer. Journ. Conchol. v, 1870, p. 170–172; vi, 1871, pp. 23–24.

Note on Cyclophorus foliaceus, *Reeve* (non Chemnitz) and C. Leai, *Tryon.* Amer. Journ. Conchol. vi, 1871, pp. 25–26.

Notes on Dr. James Lewis' paper "On the shells of the Holston River." Amer. Journ. Conchol. vii, 1872, pp. 86–88.

Catalogue of the family Cyprinidæ. Amer. Journ. Conchol. vii, 1872, p. 252.

Catalogue of the recent species of the family of Glauconomyidæ. Amer. Journ. Conchol. vii, 1872, pp. 253–254.

Catalogue of the recent species of the family Petricolidæ. Amer. Journ. Conchol. vii, 1872, pp. 255–258.

Catalogue of the recent species of the family Cardiidæ. Amer. Journ. Conchol. vii, 1872, pp. 259–275.

Catalogue and synonymy of the recent species of the family Lucinidæ. Proc. Acad. Nat. Sc. Philad., 1872, pp. 82–96.

Catalogue of the family Chamidæ. Proc. Acad. Nat. Sci. Philad. 1872, pp. 116–120.

Catalogue of the family Chametrachæidæ. Proc. Acad. Nat. Sc. Philad., 1872, pp. 120–121.

Descriptions of three new species of marine bivalve mollusca; Crassatella Adelinæ, Lucina distinguenda, Circe bidivaricata. Proc. Acad. Nat. Sc. Philad., 1872, p. 130.

Catalogue and synonymy of the family Galeommidæ. Proc. Acad. Nat. Sc. Philad. 1872, pp. 222–226.

Catalogue and synonymy of the family Leptonidæ. Proc. Acad. Nat. Sc. Philad., 1872, pp. 227–229.

Catalogue and synonymy of the family Laseidæ. Proc. Acad. Nat. Sc. Philad. 1872, pp. 229–234.

Catalogue and synonymy of the family Astartidæ. Proc. Acad. Nat. Sc. Philad. 1872, pp. 245–258.

Catalogue of the family Solemyidæ. Proc. Acad. Nat. Sc. Philad. 1872, p. 258.

On a series of land and fluviatile Mollusca from Utah. Proc. Acad. Nat. Sc. Philad. 1873, pp. 285–286.

The complete writings of Constantine Smaltz Rafinesque on Recent and Fossil Conchology. Edited by William G. Binney, and George W. Tryon Jr., members of the Academy of Natural Sciences of Philadelphia. 8vo, pp. 96+40+8 = 144; plates 3; figures 69. Bailliere Brothers, New York; J. B. Bailliere et Fils, Paris; H. Bailliere, London; C. Bailly Bailliere, Madrid. 1864.

A Monograph of the Terrestrial Mollusca inhabiting the United States. With illustrations of all the species. By George W. Tryon Jr., editor of the American Journal of Conchology; member of the Academy of Natural Sciences of Philadelphia; corresponding member of the Boston Society of Natural History; the Lyceum of New York; the California Academy of Natural Sciences; the Zoölogischen botanischen Gesellschaft in Wien, etc. Published by the author, 625 Market street, Philadelphia, 1866. 8vo, pp. 159+XLIV; plates 18, with colored duplicates; figures, 430. Bailliere Brothers, New York; J. B. Bailliere, et Fils, Paris; Trübner & Co., London; C. Bailly-Bailliere, Madrid; Asher & Co., Berlin.

A Monograph of the Fresh water univalve mollusca of the United States, in continuation of Prof. S. S. Haldeman's work, published under the above title. By George W. Tryon Jr. Published by the Conchological Section of the Academy of Natural Sciences of Philadelphia, 1870. 8vo, pp. 238, plates 32.

American Marine Conchology: or descriptions of the shells on the Atlantic coast of the United States, from Maine to Florida. By George W. Tryon Jr., member of the Academy of Natural Sciences of Philadelphia. Published by the author, No. 19 N. Sixth street, Philadelphia, 1873. 8vo, pp. 208; plates 44; figures 550.

Smithsonian Miscellaneous Collections, (253). Land and Fresh-Water Shells of North America. Part IV. Strepomatidæ (American Melanians). By George W. Tryon Jr., Smithsonian Institution, Washington, December, 1873. 8vo, pp. LV+435; 838 figures, intercalated with the text.

Manual of Conchology; Structural and Systematic; with illustrations of the species. By George W. Tryon Jr., Conservator of the Conchological Section of the Academy of Natural Sciences of Philadelphia. Published by the author. Academy of Natural Sciences, Corner Race and Nineteenth streets.

Vol. I, 1879. Cephalopoda. 8vo, pp. 316; plates 112; figures 671

Vol. II, 1880. Muricidæ including Purpurinæ, 8vo, pp. 289; plates 70; figures 977.

Vol. III, 1881. Tritonidæ, Fusidæ, Buccinidæ. 8vo, pp. 310; plates 87; figures 1287.

Vol. IV, 1882. Nassidæ, Turbinellidæ, Volutidæ, Mitridæ. 8vo, pp. 276; plates 58; figures 1345.

Vol. V, 1883. Marginellidæ, Olividæ, Columbellidæ. 8vo, pp. 276; plates 63; figures 1351.

Vol. VI, 1884. Conidæ, Pleurotomidæ. 8vo, pp. 400; plates 65; figures 1550.

Vol. VII, 1885. Terebridæ, Cancellariidæ, Strombidæ, Cypræidæ, Ovulidæ, Cassididæ, Doliidæ. 8vo, pp. 309; plates 75; figures 1301.

Vol. VIII, 1886. Naticidæ, Calyptræidæ, Onustidæ, Turritellidæ, Vermetidæ, Cæcidæ, Eulimidæ, Pyramidellidæ, Turbonillidæ. 8vo, pp. 461; plates 79; figures 1582.

Vol. IX, 1887. Solariidæ, Ianthinidæ, Trichotropidæ, Scalariidæ, Cerithiidæ, Rissoidæ, Littorinidæ. 8vo, pp. 488; plates 71; figures 1991. (The first series will be completed in eleven or twelve volumes).

Second series TERRESTRIAL MOLLUSCA.

Vol. I, 1885. Testacellidæ, Oleacinidæ, Streptaxidæ, Helicoidea, Vitrinidæ, Limacidæ, Arionidæ, etc. 8vo, pp. 364; plates 60; figures 1698.

Vol. II, 1886. Zonitidæ. 8vo, pp. 265; plates 64; figures 2072.

Vol. III, 1887. Helicidæ (begun; to be completed in three or four volumes). 8vo, pp. 313; plate 63; figures 2664.

Third series—Marine Bivalves—4 or 5 volumes.

Fourth series—Fluviatile genera—4 or 5 volumes.

NOTE—The second, third and fourth series will be continued and completed by H. A. Pilsbry, Conservator of the Conchological Section of the Academy of Natural Sciences of Philadelphia.

Church and Stage, Philadelphia, March 15, 1880, (printed for private use). 8vo, pp. 12.

Structural and Systematic Conchology: An introduction to the study of the Mollusca. By George W. Tryon Jr. Conservator of the Conchological Section of the Academy of Natural Sciences of Philadelphia. Published by the author, and issued from the Academy.

Vol. I, 1882. 8vo, pp. 312; plates 22; figures 256.

Vol. II, 1883. 8vo, pp. 430; plates 69; figures 1339.

Vol. III, 1884. 8vo, pp. 453; plates 49; figures 1492.

December 4.

Mr. Charles Morris in the chair.

Twenty-five persons present.

Theories of the Formation of Coral Islands.—Mr. Charles Morris remarked that there exist, as is well known, two theories of the formation of coral islands, the subsidence theory of Charles Darwin, and the recent theory propounded by John Murray and others, which claims that the phenomena can be explained without calling in the aid of subsidence. It was not his purpose to offer any argument on this controverted question, and he would simply say that the Darwin theory seemed to him much the most probable, the objections to it being, in his view of the case, far less cogent than those to the Murray theory.

If the subsidence theory were accepted, however, there was one consequence necessarily deducible from it which, so far as he was aware, had not yet been definitely considered, and which was not without scientific importance.

The area occupied by coral islands in the Pacific is, as stated by Dana, 6000 miles in length and from 2000 to 2500 miles in width, thus covering from 12,000,000 to 15,000,000 square miles. This includes a blank central area of 1,000,000 square miles in which the subsidence is supposed to have been too rapid to permit coral growth, beyond which is a region of small atolls, and outside this the region of ordinary atolls. Outside this again is a region in which barrier and fringing reefs replace atolls, and if this region be included the total area of subsidence must have been, according to Le Conte, about 20,000,000 square miles.

The depth of subsidence is variously stated. Dana considers that the extreme subsidence was at least 9000 or 10,000 feet. Later authorities give it at about three miles. As regards the average subsidence of the whole area it may perhaps be safely assumed as not less than 5000 feet, possibly considerably more. If the Darwin subsidence theory be accepted, then, an area of sea bottom equal to that of the largest continent must have sunk bodily to a depth of at least a mile.

This subsidence may have been correlative with a considerable elevation of the land surface, but there is no reason to believe that there was any equal elevation of other portions of the ocean bed. There are many evidences of local elevation, but all of them taken together are unimportant as compared with the great subsidence over the coral island area, and may have been balanced by local subsidence elsewhere. Yet such an immense subsidence, with no corresponding elevation of the ocean bottom, could not take place without adding greatly to the capacity of the ocean basin. It formed what we may speak of as a huge valley in the ocean bed, of 20,000,000 square miles in area and one mile in average depth. The filling of such a valley with water must necessarily have caused a marked lowering of the general ocean level. If the figures above given be assumed as correct it is easy to calculate the amount of depression of sea level.

The area in question is equal to that of Asia and Europe combined, and the effect of its sinking would be equivalent to that of the sinking of the Eurasian continent till covered with water to the average depth of one mile; since to fill such a valley in the ocean bed would require as much water as to cover a continent sinking to the same depth. The area named is very nearly one seventh of the whole ocean area, and to fill it to a depth of one mile would cause a general oceanic depression of one-seventh of this depth, or about 750 feet. If the average subsidence be taken at a somewhat greater figure, say 7000 feet, the consequence would be a depression of the ocean level of 1000 feet.

This is no fanciful conclusion. If the subsidence stated really took place, without important elevation of the ocean bed elsewhere, such a lowering of the general ocean level must necessarily have occurred to an extent governed by the average extent of subsidence. The effect on the relations of land and ocean altitude would be equivalent to an elevation of the whole land surface of the earth to a height of 750 or 1000 feet, or some other height dependant on the real degree of subsidence.

Such an effect must have left its marks, in the exposure of considerable areas of new land along sloping shores, in the draining of bays and estuaries, the possible conversion of bays into partly or fully land-locked seas, and other drainage results. In fact if such a virtual elevation of all the shore regions of the earth took place it would seem as if it must have left some generally traceable indications, which would furnish an argument in favor of the subsidence theory. Yet it may have been so complicated with actual elevations and depressions of the land surface as to destroy evidences of its existence in most localities. That land drainage and shore elevation did take place to a considerable extent during the Tertiary epoch is acknowledged, but whether these were due to actual elevation, or to a sinking of the ocean level, is a problem which cannot be definitely solved without much fuller evidence than we possess at present.

The following was ordered to be printed:—

ON TWO NEW SPECIES OF STARFISHES.

BY J. E. IVES.

While engaged in reviewing the starfishes in the collection of the Academy, I found two forms belonging to the genera *Pteraster* and *Coronaster* which do not appear to have been described. They may be thus characterized:

Pteraster tesselatus, n. sp.

Dorsal surface very convex; arms tapering at their aboral ends, and much recurved. Supradorsal membrane regularly reticulated; reticulation forming obliquely arranged hexagonal areas, which are very apparent upon the sides of the arms. No spicules found in the supra-dorsal membrane. Paxillæ about 2 mm. high. Each paxilla surmounted by eight radiating spinelets enclosing a number of smaller ones.

The spinelets when examined under the microscope are found to be composed of two or more connected many-sided hollow cylinders, the sides of which are perforated by elongated apertures as shown in the figure representing a portion of a cylinder highly magnified. The distal ends of the spinelets are inserted into the delicate membranous bands which form the reticulation of the supra-dorsal membrane. Some of the spinelets perforate this membrane in the centres of the hexagonal areas, projecting slightly on the surface. On the dorsal surface of the disk and arms, especially in the hollows of the inter-radial portions of the disk and of the recurved arm, there are numerous minute folds of the integument that produce a somewhat granulate appearance of the membrane. There are 25–30 spiracula in each hexagonal area. The oscular orifice is surrounded by a number of webbed spinelets.

On the ventral surface the actino-lateral spines are short, about 70 on each side of the ambulacral furrow. There are a corresponding number of ambulacral combs. At the base of the arm each comb has 6 spines; the three outer spines are the longest and about equal; the fourth (counting from the outside) rather smaller, the fifth very small, and the rudimentary sixth spine very minute, and directed towards the aboral end of the arm. The number of spines in a comb decreases towards the end of the arm. The ambulacral feet are in two rows, 80–90 feet in each ray. There are twelve spines at each angle of the mouth forming a single web. The four central spines are the longest, the first pair of spines on the outside of these rather smaller, the next half the size of the last pair, and the two outermost pairs very short. Two large well developed secondary mouth-spines in each interradial angle.

Greatest diameter of specimen from tip of one arm to tip of an opposite arm 100 mm.; proportion of radius of disk to radius of arm as 1 to 2: height of disk 35 mm.

A single specimen; color in alcohol, dull yellowish grey.

This species differs from *Pteraster pulvillus*, Sars, to which it appears to be closely allied, by its longer arms; the absence of large conical papillæ upon the supra-dorsal membrane; its greater size, being about half as large again; the relatively much greater number of ambulacral combs and actino-lateral spines, and the different size and number of the spines of the ambulacral combs. It also appears to be closely allied to *Pt. semireticulatus*, Sladen, but may be distinguished from it by the prominent central spinelets of the paxillæ, which perforate the supra-dorsal membrane; the greater number and difference in size of the spiracula; the absence of any tendency towards a quadruple arrangement of the ambulacral feet—the greater number of ambulacral and mouth spines, and in its greater size being about 3½ times as large as *Pt. semireticulatus*. It differs altogether from *Pteraster aporus*, described by Dr. H. Ludwig from Behring Sea,—*Pt. aporus* having no oscular orifice. *Pt. aporus* appears to be the only species of *Pteraster* that has hitherto been described from that region.

Below, I give a list of the species of *Pteraster* that have been described up to the present time.

P. militaris, O. F. Müller. Zool. Dan. Prodr. p. 234; Muller and Troschel, System der Asteriden, pp. 44, 128, pl. VI, fig. 1; Sars, Oversigt af Norges Echinodermer, p. 48, Tab. iv, v, vi, fig. 1–13.

P. militaris, O. F. Müller, var. *prolata*, Sladen. Trans. Roy. Soc. Edinb. xxxii, p 153.

P. pulvillus, Sars. Oversigt af Norges Echinodermer, p. 62, Tab. vi, figs. 14–18, Tab. vii, viii, ix, figs. 1–6.

P. multipes, Sars. Vidensk. Selskabs. Forhandlinger, 1865, p. 200; Fauna littoralis Norvegiae p. 65. Tab. viii, figs. 1–17.

P. Danæ, Verrill. Proc. Bost. Soc. Nat. Hist. vol. xii, p. 386; Trans. Conn. Acad. vol. i, p. 568, pl. IX, figs. 11, 11*a*.
P. affinis, E. A. Smith. Ann. Nat. Hist. (4), vol. xvii, p. 108.
P. rugatus, Sladen. Journ. Linn. Soc. vol. xvi, p. 195.
P. stellifer, Sladen. Journ. Linn. Soc. vol. xvi, p. 195.
P. semireticulatus, Sladen. Journ. Linn. Soc. vol. xvi, p. 195.
P. caribbæus, Perrier. Comptes Rendus xcii, p. 59; Bull. Mus. Comp. Zool. ix, p. 13; Nouv. Arch. Mus. (2) vi, p. 216.
P. aporus, Ludwig. Zoologische Jahrbücher 1886, p. 293.

Coronaster bispinosus, n. sp.

Twelve long slender arms.

Dorsal skeleton of disk reticulated; formed of imbricated ossicles, and enclosing irregularly shaped meshes in which are found from four to ten respiratory tubes. Distributed irregularly on the skeleton of the disk are short spines, each bearing a little cluster of crossed pedicellariæ. Madreporic plate small and submarginal.

Dorsal skeleton of arms reticulated: Reticulation formed by five longitudinal bands of imbricated ossicles, connected at about every fourth plate by similar transverse bands, forming large rectangular meshes. Meshes longest in the direction of the arms, containing a large number of tentacular papillæ. Sometimes closer and irregular in shape at the base of the arms. At the junction of the longitudinal and transverse bands, stand long pointed spines, each spine surrounded about its middle by a closely packed cluster of crossed pedicellariæ.

Each of the adambulacral plates carries an inner and outer spine, the outer spine being slightly more adoral than the inner one, thus showing a tendency of the two spines to alternate.

Length from centre of disk to end of arm, 140m; radius of disk, 12m.

Color of the single specimen in alcohol pale flesh color, with the skeletal portions white.

This form undoubtedly belongs to the genus *Coronaster* of Perrier (*Echinodermes du Travailleur et du Talisman*, *Annales des Sciences Naturelles*, VI[e] Serie, T. XIX. No. 8, 1885.) He gives, however, as a character of the genus the existence of a single spine on each adambulacral plate, whereas in *Coronaster bispinosus* there are two such spines to each plate. This character of the genus must therefore be modified in order to admit this species.

The form described differs from *Coronaster Parfaiti*, Perrier, the only other species of the genus, principally by the character above mentioned, viz. the existence of two spines on each adambulacral plate. It also differs by its greater size, the radius of the disk being twice as great, and the arms from the centre of the disk to their tips, three times as long.

DECEMBER 11.

The President, Dr. JOS. LEIDY, in the chair.

Twenty-three persons present.

A paper entitled "Description of a New Species of Orithopristis from the Galapagos Islands." By David S. Jordan and Burt Fesler, was presented for publication.

Double Cocooning in a Spider.—Dr. HENRY C. MCCOOK remarked that spiders may be divided into two groups in relation to their cocooning habit. The individuals of one group habitually spin several cocoons. Those of the other group habitually spin but one. The latter, however, are subject to some variation, the reasons for which have not been satisfactorily explained. *Epeira diademata* for example, habitually spins but one cocoon, and yet the Spanish investigator Termeyer,[1] in the early part of this century, discovered and announced that she would spin as many as six cocoons when specially nourished. The fact struck the speaker as an extraordinary one, and he had never yet quite obtained consent to fully admit it.

There are some facts, however, which have recently been uncovered that show a tendency to a variation of habit in this line in one of our familiar orb-weavers. Several years ago a clerical friend, the Rev. Dr. P. L. Jones, had brought him two cocoons of *Argiope cophinaria* (Walck.)[2] which had been spun on his premises by the same spider. The fact seemed to him strange and interesting, and he reported it. About a year ago, Mrs. Mary Treat brought to Dr. McCook's notice the fact that she had discovered what appeared to be a variety of *Argiope cophinaria*, which makes four cocoons, and which she had accordingly named *Argiope multichoncha*.[3] She sent him a string of these cocoons of which there were four of the usual shape and about the usual size, strung within a few inches of each other. They were spun on the wall of a kitchen in a house in western Missouri. Mrs. Treat also sent the spider which spun the cocoons. The specimen was very much dried up and in such a condition that the speaker could not make a very satisfactory study of it, but he found nothing in it differing in the least degree from *Argiope cophinaria*. If it be the same species, what are the peculiar circumstances that have caused such a remarkable variation in the habit? or is it true that this species does, more frequently than has been supposed, indulge herself in the luxury of an additional egg sac? Two cocoons of this lot were opened and found to contain young spiders that had hatched, but died within the egg-sac probably

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[1] See Walckenaer's *Apteres* Vol. I, p. 152.

[2] *Arg. riparia* (Hentz).

[3] American Naturalist, December 1887, p. 1122.

because of their unnatural condition. The spiderlings were not counted but they were very numerous.

Through information kindly given by Dr. Leidy, the President of the Academy, Dr. McCook was permitted to study on the 31st October last, (1888,) an example of this duplex cocoonery which occurred in the Farmer's Market of Philadelphia. He visited the market house at 12th and Market Streets, which is one of the largest and best of its sort in our city. He had no difficulty in finding the cocoons which had been preserved, and made a study of them which is here submitted. The facts are as follows: Some time during the summer of the present year, Mr. Charles Moore observed upon his meat stall a spider whose beauty attracted his attention, and which proved to be a female of *Argiope cophinaria.* She had probably been brought into the market from the country, hidden among the leaves of some vegetable, as the huge Tarantula and the large Laterigrade spider, *Heterapoda venatoria*, are brought to our port from the West Indies in bunches of banannas and other fruits. However, she may have floated in as a young balloonist from some city garden, for the species is very abundant in open grounds within city limits. Instead of brushing her down and killing her after the usual manner of dealing with such creatures, Mr. Moore took a fancy to preserve her, and would allow no one around his stall to inflict any injury upon her. Her movements were necessarily somewhat impeded and modified by the business of the place, and several times she changed her web until at last she spun it in a position that was practically free from interruption. This was quite at the top of the stall, the main foundation line, two feet long, was stretched from a standard beam to the end of a projecting iron hook-rod. The spider became quite a favorite and those around the stall amused themselves by feeding her with flies. She would take the flies thrown into her web, coming down from her habitual perch against the central white shield which characterizes her snare, to get them.

Sometime between the 10th and 20th of August she began to make her first cocoon. Mr. Moore, of course, made no careful study of the process; but he said that it was spun early in the morning; that at first the spinning work thrown out was as white as snow; that the spider then began to wrap it up, and it grew smaller and smaller as she wrapped, rolling it around with her feet. After the white material had been spun, a brownish silk was used, and when the spider had completed her task, the ball was not more than half as big as it seemed to him at first. About a week or ten days thereafter, she made a second cocoon, placing it in a position 15 inches above the other. Both of the cocoons were in site precisely as left by the spider. The web, however, had been destroyed, but the speaker noticed that an irregular mass of spinning work was laid along the beam between the two cocoons, which after a little observation proved to be the last snare which the spider had made in a collapsed condition. The foundation line had been broken and the web had thus shrunken up against the post. By delicate and careful manipulation, he was able to draw out this mass, and was delighted to find that he could restore with very little damage the spider's orb, the central shield and zigzag ribbons being quite intact.

The cocoons were both of them spun within tents of crossed lines five or six inches long and four or five wide, and had a thickness of between two and three inches. The lines constituting the under edges of the tents were attached to the post of the stall on which the web was spun. The lower cocoon which was spun first, had the top lines of the surrounding tent stayed against an iron bar used to support meat hooks. The upper tent has its roof lines sustained and drawn out from the post by the foundation line of the orb. The lines of which these tents were spun were of a greenish yellow silk, similar to that which the spider uses in preparing the cocoon. He took the cocoons home and dissected them. The lower one was one and one-fourth inches long, seven-eighths inch wide; was composed of a soft yellow silken plush, and inside was constructed precisely like the ordinary egg-sac of this species. It contained 120 eggs, all of them sterile. The only peculiarity in the cocoon was that the stem which one usually finds at the top was missing. The second cocoon was not quite so large, one inch long, and five-eighths inch wide, but it was more perfect in shape, containing the usual stem. The eggs within this cocoon were also sterile, and the number did not exceed 50. As he had on several occasions counted over a thousand eggs in the cocoon of this species, it will be seen that the spider was not in a normal condition. Indeed he had concieved the idea that in most cases where this spider spins more than one cocoon, it will be found that the eggs are not fertile, and that on the contrary when the eggs are in the normal condition, but one cocoon will be made.

We may probably account for the making of the second cocoon by some abnormal condition of the ovaries which prevented the ovipositing of all the eggs at once. The first lot when extruded were protected in the usual way; subsequently Nature compelled the mother to get rid of the remaining eggs, and, moved by the same impulse that caused her to cover the first lot, she was excited to overspin the second also.

This species will make an imperfect or but part of a cocoon in confinement, and Dr. McCook exhibited a specimen which shows that she sometimes does likewise in natural site. This is a branch which in one place shows the beginning of a cocoon, being the little cup against which the eggs are always spun, and also what appears to be the inner egg-bag. There is nothing more, and the whole is stayed and shut in by the usual tent-like spinning work. Near by is a perfect cocoon secured in quite the same manner. If we suppose that those two were made by the same spider (as is highly probable) we may infer that the original cocooning purpose of the mother was diverted in some manner, perhaps by alarm, which drove her from the spot. She returned to enclose the work partially done; but moved by the urgency of motherhood, presently found a neighboring site and finished her maternal duty.

The Value of Abbot's Manuscript Drawings of American Spiders.—Dr. HENRY C. McCOOK reviewed some recent criticisms upon a communication presented by him to this Academy. He spoke as follows:

In the last number of "Psyche,"[1] Mr. J. H. Emerton prints a criticism upon my paper in the Proceedings of the Academy of Natural Sciences of Philadelphia,[2] based upon the recent discovery of Mr. John Abbot's drawings of American spiders. This criticism requires some comment.

1. Mr. Emerton intimates doubt of what he calls my "off-hand identifications." I spent between one and two hours in the Zoological Library of the British Museum, aided by the courteous officials. I confined my attention almost wholly to the one tribe with which I am most familiar, the Orbweavers. Of those I published in my paper twenty one (21) numbers, embracing seventeen species. Mr. Emerton says: In 1875 I looked over these same drawings at the British Museum "I, like Mr. McCook, made hasty identifications of such few of them as I could." It might have been true thirteen years ago that Mr. Emerton was unable to determine accurately that number of common species within the time which I gave to them, but I do not hesitate to say that he could not plead such inability now after his study and publication of the New England Epeiridæ. At least, I should have small opinion of my own attainments if I could not identify "off-hand," from the admirable drawings of John Abbot, such familiar species as most of those named in my list. I think that any entomologist, familiar with Mr. Abbot's work, who will substitute for spiders seventeen species of insects with which he is most familiar, will quite agree with me that such determination is not one of great difficulty.

2. Mr. Emerton does scant justice to my paper by leaving the impression that its conclusions are based wholly upon the off-hand identifications of an hour or two. On the contrary, that was a small part of my work. I took carefully the numbers of Abbot's drawings with his notes thereon, as well as my own notes upon the same made on the spot. After my return home, I diligently compared these with Walckenaer's number, and satisfied myself that the two exactly corresponded. I then went over Walckenaer's descriptions in the original (French),[3] and compared them with the species themselves in my collection, verifying thus my first identification. This occupied the leisure hours of several months; and the indications and, in part, results of all this work may be seen in my paper, where I give the evidence and references by which the student can test my work if he will take the pains to do so.

3. Mr. Emerton institutes a comparison between my published list and a few numbers identified by him, from which he derives a

[1] Psyche, the organ of the "Cambridge Entomological Club," Vol. 5, No. 149–150, Sept.—Oct. 1888.

[2] 1888, pp. 1–6, "Necessity for Revising the Nomenclature of American Spiders."

[3] Histoire Naturelle des Insectes Apteres, Vol. II.

moral as to "the uncertainty of off-hand identifications of these drawings by two persons both familiar with the common spiders of the Northern States." But the inference is wholly deceptive, for the basis of his comparison is entirely faulty and unfair. He published a list of thirteen (13) numbers, noted by him as identified thirteen years ago when he visited the British Museum. Of these, four numbers are of other species than Orbweavers; two other numbers are Orbweavers which I did not notice or did not list. Emerton includes all these in his estimate; but it is manifest that any comparison, in order to yield just results, should throw out these six numbers not listed or considered by me, and should be confined wholly to the seven numbers which both of us attempted to identify. Such a comparison justifies a conclusion quite the reverse of Mr. Emerton's. We agree as to the following: Nos. 121, 116, 117, 79 and 80—five out of the seven. How stands it as to the remaining two numbers, (one species) 77 and 78? Mr. Emerton marks them with a generic name, "*Uloborus*." I list them as "*Cyrtophora caudata* Hentz," but in a secondary place, and in a foot-note express my uncertainty as to the identification, and think they may prove to be my own species *C. bifurca*. Concerning the only species, (embraced in these two numbers) about which we differ, I express my uncertainty, and Emerton merely gives a generic name, showing his uncertainty as to the species. In other words, we are both more or less uncertain, and thus we agree in that respect also. I submit, therefore, that instead of justifying Mr. Emerton's inference of uncertainty, and thus casting doubt upon my identifications, the contrary is shown, for we actually agree in one way or another on every number concerning which both give an opinion. In other words, we absolutely agree concerning five-sevenths of the numbers mutually identified, and agree to be uncertain concerning the other two-sevenths.

As to which list is nearer the truth in the one uncertain factor, I do not venture to decide. Turning to the original description of Walckenaer,[1] one finds that he is left in doubt, and the doubt can perhaps not be removed. Walckenaer makes one of the numbers a variety of the other. If we read the description of the animal itself, Mr. Emerton's identification as *Uloborus* is well justified; but when we turn to Abbot's account of the habits of the spider, we find that they differ entirely from all we know of *Uloborus*, and correspond exactly with the peculiar habits of *Cyclosa caudata*, especially the habit of covering the central diameter of its vertical net with pellets of silk mixed with insect detritus. *Uloborus* spins a horizontal snare; has many ribboned decorations as *caudata* frequently has, but never has been observed, so far as I know, to decorate her orb with insect scalpage.

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[1] *Op.* cit., p. 144.

4. Mr. Emerton's conclusion concerning the questions raised by my paper is that we should wait until all the common spiders of America are described before attempting to determine priority of names. This seems to me very curious reasoning. Emerton has described and figured all but two of the spiders contained in my list of Abbot's drawings. Does he intend us to count his work as worthless for comparative service? I think better of it than that. With his New England "Epeiridæ" and Hentz's "Spiders of the United States" in my hand, I have no doubt at all of my ability to determine positively therefrom the ultimate names of many species by comparing the same with Walckenaer's descriptions and Abbot's drawings. What we need chiefly is a facsimile copy of the latter somewhere in America; but in lieu of that, that some one should take up the matter in London with a good collection of American spiders.

Meanwhile, no naturalist ought to doubt that it is our duty to recognize the Walckenaer species which we know by whatever means to be identical with descriptions made by Hentz, repeated by Emerton and others, and now thoroughly familiar and recognizable. As to the doubtful species, there can, of course, be no question that they had better remain as named by Hentz and more fully described by others. Walckenaer's descriptions are undoubtedly incomplete and some are positively bad, but they are no worse in this respect than many of Hentz's, and in my opinion are just as readily identified by the aid of Abbot's drawings as are Hentz's descriptions by the aid of his own drawings.

At this point I may submit the opinion of one who stands at the very head of living araneologists, Professor T. Thorell, who thus writes me from Italy in a letter dated April 7th, 1888: "The discovery of Abbot's drawings of American spiders is indeed a fact of the greatest interest, not only to American but to all arachnologists, and I congratulate you upon having had the luck to make this discovery. Of course I have read with great attention what you have said on the subject. As to me, I do not entertain the least doubt that you and Professors Leidy, Lewis and Dall are right, and that the earlier names should in all cases be adopted. The law of priority must be respected, and is the only one that prevents arbitrariness and that gives stability to nomenclature. I think, then, that in all such cases, in which Walckenaer's species can with tolerable certainty be recognized, his names should be preferred to names more lately published, even if these names are more commonly used, or the species better described or figured under these newer names." The weight of this distinguished authority can not be questioned, and I place it in the scale against the judgment of Mr. Emerton.

I venture to add from the same letter the following sentence, with the earnest expression of hope that the suggestion therein may be realized: "Would it not be possible to have Abbot's work published? There are in America so many wealthy citizens who are willing to make sacrifices for scientific purposes; and in this case an appeal to the national feeling of your countrymen, would not, I think, be out of place." Over against such an expression as this I am willing to place my critic's words, "Mr. McCook is inclined, however, to set too high a value on these drawings."

5. Finally, I think I may say under all the circumstances that I am excusable for believing that my so called "discovery" of Abbot's drawings was a genuine novelty. I cannot remember a single allusion in any araneological literature to the existence in the British Museum or elsewhere of those drawings. The last reference made to them of which I have knowledge was Dr. L. M. Underwood's paper on the "Progress of Arachnology in America," in the *American Naturalist* of November 1887. The author alludes to Abbot's manuscripts (miscalling him "Thomas," by the way, instead of "John"), and adds, "Knowledge of the date of preparation of this series of drawings, as well as its present place and condition is wanting. But it was in London as early as 1802, and was purchased by Baron Walckenaer in 1821." Mr. Emerton, in his several admirable monographs, makes no reference to the fact that he knew of the existence of the drawings, and does not make the slightest attempt to compare the list in his possession with the descriptions of Walckenaer. This seems to me all the more remarkable in view of the fact, as above shown, that he had accurately determined some of Hentz's species as identical with some of Abbot's numbers, and could readily have made the further step of determining their correspondence with Walckenaer's descriptions. His reasons for this reserve are doubtless satisfactory to himself, and I will not venture to criticize them; but will say that I am quite satisfied with having taken the opposite course and given to the world, at the earliest available opportunity, the information which had accidentally been placed in my possession, and which I believed at the time to be new and valuable. That it was new to most students of spiders has been made very certain by the responses to my paper. That it is valuable may in some minds admit of doubt; but, on the whole, I think that I have shown here, if not before, that the measure of doubt is very small.

Food of Barnacles.—PROF LEIDY stated that last summer, in June, while walking on shore at Beach Haven, N. J., he picked up a bunch of Goose-barnacles, *Lepas fascicularis*, attached to a fragment of a grass stem, *Spartina*. Finding at the time nothing else of interest, he examined the specimens, not having previously dissected a Barnacle since 1848, when he observed the eyes in *Balanus rugosus* (See Proc. 1848, 9).

All the specimens of *Lepas*, of which there were nine, had the body distended with a brownish-yellow Cyclops, in large number, fresh in appearance and generally entire. Under the circumstances he at first suspected that they might be a larval form of the *Lepas*, though aware of the fact that the cirripeds proceed from a Nauplius embryo, which passes through a Cypris stage before assuming the Barnacle condition. On further investigation he was convinced that the Cyclops were food and filled the stomach. It appeared remarkable that they should have been so well preserved and not crushed by the strongly, six-toothed mandibles of the Barnacle. Some additional specimens of this species and a few of *Lepas anatifera*, subsequently examined did not contain such an accumulation of similar food; but usually the contents of the stomach consisted from two to half a dozen small gastropods with the shell, several species of entomostraca, some sand grains and a few vegetable fibres. In all, the brood-capsule, a thin elliptical lamina, situated between the body and the shell, contained Nauplius larvae.

DECEMBER 18.

Mr. CHARLES MORRIS in the chair.

Sixteen persons present.

DECEMBER 25.

The President, Dr. JOSEPH LEIDY, in the chair.

A paper entitled "Notes on Geology and Mineralogy" by John Eyerman was presented for publication.

The death of Dr. Casper Wister, a member, Dec. 20, was announced.

The following annual reports were read and referred to the Publication Committee:—

REPORT OF RECORDING SECRETARY.

In view of the full reports of the Treasurer, the Curators, the Librarian and the various sections of the Academy, the Recording Secretary has, as heretofore, but little to report apart from the statistics of the meetings of the society and the operations of the Publication Committee.

One hundred and sixty-eight pages of the Proceedings for 1887 and two hundred and seventy-two pages of the current volume have been issued and distributed. Provision has been made for twenty plates in illustration of the papers presented for publication during the year. These number thirty-four and are by the following authors:—

Rev. H. C. McCook 3, W. D. Hartman 3, Jos. Leidy 2, D. S. Jordan 2, Harrison Allen 2, Angelo Heilprin, 2, Thomas Meehan 2, Charles Wachsmuth and Frank Springer 2, H. C. Chapman and A. P. Brubacker 2, H. C. Chapman 1, Otto Meyer 1, B. H. Wright 1, A. M. Fielde 1, E. N. S. Ringueberg 1, E. A. Kelly 1, C. Ochsenius 1, John Ford 1, C. R. Keyes 1, H. F. Osborn 1, H. A. Pilsbry 1, J. E. Ives 1, John Eyerman 1, R. W. Schufeldt 1. One of these has been withdrawn by the author and the others are all in course of publication although two or possibly four will have to be held over until the issue of the first sheets of the volume for 1889.

Eighteen additions have been made to the list of foreign correspondents to whom the issues of the Proceedings are distributed, the number being now four hundred. The domestic exchanges are now sixty-eight, an increase of seven over last year. The subscription list remains the same, so that five hundred and eighty-two copies of the one thousand printed are promptly distributed.

The second part of the ninth volume of the quarto Journal consisting of one hundred and ten pages and five lithographic plates was distributed, after much vexatious delay in the printing office, on the sixth of August. Fifty copies were sent to foreign and twelve copies to domestic exchanges, while thirty-nine copies were supplied to subscribers, making a total distribution of one hundred and one copies of the five hundred printed.

The average attendance at the meetings has been about the same as last year. Communications, which have been interesting and varied, have been made by Messrs Leidy, Heilprin, Lewis, Meehan, Chapman, McCook, Koenig, Dolley, Ryder, Horn, Brooks, Dall, Rothrock, Binder, Willcox, Morris, Wilson, Kelly, Foote, Sharp, Meyer, Woolman, McKean, Robinson, Ford, Brinton, Redfield, U. C. Smith, Ives, Holstein and Le Boutillier.

Eleven members and four correspondents have been elected. The deaths of thirteen members and two correspondents have been announced and two members, Messrs C. L. Kilburn and Rev. Geo. D. Boardman, have resigned.

The vacancy in the Council caused by the death of Mr. S. Fisher Corlies was filled June 26, by the election of Mr. Wm. W. Jefferis.

The following extract from the will of the late Geo. W. Tryon Jr. was read at the meeting of Feb. 14, 1888:—"I give to the Academy of Natural Sciences of Philadelphia my collection of shells now deposited with that society conditioned that they shall not be loaned or removed from the immediate custody of the said Academy and of its Conchological Section." The bequest was accepted on the condition as stated.

A bond of indemnity having been given Feb. 14 to the executors of the estate of the late Mary R. D. Smith, the Academy was placed in possession of the sum of $1291.49 the proportion of said estate bequeathed to the society by Miss Smith.

The thanks of the Academy were voted to Dr. Charles Schaffer for his gift of $4939.58, the amount received by him as commissions while acting as executor under the will of the late John Bryden to whose estate, in accordance with the wish of Dr. Schaffer, the gift has been credited.

A like vote of thanks was tendered to Mr. Theodore D. Rand for the gift of $100.00, the amount received by him for professional services in connection with the same estate.

The Academy having considered a deed of trust executed by Mrs. Emma W. Hayden for the endowment of the Hayden Geological Fund of Two Thousand Five Hundred Dollars, in memory of her husband the late Prof. Ferdinand V. Hayden, the interest of which together with a bronze medal is to be awarded annually for the best publication, exploration, discovery or research in the sciences of geology and paleontology, by a committee to be appointed by the Academy, the said deed of trust was accepted by and ordered to be executed on behalf of the Academy, May, 1, 1888, and the following resolution for the appointment of the required committee was adopted:—

Resolved—That a committee not exceeding five, to be appointed under the deed of trust of Mrs. Emma W. Hayden, shall first be recommended by the Council of the Academy and shall be selected from the members at large and their names submitted to a vote of the Academy annually, and if said vote of the Academy shall show their election, they shall act as such committee under said deed.

The thanks of the Academy were ordered, November 20, to be conveyed to Mrs. Clara Jessup Bloomfield Moore for her liberal addition of \$5000.00 to the Jessup Fund endowed by her father, the late A. E. Jessup. By subsequent action of the Council the entire amount was ordered to be placed to the credit of that portion of the fund which is appropriated to the assistance of young naturalists.

All of which is respectfully submitted.

EDW. J. NOLAN,

Recording Secretary.

REPORT OF CORRESPONDING SECRETARY.

The duties of the Corresponding Secretary during the past year have been neither important nor onerous.

The correspondence has related mainly to the publications of the Academy, being either acknowledgments from corresponding societies or the usual letters transmitting their publications.

The acknowledgments number sixty by letter and forty-three by card, divided as follows:

By card, American societies 23, Foreign 20.

By letter, American societies 15, Foreign 45.

The letters of transmittal represent thirty-eight bodies, of which but one is American. These, with the latter exception, are very nearly all those continuing their sendings through the International Exchange Agency.

During the past year the duties of the office were kindly performed by the Curator-in-charge for five months in the interval of the Secretary's absence abroad.

An opportunity was afforded of seeing personally the officers in charge of the libraries of some of our corresponding societies, and of examining the series of our publications on their shelves. The deficiencies which we could probably supply were indicated, as well as those not at our disposition.

All expressed themselves satisfied with the sending of our publications by mail and promised to do the same when the size of their volume permitted.

During the year there have been elected four Correspondents of the Academy all of whom have been promptly notified.

The duty of acknowledging donations to the museum which by the by-laws, devolves on the Corresponding Secretary, has been assumed by the Curator-in-charge. The Corresponding Secretary would again suggest such modification of the laws as will render this legal. The reasons for the change are too obvious to need explanation.

Respectfully submitted,

GEORGE H. HORN, M. D.,

Corresponding Secretary.

REPORT OF THE LIBRARIAN.

The additions to the library recorded since November 30, 1887 amount to 3957, an increase of 577 over those received during the preceding year. They consisted of 659 volumes, 3284 pamphlets parts of periodicals and instalments of continued works and 14 maps.

The accessions have been received from the following sources:—

Societies,	1619
Editors,	838
I. V. Williamson Fund,	952
Authors,	203
Thomas Meehan,	47
Geological Survey of Sweden,	29
Geological Survey of Russia,	25
Wilson Fund,	23
Australian Museum,	21
In Exchange,	21
Government of Victoria,	15
Treasury Department,	12
Department of Agriculture,	12
Department of the Interior,	10
Geological Survey of India,	10
Department of State,	9
Hon. Chas. M. Betts,	7
Engineer Department U. S. A.,	7
Geological Survey of Minnesota,	4
Ministry of Public Works in France,	4
Geological Survey of New South Wales,	3
Geological Survey of Canada,	3
Mr. Wm. J. Potts,	3
Geological Survey of New Jersey,	3
Executors of the late Dr. Geo. Martin,	3
Prof. Angelo Heilprin,	2
Geological Survey of Kentucky,	2
Mrs. L. Fox,	2
Mr. Charles E. Smith,	2
Mr. J. H. Redfield,	2
Mrs. Dr. C. Hering,	2
South African Museum,	2
Indian Museum at Calcutta,	1

Geological Survey of New Zealand,	7	Henry C. Gibson,	1
Geological Survey of Roumania,	6	Department of Mines, Nova Scotia,	1
Geological Survey of Pennsylvania,	6	Dr. Benjamin Sharp,	1
Her Britannic Majesty's Government,	6	California State Mining Bureau,	1
Smithsonian Institution,	5	Prince Albert of Monaco,	1
British Museum,	5	United States Coast Survey,	1
War Department,	5	M. Marlet,	1
University of Aberdeen,	4	Boston City Hospital,	1
Geological Survey of Portugal,	4	Dr. Charles Schaffer,	1
		East Indian Government,	1
		Dr. J. W. Eckfeldt,	1

They were assigned to the several departments of the library as follows:—

Journals,	3034	Ornithology,	22
Geology,	267	Anthropology,	21
Botany,	135	Encyclopedias,	9
General Natural History,	107	Ichthyology,	8
Conchology,	43	Bibliography,	8
Mineralogy,	42	Languages,	7
Entomology,	41	Helminthology,	6
Medicine,	35	Geography,	5
Anatomy and Pysiology,	34	Mammalogy,	4
Physical Science,	32	Herpetology,	3
Voyages and Travels,	30	Agriculture,	2
Public Documents,	28	Unclassified,	12
Chemistry,	22		

The appended list of additions will indicate more specifically the nature of the year's increase.

We have procured from the publishers in Germany the parts lacking in the set of De Martius, Flora Brasiliensis, received last year from the Brasilian Government, and the work is now complete as far as issued.

The revision of the catalogue of Journals, commenced last year, has been completed with the exception of the Scandinavian and Russian publications. It is hoped that the entire work may be finished before the end of the year.

With the assistance of Signor Fronani, whose services I have been again enabled to secure, two hundred and thirty-four letters asking for supply of deficiencies, were sent in September to foreign societies. Seventy-four answers have already been received and the increase of accessions over those recorded last year is mainly, if not altogether, due to the liberality of our correspondents in supplying us with the volumes and parts asked for.

The card catalogue, exclusive of periodicals, was completed early in the year and the geographical entries of journals have also been finished. Cross references and title entries of the latter are now in course of preparation. This will complete the catalogue within its present scope which, it will be remembered, provides for author entries only in the special departments, with a few exceptions such as official geological reports and scientific explorations which are also catalogued under the names of the regions described. It is of the utmost importance that the preparation of a subject catalogue be undertaken as soon as possible, for while most of our readers know their authors, a properly classified index to the broader subdivisions of special departments of the library would result not only in a saving of time but in a more thorough and reliable acquaintance with the work already done. To complete such a catalogue within any reasonable limit of time, the employment of skilled assistance will be absolutely necessary, and, it is to be regretted, the Academy at present is unable to incur this expense. An effort will be made, however, with such clerical aid as the librarian may be able to secure, to go on as far as possible with the work in the time at his disposal during the year. Progress will necessarily be very slow, in consequence of many unavoidable interruptions.

Since the last report 321 volumes have been bound, including 68 volumes of pamphlets, and 45 volumes are now in the hands of the binders.

A careful enumeration of the library was made at the beginning of November. There are, bound and unbound, 30831 volumes at present on the shelfs, including 615 bound volumes of pamphlets, The latter embrace 8621 separate titles. To these may be added 1445 volumes in the library of the Entomological Section. Many of these are, however, duplicates of those in the main library. The latter are divided as follows:—

		Volumes	Pamphlets
Journals:—			
Germany	3430		
France	2515		
Great Britian & Ireland	2133		
N. America	1612		
Scandinavia & Russia	1302		
Austria	900		
Italy	625		
Switzerland	459		
Belgium	378		
Asia	328		
Spain and Portugal	166		
Africa and Australia	143		
South America	100	14391	
General Natural History		2350	564
Geology		2205	1007
Botany		1867	768
Voyages and Travels		1532	67
Entomology		1114	832
Anatomy and Physiology		1020	781

	Volumes	Pamphlet
Conchology	980	455
Ornithology	737	319
Bibliography	584	
Mineralogy	489	345
Physical Science	454	423
Anthropology	376	180
Encyclopedias, Dictionaries	309	
Helminthology	268	263
Public Documents	264	
Ichthyology	262	174
Agriculture	252	134
Mammalogy	246	184
Medicine	236	645
Chemistry	226	227
Geography	203	
Antiquities and Fine Arts	161	
Herpetology	161	143
Microscopy	48	
Miscellaneous	36	
	30831	8621

All of which is respectfully submitted,

EDWARD J. NOLAN,

Librarian.

REPORT OF THE CURATORS.

The Curators present the following statement of the Curator-in-Charge, Prof. Heilprin, as their report for the year 1888:—

The Curator-in-Charge respectfully reports that the collections of the Academy are in good condition, and that their status, as far as classification and arrangement are concerned, has been materially improved during the year. As heretofore, the Academy has profited largely through the work of volunteer specialists, and is hence placed under special obligation to those who have thus generously contributed their time and assistance. To Mr. J. H. Redfield, Conservator of the herbarium, and to Mr. Thomas Meehan, it is almost wholly indebted for the careful work that is being systematically applied toward the expansion and proper distribution of the botanical collections; while to the officers of the Entomological Section and of the American Entomological Society it is placed under obligation for work done in connection with the department of entomology. In the death of Mr. George W. Tryon, Jr., its Conservator in the department of conchology for thirteen years, the Academy has lost one of its truest and most efficient members—one who had for a full quarter of a century given much of his daily time to the interests of the institution. That the department will feel for some time the want of his vast experience, and the absence of his governing influence, there can be no question; but it is hoped that under the special direction of the new conservator, Mr. H. A. Pilsbry, and of the Conchological Section, it will be kept in that commanding position which it has so firmly and justly held.

In the departments other than those here specified the work has been done almost wholly under the direction of the Curator-in-Charge and his assistant, Mr. J. E. Ives. As in preceding years the alcoholics have been completely overhauled, and it is satisfactory to be able to report that there has been practically no loss in this part of the Academy's collections since the preparation of the last annual statement. It is less agreeable to report that during the latter part of the present year several attempts to force the ornithological cases have been made, with the result of robbing the collection of some 200 specimens of South American and Australian birds, mainly representatives of the family Tanagridæ. The greater number of these have been recovered, and it now seems that the full loss resolves itself to possibly not more than a half-dozen specimens. A change in the construction of the locks is urgently needed, and it is recommended that steps looking toward the greater security of the cases be immediately taken. The ornithological collections have largely profited during the year through the labors of Mr. Witmer Stone, who has, amidst other work, very carefully reviewed the extensive and intricate family of the Tanagridæ, and determined the greater number of the species that belong to this group. His work shows that the Academy's representation is a very full one, falling, in point of species, but little short of that of the British Museum. A numerical estimate of the entire collection of mounted birds in the Academy shows it to comprise somewhat more than 23,000 specimens; in addition to this there is a collection of some 3000 skins.

The work of systematically cataloguing this vast collection has been begun, but much time must necessarily elapse before such a catalogue can be satisfactorily completed.

The entire museum collection of minerals has been rearranged during the year, the specimens of the different mineral species being distributed strictly according to geographical position. This method, it is believed, will largely facilitate comparative study. The Wm. S. Vaux collection continues to receive the close and valuable superintendence of its special Conservator, Mr. Jacob Binder, through whom it has been brought into a condition of rare completeness. A large proportion of the more commanding specimens which now distinguish the collection have been obtained through purchase on the special selection and recommendation of the Conservator.

In most of the other departments of the museum the work has been mainly of a general character. Mr. Ives, under the direction of the Curator-in-Charge, has very carefully reviewed and redetermined the species of Ophiuroidea and Asteroidea, and thereby added very materially to the extent of the collection represented. Two new species, a Pteraster and a Coronaster, were determined.

By a resolution of Council of April it was recommended that a hand-book of the Museum be prepared by the Curator-in-Charge, in conjunction with the members of the Board of Curators. In conformity with this recommendation the Curator-in-Charge has devoted much time toward the preparation of such a hand-book, and it gives him pleasure to report that the same is now almost finished and ready to go to press. It is herewith submitted for approval to the Board of Curators.

The additions to the museum during the year—detailed in the accompanying list of donations—have been both abundant and important. Through the kindness of Dr. H. C. Chapman the Academy has received a fine selection of marine invertebrates from Bar Harbor, Maine, many species of which had not hitherto been represented in the general collection. The Zoological Society of Philadelphia has also contributed largely in material from their gardens, and thereby filled in many gaps that could not otherwise be readily closed.

The trip to the Bermuda Islands which was planned by the Curator-in-Charge, and toward which the Academy generously contributed its assistance, proved successful beyond anticipation, and has resulted in placing in the Academy's museum a large and important collection of sub-tropical marine forms, the greater number of which are now for the first time represented, and many of which are new to science. The results of the expedition, which are now in course of publication in the Academy's Proceedings, prove what benefits may be derived from zoo-geographical research of this kind, undertaken with only moderate expense, and with no special preparation. The value of this form of scientific research has been indicated in previous reports, and attention is once more directed to the advisability of endowing a moderate zoo-geographical research fund, the interest from which should be expended annually in the exploration of the numerous regions which still await investigation. It is believed that no other method could be suggested which would yield such important scientific results, and at the same time render the Academy a virtual centre of scientific activity in the country.

The Curator-in-Charge again desires to call attention to the absolute need of an extension to the present accommodations; the existing conditions are becoming more serious every year, and render a change, if the efficiency of the institution is not to be lessened, imperative. The collections can no longer be advantageously increased, nor can they be satisfactorily cared for in their restricted quarters. Portions of the library are being gradually encroached upon, and the work-rooms are all filled. The need for a suitable lecture-hall or amphitheatre is pressing, and the same is true of special students' rooms and laboratories. It is earnestly hoped that the generous public of this city, who have so kindly lent their assistance before, will not allow the most important institution of the kind in the country to go in want. The attempts to obtain aid from the State, although often repeated, have thus far proved abortive; but an effort will again be made during the coming session of the Legislature.

Attention is again called to the important question of Sunday opening. The numerous requests for admission into the museum on Sundays clearly speak the public mind, or at any rate, the wish of a large number of the city's inhabitants. The Academy of the Fine Art and the Zoological Society have set an example in the right direction, and there seems to be no reason, beyond an inadequacy of funds to maintain such opening, why our Academy should not follow the lead. Sunday-opening would certainly be a charity to that large body of useful citizens whose daily employment debars them from the advantages which the institution otherwise offers.

During the year specimens for study have been loaned to Prof. R. P. Whitfield, of New York; to Prof's. Osborn and Scott, of Princeton; to Dr. G. Baur, of New Haven; to Dr. George Marx, of Washington; and to Dr. Harrison Allen, of this city.

Respectfully submitted,

ANGELO HEILPRIN,

Curator-in-Charge.

JOSEPH LEIDY,

Ch'n Curators.

REPORT OF THE CURATOR OF THE WILLIAM S. VAUX COLLECTIONS.

The Curator of the William S. Vaux Collections respectfully submits his sixth annual report to the Council of the Academy.

The collections are in good order and condition, the only change made since the report of 1887, being the introduction of one hundred and two specimens purchased within the year and added to the collection. These specimens have been purchased at a cost of $420.10.

The collections now consist of the following:—

No. of minerals reported 1887,	6,786
No. of minerals purchased 1888,	102
Total,	6,888
Archæological specimens (same as reported in 1887),	2,940

The growth of the collection, since it came into the Academy's possession is as follows:—

Specimens purchased in 1884, ...	60
Specimens purchased in 1885, ...	104
Specimens purchased in 1886, ...	114
Specimens purchased in 1887, ...	156
Specimens purchased in 1888, ...	102
Total, ...	536

The aggregate cost of the 536 specimens has been . $2506.80

Most worthy of mention among the additions of the year are a fine specimen of Calcite in Malachite, a superb Vanadinite and Wulfenite from Arizona; these specimens, in color and crystalographic form, are the finest ever brought to the city. Other interesting specimens are a single crystal of Gadolenite 6 inches in width by 9 inches in length, said to be the largest crystal ever found: fine large crystals, of Troostite, Tryolite, Erenite, Opal, Turquoise, Thenardite, Trona, Hyalite, Colemanite and others.

A number of species not heretofore represented in the collection have been added.

The visitors to the collection have not been as numerous as in former years; it may be remarked, however, that those who do visit it are persons especially interested in mineralogy or archæology who have made use of it more for the purpose of study than for the gratification of mere curiosity.

Respectfully submitted,

Jacob Binder,

Curator.

REPORT OF THE BIOLOGICAL AND MICROSCOPICAL SECTION.

During the year thirteen stated meetings were held with an average attendance of ten members.

Four public lectures were given.

The following gentlemen were elected members and contributors.

Members. John T. Pennypacker,

" Lancaster Thomas.

Contributors.	Dr. Xavier Sudduth.
"	Frank Zentmayer.
"	Edwd. Bancroft.
Honorary Member.	Dr. J. Gibbons Hunt.

The section lost the following by death and resignations.

By death.—Paul P. Keller, Joseph Zentmayer, S. Fisher Corlies.

By resignation.—Members, J. D. Sergeant, Dr. Carl Seiler, Charles F. Banes, John Lambert.

Contributor, Walter Banes.

Communications were made upon the following subjects:—

December 5, 1888. Orthochromatic plates in differentiating details of color in photographing microscopic objects, by Mr. W. H. Walmsley.

December 5, 1888. Some new results in removing embryos from the uterus, by Prof. John Ryder.

December 5, 1888. Upon the fungus Rhytisma acerina, by Dr. L. Brewer Hall.

December 5, 1888. Upon the fungus Badhamia fasciculata, by Mr. Harold Wingate.

January 16, 1888. Public lecture, by Rev. Dr. H. C. McCook upon spiders and spiderlings.

February 3, 1888. Public lecture, by Prof. W. P. Wilson upon plants that feed on insects.

February 6, 1888. Presentation of a number of slides, by Dr. Isaac Norris Jr.

February 6, 1888. A series of slides illustrating the anatomy of the mouse's head, by Prof. Ryder.

March 5, 1888. Lecture by Professors Wilson and Ryder assisted by Mr. Holman with the projecting microscope, upon Celloidin mounts and the method of making sections of delicate tissues.

April 2, 1888. Upon the sexual habits of the Scale insects by Dr. L. Brewer Hall.

April 2, 1888. Molluscum contagiosum, by Dr. M. B. Hartzell.

April 2, 1888. The histology of the Skate with special reference to the formation and growth of the thymus gland and of peculiar sense organs, by Prof. Ryder.

April 2, 1888. Upon some interesting forms of fungi, by Dr. J. B. Brinton.

May 7, 1888. Upon Enterideum, by Mr. Harold Wingate.

May 7, 1888. Upon insect fertilization of plants with special reference to the common chickweed and the glands found at the base of the stamens, by Mr. Thomas Meehan.

May 7, 1888. Upon the formation of vessels in the corion and amnion, by Prof. Ryder.

May 21, 1888. Upon the specific differences between Lampoderma and Comatricha, by Harold Wingate.

April 21, 1888. Upon Cribraria argillacea by Dr. George A. Rex.

June 4, 1888. Upon two new species of Badhamia, B. reniformis and B. claviceps.

June 4, 1888. Upon the pollen of Cyrpripedium acaule, by Dr. L. Brewer Hall.

June 18, 1888. Upon the use of the parabolic reflector, by Harold Wingate.

October 1, 1888. Upon the pollen of Cobea scandens, by Dr. G. A. Rex.

October 1, 1888. Upon Bacillus tuberculosis, by Dr. G. A. Rex.

October 15, 1888. Upon Analine staining, by Prof. Ryder.

October 15, 1888. Upon chicken and hog cholera, by Dr. J. Cheston Morris.

November 5, 1888. Public lecture, by Prof. John Ryder upon the claims of biological research.

November 19, 1888. Upon the methods of teaching topographical histology, by Prof. Ryder.

November 19, 1888. Upon the formation of cartilage and bone, by Prof. Ryder.

The officers of the Section for the ensuing year are:—

Director, ...	Harold Wingate.
Vice Director, ...	John C. Wilson.
Recorder, ...	Dr. Robert J. Hess.
Corresponding Sec. . . .	Dr. Charles Schaffer.
Treasurer, ...	Dr. Isaac Norris, Jr.
Curator, ...	Chas. P. Perot.

Very respectfully submitted.

ROBERT. J. HESS, M. D.,
Recorder.

REPORT OF THE CONCHOLOGICAL SECTION.

The Recorder of the Conchological Section respectfully reports that during the year ending Dec. 1st, 1888, the Academy has continued to publish such conchological papers as have been offered.

Two members have been elected. The loss to the section by death has been the severest in its history. On January 21st, 1888, our honored Treasurer, Mr. Wm. L. Mactier, was called from works to reward, and we had hardly turned from paying our last tribute of respect to his memory, when we were again summoned to perform the same service for our beloved Conservator, the eminent Conchologist, George W. Tryon Jr. who died February 5th, 1888, while yet in the prime of life.

At a special meeting of the Section called for the purpose and held February 22nd, 1888, appropriate minutes prepared by the Director were adopted and by direction sent to the families of the deceased.

William Laurence Mactier, a member of the Academy of Natural Sciences of Philadelphia since Jan. 1860, was born in the city of New York, May 28, 1818, and died at his home in this city Jan. 21, 1888.

His father, Henry Mactier, was a native of Scotland, and his mother, a daughter of Augustine Hicks Laurence and Catherine Luquer, was born in New York.

Mr. Mactier had been prepared for admission into the College of New Jersey, intending after completing his general education there to devote himself to the medical profession. But unexpectedly, conclusive reasons forced him to abandon the project, and seek a more speedy route to a livelihood in mercantile affairs—he became a man of business. The extent and character of his preliminary education fostered in him a taste for letters which he cultivated during his leisure so well that the College of New Jersey conferred upon him the honorary degree of Master of Arts.

Mr. Mactier was one of the constituents of the Conchological Section of the Academy; and from the date of its institution, Dec. 26, 1866, was its treasurer. During twenty-two years he discharged all the duties of the office efficiently and promptly.

He served in the Council of the Academy, and was a member of its Committee on Instruction and Lectures.

He contributed $285 to the building fund, and was a member of the Board of Trustees thereof.

He was a member of the Musical Fund Society of Philadelphia, and read a historical sketch of the institution before the Society Jan. 29, 1885, which was published. He was treasurer of the Society from 1864 to 1880,—sixteen years—and vice-president since 1881.

He was long a member of the Philadelphia Atheneum. At forty-six consecutive annual elections of the Philadelphia and Reading Railroad Company he was one of the judges of the election.

He was active in the Board of Publication of the Presbyterian Church; a Director of the "Mercer Home;" Secretary of the Presbyterian Hospital; a member of the Deacon's Court, and associate superintendent of the Sunday School of the Second Presbyterian Church of Philadelphia.

The position which he held, the work he did, are significant of his friendliness to natural science, of his benevolence and public spirit as well as of the excellence of his character.

Resolved, That in the death of William L. Mactier the Conchological Section of the Academy of Natural Sciences of Philadelphia, has lost an estimable member and efficient treasurer, that, in testimony of appreciation of our loss and as a tribute to his memory, this brief of his virtues be entered upon the record of Proceedings, and that a copy thereof be transmitted to his family by the Recorder.

The Director's extended and appreciative biographical notice of Mr. Tryon is published in the present number of the Proceedings of the Academy.

Our Conservator, Mr. H. A. Pilsbry, reports:—

"The principal additions to the museum consist of suites of Mediterranean shells from Malta and the Balearic Isles received from Messrs B. Tomlin and Alfred Caruana; of Sandwich Is. land shells, a large series from Mr. Baldwin; and new Tasmanian shells from C. E. Beddome. From the family of the late Wm. L. Mactier, a number of interesting forms mostly of well known marine species. A large number of American species have been received, among which may be mentioned alpine land shells from Colorado, Florida marine shells and a series of Texas shells. A full list of the donations are included in the "Additions to the Museum."

The total number of additions made is 46, amounting to 603 trays, 3455 specimens. The collection now contains 192,605 specimens in 51,930 trays. A valuable series of alcoholic specimens has been received from Mr. Bryant Walker, Detroit, Mich. In the museum, the arrangement of the families *Neritidæ*, *Phasianellidæ* and *Turbinidæ* has been nearly completed."

No changes have been made in the By-Laws of the Section.

The officers of the Section for 1889 are:—

Director, ...	W. S. W. Ruschenberger.
Vice-Director, . . .	John Ford.
Recorder, ...	Edward J. Nolan.
Treasurer, ...	S. Raymond Roberts.
Secretary, ...	John H. Redfield.
Librarian, ...	Edward J. Nolan.
Conservator, . . .	Henry A. Pilsbry.

Respectfully submitted,

S. Raymond Roberts,

Recorder.

REPORT OF THE BOTANICAL SECTION.

The Vice-Director of the Botanical Section respectfully reports a continued interest on the part of the members. The membership continues about as heretofore, the meetings have been regularly attended, and many facts of great interest brought to the attention of the Section and discussed by the members. The Section is out of debt with a small surplus in its treasury.

The officers elected for the year ensuing are:—

Director, ...	Dr. W. S. W. Ruschenberger.
Vice-Director, . . .	Thomas Meehan.
Recorder, ...	Dr. Charles Schaffer.
Cor. Secretary and Treasurer, .	Isaac C. Martindale.
Conservator, ...	John H. Redfield.

A most gratifying announcement is the completion of the great task of mounting all the specimens in the herbarium of North American plants as covered by *Gray's Synoptical Flora*. This was commenced in 1878, by the Conservator, Mr. John H. Redfield, assisted at various times by Messrs. F. Lamson Scribner, Isaac Burk and the late Charles F. Parker.

The encouraging growth of the herbarium noted in our former annual reports, still continues. The large number of 1039 species were added to our former list, making 28,306 as the total number of species of vascular plants represented in the herbarium.

The Conservator's report to the Section, giving the details of these additions, is added as a part of this report.

Respectfully submitted,

THOMAS MEEHAN,

Vice-Director.

Conservator's Report for 1888.—The Conservator of the Botanical Section reports that during the year closing Dec. 10th, the additions to the herbarium consist of 2525 species, of which 2296 are vascular plants, and 229 are Lichens, Fungi and Algæ. Of the 2296 species of vascular plants 1040 are believed to be new to our collection, 77 of them being of genera not before represented. 693 species are North America, 1414 are from Tropical America, 171 from the Eastern Continent, and 18 are Australian.

It is gratifying to know that the rate of increase has not declined, and that so large a portion of it is of forms not previously represented.

The most important addition of the past year is the completion of the collections made by Dr. H. H. Rusby in Bolivia and the neighboring regions in 1885 and 1886, consisting of 983 species of which nearly 600 are believed to be new to us. Including the portion of this collection received by us the previous year, the whole consists of 1433 species. These have been contributed by members of the Section, supplemented by the proceeds of duplicate plants sold by its order. Other valuable additions to our representation of the flora of Tropical America are—266 species collected by C. G. Pringle in the Province of Coahuila, Mexico, and 100 species collected in the Mexican Province of Tabasco and presented by Sr. Jose N. Rovirosa, from whom we have reason to expect further contributions.

The number of species of vascular plants in the herbarium of the Academy, at the date of the last report, was estimated at . 27,267
to which add the accession of new species of this year . 1,040
giving the estimated present total 28,307
of which 8200 are North American, that is from the region covered by Gray's Synoptical Flora.

In May last was completed the work of mounting the special herbarium of North American plants. This work was begun in 1878, and has been continued from year to year in the intervals of other duties. In this the Conservator received most efficient aid from the late Charles F. Parker, from F. L. Scribner and more recently from Mr. Isaac Burk.

A complete list of the additions to the herbarium is appended, and will appear in its proper place under the head of "Additions to the Museum."

Respectfully submitted,

JOHN H. REDFIELD,

Conservator.

REPORT OF THE MINERALOGICAL AND GEOLOGICAL SECTION.

The Director of the Mineral and Geological Section of the Academy of Natural Sciences, would respectfully report that meetings of the section have been held nearly every month during the year except the summer months. Some of these have been quite well attended, at others the attendance has been small. On the whole, he regrets to say, the itnterest has not been as great as in former years, but this has been largely due to absence of active members from causes beyond their control.

The meetings during the latter part of the year have been better attended and more interest has been manifested than in the earlier part, so that the outlook is more favorable.

The following officers were elected to serve during the ensuing year:—

Director, ...	Theodore D. Rand.
Vice-Director, . . .	Dr. W. S. W. Ruschenberger.
Treasurer, ...	John Ford,
Conservator, ...	William W. Jefferis.
Recorder and Secretary, . .	Dr. Charles Schaffer.

Respectfully submitted,

THEO. D. RAND,

Director.

REPORT OF THE PROFESSOR OF INVERTEBRATE PALEONTOLOGY.

The Professor of Invertebrate Paleontology respectfully reports that he has during the year delivered a course of lectures on geology which, as heretofore, has been illustrated or supplemented with practical field demonstrations. He has also delivered in the hall of the Academy, a number of lectures before the Teachers' Institute of this city, and contributed four lectures to the Friday Evening course of the Academy. During the month of July he conducted a class in the exploration of the Bermuda Islands, which had hitherto received but little attention from naturalists. The inquiry extended as well to the zoological as to the geological features of the island group, and has resulted in bringing to the museum a rich store of material, the greater part of which is new to the collections. The details of the exploration, to which reference is also made in the Curator's Report, are being published in the Academy's Proceedings.

The collections in the department of Invertebrate Paleontology remain pretty much as they were last year. A number of additions, but none of any great significance, have been received. Perhaps the most valuable of these is a collection of cretaceous plants from Kansas, obtained from C. H. Sternberg in exchange for certain volumes of the Academy's Proceedings. Mention should also be made of a fine selection of crinoids from the Carboniferous formations of the central United States, generously given to the Academy by Messrs. Wachsmuth and Springer, of Burlington, Iowa.

The general condition of the collections is good. But here as in almost all other departments of the Academy's Museum, additional accommodations are badly needed.

Respectfully submitted,

ANGELO HEILPRIN,

Professor of Invertebrate Paleontology.

REPORT OF THE PROFESSOR OF ETHNOLOGY AND ARCHÆOLOGY.

During the past year the course of lectures usually delivered by me was omitted owing to my absence from the city.

The collections have received some but not extensive additions in this department. It would be desirable and would benefit this branch of instruction were all the ethnologic objects in the possession of the Academy arranged and classified separately from the other collections, and according to the ethnic method of display. To accomplish this the exclusive use of sufficient space would be needed to exhibit the objects and allow room to fill the lacunæ in the collection. At present, this does not appear to be within the power of the Academy; but it seems proper to state that such an arrangement is very desirable so that it may receive consideration in any future extension of the Society's building.

Respectfully submitted,

D. G. Brinton,

Professor of Ethnology and Archæology.

SUMMARY OF THE REPORT OF WM. C. HENSZEY, TREASURER,

For the Year Ending Nov. 30, 1888.

Dr.

To Balance from last account	2007 56	
" Initiation Fees	110 00	
" Contributions (semi-annual)	1590 57	
" Life Memberships	300 00	
" Popular Lectures	226 75	
" Publication Committee—Sales of Proceedings, Journal, etc	659 30	
" Interest on Investments	2503 65	
" Interest on Money awaiting Investment	889 90	
" State tax on Mortgages	113 10	
" Wilson Fund, toward Salary of Librarian	300 00	
" Rentals from Real Estate	1662 48	
" Sale of Duplicate Books	7 70	
" Miscellaneous	123 57	
		$10494 61

Cr.

By Salaries, Janitors, etc	3742 78	
" Printing and Binding Proceedings, etc	1450 79	
" Printing and Stationery	78 28	
" Plates and Engravings	248 00	
" Postage	69 77	
" Gas	102 68	
" Coal	367 50	
" Insurances	55 00	
" State Tax on Mortgage Investments	113 10	
" Taxes and Water Rents	418 25	
" Cards, Trays and Boxes	74 27	
" Municipal Expenses	179 42	
" Repairs and Expenses to Real Estate	216 80	
" Glass and Glassware	102 49	
" Lecture Fees paid to Professors	213 10	
" Specimens	75 00	
" Cases and Drawers	5 00	
" Expenses Publication Committee	150 00	
" Real Estate Title Co., Insurance of Title to 3 Mortgages for $32000	80 00	
" Miscellaneous	849 72	
" Life Memberships transferred to Investment account	300 00	
		8891 95
Balance		$1602 66

I. V. WILLIAMSON LIBRARY FUND.

Balance overdrawn last statement		307 60
Books		2284 22
Collecting		84 66
Taxes and Water Rents		200 55
Repairs to Houses		214 18
		$3091 21
Rents Collected	1041 50	
Ground Rents Collected	669 64	
Amount transferred from General Fund (Interest on money awaiting investment)	135 00	
Proportion of repairs refunded	12 04	
		1858 18
Balance overdrawn		$1233 03

THOMAS B. WILSON LIBRARY FUND.

Balance overdrawn as per last statement	57 69
Books	231 16
Transferred to General Account toward Salary of Librarian	300 00
	$588 85
Less Income from Investments	525 00
Balance overdrawn	$63 85

JESSUP FUND. (For assistance of Students.)

Balance last statement	288 01	
Interest from Investments	560 00	
		848 01
Disbursements		480 00
Balance		$368 01

WILLIAM S. VAUX FUND.

Balance per last statement	319 29	
Interest from Investments	700 00	
		1019 29
Cash paid Jacob Binder for purchase of Minerals		400 00
Balance		619 29

INVESTMENT ACCOUNT.

Balance per last statement	23149 76
Cash received from The Fidelity Insurance and Trust Co. under the will of Mary Rebecca Darby Smith	1201 49
" received from Dr. Charles Scaffer Executor of the Estate John Bryden deceased	4939 58
" received of Theo. D. Rand to be added to amount received from Dr Schaffer for Bryden Estate	100 00
" received from Emma W. Hayden (Hayden Memorial.)	2500 00
" received from W. N. Johnson for $\frac{4}{15}$ of sale of lot	800 79
" received from sale of lot to Charles R. Maguire and transferred to Mrs. A. M. Paul cash portion	333 33

" received from sale of lot in Manayunk to Edward Haugh..........	300 00	
" received from Mrs. Clara J. B. Moore (addition to Jessup Fund)..........	5000 00	
" transferred from General Account (3 Life Memberships)..........	300 00	
		38624 95
Of the above amount there has been invested in 3 Mortgages.......... on city properties..........		32000 00
Balance..........		$ 6624 95

The election of Officers, Councillors and Members of the Finance Committee, to serve during the year 1889, was held, with the following result:—

President, . . .	Joseph Leidy, M. D.
Vice-Presidents, . .	Thomas Meehan,
	Rev. Henry C. McCook, D. D.
Recording Secretary, .	Edward J. Nolan, M. D.
Corresponding Secretary,	George H. Horn, M. D.
Treasurer, . . .	William C. Henszey,
Librarian, . . .	Edward J. Nolan, M. D.
Curators, . . .	Joseph Leidy, M. D.
	Jacob Binder,
	W. S. W. Ruschenberger, M. D.
	Angelo Heilprin,
Councillors to serve three	Edward Potts,
years . . .	Isaac C. Martindale,
	Theo. D. Rand,
	J. Bernard Brinton, M. D.
Finance Committee, .	Isaac C. Martindale,
	Aubrey H. Smith,
	George Y. Shoemaker,
	William W. Jefferis,
	Joseph Willcox.

ELECTIONS DURING 1888.

MEMBERS.

January 31.—Lawrence J. Morris, Steward Culin, Roberts Le Boutillier.

February 28.—Henry A. Pilsbry.

March 27.—Gerritt H. Weaver, John B. Deaver, M. D., Lancaster Thomas.

April 24.—Samuel H. Friend.

June 26.—Benjamin P. Wilson.

August 28.—John Shallcross.

CORRESPONDENTS.

June 26.—John Donnell Smith of Baltimore.

November 27.—Auguste Sallé of Paris, Louis Bedel of Paris, Dr. David Sharp of Wilmington, Eng'd.

ADDITIONS TO THE MUSEUM.

1888.

ARCHÆOLOGY, ETHNOLOGY, ETC.

Stewart Culin. Chinese medicines.
G. Y. & W. H. McCracken. A collection of Peruvian mummies, crania, pottery, etc.
M. Sommerville. Celt, from Schleswig-Holstein.
D. G. Brinton. Human foot-print, Nicaragua.
J. Willcox. Shell remains from mound, Florida.

MAMMALIA.

E. A. Kelley. *Spermophilus grammurus*, California; *Thomomys talpoides*, California.
H. C. Chapman. Cetacean and manatee remains from South Carolina.
J. E. Ives. *Vesperugo serotinus*, Philadelphia; disarticulated skeleton of cat.
Zoological Society of Philadelphia. Marmosette (*Hapale œdipus*); *Hapale Geoffroyi*; aoudad; jaguar; elk; puma.

BIRDS, ETC.

F. Beamer. Malformed egg of fowl.
Zoological Society of Philadelphia. *Psittacula; Conurus Petyi; Penelope cristata; Conurus cactorum; Eos reticulata; Corvus monedula.*

REPTILES AND AMPHIBIANS.

E. A. Kelley. *Pityophis Sayi*, *Bascanion constrictor*, *Eumeces Skiltonianus*, *Gerrhonotus cœruleus*, *Bufo halophilus*, from California.
J. E. Ives. *Tropidonotus leberis*, Philadelphia.
F. Reynolds. *Crotalus adamanteus* (skin), Mexico.
C. W. Hoffmann. Skin of ophidian, Hammonton, N. J.
Zoological Society of Philadelphia. *Varanus Bengalensis.*

FISHES (Recent and Fossil).

C. S. Bement. Fossil fish, from Green River, Wyoming.
E. A. Kelley. *Sebastodes chlorostictus*, San Francisco.

RECENT INVERTEBRATA (excluding Mollusca).

E. A. Kelley. *Crangon Franciscorum*, California.
C. P. Perot. Sponge (2 species), *Rhipidogorgia flabellum*, *Oreaster reticularis*, from New Providence.
J. Leidy. *Cirolana concharum*, *Palæmon palæmoneticola*, *Lepas fascicularis*, Beach Haven, N. J.; *Cirolana concharum*, Atlantic City, N. J. Scorpion, Bridger Station, Wyoming.
M. Sharp. *Mygale Hentzii.*
A. M. Fielde. Annelid, Swatow, China.
J. Ford. *Arbacia punctulata*, Atlantic City, N. J.
L. Woolman. *Pleurobrachia*, Atlantic City, N. J.
J. Willcox. *Flustra foliacea*, *Pterogorgia*, from Florida.
B. Sharp. *Balanus concavus*, Chesapeake Bay.

Mollusca (recent).

W. D. Hartman. Three new species of *Partula*. Thirty-six photographs of new species of *Partula* and *Achatinella*.
W. B. Marshall. *Bythinia tentaculata*, from Albany, N. Y.
John Ford. Types of *Natica Fordiana* Simpson, and *Oliva inflata var. ovumralli* Ford. Two species of *Helix*, *Natica heros*, *Pyramidella*, *etc*.
B. P. Ruggles. Six species of *Sphæriidæ* from Vermont.
H. A. Pilsbry. Ten species of American *Rissoidæ*. Types of six new species.
Dr. W. H. Rush. Ten species of marine shells, dredged off Florida.
Bryant Walker. Fifty-four species of U. S. Limniades. Twenty-seven jars and vials of alcoholic *Limnæidæ*.
E. W. Roper. Three species of *Sphæriidæ*.
Miss A. M. Fielde. *Limnæa* from Swatow, China.
W. L. Mactier. Thirty one species of marine shells.
Wm. A. Marsh. Two species of fresh water shells.
Wm. D. Averell. Three species of *Helix*.
T. D. A. Cockerell. Fifty-two species of Colorado mollusks.
Frederick Stearns. Fourteen species of Bahaman shells.
B. H. Wright. Twenty-three Florida Uniones, including types of his new species.
Jos. Willcox. Fifty trays of Florida shells.
S. Raymond Roberts. *Acmæa vulgata* from Ireland.
F. A. Simpson. Twenty-eight species of Missouri shells.
Chas. T. Simpson. Six species of Indian Territory shells.
Henry Hemphill. Ten species of fresh-water univalves.
Hon. F. E. Spinner. One species of Florida mollusk.
Prof. Angelo Heilprin. Four species of *Cypræa*.
B. Tomlin. Thirty seven species of European marine shells.
H. E. Dore. Three species of Oregon shells.
John Campbell. *Cypræa*. . . . . .
Alfred Carnana. Forty-five species shells from Malta (in exchange).
C. W. Johnson. Twenty-one species Florida shells.
J. A. Singley. Fifty-nine trays of Texas shells.
Wm. Baldwin. Seventy-eight trays of Sandwich Is. land shells.
C. E. Beddome. Four species of Tasmanian shells.

Invertebrata (Fossil).

T. H. Aldrich. Twenty-two species from the Eocene of Wood's Bluff, Ala.
J. Singley. Six species from the Eocene of Texas.
L. Woolman. Sixty-four trays of Miocene fossils from well boring in Atlantic City, N. J., *Melanopsis Marylandica* from Cape May.
J. Willcox. Forty-eight trays of Tertiary fossils, from Florida; seventy-five trays of Paleozoic fossils from New York State; *Vasum horridum*, Florida.
J. S. Salter. *Nautilus*, *Veniella Conradi*, Cretaceous of N. J.
Chas. Wachsmuth and Frank Springer. Twenty one trays of Carboniferous crinoids, from Kentucky, Alabama and Tennessee.

Plants (Recent).

Mrs. Virginia L. Rowland. Fine specimen (in spirits) of *Cheirostemon platanoides*, (Mexican Hand Plant) with oil painting of flowers and foliage of the same.
Dr. J. Bernard Brinton. *Carex Grayi*, Brown's Mills, N. J., *Arenaria serpyllifolia*, Millington, Md.; *Dianthus prolifer*, Maryland and *Briza minor*, Oregon.
Thomas Meehan. 186 species of plants, mostly exotic species in cultivation and mostly new to the collection.
Isaac Burk. 84 species of plants collected by him in Florida and New Jersey.

Prof. Edward L. Greene, University of California. 36 species of new or choice California plants.
Prof. Thos. C. Porter of Lafayette College, Easton, Pa. 15 species of plants from Pennsylvania and New Jersey.
Frank Tweedy, of U. S. Geological Survey. *Erigeron Tweedyi* Canby, a new species from Montana.
Wm. M. Canby. 18 species of European plants, and 10 species from the mountains of North Carolina and Tennessee, including the rare species *Senecio Rugelia* Gr. and *Buckleya distichophylla* Torr.
Miss Adele Fielde, of Swatow, S. China. *Boehmeria nivea* (L.) Hk. and Arn. with specimens of its fibre and of fabrics woven therefrom; acorns of *Quercus fissa* Camp.
C. McIntyre. Nut of *Phytelephas macrocarpa*, (Vegetable Ivory).
Isaac C. Martindale. 32 species of North American and Ballast plants.
Thomas Meehan and John H. Redfield, supplemented by proceeds of Academy Duplicates:—983 species of plants collected by Dr. H. H. Rusby mostly in Bolivia in 1885 and 1866, a large majority of them being new to the collection.
J. M. Price through Wm. Hunt. 2 species of Australian *Eucalypti*, and 2 species of Australian *Acacia*, cultivated in California.
Herbert Aldrich, Springfield, Mass., through Thos. Meehan. 5 species of Arctic Plants, from north-western coast of Arctic America.
Dr. Geo. A. Rex and Dr. H. Wingate. 20th and 21st Centuries of Ellis and Everharts' North American Fungi.
Roberts LeBoutillier. *Streptosolen Jamesonii*, Miers, (cult.) a native of New Granada; *Staphylea Colchica* Stev. (cult.) and *Symphytum asperrimum* Sims, (Cult.) natives of Caucasus.
Miss Frances Whitney. Fasciate form of *Ranunculus bulbosus* L. from Bryn Mawr, Pa.
Aubrey H. Smith. 25 species of plants from mountains of western North Carolina and New Hampshire, and *Carex miliaris* Mx. from Maine.
Prof. N. L. Britton, Columbia College, N. Y. *Aesculus arguta* Buckley, Kansas, *Corema alba* L. Portugal; *Hicoria alba* (L.), *Hicoria microcarpa* (Nutt.) and *Hicoria minima* Marsh. from Staten Island, N. Y.
Wm. H. Dougherty. *Clianthus Dampieri* A. Cunn, native of Australia and *Leonotis Leonurus* L. native of South Africa, both cultivated at Mt. Pleasant, New Jersey.
John Donnell Smith. Specimens of *Darbya umbellulata* Gr. both pistillate and staminate plants.
Prof. John H. Barbour, Trinity College, Hartford, Conn. *Mimulus luteus* L., native of California, established in fields, Norfolk, Ct.
Wittmer Stone. *Oxybaphus nyctigineus* Sweet and *Bromus sterilis* L., introduced at Wayne Junction near Philadelphia; 41 species of vascular plants, 3 of Lichens and 23 of Algae collected by him in Bermuda.
Miss Van Wyck. Leaf of *Aponogeton fenestralis* Hk, native of Madagascar, from Botanic Garden of Mauritius.
Mrs. Lewars. *Sarcodes sanguinea* Torr. (Snow-plant) from California.
Prof. Joseph T. Rothrock. 60 species of plants collected by himself in Manatee Co., Florida, in spring of 1887.
José N. Rovirosa. 100 species of plants from vicinity of San Juan Bautista, province of Tabasco, Mexico, of which 52 are new to the collection,
John H. Redfield. 266 species of plants collected by C. G. Pringle in province of Coahuila, Mexico in 1887, of which 123 are new to the collection; 191 species collected by himself in New England and 220 species mostly from western states to supply desiderata in the Herbarium.

PLANTS (Fossil).

L. Woolman. *Sigillaria*, Elkland, Pa.
H. W. DuBois. Plant remains from the Trias of New Jersey; *Sagenopteris*, Newark, N. J.

Minerals, Rocks, Etc.

W. W. Jefferis. Quartz in Mica; Epidote, Pa.; Garnets, New York City; Phlogopite, Ontario; Moon-stone, Amelia C. H., Va., Haydenite, Beaumontite, Stilbite, Chabazite, Siderite, from Baltimore; Bucholzite, Philadelphia; Bowenite, R. I.; Phlogopite, Ontario and New York; Rose Tourmaline, Chesterfield, Mass.; Muscovite, Del.; Menaccanite, Parkerville, Pa.; Feldspar, Italy; Roxbury Conglomerate; Granite, Virginia City; Garnets, New York City.

J. M. Buck. Concretion formed on bolt, Pt. Pleasant, N. J.

Mineralogical Section A. N. S. Azurite and Malachite from Arizona; Bementite, Green Tourmaline, from Franklin, N. J.; Ripidolite, Brewster, N. Y.; Sepiolite, Ontario; Microlite, Amelia Co., Va.

C. E. Ronaldson. Syenite with nodules, Smedley, Pa.

S. Tyson. Tysonite, Colorado Springs, Col.

E. A. Kelley. Trap rocks. Cal.; Argentite, Montana.

M. Sommerville. Aragonite, Hyacinth, Epidote, Grossularite, Idocrase, and Iceland Spar, from France.

H. W. DuBois. Artificial pumice; Stylolite, Delaware Water Gap.

J. E. Ives. Steatite with Dolomite, Lafayette, Pa. Selenite, Siliceous Concretion, from Goat Island, N. Y.

J. M. Hartman. Hematite, Orinoco River.

W. H. Gifford. Worn rock, resembling implement.

J. E. Roberts. Umber, Lancaster Co., Pa.

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1888

Abbott, Helen C. De S. Comparative chemistry of higher and lower plants. 8vo T. Aug. and Sept. Philadelphia, 1887. The Author.

Abercrombie, Hon. Ralph. Weather, a popular exposition of the nature of weather changes from day to day. 8vo. New York, 1887. I. V. Williamson Fund.

Abich, Herman. Geologische Forschungen in den kaukaischen Ländern. III, Th. Geologie des armenischen Hochlandis. II Osthälfte. 4to. Wien, 1887. With folio atlas. I. V. Williamson Fund.

Geologische Fragmente aus dem Nachlasse Hermann Abich's. I, Karten und Profile zur Geologie der Halbinseln Kertsch und Taman. II, Zur Geologie der Ponza-Inseln.—Barometrische Höhenmessungen im Kirchenstaate, etc., etc. Text 4to, Atlas folio. Wien. 1887. I. V. Williamson Fund.

Admirality manual of scientific enquiry. 5th Ed. Edited by Sir Robert Ball 8vo. London, 1886. I. V. Williamson Fund.

Agassiz, Alexander. A contribution to American thalassography. Three cruises of the United States Coast and Geodetic Survey Steamer "Blake" from 1877 to 1880. Two volumes. 8vo. Boston and New York, 1888. I. V. Williamson Fund.

Allen, Timothy Field. The Characeæ of America. Part I. The Author.

Observations on some American forms of Chara coronata. 4to T. May, 1882. Thomas Meehan.

Allgemeine Naturkunde. Lief. 99–117. I. V. Williamson Fund.

Ami, Henry M. Flora Temiscouatensis. May, 1888. The Author.

Anderson, John, M. D. Anatomical and zoological researches; comprising an account of the zoological results of the two expeditions to Western Yunnan in 1868 and 1875; and a monograph of the two cetacean genera, Platanista and Orcella. 2vols. 4to, Text and Plates. London, 1878. I. V. Williamson Fund.

Australian Museum, catalogue of the library. 8vo. Sydney, 1883. Guide to the contents of. 8vo T. Sydney, 1883. List of old documents and relics. 8vo T. Sydney, 1884. Plan of the, and its contents. March, 1887. Report of the Trustees for 1887. Ogilby's catalogue of fishes. Part I, 1888. Bale's catalogue of zoophytes, 1884 See Authors. The Trustees.

Baer, K. E. Ueber Entwickelungsgeschichte der Thiere. 2er. Th. Schlussheft. 4to. 1888. I. V. Williamson Fund.

Baillon, M. H. Dictionnaire de botanique. 22e Fasc. I. V. Williamson Fund.

The natural history of plants. Vol. VIII. 8vo. London, 1888. I. V. Williamson Fund.

Bale, W. M. Australian Museum. Catalogue of the Australian hydroid zoophytes. 8vo. Sydney, 1884. The Trustees.

Ball, John. Notes of a naturalist in South America. 8vo. London, 1887. I. V. Williamson Fund.

Ballot. C. H. D. Buys. Verdeeling der Warmte over de Aarde. Amsterdam, 1888. Royal Academy of Amsterdam.

Baltet, Charles. Le Surgreffage des Végétaux. Thos. Meehan.

Banquet to commemorate the framing and signing of the constitution of the United States. The Committee of Arrangements.

Barcena, Mariano. Informe sobre el estado actual del volcan de Colima. The Author.

Barrande. J. Systême silurien au centre de la Bohême. VII, 1. I. V. Williamson Fund.

Bary, A. De. Comparative morphology and biology of the Fungi, Mycetozoa and Bacteria. Translation by Henry E. F. Garnsey, revised by Isaac Bayley Balfour. 8vo. Oxford, 1887. I. V. Williamson Fund.

Baur, G. Beiträge zur Morphogenie des Carpus und Tarsus der Vertebraten. 1 Th., Batrachia. 8vo. Jena, 1888. I. V. Williamson Fund.

Beecher, Charles E. A method of preparing for microscopical study the radulæ of small species of Gasteropoda. Nov. 18, 1887. 8vo T. The Author.

Berghaus H. Physikalischer Atlas. L. 14–16. I. V. Williamson Fund.

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Binet, Alfred and Charles Féré. Animal Magnetism. 8vo. New York, 1888. I. V. Williamson Fund.

Boettger, Oskar. Die Reptilien und Amphibien von Madagascar. 4to. Frankfurt a/M. 1877. I. V. Williamson Fund.

Boguslawski, G. V. and Otto Krümmel. Handbuch der Ozeanographie, II. 8vo. Stuttgart, 1887. I. V. Williamson Fund.

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Bollman, Charles H. A preliminary list of the Myriapoda of Arkansas. 8vo T. February, 1888. The Author.

Bombicci, L. Il Gabinetto Universitario di Mineralogia in Bologna XXVII anni dopo la sua fondazione. Relazione terza. Bologna, 1888.

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Sulla formazione della Grandine e sui fenomeni ad essa concomitanti. Bologna, 1888. The Author.

Borre, A. Preudhomme de. Liste des cent et cinq espèces de coléoptères lamellicornes actuellement authentiquement capturées en Belgique avec le tableau synoptique de leur distribution géographique dans le pays. Jan. 7th, 1888. The Author.

Bourgeois, M. L. Encycl. Chim. (Fremy). T. II. Metalloides. Reproduction artificielle des mineraux. 8vo. Paris, 1884. I. V. Williamson Fund.

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Boury, E. de. Description de Scalidae nouveaux des couches Eocène du Basin de Paris et révision de quelques espèces mal connues. 8vo T. Paris, 1887.

Étude sur les sous-genres de Scalidæ du Bassin de Paris. 8vo T. Paris, 1887. The Author.

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Bower, F. O. and Sydney H. Vines. A course of practical instruction in botany. Parts 1 and 2. 8vo. London, 1885–87. I. V. Williamson Fund.

Brandt, J. F. Ausführliche Beschreibung der von C. H. Mertens auf seiner Weltumsegelung beobachteten Schirmquallen nebst allgemeinen Bemerkungen, über die Schirmquallen überhaupt. 24 April, 1835. Mrs. Dr. C. Hering.

Brefeld, O. Untersuchungen aus dem Gesammtgebiete der Myologie. VII H. Basidiomyceten, II. I. V. Williamson Fund.

Brehm, A. E. Merveilles de la Nature. Les poissons et les crustacés. Les poissons par H. E. Sauvage. Les crustacés par J. Künckel d'Herculais. 8vo. Paris, n. d. I. V. Williamson Fund.

Brezina, A. and E. Cohen. Die Structur und Zusammensetzung der Meteoreisen. Lief. 2 and 3. I. V. Williamson Fund.

Brinton, Daniel G. The language of palæolithic Man. 8vo T. Oct. 5, 1888.

On the so-called Alagüilac language of Guatemala. 8vo T. 1887.

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On the Chane–Abal (Four–Language) tribe and dialect of Chiapas. 8vo T. Jan. 1888. The Author.

Brinton, D. G., Henry Phillips Jr. and Monroe. B. Snyder. Reports of the Committee appointed October 21, 1887, to examine into the scientific value of Volapük, presented to the American Philosophical Society, Nov. 18, 1887 and January 6, 1888. The Authors.

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Catalogue of the Passeriformes or perching birds. Oligomyodæ. By Phillip Lutley Sclater. London, 1888.

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Britton, N. L. Contr. from the Herb. of Columbia College, No. 5. New or noteworthy North American Phanerogams. April, 1888. 8vo T.

Note on the growth of a vinegar plant in fermented grape juice. Jan. 10, 1887. 8vo T.

On an archæan plant from the white crystalline limestone of Sussex County, N. J. Jan. 9th, 1888. 8vo. The Author.

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Brown, Jno. Allen. Palæolithic Man in N. W. Middlesex. 8vo. London, 1887. I. V. Williamson Fund.

Brown, Nathan Clifford. A catalogue of the birds known to occur in the vicinity of Portland, Me. 8vo T. 1882. Portland Natural History Society.

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Burmeister, H. Atlas de la description physique de la Republique Argentine. 2e Section. Mam., 2 and 3 L. Supplemente, text pp. 37–125. I. V. Williamson Fund.

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Letter of State Geologist, 1864–65. Address, Jan. 30, 1868. Statement of progress, 1872–73. Report of Secretary of War, Tyson's memoirs, 1850. In Exchange.

Call, R. Ellsworth. Memoranda on a collection of fishes from the Ozark Region of Missouri. May, 27, 1887. 8vo T. The Author.

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Meteorological Service. Report (Carpmail). 1885. The Survey.

Cape Horn, Mission Scientifique du, 1882–83, I, II, III, IV, VI Arachnides, Insects, Bryozoaires. I. V. Williamson Fund.

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Casey, Thomas L. On some new North American Rhynchophora. Part I. New York, 1888. 8vo T. The Author.

Challenger Reports. See Thomson, Sir C. Wyville.

Champlin, A. F. The Catawba language. 8vo T. Jan., 1888. The Author.

Chaper, M. Extraits d'un rapport de mission sur la côte nord du Vénézuéla. The Author.

Cholera, statistics of, with sanitary measures adopted by the Board of Health prior to and during the prevalence of the epidemic in Philadelphia in the summer of 1849. 8vo T. Philadelphia, 1849. Wm. J. Potts.

Ciofalo, Saverio. Eco dell' Isola. 4to T. Ottob. 22. The Author.

Clessen, S. Die Mollusken-Fauna Oesterreich Ungarns und der Schweiz. L. 1, 2, 3. 8vo. Nurnberg, 1887. I. V. Williamson Fund.

Cohen, E. Zusammenstellung petrographischer Untersuchungsmethoden. Strassburg. Marz, 1884. I. V. Williamson Fund.

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Cole, Jas. E. The Earth's orbit and distance from the sun. Reason vs. imagination. The Author.

Colin, G. Traité de physiologie comparée des animaux, II. 8vo. 1888. I. V. Williamson Fund.

Combe, George. The constitution of man considered in relation to external objects. 8vo. Boston, 1835. Mrs. L. Fox.

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On the origin of species. 6th Ed. 8vo. New York, 1887. I. V. Williamson Fund.

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Sur l'origine botanique de quelques plantes cultivées et les causes probables de l'extinction des espèces. Jan. 1887. Thomas Meehan.

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Uber Urnenfunde in Uebigau bei Dresden, 1884. The Author.

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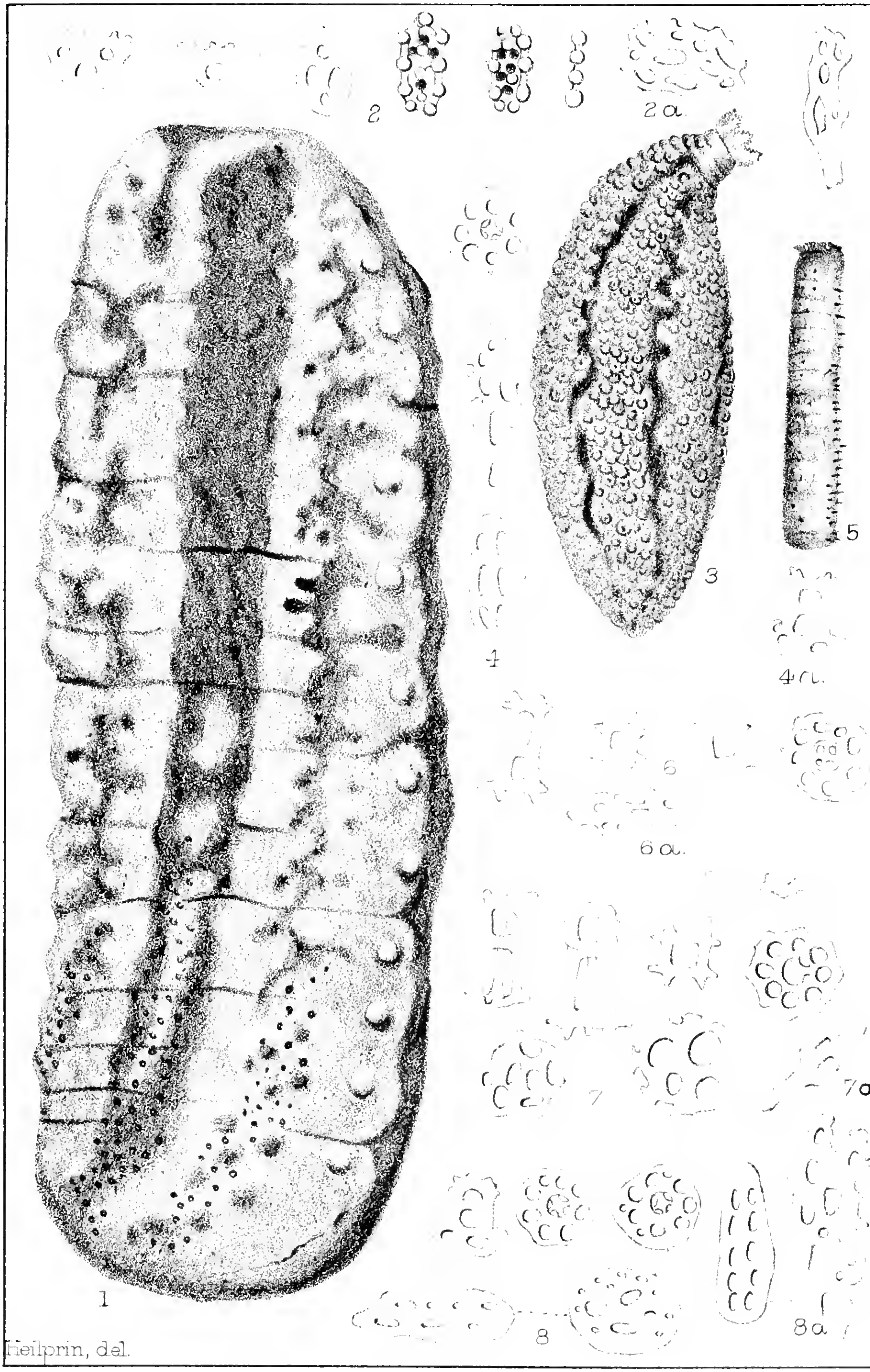

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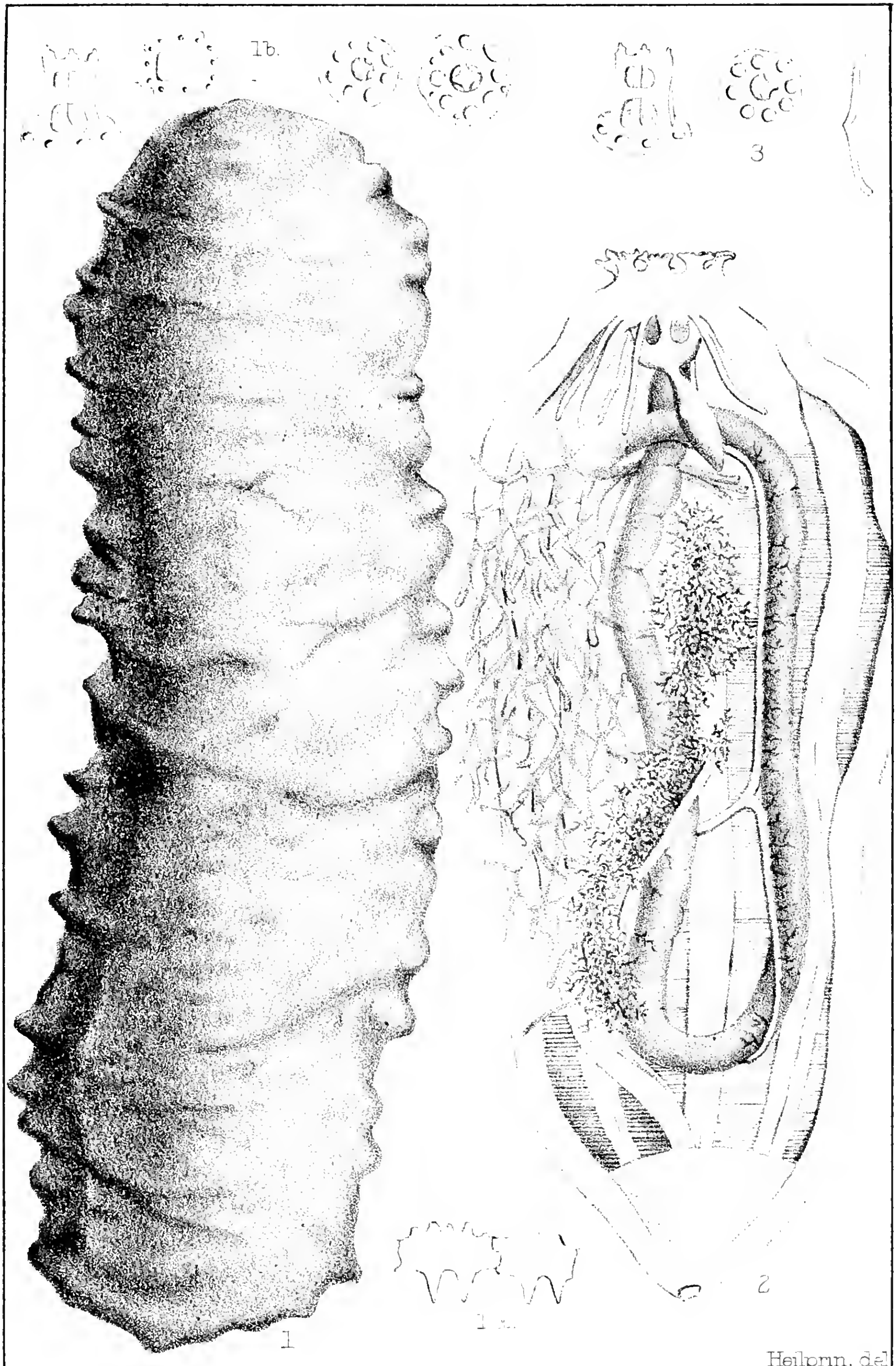

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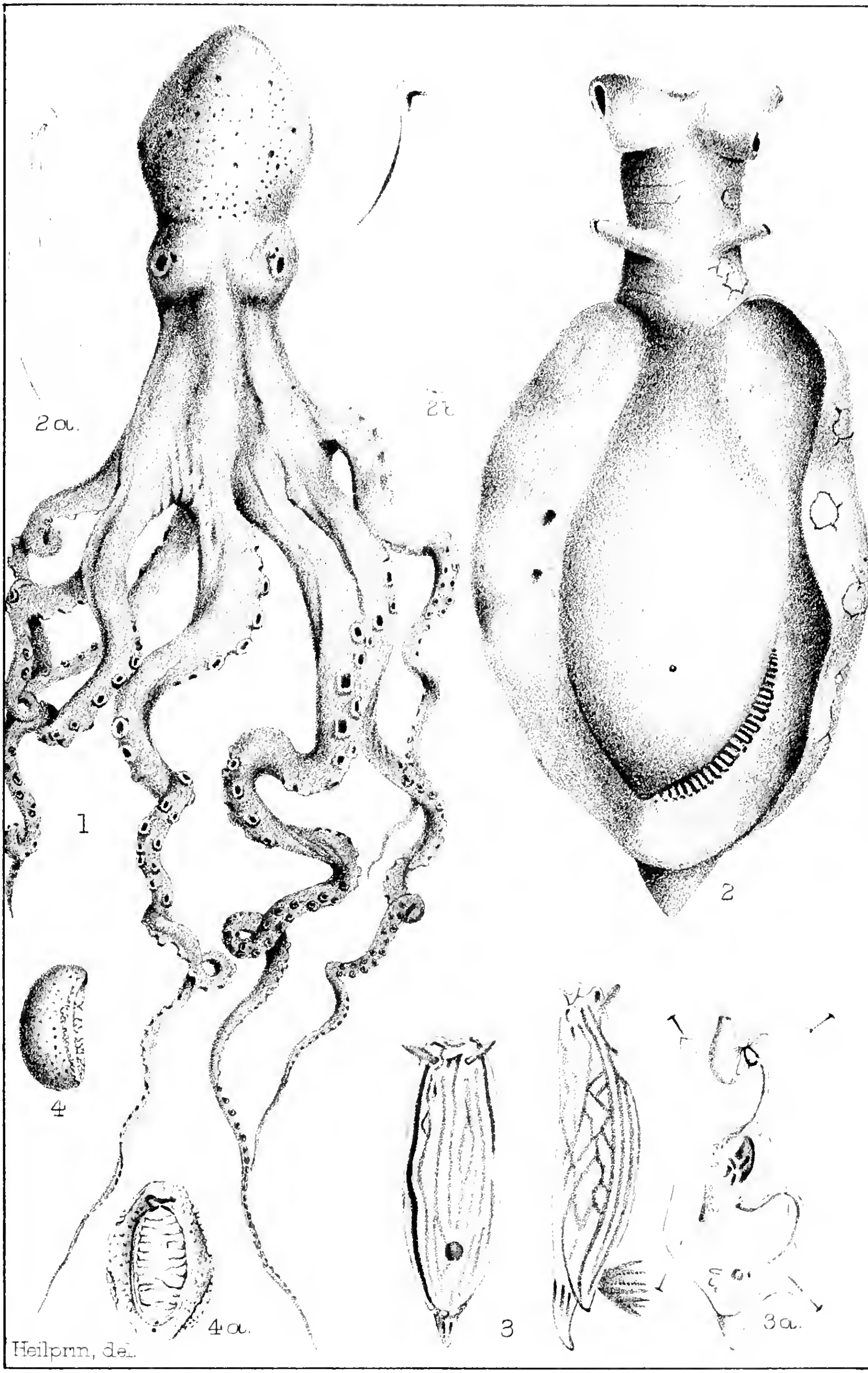

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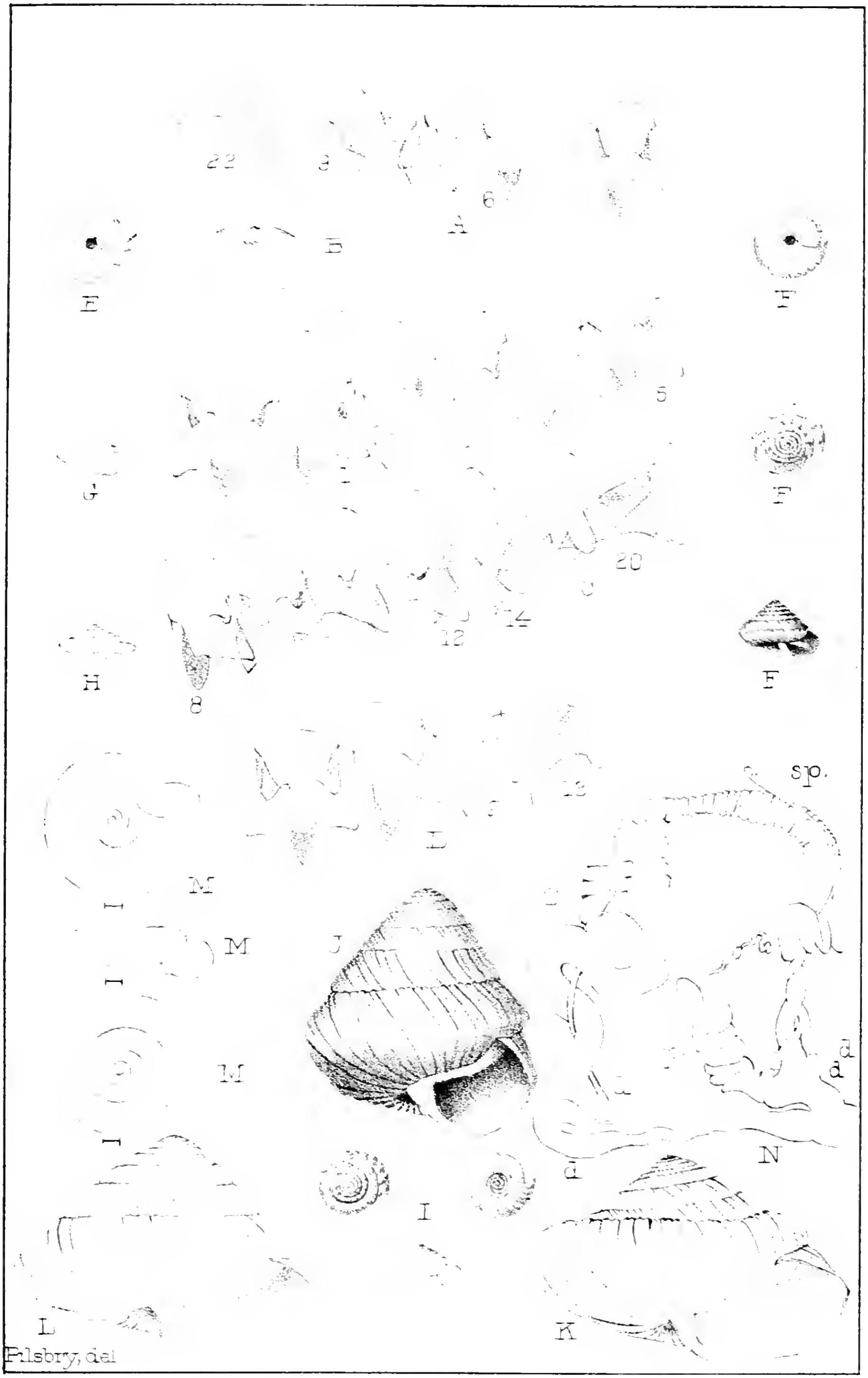

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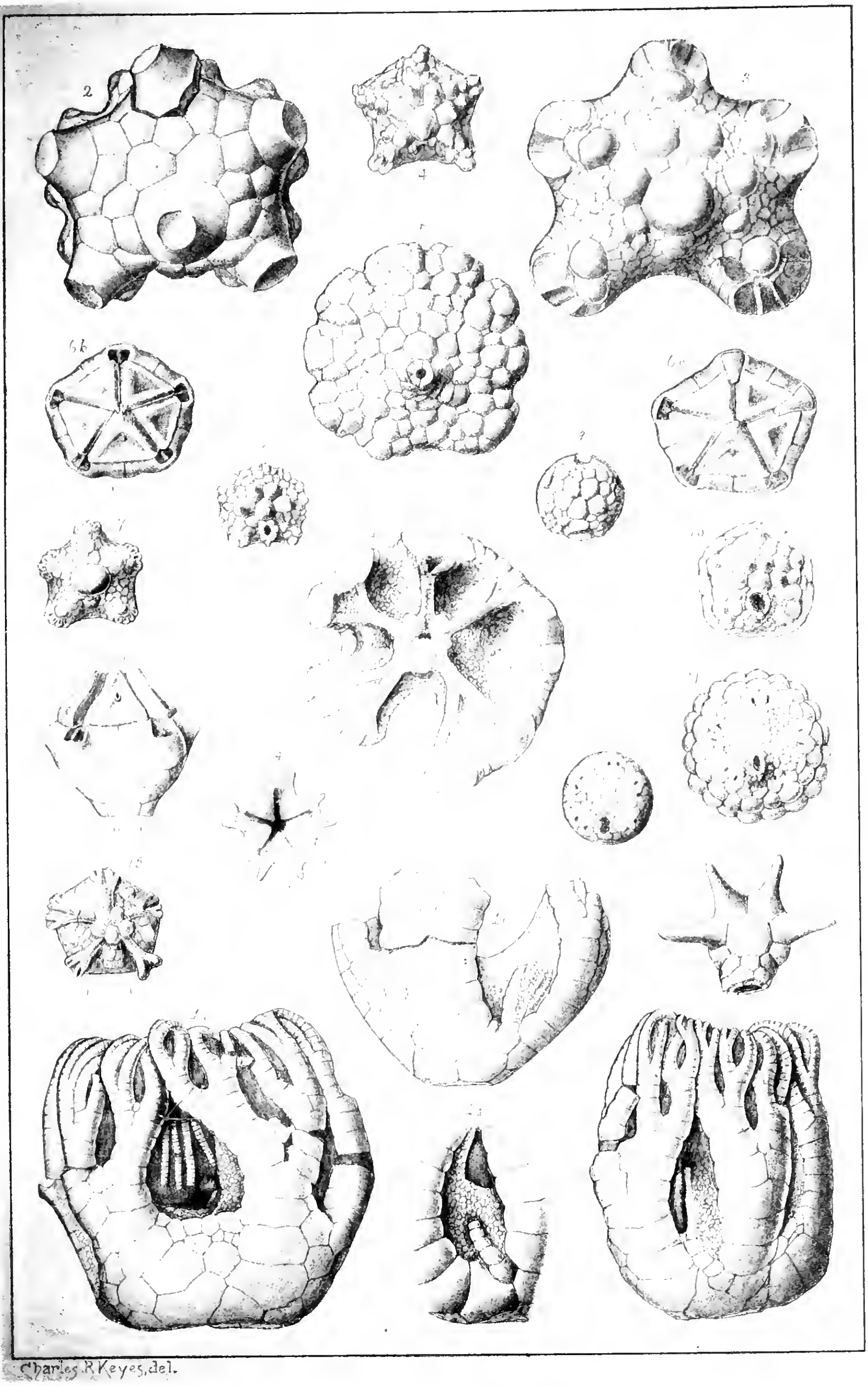

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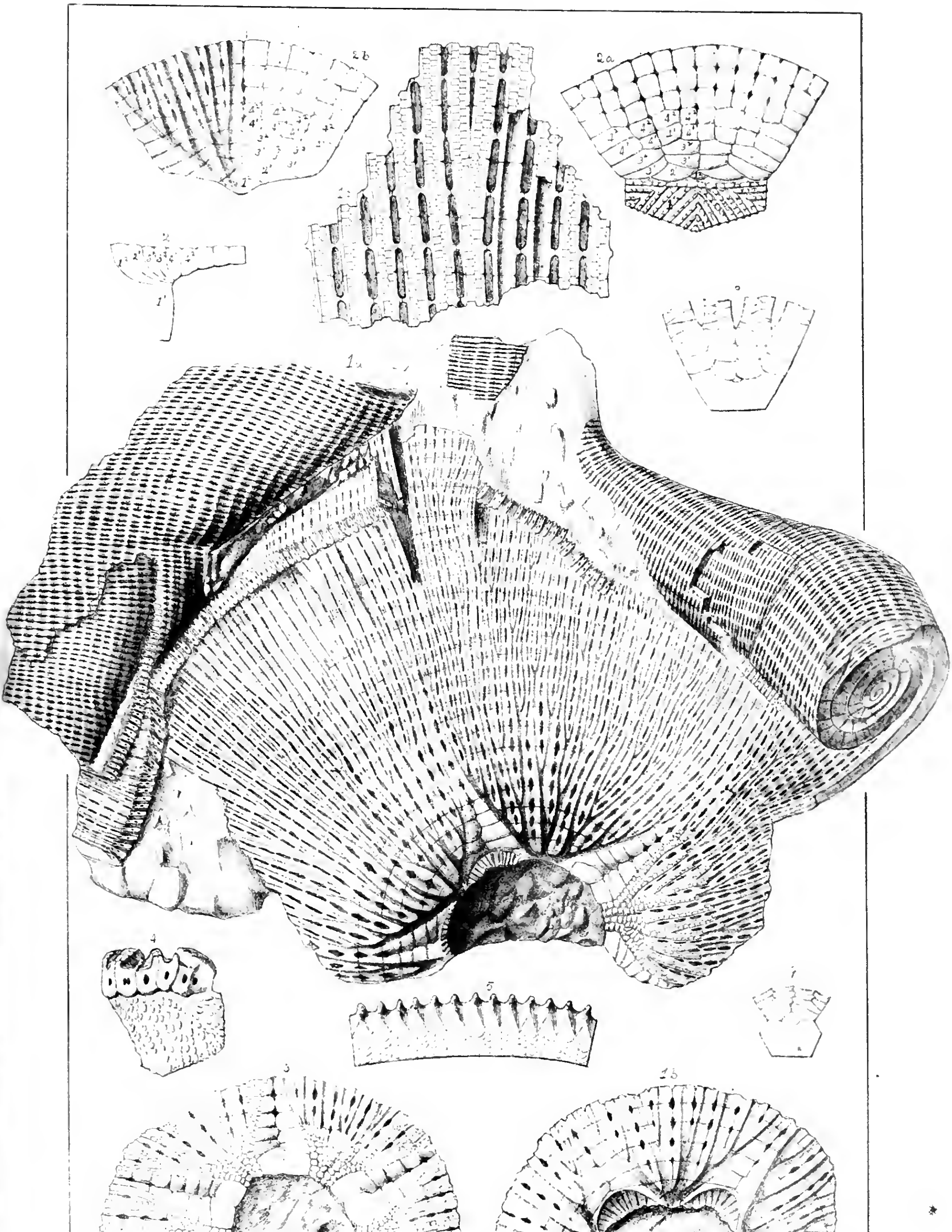

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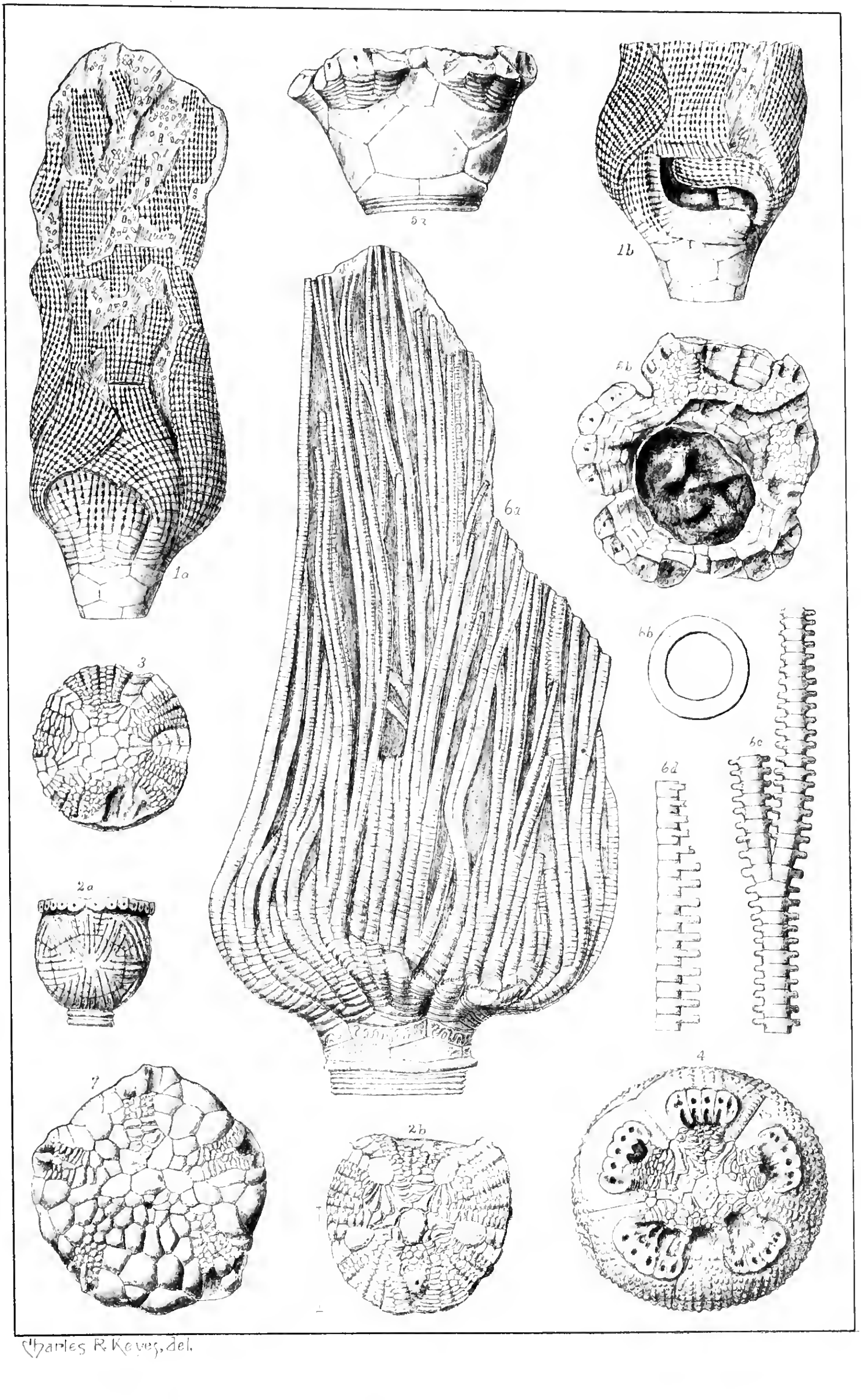

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OF THE

Academy of Natural Sciences

OF

PHILADELPHIA.

PART I. JANUARY—FEBRUARY, 1888.

PUBLICATION COMMITTEE.

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1888.

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May, 1888.

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PART II. MARCH—SEPTEMBER, 1888.

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OF THE

Academy of Natural Sciences

OF

PHILADELPHIA.

PART III. OCTOBER—DECEMBER, 1888.

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LOGAN SQUARE,
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