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"	641 to 656	"	March 1, 1902;	"	March 4, 1902.
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EDWARD J. NOLAN,
Recording Secretary.

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PROCEEDINGS

OF THE

ACADEMY OF NATURAL SCIENCES

OF

PHILADELPHIA.

1901.

JANUARY 1.

The President, SAMUEL G. DIXON, M.D., in the Chair

Ten persons present.

The Council reported that the following Standing Committees had been appointed to serve during the ensuing year:

ON LIBRARY.—Dr. C. N. Peirce, Thomas A. Robinson, Henry C. Chapman, M.D., Charles Schaeffer, M.D., George Vaux, Jr.

ON PUBLICATIONS.—Thomas Meehan, Henry Skinner, M.D., Henry A. Pilsbry, Sc.D., Philip P. Calvert, Ph.D., Edward J. Nolan, M.D.

ON INSTRUCTION.—Uselma C. Smith, Benjamin Smith Lyman, Henry A. Pilsbry, Sc.D., Philip P. Calvert, Ph.D., and Charles Morris.

ON FINANCE.—Isaac J. Wistar, William Sellers, Charles Roberts, John Cadwalader and the Treasurer.

COMMITTEE OF COUNCIL ON BY-LAWS.—Isaac J. Wistar, Theodore D. Rand, Arthur Erwin Brown and Charles Roberts.

January 8.

The President, Samuel G. Dixon, M.D., in the Chair.

Nineteen persons present.

The death of Baron Edmond de Selys-Longchamps, a correspondent, was announced.

The Food of the Cod.—Dr. Benjamin Sharp called attention to some observations he had made last fall on the contents of the stomachs of the common Cod. Several hundred stomachs were opened with the hope of finding shells of gastropods and bivalves. Numerous valuable shells had been taken from the Cod years ago by Stimpson and Gould on the New England coast, north of Cape Cod, and it was supposed that similar finds would come to light from the Cod caught off Nantucket. The stomachs examined were filled almost exclusively with crustaceans and for the most part with species of *Panopeus.* Hermit crabs, without shells, and a few Crepidulæ were also seen. Here and there young lobsters were found in the stomachs, occasionally two in one stomach. In one Cod, weighing about thirty-five pounds, pieces of a lobster were found which, when placed together, indicated that the possessor was about eleven inches in length.

The Cod examined were all taken off the eastern end of the island, between the town of Siasconset and a place called Wawinet, where the tide (current) runs at a maximum of about six miles an hour. The bottom consists of coarse sand and is probably shifting, and consequently not a good bed for mollusks, the only food for the Cod found there being crustacean.

Dr. Sharp supposed that the decrease in quantity of the lobsters, which has been so marked within the past few years, is partly due to their consumption by the Cod; and as these have of late greatly increased in numbers, owing to the work of the United States Fish Commission, the lobsters have not been able to keep pace with the increase of their enemies.

January 15.

Mr. Charles Morris in the Chair.

Fourteen persons present.

JANUARY 22.

Mr. ARTHUR ERWIN BROWN, Vice-President, in the Chair.

Fifteen persons present.

The death of Gustav Hartlaub, a correspondent, was announced.

Papers under the following titles were presented for publication:
"On Some Points in the Phylogeny of the Primates," by Arthur Erwin Brown.
"The Development and Comparative Structure of the Gizzard in the Odonata zygoptera," by Helen T. Higgins.

JANUARY 29.

The President, SAMUEL G. DIXON, M.D., in the Chair.

Sixteen persons present.

William F. Dreer, James Rorer, and W. Worrell Wagner were elected members.

H. R. H. Albert I, Sovereign Prince of Monaco, was elected a correspondent.

The following were ordered to be printed:

BIOGRAPHICAL NOTICE OF CHARLES EASTWICK SMITH.

BY THOMAS MEEHAN.

Appointed to prepare a memoir of our late fellow-member, Charles E. Smith, the author feels strongly a difficulty he has experienced on similar occasions. The members of the Academy meet for mutual improvement and study. The various subjects in which they take interest become the chief topics of conversation. They know little of the outside life of one another. A tree is to be known only by its fruit. As it grows through successive years it appears much like other trees, and no note is taken of the incidents of its growth; but when the harvest time arrives, and all are in praise of the bountiful crop, carrying pleasure and profit around it in every direction, a natural desire arises to know more of the details of such a happy career,—a desire that can only be satisfied by recalling circumstances imperfectly remembered, or that have but little bearing on the character we would illustrate.

So when the subject of this memoir passed away few of his associates could aid the author. All knew that he was one of Philadelphia's most prominent citizens; that he had been at the head of some of its great business bodies; that he had been largely concerned with the city's good name and progress; that he had long been a member of the Academy of Natural Sciences of Philadelphia, especially interested in botany and kindred subjects, a liberal contributor through the greater part of his life to its building funds, its collections and general progress, and that on his death it was found that he had generously provided for its future out of his rich estate. But few knew more than all knew. Indeed, but for aid from Dr. Edward J. Nolan and Dr. Thomas C. Porter the author would have been left solely to his own recollections and the replies to letters of inquiry sent to friends of our departed associate for material for his task.

His full name was Charles Eastwick Smith—Eastwick being the maiden name of his grandmother. He was the second of that name in the family, the first dying before he was born. His

Philadelphia ancestors were among the original party with William Penn and, like the founder of the city, strong believers in the doctrines of the Society of Friends. Little can be learned of his early life. He was born November 1, 1820, and seems to have had especial care and oversight from his mother, to whom he was deeply devoted through life, and by whose side in Laurel Hill Cemetery he was placed when his own time of rest arrived. He probably received his rudimentary education in Philadelphia, and at the age of fifteen was sent to the boarding-school of Westtown, near this city. It was here, as he related to his friend Dr. Porter, that he acquired his fondness for botany, through the influence of one of the instructors. He remained here three years, when he became attached to an engineer corps, engaged to survey for a railroad from Blossburg to Corning, in New York. He became the superintendent of the railroad, and later of the Bloomsburg coal mines, though he had scarcely attained his majority He returned to Philadelphia in 1842, and established the Fairmount Rolling Mill. This was not a financial success, from the fact, as he believed, that coöperation throughout the whole iron trade was needed to place the industry on a firm footing. He sold it out in 1846.

About this period an event occurred that had a material influence on his future life. In 1844 a fierce antagonism to Roman Catholicism arose. A number of churches were burned. The Mayor called on all able-bodied citizens to arm in defense of law and order. The Quaker youth went out with a cane, but in the excitement of the riot some one put a musket in his hands, and he patroled the streets with it for seven nights. For this violation of the principle of non-resistance he was called on to express regret, and to give a promise of strict conformity to the rule thereafter. Believing himself harshly treated, he refused to do so and was expelled from the Society. He at once dropped the garb and language of the Friends and associated with other bodies. He never married, and if the event detailed had aught to do with the fact, the secret was faithfully kept to the last.

For a short time subsequent to 1846 he became manager of the Rensselaer Iron Works, at Troy, N. Y., in which railroad iron was being manufactured. He returned to Philadelphia in 1849, to inaugurate a convention of iron men. The poverty of the constituency forced the association to be content with inferior printing and paper for its report. In a letter to a friend he says: "Mr. Colville told me we must go over the State and get the interest of every iron-maker. I asked him for money to pay my expenses. He said I must beg it, as he had none. 'You must ask for contributions as you go along.' I started with $5. Sometimes I got a wagon, sometimes a horse ride, sometimes on foot—sometimes I got fifty cents. In one case I got $10. I saw them all, came back with between $200 and $300, and the American Iron and Steel Association became a flourishing body." He traveled 2,500 miles on this mission.

There seems nothing on record as to his occupation for the succeeding ten years, but in a letter to a friend he remarks that he attended faithfully to his office work during the day and employed his evenings in studying and classifying the plants collected on Sunday.

In 1861 he was elected to the presidency of the Reading Railroad Company. From a comparatively local and almost bankrupt organization, he raised it to one of broad interest and a good dividend-paying concern—so profitable that in the trying times of the beginning of the civil war his company loaned the Government two millions and a half of dollars. In 1869 it stood in prosperity second to none in the country.

His health broke down. His medical adviser urged his resignation and suggested several things he might do At length the physician, in a peculiar way, remarked that he had "better go to grass." The joke had a good effect. He took the advice literally, resigned, and turned to botany for consolation. He still retained his position on the Board of Directors. On the 18th of April, 1869, he sailed on the "Scotia" for an extended tour of Europe, during which botanical study was his chief recreation, although he deeply enjoyed all that would interest a broad-minded man of affairs. He returned on the 15th of September, 1870.

Some years later he discovered that the great railroad company that had been the pride of his life, was bankrupt under the management of his successor in the presidency. The effect on his health was seriously depressing. By night, as by day, the railroad was ever in his mind. While greatly troubled by insomnia, he was requested by the Secretary of the Academy to read the proof-sheets of a botanical paper in course of publication. To his surprise he found that the mental application required for proof-reading was an excellent remedy for his sleeplessness. The application required for the task drove out thoughts of the railroad's disaster. He begged for more, both from the Academy and from friends, and the greater part of his subsequent life was devoted, as one of the best means for preserving health, to his favorite occupation of proof-reading.

Though not courting favors, he was highly esteemed by his fellow-citizens. For two successive years, 1877 and 1878, he was elected president of the Union League—one of the most enviable of Philadelphia's social positions.

His eminently practical character has been well illustrated by the reference to his journey through the State in the interests of the iron men, and by the details of his railroad affairs. He carried this quality into all his transactions. His close friend, Prof. T. C. Porter, relates that on a trip with him, Aubrey H. Smith and Dr. Joseph Leidy, in July and August, 1865, to Lake Superior, they were much amused by his practical test of the truth of the Abbé Huc's statement that cow "cake" was better for kindling, but that horse "apples" were better for holding heat in a fire. The result proved the correctness of Abbé Huc's assertion. Dr. Porter further notes, as illustrative of the tendency to draw valuable conclusions from little things, that one of the party, having placed over the fire a branch of a spruce tree to aid in extinguishing it, Smith noted how the turpentine oozed from the twigs, flashed into a blaze and sent up as incense a cloud of fragrant white smoke.

With all his love of facts, he was not devoid of sentiment. His private correspondence discloses an active interest in the good of others of which the world will never know. Few have succeeded so well in preventing the left hand from knowing what the right hand was doing. His selection of a burial place in Laurel Hill Cemetery for his mother, on a spot that commanded the most delightful views of the Schuylkill and the surroundings, is a striking testimony to his depth of sentiment.

We have already seen how he was early brought into a love for botany at the boarding-school. He was elected a member of the Academy in 1851, and served in some of the administrative offices until his death. He was appointed on the Publication Committee in 1892, in which position he rendered especially valuable service. He served on the Finance Committee from December, 1890, and was one of the Council from May, 1891. At the time of his death he was, and had been for a number of years, Vice-Director of the Botanical Section.

His influence on American botany, and on American science generally, was exerted in such a quiet way that its full importance will never be appreciated. His critical mind led him to prefer difficult subjects; hence carices, grasses and rushes had especial charms for him. He could readily see what others failed to observe, and he became an authority on these subjects. While in the midst of his heavy labors in reconstructing the railroad company, he was in active correspondence with Boott, Olney, Engelmann and other specialists in the study of these difficult genera. He rather prided himself on going over oft-trodden ground and noting what others failed to see. By his persistency with Dr. Gray he finally induced this great botanist to recognize two new species from oft-explored localities in New Jersey, which he named *Scirpus Smithii* and *Lobelia Canbyi*, and this after he had failed to satisfy Boott and Olney of the distinctness of the forms. In explanation of his persistency he tells a friend, "When there seems to be reason for my sentiments, I must express them or die." In a letter to a friend, dated October 15, 1867, he remarks, "At Moosehead Lake I also got *Graphephorum melicoides* and *Aspidium fragrans*, heretofore only known as Western plants. It is a comfort to penetrate the hub of the universe and make the natives acquainted with their own plants. One feels good—that is to say, much like a missionary."

Apart from the beneficent influence the concentration required by good proof-reading had in counteracting insomnia, it was through his chosen work as proof-reader that he has left his impress, especially on botanical literature. He begged his friends, as a privilege, to permit him to read proofs for them. In the course of such work the contributions of his botanical friends underwent his critical scrutiny; and the authors received the benefit of his watchful care. The corrections would often be clothed in dry humor. He once wrote to Dr. Gray on the issuance of a new edition of his *Manual*, "Have you observed from Gray's *Manual* that *Solidago altissima* grows only two to seven inches high ?" The remarkable accuracy that marks the botanical labors of the last quarter of a century is in a great measure due to the impulse given to extra care by Charles E. Smith. The last edition of Leidy's *Elementary Treatise on Human Anatomy,* although carefully read by the author, would have described a certain process of the brain as the "Hippopotamus"—instead of the Hippocampus—minor, had it not been for Smith's supervision. It is not only in the superior accuracy of the literature of botany and allied studies that science is indebted to our friend. He was ever ready with encouragement for all botanical enterprises, and especially in the case of younger students. He took an especially warm interest in the establishment of the Ladies' Botanical Club of Syracuse, N. Y., aiding the society by advice and material.

The ablest leaders relied on his judgment. Before the appearance of one of the editions of his *Manual,* Dr. Gray proposed extending the area covered by it. The question was left to Mr. Smith, who decided adversely. He believed in thorough work, and held that this was favored by concentration rather than diffusion of effort. In this spirit he commenced a herbarium of the plants growing within fifteen miles of Philadelphia. This collection he bequeathed to the Academy, and it is regarded as a masterpiece of accurate labor. Every locality is exactly noted, and in every case the existence of the plant on the spot was verified by a personal examination, its identity being carefully ascertained.

The Recording Secretary of the Academy, whose official relations brought him into intimate communication with Mr. Smith, remarks in reply to a note of inquiry:

"Although he was not a frequent visitor to the Academy, he impressed me in the early years of his connection with it as a man of singular directness and personal force. A tone of command and authority, resonant voice, clear enunciation, and erect bearing conveyed the idea of perfect mental poise and a habit of rather directing than of conferring with his associates—but all this without a suspicion of arrogance or superciliousness."

He died on Sunday, the 15th of April, 1900, in the eightieth year of his age. The Academy, proud of its contributors to the advancement of knowledge among mankind, places with them in grateful remembrance the name of Charles Eastwick Smith.

A REVIEW OF THE GENERA AND SPECIES OF AMERICAN SNAKES, NORTH OF MEXICO.

BY ARTHUR ERWIN BROWN.

In recent years, investigation of the lower groups in classification has largely taken the form of observing and noting the most minute variations, occurring in however small numbers. Among snakes, this method has been carried to such an extreme that Prof. Cope's "Characters and Variations of North American Snakes"[1] contains the names of twenty-three species and subspecies which were founded upon one, or at most two specimens each.

Two propositions, both fundamentally correct, have contributed to this result: first, that a knowledge of the laws under which new forms are developed is to be best gained by a study of variations; and second, that subspecies are an essential part of classification. As a general truth the first proposition is unassailable, but there appear to be good reasons why limits should be placed upon its application to the present group and why a cautious valuation should here be made of minor variations. This should be true if it can be shown that unmeaning departures from type are especially common among its members.

It is a law of organisms that a high degree of instability is associated with degenerative processes. That the serpents, as a whole, are a degenerate group is probable, and while some lines among them have become much specialized, there are large numbers of small and degraded forms, always highly variable, which can be connected with higher types.

It is, furthermore, a morphological fact that where repetition of parts is the rule, variability, in number at least, is to be looked for.[2] Among snakes, generic and specific characters are chiefly

[1] *Proc. U. S. National Museum*, 1892, pp. 589–684.

[2] A very simple summary of a long series of observed facts is contained in Bateson's *Materials for the Study of Variation*, p. 571 (London, 1894): "It is perhaps true that, on the whole, series containing large numbers of undifferentiated parts more often show Meristic Variation than series made up of a few parts much differentiated, but throughout the evidence a good many of the latter class are nevertheless to be seen."

found in the teeth, in the plates upon the head, and in the number and form of the rows of body scales; all of these are numerous, and variability under the above law is common.

Color is largely used in specific, and almost wholly in subspecific determination, and this, too, we should expect to find inconstant in a group whose structure is such that the whole exterior is brought into close contact, surface or subterranean, with earth, sometimes swamp and sometimes desert sand, and whose slow metabolism brings such physiological activities as temperature, nutrition and epidermal repair into close dependence upon external conditions.

There is, again, a class of anomalies not uncommon in this group, such as are shown at times in genera like *Coluber* or *Zamenis*, in which the young of some species are spotted or cross-banded, becoming striped when adult. Here, occasionally, more or less of the juvenile pattern is retained, showing through, as it were, the later stage. Examples of such are *Coluber guttatus sellatus* Cope and *C. rosaceus* Cope. This class of variations is purely physiological, and when occurring in isolated cases, has no more zoölogical significance than the occasional retention to maturity of the youthful livery of spots in lions.

Aside from anomalies, there are characters which are too variable, normally, to be of use except in broad definitions. Form and proportions, both of the whole and of parts, vary considerably; among those which change with growth are the relative length of the tail (which also varies with sex), and the reciprocal proportions of some head plates; breadth of head and stoutness of body change to an extraordinary degree with nutritive conditions, a fact which can be best learned by observation of snakes kept in captivity.[3]

The system of trinomials has added greatly to the facilities for expressing the relationship of transitional forms, but while its value is fully conceded, so also must be the existence of the danger which has attended and not infrequently overtaken it—that the very ease of its methods may lead the systematist to overvalue the importance of individual and insignificant variations.

[3] A suggestion as to the possible origin of occasional specimens presenting mixed characters, is that among snakes which breed in captivity there seems to be little or no aversion to cross-breeding. This is especially true of *Eutænia* and *Tropidonotus*, both of which produce young free from the egg, and breed not infrequently.

The chief purpose of the present paper is to inquire into the nature of these variations, and to determine if possible how far they are promiscuous and without meaning, or to what extent they may be believed to fall within those ideas of progressive modification, without which as a guiding principle, the practice of taxonomy is mere byplay. The conception which has directed the inquiry, is that a relatively high degree of constancy and isolation is essential to the recognition of a species; and that variations, to be of subspecific value, must be of such a character as to offer reasonable grounds for the belief that they are stages of change; an important part of such character being that they shall occur in sufficient numbers to constitute centres, so to speak, upon lines leading from established forms.

The color descriptions have in a large proportion of cases been taken from the living snake; to which it may be added that in addition to the alcoholic series to which I have had access, including that of the Academy of Natural Sciences of Philadelphia, which now contains the whole private collection of the late Prof. Cope, nearly four thousand living specimens of North American snakes have passed under my observation, in the course of identifying the large amount of material in this group which comes into possession of the Zoölogical Society of Philadelphia.

The more recent works which treat with modern methods, of the whole field of North American snakes, are the paper of Prof. Cope, above referred to,[4] and Mr. G. A. Boulenger's *Catalogue of Snakes in the British Museum* (1893–96).

With neither of these distinguished naturalists am I able to find myself in full accord; the one appearing to me to err in excess of analysis, quite as much as the other does in the opposing method.

The literature has been so fully worked out by Mr. Boulenger,

[4] Since the completion of the present paper (October, 1900), the *Report of the U. S. National Museum* for 1898 has appeared, containing Prof. Cope's posthumous work on North American scaled reptiles (Serpentes, pp. 688–1198). I find that few of the conclusions which I had reached are thereby altered, for the chief additions to his previous paper of 1892 result from the introduction of characters drawn from the male generative organ. These were not made use of in the present paper, for examination of much of Cope's material, and some further investigations of my own, had satisfied me that much verification and extension remains to be done before their value in generic determination can be established. Such changes as I have made have been introduced into the text, and references to the paper are given as "Cope, Rep. Nat. Mus.," "Cope, *l.c.*," indicating the previous paper, above cited.

that the references given in this paper are such only as are necessary to historical exactness, being in most cases to the original description; to the works of Cope and Boulenger cited; to Baird and Girard's *Catalogue of North American Snakes* (1853); to some late papers by Mr. Stejneger, and to a valuable paper by Mr. Van Denburg on the reptiles of the Pacific coast.[5]

GLAUCONIIDÆ.

GLAUCONIA, Grey.

Cat. Lizards, Br. Mus., 139 (1845); *Rena* B. and G., Cat. Serp. No. Am., 149 (1853); *Glauconia* and *Rena* Cope, Proc. U. S. Nat. Mus., 1892, 589, 590; *Glauconia* Boul., Cat. Snakes Br. Mus., I, 59.

No maxillary teeth; rostral large, projecting; one nasal, divided or half-divided and touching the lip; eyes covered with scales; an ocular which reaches the lip; a median row of scales extending to the rostral; body surrounded with cycloid scales; anal entire; body cylindrical; tail short and blunt; head not distinct.

Hab.—Africa; southwestern Asia; tropical America.

Two species are known in the United States:

Supraoculars present, ... 1. *G. dulcis.*
Supraoculars absent, ... 2. *G. humilis.*

Glauconia dulcis B. and G.

Rena dulcis B. and G., *l. c.*, 142; *Glauconia dulcis* Cope, *l. c.*, 590; Boul., *l. c.*, I, 65; *Leptotyphlops dulcis* Stej., Proc. U. S. Nat. Mus., 1891, 501; *Glauconia dissecta* and *G. dulcis* Cope, Rep. Nat. Mus., 716, 717.

Size small; two or three pairs of plates in front of frontal; a supraocular plate on each side with a smaller one between them; nasal divided; scales in 14 rows. Length about 200 mm. (tail about one-twentieth). Pale brown above; white on belly.

G. dissecta Cope, may prove to be distinct, but the inconstancy of the head shields in these low, burrowing forms is a strong presumption against it.

Hab.—Texas, New Mexico and Mexico.

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[5] *Occasional Papers of the California Academy of Science*, No. 5, 1897.

Glauconia humilis B. and G.

Rena humilis B. and G., *l. c.*, 143, and Cope, *l. c.*, 590; *Glauconia humilis*, Boul., *l. c.*, I, 70, and Cope, Rep. Nat. Mus., 719; *Rena humilis* Stej., *l. c.*, 501; *Siagonodon humilis* Van Den., *l. c.*, 150.

Like *G. dulcis*, but no supraoculars; the oculars being separated by one shield instead of three.

Hab.—Arizona, southern and Lower California; Mexico.

BOIDÆ.

LICHANURA Cope.

Proc. Acad. Phila., 1861, 304; *l. c.*, 590; Rep. Nat. Mus., 722; Boul., *l. c.*, I, 129.

Head covered with scales; two nasals; no labial pits; eye with vertical pupil; body short and stout; tail short, blunt and slightly prehensile; subcaudals undivided.

Hab.—Southwestern North America.

Lichanura roseofusca Cope.

Proc. Acad. Phila., 1868, 2; *L. roseofusca* and *orcutti* Cope, *l. c.*, 591, 592, and Rep. Nat. Mus., 724, 726; *L. orcutti* Stej., Proc. U. S. Nat. Mus., 1889, 96; *L. trivirgata* (part) Boul., *l. c.*, I, 129.

Head slightly distinct; rostral prominent; eye surrounded with a ring of nine or ten scales; anterior nasals in contact; 4–6 small plates behind the nasals, rest of head covered with small scales; body cylindrical; scales small and smooth, in 33–43 rows; ventrals 224–241; subcaudals 39–47. Total length about 980 mm. (tail 110).

Grayish or brownish above, sometimes with three rather indistinct brown stripes on the body; belly yellowish or reddish, irregularly mottled with brown.

Mr. Stejneger has clearly shown the great variability of scutellation in these snakes,[6] and the very wealth of observation which he brings forward destroys the value of the chief character upon which *L. orcutti* rests; the presence of an additional loreal. In addition to which is the fact that in the *Boidæ* these plates are so inconstant as to be without classificatory meaning.

Hab.—Southern California and Arizona. A closely related species, *L. trivirgata*, is found in Lower California.

[6] *Proc. U. S. Nat. Mus.*, 1891, p. 511.

CHARINA Grey.

Cat. Sn. Br. Mus., 113 (1849); Cope, *l. c.*, 592 ; Boul., *l. c.*, I, 130.

Anterior teeth longest; head covered with shields; a frontal plate; two nasals, eye small with vertical pupil; tail short, not prehensile; subcaudals undivided.

Hab.—Western coast of North America.

Charina bottæ Blainville.

Tortrix bottæ Blain., Nouv. Ann., 1834, 57, Pl. XXVI, fig. 1; *Wenona plumbea* and *isabella* B. and G., *l. c.*, 139, 140; *Charina bottæ* Cope, *l. c.*, 592, and Rep. Nat. Mus., 728; *C. bottæ* Boul., *l. c.*, I, 130.

Body short and stout; rostral prominent; two nasals, the anterior frequently fused with the internasals; loreal sometimes fused with prefrontals; head plates variable; upper labials 8–11; scales smooth in 37–49 rows; ventrals 192–211; anal entire; subcaudals 20–37, mostly entire. Total length about 550 mm. (tail 50). Grayish to brownish above, yellow beneath.

In the present genus Mr. Stejneger has again demonstrated the worthlessness of characters drawn from the scales,[7] although he prefers to provisionally retain *plumbea* B. and G. The difference of four rows of scales between the type of *bottæ* and the minimum of *plumbea* is much less than the normal range of variability in almost every known species of *Boidæ*.

Hab.—Oregon to Lower California and Nevada.

Charina brachyops Cope.

Proc. U. S. Nat. Mus., 1888, 88; *l. c.*, 592, and Rep. Nat. Mus., 727; Boul., *l. c.*, I, 131.

One specimen only is known of this species. It differs from *bottæ* in that the posterior prefrontal forms a part of the orbit, and the loreal is absent, leaving the postnasal in contact with the preocular. The constancy of these characters is not known, and the form is retained provisionally.

Hab.—Point Reyes, California.

[7] *Proc. U. S. Nat. Mus.*, 1890, p. 177.

COLUBRIDÆ.[8]

Key to the Genera.

I. AGLYPHA :

A.—Posterior dorsal hypapophyses present:
- *a.*—Maxillary teeth longer behind; scales keeled:
  - *a*[1].—Anal entire; no scale pits, ... EUTÆNIA.
  - *b*[1].—Anal divided:
    - 2 internasals; scale pits present, TROPIDONOTUS.
    - 2 internasals; no scale pits; keeled only on tail, SEMINATRIX.
    - 1 internasal; no scale pits; keeled only on tail, HELICOPS.
- *b.*—Maxillary teeth equal; scales keeled:
  - *a*[1].—Anal entire, ... TROPIDOCLONIUM.
  - *b*[1].—Anal divided:
    - *a*[2].—Loreal absent, ... STORERIA.
    - *b*[2].—Loreal present:
      - *a*[3].—1 nasal; 1 preocular, . . CLONOPHIS.
      - *b*[3].—2 nasals; preocular absent:
        - 2 internasals, ... AMPHIARDIS.
        - 1 internasal, ... HALDEA.

B.—Posterior dorsal hypapophyses absent:
- *a.*—Maxillary teeth equal, or nearly so:
  - *a*[1].—Anal entire:
    - *a*[2].—Scales smooth; size large:
      - Snout normal; scales less than 17 rows, SPILOTES.
      - Snout elongate; scales more than 25 rows, RHINECHIS.
    - *b*[2].—Scales smooth; size small and slender; no loreal; pre- and postfrontals touching labials, STILOSOMA.
    - *c*[2].—Scales keeled; size large; 4–6 prefrontals, PITYOPHIS.
  - *b*[1].—Anal divided:
    - *a*[2].—Scales keeled:
      - 2 nasals; size large; spotted or striped, COLUBER.
      - 1 nasal; size small; color green, CYCLOPHIS.

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[8] Although not strictly followed here, the plan of serial arrangement of the genera of *Colubridæ* adopted by Mr. Boulenger possesses a decided advantage, in that it does not pretend to a knowledge of close affinities which we have not gained.

b^2.—Scales smooth:

a^3.—Loreal and preocular present:

1 preocular; 1 nasal; color not green, CONTIA.

1 preocular; 1 nasal; color green, LIOPELTIS.

2 preoculars; 2 nasals, DIADOPHIS.

b^3.—Preocular absent:

2 internasals; 2 nasals; size small, VIRGINIA.

2 internasals; 1 nasal; large; bluish-black with red stripes, . . ABASTOR.

1 internasal; 1 nasal; large; bluish-black with red spots, . . FARANCIA.

1–2 or no internasals; 1 nasal; small; brown, ... CARPHOPHIS

c^3.—Loreal absent:

Nasal usually fused with first labial, FICIMIA.

Nasal usually fused with internasal, CHILOMENISCUS.

b.—Maxillary teeth longer behind; no interspace:

a^1—Anal divided:

Rostral normal, ... ZAMENIS.

Rostral with projecting edges, SALVADORA.

b^1.—Anal entire:

a^2.—2 nasals:

Rostral normal; subcaudals divided OPHIBOLUS.

Rostral projecting; subcaudals entire, RHINOCHILUS.

b^2.—1 nasal; rostral projecting, CEMOPHORA.

c.—Maxillary teeth longer behind; an interspace:

a^1.—Anal entire; 3-4 loreals; rostral with projecting edges, ... PHYLLORHYNCHUS.

b^1.—Anal divided; 1 loreal:

Scales keeled; rostral recurved, HETERODON.

Scales smooth, with pits; 2 preoculars, HYPSIGLENA.

Scales smooth, without pits; 1 preocular, RHADINEA.

II. OPISTHOGLYPHA:

a.—Anterior maxillary teeth elongated; 2 loreals, TRIMORPHODON.

b.—Anterior maxillary teeth not elongated:

a[1].—Loreal present:

Scale pits present; eye with vertical pupil, SIBON.

Scale pits absent; eye with round pupil, ERYTHROLAMPRUS.

b[1].—Loreal absent, ... TANTILLA.

III. PROTEROGLYPHA:

Scales smooth in 15 rows; red, with black and yellow rings, ELAPS.

EUTÆNIA B. and G.

l. c., 24 (1853); *Chilopoma* Cope, Wheeler Surv., 543; *Atomarchus* Cope, Am. Nat., 1883, 1300; *Eutænia* Cope, *l. c.*, 645, and Rep. Nat. Mus., 1014; *Tropidonotus* (part) Boul., *l. c.*, I, 192; *Thamnophis* Stej., No. Am. Fauna, 7, 210.[9]

Maxillary teeth smooth, gradually increasing behind, last 2–3 rather abruptly enlarged; head scales normal; 1 loreal; 2 nasals; 2 internasals; body stout to very slender; head distinct; scales keeled, without pits in 17–23 rows; anal entire.

Hab.—North America and Mexico.

The snakes of this genus seem open to every possibility of variation; they exist everywhere in great numbers between the fiftieth and fifteenth degrees of latitude; many of them are of semi-aquatic habits, and the complexity of their pattern easily runs into irregularities, the reckless naming of which has added to the confusion. In *The Primary Factors of Organic Evolution*, p. 63 (1896), Prof. Cope states that he recognizes forty-nine species and subspecies in this genus. Nevertheless, if the systematist will but remember that heredity does not act with the exact methods of mechanical reproduction, certain fairly definite groups may be made out, to which these anomalies may with some certainty be assigned.

[9] In this paper Mr. Stejneger endeavors to substitute for the well-established *Eutænia* B. and G. Fitzinger's name *Thamnophis* (*Syst. Rept.*, p. 26, 1843), and seeks to remove that author's undefined genera from the class of *nomina nuda*, by the statement that "the simple fact that Fitzinger expressly indicated the type of the genus at once removes them from that category." It is true that it does so by rule of the American Ornithologists' Union, but elsewhere, and in my opinion properly, the best usage refuses to sanction these names.

Key to the Species.

I. Body with longitudinal stripes; 2 labials in orbit:

A.—Body very slender; tail long; lateral stripe on third and fourth rows; all scales keeled, in 19 rows:

a.—Tail $\frac{1}{3}$ of length, or rather more:

7 upper labials; brown with 3 yellow stripes, 1. *E. saurita.*

8 upper labials; olive; dorsal usually absent, 2. *E. sackeni.*

b.—Tail $\frac{1}{3}$ of length or rather less; 8 upper labials, 3. *E. proxima.*

B.—Body stouter; tail shorter:

a.—Scales in 21 rows (occ. 19):

a^1.—Lateral stripe on third and fourth rows:

Usually 8 labials; 21 rows, . 4. *E. megalops.*

Usually 7 labials; occ. 19 rows, 5. *E. radix.*

b^1.—Lateral stripe on second and third rows; labials 8 (occ. 19 rows and 7 labials), 6. *E. elegans.*

b.—Scales in 19 rows (occ. 21):

Usually 8 labials; head broad, . . 7. *E. eques.*

Usually 7 labials; head narrow, . 8. *E. sirtalis.*

II. Body without stripes; 21 rows:

1 labial in orbit; brown with 7 rows of spots, 9. *E. multimaculata.*

2 labials in orbit; brown with small reddish spots anteriorly, 10. *E. rufopunctata.*

Eutænia saurita L.

Coluber saurita L., Syst. Nat., XII, 385 (1766); *Eutænia saurita* B. and G., *l. c.*, 24; Cope, *l. c.*, 650, and Rep. Nat. Mus., 1020; *Tropidonotus saurita* (part) Boul., *l. c.*, I, 212.

Upper labials 7 (rarely 8); oculars 1–3; temporals 1–2 (3); body slender and elongated; tail from .36 to .28 of total length; scales in 19 rows, all keeled; ventrals 150–170; subcaudals 95–120; chocolate brown, with three yellow stripes, the lateral on the third and fourth rows; belly yellow or greenish white; top of head dark brown; a spot on parietals; labials yellow, unmarked. The largest specimen I have seen is in the Academy's collection, from Minnesota, and measures 865 mm. (tail 240). As is usually the case with large examples, the tail is here rather short, about .27.

Hab.—United States, east of Mississippi river.

Eutænia sackeni Kennicott.

Proc. Ac. Phil., 1859, 98; Cope, *l. c.* 650, and Rep. Nat. Mus., 1019; *T. saurita* (part) Boul., *l. c.*, I, 212.

Scutellation and proportions as in *saurita*, but the upper labials are almost invariably 8, instead of 7. The color is greenish olive, or blackish in old specimens, and the dorsal stripe is usually absent, in such cases showing faintly for a short distance behind the head. Total length 710 mm. (tail 255).

Hab.—Florida.

Eutænia proxima Say.

Coluber proximus Say, Long's Exp., I, 187 (1823); *Eutænia proxima* and *E. Faireyi* B. and G., *l. c.*, 25; *E. proxima* Cope, *l. c.*, 650, and Rep. Nat. Mus., 1022; *T. saurita* (part) Boul., *l. c.* I, 212.

Head small; body slender, though stouter and with shorter tail than in the preceding species; upper labials 8; oculars 1–3; temporals 1–2 (3); scales in 19 rows, all keeled; ventrals 165–178; subcaudals 91–115; dark olive or brownish to almost black; dorsal stripe distinct, bright yellow to orange; lateral stripe on third and fourth rows, usually pale or greenish yellow; belly yellow or green, usually without markings; top of head dark, with a parietal spot; labials colored like the belly. Sometimes the dorsal and lateral stripes are of the same color; very dark specimens with such stripes, chiefly from the northern portions of its range, are *faireyi* B. and G. These have often a slightly longer tail, but the differences are not constant. The usual length of large examples from the Mississippi valley is about 800 mm., of which the tail is from .33–.28, but a living specimen lately received by the Zoölogical Society from Pecos, Tex., is 1160 mm. long (tail 280). In this the tail is but .24 of the length, being the shortest I have met with in the species. The dorsal stripe is a rich red.

Hab.—Indiana and Illinois to southern Mexico, and west through Texas. It is not certainly known from east of the Mississippi except in the States named.

Eutænia radix B. and G.

l. c., 34; Cope, *l. c.*, 650, and Rep. Nat. Mus., 1026; *T. ordinatus* var. *radix* Boul., *l. c.*, I, 211.

Body moderately stout; head broad; upper labials 7 (occ. 8); oculars 1–3; temporals 1–2; ventrals 145–170; subcaudals 51–70; scales in 21 or 19 rows, all keeled, the outer slightly. Brown, olive or almost black, with three stripes, the dorsal usually golden or orange, and the laterals on the third and fourth row, paler yellow; the spots are distinct except when the body color is so dark as to obscure them; belly green to slaty black, with a dark spot at the base of each ventral near the end; parietal spot usually present; labials yellowish or green, heavily margined with dusky. Total length 750 mm. (tail from .20–.24).

Although *radix* usually has 21 rows of scales, four out of five specimens which I have lately received from eastern Missouri have 19.

Hab.—From the Rocky Mountains to Indiana, and the British possessions to Texas. The common species of the plains.

Eutænia megalops Kennicott.

Proc. Acad. Phila., 1860, 330.

Confusion has been introduced into this species by inaccurate description and identification. Typical *megalops* is from Arizona; its Mexican representative is *macrostemma* Kenn. Sundry specimens of the latter Prof. Cope described under the name *insigniarum*, attributing to it markings obscure or wanting, as compared with *macrostemma;* five specimens in the Academy's collection from the City of Mexico, referred by Cope himself to *insigniarum*, do not, however, bear out this statement, and I can see no reason for regarding that form as distinct from *macrostemma*,[10] which probably does not enter the United States.

Eutænia megalops megalops Kennicott.

l. c., 330; *E. megalops* and *E. macrostemma insigniarum* (part) Cope, *l. c.*, 650, 651; *T. ordinatus* var. *macrostemma* (part) Boul., *l. c.*, I, 212; *E. megalops* and *E. macrostemma* Cope, Rep. Nat. Mus., 1025, 1029.

Body moderately stout; tail from .19–.26 of length; eye large; scales in 21 rows, the outer irregularly keeled; upper labials 8 (9), the last one small; temporals 1–2 (3). Brown or ashy with three narrow yellow stripes, the lateral on third and fourth rows; spots present, but not very distinct; belly usually green, bases of ventrals dusky; no parietal nor nuchal spots; a small post-oral crescent sometimes present; labials slightly margined; ventrals 158–164; subcaudals 52–65. Total length of two specimens from Tucson: 740 mm. (tail 140), 690 mm. (tail 140). Three specimens of this snake were sent to the Zoölogical Society in 1891,

[10] In his latest work Cope himself abandons *insigniarum* in favor of *macrostemma.*

from Tucson, Ariz., by Mr. Herbert Brown, and were ascribed by Cope (*l. c.*, p. 651) to *insigniarum.* They were at the time considered by me to be *megalops.* They are now in the Academy's collection, and reëxamination shows that they do not correspond to Cope's description of the first species, nor to five examples of that supposed form from Mexico, but they do agree in all respects with Kennicott's description of *megalops*, except that the spots are slightly more distinct and the upper labials are variable; one has them 8–8, another 8–9, and the third 9–9. In the five *macrostemma* Kenn. (= *insigniarum* Cope) from Mexico, the largest of which measures 990 mm., I find the tail to be about one-fourth of the length, or longer than in most adult *megalops*, which reverses the proportions given by Cope; a smaller *megalops* from Duck creek, New Mexico, in the Cope collection, 610 mm. long, has the tail about .26, and more ventrals and subcaudals, but is otherwise exactly like my Tucson specimens.

Hab.—New Mexico, Arizona and northern Mexico.

Eutænia elegans B and G.

l. c., 34.

As a rule *elegans* has 21 rows of scales and 8 labials, but variations to 19 rows and 7 labials are not uncommon, and in one form 23 rows sometimes appear; oculars 1 (2)–3 (4); temporals 1–2 (sometimes 1–1 or 1–3); posterior chin shields about equal in length to the anterior; head rather small; eye small or moderate; size rather smaller than *E. sirtalis;* tail .19–.25 of length; ventrals 144–180; subcaudals 53–90. The lateral stripe is on the second and third rows; the diversity of color is considerable, and is best stated under subspecific heads. *E. elegans* is a western form, ranging from the central plains to the Pacific coast.

Key to the Subspecies.

a.—Post-oral crescent absent:

Color dark; spots and lat. stripe often indistinct, 1. *E. e. elegans.*

Color lighter; spots encroaching on stripes, 2. *E. e. vagrans.*

Often 2 preoculars and 23 rows; otherwise like *vagrans*, 3. *E. e. biscutata.*

b.—Post-oral crescent present:

Spots and stripes distinct, ... 4. *E. e. marciana.*

Spots and stripes indistinct or absent, . 5. *E. e. couchi.*

Eutænia elegans elegans B. and G.

E. elegans B. and G., *l. c.*, 34; *E. e. elegans*, *E. e. plutonia* and *E. e. brunnea* Cope, *l. c.*, 653, 654, and Rep. Nat. Mus., 1035, 1037; *T. vagrans* (part) and *T. ordinatus* var. *infernalis* (part) Boul., *l. c.*, I, 202, 207; *Thamnophis elegans* (part) Van Den., Occ. Papers Cal. Ac. of Sc., No. 5, 207 (1897); *Thamnophis elegans* Stej., No. Am. Fauna, No. 7, 211.

Color usually dark brown, olive or black, obscuring the spots; dorsal stripe moderately wide and distinct, whitish, yellow or red; laterals usually, but not always, distinct; there are no nuchal spots and the labials are without dark margins; belly generally light, with a distinct yellowish tinge on the throat; eye moderate; posterior chin shields about equal the anterior; ventrals 155–172; subcaudals 57–80.

E. plutonia Yarrow was based upon two melanistic individuals, one from Arizona and the other from Washington.

I can see no valid reason for retaining *E. brunnea* Cope.

Hab.—California to Oregon.

Eutænia elegans vagrans B. and G.

E. vagrans B. and G., *l. c.*, 35; *E. e. lineolata* and *E. e. vagrans* Cope, *l. c.*, 655, 656, and Rep. Nat. Mus., 1038, 1039; *T. vagrans* (part) Boul., *l. c.*, I, 202; *Thamnophis vagrans* Stej., *l. c.*, 213; *T. vagrans* (part) Van Den., *l. c.*, 210.

E. vagrans has almost always 21 rows and 8 upper labials; ventrals 153–172; subcaudals 53–91; the eye is smaller than in *elegans* and the posterior chin shields either equal the anterior in length or are rather less. Color, greenish yellow or ashy to brown; the spots are rather small and numerous, they are usually distinct and often tend to join together, forming zigzag cross-bands; they usually encroach upon the stripes, which are whitish or yellow; the belly is frequently marbled with slate color, especially in the centre; head brown or blackish with parietal spot and nuchal blotches generally present; labials rarely dark bordered and then but narrowly.

Hab.—The region of the plains and the Pacific coast from southern California to Oregon.

Eutænia elegans biscutata Cope.

E. biscutata Cope, Proc. Acad. Phila., 1883, 21; *l. c.*, 651, and Rep. Nat. Mus., 1032; *T. vagrans* (part) Boul., *l. c.*, I, 202; *Thamnophis vagrans biscutata* Van Den., *l. c.*, 212.

This form was established by Prof. Cope upon a melanistic specimen of small size, with two preoculars and 21–22 rows of scales.

Mr. Van Denburgh has examined a number which have 2, 3, and occasionally 1 preocular; sometimes 7 labials and 21–23 rows; all these being from Washington and Oregon. Allowing for doubt as to the significance of these variations, the form may be provisionally retained as a subspecies of *E. elegans*.

Eutænia elegans marciana B. and G.

> *E. Marciana* B. and G., *l. c.*, 36; *E. e. marciana* Cope, *l. c.*, 656, and Rep. Nat. Mus., 1045; *E. nigrolateris* A. Brown, Proc. Acad. Phila., 1889, 421; *T. ordinatus* var. *marcianus* Boul., *l. c.*, I, 211.

Largest of the subspecies; 21 rows of scales; upper labials 8; temporals 1–2 (3); posterior chin shields rather longest; ventrals 149–163; subcaudals 53–85. Light brown or ashy; dorsal stripe narrow and not always distinct; laterals of the same shade, but frequently merged into the belly color; spots distinct and conspicuous, sometimes encroaching a little upon the stripes; belly light with a dark spot at the base of each ventral near the end; nuchal and parietal spots present; labials heavily bordered, and a conspicuous pale post-oral crescent.

E. nigrolateris A. Brown was based upon an individual from Tucson, the most striking character of which, apart from obvious abnormalties, was the extension of the preocular upward to meet the frontal. Since then I have examined several *marciana* which exhibit a tendency in this direction.

Hab.—Central Texas to western Arizona.

Eutænia elegans couchi Kennicott.

> *E. couchii* Kenn., Pac. R. R. Rep., 10 (1857), and *E. hammondii* Kenn., Proc. Acad. Phila., 1860, 332; *E. e. couchii* Cope, *l. c.*, 656, and Rep. Nat. Mus., 1042; *T. ordinatus* vars. *couchii* and *hammondii* Boul., *l. c.*, I, 210; *Thamnophis hammondii* Van Den., *l. c.*, 212.

Moderately stout; 21 rows of scales (occ. 19); upper labials 8 (rarely 7); posterior chin shields longest; ventrals 159–173; subcaudals 68–85. Grayish brown, dark brown or olive; dorsal stripe narrow, indistinct or absent; lateral stripe not very distinct; spots almost always absent, although a few black dots are sometimes visible on the scales; belly yellowish to black; labials dark bordered; nuchal blotches present; post-oral crescent less distinct than in *marciana*.

Hab.—California and Arizona.

Eutænia eques Reuss.

Coluber eques Reuss., Mus. Senck., I, 152;[11] *E. cyrtopsis*, *E. c. ocellata* and *E. aurata* Cope, *l. c.*, 656, 659; *T. ordinatus* var. *eques* (part) Boul., *l. c.*, I, 209; *E. eques* Cope, Rep. Nat. Mus., 1049.

Body moderately stout; head broad behind; eye large; scales in 19 rows, the outer smooth or faintly keeled; upper labials 8; oculars 1–3; temporals 1–3; posterior chin shields much the longest. Brownish olive; dorsal stripe narrow, said to be red in life; laterals paler, on the second and third rows; two series of large black spots between the dorsal and lateral stripes; anteriorly and on the middle of the body the spots often fuse transversely, forming zigzag bands; the spots encroach considerably upon the stripes, sometimes breaking through the lateral one, especially anteriorly; a third row of spots on the outer row of scales and the ends of the ventrals; belly whitish, each scutum black at the base on the ends; top of head olive; large and conspicuous nuchal blotches; labials yellowish white bordered with black; chin yellowish; ventrals 151–169; subcaudals 64–74; tail about .23 of length.

According to Dr. Coues, this species grows to quite the size of *E. sirtalis* around Fort Whipple, Ariz.

E. cyrtopsis ocellata Cope was founded upon specimens collected by G. W. Marnock at Helotes, Tex., in which the lateral stripe is cut completely through in places by the lower row of dorsal spots. There are two specimens in the Cope collection from the same locality and collector; one in every way corresponds with Kennicott's description of *cyrtopsis*, the other is *ocellata* for about four inches behind the head, and *eques* on the rest of the body.

It is not easy to reconcile the original description of *E. aurata* Cope with the type and only specimen, which is simply a well-fattened and stout *eques*, with the spots obscure, though indicated. The specimen is mutilated and the brown color has disappeared in the preservative fluid, but in every character not dependent upon prominence of the spots, it belongs to the present species.

Hab.—Western Texas to Arizona; northern Mexico.

Eutænia sirtalis L.

Coluber sirtalis L., Syst. Nat., Ed. X, 222 (1758).

This is rather a stout species; head distinct and moderately large; tail from .20 to .25 of the length; oculars 1 (2)–3 (4);

[11] I have been unable to verify this reference, and it is adopted here on the authority of Boulenger and Cope.

temporals 1 anterior, with 1, 2 or 3 in the second row; upper labials almost always 7, but in one subspecies 6 or 8; posterior chin shields longest; scales in 19 rows (occ. 17 or 21), the outer row smooth or faintly keeled; ventrals 138–165; sub-caudals 55–85. The color range is very great: bluish, green, olive, brown and almost black, usually with a dorsal stripe and a lateral on the second and third rows, and three rows of spots on the back and side; any or all of these may be absent; belly yellow, green or black, generally with a roundish spot near the end of each ventral; the head is dark above, usually with a parietal spot; labials margined with dusky. Maximum length about 900 mm.

Hab.—The whole of North America, wherever snakes are found, and extending into Mexico.

Key to the Subspecies.

Green, with spots, usually no stripes, . . . 1. *E. s. ordinatus.*
Stripes and spots present; no red on sides, . . 2. *E. s. sirtalis.*
Stripes and spots often obscure; generally red on sides,
3. *E. s. parietalis.*
Color very dark; 3 stripes; belly blue-black, 4. *E. s. pickeringi.*
Color dark, 3 stripes; head small; often 17 rows,
5. *E. s. leptocephala.*

Eutænia sirtalis ordinata L.

Coluber ordinatus L., Syst. Nat., Ed. XII, 379 (1766); *E. s. ordinata* and *E. s. graminea* (part) Cope, *l. c.*, 662, and Rep. Nat. Mus., 1066, 1067; *T. ordinatus* forma *typica* Boul., *l. c.*, I, 206.

Green above; usually without stripes; spots generally distinct, but in some cases obscure; belly greenish white; 19 rows of scales; 7 labials.

Hab.—United States east of Mississippi river.

Eutænia sirtalis sirtalis L.

Coluber sirtalis L., Syst. Nat., Ed. X, 222 (1758); *E. s. sirtalis, E. s. graminea* (part), *E. s. semifasciata, E. s. obscura* and *E. butleri* Cope, *l. c.*, 662, 663, 651, and Rep. Nat. Mus., 1066, 1067–74, 1031; *T. ordinatus* var. *sirtalis* (part) and var. *butleri* Boul., *l. c.*, I, 206, 212; *Thamnophis butleri* Stej., Proc. U. S. Nat. Mus., 1894, 593; *E. brachystoma* Cope, Am. Nat., 1892, 964, and Rep. Nat. Mus., 1056.

This subspecies has almost always 19 rows of scales and 7 upper labials; oculars 1–3; temporals usually 1–2 (3), occasionally 1–1; the color is variable, but is usually brown, bluish or green, with the three light stripes well defined; spots rather large and usually distinct; top of head dark; parietal spot present; labials yellowish or greenish, with dark borders; ventrals 138–165; subcaudals 61–80. Length, 750 to 950 mm., of which the tail is from .20 to .25.

Some of the specimens referred by Prof. Cope to *E. s. graminea* have the stripes more or less distinctly marked; these I assign to the present form.

E. s. semifasciata Cope is based upon a few individuals in which the spots are somewhat confluent anteriorly—a disposition by no means uncommon in many of the species of this genus.

Specimens in the Academy's collection labeled *obscura* by Cope plainly show the dorsal spots, although not prominently; similar individuals may be found in almost any lot of *E. s. sirtalis* collected in one locality; western examples of *obscura* are probably referable to *E. s. parietalis.* The only thing which appears to me out of the ordinary about the form, is that any one should have thought of giving it a name.

The basis of *E. butleri* Cope was a specimen from Richmond, Indiana, the special characters of which were: the great width of the lateral stripe, covering three rows of scales; the black borders of the stripes; the absence of defined spots and of markings on the head and labials, and the presence of but one temporal in the second row. To these distinctions Mr. Stejneger has added, from a second specimen in the National Museum, that the eye is strikingly small. I have not seen the type specimen, from Richmond, but two others (No. 6523, Ac. coll.) from southeastern Indiana, labeled by Cope *E. butleri*, present intermediate characters. In these examples, the lateral stripe nowhere "covers" the second, third and fourth rows, being everywhere restricted to the lower half of the fourth, and anteriorly, where it most extends on the fourth, it barely covers the upper margin of the second, while on the hinder half of the body it is almost wholly on the second and third. The spots are not entirely absent, though obscure against the dark body color, and in one of the specimens they form narrow broken borders to the stripes, as in many of Cope's *obscura;* the posterior labials have narrow dark borders, and there is an indistinct parietal spot. Both have two temporals in the second row; in one the lower is narrow and in contact with the anterior one only by its point; in the other, the lower is much the largest; in any event *E. s. sirtalis* not infrequently has but one second temporal.

Examination of the type of *E. brachystoma* Cope leaves little ground for regarding it as anything more than a dwarfed and shortened *E. s. sirtalis.* The colors appear to have faded; on stretching the skin, indications of the dorsal spots appear, and the ventral spots of *sirtalis* are not absent, as stated in the description, but are plainly present, though small. The body is disproportionately short, as is the mouth, which, instead of reaching back as far as the hinder end of the parietals, ends quite in advance of that point; with which shortening the reduced number of labials is doubtless correlated.

Hab.—*E. s. sirtalis* is found over the United States and southern Canada, east of the great plains, but is chiefly from east of the Mississippi river.

Eutænia sirtalis parietalis Say.

> *Coluber parietalis* Say, Long's Exp., I, 186 (1823); *E. s. parietalis*, *E. s. concinna*, *E. s. tetratænia*, *E. s. dorsalis*, *E. s. obscura* (part), *E. elegans ordinoides* and *E. infernalis infernalis* (part) Cope, *l. c.*, 654-664, and Rep. Nat. Mus., 1074-1081; *T. ordinatus* var. *sirtalis* (part) and *T. o.* var. *infernalis* (part) Boul., *l. c.*, I, 206, 207; *Thamnophis parietalis* Stej., No. Am. Fauna, No. 7, 214; Van Den., *l. c.*, 201.

This subspecies has usually 19 rows and 7 labials; occasional examples have 21 rows and the labials are sometimes 8; the color is dark brown, bluish, black or even green; dorsal stripe distinct and variable in color, white, blue, yellow or red; the laterals are distinct owing to the presence of more or less of the dark body color on the outer rows and ends of the ventrals; the upper row of spots commonly fuses into a longitudinal black stripe, with which the lower row sometimes connects above; the skin on the sides is bright red, sometimes extending on to the scales so that the sides appear to have a denticulated pattern of black and red. This is often seen in living snakes only when the scales are stretched apart, but in alcoholic specimens the spaces between the lower row of spots seem to fade rapidly to white, and the denticulated pattern is then very distinct. The belly is yellow, green or bluish slate, and the spots near the ends, though small, are plainly to be seen at the base of each ventral; top of head olive or reddish yellow; an occasional labial with a narrow dark margin.

E. s. tetratænia Cope was founded upon specimens which had been many years in alcohol. One in the Academy's collection (No. 6085) from Puget Sound, formerly known as *E. concinna*, seems to have had the red lateral spaces formed into a longitudinal stripe, extinguishing the upper portion of the lower row of spots. A small snake in the same jar, of the same date and locality, is an ordinary *parietalis*.

Considering the amount of variability in the joining of the spots in *parietalis*, and also the uncertain way in which the red pigment dissolves in alcohol, I am not disposed to attach much importance to slight differences in these very old specimens.

E. dorsalis B. and G. has the upper black dorsal stripe somewhat narrower than is usual in those examples of *parietalis* in which the spots fuse into a stripe.

E. ordinoides B. and G. is said to have the sides chestnut in life, instead of bright red, but this difference is trivial and old alcoholic specimens are distinguishable only when they have 21 rows of scales and 8 labials; but as *ordinoides* and *parietalis* vary into each other in scutellation, I see no good reason for separating them, or for assigning the former to *E. elegans*, as is done by Cope.

Whatever may or may not have been *infernalis* Blainville, I have never seen a living specimen which could be referred with certainty to *infernalis* B. and G. or Cope, and I am persuaded that those so called belong in part to the present form and in part to *E. elegans*.

The dimensions of *parietalis* are about as in *E. s. sirtalis*.

Hab.—From central California north to Washington and Oregon, and through the plains from Montana to Texas.

Eutænia sirtalis pickeringi B. and G.

E. Pickeringii B. and G., *l. c.*, 27; *E. s. pickeringii* and *E. s. trilineata* Cope, *l. c.*, 665, and Rep Nat. Mus., 1082, 1083; *T. o.* var. *infernalis* (part) Boul., *l. c.*, I, 207; *Thamnophis parietalis pickeringi* Van Den., *l. c.*, 204.

Color very dark, blackish brown or black, with three narrow light stripes; belly dark greenish or slate color; throat lighter. *E. s. trilineata* Cope is simply this form with the stripes inconsiderably wider.

Hab.—Washington, Oregon and western Montana.

Eutænia sirtalis leptocephala B. and G.

E. leptocephala B. and G., *l. c.*, 29; *E. atrata* and *E. cooperi* Kenn., Pac. R. R. Survey, 296 (1860); *E. leptocephala* and *E. infernalis vidua* Cope, *l. c.*, 658, 660, and Rep. Nat. Mus., 1058, 1055; *T. leptocephalus* (part) and *T. o.* var. *infernalis* (part) Boul., *l. c.*, I, 201, 208; *Thamnophis leptocephalus* Stej., *l. c.*, 214; Van Den., *l. c.*, 205.

Size smaller and tail relatively a little longer than in *E. s. sirtalis;* body moderately stout; head small and narrow; scales in 17–19 rows; preoculars 1 or 2 (3); postoculars 3 or 4: temporals 1–1 or 1–2; upper labials usually 7, but sometimes 6 or 8; olive, greenish or blackish brown, generally with three light stripes; these are variable and sometimes absent; the three rows of spots are hardly to be seen in dark specimens; belly yellowish, greenish or dark slate; head dark, with a parietal spot; labials yellow or olive, sometimes narrowly bordered; ventrals 139–152; subcaudals 52–77. Total length of one specimen 724 mm. (tail 164); of another 723 mm. (tail 138). Nine specimens from Washington and British Columbia, collected by Samuel N. Rhoads, have 17 rows of scales; nearly all have 7 labials; one has them 7–8, and one has 8; the preoculars are 1, 2 or 3, with 2, 3 or 4 postoculars. In all the color is dark brown or black, with the spots barely visible and the lateral stripe indistinct. Individuals with 19 rows and 7 labials so closely resemble some forms of *parietalis*, and in fact some Eastern *E. s. sirtalis*, that I cannot regard it as more than a subspecies.

In *E. infernalis vidua* Cope has merely redescribed two of Kennicott's original specimens of *E. atrata*, although he does not mention the fact, while referring to the resemblance. One of Kennicott's specimens (No. 6359 Ac. coll.; original number 970), marked *vidua* by Cope, better accords with the first description than with the later one. It has 19 rows at a point about three inches behind the head, where the number rarely reaches a maximum, but on the rest of the body it has 17 as stated by Kennicott;[12] upper labials 8; oculars 1–3; temporals 1–2; ventrals 155; subcaudals 65; length 622 mm. (tail 138), or .22 of the length, being considerably shorter than the proportion given by Cope. A second specimen (No. 6584 Ac. coll.), also from San Francisco, has the dorsal stripe somewhat narrower; spots obscure, but visible

[12] Curiously enough, Cope in his last paper, p. 1059, refers to this irregularity in the number of rows as being sometimes found in *leptocephala*.

against the dark body color, and has the belly rather lighter, with clear indications of a lateral stripe on the second and third rows; ventrals 143; subcaudals 63; length 440 mm. (tail 108, or .245 of the length). In one the labials are dark lead color, in the other yellowish green, both with traces of narrow dark borders; the chin shields are not subequal in these specimens, but the hinder are noticeably the longest, as in most *leptocephala*, and the eye is small, as in that form. Mr. Van Denburgh refers *vidua* to *elegans*, but the totality of characters in the two which I have examined comples me to regard them as *leptocephala*, to which, in fact, Cope himself has already referred *atrata*, of which *vidua* in no event could be more than a synonym.

Hab.—British Columbia, Oregon, Washington and California north of San Francisco.

Eutænia multimaculata Cope.

Atomarchus multimaculatus Cope, Am. Nat., 1883, 1300; *E. multimaculata* Cope, *l. c.*, 665, and Rep. Nat. Mus., 1087; *T. multimaculatus* Boul., *l. c.*, I, 214.

Posterior maxillary teeth shorter than in the preceding species; occasionally an azygous plate between the internasals; scales in 21 rows; upper labials 8, the fourth only touching the eye; oculars 2–3; temporals 1–3.

Grayish or brown above, with about 7 longitudinal series of brown or reddish spots with lighter centres, some of which often unite transversely; ventrals yellowish with dark edges. Length about 708 mm.

Hab.—Southern New Mexico; northern Mexico.

Eutænia rufopunctata Cope.

Chilopoma rufopunctata Cope, Wheeler Survey, 544 (1875); *E. rufopunctata* Cope, *l. c.*, 666; *T. rufopunctata* Boul., *l. c.*, I, 214.

Teeth as in *multimaculata*; head narrow; rostral large and projecting; 21 rows of scales; upper labials 8, fourth and fifth touching the eye; oculars 2 (1)–3; temporals 1–3; chin shields about equal.

Light brown, anteriorly with six rows of small reddish or orange spots; belly brownish gray, base of ventrals dark; no markings on head; labials light; ventrals 177, subcaudals 87. Only one specimen known, from southern Arizona. Length 257 mm.

TROPIDONOTUS Kuhl.

Isis von Oken, 1826, 205; Boul. (part), *l. c.*, I, 192; *Natrix* Cope, *l. c.*, 667, and Rep. Nat. Mus., 957; *Nerodia* and *Regina* B. and G., *l. c.*, 38-45.

Maxillary teeth smooth, gradually increasing posteriorly, the last three or four rather abruptly enlarged; head scales normal; 1 loreal; 2 nasals; 2 internasals; body rather stout; head distinct; scales keeled with double pits in 17–33 rows; anal divided.

Hab.—Europe, Africa, Asia, Australia, America.

This genus much resembles *Eutænia*, but has a divided anal and scale pits. Being viviparous, like *Eutænia*, these snakes breed freely in captivity, and the insignificance of slight differences in color and pattern may be instructively observed in almost any single brood of young.

Key to the North American Species.

a.—Body with stripes; scales in 19–21 rows:
- *a*[1].—Preoculars 2:
  - Brown; 3 black stripes on back; 4 on belly, 1. *T. leberis.*
  - Olive brown, with 4 narrow stripes on back, 2. *T. grahami.*
  - Brown, with 2 narrow stripes on back, 3. *T. rigida.*
- *b*[1].—Preocular 1:
  - Yellowish brown; 4 dark brown stripes on back, 4. *T. clarki.*

b.—Body with spots or cross bands:
- *a*[1].—Scales in 19–21 rows; brown, with indistinct spots or cross-bands, ... 5. *T. compressicauda.*
- *b*[1].—Scales in 23–25 rows; brown with alternating spots or cross-bands, ... 6. *T. sipedon.*[13]
- *c*[1].—Scales in 27–29 rows:
  - 27 rows; large alternating spots, . 7. *T. rhombifer.*
  - 29 rows; narrow cross-bands; eye with circle of scales, 8. *T. cyclopeum.*
- *d*[1].—Scales in 29–33 rows; size large; alternating spots; parietals broken up, ... *T. taxispilotus.*

Tropidonotus leberis L.

Coluber leberis L., Syst. Nat., Ed. X, 216 (1758); *Regina leberis* B. and G., *l. c.*, 45; *Natrix leberis* Cope, *l. c.*, 668, and Rep. Nat. Mus., 993; *T. septemvittatus* Boul., *l. c.*, I, 239.

Size moderate; oculars 2–2; temporals 1–2; upper labials 7;

[13] *Tropidonotus bisectus* Cope (*Proc. U. S. Nat. Mus.*, 1887, p. 146) is obviously abnormal in some, at least, of its characters. Its locality is uncertain and is probably referable to some form of *T. sipedon.*

scales in 19 rows; ventrals 146–151; subcaudals 64–86. Dark brown above with three narrow longitudinal black stripes on the back; a yellow stripe on the two outer rows of scales; belly yellowish with four black stripes. Length 580 mm. (tail 154).

Hab.—United States east of the Mississippi; not common in Florida.

Tropidonotus grahami B. and G.

Regina Grahamii B. and G., *l. c.*, 47; *Natrix grahamii* Cope, *l. c.*, 668, and Rep. Nat. Mus., 991; *T. grahami* Boul., *l. c.*, I, 240.

Size moderate; oculars 2–2 (3); temporals 1–2; upper labials 7; scales in 19 rows (occ. 21); ventrals 150–173; subcaudals 45–65. A light brown or clay-colored dorsal stripe, one and a half scales wide, bordered by a narrow black line; below this, an olive-brown stripe three scales wide, bordered below by another black line on the fourth row; belly and three outer rows straw yellow. There is a narrow black line along the juncture between the ventrals and the outer scale row, and frequently another along the middle of the ventrals. In old individuals the colors darken and the appearance is sometimes presented of a brown snake with three narrow black stripes on each side. Length 880 mm. (tail 130).

Hab.—The Mississippi valley, from Michigan to Texas.

Tropidonotus rigidus Say.

Coluber rigidus Say, Jour. Acad. Phila., IV, 1825, 239; *Regina rigida* B. and G., *l. c.*, 49; *Natrix rigida* Cope, *l. c.*, 668, and Rep. Nat. Mus., 989; *T. rigidus* Boul., *l. c.*, I, 240.

Size rather small; oculars 2–2; temporals 1–2; upper labials 7; 19 rows of scales; ventrals 132–142; subcaudals 51–71.

Greenish brown, with two narrow black stripes on the back; labials and belly yellow, with two series of black spots on the ventrals, which sometimes merge into a clouded stripe in front and behind. Length 536 mm. (tail 102).

Hab.—Pennsylvania, south and southwest to the Gulf; rare in Florida.

Tropidonotus clarkii B. and G.

Regina Clarkii B. and G., *l. c.*, 48; *Natrix clarkii* Cope, *l. c.*, 669, and Rep. Nat. Mus., 987; *T. clarkii* Boul., *l. c.*, I, 238.

Size moderate; oculars 1–3 (2); temporals 1–3 (2); upper labials 8 (occ. 7); scales in 19 or 21 rows; ventrals 130–135; subcaudals 57–68.

Dark olive brown above, with three light olive stripes, the dorsal one three scales wide, and the lateral on the third, fourth and part of the fifth rows; belly yellow in the middle and light olive on the sides and outer row of scales; an irregular clouded stripe of reddish brown on each side of the median yellow tract. Length 806 mm. (tail 168).

Hab.—Western Louisiana and Texas.

Tropidonotus compressicaudus Kennicott.

Proc. Acad. Phila., 1860, 335.

Size moderate; tail somewhat compressed; scales in 19 or 21 rows, very occasionally 23; oculars 1–3 (2); temporals 1–3 (2); upper labials 8. The pattern in this species is not distinct, and is best seen in the young. The body color is greenish olive, with a dorsal row of black spots and a smaller series on each side. The spots are confused and irregular, the laterals being sometimes opposite the dorsals and sometimes alternating with them; they tend to fuse together, forming cross-bands, which when they alternate, are zigzag. The anterior spots in many specimens merge lengthwise into more or less distinct stripes on the neck, which at times extend some distance on the body. The belly is yellowish or ashy, commonly blotched with black, more heavily posteriorly; anteriorly each ventral is margined with black, leaving a transverse elliptical yellow mark in the centre, with sometimes a row of similarly colored small spots on each end. Top of the head greenish olive, often with an elongated black blotch on the frontal and parietals; labials yellow, more or less margined with black.

Two color forms may be distinguished :

Three rows of spots; traces of stripes on neck, 1. *T. c compressicaudus.*

Cross-bands on body; black stripes on neck, . . 2. *T. c. ustus.*

Tropidonotus compressicaudus compressicaudus Kenn.

Nerodia compressicauda Kenn., Proc. Acad. Phila., 1860, 335; *Natrix compressicauda* Cope, *l. c.*, 669, and Rep. Nat. Mus., 979; *T. compressicaudus* (part) Boul., *l. c.*, 1, 238.

Grayish olive or ashy, with about forty dark spots on the back, distinct but irregular; the dorsal and lateral series mostly alternating, sometimes forming cross-bands in front. Indications of short stripes on the neck.

A small specimen collected by Mr. C. B. Moore, on Pine Island, Charlotte Harbor, has 133 ventrals; 74 subcaudals; length

255 mm. (tail 68). The species reaches a length of about 600 mm.

Hab.—Florida.

Tropidonotus compressicaudus ustus Cope.

T. ustus Cope, Proc. Acad. Phila., 1860, 340; *Natrix usta*, *N. compressicauda bivittata*, *N. c. walkerii*, *N. c. compsolæma* Cope, *l. c.*, 668, 669, 670, and Rep. Nat. Mus., 981–983; *N. c. tæniata* Cope, Am. Nat., 1895, 676; *T. compressicaudus* (part) Boul., *l. c.*, I, 238.

In this form the spots join to form more or less distinct cross-bands, some thirty-five to forty on the body; these are frequently obscure, especially in adults; the neck stripes occasionally extend some distance toward the tail. The body color is frequently pale yellow, more or less suffused with the reddish tinge common in many species of this genus. The whole pattern is indefinite and hardly any two specimens are alike; upon these trivial differences the forms given in the synonymy have been based.

Hab.—Florida.

Tropidonotus sipedon L.

Coluber sipedon L., Syst. Nat., Ed. X, 219 (1758).

Size moderate, to large and stout; scales in 23 or 25 rows; upper labials 8 (occ. 9); oculars 1–3 (2); temporals 1–3; ventrals 125–155; subcaudals 59–82.

In this species the color is brown, yellowish or red above, with darker transverse bands or spots on the back, or both in combination; the belly is yellowish, either spotted or unmarked. The pattern is distinct in the young, but the body color becomes dark in old specimens, until the markings are often wholly obliterated. Three well-marked color forms may be distinguished, of which *T. s. sipedon* is the common "water snake" of the Eastern Middle States; *T. s. fasciatus* of the Southern and Gulf States, and *T. s. transversus* seems to be restricted to the western part of the lower Mississippi valley.

a.—Ventrals spotted:
  Cross-bands on whole of back, . . . 1. *T. s. fasciatus.*
  Cross-bands in front; spots posteriorly, . 2. *T. s. sipedon.*
b.—Ventrals not spotted; whole body with alternating spots,
  3. *T. s. transversus.*

Tropidonotus sipedon fasciatus L.

Coluber fasciatus L., Syst. Nat., Ed. XII, 378 (1766); *Nerodia fasciata* and *N. erythrogaster* B. and G., *l. c.*, 39, 40; *Natrix fasciata fasciata, N. f. pleuralis* and *N. f. erythrogaster* Cope, *l. c.*, 673, and Rep. Nat. Mus., 965, 973, 975; *N. f. pictieventris* Cope, Am. Nat., 1895, 677, and Rep. Nat. Mus., 969; *T. fasciatus* (part) Boul., *l. c.*, I, 242.

Size large; body stout; scales in 23 rows (rarely 25); upper labials 8; oculars 1–3 (2); temporals 1–3; ventrals 125–155; subcaudals 60–82.

Yellowish, yellowish red, or brown above, with from twenty to thirty darker transverse bands on the back, narrowing on the sides, and sometimes red spots on the sides; sometimes the bands are more or less broken posteriorly; belly whitish yellow or salmon color, blotched with yellow, red or black; very often each ventral is margined all around with the darker shade; top of the head uniformly dark, generally olive; an oblique dark streak behind the orbit; labials margined with dark brown. Old specimens become very dark. A large one from Georgia, now living in the Zoölogical Gardens, is sooty black with traces of red markings on the flanks; in this specimen the posterior third of the belly is almost wholly black. Another from Florida has the body color brick red on the back, becoming almost vermilion on the sides, the cross-bands being reddish with a mixture of olive; the ventrals are yellow or orange, mostly bordered all around with darker orange. This merely fortuitous phase is *pictieventris* Cope.[14]

A young specimen, now in the Academy's collection, bred in the Zoölogical Gardens from a typical *fasciatus*, shows at the age of one day, transverse bands, posteriorly much broken up into spots. With the darkening and consequent obscurity of color, especially along the dorsal area, which results from age, this specimen would develop the pattern attributed to *pleuralis* Cope.

I have no knowledge of small individuals of *erythrogaster* Shaw, and there is not the least doubt in my mind that this form is again the result of darkening with age of the red specimens of *fasciatus* described above; although it may be that some northern examples should be referred to *T. s. sipedon.*

The largest of this subspecies which I have seen, measured 1270 mm. (tail 300).

Hab.—Virginia to Florida and west to Texas.

[14] This identification is given on the authority of Prof. Cope, who declared that this specimen belonged to his new subspecies.

Tropidonotus sipedon sipedon L.

Coluber sipedon L., Syst. Nat., Ed. X, 219 (1758); *Nerodia sipedon* B. and G., *l. c.*, 38; *Natrix fasciata sipedon* Cope, *l. c.*, 671, and Rep. Nat. Mus., 969; *T. fasciatus* (part) Boul., *l. c.*, I, 242.

Size moderate; almost invariably 23 rows and 8 upper labials; old specimens sometimes much resemble some phases of *T. s. fasciatus*, but as a rule the body is less stout. When clear enough to be distinguished, the pattern consists of a series of large brown dorsal spots, separated by very narrow light interspaces; the dorsal alternates with a series of lateral spots separated by light intervals as long as or longer than themselves. Anteriorly, the lateral spots are often obscure or wanting. In old dark individuals, the general aspect is that of a dark-brown snake crossed on the middle of the back by narrow light lines, about half a scale wide, margined with black. The ventrals are spotted, but less heavily than in *fasciatus*. Top of the head brown; there is usually no post-ocular stripe, but when the general color is light, it is sometimes indicated. Ventrals 130–150; subcaudals 59–80. Length 890 mm. (tail 205).

Hab.—New England to the Carolinas; west to Wisconsin and Kansas.

Tropidonotus sipedon transversus Hallowell.

T. transversus Hallow., Proc. Acad. Phila., 1852, 177; *Nerodia Woodhousii* and *N. transversa* B. and G., *l. c.*, 42, 148; *N. f. transversa* Cope, *l. c.*, 672, and Rep. Nat. Mus, 973; *T. fasciatus* (part) Boul., *l. c.*, I, 242.

Size rather less than *T. s. sipedon;* scales in 23–25 rows; upper labials 8 or 9; temporals 1–3; ventrals 140–150; subcaudals 64–80. Body color olive or brown; a dorsal series of 30–35 dark brown spots about four scales long and seven or eight wide, black bordered in front and behind; the interspaces aoout one scale wide; an alternating series of upright rectangular dark brown blotches on the sides, the intervals being wider than the blotches; the dorsal and lateral series are not in contact; belly yellow, with the base of each ventral dusky. Top of head dark olive, with sometimes a yellowish elongated spot on the commissure of the parietals and two small yellow dots on the anterior border of the frontal. Length about 860 mm. (tail 186).

Hab.—Western Louisiana, Texas and Arkansas.

Tropidonotus rhombifer Hallowell.

Proc. Acad. Phila., 1852, 177; *Nerodia Holbrookii* and *N. rhombifer* B. and G., *l. c.*, 43 and 147; *Natrix rhombifera* Cope, *l. c.*, 673, and Rep. Nat. Mus., 963; *T. fasciatus* (part), Boul. *l.c.*, I, 242.

Size large; scales in 25 or 27 rows (Cope states that in thirteen individuals he found only one with 25 rows; whereas, in eight, I find five with 25, one with 26 and two with 27); oculars 1–2 (occasionally 3 or 4 post-oculars); temporals 1–2 (3); upper labials 8; ventrals 141–150; subcaudals 57–78.

Reddish brown, occasionally pale yellowish brown, darker on the back; a dorsal series of 35–40 black blotches, six or seven scales wide and two or three long, separated by rather longer interspaces; on each side an alternating series of vertical rectangular blotches, each of which is connected by a black oblique bar from its upper corners to the contiguous lower corners of the dorsal spots. Irregular cross-bands on the tail. Belly yellow or gray, with an orange tinge posteriorly; a roundish black spot at the end of each ventral. Top of head olive brown; upper labials lighter olive; lower labials and throat yellow; all the labials narrowly margined with brown. This snake resembles *T. taxispilotus*, but has fewer scales and the spots are connected at the angles. Length 1,115 mm. (tail 220); probably reaches the size of *T. s. fasciatus.*

Hab.—Southern Illinois and Indiana to Texas; extends south to Vera Cruz.

Tropidonotus cyclopium Dum. and Bib.

Erp. Gen., VII, 576 (1854); Cope, *l. c.*, 673, and Rep. Nat. Mus., 961; Boul., *l. c.*, I, 244.

Size large; scales in 29 rows (occ. 31); oculars 1–2 (3); temporals 1–2 (3); upper labials 8 (7); almost always 2, 3 or 4 suboculars, forming with the pre- and post-oculars a ring around the eye; ventrals 135–150; subcaudals 64–81.

Greenish or dark olive; irregular, broken darker bands, about the width of one scale, across the back to about the seventh row, at intervals of about two scales; opposite the interspaces, on each side, a vertically elongated black blotch extending from the third to the sixth row; belly yellowish or greenish white, the exterior base of each ventral clouded with dusky, which increases posteriorly; top of head dark brown; lower half of upper labials lighter; all labials with dark margins. The whole pattern is obscure, and in old examples is not easy to make out. Length 1,200 mm. (tail 260).

Hab.—Florida to New Orleans, and sparingly up the Mississippi to southern Illinois.

Tropidonotus taxispilotus Holbrook.

No. Am. Herp., IV, 35, Pl. 8 (1843); *Nerodia taxispilotus* B. and G., *l. c.*, 43; *Natrix taxispilota* Cope, *l. c.*, 674, and Rep. Nat. Mus., 959; *T. taxispilotus* Boul., *l. c.*, I, 215.

Largest of the American water snakes; body very stout; scales in 29–33 rows, strongly keeled; oculars 1–2 (3); temporals 2–4 (5); the parietal shields are small, their hinder portion being usually broken up into small plates; upper labials 8, usually only the fourth entering the eye: ventrals 130–148; subcaudals 70–90.

Reddish brown, with a dorsal and lateral series of rectangular blackish brown blotches, which alternate but do not touch; belly yellowish white with irregular blotches of dark brown. This species resembles both *T. s. transversus* and *T. rhombifer*, but may always be known from the former by the increased number of scale rows, and from the latter by the absence of the oblique bars connecting the dorsal and lateral spots. An occasional specimen shows the orbital ring of scales found in *T. cyclopium*. Length 1,300 mm. (tail 290).

Hab.—From the Potomac river to Florida and New Orleans.

SEMINATRIX Cope.

Am. Nat., 1895, 678, and Rep. Nat. Mus., 998; *Contia* (part) Cope, *l. c.*, 599; *Tropidonotus* (part) Boul., *l. c.*, I, 192.

Maxillary teeth smooth, slightly increasing posteriorly, the last two abruptly enlarged; body rather stout; head small and slightly distinct; head scales normal; one loreal; nasal half divided; no scale pits; scales smooth on body, sometimes faintly keeled on the tail.

Hab.—Florida.

Seminatrix pygæa Cope.

Contia pygæa Cope, Proc. Acad. Phila., 1871, 222, and *l. c.*, 600; *S. pygæus* Cope, Am. Nat., 1895, 678, and Rep. Nat. Mus., 998; *Tropidonotus pygæus* Boul., *l. c.*, I, 223.

Size small, tail short; 20–24 maxillary teeth, smooth and slightly increasing posteriorly, the last two abruptly enlarged; mandibular teeth about 20, subequal; head scales normal; internasals small;

oculars 1–2; temporals 1–2, the anterior elongated; upper labials variable (in six which I have examined three have 7, one has 7–8, one has 8 and one has 9); 17 rows of scales, smooth on the body, often faintly keeled on the tail; ventrals 118–130; subcaudals 32–54. Lustrous brownish black above, with a faint pale longitudinal line on each scale, most strongly marked on the sides; belly yellow or salmon color, each ventral with a small black bar on the exterior and outer margin. Length 484 mm. (tail 109); of another specimen 330 mm. (tail 50).

Hab.—Florida.

This species was included by Mr. Boulenger in his comprehensive genus *Tropidonotus*, but the smooth body scales and absence of scale pits, together with the wide difference in form and color pattern, appear to me to warrant generic separation. I have observed that in captivity these little snakes are fond of hiding under stones or bark in moist soil, and this habit is confirmed by Mr. Lœnnberg.[15] On the whole, I suspect that *pygæa* is a degenerating *Tropidonotus* in process of acquiring subterranean habits. It is possible that the light line on the dorsal scales may indicate the former presence of keels, but lately lost.

HELICOPS Wagler.

Syst. Amph., 170 (1830); *Liodytes* Cope, *l. c.*, 666; *Helicops* Boul., *l. c.*, I, 272.

Maxillary teeth smooth, posterior slightly longest, no interspace; one loreal; one internasal; two nasals; body rather stout; scales more or less keeled, usually without pits; anal divided.

Hab.—Florida, tropical America and Africa, southern Asia.

Helicops alleni Garman.

Proc. Boston Soc. Nat. Hist., 1874, 92; *Liodytes allenii* Cope, *l. c.*, 667, and Rep. Nat. Mus., 1013; *Helicops alleni* Boul., *l. c.*, I, 275.

Maxillary teeth 16–18, syncranterian; mandibular teeth 18–20, subequal; body short and stout; head slightly distinct; tail short; head scales normal, except that the internasal is single; oculars 1–3, the anterior occasionally extending upward to meet the frontal; temporals 1–2. In one specimen in my own collection the parietals extend to the labials, behind the post-oculars; upper labials 7 or 8; scales in 19 rows, smooth excepting on the tail, where a few rows are more or less distinctly keeled; as a rule scale

[15] *Proc. U. S. Nat. Mus.*, 1894, p. 323.

pits are absent, but in one specimen which I have examined they are irregularly present; ventrals 121–129; subcaudals 58–63.

A dark brown dorsal area six to eight scales wide, on each side of this a lighter olive stripe two rows wide, then a dark lateral stripe from the third to the fifth row; belly and labials yellow. Length 484 mm. (tail 110).

Hab.—Florida.

STORERIA B. and G.

Cat. No. Am. Serp., 135 (1853); Cope, *l. c.*, 674, and Rep. Nat. Mus., 1000; *Ischnognathus*[16] (part) Boul., *l. c.*, I, 285.

Maxillary teeth smooth, equal; no loreal; two nasals; two internasals; scales keeled without pits, in 15–17 rows; anal divided; size small; head distinct.

Hab.—North and Central America.

17 rows; 1 preocular; ventrals whitish, ... 1. *S. dekayi.*
15 rows; 2 preoculars; ventrals reddish, . 2. *S. occipitomaculata.*

Storeria dekayi Holbrook.

Tropidonotus dekayi Holb., No. Am. Herp., III, 53, Pl. XIV (1842); *S. dekayi* B. and G., *l. c.*, 135; Cope, *l. c.*, 675, and Rep. Nat. Mus., 1000; *Ischnognathus dekayi* Boul., *l. c.*, I, 286.

Head scales normal; no loreal; two nasals, nostril generally between them; oculars 1–2; temporals 1–1 (2); upper labials 7; scales in 17 rows, notched at the tip; ventrals 120–140; subcaudals 40–63. Length 350 mm. (tail 70).

Grayish to reddish brown or olive above, with a lighter dorsal stripe about three scales wide, bordered by a row of black dots or a black line, sometimes traces of a second and third alternating series on the sides; belly whitish, with black dots on the ends of the ventrals.

Hab.—North America and Mexico, east of the Rocky Mountains.

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[16] There is possibly a question as to actual priority of publication between *Storeria* B. and G. and *Ischnognathus* Dum. and Bib., both bearing the date 1853; the paper of Dumeril and Bibron having been read before the Académie des Sciences, November 2, 1852, and the *Cat. of No. Am. Serpents* being accepted for publication in the same month. Both genera were established upon *S. dekayi*, but as the definition given by Baird and Girard is much more complete, usage warrants the retention of their name. Boulenger has much extended *Ischnognathus* and includes in it both *Clonophis kirtlandi* and *Tropidoclonium lineatum.*

Storeria occipitomaculata Storer.

Tropidonotus occipitomaculatus Storer, Rep. Rept. Mass., 230 (1839); *S. occipitomaculatus* B. and G., *l. c.*, 137; Cope, *l. c.*, 675, and Rep. Nat. Mus., 1003; *I. occipitomaculatus* Boul., *l. c.*, I, 287.

Head scutellation like *S. dekayi*, but there are two preoculars and five or six upper labials; the nostril is usually in the pre-nasal; 15 rows of scales. The size and proportions are similar. Color of the back much the same, but the vertebral stripe is less distinct and occasionally the outer row is lighter; belly salmon color in life with the ends of the ventrals clouded with darker; a light blotch on the vertex with a smaller one on each side of it, and a light spot on the posterior labials.

Hab.—North America, east of the Rocky Mountains.

CLONOPHIS Cope.

Proc. U. S. Nat. Mus., 1888, 391; *l. c.*, 674; *Tropidonotus* (part) Cope, Rep. Nat. Mus., 995; *Ischnognathus* (part) Boul., *l. c.*, I, 285.

Maxillary teeth smooth, equal; one loreal; one nasal; two internasals; size small, head not distinct; scales keeled; anal divided; head not distinct.

Hab.—North America.

Clonophis kirtlandi Kenn.

Regina kirtlandii Kenn., Proc. Acad. Phila., 1856, 95; *Clonophis kirtlandii* Cope., *l. c.*, 674; *Tropidonotus kirtlandii* Cope, Rep. Nat. Mus., 995; *Ischnognathus kirtlandi* Boul., *l. c.*, I, 286.

Head plates normal; 1 nasal, usually half divided; oculars 1–2; temporals 1–1 (2); upper labials 6; scales in 19 rows, all keeled; ventrals 123–133; subcaudals 50–59. Length 496 mm. (tail 115).

Brown above with a dorsal series of large dark spots and a small alternating series on the sides; belly yellowish or reddish, with a black spot at the end of each ventral; labials yellowish.

Hab.—Ohio to Michigan.

TROPIDOCLONIUM Cope.

Proc. Acad. Phila., 1860, 76; *l. c.*, 666, and Rep. Nat. Mus., 1011; *Ischnognathus* (part) Boul., *l. c.*, I, 285.

Maxillary teeth smooth, equal; one loreal; one nasal; two internasals; size rather small; head not distinct; scales keeled; anal entire. Resembles *Clonophis*, but has the anal single.

Hab.—North America.

Tropidoclonium lineatum Hallowell.

Microps lineatus Hall., Proc. Acad. Phila., 1856, 241; *T. lineatum* Cope, *l. c.*, 666, and Rep. Nat. Mus., 1011; *Ischnognathus lineatus* Boul., *l. c.*, I, 289.

Head plates normal; oculars 1–2; temporals 1–2 (1); upper labials 5 or 6; scales in 19 rows, the two outer only faintly keeled; ventrals 138–148; subcaudals 34–37. Length 350 mm. (tail 48).

Grayish brown with a light vertebral stripe, bordered by a row of black dots; a light lateral stripe on the second and third rows; belly light with two longitudinal series of black spots, more distinct posteriorly.

Hab.—Ohio to northern Texas.

AMPHIARDIS Cope.

Proc. U. S. Nat. Mus., 1888, 391; *l. c.*, 675, and Rep. Nat. Mus., 1008; Boul., *l. c.*, I, 290.

Maxillary teeth smooth, equal; one loreal; two nasals; two internasals; no preocular, the loreal extending to the eye; scales keeled; anal divided; size small; body rather stout; head not distinct; tail short.

Hab.—Texas.

Amphiardis inornatus Garman.

Virginia inornata Garm., No. Am. Rept., 97 (1883); *A. inornatus* Cope, *l. c.*, 675, and Rep. Nat. Mus., 1009; Boul., *l. c.*, I, 290.

Head scales normal; two internasals; two nasals; no preocular; loreal long, and with the prefrontals, entering the orbit; one postocular; upper labials 5; temporals 1–1; scales in 17 rows, lustrous, the outer only faintly keeled; ventrals 125–129; subcaudals 36. Length 260 mm. (tail 45).

Brownish olive above; belly white, base of ventrals dusky.

Hab.—Two specimens known, only from central Texas

HALDEA B. and G.

l. c., 122; Cope, *l. c.*, 675, and Rep. Nat. Mus., 1009; Boul., *l. c.*, I, 290.

Maxillary teeth smooth, subequal; one loreal; two nasals; one internasal; no preocular; scales keeled without pits; anal divided; size small, body slender, head distinct, tail short.

Hab.—North America.

Haldea striatula L.

Coluber striatulus L., Syst. Nat., Ed. XII, 375 (1766); *Haldea striatula* B. and G., *l. c.*, 122; Cope, *l. c.*, 676, and Rep. Nat. Mus., 1009; Boul., *l. c.*, I, 291.

Only one internasal; head plates otherwise normal; loreal long and reaching the eye; no preocular; 1 post-ocular; temporals 1–1; upper labials 5; scales in 17 rows; ventrals 120–135; subcaudals 36–50. Length 250 mm. (tail 45).

Uniform reddish or grayish brown above; salmon color underneath; sometimes an indistinct light band across the parietals.

Hab.—Virginia to Minnesota and south to Texas.

SPILOTES Wagler.

Syst. Amph., 179 (1830); *Georgia* B. and G., *l. c.*, 92; *Spilotes* Cope, *l. c.*, 636; *Spilotes* and *Coluber* (part) Boul., *l. c.*, II, 23, 24; *Compsosoma* Cope, Rep. Nat. Mus., 857.

Maxillary teeth smooth, nearly equal; head scales normal; loreal sometimes absent; one preocular; scales smooth or keeled with two pits, sometimes in an even number of rows;[17] anal entire; size large; head moderately distinct; body sometimes compressed on the back.

Hab.—North and South America.

Spilotes corais Boie.

Coluber corais Boie, Isis, 1827, 537.

This large species ranges from the southern United States to Brazil; typical *corais* is South American, but there are several subspecies, one of which only, enters the United States.

Spilotes corais couperi Holbrook.

Coluber couperii Holb., No. Am. Herp., III, 75, Pl. 16 (1842); *Georgia Couperii* and *G. obsoleta* B. and G., *l. c.*, 92, 158; *S. c. couperii* Cope, *l. c.*, 637; *Coluber corais* (part) Boul., *l. c.*, II, 31; *Compsosoma corais couperii* Cope, Rep. Nat. Mus., 858.

Maxillary teeth 17–18, slightly enlarged posteriorly; mandibular teeth about 16, a little longer in front; internasals small; two nasals; loreal quadrangular; oculars 1–2; temporals 2–2; upper labials 8 (7), either the fifth or sixth small and triangular; scales smooth in 17 rows; ventrals 184–198; subcaudals 60–73.

Lustrous black above; belly slaty black; on the anterior ven-

[17] The restriction of this genus to snakes having the dorsal rows in even number does not appear to me justifiable. The type of *Spilotes* Wagler is *S. pullatus*, which species alone, Boulenger admits in the genus. It, however, has the scales frequently in an odd number; two specimens from Trinidad, formerly in the Zoölogical Garden, had 15 and 17 rows respectively (*Proc. Acad. Phila.*, 1893, 432).

trals dark red often appears, which usually shows plainly on the chin; upper labials light, with red or blackish margins. This species is one of the largest of North American snakes; in Florida it reaches about 1900 mm. (tail 350), and along the lower Rio Grande, in Texas, it exeeds those dimensions.

Hab.—Georgia and Florida to eastern Texas; northern Mexico.

COLUBER L.

Syst. Nat., Ed. X, 216 (1758); *Scotophis* B. and G., *l. c.*, 73; *Elaphis* (part) D. and B., *l. c.*, VII, 241; *Coluber* Cope, *l. c.*, 630, and Rep. Nat. Mus., 825; *Coluber* (part) Boul., *l. c.*, II, 24.

Maxillary teeth smooth, equal; one loreal; two nasals; two internasals; one preocular; two prefrontals; scales in 19–35 rows; generally more or less keeled, with two pits; anal divided; size moderately large; head distinct.

Hab.—Northern hemisphere.

Reliable specific characters, drawn from the scutellation, are wanting in the American species of *Coluber*. The proportions of the frontal and parietal plates, upon which some stress has been laid, are so variable with age and in individuals, that little importance can be attached to them singly; except that in *vulpinus*, and still more in *lindheimeri*, the anterior border of the frontal is wide and the lateral angles are obtuse, so that the plate is often subtriangular. Cope divides the species into sections, according to the number of anterior temporals, but I find them by no means constant enough to serve that purpose. The number of ventrals and subcaudals is not diagnostic, the limits of variability overlapping in most species; although *quadrivittatus*, a long-tailed species, has the largest number of subcaudals, and *vulpinus*, which is short and thick, has the least. There are fairly constant differences in pattern and color, and upon these, with a totality of other characters, they may be divided with some certainty.

Key to the American Species.

a.—Scales smooth, or 5 to 13 rows weakly keeled:
- Light gray with brown spots, ... 1. *C. emoryi.*
- Red with brick-red spots, ... 2. *C. guttatus.*
- Yellow with four brown stripes, . . 3. *C. quadrivittatus.*

b.—Scales with 9 to 21 rows more strongly keeled:
- 9–11 rows keeled; yellow with distinct spots, 4. *C. vulpinus.*
- 9–21 rows keeled; black above, or yellow with spots; lateral spots elongated, ... 5. *C. obsoletus.*

Coluber guttatus L.

Syst. Nat., Ed. XII, 386 (1766); *Scotophis guttatus* B. and G., *l. c.*, 78; *C. guttatus* and *C. g. sellatus* Cope, *l. c.*, 633, and Rep. Nat. Mus., 833, 836; *C. guttatus* (part) Boul., *l. c.*, II, 39.

Frontal a trifle longer than broad, rather broad behind, usually a little shorter than the snout; oculars 1–2; temporals 2–3 (4); upper labials 8, fourth and fifth entering the orbit; 11 or 12 lower labials, five touching anterior chin shields; scales usually in 27 rows (rarely 29), very slightly keeled on about five rows; ventrals 215–240; subcaudals 61–79. Length 1200 mm. (tail 190).

Light red, paler on the sides; dorsal blotches darker red with black borders and a narrow margin of dark red outside of the black; the dorsal spots reach to about the seventh row of scales; below these there is a second alternating series of smaller spots, which sometimes have a tendency to run together longitudinally, and a third series on the ends of the ventrals and the two outer rows. In some specimens the dorsal spots are wider, and the laterals are mostly absent or form an indistinct longitudinal stripe; this is *C. g. sellatus* Cope, the type specimens of which had 29 rows of scales, but a very similar specimen in my own collection from Lake Kerr, Florida, has but 27. The color beneath is yellowish white, with quadrangular blotches of black on the outer ends of the ventrals. The head is usually, but not always, banded above.

Hab.—Virginia to Florida and west to the Mississippi river.

Coluber quadrivittatus Holbrook.

No. Am. Herp., III, 89, Plate XX (1842); *Scotophis quadrivittatus* B. and G., *l. c.*, 80; *C. quadrivittatus* and *C. rosaceus* Cope, *l. c.*, 633, and Rep. Nat. Mus., 838, 837; *C. obsoletus* (part) Boul., *l. c.*, II, 51.

Frontal narrow behind, a little longer than broad in front; temporals 2–2 (3); upper labials 8, occasionally 9, and in one example 7 on one side, the fourth and fifth entering the eye; lower labials 11 to 13, four or five touching the anterior chin shields; 27 rows of scales, of which from five to thirteen are weakly keeled; ventrals 232–250; subcaudals 86–105 (one examined by me has the abnormally small number of 66).

Body color yellow or buff, sometimes faintly greenish, with four longitudinal stripes of dark brown; the laterals on the fourth and part of the third and fifth, and the upper ones on the eleventh and part of the tenth and twelfth rows. In some specimens the body color is dark chestnut. Underneath and on top of head yellow, unmarked. The young in this species are spotted, the spots at subsequent stages fusing into stripes. One specimen 1720 mm. long, from Florida, now living in the Zoölogical Gardens, shows these spots quite plainly outlined on the back, forty-one in number from head to vent, with the stripes running across them. There are also faint remains of lateral spots. This mixture of immature and adult characters probably accounts for *C. rosaceus* Cope. Reaches a length of 1800 mm. (tail 300).

Hab.—North Carolina to Florida.

Coluber obsoletus Say.

Long's Exp. to Rocky Mts., I, 140 (1823).

Frontal about equals the length of snout, rather broad in front; anterior temporals usually 2, but occasionally 1 or 3; posterior temporals 3 (4); usually 8 upper labials, fourth and fifth in eye; 11 to 13 lower labials; scales in from 25 to 29 rows, from 9 to 21 of which are keeled; ventrals 224–258; subcaudals 75–86.

The color ranges from black above to gray or yellowish with dark spots; the lateral spots are more or less elongated; head not distinctly banded in adults. Size medium to large and stout.

Hab.—New England to the Gulf and west to the central plains.

Three good color forms may be distinguished:

Black above, sometimes with indistinct spots, . 1. *C. o. obsoletus.*
Yellowish with lead-colored spots; red on sides,
2. *C. o. lindheimeri.*
Gray or pale brown with brown spots, . . . 3. *C. o. confinis.*

Coluber obsoletus obsoletus Say.

l. c., 140; *Scotophis allegheniensis* B. and G., *l. c.*, 73; *C. obsoletus obsoletus* (part) Cope, *l. c.*, 635, and Rep. Nat. Mus., 844; *C. obsoletus* (part) Boul., *l. c.*, II, 50.

Frontal about equals or slightly exceeds the length of snout, rather broad behind; temporals 2–3; 8 upper labials, fourth and fifth in eye (one large specimen in the Academy's collection has 7, the third and fourth in eye; in this snake the prefrontals are only partially divided); lower labials 11, four or five touching the anterior chin shields; 27 or 25 rows of scales, nine to seventeen keeled (in adults usually fifteen or seventeen); ventrals 224–246; subcaudals 75–90.

Color black above, brownish in the young; the dorsal spots are indistinctly outlined, but not enough, as a rule, to make them out except in young or newly-shed individuals. In some specimens the skin on the sides is more or less red. The belly is usually slaty black behind, yellow anteriorly, more or less maculated with black blotches; throat and chin white; labials yellow, margined with black. A living specimen from Pennsylvania, 1080 mm. long, shows thirty indistinct dorsal spots, and has considerable red skin on the flanks, which shows between but does not invade the scales. Reaches a length of about 1850 mm. (tail 320).

Hab.—Massachusetts to Illinois and southwest to Texas; rare in Florida.

Coluber obsoletus lindheimeri B. and G.

> *Scotophis Lindheimerii* B. and G., *l. c.*, 74; *C. o. obsoletus* (part) Cope, *l. c.*, 635, and Rep. Nat. Mus., 844; *C. obsoletus* (part) Boul., *l. c.*, II, 50.

Frontal about equal, or a trifle shorter than the snout; the anterior border about equals its length and the lateral angles are obtuse, so that the shape is subtriangular; temporals 2(3)–3 (4); 8 upper labials (in one case 9), fourth and fifth in eye; 12 to 14 lower labials, from four to six touching the anterior chin shields; scales in 27 or 29 rows (five have 27, three have 29, one has 31), from 11 to 21 keeled, never very strongly; ventrals 227–231; subcaudals 76–81.

Yellowish above with a dorsal series of dark lead-colored spots, five or six scales long and thirteen to fifteen wide, the interspaces of the body color are about two scales long and many of the scales have lead-colored centres; another series of elongated blotches on the third to the seventh row; ventrals with dark spots on the ends and outer scale rows, at intervals of several scales, otherwise yellowish white, often clouded posteriorly. The bases and margins of many scales in the light interspaces are rusty red in every living specimen that I have seen; this fades rapidly in alcohol. Top of head is uniform lead color without bands. The eye is rather large. Length 1525 mm. (tail 230).

Hab.—Texas.

The distinctness of the color pattern at all ages, the red on the scales of the flanks, the slight but, as it appears to me, very general difference in the shape of the frontal, with an apparently circumscribed geographical range, are quite enough, in my opinion, to compel recognition of this subspecies.

Coluber obsoletus confinis B. and G.

Scotophis confinis and *S. lætus* B. and G., *l. c.*, 76, 77; *Elaphis spiloides* Dum. and Bib., *l. c.*, VII, 269; *Coluber confinis, C. spiloides* and *C. o. lemniscatus* Cope, *l. c.*, 632, 634, 635, and Rep. Nat. Mus., 829, 841, 849; *C. lætus* (part) Boul., *l. c.*, II, 49; *C. lætus* Cope, Rep. Nat. Mus., 850.

Frontal rather longer than wide, a little longer than the snout; temporals 2 (1)–3; upper labials 8, fourth and fifth in eye; five lower labials touching the anterior chin shields; scales in 27–25 rows, eleven or thirteen slightly keeled; ventrals 231–258; subcaudals 75–96.

Ashy or yellowish gray above, with dark brown dorsal spots narrowly margined with black, five or six scales long and thirteen to fifteen wide, longitudinally quadrate in shape; interspaces about two scales long; on the second to fifth rows the lateral spots are elongated, and exhibit sometimes a disposition to form an indistinct stripe; belly yellow, clouded posteriorly and with dark spots on the ends of the ventrals and the outer scale rows; a dark postocular stripe, some indistinct mottling on borders of the labials, but no distinct head bands in adults.

Hab.—From Virginia to Florida, west to Missouri and Texas.

I am not able to satisfy myself that *spiloides* Dum. and Bib. and *lætus* B. and G. are distinct from the present form; Cope, indeed, places them in three different sections of *Coluber*, assigning a different number of anterior temporals to each—one to *confinis*, two to *spiloides* and three to *lætus*. But the single specimen in his own collection, considered by him to be *confinis*, has two, which is the normal number; while the figures of *lætus* given by Baird in Marcy's *Report of the Red River Exp.*, Pl. VI, and *Pac. R. R. Survey*, Pl. XXX, fig. 53, both represent that species as also having two. (The three temporals in Cope's fig. 196 (p. 851) have every appearance of abnormality.) The difference in pattern stated in the description of *lætus* is probably accounted for by the youth of the type, which is but 460 mm. long, while the occurrence of 25 rows, as in *spiloides*, is quite normal, and 29, as in *lætus*, would not be startling in *C. o. confinis*.

Coluber emoryi B. and G.

Scotophis Emoryi B. and G., *l. c.*, 157; *C. emoryi* Cope, *l. c.*, 636, and Rep. Nat. Mus., 852; *C. guttatus* (part) Boul., *l. c.*, II, 39.

Frontal rather long, but little shorter than the snout; temporals 2 (3)–3 (4); upper labials 8, fourth and fifth in eye; lower labials 11, five touching the anterior chin shields; scales in 27 rows (occ. 29), all smooth or sometimes a few faintly keeled; ventrals 210–235; subcaudals 72–78.

Ground color rather pale gray, with a dorsal row of olivaceous brown blotches with black borders, three or four scales long and ten or twelve wide, separated by interspaces 1½ to 2 scales long; a second series of smaller alternating spots from the third to the seventh rows, subcircular in shape; a third indistinct series on the second and third rows, and a fourth indicated on the outer row and the ends of the ventrals; belly yellowish or white with irregular ashy blotches posteriorly; top of head much banded, and a dark oblique post-ocular stripe. The number of dorsal spots varies greatly, those now living in the collection of the Zoölogical Society ranging from thirty-one to fifty in number on the body, and from seventeen to twenty-one on the tail. Length 1330 mm. (tail 190).

Hab.—Kansas to Texas; south to Chihuahua.

Coluber vulpinus B. and G.

Scotophis vulpinus B. and G., *l. c.*, 75; *C. vulpinus* Cope, *l. c.*, 632, and Rep. Nat. Mus., 831; Boul., *l. c.*, II, 49.

Frontal shorter than snout, with anterior border about equal to its length, and with obtuse lateral angles; temporals 2–3; upper labials 8, fourth and fifth in eye; lower labials 11, five touching anterior chin shields; 25–27 rows of scales, nine to eleven feebly keeled; ventrals 196–208; subcaudals 51–69; form stout.

Ground color light brown; dorsal spots dark brown and quadrate in shape, about four scales long and from eleven to thirteen wide; interspaces about two scales long. There are from 29–42 dorsal spots on the body, and 8–14 on the tail; there is a subcircular alternating series on the third to the seventh rows, and another of square blotches on the outer row and the ends of the ventrals; rest of the belly yellow, with dark blotches in the middle, usually involving two ventrals; anteriorly the belly is unmarked; no head bands in the adult, except the oblique post-ocular stripe; edges of labials slightly margined; eye small.

Length about 1450 mm. (tail 230). *C. vulpinus* is relatively stouter, and has a shorter tail than the other American species of *Coluber*.

Hab.—Illinois to Minnesota; south to Nebraska.

A snake belonging to this genus, collected at Fort Davis, Texas, having 9 upper labials; 27 rows of scales, of which six are slightly keeled; warm grayish ash color, with a series of narrow brown dorsal spots, eighty in number, and the lateral series indistinct, was described by Dr. Yarrow under the name of *Coluber bairdi* in Cope, *Bulletin U. S. Nat. Mus.*, No. 17, p. 41 (1880). The specimen remains unique and its relations are consequently doubtful.

RHINECHIS Michahelles.

Wagl., Icon. Amph., Pl. 25 (1833); Cope, *l. c.*, 637, and Rep. Nat. Mus., 862; *Coluber* (part) Boul., *l. c.*, II, 24.

Maxillary teeth smooth, equal; one loreal; one preocular; two internasals; two nasals; rostral entering between the internasals and projecting anteriorly; scales smooth, with two pits, in 27–31 rows; anal entire; size moderate; head small and slightly distinct.

Hab.—Southwestern United States and Mexico.

Rhinechis elegans Kenn.

Arizona elegans Kenn., U. S. and Mex. Bound. Surv. Rept., 18, Pl. XIII (1859); Van Den., *l. c.*, 193; *Rhinechis elegans* Cope, *l. c.*, 638, and Rep. Nat. Mus., 863; *Coluber arizonæ* Boul., *l. c.*, II, 66.

Body not very stout; head slightly distinct; snout projecting; rostral extending posteriorly between the internasals; two nasals; oculars 1 (2)–2; loreal long and narrow; temporals 2–3 (4); upper labials 8; scales in 27–31 rows; ventrals 207–227; subcaudals 45–59.

Brownish or reddish yellow above; a dorsal series of transverse brown spots, eight or nine scales wide, edged with darker brown, and two alternating series on each side, the upper one subcircular, the lower indistinct and on the three outer scale rows; belly white or yellowish without markings; a dark oblique streak behind the eye and indistinct bands or spots on the head; a few small spots on the anterior labials. The largest of two specimens from Pecos, Tex., now living in the Zoölogical Society's collection, measures 1100 mm. (tail 150). The dorsal interspaces are pink.

Hab.—Texas to southern California and northern Mexico.

PITYOPHIS Holbrook.

Pituophis Holb., No. Am. Herp., IV, 7 (1842); B. and G., *l. c.*, 64; Cope, *l. c.*, 638, and Rep. Nat. Mus., 865; *Coluber* (part) Boul., *l. c.*, II, 24.

Maxillary teeth smooth, equal; rostral extended behind; one loreal; one preocular with sometimes a small one beneath; two nasals; two internasals; four to six prefrontals; scales keeled with pits in 29–35 rows; anal entire; size large; head moderately distinct.

Hab.—North America and Mexico.

The species of *Pityophis* within the United States may be determined upon the following grounds: *P. melanoleucus*, from the eastern States, has a high rostral, in most cases reaching the prefrontals, and has large dorsal spots, 26–35 in number, on the body; usually about the four outer rows of scales are smooth.

P. sayi, from west of the Mississippi to the Rocky Mountains, has the rostral less high, usually reaching about two-thirds of the distance to the prefrontals, and has smaller spots, 40–60, on the body, and usually seven or eight smooth rows of scales.

P. catenifer, from the Pacific coast, west of the Sierra Nevada, has a low rostral, usually not penetrating between the internasals, and agrees generally in pattern with *sayi*.

These characters of the rostral and the dorsal spots are fairly constant, but examination of a considerable number of specimens from the region of the Great Basin leaves no doubt in my mind that the form found there intergrades with both *catenifer* and *sayi*, and reduces them to subspecies. The two species recognized here may in almost every case be distinguished by color characters alone:

Rostral high; no head bands; spots large and few,
1. *P. melanoleucus.*

Rostral lower; head bands distinct; spots small and many,
2. *P. catenifer.*

Pityophis catenifer Blainville.

Coluber catenifer Bl., Nouv. Ann. du Mus., IV, 290, Pl. 24, fig. 2 (1835).

In this species the rostral varies from low and broad to high and narrow above, penetrating sometimes between the internasals but not reaching the prefrontals; prefrontals usually four, but occasionally six; preocular 1, with occasionally a small additional one below; three post-oculars; temporals 3–4 (5); upper labials 8 or 9; scales in 27–35 rows, from three to twelve outer rows smooth; the dorsal spots are quite small and range from 40–70 in number on the body; three series of more or less defined spots on the sides; the head is transversely banded between the orbits, from the orbit vertically downward on the labials, and obliquely from the post-oculars to the angle of the mouth; ventrals 205–243; subcaudals 50–72.

The three subspecies may usually be distinguished by the shape of the rostral:

Rostral low and broad, ... 1. *P. c. catenifer.*
Rostral higher, ... 2. *P. c. bellona.*
Rostral highest, ... 3. *P. c. sayi.*

Pityophis catenifer catenifer Blainville.

Coluber catenifer Bl., *l. c.*, 290; *Pituophis catenifer*, *P. Wilkesii* and *P. annectens* B. and G., *l. c.*, 69, 71, 72; *P. catenifer* Cope, *l. c.*, 641, and Rep. Nat. Mus., 876; *Coluber catenifer* (part) Boul., *l. c.*, II, 67; *P. catenifer* Van Den., *l. c.*, 195.

In this Pacific coast form the rostral is lowest of all and reaches, without penetrating, the internasals; upper labials 8 or 9; temporals 2 (3)–4; scales in 29–35 rows, none strongly keeled and from four to eleven smooth. Usually there are not more than five smooth rows, but a large specimen from Fort Tejon, Cal. (No. 3,800, Academy coll.), has eleven smooth on each side. Very little reliance can be placed, however, on the number of smooth rows in any of the species of *Pityophis*, as they not infrequently vary in different parts of the same individual. Ventrals 205–230; subcaudals 50–70.

Ground color yellowish or brownish; there are usually 50–70 dorsal spots on the body, but sometimes these are as few as 36, from 15–21 on the tail; anteriorly the spots are black, becoming brownish toward the tail; belly yellowish, with a series of dark spots on the ends of the ventrals and sometimes another ill-defined series on the middle; the head bands are distinct. Length 1,900 mm. (tail 315).

Hab.—Pacific coast west of the Sierra Nevada.

Pityophis catenifer bellona B. and G.

Churchillia bellona B. and G., Stans. Exp. Salt Lake, 350 (1852); *P. bellona* (part) B. and G., *l. c.*, 66, and Pac. R. R. Surv. Rept., Pl. XXIX, fig. 46; *P. sayi bellona* Cope, *l. c.*, 641, and Rep. Nat. Mus., 872; *Coluber catenifer* (part) and *C. melanoleucus* (part) Boul., *l. c.*, II, 67, 68; *P. catenifer deserticola* Stej., No. Am. Fauna, No. 7, Pt. II, 206.

This form appears to be found through the so-called Great Basin, from Arizona northward to Utah and Nevada. The rostral is almost always higher than in *P. c. catenifer*, but less so than in *P. c. sayi;* it commonly penetrates between the internasals about one-third of their length. No. 3,978 Academy collection, from Ogden, Utah, has the rostral barely touching the internasals, as in *P. c. catenifer*, and has a maximum of six rows of smooth scales. No. 3,782, from Owens' Valley, Cal., has the rostral penetrating further, fully one-third, and has three rows of smooth scales. No. 10,378, from Salt Lake, has the rostral as in No. 3,782. This specimen, 1,040 mm. long, was taken in 1899, and has sixty-four spots on the body, with seventeen on the tail; 31 rows of scales, of which four are smooth; the colors are very distinct, and on the posterior two-thirds of the body the light interspaces are pink. Mr. Stejneger (*l. c.*) has applied the name *deserticola* to this form, on the ground that *bellona* B. and G. is a synonym of *sayi*. It is probably true that the type of *bellona*—now lost—belonged to the plains form, but, as Prof. Cope points out, Baird's plate in the Pacific R. R. Survey represents the one now under consideration. In such a case, when there is a question as to absolute invalidity, I see no good reason for supplanting an old and well-known name by a new one. The intensity of color, including the pink tinge on the hinder half of the body, is hardly sufficient for subspecific distinction, for even if it should be constant—and some examples which have been four years in alcohol do not show it—it is of no great importance, and Florida specimens of *P. melanoleucus* would be quite as well entitled to separation on account of their rufous tints. The size of this form seems to be about as in *P. c. catenifer*.

Hab.—California east of the Sierra Nevada; Utah and Nevada south to Arizona and New Mexico.

Pityophis catenifer sayi Schlegel.

Coluber sayi Sch., Ess. Phys. Serp., II, 157 (1837); *Pituophis bellona* (part), *P. McClellanii* and *P. sayi* B. and G., *l. c.*, 66, 68, 151; *P. sayi sayi* Cope, *l. c.*, 641, and Rep. Nat. Mus., 870; *Coluber melanoleucus* (part) Boul., *l. c.*, II, 68.

The rostral is narrow above and penetrates the internasals about two-thirds of their length; an inferior preocular is frequently present; upper labials 8 or 9; scales in 27–33 rows, usually five to nine smooth; the dorsal spots are larger and usually fewer in number than in the other forms of *catenifer*, but an occasional specimen exhibits an equally large number. There are sometimes as few as forty, but two living specimens in my possession show respectively fifty-three and sixty-nine; ventrals 215–230; subcaudals 50–62.

The body color is yellowish or reddish brown; the spots are black anteriorly and more or less blackish brown posteriorly; the belly is yellowish, with a small dark blotch on the end of each alternate ventral; labials margined with dark brown; the head bands are usually distinct, but in two large specimens from Pecos, Tex., they are almost obsolete. The largest I have measured is 1,990 mm. (tail 190); greatest circumference 210 mm. This species doubtless reaches a length of over two metres.

Hab.—The range is very extensive: from Canada to Mexico, between the Mississippi river and the Rocky Mountains. It has also been taken in Illinois. No. 4,689 Academy collection, from Vernon, British Columbia, is not distinguishable from it; in fact, in this specimen the posterior extension of the rostral approaches *melanoleucus*.

Pityophis melanoleucus Daudin.

Coluber melanoleucus Daud., Hist., des Rept., VI, 409 (1803); *Pituophis melanoleucus* B. and G., *l. c.*, 65; Cope, *l. c.*, 640, and Rep. Nat. Mus., 867; *Coluber melanoleucus* (part) Boul., *l. c.*, II, 68.

In the eastern form the rostral reaches the extreme of elevation, in many cases completely separating the internasals and being in contact with the prefrontals; usually four prefrontals; oculars 1–3, sometimes a small sub-preocular; temporals small, 4 (3)–5; upper labials 8; scales in from 27–33 rows, usually 27 or 29, of which in most cases four to seven are smooth (in a large specimen from New Jersey there are seven smooth rows anteriorly and four on the hinder part of the body).

Body color whitish or buff, lighter on the sides. The dorsal spots are larger than in *catenifer*, and range from 25–35 on the body and 5–8 on the tail; they are blackish brown, more or less marked with paler brown on their centres; two or three series of rather indistinct spots on the sides; belly ivory white, with brown spots on the ends of the ventrals at intervals of about four scales. There are no distinct head bands in adults, though they are shown by the young. The top of the head is yellow, each plate more or less marked by pale brown; labials margined with brown. Of nearly one hundred Florida specimens which I have seen, all were uniformly tinged with rusty brown over the whole upper surface. Ventrals 210–230; subcaudals 52–65. The largest which I have measured was 1,837 mm. long (tail 185).

Hab.—New Jersey to Ohio, and south to the Gulf coast; most common along the seacoast.

ZAMENIS Wagler.

Syst. Amph., 188 (1830); *Bascanion* and *Masticophis* B. and G., *l. c.*, 93, 98; *Bascanium* Cope, *l. c.*, 621; *Zamenis* (part) Boul., *l. c.*, I, 379, and Cope, Rep. Nat. Mus., 787.

Maxillary teeth smooth, increasing gradually behind, with sometimes a slight interspace; one loreal; two preoculars, the lower very small; two nasals; two internasals; scales smooth or faintly keeled, with pits; anal divided; body long and slender; head distinct.

Hab.—Europe, Asia and North America.

The North American species (= *Bascanium* B. and G.) have a purely syncranterian dentition and smooth scales. The forms inhabiting the southern tier of states are puzzling in the extreme. To reach conclusions which shall at least have the merit of consistency, the changes which take place with growth in the best-known species from the eastern Gulf States, *Z. f. flagellum*, must be considered. Here the young are pale brownish with narrow, darker cross-bands on the whole upper surface; an occasional specimen also shows indistinct wider cross-bands anteriorly. The outer four or five rows of scales (rather more anteriorly) have pale edges, leaving a narrow dark line on the centre of each scale, giving the appearance of four or five narrow broken stripes on the sides. In eastern examples these markings usually disappear with age, although the cross-bands occasionally persist. From Texas westward there are forms in which the cross-bands have become fixed, and others in which more or less of the lateral stripes have become likewise permanent, and even more distinct, although in these last the narrow cross-bands have disappeared in the young, which are striped. It must also be borne in mind that there is a marked inequality in the color intensity of all the American species, as there is a tendency for the color to remain pale on the hinder half of the body, involving the disappearance of the pattern. This is the case even in the uniformly colored species, as *Z. c. constrictor*, in which the change to the light colors of western specimens first shows on the tail, and *Z. f. piceus*, in which the bases of the scales posteriorly are pale.

The relative proportions in width of the hinder part of the frontal and supraocular plates are also growth characters and therefore irregular, and in my belief will bear only a small part of the weight which has been placed upon them.

Duly considering the various combinations in adults, of these early characters, I conclude that the *Z. flagellum* group extends from Florida to California, with two forms in addition to the typical one which demand recognition; these are *Z. f. piceus* and *Z. f. frenatus.* The striped forms, extending from Texas to California, have become differentiated to the point of wider separation, and seem to me to fall into two species: *Z. tæniatus* (with a subspecies *Z. t. ornatus*) and *Z. lateralis.* *Z. schotti* B. and G. and *Z. semilineatus* Cope, I can regard only as fortuitous examples of *tæniatus* and *lateralis* respectively.

This is almost a complete reversal of the views held by Prof. Cope, but the facts appear to me to indicate that the subspecies here admitted are tending in the direction of fixed characters, while those rejected are no more than instances of incomplete development.

Key to the Species.

A.—Adults not striped; 17 rows of scales:

7 upper labials; black, bluish, olive or green, 1. *Z. constrictor.*

8 upper labials; pale brown, or dark in front, 2. *Z. flagellum.*

B.—With stripes on the sides:

17 rows; brown with a narrow yellow stripe on third and fourth rows, ... 3. *Z. lateralis.*

15 rows; brown with 3–5 narrow dark stripes on sides, 4. *Z. tæniatus.*

Zamenis constrictor L.

Coluber constrictor L., Syst. Nat., Ed. X, 216 (1758).

Body slender with long tail; head scales normal; frontal rather more than half the width of supraoculars, behind; two nasals; one loreal; oculars 2–2; temporals 2–2; upper labials 7 (rarely 8); scales in 17 rows; ventrals 164–189; subcaudals 79–110.

Length 1,525 mm. (tail one-fourth to one-fifth).

Eastern specimens are black above and slate color beneath; west of the Mississippi they are usually green or olive above, yellow beneath. There are transitional stages between these extremes and they are good subspecies:

Size larger; black above, slate color beneath, 1. *Z. c. constrictor.*
Size smaller; green or olive above; yellow beneath, 2. *Z. c. flaviventris.*

Zamenis constrictor constrictor L.

l. c., 216; *Bascanion constrictor* B. and G., *l. c.*, 93; *B. constrictor* (part) Cope, *l. c.*, 623; *Zamenis constrictor* (part) Boul., *l. c.*, I, 387, and Cope, Rep. Nat. Mus., 791.

Examples from the east are lustrous black above; belly slate color; chin and throat white. One specimen from Pennsylvania now living in the Zoölogical Gardens presents the curious anomaly of a distinctly brown snout. In the western portion of its range it becomes bluish or olive black and the belly gets lighter. The young are unlike the adults, being gray, spotted or cross-banded with darker. Ventrals 175–189; subcaudals 83–110. The length of the largest I have seen was 1,470 mm. (tail 310).

Hab.—United States east of the central plains; northern Mexico.

Zamenis constrictor flaviventris Say.

Coluber flaviventris Say, Long's Exp., II, 185 (1823); *Bascanion flaviventris* and *B. vetustus* B. and G., *l. c.*, 96, 97; *B. constrictor* (part) Cope, *l. c.*, 623; *Zamenis constrictor* (part) Boul., *l. c.*, I, 387, and Cope, Rep. Nat. Mus., 791; *B. c. vetustum* Van Den., *l. c.*, 183; *Z. stejnegerianus* Cope, Rep. Nat. Mus., 797.

Size rather smaller and body more slender than in *B. c. constrictor;* the scutellation is similar, but an eighth labial is more frequently present; ventrals 164–188; subcaudals 79–95.

Length about 1,100 mm. (tail rather more than one-fourth). In examples from the plains the color is often bright green above and bright yellow underneath; chin and throat paler yellow; such specimens are usual in Kansas and Oklahoma. Westward and on the Pacific coast the color darkens to olive, more or less yellowish green beneath.

I see no reason for regarding *Z. stejnegerianus* Cope as anything more than the present subspecies with eight labials. The subdivision of the loreal is so obviously abnormal that it is not worth considering. The type and only specimen came from southeastern Texas.

Hab.—United States west of the Mississippi river.

Zamenis flagellum Shaw.

Coluber flagellum Shaw, Gen. Zool., III, Pt. II, 475 (1802); Stej., Proc. U. S. Nat. Mus., 1894, 595.

This species has the scutellation of *Z. constrictor*, but the labials are 8; the frontal has half the width of the supraoculars behind; the muzzle is more elevated and the tail is longer; ventrals 184–210; subcaudals 80–112.

The young are cross-banded, and this pattern persists in some cases until they are grown.

Hab.—Southern United States from Florida to California.

There appear to be three color forms:

Pale brown; dark brown anteriorly, . . .	1. *Z. f. flagellum.*
Brown; narrow cross-bands in front, . . .	2. *Z. f. frenatum.*
Dark brown; pink beneath, ...	3. *Z. f. piceus.*

Zamenis flagellum flagellum Shaw.

l. c., 475; *Masticophis flagelliformis* and *Coluber testaceus* B. and G., *l. c.*, 98, 150; *B. flagelliforme* Cope, *l. c.*, 625; *Zamenis flagelliformis* (part) Boul., *l. c.*, I, 389; *Z. f. flagellum* (part) Cope, Rep. Nat Mus., 799.

Body slender with very long tail; the upper preocular very large; upper labials 8 (rarely 7); scales in 17 rows; ventrals 184–210; subcaudals 80–112.

Reaches an extreme length of 1,800 mm. (tail 385 to 430). In adults the head and anterior portion of the body is blackish brown, then dark brown back to the posterior half or third of the body, which is pale yellowish brown, each scale with a darker basal margin; belly yellowish posteriorly, black or brown under the dark anterior portion, somewhat spotted behind; sometimes each ventral is margined with brown; generally a light spot on the preoculars; chin and throat white, more or less spotted with brown.

The young have narrow cross-bands on the body which are sometimes retained to maturity. A Florida specimen 1,780 mm.

long, now living in the Zoölogical Gardens, shows these bands on the pale posterior portion of the body after shedding. Another, also from Florida, has indistinct wide cross-bands as in *Z. t. ornatus*.

Examples from west of the Mississippi are often of paler colors, with dark heads, and adults sometimes show the wide cross-bands and even indications of the light lateral stripes of *ornatus*.

I was formerly of the opinion that *testaceum* Say should be admitted as a pale desert form, but examination of a considerable number of living specimens from central Texas and westward, satisfy me that occasional individuals only, show its extreme paleness.

Hab.—South Carolina and Florida to Arizona; northern Mexico.

Zamenis flagellum frenatus Stej.

N. Am. Fauna, No. 7, 208 (1893); *Z. f. flagellum* (part) Cope, Rep. Nat. Mus., 802; *Z. flagelliformis* (part) Boul., *l. c.*, I, 389.

Mr. Stejneger has proposed to regard as a subspecies the form of *Z. flagellum* from Arizona and westward with permanent cross-bands on the anterior portion of the body. This is the retention of a juvenile character which was referred to under the preceding subspecies, and which would doubtless be more evident in eastern specimens, were it not for the dark color which pervades those parts in the adult; but there is so strong a disposition for this character to become permanent in the far west, that Mr. Stejneger is probably right in recognizing the form.

The following description is taken from a beautiful living specimen lately received from Yuma, Ariz., through the kindness of Mr. Herbert Brown:

17 rows of scales; 8 upper labials; ventrals 193; sub-caudals 100; length 1,400 mm. (tail 345). Body color rather pale brown extending to the ventrals; most of the scales are darker at the tip and faintly edged with pink; the lower edge of the outer row and the adjacent ends of the ventrals are whitish, forming an indistinct line, which is more obvious anteriorly and disappears before reaching the tail; the three or four outer rows are faintly darker in the centre, suggesting the dark lateral stripes of *Z. tæniatus*. The anterior fourth of the body is crossed by indistinct bands, one and a half to two scales wide; top of head rather darker brown, with a light spot on the pre- and post-oculars;

indications of a light line from the nostril to the eye; upper labials yellow on the lower margin, more broadly behind; belly yellowish, much clouded with pink, which tends to form longitudinal stripes in front; throat and chin yellow, spotted with dark brown.

Hab.—Arizona, Nevada, Utah and southern California.

Zamenis flagellum piceus Cope.

Bascanium piceum Cope, *l. c.*, 625; *Z. flagelliformis* (part) Boul., *l. c.*, I. 389; *B. f. piceus* Cope, Rep. Nat. Mus., 804; *B. piceum* Stej., No. Am. Fauna, No. 7, 209.

The type specimen, from Camp Grant, Arizona, has 19 rows of scales; 17 is probably the usual number, as Mr. Stejneger mentions one with that number, which agrees with a living example received at the Zoölogical Gardens in 1894 from Tucson; this specimen had 8 upper labials on one side and 9 on the other. The color in life was a rich dark brown with a purplish tinge, posteriorly most of the scales were light brown at the base; the belly was pink slightly spotted with dusky, which increased anteriorly until the throat was nearly black; there was a little pink on the preoculars and lower labials; rest of head very dark. The pink rapidly faded to yellow in alcohol. This specimen is now in the Academy's collection. Ventrals 196; subcaudals 108; length 1,650 mm. (tail 380). Cope's specimen measured 1,263 mm. and the tail was proportionately longer (355 mm).

Hab.—The three specimens known are from southern Arizona.

Zamenis lateralis Hallowell.

Leptophis lateralis Hall., Proc. Acad. Phila. 1853, 237; *Bascanium laterale laterale* Cope, *l. c.*, 628; *Zamenis tæniatus* (part) Boul., *l. c.*, I, 300; *B. laterale* Van Den., *l. c.*, 188; *Z. lateralis lateralis* and *Z. semilineatus* Cope, Rep. Nat. Mus, 808, 805.

Scales in 17 rows; upper labials 8; tail between one-third and one-fourth of the length; ventrals 190–199; subcaudals 105–123. Length about 1,500 mm.

Brown above with a narrow yellow stripe on the third and fourth rows, sometimes extending to the tail and often narrowly bordered with black; belly yellow with a few dark spots under the throat and chin; no spots on top of head; a more or less distinct light spot on the temporals and a light line from the nostril to the eye; labials light, a little spotted.

Hab.—Arizona and southern California.

Zamenis tæniatus Hallowell.

Proc. Acad. Phila., 1852, 181.

This species is characterized by the presence of 15 rows of scales, 8 upper labials, and longitudinal stripes on the sides; frontal about half the width of supraoculars posteriorly; tail very long; ventrals 188–210; subcaudals 120–157. The young are striped.

Hab.—Western Texas to California.

Pale brown; often wide cross-bands; two pale lateral stripes, 1. *Z. t. ornatus.*

Dark brown; no cross-bands; 3 or 4 narrow dark lateral stripes, 2. *Z. t. tæniatus.*

Zamenis tæniatus ornatus B. and G.

Masticophis ornatus B. and G., *l. c.*, 102. 159; *Bascanium tæniatum* subs. *ornatum* Cope, Bull. U. S. Nat. Mus., I, 40; *B. ornatum* Cope, *l. c.*, 629; *Zamenis tæniatus* (part) Boul., *l. c.*, I, 390; *Z. ornatus* Cope, Rep. Nat. Mus., 813.

Scales usually in 15 rows (No. 5,362 Academy coll., from Arizona, has 17); ventrals 200–206; subcaudals 130–152.

Length about 1,700 mm. (tail 565).

Pale brown above, with more or less distinct wide cross-bands of purplish brown on the back; the whole upper surface is sometimes suffused with the darker color, in which case the cross-bands are obscure or absent; a yellowish longitudinal line on the outer row and the edge of the ventrals, and another on the third and fourth rows; the upper one is edged with black and sometimes there is a faint dark line through the middle of it; belly yellow, more or less blotched.

Hab.—Western Texas.

Zamenis tæniatus tæniatus Hallowell.

Leptophis tæniatus Hall., Proc. Acad. Phila., 1852, 181; *Masticophis tæniatus* and *M. Schotti* B. and G., *l. c.*, 103, 160; *B. tæniatum* and *B. Schotti* Cope, *l. c.*, 629; *Zamenis tæniatus* (part) Boul., *l. c.*, I, 390; *B. tæniatus* Van Den., *l. c.*, 190; *Z. schottii* and *Z. tæniatus* Cope, Rep. Nat. Mus., 811, 815.

Snout and muzzle rather long and narrow; body slender and tail very long; scales in 15 rows (very rarely 17); upper labials 8; temporals 2–2; ventrals 188–209; subcaudals 120–157.

Length about 1,300 mm. (tail 370).

Yellowish brown to dark brown, the outer four or five rows lighter, each having a narrow black line running on the centre, and usually another on the edge of the ventrals; most of the scales on the rest of the dorsal region have dark centres; yellowish beneath, without spots except sometimes on the throat; top of head dark; an indistinct light line from the nostril to the eye; a light spot on both pre- and post-oculars; labials yellow, a little spotted.

I am unable to formulate a valid distinction between *Z. schotti* B. and G. and this species; the stripes appear not to run as far back, but they are variable in this respect in *Z. t. tæniatus*, and their disappearance on the tail is doubtless a result of the fading out of color (or, more correctly, the failure to develop it) posteriorly, which is common in the genus. No. 5,369 Academy coll. (old number 1,973), labeled *schotti*, from the Rio Grande, appears to be one of Schott's original specimens, and almost exactly corresponds to No. 5,363, a *tæniatus* from Utah, of about the same date. But it must be admitted that no great reliance can be placed upon color characters in specimens which have been for so many years in spirits.

Hab.—Arizona, Utah and southern California.

SALVADORA B. and G.

l. c., 104; Cope, *l. c.*, 618, and Rep. Nat. Mus., 817; *Zamenis* (part) Boul., *l. c.*, I, 379.

Maxillary teeth smooth, increasing posteriorly, no interspace; rostral widened laterally with projecting edges; one loreal; two internasals; two nasals; two or three preoculars; pupil round; scales smooth with pits in 17 rows; anal divided; size medium; body slender; head distinct.

Hab.—Southwestern United States; Mexico.

This genus is like *Zamenis*, but has the rostral considerably enlarged, with free, expanded lateral borders.

Salvadora grahami B. and G.

l. c., 104; Cope, *l. c.*, 619, and Rep. Nat. Mus., 818; *Zamenis grahami* Boul., *l* c., I, 393; *S. grahami* Van Den., *l. c.*, 180; *Phimothyra hexalepis* Cope, Proc. Acad. Phila., 1861, 300; *S. g. hexalepis* Stej., No. Amer. Fauna, No. 7, 205.

Head plates normal; rostral entering between internasals; lower preocular small, sometimes a third preocular; post-oculars 2 or 3; temporals 1 (2)–2 (3); upper labials 8; scales in 17 rows; ventrals 175–206; subcaudals 75–108.

Length about 1,200 mm. (tail 300).

A yellowish dorsal stripe about three scales wide, narrowing toward the tail; on each side a brown or olive stripe about the same width, bordered below by a greenish olive or brown stripe extending to the ventrals; the stripes are sometimes indistinct and at others are broken into spots; belly yellowish; head brown, usually unmarked.

Hab.—Western Texas to Utah and Arizona; Sonora and Lower California.

Several other species of *Salvadora* are found in Mexico.

PHYLLORHYNCHUS Stej.

Proc. U. S. Nat. Mus., 1890, 151; Cope, *l. c.*, 617, and Rep. Nat. Mus., 821; *Lytorhynchus* (part) Boul., *l c.*, I, 414.

Maxillary teeth smooth, longer behind, an interspace; rostral prominent with projecting lateral edges, and separating the internasals; two to four loreals; three preoculars; small scales between the eye and the labials; two nasals; two internasals; pupil vertical; one pair of chin shields; scales smooth or partly keeled, without pits, in 19 rows; anal entire; size medium; head slightly distinct.

Hab.—North America and Mexico.

Phyllorhynchus browni Stej.

l. c., 152; Cope, *l. c.*, 618, and Rep. Nat. Mus., 821; *Lytorhynchus browni* Boul., *l. c.*, I, 417.

Body slender; rostral very large, projecting, with free edges and completely separating the internasals; a transversely enlarged shield behind the parietals; loreals 3, the upper and lower small; oculars 3–4; several suboculars separating the eye from the labials; upper labials 6; temporals 3; one pair of chin shields; scales in 19 rows, nearly smooth anteriorly, keeled behind; ventrals 159; subcaudals 31.

Length 325 mm. (tail 42).

Whitish, with 15 brown blotches, mostly subquadrangular and lighter in the centre; belly white; a dark bar across the head between the eyes.

Hab.—Only two specimens known, from Tucson, Arizona.

Phyllorhynchus decurtatus Cope.

Phimothyra decurtata Cope, Proc. Acad. Phila., 1868, 310; *Phyllorhynchus decurtatus* Stej., Proc. U. S. Nat. Mus., 1890, 154, and Cope, Rep. Nat. Mus., 823; *Lytorhynchus decurtatus* Boul., *l. c.*, I, 417.

Much like *P. browni*, but the scales are smooth; there is no enlarged shield behind the parietals; the tail is shorter; the dorsal spots are more numerous and there are two series of irregular lateral spots. The type specimen in the Academy's collection is from northern Lower California, and there is a second in the National Museum from La Paz. A third, which has just reached me from Mr. Herbert Brown, collected by him at Yuma, Ariz., for the first time establishes the species within the United States. This specimen differs from the type in that the rostral penetrates between the prefrontals as in *P. browni;* there is but one subocular, and but two post-oculars on one side; there are four temporals; the tail is rather longer, and the spots are more numerous, being forty-one on the body and six on the tail (thirty-two altogether in the type). Ventrals 183; subcaudals 30. Length 403 mm. (tail 40).

Hab.—Lower California; Yuma, Arizona.

CYCLOPHIS Günther.

Cat. Col. Snakes, Br. Mus., Günth., 119 (1858); Cope, *l. c.*, 621 ; *Leptophis* B. and G., *l. c.*, 106 ; *Contia* (part) Boul., *l. c.*, II, 255.

Maxillary teeth smooth, equal; one loreal; one preocular; two internasals; one nasal; scales keeled with two pits; anal divided; size small, tail long; head distinct; color green.

Hab.—Asia; North America.

Cyclophis æstivus L.

Coluber æstivus L., Syst. Nat., Ed. XII, 387 (1766); *Leptophis æstivus* and *majalis* B and G., *l. c.*, 106 ; *Cyclophis æstivus* Cope, *l. c.*, 621, and Rep. Nat. Mus., 784 ; *Contia æstiva* Boul., *l. c.*, II, 258.

Head scales normal; loreal rather long, occasionally absent; oculars 1–2 (of two examples from New Jersey in my collection, one has a subpreocular on each side, and the other has three post-oculars on one side); temporals 1–2; upper labials 7, the third and fourth in orbit (one from Florida has the fourth and fifth in the orbit on one side); ventrals 148–166; subcaudals 111–148; scales in 17 rows, the outer smooth. Length 920 mm. (tail 330).

Uniform bright green above; labials and belly yellowish white or bright yellow.

Hab.—New Jersey to Florida, west to the Mississippi, southwest to New Mexico.

LIOPELTIS Cope.

Proc. Acad. Phila., 1860, 559 ; *Chlorosoma* B. and G., *l. c.*, 108 ; *Liopeltis* Cope, *l. c.*, 620, and Rep. Nat. Mus., 781 ; *Contia* (part) Boul., *l. c.*, II, 255.

Maxillary teeth smooth, equal; head scales normal; a loreal, occasionally absent; one nasal; scales smooth, with one pit; anal divided; size small; tail long; head distinct.

Hab.—Eastern Asia; North America.

Liopeltis vernalis Harlan.

Coluber vernalis Harl., Jour. Acad. Phila., V, 1827, p. 361 ; *Chlorosoma vernalis* B. and G., *l. c.*, 108 ; *L. vernalis* Cope, *l. c.*, 620, and Rep. Nat. Mus., 782 ; *Contia vernalis* Boul., *l. c.*, II, 258.

Head scales normal; loreal nearly square, sometimes fused with the nasal; one nasal; oculars 1 (2)–2; temporals 1–2; upper labials 7, third and fourth in orbit; lower labials 8; scales smooth in 15 rows; ventrals 120–138; subcaudals 69–94.

Uniform bright green above; labials and belly yellowish green. Length 500 mm. (tail 150).

Hab.—Canada and United States east of Rocky Mountains; rare in the southeastern States.

CONTIA B. and G.

l. c., 110 ; Cope (part), *l. c.*, 599, and *Chionactis* Cope, *l. c.*, 604, and Rep. Nat. Mus., 925, 935[18] ; *Contia* (part) Boul., *l. c.*, II, 255 ; *? Lodia* B. and G., *l. c.*, 116.

Maxillary teeth smooth, equal; one loreal; one preocular; one nasal, sometimes half divided below the nostril; two internasals; scales smooth, without pits in 15–17 rows; anal divided; size small; head not very distinct.

Hab.—North America; Asia.

Key to the American Species.

a.—13 rows of scales; pale brown, no cross-bars, . 1. *C. taylori.*
b.—15 rows of scales:
Reddish or greenish brown; sometimes cross-bands, 2. *C. episcopa.*
White, with bands or rings around body, 3. *C. occipitale.*
Brown, with a light band on each side, . . 4. *C. mitis.*

[18] Prof. Cope removes all the species included here in *Contia*, except *C. mitis*, to *Chionactis* Cope, on account of their possession of a shallow external groove on the posterior maxillary tooth. This is probably the same noted by Dr. Günther as a distinct elongated pit at the base of the hinder teeth in large specimens of the Mexican *Conopsis nasus* (Biologia Centrali Americana, Rept., p. 97). Sufficient material is not accessible to determine either the constancy or the value of this character, and it seems best for the present to retain these snakes in the genus *Contia*.

Contia taylori Boulenger.

l. c., II, 265, Pl. XII, fig. 3 ; Cope, Rep. Nat. Mus., 936.

Nasal not divided; one loreal, longer than deep; oculars 1–2; temporals 1–1 (2); upper labials 7; posterior chin shields very small; scales in 13 rows; ventrals 126–137; subcaudals 37–46; length 270 mm. (tail 55).

" Pale brown above, each scale darkest along the centre; upper lip and lower parts white."

Hab.—Duval county, Texas; northern Mexico (three specimens known).

Contia episcopa Kennicott.

Lamprosoma episcopum Kenn., U. S. Mex. Bound. Surv., p. 22, pl 8, fig. 2 (1859).

This species has the scales in 15 rows; an undivided nasal; an elongated loreal; 7 upper labials; oculars 1–2; temporals 1–2 (1); ventrals 143–167; subcaudals 35–57; tail about one-fourth of the length. Ranges from Texas to Utah, Arizona and northern Mexico.

Rosy yellow to ashy; no cross-bands, . . . 1. *C. e. episcopa.*
Orange, with black cross-bands, ... 2. *C. e. isozona.*

Contia episcopa episcopa Kennicott.

l. c., 22 ; *C. e. episcopa* and *C. e. torquata* Cope, *l. c.*, 601 ; *C. episcopa* and *C. torquata* Boul., *l. c.*, II, 265, 266 ; *Chionactis episcopa episcopa* and *C. e. torquata* Cope, Rep. Nat. Mus., 938, 939.

Ventrals 143–163; subcaudals 35–57. Length about 250 mm.

Yellowish, reddish or greenish brown, sometimes with a yellow dorsal stripe three scales wide; most of the scales tipped with light brown; top of head like the body, or brown or black; belly yellowish or greenish white.

C. e. torquata Cope rests upon degrees of color intensity which are admittedly inconstant in the two specimens known.

Hab.—Texas and northern Mexico.

Contia episcopa isozona Cope.

Proc. Acad. Phila., 1866, 304, and *l. c.*, 601 ; *C. isozona* Boul., *l. c.*, II, 266.

Ventrals 158–167; subcaudals 50–52; orange or red with black cross-bands which almost reach the ventrals, becoming complete rings on the tail; belly whitish; snout red, rest of head black. Length about 250 mm.

Hab.—Texas to Arizona and Utah; Sonora.

Contia occipitale Hallowell.

Rhinostoma occipitale Hall., Proc. Acad. Phila.; 1854, 95; *Chionactis occipitalis* Cope, *l.* c., 605, and Rep. Nat. Mus., 941; *Contia occipitale* Boul., *l. c.*, II, 266.

Snout prominent; nasal undivided; loreal small; oculars 1–2; temporals 1–2; upper labials 7; scales in 15 rows; tail about one-fifth of total length; ventrals 147–158; subcaudals 34–44.

Length about 300 mm.

Color white or pale yellow, sometimes pinkish; narrow black rings around the body at intervals of about five scales, sometimes interrupted on the ventrals; rest of belly whitish; a black crescent on the hinder part of parietals with the horns forward.

Hab.—Arizona.

Contia mitis B. and G.

l. c., 110; ? *Lodia tenuis* B. and G., *l. c.*, 116; *C. mitis* and *L. tenuis* Cope, *l. c.*, 601; *Contia mitis* Boul., *l. c.*, II, 267, and Van Den., *l. c.*, 163.

Size small; tail very short; oculars 1–1 (2); upper labials 7; temporals 1–2; scales in 15 rows; ventrals 147–186; subcaudals 30–52; length 322 mm. (tail 40). Reaches a length of 415 mm.

Dark brown with a yellowish stripe on the fourth row of scales, and a row of black dots below it; ventrals yellowish edged with black; a black streak on each side of head; chin and throat spotted with black.

Lodia tenuis B. and G., was based upon one example from Puget Sound, Oregon, agreeing with *C. mitis* except in having a small additional plate between the prefrontals, and the loreal reaching the eye under the preocular. As no further specimen has come to light in fifty years, it seems safe to refer this unique example to the class of anomalies, the head plates being usually variable in these small burrowing forms.

Hab.—Central California to Washington and Oregon.

DIADOPHIS B. and G.

l. c., 112; Cope, *l. c.*, 614, and Rep. Nat. Mus., 743; *Coronella* (part) Boul., *l. c.*, II, 188.

Maxillary teeth smooth, subequal; one loreal; two preoculars; two internasals; two nasals; scales smooth with one pit, in 15–17 rows; anal divided; size small; head distinct.

Hab.—North America; Mexico.

If due attention be paid to juvenile characters, the North

American species of *Diadophis* must be limited to three. Baird and Girard established two others, which with a third of his own making, Cope regards as subspecies of *D. amabilis*. In these forms the chief differences are in the shape of the frontal and supraocular plates, and in the extent to which the dark dorsal area invades the two outer rows of scales. But a series of the eastern form, *D. punctatus*, of all sizes, shows that exactly these differences, in that species, are age characters, and in a genus whose included forms are so nearly similar, there can be little doubt that they are so in *amabilis* as well.

Key to the Species.

17 rows of scales; 7 (8) upper labials; ventrals 237 or less,
1. *D. regalis.*
15 rows of scales; 7 (8) upper labials; ventrals 210 or less,
2. *D. amabilis.*
15 rows of scales; 8 (7) upper labials; ventrals 160 or less,
3 *D. punctatus.*

Diadophis punctatus L.

Coluber punctatus L., Syst. Nat., Ed. XII, 376; *D. punctatus* B. and G., *l. c.*, 112; *D. punctatus* and *D. amabilis stictogenys* (part) Cope, *l. c.*, 616, 617, and Rep. Nat. Mus., 751, 750; *Coronella punctata* Boul., *l. c.*, II, 206.

Head not very distinct; head plates normal; in adults the frontal is much narrowed behind and acute; oculars 2 (1)–2; temporals 1–1; upper labials 8 (occ. 7); scales in 15 rows; ventrals 136–160; subcaudals 36–62. Length 355 mm. (tail 65).

In adults the color is bluish black or brownish above, covering the whole of the dorsal scales and extending like a bar upon the end of each ventral; the belly is yellow or orange, sometimes with a series of transverse dark blotches in the middle of each ventral, these are, however, often absent; there is usually a yellow half-collar on the nape, half a scale to a full scale in width; the lower half of the upper and the whole of the lower labials is yellow with small spots of black. In the young, the back is bright reddish brown or salmon color, which reaches only the upper border of the second row of scales, and extends downward as the color deepens; the top of the head is dark brown and the nuchal collar is bordered behind by a band of the same dark color; the frontal plate is also more angular in front and less tapering behind, than in the adult.

Hab.—North America, east of the Mississippi river.

Diadophis amabilis B. and G.

l. c., 113; *D. docilis* and *D. pulchellus* B. and G., *l. c.*, 114, 115; *D. a. amabilis*, *D. a. pulchellus*, *D. a. docilis* and *D. a. stictogenys* (part) Cope, *l. c.*, 616, and Rep. Nat. Mus., 747–750; *Coronella amabilis* Boul., *l. c.*, II, 207; *D. amabilis* Van Den., *l. c.*, 164.

In this species the frontal is broader behind than in either of the others; upper labials 7 (occ. 8); temporals 1–1 (2); scales in 15 rows; the form is more elongate than in *punctatus*, the ventrals ranging from 182–210; subcaudals 53–63. Length 470 mm. (tail 80).

The coloration is much as in *punctatus;* the spots on the ventrals are small and irregular, and the nuchal half-collar is almost always present.

Hab.—Texas to the Pacific coast; south to Sonora.

Diadophis regalis B. and G.

l. c., 115; *D. regalis regalis* and *D. r. arnyi* Cope, *l. c.*, 615, and Rep. Nat. Mus., 744, 745; *Coronella regalis* Boul., *l. c.*, II, 208.

The frontal is narrow behind, as in *punctatus;* scales in 17 rows; upper labials 7 (occ. 8); temporals 1–1 (2); ventrals 183–237; subcaudals 56–75. Length 570 mm. (tail 100); being the largest of the genus.

Ashy to brownish black; belly yellow or reddish with small black spots; the nuchal collar is generally absent.

Hab.—Illinois to Arizona; south to Vera Cruz.

OPHIBOLUS B. and G.

l. c., 82; Cope, *l. c.*, 607; *Osceola* B. and G., *l. c.*, 133 and Cope, *l. c.*, 606; *Coronella* (part) Boul., *l. c.*, II, 188; *Osceola and Ophibolus* Cope, Rep. Nat. Mus., 881, 902.[19]

Maxillary teeth smooth, slightly increasing posteriorly, no interspace; one loreal; one preocular; two internasals; two nasals; scales smooth, with two pits, in 19–25 rows; anal entire; size large and stout to small and slender; head slightly distinct.

Hab.—North America and Mexico.

Key to the Species.

a.—Scales in 21 rows; dorsal spots brown or red with black borders; or rings around body, ... 1. *O. doliatus.*

[19] *Lampropeltis* Fitzinger, lately exhumed, is regarded as a *nomen nudum* for the reasons given under *Eutænia*.

b.—Scales in 21–23 rows:

Size large; black, with centres of scales white or yellow; or cross-bands of same color, ... 2. *O. getulus.*

Size small; yellow and black rings; black rings more or less divided by red, ... 3. *O. zonatus.*

Size medium; pale brown; dorsal spots much wider than long; no head bands, ... 4. *O. rhombomaculatus.*

c.—Scales in 25 rows; size medium; grayish brown, head bands distinct, ... 5. *O. calligaster.*

Ophibolus doliatus L.

Coluber doliatus L., Syst. Nat., Ed. XII, 379 (1766).

Size medium to small; head scales normal; loreal small and occasionally absent in one form; oculars 1–2; temporals 2 (1)–2 (3); frontal narrow behind in the young, broader in adults; upper labials 7; scales in 21 rows (occasionally varying from 17–23); anterior chin shields much the longest; ventrals 165–215; subcaudals 31–55; tail from one-fifth to one-seventh of the length.

This species covers the United States from the Atlantic coast to the central plains, and extends southwest into Mexico, and varies to an extreme degree, with the usual result in classification. Prof. Cope's scheme of the directive color variations of *O. doliatus*, guided by "bathmism," published in completed form in *The American Naturalist*, 1893, p. 1066, and finally in *The Primary Factors of Organic Evolution*, p. 29 (1896), is a remarkable example of the employment of that great gift, the scientific imagination, in a wrong field; for if that work be compared with a large series of *doliatus*, it becomes evident that the subspecies added by Cope to complete the chain are no more than selected cases, the numberless promiscuous variations being wholly ignored. The course of change from a brown-spotted to a red-ringed snake has not been as orderly, nor as easily marked off, as is there assumed, and in subdividing the species, natural limitations are not readily found.

Key to the Subspecies.

a.—An oblique streak behind the eye:

Dorsal spots reaching to about fifth row; an angular mark on head; ventrals 190–214, . . 1. *O. d. triangulus.*

Dorsal spots reaching to third or first row; head bands variable; ventrals 175–203, ... 2. *O. d. clericus.*

b.—No oblique streak behind eye:

a[1].—Dorsal spots reaching outer row or ventrals; no distinct headbands, ... 3. *O. d. doliatus.*

b[1].—Black borders of dorsal spots forming rings around body; no alternating spots:

No black blotch on ventrals opposite dorsal spots; top of head mostly red, ... 4. *O. d. coccineus.*

A black blotch on ventrals opposite dorsal spots; top of head mostly black, . . . 5. *O. d. gentilis.*

Ophibolus doliatus triangulus Daudin.

Coluber triangulus Daud., Rept., VI, 322 (1803); *Ophibolus eximius* B. and G., *l. c.*, 87; *O. d. triangulus* Cope, *l. c.*, 610; *Coronella triangulum* (part) Boul., *l. c.*, II, 200; *Osceola doliata triangula* Cope, Rep. Nat. Mus., 885.

Largest of the subspecies; temporals 2–2; scales in 21 rows; ventrals 190–214; subcaudals 43–55; length about 1,100 mm.

Body color gray; the dorsal spots are about thirteen scales wide and rarely extend below the fifth row; they are chocolate brown, with black borders in adults, and quite red in the young, and number 40–46 on the body, and 10–13 on the tail; a second smaller alternating series on the sides, which does not reach the ventrals, and a third series of irregular black blotches on the ends of the ventrals; the belly is whitish, blotched with black. The first dorsal spot is commonly extended forward and ends in a conspicuous angle on the frontal, the arms of which enclose a triangular light patch; there is a black band across the prefrontals, often with a light centre, and a narrow dark oblique streak behind the eye, bordered above by a light one.

Hab.—Massachusetts to North Carolina; west to Wisconsin.

Ophibolus doliatus clericus B. and G.

Ophibolus clericus B. and G., *l. c.*, 88; *O. d. collaris*, *O. d. clericus* Cope, *l. c.*, 609, 610, and Rep. Nat. Mus., 886, 888; *O. d. temporalis* Cope, Am. Nat., 1893, 1068 and Rep. Nat. Mus., 889; *Coronella triangulum* (part) Boul., *l. c.*, II, 200.

Shorter than *O. d. triangulus;* ventrals 175–203; subcaudals 36–49; length 950 mm.

The dorsal spots are less numerous, from 21–36 on the body and 6–10 on the tail; they are wider and end from the third to the first row of scales; the alternating spots are correspondingly lower and invade the ventrals. The head markings are sometimes much as in *triangulus* but less distinct; there is usually an oval light patch surrounded by a black ring, in place of the triangular mark;

this is sometimes more or less extended transversely, becoming a half-collar; this is the form called *collaris* by Cope; often the anterior ring is represented by a black bar on the nape, and sometimes the ring is altogether absent and there is a light spot on each supraocular and another on the parietals, the rest of the head markings being more or less obsolete: this is *temporalis* Cope, but the intermediate stages are so many that it is quite arbitrary to regard these patterns as distinctive. The spots range in color from brown to red. The oblique streak behind the eye is present. *O. d. clericus* is a transitional form of great variability, and it is by no means always easy to distinguish it from *O. d. triangulus* on the one side and *O. d. doliatus* on the other; but I find that on the whole, compared with *triangulus*, it has a greater width and lessened number of dorsal spots and a want of definition in the head markings, associated with fewer ventrals and subcaudals; it may be distinguished from *O. d. doliatus* by the fact that the latter lacks the oblique streak behind the eye and rarely shows any head markings beyond a dark bar or blotch across the parietals.

Hab.—This subspecies seems to occupy the southern portion of the range of *O. d. triangulus*. I have seen no examples from further north than Trenton, N. J., and central Illinois.

Ophibolus doliatus doliatus L.

l. c., 379; *O. d. doliatus*, *O. d. parallelus* and *O. d. syspilus* (part) Cope, *l. c.*, 609, and Rep. Nat. Mus., 889–893; *Coronella gentilis* (part) Boul., *l. c.*, II, 201.

Form short and stout in adults; temporals 2–2 (3); ventrals 200–210; subcaudals 44–55; length about 670 mm. (tail 100).

Ground color grayish white or yellowish; dorsal spots brownish red, or red, with black borders; they are broad and reach to the first row of scales, often extending well on to the ventrals; the lateral spots are small and largely upon the ventrals, wholly so when the dorsals are widest. The belly is whitish or yellow with black blotches; the lower borders of the dorsal spots sometimes form nearly parallel black bands on the ventrals. The extreme of this disposition is *parallelus* Cope. The top of the head is sometimes almost entirely black, but more usually this is reduced to a bar across the parietals, the rest of the head being red or yellow. The post-orbital stripe of the previous forms is absent.

I cannot find characters which will bear examination in *syspilus*

Cope. No. 3,609, Academy coll., from Hennessey, Oklahoma, collected and labeled *syspilus* by Cope himself, has more black upon the head than most *O. d. doliatus*, while underneath, anteriorly, it has the paired rings of *O. d. coccineus*, on the rest of the belly having parallel lines formed by the lower borders of the dorsal spots quite as close together as those attributed by him to *parallelus*.

Hab.—Maryland to Florida; west to Illinois, Oklahoma and Texas.

Ophibolus doliatus coccineus Schlegel.

> *Coronella coccinea* Sch., Ess. Phys. Serp., II, 67, Pl. 2 (1837); *Ophibolus doliatus* and *Osceola elapsoidea* B. and G., *l. c.*, 89, 133; *Osceola elapsoidea* and *O. d. coccineus* Cope, *l. c.*, 606, 609, and Rep. Nat. Mus., 900, 896; *Coronella gentilis* (part) and *C. doliata* (part) Boul., *l. c.*, II, 201, 205.

Body rather more slender; temporals 1–2; ventrals 175–204; subcaudals 31–54; length 535 mm. (tail 70).

Body color scarlet, completely encircled by pairs of black rings, with interspaces white in the young, yellow in adults; no lateral spots; belly paler than the back; top of head red, with the first black rings crossing the parietals. The pattern is formed by the obliteration of the lateral portion of the black borders of dorsal spots, and the extension of their transverse portion entirely around the body. The lateral spots have disappeared.

This subspecies seems to be adopting burrowing habits in portions of its range, and, as is frequent in such cases, the head plates and scales are becoming variable, specimens being found without a loreal and with the scales reduced to nineteen rows. This extreme reduction is *Osceola elapsoidea* B. and G., and is not common, but intermediate stages are frequent; out of some thirty specimens colored as in *coccineus*, I have met but two without a loreal and with 19 rows. The case is peculiar. If constant the distinction would be a generic one; on the other hand, the importance of the character involved would seem to lift it out of the ordinary category of intergradation, for we appear to have a subspecies being transformed into a genus under our eyes. On the whole, it may accord best with a sound method to take no note of this form at its present stage.

Hab.—North Carolina to Florida and west to the Mississippi river. Specimens without a loreal are rarely found outside of Florida.

Ophibolus doliatus gentilis B. and G.

Ophibolus gentilis B. and G., *l. c.*, 90; *O. d. annulatus*, *O. d. syspilus* (part), *O. d. gentilis* and O. *multistratus* Cope, *l. c.*, 609, 611; *Coronella gentilis* (part) and *C. micropholis* (part) Boul., *l. c.*, II, 201, 203; *Lampropeltis multistratus* and *L. annulatus* Stej., Proc. U. S. Nat. Mus., 1891, 502, 503; *Osceola doliata gentilis*, *annulatus*, *syspilus* (part) and *Ophibolus multistratus* Cope, Rep. Nat. Mus., 894, 895, 909.

Body rather short and stout; temporals 2–2 (3); scales in 21 rows (occasionally 23); ventrals 184–200; subcaudals 42–50; length about 700 mm.

The black rings usually extend around the body as in *O. d. coccineus*, and the colors are very similar, but the spaces between adjacent pairs of rings on the belly, opposite the red dorsal tracts, are more or less filled up by black; the whole top of the head is usually black except the end of the snout, which is red. Sometimes the scales in the yellow rings are marked with black, and often the black of the rings extends along the dorsal line, forming a dusky band on the red spaces; when the black suffusion is wanting we have *annulatus* Kenn., but it exists in all degrees.

A small specimen from Fort Harker, Kans., in the Cope collection, referred by him to *syspilus*,[20] is simply an immature *gentilis*.

O. multistratus Kenn. was founded on an individual from Nebraska having 8 upper labials; 23 rows of scales; three temporals in the second row, dorsal spots with borders uniting on the flanks, and no rings nor spots on the belly. Mr. Stejneger reports a second specimen[21] with but seven labials. Twenty-three rows of scales; temporals 2–3; with a greater or less number of dorsal spots are not without precedent in *O. doliatus*; indeed, three out of five *O. d. gentilis* which I have examined have three temporals in the second row. No. 3,613 Academy coll., from western Louisiana, is in company with a *gentilis* lacking the dorsal suffusion of black, and is exactly like it in all other respects, except that the belly is immaculate and the dorsal spots close on the outer row of scales; corresponding very closely to Kennicott's description of *multistratus*, with the scutellation of *gentilis*. I see no reason, therefore, why the first should not be included within the range of this variable form; the same may be said of *annulatus* Kenn., the differences of which are trivial.

[20] *Proc. U. S. Nat. Mus.*, 1888, p. 385.

[21] *Proc. U. S. Nat. Mus.*, 1891, p. 502.

The Mexican forms of *Ophibolus* with rings are closely related to this section. Mr. Boulenger has indeed united all of them with *annulatus*, under the name of *O. micropholis* Cope, and Dr. Günther[22] has done the same, using the name *annulatus*.

The one specimen of *micropholis*, from Nicaragua, which I have seen, is certainly very like *gentilis*, and if the southern forms are to be united, as stated above, *gentilis* will probably have to be added, and that name will have priority.

Hab.—As here restricted, *gentilis* ranges from Nebraska to western Louisiana, Texas and northern Mexico.

Ophibolus getulus L.

Coluber getulus L., Syst. Nat., Ed. XII, 382 (1766).

Size large and stout; head not very distinct; scales in 21–23 rows (occ. 25); oculars 1–2; upper labials 7; temporals 2–2 (3); anterior chin shields longest; tail rather more than one-seventh of the length; color black or brownish black; white or yellow markings on separate scales, which frequently collect into lines across the back.

Hab.—The whole United States south of latitude 40°.

Key to the Subspecies.

a.—Scales in 21 or 23 rows:
Scales with yellow centres, often forming cross-bands, 1. *O. g. sayi.*
Black with white or yellow cross-bands, bifurcating on sides, 2. *O. g. getulus.*

b.—Scales in 23 or 25 rows:
Black with white rings which widen on the sides, 3. *O. g. boylii.*
Black with many rings broken; short white stripes, 4. *O. g. californiæ.*

Ophibolus getulus sayi Holbrook.

Coronella sayi Holb., No. Am. Herp., III, 99, Pl. XXII (1842); *Ophibolus splendidus* and *O. sayi* B. and G., 83, 84; *O. g. sayi* and *O. g. splendidus* Cope, *l. c.*, 612, 613, and Rep. Nat. Mus., 911 and 918; *Coronella getula* (part) Boul., *l. c.*, II, 197.

Dorsal rows of scales 21–23 (rarely 25); ventrals 200–224; subcaudals 40–60; length about 1,500 mm.

This form is exceedingly variable in pattern, but after examination of many specimens from all parts of its range, both living

22 *Bio. Cent. Amer. Rept.*, p. 109, Pl. 23.

and alcoholic, I am not able to subdivide it. Typical *sayi* is black, and has each scale with a white or yellow centre; the belly is yellow with black blotches and the head is black with small yellow spots. In many cases the body spots collect into narrow transverse bands, leaving considerable spaces black with more or less traces of the yellow spots; sometimes the lower seven or eight rows of scales are spotted, and above them, on the dorsal area, the spots collect into narrow bands connecting the spotted sides and leaving a series of black, unspotted tracts on the back, three or four scales long and seven or eight wide. This is *splendidus* B. and G. At the present time the collection of the Zoölogical Society contains examples of both of these and more or less intermediate stages, collected at the same time at Pecos, Tex. On the other hand, No. 4,451 Academy coll. is a very fair example of *splendidus* collected at Reelfoot Lake, Tenn., in 1895, by Mr. Samuel N. Rhoads, and No. 3,585, from southern Illinois, clearly indicates the same pattern, which is therefore not associated with a restricted geographical area.

Hab.—Southern Illinois to Louisiana and through the southern portion of the plains to western Texas.

Ophibolus getulus getulus L.

> *Coluber getulus* L., Syst. Nat., Ed. XII, 382 (1766); *Ophibolus getulus* B. and G., *l. c.*, 85; *O. g. getulus* and *O. g. niger* Cope, *l. c.*, 613; *Coronella getula* (part) Boul., *l. c.*, II, 197; *O. g. getulus* Cope, Rep. Nat. Mus., 914.

Size larger than *O. g. sayi;* ventrals 210–224; subcaudals 40–53; reaches a length of 1,800 mm.

Black, crossed by transverse bands of white or pale yellow, one and a half or two scales wide, at intervals of from five to ten scales, generally bifurcating on the flanks and joining the anterior and posterior ones, thus forming a chain-like pattern enclosing a series of black dorsal blotches. An occasional Florida specimen has some scales in the black areas with light centres. Two specimens, one from Florida and one from Alabama, now in the Zoölogical Gardens, have narrow white bands crossing the back, in one at intervals of seven, and in the other of ten scales, without bifurcating. The belly is white or yellow, with black blotches; top of head black, nearly all the plates marked with white or yellow; labials yellow, heavily margined with black. *O. g. niger* does not appear to me to be more than a melanistic condition, approaches to which occur in all subspecies of *O. getulus.*

Hab.—Southern New Jersey to Florida and Louisiana; chiefly in the Atlantic States.

Ophibolus getulus boylii B. and G.

Ophibolus Boylii B. and G., *l. c.*, 82; *O. g. boylii* Cope, *l. c.*, 613, and Rep. Nat. Mus., 919; *Coronella getula* (part) Boul., *l. c.*, II, 197; *Lampropeltis boylii* Van Den., *l. c.*, 169.

Smaller than *O. g. sayi;* scales in 23 rows (occ. 25); ventrals 218–255; subcaudals 46–60. The largest measurement given by Mr. Van Denburg is 1,089 mm. (tail 135).

The body is black or brownish, with rings of white or yellow about two scales wide on the back, which widen on the sides until they are wider than the black interspaces; sometimes the direction of the rings is oblique, so that on the belly and even on the back the ends alternate, instead of meeting; the top of the head is black with small light spots and the snout is white or yellow. One of two living specimens lately received from Yuma, Ariz., by courtesy of Mr. Herbert Brown, has the light bands only indicated by white spots on a few lateral scales, across the back there being no more than a brown shade on the deep black of the body color; the top of the head is wholly black, the lower labials white, heavily margined with black.

Hab.—Nevada, Arizona and California.

Ophibolus getulus californiæ Blainville.

Coluber (*Ophis*) *californiæ* Blain., Nouv. Ann. du Mus., 1835, 292; B. and G., *l. c.*, 153; *O. g. californiæ* Cope, *l. c.*, 614, and Rep. Nat. Mus, 922; *Coronella getula* (part) Boul., *l. c.*, II, 197; *Lampropeltis californiæ* Van Den., *l. c.*, 172.

The relations of this snake to *O. g. boylii* are uncertain, and it is quite possible that the specimens known are but abnormal color variations of that species; there are usually 23 rows of scales; oculars 1–2 (3); temporals 2–3; ventrals 226–236; subcaudals 50–58. The body is black or brownish with little constancy in the markings; at times more or less of the white rings of *boylii* are present, but broken up and interspersed with short longitudinal white stripes, and according to Mr. Van Denburg, there is a white or yellow stripe or series of spots on the back; the head is colored as in *boylii*, and the belly is yellow or white, with or without black blotches.

Mr. Van Denburg's largest specimen measured 391 mm. (tail 41).

Hab.—Southern California and Lower California.

Ophibolus zonatus Blainville.

Coluber (*Zacholus*) *zonatus* Blain., *l. c.*, 293; *Ophibolus pyrrhomelas* Cope, *l. c.*, 610, and Rep. Nat. Mus., 907; *Coronella zonata* Boul., *l. c.*, II, 202; *Lampropeltis zonatus* Van Den., *l. c.*, 167.

Size rather smaller than *boylii*, body slender; scutellation generally as in that form; oculars 1 (2)–2; upper labials 7 (6); temporals 2 (1)–3 (2); scales in 21–23 rows; ventrals 199–224; subcaudals 45–66. Length about 900 mm. (tail one-sixth).

The body is encircled by narrow white or yellow rings, between which are black ones, which are more or less replaced or divided by red; all the rings are narrow, and the red is more pronounced anteriorly, being often altogether absent on the hinder part of the body; head yellow with a black band across the middle and another on the nape.

Mr. Boulenger, as it appears to me rightly, has referred this species to *zonatus* of Blainville.

Hab.—Arizona and southern California.

Ophibolus rhombomaculatus Holbrook.

Coronella rhombomaculata, Holb., *l. c.*, III, 103, Pl. 23; *O. rhombomaculatus* B. and G., *l. c.*, 86; Cope, *l. c.*, 610, and Rep. Nat. Mus., 903; *Coronella calligaster* (part) Boul., *l. c.*, II, 198; *Lampropeltis rhombomaculatus* Stej., Proc. U. S. Nat. Mus., 1891, 503.

Size moderate; body cylindrical and rigid; oculars 1–2; temporals 2–3; upper labials 7; anterior chin shields longest; scales in 23–21 rows; ventrals 200–212; subcaudals 44–51.

Length 790 mm. (tail 110).

Body color pale brown, with a dorsal series of small dark brown blotches with indistinct black borders; these are about eight or nine scales wide and not more than two long, and may number as many as fifty on the body; the interspaces are wider than the spots; a series of irregular small blotches on the side, often alternating with the dorsals and reaching the ventrals, the lower end sometimes breaking off and forming a detached spot on the end of the ventrals; belly yellowish white clouded with pale brown; no head bands, nor spots on the nape; a narrow oblique streak behind the eye; labials whitish slightly margined with dark brown.

Hab.—From the District of Columbia to South Carolina and west to the Alleghenies. Not common.

Ophibolus calligaster Harlan.

Coluber calligaster Harl., Jour. Acad. Phila., 1827, 359; *O. calligaster* Cope, *l. c.*, 610, and Rep. Nat. Mus., 905; *Coronella calligaster* (part) Boul., *l. c.*, II, 198.

Larger than *rhombomaculatus;* oculars 1–2; temporals 2–3; upper labials 7; anterior chin shields longest; scales in 25 rows; ventrals 198–210; subcaudals 41–65. Length 1,180 mm. (tail 165).

Body color pale grayish brown; a dorsal series of subquadrate blotches, dark brown with narrow black borders, two to three scales long, eight to ten wide, somewhat emarginate before and behind; the interspaces are about equal to the spots; a smaller alternating series on the sides, which often form irregular vertical bars, and a third on the outer row of scales and ends of the ventrals; belly yellowish, with or without square black blotches on the centre. The head markings are sometimes very elaborate; in a beautiful specimen formerly in the collection of the Zoölogical Society, from Minnesota, the top of the head was yellowish, with a brown band across the prefrontals; an arrow-headed mark, brown with a black border, the base on the frontal and apex just behind the parietals; a brown spot on the hinder end of the supraoculars and a faint dark oblique streak behind the eye. Labials yellow. An elongated brown blotch with black border, on each side, running back from the parietals to the neck. The markings are, however, not always as distinct; a second living specimen, from Missouri, has the whole color darker, the lateral spots quite obscure, no dark blotches on the ventrals, and the head markings indistinct. The general aspect of this snake is very like *rhombomaculatus*, but it has 25 rows of scales; the ground color is grayish brown; the dorsal spots are less narrow, and the head bands almost always distinguish it at a glance.

Hab.—Indiana to Minnesota and southwest to Kansas and northern Texas. Has been once reported from central Ohio.

STILOSOMA A. E. Brown.

Proc. Acad. Phila., 1890, 199; Cope, *l. c.*, 595, and Rep. Nat. Mus., 924; Boul., *l. c.*, II, 325.

Maxillary teeth small, smooth, subequal; body very slender and cylindrical; head not distinct; tail short; internasals frequently fused with prefrontals; one nasal; no loreal; preocular usually distinct; prefrontals and parietals in contact with labials; scales smooth without pits; anal entire.

Stilosoma extenuatum A. E. Brown.

Proc. Acad. Phila., 1890, 199; Cope, *l. c.*, 595, and Rep. Nat. Mus., 924; Boul., *l. c.*, II, 325; Stejneger (fide Lœnnberg), Proc. U. S. Nat. Mus., 1894, 323.

Maxillary teeth 10–11, about equal in size; mandibular teeth 12. Body very slender, its diameter contained about one hundred times in its length; snout rather prominent; head scales variable; of nine specimens which I have examined, six have the internasals fused with the prefrontals, one has a distinct internasal on one side; two have the preocular fused with the frontal; in all the loreal is absent and the prefrontals and parietals are in contact with the labials; upper labials 6; third and fourth in orbit, fifth largest; lower labials, 5; post-oculars 2; temporals 1–1; 2 or 3 pairs of chin shields; scales smooth in 19 rows; ventrals 223–260; subcaudals 33–40. Length 575 mm. (tail 50).

Body color silvery gray, with 60–70 irregular dark-brown dorsal spots with blackish border, on the body and about twelve on the tail; on the dorsal line the interspaces are mottled with pale red; belly blotched with black which extends on the sides and often breaks into lateral spots; on the sides the scales are finely punctulated with black; a dark patch on the parietals, with a smaller one on each side of the neck; a dark post-ocular streak; forepart of head, chin and throat maculated with black.

Hab.—Known only from Marion and Orange counties, Florida.

CARPHOPHIS Gervais.

Dict. d'Hist. Nat., III, 191 (1849); *Celuta* B. and G., *l. c.*, 129; *Carphophiops* Cope, *l. c.*, 596, and Rep. Nat. Mus., 734; *Carphophis* Boul, *l. c.*, II, 321.

Maxillary teeth smooth, subequal; a loreal; internasals one, two or absent; one nasal; no preocular; scales smooth, without pits, in 13 rows; anal divided; size very small; head flat and not distinct.

Hab.—North America.

Carphohis amænus Say.

Coluber amœnus Say, Jour. Acad. Phila., IV, 237 (1825); *Celuta amœna* B. and G., *l. c.*, 129; *Celuta helenæ* Kenn., Proc. Acad. Phila., 1859. 100; *Carphophiops amœnus* and *C. vermis* Cope, *l. c.*, 596, 597; *Carphophis amœnus* Boul., *l. c.*, II, 324.

Head small and flat; internasals often absent; no preocular, the loreal entering the orbit; post-ocular 1; temporals 1–1 (2); 13 rows of scales; ventrals 120–134; subcaudals 24–36.

Length 310 mm. (tail one-sixth).

Chestnut brown above, dark brown in adults: salmon color beneath.

Western specimens usually have but one temporal in the second row, and vary a trifle in the extension of the belly color on the sides; but as the species is a degraded and variable one, it does not seem necessary to regard them as distinct.

Hab.—New England to Kansas and southward.

FARANCIA Gray.

Zool. Misc., 68 (1842) ; B. and G., *l. c.*, 123 ; Cope, *l. c.*, 604, and Rep. Nat. Mus., 740 ; Boul., *l. c.*, II, 290.

Maxillary teeth smooth, subequal; one loreal; one internasal; one nasal half divided; no preocular; scales smooth, without pits, in 19 rows; anal divided; size moderately large; body cylindrical and rigid; head not very distinct.

Hab.—North America.

Farancia abacura Holbrook.

Coluber abacurus Holb., No. Am. Herp., I, 119, Pl. 23 (1836) ; *Farancia abacura* B. and G., *l. c.*, 123 ; Cope, *l. c.*, 604, and Rep. Nat. Mus., 741 ; Boul., *l. c.*, II, 291.

Head small and hardly distinct from the body; one internasal; one nasal, half divided; no preocular, the loreal and prefrontal entering the orbit; post-orbitals 2; temporals 1–2; upper labials 7; 19 rows of scales; ventrals 168–206; subcaudals 34–49. Ordinary specimens are about 1,000 mm. long, but it reaches 1,400 (tail one-sixth to one-seventh).

Bluish black above with vertical red spots on the sides ; belly red in life.

Hab.—North Carolina to Louisiana; possibly in Virginia.

ABASTOR Gray.

Cat. Snakes Br. Mus., 78 ; B. and G., *l. c.*, 125 ; Cope, *l. c.*, 603 ; Boul., *l. c.*, II, 289.

Maxillary teeth smooth, subequal; one loreal; two internasals; one nasal, half divided below the nostril; no preocular; scales smooth, without pits, in 19 rows; anal divided; size moderate; head not distinct; body cylindrical and rigid.

Hab.—North America.

Abastor erythrogrammus Daudin.

Coluber erythrogrammus Daud., Hist. des. Rept., 93, Pl. 83 (1803); *Abastor erythrogrammus* B. and G., *l. c.*, 125; Cope, *l. c.*, 603, and Rep. Nat. Mus., 738; Boul., *l. c.*, II, 290.

Head scarcely larger than the body; two small internasals; no preocular, the loreal and prefrontal entering orbit; post-oculars 2; temporals 1–2; upper labials 7; ventrals 157–185; subcaudals 37–55. Length 980 mm. (tail 130).

Bluish black above with three longitudinal red stripes; belly salmon color or reddish, with a series of bluish black spots on the ends of the ventrals; head dark, the plates sometimes with yellow margins; labials yellow, each with a dark spot.

Hab.—North Carolina to the Gulf coast; found once in Virginia by Prof. Cope.

VIRGINIA[23] B. and G.

l. c., 127; Cope, *l. c.*, 599, and Rep. Nat. Mus., 1006; Boul., *l. c.*, II, 288.

Maxillary teeth smooth, subequal; a loreal; two internasals; two nasals; no preocular; scales smooth, without pits, in 15–17 rows; anal divided; size small; head distinct.

Hab.—North America.

Scales in 15 rows; 2 preoculars, ... 1. *V. valeriæ.*
Scales in 17 rows; 1–3 preoculars, ... 2. *V. elegans.*

Virginia valeriæ B. and G.

l. c., 127; Cope, *l. c.*, 599, and Rep. Nat. Mus., 1006; Boul., *l. c.*, II, 289.

Head scales normal; oculars 2–2; temporals 1–2; upper labials 6; scales wide, in 15 rows; ventrals 115–127; subcaudals 25–37. Length 280 mm. (tail 40).

Yellowish or grayish brown, usually with small black dots forming longitudinal lines; belly dull yellow.

Hab.—Maryland west to the Mississippi; apparently not in Texas.

Virginia elegans Kennicott.

Proc. Acad. Phila., 1859, p. 99; Cope, *l. c.*, 599, and Rep. Nat. Mus., 1007; Boul., *l. c.*, II, 289.

Exactly like *V. valeriæ*, but the scales are narrower and in 17 rows and the post-oculars vary from one to three.

[23]Prof. Cope places *Virginia* among the genera in which the dorsal hypapophyses are continued to the tail. This is certainly not the case in one specimen of *V. elegans* which I have examined for this character.

A specimen in my collection, from Bay St. Louis, Miss., 186 mm. long (tail 27), has seven upper labials on one side; ventrals 117; subcaudals 29.

Hab.—Southern Illinois to Texas.

FICIMIA Gray.

Cat. Snakes, 80 (1849); *Gyalopium* Cope, *l. c.*, 603, and Rep. Nat. Mus., 947; *Ficimia* Boul., *l. c.*, II, 270.

Maxillary teeth smooth, equal; rostral enters between internasals and prefrontals, its upper border projecting; two internasals; one nasal, half divided, its anterior portion usually fused with the first labial; no loreal; one preocular; scales smooth, with pits, in 17 rows; anal divided; size moderate; head not very distinct.

Hab.—Southwestern United States and Mexico.

Ficimia cana Cope.

Gyalopium canum Cope, Proc. Acad. Phila., 1860, p. 243; *l. c.*, 603, and Rep. Nat. Mus., 947; *F. cana* Boul., *l. c.*, II, 272.

Rostral pointed behind, not in contact with the frontal; internasals small; nasal fused with the first labial, with a groove downward and backward from the nostril; no loreal, prefrontals reaching labials; oculars 1–2; temporals 1–2; upper labials 7; scales in 17 rows; ventrals 130–131; subcaudals 28. Length about 205 mm. (tail 28).

Reddish or yellowish, with brown, dark-edged cross-bands, about thirty in number, more or less broken into spots on the sides; belly yellowish white; a brown band across the head in front of the orbits, beginning on the labials, and another across the parietals.

Hab.—Western Texas to Arizona.

CHILOMENISCUS Cope.

Proc. Acad. Phila., 1860, 339; *l. c.*, 593, and Rep. Nat. Mus., 948; Boul., *l. c.*, II, 272.

Maxillary teeth smooth, subequal, the posterior sometimes a little enlarged; rostral prominent and separating the internasals; no loreal; one nasal, fused with the internasal; one preocular; scales smooth, with pits, in 13 rows; anal divided; size small; head not distinct.

Hab.—Nevada to Sonora; Lower California.

Preocular touching nasal; black cross-bands on back,
1. *C. ephippicus.*

Preocular not touching nasal; black rings around body,
2. *C. cinctus.*

Chilomeniscus ephippicus Cope.

Proc. Acad. Phila., 1875, 85; *l. c.*, 594; Rep. Nat. Mus., 951; Boul., *l. c.*, II, 273.

Head small with prominent snout; scales in 13 rows; rostral just reaches the prefrontals; nasal elongated and touching the preocular; oculars 1–2; temporals 1–1; upper labials 7; ventrals 109–113; subcaudals 22–28. Length 235 mm. (tail 30).

Yellow or red with a series of black cross-bands, the ends of which are rounded; on the tail they nearly form rings; the interspaces are quite as wide as the bands; belly white; top of head black; snout red.

Hab.—Nevada and Arizona; probably southern California.

Chilomeniscus cinctus Cope.

Proc. Acad. Phila., 1861, 303; *C. stramineus cinctus* Cope, *l. c.*, 594; *C. stramineus* (part) Boul., *l. c.*, II, 273; *C. cinctus* Cope, Rep. Nat. Mus., 952.

Very similar to *C. ephippicus*, but the nasal is separated from the preocular by the prefrontals, which reach the labials. Color reddish white; body completely encircled by black rings which are narrower on the belly.

But three specimens are known, and the full value of the characters are in doubt.

Hab.—Lower California and southern Arizona.

CEMOPHORA Cope.

Proc. Acad. Phila., 1860, 244; *l. c.*, 602, and Rep. Nat. Mus., 928; Boul., *l. c.*, II, 213; *Rhinostoma* B. and G., *l. c.*, 118.

Maxillary teeth smooth, longer behind, no interspace; a loreal; one or two preoculars; one nasal, sometimes divided; rostral slightly projecting; scales smooth, with pits, in 19 rows; anal entire; size moderate; head not distinct.

Hab.—North America.

Cemophora coccinea Blumenbach.

Coluber coccineus Blum., Voigt's Mag. of Phys., 1788, 11, Pl. 1; *Rhinostoma coccinea* B. and G., *l. c.*, 118; *Cemophora coccinea* Cope, *l. c.*, 602, and Rep. Nat. Mus., 928; Boul., *l. c.*, II, 214.

Body slender; head not distinct; snout projecting; eye small; one nasal, half divided or double; loreal small; oculars 1 (2)–2

(1); temporals 1 (2)–2; upper labials 6 or 7; scales in 19 rows; ventrals 156–188; subcaudals 35–45. Length 560 mm. (tail 80).

Back scarlet, crossed by pairs of black bands, each pair enclosing a whitish or yellow one about three scales wide; most scales in the yellow band are dotted with black; belly yellowish, unmarked; top of head red or yellow, with a black bar between the orbits.

Hab.—South Carolina and Florida, west to the Mississippi.

RHINOCHILUS B. and G.

l. c., 120; Cope, *l. c.*, 605, and Rep. Nat. Mus., 930; Boul., *l. c.*, II, 212.

Maxillary teeth smooth, increasing posteriorly, no interspace; one loreal; one or two preoculars; two internasals; two nasals; rostral somewhat projecting; scales smooth, with pits, in 17–23 rows; anal entire; subcaudals usually entire; size medium; head slightly distinct.

Hab.—North and South America.

Rhinochilus lecontii B. and G.

l. c., 120; Cope, *l. c.*, 606, and Rep. Nat. Mus., 931; Boul., *l. c.*, II, 212; Van Den., *l. c.*, 174.

Body moderately stout; head scales normal; one large preocular, occasionally with a small one below; two post-oculars; temporals 2–3 (one in my collection has a small additional temporal in the first row on one side); upper labials 8; scales in 23 rows; ventrals 189–212; subcaudals 40–55, not divided. The largest I have seen, measured 965 mm. (tail 135).

There is a series of blotches on the back, alternating black and red or orange: the red ones nearly quadrate, the black ones transversely wider; on the sides, below the blotches, some scales are marked with black or yellow; belly white or yellow, with black blotches on the ends of some ventrals. A living specimen from Pecos, Tex., has twenty-seven brilliant scarlet blotches on the body and twelve on the tail; below the scarlet blotches each scale is yellow with a black centre, while on the corresponding portion of the black areas, which extend to the fourth row, each scale has a yellow centre; many of the scales in the outer rows are tinged with red. The snout in front of the frontal plate is red, behind that black, each scale marked with yellow. Labials yellow, all the upper ones posterior to the third, heavily margined with black. A second specimen is very similar in color, but the black on the ends of the ventrals often runs up on the scales to about the fourth row.

According to Mr. Van Denburg, the spots on the back, which ordinarily are red, are at times white, but I have never myself seen such a specimen.

Hab. —Southwestern Kansas and western Texas to California.

HYPSIGLENA Cope.

Proc. Acad. Phila., 1860, 246 ; *l. c.*, 617, and Rep. Nat. Mus., 952 ; Boul., *l. c.*, II, 208,

Posterior maxillary teeth strongly enlarged, smooth, diacranterian; one loreal; two internasals; two nasals; vertical, elliptical pupil; scales smooth, with pits, in 19–21 rows; anal divided; size medium to small; head distinct.

Hab.—North and Central America.

Hypsiglena ochrorhyncha Cope.

Proc. Acad. Phila., 1860, p. 246 ; *l. c.*, 617, and Rep. Nat. Mus., 953 ; Boul., *l. c.*, II, 209 ; *H. chlorophæa*, *H. ochrorhyncha* and *H. texana* Stej., No. Am. Fauna, No. 7, 205.

Size small; body round; head distinct; head plates normal; 2 nasals; 1 loreal; 1 large preocular, with usually a small one below it; post-oculars 2; labials 8; temporals 1–2; scales in 21 rows; ventrals 168–187; subcaudals 40–55.

Length 320 mm. (tail 60).

Gray or yellowish, with a dorsal series of dark-brown blotches and two alternating series on each side; a dark stripe through each eye, running back to the nape, and a median one between them; upper surface of head and labials faintly dotted with brown; belly white.

The convexity of the head attributed to *H. texana* Stejn. appears to me abnormal, and the difference in the lateral head stripe is trivial.

Hab.—Texas to southern California; northern Mexico.

RHADINEA Cope.

Proc. Acad. Phila., 1863, 100, and *Dromicus*, *l. c.*, 618 ; *Liophis* (part) and *Rhadinea* Boul., *l. c.* II, 127 and 160 ; *Rhadinea* Cope, Rep. Nat. Mus., 754.

Posterior maxillary teeth slightly lengthened, smooth, sometimes a slight interspace; one loreal; one preocular; two internasals; two nasals; scales smooth, without pits, in 15–21 rows; anal divided; size very small; head distinct.

Hab.—North and South America.

Rhadinea flavilata Cope.

Dromicus flavilatus Cope, Proc. Acad. Phila., 1871, p. 222, and *l. c.*, 618; *Liophis flavilatus* Boul., *l. c.*, II, 143; *Rhadinea flavilata* Cope, Trans. Am. Phil. Soc., XVIII, 202 (1895), and Rep. Nat. Mus., 759.

Head slightly distinct; maxillary teeth 12–13, the last two enlarged and separated from the others by a slight interval; mandibular teeth 17, subequal; head plates normal; loreal obliquely quadrangular; nasal indistinctly divided above and below the nostril; one large preocular; two post-oculars, the lower one small; temporals 1–2; upper labials 7; lower labials 8; posterior chin shields longest and separated behind; scales in 17 rows, smooth, without pits; ventrals 126–129; subcaudals 66–77.

Length 270 mm. (tail 77).

Reddish brown above, somewhat lustrous in life, each scale finely dotted with dark brown; belly light yellow, invading the edges of the two outer rows of scales; top of head a little darker than the back and indistinctly vermiculated with light brown; a faint dark band from the rostral to the temporals, slightly bordered above with yellow and below with black; labials colored like the ventrals, the upper ones slightly spotted with dark brown. The foregoing description is taken from two living specimens, one from Florida and one from Bay St. Louis, Miss.

As none of the three examples of this rare snake which I have examined, possess scale pits, it cannot be placed in *Liophis*, as is done by Boulenger, but falls into the section of *Rhadinea* with slightly diacranterian dentition.

Hab.—North Carolina to Florida and Mississippi.

HETERODON Latreille.

Hist. des Rept., IV., 32 (1800); B. and G., *l. c.*, 51; *l. c.*, Cope, 153, and Rep. Nat. Mus., 760; Boul., *l. c.*, II., 153.

Posterior maxillary teeth much enlarged, smooth, an interspace; body stout; head long and slightly distinct; snout short; rostral strongly projecting and recurved; a small plate behind the rostral; sometimes a number of small scales separating internasals and prefrontals; eye surrounded by a circle of scales; 1 loreal; 2 nasals, occasionally a small post-nasal below; scales keeled, with two pits, in 23–25 rows; anal divided.

Hab.—North America.

The "sand snakes," "hog-nosed snakes," or "blowing vipers," as they are variously called, are able to expand and flatten the anterior portion of the body when alarmed, and thereby to assume a threatening aspect, as in the cobras, but they are absolutely harmless.

Key to the Species.

a.—Rostral narrower than space between eyes:
No scales between prefrontals; size larger, 1. *H. platyrhinus.*
Prefrontals separated by scales; size smaller, 2. *H. simus.*
b.—Rostral as broad as space between eyes:
Prefrontals and internasals separated by scales, 3. *H. nasicus.*

Heterodon platyrhinus Latreille.

l. c. 32; *H. platyrhinos, H. cognatus, H. niger* and *H. atmodes* B. and G., *l. c.*, 51–57; *H. platyrhinus* Cope, *l. c.*, 643, and Rep. Nat. Mus., 761; Boul., *l. c.*, II, 154.

Largest of the genus; maxillary teeth 11–12, the last two much enlarged and separated by a wide interval; 1, sometimes 2, small azygous plates behind the rostral, separating internasals; usually without small plates between the prefrontals; frontal a little longer than broad; 9–11 scales in the orbital ring, in addition to the supraoculars; upper labials 8 (9); temporals 4 (3)–5; 1 pair of chin shields; scales usually in 25 rows (occ. 23); ventrals 120–150; subcaudals 37–60. Length 810 mm. (tail 153).

Color variable, sometimes entirely black above; usually brown, reddish brown or yellow, with a dorsal series of dark brown or black spots, separated by narrow interspaces, one and a half or two scales wide; a lateral alternating series of small dark blotches, and sometimes traces of a third; belly greenish white, yellowish or reddish, often clouded with dusky; two dark blotches on the nape, a band across the prefrontals and an oblique streak behind the eye.

Hab.—New Jersey west to the Missouri river, and south to Florida and Texas.

Heterodon simus L.

Coluber simus L., Syst. Nat., Ed. XII, 375; *H. simus* B. and G., *l. c.*, 59; Cope, *l. c.*, 643, and Rep. Nat. Mus., 770; Boul., *l. c.*, II, 156.

Smaller than *platyrhinos;* snout moderate; maxillary teeth 10–11; 3 to 9 scales, in addition to the azygous plate separating the internasals and prefrontals; frequently a small subpost-nasal; frontal as broad as long; 10–11 scales in orbital ring; labials 8; temporals small; 1 pair of chin shields; scales in 25 rows (rarely 27); ventrals 114–134; subcaudals 30–55. Length 490 mm. (tail 90).

Color usually grayish or yellowish brown, with the dorsal series of spots blackish brown, separated by narrow interspaces usually tinged with yellow; one or two series of small blackish blotches on the sides; belly white or yellow, more or less clouded with dusky; two dark blotches on the nape, parietals blackish, the bar on prefrontals and post-ocular streak present. In some color phases this form resembles both of the other species; but may always be known from *platyrhinus* by the small plates behind the rostral being from 4–10, instead of one or two; and from *nasicus* by the presence of two more scale rows and a much lighter abdomen.

Hab.—Georgia and Florida to the Mississippi.

Heterodon nasicus B. and G.

l. c., 61; *H. n. nasicus* and *H. n. Kennerlyi*, Cope, *l. c.*, 641, and Rep. Nat. Mus., 772, 773; *H. nasicus* Boul., *l. c.*, II, 156.

Snout very short and much recurved; maxillary teeth 8–10; azygous plates as in *simus*, sometimes 20 or more; 10–11 scales in orbital ring; as a rule no inferior post-nasal; sometimes an additional loreal; upper labials 8; 1 pair of chin shields; scales in 23 rows; ventrals 128–146; subcaudals 32–45 (a specimen in my collection has one or two subcaudals undivided). The largest I have seen, came from Pecos, Tex., and measured 610 mm. (tail 78); another, 555 mm. (tail 100).

Grayish brown, sometimes yellow on the back; a dorsal and two lateral rows of spots, usually smaller than in *simus* and often not distinct, sometimes the dorsal spots are only indicated by a darker shade; the belly is whitish with black blotches, usually entirely black in the centre; three elongated black blotches on the nape; an oblique streak behind the eye; a narrow band across the frontal and another on the prefrontals; parietals blackish.

Hab.—Montana to Texas and Arizona; northern Mexico.

TRIMORPHODON Cope.

Proc. Acad. Phila., 1861, 297; *l. c.*, 678, and Rep. Nat. Mus., 1101; Boul., *l. c.*, III. 53.

Posterior maxillary teeth elongated, grooved and separated by an interval; anterior teeth elongated; 2 loreals; 1 or 2 preoculars; 2 internasals; 2 nasals; pupil vertical; scales smooth, with pits, in 21–27 rows; anal divided; size medium.

Hab.—North America and Mexico.

Trimorphodon lyrophanes Cope.

l. c., 297; *l. c.*, 679, and Rep. Nat. Mus., 1102; Boul., *l. c.*, III, 56.

Seven maxillary teeth; head distinct; head plates normal; 2 loreals, one in front of the other; 2 preoculars, usually a small subocular; 3 post-oculars; labials 9; scales in 21 rows; ventrals 236; subcaudals 70. Length 710 mm. (tail 110).

Light gray; deep brown spots, in pairs, on the back (21 pairs in the type specimen); an irregular series of lateral spots; belly white, with small dark spots on the ends of some ventrals; head light gray, banded with darker.

Hab.—Arizona and Lower California.

SIBON Fitzinger.

Neue Class Rept., 29 (1826); Cope, *l. c.*, 676, and Rep. Nat. Mus., 1106; *Leptodira* (part) Boul., *l. c.*, III, 88.

Posterior maxillary teeth elongated, grooved and separated by an interspace; 1 loreal; 1 to 3 preoculars; 2 nasals; 2 internasals; pupil vertical; scales smooth, with pits, in 19–25 rows; anal divided; size moderate.

Hab.—North and South America.

Cope appears to be justified in separating the American species with divided anal, from the Asiatic with single anal; *Leptodira* Gunther having included both, an arrangement which is followed by Boulenger.

Sibon septentrionalis Kennicott.

Dipsas septentrionalis Kenn., U. S. Mex. Bound. Surv., II, 16, Pl. 8, fig. 1; *Sibon septentrionale* Cope, *l. c.*, 678, and Rep. Nat. Mus., 1107; *Leptodira septentrionalis* Boul., *l. c.*, III, 93.

Head very distinct; body tapering; head scales normal; 3 preoculars, the lower one very small; post-oculars 2; temporals 1–2; labials 8; scales in 21–23 rows; ventrals 194; subcaudals 65–72. Length 750 mm. (tail about one-fifth).

Grayish or yellow above, with dark-brown saddle-shaped spots, six or eight scales long and nearly reaching the ventrals; belly yellowish; top of head and part of the upper labials light brown with blackish markings; an indistinct pale band across the nape.

Hab.—Texas to Arizona; northern Mexico.

ERYTHROLAMPRUS Wagler.

Syst. Amph., 187 (1830); Cope, *l. c.*, 676; Boul., *l. c.*, III, 199; *Coniophanes* Cope, Rep. Nat. Mus., 1096.

Posterior maxillary teeth elongated, grooved and separated by an interspace; 1 loreal; 1 or 2 preoculars; 2 nasals; pupil round; scales smooth, without pits, in 15–25 rows; anal divided; size moderate.

Hab.—North and South America.

Erythrolamprus imperialis Baird.

Tæniophis imperialis Baird, U. S. Mex. Bound. Surv., II, 23, Pl. XIX, fig. 1; *E. imperialis* Cope, *l. c.*, 676; Boul., *l. c.*, III, 206; *Coniophanes imperialis* Cope, Rep. Nat. Mus., 1097.

Head not very distinct; size small; head shields normal; 2 nasals; 1 loreal; oculars 1–2; temporals 1–2; upper labials 8 (7); scales in 19 rows; ventrals 120–143; subcaudals 67–94. Length about 410 mm. (tail 160).

Light brown, with a blackish vertebral stripe, and one on each side; scales below the lateral stripes pale brown; a yellow line with black edges from nostril to temporals; upper labials whitish, dotted with black; belly reddish, sometimes with black dots.

Hab.—Southern Texas to Central America.

TANTILLA B. and G.

l. c., 131; Cope, *l. c.*, 597, and Rep. Nat. Mus., 1110; *Homalocranium*[16] Boul., *l. c.*, III, 212.

Posterior maxillary teeth slightly elongated, grooved and separated by an interspace; no loreal; 1 preocular; 2 nasals; 2 internasals; scales smooth, without pits, in 15 rows; anal divided; size small; head flat and not very distinct.

Hab.—North and South America.

[16] *Tantilla* is preferred to *Homalocranium* for the reasons given under *Storeria*.

Key to the Species in United States.

a.—Upper labials 7:
  a^1.—A yellow or white collar on nape:
    A black band behind collar; ventrals less than 158, 1. *T. coronata.*
    Black dots behind collar; ventrals more than 167, 2. *T. eiseni.*
  b^1.—No collar on nape; head black, . . 3. *T. nigriceps.*
b.—Upper labials 6, ... 4. *T. gracilis.*

Tantilla coronata B. and G.

l. c., 131; Cope, *l. c.*, 598, and Rep. Nat. Mus., 1114; *Homalocranium coronatum* Boul., III, 218.

Size small and slender; head not distinct; head plates normal; no loreal; posterior nasal in contact with preocular; oculars 1–2; temporals 1–1 (2); upper labials 7; scales in 15 rows; ventrals 138–158; subcaudals 35–58. Length 220 mm. (tail 35).

Reddish brown above; belly whitish; top of head dark brown with a yellow cross-band behind the parietals, bordered behind by a black one two scales wide.

Hab.—Gulf States; Georgia to Mississippi.

Tantilla eiseni Stejneger.

Proc. U. S. Nat. Mus., 1895, 117.

Size rather larger; post-nasal almost separated from the preocular by the prefrontal; ventrals 167–181; subcaudals 58–65. Length 365 mm. (tail 82). Much resembling *T. coronata*, but with a more slender body, a longer tail and a greater number of ventrals and subcaudals. The only specimens known have been more than twenty years in spirits, but from Mr. Stejneger's description the color must have been like *coronata*, but the collar was bordered behind by black dots in place of a band.

Hab.—Seven specimens known, all from Fresno, California.

Tantilla nigriceps Kennicott.

Proc. Acad. Phila., 1860, 328; Cope, *l. c.*, 598, and Rep. Nat. Mus., 1113; *H. planiceps* (part) Boul., *l. c.*, III, 226.

Size small; post-nasal usually in contact with preocular; oculars 1–1 (2); temporals 1–1; upper labials 7; scales in 15 rows; ventrals 121–168; subcaudals 42–66. Length 275 mm. (tail one-fifth).

Yellowish brown above; white underneath; top of head blackish brown; no collar.

Mr. Boulenger considers this form identical with *Coluber planiceps* Blain.; the type of that species, however, came from Lower California, and there is no proof that *nigriceps* extends west even to California proper. Van Denburg does not mention it as an inhabitant of the State, and the evidence of its presence even in Arizona is not of the best.

Hab.—Texas and New Mexico; possibly Arizona.

Tantilla gracilis B. and G.

l. c., 132; Cope, *l. c.*, 598, and Rep. Nat. Mus., 1111; *H. gracilis* Boul., *l. c.*, III, 228.

Size small; post-nasal occasionally separated from preocular by prefrontal; oculars 1–1; temporals 1–1; upper labials 6; 15 rows of scales; ventrals 112–137; subcaudals 41–51. Length 215 mm. (tail 43).

Reddish or greenish brown above, some scales speckled with darker; belly salmon color in life; top of head dark brown; labials yellowish brown. Through the courtesy of Mr. Julius Hurter, of St. Louis, the Zoölogical Society has lately received five living specimens of this little snake, taken by him in Jefferson county, Mo.

Hab—Missouri to Texas.

ELAPS Schneider.

Hist. Amph., II, 289 (1801); B. and G., *l. c.*, 21; Cope, *l. c.*, 679, and Rep. Nat. Mus., 1119; Boul., *l. c.*, III, 411.

A pair of large, perforated poison fangs in front; no other maxillary teeth; no loreal; 2 internasals; 2 nasals; pupil vertical, elliptical; scales smooth, without pits, in 15 rows; anal divided; subcaudals single or double, or both; body cylindrical; head not very distinct; tail short.

Hab.—North and South America.

The snakes of this genus are beautifully ringed with black, re and yellow in varying proportions. All are venomous and structurally related to the cobras. Several species of harmless snakes so nearly resemble them in color, especially the red and yellow-ringed forms of *Ophibolus doliatus*, that novices in herpetology should beware of handling living specimens presenting these colors, until assured that they are not dealing with an *Elaps*. There are some twenty-five known species, extending from South Carolina to Brazil, two only being found within the United States.

Snout black; parietals yellow; first wide ring black, 1. *E. fulvius.*

Snout and parietals black; first wide ring red, 2. *E. euryxanthus.*

Elaps fulvius L.

Coluber fulvius L., Syst. Nat., Ed. XII, 381; *Elaps fulvius*, *E. tenere* and *E. tristis* B. and G., *l. c.*, 21–23; *E. fulvius* and *E. distans* Cope, *l. c.*, 680, 681, and Rep. Nat. Mus., 1120, 1123; *E. fulvius* (part) Boul., *l. c*, III, 422; *E. fulvius* Stej., Rep. U. S. Nat. Mus., 1893, 359.

Rostral small, not extending between the internasals, which are rather small; oculars 1–2; temporals 1–1 (2); upper labials 7, third largest; ventrals 203–237; subcaudals 25–45. The largest I have seen, measured 930 mm. (tail 70).

There are 11–17 black rings from seven to ten scales long, and the same number of red ones from 8–12 scales long on the body; the black ones are bordered before and behind by yellow rings, one or two scales long; many scales in the red rings are mottled with black; there are three or four black and an equal number of yellow rings on the tail, but no red. Top of the head in advance of the parietals is black, followed by a yellow ring extending to the angle of the mouth; then a black one 5–8 scales long. Examples are said to be found in Florida with the black rings much narrowed, and the snout red instead of black. These are referred by Prof. Cope to *E. distans* Kenn., the type of which was from Chihuahua. Such specimens must in any event be very rare, for the Zoölogical Society has received more than eighty *Elaps* from Florida, not one of which has exhibited the characters of *distans.*

Hab.—South Carolina to western Texas and up the Mississippi valley, occasionally to southern Ohio; northern Mexico.

Elaps euryxanthus Kennicott.

Proc. Acad. Phila., 1860, 337; Cope, *l. c.*, 681, and Rep. Nat. Mus., 1125; Boul., *l. c.*, III, 415; Stej., *l. c.*, 362.

This little-known species closely resembles *E. fulvius;* the rostral is produced posteriorly and extends slightly between the internasals; the frontal is very small; the black of the snout extends back over the parietals and is followed by a yellow ring, then by a wide red one; the red rings do not show black mottling on the scales. Ventrals 215–241; subcaudals 21–29.

Hab.—Central and southern Arizona; northern Mexico.

VIPERIDÆ.

Key to the Genera.

a.—No rattle, ... ANCISTRODON.
b.—A rattle:
Top of head with large plates, ... SISTRURUS.
Top of head with small scales, ... CROTALUS.

ANCISTRODON Beauvais.

Trans. Amer. Phil. Soc., IV, 381 (1799); *Agkistrodon* and *Toxicophis* B. and G., *l. c.*, 17–19; *Ancistrodon* Cope, *l. c.*, 681, and Rep. Nat. Mus., 131; Boul., *l. c.*, III, 519.

A pair of large erectable, perforated poison fangs in front of upper jaw; no other maxillary teeth; a pit between the eye and the nostril; no rattle; top of head covered with large plates; scales keeled, with pits, in 21–27 rows; anal entire; subcaudals single or double, or both; size large to medium.

Hab.—Asia, North and Central America.

Key to the Species of the United States.

No loreal plate; a pair of post-parietals, . . . 1. *A. piscivorus.*
A loreal plate; no post-parietals, ... 2. *A. contortrix.*

Ancistrodon piscivorus Lacépède.

Crotalus piscivorus Lacep., Serp., II, 130 and 424 (1789); *Toxicophis piscivorus* and *T. pugnax* B. and G., *l. c.*, 19, 20; *A. piscivorus* Cope, *l. c.*, 683, and Rep. Nat. Mus., 1133; Boul., *l. c.*, III, 520; Stej., *l. c.*, 406.

Size large; body very stout; tail short, from one-seventh to one-sixth of length; head broad behind, flat on top; snout rounded; canthus sharp; head plates normal, but with usually a pair of small additional plates behind parietals; no loreal; preoculars 2, the upper much the largest; post-oculars 2, with one or two suboculars; upper labials 8 (occ. 7), the third entering the orbit; scales in 25 rows, strongly keeled; ventrals 130–147; subcaudals 39–48, more or less of which are undivided, usually the anterior ones. A specimen from Florida, now living in the Zoölogical Gardens, 1,550 mm. long and 250 mm. in circumference, is the largest I have ever seen.

The color pattern is obscure; half-grown examples are usually dark chestnut or greenish olive, with blackish brown cross-bands with irregular borders. Older ones become much darker and the bands are obscured; belly yellow, clouded with brown. Head blackish brown; an oblique streak behind the eye and a yellowish white band on the upper labials.

Hab.—North Carolina and Florida, through the Gulf States to Texas; up the Mississippi valley, occasionally to Illinois.

The name "water moccasin," properly belonging to this species, is often wrongly applied to large, dark individuals belonging to *Tropidonotus;* but the shape of the head, the presence of the loreal pit, and the sharply tapering tail, easily distinguish it.

Ancistrodon contortrix L.

> *Boa contortrix* L. Syst. Nat., Ed. XII, 373; *Agkistrodon contortrix* B. and G., *l. c.*, 17; Stej., *l. c.*, 401; *Ancistrodon contortrix* Cope, *l. c.*, 683, and Rep. Nat. Mus., 1135; Boul. *l. c.*, III, 522.

Smaller and less stout than *A. piscivorus;* no post-parietal plates; loreal present; eye entirely separated from labials by the suboculars; upper labials 8 (occ. 7); scales in 23 rows (rarely 25); ventrals 145–155; subcaudals 31–52, some of the anterior ones usually undivided. A large specimen from Pennsylvania measures 1,000 mm. (tail 130).

Body color peculiar yellowish pink, often pale drab, crossed by irregular brownish red bands with darker borders, wider and often with pale centres on the sides; a series of small circular brownish red spots on outer rows and ends of the ventrals, anteriorly these are mostly on the ventrals; belly yellowish or pink, sometimes maculated with darker; chin and throat yellowish white; sides of head cream color; top often bright copper, whence the name "copperhead." In life, the markings vary greatly in outline and richness of color.

Hab.—Massachusetts south to Florida; west to Illinois, Oklahoma and central Texas.

SISTRURUS Garman.

> No. Amer. Rept., 110 (1883); *Crotalophorus* B. and G., *l. c.*, 11; Cope, *l. c.*, 684; *Sistrurus*, Boul., *l. c.*, III., 569; Stej., *l. c.*, 410; Cope, Rep. Nat. Mus., 1140.

A pair of large erectable, perforated poison fangs in front of upper jaw: no other maxillary teeth; loreal pit and rattle present; top of head covered with large plates; scales keeled, with pits, in 21–25 rows; anal and subcaudals not divided; sizes small to medium.

Hab.—North America and Mexico.

Key to the Species in United States.

Post-nasal in contact with preocular; the light line to angle of mouth begin at nostril, ... 1. *S. catenatus.*
Post-nasal separated from preocular, by loreal; light line to angle of mouth begins at the eye, ... 2. *S. miliarius.*

Sistrurus catenatus Rafinesque.

Crotalinus catenatus Raf., Amer. Monthly Mag., 1818, p. 41.

Short and stout; tail about one-ninth of length; rattle small; head plates normal; there is no large loreal, and the upper preocular is in contact with the post-nasal; occasionally the anterior end of the preocular is cut off, forming a small upper loreal; scales in 23–27 rows, one or two of the outer smooth; ventrals 135–157; subcaudals 17–34.

The color is gray, brown or even black, with seven series of blotches on the back; the dorsal series dark brown with a narrow light border, anteriorly often crescent-shaped, posteriorly becoming subcircular; the second series roundish and indistinct, more or less alternating with the dorsals; third, vertically elongated, colored like the dorsals and opposite to them; fourth small and on the outer rows and ends of the ventrals; belly yellowish, more or less marked with black. Top of head with a light band across the anterior end of frontal; two dark bands running back from the supraoculars to the first dorsal spot, and a dark spot between them on the parietals and frontal; a dark oblique streak behind the eye bordered above and below by a light line, the lower one beginning at the nostril and running to the angle of the mouth; two light lines from the loreal pit to the labial border.

It has been customary to divide this species into a northern and a southern race, but the characters ascribed to them are less constant than has been supposed, and they were, in fact, united by Mr. Boulenger; nevertheless, the greater proportion of the individuals found within each geographical area do present sufficient differences to warrant their separation:

Scales usually in 25 rows; dorsal spots usually less than 40, 1. *S. c. catenatus.*
Scales usually in 23 rows; dorsal spots usually more than 40, 2. *S. c. consors.*

Sistrurus catenatus catenatus Rafinesque.

l. c., 41; *Crotalophorus tergeminus* and *C. Kirtlandii* B. and G., *l. c.*, 14, 16. *C. c. catenatus* Cope, *l. c.*, 685; *Sistrurus catenatus* (part) Boul., *l. c.*, III, 570; *S. catenatus Stej.*, *l. c.*, 411; *S. c. catenatus* Cope, Rep. Nat. Mus., 1146.

In this northern race, the scale rows are usually 25, but occasionally 23 or 27; the dorsal spots are larger and fewer in number than in *consors*, being generally from 37–41 in number, of which 3–5 are on the tail, but an occasional example has them as numerous as in the southern form. No. 7,241 Academy coll. is a *catenatus* from Fort Riley, Kans., with 27 rows of scales and 44 dorsal blotches, of which 9 are on the tail, leaving the number of body spots about as they should be. No. 7,240 has also 27 rows, and only 37 spots, with a black belly. Nos. 7,243–44 are two interesting specimens, collected together in Michigan; the former has 23 rows and 37 spots and the belly is immaculate yellow; the other one has 27 rows and the belly is wholly black.

The colors are usually darker and the lateral spots more distinct than in *consors*. Occasional examples are entirely black. Ventrals 136–150; subcaudals 17–29.

Length about 900 mm.

Hab.—Ohio to Kansas, and north into Canada. Formerly found in western New York, but it has now disappeared from most cultivated localities.

Sistrurus catenatus consors B. and G.

Crotalophorus consors and *C. Edwardsii* B. and G., *l. c.*, 12, 15; *C. c. edwardsii* Cope, *l. c.*, 685; *Sistrurus catenatus* (part) Boul., *l. c.*, III, 570; Garman., Bull, Ess. Inst., XXIV, 101, 1894; *S. c. consors* and *S. c. edwardsii* Stej., *l. c.*, 415, 416; *S. c. edwardsii* Cope, Rep. Nat. Mus. 1144.

Compared with the preceding this subspecies is probably rather smaller; the scutellation is similar, but the scale rows are usually 23, though sometimes 25; the dorsal spots are smaller and more numerous, being in most cases 40–50 in number, of which 4–6 are on the tail. Variations toward *S. c. catenatus* are not uncommon, however; No. 7,234 Academy coll. from Hennessey, Okla., labeled *edwardsi*, has 25 rows of scales and 44 spots, and No. 7,235, from Texas, has 23 rows of scales and but 37 spots.

The correct name of the southwestern form of *Sistrurus* has been in doubt, owing to the loss of Baird and Girard's type of *C. consors*, and the omission of some important details from their original description. The Zoölogical Society has lately received a living *Sistrurus* from Port Lavaca, Calhoun county, Tex., practically the type locality of *consors*, which agrees with Baird and Girard's description of that species in all respects, as well as with Garman's Matagorda specimens. It has 25 rows of scales, the two outer, smooth; 53 dorsal blotches (45 on the body and 8 on the tail); ventrals 153; subcaudals 27; length 520 mm. (tail 70). There is no large loreal and the preocular is in full contact with the post-nasal. As *edwardsi* is known to sometimes present 25 scale rows, there is nothing to separate the two forms except an insignificant difference in the number of spots. Regarding them as identical, the name *consors* has priority.

Hab.—Indian Territory to northern Mexico; west to Arizona.

Sistrurus miliarius L.

Crotalus miliarius, L., Syst. Nat., Ed. XII, 372 ; *Crotalophorus miliarius* B. and G., *l. c.*, 11 ; Cope, *l. c.*, 685 ; *Sistrurus miliarius* Boul., *l. c.*, III, 569 ; Stej., *l. c.*, 418 ; *Sistrurus miliarus*, Cope, Rep. Nat. Mus., 1141.

Smaller and more slender than *S. catenatus ;* rattle very small; loreal present, separating the post-nasal from the preocular; scales in 23 rows (occ. 21); ventrals 127–140; subcaudals 20–36. Length about 550 mm. (tail between one-seventh and one-eighth).

Gray, yellowish or brown, more or less dark; seven series of blotches on the body, disposed much as in the genus; the dorsals are dark, often purplish, irregular in shape, and from 38–45 in number; the interspaces on the vertebral line are often red; the head markings are much as in the last species, but the dark spot on the parietals is absent and the lower light line on the side of the head begins on the post-oculars, instead of the nasal; belly yellow with blackish blotches.

Hab.—North Carolina and Florida to Texas; up the Mississippi valley, probably to Illinois.

CROTALUS L.

Syst. Nat., Ed. X, 214 ; B. and G., *l. c.*, 1 ; Cope, *l. c.*, 686, and Rep. Nat. Mus., 1149 ; Boul., *l. c.*, III, 572.

A pair of large erectable, perforated poison fangs in front of the upper jaw; no other maxillary teeth; loreal pit and rattle present; top of head covered with small scales; scales keeled (outer sometimes smooth), with pits, in 23–31 rows; anal and subcaudals not divided. Size medium or large.

Hab.—North and South America.

Notwithstanding the wide range of this genus, through the whole of America from lower Canada to Brazil, its members form a very compact group and though many of the species resemble each other closely, there is a curious absence of transitional characters, so that it is necessary to recognize as distinct species, forms as closely similar as *adamanteus* and *atrox*, as well as *confluentus* and *oregonus* (= *lucifer* B. and G.), in which the differences, though slight, are, as far as I can discover, absolutely constant.

Key to the Species of the United States.

A.—Anterior nasal in contact with rostral:

a.—Back with chevron-shaped cross-bands; tail black. 1. *C. horridus.*

b.—Back with spots; or cross-bands posteriorly:

a^1.—Rostral as high or higher than wide; 3–5 scales between suboculars and labials:

a^2.—Dorsal spots lozenge shaped:

Lozenges distinct; a light vertical line in front of nostril; bands on tail not very distinct, 2. *C. adamanteus.*

Lozenges with angles cut off; no light line in front of nostril; tail white with black bands, 3. *C. atrox.*

b^2.—Dorsal spots rhomboid; cross-bands behind:

Head scales larger; dark streak beginning at anterior corner of eye, . 4. *C. confluentus.*

Head scales smaller; dark streak beginning at posterior corner of eye, . 5. *C. oregonus.*

c^2.—Dorsal spots with a light centre on each side of the median line, ... 6. *C. molossus.*

d^2.—Dorsal spots small, in two rows, . 7. *C. pricei.*

b^1.—Rostral wider than high; 2 scales between suboculars and labials:

a^2.—Supraoculars not produced into a horn:

Spots anteriorly; cross-bands behind, 8. *C. tigris.*

Greenish, with black cross-bands, 9. *C. lepidus.*

b^2.—Supraocular produced into a horn, 10. *C. cerastes.*

B.—Anterior nasal separated from rostral by scales, 11. *C. mitchellii.*

Crotalus molossus B. and G.

l. c., 10; Cope, *l. c.*, 689, and Rep. Nat. Mus., 1154; Stej., *l. c.*, 424; *C. terrificus* (part) Boul., *l. c.*, III, 573.

Snout broad; rostral rather small, its width about equal to its height; scales on top of the muzzle larger than in any other North

American species, and usually about eight in number; five or six rows of scales between supraoculars, often two larger ones in front; four or five rows of scales between the suboculars and upper labials; 29 rows of dorsal scales; ventrals 187–203; subcaudals 25.

Length about 1,400 mm.

Sulphur yellow above; tail black or dark brown; dorsal spots chestnut brown, transversely wide and irregularly lozenge shaped, usually lighter in the centres of their lateral parts; these spots are commonly prolonged down to the ventrals; belly yellowish, clouded posteriorly; a dark oblique streak behind the eye.

Hab.—New Mexico, Arizona and Sonora.

In the size and arrangement of the plates on the muzzle, this species approaches *C. durissus* of South America.

Crotalus adamanteus Beauvais.

Trans. Am. Phil. Soc., IV, 368 (1799); B. and G., *l. c.*, 3; *C. a. adamanteus* Cope, *l. c.*, 690, and Rep. Nat. Mus., 1161; *C. durissus*[24] Boul., *l. c.*, III, 578; *C. adamanteus* Stej., *l. c.*, 432.

Largest of the genus; head broad behind, triangular; rostral higher than wide; usually two plates on the muzzle behind the nasals, the rest of the head covered with small scales; 6–8 rows between supraoculars; 3–5 rows between suboculars and labials;

[24] There has been disagreement as to whether the Linnæan name *durissus* belongs to this or to the South American species. Mr. Boulenger adopts it for this species and uses *terrificus* Laur. for the South American. To me the case appears otherwise. Linnæus' scanty description does not sufficiently indicate either, but examination of his references, to determine the basis of his species, shows that Seba's plates best indicate the South American form, and in the text (Seba, II, 99) Mexico is the most northern locality referred to. Linnæus' paper in the *Amœnitates Academicæ*, I, 500, and Gronovius both treat of specimens from South America; while the only North American rattlesnake apparently known to Kalm was the most northern of all (*horridus* L.). It appears then that *durissus* L. is a compound, not of the South American and the diamond rattlesnakes, but of the former and the Northern banded species. But Linnæus' description, "*Albo flavoque varius, maculis rhombeis disco albis*," cannot apply to the latter; *durissus*, therefore, should be restricted to the South American form. Laurenti's description of *terrificus* is not much more ample than that of Linnæus, but he refers his species to Seba's Pl. 95, fig. 1, in which the only recognizable detail, the scutellation on the muzzle, most clearly indicates the South American species; *terrificus* Laur. is, therefore, a synonym of *durissus* L.; *durissus* Laur. is a compound of Linnæus' description, above quoted, and Catesby's Pl. XLI, Vol. ii, which is *horridus*. I am unable to find evidence than any of these authors knew of the existence of a rattlesnake in North America other than *horridus*; and the large diamond rattlesnake of the Gulf States remained unrecognized until 1799, when Beauvais applied to it the name *adamanteus*.

scales in 27–29 rows, as in most of the species the first and second rows are faintly keeled or smooth; ventrals 169–178; subcaudals 25–32. The largest specimen I have seen, measured 1,910 mm. and came from St. Simon's Island, Ga. It was formerly in possession of the Zoölogical Society. There is little doubt that the species reaches 2,200 mm. or more.

Yellowish gray above, with lozenge-shaped dorsal blotches sharply defined, blackish, with centres of the body color, and separated by oblique yellow lines crossing each other on the back; on the sides in the triangular open spaces which alternate with the lozenges, there is a black spot; other indistinct markings sometimes appear on the sides; posteriorly the colors are somewhat darker and the lozenges take the shape of cross-bands, which form not very well-defined rings on the tail, but the colors there are not sharply contrasted; belly yellowish white, clouded with brown toward the sides. There is a wide dark oblique streak from below the eye to the labials, bordered in front and behind by a light one; two light bars from the loreal pit to labials, and another in front of the nostril.

Hab.—North Carolina and Florida; west to Louisiana and probably eastern Texas.

Crotalus atrox B. and G.

l. c., 5.

The western representative of the diamond rattlesnake is very like it in appearance, but may always be distinguished by the absence of the light vertical line in front of the nostril, by the absence of sharply defined angles to the dorsal spots and by the strongly contrasted black half rings on the tail. A rare form, known only from southern California, is retained as a subspecies.

Color grayish or brown; markings distinct, . .	1. *C. a. atrox.*
Color red; markings not very distinct, . . .	2. *C. a. ruber.*

Crotalus atrox atrox B. and G.

l. c., 5; *C. adamanteus atrox* and *C. a. scutulatus* Cope., *l. c.*, 690, and Rep. Nat. Mus., 1164, 1159; *C. scutulatus* and *C. confluentus* (part) Boul., *l. c.*, III, 575, 576; *C. atrox* Stej., *l. c.*, 436.

Size rather less than *adamanteus*, but form and scutellation very similar; the supraoculars are sometimes but not always bordered internally by a row of enlarged scales; rows of scales between supraoculars often 4, but sometimes 5 or 6; 3–4 scales between suboculars and labials; scales in 27–25 rows; ventrals 173–187; subcaudals 23–28. Of many specimens the largest I have seen measured 1,670 mm.

Yellowish or grayish, sometimes quite brown, with a series of dark brown or black dorsal spots, with centres of the body color; the angles of the spots are not sharp as in *adamanteus*, but are cut off, forming irregular hexagons; the lateral markings are indistinct; tail gray or white, with 3–5 dark brown or black half-rings; belly yellowish, more or less clouded on the sides. The oblique streak behind the eye is present, but the light line in front of the nasal is always absent. Some young examples have a narrow light line across the middle of supraoculars.

Hab.—Central Texas to Arizona; northern Mexico.

Crotalus atrox ruber Cope.

l. c., 690; *C. confluentus* (part) Boul., *l. c.*, III, 576; *C. a. ruber* Stej., *l. c.*, 439; *C. ruber*, Van Den., *l. c.*, 222; Cope, Rep. Nat. Mus., 1167.

Size smaller than *C. a. atrox;* rostral wider; canthus less distinct; head scales small; 8 rows between supraoculars; 5 between suboculars and labials; 27 rows of scales; ventrals 183–186; subcaudals 22–26.

Length about 1,300 mm.

Pale red; dorsal spots darker red; lateral spots and head markings indistinct, although a specimen from San Diego, formerly living in the Zoölogical Gardens, plainly showed the oblique streak behind the eye; belly yellowish; tail whitish with black cross-bands.

Hab.—Southern California.

A better acquaintance with this rare snake may require that it be given specific rank, especially as Mr. Van Denburg does not include *C. a. atrox* in his list of California snakes.

Crotalus confluentus Say.

Long's Exp., II, 48 (1823); B. and G., *l. c.*, 8; *C. c. confluentus* and *C. c. pulverulentus* Cope, *l. c.*, 692, and Rep. Nat. Mus., 1170, 1174; *C. confluentus* (part) Boul., *l. c.*, III, 576; *C. confluentus* Stej., *l. c.*, 440.

Body rather slender; rostral higher than wide; no very distinctly enlarged plates behind the nasals; head scales of moderate size, 3–6 between supraoculars, 2–4 between suboculars and labials; 27–29 rows of scales; ventrals 173–188; subcaudals 23–28.

Length about 1,400 mm.

Grayish or yellowish brown, with a dorsal series of subquadrate dark brown blotches with rather lighter centres, and sometimes a yellowish border; the corners are often rounded, and posteriorly the spots become cross-bands; two series of smaller alternating blotches on the sides; belly dull yellow; a transverse light line on the centre of the supraoculars, which widens and sometimes bifurcates internally; in the young this is very distinct and the anterior arm of the bifurcation is continued across the vertex to meet its fellow; the oblique eye streak begins very constantly at the lower anterior corner of the eye and is bordered by narrow white lines; a light line below loreal pit, and the borders of the rostral are light in the young.

Examination of the type of *C. c. pulverulentus* Cope does not afford any good ground for distinction.

Hab.—Southern Manitoba to central Texas; west to Idaho and Arizona.

Crotalus oregonus Holbrook.

No. Am. Herp., III, 21, Pl. 3 (1842); *C. lucifer* and *C. oregonus* B. and G., *l. c.*, 6, 145; *C. a. adamanteus* (synonomy), *C. confluentus lecontii* and *C. c. lucifer* Cope, *l. c.*, 690, 692; *C. confluentus* (part) Boul., *l. c.*, III, 576; *C. lucifer* Stej., *l. c.*, 445, and No. Am. Fauna, No. 7, 218; Van Den., *l. c.*, 216; *C. c. lecontei* and *C. c. lucifer* Cope, Rep. Nat. Mus, 1175, 1176.

Examination of the type of *C. oregonus* Holb. leaves me with little doubt that it is identical with *lucifer* B. and G. The specimen has become much distorted and shriveled during the sixty years since Holbrook examined it, but it shows no important difference in scutellation. There are 6 scales between the supraoculars; 3 between the suboculars and labials; 25 rows of scales. Holbrook's plate does not quite correctly render the color pattern; the dark streak behind the eye begins further back than is shown, and really takes origin as in *lucifer*, posterior to the centre of the eye. The dorsal spots are not as emarginate on the anterior border as many of them are represented in the plate; they are, in fact, sharply angled, giving a superficial resemblance to *adamanteus* (which can be the only reason why Cope includes it in the synonomy of that species); but much weight cannot attach to this single point in which the specimen differs from *lucifer*, for the reason that the epidermis has long since peeled off, leaving the whole pattern accentuated; and the youth of the animal (315 mm.

long) would also show these lines more sharply defined than they would become later in life. The transverse light line on the supraoculars is precisely as in *lucifer*.

This species comes very near to *confluentus*, but, on account of the constancy of the slight differences, I am obliged to give it specific rank; the head scales are rather smaller, the rows between supraoculars numbering in six examples 4, 5, 8, 8, 8, 9; between suboculars and labials 2–4; scales in 25–27 rows; ventrals 165–189; subcaudals 18–26. Size about the same as *confluentus*. The pattern is closely similar, but the dark oblique streak behind the eye always begins posterior to its centre and runs backward directly to the angle of the mouth, not curving downward as sharply as in *confluentus;* the light lines bordering it are wider; the transverse light line on supraoculars is present; the belly is yellow or greenish, with the posterior border of each ventral lighter. In some specimens the general color is dark, approaching even to black.

Hab.—The Pacific coast; California to British Columbia, Idaho and northern Nevada and Utah.

Crotalus horridus L.

Syst. Nat., Ed. X, 214; *C. durissus* B. and G., *l. c.*, 1; *C. horridus* Cope, *l. c.*, 693, and Rep. Nat. Mus, 1185; Boul., *l. c.*, III, 578; Stej. *l. c.*, 426.

Size smaller and body more slender than in *adamanteus;* rostral high; two rows of small plates behind nasals; 4–8 scales between supraoculars; 2–4 between suborbitals and labials; usually but one plate on canthus; scales in 23–25 rows (occ. 27); ventrals 165–178; subcaudals 18–25.

Average specimens are about 900 to 1,000 mm. long, and it is doubtful if the species ever much exceeds 1,400.

The body color is variable—sulphur yellow, ashy and almost black (one specimen from Alabama was in life a peculiar pale drab), crossed by twenty or more irregular chevron-shaped black bands; the bands are sometimes complete, but often broken into angular spots on the sides, but they always have a ragged or zigzag appearance. The tail is black; belly yellow marked with dusky; head dark, without distinct markings.

Hab.—New England to northern Florida; west to Iowa, Oklahoma and northern Texas.

Crotalus tigris Kennicott.

U. S. Mex. Bound. Surv. Rept., 14, Pl. IV (1859); Cope, *l. c.*, 693, and Rep. Nat. Mus., 1181; Boul., *l. c.*, III, 580; Stej., *l. c.*, 449, and No. Am. Fauna, No. 7, 214; Van Den., *l. c.*, 220.

Body rather slender; rostral wider than high; two rows of small plates on the muzzle; about six rows of scales between supraoculars; generally two rows between suboculars and labials; scales in 21–23 rows (occ. 25); ventrals 170–181; subcaudals 19–21. Length about 800 mm.

Grayish or yellowish, with a dorsal series of rather small dark blotches and an indistinct lateral series; on the posterior two-thirds of the body the spots are replaced by cross-bands; belly whitish or yellow; a dark oblique streak behind the eye.

Hab.—Arizona, southern Nevada and southern California.

Crotalus lepidus Kennicott.

Proc. Acad. Phila., 1861, 206; Cope, *l. c.*, 692, and Rep. Nat. Mus., 1191; Boul., *l. c.*, 582; Stej., *l. c.*, 452.

Size small; rostral wider than high; eight plates on top of muzzle; 3–4 rows between supraoculars; 2 between suboculars and labials; one nasal, half divided; the upper preocular divided vertically; scales in 23 rows; ventrals 153–169; subcaudals 27–31. Length 600 mm.

Greenish gray, with about 20 dark brown or black dorsal spots; tail with several dark half-rings; belly whitish clouded with brown; two large dark spots in contact on the nape; the dark oblique streak behind the eye is sometimes indicated.

Hab.—Western Texas to central Arizona; northern Mexico.

Crotalus cerastes Hallowell.

Proc. Acad. Phila., 1854, 95; Cope, *l. c.*, 694, and Rep. Nat. Mus., 1196; Boul., *l. c.*, III, 583; Stej., *l. c.*, 450, and No. Am. Fauna, No. 7, 216; Van Den., *l. c.*, 222.

Size small; rostral as wide as high; head scales small, 5–7 between supraoculars; 2 between suboculars and labials; one nasal; supraoculars elevated into a horn-like projection; scales in 21 rows; ventrals 134–146; subcaudals 16–21. Length about 600 mm.

Yellowish, with a dorsal series of small brown blotches, and several indistinct series of smaller ones on the sides; belly yellowish; a narrow oblique streak behind the eye.

Hab.—Arizona, southern Nevada, Utah and California.

Crotalus pricei Van Denburg.

Proc. Cal. Acad. Sci., 1895, 856; Cope, Rep. Nat. Mus., 1184.

This species is known from five small specimens in the museum of the Leland Stanford University, California.

From Mr. Van Denburg's description it appears to be characterized by a rostral slightly higher than wide; enlarged plates on the muzzle; one to three rows between supraoculars; one row between suboculars and labials; and the presence of but nine upper labials, the number in other species being 12–18; 21 rows of scales; ventrals 153–159; subcaudals 21–27. Length to rattle 447 mm. (tail 41).

Olive gray, thickly covered with small brown dots. Fifty-four to sixty small brown blotches arranged in two series on the back, somewhat alternating anteriorly, but forming cross-bands behind; seven brown cross-bands on the tail; two or three rows of smaller alternating brown spots on the sides; belly dark slate, ends of the ventrals and outer row of scales whitish; a dark brown oblique streak behind the eye; two small brown spots on the occiput; throat yellow tinged with vinaceous.

The peculiar characters of these specimens are quite sufficient, as far as they are now known, to entitle them to recognition.

Hab.—Huachucha Mountains, Arizona.

Crotalus mitchelli Cope.

Proc. Acad. Phila., 1861, 293; *C. mitchellii* and *C. pyrrhus* Cope, *l. c.*, 694; *C. mitchelli* Boul., *l. c.*, III, 580; *C. mitchellii* Cope, Rep. Nat. Mus., 1193; *C. m. mitchelli* and *C. m. pyrrhus* Stej., *l. c.*, 454, 456; *C. mitchelli* Van Den., *l. c.*, 224.

Differs from all others of the genus in having the rostral separated from the anterior nasal by small granular scales; canthus not sharp and without large plates; 6–7 scales between supraoculars; 3 rows between suboculars and labials; preocular sometimes divided; 23–25 rows of scales; ventrals 178–198; subcaudals 26.

Length about 1,100 mm.

Ordinary specimens are grayish yellow, with brown punctulations on the back, which are collected into about forty transversely angular spots, which form cross-bands on the posterior fourth of the body; tail light with distinct black half-rings; an indistinct brown streak behind the eye, with a light one in front of it. Occasional examples are more or less red of varying shades; upon such specimens *C. pyrrhus* Cope was founded.

Hab.—Arizona and southern California.

Serial Index.

CRUSTACEA OF THE CRETACEOUS FORMATION OF NEW JERSEY.

BY HENRY A. PILSBRY.

From the earliest exploitation of the Cretaceous beds of New Jersey, remains of crustacea have been encountered by various observers, most of whom contented themselves with merely mentioning the occurrence of crabs' claws. These remains have until now escaped scientific description.

The first notice of crustacean fossils from the State, so far as I know, is contained in Vol. I, part 2, pp. 195–198, of the *Annals of the Lyceum of Natural History of New York* (1824), where Dr. J. Van Rensselaer gives a brief account and figures of four supposed species from "the triangular peninsula comprised between the ocean and the Delaware and Raritan rivers." The species are not named, and from the information given cannot be identified with certainty, but Nos. 1 and 3 may be *Callianassa mortoni*, and No. 4 is possibly *C. conradi*.

Dr. S. G. Morton, in the *American Journal of Science and Arts*, XVII, No. 2, p. 287 (1830), notices Van Rensselaer's work, and mentions the finding of *Astacus* remains in Delaware; paraphrasing his remarks in the *Synopsis of Organic Remains of the Cretaceous Group of the U. S.*, p. 74 (1834).

The collection of the Academy of Natural Sciences of Philadelphia contains many specimens from the deep cut of the Chesapeake and Delaware canal, Delaware, and from Monmouth and Burlington counties, N. J., together with numbers without locality further than "Cretaceous, New Jersey." During the last few years various members of the Academy have added specimens from Lenola, N. J., a locality unknown to the earlier collectors of Cretaceous fossils.

It is noteworthy that all the specimens thus far seen are from the "Lower Marl" beds; none have come to my notice from the Middle or Upper Marls.

I am indebted to Mr. Charles W. Johnson, Curator of the Wagner Free Institute of Science, for various references and the use of material in the museum in his charge, including specimens

collected by William Wagner, Thomas H. Montgomery, Jr., and himself.

CALLIANASSA Leach.

The glauconitic sands of the New Jersey Cretaceous are ill-adapted for the preservation of delicate structures, and therefore only the hard large claws of these soft-bodied Macrura are found. Most of the species described from the Cretaceous, Eocene and Miocene of Europe are likewise based upon chelæ.

In the United States one Eocene species has been described, *C. ulrichi* White,[1] from specimens collected by Mr. E. O. Ulrich near Little Rock, Ark., in a bed at first supposed to be Cretaceous. The specimens before me were collected by Mr. C. W. Johnson at Mabelvale, Ark. The propodite in this species is short and squarish, much as in *C. conradi*; the lower border is somewhat crenate, and well-preserved specimens show a tuberculate tract on each side behind the commissure between the fingers. The hand is compressed, as in *C. conradi.*

In Europe the fossil species from Mesozoic and Tertiary strata are numerous and an excellent account of them has been given by Milne-Edwards,[2] while notices and descriptions of various species occur in the works of many other authors. The older species are very similar to living forms, weak and soft-bodied burrowers in the sand, and yet the genus has outlived most of its companions on the shores of the Cretaceous seas. There is nothing like being adapted to your circumstances.

Our species apparently belong to that division of the genus in which the fingers are of equal length, but they are clearly distinct from any described European form.

Callianassa mortoni n. sp. Pl. I, figs. 1-7.

Propodite (figs. 1–4) rhombic, its breadth about two-thirds the length, the outer face (fig. 1) very convex, the greatest convexity posterior and nearer the upper side. Surface nearly smooth, usually showing a series of four distant punctures extending backward from the root of the fixed finger, and two on the other or more

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[1] C. A. White, *Proc. U. S. Nat. Mus.*, III, 1880, p. 161; IV, 1881, p. 137, Pl. 1, figs. 10, 11 (left propodite); G. H. Harris, *Ann. Rep. Geol. Surv. Arkansas*, II, 1892, p. 36, Pl. 1, fig. 2a, 2b (left hand).

[2] *Annales des Sciences Naturelles*, 4 ser., XIV, Zool., p. 301 (1860); a supplement in *Nouv. Arch. du Mus.*, 1870, Vol. VI.

convex side; *the posterior margin abruptly falling* near the joint, a prominence bearing a group of small tubercles at the summit before the deflection. Inner surface or palm (fig. 2) much less convex, becoming concave near the lateral margins, nearly smooth, the anterior margin slightly excavated between the root of the fixed finger and the dactylopodite, and bordered there with a short row of small tubercles. On the median portion of the palm there are two punctures, marking it off into thirds longitudinally. Lateral margins of the propodite acute, closely, finely and regularly crenulate; the lower margin straight, with a row of punctures along the inner side but extremely near the edge, and another less close to the edge outwardly; upper margin deeply curved down posteriorly, produced into a deflexed lobe, and similarly margined with spaced punctures. Fixed finger about one-third the total length of the whole propodite, curved at the tip, finely crenate along the grasping margin when unworn, and with a blunt median tooth.

Dactylopodite with two contiguous crenulate carinæ along its outer edge.

Carpopodite (Pl. I, figs 5, 6) somewhat shorter than the palmar surface of the propodite, equally convex inside and out, turgid anteriorly, its outer face with an oblique groove bordered with small tubercles near the distal lower angle. Posterior upper angle produced backward in a rather slender process.

Meropodite (Pl. I, fig. 7) subtriangular in section, the upper keel strongly arched, lower keel nearly straight and more strongly serrate, the middle of the very convex outer surface granulose, with two rounded tubercles at the anterior extremity; the opposite or inner face nearly flat. In all specimens preserved with the members in place, the meropodite is flexed at a right angle with the carpopodite.

Measurements of propodite, in millimeters.

	Length.	*Length exclusive of finger.*	*Width in the middle.*	*Thickness.*
(*a*)	—	29	19	9.5
(*b*)	25	18	11	6

The left chela of another specimen measures: Total length of propodite 27, palmar surface (without finger) 20 mm.; width in middle 13 mm.; greatest length of carpopodite, measured obliquely 20, or from middle of distal to middle of proximal margin

14 mm.; width in middle 12 mm.; length of meropodite 13 mm. (No. 10,095 Wagner Free Institute of Science, collected at Crosswicks, N. J., by Dr. Thomas H. Montgomery, Jr.).

Lower Marl beds of New Jersey, Lenola (C. W. Johnson, Louis Woolman, H. C. Borden); Crosswicks (Dr. Thomas H. Montgomery, Jr.); Tinton Falls, Monmouth county (Coll. A. N. S.). Also Delaware, deep cut of the Delaware and Chesapeake canal (Coll. A. N. S.). Types in Coll. A. N. S.

What *Callianassa faujasi* is in Europe to the Mæstrichtien, *C. mortoni* is on this side of the Atlantic to the "Lower Marl" beds. It is an abundant species, known by remains of over one hundred individuals, chiefly the propodites only, though sometimes the meropodite, carpopodite and propodite are preserved in place; when this is the case, it is usually due to their being more or less imbedded in hard nodules. The abrupt deflection of the hind margin of the more convex face of the propodite, and the downward bend, posteriorly, of its upper margin (as in fig. 3) are characteristic of the species.

Both chelæ of a Lenola individual preserved in one nodule show the right claw to be somewhat the larger. Otherwise the two claws seem to be counterparts. I can find no other difference.

The largest specimens show a shallow, vermiculate wrinkling of the surface, but the smaller are almost smooth to the eye or touch. The crenulation of the margins becomes stronger with age, and is occasionally lost or obscured by chipping of the edges.

It is named for Samuel George Morton, one of the earliest explorers of the American Cretaceous.

Callianassa conradi n. sp. Pl. I, figs. 8, 9, 10.

Propodite rhombic, its length (without finger) not much exceeding the width, somewhat more convex on the outer than on the inner face, *the posterior margin neither abruptly nor deeply deflexed.* Surface smoothish, with some small tubercles on each side of the slight excavations on both sides of the hand near the commissure between the bases of the fingers; the acute lateral edges crenulated, as in *C. mortoni*, but the lower edge is not deflexed posteriorly as in that species. *Fixed finger triangular in section,* the angles crenulated, the flat grasping face with a short smooth rib near the base, which joins the keel along the outer angle of the finger.

Measurements of propodite.—Length about 30 mm.; exclusive of finger 18.5; width 16.5; thickness 7.6 mm.

Crosswicks and Monmouth county, N. J., with *C. mortoni* (Coll. A. N. S.).

In a few specimens the dactylopodite remains as a short stump only. No carpopodite or other part is known. Thirteen propodites, probably belonging to as many individuals, are before me, the most perfect being one of two in the collection of the Wagner Free Institute of Science.

The claw of *C. conradi* differs from that of *C. mortoni* in being much shorter and broader; more evenly convex on the two sides, the posterior margin of the outer side and the keel along the upper edge are not abruptly deflexed behind; the fixed finger of the propodite of *C. conradi* has no median tooth on its grasping face, which is flat with a short smooth ridge and bounded by two crenulate angles, while in *C. mortoni* there is a median tooth, a crenulate ridge on the face, and no crenate angle along the lower inner part of the finger.

The name is in honor of Timothy Abbott Conrad, the ablest of the early expositors of the Cretaceous and Tertiary faunas of the United States.

Figured type in collection of the Wagner Free Institute of Science, No. 5,478 W.

HOPLOPARIA McCoy.

The following species are referred to this genus with due reserve, as until the cephalothorax is known their exact position in the Astacoid series must remain doubtful. The *specific* characters of the fossils, however, may be readily appreciated; and the definition of the species may call attention to the matter and lead someone to search for the missing parts.

Hoploparia gabbi n. sp. Pl. I, figs. 11, 12, 13, 14.

Right propodite robust, evenly convex on both sides, but slightly more convex above than below, the surface slightly roughened everywhere by small flattened, separated, scale-like asperities; lower margin bluntly angular and marked by a slight groove; upper margin narrowly rounded, bearing a couple of short conic spines, inserted slightly below the edge and directed downward and forward; and on each side there is a rounded tubercle at the base of the dactylopodite. Fixed finger rather slender, with a series of coarse tubercles (worn flat) along its grasping edge.

Dactylopodite armed with a short conic spine near its base (continuing the row of similar spines on the upper margin of the propodite), its grasping face with a series of coarse tubercles, worn flat.

Carpopodite (?) irregularly cylindrical, gibbous, a little compressed and faintly grooved along the outer side, bearing a series of several short spines along the inner.

Abdominal somites (Pl. I, figs. 13, 14) with highly arched tergum, the surface punctate.

Lower Marl beds, Lenola, N. J. (C. W. Johnson, Uselma C. Smith); Monmouth county (William Cleburne). Also deep cut of the Delaware and Chesapeake canal.

Cotypes are No. 527 Coll. A. N. S. and 5,941 Coll. Wagner Institute, from Lenola, N. J.

This species is based upon a right hand and group of four abdominal somites in the collection of the Academy of Natural Sciences of Philadelphia, and a right hand and carpopodite (?) in that of the Wagner Free Institute. The fixed finger is broken in both specimens, and the proximal portion of the hand is wanting. In the Wagner Institute specimen the base of the dactylopodite remains.

A much smaller propodite from Monmouth county, N. J., shows a series of four short spines along the upper margin; but perhaps this specimen belongs to an allied but distinct species, as it is much less convex inside than the larger claws. In the large specimens from Lenola only the anterior two spines remain, as described above, owing to the loss of the posterior portion of the hand.

On account of the mutilated condition of the remains, measurements cannot readily be given; but an Astacoid somewhat larger than the common Eastern crayfish is indicated. The figures are of the natural size. The high arch of the abdomen may be partly due to lateral compression. Until further remains come to light, and especially the cephalothorax, the generic position of the species will be uncertain. It is named in honor of William M. Gabb.

Hoploparia gladiator n. sp. Pl. I, figs. 15, 16

Propodite long and narrow, parallel sided, its thickness more than half the width, about equally convex on the two sides, smoothish, showing scattered punctures and under a lens a very fine punctulation; on both sides of the hand a row of three or four small pointed tubercles runs lengthwise along the median convexity; lower edge bluntly biangular. Fixed finger nearly double the width of the dactylopodite, pyriform in section, with a row of tubercles along the grasping edge. Dactylopodite oval in section, also bearing pointed tubercles opposed to those on the fixed finger.

Length of propodite as broken 35 mm.; width 11.5, thickness 7 mm.

Lower Marl beds, Lenola, N. J. (Charles W. Johnson). Deep cut of the Chesapeake and Delaware canal (Coll. A. N. S. P.).

Types are No. 10,120 Coll. Wagner Free Institute of Science, and consist of an imperfect propodite with broken dactylopodite in place, a fragment of the fixed finger, apparently of the same specimen, and a fragment of another hand of larger size, width 14, thickness 9 mm. They were exposed by breaking hard nodules which occur in the clay at Lenola. Another broken propodite is in the collection of the Academy from the deep cut of the Chesapeake and Delaware canal, in Delaware.

The species is readily recognizable by the long, narrow shape of the hand and the minute punctulation of the surface, the biangulate lower edge of the fixed finger and hand, etc. It can hardly be the smaller chela of *H. gabbi* on account of the different surface-sculpture, etc.

BRACHYURA (?)

Remains of three crustaceans, probably short-tailed crabs, are contained in the collection of the Academy, but while *specifically* characteristic by their peculiar sculpture, they are too fragmentary to admit of generic reference, at least from my knowledge of the group.

One fragment shows keels on a smooth surface, somewhat like the hand of *Callinectes*, though it is probably something very different.

Another (Pl. I, fig. 17) seems to be the finger of some very long-handed form. It has three rows of long tubercles along the grasping (?) face, three of smaller ones along the rounded and narrower outer margin, while a furrow runs along each side. This and the preceding are from Monmouth county, N. J., but other fragments, probably referable to the long-fingered crab, are in the collection from Crosswicks, N. J.

Still other fragments (Pl. I, fig. 18) are strongly spinose. I take that figured to be a portion of a hand from which the fixed finger has been broken off at the position marked *f*. The opposite side bristles with three irregular rows of short spines, while smaller ones are scattered over the palm. The socket for the dactylopodite is very large.

These fragments are so strongly marked and easily recognizable specifically that I call the species *Cancer(?) whitfieldi;* the generic reference being admittedly merely provisional and to call attention to the necessity of examining further material; for it would be a *Cancer* only in the Linnæan limits of that genus. These fossils are from Burlingtor county, N. J. The name is for Prof. R. P. Whitfield, whose volumes upon the paleontology of New Jersey have been of great use to workers in this field.

There are also some densely granulose remains of portions of limbs, possibly referable to *Hoploparia* or *Astacodes*, in the collection of the Wagner Institute from Lenola, N. J.; but they are too imperfect to afford data of value at present.

EXPLANATION OF PLATE I.

Fig. 1. *Callianassa mortoni.* Right propodite, outside. 2. Right propodite, inside; the fingers broken off. 3. Right propodite, profile from above. 4. Right propodite, posterior view. 5. Right carpopodite, inside. 6. Right carpopodite, outside. 7. Left meropodite, outside (No. 4,059 W, Coll. Wagner Inst.).

Fig. 8. *Callianassa conradi.* Left propodite, inner face (No. 5,478 W, Coll. Wagner Inst.). 9. Left propodite, posterior view. 10. Left propodite, profile.

Fig. 11. *Hoploparia gabbi.* Left propodite, outer face; the dactylopodite supplied from another specimen. 12. Left propodite, profile. 13. Portions of four abdominal somites. 14. Section of anterior end of same.

Fig. 15. *Hoploparia gladiator.* Outlines of broken fingers of the large fragment (fig. 16) (No. 10,120 Coll. Wagner Inst.). 16. Propodite, with dactylopodite.

Fig. 17. Fragment of a finger (?), species unknown.

Fig. 18. *Cancer (?) whitfieldi.* Fragment of a propodite.

Figs. 1–4, 11–14, 17, 18 are from specimens in the collection of the Academy. Figs. 5–10, 15, 16 are from specimens in the collection of the Wagner Free Institute of Science.

ON SOME POINTS IN THE PHYLOGENY OF THE PRIMATES.

BY ARTHUR ERWIN BROWN.

The suggestions here offered, as to the possible origin of certain structural resemblances noted between anthropomorpha and one of the family groups of existing lemurs, have resulted as a by-product from a study of the interrelations of the *Primates*, undertaken with a different purpose; they are put forth simply as a contribution to the sum total of possibilities which, upon final sifting, shall some day determine the exact degree and manner of the relationship between men, apes and monkeys, and not in any sense as a demonstrated conclusion—for the reaching of which more detailed knowledge of the early Tertiary mammals is required.

In accounting for the later stages in the phylogeny of man, three hypotheses are to be considered.

The view of Darwin,[1] now held by a majority of systematists, is that the anthropomorpha (here used to include man and the higher apes) branched off from the main stem of monkeys after its divergence from the lemurs.

In 1860, Gratiolet[2] was led by a study of brain characters alone, to the conclusion that each genus of anthropoid apes was descended from an existing genus of monkeys; thus he derived *Gorilla* from *Cynocephalus; Anthropopithecus* from *Macacus; Simia* and *Hylobates* from *Semnopithecus*. This view has received little support and the facts now known show its complete untenability.

Lastly, Prof. E. D. Cope[3] has suggested a common origin for the anthropomorpha directly from the Eocene lemuroids, independently of the line by which the monkeys came from the same stock, being led to this conclusion by a study of the tendency in certain races of men to the production of tritubercular upper molars, which tendency he interprets as reversion, or retrogressive

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[1] *Descent of Man*, Chapter VI.

[2] *Comptes Rendus*, 1860, p. 801.

[3] *Journal of Morphology*, 1888, p. 21, and *Primary Factors of Organic Evolution*, p. 154 (1896).

evolution toward an ancestral lemuroid tritubercular dentition. It appears to me that this observation of Cope's does not stand alone, and my present purpose is to indicate certain homologies which appear to fall into line with it.

In estimating the degree of relationship between men and apes, on the one hand, and catarrhine monkeys on the other, and that borne by each series to their ancestral group, two sets of homologies are of especial value—those which the anthropomorpha share with some, at least, among lemurs (in which catarrhine monkeys have no part), and those connecting catarrhines with lemurs, which are, conversely, absent from anthropomorpha.

Some correspondences of much weight are disclosed by the teeth and the vertebral column; these will be briefly recapitulated without extended description of details, which have already been given in each case by recognized authorities, although it does not appear that due weight has been given to their bearing upon the present question. It may be added that almost all have been verified by my own observations.

In anthropomorpha there is an oblique ridge crossing the crowns of the upper molars from *protocone* to *metacone*.[4] This is present with great uniformity in the first and second human molars, as well as in the third when it presents the quadritubercular form, and in examination of a considerable number of skulls belonging to all four genera of anthropoids, I have found it in every case where the crowns were sufficiently unworn to permit its disclosure. Topinard lays much stress upon this crest and expresses the opinion that it represents the posterior border of the primitive three-cusped tooth,[5] from which the four-cusped has been evolved by addition of a postero-internal cusp (*hypocone*). He states, further,[6] that the crest is never absent in platyrrhine monkeys—an assertion which appears to me too sweeping, but traces of it are certainly found in *Ateles* and *Alouatta*, and perhaps irregularly in other genera. It is not found in any catarrhine monkey, but reappears in the quadritubercular lemurs of the family *Nycticebidæ*,[7] comprising

[4] Owen, *Odontography*, Pl. 116, fig. 6, and *Comp. Anat.*, III, p. 320; Huxley, *Anat. Vert.*, pp. 390, 396, 412 (direction of ridge reversed), and *Proc. Zool. Soc. of London*, 1864, p. 314 *et seq.*; Mivart, *P. Z. S.*, 1864, p. 611 *et seq.*; Topinard, *L'Anthropologie*, 1892, p. 641 *et seq.*

[5] *l. c.*, p. 650.

[6] *l. c.*, p. 683.

[7] Huxley, *l. c.*, pp. 322–324; Mivart, *l. c.*, p. 631; Topinard, *l. c.*, p. 691.

Loris, *Nycticebus*, *Perodicticus* and *Arctocebus*, and irregularly in *Microcebus*[8] and *Galago*.[9] Of especial significance is the fact that some of the more recently described Eocene *Primates*[10] present both a small fourth cusp and traces of the oblique ridge on the first and second upper molars. In all catarrhine monkeys both upper and lower molars are quadricuspid, with strong transverse ridges connecting the opposite cusps.[11] This arrangement is not found in anthropomorpha, but is shown both above and below in *Indris*,[12] while *Loris* and *Arctocebus* show it in the lower jaw.

Mr. Mivart[13] directs attention to the fact that in man the spinous process of the third cervical vertebra is short and bifurcated; in anthropoids it is elongated and simple, while in monkeys generally it is short and simple, as is the case in lemurs excepting in the *Nycticebidæ*, among which in *Nycticebus* it is quite human, while in *Perodicticus* and *Arctocebus* it is anthropoid. Similar correspondences are exhibited by other parts of the spinal column. In anthropomorpha the spinous processes of the lumbar and the last, or last two, dorsal vertebræ are directed backward, the transverse processes are turned slightly backward (dorsally), and the anapophyses and metapophyses are few in number and feebly developed. In catarrhine monkeys the corresponding spinous processes are bent forward, so as to make a distinct point of convergence about the next to the last dorsal with those of the anterior vertebræ, which are inclined strongly in the opposite direction; the transverse processes are horizontal or more usually slightly bent forward (ventrally), and the anapophyses and metapophyses are strongly developed and begin usually in advance of the seventh dorsal, extending posteriorly through the whole of the lumbar vertebræ.

In all these respects lemurs agree with monkeys, excepting again the *Nycticebidæ*, where the disposition is generally as in anthropomorpha.

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[8] Mivart, *l. c.*, p. 621.

[9] Huxley, *l. c.*, p. 325, fig. 5; Mivart, *l. c.*, p. 625; Topinard, *l. c.*, p. 692.

[10] H. F. Osborn, *Bull. Am. Mus. of Nat. Hist.*, 1895, p. 19, fig. 4, and *International Dental Journal*, July, 1895, Pl. AA, fig. 10.

[11] Huxley, *Anat. Vert.*, p. 401; Topinard, *l. c.*, p. 679.

[12] Huxley, *P. Z. S.*, 1864, p. 326; Topinard, *l. c.*, fig. 8, T.

[13] *P. Z. S.*, 1865, p. 550.

[14] Mivart, *P. Z. S.*, 1865, p. 545 *et seq.*

The sacrum in anthropomorpha is composed of five or six coalesced vertebræ; in monkeys the normal number is two or three, and a like number is shown by lemurs, except *Indris,* which has four, and *Perodicticus* and *Arctocebus,* each of which has five.[15]

Now if we attempt, from Gratiolet's standpoint, to account for the presence in anthropoids of so many of the above characters as their supposed ancestors do not possess, inheritance being excluded by the very terms of the hypothesis, we are driven to analogous variation as the only process with which we have any acquaintance which might be held competent to explain them.

But, so far from there being any good reason to assume that analogous variation has been a frequent method in nature, there is, on the contrary, warrant for an *à priori* belief that the mere mathematical chances against the occurrence of any single case of it are very great; so that where, as in the present circumstances, seven cases of the independent development of almost exactly similar characters must have taken place in each of four genera (to say nothing of man, who is not provided for by the hypothesis), the improbability becomes so enormous as to remove it from rational consideration.[16]

The theories of Darwin and of Cope remain to be examined, and it may be said at once that no one of the homologies which have been noted is excluded by either of them, but there is, in my belief, a wide difference in their relative probability; that of Cope being so far the most simple, that it is logically indicated for our acceptance.

Darwin's hypothesis requires us either to suppose that there has been an extensive and complicated process of preservation of certain structures and suppression of others, in which the family groups now differ, or to take refuge again in analogous variation. Both are rendered difficult of acceptance by the reflection that of the characters here advanced few, if any, can be believed to have been adaptive. It is unsafe to dogmatically assert that a given structure

[15] Mivart, *P. Z. S.*, 1865, p. 560.

[16] Furthermore, the same principle must be invoked to account for the absence of the cusp-bearing heel on m , possessed by each of the supposed ancestral genera; for the presence of three external cusps on the lower molars; the presence of a vermiform appendix; the independent origin of the left common carotid from the arch of the aorta, and the converging direction of the hair on the arms toward the elbow, all of which are peculiar to anthropomorpha.

can never have been of adaptive character, but we are at least entitled to consider that if monkeys in general have flourished luxuriantly with transverse ridges on the crowns of their upper molars, and at most three sacral vertebræ, a slight oblique ridge on the upper teeth and two or three additional vertebræ in the sacrum can hardly be supposed to have had selective value to anthropoids.

The remaining theory, that of Cope, would account for the conditions noted by the process of direct and simple inheritance, and requires no greater amount of assumption than has more than once been justified in the course of phylogenic speculation. Fragmentary as are the remains of the Eocene lemuroids which have come to light, they are enough to show that while the group as a whole was generalized, it yet presented at that early period, a considerable amount of variety in details, many of which have been preserved in existing lemurs. Of these early forms we have remains of little but jaws and teeth, but the many and curious correspondences which have been noted between anthropomorpha and the *Nycticebidæ* are best intelligible upon the supposition that they originated in a group which, possessing the tooth characters shown by each, had associated with them the other structures as well; such may have existed among the *Anaptomorphidæ*, but in the present state of ignorance as regards the details of the remaining skeletal structure of that group, it would be rash to attempt a close specification, either of the particular form or of its geographical region.

Cope's view of the independent origin of the anthropomorpha was based upon the supposed tendency in the human race to revert to a tritubercular form of molar. There are minds to which reversion is but a convenient term denoting a process which it is rarely possible to either prove or disprove; but whether or not it be accepted in this case,[17] Prof. Osborn has figured the upper jaw of a *Primate*[18] (possibly *Indrodon*) from the Puerco beds, possessing quadritubercular upper molars, with traces of an oblique ridge—an observation which greatly fortifies Cope's position. His case of reversion, if admitted, would then lead a stage further back to

[17] It is to be observed that Topinard's refutation (*l. c.*, p. 707) of Cope's hypothesis is based upon a misunderstanding of its real terms.

[18] *Bull. Am. Mus. of Nat. Hist.*, 1895, p. 19, fig. 4.

the primitive three-cusped molar, which was in all certainty that typical of the earliest lemuroids.

The better agreement of this hypothesis with the successional relations shown by palæontology, must be emphasized, for as far as can now be determined, apes of anthropoid character, such as *Pliopithecus* and *Dryopithecus*, were already differentiated in the middle Miocene, at which time, or even later, monkeys appear to have been represented only by such intermediate forms as *Mesopithecus*. No existing genus of catarrhine monkeys is known from earlier deposits than *Papio* and *Macacus* from the Sivalik beds of lower Pliocene age, in which deposits other remains have been found which there is reason to regard as referable to *Anthropopithecus* and *Simia*. The fact that before monkeys as now known, began to exist, man-like apes were far advanced in development, and that the earliest evidence of existing genera of apes is coeval with that of existing genera of catarrhines, tells enormously in favor of the early and independent origin of anthropomorpha.

The objections to this view which arise from the closer correspondence of anthropomorpha with monkeys, rather than with lemurs, in many soft parts of the organism, are not to be overlooked; but the remarkable differences in placentation and in the anatomy of the sexual organs disclosed by closely related genera, and even species, in other groups; the smooth brains of marmosets among monkeys, and the readily adaptable character of muscular dispositions, and all structures relating to locomotion, renders these characters of more or less uncertain value in classification.

It is no part of the present purpose to inquire closely into the corresponding stages in the pedigree of the remaining *Primates*, to do which, indeed, we are yet too ignorant of many essential details, but this much may be said: the *Nycticebidæ*, which suggest so many human and simian traits, are far from being typical lemurs, with which in general structure the monkeys show much agreement; but catarrhines and platyrrhines are wide enough apart in many ways, and the period during which they have been thus separated is so immeasurable, as to suggest the greater probability that their chief characteristics were already differentiated in their respective Tertiary forerunners. The remarkable fact that some platyrrhine genera, as *Ateles*, present traces of nearly all the modifications which have been noted as characteristic of anthropomorpha and the *Nycticebidæ*, perhaps supports this view, but at the same time well illustrates the complexity of the problem.

If the progress of palæontology should justify these speculations, it seems to follow that it is likely to also demonstrate the multiple rather than the single origin of the present *Lemuroidea*.

THE DEVELOPMENT AND COMPARATIVE STRUCTURE OF THE GIZZARD IN THE ODONATA ZYGOPTERA.

BY HELEN T. HIGGINS.

The following study[1] was undertaken on the advice and under the direction of Dr. Philip P. Calvert, instructor in Zoölogy in the University of Pennsylvania.

Dr. Ris' work on the gizzard of the *Odonata* and Dr. Calvert's study of Californian forms strongly suggested the phylogenetic importance of this organ.

The present study has been limited to the more primitive *Odonata*—the suborder *Zygoptera.*

I am indebted to Dr. Calvert for the material placed at my disposal, for many of my preparations, including his slides used in his paper of 1899 mentioned later, for the determination of genus and species in every case, and for the suggestion of the structural formula used in describing the gizzards.

In 1896, Dr. F. Ris published[2] a paper entitled *Untersuchungen über die Gestalt des Kaumagens bei den Libellen und ihren Larven.*

The results of his investigations are briefly outlined here:

In the *Odonata* the fore-gut extends to the third abdominal segment. In larva and imago alike the gizzard is found at the posterior end of the fore-gut in the second abdominal segment. It is formed by a thickening of the muscle layer, and by a modification of the chitinous coat of the fore-gut to form folds armed with teeth. The number of these folds is four, eight or sixteen. The metamorphosis to the imago shows a regular reduction in the strength and complication of the elements, but their number varies greatly. At the metamorphosis, the larval lining is shed with the chitinous coat of the exterior of the body; Dr. Ris states that he found in a *Libellula*, directly after metamorphosis, the old gizzard lining enclosed within the new. He examined the larval and adult

[1] Accepted by the University of Pennsylvania as a thesis for the degree of Bachelor of Science in Biology, June, 1900.

[2] *Zoolog. Jahrbüch.*, IX.

form of *Calopteryx virgo*, *C. splendens*, *Pyrrhosoma minium*, *P. tenellum*, *Agrion puella* and *pulchellum*, *Erythromma* (*najas*), *Enallagma* (*cyathigerum*), *Ischnura* (*elegans*) and *Platycnemis pennipes*, *Lestes virens*, *Gomphus*, *Æschna*, *Anax*, *Cordulegaster annulatus* and *bidentatus*, *Cordulia ænea*, *Diplax*, *Libellula*, *Orthetrum*.

The conclusions drawn by Dr. Ris from his investigations are as follows:

Larvæ.—The original form of the gizzard shows a division into sixteen longitudinal folds, eight broad and eight narrow, which bear an armature of irregularly placed teeth. This type is found in the *Calopteryginæ*.

A higher development of the organ appears in the typical group of the *Agrioninæ*; the sixteen folds show a greater number of teeth and a more complicated arrangement of these.

The legion *Lestes* shows a reduction of the sixteen folds to eight, apparently through the loss of the smaller folds. These eight folds are again divided into four broad and four narrower folds. In the *Anisoptera* (*Gomphus* and *Æschna*) there is reduction to four equal, similar folds. Finally, *Cordulegaster* and the *Libellulidæ* differentiate the folds into two pairs of teeth, so that the original radial symmetry is changed to bilateral.

Imagos.—The series easily traced in the larval forms is somewhat confused in the imagos, owing to the reduction which invariably occurs. The least reduction from larva to adult is found in the *Calopteryginæ*; more is shown in the *Agrioninæ*, where is seen the tendency to eliminate the smalier fold in certain individuals; the strongest reduction occurs in *Gomphus* and *Æschna*; in *Cordulegaster* and in the *Libellulidæ* scarcely more than a hint of the relation to the larva remains.

This purely morphological development from the radial symmetry of numerous elements of an organ to the bilateral symmetry of a few elements runs parallel with the phylogenetic relationships of the single groups.

In a paper on the *Odonata* from Tepic, Mex.,[3] 1899, Dr. Calvert gives notes on the gizzards of the forms studied by him. Contrary to Dr. Ris and other previous writers, he finds the position of the junction of fore- and mid-gut, and therefore of the

[3] *Proc. Cal. Acad. of Sciences* (Third Series, Vol. I, No. 12, 1899).

gizzard, to be very variable. He examined the gizzards of *Hetærina americana*, *Archilestes grandis*, *Lestes tenuatus*, *Argia pulla* and *agrioides*, *Erythagrion salvum*, *Ischnura Ramburii* var. *credula*, *Anax junius*, *Herpetogomphus elaps*, *Pantala hymenæa*, *Pseudoleon superbus*, *Tramea onusta*, *Dythemis sterilis*, *Micrathyria Hageni*, *Orthemis ferruginea* and *Diplax corrupta*.

Dr. Ris and Dr. Calvert agree generally on the morphology of the forms studied by both. They differ, however, in the phylogenetic position of the legion *Lestes*.

Dr. Calvert does not draw any phylogenetic conclusions from his studies, considering the examination of many more forms necessary before this can safely be done.

Preparation of Present Material.—The present study has been based upon representatives of the sub-families *Calopteryginæ* and *Agrioninæ* collected from every continent.

The preparations have largely been made from dried[4] specimens. From these the abdomens were cut off at the base of the third segment and soaked in seventy per cent. alcohol until softened. Some of these, even after long soaking, were so brittle that only fragments of the gizzard could be mounted. In cases where, because of its fragmentary condition, the structure of the gizzard is at all doubtful, I have put an interrogation point after the descriptive formula. The remainder of the material studied had been preserved in alcohol or formaline.

To obtain and prepare the chitinous lining of the gizzard for study, the abdomen was slit open along one of the membranous pleura, the gizzard located, and separated from the rest of the alimentary canal by a fine pair of scissors. The gizzard was cut open, the muscular coat removed with needles, and the chitinous lining spread out flat upon a slide. After cleaning, this was mounted in Canada balsam, making a very distinct preparation for study. In nearly every case the dried specimens from which the gizzards have been removed have been again put together, so that their value as ordinary museum material has been little, if at all, impaired.

The larvæ studied belong mainly to the sub-family *Agrioninæ*. They were collected from the vicinity of Philadelphia and were either fresh or preserved in alcohol.

[4] See the report of the meeting of the Academy of Natural Sciences of Philadelphia of January 17, 1899, in *Science*, Vol. IX, p. 183.

Development of the Gizzard.

The gizzard is a specially thickened and cuticularized portion of the alimentary canal, appearing at the junction of fore- and mid-gut, and projecting slightly into the latter. Externally is a coat of circular muscle fibres, thicker in the larvæ than in the adult and varying in thickness in adults of different genera. Within is a layer of epithelial cells, at first one cell in thickness, but later becoming many cells thick in definite areas, to form folds projecting into the lumen of the canal.

In the forms examined, four folds or some multiple of four to as many as thirty-two have been found—sixteen and eight being the numbers most commonly occurring.

From the epithelial cells is developed the inner chitinous coat of the gizzard, which is thin on the spaces between folds, becoming thickened on the folds and forming here horny teeth of various sizes.

The writer has examined Agrionine larvæ from the time of hatching to the period immediately preceding metamorphosis.

In larvæ just hatched no evidence of any gizzard-armature was found.

The following statements refer to larvæ of *Ischnura verticalis* Say:

In larvæ 3 and 4 mm. in length[5] the gizzard is quite clearly marked (fig. 25). The chitinous coat shows sixteen folds or fields, eight larger alternating with eight smaller. Each larger field is armed with teeth arranged in two groups, an anterior and a posterior, the latter occupying about the centre of the gizzard. The posterior group consists of two large pointed teeth, each enclosed on its outer side by four to five small teeth. The anterior group comprises two pointed narrow teeth intermediate in size between the two sets mentioned above.

Each smaller field has one group of three to four small teeth, which are at the same level as that of the posterior group of the larger fields.

A larva 6 mm. long shows practically the same armature, but on the smaller fields also there are often two groups, the anterior comprising one to two teeth, the posterior three to four.

[5] In all of these larvæ, by length I mean the distance measured from the external anterior part of the head to the posterior limit of the last abdominal segment, the gills being excluded.

A larva 8 mm. long shows considerable difference in the size and number of the teeth (Pl. IV, fig. 26). The anterior groups of both fields show an increase in the number of teeth, which remain approximately the same in size. In the posterior groups the smaller teeth show decrease in size with increase in number; the two large teeth of the larger fold remaining the same in size.

A larva of 10 mm. length shows much the same structure.

Three larvæ of 15 mm. length show the same line of development carried a little further (fig. 27), an increase in number of the teeth of the anterior groups of both folds, slight increase in number with continued decrease in size of the small teeth of the posterior groups of both folds.

In all larvæ studied the gizzard was found in the second abdominal segment.

Young imagos of *Ischnura verticalis* were examined soon after metamorphosis. In those dissected directly after the spreading of the wings only the larval gizzard was observed. This lay in the sixth segment. In an adult in which the coloring was distinctly developed, the larval gizzard lining lay immediately within that of the adult, which latter bore a very different armature (Pl. III, fig. 17). In still other individuals the adult gizzard was in the sixth segment, while the lining of the larval gizzard and of the fore-gut of the larva, coiled up in a mass, lay in the lumen of the canal in the seventh segment. These observations suggest the possibility of learning something of the structure of the gizzard of the larvæ of *exotic* species by inspecting the contents of the alimentary canal of imagos whose colors show them to have but recently transformed.

To sum up the development of the gizzard lining in *Ischnura verticalis*, it is seen that from its earliest appearance (which in the present study was found in a larva 3 mm. long) there is a steady increase in the number of teeth on all folds with a decrease in size in those of posterior groups. At metamorphosis the gizzard moves backward from the second to the sixth abdominal segment. A new chitinous coat is formed on the fore-gut, with a new gizzard armature. The larval lining lying within the adult lining becomes loosened from it and finally separates entirely, and is found, within a few hours after metamorphosis, lying coiled up within the canal. It is probable that in still older imagos the cast-off larval gizzard lining lies still further posterior in the canal, and is finally voided through the anus.

The Gizzard of Various Adults.

The position of the gizzard in the imago was found to vary from the third abdominal segment to the seventh. In the majority of forms examined the gizzard lies in the centre or posterior extremity of the sixth segment; in a small number it lies in the fifth, in a still smaller in the seventh, and in a very few in the third or fourth segment.

Variations in the position are frequently found in different species of the same genus and even in different individuals of the same species.

A male of *Calopteryx apicalis* had the gizzard in the anterior end of the sixth segment, a female in the centre of the fifth; while in a male of *C. cornelia* it was located in the fifth segment.

In a male of *Phaon iridipennis* the gizzard was found in the posterior end of the sixth segment; in a male of *P. fuliginosus* in the third, and in a female of the same species in the sixth segment.

In four species of *Vestalis* the position varied only from the posterior end of the fifth to the middle of the sixth segment. The same variation was seen in five species of *Hetærina*, and likewise in four species of *Euphæa*.

In the ♀ of *Libellago caligata* the gizzard was found in the third segment, in the ♂ in the fifth, and in *L. curta*, ♂, in the fourth segment. In four individuals—two species—of *Micromerus* it was found in the fifth; in *Thore boliviana*, ♂, in the centre of the fifth, in ♀ in anterior end of seventh; in *Euthore hyalina*, ♂, in the anterior end of sixth, in ♀ in posterior end of fifth.

Of the *Agrioninæ*, legion *Pseudostigma*, its position varied in eight individuals, of five genera, from the middle of the sixth to the anterior extremity of the seventh segment; in the Legion *Podagrion*, in five males and one female of *Paraphlebia* sp. (group of *Zoe*), the position varied only from the anterior end to the centre of the sixth segment; in five species of the genus *Heteragrion*, from the posterior end of the fifth to the anterior of the seventh; in the legion *Platycnemis*, in four genera, the organ was found in the sixth or seventh segment; in the legion *Protoneura*

—in three species of *Disparoneura*, in three of *Neoneura* and in three of *Protoneura*—the same variation is seen, from the posterior end of the sixth to the anterior of the seventh; of the Legion *Agrion* it appears in the sixth segment in *Hyponeura lugens*, *Ischnura heterosticta*, *Enallagma ebrium*, *geminatum* and *aspersum*, in *Nehalennia lais*, *Ceriagrion glabrum*, *Anisagrion allopterum* and *Hemiphlebia mirabilis;* in the fifth in *Argia putrida*, *Pyrrhosoma tenellum;* in the seventh in *Leptagrion macrurum* and *Leptobasis vacillans;* of the legion *Lestes* it appears in the sixth segment in *Lestes disjuncta* and *L. leda*.

Armature of the Adult Gizzard.

To save the necessity of giving lengthy descriptions of the armature of each gizzard studied, and more especially to render the comparison of these armatures more easy, it was found convenient to construct a formula whereby the general structure of the armature might be indicated.

Below is given an explanation of the formulæ used:

F, F, f, indicate specially chitinized areas of the gizzard lining, whether they bear teeth or not. They may stand as abbreviations of "field" ("Felder" of Ris) or "fold." When the fields are approximately alike only one size letter may be used—F; when unlike, F will denote the largest sized areas, F medium sized, f small sized When the areas are of but two sizes F and f may be used.

Arabic figures following F, F, f, denote the number of teeth borne by each field respectively; when the number is great (40 or more) *n* is used to denote this fact. When in one and the same gizzard the teeth are of different sizes this is indicated by use of the marks ′, ″, ‴; ′ denotes the largest sized teeth, ″ medium sized, ‴ smallest sized.

Wherever a gizzard consists of a repetition of similar fields, the formula may be shortened by enclosing the repeated arrangement within parentheses, and placing the proper coëfficient before the parenthesis to indicate the number of times the repetition occurs.

When the same field contains two groups of teeth separated by a distinct interval, these two groups are indicated in the formula by placing one above the other with a horizontal line between them, as in common fractions, the anterior group of teeth being represented by the numerator, the posterior group of teeth by the denominator.

The abbreviation *rec.* is used to indicate recurved teeth, as in *Paraphlebia.*

To illustrate the application of the formula, I may refer to fig. 13, Pl. III, of *Argia bipunctulata.* In this species there are sixteen folds, eight larger and eight smaller. The formula would be therefore: 8 (F 12–14, f 1–3), where F represents the larger fields, with teeth varying in number from twelve to fourteen; f, the smaller folds with teeth varying from one to three.

The teeth here are all of approximately the same size.

For *Xanthagrion erythroneurum* (fig. 15), where the teeth have a definite arrangement into groups, we must use a more complicated formula. Here there are sixteen fields, each field showing two distinct groups of teeth. The anterior groups are represented by the numerators of the fractions, the posterior by the denominators. The difference in size of the teeth is indicated by the marks ′ and ″, the former representing the larger teeth, the latter the smaller ones.

The formula therefore is $8\ (F\ \frac{6''\text{-}8''}{2' + 10''\text{-}12''},\ f\ \frac{1''\text{-}3''}{5''})$.

The omission of one or more folds from an individual gizzard is not uncommon (see fig. 12), so that often it is only possible to construct a formula when several specimens of a given species are examined and compared.

The following list of the species of adults whose gizzard-armatures have been studied gives the number of each sex examined, the abdominal segment in which the gizzard was found (and often whether in the anterior or posterior part of the segment), the locality whence the material came and the armature formula:

Sub-family CALOPTERYGINÆ.

Legion 1.—**Calopteryx** Selys.

Calopteryx maculata Beauv. 2 ♂. Pennsylvania. 4 (F 6–8, f 2–4, F 4–5, f 2–4).

Calopteryx apicalis Burm. ♂. 6th segment, ant. Tom's River, N. J. 4 (F 6–8, f 2–4, F 5–7, f 2–4).

Calopteryx apicalis Burm. ♀. 5th segment, ant. Tom's River, N. J. 4 (F 6–8, f 2–4, F 5–7, f 2–4).

Calopteryx cornelia Selys. 2 ♂. 5th segment, post. Japan. 4 (F 12–13, f 6–7, F 11–12, f 6–7).

Sapho orichalcea McLach. 1 ♀. 4–5th segments. Kamerun, W. Africa. 4 (F 5–7, f 5–6, F 6–7, f 5–6).

Sapho ciliata Fabr. 1 ♂. 5th segment, post. Bismarckburg, W. Africa. 8 (F 8–9, f 3–6).

Umma (Cleis) longistigma Selys. 1 ♂. Kamerun, W. Africa. 8 (F 20–25, f 3–5).

Mnais strigata Selys. 1 ♀. 4th segment. Japan. 4 (F 8–10, f 7–9, F 8–9, f 7–9).

Phaon fuliginosus Selys. 1 ♀. 6th segment. Madagascar. 4 (F 4–8, f 3–4, F 4–5, f 3–4).

Phaon fuliginosus Selys. 1 ♂. 3d segment. Madagascar. 4 (F 4–8, f 3–4, F 4–5, f 3–4).

Phaon iridipennis Burm. 1 ♂. 6th segment, post. Be Kilus. 4 (F 4–6, f 2–3, F 5–6, f 2–3).

Vestalis luctuosa Burm. 1 ♂. 6th segment, ant. Java. 4 (F 25–30, f 20–25).

Vestalis luctuosa Burm. 1 ♀. 5th segment, post. Java. 4 (F 25–30, f 20–25).

Vestalis gracilis Ramb. 1 ♂ and 1 ♀. 6th segment. Palone, Burma. 4 (F 20–25, f 15).

Vestalis amœna Selys. ♂ and ♀. 6th segment. Deli, Sumatra. 4 (F 15–20, f 10–12).

Vestalis apicalis Selys. ♀. 6th segment, ant. Nilgiris. 4 (F 10–15, f 8–10).

Hetærina occisa Selys. ♂ and ♀. 6th segment. Mexico. 8 (F n).

Hetærina titia Drury. ♂ and ♀. 6th segment. Texas. 4 (F n, f n).

Hetærina cruentata Ramb. ♂. 6th segment. Mexico. 8 (F n).

Hetærina vulnerata Selys. ♀. Dublan, Mex. 4 (F n, f n, F n, f n).

Hetærina vulnerata Selys. ♂. 5th segment. Dublan, Mex. 8 (F n, f n).

Hetærina americana Fabr. 4–6th segments. Tepic, Mex. 4 (F n).

Hetærina americana. ♂. 6th segment. Pennsylvania. 4 (F n″ + 4′–6′, f n″ + 3′–6′).

Hetærina americana. Larval-gizzard from preceding ♂. 4 (F n″ + 8′–12′, f n″ + 5′–6′).

Legion 2.—**Euphæa** Selys.

Euphœa impar Selys. 1 ♂. 5th segment, post. Borneo. 8 (F n, f 0-n, F n, f 0-n). The fields, f, which are very short, vary greatly in the number of teeth; these in some cases being numerous, in others 2–4, in others seeming to be absent altogether.

Euphœa lara Krüger. 1 ♂. 6th segment, post. Borneo. 8 (F n, f 0-n, F n, f 0-n).

Euphœa variegata Ramb. ♂. Java. 8 (F n, f n, F n, f n).

Euphœa ochracea Selys. ♂. Sixth segment, post. Burma. 8 (F n, f n, F n, f n).

Epallage fatime Charp. ♀. 4th segment. Taurus, Asia Minor. 8 (F n, f n).

Legion 3.—**Amphipteryx** Selys.

Amphipteryx agrioides Selys. 2 ♂. 6th segment. Guatemala. 8 (F 8–10, f 4–5).

Legion 4.—**Libellago** Selys.

Libellago curta Selys. ♂. 4th segment. Abyssinia. 4 (F 10–14, f 6–8, F 10–12, f 6–8).

Libellago caligata Selys. ♂. 5th segment. Abyssinia. 4 (F 12–15, f 5–9, F 12–16, f 6–9).

Libellago caligata Selys. ♀. 3d segment. Abyssinia. 4 (F 12–15, f 5–9, F 12–16, f 6–9).

Rhinocypha biseriata Selys. ♀ and ♂. 4th segment. Borneo. 4 (F 6–9, f 3–5, F 6–8, f 3–5).

Rhinocypha Pagenstecheri Först. ♂. Sumbawa. 4 (F 8–10, f 5, F 7–10, f 5).

Micromerus lineatus Burm. 3 ♂. 5th segment. Java, Ceylon. 4 (F 10–13, f 3–5, F 9–10, f 3–5).

Micromerus obscurus Kirby. ♂. 5th segment. Ceylon. 4 (F 10, f 4–6, F 6–8, f 4–6).

Legion 5.—**Thore** Selys.

Thore boliviana McLach. ♂. 5th segment. Chulumani, Bolivia. 4 (F n, f n)?

Thore boliviana McLach. ♀. 7th segment, ant. Chulumani, Bolivia. 4 (F n, f n)?

Euthore hyalina Selys. ♀. 5th segment, post. Road to Coroico, Bolivia. 4 (F n, f n)?

Cora marina Selys. 2 ♂. 5th segment, post. Vera Cruz. 4 (F n, f n)?

Cora inca Selys. ♀. 6th segment. Chulumani. 4 (F n, f n)? These became so much broken in dissection and mounting that the formula cannot be stated positively. Some seem to show twelve bands.

Sub-family **AGRIONINÆ.**

Legion 1.—**Pseudostigma** Selys.

Megaloprepus cœrulatus Drury. 2 ♂. 6th segment. 8 (F 30–35, f 20–25).

Microstigma rotundatum Selys. 1 ♂. 7th segment, ant. Bolivia. 4 (F 35–40, f 10–16, F 30–35, f 10–16).

Microstigma anomalum Ramb. ♂. 6th segment. Apehu, Brazil. 4 (F 18–20, f 6–8, F 10–12, f 6–8).

Anomisma abnorme McLach. 6th segment. Rio Bobonaza, Ecuador. 8 (F 18–20, f 8–10)?

Mecistogaster modestus Selys. ♀. Bugaba. 8 (F n, f n).

Mecistogaster ornatus Ramb. ♂. 7th segment. Tepic, Mex. 8 (F n, f n).

Pseudostigma aberrans Selys. ♂. 5th segment. Atoyac, Mexico. 8 (F n, f n)?

Legion 2.—**Podagrion** Selys.

Paraphlebia sp. (group of *Zoe*). 5 ♂, 1 ♀. 6th segment. Guatemala. 8 (F 2′ + 11″–13″ + 4″–5″ rec., f 3″–4″).

Paraphlebia sp. (group of *Zoe*) var. ♂. Misantla, Mexico. 8 (F 2′ + 8″–9″ + 2″ rec.).

Philogenia Berenice Hag. ♂. 6th segment. Equitos, Peru. 8 (F n, f n).

Philogenia cassandra Hag. ♂. 6th segment. Chiriqui. 8 (F n, f n). Teeth much smaller than in *Berenice*.

Megapodagrion venale Selys. ♂. 6th segment. Probably Porto Cabello, Venezuela. 8 (F 3–7, f 1–2).

Heteragrion erythrogastrum Selys. ♂. 7th segment. Bugaba. 4 (F n, f n).

Heteragrion chrysops Hag. ♂. 6th segment, post. Guatemala. 4 (F n, f 5–8, F 30–35, f 5–8).

Heteragrion chrysops Hag. ♂. 7th segment, ant. Guatemala. 4 (F n, f 5–8, F 30–35, f 5–8).

Heteragrion inca Hag. 2 ♂. 5–6th segment, 7th segment, ant. 4 (F n, f 20–25, F n, f 20–25).

Heteragrion n. sp. (group of *Chrysops*). ♂. Atoyac, Mexico. 8 (F n, f 5–35).

Legion 3.—**Platycnemis** Selys.

Tatocnemis malagassica Kirby. ♀. 7th segment. Madagascar. 8 (F $\frac{n'}{n''\ \text{rec.}}$, f $\frac{20'–30'}{0}$).

Leptocnemis bilineata Selys. ♂. Seychelle Islands. 8 (F n, f 15–20).

Leptocnemis bilineata Selys. ♀. Seychelle Islands. 4 (F n, f 12–19, F n, f 12–19).

Cœliccia octogesima Selys. ♂ and ♀. 7th segment, ant. Borneo. 4 (F 6–12, f 2–4, F 5–8, f 2–4).

Copera atomaria Selys. ♂. 6th segment, post. Borneo. 4 (F 5′–7′ + n‴ rec., f 1″–2″, F 4″, f 1″–2″).

Legion 4.—**Protoneura** Selys.

Disparoneura analis Selys. ♂. 6th segment, post. Borneo. 4 (F 3′ + n″, f 3′ + n″).

Disparoneura collaris Selys. ♂ and ♀. 6th segment, post. Borneo. 4 (F n, f n).

Disparoneura sp. (near *delia*). ♂. Borneo. 4 (F n, f n)?

Caconeura dorsalis. ♂ and ♀. 7th segment, ant. Borneo. 4 (F n, f n).

Neoneura n. sp. (group of *carnatica*). ♂. 7th segment, ant. Guatemala. 4 (F 2′ + 2″–4″, f 1′, F 2′ + 1″–2″, f 1′).

Neoneura n. sp. (group of *rubriventris*). ♂. 7th segment, ant. Equitos, Peru. 8 (F 2′ + 20″–30″, f 1′–2′ + 10″–20″).

Protoneura n. sp. (group of *humeralis*). ♂. 6th segment, post. Guatemala. 8 (F 2′ + n″, f 1′ + n″).

Protoneura aurantiaca Selys. ♂. 7th segment, ant. Tabasco, Mex. 8 (F 1′–2′ + n″, f 1′ + n″).

Protoneura n. sp. (group of *sancta*). 2 ♂ and 2 ♀. 7th segment, ant. Tabasco, Mex. { 8 (F 2′ + n″, f 1″ + n″). 8 (F 2′ + n″, f n″).

Legion 5.—**Agrion** Selys.

Hyponeura lugens Hag. ♂. 6th segment. Guatemala. 8 (F 17–25, f 4–7).

Hyponeura lugens Hag. ♂. 5th segment, post. Guatemala. 8 (F 17–25, f 4–7).

Argia putrida Hag. ♂. 5th segment. 8 (F 14–21, f 2–10).

Argia bipunctulata Hag. New Jersey. 8 (F 12–14, f 1–3).

Argia agrioides Calv. ♂ and ♀. San Jose del Cabo, Baja Cal. 4(F $\frac{10'\ 14'}{10''\text{–}14''\ \text{rec.}}$, f 2′–5′, F 11′–15′, f 2′–5′).

Argia pulla Selys. ♂. Tepic, Mex. 8 (F 7–9, f 2–3).

Ischnura heterosticta Burm. ♂. 6th segment. Victoria, Australia. 8 (F 13–15).

Ischnura Ramburii Selys var. *credula*. ♀. San Jose del Cabo. 8 (F 10–15).

Anomalagrion hastatum Say. ♂. Pennsylvania. 8 (F 9–10).

Enallagma ebrium Hag. ♀. 6th segment. New York. ? 8 (F 16′–18′ + 6″–12″, f 0–3′ + n″).

Enallagma geminatum Kell. ♀. 6th segment. New York. 4 (F 15′–18′, f n″, F 14′–16′, f n″).

Enallagma aspersum Hag. ♂. 6th segment. New York 8 (F 20′–22′, f n″).

Nehalennia lais Brauer. ♂. 6th segment. Morelos, Mex. 4 (F 25–30, f 18–20).

Pyrrhosoma tenellum Vill. ♂. 5th segment. Le Blnc, France. 8 (F 25–30, f 8–12).

Pyrrhosoma minium Harr. ♂. Le Blanc, France. 8 F 2′ + n″).

Xanthagrion erythroneurum Selys. ♂. Victoria, Autralia. 8 (F $_{2'\ +\ 10''\text{–}13''}^{6''\text{–}9''}$, f $^{1''\text{–}3''}_{5''}$).[6]

Ceriagrion glabrum Burm. 3 ♂. 6th segment, post. Madagascar. 8 (F 2′ + 18″–20″, f 5″–10″).

Anisagrion allopterum Selys. ♂. 6th segment. Csta Rica. 8 (F 10–12, f 1–2).

Erythagrion salvum Hag. ♂. San Jose del Cabo Baja Cal. 8 (F 2′ + 4″–6″, f 1″).

Erythagrion salvum Hag. ♂. San Jose del Cab Baja Cal. 8 (F 7–9, f 1–2).

[6] It is quite likely that this is a larval gizzard; compare ith figs. 25–27.

Leptagrion macrurum Burm. ♂. 7th segment, ant. Brazil. 8 (F 6′–8′ + n″, f 10″–20″ + 2′–3′).

Leptobasis vacillans Selys. 2 ♂. 7th segment, ant. Tabasco, Mex. 4 (F 13–15, f 10–12).

Agriocnemis femina Brauer. ♂. 6th segment. Borneo. 4 (F 10–15, f 8–10)?

Hemiphlebia mirabilis Selys. ♀. Victoria. 4 (F 2′–4′ + n″, f n″, F n″, f n″).

Legion 6.—**Lestes** Selys.

Archilestes grandis Ramb. ♂. San Jose del Cabo, Baja Cal. 8 (F n).

Lestes disjunctus Selys. 6th segment, New York. 8 (F n).

Lestes vigilax Selys. ♂. New York. 4 (F n, f n).

Lestes leda Selys. ♂. 6th segment. Victoria. 4 (F n, f n).

Lestes tenuatus Ramb. ♀. Tepic, Mex. 8 (F n)?

Intra-generic Variations.

By an examination of the structural formulæ given above it will be seen that a classification into genera based on resemblances in gizzard structure would agree in most cases with that now in use based upon the structure of wings and other external features of the body. If, for instance, we examine the structural formulæ for *Sapho orichalcea* and *S. ciliata*, we find very little difference between the two species. In both we see sixteen fields, which in the former are of three sizes, and in the latter of two. But the number and size of the teeth are approximately equal.

Where a number of species of one genus have been studied, these all, as a rule, show the same number of folds. Exceptions are seen in the genera *Hetærina* and *Heteragrion*. Of five species of *Hetærina* examined, four show eight folds of the gizzard lining, and one, *americana*, four folds, although another specimen of the same species (Pl. II, figs. 2 and 3) shows eight folds in both larval and adult gizzard linings; of four species of *Heteragrion* three have sixteen folds; one, eight.

Even when they vary in the number of folds, species of the same genus are seen to agree almost invariably in the size and number of teeth on each fold, as well as in the arrangement of these.

A marked exception to this was found in the genus *Heteragrion.* Of four species of this genus, three had sixteen folds, varying in size, the largest folds bearing numerous teeth (above forty), the smaller ones bearing from five to thirty, while the fourth species had but eight folds, each fold bearing numerous teeth.

Again, of four species of *Argia*, three are similar, bearing eight "F" folds and eight "f" folds, the teeth on all folds being of equal size. But in the fourth species, *A. agrioides*, there are four "F" folds, eight "f" folds, and four "F" folds; on the two latter the teeth are equal in size, but on the four "F" folds they are arranged in two groups, those of the anterior group being similar to the teeth on the other folds, those of the posterior being much smaller and recurved.

Data for Phylogeny.

When the studies whose results are contained in the present paper were begun, it was hoped that they would yield data of value in determining the phylogeny of the insects investigated. The data are now at hand, but the desired interpretation is yet to be made. One may spin several different theories on the lines of descent of these *Odonata* if regard be had merely to the armature of the gizzard. But since these theories would rest on precisely the same evidence in each case, it is wise to refrain from such theorizing until these results can be correlated with others drawn from embryological and comparative anatomical data.

It is worth pointing out, however, as one present gain to our knowledge which will bear on the question of phylogenies, that the occurrence of numerous minute teeth only is a phenomenon of frequent repetition, since it is met with in the genus *Hetærina* of the legion *Calopteryx*, and in all species of the legions *Euphæa* and *Thore* of the *Calopteryginæ*, while in the *Agrioninæ* it is observed in *Mecistogaster* and *Pseudostigma* (legion *Pseudostigma*), *Philogenia* (legion *Podagrion*), some *Disparoneura* and *Caconeura* (legion *Protoneura*) and all of the legion *Lestes*.

The problem which this phenomenon suggests is to determine whether it represents a more primitive condition, originally common to all groups to which the genera named belong, or whether it represents independent, parallel and similar modifications in each group from some other and different form of gizzard-armature.

EXPLANATION OF PLATES II, III AND IV.

All the figures are camera lucida drawings, and represent portions of the gizzard linings, spread out flat. The fraction after each name indicates how much of each lining is shown. A line indicting a scale length of one-tenth millimeter is placed alongside most of the figures.

Plate II.

Fig. 1. *Calopteryx maculata.* ♂. $\frac{1}{4}$.
Fig. 2. *Hetærina americana.* ♂ from Pennsylvania. $\frac{1}{4}$.
Fig. 3. *Hetærina americana.* Larva. $\frac{1}{4}$.
Fig. 4. *Protoneura* sp., group of *sancta.* ♀. $\frac{1}{8}$.
Fig. 5. *Hetærina vulnerata.* ♀. $\frac{1}{4}$.
Fig. 6. *Vestalis luctuosa.* ♂. $\frac{1}{4}$.
Fig. 7. *Vestalis apicalis.* ♀. $\frac{1}{4}$.
Fig. 8. *Amphipteryx agrioides.* ♂. $\frac{1}{8}$.
Fig. 9. *Libellago caligata.* ♂. $\frac{1}{4}$.
Fig. 10. *Euphœa impar.* ♂. $\frac{1}{4}$.

Plate III.

Fig. 11. *Microstigma rotundatum.* ♂. $\frac{1}{4}$.
Fig. 12. *Enallagma ebrium.* ♀. $\frac{3}{16}$. The small fold f is not developed in the portion figured.
Fig. 13. *Argia bipunctulata.* $\frac{1}{8}$.
Fig. 14. *Megaloprepus cœrulatus.* ♂. $\frac{1}{8}$.
Fig. 15. *Xanthagrion erythroneurum.* $\frac{3}{16}$. Probably larval gizzard; compare figs. 25–27.
Fig. 16. *Megapodagrion venale.* ♂. $\frac{1}{8}$.
Fig. 17. *Ischnura verticalis.* $\frac{1}{4}$.
Fig. 18. *Heteragrion inca.* ♂. $\frac{1}{4}$.
Fig. 19. *Tatocnemis malagassica.* ♀. $\frac{1}{8}$.
Fig. 20. *Paraphlebia* sp. $\frac{1}{8}$.
Fig. 21. *Hemiphlebia mirabilis.* ♀. $\frac{1}{8}$.
Fig. 22. *Lestes vigilax.* ♂. $\frac{1}{4}$.
Fig. 23. *Mnais strigata.* ♀. $\frac{1}{4}$. On either side of the right-hand f fold is a row of 2–3 teeth, representing, probably, a series of still smaller folds.
Fig. 24. *Leptocnemis bilineata.* ♂. $\frac{1}{8}$.

Plate IV.

Fig. 25. *Ischnura verticalis.* Larva, length 4 mm. $\frac{15}{16}$.
Fig. 26. *Ischnura verticalis.* Larva, length 8 mm. $\frac{1}{2}$.
Fig. 27. *Ischnura verticalis.* Larva, length 15 mm. $\frac{1}{2}$.

February 5.

Mr. Arthur Erwin Brown, Vice-President, in the Chair.

Thirteen persons present.

A paper entitled "New Marine Mollusks," by Edward G. Vanatta, was presented for publication.

Relationships of the Genus Neobeliscus.—Dr. H. A. Pilsbry, referring to an account of the anatomy of this genus of South American land snails,[1] stated that in commenting upon the peculiarities of the reproductive organs he had overestimated their divergence from structures of African *Achatinidæ*, having overlooked a paper by Arruda Furtado,[2] in which the anatomy of *Atopocochlis exaratus* is described. This genus and species, the speaker continued, is confined to the island San Thome, in the Gulf of Guinea; and resembles *Neobeliscus* in having the retractor muscle of the penis inserted upon the right ocular band (instead of upon the diaphragm, as usual in land snails), and as in *Neobeliscus* the albumen gland is reduced to very small proportions. The separation of the male and female ducts clearly indicates that *Atopocochlis* is viviparous, like *Neobeliscus*, although no information is given by Furtado upon this point. The podocyst described in embryos of *Neobeliscus* is similar to that of *Achatina*. These facts indicate that the South American genus has its nearest existing allies in West African genera, and accordingly modify the general conclusions set forth in his former paper.

February 12.

Mr. Arthur Erwin Brown, Vice-President, in the Chair.

Nine persons present.

A paper entitled "New Species of Mollusks from South Africa and Burma," by Henry A. Pilsbry, was presented for publication.

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[1] These *Proceedings* for 1899, p. 366, Pl. XV.

[2] *Journal de Conchyliologie*, XXXVI, p. 5, Pl. II.

FEBRUARY 19.

Mr. ARTHUR ERWIN BROWN, Vice-President, in the Chair.

Fifteen persons present.

FEBRUARY 26.

Mr. ARTHUR ERWIN BROWN, Vice-President, in the Chair.

Twenty-eight persons present.

Papers under the following titles were presented for publication:

"Descriptions of New Bees collected by Mr. H. H. Smith in Brazil, II," by T. D. A. Cockerell.

"Note on the Odontostomidæ," by Henry W. Fowler.

"The Development of the Tympano-Eustachian Passage and Associated Structures in the Common Toad, Bufo lentiginosus," by Henry Fox.

"Farther Studies on the Chromosomes of the Hemiptera heteroptera," by Thomas H. Montgomery.

Mr. C. Hartman Kuhn was elected a member.

The following were ordered to be printed:

CRUSTACEA AND PYCNOGONIDA COLLECTED DURING THE PRINCETON EXPEDITION TO NORTH GREENLAND.

BY DR. A. E. ORTMANN.

A preliminary but not quite complete list of the species collected during the Princeton Expedition to North Greenland (Peary Auxiliary Expedition, 1899) has been published in *The Princeton Bulletin*, Vol. 11, No. 3, February, 1900, pp. 38–40; in the same periodical, Vol. 11, No. 2, December, 1899, pp. 25–26, a list of stations has been given. It seems hardly necessary to repeat this list here, since under each species not only the number of the station, but also the location of the latter and the depth is given.

Most of the localities are situated on the coast of North Greenland, between Cape York and Foulke Fjords (ca. 76–79° N. L.); a few are situated on the opposite side of Smith Sound (Ellesmere Land, Payer Harbor); the rest is farther south, on the coast of West Greenland (Upernavik, Waigat Channel, and Godhavn, Disco Island), and the coast of Labrador (Domino Run and Battle Harbor).

Only a few expeditions have previously collected material in these parts (North water of Baffin Bay, Smith Sound and Grinnell Land). The following reports on Crustacea have been published:

Hayes' Expedition, 1860–61 (see J. J. Hayes, *The Open Polar Sea*, 1867), published by W. Stimpson: "Synopsis of the Marine Invertebrates collected by the Late Arctic Expedition under Dr. J. J. Hayes."[1]

Nares' Expedition, 1875–76, published by E. J. Miers, in G. S. Nares, *Narrative of a Voyage to the Polar Sea*, Vol. 2, 1878, Appendix 7.

Expedition of the Academy of Natural Sciences of Philadelphia, connected with the *Peary Expedition of 1891*, published by J. E.

[1] *Proc. Acad. Nat. Sci. Phila.*, 1863.

Ives: "Echinoderms and Crustaceans collected by the West Greenland Expedition of 1891."[2]

Peary Auxiliary Expedition of 1894, published by A. Ohlin: *Bidrag till Kaennedomen om Malakostrakfaunan i Baffin Bay och Smith Sound*, Lund, 1895.

A number of species has been mentioned by Hansen from near Cape York in H. J. Hansen, "Malacostraca marina Groenlandiæ occidentalis."[3]

The collections described here have been made by Prof. William Libbey and the writer, by means of small hand dredges and a larger beam-trawl, surface and dip nets. Since the chief value of the material collected lies on the zoögeographical side, I shall take particular pains to give an account of the previously known facts of distribution in every species.

CRUSTACEA.

1. **Branchinecta paludosa** (Mueller).

Packard, 12th Ann. Rep. U. S. Geol. Surv. Terr. for 1878 part 1, 1883, p. 336, Pl. 9, 10, figs. 1-5.

Station 13. Payer Harbor. Ellesmere Land. Fresh-water ponds (several hundred).

Station 46. Northumberland Island. Fresh-water ponds (many hundred).

Distribution.—Finmark, Lapland, North Siberia (Taimyr), Point Barrow (Alaska), Cape Krusenstern (Arctic America), Labrador, Grinnell Land, North and West Greenland.

Grinnell Land: Discovery Bay (Miers); North Greenland: Polaris Bay (Packard).

2. **Lepidurus glacialis** (Kroeyer).

Packard, *l. c.*, p. 316, Pl. 16, fig. 1.

Station 46. Northumberland Island. Fresh-water ponds (46).

Distribution. —Lapland, Novaja Semlja, Spitzbergen, South and West Greenland, Cape Krusenstern, Point Barrow.

There are *Cladocera* (a fresh water *Daphnia*, possibly *rectispina* Kr., from Stations 13 and 46) and a number of marine *Ostracoda* and *Copepoda* in the collection which have not yet been identified.

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[2] *Proc. Acad. Nat. Sci. Phila.*, 1891.

[3] *Vidensk. Meddel. fra den naturh. Foren. i Kjoebenhavn*, 1887.

3. **Balanus porcatus** Costa.

Darwin, Monogr. Cirrip. Balan., 1854, p. 256, Pl. 6, fig. 4; Weltner, Arch. f. Naturg., 1897, p. 267; Weltner, Die Cirripedien der Arktis (Fauna Arctica, Vol. 1), 1900, p. 292.

Station 26. Cape Alexander, 27 fathoms (1).

Station 45. Barden Bay, 10–40 fathoms (8).

Station 51. Robertson Bay, 35–40 fathoms (6).

Distribution.—England, Denmark, Norway, Iceland, Maine, Massachusetts, Novaja Semlja, Spitzbergen, Bear Island, East and West Greenland, Grinnell Land, Lancaster Sound, Japan, New Zealand and Campbell Island. Depth: to ca. 200 fathoms.

Grinnell Land: Cape Napoleon, Franklin Pierce Bay, Richardson Bay and Discovery Bay.[4]

4. **Balanus crenatus** Bruguière.

Darwin, *l. c.*, p. 261, Pl. 6, fig. 6; Weltner, *l. c.*, 1897, p. 268; Weltner, *l. c.*, 1900, p. 298.

Station 57. Sarkak (Waigat), 9 fathoms (1).

Distribution.—Mediterranean, West Indies, Cape of Good Hope, England, Scandinavia, New England coast, Spitzbergen, Kara Sea, West Greenland, Labrador, Baffin Bay, Lancaster Sound, Grinnell Land, Bering Straits, North Japan. In deeper water.

Grinnell Land: Discovery Bay (Miers, *l. c.*, 1881).

5. **Balanus balanoides** (Linne).

Darwin, *l. c.*, p. 267, Pl. 7, fig. 2; Weltner, *l. c.*, 1897, p. 269; Weltner, *l. c.*, 1900, p. 302.

Station 3. Godhavn, Disco Island. Between tides (4, and several broken).

I have seen also on the rocks of the shores of Foulke Fjord remains of a *Balanus* (bases only) which may belong to this species.

Distribution.—Azores, Portugal, England, France, Norway, Atlantic coast of the United States, Novaja Semlja, White Sea, Bear Island, Iceland, West and North Greenland, Labrador. Within tidal limits.

North Greenland: Fort Foulke (Stimpson).

6. **Nebalia bipes** (O. Fabricius).

Kroeyer, Naturhist. Tidsskr. (2), Vol. 2, 1849, p. 436; Grube, in Arch. f. Naturg., 1853, p. 162; Buchholz, Zweite deutsche Nordpolfahrt, Vol. 2, 1874, p. 388.

Station 9. Saunders Island, 5–10 fathoms (1).

[4] Miers, *Journ. Linn. Soc. London*, 15, 1881, p. 73.

Distribution.—England, Labrador, East and West Greenland, North Greenland. Depth : to 150 fathoms.

North Greenland: Cape Dudley Digges (Ohlin).

7. **Hyperia galba** (Montague).

G. O. Sars, An Account of the Crustacea of Norway, Vol. 1, 1895, p. 7, Pl. 2, 3, fig. 1.

Station 29. Olriks Bay, 7–25 fathoms (1).

Distribution.—France, England, Sweden, Norway, Kara Sea, Murman coast, Spitzbergen, West Greenland, Point Barrow. Pelagic.

8. **Euthemisto libellula** (Mandt).

Sars, *l. c.*, 1895, p. 13, Pl. 6. fig. 1.

Station 6. Melville Bay, surface (4).

Station 29. Olriks Bay, 7–25 fathoms (1).

Station 41. Whale Sound, surface (2).

Station 42. Barden Bay, surface (7).

Distribution.—Finmark, Novaja Semlja, Spitzbergen, Jan Mayen, East, West and North Greenland, Ellesmere Land, Point Barrow. Pelagic.

North Greenland: Melville Bay (Ives), Inglefield Gulf (Ohlin); Ellesmere Land: Cape Faraday (Stimpson).

9. **Socarnes bidenticulatus** (Bate).

Lysianassa bid. Bate, Ann. Mag. Nat. Hist., Ser. 3, Vol. 1, 1858, p. 362; *Lys. nugax* Bate, Catal. Amphip. Brit. Mus., 1862, p. 65, Pl. 10, fig. 3; *Anonyx bid.* Miers, Ann. Mag. Nat. Hist., Ser. 4, Vol. 19, 1877, p. 138; *Socarnes ovalis* Hoek, Niederl. Arch. Zool. Suppl., 1881, p. 42, Pl. 3, fig. 29; *Soc. bid.* Sars, Den Norsk. Nordhavs Exp. Crust., 1, 1885, p. 139, Pl. 12, fig. 1; Hansen, Malac. mar. Groenl. occ., 1887, p. 62.

Station 11. Northumberland Island, 10–15 fathoms (2).

Station 45. Barden Bay, 10–40 fathoms (2).

Station 52. Robertson Bay, 5–15 fathoms (4).

Distribution.—Spitzbergen, Jan Mayen, West Greenland, North Greenland, Ellesmere Land ; 4–160 fathoms.

North Greenland: Cape Dudley Digges; Ellesmere Land: Cape Faraday (Ohlin).

10. Anonyx nugax (Phipps).

Cancer nug. Phipps, Voy. North Pole., Append., 1774, p. 192, Pl. 12, fig. 2; *Lysianassa lagena* and *appendiculata* Kroeyer, Dansk. Vid. Selsk. Afh., 7, 1838, pp. 237 and 240, Pl. 1, figs 1, 2; *Anonyx ampulla* Kroeyer, Naturh. Tidssk. (2), Vol. 1, 1845, p. 578; *An. lagena* Bate, Catal. Amph. Brit. Mus., 1862, p. 77, Pl. 12, fig. 7; *An. nugax* Miers, Ann. Mag. Nat. Hist., Ser. 4, Vol. 19, 1877, p. 135; Ives, Proc. Acad. Philad. 1891, p. 480; Sars, Crust. Norway, 1895, p. 88, Pl. 31.

Station 45. Barden Bay, 10–40 fathoms (5).

Station 47. Northumberland Island, surface (1).

Distribution.—Shetland Islands, Norway, northeast coast of North America, Labrador, Northumberland Sound, Ellesmere Land, Grinnell Land, North, West and East Greenland, Spitzbergen, Franz Joseph Land, Kara Sea, North Siberia (East Taimyr and Tchukchee coast), Bering Straits, Sea of Ochotsk; 2–658 fathoms.

Ellesmere Land: Gale Point (ten miles below Cape Isabella) (Stimpson); Grinnell Land: Floeberg Beach and 83° 19′ N. L., Discovery Bay (Miers); North Greenland: Murchison Sound (Ohlin), McCormick Bay (Ives).

11. Pseudalibrotus littoralis (Kroeyer).

Alibrotus litt. Sars, Crust. Norway, Vol. 1, 1895, p. 102, Pl. 35, fig. 2.

Station 14. Payer Harbor, Ellesmere Land, mouth of small fresh-water stream (1).

Station 42. Barden Bay, surface (2).

Station 44. Barden Bay, sandy beach (17).

Station 47. Northumberland Island, surface (several hundred).

Station 53. Littleton Island, surface (2).

The generic name *Pseudalibrotus* has been proposed by Stebbing.[5]

Distribution.—Finmark, Spitzbergen, Jan Mayen, East, West and North Greenland, Baffin Bay, Point Barrow. Surface to 100 fathoms.

North Greenland: Murchison Sound (Ohlin).

12. Onesimus edwardsi (Kroeyer).

Sars, *l. c.*, 1895, p. 105, Pl. 36, fig. 1.

Station 39. Granville Bay, 30–40 fathoms (3).

Station 40. Granville Bay, 20–30 fathoms (2).

Station 49. Olriks Bay, 15–20 fathoms (4).

Distribution.—Kattegat, Norway, Labrador, West Greenland,

[5] *Ann. Mag. Nat. Hist.*, Ser. 7, Vol. 5, 1900, p. 15.

Grinnell Land, Iceland, Jan Mayen, Spitzbergen, Murman coast, Franz Joseph Land, Kara Sea, eastern part of Siberian Polar Sea; 2–60 fathoms.

Grinnell Land: Discovery Bay and Floeberg Beach (Miers).

13. Byblis gaimardi (Kroeyer).

Sars, *l. c.*, 1895, p. 183, Pl. 64.

Station 43. Barden Bay, 20–25 fathoms (11).

Distribution.—Kattegat, Norway, Finmark, Labrador, West Greenland (northward to Disco Island), Iceland, Spitzbergen, Murman coast, Kara Sea; 2–280 fathoms.

14. Stegocephalus inflatus Kroeyer.

Sars, *l. c.*, 1895, p. 198, Pl. 69.

Station 12. Foulke Fjord, 35 fathoms (2).

Station 29. Olriks Bay, 7–25 fathoms (2).

Station 39. Granville Bay, 30–40 fathoms (11).

Station 40. Granville Bay, 20–30 fathoms (1).

Station 43. Barden Bay, 20–25 fathoms (19).

Station 49. Olriks Bay, 15–20 fathoms (65).

Station 50. Karnah (Inglefield Gulf), 30–40 fathoms (1).

Distribution.—Norway, Shetland Islands, Nova Scotia, Northumberland Sound, Berry Island, North, West and East Greenland, Spitzbergen, Murman coast, White Sea, Franz Joseph Land, Kara Sea, eastern part of Siberian Polar Sea; 7–150 fathoms.

North Greenland: Cape Dudley Digges and Murchison Sound (Ohlin).

15. Parœdicerus lynceus (M. Sars).

G. O. Sars, *l. c.*, 1895, p. 292, Pl. 103, fig. 2, Pl. 104, fig. 1.

Station 37. Saunders Island, 5 fathoms (1).

Station 52. Robertson Bay, 5–15 fathoms (1).

Distribution.—Nova Scotia, Labrador, Ellesmere Land, North, West and East Greenland, Iceland, Spitzbergen, Barents Sea, Finmark, Murman coast, Kara Sea; 2–160 fathoms.

Ellesmere Land: Cape Faraday (Ohlin); North Greenland: Murchison Sound and Cape Dudley Digges (Ohlin), Cape York (Hansen).

16. Monoculodes borealis Boeck.

Sars, *l. c.*, 1895, p. 298, Pl. 106, fig. 2.

Station 49. Olriks Bay, 15–20 fathoms (1).

Distribution.—England, Norway, Finmark, Kara Sea, Spitzbergen, East Greenland, West Greenland (northward to the Waigat); 3–100 fathoms.

17. Pleustes panoplus (Kroeyer).

Sars, *l. c.*, 1895, p. 344, Pl. 121.

Station 29. Olriks Bay, 7–25 fathoms (3).

Distribution.—Norway, Nova Scotia, Labrador, North, West and East Greenland, Iceland, Jan Mayen, Spitzbergen, Novaja Semlja, Murman coast, Kara Sea, Point Barrow; 4–100 fathoms.

North Greenland: Cape Dudley Digges (Ohlin), Cape York (Hansen).

18. Paramphithoe bicuspis (Kroeyer).

Sars, *l. c.*, 1895, p. 349, Pl. 123, fig. 1.

Station 4. Upernavik, 8–10 fathoms (3).

Station 29. Olriks Bay, 7–25 fathoms (4).

Distribution.—England, France, Kattegat, Norway, Finmark, Spitzbergen, Bear Island, Iceland, Labrador, West and North Greenland; 3–60 fathoms.

North Greenland: Cape Dudley Digges (Ohlin).

19. Acanthozone cuspidata (Lepechin).

Sars, *l. c.*, 1895, p. 370, Pl. 130.

Station 45. Barden Bay, 10–40 fathoms (21).

It has been suggested (Miers, Stebbing) that the species figured by Buchholz[6] is different from this species. But, as Hoek points out,[7] and Koelbel confirms,[8] the differences of Buchholz's figure from this species are due to inaccuracies in the drawing. That the drawing in fig. 1 is incorrect, especially as regards the last three pairs of pereiopods, is shown conclusively by the fact that Buchholz gives, in fig. 1*h*, a correct reproduction of the last pereiopod.

Distribution.—Norway, Finmark, Labrador, Polar Islands of North America, Grinnell Land, North, West and East Greenland, Jan Mayen, Spitzbergen, Murman coast, White Sea, Kara Sea, Siberian Polar Sea (East Taimyr peninsula); 7–100 fathoms.

Grinnell Land: Franklin Pierce Bay, Discovery Day (Miers); North Greenland: Cape Dudley Digges (Ohlin).

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[6] *Zweite deutsche Nordpolfahrt*, Vol. 2, 1874, p. 362, Pl. 11.

[7] *Niederl. Arch. Zool. Suppl.*, 1881, p. 48.

[8] *Œsterreich. Polarstat. Jan Mayen*, Vol. 3, 1886, p. 45.

20. Rachotropis aculeata (Lepechin).

Sars, *l. c.*, 1895, p. 434, Pl. 149.

Station 11. Northumberland Island, 10–15 fathoms (1).
Station 12. Foulke Fjord, 35 fathoms (2).
Station 27. Cape Chalon, 35 fathoms (1).
Station 39. Granville Bay, 30–40 fathoms (8).
Station 40. Granville Bay, 20–30 fathoms (13).
Station 45. Barden Bay, 10–40 fathoms (2).
Station 49. Olriks Bay, 15–20 fathoms (11).
Station 50. Karnah, 30–40 fathoms (4).
Station 51. Robertson Bay, 35–40 fathoms (1).

Distribution.—Nova Scotia, Labrador, Polar Islands of North America, Baffin Bay, Grinnell Land, North Greenland, West and East Greenland, Jan Mayen, Spitzbergen, Finmark, Novaja Semlja, White Sea, Franz Joseph Land, Point Barrow; 3–220 fathoms.

Grinnell Land: Dobbin Bay, Cape Frazer, Franklin Pierce Bay, Cape Napoleon, Discovery Bay, Floeberg Beach (Miers); North Greenland: Cape Dudley Digges and Murchison Sound (Ohlin).

21. Halirages fulvocinctus (M. Sars).

G. O. Sars, *l. c.*, 1895, p. 436, Pl. 154; *Pherusa tricuspis* Stimpson, Proc. Acad. Phila., 1863, p. 139.

Station 4. Upernavik, 8–10 fathoms (8).
Station 52. Robertson Bay, 5–15 fathoms (5).
Station 54. Foulke Fjord, 5 fathoms (1).

Distribution.—Norway, Finmark, Nova Scotia, Labrador, Grinnell Land, North, West and East Greenland, Spitzbergen, Novaja Semlja, Murman coast, Kara Sea, Franz Joseph Land; 2–110 fathoms.

Grinnell Land: Discovery Bay (Miers); North Greenland: Littleton Island (Stimpson).

22. Pontogeneia inermis (Kroeyer).

Sars, *l. c.*, 1895, p. 451, Pl. 159.

Station 4. Upernavik, 8–10 fathoms (7).
Station 36. Saunders Island, 6 fathoms (1).
Station 37. Saunders Island, 5 fathoms (2).
Station 54. Foulke Fjord, 5 fathoms (4).

Distribution.—Norway, Labrador, East and West Greenland (northward to Upernavik); 0–120 fathoms. ? Siberian Polar Sea (see Sars).

23. Amphithopsis megalops (Buchholz).

Paramphitoë megalops Buchholz, Zweite deutsch. Nordpolf., Vol. 2, 1874, p. 369, Pl. 12; Hansen, Malac. mar. Groenl. occ., 1887, p. 125; *Amphithopsis megalops* Hansen, Meddelelser om Groenland, 19, 1895, p. 129.

Station 29. Olriks Bay, 7–25 fathoms (11).

Station 49. Olriks Bay, 15–20 fathoms (3).

Station 54. Foulke Fjord, 5 fathoms (2).

Distribution.—So far only known from East and West Greenland, 2–60 fathoms.

East Greenland: Sabine Island, Germania Harbor, Shannon (Buchholz), Hecla Havn, Tasiusak (Hansen); West Greenland: from Godthaab to Upernavik (Hansen).

24. Atylus carinatus (Fabricius).

Sars, *l. c.*, 1895, p. 471, Pl. 166, fig. 1.

Station 9. Saunders Island, 5–10 fathoms (1).

Station 11. Northumberland Island, 10–15 fathoms (58).

Station 12. Foulke Fjord, 35 fathoms (1).

Station 24. Northumberland Island, 10 fathoms (1).

Station 39. Granville Bay, 30–40 fathoms (1).

Station 52. Robertson Bay, 5–15 fathoms (3).

Distribution.—Grinnell Land, Ellesmere Land, North, West and East Greenland, Jan Mayen, Spitzbergen, Finmark, Novaja Semlja, Murman coast, Franz Joseph Land, Kara Sea, Siberian Polar Sea (East Taimyr peninsula and Tchukchee coast); 3–250 fathoms.

Grinnell Land: Discovery Bay (Miers); Ellesmere Land: Cape Faraday (Ohlin); North Greenland: McCormick Bay (Ives), Murchison Sound (Ohlin), Cape York (Hansen).

25. Amathilla pinguis (Kroeyer).

Gammarus pinguis Kroeyer, Dansk. Vid. Selsk. Afh., Vol. 7, 1838, p. 252, Pl. 1, fig. 5; *Amathilla pinguis* Buchholz, *l. c.*, 1874, p. 353, Pl. 9, fig. 2; Boeck, Scand. and Arct. Amphip, Vol. 2, 1876, p. 411.

Station 4. Upernavik, 8–10 fathoms (1).

Station 9. Saunders Island, 5–10 fathoms (2).

Station 17. Payer Harbor, Ellesmere Land, 16 fathoms (4).

Station 49 Olriks Bay, 15–20 fathoms (1).

Sars (1895, p. 490) does not think that this is a true *Amathilla.*

Distribution.—Ellesmere Land, Grinnell Land, North, West and East Greenland, Spitzbergen, Kara Sea; 2–90 fathoms.

Ellesmere Land: Cape Faraday (Ohlin); Grinnell Land: 82° 24′ N. L. (Miers); North Greenland: Cape York (Hansen).

26. Gammaracanthus loricatus (Sabine).

Gammarus loricatus Sabine, in Parry's Voy. Append., 1821, p. 231, Pl. 1, fig. 7; *Gammaracanthus loricatus* Bate, Catal. Amphip. Brit. Mus., 1862, p. 202, Pl. 36, fig. 2.

Station 4. Payer Harbor, mouth of fresh-water stream (1).

Our individual has been taken at the mouth of a small stream in perfectly fresh water. This fact is the more interesting, since we have in fresh-water lakes of Sweden, Norway, Finland and Russia a slightly different form (var. *lacustris* Sars = *relictus* Sars, 1895, p. 494, Pl. 174). Our specimen represents the typical form.

Distribution.—Kara Sea, Spitzbergen, Greenland (rare), Grinnell Land, Ellesmere Land, Polar islands of North America, Point Barrow; 0–10 fathoms.

Grinnell Land: Floeberg Beach (Miers); Ellesmere Land: Cape Faraday (Ohlin).

27. Gammarus locusta (Linne).

Sars, *l. c.*, 1895, p. 499, Pl. 1, 176, fig. 1.

Station 3. Godhavn, Disco Island, beach (34).

Station 14. Payer Harbor, fresh water (24).

Station 44. Barden Bay, beach (3).

Station 55. Foulke Fjord, beach (22).

Distribution.—Norway and southward to the Mediterranean Sea, Labrador, Ellesmere Land, Grinnell Land, North, West and East Greenland, Iceland, Spitzbergen, Barents Sea, Franz Joseph Land, Kara Sea, Siberian Polar Sea (eastern part), Point Barrow; 0–5 fathoms, rarely in deeper water; sometimes pelagic.

Ellesmere Land: Cape Faraday (Ohlin); Grinnell Land: Floeberg Beach (Miers); North Greenland: Port Foulke (Stimpson), McCormick Bay (Ives).

28. Melita dentata (Kroeyer).

Sars, *l. c.*, 1895, p. 513, Pl. 181, fig. 1.

Station 52. Robertson Bay, 5–15 fathoms (2).

Distribution.—England, Kattegat, Norway, New England coast, Labrador, Polar islands of North America, West Greenland (northward to Disco Island), Iceland, Spitzbergen, Novaja Semlja, White Sea, Puget Sound (north Pacific); 2–160 fathoms.

29. Ischyrocerus anguipes (Kroeyer).

Sars, *l. c.*, 1895, p. 588, Pl. 209.

Station 29. Olriks Bay, 7–25 fathoms (1).

Station 37. Saunders Island, 5 fathoms (1).

Distribution.—Kattegat, Norway, Finmark, Grand Manan, West Greenland (northward to Upernavik (Hansen) and Duck Islands in Melville Bay (Ohlin)), East Greenland, Iceland, Spitzbergen, Murman coast, White Sea, Kara Sea; 2–110 fathoms.

30. Unciola leucopis (Kroeyer).

Sars, *l. c.*, 1895, p. 620, Pl. 222 (= *U. irrorata* Hansen, *l. c.*, 1887, p. 164).

Station 49. Olriks Bay, 15–20 fathoms (1).

Specimens from Labrador have been recorded by Packard as *U. irrorata* Say, which is, according to Sars, a different species, but perhaps the Labrador form belongs to *U. leucopis.*

Distribution.—Norway, Finmark, ? Labrador, West Greenland (northward to Disco Island), East Greenland, Spitzbergen, Barents Sea, Kara Sea; 30–120 fathoms.

31. Paradulichia typica Boeck.

Sars, *l. c.*, 1895, p. 642, Pl. 232, fig. 2.

Station 49. Olriks Bay, 15–20 fathoms (1 ♂, 2 ♀).

This species has been recorded hitherto only from Norway, where it seems to be rare. The male sex has not been observed before; our male differs not materially from the female, especially the structure of the posterior gnathopods is essentially the same as in the female, both in shape and size.

Sars describes the eyes as dark red; in our specimens they are white, but this is possibly due to the action of the alcohol. Length of our specimens (without antennæ): ♂ 7 mm., ♀ 6 and 7 mm. (Sars gives 5 mm. for the adult female).

Distribution.—Norway: Hardangerfjord, 30 fathoms (Boeck and Sars).

32. Æginella spinosissima (Stimpson).

Ægina spinosissima Stimpson, Synops. mar. Invert. Grand Manan, 1854, p. 44; Miers, Ann. Mag. Nat. Hist., ser. 4, Vol. 20. 1877; *Caprella spinifera* Bell, Last Arctic Voy. Belcher, Vol. 2, 1855, p. 407, Pl. 35, fig. 2; *Caprella spinosissima* Bate, Cat. Amph. Brit. Mus., 1862, p. 361, Pl. 57, fig. 3; *Ægina spinifera* Sars, Den Norske Nordh. Exp. Crust., 1, 1885, p. 228, Pl. 18, fig. 5; Ives, Proc. Acad. Phila., 1891, p. 481.

Station 21. Murchison Sound, 25 fathoms (1).

Station 26. Cape Alexander, 27 fathoms (1).

Station 39. Granville Bay, 30–40 fathoms (1).

Station 40. Granville Bay, 20–30 fathoms (3).

Station 43. Barden Bay, 20–25 fathoms (1).

Station 49. Olriks Bay, 15–20 fathoms (7).

The genus *Æginella* is the same as *Ægina.*[9] *Ægina echinata* Boeck seems to be different from this species.

Distribution.—Grand Manan, Polar islands of North America, Grinnell Land, North, West and East Greenland, Iceland, Jan Mayen, Spitzbergen, Kara Sea, Siberian Polar Sea (West and East Taimyr peninsula); 3–300 fathoms.

Ginnell Land: Cape Napoleon, Dobbin Bay (Miers); North Greenland: Northumberland Island, Cape Dudley Digges (Ohlin), McCormick Bay (Ives), Cape York (Hansen).

33. Caprella linearis (Linné).

Mayer, Flor. and Faun. Golf von Neapol., 6 Monogr., 1882, p. 60, figs. 17-19; Sars, *l. c.*, 1895, p. 657, Pl. 236.

Station 60. Battle Harbor, Labrador, 12–14 fathoms (18).

Among our material are four ovigerous females, in which the 5–7 segments have dorsally only slight indications of tubercles; some of the other individuals are quite smooth. No adult males are present.

This species differs from *C. septentrionalis*, (1) in the lack of tubercles on the anterior part of the body; (2) in the arm of the second pair of legs, which is longer; (3) in the reddish color (they were found in red algæ).

Although there are no males, I believe, we have to deal here with *C. linearis*. *C. septentrionalis* grows much larger, and my females with eggs are small, much smaller than ovigerous females of *C. septentrionalis*. Among the young *C. septentrionalis* from Godhavn (about as large as my individuals of *C. linearis*) are no adult females, and they have all a brownish color (found among brown algæ).

Distribution.—Scandinavia, England, France, Iceland, Greenland, Grand Manan (Stimpson's *C. lobata*), St. Johns, Newfoundland (Ohlin).

34. Caprella septentrionalis Kroeyer.

Sars, *l. c.*, 1895, p. 659, Pl. 237, fig. 1.

Station 3. Godhavn, Disco Island, 0–1 fathom (63 jun.).

Station 4. Upernavik, 8–10 fathoms (6).

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[9] Stebbing, *Challenger Amphip.*, 1888, p. 1,248.

Station 9. Saunders Island, 5–10 fathoms (1).

Station 11. Northumberland Island, 10–15 fathoms (3).

Station 37. Saunders Island, 5 fathoms (14).

Station 52. Robertson Bay, 5–15 fathoms (1).

Station 57. Sarkak, Waigat, 9 fathoms (10).

Distribution.—Denmark, Norway, Finmark, Labrador, North, West and East Greenland, Jan Mayen, Spitzbergen; 2–100 fathoms

North Greenland: Cape York (Hansen).

35. Synidotea marmorata (Packard).

Benedict, Proc. Acad. Phila., 1897, p. 392, fig. 2.

Station 60. Battle Harbor, Labrador, 12–14 fathoms (2).

Distribution.—St. Lawrence Gulf (Whiteaves), Newfoundland Bank, 36–129 fathoms (Benedict); Labrador: Kynetarbuk Bay, 7 fathoms (Packard).

36. Arcturus baffini (Sabine).

A. baffini and *feildeni* Benedict, Proc. Biol. Soc. Washington, Vol. 12, 1898, p. 43.

Station 26. Cape Alexander, 27 fathoms (62).

Station 27. Cape Chalon, 35 fathoms (13).

Station 39. Granville Bay, 30–40 fathoms (3).

Station 40. Granville Bay, 20–30 fathoms (several hundred).

Station 45. Barden Bay, 10–40 fathoms (1).

Station 49. Olriks Bay, 15–20 fathoms (109).

Station 51. Robertson Bay, 35–40 fathoms (85).

Station 52. Robertson Bay, 5–15 fathoms (1).

The large amount of material at hand enables me to pronounce *A. baffini* and *feildeni* varieties of one and the same species. We possess both forms, and the var. *feildeni* prevails for instance at Station 40, and is represented at Station 49. But, besides, there are many intermediate specimens in the different hauls, especially in Nos. 40, 49 and 51.

Miers found his *feildeni* under the same conditions, associated with the typical form. Benedict's and Sars' material consisted only of a few individuals of each form.

Very young individuals are always without spines, and thus young individuals *always* belong to the var. *feildeni*, although their mother, to whose antennæ they cling, may be a true *baffini*. In larger individuals the spines are developed in a different degree, and there are all intermediate stages between the strongly spinous *A. baffini* and the almost smooth *A. feildeni.*

Sars [10] claims that his *A. tuberosus* antedates Miers' *A. feildeni*, giving 1876 as the date of publication of the former. But the *Arch. Math. og Naturvid.*, Vol. 2, p. 350, where the diagnosis of *A. tuberosus* is printed, bears the date 1877, *not* 1876. Miers' *A. feildeni* was published in the *Ann. Mag. Nat. Hist.*, Series 4, Vol. 20, p. 14, Pl. 3, fig. 1, in the year 1877; but since this volume was not issued before the second half of that year, we may grant the priority of Sars' name, although the date of 1876 is not correct.

Distribution.—Farœs, Norway, Iceland, Spitzbergen, East Greenland, Davis Straits, West Greenland, North Greenland, Ellesmere Land, Grinnell Land, 5–400 fathoms.

North Greenland: Cape York (Hansen), McCormick Bay (Ives), Murchison Sound (Ohlin); Ellesmere Land: Cape Faraday (Ohlin), Cape Sabine (Benedict); Grinnell Land: Cape Napoleon, Dobbin Bay, Franklin Pierce Bay, Floeberg Beach (Miers).

37. Tole libbeyi (Ortmann).

Ortmann, The Princeton University Bulletin, Vol. 11, No. 3, February, 1900, pp. 39, 40.

Station 26. Cape Alexander, 27 fathoms (5).

Length of body 8 mm. Rostrum about as long as the head, directed obliquely upward. Head with one lateral angulation, directed forward. Eyes elliptical. Segments of pereion dorsally smooth, without any spines or tubercles. First segment laterally with two angulations, both of them directed obliquely forward. Second and third segments with four short angulations, the anterior and posterior subequal, the third the smallest. Fourth segment with two angulations, the anterior directed forward, the posterior smaller and directed a little backward. Fifth, sixth and seventh segments with a large anterior and a very small posterior angulation. All the angulations of these segments are comparatively short. Pleon with two bluntly triangular angulations on either side of a bluntly triangular central portion. Uropods about as long as pleon, styliform, outer branch a little shorter than inner. Flagellum of first antenna 15 articulate; flagellum of second antenna with more than 150 annulations.

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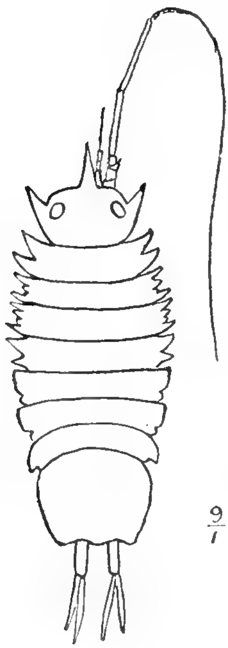
[10] *Den Norske Nordh. Exp. Crust.*, 1, 1885, p. 109.

In the wanting tubercles of the dorsal surface and the form of the lateral angulations, this species is related to the two species of the genus known from the North Pacific, and the form of the pleon recalls that of *J. erostrata* Rich. (Aleutian Islands). But it differs (1) in the presence of a long rostrum, (2) in the stronger development of the lateral angulations of the head, (3) in the slightly different angulations of the second and third segments of the pereion.



9/1

The generic name *Tole* has been given to replace *Janthe* Bovallius nom. præoccup. (1865 Mars, 1867 Stål). (Type, *J. speciosa* Bov. = *spinosa* Harg.)

The following key to the species of *Tole* = *Janthe* may serve to express the affinities of our new species:

a'.—Pleon produced backward into two large angulations, between which the uropods are inserted (*b*).

a''.—Pleon produced into one small median extension, on each side of which there are incisions for the insertion of the uropods. (Rostrum very short. Two lateral angulations of the head. Segments of pereion each with one median, obtuse tubercle, *J. bovallii* (Studer)).[11] East Patagonia.

b'.—Segments of pereion dorsally with spines or tubercles (*c*).

b''.—Segments of pereion dorsally smooth (*d*).

c'.—Segments of pereion dorsally each with two submedian, short. spine-like tubercles. First segment with one, second to fourth with two large angulations, fifth to seventh with one large and one (posterior) small angulation, *J. spinosa* (Harger).[12] Nova Scotia, Baffin Bay, West Greenland.

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[11] *Abh. Akad. Wiss.*, Berlin, 1883, p. 10, Pl. 1, fig. 2.

[12] Harger, *Proc. U. S. Mus.*, Vol. 2, 1879, p. 158, and *Rep. U. S. Fish Comm.*, 1880, p. 323, Pl. 2, fig. 10 (*Janira spinosa*); Hansen, *Mal. mar. Grœnl. occ.*, 1887, p. 191; *Janthe speciosa* Bovallius, *Svensk. Vet. Ak. Handl.*, Vol. 6, No. 4, 1881, p. 4.

e''.—Segments of pereion dorsally with one median, spine-like tubercle. All segments with two angulations on each side, *J. laciniata* (Sars). West coast of Norway.

d'. —Head with two lateral angulations, *J. triangulata* (Rich.).[13] California.

d''.—Head with one lateral angulation (*e*).

e'. —Rostrum well developed, long, ... *J. libbeyi.*

e''.—Rostrum represented only by a small median point, *J. erostrata* (Rich.).[14] Aleutian Islands.

38. Munnopsis typica M. Sars.?

Harger, Rep. U. S. Fish Comm. for 1878, part 6, 1880, p. 330, Pl. 2, fig. 11; Sars, Acc. Crust. Norway, Vol. 2, 1897, p. 133, Pls. 57, 58.

Station 12. Foulke Fjord, 35 fathoms (2).

Station 39. Granville Bay, 30–40 fathoms (18).

Station 40. Granville Bay, 20–30 fathoms (2).

Station 49. Olriks Bay, 15–20 fathoms (1).

Distribution.—Norway, Shetland Islands, Bay of Fundy, Gulf of St. Lawrence, Baffin Bay, Grinnell Land, North, West and East Greenland, Iceland, Spitzbergen, Franz Josef Land, Novaja Semlja, Kara Sea, Siberian Polar Sea (East Taimyr); 5–500 fathoms.

Grinnell Land: Cape Napoleon, Cape Frazer (Miers); North Greenland: Murchison Sound (Ohlin).

The *Bopyridæ* in the collection have not yet been identified.

39. Diastylis rathkei (Kroeyer).

Sars, Acc. Crust. Norway, Vol. 3, 1900, p. 44, Pls. 33, 34.

Station 43. Barden Bay, 20–25 fathoms (3).

Distribution.—Baltic Sea, Kattegat, Norway, England, Atlantic coast of North America, Labrador, Baffin Bay, North and West Greenland, Barents Sea, Franz Josef Land, Kara Sea, Siberian Polar Sea (mouth of Jenesei, East Taimyr, Tchukchee coast); to 400 fathoms.

North Greenland: Murchison Sound (Ohlin).

40. Diastylis goodsiri (Bell).

Sars, *l. c.*, 1900, p. 54, Pl. 41.

Station 18. Foulke Fjord, 15–20 fathoms (1).

Distribution.—Polar islands of North America, Baffin Bay,

[13] *Janthe triangulata* Richardson, *Proc. U. S. Mus.*, Vol. 21, 1899, p. 857.

[14] *Janthe erostrata* Richardson, *ibid.*, p. 858, fig. 30.

North and West Greenland, Jan Mayen, Spitzbergen, Barents Sea, Kara Sea, Siberian Polar Sea (East Taimyr and Tchukchee coast); to 80 fathoms.

North Greenland: Murchison Sound (Ohlin).

41. **Diastylis scorpioides** (Lepechin).

Sars, *l. c.*, 1900, p. 58, Pl. 44.

Station 40. Granville Bay, 20–30 fathoms (1).

Station 43. Barden Bay, 20–25 fathoms (1).

Station 52. Robertson Bay, 5–15 fathoms (3).

Distribution.—Finmark, Lofoten Islands, White Sea, Kara Sea, Jan Mayen, West and North Greenland, West coast of Baffin Bay; to 200 fathoms.

North Greenland: Murchison Sound (Ohlin).

42. **Campylaspis rubicunda** (Liljeborg).

Sars, *l. c.*, 1900, p. 84. Pls. 56, 57.

Station 49. Olriks Bay, 15–20 fathoms (1 ♂, 1 ♀).

Distribution.—Kattegat, Norway, Atlantic coast of North America, West Greenland (Holsteinborg and Kekertak); to 70 fathoms.

43. **Mysis oculata** (O. Fabricius).

Sars, Monogr. Mysider, Vol. 3, 1879, p. 69, Pl. 31.

Station 2. Godhavn, Disco Island, 8 fathoms (1).

Station 17. Payer Harbor, Ellesmere Land, 16 fathoms (3).

Station 24. Northumberland Island, 10 fathoms (1).

Station 36. Saunders Island, 6 fathoms (3).

Station 37. Saunders Island, 5 fathoms (1).

Station 39. Granville Bay, 30–40 fathoms (2).

Station 40. Granville Bay, 20–30 fathoms (56).

Station 43. Barden Bay, 20–25 fathoms (3).

Station 52. Robertson Bay, 5–15 fathoms (1).

Distribution.—Labrador, Grinnell Land, North, West and East Greenland, Iceland, Jan Mayen, Spitzbergen, Finmark, Kara Sea Siberian Polar Sea (Tchukchee coast); 2–30 fathoms.

Grinnell Land: Cape Napoleon (Miers); North Greenland: Port Foulke (Stimpson), Murchison Sound and Inglefield Gulf (Ohlin).

44. Pandalus borealis Kroeyer.

Kroeyer, Naturhist. Tidsskr., Vol. 2, 1839, p. 254; *ibid.* (2), Vol. 1, 1845, p. 116; Smith, Trans. Connect. Ac., Vol. 5, 1879, p. 86; Hoek, Niederl. Arch. Zool. Suppl., 1881, p. 21; Doflein, Dekap. Krebs. arkt. Meere. (Fauna Arctica, Vol. 1, part 2), 1900, p. 321.

Station 59. Kudlisat, Waigat, 15–30 fathoms (8).

Distribution.—Massachusetts to Nova Scotia, West Greenland (northward to Umenak), Norway, Barents Sea, White Sea, Spitzbergen, Franz Josef Land, Bering Sea; to 260 fathoms.

45. Spirontocaris phippsi (Kroeyer).

Hippolyte phippsi Smith, Trans. Conn. Ac., Vol. 5, 1879, p. 73; Hansen, Malac. Groenl. occ., 1887, p. 43; Doflein, *l. c.*, 1900, p. 332.

Station 4. Upernavik, 8–10 fathoms (15).

Station 12. Foulke Fjord, 35 fathoms (1).

Station 26. Cape Alexander, 27 fathoms (2).

Station 27. Cape Chalon, 35 fathoms (1).

Station 29. Olriks Bay, 7–25 fathoms (3).

Station 39. Granville Bay, 30–40 fathoms (5).

Station 40. Granville Bay, 20–30 fathoms (16).

Station 43. Barden Bay, 20–25 fathoms (1).

Station 49. Olriks Bay, 15–20 fathoms (3).

Station 52. Robertson Bay, 5–15 fathoms (1).

Station 54. Foulke Fjord, 5 fathoms (2).

Station 60. Battle Harbor, Labrador, 12–14 fathoms (1).

Distribution.—Norway, Sweden, Massachusetts Bay to Labrador, Grinnell Land, North, West and East Greenland, Spitzbergen, Franz Joseph Land, Siberian Polar Sea (Tchukchee coast), Point Barrow, Bering Sea, Ochotsk Sea, North Japan; 2–125 fathoms.

Grinnell Land: Cape Frazer, Franklin Pierce Bay, Discovery Bay (Miers); North Greenland: Port Foulke (Stimpson), Cape Dudley Digges, Northumberland Island, Inglefield Gulf, Murchison Sound (Ohlin).

46. Spirontocaris spinus (Sowerby).

Hippolyte sowerbyi Milne-Edwards, Hist. Nat. Crust., Vol. 2, 1837, p. 380; *H. spinus* Smith, *l. c.*, 1879, p. 68; Doflein, *l. c.*, 1900, p. 332.

Station 29. Olriks Bay, 7–25 fathoms (2).

Station 39. Granville Bay, 30–40 fathoms (1).

Station 40. Granville Bay, 20–30 fathoms (2).

Station 49. Olriks Bay, 15–20 fathoms (1).

Station 50. Karnah, 30–40 fathoms (1).

Station 52. Robertson Bay, 5–15 fathoms (1).

Distribution.—Scotland, Norway, Massachusetts Bay to Labrador, Grinnell Land, North and West Greenland, Jan Mayen, Spitzbergen, Bering Straits, Point Barrow; 2–240 fathoms.

Grinnell Land: Discovery Bay (Miers); North Greenland: Northumberland Island, Inglefield Gulf, Murchison Sound (Ohlin).

47. Spirontocaris gaimardi (Milne-Edwards).

Hippolyte gaimardi Milne-Edwards, Hist. Nat. Crust., Vol. 2, 1837, p. 378; Smith, *l. c.*, 1879, p. 67; Doflein, *l. c.*, 1900, p. 330.

Station 4. Upernavik, 8–10 fathoms (18).

Station 11. Northumberland Island, 10–15 fathoms (3).

Station 36. Saunders Island, 6 fathoms (4).

Station 37. Saunders Island, 5 fathoms (1).

Station 43. Barden Bay, 20–25 fathoms (7).

Station 54. Foulke Fjord, 5 fathoms (47).

Distribution.—Baltic Sea, Denmark, Sweden, Norway, Scotland, Massachusetts Bay to Labrador, Polar islands of North America, Grinnell Land, North and West Greenland, Iceland, Jan Mayen, Spitzbergen, Novaja Semlja, Kara Sea, Tchukchee coast, Point Barrow, Bering Sea; 2–250 fathoms.

Grinnell Land: Franklin Pierce Bay (Miers); North Greenland: Port Foulke (Stimpson), Inglefield Gulf (Ohlin).

48. Spirontocaris grœnlandica (Fabricius).

Hippolyte grœnlandica Smith, *l. c.*, 1879, p. 85, Pl. 10, fig. 2; Doflein, *l. c.*, 1900, p. 336.

Station 4. Upernavik, 8–10 fathoms (11).

Station 9. Saunders Island, 5–10 fathoms (1).

Station 12. Foulke Fjord, 35 fathoms (1).

Station 18. Foulke Fjord, 15–20 fathoms (1).

Station 21. Murchison Sound, 25 fathoms (5).

Station 26. Cape Alexander, 27 fathoms (19).

Station 27. Cape Chalon, 35 fathoms (20).

Station 29. Olriks Bay, 7–25 fathoms (23).

Station 37. Saunders Island, 5 fathoms (3).

Station 39. Granville Bay, 30–40 fathoms (2).

Station 40. Granville Bay, 20–30 fathoms (24).

Station 45. Barden Bay, 10–40 fathoms (1).

Station 49. Olriks Bay, 15–20 fathoms (8).

Station 50. Karnah, 30–40 fathoms (4).

Station 54. Foulke Fjord, 5 fathoms (23).

Distribution.—Norway, Massachusetts to Labrador, Polar islands of North America, Grinnell Land, North, West and East Greenland, Tchukchee coast, Bering Sea, Kamchatka, Puget Sound; 2–200 fathoms.

Grinnell Land: Franklin Pierce Bay, Dumbell Bay (Miers); North Greenland: Cape Dudley Digges, Northumberland Island, Murchison Sound, Inglefield Gulf (Ohlin).

49. Spirontocaris polaris (Sabine).

Hippolyte polaris Smith, *l. c.*, 1879, p. 80, Pl. 11, figs. 1–4; *H. polaris* and *borealis* Doflein, *l. c.*, 1900, pp. 334, 335.

Station 4. Upernavik, 8–10 fathoms (35).

Station 9. Saunders Island, 5–10 fathoms (15).

Station 12. Foulke Fjord, 5 fathoms (4).

Station 21. Murchison Sound, 25 fathoms (3).

Station 26. Cape Alexander, 27 fathoms (10).

Station 27. Cape Chalon, 35 fathoms (9).

Station 29. Olriks Bay, 7–25 fathoms (51).

Station 32 Foulke Fjord, 14 fathoms (1).

Station 37. Saunders Island, 5 fathoms (5).

Station 39. Granville Bay, 30–40 fathoms (21).

Station 40. Granville Bay, 20–30 fathoms (33).

Station 43. Barden Bay, 20–25 fathoms (2).

Station 45. Barden Bay, 10–40 fathoms (4).

Station 51. Robertson Bay, 35–40 fathoms (4).

Station 54. Foulke Fjord, 5 fathoms (37).

Distribution.—Sweden, Norway, Cape Cod to Labrador, Polar islands of North America, Grinnell Land, North, West and East Greenland, Jan Mayen, Spitzbergen, Bear Island, Franz Joseph Land, north of Bering Straits; 2–260 fathoms.

Grinnell Land: Dobbin Bay, Franklin Pierce Bay, Cape Napoleon, Discovery Bay (Miers); North Greenland: Littleton Island, Port Foulke (Stimpson), Cape Dudley Digges, Northumberland Island, Murchison Sound, Inglefield Gulf (Ohlin).

50. Crangon (Sclerocrangon) boreas (Phipps).

Ortmann, Proc. Acad. Phila., 1895, p. 178; Doflein, *l. c.*, 1900, p. 323.

Station 9. Saunders Island, 5–10 fathoms (7).

Station 21. Murchison Sound, 5 fathoms (1).

Station 26. Cape Alexander, 27 fathoms (6).
Station 27. Cape Chalon, 35 fathoms (6).
Station 29. Olriks Bay, 7–25 fathoms (11).
Station 39. Granville Bay, 30–40 fathoms (2).
Station 40. Granville Bay, 20–30 fathoms (21).
Station 45. Barden Bay, 10–40 fathoms (3).
Station 49. Olriks Bay, 5–20 fathoms (10).
Station 50. Karnah, 30–40 fathoms (6).
Station 51. Robertson Bay, 35–40 fathoms (10).
Station 52. Robertson Bay, 5–15 fathoms (8).
Station 54. Foulke Fjord, 5 fathoms (2).

Distribution.—Norway, Massachusetts to Labrador, Polar islands of North America, Grinnell Land, North, West and East Greenland, Iceland, Jan Mayen, Spitzbergen, Novaja Semlja, Franz Joseph Land, Tchukchee coast, Point Barrow, Bering Straits; 4–200 fathoms.

Grinnell Land: Franklin Pierce Bay, Cape Napoleon, Discovery Bay (Miers); North Greenland: Littleton Island, Port Foulke (Stimpson), Cape Dudley Digges, Northumberland Island, Murchison Sound (Ohlin).

51. Nectocrangon lar (Owen).

Ortmann, *l. c.*, 1895, p. 181; Doflein, *l. c.*, 1900, p. 327.

Station 9. Saunders Island, 5–10 fathoms (3).
Station 11. Northumberland Island, 10–15 fathoms (2).
Station 12. Foulke Fjord, 35 fathoms (4).
Station 26. Cape Alexander, 27 fathoms (1).
Station 27. Cape Chalon, 35 fathoms (4).
Station 39. Granville Bay, 30–40 fathoms (5).
Station 40. Granville Bay, 20–30 fathoms (20).
Station 43. Barden Bay, 20–25 fathoms (1).
Station 45. Barden Bay, 10–40 fathoms (1).
Station 50. Karnah, 30–40 fathoms. (2).

Distribution.—Nova Scotia, Newfoundland, Labrador, East Greenland (Hecla Havn, 70° 11′ N. L., Hansen, 1895, p. 125), West Greenland, North Greenland, Point Barrow, Bering Sea, Tchukchee coast; 4–120 fathoms.

North Greenland: Inglefield Gulf (Ohlin).

52. Sabinea septemcarinata (Sabine).

Ortmann, *l. c.*, 1895, p. 188; Doflein, *l. c.*, 1900, p. 328.

Station 12. Foulke Fjord, 35 fathoms (1).
Station 18. Foulke Fjord, 15–20 fathoms (1).
Station 39. Granville Bay, 30–40 fathoms (13).
Station 40. Granville Bay, 20–30 fathoms (65).
Station 43. Barden Bay, 20–25 fathoms (1).
Station 49. Olriks Bay, 15–20 fathoms (18).
Station 50. Karnah, 30–40 fathoms (6).

Distribution.—Norway, Massachusetts Bay to Labrador, Grinnell Land, North and West Greenland, Iceland, Spitzbergen, Novaja Semlja, Kara Sea, Siberian Polar Sea (East Taimyr peninsula and Tchukchee coast); 5–160 fathoms.

Grinnell Land: Dobbin Bay, Cape Napoleon, Discovery Bay (Miers); North Greenland: Murchison Sound (Ohlin).

53. Eupagurus pubescens (Kroeyer).

Smith, *l. c.*, 1879, p. 47; Doflein, *l. c.*, 1900, p. 341.

Station 61. Battle Harbor, Labrador, 0–1 fathom (1).

Distribution.—Northeast America: New Jersey to Labrador; Greenland (west coast northward to Umenak, ca. 71° N. L.), North Europe, Spitzbergen, Murman coast, White Sea, Bering Sea, Kamchatka, Puget Sound.

54. Hyas araneus (Linné).

Rathbun, Proc. U. S. Mus., Vol. 16, 1893, p. 67; Doflein, *l. c.*, 1900, p. 352.

Station 1. Domino Run, Labrador, 0–1 fathom (1).
Station 60. Battle Harbor, Labrador, 12–14 fathoms (3).

Distribution.—Northern Europe to Novaja Semlja and Spitzbergen, Iceland; Northeast America: Cape Cod to Labrador; West Greenland (northward to Godhavn); Tchukchee coast, Ochotsk Sea; 0–100 fathoms.

PYCNOGONIDA.

1. Nymphon longitarse Kroeyer.

Wilson, Trans. Connect. Acad., Vol. 5, 1878, p. 19, Pl. 7, fig. 2; Wilson, Rep. U. S. Fish Comm. for 1878, part 6, 1880, p. 489, Pl. 6, figs. 30, 31; Hoek, Challenger Pycnogon. 3, 1881, p. 20; Hoek, Niederl. Arch. Zool. Suppl., 1881, p. 15, Pl. 1, figs. 22, 23.

Station 39. Granville Bay, 30–40 fathoms (2 ♂).
Station 40. Granville Bay, 20–30 fathoms (2 ♀).
Station 52. Robertson Bay, 5–15 fathoms (1 ♂).

Distribution.—Massachusetts, Maine, Nova Scotia, Greenland, Norway, Novaja Semlja, Point Barrow; 2–220 fathoms.

2. **Nymphon grossipes** (Linné).

Wilson, *l. c.*, 1878, p. 20, Pl. 7, fig. 1; Wilson, *l. c.*, 1880, p. 491, Pl. 6, figs. 32-37, Pl. 7, fig. 42,; Hoek, Chall., 1881, p. 20, p. 44, Pl. 3, figs. 9–12, Pl. 4, fig. 1; Hoek, Nied. Arch., 1881, p. 12, Pl. 1, figs. 17-21.

Station 26. Cape Alexander, 27 fathoms (1 ♀).

Station 27. Cape Chalon, 35 fathoms (1 jun.).

Station 40. Granville Bay, 20–30 fathoms (2 ♂, 1 jun.).

Station 43. Barden Bay, 20–25 fathoms (1 ♀).

Station 49. Olriks Bay, 15–20 fathoms (2 jun.).

Distribution.—North Sea, Norway, Long Island Sound to St. Lawrence Gulf, Polar islands of North America, North Greenland, East Greenland (North Shannon), Spitzbergen, Barents Sea, Novaja Semlja, Point Barrow; 0–540 fathoms.

North Greenland: Northumberland Island (Ohlin).

3. **Nymphon hirtipes** Bell.

N. hirtipes Wilson, *l. c.*, 1878, p. 22, Pl. 5, fig. 2, Pl. 6, fig. 2; Hoek, Chall., 1881, p. 17; Hoek, Nied. Arch., 1881, p. 6, Pl. 1, figs. 1–8; *N. hirtum* Wilson, *l. c.*, 1880, p. 495, Pl. 7, figs. 38, 41.

Station 39. Granville Bay, 30–40 fathoms (2 ♂, 1 ♀, 3 jun.).

Distribution.—Massachusetts, Nova Scotia, Polar islands of North America (Northumberland Sound), Grinnell Land, North Greenland, East Greenland, Spitzbergen, Barents Sea; 10–299 fathoms.

Grinnell Land: Franklin Pierce Bay, Discovery Bay, Floeberg Beach (Miers); North Greenland: Inglefield Gulf (Ohlin).

4. **Nymphon serratum** G. O. Sars.

Sars, Arch. Math. og Naturv., Vol. 4, 1879, p. 471; Hoek, Nied. Arch., 1881, p. 10, Pl. 1, figs. 24, 28, Pl. 2, fig. 29.

Station 40. Granville Bay, 20–30 fathoms (2 ♂).

Distribution.—Spitzbergen Sea, 146–180 fathoms (Sars); Barents Sea, 160 fathoms (Hoek).

5. **Pallene discoidea** Kroeyer.

Pseudopallene hispida and *discoidea* Wilson, *l. c.*, 1878, pp. 10, 12, Pl. 3, figs. 1, 2; Wilson, *l. c.*, 1880, pp. 478, 479, Pl. 2, figs. 9, 10; *Pallene discoidea* and *hispida* Hoek, Chall., 1881, p. 31.

Station 39. Granville Bay, 30–40 fathoms (1 ♂, 1 ♀).

Station 40. Granville Bay, 20–30 fathoms (1 ♀).

The ovigerous male of Station 39 agrees in all essential points with *P. hispida* as figured by Wilson. The two females, however, show the chelæ of the mandibles (antennæ) as figured by Wilson for *P. discoidea* (1880, fig. 10*b*), and the rostrum is more obtuse than in the male, which is another diagnostic character assigned to *discoidea*. In the shape of the end of the abdomen I do not find any difference; all three individuals have it obtuse, and not pointed and slightly bifid.

In my opinion *P. hispida* is not different from *discoidea*, but represents merely the male sex.

Distribution.—Maine, Grand Manan (12–55 fathoms), South Greenland, North Norway, Lapland, White Sea.

In conclusion I add here a list of species recorded previously from the northern parts of Baffin Bay and Smith Sound, but not found by our expedition in the same latitudes:

1. *Balanus crenatus* Brug. Grinnell Land: Discovery Bay (Miers, *Journ. Linn. Soc. Zool.*, Vol. 15, 1881, p. 73).
2. *Balanus balanoides* (L.). Port Foulke (Stimpson) (possibly seen by the present writer at Foulke Fjord).
3. *Orchomenella minuta* (Kr.). North Greenland: Cape Dudley Digges, and Ellesmere Land: Cape Faraday (Ohlin).
4. *Anonyx affinis* Ohl. Cape Dudley Digges (Ohlin).
5. *Hoplonyx cicada* (Fabr.) = *Anonyx gulosus* Kr. Grinnell Land: Discovery Bay (Miers).
6. *Ampelisca eschrichti* Kr. North Greenland: Murchison Sound (Ohlin).
7. *Haploops tubicola* Lilj. North Greenland: Cape Dudley Digges (Ohlin).
8. *Acanthostepheia malmgreni* (Goës). Murchison Sound (Ohlin).
9. *Eusirus cuspidatus* Kr. Grinnell Land: Franklin Pierce Bay (Miers).
10. *Apherusa glacialis* (Hans.). North Greenland: Wolstenholme Sound (Ohlin).
11. *Paratylus smitti* (Goës). Murchison Sound (Ohlin).
12. *Amathila homari* (Fabr.). North Greenland Cape Dudley Digges, Northumberland Island; Ellesmere Land: Cape Faraday (Ohlin).
13. *Neohela monstrosa* (Boeck). North Greenland: Murchison Sound (Ohlin).
14. *Caprella monocera* Sars. Cape Dudley Digges (Ohlin).

15. *Glyptonotus sabinei* (Kr.) Cape York (Hansen), Cape Dudley Digges and Cape Faraday (Ohlin).
16. *Diastylis spinulosa* Hell. Murchison Sound (Ohlin).
17. *Nymphon stroemi* Kr. Grinnell Land: Cape Frazer and Floeberg Beach (Miers).
18. *Nymphon robustum* Bell. Grinnell Land: Discovery Bay (Miers, *Journ. Linn. Soc.*, Vol. 15, 1881, p. 72).

ECHINODERMS COLLECTED OFF THE WEST COAST OF GREENLAND BY THE PRINCETON ARCTIC EXPEDITION OF 1899.

BY WALTER M. RANKIN.

The following Echinoderms were collected by the Princeton Arctic Expedition of 1899.

In compiling the list I have endeavored to give, in addition to the identification of the species, some notes on the specimens—their number, locality and peculiarities, together with a tabulation of the distribution of the species in area and depth.

I have not attempted to give a complete synonomy of the species, but merely to quote the original author and, ordinarily, the reference where a more complete description or figure of the species may be found.

HOLOTHURIOIDEA.

1. Cucumaria frondosa (Gunn.).

Holothuria frondosa Gunnerus, Abband. der Kgl. Schwed. Akad. der Wissenschaften, p. 115, Pl. IV, figs. 1, 2, 1767.
Cucumaria frondosa Forbes, History of British Starfishes, p. 209, 1841.

Station 49. Olriks Bay, upper narrows, 15–20 fathoms. 1 specimen.

A single small specimen, 47 mm. long, 34 mm. in diameter as contracted in alcohol. One tentacle, the ventral, is dark colored; the others light.

Distribution.—Florida reefs (dredged), Massachusetts to Labrador, Baffin's Bay (Nares Ex.), Assistance Bay (Penny's voyage), Iceland, North Cape, Spitzbergen, Kara Sea, north coast of Alaska. "The form discovered by Ayres at San Francisco may perhaps be *C. californica*, a closely allied species" (Ludwig).

Ludwig, in *Fauna Arctica*, Bd. 1, pp. 142, 143 (1900), gives the distribution as a two-thirds circumpolar, the species being still unrepresented in the north Asian region, from 70° E. L. to 170° W. L. North and south its extreme points of distribution are, Florida reefs, 24° N. L. on the west, and Plymouth, England, 50° N. L. on the east of the Atlantic, to Spitzbergen, 80° N. L.

Its vertical distribution ranges from 0 to 220 fathoms on the west coast of Iceland. The usual depth is from 3 to 30 fathoms.

2. Myriotrochus rinkii Steenstrup.

Myriotrochus rinkii Steenstrup, Videnskabelige Meddelelser Naturhist. Forening i Kjöbenhavn, pp. 55-60, Pl. III, figs. 7-10, 1851; Theel, Challenger Reports, Zoology, Vol. XIV, Holothuria, p. 37, 1886.

Station 9 Saunders Island, 5-10 fathoms. 1 specimen.

Station 45. Barden Bay, 10-45 fathoms. 32 specimens.

Distribution.—West coast of Greenland to Discovery Bay (Nares Ex.), Assistance Bay (Penny's voyage); east coast of Greenland, Spitzbergen, Barents Sea, Nova Zembla, Kara Sea, Bering Sea, Point Barrow.

As *Cucumaria frondosa*, this also is a two-thirds circumpolar form, being absent in the north Asian region, 71° E. L. to 170° W. L., and in the North American, 156° W. L. to 95° W. L.

It is a strictly Arctic form, its extreme points of distribution north and south being 81° 41′ N. (Discovery Bay) to 57° N. (Skager Rak).

It belongs principally to the littoral region, but has been dredged at a depth of 360 fathoms.

ECHINOIDEA.

3. Strongylocentrotus dröbachiensis (O. F. Müller).

Echinus dröbachiensis O. F. Müller, Zool. Dan. Prodr., p. 235, 1776.
Strongylocentrotus dröbachiensis A. Agassiz, Revision of the Echini, Ill. Cat. Mus. Comp. Zool. Cambridge, pp. 162-267, 1872.

Station 17. Payer Harbor, Cape Sabine, 16 fathoms. 2 specimens.

Station 26. South of Cape Alexander, 27 fathoms. 2 specimens.

Station 29. Olriks Bay, lower narrows, 7-25 fathoms. 7 specimens.

Station 34. Cape York, 10 fathoms. 3 specimens.

Station 39. Granville Bay, 30-40 fathoms. 8 specimens.

Station 49. Olriks Bay, upper narrows, 15-20 fathoms. 1 specimen.

Station 50. Karnah, 30-40 fathoms. 11 specimens.

Station 51. Robertson Bay, 35-40 fathoms. 30 specimens.

Station 52. Robertson Bay, 5–15 fathoms. 4 specimens.

Station 61. Battle Harbor, Labrador, 1 fathom. 33 specimens.

The series of 101 specimens, ranging from 5 mm. to 58 mm. in diameter, shows considerable variation among themselves and from the typical form, as has been noted by Duncan and Sladen in their report on the Echinoderms of the Nares Expedition.[1] The height in two specimens of approximately the same diameter may differ by as much as 10 mm.—as 55 : 35 and 52 : 25 mm.

The specimens on the whole are more depressed than specimens of similar size collected on the Massachusetts coast, and the spines are shorter and less numerous, the cleaned test showing only comparatively few large tubercles.

Distribution.—Numerous stations on the west coast of Greenland: Discovery Bay (Nares Ex.), Assistance Bay (Penny's voyage); Great Britain, Scandinavia, Spitzbergen, Nova Zembla, north coast of Siberia, Ochotsk Sea, Kamschatka, Bering Strait.

An Arctic and Sub-Arctic form, extending as far south on the North American coast as off Chesapeake Bay. A circumpolar form, being found both in the north Atlantic and north Pacific. Its extreme depth is given by Verrill as 640 fathoms.

ASTEROIDEA.

4. Asterias polaris (M. and T.).

Asteracanthion polaris Müller and Troschel, System der Asteriden, p. 16, 1842.

Asterias polaris Verrill, Proc. Boston Society Natural History, X, p. 356, 1866.

Station 1. Domino Run, Labrador, 1 fathom. 4 specimens (3 dry).

Station 2. Godhavn, Disco Island, 8 fathoms. 2 specimens (juventi).

Station 61. Battle Harbor, Labrador, 1 fathom. 12 specimens (4 dry).

A six-armed species. The size of the sixteen adult specimens averages from 160–200 mm. in total diameter. The smallest of the young specimens has a radius of 10 mm. Four of its six arms are in the form of buds.

Distribution.—Greenland, Torske Beach, and at 65° N.,

[1] *Annals of Natural History* (IV), Vol. XX, p. 452, 1877.

twenty-six miles from the coast, at a depth of 30 fathoms (Nares Ex.); Labrador, Gulf of St. Lawrence.

5. **Asterias grœnlandica** (Lütken).

Asteracanthion grœnlandica Lütken, Vid. Meddel. N. Forening i Kjöbenhavn, p. 29, 1857.

Asterias grœnlandica Stimpson, Proc. Acad. Nat. Sci. Phila., p. 142, 1863.

Station 9. Saunders Island, 5–10 fathoms. 5 specimens (2 juv.).

Station 11. Northumberland Island, 10–15 fathoms. 11 specimens.

Station 21. Murchison Sound, 25 fathoms. 1 specimen.

Station 27. Off Cape Chalon, 35 fathoms. 2 specimens.

Station 29. Olriks Bay, lower narrows, 7–25 fathoms. 1 specimen.

Station 32. Foulke Fjord, 14 fathoms. 1 specimen.

Station 40. Granville Bay, 20–30 fathoms. 3 specimens.

Station 50. Karnah, 30–40 fathoms. 1 specimen.

Station 51. Robertson Bay, 35–40 fathoms. 2 specimens.

Station 52. Robertson Bay, 5–15 fathoms. 7 specimens (2 juv.).

The largest of this five-armed species has a radius of 37 mm. Among those from Stations 9 and 52 are very young forms, the smallest measuring only 5 mm. in total diameter.

Distribution.—West coast of Greenland and extending north to Discovery and Assistance Bays, Labrador, Gulf of St. Lawrence, Grand Manan, Spitzbergen and Nova Zembla.[2]

6. **Asterias gunneri** Danielssen and Koren.

Asterias gunneri Danielssen and Koren, Den Norske Nordhavs-Expedition, Asteroidea, p. 7, Pls. II, III, figs. 8, 9, 1884.

Station 49. Olriks Bay, upper narrows, 15–20 fathoms. 1 specimen.

This single fine specimen corresponds very closely to the description given by Danielssen and Koren. The size is slightly larger than the type, diam. 360:330 mm., diam. of disk 54:52 mm. There are some minor differences, as follows: The five rows of spines on aboral surface of the rays are not so regularly arranged and the middle ones are not higher than the lateral. At the sides of

[2] *Challenger Report.*

the rays the spines seem to be less regular in their arrangement; both the dorso- and ventral-laterals are about thirty in number. The rectiform pedicellariæ are similar to the type (*l. c.*, Pl. II, figs. 3 and 4). Those near the dorsal spines are smaller than those round the lateral. The cruciform pedicellariæ, however, seem to differ, being somewhat longer than in the type, and the jaws more convex on their outer surfaces. At the biting tip are two very large, sharp teeth and smaller, scattered teeth are on the concave surface. These cruciform pedicellariæ form very prominent clusters around the two lateral rows of spines.

The species was found originally by its authors in Advent Bay, Spitzbergen, at a depth of 60 fathoms, and they also report two specimens from the Kara Sea as a variety of *A. gunneri*.

This is the first recorded specimen from Greenland waters. The color in the living state corresponds, Dr. Ortmann tells me, to the description given by Danielssen and Koren, "deep red on the aboral surface, whity-yellow on the oral surface." The present alcoholic specimen is yellowish-brown.

7. **Stichaster albulus** (Stimpson).

Asteracanthion albulus Stimpson, Synopsis Marine Invertebrates of Grand Manan, p. 14, Pl. XIV, fig. 5, 1853.
Stichaster albulus Verrill, Proc. Boston. Soc. Nat. Hist., X, p. 351, 1866.

Station 4. Upernavik, 8–10 fathoms. 2 specimens.

Station 9. Saunders Island, 5–10 fathoms. 4 specimens.

Station 11. Northumberland Island, 10–15 fathoms. 5 specimens.

Station 18. Foulke Fjord, 15–20 fathoms. 10 specimens.

Station 29. Olriks Bay, lower narrows, 7–25 fathoms. 3 specimens.

Station 40. Granville Bay, 20–30 fathoms. 1 specimen.

Station 50. Karnah, 30–40 fathoms. 2 specimens.

All the specimens have the characteristic three short and three long arms. Largest specimen: radius of long arm 24.5 mm., of short arm 5.5 mm.

Distribution.—Eastport, Me., and Grand Manan; south of Halifax, 85 fathoms;[3] Greenland, Godhavn and Holsteinborg (Valorous Ex.), Port Foulke (Hayes Ex.), Franklin Pierce Bay (Nares Ex.), Iceland, Spitzbergen, Nova Zembla.

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[3] *Challenger Report.*

An Arctic and Sub-Arctic species. Range, from 3 to 192 fathoms.

8. Cribrella oculata (Linck).

Pentadactylogaster oculatus Linck, De Stellis Marinis, p. 35, Pl. XXXVI, No. 62, 1773.
Cribrella oculata Forbes, Hist. Brit. Starfishes, p. 100, 1841.
Cribrella sanguinolenta Lütken. Vid. Meddel. N. Forening i Kjöbenhavn, p. 31, 1857.

Station 27. Off Cape Chalon, 35 fathoms. 1 specimen.

Station 39. Granville Bay, 30–40 fathoms. 1 specimen (dry).

Station 45. Barden Bay, 10–40 fathoms. 2 specimens.

Station 49. Olriks Bay, upper narrows, 15–20 fathoms. 2 specimens.

The specimens are small (from 17 to 45 mm. in diameter), except the two from Station 45. These are 120 mm. in diameter, and in addition to their size vary from the other specimens in the greater length of the spines, the marked openness of the mesh of the aboral surface, and the irregular arrangement of the spines on the oral surface of the rays. In all these points, however, the specimens closely resemble examples from Eastport, Me., which I have examined in the Peabody Museum at New Haven.

Distribution.—A widely distributed Arctic and Sub-Arctic species. (?)Circumpolar.

From Nantucket shoals north, Labrador, Hall Island, Greenland (Valorous Ex.), Iceland, British coasts, Scandinavia, Spitzbergen, Nova Zembla, White Sea, off north coast of Asia (Brandt), Java (von Martens).

9. Crossaster papposus (Linck).

Triskaidecactis papposa Linck, De Stellis Marinis, p. 43, 1773.
Crossaster papposus Müller and Troschel, System der Asteriden, p. 26, 1842.
Crossaster papposus Sladen, Challenger Reports, Asteroidea, p. 444, 1889.
Solaster papposa Forbes, British Starfishes, p. 112, 1841.
Solaster papposa Danielssen and Koren, Den Norske Nordhavs-Expedition, Asteroidea, p. 48, 1884.

Station 39. Granville Bay, 30–40 fathoms. 3 specimens.

Station 49. Olriks Bay, upper narrows, 15–20 fathoms. 2 specimens.

Of the specimens collected all are 10-rayed, thus differing from the typical form which has 11–13 rays.

The two specimens from Station 49 have an extreme diameter of

80 and 68 mm. respectively, and the proportion of the radii is as two to one. The rays are broader at the base and more tapering than the typical form. As to the adambulacral armature, there are five or six spines in each plate of the longitudinal series and six in the transverse; the former are somewhat webbed at the base.

From Station 39 one specimen resembles very closely the larger one from Station 49. The other two (60 and 80 mm. in diameter respectively) have longer, more slender and less tapering rays; in this respect coming closer to the typical *C. papposus*, the proportions of the radii being about 2¼–2½ to 1. The longitudinal series of adambulacral plates have each three or four spines to a plate, and the transverse series five spines. In all five specimens the paxillæ have longer, more numerous and more divergent spines than does the typical form.

Danielssen and Koren (*l. c.*, p. 44) discuss the relation of *Solaster affinis* (Brandt) to *Crossaster* (*Solaster*) *papposus*, and Sladen (*l. c.*, p. 44) describes a form from the Faröe Islands which he calls variety *septentrionalis* of *C. papposus*, while Duncan and Sladen, in the report of the Echinoderms of the Nares Expedition,[4] mention the variations from the type form in their specimens of *C. papposus*. The present specimens agree with these cited descriptions in the number of the rays (10), but otherwise there are minor deviations from them all. I am inclined to think that all are merely local varieties of an extremely variable species.

Distribution.—Widely distributed over the whole north area of the Atlantic; Arctic and Sub-Arctic: Massachusetts, Newfoundland, Discovery Bay and Franklin Pierce Bay (Nares Ex.), Assistance Bay (Penny's voyage), Iceland, British and north French coasts, Faröe Islands, Scandinavia, Finmark, Murman coast, Spitzbergen, Barents Sea, Nova Zembla. (?) Bering Straits (*C. affinis* Brandt).

10. Solaster endeca (Retzius).

Asterias endeca Retzius, K. Vet. Akad. Handl. Stockholm, IV, p. 237, 1783.
Solaster endeca Forbes, Mem. Werner Soc., VIII, p. 121, 1839.

Station 39. Granville Bay, 30–40 fathoms. 1 specimen.

A single nine-rayed specimen, diameter 30 mm.

Distribution.—North coast of North America, Greenland (dredged at 30 fathoms) (Nares Ex), Iceland, coast of Great

[4] *Annals of Nat. Hist.* (4), XX, p. 457, 1877.

Britain, Faröe Islands, Norway, Spitzbergen, Murman coast. A variety, *decemradiata*, with ten rays at Sitka (Brandt).

11. Pteraster militaris (O. F. Müller).

Asterias militaris O. F. Müller, Zool. Dan. Prodr., p. 234, 1776.
Pteraster militaris Müller and Troschel, Syst. der Asteroid., Suppl., p. 28, 1842.

Station 39. Granville Bay, 30–40 fathoms. 1 specimen.

Station 50. Karnah, 30–40 fathoms. 2 specimens.

The specimen from Granville Bay has R. 23, r. 10. The other two specimens are badly damaged.

Distribution.—North American coast, Bay of Fundy and south to Cape Cod, west coast of Greenland, Dobbin Bay (Nares Ex.), Davis Strait (Valorous Ex.), Smith Sound, British coast, Norway Finmark, Spitzbergen, Nova Zembla, Kara Sea.

OPHIUROIDEA.

12. Ophioglypha sarsii (Lütken).

Ophiura sarsii Lütken, Vid. Meddel. N. Forening i Kjöbenhavn, p. 7, 1854.
Ophioglypha sarsii Lyman, Ill. Cat. Mus. Comp. Zool. Cambridge, No. 1, p. 41, figs. 2, 3, 1865.

Station 39. Granville Bay, 30–40 fathoms. 1 specimen.

Station 40. Granville Bay, 20–30 fathoms. 1 specimen.

Station 45. Barden Bay, 10–40 fathoms. 1 specimen.

Station 49. Olriks Bay, upper narrows, 15–20 fathoms. 3 specimens.

Station 50. Karnah, 30–40 fathoms. 1 specimen.

Station 51. Robertson Bay, 35–40 fathoms. 1 specimen.

The specimens range in size from 20 to 30 mm. disk-diameter.

Distribution.—Arctic and Sub-Arctic, Circumpolar (Ludwig): coast of Maine, Massachusetts Bay and off Martha's Vineyard, Greenland, Discovery Bay and Hayes Point (Nares Ex.), coast of Norway, Spitzbergen, Franz Josef Land, Kara Sea, Barents Sea. Range in depth, 5–2941 meters (Ludwig).

13. Ophioglypha robusta (Ayres).

Ophiolepis robusta Ayres, Proc. Boston Soc. Nat. Hist., IV, p. 134, 1851.
Ophioglypha robusta Lyman, Ill. Cat. Mus. Comp. Zool. Cambridge, No. 1, p. 45, 1865.
Ophiura squamosa Lütken, Vid. Meddel., etc., p. 6, November, 1854.

Station 11. Northumberland Island, 10–15 fathoms. 1 specimen.

Station 12. Foulke Fjord, 35 fathoms. 2 specimens.

Station 18. Foulke Fjord, 15–20 fathoms. 1 specimen.

Station 21. Murchison Sound, 25 fathoms. 3 specimens.

Station 27. Off Cape Chalon, 35 fathoms. 6 specimens.

Station 29. Olriks Bay, lower narrows, 7–25 fathoms. 3 specimens.

Station 45. Barden Bay, 10–40 fathoms. 3 specimens.

Station 51. Robertson Bay, 35–40 fathoms. 2 specimens.

Station 52. Robertson Bay, 5–15 fathoms. 5 specimens.

The specimens vary in size from 5.5 mm. to 11 mm. disk-diameter. In alcohol they have a blue-gray color. Arms are usually marked with lighter transverse bars. According to Lyman's description the side arm-plates do not meet above until about the middle of the arm. I find that in the smaller specimens the side arm-plates meet nearer the disk—at about the fifth to tenth dorsal arm-plate.

Distribution.—Arctic and Sub-Arctic, Circumpolar (Ludwig): North American coast as far south as Cape Cod, Greenland, Discovery and Franklin Pierce Bays (Nares Ex.), Godhavn and Port Foulke (Hayes Ex.); Assistance Bay, *O. fasciculata* (Penny's voyage); Wellington Channel, north of England, Faröe Islands, European Arctic Ocean.

Range in depth, 5 to 18 meters.

14. Ophiocten sericeum (Forbes).

Ophiura sericea Forbes, Sutherland's Jour. Voyage Baffin's Bay, Vol. II, App., p. ccxv, 1852.

Ophiocten sericeum Ljungman, Tilläg. Skan. Oph. öf Kong. Akad., p. 360, 1864.

Ophiocten kröyeri Lütken, Lyman, Ill. Cat. Mus. Comp. Zool., No. 1, p. 53. 1865.

Station 12. Foulke Fjord, 35 fathoms. 12 specimens.

Station 18. Foulke Fjord, 15–20 fathoms. 3 specimens.

Station 21. Murchison Sound, 25 fathoms. 2 specimens.

Station 27. Off Cape Chalon, 35 fathoms. 4 specimens.

Station 34. Cape York, 10 fathoms. 4 specimens.

Station 39. Granville Bay, 30–40 fathoms. 199 specimens.

Station 40. Granville Bay, 20–30 fathoms. 53 specimens.

Station 43. Barden Bay, 20–25 fathoms. 2 specimens.

Station 45. Barden Bay, 10–40 fathoms. 10 specimens.

Station 49. Olriks Bay, upper narrows, 15–20 fathoms. 181 specimens.

Station 50. Karnah, 30–40 fathoms. 30 specimens.

Station 51. Robertson Bay, 35–40 fathoms. 20 specimens.

Station 52. Robertson Bay, 5–15 fathoms. 53 specimens.

This was by far the most numerous Ophiurid found by the expedition, and indeed one of the most common forms brought up by the dredge or trawl. The series contains individuals ranging in size from 2 mm. (Station 34) to 15 mm. (Station 45), disk-diameter.

Distribution.—Arctic and Sub-Arctic: coast of Massachusetts, northeast Atlantic (1,207 to 2,435 fathoms, Porcupine Ex.), Greenland, Discovery Bay, Hayes Point, Franklin Pierce Bay (Nares Ex.), Assistance Bay (Penny's voyage), Iceland, Jan Mayen Island, Faröe Channel, Lofoten Islands, Spitzbergen, Nova Zembla, Kara Sea. Range in depth, 5–4,453 meters (Ludwig).

15. Ophiopholis aculeata Gray.

Ophiopholis aculeata Gray, Radiate Animals of the British Museum, p. 25, 1848.
Ophiopholis bellis Lyman, Ill. Cat. Mus. Comp. Zool., I, p. 96, Pl. I, figs. 4–6, 1865.

Station 60. Battle Harbor, Labrador, 12–14 fathoms. 1 specimen.

This widely distributed species is represented by a single small specimen (3.5 mm. disk-diameter), and thus not strictly among the Greenland collections.

Distribution.—Arctic and Sub-Arctic, Circumpolar: North American coast as far south as Cape Hatteras, Greenland (Nares Ex., lat. 65°), Godhavn (Hayes Ex.), British coasts, Faröe Islands, Iceland, Jan Mayen Island, Spitzbergen, Kara Sea, Bering Straits.

Range in depth, 0 to 1,829 meters (Ludwig).

16. Amphiura sundevalli (Müller and Troschel).

Ophiolepis sundevalli Müller and Troschel, Syst. der Asteriden, p. 93, 1842.
Amphiura sundevalli Ljungman, Oph. Viventia öf K. Akad. p. 320, 1866.
Amphiura holböli Lütken, Vid. Meddel., November, 1854, p. 98.
Amphiura holböli Lyman, Ill. Cat., etc., p. 118, 1865.

Station 27. Off Cape Chalon, 35 fathoms. 1 specimen.

Station 45. Barden Bay, 10–40 fathoms. 4 specimens.

The disk-diameter of these specimens is from 8 to 9 mm.

Distribution.—Arctic and Sub-Arctic, Circumpolar: European and Arctic seas, Greenland, Franklin Pierce Bay (Nares Ex.).

Range in depth, 5 to 201 meters (Ludwig).

17. Ophiacantha bidentata (Retzius).

Asterias bidentata Retzius, Dissertatio, p. 33, 1805.
Ophiacantha spinulosa Müll. and Trosch., Syst. Aster., p. 107, 1842.
Ophiacantha bidentata Ljungman, Oph. Vivent. öf K. Akad., p. 652, 1871.

Station 12. Foulke Fjord, 35 fathoms. 1 specimen.

Station 26. South of Cape Alexander, 27 fathoms. 2 specimens.

Station 27. Off Cape Chalon, 35 fathoms. 4 specimens.

Station 29. Olriks Bay, lower narrows, 7–25 fathoms. 2 specimens.

Station 39. Granville Bay, 30–40 fathoms. 23 specimens.

The specimens vary in size from 6 to 15 mm. disk-diameter.

Distribution.—Arctic and Sub-Arctic: Eastport, Me.; Grand Manan, Newfoundland; Greenland (Nares Expedition). Discovery and Franklin Pierce Bays and Cape Fraser—the most numerous Ophiurian collected by that expedition. (Duncan and Sladen consider the *Ophiura fragilis* of the Parry Expedition to be this species); Penny's voyage—Assistance Bay, *Ophiocoma echinulata*; Iceland, Faröe Channel, coast of Norway from Lofoten Islands to North Cape, Spitzbergen, Barents Sea, Kara Sea. Dredged by "Albatross" at 1,606 fathoms (2,890 meters) off the coast of North Carolina, and by the "Challenger" at 1,350 fathoms, lat. 40° 17′ N., long. 66° 48′ W.

The reported finding by Pfeffer of this specis in Bering Strait is considerd by Ludwig to be doubtful.

CRINOIDEA.

18. Antedon eschrichti (Müller).

Alecto eschrichti Müller, Monatsbericht. d. k. preuss. Akad. d. Wiss., Berlin, p. 183, 1841.
Antedon eschrichti. See Carpenter, in Challenger Report Zool., Vol. XXVI, p. 138, for synonomy.

Station 26. South of Cape Alexander, 27 fathoms. 1 specimen.

Station 27. Off Cape Chalon, 35 fathoms. 2 specimens.

Station 29. Olriks Bay, lower narrows, 7–25 fathoms. 1 specimen.

Station 39. Granville Bay, 30–40 fathoms. 2 specimens.

Station 40. Granville Bay, 20–30 fathoms. 3 specimens.

Station 49. Olriks Bay, upper narrows, 15–20 fathoms. 1 specimen.

Station 51. Robertson Bay, 35–40 fathoms. 6 specimens.

19. Antedon quadrata Carpenter.

Antedon quadrata Carpenter, Challenger Report Zool., Vol. XXVI, p. 149, 1888.

Antedon celtica Duncan and Sladen, Memoir Arctic Echinoderms, London, 1881, p. 75, Pl. VI.

Station 39. Granville Bay, 30–40 fathoms. 3 specimens.

Station 40. Granville Bay, 20–30 fathoms. 2 specimens.

Carpenter (*l. c., supra*, pp. 136ff.) discusses at length the species of Antedon belonging to the *Eschrichti* group of Comatulæ, and gives a complete synonomy of the two species, *eschrichti* and *quadrata.* I find the differences in the material collected by this expedition to be very slight; but there are five specimens from Granville Bay which seem to belong to Carpenter's *quadrata.* Dr. Ortmann tells me that in life there is a distinct difference in their appearance, but this is less evident in the alcoholic material. The color of *quadrata* is lighter and the arms have a less feathery appearance, due to the slightly greater length of the arm-joints and the consequently greater distance between the pinnules. The character, however, of *quadrata* to which Carpenter gives special weight—*i.e.*, the shorter third pinnule as compared with the second —I cannot find at all well marked, though its joints seem, as Carpenter says, to be slightly longer than those of the same pinnule in *eschrichti.*

According to Carpenter the two species are widely distributed through the Arctic Ocean. *Eschrichti* reaches, in Smith's Sound, 79° N. lat., and *quadrata*, 81°.

Both were obtained by the Challenger Expedition as far south as off Halifax, at a depth of 51 fathoms. *Eschrichti* was found by the "Vega" as far east as long. 92° 20′ E.

In depth *eschrichti* has been dredged from 632 fathoms, *quadrata* from 466 fathoms.

The Nares Expedition reports both from Discovery Bay, and other localities are, for *eschrichti*, Davis Strait, Melville Bay, Spitzbergen, and coast of Siberia; for *quadrata*, Barents Sea and Kara Sea.

Of these nineteen species it will be observed that two, *Asterias polaris* and *Ophiopholis aculeata*, are not strictly to be reckoned with the others as they were collected in more southern stations—the former off the coast of Labrador and off Disco, the latter in Battle Harbor, Labrador. The other species are all from between lat. 76° and 79° N., though some species were also found at the more southern stations.

The Arctic Echinoderm fauna has been examined with care, and it was hardly to be expected that any new species would be added to the list of those already known. It is interesting, however, to note at least a new distribution, for *Asterias gunneri* has before this, I believe, never been recorded from Greenland waters.

A comparison is naturally suggested between this list and that of the collection made by Capt. Nares, of the "Alert" and "Discovery," in 1875–6 from the same region, and published by Duncan and Sladen in the *Annals of Natural History* (IV), Vol. XX, 1877.

We have in addition to that list one Holothurid, *M. rinkii*, and two Asterids, *Asterias gunneri* and *Cribrella oculata*; while in the Princeton collection *Asteracanthion* (*Pedicellaster*) *palæocrystallus*, *Solaster forcifer*, *Ophioglypha struwitzii* and *Astrophyton arcticum* (a deep-water form) of the Nares collection are not represented.

Of the nineteen species in the Princeton collection, all but *Asterias polaris* are more or less widely distributed in both American and European Arctic seas.

Increased knowledge of the distribution of Arctic Echinoderms seems to increase the probability that they are nearly all circumpolar and not confined to local areas.

NEW MARINE MOLLUSKS.

BY EDWARD G. VANATTA.

The species herein described were encountered in determining material for the collection of the Academy of Natural Sciences of Philadelphia.

Haminea zanzibarica n. sp. Pl. V, fig. 12.

Shell large, subglobose, thin, shining, translucent, pinkish white, slightly orange-tinted at the vertex and the base. The surface is covered with very close microscopic wavy spiral striæ, longitudinally irregularly coarsely wrinkled, sometimes with several angular spiral ridges caused by spiral malleation. Vertex impressed, imperforate, whitened by an internal thickening of the shell. The aperture is narrow above, ample below. The right lip rises from the left side of the apical depression. Parietal callus very thin. The columellar lip is evenly concave, broadly reflexed, and the edge is not adnate except at the upper end, forming a crescent-shaped free plate over the axial region.

Alt. 20, diam. 14 mm.

Alt. 21, diam. 15.5 mm.

Locality.—Zanzibar.

The type is in the collection of the Academy of Natural Sciences of Philadelphia, No. 57,552.

This species may easily be distinguished from *H. zelandiæ* Gray by its less globular form, less convex parietal wall and the microscopic waved spiral striæ and free edge of the columellar callus. This species is larger than *H. natalensis* Krauss, and the right lip does not rise so high above the vertex. The spiral malleation is similar to that of *Limnæa palustris*.

Haminea succinea var. **solidior** n. Pl. V, fig. 8.

Shell solid, imperforate, finely wave striate, color waxen white.

This variety may be easily distinguished from the typical *H. succinea* Conr. by being heavier and smaller.

Alt. 7, diam. 3 mm.

Locality.—St. Martin and St. Bartholomew, West Indies, and Progreso, Yucatan.

The type is in the collection of the Academy of Natural Sciences of Philadelphia, No. 57,900, collected by Dr. B. Sharp at St. Martin.

Atys sharpi n. sp. Pl. V, fig. 9.

Shell small, subcylindrical, solid, porcellanous, glossy, translucent bluish white, very finely spirally striate, striæ strongest above and below. Apex with an extremely small perforation. Base umbilicate. Aperture narrow above, broader below. The lip rises from the right side of the apical perforation and describes a more or less even arc above without the twist so common in this genus; the outer lip descends in a gentle curve and the basal lip is arcuate. The columella is concave with a slight twist.

Alt. 7.84, diam. 3.8 mm.

Locality.—St. Martin, West Indies.

Types in the collection of the Academy of Natural Sciences of Philadelphia, No. 60,735, collected by Dr. B. Sharp.

This species is easily recognized by the lack of a twist on the evenly curved upper part of the lip.

Tornatina bermudensis n. sp. Pl. V, figs. 6, 7.

Shell small, cylindrical, porcellanous, shining bluish white, smooth. The spire is composed of about three whorls, the first being turned up forms a large tubercle, the other two are round-shouldered. The suture is a very slightly impressed canal, body whorl descending in front. The aperture is nearly four-fifths the entire length of the shell, narrow above and broader below, upper part of aperture with a deep wide sutural notch, parietal wall and columella covered by a very heavy callus, no columellar fold. The base is squarely truncate and receding.

Alt. 2.87, diam. 1.41 mm.

Locality.—Bermuda.

Type in the collection of the Academy of Natural Sciences of Philadelphia, No. 70,160, collected by Prof. Angelo Heilprin.

This species may be distinguished from *T. canaliculata* and *T. decurrens* V. and B. by its heavy parietal callus and the lack of a columellar fold.

Lucina (Divaricella) dalliana n. sp. Pl. V, figs. 10, 11.

Shell almost circular, somewhat truncate posteriorly, nearly equilateral, moderately convex, shining white, porcellanous, surface sculpture divaricate; in full-grown examples there is a smooth band where the diverging lines would meet. The beaks are slightly raised above the hinge line, directed forward and located hardly in advance of the centre; they are sculptured with microscopic concentric striæ only which are worn off in the largest specimen we have. The lunule is about one-eighth the length of the shell The anterior area under the lunule is not distinctly marked. The groove of the ligament is long and narrow. The margin has the interior layer very finely crenulate, but the outer layer smooth. The hinge of the right valve is provided with a heavy cardinal tooth with a pit on each side, and a single tubercular anterior and posterior lateral, the posterior one being about twice as far from the beak as the anterior one. The muscle scars are of moderate size, the anterior one being long and narrow, while the posterior one is more elliptical.

Alt. 19, diam. 20, thickness of right valve 4.5 mm.

Alt. 21, diam. 22.5, thickness of right valve 5.5 mm.

Locality.—In ballast from South Africa.

Types in the collection of the Academy of Natural Sciences of Philadelphia, No. 79,380, collected by Mr. J. G. Malone.

This species is distinguished from *L. dentata* Wood by not having the outer layer of the margin heavily dentate; from *L. cumingii* A. and A. in having the diverging sculpture extending across the anterior area to the lunule, and the inner layer of the margin is crenulate; from *L. quadrisulcata* Orb. in having a smooth band where the diverging lines would meet in full-grown examples; from *L. huttoniana* n. sp. in having the inner layer of the margin crenulate, and in the smooth band.

Lucina (Divaricella) huttoniana n. sp. Pl. V, figs. 14, 15.

Shell almost circular, posterior extremity squarely truncate, nearly equilateral, bluish white with white concentric streaks, glossy, porcellanous, surface sculpture divaricate, the diverging sculpture extending to the edge of the comparatively broad anterior area below the lunule. The beaks are slightly raised above the hinge line, directed forward, located slightly in advance of the centre, sculptured with rather coarse close concentric costellæ only. The lunule is very narrow, beginning as a broad impression under the beak and tapers forward, ending in a shallow point just above the anterior lateral tooth of the hinge. The anterior area under the lunule is strongly defined by the termination of the diverging lines, and is sculptured with irregular rough concentric striæ with more or less yellow epidermis in the interstices. The groove of the ligament is bounded on the inner side by a ridge which begins as an angle near the beak and gradually becomes higher to a point about four millimeters from the end of the hinge line, then suddenly descends almost to the end of the hinge line. The inner margin of the shell is smooth, neither layer being crenulate. The hinge of the right valve has a large heavy cardinal tooth in the centre, with a deep pit on each side and a smaller cardinal in front directed forward. The anterior lateral is a large tubercle with a deep chink where the adductor muscle truncates it; there is scarcely any trace of a tubercle at the posterior end of the hinge. The left valve has the pits for the corresponding cardinals of the right valve and a rather large posterior cardinal, an anterior lateral like the other valve and no posterior lateral. The anterior adductor muscle scar is very long and narrow, while the posterior scar is short oval.

Alt. 29.5, diam. 32, thickness of right valve 8 mm.

Locality.—Auckland, New Zealand.

Types in the collection of the Academy of Natural Sciences of Philadelphia, No. 63,758.

This species differs from *L. dentata* Wood in lacking the dentate margin, from *L. quadrisulcata* Orb. in lacking the crenulate margin. It is distinguished from *L. cumingii* Ad. and Ang. by having a long narrow lunule, more delicate texture and lower beaks; it is also much less globose.

Venus (Anomalocardia) malonei n. sp. Pl. V, figs. 4, 5.

Shell triangular, posteriorly rostrate, moderately convex, longer than high, solid. The color is variable: some specimens are creamy white with irregular transverse zigzag brown spots or stripes, some are almost entirely dark brown, and others are light brown with a few very light radial bands and dark-brown blotches. The interior is generally purple, shading into a white margin with a brown band within the pallial line, but some lack the white margin. Sculpture both concentric and radial. The radial ribs predominate at each end, while the concentric sculpture is strongest in the middle of the valve. Anteriorly the first eight radial ribs are prominent and densely granulose; the median portions of the valves are regularly concentrically costate and radially ribbed, with finer closely packed costæ prominent in the interstices; the concentric costæ are cut into even granules by the crossing radial costæ; at the posterior angle of the valve there are about five or six prominent heavy squamose radial ribs; from this point the radial ribs predominate, and gradually become finer to the posterior margin. Beaks prominent, directed forward, smooth, except a few concentric growth lines. Lunule impressed, a little convex, narrow, about one-fourth the length of the shell, generally of a darker color than the rest of the shell and provided with six or eight longitudinal granulose ribs. The groove of the ligament is linear, tapering at the extremities. The margin is dorsally quite evenly arcuate; rounded anteriorly, a trifle convex at the lunule; evenly arcuate ventrally; posterior obliquely truncate, with a very blunt obtuse angle near the centre. The margin is very finely crenulate; beginning at the anterior side of the beak it is minutely crenulate along the edge of the lunule, becoming coarser ventrally, then gradually becoming finer, and ends abruptly at the posterior end of the ligament. The hinge is broad under the convex lunule, narrower posteriorly, with three teeth in each valve. The right valve has the anterior tooth small, lamellar and nearly parallel with lunule; the middle tooth is triangular and directed forward, its posterior end is nearly vertical, while the anterior end is oblique and almost parallel to the anterior tooth; posterior tooth large, about the size of the triangular central, slightly bifid or grooved at the summit, directed backward. The left valve is three-toothed, anterior tooth lamellar, higher than the rest, directed forward; central nearly lamellar, vertical, with a bifid or grooved summit; posterior small, lamellar, directed obliquely backward, with a pointed summit. The adductor muscle scars of nearly equal size, pallial line evenly arched, with a moderately deep pallial sinus. Alt. 15, diam. 21, diam. 9 mm.

Locality.—In ballast from South Africa.

Types in collection of the Academy of Natural Sciences of Philadelphia, No. 79,395, collected by Mr. J. G. Malone.

This species differs from *V. squamosa* Linn. by being smaller and less rostrate, also in having a predominance of concentric sculpture in the median portion of the valve; the posterior end radially closely ribbed, narrower lunule and much finer crenulation of the ventral margin. The crenulation of the margins inside is much like *V. marica.*

EXPLANATION OF PLATE V.

Fig. 1.—*Vivipara henzadensis* Pils., p. 188.
Fig. 2.—*Ampullaria winkleyi* Pils., p. 189.
Fig. 3.—*Ampullaria winkleyi*, operculum.
Figs. 4, 5.—*Venus malonei* Van., p. 185.
Figs. 6, 7.—*Tornatina bermudensis* Van., p. 183.
Fig. 8.—*Haminea succinea* var. *solidior* Van., p. 182.
Fig. 9.—*Atys sharpi* Van., p. 183.
Figs. 10, 11.—*Lucina* (*Divaricella*) *dalliana* Van., p. 184.
Fig. 12.—*Haminea zanzibarica* Van., p. 182.
Fig. 13.—*Fossarus capensis* Pils., p. 190.
Figs. 14, 15.—*Lucina* (*Divaricella*) *huttoniana* Van., p. 184.

NEW SPECIES OF MOLLUSKS FROM SOUTH AFRICA AND BURMA.

BY HENRY A. PILSBRY.

The Academy has received from the Rev. H. W. Winkley good series of an *Ampullaria* and a *Vivipara* from Henzada, Burma, which though without striking features do not seem referable to any of the numerous described species.[1]

Vivipara henzadensis n. sp. Pl. V, fig. 1.

Shell umbilicate, broadly ovate-conic; olive-green with some narrow slightly darker streaks; surface glossy and smooth, under a lens showing fine, delicate and spaced spiral striæ, which become crowded and somewhat granulose on the base. Spire short, obtuse, the earlier whorls eroded, the eroded portion reddish, tipped with black. Sutures deeply impressed, the whorls strongly swollen just below them; last whorl angular at the periphery in front, the angle disappearing on the last half whorl, which is rounded; umbilicus narrow, excavated behind the columellar lip, surrounded by an angle. Aperture oblique, rounded-ovate, bluish white inside; peristome narrowly expanded at the edge, blunt, black, with a blackish border inside and out; continuous across the parietal margin.

Alt. 23, diam. 16½–17½ mm.

Operculum chestnut-brown and slightly wrinkled outside, with a conspicuous raised or reflexed cuticular border; inside with a conspicuously raised and minutely roughened ovate area nearer the columellar side, radiating striæ on the outside of this area, and a raised border all around.

This species closely resembles the African *V. heliciformis* Ffld. in form and color. It belongs, however, to a group of south-

[1] From Cochin China and neighboring countries Fischer enumerates no less than fifteen species of *Ampullaria* and thirty-eight of *Paludina*, in his useful *Catalogue et Distribution Géographique des Moll. terr., fluv. et marins d'une partie de l'Indo-Chine* (Autun, 1891). To this number a few additions have been made since the publication of that catalogue.

eastern Asia in which the operculum is peculiarly modified, as described above. This subgeneric group I propose to call *Idiopoma*, the above-described species being the type.

Ampullaria Winkleyi n. sp. Pl. V, figs. 2, 3.

Shell narrowly umbilicate, globose; yellowish-olive, uniform or with few or numerous dusky olive spiral bands, the earlier whorls eroded, blackish or ruddy. Surface smooth, somewhat shining, under a strong lens seen to be very densely, microscopically striated spirally, the striæ minutely granulose; spire low-conic; sutures impressed, the whorls flattened below them, elsewhere symmetrically convex. Aperture vertical, semi-rotund, narrower above, reddish-tawny and sometimes banded within, becoming white near the lip; peristome a trifle expanded below, white or dirty yellowish, the outer margin equably curved, columella concave, blunt and more or less thickened but not reflexed, parietal callus rather thin, white, thinner within.

Alt. 58, diam. 50, longest axis of aperture 43 mm.

Operculum (fig. 3) thick and solid, concave externally, and partially covered with a thin, yellowish-brown cuticle. Inside bluish, with a mica-like gleam, the scar of attachment sunken, the columellar side concentrically striate, the enclosed eminence narrow, curved and smooth.

Henzada, Burma. Types No. 76,011, Coll. Acad. Nat. Sci. Phila.

It is somewhat allied to *A. Begini* Morlet.

Donax Bertini n. sp.

Shell long and narrow, the height contained about 2½ times in the length, thin, polished, the color varying from pure white through various tints of pink to purple; beaks situated at the posterior third of the length; anterior end rounded, posterior end obliquely truncate, rounded at the extremity; the upper margin anterior to the beaks straight, basal margin but slightly curved; ridge defining the posterior area rounded. Surface sculptured with slight growth wrinkles, and faintly showing some fine radial striæ, which, however, are almost completely obsolete, though plainly visible by looking through the shell, except near the anterior end; the *posterior area is sculptured with deep oblique grooves*, the summits of the intervening ridges cut by finer radial striæ. Interior smooth or radially striate; pallial sinus extending nearly to the middle of the shell's length; the margin finely crenate.

Length 15.5, alt. 6, diam 4.5 mm.

Found by Mr. J. G. Malone in ballast from South Africa.

Types are No. 79,532, Coll. Acad. Nat. Sci. Phila.

This species is somewhat allied to *D. Oweni* Gray, but the beaks are nearer the posterior end, the valves are not keeled; the posterior costulation extends further, and between and upon the riblets fine radial striæ are conspicuous; finally, the basal margin is finely and strongly crenulated inside and the shell is smaller.

It is named in honor of M. Victor Bertin, whose excellent *Revision des Donacidées* (1881) and various other papers on bivalves give evidence of a well-trained and acute mind, unfortunately lost to science by death at the beginning of a useful career.

The following species of *Donax* occurred with *D. Bertini*: *D. Madagascariensis* Wood, *D. bipartitus* Sowb., *D. spiculum* Rve., *D. Erythrœensis* Bertin.

Fossarus capensis n. sp. Pl. V, fig. 13.

Shell perforate, turbinate, white, the last whorl encircled by three very strong, compressed, flange-like keels, the largest peripheral in position, the smallest surrounding the columellar region, another of intermediate size between these two. Surface irregularly striatulate, with some lamellar riblets toward the aperture; densely spirally striate, especially between the keels. Spire acute; whorls about 6, the last three showing the peripheral keel above the sutures. Aperture semicircular, the peristome continuous, notched at the terminations of the keels.

Alt. 6, diam. 4 mm.

In ballast from South Africa.

Type in Coll. Acad. Nat. Sci. Phila., No. 79,820.

The spire is more elevated than in *F. ambiguus* (L.) or *F. pusillus* (Gld.).

March 5.

Mr. Charles Roberts in the Chair.

Twelve persons present.

March 12.

Mr. Arthur Erwin Brown, Vice-President, in the Chair.

Seventeen persons present.

A paper entitled "Observations made in 1900 on Glaciers in British Columbia," by George and William S. Vaux, Jr., was presented for publication.

March 19.

The President, Samuel G. Dixon, M.D., in the Chair.

Eighteen persons present.

Papers under the following titles were presented for publication:

"New Mollusca from Japan, Formosa and the Philippine Islands," by Henry A. Pilsbry.

"The Forficulidæ, Blattidæ, Mantidæ and Phasmidæ collected in Northeast Africa by Dr. A. Donaldson Smith," by James A. G. Rehn.

"The Limits of Variation in Plants," by John W. Harshberger, M.D.

March 26.

The President, Samuel G. Dixon, M.D., in the Chair.

Twenty-three persons present.

The death of E. O. Thompson, a member, on the 21st inst., was announced.

F. S. Manderson was elected a member.

Y. Hirase of Kioto, and Carlos de la Torre of Havana, were elected correspondents.

The following were ordered to be printed:

NEW MOLLUSCA FROM JAPAN, THE LOO CHOO ISLANDS, FORMOSA AND THE PHILIPPINES.

BY HENRY A. PILSBRY.

The discovery of the major portion of the species herein defined is due to the untiring industry of Mr. Y. Hirase, of Kyoto, Japan, whose researches bid fair to surpass those of any previous naturalist in the extent of his additions to our knowledge of the Japanese molluscan fauna.

Illustrations of the following species will accompany a continuation of this paper, now in preparation.

HELICIDÆ.

Eulota succincta var. **amblytropis** n.

Differs from *succincta* in having the peripheral keel obsolete on the latter part of the last whorl, which is quite rounded. Pale yellowish, with a dark reddish-chestnut peripheral band, and two somewhat lighter reddish bands, one above, the other wider, midway between periphery and umbilicus. Surface rather smoother than in *succincta*.

Alt. $17\frac{1}{2}$, diam. 26 mm.

Alt. 16, diam. 23 mm.

Alt. 14, diam. 21 mm.

Formosa. Coll. A. N. S. P. (No. 78,187), and Univ. of Michigan.

Eulota Sargentiana n. sp.

Shell narrowly umbilicate, globose-turbinate, rather thin, slightly shining; light yellowish brown with a narrow red-brown band or line at the periphery, and reddish within the umbilicus. Spire elevated, conic, the apex acute; whorls 6, somewhat convex, slowly increasing, the last angular at the periphery in front, becoming rounded on the latter half, rather swollen below, but distinctly flattened around the umbilicus, especially just behind the basal lip. Aperture quite oblique, irregularly lunate; peristome thin, distinctly though narrowly expanded, the basal lip straightened, reflexed; rather suddenly dilated at the columellar insertion, half covering the umbilicus; parietal callus scarcely perceptible.

Alt. 22, diam. 28 mm.

Formosa. Coll. A. N. S. P. (No. 78,188), and Univ. of Michigan.

This species belongs to the group of *E. succincta*, differing from that form in the more globose and conic shell, rather acute spire, and straightened basal lip. It is named in honor of Mr. H. E. Sargent, the efficient curator of the museum of the University of Michigan.

ZONITIDÆ.

Lamprocystis spadix S and B., var. **cinctus** n. v.

Shell white, with a supraperipheral red-brown band. Formosa (J. B. Steere). Numerous examples of the typical *L. spadix* were also taken by Mr. Steere.

Vitrinoconus Moellendorffi n. sp.

Shell high-conic, thin, light brown; rather strongly but irregularly striate, the striæ slightly arcuate, weaker beneath and disappearing on the early whorls; outlines of the spire almost straight, the apex obtuse. Whorls 9, very slowly increasing, very slightly convex, the sutures filled by a seam-like cord; last whorl acutely keeled, the keel compressed, projecting: base slightly convex. Umbilicus contained 3⅓ times in the total diameter of the shell, well-like, with flattened sides, bordered by a projecting and compressed cord-like keel. Aperture oblique, small: acutely angular at the position of the peripheral keel, and emarginate where the umbilical keel terminates; the basal margin arcuate; peristome perceptibly thickened, the outer lip simple, basal and columellar margins a little expanded.

Alt. 7.7, diam. 10 mm.; umbilicus 3 mm.

Alt. 8.2, diam. 10 mm.; umbilicus 3 mm.

Panay, Philippines (J. B. Steere Exped.).

This species belongs to the "group of *V. cyathellus*" in Dr. von Möllendorff's excellent arrangement of the genus (Semper's *Reisen*, VIII, p. 42), and to the first division of that group in von Möllendorff's key, which to accommodate this species may be supplemented thus:

A.—Umbilicus bounded by an angle :
- *a.*—Umbilical angle simple; whorls $8\frac{1}{2}$, . *V. goniomphalus.*
- *a'.*—Umbilical angle bearing a cord-like keel:
  - *b.*—Alt. two-thirds of the diam. Width of umbilicus contained $4\frac{1}{2}$ times in diam. of base. Whorls $9\frac{1}{2}$, *V. omphalotropis.*
  - *b'.*—Alt. somewhat exceeding three-fourths the diam. Umbilicus contained $3\frac{1}{3}$ times in diam. Whorls 9, *V. Moellendorffi.*

Besides the differences between *Moellendorffi* and *omphalotropis* given in the above table, the former has the base decidedly more flattened.

SUCCINEIDÆ.

Succinea ogasawaræ n. sp.

Shell short and broad for the genus, squarish-oblong; very thin, translucent and corneous with whitish streaks and clouds, rather coarsely wrinkled in harmony with the lines of growth. *Spire excessively short, obtuse,* flattened above, there being barely two whorls separated by a comma-shaped suture; the last whorl quite convex, its earlier portion very convex. Aperture very large, eleven-twelfths the greatest length of the shell, very broadly ovate in form. Greatest length of shell (measured obliquely to the axis) 12.5, greatest width (measured at right angles to preceding) 8.5; convexity 4.8; longest axis of aperture 11.5, width $8\frac{1}{2}$ mm.

Ogasawara (Bonin) Islands (Mr. Y. Hirase, No. 617*a*).

A remarkable species, in which the spire is reduced to a mere papilla, and the last whorl is large and convex. If the measurements were taken in the conventional manner, the diameter would about equal the altitude, but in a species so oblique in two planes as this one, I have preferred to give measurements not involving the direction of the columellar axis.

Succinea punctulispira n. sp.

Shell ovate, very thin and fragile, pale yellow, subtranslucent, the spire sometimes slightly tinted with red; sculpture of moderately coarse growth wrinkles, and upon the spire and earlier portion of the last whorl minutely and densely punctate, the pits arranged in spiral series. Spire rather short and conically projecting, composed of $2\frac{1}{2}$ whorls, the first one very convex; last whorl convex, *distinctly dilated or bell-shaped at the mouth.* Aperture regularly ovate, the outer lip evenly curved, columellar lip simple and narrow. Length (measured in the ordinary manner) 13, diam. 9, longest axis of aperture 11, width 7.5 mm. Largest specimen in type lot 14.5 mm. long.

Ogasawara, or Bonin, Islands (Mr. Y. Hirase, No. 617*b*.).

I am no enthusiast on the subject of specific differentiation in the genus *Succinea*, but the two species described above differ from those previously known so strongly that they become of some interest. It is questionable whether these species are of common ancestry with *S. lauta* or *S. horticola*, the two Japanese *Succineas*. I incline to the view that they have no direct relationship.

Some years ago, the Abbe A. Vathelet gave me specimens of *Succinea lauta* under the name "*S. Vatheleti* Mabille." I do not know that this supposed new species has been published.

COLUMBELLIDÆ.

Columbella polynyma n. n.

Columbella misera Sow., Dunker, Index Moll. Mar. Jap., p. 54. Not *C. miser* Sowb., Thes. Conch., I, p. 129 *bis*, Pl. 38, fig. 111.

Columbella japonica Martens, Conchol. Misc., in Archiv f. Naturg., LXIII, 1897, p. 170, Pl. 16, fig. 6. Not *C. japonica* Reeve, Conch. Icon., 1858.

Shell short-fusiform, solid, yellow or orange-yellow, typically with a subsutural white band irregularly marked with black-brown or red-brown, the slender lower portion of the base also whitish with dark or reddish dots or stripes; two white lines or girdles likewise dark-dotted upon the intermediate part of the last whorl; but sometimes the dark markings are faint or in part wanting. Surface glossy, sculptured with very short longitudinal folds above, scarcely reaching the suture and not extending below the periphery; the folds on the spire becoming weak at both sutures. Base spirally lirate. Whorls about 6½. Aperture rather narrow, the outer lip thick and furnished with a series of short folds within; columella smooth. Length 11, diam. 5.3, length of aperture 5.5 mm.

Kumihama, prov. Tango (Mr. Y. Hirase). Types No. 80,556, coll. A. N. S. P., from 1,097 of Mr. Hirase's collection.

This pretty little *Columbella* has fared ill in the matter of names, as the references above bear witness. It is closely related to the true *C. misera* of Sowerby, but that species has stronger folds, especially those upon the spire, and a white or nearly white ground-color profusely marked with blackish-brown, the summit of each fold having a vertical line or a spot of that shade. In *C. polynyma* the folds are weaker, and the color-scheme quite different.

C. misera was taken in some numbers by Mr. F. Stearns at Kamakura, prov. Sagami. The specimens vary from completely typical to a broader form. The habitat of the type was unknown, but from the exact agreement of Japanese examples with the original figure, it may not unlikely have been from Japan. I know of no other positive locality for the species.

Prof. von Martens has quoted the figures of *C. miser* Duclos in Chenu, *Illust. Conchyl.*, Pl. 21, figs. 13–16, as representing his *C. japonica;* but these figures show the characteristic spots on the ribs of *C. misera*, and in my opinion do not represent any form of the present species.

BUCCINIDÆ.

Chrysodomus intersculptus var. **frater** n.

Shell differing from *C. intersculptus* Sowb.[1] in having fewer and comparatively stronger spiral ribs, the intervals densely and finely striate spirally, the anterior canal longer, more slender, with no appearance of a siphonal funicle. Length 84, diam. 45, length of aperture 50 mm.

Kizennuma, prov. Rikuzen (Mr. Y. Hirase).

Typical *C. intersculptus* comes from the west coast of the main island. This form probably replaces it on the east or ocean coast.

FASCIOLARIIDÆ.

Peristernia ustulata var. **luchuana** n.

Similar in form and sculpture to *P. ustulata* (Rve) from the Fiji Islands, but with fewer and larger longitudinal folds, 7 on the last whorl; fleshy buff, usually with a brown spot in each interval at the periphery, the aperture yellow and lirate within, the end of the anterior canal blackish purple. Columella with two folds, stronger than in *P. ustulata*. Length 28, diam. 12, length of aperture 14 mm.

Loo Choo Islands (Mr. Y. Hirase).

This form resembles *Peristernia infracincta* (Kobelt)[2] in coloration, but differs in wanting the subcentral stronger spiral on the upper whorls, and four larger spirals below the periphery of the last whorl, which Kobelt found constant in ten specimens of his

[1] *Ann. Mag. Nat. Hist.* (7), IV, p. 371, Nov. 1899. Mr. Hirase sends this species from Kumihama, prov. Tango.

[2] *Conchylien Cabinet*, "Turbinella," p. 92, 157.

species. *P. ustulata*, in the wide limits given by Tryon,[3] has a somewhat extended range in the southwest Pacific, but it has not before been reported from so far north as the Loo Choo group.

LITTORINIDÆ

Echinella Cumingi var. **luchuana** nov.

Shell similar to *E. cumingi* Phil. in having a circular, deep umbilicus bounded by a white marginal rib; but narrower, with the last whorl less depressed, the two peripheral series of tubercles much less prominent, some coarse, subtuberculate cords revolving between them, and also below the sutural series. Base more convex, with finer and not granose spiral striæ below the subperipheral series of granules. Flesh-colored, violet or bluish, the tubercles whitish. Aperture orange-brown inside; dark brown with the columella purple, in violet or bluish shells.

Alt. 16, diam. 14 mm.

Alt. 13, diam. 11 mm.

Loo Choo Islands (Frederick Stearns, Y. Hirase).

This is the form I reported from the Loo Choo Islands in *Catal. Mar. Moll. Jap.*, p. 175. I have seen a great many specimens, but none approach the real *Cumingi* of Polynesia.

TURBONILLIDÆ.

Turbonilla varicifera n. sp.

Shell long and slender, white, composed of at least 15 whorls (the nuclear portion broken off). Sculpture of close, rather stout rounded ribs only very slightly sinuous or oblique, about 19 in number on the last whorl (which ends with a broad varix), as wide as or slightly wider than the intervals, and stopping abruptly just below the periphery, the somewhat convex base very faintly striated spirally. Scattered among the ribs there are a few stout, wide, rounded varices, at intervals of several whorls. Aperture small, subtrapezoidal, the columella straight and vertical.

Length 11.8, diam. 2.6 mm.

Hirado, Hizen (Mr. Y. Hirase).

This rather large, many-whorled and varicose species differs from *T. varicosa* in having the columella straight above, not "superne valde sinuata," as Dunker describes his species.

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[3] *Manual of Conchology*, III, p. 84.

TROCHIDÆ.

Cantharidus (Phasianotrochus) Hirasei n. sp.

Shell ovate-pyramidal, solid, of a uniform olive or brownish-olive color, or belted with numerous reddish spiral bands. Smooth except for faint growth-lines above, the base scored by 5 or 6 narrow, spaced, concentric grooves, stronger near the axis. Spire conic, whorls 6½, convex, the last subangular at the periphery, convex beneath. Aperture oblique, brilliantly green inside, with a dusky submarginal band, the edge pale; columella opaque white, rounded; the umbilical region imperforate or with a very minute perforation.

Alt. 10, diam. 6.5 to 7 mm.

Hirado, Hizen (Mr. Y. Hirase).

This is a true *Phasianotrochus*, the first made known from Japan, having the green nacre of the interior iridescent with the characteristic splendor of the subgenus. The other species of this division are from Australia and Tasmania.

In one banded specimen the earliest three whorls are variegated with pink and white, like a *Phasianella*, and assimilating to some Australian species of *Phasianotrochus*.

Cantharidus bisbalteatus n. sp.

Shell elevated conic, imperforate or minutely rimate, glossy. Encircled by a crimson or scarlet belt at the periphery and another bordering the suture below, continuous or interrupted by white streaks or spots, and roseate around the umbilical tract, the intervening spaces somewhat olivaceous, with a few narrow spirals of alternate blue or white and red-brown dots; two or three of these spiral lines ascending the spire. Sculpture of slight growth-lines and fainter or wholly obsolete fine spiral striæ above, and about 6 fine-spaced grooves around the umbilical region, stronger toward the middle. Spire conic, the apex acute; whorls about 6½, quite convex, separated by an impressed suture, the last whorl subangular at the periphery, convex beneath. Aperture oblique, rounded-rhombic, pearly and iridescent within, with green, or green and red reflections; scarcely showing any appearance of sulcation. Columella white, concave above, somewhat straightened in the middle; columellar area excavated, white.

Alt. 12.5, diam. 8.5 to 9 mm.

Hirado, Hizen (Mr. Y. Hirase).

Compared with the excessively variable *C. japonicus* (A. Ad.), described as *Zizyphinus japonicus*, the present species differs in being shorter and broader. with more convex whorls, less angular periphery and smoother base, the concentric grooves being finer, and not extending outward so far.

Clanculus gemmulifer n. sp.

Shell low-trochiform, solid, angular at the periphery, slightly convex beneath. Ground-color red or dull red. Sculpture of spiral cords cut into smooth rounded beads, these cords a little narrower than the intervals on the upper surface, smaller on the base and about equal in width to their intervals. Above the periphery on the last whorl there are five bead-rows, all of them dotted, either having a black interval between two white beads, or with a black and a white bead, the intervals consisting of two or three red beads; base similarly variegated, but the dots are sometimes brown. Furrows between the bead-rows finely and densely decussate by spiral and oblique raised striæ or threads. Spire straightly conic, the apex acute, roseate. Whorls about 6, the last deflexed in front. Aperture oblique, contracted by a simple, rather compressed fold at the foot of the columella, and another near the upper end of the outer lip, several small folds between them. Columella contorted above, deeply entering the false-umbilicus, the margin of which is toothed. Parietal callus strongly plicate.

Alt. 7.5, diam. 9 mm.

Hirado, Hizen (Mr. Y. Hirase).

Closely related to *C. margaritarius* Phil., which occurs at the same locality, but is larger and more elevated, with more whorls, and further differs in the trifid columellar tooth, more rounded periphery, and in having the first and third bead-rows unspotted except close to the aperture. A well-grown specimen of *C. margaritarius* measures: alt. 15, diam. 16 mm. *C. unedo* is a more elevated species, with heavier columellar fold and some unspotted bead-rows.

Clanculus microdon var. **ater** n. v.

Shell black with a few inconspicuous whitish dots and bright rose apex, the coloration resembling *C. atropurpureus* Gld. Spiral liræ about 17 on the last whorl, with threads or minor liræ in some of the intervals. Whorls of the spire angular by the prominence of the middle beaded cord. Whorls 6.

Alt. 11, diam. 13 mm.

Hirado, Hizen (Y. Hirase).

Seems to agree with *C. microdon* except in coloration, greater number of spiral cords and other characters given above, but will probably be considered a separate species eventually. From the Polynesian *C. atropurpureus*, which von Martens reports from the Mergui Archipelago, it is distinct in sculpture, etc.

Clanculus hizenensis n. sp.

Shell turbinate, moderately solid, alternately whitish and dark brown in broad radial flames above, whitish profusely speckled with olive-brown beneath. Sculpture of four coarse, spaced, beaded, spiral cords above, separated by intervals of their own width, sharply and densely striate by the growth-lines; the base with 9 much smaller, closer, concentric cords, slightly cut by obliquely radial grooves, the outer cord larger. Whorls nearly 6, the last rounded at the periphery, slightly convex beneath. Aperture oblique, rounded, the outer lip usually weakly plicate within in fully mature shells; columella having a weak fold above, and inserted on the right side of the umbilicus, terminating below in a strongly projecting, simple, tooth-like fold. Marginal rib of the umbilicus having a few weak nodules.

Alt. 7, diam. 7.5 mm.

Hirado, Hizen (Mr. Y. Hirase).

Closely resembles the more plain-colored specimens of *C. Thomasi* Crosse, from New Caledonia, but the spirals above are less unequal, more strongly beaded and more spaced, with sharply striate intervals. It is a somewhat larger shell than *C. Thomasi*. Sometimes one or two of the spaces between the cords of the upper surface bear a minute thread.

Euchelus ruber A. Ad., var. **brunneus** n. v.

Shell similar to *E. ruber*, but dull brown or fleshy brown, with scattered brown dots.

Alt. 6½, diam. 6 mm.

Hirado, Hizen.

Similar to *E. ruber* in sculpture, but as all the Japanese specimens I have seen are different in color, it is probably distinguishable as a dull-colored race.

Chlorostoma argyrostomum var. **basiliratum** n.

Shell imperforate, smaller than the typical form, with coarser corrugation above, the base strongly lirate concentrically.

Hirado, Hizen (Mr. Y. Hirase).

This form is intermediate between the finely corrugated Chinese *argyrostomum* and the coarsely sculptured Japanese species of *Chlorostoma*. I know of no authentic record of *C. argyrostomum* from Japan.

ACMÆIDÆ.

Acmæa Heroldi var. **signata** nov.

About the size and form of *A. Heroldi*. Nearly smooth or with very low, weak radial ribs; white, with eight gray rays variegated with brown. Interior white or brownish within the muscle-scar, the edge dotted and maculate with brown.

Length 13, breadth 10, alt. 4 mm.

Otoshima, prov. Bitchu (Mr. Y. Hirase).

A form from Kamakura, taken by Mr. F. Stearns, seems referable to this variety. It is smaller and higher, length 9.5, breadth 7.5, alt. 4 mm., without a marked internal margin or central area, the rays showing through.

It may be well to say in this connection that the *Patella pallida* of Gould, formerly referred by me to *Helcioniscus*, is a true *Acmæa* in shell characters. Mr. Hirase has sent specimens from Mashike, Teshio, in Hokkaido.

Patella grata Gould has "about the contour of *Helcioniscus eucosmius* Pils., is quite acutely conic, with strongly spinose ribs," according to a note I made on the type, No. 1,965, U. S. National Museum.

PATELLIDÆ.

Patella luchuana n. sp.

Shell small, solid, rounded-oval, conic, the altitude nearly half the breadth; apex erect and acute, situated a little in front of the centre; anterior and posterior slopes somewhat convex. Surface dull, sculptured with many narrow riblets, several inconspicuous radial threads in each interval. Greenish gray, indistinctly speckled with dark brown. Interior bluish or livid white, the area within the muscle-impression large, calloused, the impression distinct, impressed. Edge beveled, having a narrow gray or greenish border and profusely or sparingly dotted with black-brown.

Length 12, breadth 10, alt. 4.5 mm.

Length 13, breadth 10.5, alt. 4.5 mm.

Loo Choo Islands (Mr. Y. Hirase).

A small species with inconspicuous sculpture, but so solid that I take the specimens to be adult. The base is curved in some specimens, as though they had lived on shells, while in others it is nearly level. None of the species described from the region resembles this one.

CHITONIDÆ.

Onithochiton Hirasei n. sp.

Oblong, moderately elevated, not carinate, the dorsal ridge being rounded, side slopes straight; smooth and glossy, yellow marbled with whitish, having a chestnut triangle or some chestnut dots at the ridge of each valve, several blue and olive clouds or blotches in front of the diagonal lines, and with more or less variegation of the same colors on the lateral areas.

Anterior valve having black eyes arranged in about 10 primary radii, with many others irregularly scattered or in shorter rows. Valve ii, as usual, longer than iii to viii; all intermediate valves beaked, having the lateral areas indistinctly defined, the diagonal ridge inconspicuous except near the beaks; growth-lines fine, curving backward on the ridge; and adults have several spaced, deeper concentric grooves near the sides and anterior margin of each valve; *near the beaks the diagonal ridge becomes raised and beaded, and there are irregular, forwardly-converging zigzag grooves upon the pleural tracts.* A narrow line of eyes radiates along the anterior part of each lateral area; and there are pits as large as the eyes, but not pigmented, scattered sparsely upon the pleural tracts. Valve viii depressed, triangular, with the usual terminal apex, and linear, rugose, posterior area; the breadth of the tegmentum twice its length.

Interior white, stained with dull purple and punctulate in the middle; valve-callus heavy; reflexed border rather wide; sinus rather wide, finely denticulate; insertion plates moderately long, finely pectinated outside; slits 9 in valve i, 1–1 in valves ii to vii; a wide, flat ledge in place of the insertion-plate in valve viii.

Girdle dark brown with irregular buff patches, smooth to the eye, but seen to be microscopically granulose under a strong lens.

Length about 36, width 20 mm.

Hirado, prov. Hizen. Types No. 80,571, coll. A. N. S. P., from No. 1,176 of Mr. Hirase's catalogue.

This is the first species of the genus described since the publication of my monograph in 1892, and the only one known from north of the equator. The sculpture of the valves is unlike any described *Onithochiton*. A very young specimen was reported as "*Tonicia* sp." in the *Nautilus*, XII, p. 50.

It is named in honor of my esteemed Japanese correspondent.

CRYPTOPLACIDÆ.

Two species of *Cryptoplax*, the first known from north of the equator, have been found by Mr. Hirase, at Hirado, Hizen. One of them, which I call *C. japonicus* n. sp., has valve-sculpture like *C. Gunnii* (Rve.) of South Australia, and the spacing of the valves along the back is similar; but in the Japanese species the last four valves are smaller, valve viii being scarcely longer than valve ii, while in *C. Gunnii* and *C. striatus* it is a fourth longer. The girdle is densely spiculose, much as in *C. striatus*. The articulamenta are green.

Length of dried animal about 26, breadth 5.5 mm.

In another species, *C. rhodoplax* n. sp., the valves are spaced about as in *C. japonicus*, but are sculptured much as in *C. larvæformis*, with low, irregular ridges parallel to the lateral margins of the valves, the articulamenta being bright rose colored. Valve vi is the smallest. The posterior insertion-plate of valve viii is vertical; and the sutural laminæ and insertion-plates of all the valves are much shorter than in *C. larvæformis*.

Length of the dried animal 28 mm.

A full account of these species will be given later; and meantime I hope to procure alcoholic specimens for description and illustration.

PETRICOLIDÆ.

Petricola cyclus n. sp.

Shell solid, white, subcircular though with somewhat irregular outline, swollen, the beaks full, projecting, turned forward, situated at about the anterior third of the length. Periphery convex throughout, the posterior end sometimes a little produced. Sculpture of slightly irregular radial riblets about equal to their intervals, often stronger posteriorly, gradually weakening anteriorly and wholly obsolete on the anterior half or third of the valve; rude, crowded, bluntly lamellar circular striæ everywhere minutely roughening the surface. Interior white, the pallial sinus large and rounded, extending to about the middle of the shell's length. Hinge rather strong, the right valve with two diverging, rather compressed, and long, erect, cardinal teeth, the posterior one the more slender; left valve with an erect, triangular, bilobed cardinal, with a subobsolete, diverging tooth on either side. Ligament short, almost entirely immersed.

Length 15, alt. 15, diam. 12 mm.

Hirado, Hizen (Mr. Y. Hirase). Types No. 80,580, coll. A. N. S. P., from No. 1,199 of Mr. Hirase's collection.

A very short, subglobular species, somewhat related to *P. lithophaga* Retz. of Europe, but rounder, with more deeply immersed ligament, stouter hinge, different shaped and stronger teeth. The sculpture in some specimens is not dissimilar. As usual in the genus, the teeth are liable to fracture, and when broken often do not show plainly that they are injured.

In a variety which may be called var. *sculpturata* the posterior end is more prolonged, and the entire surface of the valves ribbed. The teeth agree with *P. cyclus*. Types from Puttalam, Ceylon (Coll. A. N. S. P.). One specimen from Hirado, Hizen, seems to belong here.

Petricola cyclus belongs to the section *Rupellaria*,[4] as defined by Prof. Dall in his exposition of the *Petricolidæ*;[5] the section *Claudiconcha* being represented in Japan by *P. monstrosa*, and the section *Petricolaria* by *P. æquistriata* Sowb.

VENERIDÆ.

Venus Hirasei n. sp.

Shell rounded-oval, ventricose, inequilateral, very solid and strong; cream-white, clouded and maculate with dull brown. Surface lustreless, sculptured with 24 to 28 strong, curved, radial

[4] Fleurieu-Bellevu, *Journ. de Phys.*, LIV, 1802, p. 345; *Bull. Soc. Philomath. de Paris*, III, 1802, p. 106.

[5] *Trans. Wagner Free Institute of Science*, III. Pt. 5 (December 1, 1900), p. 1058.

ribs, fully double the width of the interstices, closely and irregularly crenulated by low concentric blunt, crowded laminæ, which on the later growth are obsolete in the grooves, but toward the beaks are narrower and sharper, less crowded, and continuous across ribs and intervals. Beaks full, projecting, curved forward. Lunule heart-shaped, dark brown, ribbed and defined by a groove. Area well sunken, ribless and wide in the left valve, indistinct in the right.

Anterior end short, rounded; posterior end more broadly rounded. Interior pure white, the right valve with three diverging cardinal teeth, the posterior two grooved; left valve with two cardinals, the anterior one slender, posterior stouter, shorter and deeply grooved.

Cavity of the beaks deep. Pallial sinus small, triangular, narrow and acute. Valve margins, except the hinge line, very weakly fluted and closely crenulate.

Length 43, alt. 37.5, diam. 29 mm.

Hirado, Hizen (Mr. Y. Hirase).

This species resembles *V. jedoensis* Lischke, but has hardly more than half as many, and stronger, ribs. There is a specimen before me from Susaki, Awaji Island, besides several from the type locality.

Tapes platyptycha n. sp.

Shell oblong, compressed, the length somewhat exceeding $2\frac{1}{2}$ times the diameter; white, profusely marked with angular red-brown reticulating lines grouped into triangular spots, or with inverted V-shaped markings, and four radial series of brown blotches alternating with white spots. Sculptured with concentric ridges wider than their intervals, broad and flattened toward the lower margin and especially posteriorly, fine and close toward the beaks. Beaks low, yellow or purple, situated at about the anterior fifth of the length, the dorsal margin behind them nearly straight; posterior end obliquely truncate, bluntly regular at its junction with the upper and basal margins. Anterior end short, rather attenuated, much as in *T. adspersa.* Lunule narrow, indistinctly defined by an impressed line, flattened, marked with some oblique brown lines. Area depressed, transversely maculate with groups of dark lines. Interior white, tinted with sulphur yellow within the pallial line. Pallial sinus broad and rounded, not quite reaching the middle of the length of the shell. Anterior cardinal tooth in each valve compressed and simple, the middle one stouter, bifid.

Length 54, alt. 37, diam. 21 mm.

Hirado, Hizen (Mr. Y. Hirase).

This species stands near *T. quadriradiata* Desh., differing in the coarser sculpture, more distinctly truncate posterior end, and decidedly shallower pallial sinus. The color of the interior is also different. *T. deshayesii* Hanley has a narrower and deeper pallial sinus.

Tapes phenax n. sp.

Shell oblong, rather swollen, the diameter contained 2¼ times in the length; pale yellow, densely reticulated with angular reddish-brown and purplish lines, darker in four wide rays, which are more or less blotched with brown; pale flesh-tinted or whitish toward the beaks. Sculpture of fine, crowded, concentric rib-striæ. Beaks moderately prominent, at about the anterior fifth of the shell's length. Dorsal margin moderately curved; posterior end rounded; basal margin well arched; anterior end short, rounded. Lunule rather broadly lanceolate, defined by slight grooves, dark, with irregular darker lines. Area lanceolate, sunken, smooth, variegated. Interior white at the margins, ochre or reddish-yellow in the cavity. Pallial sinus broad and deep, reaching the middle of the shell's length or slightly past it.

Length 46, alt. 31, diam. 20.5 mm.

Loo Choo Islands (Mr. Y. Hirase).

This handsome species is far more finely sculptured and more inflated than *T. quadriradiata* Desh., but in my opinion it is the form identified as *quadriradiata* by Roemer in his magnificent monograph of *Venus*, Part 2, Pl. 18, fig. 2. The crowded rib-striæ of the surface do not become wider on the lower and posterior portions of the valves as they do in *T. quadriradiata* Desh., and the posterior cardinal tooth of the right valve, while grooved at the tip, is not broadly bifid as in Deshayes' species.

DONACIDÆ.

Donax kiusiuensis n. sp.

Shell small, rather thin, white with one or two ill-defined ochraceous rays, or yellow with some dusky concentric streaks, the beaks brown-tipped; irregularly triangular, the length somewhat less than twice the altitude, and nearly three times the diameter; anterior end longer, tapering, rounded; posterior end slightly convex, bluntly angular below; the beaks situated at about the posterior two-fifths of the length. Surface glossy, sculptured with slight growth-lines and exceedingly fine, subobsolete radial striæ, angular posteriorly, the *posterior area sculptured with strong, smooth radial ribs* narrower than their flat intervals and terminating on the angle. Ligament very short and swollen. Interior white with brown stains near the ends; posterior lateral tooth strong; basal margin finely but distinctly crenulated.

Length 9, alt. 5.5, diam. 3.3 mm.

Hirado, Hizen (Mr. Y. Hirase).

A small species belonging to the section *Chion*, chiefly distinguished by the strong sculpture of the posterior end.

ANATINIDÆ.

Anatina impura n. sp.

Shell oblong, fragile, rather ventricose, widely gaping posteriorly, but slightly so in front; sculptured with low, irregular wrinkles, and where unworn, with the usual granulation. White and pearly above, where worn through the very thin porcellanous coat, covered at the margins with a dirty yellowish cuticle, which is more persistent and lamellose on the posterior rostrum. *Beaks at the middle of the shell's length*, not turned forward, contiguous, one of them worn through, both slit as usual. Anterior end broadly rounded; dorsal margin almost straight; posterior end narrow, the margins hardly expanded; basal margin parallel with the upper margin except posteriorly where it rises suddenly. Interior whitish, slightly wrinkled, the chondrophore and buttress as usual.

Length 38, alt. 20, diam. 15 mm.

Kamakura, province of Sagami (types No. 68,536 and 70,812, coll. A. N. S. P.).

This species differs from *A. japonica* Lischke in the median position of the beaks and different shape of the posterior end. Lischke has figured two somewhat diverse forms under the head *A. japonica*. That represented in his figs. 9, 10, has been taken by Mr. Hirase at Hirado, Hizen. Having before me all of the species of *Anatina* credited to Japan, as well as most of the Philippine forms, I find myself unable to place the specimens described above in any of the accepted species. *A. kamakurana*, of which

I have seen a good many specimens, differs constantly in its long form and the different shape of the posterior end.

LIMIDÆ.

Lima Hirasei n. sp.

Shell inequilateral, thin, white, broadly gaping anteriorly, slightly so posteriorly, compressed, the valves but little convex; beaks a trifle in front of the middle of the short hinge-line. Anterior auricle minute, triangular, acuminate, bent inward; posterior auricle narrow. Cavity of the beaks rather deep. A strong rib runs along the posterior margin slightly within the edge. Surface closely and very finely striate radially, the striation obsolete anteriorly and on the posterior slope and auricle.

Length 18, alt. 21, diam. 7.5 mm.; length of hinge-line 6.5 mm.

Hirado, prov. Hizen, Kiusiu, Japan (Mr. Y. Hirase).

L. orientalis Adams and Reeve, and most of the other small Oriental species, are much more coarsely sculptured than this species. *L. Dunkeri* E. A. Smith is evenly striated throughout, the striæ slightly diverging from a median line, and it is nearly equilateral. In *L. Hirasei* striation gradually becomes obsolete on the anterior half of the valves, is abruptly discontinued at the posterior slope, and there is no divarication from a median line. The shell is conspicuously inequilateral.

The species is named for my esteemed Japanese correspondent. *L. Dunkeri* also occurs at Hirado, Hizen, whence specimens have been received from Mr. Hirase.

ARCIDÆ.

Arca (Scapharca) nipponensis n. sp.

Shell of medium size, thin, inflated, the left valve decidedly larger, the beaks full, moderately elevated, incurved and turned slightly forward, situated at the anterior two-fifths of the hinge-line. Sculpture the same in both valves, consisting of 37 or 38 equal radial ribs, which are nearly flat-topped, at least near the periphery, and separated by interspaces narrower than the ribs; the whole marked by slight growth-lines in denuded shells. Covered with a thin chestnut cuticle, which is densely, minutely striate, and bears spaced bristles in the intercostal spaces, on the median and posterior portions of the valves, and on the anterior portion is lamellose and bears flat, triangular processes in the interspaces. Toward the beaks the cuticle is worn off. Hinge-line two-thirds the greatest length of the shell, straight, strongly angular at both ends. Anterior margin evenly rounded; basal margin well-arched, the posterior end noticeably arcuate, oblique, meeting the basal margin in a blunt angle. Cardinal area very narrow, sunken behind the beaks, with an elevated margin; slightly wider and less sunken in front. Hinge teeth small and vertical in the middle, well inclined and larger toward the two ends; a distinct though narrow ledge below the posterior teeth. Interior pure white, slightly grooved and delicately striate radially in the cavity of the valves, becoming very deeply grooved toward the margins, the summits of the intervening ridges concave.

Length 45, alt. 36, diam. 29 mm.; sometimes larger, length 55, alt. 46 mm.

East coast of Hondo (Miss A. C. Hartshorn). Types No. 79,009, coll. A. N. S. P.

This species, of which we have six specimens from two sources (Nos. 79,009, 78,749, 70,970), is distinguished by its well-rounded contours, unusually narrow cardinal area, the marked disparity in size of the valves, and the large number of ribs. It is somewhat allied to *A. disparilis* Reeve,[6] of which we have specimens from Singapore, but that is less orbicular, with more of a ridge or angle defining the posterior slope, and densely lamellose, not bristly, in the intercostal spaces.

In some specimens of *A. nipponensis* the cuticle is greenish in places.

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[6] *A. disparilis* of Kobelt's monograph is clearly a species different from that of Reeve.

NOTE ON THE ODONTOSTOMIDÆ.

BY HENRY W. FOWLER.

Dr. Pilsbry, Conservator of the Conchological Section of The Academy of Natural Sciences of Philadelphia, has called my attention to the fact that the name *Odontostomus* was first proposed for mollusca in the *Index Molluscorum præsentis ævi Musei Principis augustissimi Christiani Frederici*, edited by H. Beck in 1837, thus having one year of priority over its use in ichthyology.

I take pleasure in dedicating the necessary changes to Dr. B. W. Evermann, the distinguished ichthyologist of the United States Fish Commission, and joint author of that monumental work, *The Fishes of North America*.

The natural derivative, *Evermannia*, is already used in ichthyology, so I propose *Evermanella*.

The changes, with nearly all of the synonymy, will result in the following:

Family EVERMANNELLIDÆ.

Odontostomidæ Gill, in Goode and Bean, Oceanic Ichthyology, 1896, p. 121.
Odontostomidæ Jordan and Evermann, Bull. U. S. Nat. Mus., No. 47, I, 1896, p. 597.

Genus EVERMANNELLA.

Odondostomus Cocco, Nuovi Annali delle Scienze Naturali, Bologna, II, 1838, p. 192.
Odontostomus Günther, Cat. Fish. Brit. Mus., V, 1864, p. 417.
Odontostomus Günther, Rep. Sci. Res. Voy. Challenger, Zool. XXII, 1887, p. 200.
Odontostomus Alcock, Desc. Cat. Ind. Fish Investigator, 1899, p. 166.
Odontostomus Garman, Mem. Mus. Comp. Zool., XXIV, Fish, XXVI, 1899, p. 402.

1. Evermannella balbo (Risso).

Scopelus Balbo Risso, Mem. del. Reale Accad. del. Sci. Torino, XXV, 1820–22, p. 268, Pl. X, fig. 3.
Scopelus balbo Risso, Hist. Nat. Eur. Mérid., III, 1826, p. 466.
Odontostomus balbo Bonaparte, Cat. Met. Pesci Europei, 1846, p. 37.
Odondostomus hyalinus Cocco, Nuovi Annali delle Scienze Naturali, Bologna, II, 1838, p. 192, Tav. VIII, fig. 11.

Odontostomus hyalinus Bonaparte, Fauna Italica, Pesci, Tomo III, XXVII, 1840, 139, Pl. 120, fig. 6.
Odontostomus hyalinus Bonaparte, Cat. Met. Pesci Europei, 1846, p. 37.
Odontostomus hyalinus Cuvier and Valenciennes, Hist. Nat. Poiss., XXII, 1849, p. 315.
Odontostomus hyalinus Günther, Cat. Fish. Brit. Mus., V, 1864, p. 417.
Odontostomus hyalinus Günther, Rep. Sci. Res. Voy. Challenger, Zool., XXII, 1887, p. 200, Pl. LII, fig. A.
Odontostomus hyalinus Goode and Bean, Oceanic Ichthyology, 1896, p. 121, fig. 145.
Odontostomus hyalinus Garman, Mem. Mus. Comp. Zool., XXIV, Fish., XXVI, 1899, p. 402.

2. **Evermannella atrata** (Alcock).

Odontostomus atratus Alcock, Journ. Asiatic Soc. Bengal, LXII, Pt. 2, 1893, p. 182, Pl. IX, fig. 4.
Odontostomus atratus Alcock, Desc. Cat. Ind. Fish Investigator, 1899, p. 167.
Odontostomus atratus Garman, Mem. Mus. Comp. Zool., XXIV, Fish., XXVI, 1899, p. 402.
Odontostomus atratus Alcock, Illust. Zool. Investigator, Fish., Part VII, 1900, Pl. XXXIII, fig. 3.

Genus **OMOSUDIS**.

Omosudis Günther, Rep. Sci. Res. Voy. Challenger, Zool., XXII, 1887, p. 201.
Omosudis Goode and Bean, Oceanic Ichthyology, 1896, p. 122.
Omosudis Jordan and Evermann, Bull. U. S. Nat. Mus., No. 47, I, 1896, p. 598.
Omosudis Garman, Mem. Mus. Comp. Zool., XXIV, Fish., XXVI, 1899, p. 401.

1. **Omosudis lowii** Günther.

Omosudis lowii Günther, Rep. Sci. Res. Voy. Challenger, Zool., XXII, 1887, p. 201, Pl. LII, figs. C, C′.
Omosudis lowii Goode and Bean, Oceanic Ichthyology, 1896, p. 122, fig. 150.
Omosudis lowii Jordan and Evermann, Bull. U. S. Nat. Mus., No. 47, I, 1896, p. 598.
Omosudis Lowii Garman, Mem. Mus. Comp. Zool., XXIV, Fish., XXVI, 1899, p. 401.

OBSERVATIONS MADE IN 1900 ON GLACIERS IN BRITISH COLUMBIA.

BY GEORGE AND WILLIAM S. VAUX, JR.

While the glaciers noted in the following report form but a small fraction of the hundreds in the Rocky Mountains of Canada, their continued recession may be taken as an indication of the changes which are taking place in the glaciers of the region. A moderate winter, followed by an early and warm spring melted the snow and flooded the rivers at an early date. The continued wet and stormy weather, which extended far into the spring and summer, did much to increase the amount of melting. So far as it has been possible to determine, all the glaciers of this region are still receding. One exception to this rule was reported, but the advance could not be proved with any certainty.

Victoria Glacier.

The rocks marked last year to determine the motion and shrinkage of this glacier were again noted on July 24, 1900. The large block of limestone about one mile from the tongue marked "VX '99" appeared to have moved 147 feet, while a large block of sandstone near the terminal moraine had an apparent motion of 115 feet. The general condition of the glacier appears practically the same as last year. Measurements taken on the northwest side indicate a shrinkage of about six feet for the year. Several very fine glacier tables were noted, one being a block of sandstone eighteen inches thick, from ten to twelve feet in diameter, and elevated not less than five feet from the surface of the surrounding ice.

Asulkan Glacier.

This glacier has receded perceptibly since last year, the tongue being twenty-four feet further up the valley than when last noted. There has also been a marked shrinkage in every dimension.

Illecillewaet Glacier.

The very small recession in the tongue of the Illecillewaet Glacier during the summer of 1899 was found to have been largely made up in 1900, so that the average of the two years was not far from that of the past thirteen, as previously noted.[1] A distinct shrinkage was observed in all dimensions, but this was most noticeable at the tongue which was now 140 feet above the rock "C," nearly twice the distance of the previous year.

Our work the past summer consisted: (*a*) in taking the test picture of the lower part of the glacier, which was made under unfavorable conditions on August 7, 1900; (*b*) location of the border of the ice on the map of 1899, and (*c*) location and measurement of motion of line of plates across the glacier.

a. Of the test picture nothing need be added except that the series is now complete for three consecutive years and furnishes a most interesting illustration of the comparatively slight and yet none the less constant changes in the contour of the ice.

b. The position of the edge of the ice was easily located with reference to the several fixed rocks laid out on the general survey of 1899. The plotting of this border line showed that the glacier had receded an average of not far from twenty feet on the sides and sixty-four feet on the extreme tongue. At one point the ice seemed to have changed but little since last year, while at others the recession was more than 100 feet. This constant yearly recession has been proved to be in progress at least since 1887.

c. The location and measurement of the line of eight plates across the glacier, which were first laid out on July 31, 1899, and had consequently been on the ice almost exactly one year, was taken up on the 6th of August, 1900, on which date plates Nos. 1, 2, 3, 4, 5, 6 and 7 were located. Plate No. 8 could not be found, and it was not discovered till several days later, when its position also was obtained.

All the plates seem to have moved in lines almost parallel with the centre line of the glacier. The following table shows the motion of the plates for the year, and also repeats for comparison the motions determined in the fall of 1899, after the plates had been on the ice but thirty-six days. It will be noted that the con-

[1] *Proceedings of the Academy of Natural Sciences of Philadelphia*, 1899, p. 124.

cave or northeast side has a greater daily motion than last year, while the convex or southwest has not moved at quite so rapid a rate. Whether this change is accidental or is the result of peculiar conditions has not been determined.

While the plates were left on the surface of the glacier, it is hardly likely that future measurements will be of great value, should the plates be again found. They are approaching a much rougher portion of the glacier, broken by crevasses, deep wells and seracs, and even should they remain on the surface, in many instances it will be impossible to see them from the base line. They have, however, served their purpose in demonstrating that the average motion of nearly two feet per day as determined by Dr. W. S. Green in 1888 was either much greater than the actual motion, or was the result of conditions which do not now exist.

Table showing Total Average Daily Motion of Line of Plates on Illecillewaet Glacier, Glacier House, B. C.

Number of Plate.	Total Motion from July 31, 1899, to August 6, 1900—372 days(inches).	Average Daily Motion from July 31, 1899, to August 6, 1900—372 days (inches).	Average Daily Motion from July 31, 1899, to September 5, 1899—36 days (inches).
1	1063	2.85	2.56
2	1488	4.	3.90
3	1677	4.51	5.51
4	2172	5.84	6.77
5	2256	6.07	6.06
6	2364	6.36	6.79
7	1902	5.11	6.16
8	2040	5.48	6.

DESCRIPTIONS OF NEW BEES COLLECTED BY MR. H. H. SMITH IN BRAZIL.—II.

BY T. D. A. COCKERELL.

Lithurgus corumbæ n. sp.

♀.—Length 7 mm., black; with silvery-white pubescence, dense on the face (except the elevated portion, which is bare) and cheeks; rather dense on metathorax (except basal area and middle of sides) and pleura; hind margin of prothorax, and tubercles, edged with dense white hair, forming a conspicuous white line; lateral hind margins of abdominal segments 1 to 3, and the whole hind margins of 4 and 5, with snow-white hair-bands; apical segment of abdomen, and dark parts of the two previous segments, with some short black hair, but it is very inconspicuous, and there is no apical fimbria; ventral scopa white, tinged with ferruginous on the fifth segment; legs with white hair, that on hind tarsi long and slightly ferruginous; femora, and basal two segments of abdomen, dark ferruginous; facial eminence rather low but distinct, obscurely bituberculate; head and thorax strongly and densely punctured; antennæ short, flagellum stout, and obscurely brown beneath; tegulæ dark reddish-brown; wings brownish, nervures and stigma piceous; hind tibiæ with numerous short spines on the outer side, as usual in the genus; spurs white.

Hab.—Corumbá, April. This is the smallest *Lithurgus* I have ever seen, but *L. rufipes* Sm., from South Africa, is nearly as small. The genus is new to the fauna of Brazil. The stigma of *L. corumbæ* is somewhat larger than is usual in the genus. The marginal cell is shaped as in the North American and European species, not acutely pointed as in the Indian *L. atratus* Sm.

Ceratina maculifrons Smith, 1853.

Chapada, January. 1 ♀.—Length 6½ mm.; differs from Smith's description by having no yellow on the four posterior tibiæ, the sides of the metathorax having no white pubescence, and the hind femora having an apical tooth or projection. The peculiar face-markings, the tooth on the outer side of the hind tibia near the base, etc., are as described by Smith, and I have little doubt that the identification is correct. Smith's description reads as if the thorax were yellow, but of course this was not intended. A different *Ceratina*, also taken at Chapada (in December), is apparently the undescribed ♀ of *C. viridula* Sm. It is a brilliant insect, and the face is without light markings.

Temnosoma metallicum Smith, var. **chapadæ**, n. var.

♀.—Differs from Smith's description of *metallicum* by the larger size (about 8½ mm.); mandibles green at base; scape green; mesothorax closely and more or less confluently punctured; wings little iridescent, not noticeably clouded at apex; tarsi practically black, basal joint of hind tarsi green; abdomen with purple reflections, basal margin of second and third segments brilliant purple. Enclosure of metathorax sculptured as Smith describes for *metallicum*.

♂.—7½ mm. long, similar to the ♀, abdomen with scarcely any purple.

Hab.—Chapada, March, ♂ and ♀; also in November. Probably a valid species, but I leave it as a variety until I can compare it with authentic material of *T. metallicum*.

The following table will facilitate the determination of *Temnosoma*:

Abdomen impunctate, ... *T. lævigatum* Sm.
Abdomen punctate, ... 1.
1. Margin of metathoracic enclosure smooth, *T. æruginosum* Sm.
   Margin of metathoracic enclosure transversely striate, . . . 2.
2. Wings smoky (Mexico), ... *T. smaragdinum* Sm.
   Wings almost clear (Brazil),
   T. metallicum Sm. and var. *chapadæ* Ckll.

T. smaragdinum occurs as far north as San Rafael, Vera Cruz, Mexico, where Townsend took it at flowers of *Cordia*, at the end of June.

Corynura atromarginata n. sp.

♀.—Length 8½ mm., dull from the excessively close punctures; black; lateral projections of prothorax, hind margin of mesothorax very narrowly, postscutellum and metathorax, greenish; sides of basal segment of abdomen and extreme base of second segment also green; clypeus prominent, with rather sparse large punctures on a tessellated surface; mandibles long and dark; antennæ dark, scape long, flagellum brownish beneath and delicately pubescent; tegulæ very dark brown; base of metathorax with oblique radiating striæ; wings hyaline, the costal margin, including the marginal cell, very broadly dark fuliginous (as in some Tachinidæ); legs very dark reddish-brown; abdomen with long white hairs beneath; punctures of first dorsal segment of abdomen stronger and less dense than on second, which has the punctures minute and as close as is possible; hind spur of hind tibia pectinate, with three large teeth.

Hab.—Chapada, March and April; five specimens. Very close to the Mexican *C. discolor* (Smith), thus adding another to the now rather numerous instances of Brazilian bees representative of, but not identical with, those of Mexico or the adjacent parts of the United States.

This might be held to differ subgenerically from the type of *Corynura*, but in that case *Cacosoma* Smith is not available, because of the prior *Cacosoma* Felder, 1874.

C. atromarginata is one of five species flying at Chapada, all having the first recurrent nervure interstitial with the second transverso-cubital, and the mesothorax very densely punctured.

These species are readily distinguished as follows:

Costa fuliginous from base to marginal cell, *atromarginata* n. sp., ♀.
Costa not fuliginous from the base, or not at all, ... 1.
1. Abdomen long and narrow, clavate, like *Baccha clavata*, . 2.
   Abdomen oval or suboval, hardly or not clavate, . . . 3.
2. Head and thorax bright golden-green, *pseudobaccha* n. sp., ♂.
   Head and thorax dark, suffused with olive-green, *jucunda* (Smith), ♂.
3. Marginal cell fuliginous, ... *semimarginata* n. sp., ♀.
   Tip of wing only fuliginous, . , . . . *chapadicola* n. sp., ♀.

Corynura jucunda (Smith); n. syn. **C. ænigma** (Gribodo).

Hab.—Chapada, December; 2 ♂. So far as I can make out, *C. jucunda* and *ænigma* are the same and identical with the insect now before me. This gives it a range from S. Paulo and Chapada, Brazil, to Rioja, Argentine Republic, the extremes being about 1,250 miles apart. In view of what Sichel states about the two sexes of *Corynura*, it seems likely that *C. semimarginata* or *C. chapadicola* may prove to be the ♀ of *C. jucunda*, but as I have no proof of this, I treat both for the present as distinct.

Corynura pseudobaccha n. sp.

♂.—Length about 8 mm.; size and form of *C. jucunda*, but easily distinguished by its very brilliant golden-green head and thorax; the green of the abdomen also is bright, occupying the sides of the first segment, the bases of the second, third, and most of the fourth and fifth segments. Clypeus very prominent, with large punctures on a shining surface; cheeks and sides of face with short white hair; antennæ very long, flagellum ferruginous beneath; tegulæ bright reddish-testaceous; wings dusky at tips; nervures and stigma very dark brown; second submarginal cell narrow; femora and tibiæ green; knees, ends of tibiæ and all of tarsi light ferruginous.

Hab.—Chapada, January and November; 3 ♂.

Corynura semimarginata n. sp.

♀.—Length about 8 mm.; rather robust, black with green on sides of face, hind edge of mesothorax, scutellum, postscutellum, upper parts of metathorax, and basal portions of the abdominal segments; first abdominal segment subpetiolate, decidedly longer than broad, bright ferruginous at its extreme base; antennæ dark, scape long, red-brown; wings with the marginal cell and beyond fuliginous, stigma and nervures dark brown; second submarginal cell not so narrow as in the last species; inner lower angle of third submarginal less than a right angle, whereas in *pseudobaccha* it is quite a right angle: basal area of metathorax with oblique radiating striæ, and some transverse ones posteriorly, recalling the sculpture of *Temnosoma metallicum;* first abdominal segment with sparse weak punctures, second finely rugulose with close minute punctures; hind spur of hind tibia pectinate with large teeth.

Hab.—Chapada, April and November; 2 ♀. Allied to *C. agile* (Smith).

Corynura chapadicola n. sp.

♀.—Length about 8 mm.; robust, black, sides of face and hind margin of mesothorax very narrowly dark green; legs very dark reddish-brown, with the pubescence mostly black or nearly so; abdomen with the first two segments black, the extreme base of the second green, the remaining segments golden green, largely covered with very fine appressed yellowish pubescence, with black bristles intermixed; antennæ dark brown, flagellum ferruginous at extreme tip; tegulæ very dark brown; wings hyaline, apex fuliginous; nervures and stigma sepia-brown; clypeus with large, sparse punctures on a tessellate surface; mesothorax microscopically tessellate, dull, with numerous minute punctures and scattered black hairs; basal area of metathorax not defined, with feeble oblique striæ; lower inner angle of third submarginal cell less than a right angle; most of basal segment of abdomen smooth and shining, but its apical portion and all of second segment rough and minutely sculptured; under side of abdomen with long yellowish-white hair; hind spur of hind tibia pectinate, with three large blunt teeth. The basal segment of the abdomen is broader than long, thus much broader than in the last species.

Hab.—Chapada, January, March, September, November, December; 33 specimens. The middle of the third abdominal segment is often black. This species evidently belongs with *Corynura;* but, at least in the ♀, it has the abdomen formed as in *Augochlora.* The maxillary palpi have six subequal joints, the first two stout, the third subtriangular.

In all the species of *Corynura* the anterior part of the mesothorax overlaps the middle of the prothorax, and in *C. chapadicola* this is particularly well marked, the projecting portion being bilobed.

CORYNUROPSIS n. subg.

First recurrent nervure received by second submarginal cell before its end; mesothorax smooth and shining, with strong very sparse punctures, its anterior margin prominently overlapping prothorax; hind spur of hind tibia of ♀ pectinate with large teeth.

Type, *C. darwini* n. sp.

Corynura (Corynuropsis) darwini n. sp.

♀.—Length about 7 mm.; head circular, a trifle broader than thorax, dark yellowish-green, eyes emarginate; sides of face with appressed pale plumose hair; clypeus short, it and the supraclypeal area with numerous very large punctures; ocelli small and close together; front densely and closely punctured; labrum binodulose; mandibles ferruginous at apex; mesothorax shining, purple-black, with large sparse punctures; parapsidal grooves very deep; other parts of thorax dark green; pleura with thin white pubescence; base of metathorax smooth and shining, with a deep transverse sulcus; truncation of metathorax with a deep longitudinal groove; tegulæ shining, red-brown, not punctured; wings rather dusky, especially at tips, minutely but conspicuously hairy; nervures and stigma dark brown, second submarginal cell narrow, legs dark red-brown, anterior tibiæ and tarsi ferruginous; abdomen with a decided constriction between first and second segments; first segment only moderately narrowed at base; first two segments piceous, first with very large close punctures, second with large and small punctures on its anterior half, extreme base greenish; remaining segments greenish, pruinose with a short pubescence, their hind margins testaceous; antennæ dark, flagellum ferruginous beneath at apex.

♂.—Length about 6 mm.; similar to ♀, but narrower, especially the abdomen; antennæ much longer, flagellum dark at apex; anterior femora, tibiæ and tarsi entirely bright ferruginous; second abdominal segment with large punctures like first; fourth ventral abdominal segment emarginate.

Hab.—Chapada; 4♂, 1♀; January, December.

Corynura (Corynuropsis) sublata n. sp.

♀.—Length about 8 mm., more robust than *C. darwini*, with the first abdominal segment broader; eyes somewhat more parallel; mesothorax more decidedly purplish; wings perhaps a little browner; supraclypeal area more or less coppery red.

Hab.—Chapada, 1 ♀; December. Perhaps only a variety of the last, but it is larger and seems distinct. The pleura is roughened, and has also sparse shallow punctures. In *C. darwini* the second abdominal segment is conspicuously wider than the first, widening from its base to its hind margin; in *C. sublata* the second segment has nearly parallel sides, and is very little wider than the first.

Augochlora callichroma n. sp.

♀.—Length about 5 mm.; head and thorax brilliant golden green; legs honey-color; *abdomen pale ferruginous* with dark-brown blotches, small at sides of first segment, large at sides of second, covering all of third except a variable patch on disk, and also occupying the whole of fourth and fifth segments, so that the hind portion of the abdomen is dark brown; *at each extreme side of segments 2 to 5, quite at the base, is a clear yellow triangle*, with its apex directed mesad; *clypeus with a broad apical yellow band*, which sends a projection upward in the middle line; mandibles yellow, ferruginous at ends; labial palpi 4-jointed, the last joint smallest; antennæ dark brown above, yellow beneath, the scape long and slender; mesothorax with very numerous minute punctures; scutellum sculptured like mesothorax; basal area of metathorax microscopically tessellate, the lines mostly running in a transverse direction; abdomen impunctate; *hind spur of hind tibiæ pectinate, with only three teeth;* tegulæ pale testaceous; wings faintly dusky at tips; nervures and stigma dark brown; first recurrent nervure not quite interstitial with the second transverso-cubital, being just the least before it.

Hab.—Chapada, December, January; five examples. This may be compared with *A. nana* Smith and *A. festivaga* Dalla Torre, but it is quite distinct by the yellow markings on the abdomen and other characters. It has a certain superficial resemblance to the genus *Nomioides.*

Augochlora beatissima n. sp.

♀.—Length 5 mm.; head cordate, shining yellowish-green; eyes only shallowly emarginate; clypeus with strong scattered punctures, its anterior half testaceous, its lower margin with a fringe of orange hairs; supraclypeal area smooth and shining, with a very few punctures; mandibles yellowish, dark at apex and extreme base; scape piceous, flagellum dull orange-testaceous, except at base; thorax brilliant bluish-green, *the mesothorax and scutellum purple;* the hind margin of the mesothorax very narrowly, the margins and a central band of the scutellum, golden; tubercles yellow; tegulæ testaceous, yellow at base; mesothorax and scutellum minutely lineolate, with very sparse weak punctures; basal area of metathorax not at all defined, minutely transversely lineolate; pleura with scattered short white hairs; legs reddish-brown, more or less dark; anterior femora apically, anterior tibiæ and tarsi, chrome yellow; hind spur of hind tibia pectinate; wings dusky; nervures and stigma very dark brown; lower inner angle of third submarginal cell a trifle greater than a right angle; *abdomen piceous,* scantily hairy posteriorly, the hind margins of the second and third segments broadly dark ferruginous.

Hab.—Chapada, January; one ♀. A beautiful little thing.

THE DEVELOPMENT OF THE TYMPANO-EUSTACHIAN PASSAGE AND ASSOCIATED STRUCTURES IN THE COMMON TOAD (BUFO LENTIGINOSUS).

BY HENRY FOX.

A perusal of the literature relating to the subject reveals the existence of considerable diversity of opinion among investigators as to the exact morphological significance of the tympano-Eustachian passage of the higher vertebrates. So far as its adult structure and relations are concerned, the passage would seem to be the homologue of the spiracle or hyomandibular cleft of the elasmobranch fishes. Both structures occupy the same relative position between the mandibular and hyoid arches, and, moreover, above the dorsal margin of each the facial nerve divides into its two main branches, one of which, the ramus palatinus, courses in front of the cleft (or tube, as in the higher forms), while the other, the ramus hyomandibularis, extends ventrally along its posterior wall. Embryologists, however, in studying the development of the tympano-Eustachian passage in various species of the higher vertebrates, have found that its homology with the hyomandibular cleft is not so clearly expressed as the mature structure of the organ would lead one to infer, so that certain morphologists, basing their conclusions on the facts revealed by embryology, hold that the tympano-Eustachian passage is a structure entirely, or in large part, independent of the hyomandibular cleft.

In order to determine, if possible, the exact relation of the tympano-Eustachian passage to the hyomandibular cleft, I undertook to follow out its entire embryonic history in the common toad of the eastern United States, *Bufo lentiginosus*.[1] Contributions to the knowledge of the development of the structures under consideration had been made in the case of the *Anura* by Goette,[2]

[1] The investigations have been made in the Zoological Laboratory of the University of Pennsylvania.

[2] *Entwicklungsgeschichte der Unke, Bombinator igneus*, Leipzig, 1875.

Villy,[3] and Gaupp.[4] Shortly after I had begun the present research a very important paper on the subject by Dr. Hans Spemann appeared, treating of the earlier stages in the development of the Eustachian tube in *Rana temporaria.*[5] All the investigators mentioned state that the development of the tympano-Eustachian passage in the forms studied is a very indirect one and that it can be traced only with considerable difficulty. This difficulty is attributed to the almost complete atrophy of the hyomandibular cleft, which at an early period becomes so greatly reduced as to be readily overlooked unless special attention is bestowed on it.

Of the investigators mentioned Goette correctly described the degeneration of the hyomandibular cleft, but his other results concerning the development of the Eustachian tube may be disregarded, since his investigations were conducted at a time when less favorable methods were at his disposal than we have at present. From the results arrived at by the other three investigators a fairly complete history of the Eustachian tube may be made out in the case of *Rana temporaria.* Of these the work of Villy covers fairly well the period of the metamorphosis, although his descriptions are somewhat inexact,[6] and his conclusion, that the Eustachian tube "has almost certainly nothing to do with the hyomandibular cleft," and that "the evidence offered by the frog tends to show that the two organs have no connection whatever with each other," is certainly unsound, since such a connection between the two has been established by the very careful work of Spemann on the earlier stages of the tube in the same species. The correctness of Spemann's conclusions are corroborated by the results which I have obtained in *Bufo.* Gaupp's chief contribution consists in his calling attention to the appearance of the tubal *Anlage* at a stage earlier than that in which it was first observed by Villy. For further information concerning the results arrived at by these investigators the reader is referred to the papers mentioned.

[3] "The Development of the Ear and Accessory Organs in the Common Frog, Rana temporaria," *Quar. Jour. of Micros. Sci.*, 1890.

[4] "Beiträge zur Morphologie des Schädels, I, Primordial-cranium von Rana fusca," *Morph. Arb.*, V, 2, 1893.

[5] Spemann, "Ueber die erste Entwicklung der Tuba Eustachii und des Kopfskelets von Rana temporaria," *Zoologische Jahrbücher*, 1898.

[6] As, for instance, he speaks of the tube as extending forward beneath the palato-pterygoid bar, which it never does, but, instead, passes beneath the quadrate. Moreover, his figures show it in the latter position.

I. Observations and Results.

I now turn to the description of the development of the tympano-Eustachian passage in the common toad. In this undertaking I shall first treat in detail the condition and relations of the structures under consideration in the different stages, beginning with the earliest, and then at the end of the paper summarize the chief features of this development.

Stage I (Pl. VI, fig. 1).—I begin at a stage when the hitherto almost spherical embryo has elongated and when the tail has grown out as a short stump. No external gills are as yet apparent. The head has become differentiated from the body proper and the region immediately posterior to it is marked by two or three slight dorsi-ventral grooves, indicating the position of the future branchial-clefts.

Pl. VI, fig. 1 is a coronal section of the anterior portion of an embryo of this stage. The section is slightly oblique, the right side being cut at a higher plane than the left. In this figure one will notice that the anterior extremity of the pharynx is still separated from the exterior, the conjoined endoderm and ectoderm forming at this point a solid partition of cells—the stomatodeal plate (*st.*). From this region posteriorly the cavity of the pharynx gradually widens out until it forms a spacious chamber, the sides of which are marked by four dorso-ventral grooves, marking the inner openings of the visceral-clefts. Just back of the fourth visceral-cleft the cavity narrows very suddenly to form the lumen of the œsophagus.

As shown by the figure, there are only four visceral-clefts (*Hym.*, 2–4 *v.f.*) marked out at the present stage. With the exception of the fourth, each of the clefts extends outward as a solid, double-layered plate of endoderm, continuous at its inner end with the epithelial lining of the pharynx and externally in contact with the deeper layer of the ectoderm. Only the medial portion of each cleft shows a lumen. The fourth visceral-cleft resembles the others, except that it does not as yet quite reach the epiblast.

[6] In the drawing the distal extremities of the clefts are shown separated by a narrow, clear area from this layer, but this condition, I think, must have been produced by shrinkage, a supposition which receives support from the rough and irregular character of the distal edge.

Between the visceral-clefts intervene the visceral-arches. The interior of each arch is made up of a mass of rather compact mesenchyme, consisting of scattered cells, containing numerous large yolk-spheres, barely distinguishable from those occurring in the endodermic lining of the pharynx. From this circumstance the limits of the endoderm are somewhat difficult to define clearly, and accordingly considerable care had to be taken in outlining it. The endoderm is, however, much more densely crowded with yolk-spheres and hence appears as a darker layer more or less clearly marked off from the surrounding lighter mesenchyme. Four visceral-arches are clearly differentiated, the two anterior of which are the mandibular (*k.m.*) and hyoid (*h.m.*) arches, while the other two are the first and second branchial-arches. In the former two a somewhat dense patch of mesenchyme can be seen occupying the centre of each. These patches are the *Anlagen* of the future muscles of these arches (*k.m.* and *h.m.*).

An examination of the remaining sections of the series to which fig. 1 belongs, shows that the pharyngeal cavity retains approximately the same size throughout its entire dorso-ventral extent and that throughout their entire length the visceral-clefts have about the same direction and relations as shown in the figure. Hence we may look upon the clefts as being solid folds of endoderm, compressed antero-posteriorly and elongated dorso-ventrally. Throughout their entire extent the first three clefts are apparently in contact with the deeper layer of the ectoderm.

The first or hyomandibular cleft resembles the other clefts in all essential respects, except that it extends slightly forward whereas the second extends transversely outward, while the remaining two course obliquely backward. A section of the cleft in almost any coronal plane presents the condition shown in the figure. Immediately dorsal to the outer extremity of the cleft the distal portion of the facial ganglion becomes continuous with the deeper or sensory layer of the ectoderm.

Stage II (Pls. VI, VII, figs. 2–7).—In this stage all five visceral-clefts are present, none of which opens to the exterior. The mouth is still separated from the pharynx by the stomatodeal plate. The external gills have budded forth as two minute, blunt, undivided processes from the sides of the first and second visceral-arches.

In specimens of the present stage the *Anlagen* of the various structures have so far differentiated that they are in most cases readily recognizable. The mesenchyme is less compact than hitherto. The *Anlagen* of the muscles are particularly well marked out as prominent patches of densely aggregated mesenchyme cells, containing numerous yolk-spherules. The blood-vessels also have begun to form in the head region.

Pl. VI, figs. 2, 3 and 4 are coronal sections of a tadpole of this stage. Of these fig. 2 was taken at a plane a slight distance above the floor of the pharynx. Comparing it with fig. 1 we find that anteriorly the stomatodeal invagination (*st.*) has deepened very considerably, although as yet not communicating with the pharyngeal cavity. The latter has much the same form as in fig. 1, except that posteriorly an additional visceral-cleft is present. Of these clefts the most anterior, the hyomandibular (*Hym.*), can be seen as a narrow, solid diverticulum of the pharyngeal wall, extending outward and terminating bluntly in the mesenchyme a short distance below the external ectoderm. All the remaining cleft outgrowths reach to and blend with the external ectoderm, although as yet not opening to the exterior. Within the body of each of the two anterior visceral-arches—*i.e.*, mandibular and hyoid—the muscles can be made out as irregularly defined patches of denser mesenchyme. That in the mandibular arch is the *Anlage* of the muscles of mastication (*k.m.*), while that in the hyoid arch is the *Anlage* of the depressor mandibulæ + depressor ossis hyoidei[7] (*h.m.*). Anterior to the first cleft is a small vessel, the mandibular aortic arch (*m.a.*), while on the left of the figure another vessel is to be seen posterior to the cleft. The latter is the hyoidean aortic arch (*h.a.*).

Pl. VI, fig. 3 is taken at a considerably higher level. On the right side we have passed above the dorsal margins of the visceral-clefts, so that the latter are shown only on the left side. This section passes in a plane approximately on a level with the base of the brain, the small dark patch in the median line in front of the pharyngeal cavity being the floor of the infundibulum (*inf.*). The hyomandibular fold can be seen extending outward and slightly forward. It will also be noticed that its distal[8] end approaches the

[7] Spemann includes these two muscles under the term "orbito-hyoideus."

[8] A word of explanation is necessary concerning my use of the terms "distal" and "proximal." Ordinarily these terms are used only in connection

skin more closely than in fig. 2. In fig. 4 we see the fold at its dorsal origin from the pharyngeal wall (*Hym.*). Here it is to be seen as a rather wide, shallow, blunt diverticulum of the latter. In the sections intervening between this and fig. 3 the distal end progressively moves peripherally as we pass down until it comes to occupy the position shown in the latter figure. Hence the dorsal edge of the cleft is higher in its proximal portion than in its distal part. In fig. 4 it will also be noticed that the proximal portion of the cleft in its dorsal portion approaches very closely to the origin of the second visceral-cleft. In the other two figures the cleft is separated throughout by a considerable interval from the second cleft. It follows from this that as it descends the plane of the first cleft moves forward also.

Grouping the facts so far obtained we find the hyomandibular cleft as a solid, two-layered diverticulum of the pharyngeal wall, which extends outward and somewhat forward to a point a short distance removed from the external ectoderm. Here it terminates in a blunt, rounded edge, extending downward and slightly forward and presenting throughout its course no well-marked indentations or depressions. Above and below, however, the outer edge gradually recedes more and more from the skin until it blends imperceptibly with the lining of the pharyngeal cavity. The edge thus has the form of a gentle arch. In general the cleft outgrowth is elongated dorso-ventrally, but it also is directed obliquely forward. This forward direction is more pronounced in its dorsal than in its ventral portion. In its lower portion the cleft is widely separated from the second visceral-cleft, but in its dorso-posterior portion it approaches the latter very closely, particularly in its proximal, internal part.

These observations are further confirmed by transverse sections (Pls. VI, VII, figs. 5–7). In fig. 5 the hyomandibular cleft can be seen as a short, blunt diverticulum from the inferior, outer angle of the pharynx (*Hym.*). The cleft here is cut through its antero-

with processes or appendages of the body. In the present paper, however, I designate by "distal" that portion of the hyomandibular fold (or of its derivative, the Eustachian cord) which is farthest removed from its connection with the pharynx, while I employ the term "proximal" to denote that part of the same structure which is nearest the point of origin from the pharynx. My use of these terms in connection with the structure mentioned is due to the necessity of having some fixed term to apply to each of its extremities, the relative position of which vary in the different stages.

ventral portion. In the fifth section posterior to this (fig. 6) the cleft is cut throughout the greater part of its dorso-ventral extent, and hence appears as a broad, solid mass extending out from the side of the pharynx and reaching nearly to the skin, where it all but meets a slight papilla projecting inward from the latter (*Hym.*). This figure also reveals another feature of the cleft-outgrowth which is of particular importance. It will be noted that it is the upper portion of the cleft-fold which approaches most nearly the skin, whereas the ventral portion recedes gradually from it as we descend. About the middle of this ventral portion is a small indentation in the outer edge occupied by a small blood-vessel (*x.*). It will be also noticed that the proximal (inner) portion of the cleft is situated at a higher level than in fig. 5. From this it follows that the line of origin of the fold from the pharynx extends from below upward and backward.

Posterior to this region the hyomandibular fold bends more sharply backward and accordingly in transverse section appears considerably narrower (fig. 7, *Hym.*, right side). We next obtain the condition shown in fig. 5 (left side), where the fold (*Hym.*) is cut approximately at right angles to its surface and hence appears extremely narrow. Below the fold is a large oval mass, the *Anlage* of the hyoidean muscles, *i.e.*, depressor mandibulæ and depressor ossis hyoidei (*h.m.*). Spemann has noticed a relation between the subsequent development of these muscles and the degeneration of the hyomandibular fold. I have found the same relation to exist in *Bufo*, but shall call attention to it later. The fold next enlarges somewhat, and then, gradually receding more and more from the exterior, blends imperceptibly with the pharyngeal wall. These stages are shown consecutively in figs. 6 and 7 (left sides).

The transverse sections also show some structural features, which are of importance in tracing certain stages in the subsequent history of the cleft-fold. Anterior to the cleft is the efferent mandibular aortic artery, a branch from the carotid. At the present stage this vessel is rather difficult to trace, but with some care can be worked out. Since, owing to the general antero-ventral direction taken by the plane of the hyomandibular fold, the anterior wall of the latter faces forward and also upward, it follows that in transverse section structures anterior to the fold will be seen dorsal to it. Thus in the figures the region immediately dorsal to the fold is the mandibular arch, whereas that ventral to it is the hyoid arch. In fig. 7 the efferent portion of the mandibular aortic arch can be seen as a transversely placed vessel (*m.a'.*) just above the roof of the pharynx and extending outward above the hyomandibular diverticulum. Internally the vessel unites with the carotid (*car.*). The course of the mandibular aortic arch can be followed by comparing the figures. At first it is very small, as seen in fig. 5 (*m.a'.*). Tracing it forward, however, it is soon found to be continuous with a much larger vessel with a well-marked lumen. This vessel is the afferent portion of the mandibular aortic arch (*m.a''*). Immediately beneath the antero-inferior extremity of the hyomandibular fold the mandibular aortic arch is joined by the hyoidean aortic arch, and the common trunk thus formed communicates with the large inferior jugular sinuses beneath the mouth.

The other structure to which I desire to call attention is the hyomandibular ramus of the facial nerve. The facial ganglion at present lies just back of and above the dorsal margin of the hyomandibular fold. The anterior edge of the ganglion is in actual contact with the outer margin of the fold (fig. 7, *vii*). From the ventral surface of the ganglion the hyomandibular ramus (fig. 6, *vii h.*) is given off as a large nerve supplying the muscles of the hyoid arch. It is hence posterior to the hyomandibular fold.

Stage III (**Pls.** VII, VIII, figs. 10–14, 16–18).—Young tadpole. External gills prominent and considerably branched, not covered as yet to any marked extent by the opercular fold. Third visceral-cleft opening to the exterior. Mouth communicating with pharynx. The tail has attained its full development.

A considerable departure from the conditions observed in the preceding stage is shown in the present. The different organs are quite clearly differentiated, while the *Anlagen* of the more important cartilages can be made out as dense aggregations of the mesenchyme. The first visceral-cleft especially has undergone marked modifications. We can follow out its course by comparing figs. 10–14. Consulting fig. 10, we notice that the pharyngeal wall is separated from the exterior by a considerable interval occupied by scattered mesenchyme cells, which in the region immediately surrounding the pharynx are segregating to form the *Anlagen* of the skeletal structures. Since it will be necessary hereafter in studying the development of the Eustachian tube to take into consideration the modifications undergone by the neighboring skeletal parts, it may be well to point out these parts in the present stage. The very dense segregated mass which may be seen in fig. 10 (*M.* and *Q.*), immediately external to and beneath the pharynx, is the *Anlage* of the cartilaginous mandibular arch. That portion of the arch which underlies the pharynx is the mandibular or Meckel's cartilage (*M.*), while that external to it is the quadrate or suspensorium (*Q.*). In the figure there is no distinct separation between these two portions, but more anteriorly the mandibular *Anlage* can be seen to be separated from the quadrate by a slight space in which the mesenchyme cells are less densely aggregated (fig. 11, *M.*—shown here owing to the oblique section, the left side being cut more anteriorly than the right). In fig. 10 (*M.*) only the most posterior part of the mandible can be seen. The mandible, as in all anuran tadpoles, extends transversely beneath the floor of the mouth. External to the lateral wall of the pharynx (right side) is the quadrate cartilage (*Q.*), which ventrally becomes continuous with the mandible and at the same point sends upward and outward a strong process, the orbital process or processus muscularis (*Pr.M.*) (Gaupp). This process with the inner portion of the quadrate forms a deep concavity, underlying the eye and containing the muscles of mastication. That portion of the quadrate which lies in contact with the pharyngeal wall is the palato-pterygoid process or commissura quadrato-cranialis anterior of Gaupp (fig. 11, *Pr.q.c.a.*). At its dorsal extremity this part approaches, but is still separated from, a patch of dense tissue in immediate contact with the dorso-lateral border of the pharynx, the *Anlage* of the trabecula cranii (*Tr.*).

On the right side of fig. 11 (fourth section posterior to that of fig. 10), the mandibular cartilage has been passed, and in its stead we find a very slight aggregation of mesenchyme forming a portion of the cartilaginous hyoid bar. The trabecula cranii of the same side has become much less distinct, and in the third section following (fig. 12) has ceased to be any longer distinguishable from the surrounding mesenchyme. The trabeculæ cranii at present are thus marked out only in their more anterior portion. Of the quadrate cartilage we have only the body with its processus muscularis, having passed beyond the transversely placed commissure quadrato-cranialis anterior (palato-pterygoid). Of the quadrate the outer, distal portion of the processus muscularis is most distinct at the present stage. Above this process are the muscles of mastication (*k.m.*) already mentioned, while to its outer or ventral surface are attached two muscles, the depressor mandibulæ (*m.d.m.*) and depressor ossis hyoidei (*m.d.h.*). Between these two muscles courses the ramus hyomandibularis of the facial nerve (*vii h.*). Both of these muscles belong to the hyoid or second visceral-arch and have been differentiated out of the common muscle mass of that arch.

The quadrate in the region posterior to that just considered blends gradually and imperceptibly with the surrounding mesenchyme. This can be followed by examining the figures consecutively.

We will now turn to the consideration of the hyomandibular fold in the present stage. In fig. 12 the rhomboidal cavity of the pharynx is sharply prolonged at its right ventro-lateral angle, and from the wall of the cavity immediately above this prolongation a narrow, solid cord, representing an extension of the wall, extends upward and outward in close contact with the ventral surface of the processus muscularis (*Eu.*). Just internal to its blind, distal extremity can be seen a small vessel interposed between the cord and the cartilage. This vessel is the mandibular aortic arch. Ventral to the cord is a semicircular mass of procartilage, in the hollow of which is placed the depressor mandibulæ. This is the *Anlage* of the hyoid, a more complete view of which can be obtained in fig. 13 (*H.*). The hyoid, like the mandible, is a stout, thick bar placed transversely beneath the floor of the pharynx and separated from its fellow in the mid-line by a less compact tissue. Anteriorly the two are separated by the thyroid gland outgrowth (*Th.*). At its outer extremity the hyoid turns sharply upward as a flattened plate with a concave outer surface in which is lodged, as already mentioned, the depressor mandibulæ. Its inner surface is closely applied to the outer and ventral wall of the hyomandibular fold (*Eu.*).

In the region posterior to that shown in fig. 12 the hyomandibular fold presents much the same appearance as in the last stage (compare figs. 13 and 14 with 6 and 7). It will be noticed, however, that the fold is considerably narrower than in the preceding stage, and also that its distal extremity is much farther removed from the external surface. This condition will be more fully considered presently. The narrowing of the fold, however, is more apparent than real. If one will bear in mind the statement already made that the fold extends downward and obliquely forward, a true explanation of the difference will suggest itself. Naturally a section which passes through in the same plane as that of the fold will show the latter as a broad mass. This explains the appearance of the fold as shown in fig. 6 (right side). In this figure the section on the right side passes through the eye, whereas on the left side it passes some distance behind the eye. Hence the section traverses the right side in an obliquely forward direction, thus coinciding in the main with the plane of the fold. In the same specimen the fold on the left side is cut throughout transversely, so that, except in its most posterior portion, it appears as a narrow, two-layered lamina.

It is in its distal anterior portion that the hyomandibular fold has undergone its greatest modification. In fig. 12 the fold is continuous with the wall of the pharynx. In fig. 11, which is the third section anterior to that of fig. 12, this connection no longer exists. The fold appears as a solid, somewhat flattened cord (*Eu.*), closely underlying the upper, outer extremity of the processus muscularis. Its internal surface is in intimate contact with the mandibular aortic arch (*m.a.*), while externally the two muscles of the hyoid arch—*i.e.*, depressor mandibulæ (*m.d.m.*) and depressor ossis hyoidei (*m.d.h.*)—approach it very closely. The proximal portion of the anterior part of the fold can be seen in the figure as a relatively broad diverticulum from the wall of the outer, inferior angle of the pharynx (*Hym.*).

Anterior to the region just considered this cord-like extension of the fold extends forward a short distance and then bends sharply outward in front of the two muscles just mentioned (fig. 18, *Hym.*, right side). In this region it enlarges considerably and finally terminates as a blind, bulbous swelling in the mesenchyme a short distance below the external epithelium. This part is shown in fig. 10 (*Tym.*), also in fig. 17 (*Tym.*).

Perhaps a clearer conception of the state of the fold may be gained by a comparison with some coronal sections. In fig. 16 we have such a section, in which, however, the plane is lower on the right side than on the left. Commencing below, we observe on the right of the figure a short, blunt diverticulum of the pharyngeal wall, extending outward and slightly forward between the *Anlagen* of the mandibular and hyoid cartilages. This part corresponds to broad proximal portion of the fold shown in fig. 11 as continuous with the pharyngeal wall. In the fourth section dorsal to this (fig. 17) the same portion of the fold is still seen, and just external to its distal extremity is an elongated strand of like nature (*Tym.*), somewhat swollen in its outer portion, where it terminates just beneath the external epithelium. This part is the swollen portion of the cleft, which, as already mentioned, extends out in front of the hyoidean muscles and forms the distal expanded portion of the cord-like extension of the fold. In the second section above this (fig. 18) these two parts of the fold join, so that it now appears continuous throughout (*Hym.*). The present section gives a very good view of the course taken by the hyomandibular fold. One will observe that it has a very broad origin from the pharyngeal wall, and that from this point it extends outward and also considerably forward. In its middle portion the fold is considerably constricted, while in its distal outer extremity it is enlarged to form the swollen, bulbous portion which curves outward in front of the hyoidean muscles, as is well shown in the figure.

One notices that in fig. 18 the outer, distal extremity of the fold is farther removed from the exterior than in fig. 17. If the left side of fig. 16 (*Hym.*)—which represents a plane slightly more dorsal than that of the right of fig. 18—be now consulted it will be seen that this portion is still farther removed from the exterior, and by comparing the same fold (*Hym.*) in the following two figures (17 and 18) the distance between the two will be seen to be still more increased. In the latter two figures the fold approaches very closely the proximal portion of the second visceral-cleft (*2 v.f.*)—a feature to which we have already called attention.

Bringing together the facts so far obtained relating to the third stage, we shall now endeavor to form a conception of the hyomandibular fold as a whole. It arises as a solid fold of the wall of the pharynx and extends downward and obliquely forward as a thin plate between the first and second visceral-arches. Its origin from the pharynx extends downward and forward, beginning above just anterior to the dorsal origin of the second visceral-cleft (figs. 14, 17, 18, *Hym.*) and terminating at the position of the future quadrato-mandibular articulation (fig. 10, *Hym.*). The outer or distal border begins dorsally in continuity with the roof of the pharynx (fig. 14, *Hym.*), and then extends in a gentle curve downward, outward and forward until it reaches the point where the distal, cord-like extension is given off and which I shall now designate as the "diverticulum." The latter is at first a flattened cord (fig. 11, *Eu.*), which at first extends forward a short distance, but, when it reaches the anterior border of the depressor ossis hyoidei, turns sharply outward and slightly downward in front of the latter and then expands to form a solid, bulbous swelling, which terminates blindly in the mesenchyme a short distance below the external ectoderm (figs. 10, 17, *Tym.;* also fig. 18, *Hym.*). This portion of the hyomandibular fold is the only part which comes into close proximity with the external epithelium. The remainder of the fold lies at a considerably deeper level. The distal border of the latter, below the origin of the "diverticulum," bends downward and inward and at its ventral end blends with the floor of the pharynx (figs. 10, 11, *Hym.;* 12, 13, 14, *Hym.* [left side]; 16, 17 [right]). This portion of the distal border is continuous with the ventral border of the "diverticulum," and, owing to the slightly downward direction taken by the latter, forms with it a shallow sinus or depression, the concavity of which faces downward and outward. By its anterior surface the hyomandibular fold is in close contact with the quadrate, although partly separated from it by the mandibular aortic arch (*m.a.*). Owing to the obliquely anterior direction taken by the hyomandibular fold, this surface faces both forward and upward, so that in transverse sections it appears as the dorsal border. Hence it follows that all structures found above the fold are anterior to it, whereas those ventral to it are posterior. The posterior surface faces backward and downward and has in close relation the *Anlagen* of the hyoid cartilage and associated muscles. Between the two muscles is the ramus hyomandibularis of the facial nerve (*vii h.*) which occupies its definitive position posterior to the hyomandibular fold.[9]

[9] The reader will do well to consult figure 3 of Dr. Spemann's paper, which shows a reconstruction of the hyomandibular fold of *Rana temporaria* at a similar stage. I find that the fold in *Bufo lentiginosus* is in all essential respects similar.

It now remains for us to point out the differences between the hyomandibular fold in the present and preceding stages and, if possible, to ascertain how such differences have been produced. In the first place, one will recall that the outer border of the fold in the last stage described a gentle curve, arching from above downward and forward, and that throughout the greater part of its length this border approached very closely the external epiblast. In the present stage the arch described by the outer border is interrupted about its middle by a club-shaped "diverticulum," which, again, is the only portion of the fold which approaches closely the external epithelium. The remainder of the outer border lies a considerable distance below the skin. Again, a comparison of coronal sections shows that the anterior extension of the fold is more marked than in the earlier stage. Hence there are at least three differences to be accounted for, *i.e.*, (1) the recession of the outer border of the fold from the external epithelium; (2) the formation of the blind, distal "diverticulum," which still retains the original position of the fold near the skin, and (3) the more anterior direction taken by the fold.

In order to account for these changes it is evident that at least two factors must be borne in mind. These are (1) the growth process—*i.e.*, the general increase in size of the parts in accordance with the growth of the individual—and (2) the differentiation of new structures. First, as regards the recession of the outer border of the fold from the skin: By comparing the figures illustrating the two stages, one will observe that a considerable increase in the transverse diameter of the head has taken place, whereas little, if any, increase has occurred in the vertical plane. On the other hand the pharynx has not increased concomitantly in size, but, instead, has undergone an actual decrease, so that it is not only relatively, but also absolutely, smaller in size than in the earlier stage. However, between the points of origin of the hyomandibular fold the pharyngeal cavity retains approximately its original width, a feature due to the fact that in this region it forms a pair of shallow evaginations (fig. 16). The smaller size of the pharyngeal cavity can be readily made out in the transverse sections (compare figs. 5–7 with 10–14). This reduction is in all probability connected with the increase in amount of mesenchyme and particularly with the segregation of the latter to form the *Anla-*

gen of the cartilages and muscles. The cartilages are laid down close to the wall of the pharynx, and with their increase in size the latter is naturally reduced; while at the same time the increase in amount of the general mesenchyme accounts for the increase in width of the entire head.

As a consequence of the retarded growth of the pharynx and of the increase in width of the head it follows that, unless there is sufficient rapidity of growth in the fold to compensate for the arrested growth of the pharynx, the distal extremity of the hyomandibular fold will be removed more and more from the exterior and that ultimately it will come to lie quite deeply. To such causes, I think, must be attributed the recession of the hyomandibular fold from the exterior. The head has increased in width, while the pharynx has remained stationary, and even been reduced in size, so that its appendage, the fold, quite naturally recedes from the ectoderm.

But this explanation suggests another problem: Why does the fold not exhibit sufficient rapidity of growth to enable it to retain throughout its original position near the external epithelium, as in the case of the remaining visceral-clefts, and, moreover, why does it retain this position at one point, *i.e.*, where the blind, bulbous "diverticulum" terminates? This question brings us to our second topic—the formation of the "diverticulum." This part is not, I consider, a new formation, but merely that portion of the fold which has managed by its normal growth to retain its original position near the ectoderm. In this connection I wish again to call attention to the condition in stage II. The distal border then formed a gentle arch, which for a considerable part of its extent was in close proximity to the skin. However, at both its dorsal and ventral extremities this border recedes progressively more and more from the exterior until finally it blends at both ends with the lining of the pharynx. Hence in sections the dorsal and ventral portions of the distal border are seen at varying levels below the ectoderm, while the crown (of the arched plate) is situated near the latter (compare figs. 2–7). Fig. 6 is instructive in this connection. Take the fold as shown on the right side. It will be seen that the distal edge is in close proximity to the ectoderm for a considerable part of its length. However, the upper portion of this border is closer to the ectoderm than the remainder. This part represents a region slightly dorsal to the middle portion of the distal border. Below this the edge recedes to a slight extent from the exterior and in its middle portion forms a slight, barely perceptible depression. If we now conceive that in the future growth of the animal all the lower portion of the distal edge remains stationary and that the middle depression deepens considerably, while the upper portion alone remains in proximity to the ectoderm, then we should obtain a condition very similar to that shown in fig. 12, except that complete outward extension of the fold is not shown in the figure (see instead fig. 10). In fig. 12 the arrested ventral portion can be seen as an extension of the right inferior angle of the pharynx, while the concavity between it and the plate-like hyomandibular fold is the much-deepened depression (see also fig. 11). In the latter figure the lower portion of the fold can be seen as a blunt extension from the ventro-lateral wall of the pharynx, while the flattened, oval mass external to and above it is the dorsal portion, or, as we have temporarily termed it, the "diverticulum." More posteriorly, as shown in fig. 12, this "diverticulum" becomes continuous with the proximal portion of the fold, and accordingly the area embraced between these two portions anteriorly represents the depression, which we saw beginning in fig. 6. One will notice that in this area a muscle—the depressor mandibulæ (*m.d.m.*) —has just attained attachment to the *Anlage* of the quadrate cartilage, while external to it its companion muscle, the depressor ossis hyoidei (*m.d.h.*), has acquired attachment to the tip of the processus muscularis. The "diverticulum" lies between these two muscles and, as already mentioned, extends anteriorly between them until it reaches the anterior surface of the outer muscle (depressor ossis hyoidei), around which it curves outward (fig. 10, also 17 and 18). In the behavior of these two muscles lies the clue to the solution of the problem under consideration. One will recall that both of these muscles belong originally to the hyoid arch, and consequently their acquirement of attachment to the quadrate is a later affair. In stage II the original hyoidean muscle-mass, from which these two are subsequently differentiated, extends in its long axis almost vertically and is situated entirely behind the hyomandibular fold (see figs. 2–7). Later, however, as the muscle increases in size its long axis becomes extended in an obliquely anterior direction, the superior border facing forward. At this time the common muscle divides into an inner and anterior mass, the depressor mandibulæ, and an outer and posterior mass, the depressor ossis hyoidei. With subsequent growth both muscles extend forward more and more until one of them—the depressor mandibulæ—invades the area intervening between the skin and the inferior portion of the distal edge of the hyomandibular fold at the point indicated by the slight depression shown in fig. 6 (x). Here its anterior extremity comes into close relation with the segregating *Anlage* of the quadrate at a point just in front of and below the fold. The outer muscle—the depressor ossis hyoidei—also acquires attachment to the quadrate *Anlage*, but at a point above and posterior to the fold.

I have just mentioned that the depressor mandibulæ extends forward in the space between the lower portion of the distal border of the hyomandibular fold and the skin. With this invasion an effective barrier is interposed between the two ; and as a result of the subsequent increase in size of the muscle and of the extension in width of the head, it follows that this lower portion of the hyomandibular fold will be arrested in its growth and will consequently come to be more and more removed from the exterior. At the same time the segregation of the mesenchyme to form cartilage *Anlagen* interposes additional barriers to the outward growth of the fold. Hence it is possible to understand why it is that the lower part of the fold should lie so far beneath the ectoderm as shown in the present stage (figs. 11, 16, 17). On the other hand, the dorsal portion of the hyomandibular fold—*i.e.*, that which forms the " diverticulum "—is situated above the depressor mandibulæ, so that the latter does not interfere with its normal growth and as a result this portion of the fold still retains its proximity to the skin. With the increase in width of the head it has been carried outward with the skin. In its proximal portion, however, this part also has been encroached upon by the developing depressor mandibulæ, and as a result it presents the form of a long-drawn-out cord, narrow and flattened in its proximal part and swollen in its terminal part, where it is not encroached upon to any great extent by the surrounding structures.

Along the dorsal edge of the fold no well-marked changes, so far as I have been able to determine, seem to have taken place.

In the figures (particularly figs. 17 and 18 [left side]) one will notice that the distal extremity is removed some distance from the skin, but this appearance, I consider, is simply produced by the obliquely ventral direction taken by the dorsal border, as has been already described.

This brings us to our third problem, *i.e.*, the more pronounced anterior extension of the fold. This, I consider, is correlated with the growth anteriorly of the two hyoidean muscles. Naturally as these extend forward they carry the fold with them. As a result of this the posterior surface of the fold comes to face outward, and the anterior inward. Hence in transverse sections structures external to the fold are also morphologically posterior, whilst those internal to it are morphologically anterior (compare transverse with coronal sections of present stage).

Stage IV.—Young tadpole. Opercular fold well developed, ending freely posteriorly and with the ends of the external gills protruding beyond its posterior margin. The various tissues for the most part clearly differentiated. True cartilage developed in the mandibular and hyoid arches (Pl. VIII, figs. 15, 19; Pl. IX, figs. 23, 24).

Beginning anteriorly the distal, blind extremity of the "diverticulum" appears as a transversely extended cord of cells, somewhat expanded distally, lying in the loose mesenchyme some distance below the external epithelium (fig. 24, *Tym.*). This cord is clearly distinguished from the surrounding fibrous tissue by its greater density, which naturally causes it to stain more deeply, and also by the presence within its substance of yolk spherules and numerous pigment granules, similar to those found in the mucous membrane of the pharynx. In the present stage the yolk spherules, although still present, are much less numerous than in the earlier stages and they soon disappear altogether, so that the dark pigment becomes the distinguishing feature of the cord. The lower proximal portion of the hyomandibular fold can be seen in the figure as a shallow protrusion (*Hym.*) from the ventro-lateral angle of the pharynx (compare with figs. 10 and 11). In the region immediately posterior the proximal portion is practically blended with the wall of the pharynx (figs. 15 and 19). In fig. 19 (right side) it again becomes distinguishable and soon becomes continuous with the prominent diverticulum *Eu.* (left side of fig. 19).

I will now return to the "diverticulum" in order to trace its further course. From its distal extremity the "diverticulum" extends inward and slightly backward in close contact with the anterior surface of the depressor ossis hyoidei (*m.d.h.*, fig. 24, *Tym.*), and then ascending slightly to pass over a large vessel, the mandibular aortic arch (*m.a.*), it comes into close relation with the external surface of the processus muscularis of the quadrate. As it progresses inward the cord gradually decreases in diameter, so that when it reaches the quadrate it is reduced to about a half or even a third of the diameter of its distal expanded portion.

After reaching the external surface of the quadrate the reduced "diverticulum" turns sharply posteriorly at the inner edge of the depressor ossis hyoidei as a minute, cylindrical cord, (figs. 23, 15, 19, *Eu.*). Here it is closely applied to the processus muscularis of the quadrate. Below and internal to it is the mandibular aortic arch (*m. a.*), while bounding it externally is a small, accessory slip from the depressor mandibulæ (fig. 15, *m.d.m'.*), the main body of which is attached to the quadrate anterior and internal to the cord (fig. 24, *m.d.m.*). The cord extends posteriorly in the same position, usually closely applied to the quadrate, and showing more or less reduction in size, so that in certain parts of its course it is difficult to trace clearly. Throughout its entire extent, however, it contains numerous pigment granules, the presence of which facilitates considerably the tracing of the cord, as does also the scattered yolk-bodies apparent for the last time in the present stage.

In fig. 15 the cord can be seen, much reduced, just under the transversely extended processus muscularis and external to the mandibular aortic arch (*m.a.*). In fig. 19 (right side) the cord (*Eu.*) still occupies the same relative position. Just external to it is the ramus hyomandibularis of the facial nerve (*vii h.*). Internal to it the mandibular artery (*m.a.*) intervenes between it and the pharyngeal wall. At this point the mandibular aortic arch begins to turn inward in order to reach the carotid. Immediately behind the artery the cord fuses with the distal extremity of the diverticulum extending up from the pharyngeal wall (see fig. 19, *Eu.*, left side). Here both the cord and proximal portion of the hyomandibular fold become continuous. The fold becomes more prominent in the following sections (fig. 23, *Eu.*) and ultimately blends with the wall of the pharynx dorsal to the inner opening of the first branchial-cleft.

To recapitulate briefly the state of the hyomandibular fold at the present stage: we have found the ventral portion of the fold present only as an inconspicuous protrusion of the ventro-lateral angle of the pharynx. Only the dorsalmost portion of the original fold is well developed, and from this the greatly prolonged "diverticulum" extends forward as a solid cord of cells. The latter originates posterior to the quadrato-hyoid articulation. Throughout the greater part of its length the cord is closely applied to the outer surface of the processus muscularis. Anteriorly, however, it bends sharply outward in front of the depressor ossis hyoidei and terminates blindly as a somewhat bulbous enlargement in the subcutaneous tissue.

I may here describe briefly the condition of the neighboring skeletal structures, since in the present stage these have acquired the relations which they retain throughout the entire larval period. The animal has now passed beyond the pro-cartilage stage and consequently the cartilages can be readily traced. In most cases they already show a well-defined perichondrium. The quadrate cartilage is prolonged in an antero-posterior direction almost parallel with the corresponding trabecula cranii. Its course is thus quite the reverse of that which characterizes its adult condition. Its distal articular end is prolonged as the processus articularis downward and forward to a point beneath the anterior surface of the eye and at a later period still farther forward. At its distal extremity it bears the transversely placed mandibular cartilage (Meckel's). The greater part of the quadrate is prolonged upward and outward as a stout plate immediately underlying the orbit—the processus muscularis—to the outer side of which are attached the depressor mandibulæ and depressor ossis hyoidei. In the concavity formed in the inner (and upper) surface are lodged the muscles of mastication (fig. 24, *k.m.*). On the ventral surface near the point of junction between the body of the cartilage and the processus muscularis there is forming at the present stage a shallow, concave articular surface for the head of the hyoid cartilage. The latter is a stout bar of cartilage extending transversely beneath the floor of the pharynx and joined to its fellow of the opposite side by the intervention of a median plate, the copula. In its outer portion the hyoid turns sharply upward to form an ascending process, which articulates with the quadrate.

In its anterior portion—*i.e.*, where the processus articularis is given off—the quadrate is joined to the trabecula of the same side by an ascending bar of cartilage, the commissura quadrato-cranialis anterior (Gaupp) or palato-pterygoid bar. Posteriorly again the quadrate bends sharply upward and then as a stout bar (processus ascendens, fig. 19, *Pr.A.*) extends inward back of the eye and in front of the auditory capsule to join with the trabecula just in front of the basilar plate (parachordal). There is no distinct separation between these connected cartilages, the matrix of each being perfectly continuous with that of the others.

It now remains to connect the conditions observed in the present stage with those seen in the preceding. The chief differences between the former and the latter are briefly these: (1) The relatively much greater length of the "diverticulum," a condition associated with the removal of the part connecting it with the pharyngeal wall to a point more posterior, *i.e.*, back of the quadrato-hyoid articulation; (2) the reduction in size of the middle portion of the "diverticulum," and (3) the almost complete obliteration of the ventro-anterior portion of the hyomandibular fold.

These differences are, I believe, correlated with a continuation of the same processes treated of under the description of the preceding stage. These are chiefly the modifications undergone by the neighboring muscles and cartilages. The general growth of the animal has had little, if anything, to do in producing the differences between the two stages. There has been a considerable increase in width of the head—an increase in which, however, the contained structures have taken part. The greater length of the "diverticulum" has been produced by the continued increase in depth of the depression in the distal border of the fold. In stage III this depression was relatively shallow, so that the "diverticulum" was very short and blunt. In the present stage the "diverticulum" is very long, having the form of a long, narrow cord somewhat expanded at its distal extremity. The insinking of the distal border was associated with the growth of the depressor mandibulæ, in consequence of the latter's acquisition of a point of attachment to the quadrate in front of and below the distal border of the hyomandibular fold. In the present stage this muscle has increased in size and extended its area of attachment to the quadrate. It has also given off an accessory slip, which extends upward external to the cord-like "diverticulum" to attach to the processus muscularis (fig. 15, *m.d.m'.*). Moreover, immediately behind the posterior edge of the depressor mandibulæ, the hyoid cartilage is drawn up to form an articulation with the quadrate, and following this the enlarged mandibular aortic arch turns inward to join with the carotid (fig. 19, *m.a.*) just in front of the point where the "diverticulum" joins the extension from the pharyngeal wall (fig. 19, *Eu.*, left side). Thus changes in three structures have been instrumental in producing the deepening of the depression, *i.e.*, (1) the increase in size and area of attachment of the depressor mandibulæ; (2) the articulation of the hyoid to the quadrate, and (3) the increase in size of the mandibular aortic arch.

The reduction in size of the middle portion of the "diverticular" cord (compare figures with fig. 11 of last stage) has been associated with two factors: (1) the increase in size of the accompanying mandibular aorta, and (2) the differentiation and growth of the outer, accessory slip of the depressor mandibulæ. By examining figure 15, one will notice the reduced cord tightly wedged in between the enlarged artery internally and the accessory slip externally.

The decrease of the ventro-anterior portion of the hyomandibular fold to form a mere shallow protrusion of the ventro-lateral angle of the pharynx (fig. 24, *Hym.*) has in all probability been produced by the deepening of the depression and its final blending with the pharyngeal wall. Naturally, as the depression deepened its deepest part would ultimately blend with the pharyngeal wall, so as to be no longer distinguishable (fig. 15). As the ventro-anterior portion of the fold formed the lower border of the depression, it would naturally be drawn in with the deepening of the depression until it formed the shallow protrusion mentioned (fig. 24, *Hym.*). This decrease is also accelerated by the increase in size and density of the skeletal and muscular parts.

Stage V.—Young tadpole of about 9 mm. Opercular cavity communicating with the exterior by a single opening on the left side. No external gills.

The condition of the hyomandibular fold is essentially similar to that in the preceding stage. The tissues of the animal are more compact and definitely limited than in the last stage. The external, distal extremity of the "diverticulum" (or, as I may now term it, the Eustachian cord, since the structure under consideration ultimately gives rise to the greater part of the tube of that name) has the same general appearance as before. It, however, does not extend so far out from the processus muscularis as before, a condition probably produced by the increase in size of the process. A slight reduction has also taken part in this portion of the cord ("diverticulum"). More marked, however, has been the change in the middle portion of the cord. After extending inward to the processus muscularis the cord rapidly degenerates, becoming greatly flattened and much reduced in size, so that for a part of its course it is very difficult to recognize, the presence of scattered nuclei and numerous pigment granules alone serving to mark its existence. This great reduction has been associated with a continuation of the processes described in the last stage, *i.e.*, the growth of the hyoidean muscles (depressor mandibulæ and depressor ossis hyoidei), the articulation of the hyoid with the quadrate and the increase in size of the mandibular artery (Pl. VII, fig. 8 and Pl. IX, fig. 25, *Eu.*).

The cord retains the degenerate condition just described until it reaches a point just back of the region where the mandibular aorta turns inward to join the carotid. A good idea of the condition of the cord can be obtained from coronal sections (fig. 8). In such it appears as a faint, narrow cord (*Eu.*), coursing in an antero-posterior direction in contact with the outer surface of the processus muscularis. This cord contains no lumen and shows no indication of a tubal character. It contains throughout its course scattered nuclei arranged end to end, and it is largely colored by numerous black pigment-granules. The yolk-spherules have now disappeared entirely. There is very little substance to the cord and in places where nuclei and pigment are lacking it becomes very difficult to trace.

Immediately posterior to the inflexed mandibular aorta the Eustachian cord is joined to the pharyngeal wall by a narrow strand of somewhat elongated cells. These cells are not easily distinguishable from the cells of the surrounding connective tissue, but they form a rather dense patch in the latter stretched between the pharyngeal wall and the tubal *Anlage*. Immediately beyond this region this connecting portion broadens out considerably to form a rather shallow bulging of cells from the roof of a "lateral recess" (fig. 25, *l.r.*) or pouch of the pharynx, from the outer extremity of which the thymus gland is given off. This "lateral recess" is really formed by an extension outward of the branchial portion of the pharynx over the internal branchial openings, so that the latter are now situated on the floor of the cavity. In the preceding stage this "lateral recess" was just beginning to form as a slight bulging beneath the proximal portion of the tubal *Anlage*. With the extension externally of the "lateral recess" the proximal portion of the Eustachian cord comes to appear as an inconspicuous protuberance over the inner part of the roof of the "recess" (fig. 25, immediately internal to *vii h*).

Stage VI.—Tadpole of 18 mm. Posterior limbs appearing as minute buds below the root of the tail (Pl. IX, fig. 26).

In this stage the Eustachian cord has about reached the height of its degeneration. The cord still maintains the same general relations to the surrounding parts as before. Its distal, expanded extremity remains distinct, and from thence the cord can readily be traced to its characteristic position next to the outer surface of the processus muscularis. Here, however, it soon becomes very small and then can be traced only with the greatest difficulty. The cord lies immediately above the mandibular aorta, and by following the latter it may be traced as a minute, more or less flattened pigmented patch, which in certain parts contains one or two nuclei not readily distinguishable from the nuclei of the surrounding fibrous tissue (fig. 26, *Eu.*). Immediately posterior to the quadrato-hyoid articulation the cord again enlarges slightly and can be traced thence for a considerable distance. Then in the region where the ramus hyomandibularis begins to come into close relations with its external surface all distinct traces of the cord are lost. Nothing more of the cord is to be made out until we come to the region where the mandibular artery turns inward, where for a short space the cord is again revealed and then terminates without forming any clear connection with the pharyngeal wall. This most posterior fragment of the cord is situated below the quadrate, dorsal to the upper anterior end of the "lateral recess" of the pharynx. There is no distinct proliferation from the dorsointernal wall of this portion to indicate the proximal, connecting part of the tubal cord. The proliferation has very likely opened out with the formation of the " lateral recess," and has been merged into the dorsal wall of the latter.

It thus appears that in the present stage the Eustachian cord for the greater part of its length has undergone remarkable fragmentation, having broken up into a number of sections of variable length. Each of these fragments, however, retains exactly the same relations to the surrounding structures that the corresponding part of the cord showed in the preceding stage. It is quite possible that the various fragments may still be connected by the transparent cell-walls of the cord, and in that case the apparent fragmentation is simply due to the restriction of the more vital, stainable portions to areas less subject to the action of unfavorable forces. I am somewhat inclined to consider this the actual condition in the present stage, since in a longitudinal series I have been enabled to follow out with great care a pale, almost transparent cord connecting some of the fragments. Posteriorly this cord approaches very closely the wall of the pharynx. I have not been able to make out any distinct connection between the two, but their proximity would incline me to believe such a union to exist. Still I have not been able to satisfy myself on this point.

I have not been able to determine to my satisfaction the factors which have been concerned in the degeneration of the Eustachian cord. One of them is probably to be found in the pressure exerted by the surrounding structures, particularly by the two muscles already mentioned. Owing probably to its unfavorable position the tubal cord appears to have little, if any, power of independent growth. It therefore may have been acted on by the growth anteriorly of the head whereby a pull has been exerted on it, causing its wall to extend and its contents to be restricted to more or less limited regions of the cord.

Stage VII.—Tadpole of 21 mm. Hind limbs well developed. This stage very closely resembles the preceding. Owing to an accident the more anterior sections of the Eustachian cord in the specimen examined are lacking, but I have no doubt but that this portion of the cord in the present stage corresponds in all essential respects with that in the preceding, since in the succeeding stage the anterior portion is very similar to that in stage VI. So far as the remaining parts are concerned, they present the same fragmentary character as in the preceding stage, being in certain locations almost unrecognizable. I noticed in the present series (and likewise in several later ones) that there is no necessary correspondence either in the number, length or distribution of the fragments of the two sides. In the case of the specimen of the present stage examined the sections were almost exactly transverse, so that the same parts were cut on both sides. Yet the tubal cord may be present for a considerable distance on one side and apparently altogether absent on the other. This irregularity is a marked feature during the entire metamorphic period. I find that there is also marked individual variation in this respect. This variability would seem to indicate that the character of the fragmentation is not due to some inherited tendency, but is produced by mechanical forces exerted by the surrounding structures.

Posteriorly the Eustachian cord terminates suddenly in the usual position, dorsal to the anterior extremity of the "lateral recess" of the branchial portion of the pharynx. In the same region a prominent proliferation arises from the dorsal wall of the "recess," and extends upward to the same relative position as that occupied by the cord in the more anterior sections. This structure may represent the same mass of cells which originally established the connection between the tubal cord and the wall of the pharynx, but of this interpretation I am uncertain, since I was unable to discover any sign of such proliferation in the preceding stage or in a number of later stages. Possibly its occurrence or absence is a matter of individual variation.

There has been but little change in the skeleton since the last period. Posteriorly, however, the quadrate has developed a posteriorly projecting processus oticus, which comes in contact with the ventral surface of the auditory capsule. The processus oticus arises at the angle formed by the body of the quadrate with the processus ascendens. The stapes appears for the first time as an oval chondrification within the membrane closing the fenestra ovalis. There are no distinct traces of a columella auris.

Stage VIII.—Tadpole of 21 mm. Preceding the appearance of the fore-limbs.

At this time we have the earliest distinct appearance of the annular cartilage (Pl. IX, fig. 28, *An.*). About opposite the point where the pterygo-palatine bar (processus quadrato-cranialis anterior) joins the quadrate, a very conspicuous proliferation from the perichondrium of the latter occurs. This proliferation forms a dense strand of cells, which reach outward in the subcutaneous tissue and aggregate themselves in a somewhat concentric fashion about the distal, expanded termination of the Eustachian cord (*Tym.*). The dense patch there formed is the *Anlage* of the future annular cartilage. From this region the Eustachian cord pursues the same course that characterized the preceding stages. The cord is, however, much more distinct than in any of the latter, and its tubular character is plainly indicated by its nuclei, which are now grouped about the periphery of the cord, thus giving the latter the appearance of a duct with an obliterated lumen (Pl. XI, fig. 29, *Eu.*). In certain parts of the cord slight indications of a central lumen can be made out, but, as a rule, any cavities that do appear are neither very extensive nor pronounced. The cord, however, as in the preceding stages, becomes smaller as it extends posteriorly and in the region of the quadrato-hyoid articulation disappears. It soon reappears, however. Posterior to the hyoid articulation the cord again becomes much reduced, but does not lose its continuity with the most posterior portion. In the most posterior part of its course the cord again enlarges, becomes clearly tubular, and exhibits a more or less well-defined lumen. In this portion the cord occupies its characteristic position, ventral to the quadrate cartilage and internal to the ramus hyomandibularis, which in the region of the quadrato-hyoid articulation ascends from the ventral portion of the hyoid arch to come into close relation with the outer wall of the cord. From the dorsal wall of the "lateral recess" of the pharynx a conspicuous strand of cells arises, the dorsal end of which closely approaches the Eustachian cord, but before actual contact takes place the cord rather suddenly terminates. I am not certain of the significance of this strand. It may be the part which originally connected the cord with the pharynx, but of this I am uncertain, since I found no evidence of it in stage VI.

Stage IX.—Tadpole of 18 mm. Both fore and hind limbs present.

This stage marks the commencement of the metamorphosis. Since the changes which the Eustachian cord (or tube) undergoes during this period are obviously correlated with modifications taking place simultaneously in the skeletal structures, it is necessary, in order to follow the former, to obtain a right conception of the latter. Hence in the present stage I will first treat of the essential skeletal parts. In the first place, the axis of the quadrate extends in a more dorso-ventral direction than formerly, so that now the mandibular articulation lies below the anterior edge of the eye, instead of being entirely in front of it as before. This position implies that the lower part of the quadrate has moved or rotated backward through a slight angle. The processus quadrato-cranialis anterior (pterygo-palatine) is now considerably elongated in an antero-posterior direction, a change obviously associated with the backward rotation of the quadrate. The processus muscularis (orbital) begins to show signs of degeneration, especially along its dorso-external edge. The hyoid still articulates to the ventral surface of the quadrate. Posteriorly the processus ascendens has degenerated and consequently the quadrate has lost its connection with the wall of the brain-case, but instead it now joins by means of its processus oticus the wall of the auditory capsule anterior to the fenestra ovalis. In the membrane closing the latter the stapes now appears as a large, oval mass of fully differentiated cartilage. The columella auris is a delicate rod of primitive cartilage, closely applied to the wall of the capsule. Anteriorly it terminates without forming any connection whatever with either the quadrate or any portion of the Eustachian tube and posteriorly it unites with the stapes. The columella is most distinct and its tissue most compact in its posterior portion, so that it cannot be regarded as a derivative of the quadrate.

As a consequence of the posterior rotation of the distal portion of the quadrate, the distal extremity of the Eustachian cord is now situated somewhat posterior to its former position, but its relation to the immediately surrounding structures is the same as before, since these likewise have been affected by the quadrate's change of axis. The annular cartilage, now a dense cellular mass, is situated under the anterior margin of the eye and above the mandibular articulation. To its ventral surface the more anterior fibres of the depressor ossis hyoidei have acquired attachment. Imbedded in the cartilage is the distal end of the Eustachian cord, the future tympanic cavity. The general appearance of the cord is similar to that in the preceding stage. The cord still shows fragmentation, although the length and distribution of the fragments differ on the two sides. No connection between the cord and the pharynx can be determined with certainty, although the proliferation attached to the dorsal wall of the "lateral recess" is still present.

Stage X.—Tailed toad of 15.5 mm. Fore and hind limbs well developed.

This stage very closely resembles the preceding, the most marked differences being the greater antero-posterior elongation of the processus quadrato-cranialis anterior and the associated greater posterior rotation of the quadrate. The Eustachian cord, also, is very distinct, particularly in its anterior and posterior portions. In the region just back of the quadrato-hyoid articulation it is greatly reduced and traceable only with difficulty. In several places the cord shows a distinct lumen. There are no distinct signs of a proliferation attached to the pharyngeal wall extending toward the cord.

Stage XI.—Tailed toad, 6.8 mm., tail 1.5 mm. Close of the metamorphosis.

The processus quadrato-cranialis anterior has now increased considerably in length, so that it extends in a direct antero-posterior direction as in the adult toad. The axis of the quadrate has attained an almost vertical direction, but it still extends somewhat forward, its distal, articular end being located under the middle or posterior part of the eye. The hyoid still maintains its union with the quadrate. More posteriorly, in the region of the auditory capsule, the columella auris can be traced farther forward. At its anterior, distal extremity it is prolonged forward as a dense strand of cells, which forms a connection with the posterior surface of the quadrate. Only the more posterior portion of the columellar rod is formed of true cartilage, the anterior portion being as yet only a dense, undifferentiated mass of cells.

The most conspicuous changes which the tympano-Eustachian tube has undergone since the preceding period have been associated with the change of axis of the suspensory cartilages. As a result of this the tympanic portion of the tube, together with the annular cartilage, has moved backward to a region below the posterior portion of the eye. The tube, as a whole, exhibits the same fragmentary character as hitherto, and I have remarked here, as in a number of other stages, a difference in the condition of the tubes of the two sides. Posteriorly the tube terminates without forming any connection with the pharynx. The proliferation from the pharynx is not very distinct. It probably tends to disappear in connection with the degeneration of the branchial apparatus.

Stage XII.—Tailed toad, 7 mm. Close of metamorphosis.

The quadrate cartilage now stands almost vertical, its distal, articular extremity lying under the posterior border of the eye. The hyoid bar has separated completely from the quadrate and its dorsal extremity is now joined by the intervention of a dense strand of cells to the base of the auditory capsule.

The distal part of the tympano-Eustachian tube now lies immediately posterior and ventral to the eye. Since the distal portion of the quadrate rotates backward more rapidly than the remaining part, it results that the posterior, hitherto ventral, surface of the cartilage forms a shallow concavity. From this behavior it follows that the distal, expanded portion of the tube—*i.e.*, tympanic portion—comes to lie farther posterior in relation to the rest of the cord, so that the latter no longer presents an almost direct antero-posterior course, but instead now lies in an almost transverse plane, except for a slight anterior inclination. The tympanic region of the tube is thus brought into relation with the auditory capsule. In the present period it has not quite reached the region of the latter, but is not far removed, being located just back of the eye. Another feature shown by the present stage is the union of the various fragments of which it was hitherto composed. This union is also probably to be connected with the quadrate's change of axis, since this would result in carrying the more anterior fragments backward and thus bringing them into closer relation with the posterior parts. At present the tube can be traced without a break throughout its entire course. This fact speaks strongly for the view that these parts have all along been united by an attenuated cord. The fragments are simply the contents of this cord which have been restricted to certain areas. As a result of the backward rotation of the quadrate, the stretching to which the cord had hitherto been subjected is relieved and accordingly the various fragments of the substance flow together, thus producing the union described. Proximally, however, the tube forms no connection with the pharyngeal wall, but immediately internal to its proximal termination the pharynx sends out a narrow cleft between the hyoid and the base of the auditory capsule. Posteriorly the tube ceases immediately in front of the dense strand connecting the hyoid cornua with the auditory capsule, so that at this stage the tube occupies its definitive position between the quadrate and hyoid cartilages. As a result of the changes that have taken place in the hyoid its nerve, the ramus hyomandibularis, now lies ventral and posterior to the tube—a position which characterizes it in the adult condition. In the branchial region the entire branchial apparatus, including the "lateral recess" of the pharynx, has become largely obliterated.

Stage XIII.—Young toad, 6 mm. Metamorphosis complete.

This period marks the close of the metamorphosis. The inferior, articular portion of the quadrate extends more posterior, so that the quadrate on its posterior surface shows a marked concavity. The general course of the quadrate is about as follows: Dorsally from its union with the base of the auditory capsule it extends forward and downward for some little distance, it then describes a wide curve downward and backward for the remainder of its length, so that its distal end, bearing the mandibular cartilage, now comes to lie under or even slightly behind its dorsal, proximal extremity. The hyoid arch is now fused completely with the auditory capsule, the intervening cellular strand having become cartilaginous.

The annular cartilage is now located posterior to the eye and ventral to the anterior portion of the auditory capsule. It closely underlies the skin and is external to the outer surface of the quadrate. The Eustachian tube itself differs but little from its condition in the preceding stage, except that its lumen, where present, is more distinct and extensive. A short distance above the tube the distal extremity of the columella auris may be observed as a dense cellular mass, which posteriorly grades into true cartilage.

Stage XIV.—Young toad, about 9 mm (figs. 30, 31).

In this stage the tympano-Eustachian passage has the same general position and relations that distinguish it in the fully mature animal. Relatively it is not so large as in the latter, nor is its lumen complete throughout, but in all other respects it is essentially like the adult structure. Figs. 30 and 31 illustrate the condition of the tube at this time. In fig. 30 we have a transverse section through one side of the head immediately back of the eye. To the outer side is shown the quadrate cartilage, which in the present stage stands almost vertical and hence is shown in the figure cut throughout the greater part of its length. External to the upper portion of the cartilage is the tympanic portion of the Eustachian tube, showing a slight lumen (*Tym.*). I have another specimen of approximately the same age in which the lumen is much larger, forming a considerable cavity. Underlying this portion is the tympanic or annular cartilage, which in its ventral portion, at least, is completely chondrified (*An.*). The fully formed cartilage does not, however, form a complete ring. Internally the tube approaches the outer surface of the quadrate, as was the case in the earlier stages. Applied to the dorso-external wall of the tympanic cavity is the distal extremity of the columella auris, at present a very compact cellular mass, not yet differentiated into true cartilage (*Cl.*). The apparent inclusion of the columella within the tympanic cavity is produced by the subsequent growth of the latter around this portion of the cartilage. Attached to the ventral surface of the annular cartilage are fibres of the depressor ossis hyoidei (*m.d.h.*). The attachment of the muscle to the cartilage was acquired soon after the earliest *Anlage* of the latter had appeared. At its ventral end the muscle has lost its attachment to the hyoid cartilage and has acquired a new insertion into the angle of the mandible, so that like the depressor mandibulæ it serves to depress the latter (compare also fig. 31). The bulk of the muscle lies posterior to the Eustachian tube. Internal to the muscle and between it and the quadrate are two blood-vessels, which correspond to the original mandibular aorta (*m.a.*). This vessel, as we have seen, was an important one during the tadpole period, but during the metamorphosis it underwent some profound changes. Its middle portion largely degenerated, so that the vessel became divided into a proximal and a distal half. The vessel undergoes other changes, but these I have not been able to follow satisfactorily with the material at hand.

Fig. 31 shows a section through the tympano-Eustachian tube near its posterior boundary. The quadrate (*q.*) is here seen in two separate portions, a dorsal and a ventral. This condition can be readily understood by referring to the description of the cartilage as given in stage XIII. It suffices to mention that the section passes back of the point where the quadrate curves backward on itself, so that the dorsal is the proximal, the ventral the distal portion of the cartilage. The distal portion bears the mandible. Underlying the proximal portion is the Eustachian tube (*Eu.*), here shown in three detached segments. Other sections, however, show these segments continuous, so that the tube is now complete. Moreover, the proximal innermost segment is continuous with the pharynx and in reality represents a diverticulum (*div.*) from the latter. In the other specimen that I have of this stage this portion is continuous with the pharynx, but its distal extremity ends blindly without forming a connection with the Eustachian tube. In the toad of stage XIII this diverticulum of the pharynx was also present, and connecting it with the widely separated tubal *Anlage* was a dense strand of connective tissue cells, whose long diameters were extended in a direction coinciding with a line drawn between the separated parts. By means of this diverticulum the tympano-Eustachian tube is now united to the pharynx. The tube presents throughout an irregular lumen, bounded by a well-defined columnar epithelium. That portion of the tube which is most externally situated is the posterior part of the tympanic cavity (*Tym.*). Attached to the dorsal wall of the latter is the columella auris (*Cl.*). The ramus hyomandibularis of the facial nerve is not shown in this section, since, owing to the posterior flexure of the quadrate and the separation of the hyoid from the latter, the nerve now lies entirely posterior to the tube.

SUMMARY.

The results recorded in the preceding pages may be briefly summarized as follows:

1. The tympano-Eustachian passage is in the main derived from the dorsalmost portion of the hyomandibular fold (cleft).

2. In the earliest stages described, the hyomandibular fold is present as a solid, plate-like fold extending outward and forward beneath the eye region and terminating laterally in a free edge situated a short distance below the ectoderm. Its attachment to the ectoderm is lost at about this stage.

3. At first the outer or distal edge of the hyomandibular fold is smooth and unbroken throughout its entire extent. Later, this edge becomes interrupted in its middle portion by the formation of a progressively deepening depression, which ultimately reaches the pharyngeal wall and divides the hyomandibular fold into two parts—a dorsal cord-like portion, the future tympano-Eustachian passage, and a ventral portion forming a shallow sacculation to the ventro-lateral portion of the pharyngeal cavity.

4. The ventral portion of the hyomandibular fold ceases to be recognizable after the late tadpole stages. It is this portion which Villy considers as the last remnant of the hyomandibular fold.

5. The earliest evidence of the degeneration of the hyomandibular fold is afforded by the recession of its outer edge from the neighborhood of the external ectoderm. Only the dorsalmost portion of the fold continues in intimate proximity to the skin. The withdrawal of the remainder is associated with (1) the reduction in size of the pharynx, in consequence of the segregation of the surrounding mesenchyme to form the *Anlagen* of muscles and cartilages, and (2) the development of the muscles of the hyoid arch—the depressor mandibulæ and ossis hyoidei. Of these muscles the depressor mandibulæ extends forward between the skin and the outer border of the hyomandibular fold and acquires attachment to the developing quadrate cartilage in front of the fold. It thus interposes an effective barrier to further outward extension of the fold. Only the dorsalmost portion of the fold remains unimpeded by the muscle, and this accordingly retains its proximity to the ectoderm and in the subsequent growth of the head is carried outward as a narrow, cord-like strand expanded at its outer extremity into a club-shaped swelling. This portion I have designated the "diverticulum." It is the *Anlage* of the tympano-Eustachian passage.

6. The outer hyoidean muscle, the depressor ossis hyoidei, also acquires attachment to the quadrate *Anlage* at a point above and posterior to the hyomandibular cleft. The "diverticulum" or *Anlage* of the tympano-Eustachian passage thus comes to lie between the two hyoidean muscles.

7. The growth anteriorly of the hyoidean muscles produces a marked antero-posterior extension of the hyomandibular fold and of its derivative, the tympano-Eustachian *Anlage*. This antero-

posterior direction taken by the tubal *Anlage* is characteristic of it during the entire larval period.

8. The further degeneration of the hyomandibular fold is correlated with the subsequent increase in size of the muscles already mentioned, the union of the hyoid cartilage with the quadrate and the enlargement of the mandibular aortic arch.

9. After the degeneration of the hyomandibular fold the *Anlage* of the tympano-Eustachian passage persists as a minute, solid cord, extending along the outer surface of the processus muscularis of the quadrate. Posteriorly it is attached to the wall of the pharynx at a point posterior to the quadrato-hyoid articulation. Anteriorly and distally it expands to form the club-shaped *Anlage* of the tympanic cavity.

10. During the active tadpole period the tympano-Eustachian *Anlage* undergoes marked degeneration. This degeneration is confined to the middle and posterior parts of the *Anlage*, the distal expanded portion retaining its original relative size throughout the entire larval period. The degeneration is in all probability connected with the growth of the two muscles—depressor mandibulæ and ossis hyoidei—between which it lies. Owing to the lack of space it is unable to keep pace with the surrounding structures in the subsequent growth of the animal.

11. In the early tadpole period the tympano-Eustachian *Anlage* is continuous posteriorly with the wall of the pharynx. Later the connection between the two apparently disappears, though the time of its disappearance seems to vary in different individuals. An indistinct strand may continue to unite the two parts, but this I have been unable to demonstrate.

12. The degeneration of the tympano-Eustachian *Anlage* is carried to an extreme in the later tadpole stages. At this time it is apparently broken up into a number of fragments of varying length. This fragmentation is probably more apparent than real, being produced by the restriction of the more vital stainable substance of the tubal *Anlage* to areas less subject to the pressure of the neighboring structures. The irregular distribution of the fragments, both in different individuals and on different sides of the same individual, favors the view that a compressed, transparent cord still connects the apparently separate parts. In one specimen

(tadpole of about 18 mm.) I have been enabled to trace out such a connecting cord.

13. Regeneration of the tympano-Eustachian *Anlage* begins at a period immediately preceding the period when the fore-limbs break out of the opercular cavity.

14. The later metamorphosis of the tubal *Anlage* is connected with the modifications of the neighboring skeletal structures, particularly with the posterior rotation of the quadrate. By this means the tubal cord comes into relation with the auditory region of the skull and the various fragments are brought closer together, so that they can readily unite.

15. The acquisition of a lumen by the tubal *Anlage* takes place gradually, beginning at the close of the metamorphosis. Details apparently vary in different individuals.

16. Completion of the tympano-Eustachian passage is effected by an outgrowth from the pharynx which unites with the tubal *Anlage.*

17. The final position of the tympano-Eustachian tube between the mandibular and hyoid bars is produced by the separation of the latter from the quadrate and its attachment to the auditory capsule posterior to the tube.

18. The annular cartilage arises at a stage immediately preceding the protrusion of the fore-limbs. Its *Anlage* forms a dense cellular strand derived from the perichondrium of the quadrate and surrounding the tympanic portion of the tubal *Anlage.* It does not begin to form fully differentiated cartilage until after the close of the metamorphosis.

19. The stapes arises within the membrane closing the fenestra ovalis. It has no connection with any of the visceral-arches.

20. The columella auris is first met with in the early stages of the metamorphosis, as a compact cellular strand extending forward from the stapes and terminating imperceptibly in the connective tissue. It continues to grow forward and acquires connection with the quadrate. Continued growth brings it in contact with the tympanic cavity. Chondrification begins in the posterior portion of the rod.

EXPLANATION OF PLATES VI, VII, VIII, IX.

The drawings were outlined by aid of the camera lucida, and with the exception of figures 26 and 29 were all drawn to the same scale. With the exception of the two mentioned they are also slightly diagramatic—those on plates VI–VIII reduced one-third ; on plate IX, one-half.

Reference Letters.

An.—Annular cartilage.
Aud.—Auditory capsule.
Car.—Carotid artery.
Ch.—Chorda.
Cl.—Columella auris.
div.—Diverticulum from pharynx.
E.—Eye.
Eu.—Eustachian cord (or tube).
Ext.—External gill.
H.—Hyoid cartilage.
h.a.—Hyoidean aortic arch.
h.m.—Hyoidean muscle mass.
Hym.—Hyomandibular fold.
inf.—Infundibulum.
k.m.—Muscles of mastication.
l.r.—Lateral recess of pharynx.
M.—Meckel's cartilage.
m.a.—Mandibular aortic arch.
m.a′.—Its efferent portion.
m.a″.—Its afferent portion.
m.d.h.—Depressor hyoidei.
m.d.m.—Depressor mandibulæ.
m.d.m′.—Its accessory slip.
Ol.—Olfactory depression.
Pr.A.—Processus ascendens.
Pr.q.c.a. — Commissura quadrato-cranialis anterior.
Pr.M.—Processus muscularis.
Q.—Quadrate.
St.—Stomatodeal plate.
Th.—Thyroid.
Tr.—Trabecula cranii.
Tym.—Tympanic (distal) portion of Eustachian cord.
X.—Small blood-vessel connecting mandibular and hyoid aortic arches.
Y.—Small blood-vessel external to ramus hyomandibularis.
2, 3, 4, 5, v.f.—Second, third, fourth and fifth visceral-clefts.
V.—Trigeminal ganglion.
V′.—Ophthalmic ganglion.
V″.—Maxillary ganglion.
V.m.—Maxillo-mandibular nerve.
VII.—Facial ganglion.
vii h.—Ramus hyomandibularis.
vii pl.—Ramus palatinus.

Plate VI, Fig. 1.—Coronal section through the pharynx and visceral-clefts of an embryo of stage I.

Fig. 2.—Coronal section through the same region of a slightly older embryo (stage II).

Fig. 3.—Coronal section of the same embryo at a somewhat higher plane.

Fig. 4.—Coronal section through the dorsalmost portion of the pharynx of the same embryo.

Fig. 5.—Transverse section through the head of an embryo of approximately the same stage as the last. The section on the right side passes through the extreme anterior portion of the hyomandibular fold (*Hym.*). The plane of section is considerably farther posterior on the left side.

Fig. 6.—Transverse section of the head of the same embryo. On the right side the hyomandibular fold is cut throughout the greater part of its length (*Hym.*). The dorsalmost portion of its outer (distal) border approaches most closely the skin. On the left the facial ganglion gives off the ramus hyomandibularis just external to the outer end of the fold (*vii h.*).

Plate VII, Fig. 7.—Transverse section of the head of the same embryo slightly posterior to the last.

Fig. 8.—Coronal section of head of tadpole of stage V. One side alone shown.

Fig. 10.—Transverse section of the head of a young tadpole of stage III. The section is through the anterior end of the pharynx. The plane of section is more posterior on the right side than on the left.

Fig. 11.—Fourth section posterior to that of figure 10. *Eu.* designates the "diverticulum," while at *Hym.* is the antero-inferior portion of the hyomandibular fold.

Fig. 12.—Third section posterior to the last. The diverticulum (*Eu.*) is now continuous with the antero-inferior portion (*Hym.*) of the hyomandibular fold. Between the two is the depression lodging the muscles (*m.d.m.* and *m.d.h.*). The small vessel above *Eu.* is the mandibular aortic arch.

Fig. 13.—Sixth section posterior to the last. The mandibular aortic arch is dorsal to *Hym.*

Plate VIII, Fig. 14.—Third section posterior to last. The mandibular aortic arch on the right side is just internal to *vii pl.*

Fig. 15.—Transverse section of head of tadpole of stage IV in the region immediately posterior to that shown in figure 24.

Fig. 16.—Coronal section of the head of a young tadpole of stage II. On the right side the section passes a slight distance above the floor of the pharynx, while on the left it is considerably higher. The small vessel in front of *Hym.* is the mandibular aortic arch.

Fig. 17.—Fourth section dorsal to the last. On the right side the little protrusion of the pharyngeal wall just internal to *Tym.* is the antero-inferior portion of the hyomandibular fold just below the point where it becomes continuous with *Tym.* The space between the two is the depression.

Fig. 18.—Coronal section of the head of the same animal a slight distance below the roof of the mouth.

Fig. 19.—Transverse section of the head of a tadpole of stage IV in the region of the processus ascendens.

Plate IX, Fig. 23.—Transverse section of the head of a tadpole of stage IV, passing through a region slightly anterior to the auditory sac.

Fig. 24.—Transverse section of the head of a tadpole of stage IV, showing the anterior expanded portion (*Tym.*) of the Eustachian cord. *Hym.* denotes the proximal anterior portion of the hyomandibular cleft.

Fig. 25.—Transverse section of the head of a tadpole of stage V. On the left the section is immediately posterior to the eye. The minute upgrowth from the dorsal wall of *l.r.* just internal to *vii h.* is the Eustachian proliferation.

Fig. 26.—Transverse section of a portion of the right side of the head of an old tadpole of 18 mm. (stage VI). This section is considerably more magnified than the others and is intended to show the extremely rudimentary character of the Eustachian cord at this stage.

Fig. 28.—Transverse section of the right side of the head of a tadpole at the beginning of the metamorphosis (stage VIII), showing the formation of the annular cartilage.

Fig. 29.—Transverse section of a portion of the right side of the head of the same animal. The section was drawn with the same degree of magnification as figure 26 and is intended to show the Eustachian cord when it begins to regenerate.

Fig. 30.—Transverse section through one side of the head of a young toad (stage XV). The section passes through the region immediately in front of the ear-capsule.

Fig. 31.—Transverse section through one side of the head of the same animal. The section passes through the anterior portion of the ear-capsule.

FURTHER STUDIES ON THE CHROMOSOMES OF THE HEMIPTERA HETEROPTERA.

BY THOMAS H. MONTGOMERY, JR., PH. D.

The present account deals with the relations of the chromosomes in the spermatogenesis of certain *Hemiptera*, and is practically a continuation of a previous paper of mine.[1] In the present paper will be found a description of the chromosomal relations, as far as they could be determined, in certain species not heretofore examined.

The material was collected last summer at Woods Holl, Mass., and was kindly identified for me by Dr. Philip R. Uhler, of Baltimore. The testes of some of the species (*Tingis clavata, Corixa verticalis, Cymus luridus, Lygus pratensis*) were fixed simply in Conklin's picro-acetic mixture, and this fixation not allowing successful staining with Hermann's saffranine-gentian violet method the relations of the nucleoli and of the chromatin nucleoli could not be determined. But in the remaining species (*Nabis annulatus, Corizus alternatus* and *Harmostes reflexulus*) the testes were fixed in Hermann's platinic chloride-osmic-acetic mixture which allowed the saffranine-violet stain, so that for these species the distinction of nucleoli and chromatin nucleoli could be made.

As in my preceding paper (*l. c.*) on this subject, the term "chromatin nucleolus" is applied to that peculiar nuclear element which is a chromosome peculiarly modified in preserving its form and dense structure, which chromosomes as a rule show only in the height of mitosis, throughout every stage of the spermatogenetic cycle. With the saffranine-violet method, the chromosomes proper stain red only in mitosis, and violet in other stages, but the chromatin nucleolus maintains the red stain in all stages.

1. Tingis clavata Stål.

Three testes were studied, none of them showing spermatogonic monaster stages.

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[1] "A Study of the Chromosomes of the Germ Cells of Metazoa," to be published in the *Transactions of the American Philosophical Society.*

Pole views of the monaster stage of the first maturation mitosis (Pl. X, fig. 1) show seven chromatin elements of relatively equal volume, and lateral views of the chromosomes in this stage show that they are all dumbbell-shaped, and hence probably bivalent (fig. 2). This mitosis results in a transverse (reduction) division of all these elements. Very frequently one of them is seen to be characterized in having its two components of very unequal volume.

Since these preparations were stained merely by the iron-hæmotoxylin method, the presence of chromatin nucleoli could not be positively determined owing to the lack of differential staining. But in the prophases of the first maturation mitosis can be seen a large true nucleolus, and two smaller rounded bodies (generally of different volumes) which are sometimes in mutual apposition, and sometimes not. If the latter are chromatin nucleoli, they are much smaller than any of the seven bivalent chromatin elements of the maturation division, so that the latter are possibly all unmodified chromosomes.

This species of the *Tingitidæ*, in having such a small number of chromosomes, may be regarded rather as a specialized than a primitive form.

2. Corixa verticalis Fieber.

The chromosomes could not be counted in the monaster stages of the spermatogonia. Two testes were examined.

Pole views of the monaster stage of the first maturation mitosis (Pl. X, fig. 3, in which two of the chromosomes are seen laterally) show twelve chromatin elements, of which one regularly is placed in the centre of a circle composed of the remaining eleven. Lateral views (fig. 4, in which four of the large and two of the small elements are shown) show that all these elements are dumbbell-shaped, and hence probably bivalent. Three are much smaller than the remaining nine, and the very smallest is the one that occupies the centre of the chromosomal plate. All these elements divide by a transverse (reduction) division, and in the daughter cells (second spermatocytes) the chromosomes are arranged all close together in the equatorial plane; it is the case in a number of species of the *Hemiptera* that the chromosomes show different plans of arrangement in the two maturation mitoses.

In the post-synapsis stage there is found in the nucleus a peripheral, compact, densely staining body of dumbbell form (Pl. X, fig. 5, the chromatin reticulum not shown in this figure). This possibly represents a true nucleolus and a chromatin nucleolus in apposition, but this point could not be determined. Similarly I could not ascertain whether the three small chromatin elements of the maturation mitoses are chromatin nucleoli.

3. Cymus luridus Stål.

There were no spermatogonic mitoses in the two testes examined of this Lygæid.

Pole views of the monaster stage of the first maturation mitosis show fifteen chromatin elements of very varying volumes (fig. 6), though one (*N. 2?*) is always much smaller than the others and, by analogy with many other *Hemiptera*, probably represents a chromatin nucleolus. Lateral views of the same stage show that all these elements are dumbbell-shaped, and so probably bivalent (fig. 7 showing the smallest and four of the larger elements). All these elements become transversely divided.

In the growth period of the spermatocytes, preceding the maturation divisions, the nucleus contains a large true nucleolus, very irregular in form and peripheral in position. There are also found as many as four smaller, rounded bodies, two of which are frequently mutually apposed; if these be chromatin nucleoli there would be potentially two bivalent chromatin nucleoli in the resting spermatocyte (four univalent ones), though apparently only a single bivalent one in the maturation mitosis.

This species has a larger number of chromatin elements in the first maturation mitosis than does the closely similar *C. angustatus*, which I have shown to possess only thirteen.

4. Lygus pratensis Linn.

The individuals of this species of Capsid were labeled by Dr. Uhler, "*Lygus pratensis* var.;" whether Dr. Uhler regarded them as simply showing slight differences in color, or as a good geographical variety, I cannot say. In the two testes studied there were no spermatogonic monasters.

In the monaster stage of the first maturation division are found eighteen chromatin elements (Pl. X, figs. 8, 9), namely, sixteen larger and two (*N. 2*) much smaller; while in the monaster of the second maturation mitosis (fig. 10) are present seventeen elements, sixteen larger and one smaller (*N. 2*). The sixteen larger elements in the first mitosis are all bivalent, and probably are all true chromosomes; they all divide transversely. The two small elements (those marked *N. 2* in the figures) of this mitosis do not divide, but one of them goes undivided into the one daughter cell (second spermatocyte), the other one into the other—this explaining why in the first spermatocytes there are eighteen elements, in the second only seventeen. On account of these small elements not dividing, each of them must be considered univalent; for so far as my observations on the *Hemiptera* have gone, all bivalent elements divide transversely in the first maturation mitosis.

The species of *Capsidæ* thus far examined (compare the preceding paper, *l. c.*) show a remarkable agreement in the number of their chromosomes. Thus, if we count each bivalent chromatin element of the first maturation mitosis as two, there would be the following number of univalent elements (counting in also chromatin nucleoli) in this mitosis of the following species: *Lygus pratensis*, 34; *Leptopterna dolobrata*, 34; *Calocoris rapidus*, 33; *Pœcilocapsus lineatus*, 35?; *P. goniphorus*, 34 or 36. There is not found in the *Capsidæ* such a disparity in the number of chromosomes as is found between the species of some other families (*e.g.*, the *Lygæidæ* and *Coreidæ*), so that the *Capsidæ* would appear to be a more homogeneous group. Then if the number of the chromosomes may be loosely taken as a criterion of the degree of specialization, a smaller number of chromosomes marking a more specialized stage (and this I hold to be true within certain bounds), the *Capsidæ*, like the *Reduviidæ* and *Phymatidæ*, may be considered relatively primitive *Hemiptera heteroptera*, in comparison with the *Pentatomidæ*, *Lygæidæ* and *Coreidæ*. This, it seems to me, is a vital interest in the study of the chromosomes—to find criteria for testing relationships.

5. Nabis annulatus Reut.

I had only a single testis for examination, and it showed no spermatogonic mitoses.

There is no complete rest stage in the growth period of this species (in which regard it is like certain of the *Coreidæ*). In the late telophase there is found in the nucleus (Pl. X, fig. 11) a large, usually centrally placed chromatin nucleolus (*N. 2*), with more or less uneven contours; and attached to it is a smaller true nucleolus (*N.*) which disappears in the following prophase by gradual decrease in volume. Sometimes there are two chromatin nucleoli, generally of different volumes; since in such cases neither of these has the volume of the single one, they probably represent separated parts of the latter.

In the prophases of the first maturation mitosis, which follow immediately upon the stage just described, the chromatin nucleolus shows itself to be composed of four dumbbell-shaped (hence bivalent) parts of unequal volumes, arranged close together (*N. 2*, fig. 13). Necessarily all four parts must have been present in the preceding stage, but have been optically inseparable; the apparently single chromatin nucleolus of the growth period is made up in reality of four bivalent ones. There is great diversity in the mode of mutual apposition of the latter in the prophases; sometimes the long axes of all may be parallel, but more frequently they cross one another at varying angles; no case was seen where all four lie in the same plane. Quite frequently there are only three chromatin nucleoli in mutual contact near the centre of the nucleus, while the fourth is separated from them and placed against the nuclear membrane (fig. 12). All four are true chromatin nucleoli, maintaining throughout the growth period their dense structure, even contours, and red stain with the saffranine-violet method of Hermann, while the chromatin of the chromosomes proper stain violet. In the prophase we are considering are found also six bivalent chromosomes (portions of all of which are seen in fig. 13); these are tetrads with very wide longitudinal splitting of the type characteristic for *Anasa* (Coreid). Toward the close of the prophase these chromosomes shorten and become much more compact structures.

Pole views of the monaster stage of the first maturation mitosis (fig. 14) show in every case ten chromatin elements of comparatively large size. Four of these must correspond to the four chromatin nucleoli, and six to the six chromosomes proper of the preceding stages, since there has been no loss nor multiplication of any of these elements. Of the ten elements of the stage of fig. 14, one (*p.*) on pole view always appears round, on lateral view (*p.*, fig. 16) it shows a simple dumbbell shape; this one, much smaller than any of the others, probably represents one of the chromatin nucleoli. The nine remaining elements are likewise all dumbbell-shaped, but on pole view of the spindle (fig. 14) each of them appears elongate, sometimes showing a split in the long axis. On lateral views of the spindle (figs. 15, 16) they sometimes appear bipartite, sometimes quadripartite. As a study of them in the preceding prophases demonstrates, each becomes placed in the equatorial plane of the spindle so that the transverse split (the line of junction of the two component univalent chromosomes) lies in the equator of the spindle, and the longitudinal split of each univalent chromosome lies perpendicular to this plane. Thus the nine larger chromatin elements of fig. 14 appear elongate on pole view of the spindle, because each of these bivalent chromosomes is composed of two univalent chromosomes with their long axes parallel to one another and to the equatorial plane of the spindle. Hence on pole view of this spindle we see a plate of (univalent) chromosomes, each seen longitudinally; whereas such a view in the other *Hemiptera* studied by me shows the chromosomes seen from their ends, since in other *Hemiptera* it is the general rule that two univalent chromosomes are joined end to end, and not (as in *Nabis*) side to side.

All ten elements divide transversely in this mitosis, so that whole univalent elements become separated from one another. A pole view of one of the plates of daughter chromosomes resulting from this division (fig. 17) shows one smallest element (*p.*), the half of the corresponding element of figs. 14 and 16, and nine larger elements, the halves of those of fig. 14. In fig. 17 each of the nine larger univalent elements shows a well-marked longitudinal split, which had been usually hidden in the preceding monaster stage (fig. 14); it is a general rule in the *Hemiptera* that the longitudinal split becomes temporarily hidden in the monaster stage of the first maturation mitosis.

One point needs to be emphasized: there are in the prophases four chromatin nucleoli and six chromosomes, and in the monaster stage of the first mitosis again ten elements, that is, obviously the same as those in the prophases. But the four chromatin nucleoli of the prophases (figs. 12, 13) are smaller than any of the chromatin elements of the monaster stage (fig. 14), except the small element in the latter marked *p.* Accordingly three at least of the chromatin nucleoli must have increased in volume before the latter stage. This is remarkable, since in all other *Hemiptera* studied by me the chromatin nucleoli regularly decrease somewhat in volume, generally to considerable degree, before they take their position in the equator of the spindle.

In *Coriscus ferus* Linn., the only other species of the *Nabidæ* studied, I found (preceding paper, *l.c.*) in the monaster stage of the first maturation mitosis nine bivalent chromosomes and one bivalent chromatin nucleolus. In the growth period preceding there is present in the nucleus one bivalent chromatin nucleolus of large size and a smaller one; but not a group of four bivalent chromatin nucleoli as in *Nabis*. If the chromatin nucleoli be regarded as disappearing chromosomes, for which view I have given reasons, then we may conclude that *Nabis annulatus*, by virtue of showing four of the chromatin elements on the way to disappearance, has advanced beyond the stage of *Coriscus ferus*.

6. Corizus alternatus Say.

Five testes of this species were studied.

Only two clear cases of spermatogonic monasters were found where all the chromatin elements could be readily counted; each of these showed fourteen elements. As Pl. X, fig. 18 shows, two of the elements are rounded and much smaller than the others (*N. 2*), and these are chromatin nucleoli. Of the twelve elongate chromosomes proper, two (those marked *A*, fig. 18) are considerably larger than the others; and one of these appears always to have the form of a rod, while the other has a bent V-shape. All fourteen elements are halved in the metakinesis.

In the early portion of the growth period each spermatocytic nucleus contains a clearly bipartite chromatin nucleolus, representing a union of the two chromatin nucleoli derived from the spermatogonia; each of its univalent components appears occasionally longitudinally split, which is unusual in the *Hemiptera*.[2] In the rest stage following (there is a complete rest stage in this species) the nucleus (fig. 19) contains a bivalent chromatin nucleolus (*N. 2*), which has increased in volume and generally is ovoid in outline; but sometimes during the whole growth period the two

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[2] Dr. F. C. Paulmier, who has worked out the spermatogenesis of *Anasa tristis* De G., has demonstrated to me a longitudinal splitting of the chromatin nucleolus in the growth period of the Lygæid, *Myodocha serripes* Oliv.

univalent chromatin nucleoli may remain entirely disconnected. In this rest stage the nucleus contains also one or two larger, irregularly shaped true nucleoli (fig. 19, *N.*) which are not apposed to the chromatin nucleolus.

Pole views of the monaster stage of the first maturation mitosis (Pl. X, fig. 20) show seven chromatin elements; and lateral views of such cases show that all seven are dumbbell-shaped, and hence bivalent. The smallest of these elements is the chromatin nucleolus (*N. 2*, figs. 20, 21), and, as is generally the case in *Hemiptera*, this divides in metakinesis before the chromosomes do. Of the six chromosomes proper, one is always much larger than the others (figs. 20, 21), and this one evidently represents the union of the two largest univalent chromosomes of the spermatogonia (in fig. 21 is shown, besides the chromatin nucleolus, *N. 2*, thi largest chromosome and three of the five smaller chromosomes); and one chromosome is much smaller than the others, often little larger than the chromatin nucleolus (this is the one lying nearest to the largest chromosome in fig. 21). All these elements are transversely divided in the metakinesis. Occasionally pole views of the monaster stage of the first maturation mitosis show eight chromatin elements instead of seven; this is due to one of the seven bivalent elements having precociously divided into its univalent components. In the second spermatocyte are regularly found seven univalent elements.

Corizus annulatus in its spermatogenesis thus shows a very close similarity to *C. lateralis* Say, previously described by me.

7. Harmostes reflexulus Say.

The individuals collected at Woods Holl were marked by Dr. Uhler, "*Harmostes reflexulus* Say, variety"; whether a geographical race was thereby intended I cannot say.

Five testes were examined. The whole process of spermatogenesis seems exactly similar to that described by me previously for individuals of this species from Pennsylvania.

This is one of the *Hemiptera* with an *uneven* normal number of chromosomes, there being found in the spermatogonia thirteen chromatin elements, namely, two smaller chromatin nucleoli (*N. 2* of figs. 22 and 23) and eleven larger chromosomes proper. The uneven normal number of chromosomes being a relatively rare phenomenon, it having been observed so far only in four species of

Hemiptera (described in my previous paper. *l. c.*), I have counted in the testes of the Woods Holl individuals the chromatin elements in all the cases of spermatogonic monasters which were favorable for such counting, with the following results: Nine spermatogonia showed exactly thirteen elements; in one case I could not determine whether thirteen or fourteen were present. These cases from four different testes, as well as those from four testes of Pennsylvania individuals previously described by me, are sufficient to show that the uneven number is not an individual variation, due *e.g.* to some pathological condition, but is probably characteristic of every individual of the species.

The uneven normal number of chromosomes which I have demonstrated also for *Protenor belfragei*, *Alydus eurinus* and *Œdancala dorsalis*, represents a stage in the change of the number of chromosomes from one even number to the next successive even number. For *Protenor* I have shown that the uneven spermatogonic number is produced by a failure of two of the spermatogonic chromosomes to separate from one another. This I can now prove for *Harmostes* also. For while in most of the monaster stages, as in fig. 22, all eleven chromosomes appear more or less simply rod-shaped, in a few cases, as in fig. 23, one of the eleven shows a well-marked transverse constriction. Were this constriction a complete division, there would be the even number twelve. Hence, for *Harmostes* the ancestral number of chromosomes must have been twelve, and if, as is the case in *Protenor*, the odd bivalent chromosome is destined to change from a chromosome into a chromatin nucleolus, in the course of time ten chromosomes will be the number for the species.

In conclusion, I would again call attention to the importance of studying the chromosomal relations comparatively in a large number of species of a group. By such investigations not only may much of importance be obtained regarding the evolution of cell structures themselves, but by implication a criterion may thereby be obtained for testing genetic relationships. In opening up this line of research, I have drawn attention so far mainly to the numerical relations of the chromosomes, and to the chromatin nucleoli as representing chromosomes on the way to disappearance during progressive evolution. These are the facts most easily determined; and there is the surety in such study that the chromosomes are relatively large structures, which exist in fact and are not artificially produced by the mode of preparation necessary for their study. The chromosomes are not apparently formed *de novo*—at least there is as yet no good proof in any case that they are so formed; while, on the contrary, there is a considerable amount of evidence to show that they are structures which persist from generation to generation, even though this is a persistence nvolving a great amount of metabolic change. Astral radiations appear and disappear, or at least disappear as *radiations;* nucleoli are apparently accumulations of metabolic substances of no morphological regularity, as I have shown in another place;[3] and recent experimental studies would show, though perhaps in contradiction to the anatomical studies, that the centrosomes may be formed anew. But the chromosomes show more fully than any of these cellular structures a certain degree of morphological stability, and this fact, taken in connection with their greater adaptability for study, entitles them to a basic place in the study of the cell's evolution, as well as in the study of evolution in general.

EXPLANATION OF PLATE X.

All figures have been drawn to the same scale with the camera lucida at the level of the base of the microscope, with the Zeiss homogeneous immersion $\frac{1}{12}$, ocular 4, tube length 180 mm.

The bounding line in figs. 1–4, 6–10, 14–18, and 20–23 represents the cell membrane; in figs. 5, 11–13, and 19, the nuclear membrane. In lateral views of the mitotic spindles (figs. 2, 4, 7, 15, 16, 21) the mantle fibres are the only achromatic elements shown, and are represented thicker than they are in reality.

PLATE X, fig. 1.—*Tingis clavata*, pole view of monaster stage of the first maturation mitosis.

Fig. 2.—*Idem*, lateral view of the same stage.

Fig. 3.—*Corixa verticalis*, pole view of monaster stage of the first maturation mitosis.

Fig. 4.—*Idem*, lateral view of the same stage.

Fig. 5.—*Idem*, nucleus in post-synapsis stage.

Fig. 6.—*Cymus luridus*, pole view of monaster stage of the first maturation mitosis.

Fig. 7.—*Idem*, lateral view of the same stage.

Figs. 8, 9.—*Lygus pratensis* var., pole views of monaster stage of first maturation mitosis.

Fig. 10.—*Idem*, pole view of monaster stage of second maturation mitosis.

Fig. 11.—*Nabis annulatus*, nucleus in growth period (late telaphase).

[3] *Journal of Morphology*, Vol. XV, 1898.

Figs. 12, 13.—*Idem*, nuclei in prophases of first maturation mitosis.

Fig. 14.—*Idem*, pole view of monaster stage of first maturation mitosis.

Figs. 15, 16.—*Idem*, lateral views of metakinesis of first maturation mitosis.

Fig. 17.—*Idem*, pole view of one plate of daughter chromosomes, early anaphase of first maturation mitosis.

Fig. 18.—*Corizus alternatus*, pole view of monaster stage of a spermatogonium.

Fig. 19.—*Idem*, nucleus of first spermatocyte, rest stage.

Fig. 20.—*Idem*, pole view of monaster stage of first maturation mitosis.

Fig. 21.—*Idem*, lateral view of the same stage.

Figs. 22, 23.—*Harmostes reflexulus* var., pole views of monaster stage of spermatogonia.

April 2.

Mr. Arthur Erwin Brown, Vice-President, in the Chair.

Twenty persons present.

April 9.

The President, Samuel G. Dixon, M.D., in the Chair.

Eleven persons present.

April 16.

Mr. Charles Morris in the Chair.

Twelve persons present.

Papers under the following titles were presented for publication:

"The Identity of the Gordiacean Species, Chordodes morgani and C. puerilis," by Thomas H. Montgomery.

"Description of a New Hemiramphid," by H. W. Fowler.

April 23.

Mr. Arthur Erwin Brown, Vice-President, in the Chair.

Twenty-three persons present.

A paper entitled "A Study of the Genus Centurio," by James A. G. Rehn, was presented for publication.

April 30.

Mr. Charles Morris in the Chair.

Fourteen persons present.

A paper entitled "Certain Aboriginal Remains of the Northwest Florida Coast, Part I," by Clarence B. Moore, was presented for publication.

Mr. Anthony W. Robinson was elected a member.

The following were ordered to be printed:

Yours very truly,
Robt. H. Lamborn

THE FORFICULIDÆ, BLATTIDÆ, MANTIDÆ AND PHASMIDÆ COLLECTED IN NORTHEAST AFRICA BY DR. A. DONALDSON SMITH.

BY JAMES A. G. REHN.

The material of which the present paper is a study was collected by Dr. A. Donaldson Smith on his two expeditions into northeast Africa, and presented by him to the Academy of Natural Sciences of Philadelphia. The first of the expeditions was made in the years 1894 and 1895, and extended as far west as Lake Rudolf, the whole account of which has been published in book form.[1] The last expedition was made in 1899 and 1900, the route being by Lake Rudolf on through the unknown to the Nile. On this last expedition but two specimens of Orthoptera were collected. The total number of specimens of Orthoptera secured is 239, perhaps the most important collection ever brought from that country. The remaining portion (*Acridida*, *Locustidæ* and *Gryllidæ*) will shortly be reported upon.

Family FORFICULIDÆ.

Labidura sp.

Three immature specimens; Sheikh Husein, Gallaland, September 23 and 27, October 3, 1894.

Anisolabis mœsta (Serville).

1839. *Forficesila mœsta* Serville, Orthoptères, p. 28.

One specimen, ♂; between Ginea and Dada, near the Darde river, Gallaland, November 20, 1894.

Anisolabis sp.?

One immature female; Sheikh Husein, Gallaland, September 23, 1894.

Apterygida huseinæ n. sp.

Types, one male and two females:

♂, October, 5, 1894, Sheikh Husein, Gallaland.

♀, September 23, 1894, Sheikh Husein, Gallaland.

♀, September 21, 1894, Sheikh Husein, Gallaland.

This species apparently has no close affinity with any of the described forms.

[1] *Through Unknown African Countries*, by A. Donaldson Smith.

♂.—Size large. Antennæ composed of nineteen segments. Pronotum quadrate, the posterior angles moderately rounded, lateral margins somewhat extended, posterior section with a distinct median sulcation, tumid anteriorly with a moderate depression centrally, the posterior portion being moderately scabrous. Elytra rather elongate, the posterior margin very broadly rounded, the whole with the small exposed portion of the wing scabrous. Abdomen entirely punctate; anterior segments with the posterior margins rather indistinctly beaded, each segment laterally with two longitudinal indistinct tuberculations. Anal segment transverse, somewhat glabrous, centrally with a broad sulcus, the median portion of the posterior margin truncate. Forceps not quite half as long as the body, widely separated at the base, the shafts directed inward, the tips incurved, the internal margin bearing centrally a well-marked tooth. Subgenital plate with the posterior margin triangularly extended, the apex truncate.

♀.—Size large. Antennæ composed of twenty-four to twenty-six segments Subgenital plate with the posterior margin rather broadly rounded. Forceps straight, tips incurved, the internal margin dentate anteriorly, crenulate posteriorly.

General color blackish brown, the lower surface of head and pronotum dull ochraceous, in one specimen this is entirely suffused with dark brownish. Limbs dull luteous washed with blackish.

Measurements.

	♂	♀
Length of body (with forceps), . .	21 mm.,	22 mm.
Length of forceps, ...	5.75 "	5 "
Length of pronotum, ...	2 "	2.75 "
Length of anal segment, ...	2.1 "	2.1 "
Length of elytra, ...	4 "	3.75 "
Width of elytra, ...	3.5 "	3.75 "

Family BLATTIDÆ.

Aphlebia algerica Bolivar.

1881. *Aphlebia algerica* Bolivar, Ann. Soc. Esp. Soc. Nat., X, p. 499.

Two females; Roka and Luku, Gallaland, September 11 and 17, 1894.

Theganopteryx senegalensis Saussure.

1868. *Blatta senegalensis* Saussure, Revue et Magasin de Zoologie (2), XX, p. 354.

One female; Sheikh Husein, Gallaland, October 3, 1894.

Blatta germanica Linnæus.

1767. *Blatta germanica* Linnæus, Syst. Nat., XII ed., II, p. 688.

One male; Sheikh Husein, Gallaland, October 6, 1894.

Ischnoptera picea Schulthess.

1898. *Ischnoptera picea* Schulthess-Schindler, Ann. Mus. Civ. Genova, XXXIX, p. 166.

One male; Daro Mountains, between Ginea and Dada, Gallaland, November 19, 1894.

Periplaneta atricollis Saussure.

1899. *Periplaneta atricollis* Saussure, Abhandl. d. Senckenb. Naturforsch. Gesellsch., XXI, p. 580.

Four specimens; Sheikh Husein, Gallaland, September 21 and 25 and October 10, 1894.

Deropeltis autraniana Saussure.

1895. *Deropeltis autraniana* Saussure, Ann. Mus. Civ. Genova, XXXV, p. 78.

Two females; Jara, southern Gallaland, October 23, 1899.

These two specimens were the only Orthoptera collected by Dr. Smith on his last expedition.

Deropeltis schweinfurthi Saussure.

1895. *Deropeltis schweinfurthi* Saussure, Ann. Mus. Civ. Genova, XXXV, p. 79.

One female; Daro Mountains, Gallaland, November 18, 1894.

Deropeltis wahlbergi (Stål).

1856. *Periplaneta wahlbergi* Stål, Ofv. Vet.-Akad. Forhand., p. 167.

Two males; between Luku and Dago Tula, Gallaland, September 18, 1894.

Heterogamia africana (Linnæus).

1764. *Blatta africana* Linnæus, Mus. Lud. Ulric., p. 108.

One female; Gagap, near Milmil, Somaliland, July 30, 1894.

Heterogamia sp.

One female; no data.

This specimen resembles *S. dohrniana* Saussure from North China to a very great extent. In the absence of material and in the face of the widely different localities, it seems best not to attempt to make any definite statement regarding its possible identity.

Oxyhaloa ferretti (Reiche and Fairmaire).

1847. *Blatta ferretti* Reiche and Fairmaire, Ferret and Galinier's Voy. en Abyssinie, III, p. 420, Pl. 27, figs. 1, 2.

Two males; one Sheikh Husein, Gallaland, October 1, 1894, the other without data.

Nauphœta gestriana Saussure.

1895. *Nauphœta gestriana* Saussure, Ann. Mus. Civ. Genova, XXXV, p. 86.

Three specimens; Sheikh Husein, Gallaland, October 1 and 6, 1894.

Stenopilema capucina (Gerstaecker).

1873. *Derocalymma capucina* Gerstaecker, in Van der Decken's Reise, III, Abth. II, p. 8.

One male and one female; the former without data ; the latter Sheikh Husein, Gallaland, October 1, 1894.

Stenopilema somali Saussure and Zehntner.

1895. *Stenopilema somali* Saussure and Zehntner, Revue Suisse Zoolog., III, p. 27.

One female; no data.

Derocalymma erythrenia Saussure and Zehntner.

1895. *Derocalymma erythrenia* Saussure and Zehntner, Revue Suisse Zoolog., III, p. 31.

Three females; two Hargesa and Bodele, Somaliland, July 21 and August 15, 1894; the other with no data.

These specimens range from 12.5 to 20 mm. in total length.

Calolampra aptera Schulthess.

1898. *Calolampra aptera* Schulthess-Schindler, Ann. Mus. Civ. Genova, XXXIX, p. 169.

Three females; Daro river near Laga, Somaliland, November 28, 1894.

Phenacisma peltata Karsch?

1896. *Phenacisma peltata* Karsch, Entomol. Zeitung, LVII, p. 243.

One female (immature); Tug Terfa, Somaliland, August 21, 1894.

This specimen is referred here with some doubt.

Family MANTIDÆ.

Eremiaphila somalica n. sp.

1899. *E. spec.* vic. *arabicæ* Schulthess-Schindler, Ann. Mus. Civ. Genova, XXXIX, p. 170.

Types, two females; one The Haud, July 13, 1894, and the other without locality or date (there can be little doubt but that it was taken in the same general region).

Apparently approaching *E. arabica* Saussure, but differing in numerous details; with *E. aristides* Lucas, from Suez, the relationship is also close, but that species is described as wingless.

The specimens (or at least one of them) were collected in the same character of country frequented by the other species of the genus—barren and waterless plains or absolute deserts.

Size medium. Head, with eyes, wider than deep (excluding the clypeus), anterior border viewed superiorly truncate; antennæ slender. Pronotum sparsely tuberculate, broader anteriorly than long, posteriorly converging; anterior border with a broad, low central convexity which is perceptibly impressed in the median section, the margin free; angles rect-acute angulate; posterior border apparently truncate.[2] Tegmina as in *E. arabica*, except that the main veins ramify and become lost in the reticulations of the posterior portion of the tegmina. Wings well developed, extending to the tips of the tegmina. Abdomen with the supra-anal plate transverse, subsinuate centrally; subgenital plate rather elongate, the apex broadly rounded. Limbs sparsely tuberculate, the tubercles sometimes arranged in regular series. Anterior tibiæ with four rather blunt spines on the external margin. Median and posterior femora each with a row of blunt teeth along the posterior margin, the distal extremities bearing a moderate-sized spine. Posterior tibiæ slightly longer than the femora.

General color ranging from purplish brown on the head and pronotum to clay yellow on the abdomen. Eyes, labrum and lower part of clypeus ferruginous. Exposed surface of tegmina pale clay yellow becoming dull reddish centrally; lower surface with a bar of blackish purple. Limbs and lateral borders of pronotum pale yellowish pink, in one specimen (The Haud, July 13, 1894) the tibiæ are obscurely ringed with whitish, in the other (unknown locality and date) the femora are decidedly clay yellow at the bases.

Measurements.	♀ (The Haud. 7-13, '94.)	♀ (?)
Total length,	16.5 mm.,	18 mm.
Length of pronotum	3 "	3 "
Anterior width of pronotum,	5 "	4.75 "
Length of tegmina,	7 "	7.50 "
Width of abdomen,	7 "	6.75 "
Length of hind femora,	9.25 "	9.50 "

[2] This portion was somewhat damaged in both specimens by the insertion of the pin.

It is interesting to know that *E. arabica* has been recorded from Webithal, Ogaden, by Schulthess[3]; later the same author[4] considers specimens from Obbia somewhat removed from true *arabica*.

Tarachodes smithi n. sp.

Types, male and female, the latter immature: Tug Terfa and Tug Berka, northern Somaliland, August 21 and 23, 1894.

This rather peculiar species is evidently allied to *T. media* Schulthess-Schindler[5] and *T. æstuans* Saussure[6], systematically and geographically fitting between the two. From *media* it differs in the form of the head, which is anteriorly truncate instead of irregularly arcuate, and the prosternum which is unifasciate instead of trifasciate; from *æstuans* it differs also in the form of the head, and in the form and size of the joints of the cerci.

♂.—Size rather large, moderately robust. Head with vertex transverse, subtruncate. Pronotum about twice as long as the greatest width, considerably narrower posteriorly than anteriorly; the anterior and posterior margins broadly rounded, the lateral margins sinuate, the whole spineless; dorsum bearing four obsolete tubercles centrally. Tegmina long, surpassing the abdomen, about four times as long as broad. Anterior limbs with the femora rather stout and heavy, the external margin bearing five large and twelve small teeth, the internal margin bearing twelve teeth alternating in size. Median and posterior limbs lightly built, hirsute. Abdomen rather slender. Cerci damaged.

General color grayish brown suffused, except the tegmina, with dull purplish brown. Clypeus, labrum and facial shield ochraceous with four transverse blackish bars, the superior pair continued upon the olive-tinged eyes. Pronotum with the suffusing tint arranged in a pair of broken parallel lines along the median section, posteriorly tinged with green, the lateral margins being thickly speckled. Limbs irregularly marked with the suffusing tint, except the anterior coxæ and the lower surface of the tibiæ which are pale yellowish, the internal section of the tibiæ being broadly lined with black. Below dull yellowish except a single band of black across the prosternum. Tegmina hyaline, the longitudinal veins blackish irregularly broken by whitish spaces.

[3] *Zool. Jahr.*, Syst., VIII, p. 69.
[4] *Ann. Mus. Civ. Genova*, XXXIX, p. 170.
[5] *Ann. Mus. Civ. Genova*, XXXIX, p. 171.
[6] *Ibid.*, XXXV, p. 91.

♀.—Size medium, robust. Head with vertex transverse, truncate. Pronotum less than twice as long as the greatest width; the anterior margin rather broadly rounded, the posterior truncate with the angles cut off, the lateral margins sinuate, spined throughout their length, one large spine anteriorly; the dorsum with two obsolete tubercles near the anterior margin, and six paired tubercles placed equidistant from the sulcus to within about three millimeters of the posterior margin. Tegmina and wings short and undeveloped. Anterior limbs with the tibiæ very deep and robust, the external margin bearing five large and ten small spines, the internal bearing ten spines. Median and posterior limbs rather heavy, hirsute; the femora rather angular. Abdomen with a median ridge and each segment with four crescentic crenulations; the median ridge on the four anterior segments lobulate posteriorly. Cerci rather long, the terminal segment almost as long as the preceding two.

General color above wood brown irregularly suffused with darker brown, strongest on the abdomen, weakest on the anterior limbs. Eyes intense brownish black. Clypeus, labrum and facial shield barred as in the male, but not so distinctly. Below pale yellowish, clouded with blackish on the abdomen, the prosternum with one broad transverse blackish band.

Measurements.

	♂		♀	
Total length,	40	mm.,		
Length of body,	36.5	"	29	mm.
Length of tegmina,	29	"		
Length of pronotum,	9.25	"	7.8	"
Greatest width of pronotum,	4.40	"	4.25	"
Length of anterior tibiæ,	8	"	6.6	"

Tarachodes schulthessi n. n.

1895. *Chiropacha modesta* Schulthess-Rechberg, Zool. Jahrb., Syst., VIII, p. 69.

1898. *T[arachodes] modesta* Schulthess-Schindler, Ann. Mus. Civ. Genova, XXXIX, p. 173 (not of Gerstaecker, 1869).

Two males; Sheikh Husein, Gallaland, September 24 and October 1, 1894.

The name *Tarachodes modesta* was first used by Gerstaecker[7] for a species of the genus from Zanzibar; later Schulthess, in

[7] *Archiv. f. Naturgesch.*, XXXV, p. 208.

describing a species of *Chiropacha*, applied the name *modesta* to it,[8] and later he used it under *Tarachodes*[9]. The maintenance of two identical names in the same genus not being permitted, I have dedicated this species to its original describer.

Tarachodes sp.

One immature specimen; Gagap, near Milmil, northern Somaliland, July 30, 1894.

This specimen is too immature to make any definite statement regarding its specific affinities.

Elæa somalica Schulthess.

1898. *Elæa somalica* Schulthess-Schindler, Ann. Mus. Civ. Genova, XXXIX, p. 170.

Three specimens, two males, one female; Selou and Lafarok, Somaliland, August 6 and 13, 1894; Fertza, Gallaland, September 12, 1894.

Compsothespis falcifera n. sp.

Type, one specimen, near the Darde river, Raia Wacheli, eastern Gallaland, September 1, 1894.

This species differs from *C. anomala* Saussure in the much greater size, in the non-mamillate eyes, the smaller and weaker forelimbs, and various other details.

Form slender. Head elongate with a broad, low median ridge, vertex not at all prominent, ocelli small; eyes subelliptical; antennæ filiform. Pronotum rather elongate, slightly broader posteriorly than anteriorly, the length being more than six times the greatest width; lateral margins almost straight, slightly constricted anterior to the insertion of the coxæ, finely tuberculate; anterior and posterior margins arcuate, the latter flattened centrally with an obscure emargination; the whole surface finely tuberculate. Tegmina abbreviate, semi-hyaline, rather coriaceous at the base. Abdomen depressed, narrow, the lateral margins almost straight, the basal and median segments one and a half times as long as wide, terminal segments short, the posterior margins with a median rounded lobe. Supraanal plate triangular, moderately produced, the apex truncate, subemarginate and obscurely carinate centrally, the latter flanked by two longitudinal depressions, each of which is laterally bordered by another carinæ. Cerci broad, compressed,

[8] *Zool. Jahrb.*, Syst. VIII, p. 69.

[9] *Ann. Mus. Civ. Genova*, XXXIX, p. 173.

composed of six segments increasing in length, the terminal one almost half again as long as its predecessor, the whole bearing an obsolete median ridge. Subgenital plate compressed, deeply folded, the central inclosure very narrow; styles moderately long, subspatulate. Anterior limbs very slight and weak; the coxæ and femora being about the same length and bulk, the outer margin of the latter bearing four very minute spines, discoidal spines numbering three; tibiæ not half as long as the femora, the margin not dentate; metatarsi about as long as the tibiæ. Median and posterior pairs of limbs very long and slender; the median femora each bearing two genicular spines; tibiæ longer than the femora.

General color pinkish brown, the limbs touched with dull brownish; eyes testaceous; lower surface of the pronotum suffused with dull reddish; elytra decidedly pinkish at base; anterior femora with a line of reddish black on the lower margin.

Measurements.

Total length,	41	mm.
Length of pronotum,	13.25	mm.
Greatest width of pronotum,	2	mm.
Greatest width of abdomen,	3	mm.
Length of tegmina,	15.5	mm.
Length of anterior femora,	5.75	mm.
Length of posterior femora,	12.2	mm.
Length of posterior tibiæ,	14	mm.

Ligaria producta n. sp.

Type, one immature female; Sheikh Husein, Gallaland, September 30, 1894.

Closely allied to *T. trigonalis* Saussure[10] from South Africa, but differing in the shape of the pronotum. The pronotum of *trigonalis* is described as having "parte antice lata ac late rotundata, ... marginibus haud dentatus;" while in the specimen before me the pronotum is somewhat produced anteriorly, the margin being very narrowly rounded.

Size medium. Head from the facial aspect about equally long and broad; occiput subtruncate; eyes subfusiform, little attenuate superiorly. Pronotum about two-thirds as broad as long, centrally with moderate dilations, the borders crenula-dentate; anterior section diminishing in width, the margin narrowly rounded;

[10] *Abhand. Senckenb. Nat. Gesellsch.*, XXI, p. 596.

posterior section slightly constricted, the margin truncate. Anterior femora stout and heavy, the inner margin spined very much as in *L. trigonalis*, the apical spines being alternately large and small, except the two terminal spines which are large with a diastema between them; tibiæ armed with seven spines; tarsus with the first joint (metatarsus) about equaling the other four. Median and posterior limbs slender, the apical spines equally visible on each; the first tarsal joint (metatarsus) of the median pair slightly shorter than the other segments. Abdomen depressed, with a central carinal fold, which is more elevated posteriorly than anteriorly on each segment, the four anterior segments having the posterior margin centrally emarginate, while the others have the same truncate. Subgenital plate somewhat produced, broadly rounded, with minute styles.

General color dull wood brown, irregularly sprinkled with blackish spots. The occiput bears a transverse line of grayish, which is visibly continued to a greater or less extent upon the eyes. The upper surface of the abdomen is tinged with yellowish, while the limbs are obscured with blackish brown.

Measurements.

Length of body, ...	15.5 mm.
Width across eyes, ...	3 mm.
Length of pronotum, ...	3.25 mm.
Width of pronotum, ...	2.25 mm.
Length of anterior femora, ...	4.00 mm.

Sphodropoda rudolfæ n. sp.

Type, one female; near southern end of Lake Rudolf, western Gallaland, September 1, 1895.

Allied to *S. trimacula* Saussure, but differing in the shape of the anterior portion of the pronotum and the general thickness of the shaft, besides the much shorter tegmina.

Size smaller than *S. trimacula*, but very stoutly built. Head rather long, the facial aspect broader than deep; occiput slightly arcuate; facial shield as wide as deep, superiorly obtuse angulate, the extreme tip truncate, centrally with a pair of very obscure carinæ; eyes rather large, globose, the lower margin somewhat produced. Pronotum over twice as long as the greatest width which is anterior to the middle; the shaft bearing a prominent median carinæ, and somewhat constricted posterior to the dilation, the width here being but half that of the latter; the collar rather acuminate, the anterior angle rather narrowly rounded, the posterior margin truncate, the dilation having dentate margins. Tegmina moderately long, not quite reaching the tip of the supraanal plate; the marginal field coriaceous, the stigma large and opaque, the discoidal and anal fields semi-hyaline, the costal margin pectinate. Anterior coxæ bearing on the proximal extremity a blunt tooth-like projection, the inferior margin bearing five large spines, a small one occupying each diastema; femora rather heavy, the external margin with four spines, fifteen on the internal with some of the apical ones reduced in size and presenting a formula which would give for the anterior spines, reading posteriorly, IiiIi; tibiæ almost half as long as the femora, bearing ten spines on the external and fifteen on the internal margins. Median and posterior limbs moderately slender; the tibiæ much lighter and more slender than the femora; the first tarsal joint (metatarsus) very much elongate and equaling the succeeding segments. Supraanal plate very broad and shallow, the margin broadly rounded. Subgenital plate very large, the posterior portion deeply folded and supplied with short, thick, fleshy styles.

General color dull ochre yellow tinged with dragon's blood red[11] on the posterior border of each abdominal segment and on the limbs, the median and posterior tibiæ being little suffused. Head obscurely suffused with olivaceous, this tint being especially noticeable on the eyes, clypeus and mandibles. Tegmina dilute dragon's blood red, palest at the anal border, richest around the stigma, which is cream colored.

Measurements.

Length of body,	50.5 mm.
Width of head,	9.5 mm.
Length of pronotum,	17.25 mm.
Greatest width of pronotum,	7 mm.
Least width of pronotum,	3.75 mm.
Length of tegmina,	26.5 mm.
Greatest width of tegmina,	10 mm.
Length of anterior femora,	16.5 mm.

[11] Ridgway's *Nomenclature of Colors.*

Sphodromantis bioculata Burmeister.

1838. *Sphodromantis bioculata* Burmeister, Handb. d. Ent., Bd. II, Abth. II, Pt. I, p. 537.

One female (immature); Sheikh Husein, Gallaland, October 8, 1894.

Mantis sacra Thunberg.

1815. *Mantis sacra* Thunberg, Mém. Acad. St. Petersb., V, p., 289.

One male; Sheikh Husein, Gallaland, September 30, 1894.

Hoplocorypha bottegi Saussure.

1895. *Hoplocorypha bottegi* Saussure, Ann. Mus. Civ. Genova, XXXV, p. 91.

One immature specimen; Aimola, Gallaland, March 16, 1895.

Hoplocorypha rapax Bormans.

1881. *Hoplocorypha rapax* Bormans, Ann. Mus. Civ. Genova, XVI, p. 211.

One immature specimen; near the Daro Mountains, between Ginea and Tulu, Gallaland, November 18, 1894.

This specimen is referred here with some little doubt; the character "tibiis tarsisque posticis nigro multipilosus" not being at all appreciable.

Miomantis fenestrata Fabricius.

1781. *Mantis fenestrata* Fabricius, Spect. Ins., I, p. 349.

One female (immature) and one male; Luku, Gallaland, September 17 and 18, 1894.

Miomantis sp.

One female (immature); Sheikh Husein, Gallaland, October 1, 1894.

Fischeria sp.

One male; Sheikh Mahomet, Gallaland, October 30, 1894.

This large specimen is unfortunately headless.

Ischnomantis media n. sp.

Type, female (somewhat immature); near the upper Webi Shebeli, Gallaland, December 24, 1894.

Closely allied to *I. spinigera* Schulthess,[12] but differing in the length of the supraanal plate which in the new form is less than the length of the anterior coxæ, while in *spinigera* it equals the anterior femora.

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[12] *Ann. Mus. Civ. Genova*, XXXIX, p. 176.

Size large. Head viewed facially much broader than deep, the occiput arcuate; eyes prominent; clypeus bearing a transverse ridge. Pronotum four times as long as its greatest width; the lateral margins dentate anterior to the dilation, denticulate posterior to the same; anterior margin somewhat produced, rounded; posterior margin truncate, the angles obliquely trimmed; median carina visible on the shaft, replaced by a sulcus on the collar. Anterior coxæ with the lower margin dentate, the other margins denticulate; femora rather elongate, five spines on the external margin, fifteen spines anteriorly and eleven to twelve denticules posteriorly on the internal, the superior margin with a very slight concavity; tibiæ with nine spines on the external margin with a basal diastema, fourteen on the internal. Median and posterior pair of limbs very slender and light; tibiæ with the internal margins spined; metatarsus of the posterior limbs very much longer than the other tarsal joints, and closely spined below. Abdomen with lateral elongate crescentic convolutions. Supraanal plate elongate, lanceolate, the apex narrowly rounded, centrally keeled, the whole shorter than the anterior coxæ.

General color wood brown,[13] sprinkled and finely mottled with umber, the ground tint being purest on the anterior limbs. Eyes walnut brown, mottled with blackish. Anal region and lower surface of abdomen tinged with ochraceous.

Comparative Measurements.

	♀ *media.*	♀ *spinigera* (from Schulthess).
Length of body,	107.5 mm.	113 mm.
Length of pronotum,	30.5 "	30 "
Greatest width of pronotum,	7 "	6.3 "
Length of supraanal plate,	12.5 "	20 "
Length of anterior coxæ,	19.5 "	
Length of anterior femora,	24 "	
Length of posterior femora,	35.75 "	

Parasphendale minor Schulthess.

1898. *Parasphendale minor* Schulthess-Schindler, Ann. Mus. Civ. Genova, XXXIX, p. 177.

Two females, one immature; Sheikh Husein and Tulu, Galla-land, September 29 and November 22, 1894.

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[13] Ridgway's *Nomenclature.*

Oxyophthalma gracila Saussure.

1861. *Oxyophthalmus gracilis* Saussure, Ann. Soc. Ent. France (4), I, p. 470.

One male; Bodele, Tug Terfa, Somaliland, August 20, 1894.

As far as it is possible to judge from Saussure's description and figure, this specimen is identical with his *gracilis*, except that in the specimen before me the eyes are not so mammillate as in his figure.

Oxypila annulata Serville.

1831. *Oxypila annulata* Serville, Rev. Orthopt., p. 23.

Four specimens, one male, three females (one immature); Sheikh Husein (3) and Dabuli (1), Gallaland, September 16 and October 6, 1894.

Pseudocreobotra amaræ n. sp.

Type, female; headwaters of the Burga river, near Dagugi, country of the Amara, western Gallaland, April 24, 1895.

This species is related to *P. wahlbergii* Stål from Zanzibar, but it is larger and differs in the form and comparative size of the pronotum.

Size rather large. Head transverse; the vertex prolonged into a shallowly bifid peduncle; ocelli very large and prominent; clypeus and labrum carinate, the former triangularly produced into falcate extensions; eyes very prominent, bluntly acuminate, each flanked on the posterior margin by a blunt tubercle. Pronotum with two lateral and one posterior prominent rounded lobes, the anterior margin being broadly rounded; the central section heavily bossed forming four tubercles, the large anterior one being considerably cristate; the lateral lobes thin, coriaceous and ascending. Tegmina long and moderately broad, central and basal sections opaque, apical section hyaline. Anterior coxæ finely scabrous, the lower margin with both large and small spines to the number of 6 or 7; femora bearing four spines on the external margin, each spine being thick and heavy at the base, the tip being constricted and sub-ungiculate, the internal margin with nine spines, the second, third and fifth being reduced in size; metatarsi superiorly lamellate, the external margin subpectinate, the internal margin with fourteen spines increasing in size from the proximal extremity. Median and posterior limbs rather slender, the femora with apical rotundate dilations on the posterior margin. Abdomen broad and heavy, each segment with a lateral angular production. Subgenital plate broadly rounded, with a central depression and a posterior median emargination.

General color between gamboge yellow and lemon yellow,[14] strongest on the head, pronotum, limbs and tegminal rings. Head with the superior aspect clouded with greenish; eyes walnut brown clouded with blackish, palest inferiorly. Pronotum with the posterior half deeply suffused with dull greenish. Tegmina basally pale pea-green with a blotch of chromium green,[15] the characteristic rings surrounded by the latter tint, the rings arranged as follows: a central black spot, a moderately broad ring of chromium green followed by a bar of slightly greater width of modified lemon yellow, and externally a narrow black ring. Limbs all ringed with narrow bands of dull emerald green; the lower surface of each of the anterior femora with two spots of orange.

Measurements.

Total length,	33.	mm.
Width of head,	6	"
Length of pronotum,	6.75	"
Greatest width of pronotum,	9	"
Length of elytra,	32.5	"
Greatest width of elytra,	7.5	"
Length of anterior femora,	10.5	"
Length of posterior femora,	8.25	"

Pseudoharpax virescens (Serville).

1839. *Creobroter virescens* Serville, Orthoptères, p. 162, Pl. 3, fig. 7.

Four specimens, one male, three immature females; Sheikh Husein, Gallaland, September 28 and 30, October 9 and 10, 1894.

The male has a broad dorsal median stripe of black on the pronotum.

Popa undata (Fabricius).

1793. *Mantis undata* Fabricius, Ent. Syst., II, p. 19.

Three specimens, two males (one immature, one larval), one female; Sheikh Husein, Gallaland, and near Tug Lomo, between Milmil and Bodele, Somaliland,[16] August 12, September 30 and October 10, 1894.

The males have the supraanal plate apically truncate, while that portion of the female is much more acuminate.

[14, 15] Ridgway's *Nomenclature.*

[16] The data with this specimen reads "Smith River, VIII 12, 94." Smith River cannot be found on any of Dr. Smith's charts, and the locality above s that of the date.

Empusa egena Charpentier.

1841. *Empusa egena* Charpentier, Germar's Zeitschr., III, p. 297.

One larval female; Laga, Gallaland, November 29, 1894.

Idolomorpha dentifrons Saussure.

1895. *Idolomorpha dentifrons* Saussure, Grandidier's Hist. de Madagascar, Orthoptères, Pt. I, p. 244.

One female; Daro Mountains, between Ginea and Tulu, Gallaland, November 19, 1894.

Blepharis cornuta Schulthess.

1895. *Blepharis cornuta* Schulthess-Rechberg, Zoolog. Jahrb., Syst. Abth., VIII, p. 72.

Two immature females; vicinity of Laga, Gallaland, November 28 and 30, 1894.

The two specimens before me differ somewhat from the figure of *cornuta*, the anterior tibiæ being longer than those figured, though this may be due to foreshortening in the figure. On the whole the variations amount to so little that there is no doubt as to their identity.

Family **PHASMIDÆ.**

Palophus reyi (Grandidier).

1869. *Ischnopoda reyi* Grandidier, Revue et Magasin de Zool. (2), XXI, p. 292.

One female; no data.

Total length,	202 mm.
Length of tegmina,	25 "
Length of wings,	67 "
Length of anterior femora,	56 "
Length of median femora,	42 "
Length of posterior femora,	54 "

Clonaria gracila (Burmeister).

1838. *Bacillus gracila* Burmeister, Handb. d. Ent., II, Abth. II, Pt. I, p. 561.

One male; Berbera, Somaliland, July 3, 1894.

The collection also includes four female specimens of *Phasmidæ* taken at the following localities:

Sheikh Husein, Gallaland, October 8, 1894.

Sheikh Mahomet, Gallaland, October 30, 1894.

Luku, Gallaland, September 17, 1894.

Between Tug Lomo and Bodele, Somaliland, August 12, 1894.

These are damaged to such an extent that determination is very difficult or impossible, many of the portions used in classification being absent or badly damaged.

THE IDENTITY OF THE GORDIACEAN SPECIES, CHORDODES MORGANI AND C. PUERILIS.

BY THOMAS H. MONTGOMERY, JR., PH.D.

In a preceding contribution[1] I described as new and distinct species *Chordodes morgani* and *C. puerilis*, the former based on two females, the latter on two males. The differences in the sculpturation of the surface of the cuticle seemed then to justify the separation of these two species. In a later paper[2] I stated that "*Chordodes puerilis* and *C. morgani* may eventually be found to be the two sexes of the same species;" and the truth of this supposition is now confirmed. *C. puerilis* thus becomes a synonym of *C. morgani*, since the latter was first described in the original paper.

Material consisting of seven females and five males, all collected together at the same time (July 27, 1899), on the shore of South Bass Island, in the western end of Lake Erie, in the explorations of the Great Lakes conducted by the U. S. Fish Commission, were very kindly sent to me for identification by Prof. Jacob E. Reighard; and I am indebted to him and to Mr. George M. Bowers, Fish Commissioner, for permission to publish my conclusions. An examination on cross sections of the cuticle of a number of these specimens shows very considerable variation, but variation with intergradation; and shows also that there is more or less of a sexual difference in the form of the papillæ of the cuticle. In each individual the cuticle of the middle region of the body was examined.

In the following description the original specimens, as well as the new material, shall be described together. In my first paper the form of the body was described, and there is nothing new to be added to that account.

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[1] "The Gordiacea of Certain American Collections, with Particular Reference to the North American Fauna," *Bull. Mus. Comp. Zool.*, Harvard College, Vol. 32, No. 3, 1898.

[2] "Synopses of North American Invertebrates. II, Gordiacea (Hair Worms)," *American Naturalist*, Vol. 33, No. 392, 1899.

Size and Color.—The largest female (the type of *C. morgani*) measures 222 mm. in length, the largest male 220 mm., the smallest individual seen (male, co-type of *C. puerilis*) 64 mm. The color varies from a dull chocolate brown to a light buff brown, averaging darker in the males; the head end is always white.

Cuticle.—Cross sections of the cuticle examined with high powers show the following kinds of prominences:

1. Low papillæ of irregular outline, rarely higher than broad, which bear no spines. These are shown in Plate XI, figs. 1–3, 9. In general they are, next to the following kind, the most numerous, and are generally the smallest.

2. The most numerous are small papillæ, rounded or more frequently conical on outline, each of which bears a delicate, stiff spine of nearly its own height. These are shown in Plate XI, figs. 1–3, 5–11. Generally they are rather evenly distributed between the larger papillæ, but in one female (fig. 7) considerable portions of the cuticle show them arranged in close patches, without papillæ in the spaces intervening. In none of the males was such an arrangement found.

3. Large papillæ, considerably higher and broader than the preceding, shown in Plate XI, figs. 1, 3, 5, 6, 10, 11. In the smallest female (length 125 mm.) these were entirely absent. Their crowns are generally flattened or rounded, and bear each a circlet of short, stiff, delicate spines, few and variable in number; in the largest female, the type of *C. morgani*, fig. 11, most of the papillæ were not provided with such spines. Sometimes, not frequently, the bases of these papillæ are tuberculated or dentated. In the males these large papillæ are generally higher than broad, except in the smallest male (fig. 1, co-type of *C. puerilis*), where they are about as broad as high. In the females they are relatively less numerous than in the males, and relatively broader and shorter, more rectangular in outline and with their summits more regularly flattened. Fig. 11 shows their appearance in the largest female, which may be compared with the appearances in the largest males (Plate XI, figs. 3, 5, 6).

4. Small rounded papillæ, each of which bears on its summit a long, hyaline, finger-shaped process (Plate XI, figs. 1, 3, 8, 11). These are present in all the individuals, but very much less numerous than any of the preceding kinds, generally occurring at

considerable distances apart. Such processes are found in most species of the genus.

5. Papillæ, each of which bears a thick, more or less curved, conical spine, refractive and homogeneous in appearance (Plate XI, figs. 2, 4, 11). These are the least numerous. I did not find them in the specimens from Lake Erie, but they are present in the types and co-types of *morgani* and *puerilis* (I had overlooked them at the time of my former description). The size and form of the spines is variable.

Surface views of the cuticle were given in my preceding paper. In the males the large papillæ (the third kind) always appear darker and larger than the other papillæ; they may be arranged close together or, when less numerous, show the tendency to form large, irregular groups. In the largest females the cuticle on surface view is like that of the males, except that the third kind of papillæ are less numerous; in females which lack the third kind of papillæ, the darker disks on the surface of the cuticle represent patches of papillæ of the second kind.

Diagnostic Characters.—The sculpturation of the cuticle is so variable that it is difficult to give a sharp diagnosis. But the regular occurrence of papillæ (the second kind) of more or less conical form, each bearing a short delicate spine; the quite general occurrence of higher papillæ (the third kind), each generally with a circlet of a few similar spines, and the occasional occurrence of papillæ bearing each a thick conical spine, seem to distinguish *C. morgani* from any hithero described species of the genus. But the degree of variation in this form, individual and sexual, shows how necessary it is to examine large series of individuals in separating the species of the *Gordiacea;* an individual variation about as great is found in *C. occidentalis* Montg., as has been shown by me in a preceding paper.[3]

All the specimens seen by me of *Chordodes morgani* were from the United States of America, from the following localities: Lake Erie, Maryland, Iowa and Pennsylvania; thus it would seem to be a species of the eastern portion of North America.

[3] *Proc. California Acad. Sciences,* Third Series, Vol. I, No. 9, 1898.

EXPLANATION OF PLATE XI.

All the figures represent portions of transverse sections of the cuticle, except fig. 4, which represents a single papilla; all were drawn with the camera lucida at the height of the microscope stage with a Zeiss microscope, length of tube 100 mm., ocular 4, homogeneous immersion objective $\frac{1}{12}$th.

Figs. 1, 2.—Male (co-type of *C. puerilis*, length 64 mm.).
Figs. 3, 4.—Male (type of *C. puerilis*, length 228 mm.).
Fig. 5.—Male (length 150 mm.).
Fig. 6.—Male (length 220 mm.).
Fig. 7.—Female (length 127 mm.).
Figs. 8, 9.—Female (length 190 mm.).
Fig. 10.—Female (length 180 mm.).
Fig. 11.—Female (type of *C. morgani*, length 220 mm.).

DESCRIPTION OF A NEW HEMIRAMPHID.

BY HENRY W. FOWLER.

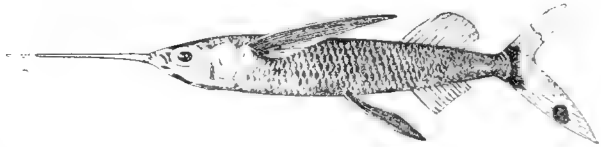
The specimen described below was found among a miscellaneous collection of small and young fishes presented to the Academy of Natural Sciences of Philadelphia many years ago by Dr. William H. Jones, of the United States Navy.

I propose a new genus and species for this specimen after a comparison with equally small examples, some smaller, of *Hyporhamphus* and *Hemiramphus*. These seem to differ but little from the adults, and that principally in the shorter beak, which is absent altogether in some. Perhaps a comparison of the adults and young of the other members of the *Hemiramphidæ* may result in still greater differences.

The specimen in question is strikingly like *Fodiator acutus* (Cuvier and Valenciennes), which it resembles in many respects, though differing altogether in having a beak one and a half times the length of the head. The young of all the *Exocœtidæ* examined do not differ materially from the adults, and it seems hardly likely that a beak as long as the present specimen possesses is developed in the young of *Fodiator*. Undoubtedly we have in this specimen an annectant form between *Euleptorhamphus* among the *Hemiramphidæ* and *Fodiator* among the *Exocœtidæ*.

HEMIEXOCŒTUS gen. nov.

Body moderately elongate, compressed and covered with rather large deciduous scales. The sides of the body are more or less rounded and not especially flattened or compressed. The dorsal and ventral lines are more or less parallel. The upper jaw is very short, and the lower jaw is produced into a long, pointed, slender



beak, at least one and a half times as long as the head. Teeth minute. Head large and the eye is also large. No finlets. Caudal forked and the lower lobe much the longest and strongest. D. and A. more or less similar, and the origin of the former in advance of the latter. P. very long, reaching the origin of the D. V. very long, reaching half-way in the space between their own origins and the base of the caudal.

Hemiexocœtus caudimaculatus sp. nov.

No. 7,508. Type. Taken in lat. 23° N. long. 106° W. (Mazatlan, Mexico). Dr. William H. Jones.

The form of the body is somewhat elongate, moderately compressed, with the sides more or less rounded, and with the dorsal and ventral profile lines equally convex. The greatest depth of the body is nearly median, and it is contained in the total length (exclusive of the beak and the caudal) about six times. The head is large and compressed, not very broad above, and contained in the body (as measured before) about four times. The eye is large and superior, and it is contained in the head (exclusive of the beak) about three times. The eye is also greater than the interorbital space. The mouth is small and superior, and furnished with minute teeth. Opercles large. The origin of the P. is superior, level with the upper part of the eye, and near the branchial aperture. Branchial apertures large. The P. are exceedingly large and long, reaching at least to the origin of the D., and thus for about half the length of the V. The origin of the V. is nearer the branchial aperture than the base of the caudal, and the fins reach posteriorly for at least half the distance between their own bases and the base of the caudal. The origin of the D. in advance of that of the A., the fins similar, but the longest rays of the former equal to the depth of the body at that point. The general color of the body is a rich plumbeous brown above and silvery beneath. The upper or outer rays of the P., except the first, are blackish. The first ray of the P., together with the 5 basal rays, white. D. and A. brownish. V. edged upon the outer and inner rays with white, the inner rays blackish like the same of the P. Caudal whitish, except the bases of the rays and the jet black spot upon the outer portion of the lower lobe. The body was covered with rather large scales, but as the squamation is injured I am unable to give any count. Traces of a lateral line existed upon the inferior scales along the sides of the ventral region. D. 10, A. 11, P. 11.

This small example measures 25 mm. from the tip of the upper jaw to the base of the caudal.

A STUDY OF THE GENUS CENTURIO.

BY JAMES A. G. REHN.

A recent study of the Bats in the collection of the Academy revealed the fact that three alcoholic specimens of the curious genus *Centurio* were preserved therein. As comparatively little material of the genus had ever been examined, I secured, through Mr. Gerrit S. Miller, Jr., a loan of the three representatives contained in the collection of the United States National Museum. The acquisition of these specimens considerably enlarged the series for examination so that it numbered five alcoholic specimens, one skin and one odd skull.

With this series, probably the largest ever gathered together, I have made some notes and observations, the results of which have induced me to publish a summary of our knowledge of the genus.

Record of Specimens.—The first specimen of *Centurio* known to naturalists was collected on the cruise of H. M. S. "Sulphur," and was examined by Dr. Gray, of the British Museum, who described the genus and applied the specific name *senex* to the specimen.[1] The locality was stated to be Amboyna, but later[2] Gray seemed doubtful of this, as he says: "Captain Sir Edward Belcher informed me this bat was found in Amboyna, but Mr. Hinds (surgeon of the expedition) does not appear to be so confident on the subject, and rather suspects it came from South America. It was taken from a bottle containing animals from both countries."

In 1854 Lichtenstein and Peters described a specimen supposed to be from Cuba as *C. flavogularis*,[3] but later Alston[4] informs us Dr. Peters had written him that the locality was erroneous.

Saussure was the next author to inform us further regarding this genus, a specimen from "les régions chaudes du Mexique" being described by him as *C. mexicanus*.[5]

The acquisition by the Smithsonian Institution of a specimen

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[1] *Ann. and Mag. Nat. Hist.*, X, p. 259. 1842.
[2] *Voyage of the "Sulphur," Mamm.*, p. 26. 1844.
[3] *Monatsb. K. Preuss. Akad. Wissensch.*, Berlin, p. 335. 1854.
[4] *Biol. Cent. Amer., Mamm.*, p. 51. 1879.
[5] *Rev. et Mag. de Zool., 2e ser.*, XII, p. 381. 1861.

from Mirador, Mexico, with the throat folds greatly developed caused Dr. Harrison Allen to describe the subgenus *Trichocoryes* and the species *mcmurtrii*, which he placed therein.[6] A specimen of *C. mexicanus* from the same locality accompanied the one described. Alston mentions[7] that Dr. Peters had informed him that the Berlin Museum possessed a specimen of *C. mcmurtrii* as well as one of *C. senex*.

The only remaining published record of specimens of this genus is that of one female from Cerro de los Pajeros, Las Vegas, Vera Cruz, Mexico, which was described by Mr. Henry L. Ward as a new species, *Centurio minor*.[8]

General Relations.—A very superficial examination of a specimen of *Centurio* reveals the gap which exists between it and the other genera of the subfamily in which it has previously been placed. Of the genera of the *Stenodermatinæ* I have examined all but two, *i.e.*, *Ametrida* and *Ectophylla*, and the resulting belief is that *Centurio* should stand apart. The singular facial structure, throat folds, absence of true nose-leaf, and peculiar canines all present an individuality not shared by the other genera.

Accordingly I propose to separate *Centurio* as a new subfamily, the differential characters of which would be as follows:

STENODERMATINÆ.	CENTURIONINÆ.
Rostral portion of skull not very broad (except in *Sphæronycteris* and probably *Ametrida*).	Rostral portion of skull very broad.
Upper canines without anterior basal concavity.	Upper canines with anterior basal concavity.
Face with distinct nose-leaf, and without distinct cutaneous facial ornaments (except in *Sphæronycteris*).	Face without distinct nose-leaf, and with distinct cutaneous facial ornaments (nostrils not opening directly upon the surface).
Upper lip not emarginate.	Upper lip centrally emarginate.
Ears without additional lobe on the internal margin.	Ears with additional lobe on the internal margin.
Throat without transverse folds of skin.	Throat with transverse folds of skin.

[6] *Proc. Acad. Nat. Sci. Phila.*, pp. 359-361. 1861.
[7] *Biol. Cent. Amer., Mamm.*, p. 52. 1879.
[8] *Amer. Natur.*, XXV., p. 750. August, 1891.

The *Centurioninæ* have no close affinity with the other divisions of the *Phyllostomatidæ*, for while some of the above characters are shared by the *Mormoopinæ*, the absence of enlarged cutaneous plates on the lower lip immediately shows the distinctness of the subfamilies. The genetic relations are undoubtedly with the *Stenodermatinæ*, but to which portion of it seems doubtful, though *Sphæronycteris* is possibly the closest related of any.

CENTURIO Gray.

1842. *Centurio* Gray, Ann. and Mag. Nat. Hist., X, p. 259. Type, *Centurio senex* Gray.
1861. *Trichocoryes* H. Allen, Proc. Acad. Nat. Sci. Phila., p. 359. Type, *Centurio mcmurtrii* H. Allen (=*Centurio senex* Gray).

Generic Characters.—The same as those of the subfamily of which it is the only genus. Dentition i. $\frac{2-2}{2-2}$, c. $\frac{1-1}{1-1}$, p. $\frac{2-2}{2-2}$, m. $\frac{2-2}{2-2}$.

The characters used by most of the describers of these species were color and the form of the upper incisors.

The color differences are slight and can readily be accounted for by the difference of time of immersion in alcohol. The upper incisors also appear to be both two and three lobate, beside bluntly conic.

Centurio senex Gray.

1842. *Centurio senex* Gray, Ann. and Mag. Nat. Hist., X, pp. 259–260 ("Amboyna," very probably some point on the west coast of Mexico or Central America).
1844. *Centurio senex* Gray, Voyage of the Sulphur, Mammalia, pp. 26, 27, Pl. VIII.
1878. *Centurio senex* Dobson, Catal. Chirop. Brit. Mus., pp. 543-545, Pl. XXX, fig. 6.
1879. *Centurio senex* Alston, Biol. Cent. Amer., Mammalia, p. 51.
1854. *Centurio flavogularis* Lichtenstein and Peters, Monatsber. K. Preuss. Akad. Wissensch., Berlin, p. 335 ("Cuba").
1855. *Centurio flavogularis* Lichtenstein and Peters, Abhandb. K. Akad. Wissensch., Berlin (1851), pp. 87–89, taf. I.
1860. *Centurio mexicanus* Saussure, Revue et Mag. d. Zool., 2e ser., XII, pp. 381–383 (warm region of Mexico).
1861. *Centurio mcmurtrii* H. Allen, Proc. Acad. Nat. Sci. Phila., pp. 360-361 (Mirador, Vera Cruz, Mexico).
1879. *Centurio mcmurtrii* Alston, Biol. Cent. Amer., Mammalia, p. 51, Pl. III, fig. 8.
1891. *Centurio minor* Ward, American Naturalist, XXV, pp. 750–753, fig. (Cerro de los Pajeros, Las Vegas, Vera Cruz, Mexico).

Type Locality.—Erroneously given as "Amboyna" (East Indies). As Gray afterward believed, it in all probability came from America, and a comparison of the route of the "Sulphur" (on the voyage of which the specimen was collected) with the present distribution of the species shows that the specimen was evidently collected on the west coast of Mexico or Central America, at some one of the points visited between San Blas and Panama.

Distribution.—The only accurate records for the occurrence of this species give us little information as to its exact distribution. Aside from Mirador and Cerro de los Pajeros, Vera Cruz, Mexico, the only other accurate captures are from Guatemala[9] and Cartago, Costa Rica; U. S. Nat. Mus., No. $\frac{12912}{37649}$.

It has been recorded from "les régions chaudes du Mexique" by Saussure, and erroneously from Cuba by Lichtenstein and Peters. The whole data shows the species to range from south-central Mexico (Cerro de los Pajeros) to Costa Rica (Cartago), probably within zonal limits, but as to this we know little, for while both of the localities in the State of Vera Cruz are well elevated (above 6,000 feet), Cartago lies in a valley between moderately high ranges of mountains, and Saussure's specimen was stated to have come from the warm section of Mexico.

General Characters.—Those of the genus and subfamily of which it is the only representative.

Head.—Short, broad and deep; the upper lip emarginate, the lower jaw extending beyond the upper, both with the margin beaded. Face with a median depression between the eyes, this being flanked by a fold of skin with a sinuate border, superior to this lies a semicircular thickening, above which, between the ears, is a large appressed fan-like structure with a crenulate border; above each eye lies an irregular protuberance, between the eyes extends a narrow sinus which forms the lower margin of the folds mentioned above; between the nostrils lies a flat oblong plate, the upper border of which is rounded in some specimens and produced in others, the nostrils being laterally bordered by raised converging ridges which terminate below in lobes on the upper lip on each side of the central emargination, the latter having a small central lobule. The chin folds in the male are highly developed, numbering three, the anterior one extending from one corner of the mouth to the other, and the posterior one from antitragus to antitragus, the whole being more or less thickly and heavily haired;

[9] Peters, see Alston, *Biol. Cent. Amer., Mamm.*, p. 52.

the anterior fold bears a central thickening which is enlarged and extends back toward the second fold which bears a central glandular structure, the third fold having a fold of skin of very considerable lateral extent, the whole when pulled forward covering the lower part of the face as a mask; the female presenting rudimentary folds on much the same pattern. Ears not exceeding the muzzle and bearing a large, rather elongate, apically rounded lobe on the internal margin; tragus moderately long, the external margin bearing several lobules, those near the apex usually little developed.

Limbs.—Forearm of moderate length, the thumb compressed, the third finger moderately long. Tibia and foot rather weak. Calcaneum short.

Membranes and Fur.—Membranes moderately tough; the interspace between the fourth and fifth digits and the digital area of the mesopatagium transversely gathered, the tension bars being corded. Uropatagium reaching beyond the middle of the femora, the margin haired. The fur extends upon the wing membrane to a line drawn between the elbow and knee.

Color.—General color above between drab and broccoli brown (Ridgway's *Nomenclature*, Pl. III), tending toward isabelline in some alcoholic specimens and mummy brown (Pl. III) in others; below isabelline. Membrane rather pale mars brown (Pl. III), the interspace between the second and third digits, the gathered portions of the mesopatagium and of the interspace between the fourth and fifth digits semi-transparent.

Skull.—The skull is short and deep, with the rostral portion very broad and steeply descending. Zygoma flaring. Palate short, twice as broad as long, the cleft being acute-angulate anteriorly. Auditory bullæ flattened and not very conspicuous. The figure given by Peters (*l.c.*) is excellent and will show many points hard to bring out in a description.

Teeth.—Upper incisors small, the central pair largest though little exceeding the others in vertical extent; apex bluntly conic, bifid or trifid; upper canines robust, with an anterior basal concavity; upper premolars very unequal in size, the first half the size of the second which bears several lobules on the posterior margin; upper molars twice as broad as long, the crowns rather flat with three principal cusps, the anterior one larger, the external margin of each bearing one prominent anterior lobe and several posterior to this, the last one of which is considerably developed in the first molar. Lower incisors small, uniform, bifid; lower canines hastate, with an external basal shoulder; lower premolars unequal, the first a simple cone, the second larger, with a posterior shoulder; lower molars low, the anterior somewhat larger than the posterior, the latter ranging from subquadrate to subtriangulate in section, each bearing two low angulate cusps.

Remarks.—It is evident that the species presents some diversity in size and probably some in color, but it is quite as evident that such variation is individual or sexual (the males being on an average slightly larger than the female), and cannot be separated into geographic forms. The single specimen from Costa Rica cannot be separated from specimens from Vera Cruz, Mexico, and the five specimens (three males, two females) from Mirador present considerable variation among themselves.

The species described by Lichtenstein and Peters (*C. flavogularis*) and Saussure (*C. mexicanus*) can readily be placed as synonyms of *C. senex*, Peters afterward admitting such to be the case with *C. flavogularis;* and Saussure's *C. mexicanus* can be matched with specimens of *senex*, the difference in color being very likely due to the length of immersion in the preserving fluid. The species *C. mcmurtrii* H. Allen was based on the adult male,[10] the folds being in all probability secondary sexual characters.

A close examination of the description of *C. minor* Ward shows that the describer was probably misled by Dobson's description of the chin folds, and in the absence of material for comparison he described a female which agrees exactly with two females before me; the discrepancies in measurement beng simply individual, while the second lower premolar of all the available specimens is more than half the size of the first and some are decidedly not triangular in section. The describer of *C. minor* stated that he would not be surprised "if *minor* should eventually prove to be but a variety of *senex*."

Specimens Examined.—Seven: one skin, five alcoholics and one odd skull.

U. S. N. M., $\frac{8239}{37806}$, alc., Mirador, V. C., Mex. ♂. Coll. Dr. C. Sartorius. Type of *Centurio mcmurtrii* H. Allen.

[10] A fact quite evident on the examination of four males, one of which is the type of the species.

U. S. N. M., $\frac{11179}{37786}$, alc., Mirador, V. C., Mex. ♂. Coll. Dr. C. Sartorius.

A. N. S., 1,788, alc., Mirador, V. C., Mex. ♂. Coll. Dr. C. Sartorius.

A. N. S., 1,787, alc., Mirador, V. C., Mex. ♀. Coll. Dr. C. Sartorius.

A. N. S., 5,500, alc., Mirador, V. C., Mex. ♀. Coll. Dr. C. Sartorius.

A. N. S., 5,063, skull. Pres. Dr. Harrison Allen.

U. S. N. M, $\frac{12912}{37549}$, skin, Cartago, Costa Rica. ♂. December, 1877. Coll. C. Cervantez. Pres. J. C. Zeledon.

Comparative Measurements (in millimeters).

	L. Head and Body.	L. Head.	L. Ear.[11]	L. Tragus.	L. Fore-arm.	L. Thumb.	L. Third Finger.	L. Tibia.	L. Calcaneum.	L. Foot.	Total Length Skull.	Great. Zyg. Width.	Intero. Width.	Height at Base 2 Prem.	Height Br. Case.	Width Palatal Constriction.	Lgh. Palate. f. Foramen.	Width Palate with Teeth.
Dobson's measurements of *C. senex*........	76.2	25.4	16.5	7.6	53.3	12.7	93.9	16.5	6.3	10.6								
Lichtenstein's and Peters' measurements of *C. flavogularis*	75	20	15		42	13.5	86	19	5	13								
Saussure's measurements of *C. mexicanus*	65				45				6									
Ward's measurements of *C. minor*........	65	20	13	4	40	13	84	17	5.5	14								
No. $\frac{11172}{37748}$, U. S. N. M., Mirador, Mexico.	54	22	12	4	41	12	74	19.5	4.7	10	16.2	14.7	5	5.75	11.5	3.5	3	10.5
No. $\frac{8289}{37806}$, U. S. N. M, Mirador, Mexico. Type of *C. mcmurtrii*	52	22	11	4	40	11	78.2	20	4	10.5	17	14.7	5	5.5	11.5	3.3	3	10.5
No. 1,788, A. N. S., Mirador, Mexico....	55.5	20	12	1.1	42.5	11.2	80	20.5	5.2	11								
No. 1,787, A. N. S., Mirador, Mexico ...	50.5	20	13	4	43.5	13.5	86	19	6.5	10.25								
No. 5,500, A. N. S., Mirador, Mexico....	52	20	13	3.5	44.2	10	83	17	5.75	10								
No. $\frac{12912}{37549}$, U. S. N. M., Cartago, Costa Rica (dried skin)...	60	circa 20	12		42	12			5	10.75	17	15	5	5.2	12	3.5	3.5	10.2

[11] All of the ear measurements taken by myself are from the external notch.

THE LIMITS OF VARIATION IN PLANTS.

BY JOHN W. HARSHBERGER, PH.D.

One of the most important questions on which the work of the biologist should be brought to bear is the problem of species. We see all living nature—animals and plants—divided into groups which are denominated species. These groups are often clearly and sharply defined, and, on the other hand, often very irregularly characterized. What are the causes which have brought this about? What are the facts underlying the phenomenon of species? Two difficulties are presented to the earnest student who attempts to formulate an answer to the above-mentioned questions. The well-known reasoning starts from the fact that more animals or plants are born than can survive; some must therefore perish and leave no descendants, and only those persist which have structures and aptitudes that fit those organisms possessing them to bear their part in the struggle for existence. On the whole, we find that the fittest will survive and breed.

The first difficulty which presents itself is one which hangs on the magnitude of the variations by which new forms arise. What are the limits of variation? The older books on evolution consider that the variations by which new species arise are at first small. But if they are small, how can they be sufficiently useful to give to those organisms possessing them an advantage in the struggle for existence? This is the difficulty of small or initial variations.

The second difficulty is one known as that of the swamping effect of intercrossing. Granting that variations do occur, how can they be perpetuated? For if the varying individuals breed with each other, will not these variations be obliterated?

The following statistical study was undertaken with the purpose of answering the first question, viz.: By what steps—by what integral changes, of what size—did the new form come into existence? At the International Botanical Congress, held in Paris in 1900, M. Angel Gallardo spoke highly of the employment of the statistical method in the study of variation,[1] and it appears to the writer that this method is the only accurate and scientific one that can be employed. Several plants, therefore, were chosen, because of their easy procurement, and measurements were made of their several parts and these measurements tabulated. Several striking facts were brought out during the course of the statistical inquiry, and these are referred to in their proper place throughout the paper.

The following common plants were chosen for a somewhat detailed measurement of the parts mentioned, viz.: Fruits of the May apple (*Podophyllum peltatum*), leaves of the tulip poplar (*Liriodendron tulipifera*), leaves of the Japanese ivy (*Ampelopsis Veitchii*), fruits of white oak (*Quercus alba*), fruits of the swamp chestnut oak (*Quercus prinus palustris*), leaves of the moon-seed (*Menispermum canadense*), entire plants of Indian turnip (*Arisæma triphyllum*), leaves of bloodroot (*Sanguinaria canadensis*), leaves of the tree of heaven (*Ailanthus glandulosa*)—the latter plant not being studied statistically, but in a comparative way to bring out some peculiarities of its pinnation. The material was used either in the green condition or it was used in the preserved state (dry or alcoholic). In all cases where leaves were taken, careful tracings were made by a sharp-pointed lead pencil upon ordinary drawing or manila paper, and these tracings were afterward accurately measured. The character of the material, whether fresh, dry or alcoholic, is mentioned in connection with the subjoined tables. Prof. Halsted[2] has shown that leaves suffer in drying, but in drying, as they all maintain the same relative size, the results which are mainly comparative do not seem to be vitiated.

The measurement of the linear dimensions of the leaves and parts of the plants was made by a standardized boxwood scale manufactured by Keuffel & Essler Co., New York, which ruler was divided into centimeters, millimeters and half-millimeters, the length of the scale being twenty centimeters in all. Superficial dimensions, in order to be accurate and expressive of the real size of the leaf or other part, require a detailed trigonometrical calcu-

[1] 1900, *Botanical Gazette*, "Account of the International Botanical Congress," xxx, p. 405.
[2] Halsted, *Bulletin Torrey Botanical Club*, xxi, p. 127.

lation of areas by means of the angles and the sides of plane and spherical triangles, the sides of squares, rectangles, trapezoids and the like. Nothing being gained by such a mathematical study, measurements of the superficial extent of the vegetal parts are omitted. Linear dimensions in the tables are given in decimeters, centimeters and millimeters.

The weight of the fruit and seeds of the May apple are given in grams and decimals of the gram. The volume in cubic centimeters was determined by the amount of distilled water displaced by putting the fruits, the carefully cleaned and dried seeds, in a vessel filled to the brim with that liquid.

The linear measurements of the veins of the leaves used were obtained by adopting the following method of procedure. The midrib was first carefully measured, then the first line drawn on the left side from the base of the leaf to the apex of the first left lobe, and the second and third lines were also measured in the same manner.[3] The length of the parts on the right side was then determined, as also the depth in certain cases of the sinuses, beginning with the first sinus on the left of the middle lobe. Proceeding in the same way, after completing the measurements on the left, the right-hand side of the leaf was measured, the apex pointing away from one's person. The greatest width of the several lobes is also given in the tables, and the width of the widest portion of the leaf itself is also stated by way of a comparison.

Measurements.

Podophyllum peltatum (Mayapple).

Twenty fruits were gathered in an open wood, carefully washed and wiped to remove adhering soil particles. After weighing, the volume of each fruit was determined, and afterward the seeds were removed, dried carefully, cleaned and weighed. The volume of the seeds was also ascertained by displacement. By subtracting the weight of the seeds from the weight of the fruit, the weight of the pulp may be ascertained, and in the same manner, by sub-

[3] Measurements of the fifth and sixth leaves of Table IV, part 1 were made from a base line drawn from lowest part of the two basal lobes. In the same manner also for leaves 1, 2, 3 of Table III, part 1, for D and E leaves Table V.

tracting volumes, its volume. The following table (I) presents the results of these determinations:

I. Fresh Fruits of Mayapple (Podophyllum peltatum).

Number.	Weight of Fruit, in Grams.	Volume of Fruit.	Number Seeds.	Weight of Seeds, in Grams.	Volume of Seeds.
1	30.05	34 c.c.	44	0.70	1.00 c.c.
2	35.50	36 "	52	0.90	1.25 "
3	27.00	30 "	43	0.45	0.75 "
4	28.50	30 "	43	0.55	1.00 "
5	32.50	36 "	36	0.38	0.75 "
6	27.00	26 "	36	0.40	0.75 "
7	27.00	30 "	58	0.80	1.00 "
8	23.10	25 "	32	0.30	0.75 "
9	19.80	18 "	28	0.05	0.50 "
10	22.60	30 "	33	0.25	0.50 "
11	20.50	28 "	43	0.43	0.75 "
12	19.00	20 "	42	0.32	0.75 "
13	17.00	17 "	31	0.05	0.50 "
14	16.50	18 "	32	0.25	0.50 "
15	16.50	13 "	—	——	——
16	13.50	13 "	27	0.15	0.625 "
17	14.70	10 "	36	0.20	0.50 "
18	13.80	15 "	39	0.20	0.50 "
19	10.30	10 "	2	0.06	——
20	14.50	9 "	42	0.35	0.875 "

A study of this table shows that the size of the fruits and the number of the seeds varies within wide limits. The largest fruit with 52 seeds (No. 2) weighed 35.50 grams and displaced 36 c.c. of water. The smallest fruit (No. 19) with 2 seeds weighed 25.20 grams less, and displaced 10 c.c. of water, a difference of 26 c.c. This difference is due, without doubt, to imperfect fertilization of the ovules of the nineteenth plant. However, if we compare fruits No. 3 and No. 11, having the same number of good seeds, we find a very considerable difference; or if we institute a comparison between fruits No. 5 and No. 17, we find the variations to be even more striking. The table also shows that the weight of the fruit largely depends on the amount of the pulpy pericarp.

Sanguinaria canadensis (Bloodroot).

There arise from the rootstock of this plant two lanceolate, membranous scale leaves, and a single palmate, glaucous foliage leaf variously lobed, sometimes only undulate. A reference to the table will show that the thirty-three leaves taken for comparison are extremely variable, the variations being within wide limits. The first leaf, an evolved one, was the largest one measured. If it is contrasted with a juvenile leaf No. 15, one of the smallest leaves, a wide divergence is noted. It is important, however, to notice here that an absolute comparison cannot be drawn, because of the wide variation in parts of the leaves themselves. For example, although in most of its dimensions leaf No. 15 is a small one, yet its midrib is longer than the midrib of No. 9, which is a middle-sized one. Therefore in comparing the large leaf No. 1 with the smallest leaf No. 15, these variables must be taken into consideration.

It is important to distinguish between the juvenile and adult forms of leaves. The differences in the construction of the juvenile and adult form are in general more different when the external conditions to which they are severally adapted are different; whilst if these do not operate, the primary leaves with which we have here first to deal are only arrested formations. In many plants reversion of the adult to the juvenile form frequently occurs. Evidently leaf No. 15 represents a juvenile form of leaf, that is, one derived from a rootstock which has been directly formed from the seedling plant, and the larger more deeply lobed leaves, such as No. 1, represent forms derived from a rhizome which has persisted for some years. In making these statistical measurements, therefore, the amount of the difference between the juvenile and adult forms is clearly set forth, as also the adult leaf variations mathematically expressed.

In the accompanying tables (II and II*a*), L. = length, W. = width of lobe, a star (*) beside a number indicates that the determination of the width of that lobe was made by measuring the length of a perpendicular from a line drawn from the base of a leaf to the apex of the lobe. The measurements were made from a basal point where the primary veins of the leaf meet. Fresh leaves were used in making the sketches from which the dimensions later were taken. The lowest point of the leaf was ascertained by measuring from the vein of the last and lowest lobe of the leaf on the right and left sides to the apex of the most projecting curve or angle toward the base of the leaf. The breadth of the leaf was determined by measuring across the widest portion of the leaf lamina.

II. Sanguinaria canadensis. Left Sides of Leaves.

Number of Leaf.	Mid-Lobe.		Depth Basal Sinus	1st Left Lobe		Depth of First Left Sinus.	2d Left Lobe		Depth of Second Left Sinus.	3d Left Lobe		Depth of Third Left Sinus.	Lowest Point Left Side.
	L.	W.		L.	W.		L.	W.		L.	W.		
1	.130	.025	.034	.170	.023	.065	.120	.040	.065	.120	.040	.069	.085
2	.053	.018	.024	.055	.021	.027	.050	.042	.020				.040
3	.112	.040	.050	.109	.038	.045	.100	.037	.037	.095	.039	.029	.074
4	.073	.025	.032	.070	.095	.022							.055
5	.063	.020	.037	.064	.027	.027	.051	.058					.044
6	.073	.028	.050	.071	.105	.026	.072						.060
7	.074	.029	.034	.062	.032	.026	.064	.064	.019				.047
8	.083	.026	.040	.081	.032	.030	.080	.077	.020	.078			.061
9	.046	.018	.047	.056		.017	.065	.087					.050
10	.055	.020	.050	.065		.017	.072	.105					.063
11	.063	.024	.040	.062	.095	.025	.056						.050
12	.070	.023	.037	.069	.027	.030	.064	.029	.021	.063	.046	.017	.050
13	.096	.043	.066	.100	.047	.047	.073	.096	.026				.069
14	.065	.022	.040	.067	.028	.025	.056	.028	.017	.058	.034	.016	.050
15	.050	.013	.030	.052	.072	.015	.046						.037
16	.057	.015	.033	.053	.082	.018	.053						.042
17	.104	.040	.050	.094	.047	.043	.093	.037	.034	.090	.039	.027	.064
18	.083	.028	.040	.071	.026	.038	.070	.077	.028				.056
19	.090	.029	.038	.082	.030	.039	.064	.030	.025	.063	.045	.021	.053
20	.070	.031	.064	.068	.035	.035	.070	.028	.028	.073	.044	.022	.068
21	.090	.037	.063	.085	.040	.045	.077	.045	.028	.076	.050	.021	.067
22	.092	.036	.052	.092	.036	.044	.079	.042	.023	.076	.043	.023	.063
23	.087	.030	.045	.088	.044	.043	.078	.035	.020	.080	.040*	.016	.060
24	.082	.026	.061	.075	.036	.045	.070	.086	.030				.070
25	.085	.032	.051	.088	.035	.040	.078	.036	.035	.074	.050	.022	.065
26	.070	.030	.033	.067	.032	.031	.063	.041*	.021				.050
27	.097	.032	.066	.090	.032	.051	.086	.034	.035	.080	.051	.025	.080
28	.066	.028	.034	.061	.025	.029	.056	.029	.023	.056	.023*	.015	.040
29	.097	.036	.051	.095	.043	.045	.091	.040	.034	.087	.038*	.026	.068
30	.088	.030	.054	.085	.036	.042	.083	.038	.031	.068	.060	.016	.062

IIa. Sanguinaria canadensis. Right Sides of Leaves.

Number of Leaf.	1st Right Lobe.		Depth of First Right Sinus.	2d Right Lobe		Depth of Second Right Sinus.	3d Right Lobe.		Depth of Third Right Sinus.	Breadth of Leaf, Widest.	Lowest Point Right Side.
	L.	W.		L.	W.		L.	W.			
1	.120	.032	.068	.121	.042	.066	.122	.046	.057	.242	.098
2	.048		.025	.045	.057					.095	.032
3	.108	.037	.044	.098	.035	.030	.097	.055	.027	.177	.074
4	.072	.091	.022							.134	.051
5	.062	.024	.025	.062	.058					.110	.041
6	.069	.030	.024	.067	.070					.139	.058
7	.065	.035	.026	.064	.050	.020				.127	.048
8	.083	.029	.026	.076	.076	.019	.074			.151	.055
9	.053		.016	.064	.085					.120	.052
10	.058		.016	.061	.095					.115	.057
11	.064	.092	.023	.053						.113	.041
12	.065	.028	.030	.064	.062	.020	.063		.011	.125	.051
13	.090	.043	.050	.066	.100	.030				.136	.080
14	.064	.024	.024	.050	.031	.019	.054	.037	.013	.123	.042
15	.052	.071	.012	.045						.098	.040
16	.052	.078	.018	.050						.106	.042
17	.092	.042	.046	.085	.056	.035	.085	.056	.024	.172	.064
18	.070	.028	.026	.067	.071	.026				.130	.053
19	.085	.025	.035	.070	.033	.029	.066	.063	.023	.128	.055
20	.070	.033	.036	.067	.035	.033	.069	.049	.021	.130	.066
21	.088	.043	.044	.072	.033	.025	.072	.050	.020	.145	.069
22	.088	.043	.043	.080	.045	.028	.075	.047	.022	.158	.062
23	.080	.035	.043	.082	.036	.029	.081	.040*	.023	.160	.062
24	.078	.033	.042	.067	.080	.023				.137	.068
25	.086	.040	.046	.082	.032	.036	.072	.075	.024	.137	.060
26	.067	.030	.031	.062	.042*	.018				.123	.051
27	.089	.032	.048	.077	.035	.037	.076	.047	.019	.162	.076
28	.059	.024	.029	.055	.027	.026	.053	.030	.020	.108	.044
29	.092	.040	.042	.090	.037	.027	.086	.045*	.028	.170	.062
30	.092	.035	.040	.068	.030	.028	.068	.045	.030	.131	.060

Liriodendron tulipifera (Tulip Poplar).

The leaves of this tree are extremely variable, and different forms of leaves are found by careful examination on the same tree, as so clearly shown by Holm,[4] who has reduced many of the fossil species established by Heer, Lesquereux and Saporta to the *tulipifera* form, by finding that a large number of the fossil leaves upon which specific characters were founded are duplicated by the leaves from living trees. Goebel[5] has shown that it is necessary, in studying leaf forms, to contrast the juvenile and adult conditions, because these vary from each other within wide limits. It is of course impossible to limit these sharply. The difference between these juvenile stages and the adult form may be more or less great. The present statistical inquiry is intended to mathematically contrast these variations. The juvenile forms of leaves in *Liriodendron*, beginning with the first leaf above the cotyledons, may be described as follows: The first leaf is obreniform, *i.e*, two rounded lobes and rather deep angular sinus; the second leaf is approximately bilobed, somewhat squarer than a typical obcordate leaf; the third and fourth leaves are deltoid with shallow apical sinus, and therefore almost horizontal on top; the fifth leaf from the cotyledons is four-lobed with deep, rounded left and right sinuses, shallow apical sinus and two distinct obtuse apical lobes; the sixth leaf is entire, almost square, with two small lateral lobes and narrowed apical portion. In general, the first four or even five leaves on the very young tulip tree have the same form as the oldest and youngest on the branches of the full-grown tree. The best description of the adult leaf is by A. Michaux,[6] as follows: "Foliis abscisso-truncatis, quadri-lobatis," and this description has been accepted by such authorities as Bentham and Hooker, and Gray. Britton[7] describes the leaves in this manner: "Leaves glabrous, very broadly ovate or nearly orbicular in outline, truncate or broadly notched at the apex, truncate, rounded or cordate at the base, 3′–6′ long with 2 apical and 2–4 basal lobes with rounded sinuses, or occasionally entire." The juvenile leaves, as above described, vary remarkably from those adult forms described

[4] 1890, Holm, "Notes on the Leaves of Liriodendron," *Proceedings of the National Museum*, XIII, p. 15.

[5] Goebel, *Organographie der Pflanzen*, I. Theil, pp. 121–151.

[6] 1803, A. Michaux, *Flora Boreali-Americana*, p. 326.

[7] 1897, Britton and Brown, *Illustrated Flora*, II, p. 49.

so carefully by Britton and Michaux. In order to correlate the different varieties with one another, it is necessary to ask two questions: Is the leaf form an arrested one, or does it represent an advanced condition of growth? I believe that all the forms known can be classified either as arrested, evolved or reverted forms. Before, however, making this classification, it is necessary to state the fact that the oldest and youngest leaf on the same branch show an entirely different form from the intermediate ones, of which the form with four-lobed leaf may be taken as the normal one for our *Liriodendron tulipifera.*[8] The fact that the oldest and youngest leaf on the same branch can differ so much from the other ones seems to be almost constant for the full-grown tree. It must also be emphasized that the intermediate leaves have, instead of four lobes, sometimes six or even eight lobes as teeth.

Arrested Leaves.—The oldest and youngest leaves which have a shape somewhat like those of the seedling plant are evidently arrested ones. The primordium of the youngest leaf of a normal branch has been arrested in its development at a certain stage, and therefore the leaf exhibits an evident often extremely different configuration.

Reverted Leaves.—The gigantic leaves from the sprouts (measures below) evidently belong to this category, and are in shape like leaf No. 5 of the seedling tree.

Evolved Leaves.—The four-lobed leaves, whether provided with deep or shallow sinuses, and the six to eight-lobed leaves referred to above have acquired their different character by passing through a further transformation. In other cases where this rough classification does not apply, the form of the leaf may be explained by the persistence or duration of the juvenile form, which produces leaves scarcely less variable than the others mentioned above. All of these facts have been taken into consideration in making the measurements.

In Table III are presented the measurements of two terminal normal branches, the leaves being counted from the base in an ascending direction. The amount of variation is shown by comparing the leaves of the same position on the two shoots. The statistical study of the youngest, oldest and intermediate leaves of the normal branch brings out quantitatively the effect which the light exercises upon the development of the leaves. That light is

[8] Holm, *l. c.*

the controlling influence in regulating the size of dorsiventral organs, such as foliage leaves, has been abundantly proven. The measurements presented in Table III will at some future time be compared with those obtained from seedling plants, so as more clearly to present statistically the similarity of the youngest and oldest leaves of the normal shoot and the juvenile ones of the seedling tree.

Table IV presents the statistical study of the leaves of a normal shoot taken from a tree growing at Raven Rock, Pa. In comparing the figures of this table with those of Table III, it is necessary to read from the bottom up, leaf No. 7 of Table IV being compared with leaf No. 1 of Table III.

The leaves obtained from sprouts growing from a stump were out of all proportion to the size of the leaves on normally produced shoots. Table V shows the largest of the leaves studied to be .370 mm. long and .432 mm. wide. A comparison also of the leaves of the sprouts with each other indicates that a very considerable variation occurs. By contrasting these sprout leaves with normal ones, the limits of the variations in this one plant are clearly set forth. Variations which are due to the reversion of the sprout leaves to the juvenile forms on the seedling plants, however, enormously increased in size. It should be mentioned, also, that the stipules of the leaves on the sprouts are correspondingly increased in size, are permanent and assimilative, not caducous, as the small stipules of normal leaves. Measurements of these stipules are also given:

III. Fresh Leaves of Liriodendron tulipifera (two terminal shoots counting from base to apex).

No. of Leaf.	Midrib.	First L. Vein.	Second L. Vein.	Third L. Vein.	First R. Vein.	Second R. Vein.	Third R. Vein.	Breadth Across Apex.	Breadth of Leaf.
1	.062	.083	.050		.081	.048		.078	.090
2	.090	.111	.068		.109	.065		.100	.116
3	.078	.099	.068		.101	.065		.090	.115
4	.084	.103	.067		.103	.068		.080	.111
5	.075	.092	.058		.089	.036		.067	.093
6	.081	.104	.056		.105	.060		.097	.113
Second Shoot.									
1	.080	.094	.075	.058	.098	.078	.062	.067	.136
2	.092	.108	.092	.072	.108	.088	.070	.071	.142
3	.094	.112	.092	.074	.115	.092	.073	.065	.140
4	.105	.121	.093		.138	.089		.073	.138
5	.087	.100	.079		.096	.075		.057	.105
6	.096	.108	.079		.112	.088		.068	.121
7	.082	.092	.073		.093	.073		.052	.098

IV. Normal Tree, Liriodendron tulipifera, Raven Rock, July 4, 1900 (open leaves counted from top).

	No. of Leaf.	Midrib.	First L.Vein.	Second L.Vein.	Third L.Vein.	First R.Vein.	Second R.Vein.	Third R.Vein.	Bre'dth Across Apex.	Bre'dth of Leaf.
Leaves from Terminal Shoot.	1	.135	.149	.120		.134	.141		.096	.164
	2	.165	.188	.147		.193	.153		.143	.221
	3	.156	.184	.142		.182	.131		.134	.226
	4	.147	.172	.126		.185	.146		.130	.213
	5	.156	.186	.157	.110	.179	.141	.102	.128	.236
	6	.133	.153	.105	.068	.156	.103	.069	.122	.182
	7	.080	.102	.083	.060	.093	.066	.044	.069	.132
Leaves from Lateral Sprout.	1	.068	.087	.075	.051	.088	.075	.051	.060	.115
	2	.076	.095	.076	.055	.090	.068	.046	.070	.127

V. Leaves of Liriodendron tulipifera Produced on Sprouts from the Stump (alcoholic material).

No. of Leaf.		Stipule.		Midrib.	First L.Vein.	Second L.Vein.	First R. Vein	Second R. Vein	Width Across Apex.	Width of Leaf.	Width of L'w'r Lobes.
		Length.	Breadth.	Length.	Length.	Length.	Length.	Length.			Meas. from Middle Vein.
Leaves on a Sprout Shoot	1	.031	.016	.035*	.039*	.028*					
	2	.028	.017	.097	.110		.114	.088	.052		.022
	3	.027	.018	.082	.108		.110		.085	.115	
	4	.040	.027	.370	.308	.213	.312	.253	.187	.432	.083
	5	.033	.034	.180	.198	.142	.212	.170	.121	.381	.056
Single Le'ves from Sprout.	A	.063	.044	.320	.362	.275	.355	.275	.203	.430	.108
	B			.276	.310	.227	.311	.245	.210	.432	.090
	C			.300	.337	.270	.338	.225	.218	.455	.100
	D			.343	.380	.300	.370	.282	.225	.435	.070
	E			.322	.342	.238	.364	.275	.206	.430	.074

* Unopened leaves.

Menispermum canadense (Moonseed).

The leaves of two entire plants of this species were taken, the leaves being numbered from the apex toward the base. In the first place, the table shows the limits of variability in the adult leaves of the same stem, and also contrasts the individual leaves of the two plants, leaf 5 or 6 of one plant being compared with leaf 5 or 6 of the other plant:

VI. Menispermum canadense (two plants in fresh state).

	No. of Leaf.	Mid-vein. Length.	First L.Vein. Length.	Second L.Vein. Length.	Third L.Vein. Length.	First R. Vein	Second R. Vein	Third R. Vein	Width of Leaf.	Petiole Attachment to Lower Edge.
I.	1	.012	.011			.010			.012	
	2	.021	.015			.014			.018	
	3	.020	.016	.009		.016	.010		.024	.004
	4	.029	.021	.013		.021	.013		.033	.003
	5	.040	.032	.019		.030	.019		.050	.005
	6	.052	.044	.029		.040	.026		.058	.004
	7	.062	.054	.039		.051	.032		.071	.008
	8	.079	.071	.056	.041	.073	.058	.044	.100	.009
	9	.043	.044	.034	.028	.041	.035	.026	.065	.004
II.	1	.008	.008			.008			.012	.030
	2	.018	.015			.014			.022	.002
	3	.033	.028	.020		.026	.018		.038	.005
	4	.053	.047	.037		.041	.032		.065	.008
	5	.067	.059	.050		.054	.045		.084	.007
	6	.067	.055	.047		.054	.047		.082	.007
	7	.060	.056	.051	.036	.054	.038	.038	.071	.008
	8	.057	.056	.036	.034	.048	.040	.032	.058	.005
	9	.049	.045	.034	.029	.045	.036	.028	.062	.003

Quercus alba (White Oak).

The size of the nuts enclosed by the cupule in the oak varies in an interesting manner. The fruits of two species of oak collected by Dr. J. T. Rothrock on October 19, 1863, were studied statistically. It is supposed that the fruits in drying preserved the same relative size that they had when in the fresh, fully ripe condition. The three swamp chestnut oaks from which the fruits were obtained were standing close together, and each was fully three feet in diameter. Table VIII presents the measurements of the swamp chestnut oak acorns, and Table VII those of the white oak:

VII. Quercus alba.

Large Fruits (Dry), Oct. 20, 1863.

No. of Acorn.	Length.	Breadth.
1	.026	.018
2	.025	.016
3	.023	.016
4	.021	.015

Small or Ordinary Fruits.

1	.020	.014
2	.019	.014
3	.017	.013
4	.018	.013
5	.018	.013
6	.020	.014

VIII. Quercus prinus var. palustris.

Small Fruited (Dry) October 19, 1863.

No. of Acorn.	Length.	Breadth.
1	.015	.013
2	.016	.013
3	.015	.014
4	.015	.014
5	.015	.013
6	.016	.014
7	.016	.014

Middle Sized Fruit.

1	.021	.017
2	.020	.017
3	.018	.016
4	.018	.016
5	.017	.015
6	.017	.016
7	.017	.015

Large Fruits.

1	.023	.019
2	.022	.021
3	.022	.020
4	.022	.020
5	.019	.018

Arisæma triphyllum (Indian Turnip).

Two plants were collected in the woods at Shawmont, Pa., growing under exactly similar conditions of soil and light exposure. The following measurements present in a statistical manner the variations which occur in the leaves and other parts of the two plants. The number of perfect fruits depended upon the success of the process of fertilization. The number of seeds in each berry varies from 1 to 4 in number:

IX. Arisæma triphyllum (two plants).

Number of Plant.	Corm.		Scape.	Petiole.	Leaf Sheath.	Fruits.	
	Width.	Height.	Length.	Length.	Length.	Perfect.	Abortive.
First Plant....	.030	.033	.335	.630	.260	55	10
2d Plant { A Leaf			.430	.665		86	
2d Plant { B Leaf				.645			

X. Arisæma triphyllum (leaves of two plants).

Number of Plant.	Mid-Leaflets.		1st Left Leaflet.		2d Left Lobe or Leaflet.		1st Right Lobe or Leaflet.		2d Right Lobe or Leaflet.	
	Length.	Breadth.	Length.	Breadth.	Length.	Breadth.	Length.	Breadth.	Length.	Breadth.
First Plant.........	.194	.155	.215	.145	.075 lobe	.030 lobe	.225	.146	.155	.094
Second Plant { A Leaf....	.178	.159	.220	.147	.152	.083	.218	.150	.157	.083
Second Plant { B Leaf....	.195	.127	.180	.123			.180	.116	.078	

Ampelopsis Veitchii (Japanese Ivy).

The measurements of the leaves of this plant are presented in Table X. The young plants have normally trifoliate leaves and unifoliate ones interspersed. The seedlings always have trifoliate leaves without any unifoliate ones. This points to the ancestor of both the Japanese species (*Ampelopsis Veitchii*) and the American species (*A. quinquefolia*) as one with three leaflets, the Japanese species later becoming unifoliate, the American species developing five leaflets, the seedlings of both plants being trifoliate.

X. Ampelopsis Veitchii. Measurements of Leaves (Fresh).

		Trilobed or Trifoliate Leaves.								Unifoliate Leaves.					
		Mid 1st Leaflet.		L. 2d Leaflet.		R. 3d Leaflet.		1st Sinus Depth.	2d Sinus Depth.	Midrib Length.	1st Left Vein.	2d Left Vein	1st Right Vein.	2d Right Vein.	Breadth.
	Number.	Length.	Breadth.	Length.	Breadth.	Length.	Breadth.	Left Side.	Right Side.						
1st Lateral Spur.	1	.037	.018	.032	.022	.026	.014								
	2	.023	.015	.025	.016	.024	.018	.023	.014						
	3	.023	.015	.017		.020	.013		.016						
	4	.016	.011	.020	.012	.015	.010								
2d Lateral Spur	1									.021	.017		.017		.026
	2	.035	.015	.026	.014										
	3	.034	.019	.028	.016										
3d Lateral Spur.	1									.023	.015		.016		.025
	2	.038	.021	.032	.018	.030	.018								
	3	.028	.015	.025	.014	.031	.019								
	4	.037	.027	.032	.022	.033	.020								
4th Lateral Spur	1									.040	.036	.018	.038	.020	.043
	2	.025	.017	.019	.015	.015	.011	.009	.008						
	3	.050	.030	.043	.015	.039	.020								

Ailanthus glandulosa (Tree of Heaven).

Some interesting facts were brought out in the study of the leaves of this species. Two kinds of leaves were met with, viz., transformed or evolved leaves and arrested ones. In order properly to understand the variations which have taken place, it is necessary to refer to the seedling condition as a starting-point. According to Lubbock,[9] the first leaves are compound, trifoliate, petiolate, exstipulate; terminal leaflets acuminate, subacute, entire; lateral ones slightly toothed, ultimately glabrescent, petiolate, light green, alternately pinnate-nerved ; petioles ribbed or striated, covered with short glandular hairs; the young leaves are also covered with fine silky hairs near their edges. The normal fully developed leaves are pinnate with an odd leaflet provided, as a rule, with from 5 to 9 pairs of lateral leaflets. The youngest leaves of the side or terminal branches are juvenile in form and of two kinds, viz., undeveloped or arrested juveniles and seedling juveniles. For example, on one branch the lowest leaf is broadly lanceolate with two small lobes with glandular apices on the upper entire margin; the lower side has a larger glandular tipped lobe and an acute sinus. This leaf is an arrested juvenile one, the primordium growing out into the terminal leaflet before the formation of the paired lateral ones. The second leaf of the same branch is pinnately trifoliate; the lateral paired leaflets asymmetric, cut away obliquely on the lower margin and rounded on the upper, while the terminal leaflet is broadly ovate, acuminate with a single basal, glandular-tipped lobe on the upper margin. The other leaves of this branch are pinnate with an odd leaflet provided with 5 to 6 pairs of lateral leaflets. The odd leaflet is lanceolate with two glandular teeth on the lower margin and one on the upper.

The second branch studied shows a somewhat similar condition of affairs; the earliest formed leaf is more deeply lobed at the base, each lobe with rather deep sinuses, the upper narrow sinus cutting in almost to the midrib. The terminal leaflets of the pinnate leaves are also narrowly lanceolate with glandular teeth at the base. One leaf, however, is abruptly pinnate by the non-development of the terminal odd leaflet.

Two divergent types of leaves may be said thus to exist on the same tree, one type of leaf being due to the arrestment of the

[9] 1892, Lubbock, *Seedlings*, I, p. 327.

terminal odd leaflet. Several steps in this suppression of the odd leaflet were gathered. One pinnate foliage leaf shows a very narrow somewhat unequally trilobed odd leaflet; another a still narrower almost linear, glandular-toothed terminal leaflet. A third one has a filiform odd leaflet; a fourth pinnate foliage leaf has a simple boss in place of the odd leaflet, this small protuberance seeming to persist as a rudiment in all of the leaves studied. This arrestment of the normal development is carried a step farther, the terminal paired lateral leaflets beginning to manifest a reduction in size, becoming in one leaf studied small, elliptical in outline with a retuse apex, all the other leaflets studied having an acuminate apex. The other line of variation starts with the lanceolate odd leaflet which becomes increasingly broader. Some have a rounded, retuse apex, others have an acuminate point. From simple glandular teeth at the base of the odd leaflet, these glandular teeth increase in size until they become glandular tipped lobes separated from each other by rather shallow, acute sinuses, this line of advanced development proceeding until the terminal leaflet reaches a broadly ovate, trilobed form, each lobe being narrowly acuminate. Finally, as if to approach a climax, one of these lobes becomes almost distinct at the base, but is still concrescent with the basal part of the leaflet and the upper side of its petiole. In another leaf gathered, as representing the climax, this lanceolate entire basal lobe is separated by the cutting in of the sinus to the midrib; the asymmetric upper portion also becomes deeply lobed by the formation of rounded depressions. The lateral intermediate leaflets of the pinnate leaves are all asymmetric with an oblique base, the obliquity inclining downward. A glandular tooth is usually found on the upper and lower margins; if three glands are present, two are found on the lower margin, one on the upper. If only one gland is present it is always on the rounded, oblique lower edge. Occasionally a basal, rounded, glandular-tipped lobe is found on the lower edge of the lateral pinnæ of a large foliage leaf. We cannot doubt that asymmetry of leaflets chiefly appears when their parts are unsymmetrically related to their environment.[10] We may say in general, with Herbert Spencer, that that side of the leaf is the smaller which is shaded, and

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[10] Herbert Spencer, *Principles of Biology*, II, p. 143.

that the obliquity of the leaf is occasioned by its fitting itself to utilize the space at its disposal.

Summary and Conclusion.

1. This study of the limits of variations in plants was undertaken as, in part, a contribution to the problem of species.

2. Moreover, this study was undertaken to provide statistical data which would throw light upon the difficulty, from an evolutionary standpoint, of small or initial variations.

3. Considerable variation in the size and shape of leaves is evident, and the amount of the variation was determined statistically; the weight and volume of fruits were calculated; the number of seeds was determined.

4. The quantitative amount of variation in the juvenile, arrested and transformed leaves of a number of plants was also determined and tabulated.

5. In *Liriodendron tulipifera*, *Sanguinaria canadensis*, and *Ailanthus glandulosa* it was ascertained that variation in the size and configuration of the leaves of these plants is in part due to the persistence of juvenile forms, to the arrested development of such leaves, to their evolution and transformation to higher forms. The amount of these differences was also tabulated.

6. In conclusion, it may be stated that these changes in most cases are due to two causes: the internal hereditary impulse determining, as in *Ailanthus glandulosa*, the asymmetry of the lateral paired leaflets, and the direct environmental influence fitting the leaf to utilize the space at its disposal, and thus enabling it to present the largest amount of leaf surface to light action. We have, therefore, in the tables an exact mathematical expression of the influence of the various operating factors which determine plant form.

May 7.

The President, Samuel G. Dixon, M.D., in the Chair.

Twenty-two persons present.

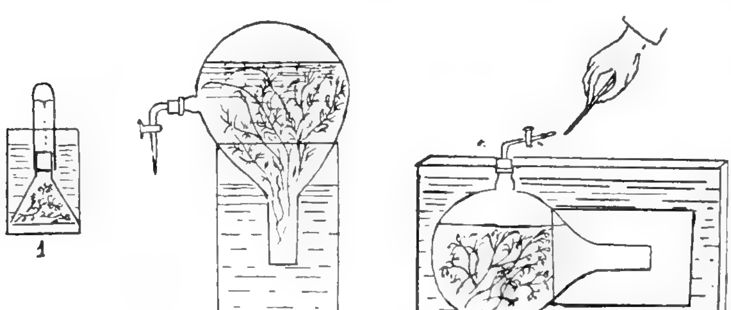
May 14.

The President, Samuel G. Dixon, M.D., in the Chair.

Fifteen persons present.

Demonstration that Plants give off Oxygen.—Dr. Ida A. Keller remarked that there is no process in plant life of greater importance than the evolution of oxygen in the synthetic preparation of starch by the chlorophyll in the presence of sunlight. In teaching such physiological phenomena it is important to demonstrate them in such a manner as to leave no doubt in the mind of the pupil. The method usually described (by Detmer and others) to illustrate this process is quite familiar to all students of botany. It is represented by figure 1.

A piece of *Elodea Canadensis* is placed in a jar containing water. A funnel is inverted over the plant and a test tube filled with water is inverted over the funnel. The water is charged with carbon dioxide and the apparatus is placed in the sunlight. Very soon bubbles of gas are disengaged and collected in the test tube. The gas may then be shown to be oxygen. On account of the limited capacity of the apparatus employed and the comparatively small extent of the assimilating surface, this method is not very useful for purposes of demonstration because of the small volume of gas liberated.



1 2 3

She had found the following extremely satisfactory:—A receiver holding two or three litres is employed and into this a considerable quantity of *Cabomba Caroliniana* or *Myriophyllum spicatum* is introduced (fig. 2). The water is thoroughly charged with carbon dioxide and the plants are then exposed to the sunlight. Little streams of gas are seen to pass upward from various points, and when sufficient gas has collected at the top of the flask, the latter is immersed in a tank of water in a horizontal position in such a manner that the gas is directly under the opening (fig. 3). On turning the stop-cock and applying a splinter of wood with a spark on the end of it the gas will be found to be oxygen.

When the supply of carbon dioxide in the water has been exhausted the plant will no longer give off bubbles of oxygen. The process may be again initiated by passing carbon dioxide into the receiver. Before testing it is best to allow the carbon dioxide to become exhausted, since in recharging the water it is impossible to avoid collecting some of this gas over the liquid and adulterating the oxygen. On standing it is gradually absorbed by the water and consumed by the plant. In any case the gas collected is not pure oxygen, but it is sufficiently rich in this substance to make an effective demonstration.

The deaths of D. Shepherd Holman, a member, May 13, and of Thomas C. Porter, a correspondent, April 27, were announced.

May 21.

Mr. Charles Morris in the Chair.

Seventeen persons present.

Papers under the following titles were presented for publication:

"Fishes from the Caroline Islands," by Henry W. Fowler.

"Types of Fishes," by Henry W. Fowler.

Structure of Diatoms.—Mr. Frank J. Keeley remarked that in studying the structure of diatom valves some years ago the method employed: mounting broken valves at right angles to the cover glass, proved efficient for most of the coarsely marked forms, but failed with certain species of *Aulacodiscus.*

Such forms as *A. Sollittianus*, *A. margarataceous*, etc., yielded satisfactory sectional views and proved not to differ materially in structure from *Coscinodiscus;* but another group, including *A. Oreganus*, *A. Rogersii*, *A. Janischii*, etc., proved too opaque for the elucidation of their structure by this method. Further examination of fragments in which the plates were separated indicated, however, that the typical "honeycomb" cellular structure was likewise present in these species, but masked by the unusual character of the external plate, which differs from that of other diatoms in having the finer secondary structure between, rather than over, the large cells of the middle plate.

Recently, with the view of further determining the relations of this structure to that of other species, a special mount was prepared, including *A. Oreganus*, *A. Rogersii*, with typical species of *Coscinodiscus*, *Triceratium*, *Actinocyclus*, *Actinoptychus*, etc. The various forms were arranged in a line on a square cover-glass, supported on the slide by bands of cement at two opposite edges, thus permitting fluids of varying refractive indices to be passed under the cover and withdrawn by the use of blotting paper in the manner familiarly known as "irrigation."

The fluids employed consisted of absolute alcohol, cedar oil, oil of cassia and mixtures of same, giving refractive indices from about 1.37 to over 1.60. Starting with the lowest refractive index, the appearance of each diatom was carefully noted under low, medium and high aperture objectives, and it was found that all the species represented, with the exception of the two *Aulacodiscii*, became fainter as the refractive index was increased up to about 1.435, when they were entirely invisible, except where in contact with the cover glass. As the index of the medium surrounding them was increased above this point they became more distinct, the coarser forms being almost opaque in oil of cassia. This is exactly what should have been expected, either on theoretical grounds or based on previously published experiments, but in the case of the two species of *Aulacodiscus* mentioned the distinctness of visibility under a low power seemed to increase from the start, and in the medium where other forms disappeared they were even more strongly outlined than in alcohol, while under an oil immersion-objective no difference could be noted in the sharpness and contrast with which the secondary structure was shown in any of the various fluids, although portions of the internal plates, which extended beyond the external plate in broken forms, were extinguished with the rest of the diatoms on the slide, showing that the anomalous behavior of these species was confined to the external plate, containing the secondary structure. Neither heating to redness on platinum foil nor boiling in strong acids has the least effect on the appearance of the secondary structure, nor is there anything to indicate that its appearance is due to difference in composition rather than of structure. With the facts at present available it would be useless to hazard a conjecture as to the true nature of this structure, but it may be safely affirmed that in the external plate of this group of species of *Aulacodiscus* we have a structure essentially different from that found among other diatoms.

Aulacodiscus Oreganus is one of the few diatoms that show bright colors with central transmitted light. The two valves of this species included on slide under observation, when examined with a three-fourths-inch objective of .25 N.A., were bronze-yellow when dry, yellowish gray in alcohol, bluish gray in medium of 1.41 R.I., iridescent blue in medium of 1.44 R.I., deep greenish blue in cedar oil, dark green and pink in oil of cassia.

The question of colors shown by diatoms in direct light has recently been treated in the *Journal of the Queckett Club*, with special reference to *Actinocyclus Ralfsii*, by E. M. Nelson, who has shown that the color cannot be due to diffraction. The two valves of *A. Ralfsii* which were included in the previously described slide showed only pale brown and grayish tints in media of R.I. below 1.50, and extinguished with the other forms in one of R.I. about 1.43. In cedar oil one valve showed a blue color and in oil of cassia both became brilliant with green, blue, purple and yellow. Under wide aperture objectives the color is not visible when diatom is sharply in focus, but appears as soon as thrown slightly out of focus. This color appears to be due to dispersion, and its nature and cause might possibly be further elucidated by studying the effect produced by different media such as were employed in this case.

May 28.

Mr. Arthur Erwin Brown, Vice-President, in the Chair.

Eighteen persons present.

Papers under the following titles were presented for publication:

"Contributions to the Life History of Plants, No. XV," by Thomas Meehan.

"Observations on the Placenta and Young of Dasypus sexcinctus," by Henry C. Chapman, M.D.

The death of Dr. D. B. McCartee, a correspondent, July 1, 1900, was announced.

Mr. Adolph Fredholm was elected a member.

The following were ordered to be printed:

FISHES FROM CAROLINE ISLAND.

BY HENRY W. FOWLER.

In the *Proceedings* of the Academy of Natural Sciences of Philadelphia for 1899, pp. 482 to 496, the writer has wrongly ascribed to the Caroline Islands a collection of fishes the Academy had lately received.

The error was due in part to the similarity of names and in part to confusion of labels.

The Caroline Islands, sometimes called New Philippines, comprise the greater part of Micronesia, and are entirely different and remote from the Caroline Island. Caroline or Thornton Island is a group of low coral islands on a single reef seven miles long and one mile wide, situated in Lat. 10° 0′ 01″ S., Long. 150° 14′ 30″ W.

Since the collection referred to came into the Academy's possession, others from the estate of Prof. E. D. Cope have been received. Among these were a few fishes from Caroline Island, none of which are recorded in the preceding paper. To Dr. H. A. Pilsbry, who has examined these later collections, I am indebted for more complete and precise data.

He states that the collections were made by Mr. C. D. Voy, who was an enthusiastic collector residing in California a number of years ago. He accumulated private collections, of which he disposed, using the proceeds to make an expedition across the Pacific to New Zealand. Upon this expedition he visited the Sandwich Islands and several of the islands of the south seas, among them Caroline Island, where all the fishes were collected. At least the Academy has not received any from other localities visited on this expedition. How Prof. Cope obtained the collection I do not know.

GALEIDÆ.

1. **Carcharhinus melanopterus** (Quoy and Gaimard).

Carcharias melanopterus Quoy and Gaimard, Voyage de l'Uranie, Zool., 1824, p. 194, Pl. 43, figs. 1 et 2.

No. 23,768. (Dried skin.)

Form of the body elongate. Head rather flattened or compressed and with a rounded obtuse snout. Eyes lateral. No spiracle. The origin of the D. is much nearer the origin of the P. than the origin of the V. The tip of the D. not reaching the origin of the V. when depressed. The origin of the posterior D. is slightly in advance of the origin of the A. Upper lobe of the caudal long. All of the fins with a black distal spot or edge. Above dark brownish, below whitish. Total length with caudal 47 cm.

HOLOCENTRIDÆ.

2. **Holocentrus microstomus** (Günther).

Holocentrum microstoma Günther, Cat. Fish. Brit. Mus., I, 1859, p. 34.

No. 23,769.

A single small specimen, appearing to agree in most particulars with the descriptions of the present species. The black D. spots upon the upper portion of the membranes between the first 4 spines distinct. There are also 4 blackish spots upon the upper surface of the head.

SCARIDÆ.

3. **Scarus** ?

There are a number of pharyngeal teeth in the collection which belong either to species of the present genus or *Pseudoscarus*.

TEUTHIDIDÆ.

4. **Teuthis triostegus** (Linnæus).

Chætodon triostegus Linnæus, Syst. Nat. Ed. X, 1758, p. 274.

Nos. 23,771 and 23,772.

5. **Teuthis** sp.?

No. 23,770.

A young specimen resembling species of *Acronurus* described by Günther, *Cat. Fish. Brit. Mus.*, III, 1861, p. 346.

The depth of the body is $1\frac{1}{2}$ in the length without caudal. Crests of the head serrated.

TETRAODONTIDÆ.

6. **Spheroides** sp.?

No. 23,773.

The skin is perfectly smooth above, and the inflated abdomen is beset with rather large and sparsely distributed prickles. The eye is contained about twice in the somewhat flat interorbital space. The origin of the D. in advance of the A. Above blackish, below lighter, and the caudal with a median black blotch. Sides of the body with a number of blackish spots about the size of the eye.

This example is in very bad condition.

CANTHIGASTERIDÆ.

7. **Canthigaster margaritatus** (Rüppel).

Tetraodon margaritatus Rüppel, Atlas zu der Reise im Nördl. Afrika, 1826, p. 66.

Nos. 23,774 and 23,775.

SCORPÆNIDÆ.

8. **Pterois radiata** Cuvier and Valenciennes.

Pterois radiata Cuvier and Valenciennes, Hist. Nat. Poiss., IV, 1829, p. 271.

Nos. 23,776 and 23,777.

BLENNIDÆ.

9. **Salarias periophthalmus** Cuvier and Valenciennes.

Salarias periophthalmus Cuvier and Valenciennes, Hist. Nat. Poiss., XI, 1836, p. 230, Pl. 328.

No. 23,778.

TYPES OF FISHES.

BY HENRY W. FOWLER.

The history of the Academy's collection of fishes, like that of others in possession of the Society, begins with contributions during the early days of its existence. These contributions were at first mainly small donations from members and others, the number gradually increasing by additions from special regions. In 1868 we find that owing to the then greatly increased size of this department of the museum, a joint report of a Committee on herpetology and ichthyology was printed. Exploration of different parts of America then furnished the Academy with many of the most valuable additions. Accessions were received from Dr. J. K. Townsend, Prince Charles Lucien Bonaparte, Drs. W. O. Ayres, W. S. W. Ruschenberger, Charles Hering, William A. Hammond, Charles C. Abbott, J. H. Slack, H. C. Wood, W. H. Jones, Messrs. Samuel Ashmead, P. Duchaillu, Samuel Powel, Rev. Alden Grout, Prof. William M. Gabb, the Smithsonian Institution, Prof. E. D. Cope, and the United States Fish Commission. Many other collections of greater or less size were also received, but as the writer wishes to call attention to only a few of the more important reference to them may be omitted. Most of these have been treated of fully or in part in the publications of the Academy or other American journals.

The collection of Prince C. L. Bonaparte was purchased and presented by Dr. Thomas B. Wilson, who was also a generous contributor to many other departments of the Academy. This collection, consisting for the most part of Italian fishes, contained all the species figured and described in the *Fauna Italica*, most of which are still well preserved. The greater part of this collection consisted of alcoholics, though there were 177 examples of dried skins.

Mr. Ashmead's collections were mostly local, like those of Dr. Abbott, who published a number of his observations. Dr. Ayres made collections principally in California, Dr. Hammond in Kansas and Mr. Powel in Rhode Island. In the West Indies Dr. Van Rijgersma collected at St. Martins, Dr. Griffith in St. Croix and Dr. H. C. Wood in New Providence. Dr. Hering collected fishes in Surinam and Dr. Ruschenberger at Rio Janeiro and various other localities. Many of the most valuable additions were presented by the Smithsonian Institution, among which are a series of typical examples, mostly Catostomidæ and Cyprinidæ. The explorations in the west and southwestern regions of the United States secured many novelties described by Dr. Charles Girard and Prof. S. F. Baird.

The most extensive and numerous contributions are due to the exertions of Prof. E. D. Cope. Collections from the Kanawha, Holston and Roanoke rivers included large series of species with many types. His entire alcoholic collection was bequeathed to the Academy, including many fresh-water fishes from the upper Amazons, made by Prof. James Orton and John Hauxwell.

The fishes obtained in the province of Rio Grande do Sul, Brazil, should be mentioned, as they are the basis of Cope's last important contribution to South American ichthyology. His other noteworthy collections are from Pennsylvania, North Carolina, Texas and Florida.

In the present paper it is intended only to treat of the Marsipobranchii, Selachii and Ganoidei, and it is believed that references to all the typical representatives of these groups that are preserved in the collections are included.

I have appended rather rough descriptions of the alimentary or enteric canal to most of the species fit for dissection, which are represented by duplicates.

To the authorities of the Academy I am much indebted for permission to make these dissections from duplicate specimens.

PETROMYZONIDÆ.

1. **Ichthyomyzon concolor** (Kirtland).

Ammocœtes concolor Kirtland, Bost. Journ. Nat. Hist., III, 1841, p. 473, Pl. XXVII, fig. 1.

No. 354. Type of *Ammocœtes æpytera* Abbott, *Proc. Acad. Nat. Sci. Phila.*, 1860, p. 327. Ohio river. Dr. Hildreth.

As I am unable to determine this larval specimen satisfactorily, I have followed Profs. Jordan and Evermann in provisionally referring it to the above species. It has about 56 muscular bands between the posterior gill-opening and the anus.

SCYLLIORHINIDÆ.

2. Pristiurus melastomus (Rafinesque).

Galeus Melastomus Rafinesque, Caratt. Anim. Sicil., 1810, p. 13.

Nos. 566 to 574. Types of *Scyllium melanostomum* Bonaparte, *Fauna Italica*, Pesci, Tomo III, vii, 1834, 89, Pl. 131, fig. 3 (two figures). Italy. Bonaparte Coll. (No. 253). Dr. T. B. Wilson.

Mouth.—Moderately large, somewhat spacious and compressed. The jaws alone are furnished with teeth. Tongue a little free in front, broad and flat, though somewhat rounded anteriorly. The inside of the mouth is lined with smooth integument altogether destitute of shagreen.

Pharynx.—Spacious, elongate and compressed. Upon the walls of the branchial arches are patches of fine shagreen, otherwise the rest of the integument lining this region is perfectly smooth. There are 5 gill-openings within the pharynx, which lead into as many gill-pouches, and finally communicate externally by as many gill-slits. Of the internal gill-openings, which are greater than those which are external, the anterior is the largest, and they all gradually diminish in length until the last, which is not more than $\frac{1}{3}$ the length of the first. The gill-pouches contain the gill-filaments, and they are separated from each other by means of inter-branchial septa. The gill-filaments are distributed in each gill-pouch, so as to appear continuous, except in the last, where they are only upon the anterior walls. They are of moderate number, compressed, and adnate, except distally, to the walls of the gill-pouches. There is a well-developed spiracle aperture within the pharynx, anterior and superior to the first gill-opening. It is furnished with pseudobranchiæ.

Œsophagus.—Short and somewhat constricted. The walls more or less plicate.

Stomach.—Spacious and bulky, and the walls greatly plicated, except in the pyloric region. The tissues of this division of the enteric canal are thicker than any other.

Intestine.—The duodenum is very short, existing as a simple tube greaty constricted, until the presence of the colon is indicated by the spiral valve. The diameter of the colon is much greater than any other division of the intestine, and posteriorly its boundaries are fixed by the terminus of the spiral valve, and the last division of the intestine is formed. This is the rectum. It is of more constricted dimensions than the colon, persisting as a short simple tube to the cloaca, into which its contents are conveyed by means of the rectal aperture. There is a rectal gland which is confluent with the rectum.

Liver.—Large and bulky, the left lobe greatly exceeding the right in dimensions.

Spleen.—Present in the usual position.

Pancreas.—Developed.

GALEIDÆ.

3. Galeus mustelus (Linnæus).

Squalus Mustelus Linnæus, Syst. Nat., Ed. X, 1758, p. 235.

Nos. 605 to 608. Types of *Mustelus equestris* Bonaparte, *Fauna Italica*, Pesci, Tomo III, vii, 1834, 43, Pl. 132, fig. 2. Italy. Bonaparte Coll. (No. 254). Dr. T. B. Wilson.

Mouth.—Moderately large, somewhat spacious and compressed. Sharp teeth upon the jaws. Tongue broad, flat and free in front. Inside of the mouth roughened more or less with fine shagreen.

Pharynx.—Spacious, elongate and compressed. The walls of the branchial arches are roughened and also the floor of the pharynx. Gill-openings 5 within the pharynx, which lead into as many gill-pouches, and finally communicate externally by as many gill-slits. The internal gill-openings, in fact the entire branchial system, resembles that of *Pristiurus melastomus* so far as observed. The spiracle aperture within the pharynx, anterior and superior to the first gill-opening.

Œsophagus.—Short and constricted, with the walls plicate.

Stomach.—Rather long, spacious and bulky. There are few plications upon the walls of the cardiac region. Pyloric region short.

Intestine.—Duodenum short. Colon large and very bulky, especially its median portion, and furnished with a spiral valve. The rectum short and simple, terminating in the cloaca. A rectal gland is developed which is confluent with the rectum.

Liver.—Exceedingly large, occupying the greater part of the abdominal cavity. Both lobes are equal.

4. Galeus mento (Cope).

Mustelus mento Cope, Proc. Amer. Philos. Soc., XVII, 1877, p. 47.

No. 21,104. Type of *Mustelus mento* Cope. Pacific Ocean at Pecasmayo, Peru. Coll. of Prof. James Orton, 1876–77. Prof. E. D. Cope.

Body elongate, slender, and tapering much after the first D., where the greatest depth is located. Head large, with a flattened snout which is pointed. The interorbital space is broad, broader than the snout. Eye of moderate size, lateral, and its anterior margin over the tip of the mandible. Posterior to the eye and very near its posterior edge is the spiracle which is furnished with small pseudobranchiæ. The nostrils are each furnished with a flap.

The snout anterior to the mouth is greater than the space between the external borders of the nostrils, and it is also greater than the width between the external corners of the mouth. The teeth are smooth, rounded and rhombic. Mouth furnished with a broad flattened tongue, and there are also two entire buccal flaps at the bases of the jaws. Gill-slits 5, about equal, and the last above the base of the P. Origin of the first D. about over the middle of the P. The fin itself is large, and its base is greater than its height. It has a posterior projection, the tip of which seems to me to be slightly in advance of the origin of the V. The origin of the second D. is much in advance of that of the A., and its posterior base is about over the last third of the base of the A. The base of the second D. is much greater than the height of the fin, and it is also furnished with a posterior projection which is attenuated. The middle of the first D. is about midway between the posterior root of P. and anterior root of the V. The P. very broad, and flattened. The space between the inner edges of the bases of the P. less than the width of the mouth. The V. broad and blunt, and without inner posterior projections. The A. is very small and with a sharp posterior projection. Caudal notched. Lateral line present, its course somewhat decurved posteriorly in the region of the second D.

The coloration is not entirely uniform as described by Prof. Cope. The general color of the body is a leaden-brown, somewhat darker dorsally. There are several bands of dark blackish-brown upon the upper anterior portion of the body. These are about 6 in number, and the two behind the eye, and over the anterior gill-slits, are the most distinct. Below light brownish, with a pale buff or ochraceous tinge.

5. Galeorhinus galeus (Linnæus).

Squalus Galeus Linnæus, Syst. Nat., Ed. X, 1758, p. 234.

Nos. 617 to 620. Types of *Galeus canis* Bonaparte, *Fauna Italica*, Pesci, Tomo III, viii, 1834, 43, Pl. 132, fig. 3. Italy. Bonaparte Coll. (No. 248). Dr. T. B. Wilson.

Mouth.—Moderate, spacious and compressed. Jaws furnished with more or less flattened teeth. The tongue is flat, free anteriorly, and of a slightly triangular shape with the front margin rounded obtusely. Patches of fine shagreen upon the roof of the mouth and the tongue.

Pharynx.—Of the usual spacious, elongate, and compressed pattern. Patches of fine shagreen upon the walls of the branchial arches. There are 5 gill-openings within the pharynx, leading in turn into as many gill-pouches, and communicating externally by as many gill-slits. The internal gill-openings are largest anteriorly, and gradually diminish until the last, which is the shortest. Each gill-pouch contains the usual complement of gill-filaments, the last pouch with only ½ the number of the others and adnate to the anterior walls. Spiracle developed within the pharynx anterior and superior to first gill-opening. No pseudobranchiæ.

Œsophagus.—Short, spacious and walls plicated.

Stomach.—Elongate and spacious, the walls sparingly plicate. Pyloric region moderate.

Intestine.—Duodenum short. Colon large and bulky, also furnished with a spiral valve. Rectum short and simple, and opening into a cloaca. Rectal gland present.

Liver.—Large, occupying the greater portion of the abdominal cavity. Both lobes about equal.

Spleen.—Present in proximity to the pyloric region.

Pancreas.—Present.

DALATIIDÆ.

6. Dalatias licha (Bonnaterre).

Squalus Licha Bonnaterre, Tabl. Encyclopéd., Ichth., 1788, p. 12.

Nos. 478 and 479. *Scymnorhinus* Bonaparte, *Cat. Meted. Pesc. Europ.*, 1846, p. 16 = *Dalatias* Rafinesque, *Caratt. Anim. Sicil.*, 1810, p. 10 = *Scymnus* Cuvier, *Règne Animal*, II, 1817, p. 130, which is preoccupied in Insects. Italy. Bonaparte Coll. (No. 240). Dr. T. B. Wilson.

RHINOBATIDÆ.

7. **Rhinobatis columnæ** (Bonaparte).

Rhinobatus columnæ Bonaparte, Fauna Italica, Pesci, Tomo III, xiv, xvii, 1835–36, 86, Pl. 152 (two figures).

Nos. 476 and 477. Types of *Rhinobatus columnæ* Bonaparte. Italy. Bonaparte Coll. (No. 228). Dr. T. B. Wilson.

There is also a dried specimen of this species, No. 16,920, Bonaparte Coll. (No. 73). Dr. T. B. Wilson.

8. **Platyrhinoides triseriatus** (Jordan and Gilbert).

Platyrhina triseriata Jordan and Gilbert, Proc. U. S. Nat. Mus., 1880, p. 36.

No. 528. Cotypical of *Platyrhina triseriata* Jordan and Gilbert. Santa Barbara, Cal. From the U. S. Fish Commission (No. 26, 893). This is one of the several specimens described by Profs. Jordan and Gilbert, and they have indicated an adult male, taken at Santa Barbara, Cal., February 8, 1880, by A. Larco, an Italian fisherman, as the type. This specimen is in the collection of the U. S. National Museum.

RAJIDÆ.

9. **Raja punctata** Risso.

Raja Punctata Risso, Ichth. Nice, 1810, p. 12.

Nos. 503 to 515. Types of *Dasybatis asterias* Bonaparte. *Fauna Italica*, Pesci, Tomo III, xxix, 1840, 154, Pl. 149, fig. 2. Italy. Bonaparte Coll. (No. 230). Dr. T. B. Wilson.

Mouth.—Broad or compressed. Teeth only upon the jaws. Tongue absent. Superior buccal flap bilobed and fringed. Inferior buccal flap entire. The inside of the mouth is smooth, and destitute of fine shagreen patches.

Pharynx.—Of the usual spacious, compressed and elongate pattern. The posterior portions of the roof and floor of the pharynx, together with the inner surfaces of the branchial arches, with patches of fine shagreen. Gill-openings 5, the median the longest, the second and fourth next in size, and the first and fifth the smallest and about equal. The gill-openings lead into as many gill-pouches, and finally communicate externally by as many gill-slits. All the gill-pouches, except the last, and that has only its anterior half, furnished with the usual continuous complement of gill-filaments. These gill-filaments are adnate to the inter-branchial septa for the greater part of their length, and are free only at their distal extremities. Spiracle aperture well developed within the pharynx, superior and anterior to the first gill-slit. It is furnished with pseudobranchiæ.

Œsophagus.—Short and constricted, the walls more or less plicate.

Stomach.—Moderate and rather bulky, the walls more or less smooth though furnished with a few convoluted plications, especially in the lower cardiac region. Pyloric region moderate.

Intestine.—Duodenum short. Colon large and bulky, furnished with a spiral valve. Rectum a short simple tube finally merging into the cloaca. Rectal gland developed and confluent with the rectum.

Liver.—Large and trilobed, though the median and left lobes are rightly two divisions of one and the same lobe. Gall-bladder developed.

Spleen.—Developed.

Pancreas.—Present.

10. Raja miraletus Linnæus.

Raja Miraletus Linnæus, Syst. Nat., Ed. X, 1758, p. 231.

Nos. 404 and 405. Types of *Raja quadrimaculata* Bonaparte, *Fauna Italica*, Pesci Tomo III, iii, 1833, 18, Pl. 146, fig. 2. Italy. Bonaparte Coll. (No 221). Dr. T. B. Wilson.

Mouth.—Broad, flat and compressed. Teeth only upon the jaws. No tongue. Superior buccal flap quadrilobate and fringed. Inferior buccal flap broadest medianly and also fringed. Inside of the mouth smooth and destitute of shagreen.

Pharynx.—Spacious, elongate and compressed. Patches of shagreen are distributed upon the inner surfaces of the branchial arches, the roof and the floor of the pharynx. The gill-openings within the pharynx are 5, the median the longest, the second and fourth next in size, and the first and fifth the smallest, and equal. The gill-openings communicate next with as many gill-pouches and finally open externally by as many gill-slits. There is a continuous complement of gill-filaments within each gill-pouch, except the last, and that is furnished only upon the anterior half. The gill-filaments are adnate to the inter-branchial septa for their greater portion, only free proximally. The spiracle aperture is anterior and superior to the first gill-opening, and it is furnished with small pseudobranchiæ.

Œsophagus.—Short and constricted, with wrinkled walls.

Stomach.—Sac-like, moderately bulky, and the walls somewhat plicate, especially in the lower cardiac region.

Intestine.—Short duodenum which is simple. Colon spacious and with a spiral valve. The rectum a short simple tube merging finally into a cloaca. A rectal gland is developed which is confluent with the rectum.

Liver.—Large and trilobed. The median and left lobes are properly two divisions of the left lobe. Gall-bladder well developed.

Spleen.—Rather large.

Pancreas.—Present.

This species preys upon small fishes, as remains of small Teleosts, one three inches or more in length were taken from the gullet.

11. Raja radula De la Roche.

Raja radula De la Roche, Ann. Mus. Hist. Nat., Paris, XIII, 1809, p. 321.

No. 389. *Batis* Bonaparte, *Cat. Meted. Pesc. Europ.*, 1846, p. 12. Italy. Bonaparte Coll. (No. 233). Dr. T. B. Wilson.

12. Raja circularis (Couch).

Raia Circularis Couch, Cornish Fauna, Part I, 1838, p. 53; preliminary description in Loudon's Magazine of Natural History, Charlesworth, New Series, Vol. II, 1838, p. 71 (with fig.).

No. 406. Type of *Raja falsavela* Bonaparte, *Fauna Italica*, Pesci, Tomo III, xxvi, 1839, 136, Pl. 148, fig. I. Italy. Bonaparte Coll. (No. 221). Dr. T. B. Wilson.

This specimen is almost dissolved and I identify it only from the original label which is certainly referable to this species.

13. Raja oxyrinchus Linnæus.

Raia Oxyrinchus Linnæus, Syst. Nat., Ed. X, 1758, p. 231.

Nos. 523 to 527. *Laeviraja* Bonaparte, *Fauna Italica*, Pesci, Tomo III, xxv, 1839, 130, Pl. 151, fig. 2. Italy. Bonaparte Coll. (No. 226). Dr. T. B. Wilson.

14. **Raja stellulata** (Jordan and Gilbert).

Raia stellulata Jordan and Gilbert, Proc. U. S. Nat. Mus., 1880, p. 133.

No. 414. Typical of *Raia stellulata* Jordan and Gilbert. Monterey. From the U. S. Fish Comm. (No. 26,975).

This species was described from eight examples, of which this is one, and were at that time said to have been in the U. S. Nat. Mus.

15. **Psammobatis brevicaudatus** Cope.

Psammobatis brevicaudatus Cope, Proc. Amer. Philos. Soc., XVII. 1877, p. 48.

No. 21,261. Type of *Psammobatis brevicaudatus* Cope. Bay of Pecasmayo, Peru. Coll. of Prof. James Orton. Prof. E. D. Cope.

NARCOBATIDÆ.

16. **Tetronarce nobiliana** (Bonaparte).

Torpedo nobiliana Bonaparte, Fauna Italica, Pesci, Tomo III, xii. 1835, 63, Pl. 154 (two figures).

Nos. 426 to 440, 461 to 470, and 16,948. Types of *Torpedo nobiliana* Bonaparte. Italy. Bonaparte Coll. (Nos. 234 and 15). Dr. T. B. Wilson.

In these specimens the first D. is inserted almost over the posterior edge of the V.

Mouth.—Moderate, though not particularly spacious. Teeth only upon the jaws. Tongue absent. Buccal flaps both entire, of rather even width, and not papillose or fringed. Inside of the mouth smooth and entirely destitute of shagreen.

Pharynx.—Elongate and spacious and with apparently smooth integument, except upon the inner surfaces of the branchial arches which are asperous with fine shagreen. Gill-openings 5, the median the largest, the second and fourth next in size, and the first and fifth the smallest, and about equal. The gill-openings open into 5 gill-pouches, which also communicate externally by 5 gill-slits. The gill-pouches are separated from each other by the inter-branchial septa, and each one contains a continuous complement of gill-filaments, except the last, which has only its anterior half furnished. The gill-filaments are joined for most of their length to the walls of the inter-branchial septa, though their distal extremity is free for a short distance. Spiracle aperture anterior and superior to the first gill-opening from which it is separated by a considerable space. It is furnished with small pseudobranchiæ, though in moderate number.

Œsophagus.—Constricted and somewhat short, the walls much plicated.

Stomach.—Moderate and bulky, and the walls strongly plicated.

Intestine.—Duodenum the usual short simple tube merging into the short and very bulky colon which is furnished with a spiral valve. The rectum is a short simple tube, finally terminating in the cloaca. A rectal gland is developed and confluent with the rectum.

Liver.—Large and bilobed, and with the left lobe the largest. It is furnished with a gall-bladder.

Spleen.—Present.

Pancreas.—Present.

DASYATIDÆ.

17. Dasyatis brucco (Bonaparte).

Trygon brucco Bonaparte, Fauna Italica, Pesci, Tomo III, *VI*, 1834, 34, Pl. 151 (two figures).

Nos. 378 and 379. Types of *Trygon brucco* Bonaparte. Italy. Bonaparte Coll. (No. 218). Dr. T. B. Wilson.

Mouth.—Moderate and broadly compressed. Teeth only upon the jaws. Tongue absent. Superior buccal flap of almost uniform width and with a fringed edge. Inferior buccal flap entire, except 5 or so filaments which are distributed at nearly equal distances. Integument of the inside of the mouth smooth and without any shagreen.

Pharynx.—Broad and compressed, and without any shagreen patches, even upon the inner surfaces of the branchial arches. Gill-openings 5, the median the largest, the second and fourth next in size, and the first and fifth the smallest. They open into as many gill-pouches and externally by as many gill-slits. Gill-filaments in the usual continuous series in each gill-pouch, except in the last, where they are only upon the anterior portion. They are flattened or compressed, and adnate to the inter-branchial septa, except distally for a very short portion, which is free. Aperture of the spiracle superior and anterior to the first gill-opening. No pseudobranchiæ appear to exist.

Œsophagus.—Short and constricted with plicate walls.

Stomach.—Moderate and not very bulky, though it may be very distensible. Its walls are plicate. Pyloric region moderate.

Intestine.—Duodenum a simple tube of short length. Colon bulky and furnished with a spiral valve. Rectum a short simple tube, merging into the cloaca. Rectal gland present.

Liver.—Exceedingly large, consisting of two lobes, of which the left is the largest. A gall-bladder is present.

Spleen.—Large.

Pancreas.—Present.

This species preys upon small Teleosteans, as a number of scales and other remains were taken from the pharynx of the example described.

18. Dasyatis violacea (Bonaparte).

Trygon violacea Bonaparte, Fauna Italica, Pesci, Tomo III, *I*, 1832, 6, Pl. 155 (two figures).

Nos. 385 and 386. Types of *Trygon violacea* Bonaparte. Italy. Bonaparte Coll. (No. 220). Dr. T. B. Wilson.

Mouth.—Moderate and broadly compressed. Teeth only upon the jaws. Tongue absent.

Pharynx.—Broad and compressed. Gill-openings 5 and like the preceding. In fact, the pharynx in general is much like the preceding.

Œsophagus.—Short and constricted.

Stomach.—Rather large and bulky, more so in the lower cardiac region. Pyloric region developed.

Intestine.—Duodenum short. Colon very large and bulky, and furnished with a spiral valve. Rectum short and simple, emptying its contents into the cloaca to which it is joined. Rectal gland confluent with the rectum.

Liver.—Large and bilobed, the left lobe the largest. Gall-bladder present.

Spleen.—Present.

Pancreas.—Present.

ACIPENSERIDÆ.

19. Acipenser naccarii Bonaparte.

Acipenser naccarii Bonaparte, Fauna Italica, Pesci, Tomo III, *XVI*, *XVII*, 1836, 87, Pl. 129, fig. 2.

Nos. 624 and 625. Types of *Acipenser naccarii* Bonaparte. Mediterranean. Bonaparte Coll. (No. 2). Dr. T. B. Wilson.

Mouth.—Moderately large and capacious. No asperities whatever upon the walls and teeth absent. No buccal flaps. A broad tongue, bluntly rounded and hardly free in front.

Pharynx.—Rather large, long and compressed, and also destitute of asperities. The apertures of spiracles are placed superior and anterior to the first gill-opening. The gill-openings are 5 in number, the first the largest and the others gradually decreasing in size until the last, which is the smallest or shortest. They all communicate with the branchial chamber, forming 4 separate or free branchial arches and one adnate to the posterior part of the pharynx. The four free branchial arches are furnished with the usual complement of gill-filaments, distributed along their outer edges. No gill-filaments upon the last branchial arch. Upon the inner anterior and posterior edges of the branchial arches are short, fleshy, filamentous gill rakers. They are not very numerous, not $\frac{1}{3}$ the length of the longest gill-filaments, and longest medianly. The branchial arches themselves seem rather broad.

Œsophagus.—The enteric canal is now somewhat constricted, persisting posteriorly until under the posterior portion of the air-bladder, when it turns and is produced anteriorly until posterior to the pericardial cavity. Here it forms a somewhat exaggerated condition known as the stomach.

The œsophagus is connected by a large tube, though short, with the air-bladder. This is placed a short distance from the pharynx and upon the first or upper division of the œsophagus.

Stomach.—Rather small and apparently not very capacious or distensible. The walls are considerably thickened, the tissue being muscular. After this the pyloric region is marked by a large, compressed and rounded sac, which is nearly as large as the stomach itself.

Intestine.—The duodenum persists first posteriorly, then runs forward a short distance, after which the colon is formed. Its walls are porous and not muscular.

The colon is furnished with a spiral valve and no rectal gland is present. The rectum is well developed.

Liver.—Large, anterior and superior, and bilobed.

Ryder[1] says under *Acipenser brevirostris* Le Sueur: "How much more extensive than the Delaware River its range may be I

[1] *Bull. U. S, Fish Comm.*, VIII, 1888, p. 236.

have no means of knowing, as I have found only one specimen, besides the five obtained by myself at Delaware City, which can be regarded as an authentic example of the species. This single specimen is in the museum of the Academy of Natural Sciences of Philadelphia, and consists of a dried and stuffed varnished skin marked in white paint ' 84.' It agrees in every essential external particular with my own alcoholic specimens, but no record of its history is accessible amongst the catalogues of the collections of that institution ; all traces of the old manuscript catalogues of the Bonaparte and the other old collections of fishes belonging to the Academy's museum having been lost. I have, however, the strongest suspicion that this specimen, which is evidently very old, judging from its present condition, may be one of the originals of Le Sueur's description published in the *Transactions* of the American Philosophical Society for 1818, though it does not correspond in minor details. That it may possibly be one of the types of the species seems to me not at all improbable, from the fact that Le Sueur was also one of the early members of the Academy and may have presented the specimen."

I have not been able to find this specimen, and so far as I know the only specimen from Le Sueur's collection at present in the Academy is his *Cyprinus maxillingua.* Many of the typical specimens he described were in the old Philadelphia Museum, and after its dissolution they may have been destroyed in the conflagration of P. T. Barnum, who purchased part of the natural history material. For a short account of Peale's Museum see Stone, *Auk,* XVI, 1899, pp. 167 to 169.

LEPISOSTEIDÆ,

20. Lepisosteus osseus (Linnæus).

Esox osseus Linnæus, Syst. Nat., Ed. X, 1758, p. 313.

No. 16,971. Type of *Lepidosteus crassus* Cope, *Proc. Acad. Nat. Sci. Phila.*, 1865, p. 86. (Dried skin.)

Cope says: " The type specimen was probably taken in brackish water at Bombay Hook, near the mouth of the Delaware river." In the *Proc. Acad. Nat. Sci. Phila.*, 1859, a *Lepisosteus,* most likely this specimen, is entered among the donations to the museum on the 8th of March as " Gar Fish. *Lepidosteus bison?* Caught in the Delaware river at Bombay Hook. Presented by Mr.

Andrew Vanderslice." No. 14,405 is a specimen belonging to the present species which was secured in the Delaware Bay many years ago. It is labeled as having been obtained from Mr. Holbrook.

No. 16,968. Type of *Lepidosteus otarius* Cope, *Proc. Acad. Nat. Sci. Phila.*, 1865, p. 86. (Dried skin.)

This specimen was one of a collection of fishes said by Prof. Cope,[2] to have been "brought from the Platte river, near Fort Riley, by Dr. William A. Hammond." It is very evident, as Profs. Jordan and Evermann have observed, "Fort Riley was on the Kansas river."

21. Lepisosteus platostomus Rafinesque.

Lepisosteus platostomus Rafinesque, Ichth. Oh., 1820, p. 72.

No. 16,958. Type of *Cylindrostreus productus* Cope, *Proc. Acad. Nat. Sci. Phila.*, 1865, p. 86. San Antonio, Tex. (Dried skin.) Dr. A. L. Heermann.

EXPLANATION TO PLATES XII, XIII, XIV, XV.

PLATE XII, fig. 1.—*Acipenser naccarii* Bonaparte.
Fig. 2.—*Pristiurus melastomus* (Rafinesque).
PLATE XIII, fig. 3.—*Galeus mustelus* (Linnæus).
Fig. 4.—*Galeorhinus galeus* (Linnæus).
PLATE XIV, fig. 5.—*Raja punctata* Risso.
Fig. 6.—*Dasyatis violacea* (Bonaparte).
Fig. 7.—*Raja miraletus* Linnæus.
PLATE XV, fig. 8.—*Tetronarce nobiliana* (Bonaparte).
Fig. 9.—*Dasyatis brucco* (Bonaparte).
The letters referring to the different parts of the viscera are the same in all the figures: *a.* left lobe of liver; *b.* right lobe of liver; *c.* stomach; *d.* pyloric region; *e.* spleen; *f.* small intestine; *g.* colon; *h.* rectal gland; *i.* rectum; *k.* median lobe of liver; *l.* air bladder; *m.* œsophagus.

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[2] *Proc. Acad. Nat. Sci. Phila.*, 1865, p. 85.

JUNE 4.

MR. CHARLES MORRIS in the Chair.

Fourteen persons present.

A paper entitled "New Japanese Marine and Fresh-water Mollusca," by Henry A. Pilsbry, was presented for publication.

Occurrence of Hyla andersonii at Clementon, N. J.—MR. WITMER STONE exhibited a specimen of *Hyla andersonii* obtained at Clementon, N. J., May 12, 1901, by Mr. Henry L. Viereck, and presented by him to the Academy.

The species was heretofore known only from five examples—the type secured at Anderson, S. C.; one obtained by Dr. Joseph Leidy, at Jackson, N. J., July 1860; one from May's Landing, N. J., J. E. Peters, June 1, 1888, and two from Pleasant Mills, June 17, 1889, Dr. J. Percy Moore.

Mr. Stone stated that, though probably of restricted distribution, the species would no doubt prove more abundant if specially sought for, the comparative remoteness of the New Jersey barrens, where most of the specimens were found, and the retiring habits of the animal both tending to make its detection difficult.

A few months since he had heard some tree frogs in a swamp near Medford, N. J., whose call was different from that of any other species with which he was acquainted, and he was inclined to attribute it to the present form; diligent search, however, failed to discover the animals.

JUNE 11.

MR. ARTHUR ERWIN BROWN, Vice-President, in the Chair.

Fifteen persons present.

Papers under the following titles were presented for publication:

"Zygeupolia litoralis, a New Heteronemertean," by Caroline Burling Thompson.

"New Mollusca from Japan and the Loo Choo Islands," by Henry A. Pilsbry.

"A Peculiar Condition of Œdogonium," by Ida A. Keller.

"Crystalline and Crystalloidal Substances and their Relation to Plant Structure," by Henry Kraemer.

JUNE 18.

Mr. ARTHUR ERWIN BROWN, Vice-President, in the Chair.

Ten persons present.

Papers under the following titles were presented for publication:

"The Acrididæ, Tettigonidæ and Gryllidæ Collected by Dr. A. Donaldson Smith in Northeast Africa," by James A. G. Rehn.

JUNE 25.

Mr. ARTHUR ERWIN BROWN, Vice-President, in the Chair.

Nine persons present.

A paper entitled "The Nasal Passages of the Florida Alligator," by A. M. Reese, was presented for publication.

Henry Kraemer was elected a member.

The following were ordered to be printed:

NEW LAND MOLLUSCA FROM JAPAN AND THE LOO CHOO ISLANDS.

BY HENRY A. PILSBRY.

The collectors sent out by Mr. Hirase in the early months of this year have already transmitted much new and valuable material, in the study of which it is my privilege to assist. As Mr. Hirase desires to supply such species as have been collected in copious quantity to his correspondents in America and Europe, the prompt publication of full descriptions of the novelties is necessary to avoid the inconvenience attending the publicity of manuscript names. The full report, with figures of the new forms, may best be deferred until the results of the season's collecting can be presented in connected form. Most of the following species are from Kunchan, the northern and least setled province of the island Okinawa, or Great Luchu (Loo Choo), and from Oshima, hitherto unexplored for land mollusks.

Trochomorpha horiomphala (Pfr.).

Specimens have been sent by Mr. Hirase (No. 631) from Kunchan, the northern province of Okinawa. They are more depressed than Pfeiffer's type, but there is considerable variation in the species in this respect. *Trochomorpha Fritzei* Bttg. is a synonym. No definite locality has been known hitherto for Pfeiffer's species, which, moreover, has been lost, so to speak, in the group *Plectotropis.* It was doubtless this error of classification which led Boettger to redescribe the shell as *T. Fritzei.*

Trochomorpha Gouldiana n. sp.

Shell low-conic above, convex beneath, umbilicate, the umbilicus one-fourth the diameter of the shell, broadly open to the apex; of a dark reddish brown color, glossy; delicately striate, the striæ cut into minute granules by finer, very shallow spiral striæ, both above and below. Spire straightly conic, the apex slightly obtuse. Whorls $6\frac{1}{2}$, slowly widening, slightly convex below, and slightly concave above each suture; the last whorl acutely carinate, concave above and below the keel; base convex in the middle, the margin of the umbilicus abrupt but not keeled. Aperture small, rhombic, the peristome simple, obtuse and whitish in fully adult specimens. Alt. 5.3, diam. 12.7 mm

Oshima (Mr. Y. Hirase, No. 650).

This species differs widely from *T. cathcartæ* (Rve.) and *T. horiomphala* (Pfr.), the two species known from the Loo Choo group, in its higher spire and less spreading form. It is closely related to *T. Shermani* (Pfr.) of Formosa, but differs in being smaller, with straightly conic spire, the whorls concave above keel and suture, and the aperture narrower, less rounded below.

It is named in honor of Dr. A. A. Gould, who described the Japanese shells collected by the Ringgold and Rogers Expedition. I find two specimens in the collection of the Academy, labeled "*H. horiomphala* Pfr. Oosima."

Macrochlamys perfragilis n. sp.

Shell perforate, depressed, excessively thin, transparent, pale yellow, fragile. Surface brilliantly glossy, with faint growth-lines and almost obsolete, scarcely perceptible spiral striæ. Spire low-conic. Whorls 4½, somewhat convex, rather slowly widening, separated by a narrowly margined suture, the last whorl much wider, rounded at the periphery, rather convex beneath, narrowly impressed around the perforation. Aperture very broadly lunate, somewhat oblique, the lip fragile, columellar margin with a short, triangular reflection partially concealing the perforation.

Alt. 10, greater diam. 18, lesser 15 mm.

Alt. 8½, greater diam. 16, lesser 14½ mm.

Kunchan, Okinawa (Mr. Y. Hirase, No. 637).

A capacious, very fragile species, somewhat like *M. Stearnsi* Pils. of China, and quite different from anything yet described from Japan or the Loo Choo group.

Macrochlamys Gudei n. sp.

Shell minutely perforate, depressed-conoidal, thin, somewhat translucent, corneous-brown. Surface glossy, sculptured with weak growth-wrinkles, and on the base some coarse but shallow and inconspicuous spiral sulci, obsolete in places. Spire conic; whorls 6¾, rather strongly convex, slowly widening, the last wider, subangular at the periphery, the angle obvious in front, but disappearing near the aperture. Base convex, sunken around the perforation. Aperture lunate, the lip simple and thin, columellar margin hardly thickened, dilated above, a triangular reflection partially covering the perforation.

Alt. 7, diam. 10 mm.

Kunchan, Okinawa (Mr. Y. Hirase, No. 635).

This species has about the size, form and appearance of the American *Gastrodonta ligera* (Say), though the whorls are more convex and less striate above, and there is, of course, no callus lining the basal part of the interior. The generic position assigned is somewhat doubtful.

It is named in honor of my friend G. K. Gude, who has produced several meritorious papers upon Japanese land snails.

Kaliella borealis n. sp.

Shell minutely perforate, pyramidal with slightly convex lateral outlines and flattened base, thin, corneous-brown. Surface somewhat shining, sculptured above with regularly spaced, very delicate whitish hair-like striæ, the base showing fine spiral striæ, and except near the periphery, minutely but rather roughly pitted. Whorls 7, nearly flat, the suture but slightly impressed, narrowly margined; the last whorl acutely carinate. Aperture rhombic, the peristome thin and fragile, columellar margin abruptly dilated and reflexed partly over the perforation.

Alt. 3¾, diam. 3¼ mm.

Kayabe, Ojima, Hokkaido Island (Mr. Y. Hirase, No. 641).

A rather straightly pyramidal species, distinct from any of the numerous species known to me from Hondo.

Eulota (Euhadra) oshimæ n. sp.

Shell globose-subdepressed, umbilicate, rather thin but solid, of a rich reddish chestnut color, darker within the umbilicus and on the back of the lip, and with a very dark chestnut, almost black band just above the periphery, bordered above and below with greenish-yellow bands; the convexity of the base sometimes fading to the same pale tint. Surface rather glossy, but in part dull, sculptured with slight growth-striæ only; several inner whorls, after the apical one, minutely wrinkled and marked with points in oblique lines. Spire conic, more or less elevated. Whorls varying from 6¾ in large to 5¾ in small specimens, quite convex, slowly widening, the last rounded at the periphery, very slightly and slowly descending in front, convex beneath. Aperture broadly lunate, slightly oblique, bluish and showing the band inside; peristome expanded and rather narrowly reflexed, thickened within, purple, with the extreme edge pale ; columellar margin broadly dilated, very dark, half covering the umbilicus.

Alt. 35, diam. 43 mm.

Alt. 29, diam. 37 mm.

Alt. 26, diam. 33 mm.

Alt. 25, diam. 32 mm.

Alt. 20½, diam. 27 mm.

Alt. 19½, diam. 26 mm.

Oshima, (Mr. Y. Hirase, No. 357).

This magnificent species is related to both *E. caliginosa*[1] and *E. mercatoria*,[2] but is more globose than either, with more convex whorls. It differs conspicuously from *E. caliginosa* in having the base of the shell and aperture rounded, not conspicuously flattened, as they are in *caliginosa*. The basal lip, moreover, is not sinuous. *E. oshimæ* resembles *E. mercatoria* in the form of the aperture, but differs in being more globose, with a larger umbilicus in shells of the same size, and the whorls are more convex.

The variation in size, as shown by the above measurements, is extraordinary, but there seems to be a complete series of intermediate specimens. The smaller shells are those most resembling *E. mercatoria*. *E. oshimæ* is thus related to species of Okinawa, and not to the *luchuana* group of Japan proper.

Chlorites eucharistus n. sp.

Shell umbilicate, thin, concave above, of a rich, dark chestnut color. Densely hairy, the hairs long, regularly arranged in diagonal lines descending forwardly and backward, the surface between them minutely papillose. Whorls 4½, the earlier ones forming a rather deeply sunken spire, the last third of the last whorl deeply descending to the periphery, the whorl preceding this coiled in a plane. The first whorl is glossy and smooth; the last whorl widens toward the aperture, and is obscurely gibbous and then contracted behind the lip; the base convex, having a small excavation behind the basal lip, producing a low prominence just within the basal margin of the aperture. Aperture very oblique,

[1] *Catal. Marine Moll. Japan*, Pl. 10, figs. 1–3, 6.

[2] *Ibid.*, fig. 5.

very broadly lunate; peristome rather narrowly reflexed, purple, the margins somewhat approaching, connected across the parietal wall by a slender, raised cord.

Alt. 9, greater diam. 19, lesser 15½ mm.

Alt. 9½, greater diam. 18, lesser 15 mm.

Alt. 7½, greater diam. 15, lesser 12 mm. (small form).

Oshima, (Mr. Y. Hirase, No. 354).

This fine species has the sunken spire of the typical forms of the genus from the Moluccas, etc. It is a larger and much finer species than the two hitherto described from Japan, *C. oscitans* (Martens) and *C. fragilis* Gude, neither of which has the well-developed peristome of *C. eucharistus.* Three of the specimens sent are of about the same size, but another is conspicuously smaller, with the spire perceptibly more sunken, and the low " tooth " within the basal margin of the peristome is subobsolete.

Succinea Hirasei n. sp.

A species grouping with *S. pfeifferi* of Europe and *S. retusa* of America. Elongate, fragile, reddish or corneous, amber-colored, composed of 2½ very rapidly enlarging whorls, the last one very large, roughened by rather coarse growth-wrinkles. Aperture long-ovate, somewhat effuse below, the margins regularly arcuate.

Length 16, diam. 9, longest axis of aperture 13, width 6½ mm.

Tsuchiura, Hitachi, in eastern Hondo (Mr. Y. Hirase, No. 642).

Both of the Succineas previously known from Japan, *S. lauta* Gld. and *S. horticola* Reinh., belong to the group of species having very convex whorls, like *S. putris* or *S. obliqua.* This new one goes with the lengthened species, and is very like *S. retusa* Lea (*ovalis* Gld.), but the Japanese form is rather less effuse than the American.

Cyclophorus Hirasei n. sp.

Shell narrowly umbilicate, turbinate, with elevated spire, solid; greenish yellow, with a rather wide black belt just below the periphery, which is marked with a pale belt, and several dark lines and bands beneath, more or less interrupted at short intervals; the upper surface marked with numerous dark bands, interrupted obliquely or in zigzag fashion; the bands retaining their distinctness or more or less confluent into zigzag stripes. Whorls 5½ to nearly 6, very convex, the last flattened below the suture, elsewhere well rounded. Aperture circular, somewhat oblique, bluish and showing the bands inside; peristome rather narrowly reflexed, its face rounded, faintly red-tinted or bright red, continued in a callus across the very short parietal wall; the columellar margin overhanging and partially concealing the small umbilicus.

Alt. 30, diam. 32 mm.; antero-posterior diameter of aperture 21, width 19½ mm.

Alt. 29, diam. 31 mm.; antero-posterior diameter of aperture 20½, width 19 mm.

Operculum circular, multispiral, concave externally; diam. 15½ mm.

Oshima, (Mr. Y. Hirase, No. 644).

Related to *C. jourdyi* Morl., *fulguratus* Pfr., *courbeti* Anc., and their allies, species of Tonquin and Burma. It is remarkable for its elevated spire and brilliant peristome.

Pupinella oshimæ n. sp.

Shell pupiform, dark purplish brown under a papery whitish outer color, apparently the result of weathering, densely and finely striate when unworn. Whorls 6, slightly convex, the first four forming a conic spire, the penultimate and last whorls of about equal diameter; last whorl somewhat produced forward below. Aperture vertical, the opening small and circular; peristome broadly reflexed, white or nearly so, very heavily thickened on the face, produced forward in a flange around the opening, interrupted by minute channels at the base of the columella and posterior end of the lip, these channels expanding funnel-like outwardly; parietal callus very strong at its right end, emitting a branch which rises high above the termination of the outer lip.

Length 10, diam. 4.8 mm.; diam. of aperture, inside of peristome, 2.2 mm.

Oshima (Mr. Y. Hirase, No. 645).

This species differs strongly from *P. rufa* Sowb. and its slightly differentiated local forms *fruhstorferi* and *tsushimana*, in the relatively enormous development of the peristome, reducing the opening of the aperture; in the vertical, not oblique plane of the aperture, and especially in having the tongue of the parietal callus defining the posterior canal, very much longer, rising high above the termination of the outer lip. The latter is abruptly truncated on a level with the suture, not produced upward, as in the other species mentioned. The upper foramen of the lip shows from in front as a slit, not an orifice, as in *P. rufa.*

P. fruhstorferi and *tsushimana*, from Iki Island and Tsushima respectively, are hardly distinguishable from *rufa.* With a series of *P. rufa* before me from Kobe, Awaji, Hyuga province in Kiushiu, and other localities, and specimens of *fruhstorferi* and *tsushimana* Mlldff. received from Fruhstofer, I am unable to find any differential characters for Dr. von Möllendorff's supposed species and subspecies except their distribution. The deeply dissected western coast of Kiushiu indicates subsidence of an area long exposed to denudation, and points to the recent isolation of Tsushima and neighboring islands. Their fauna has much in common with Kiushiu, and, so far as we now know, but few special species strongly differentiated from those of the greater island.

DIPLOMMATINIDÆ.

The Japanese *Diplommatinidæ* fall into three groups: *D. pusilla* v. Mart. and its var. *omiensis* Pils. are sinistral forms, *pusilla* being placed in the genus *Palaina*, subgenus *Cylindropalaina* by Kobelt and Möllendorff;[3] but their genera *Palaina* and *Diplommatina* seem to stand in need of some rearrangement, judging by the lists of species.

All of the other Japanese species apparently belong to the section *Sinica* of the genus *Diplommatina*, with the single exception of *D. turris*, which differs strongly from all other known Japanese species.

Diplommatina turris n. sp.

Shell minute, tapering-turreted, whitish; the last two whorls of about equal diameter, those above slowly tapering. Whorls $7\frac{1}{2}$ to 8, extremely convex, the first two smooth, the apex obtuse; the last whorl but slightly ascending in front. Surface regularly sculptured with rather widely spaced thread-like rib-striæ. Aperture subcircular, the columellar tooth hardly visible from in front, but seen in an oblique view in the aperture to be moderately strong; peristome narrowly expanded, its inner edge built forward beyond

[3] *Catalog der gegenwärtig lebend bekannten Pneumonopomen*, p. 53.

the expansion; continued in an adnate callus across the parietal wall. Palatal fold short, to the left of the parietal callus.

Length 2.2, diam. 0.9 mm.

Oshima (Mr. Y. Hirase, No. 648).

This species is not related to any other form known from Japan or the Loo Choo group. The turreted shape, extremely convex whorls, and regular spaced rib-striæ are its prominent features.

Diplommatina saginata n. sp.

Shell dextral, imperforate, shortly oblong-conic, obese, amber-colored or white, densely sculptured with delicate thread-like rib-striæ, about 25 in the space of a millimeter on the penultimate whorl, slightly wider apart on the earlier whorls; no spiral striation. Penultimate whorl widest, those above forming a regularly conic spire. Whorls $6\frac{1}{2}$, the first obtuse and smooth; last whorl much smaller than the penultimate, strongly ascending in front. Aperture subcircular; columellar tooth strong, as usual. Peristome narrowly reflexed, thickened on the face, continuous in a delicate cord across the parietal margin. Palatal fold above the columella, rather long.

Length 2.3, diam. 1.2 mm.

Nase, Oshima (Mr. Y. Hirase, No. 649*b*); also Furuniga, Oshima (No. 649*a*).

A smaller, shorter species than *D. insularum* of Kunchan, Okinawa, or *D. cassa* of Hondo. In one specimen the outer lip is duplicate, in the others merely thickened. The upper margin of the peristome rises nearly to the preceding suture. A specimen from Furuniya measures, length 2.24, diam. 1.28 mm.

Diplommatina oshimæ n. sp.

Shell dextral, imperforate, bright red-amber colored, the penultimate whorl widest, those above regularly tapering, forming a long, *attenuated* spire. Whorls 7, convex, the first two or three dark red, smooth, the next two having *conspicuous thread-like, wide-spaced riblets*, the last two whorls densely sculptured with low, more delicate rib-striæ; the last whorl somewhat contracted, ascending in front, gibbous on the base behind the columellar lip. Aperture circular, the peristome reflexed, not doubled, its inner edge a little thickened and built forward, scarcely continuous, the parietal callus being but slightly developed. Columellar tooth strong, as usual. Palatal fold wanting.

Length 3, diam. 1.4 mm.

Oshima (Mr. Y. Hirase, No. 651).

This species has a longer, more attenuated spire than *D. luchuana*, and it differs from that and all other described Japanese species in the widely spaced riblets of the spire. Moreover, no palatal fold is seen through the front of the whorl, and upon opening a specimen I found it wanting.

Diplommatina luchuana n. sp.

Shell small, dextral, oblong-conic, brown, finely striate, the striæ much less strong than in other described species of Japan or the Loo Choo Islands. Whorls 6, convex, the penultimate and last of about equal diameter, those above regularly tapering, forming a long, conic spire. Last whorl ascending to the aperture, constricted at its beginning in front. Aperture somewhat longer than wide, the left margin straightened; peristome continuous, the outer lip reflexed, duplicate by a narrow crest close behind it; columellar tooth strong; palatal fold very short. Length 2.3, diam. 1.15 mm.

Province of Kunchan, Okinawa (Loo Choo) Island (Mr. Y. Hirase, No. 629).

Decidedly conic above, as in the larger *D. Kobelti* Ehrm. The striation is weaker than in other Japanese species of the group, none of which, except *D. Kobelti*, have so tapering a spire. The palatal fold is shorter than in the other species of the region. The surface seems to have no spiral striæ between the longitudinal striæ.

Diplommatina septentrionalis n. sp.

Shell dextral, corneous or pale brown, cylindric-oblong, finely rib-striate, about 12 striæ in the space of a millimeter on the penultimate whorl, the striæ more widely spaced on the last whorl; under a high magnification showing excessively minute, close, crenulated spiral striæ between the rib-striæ. Whorls nearly 6½, convex, the first three forming a short terminal cone, the others wide, last whorl ascending to the aperture. Aperture subcircular, the lip continuous, reflexed, duplicate by a narrow crest close behind it; columellar tooth moderately strong; palatal fold rather long. Length 2.9, diam. 1.56 mm.

Kayabe, prov. Ojima, Hokkaido Island (Mr. Y. Hirase, No. 639).

This is one of the northernmost known species of the genus. It is somewhat larger than *D. uzenensis*, the rib-striæ are more widely spaced and under a high power there are fine, dense, spiral striæ, wanting in *D. uzenensis*. *D. cassa* is somewhat more cylindric, with finer striation.

D. pusilla Mart. also occurs at Kayabe, Ojima, whence specimens have been sent by Mr. Hirase. They measure 2.1 mm. long, 1 wide, and have about 11 or 12 riblets in the space of a millimeter, measured on the last or penultimate whorls. The surface between the riblets has excessively fine spiral striæ, and I find that these are present in var. *omiensis*, as well as in what I take to be typical *D. pusilla*, although I overlooked them on the occasion of a former examination.[4] I cannot see that the specimens from Hokkaido Island differ from those of middle Hondo.

[4] These *Proceedings* for 1900, p. 382.

CONTRIBUTIONS TO THE LIFE-HISTORY OF PLANTS. No. XV.

BY THOMAS MEEHAN.

The Bending of Mature Wood in Trees.

At the meeting of the American Association for the Advancement of Science held in Philadelphia in 1884, Prof. Charles E. Bessey exhibited a drawing of the trunk of a Balsam Fir that had blown over and had bent in such a manner that the curvature could only have occurred after the trunk had become several years old. The prevalent impression is that trees and branches grow into their various forms; or, as the popular phrase expresses it, "as the twig is bent the tree's inclined." No one was prepared to believe that the tree, once inclined, could at any time thereafter change its form. There was nothing in the text-books to indicate the possibility of such phenomena. Prof. Bessey's specimen was looked upon as interesting and curious, but it has had no influence in our text-book teachings. Up to the present time we are taught to look to light, gravitation, tension, turgescence, or some one or another of the surrounding conditions to account for the direction which stems or branches assume—the independent energy developed from plant life itself receiving but slight recognition, probably because its exact nature is so far incomprehensible. Prof. Bessey's experience seemed to throw more light on some of my own observations. In the *Proceedings* of the Academy of Natural Sciences of Philadelphia for 1866, p. 401, appears my paper "On the Consumption of Force by Plants in Overcoming Gravitation," in which is clearly shown that life-energy, sustained by nutrition, was an enormous power in the life-history of the plant. I was encouraged to make actual experiments and wide observations, that have extended from that time till now, only to find the surprising fact that the recurving and incurving of mature growth is among the commonest of phenomena in the vegetable world. Before proceeding to prepare this paper, I inquired of Prof. Bessey if he had investigated the matter further, and received the following interesting letter:

"LINCOLN, NEB., Dec. 29, 1900.

"*My Dear Professor Meehan:*—In regard to the bending of the mature internodes of conifers, I may say that it was in 1884 that I made the first public statement before the Botanical Club of the A. A. A. S., or possibly before the Biological Section itself. It was to the effect that in the spring of the year 1882 (exactly April 8) a tornado crossed the campus of the Agricultural College at Ames, Ia., and among other things which it did, it partly uprooted a number of conifers, bending them over almost to the ground in some cases. After a while I noticed that these trees were bending upward, and that the bending was not confined to the youngest internodes, but that the older internodes were more or less bent also. I noticed this particularly in the case of some Balsam Fir trees, *Abies balsamea*, in which the bending extended several years back of the time when the trees were first partly uprooted.

"This year (in August) I had the opportunity of noticing the same thing in connection with the Foxtail Pine, *Pinus flexilis* var. *Murrayana*, in the Yellowstone Park. A slender tree had been bent to the ground by the fall of a larger tree, and yet the smaller tree had been able to bend a considerable portion of its top so as to bring it approximately erect. A careful examination of the larger tree in regard to the time of its fall made it certain that several of the mature internodes of the smaller tree bent after reaching the horizontal position. I have seen something like this in case of the destruction of the central 'leader' of the Austrian Pines on the University campus, during the past ten or twelve years, but these cases are not as striking as those cited above.

"I am glad that you are to bring this out, as I know that it will be so done that there will be no doubt at all in regard to it.

"I am very truly, etc.,

"CHARLES E. BESSEY."

My own work began by inclining an Arbor Vitæ, *Thuja occidentalis*, to an angle of about 45°. It was about eight feet high and perfectly straight. About the middle of May the following year the apex began to curve upwardly. The process continued for about three weeks, by which time the curving had extended down to some three feet, reaching the five-year-old wood of the main stem. In the course of this process the upper portion, that had commenced the incurving motion, would again become erect, so that the curve would only occupy a few feet in extent in the region of the three to five-year-old wood. The upper or erect portion would, however, be considerably out of line with the perpendicular of the tree's original growth from the ground. The following year the incurve extended down to the six or seven-year wood, and the upper portion recurved so that it might again assume a perpendicular position. No further curving occurred in after years. The tree is yet one of the curiosities on my grounds.

Following this was an experiment with a Lawson Cypress, *Cupressus Lawsoniana.* The results were similar, the incurving being just after active growth in spring.

So far we have the lesson from direct experiment. But when we look around us we see the bending power abundantly illustrated. The Galena Weeping Elm, a form of *Ulmus Americana,* grafted on stems eight or ten feet high, starts from the first with cord-like pendent branches reaching to the ground. But I have trees between thirty and forty years old that are nearly as many feet high. I have never seen an erect one-year-old branch on the trees. At the end of every branch there is pendent a growth of two or three years. For several years I have watched a leading branch that is straight and nearly horizontal, now over twenty feet in length ; a pendent growth of three years is always at its terminus. I find that in June the third year's growth straightens, the new growth still forming a continuous three-year bend. The Weeping Willow will occasionally make a few vigorous straight stems to aid in the upward growth, but the majority of the curved branches take to straightening after two or three years. The Hemlock Spruce, *Abies canadensis,* curves its new growth, which continues curved till the next season, when it rapidly becomes erect, the new growth taking the curve of the previous year.

The most interesting features of the study relate to the incurving and recurving of very old branches. In many trees there is no evidence of a tendency to bend till after the fifth year. For some ten years after this, or in ten- or fifteen-year-old wood, the phenomena is common. It may often be seen in the Tulip Poplar, *Liriodendron tulipifera,* the White Ash, *Fraxinus Americana,* the Pear tree, and many others. One of the best illustrations is afforded by the Horse Chestnut, *Æsculus Hippocastanum.* The branches all keep at an acute angle till the tree reaches an age of about twenty-five years. Then the ten-year-old branches begin to droop from near the basal region at the trunk. They spend several years in curving downward, and then make an incurve between the recurve and the apex. This method of first becoming a little more horizontal, then recurving near the base and incurving toward the apex is quite common among coniferous trees. The actual bending of the main trunk, which Prof. Bessey and myself ascertained by actual observation in three species of coniferæ, may have another illustration in a specimen of the Himalayan Pine, *Pinus excelsa,* on the estate of Caspar Heft in Germantown. It is about fifty years old, and probably among the earliest introduced to American gardens. The heavy trunk is curved from near the ground to about twenty feet upwardly. The verticels of branches in this species of Pine extend all around the trunk in a regular horizontal line. In the curved portion of this tree the straight branches on one side are directed above the horizontal line, on the other side they point below. There can be no other explanation of this than that the tree blew over when about twenty-five feet high, and that the whole of this early twenty-five-year growth had been made to curve.

Most species of trees will have some of their mature branches incurve or recurve at various ages; and this curving is often characteristic of the species. The list is made up from specimens growing on my own property, with the exception of a few left of the original forest, all planted by myself within the past forty years:

Magnolia.

In *M. tripetela, M. Fraseri, M. conspicua* and *M. macrophylla* I observe no disposition to curve at any age. But *M. acuminata* sends out its upper branches at an acute angle, with the apices incurved. After about five years they commence to descend by a curve near the base. These curves of the lower branches increase in width, until finally the upper portions of the branches again incurve, as noted in many coniferæ, especially of the Spruce family. Plate XVI represents a thirty-five-year-old tree.

Tilia.

The Lindens: No curving observed in *T. Europæa,* but in mature trees of *T. Americana* they are common and striking.

Ilex.

I have no large specimens of *I. Aquifolium.* In bushy specimens of *I. opaca* no curving noticed; but where the plant has assumed a tree-form descent commences in the five-year-old branches, and they finally curve and recurve as in the Spruces.

Kœlreuteria.

This seems naturally tortuous; but the branches, once formed, seem unchangeable.

Æsculus.

A. Hippocastanum recurves remarkably, even in branches of considerable age.

Acer.

The Maple family: *A. dasycarpum*, the Silver Maple, is remarkable for its eccentricity as regards the curving of its branches. One form known in gardens as "Wier's Cut-leaved," has cord-like pendulous branches, some of which straighten eventually and ascend. The leading branches are mostly erect, and aid in the heightening of the tree. Some individuals of the ordinary trees recurve branches in great numbers when these are several years old; other specimens show no recurving of individual branches. The recurving of weaker branches is a common feature. *A. saccharinum*, the common Sugar Maple, seldom recurves the larger branches; but the weaker ones frequently begin to curve when two or three years old, and continue to such an extent as often to form almost a circle. The species can be recognized at long distances by this character. In *A. rubrum*, the Red Maple, I see no disposition to curve; in *A. platanoides* none; but it occurs to a small extent in *A. Pseudo-Platanus*. *A. macrophyllum*, the Oregon Maple, has the branches at a rather acute angle, with an incurved apex. This character seems unchangeable, and my thirty-year-old tree has a broomy character. *A. campestre*, *A. lætum* show no curving characters.

Negundo.

In the Ash-leaved Maple I observed no tendency to curve in either the Atlantic or Pacific coast species.

Sophora.

Neither in this nor in *Robinia*, *Gleditschia* nor any leguminose plant have I noted any disposition to curve mature branches.

Pyrus.

In the rosaceous family the Pear is characteristic in recurving its mature branches as it advances in life. In my earlier years the familiar arching was attributed to the weight of fruit. This I have found erroneous. The curving of the large branches does not begin until the tree has reached nearly the height it is to eventually become. It is not seen on younger trees, no matter how much fruit they may have to bear. This is also true of the Apple. The Cherry does not curve. The *Cerasus serotina*, Wild Cherry, shows no disposition to curve, but in old specimens of *C. Padus* the maturer lower branches often curve considerably. In *Cratægus*, *Amelanchier*, and allies no tendency is observable.

Cornus.

Old bushes of *Cornus Mas* have the branches curved considerably with age. *Nyssa*, the Sour or Black Gum, starts horizontally from the first.

Diospyros.

Diospyros Virginiana, the Persimmon, has its branches more or less tortuous at an early stage, but in about ten years the laterals become more horizontal, and the ends of the branches curve up from the fifth year's growth.

Halesia.

In *H. tetraptera* and *H. diptera* there is no apparent curving, but *H. Meehani*, a remarkable seedling sport in my garden from *H. tetraptera*, has erect branches that recurve remarkably when a few years old, giving the tree a curious wind-swept appearance.

Catalpa.

Catalpa bignonioides and *C. speciosa*, old trees, give the impression of curvature with age, but I have not been able to decide this to my satisfaction. The tortuosity may be due to early growth alone.

Laurus.

The branchlets of *Laurus Sassafras* start out in early life at an angle of about 45°, but after about five years assume a horizontal direction. The succeeding branch system is tortuous, but seldom becomes decumbent.

Morus.

The Mulberry family shows little disposition to depart from the original plan of divergence. In some specimens of *Morus alba* I have seen some of the lower branches curved, which must have occurred late in life, but this seems exceptional.

Platanus.

In *P. occidentalis* I have found no sign of adult curving, but in *P. orientalis*, the European species, the laterals change from angular divergence to horizontal positions, and even recurving in many cases.

Juglans.

The Walnut family, I believe, retain their early character through life, though the English Walnut has a tortuous appearance.

Quercus.

It is in *Quercus*, or the Oak family, that we find the most interest, as the numerous species afford material for comparison. The angular divergence and ultimate positions seem so characteristic that we may have a reasonable assurance of the species when a tree is seen from a rapidly passing railroad train. *Quercus palustris*, the Pin Oak, is a good illustration of what occurs in many species (Plate XVII).

The upper branches grow at an acute angle, but after about five years proceed to decline, the point of departure being at the base, near the main trunk. By fifteen years they have become horizontal, and continue declining until the divergence again reaches an acute angle. Much the same procedure marks *Quercus Phellos*, the Willow Oak. *Quercus tinctoria*, the Black Oak, has the lateral branches horizontal at an early age, but I have never found any go lower. This is true of the *Quercus coccinea*, the Scarlet Oak, though to a less degree (Plate XVII). *Quercus bicolor*, the Swamp White Oak, departs from its angular position toward the horizontal when about ten years old, but never gets below the horizontal line. *Quercus macrocarpa* (the Burr Oak), *Q. lyrata* (the Over-cup), *Q. Prinus* (the Rock Chestnut), *Q. rubra* (the Red), I have not found to vary from the original framework. This also seems true of the European *Quercus Robur*, *Q. Cerris* (the Turkey Oak), and of the Japan *Q. dentata*. *Q. alba*, with its frame of branchlets almost as huge as its trunk, has been a puzzle to me. I am inclined to believe that the angular divergence of the lateral branches has not changed from the original plan. It may be noted that most species of Oak, when growing and in nursery rows, produce some weak side branches that soon become horizontal and finally curve.

Liquidambar.

The Sweet Gum, *Liquidambar styraciflua*, seems never to change the angular divergence of its laterals so far as a few inches from the base is concerned, but at a little beyond this they commence to decline at about ten years old in much the same manner as the Pin Oak, but eventually they take an upward bend, so that there is a curving and incurving feature as in the Norway Spruce.

Fraxinus.

The Ashes, as a rule, retain their original plan through life, but *F. Americana* and *F. sambucifolia*, the White Ash and the Black, become very much curved in the older branches.

Salix.

In the Willow family I have noted no departures from the original plan; the weeping variety of *Salix Japonica*, the well-known Weeping Willow, excepted, as already noted.

Ulmus.

There seems to be some tendency in young plants of *U. racemosa*, the Thomas Elm, to have the weaker branchlets recurve; but I have no mature specimen.

Coniferæ.

In the Cypresses, Junipers and some Pines I have found no evidence of the curving of mature branches, but in the Pines, Firs and Spruces the fact is self-evident. The upper series of about ten years of branching take an acute angle, then a horizontal direction at the base, which is eventually recurved, and finally an incurving occurs toward the younger portion of the branches. In many Pines—*Pinus pungens*, for instance—when the natural height is about reached, the upper branchlets become horizontal. The top of the tree is often as flat as if sheared to make a plane surface. Judging by pictures of European scenery *Pinus Pinea* has this habit in the Old World.

Among monocotyledons, I have noted in the South specimens of *Chamærops Palmetto*, that had been evidently turned aside somewhat in their earlier growth, that had curved the main stem in the effort to secure again the upright position.

The facts adduced reveal to us a stupendous power in plant life, of which biologists hitherto have taken little heed. True we have had casual notes of mushrooms lifting heavy paving stones in a single night; of the roots of trees throwing down stone walls and cleaving dense rocks in wedge-like fashion. I have myself recorded a case where a large tree growing on a rock had by accretions below lifted the whole of its immense weight of trunk and branches, so that it did seem that the trunk had elongated and that a side branch had been carried several inches above its original distance from the ground, but the great significance of these facts has not been made clear to us. The action of light, of gravitation, or of any external condition as a factor in direction fails to satisfy us. It has been usual, especially of recent years, to refer to conditions of environments as accounting for many of the phenomena of life. Undoubtedly these conditions must operate to some extent, or the speculations based on them could not command the assent of so many great minds. We know, for instance, that a plant growing vigorously in a cellar or dark room will incline toward the light; but I have shown in the *Proceedings* of the Academy that in the dense darkness of mines species of Agaric, growing from the roof or sides, curve their stipes upwardly, as do mushrooms that spring up in a dark night on the side of a sloping bank. I have also shown in the same publication that many plants closely observed by me carry on their curving operations by night rather than in the light of day. So in regard to the thought that the operations of plant life are carried on for individual good—the great weapon in the battle for life among modern hypotheses of evolution, this must be true to a limited extent. In the case of the *Magnolia acuminata* herewith illustrated (Plate XVI), we can see that if the curvings of the young shoots continued without any change in the original direction of the main laterals, the head of the tree would become as round as a cabbage and the interior branches would be smothered out. The declination in time gives scope to the young growth, and even the final uprising of the branch toward its apex is still kept within regulation distance of its fellows. In the Fir and Spruce the self-utility of the curvatures is clearly apparent. The tree could scarcely keep a mass of foliage in healthy condition wholly to the ground if it adhered strictly to the acute-angular method that marks the upper growths.

So far we may trace the effort for individual benefit in the direction changes, but that conditions of environment are active forces in the work may well be doubted from the fact of great variation in the degrees of curvature.

It has already been stated that the observations were made on my own grounds. Comparing, however, trees of my own with others of the same species on neighboring properties, we find wide divergencies. In some trees of the same species there will be few illustrations of curving, while in others nearly every large branch will take on an arcuate form. This fact is illustrated in Plate XVI of *Magnolia acuminata*. The two trees are within thirty feet of each other. The one on the right shows considerable incurving. The upper branches have retained their original angular divergence, and the bend toward the horizon as age advanced has been gradual; only a few at the base and on the one side have reached that point. We can see that if this tree had wholly lost the recurving power we should have a fastigiate individual, closely imitating a Lombardy Poplar in form. But the one on the left took early to recurving, and to such an extent that it seemed to the good of the tree that these should ultimately incurve in order to afford room for a healthful branching development.

With all these individual variations there is still a general character assumed by each species, by which it may be distinguished as well as by the characters derived from leaves, flowers or fruits. In *Quercus palustris*, for instance (Plate XVII), there is little disposition to curvature in the decumbent branches. They bend very close to the main trunk. They commence to diverge when about five years old, and the continuously increasing degree of divergence can be seen at a glance. This character will vary more or less in different trees, but there is almost always enough in evidence to enable one to distinguish the Pin Oak from other species. The Scarlet Oak, *Quercus coccinea*, rarely shows any disposition to curve mature branches. A representation of this species is given on the right hand of the Pin Oak (Plate XVII). But here we may note again that there is no necessity for it, as the original angle of divergence is sufficient to allow for a fair development without subsequent change. May we not borrow a simile from a class of metaphysicians who contend that "man is not merely a creature of circumstances, but his character is mainly made for him and not by him," and believe that an inborn direction, and not environment to any great extent, is the ruling power in vegetable life?

What is the nature of this power that is capable of bending with ease and without a break an old branch or trunk of a thickness that would require an immense mechanical pressure for man to accomplish? How does it operate?

In the paper already cited[1] I drew attention to the fact that the life-growth of a plant was in a measure a struggle against gravitation, and that a great part of the nutrition prepared by the plant was spent in supplying energy in this struggle. Consequently when a plant received extraneous aid in the contest, the extra nutrition saved by this assistance was diverted to extra growth and luxuriance. Many observations have since shown that to energy transmuted from nutrition we have to look for the various forms that plants assume. To the highest degree of energy we may attribute the chief triumph of growth force over gravitation. This is exemplified in the leading shoot of Pine trees. Observers know that in this leading shoot the highest vegetative force is exhibited. It so successfully resists all gravitating influences that it is drawn in no degree from an exact perpendicular. If, however, the main growing shoot of a vigorous tree is broken off, the extra nutrition diverted from the centre to the lateral branches supplies one of these with an extra degree of energy, and a new leader arises in place of the lost one. From this we deduce the law that plants are engaged in a contest with gravitation, and that geotropism is in proportion to the degree of energy lost in the contest.

Going over the list of plants enumerated in this paper, we note that decumbency is in proportion to the decline of vigor, and we find this to be the case in individual trees generally. What are known in gardens as fastigiate trees, of which the Lombardy Poplar is a type, are remarkable for the vigor of the central shoot and laterals. Weeping trees, on the other hand, are characterized by decreased vigor. The normal form of *Salix Japonica*, of which the so-called Babylonian Willow is an offspring, is very

[1] *Proc. Acad. Nat. Sci. Phila.*, 1866, p. 401.

strong in comparison with the variety. The Kilmarnock Weeping Willow is weak in comparison with *Salix caprea*, its parent, and this is true of all the weeping trees in gardens—they are all in various degrees more slender and delicate than the normal forms of the same species.

The ability to overcome gravitation has been lost, in proportion to the lessened degree of energy.

How does this view account for the case of the incurving of branches that have become decumbent?

It seems like a mere restatement of the fact to say that the incurving branch has simply regained a power to successfully resist gravitation it had never wholly lost. When we note, however, that these incurves are all methodical, and only occur when they are evidently beneficial to the plant, we may infer that energy itself is not blindly directed, but is under the control of a life-power within the plant that is able to strengthen a weak position when it is for the general good. We see this when it undertakes to heal a wound; we only extend our view of this power to meet these new cases.

In conclusion, trees have the power, not merely to grow into various forms as it is usually understood, but to bend mature branches when exigencies require it; and this display of power results from varying degrees of energy employed by plants in their struggle with gravitation.

OBSERVATIONS UPON THE PLACENTA AND YOUNG OF DASYPUS SEXCINCTUS.

BY HENRY C. CHAPMAN, M.D.

The Edentata, so called by Cuvier on account of the teeth being so imperfectly developed or absent in the representatives of the order, includes a very heterogeneous assemblage of animals—ant-eaters, sloths, armadillos—differing very much in their internal organization, especially in the character of their placentation. Thus the placenta in the Cape ant-eater, *Orycturopus,* is deciduous and, according to some authorities,[1] discoidal, to others[2] zonular in form. In the Tamandua, *T. tetradactyla,* it is possibly deciduous and discoidal;[3] in the sloths, *Cholœpus Hoffmanni,* it is deciduous and loboid in form;[4] in the Pangolin, *Manis, ?* non-deciduous and diffuse;[5] in certain species of armadillos, *e. g. Dasypus novemcinctus,* possibly deciduous and discoidal.[6]

In view of the fact that such profound differences exist in the placentation of the Edentata, it is hoped that the following observations upon the placenta and young of the six-banded armadillo born in the Philadelphia Zoological Garden and submitted to the author for examination by Mr. A. E. Brown, Secretary of the Society, will prove acceptable. It should be mentioned in this connection that in the case of the placenta of *Dasypus novemcinctus* as described by Milne-Edwards,[7] four fœtuses were found enclosed in one chorion. Such a disposition, far from being an abnormal one, would seem to be that usually obtaining, at least in that species of armadillo, since the same number of fœtuses were

[1] T. H. Huxley, *Introduction to the Classification of Animals,* London, 1869, pp. 98, 104.

[2] W. Turner, *Journal of Anat. and Phys.,* Vol. 10, 1876, p. 693.

[3] A. Milne-Edwards, *Ann. des Sciences Nat.,* Cinquième Série, Zool., XV, 1872, p. 2.

[4] W. Turner, *Trans. Royal Society of Edinburgh,* Vol. XXVII, 1876, pp. 76, 78.

[5] T. H. Huxley, *op. cit.,* p. 104.

[6] Alph. Milne-Edwards, *Annales des Sciences Naturelles,* Sixième Série, Zoologie, VIII, 1879, pp. 2, 3.

[7] *Op. cit.,* p. 2.

observed enclosed in a common chorion by Kölliker[8] before, and by Duges[9] after Milne-Edwards' observations. Different explanations have been offered by anatomists of this apparent anomaly of one chorion enclosing a number of fœtuses. The most satisfactory as yet offered, though hypothetical, the early development of the armadillo being unknown, is that originally the number of chorions correspond to the number of fœtuses, but that as development advances the adjacent walls of the primitively distinct chorions fuse together and ultimately break down, the result being the formation of one chorion. In the case of the six-banded armadillo, *Dasypus sexcinctus*, the mother gave birth to but one young, and there were no reasons for supposing that more than one was developed during the pregnancy.

The young armadillo (Plate XVIII, fig. 1), the first born at the Philadelphia Zoological Garden, a male which lived but a few hours, was perfectly developed and measured from snout to end of tail 25 centimeters (10 inches). The most striking feature of the young animal externally was the size of the penis, it measuring 3.7 centimeters (1.5 inches). It is well known that this organ attains an enormous size in the adult armadillo, absolutely as well as relatively. Six distinct broad bands and two indistinct narrow ones were observed on the dorsal surface, but they were as yet soft to the touch.

No trace was found of an umbilical vesicle, amnion, or any part of the chorion except that entering into the formation of the placenta. The umbilical cord measured 22.5 centimeters (9 inches), the vessels not being spirally disposed, as was also observed by Milne-Edwards to be the case in the Tamandua. The umbilical vessels were so much torn (having been apparently gnawed by the mother) as to make it impossible to inspect the placenta through them. A mixture of gelatine and carmine was, however, forced directly into a few of the small vessels of the placenta, which consisted of the villous processes of the chorion only, without admixture of any maternal tissue, and was therefore non-deciduate. The fœtal villi were disposed as a girdle or zone (Plate XVIII, fig. 2) on that part of the chorion in contact with the

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[8] *Entwicklungsgeschichte des Menschen*, 1879, S. 362.
[9] *Annales des Sciences Naturelles*, Sixième Sér., Zoologie, IX, 1879–80, p. 1.

uterus. The zone measured from outer edge to outer edge about 5 centimeters (2 inches), the average breadth of the rim of the zone 1.2 centimeters (.5 inch), the breadth of the space between the inner edges of the zone and destitute of villi 2.5 centimeters (1 inch). The placenta in the six-banded armadillo is not, however, a zonular one in the sense in which that word is used by anatomists. It does not surround the chorion as a broad band, the poles of the latter being bare as in the "diffuse" non-deciduate placenta of the pig; nor as a narrow one as in the "zonular" deciduous placenta of the Carnivora, etc. It should be regarded morphologically rather as a discoidal placenta, the central portion of the disk—that is, the part of the chorion lying within the inner edges of the rims of the villous zone—presenting, however, no villi. The placenta in *Dasypus sexcinctus* being therefore ring-shaped, rather than discoid in form, if it be permitted to introduce a new name in anatomical nomenclature, it might be described as a non-deciduate cricoid placenta.[10] The villi, measuring on an average 20 mm. (.8 inch), were not simple as in the Pachydermata, Camelidæ and Tragulidæ, but compound as in Man. They presented a beautiful arborescent appearance (Plate XVIII, fig. 3), the terminal twigs ending in bulbous or rounded extremities (fig. 4). As is well known, Von Baer,[11] Eschricht,[12] the elder Milne-Edwards,[13] Huxley,[14] and in recent times Haeckel,[15] advocated classifying the monodelphous mammalia according to the character of the placentation. It is obvious, however, as shown by the summary given below, that on such a basis the different members of the Edentata would be associated with mammals with which they have no natural affinities, just as, according to such classification, totally different animals like the Hyrax, Elephant, and Carnivora are associated, and which constitutes one of the most important objections that have been urged to the acceptance of such classification.

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[10] Κρικος, a ring.

[11] *Untersuchungen über die Gefässverbindung zwischen, Mutter und Frucht*, 1828.

[12] *De Organis quæ Respiratione et Nutritioni Fœtus Mammalium inserviunt*, 1837.

[13] *Annales des Sciences Naturelles*, Série 3, Tome I, 1844, p. 65.

[14] *Elements of Comparative Anatomy*, p. 112.

[15] *Anthropogenie*, 1891, S. 591.

Placenta	Deciduous	Discoidal	Primates, etc.
			Bradypus.
		Zonular	Elephant.
			Carnivora.
			Orycteropus.
	Non-deciduous	Diffuse	Sus.
			Manis.
		Cotyledonary	Bos.
			Ovis.
		Cricoid	Dasypus sexcinctus.
		Discoidal	Dasypus novemcinctus.[16]
			Tamandua tridactyla.[16]

EXPLANATION OF PLATE XVIII.

Fig. 1.—Young Armadillo and fœtal face of placenta.
Fig. 2 —Uterine face of placenta.
Fig. 3.—A villous process of the chorion.
Fig. 4.—A portion of the same as seen when magnified.

[16] Incertum sedis.

THE ACRIDIDÆ, TETTIGONIDÆ AND GRYLLIDÆ COLLECTED BY DR. A. DONALDSON SMITH IN NORTHEAST AFRICA.

BY JAMES A. G. REHN.

As a portion of this collection has been previously reported on,[1] it is not necessary to repeat any of the preliminary remarks then made.

Family ACRIDIDÆ.

Subfamily Acridinæ (*Tryxalinæ* auct.).

Acrida nasuta (Linnæus).

1758. *Gryllus* (*Acrida*) *nasuta* Linnæus, Syst. Nat., X ed., I, p. 427.

Ten specimens, four males, two females, four immature.

Grorgora, Gallaland, September 13, 1894. ♂.

Near Hargeisa, Somaliland, July 21, 1894. ♂, ♀.

Sheikh Husein, Gallaland, September 21, 1894. ♂, 3 immature.

Near Lake Abaya, country of the Amara, western Gallaland, May 9, 1895. ♂.

No data. ♀ and 1 immature.

Acrida unguiculata (Rambur).

1838. *Tryxalis unguiculata* Rambur, Faune de l'Audal., p. 72.

Four specimens, two males, one female, one immature.

Tug Berka, Somaliland, August 23, 1894. ♂.

Sheikh Husein, Gallaland, October 6, 1894. Immature.

Daro Mountains, Gallaland, November 19, 1894. ♀.

Le, southern Gallaland, March 29, 1895. ♂

The single female resembles the specimen figured by Klug[2] as *T. conspurcata*.

Machæridia bilineata Stål.

1873. *Machæridia bilineata* Stål, Recensio Orthopterorum, I, p. 100.

Two females; near Lake Abaya, country of the Amara, western Gallaland, May 9, 1895.

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[1] *Proc. Acad. Nat. Sci. Phila.*, 1901, pp. 273-288.

[2] *Symbolæ Physicæ*, II, tab. xvii, fig. 1.

These specimens lack the black on the lower surface of the posterior femora.

Phlœoba mossambicensis Brancsik?

1895. *Phlœoba mossambicensis* Brancsik, Jahresh. Naturw. Ver. Trencsén, XVII, p. 249, tab. VIII, fig. 1.

One female; Luku, Gallaland, September 17, 1894.

This specimen very likely belongs to Brancsik's species. It is clearly not *P. antennata* Schulthess, which was described from Somaliland, and with the other species of the genus it exhibits no affinity.

Locusta sp.

One ♀; Sheikh Husein, Gallaland, September 23, 1894.

This specimen is so badly distorted and discolored that it is not possible to determine more than the genus. For the use of this generic name in place of *Stenobothrus* Fischer, see *Canadian Entomologist*, XXXIII, p. 121.

Epacromia thalassina (Fabricius).

1793. *Gryllus thalassinus* Fabricius, Ent. Syst., II, p. 57.

One female; Sheikh Husein, Gallaland, September 27, 1894.

The collection contains six immature specimens of *Acridinæ*, which it is hardly possible to determine. They were collected at the following localities and dates:

Near Lake Abaya, country of the Amara, western Gallaland, May 9, 1895 (2).

Sheikh Husein, Gallaland, October 5, 1894 (2).

Sheikh Mahomet, Gallaland, November 6, 1894.

No data.

Subfamily Œdipodinæ.

Gastrimargus verticalis (Saussure).

1884. *Œdaleus verticalis* Saussure, Prodr. Œdipod., p. 111.

Two specimens, one ♀, one immature.

Daror, Gallaland, September 15, 1894.

Budda, west of Sheikh Mahomet, Gallaland, November 11, 1894.

The adult has the maculations of the elytra decidedly blackish.

Gastrimargus marmoratus (Thunberg).

1815. *Gryllus marmoratus* Thunberg, Mém. Acad. St. Petersb., V, p. 232.

One ♂; Sheikh Husein, Gallaland, October 5, 1894.

Œdaleus instillatus Burr.

1900. *Œdaleus instillatus* Burr, Proc. Zool. Soc. London, p. 39.

One ♂; near Hargeisa, Somaliland, July 21, 1894.

It is interesting to note that the specimen before me has a general pinkish suffusion.

Pachytylus migratoroides (Reiche and Fairmaire).

1847. *Œdipoda migratoroides* Reiche and Fairmaire, in Ferret and Galinier, Voy. en Abyss., III, p. 430.

Four specimens, two males, two females.

Sheikh Mahomet, Gallaland, November 6, 1894.

Between Luku and Dago Tulo, Gallaland, September 18, 1894.

To one specimen is attached the following data: "Caught from swarm. Migrating flocks of predaceous birds following them."

Cosmorhyssa fasciata (Thunberg).

1815. *Gryllus fasciatus* Thunberg, Mém. Acad. St. Petersb., V, p. 230.

Two males; Tug Terfa, eastern Gallaland, August 21, 1894.

Sheikh Husein, Gallaland, September 30, 1894.

Dittopternis couloniana Saussure.

1884. *Dittopternis couloniana* Saussure, Prodr. Œdip., p. 125.

One ♂; near Tug Lomo, between Lefkei and Bodele, Somaliland, August 12, 1894.

This species was previously known from West Africa.

Chlœbora gracilis Schulthess.

1895. *Chlœbora gracilis* Schulthess-Rechberg, Zoolog. Jahrbuch, Syst. Th., VIII, p. 74.

Two females; Hargeisa, Somaliland, July 21, 1894.

The Haud, between Hargeisa and Gagaap, Somaliland, July 25, 1894.

Pycnodictya galinieri (Reiche and Fairmaire).

1847. *Œdipoda galinieri* Reiche and Fairmaire, in Ferret and Galinier, Voy. en Abyss., III, p. 432, Pl. 28, fig. 3.

Two females, one immature; Tug Dado, near Laga, Gallaland, December 2, 1894 (1).

No data (1).

Acrotylus longipes (Charpentier).

1845. *Œdipoda longipes* Charpentier, Orthop descr., tab. 54.

Two females, one immature; Berbera, Somaliland, July 3, 1894.

Sheikh Husein, Gallaland, September 30, 1894.

The collection contains a number of specimens of *Œdipodinæ*, which I have not attempted to determine. They were collected as follows:

Sheikh Husein, Gallaland, September 30, 1894 (1).

Sheikh Husein, Gallaland, October 1, 1894 (1).

Sheikh Husein, Gallaland, October 5, 1894 (5).

Northern end of Lake Stephanie, western Gallaland, June 5, 1895 (1).

No data (1).

Subfamily **Pyrgomorphinæ.**

Atractomorpha aurivillii Bolivar.

1884. *Atractomorpha aurivillii* Bolivar, Ann. Soc. Esp. Hist. Nat., XIII, Cuad. I, p. 67.

One ♀; Dabuli, Gallaland, September 16, 1894.

Ochrophlebia subcylindrica Bolivar.

1881. *Ochrophlebia subcylindrica* Bolivar, Journ. de Sc. Math. Lisboa, XXX, p. 109.

One female; between Berbera and Hargeisa, Somaliland, July 14, 1894.

Except for a few discrepancies in color, this is essentially the same as Bolivar's specimens.

Cawendia gallæ n. sp.

Type, ♂; Sheikh Husein, Gallaland, September 30, 1894.

Differing from *C. glabrata* Karsch[3] in the absence of pubescence, the subequal vertex, the presence of lateral carinæ and the greater length of the tegmina.

General outline fusiform. Head fairly elongate; face sharply retreating, concave; vertex horizontal, anteriorly subtruncate, the apex equal to the interspace between the eyes; frontal costa very strongly compressed from the vertex to between the antennæ, the sulcus below this point being fairly broad, slightly ampliate at the ocellus; eyes subspherical, moderately prominent; postocular line of tubercles very marked, extending downward as well as backward; antennæ filiform, as long as the head and pronotum. Pronotum strongly punctate posteriorly, the dorsum well rounded and with very insignificant traces of a median carina; anterior margin truncate with a shallow central emargination, posterior margin with a central emargination which divides the border into two rounded

[3] *Ent. Nachr*, XIV, p. 345.

lobes; lateral carinæ consisting of broken callous ridges, only slightly marked on the metazona, each cut by two sulci; lateral lobes with the lower margin sinuate with a post-median lobule, this section of each lobe having a longitudinal series of large tubercles, thus forming a continuation of the line on the head. Tegmina elongate, not appreciably expanded. Abdomen with the basal segments strongly punctate; subgenital plate large, the posterior portion produced and superiorly forming a keel which extends from the tip to the genital aperture; supraanal plate and cerci elongate, acuminate. Posterior femora with all the carinæ well marked, genicular lobes rather small; tibiæ with eight spines on the external and nine spines on the internal margin.

General color brownish olivaceous varied with ochraceous, under parts yellowish. Posterior portion of the pronotum and a median line on the abdomen dull reddish. Tubercles on the head, lower part of the lateral lobes, metapleuræ and four lines (two superiorly and two laterally) on the abdomen ochraceous. Posterior femora with a dull ochraceous bar on the lower portion of the external face; tibiæ tinged with purplish, the spines tipped with reddish black.

Length of body,	24	mm.
Length of head,	5	"
Length of pronotum,	5.5	"
Length of hind femora,	12.5	"

Pœcilocerus vittatus (Klug).

1829. *Decticus vittatus* Klug, Symbol. Physicæ, t. XXV, figs. 6 and 7.

Two males; between Berbera and Hargeisa, Somaliland, July 14, 1894.

Phymateus ægrotus (Gerstæcker).

1869. *Pœcilocerus ægrota* Gerstæcker, Archiv. f. Naturg., XXXV, p. 216.

One ♀; Sheikh Husein, Gallaland, October 15, 1894.

Phymateus morbillosus (Linnæus).

1758. *Gryllus (Locusta) morbillosus* Linnæus, Syst. Nat., X ed., p. 431.

Seven specimens, one male, six females:

Feji, near the Darde, eastern Gallaland, September 7, 1894 (♀).

Duror, Gallaland, September 15, 1894 (♂, ♀).

No data (4 ♀).

Phymateus sp.

Eight immature specimens:

Dabuli, Gallaland, September 16, 1894 (2).

Daga Tula, near Sheikh Husein, Gallaland, September 19, 1894 (5).

No data (1).

Taphronota thælephora (Stoll).

1789. *Gryllus (Locusta) thælephora* Stoll, Represent., Pl. XVI*B*, fig. 59.

One ♀; Dumbola Kalta, country of the Boran, east of Lake Stephanie, western Gallaland, April 20, 1895.

Petasia grisea Reiche and Fairmaire.

1847. *Petasia grisea* Reiche and Fairmaire, in Ferret and Galinie, Voy. en Abyss., III, p. 428, Pl. 28, figs. 2 and 2*a*.

Two specimens; Sheikh Husein, Gallaland, October 8, 1894; Ginea, Gallaland, October 28, 1894.

These specimens show a decided approach to *P. anchietæ* Bolivar, in the markings and form of the posterior part of the pronotum, though their closest affinity is with *grisea*.

Petasia sp.

One immature specimen; Sheikh Mahomet, Gallaland, November 6, 1894.

Subfamily **Pamphaginæ**.

Xiphocera brunneriana Saussure.

1887. *Xiphocera brunneriana* Saussure, Spicil. Ent. Genav., 2, p. 43.

Three females; Daga Tula, near Sheikh Husein, Gallaland, September 20, 1894; Sheikh Husein, Gallaland, September 29, 1894; no data.

Xiphocera ensicornis Saussure.

1893. *Xiphocera ensicornis* Saussure, Entom. Month. Mag., XXIX, p. 152.

One ♀; no data.

Xiphocera sp.

One ♂; Daga Tula, near Sheikh Husein, Gallaland, September 20, 1894.

Owing to the great difficulty of satisfactorily determining specimens of this genus without a series of others for comparison, I have not attempted to determine this specimen, which is badly crushed and twisted. It is quite evident that it is not *brunneriana*.

Subfamily **Calopteninæ** (*Acridinæ* auct.).

Anthermus cephalicus Bolivar?

1890. *Anthermus cephalicus* Bolivar, Journ. Scienc. Math. Phys. Nat., Lisboa, (II) I, p. 157.

Two immature females; Sheikh Husein, Gallaland, October 1 and 7, 1894.

Cyrtacanthacris tataricus (Linnæus).

1758. *Gryllus (Locusta) tataricum* Linnæus, Syst. Nat., X ed., I, p. 432. The use of the name *Cyrtacanthacris* is preferable to *Acrydium*, the status of which is rather uncertain.

Three specimens, one male, two females:

Luku, Gallaland, September 17, 1894.

Sheikh Husein, Gallaland, September 29, 1894.

No data (1).

Cyrtacanthacris ruficornis (Fabricius).

1793. *Gryllus ruficornis* Fabricius, Entom. Syst., II, p. 54.

Six specimens, one male, three females.

No data.

Near Bodele, eastern Gallaland, August 15, 1894.

Grorgora, eastern Gallaland, September 13, 1894.

Sheikh Husein, Gallaland, September 25, 1894 (2).

Sheikh Husein, Gallaland, October 10, 1894.

Acrostegastes affinis Schulthess.

1898. *Acrostegastes affinis* Schulthess, Ann. Mus. Civ. Genova, XXXIX, p. 192.

One female; no data.

This specimen differs from the one described by Schulthess in having ten spines on the external margin of the posterior tibiæ.

Exochoderes aurantiacus Bolivar.

1881. *Exochoderes aurantiacus* Bolivar, Jorn. Scien. Math. Phys. Nat., Lisboa, XXX, p. 114.

Two females; Sheikh Husein, Gallaland, October 1, 1894; Kurava Wells, between Aimola and Le, southern Gallaland, March 25, 1895.

Sauracris lacerta Burr.

1900. *Sauracris lacerta* Burr, Proc. Zool. Soc. London, p. 41.

Four females.

Tug Berka, eastern Gallaland, August 23, 1894.

Near Lefkei, Somaliland, August 7, 1894.

Tulu, between Ginea and Laga, Gallaland, November 23, 1894.
No data.

The specimen from Tulu is much larger, more deeply colored and more coarsely scabrous on the vertex than the other specimens, and the spines on the outer border of the hind tibiæ number eight against six in the others, though Burr says, "tibiæ posticæ spinis extus 6–8." On the whole, the large specimen may represent a geographical race. As comparative measurements might be of interest, I have taken some of the dimensions.

	Average of 3 small sp.	Large sp.
Total length, ...	32 mm.,	41 mm.
Width across eyes, ...	5.8 "	6.8 "
Length of pronotum, ...	6.1 "	7.8 "
Greatest width of pronotum, . . .	7.1 "	8.25 "
Length of hind femora, ...	12.2 "	15 "

Catantops melanostictus Schaum.

1862. *Catantops melanostictus* Schaum, in Peter's Reise nach Mossambique, Zool., V, p. 134.

Eight specimens, three males, five females (two immature).
Duror, Gallaland, September 15, 1894.
Sheikh Husein, Gallaland, September 21, 1894.
Sheikh Husein, Gallaland, October 1, 1894, (2)
Sheikh Husein, Gallaland, October 7, 1894.
No data (3).

Stenocrobylus festivus Karsch.

1892. *Stenocrobylus festivus* Karsch, Berlin Ent. Zeitsch., XXXVI, p. 190.

One female; Rassa Allah, western Gallaland, September 6, 1894.

This specimen agrees very well with Karsch's description of the structural characters of *festivus*, but the color shows a marked difference. As to whether the specimen in the collection is faded or represents a race distinguished by a more uniform coloration remains to be seen.

Eyprepocnemis somalicus n. sp.

Types; one male and two females; Gagap, Somaliland, July 30, 1894; Berbera, Somaliland, July 3, 1894; near Lefkei, Somaliland, August 6, 1894.

This new form evidently belongs to the section of the genus containing *herbaceus* Serville and *charpentieri* Stal, though it shows a rather close relationship to *E. guineensis* Krauss.

Form rather elongate. Head with the face somewhat declivent; the frontal costa broad, slightly expanded inferiorly, not sulcate; vertex broad, rounded; eyes rather elongate. Antennæ filiform, longer than head and pronotum. Pronotum slightly expanding posteriorly, median carina well marked, cut by two transverse sulci; anterior and posterior margins very slightly rounded; lateral lobes sharply deflected, the lower margins sinuate, angles obtuse-angulate. Tegmina long, rounded at the tips which reach the extremities of the hind femora. Pleuræ strongly punctate. Hind femora robust, elongate, genicular lobes well developed; tibiæ with 12–15 spines on the external and 10–12 on the internal margins. Tarsi with the areolæ large. Subgenital plate of the male large and spatulate, the apex with a subelliptical fissure; supraanal plate broad and flat, the apex angulate; cerci apically expanded, flabellate, the tips decurved.

General color ochraceous-rufous (Ridgway's *Nomenclature*, Pl. V, No. 5), marked with brownish-black, as follows: a median stripe on the pronotum, the upper margin of the prozona and the posterior region of the metazona, a line of spots on the anal field of the tegmina, and the regular subcircular spots on the radial field of the same. Upper surface of the hind femora pinkish, the outer face of the same with two superior blackish blotches; genicular arches blackish.

	♂	♀
Length of body, ...	40 mm.,	47.5 mm.
Length of pronotum, ...	7 "	9 "
Length of tegmina, ...	32 "	43 "
Length of hind femora, ...	26 "	30 "

Euryphymus erythropus (Thunberg).

1815. *Gryllus erythropus* Thunberg, Mém. Acad. St. Petersb., V, p. 248.

One immature female; Sheikh Husein, Gallaland, September 21, 1894.

This immature specimen agrees with the descriptions of Thunberg's *erythropus*, a species apparently known only from South Africa.

Euryphymus sp.

One immature female; Berbera, Somaliland, July 3, 1894.

Sphodromerus sanguiniferus n. sp.

Type; ♂; no data.

Closely allied to *S. inconspicuus* Schulthess[4], but differing in the number of spines on the external margin of the hind tibiæ (*inconspicuus* 9, *sanguiniferus* 7), and the absence of a black fasciation on the same. A close relationship also exists with *S. decoloratus* Finot,[5] but several characters are quite at variance.

Form thickset and robust. Head with the vertex declivent, posteriorly with a slight carina; frontal costa expanding inferiorly, sulcate except immediately around the ocellus; eyes prominent, globose; antennæ depressed, longer than head and pronotum. Pronotum rugose, posteriorly expanding, median carina well developed, cut by three sulci; anterior margin subtruncate, posterior rectangulate, the border somewhat sinuate; lateral lobes separated from the dorsum by well-marked lateral carinæ, posterior angle subrotundate, the matazona punctate. Tegmina short, not reaching the tip of the femora. Anterior and median femora robust, slightly bowed. Posterior femora very robust, the superior and inferior margins well developed, the former serrate; tibiæ stout, armed with seven spines on the external and internal margins. Subgenital plate bowl-shaped, the posterior portion very slightly produced; supraanal plate subtriangular with two median ridges, subobsolete anteriorly; cerci very heavy, with an external blunt denticle.

General color ferruginous; lower part of head, outer face of posterior femora and lower surface yellowish, the head very pale. Pronotum and tegmina washed with dull reddish. Tegmina with four longitudinal rows of blackish spots. Lateral and superior surfaces of the hind femora with two obsolete blackish bars, the inferior internal face of the same sanguineous. Posterior tibiæ sanguineous, the spines ochraceous with black tips.

Measurements.

Length of body,	26	mm.
Length of pronotum,	5.5	"
Length of tegmina,	13	"
Length of hind femora,	13	"

[4] *Zool. Jahrb., Syst. Abth.*, VIII, p. 78.
[5] *Ann. Soc. Ent. France*, LXIII, p. xiii.

The collection contains six specimens of the *Caloptenince* too immature to be identified.

Erer river, eastern Gallaland, August 18, 1894.

Sheikh Husein, Gallaland, October 1, 3 and 7, 1894.

Family TETTIGONIDÆ.

The greater part of the material belonging to this family is so badly broken and crushed that I am unable to determine fifteen specimens, collected as follows:

East of Milmil, Somaliland, July 25, 1894.

Sheikh Mahomet, Gallaland, October 30, 1894.

Sheikh Mahomet, Gallaland, November 9, 1894.

Sheikh Husein, Gallaland, September 30, 1894.

Sheikh Husein, Gallaland, September 29, 1894.

Sheikh Husein, Gallaland, October 7, 1894.

Sheikh Husein, Gallaland, October 1, 1894.

Between Tulu and Abdula, Gallaland, November 24, 1894.

Near Lake Abaya, country of the Amara, western Gallaland, May 9, 1895.

Cymatomera hyperborea n. sp.

Types; two males, one female; Higo, country of the Boran, Gallaland, April 8, 1895 (2); near the Galena Amara, between Lenja Amara and El Re, Gallaland, May 25, 1895.

This species is allied to *C. modesta*, from which it differs in numerous particulars, as the truncate anterior margin of the pronotum, the different development of the metazona of the same, besides the almost total absence of black in the coloring. The new form also exhibits a close affinity to *C. brunneri* Brancsik,[6] but it differs from that species in the much lower metazonal crest and the absence of any foliaceous development of the superior margins of the posterior femora.

General form elongate. Head with the vertex produced, the apex narrowly truncate, the lateral margins being sinuate; front broad and flattened, finely punctate; eyes very prominent, spherical; antennæ exceeding the total length. Pronotum with the anterior margin truncate, posterior subrotundate; prozona with a central lamellate ridge, the margin being dentate, the exact number of teeth (3-7) being

[6] *Jahresb. Naturw. Ver. Trencsen*, XVII, p. 257.

variable, the anterior lateral angle with a spine followed after a short space by another; central metazonal ridge lamellate, the margin crenulate, in one case decidedly bidentate, the postero-lateral angle occupied by a bifid process which roofs the humeral sinus; lateral lobes with the lower margin centrally emarginate, the median area of the lobes occupied by three spines arranged longitudinally, the central one smaller than the others. Tegmina with the apex subacute, the cross veins of the discoidal area very prominent. Femora of all the limbs with both margins with foliaceous extensions, except the superior surfaces of the anterior and posterior femora, the extensions with the margins crenulate; foramina on the anterior femora very prominent; posterior femora feebly spined below on both margins. Sternal plate with very large foveolæ. Ovipositor considerably longer than the pronotum.

General color pale ferruginous (probably green in life, as one specimen bears traces of that color), varied with whitish on the head, pronotum and limbs, and sienna on the transverse veins of the discoidal area of the tegmina. Lower surface pale yellow. Antennæ whitish, annulated with umber; head and pronotum laterally dusted with whitish. Costal area of the tegmina anteriorly blackish.

Measurements.

Length of head and body,	26	mm.
Length of pronotum,	5.5	"
Length of tegmina,	36.5	"
Length of hind femora,	12.5	"

Conocephalus mandibularis (Charpentier).

1825. *Locusta mandibularis* Charpentier, Horæ entom., p. 106.

One female; Daga Tula, Gallaland, September 19, 1894.

Pornotrips horridus (Burmeister).

1838. *Hetrodes horridus* Burmeister, Handb. d. Ent., II, p. 679.

One female; no data.

Family **GRYLLIDÆ**.

Gryllotalpa africana Palis. d. Beauv.

1821. *Gryllotalpa africana* Palis. d. Beauv., Ins. d'Afr. et d'Amer., p. 229, Pl. IIc, fig. 6.

One male; near Tug Berka, east of Finik, Gallaland, December 18, 1894.

Gryllus ater Saussure.

1877. *Gryllus ater* Saussure, Mélanges Orthoptérologiques, V, p. 327.

Two specimens. ♂ and ♀; Sheikh Husein, Gallaland, September 23, 1894.

Gryllus sp.

Three immature specimens.

Hargeisa (Argassa), Somaliland, July 18, 1894.

Dubuli, Gallaland, September 16, 1894.

Between Budesa and Guo Soti, country of the Borau, western Gallaland, May 17, 1895.

Phæophyllacris abyssinica Saussure.

1878. *Phæophyllacris abyssinica* Saussure, Mélanges Orthoptérologiques, VI, p. 587.

One female; Sheikh Husein, Gallaland, September 21, 1894.

Œcanthus pelluceus (Scopoli).

1763. *Gryllus pelluceus* Scopoli, Ent. Carn., p. 32.

One male; Sheikh Husein, Gallaland, September 30, 1894.

Brachytrupes membranaceus (Drury).

1773. *Gryllus membranaceus* Drury, Illust. Ms., II, tab. 43, fig. 2.

One immature male; Sheikh Husein, Gallaland, September 29, 1894.

Heterotrypus africanus Saussure.

1878. *Heterotrypus africanus* Saussure, Mélanges Orthoptérologiques, VI, p. 680.

Two specimens, ♂ and immature ♀.

East of Tug Berka, near Finik, Gallaland, December 19, 1894.

Near Abdula, between Tulu and Laga, Gallaland, November 26, 1894.

July 2.

Mr. Charles Morris in the Chair.

Seven persons present.

A paper entitled "The Land Mollusks of Loo Choo Islands," by Henry A. Pilsbry, was presented for publication.

July 9.

Mr. Arthur Erwin Brown, Vice-President, in the Chair.

Seven persons present.

A paper entitled "A Study of an Ant," by Adele M. Fielde, was presented for publication.

July 16.

Mr. Charles Morris in the Chair.

Eight persons present.

Papers under the following titles were presented for publication:

"Certain Aboriginal Mounds of the Tombigbee River," by Clarence B. Moore.

"Additions to the Japanese Land Snail Fauna, IV," by Henry A. Pilsbry.

"The Spermatogenesis of Oniscus asellus Linn., with Special Reference to the History of the Chromatin," by M. Louise Nichols.

July 23.

Mr. Charles Morris in the Chair.

Six persons present.

Papers under the following titles were presented for publication:

"Cymbuliopsis vitrea, a New Species of Pteropod," by Harold Heath.

"Biographical Notice of Robert Henry Lamborn," by Carrie B. Aaron.

The Publication Committee reported July 29 in favor of publishing papers entitled "Certain Aboriginal Remains of the Northwest Florida Coast, Part I," and "Certain Aboriginal Remains of the Tombigbee River," by Clarence B. Moore, in the *Journal*, and on the following for publication in the *Proceedings*:

NEW JAPANESE MARINE, LAND AND FRESH-WATER MOLLUSCA.

BY HENRY A. PILSBRY.

The present paper continues the description of new species of mollusks discovered by Mr. Y. Hirase. I have taken this opportunity to illustrate the Japanese marine shells described in a former communication.[1]

PLEUROTOMIDÆ.

Daphnella fragilis var. **articulata** nov. Pl. XXI, fig. 26.

General form of *D. fragilis* (Rve.) or *D. lymnæformis* (Kien.). Apical two whorls smooth; several whorls following sculptured with unequal spiral cords, as coarse as those on the last whorl, densely crenulate or beaded by close fine longitudinal laminæ, much less prominent and closer than the spirals. Last whorl densely and evenly latticed by alternately larger and smaller spiral cords intersecting scarcely less prominent, but rather closer, longitudinal rib-striæ. Pale brown, every fourth cord marked with brown in narrow lines along the cord, alternating with diffused white spots; a row of alternately brown and white squarish spots below the suture; the early whorls brown. Aperture smooth within, the outer lip thin, regularly arcuate, rather strongly retracted above. Length 19, diam. 7, largest axis of aperture 11 mm.

Hirado, Hizen, in western Kiusiu (Mr. Y. Hirase, No. 903), types No. 80,634 Coll. A. N. S. P.; Kamakura, just below Tokyo Bay, on the eastern side of Hondo (Acad. Coll.).

Mr. Tryon has lumped several totally distinct species under *D. lymnæformis,* but the form so called by Kiener is less plump than *articulata,* with even, close spirals and inconspicuous longitudinal sculpture on the last whorl, while the spire has comparatively strong costæ and rather coarse spirals. The color, well shown in Kiener's figure, is whitish, with tawny, waved and anastomosing longitudinal stripes. *D. fragilis* has not yet, to my knowledge,

[1] These *Proceedings*, p. 193.

been adequately defined; but the form I have considered to be that species has a small, elevated nucleus of $2\frac{1}{2}$ whorls, followed by about three costate whorls, the ribs crossed by two or three coarse spiral cords; after which the sculpture becomes comparatively fine. If I am correct in this identification, then *articulata* is a distinct species; but as Hedley has lately hinted, many of the more critical or difficult species of the "London School" of conchologists, of which A. Adams and Reeve were shining lights, can be identified with certainty only by visiting the British Museum.[2] Under the circumstances I subordinate my form from Japan to *D. fragilis* as a variety, content to have a name for this well-marked shell, evidently of wide distribution in Japanese waters.

D. supercostata of E. A. Smith seems, from a specimen before me, to belong near *fragilis,* though clearly distinct in both form and sculpture. *D. ornata* Hinds from New Guinea is evidently allied, though with a different color-pattern.

MITRIDÆ.

Mitra (Costellaria) hizenensis n. sp. Pl. XXI, fig. 31.

Shell slender, solid, dusky olive, with a brown or orange-brown and rather prominent subsutural line and an ill-defined white zone at the shoulder, in which the summits of the ribs are transversely marked with short scattered brown lines; the narrow portion of the base is pale yellow, with brown spots and dots. Surface rather glossy, sculptured with rounded longitudinal ribs, nearly or quite as wide as their intervals, 13 or 14 in number on the penultimate whorl, becoming gradually weaker below the periphery of the last whorl, and in adults obsolete toward the aperture; the concave intervals crossed by very low, flat spirals, rather wider than the shallow, oblong pits between them, and about 6 in number on the penultimate whorl. The last whorl is attenuated below, and has a number of large spiral ribs and small cords and striæ, the largest rib continuous with the upper columellar plait. Whorls about 9; apex dark. Aperture small, dark purple-brown within, the lip thin, white-bordered, multilirate inside. Columella with four simple plaits. Length 14.5, diam. 5, longest axis of aperture 7.5 mm.; length 17, diam. 6.5 mm.

[2] Or by imposing upon the present custodian of the collection of Mollusca, whose good nature is admitted to be well-nigh inexhaustible.

Hirado, Hizen, western Kiusiu (Mr. Y. Hirase). Types No. 80,475 Coll. A. N. S. P., from 688*a* of Mr. Hirase's collection.

Near *M. fuscoapicata* E. A. Smith, but it has more and shallower spiral sulci in the intervals between the ribs, which are fewer in number; it is smaller, the upper two plaits of the columella are not grooved, and the coloration is somewhat different. *M. gotoensis* and *M. collinsoni* have more numerous ribs. In adult specimens of *M. hizenensis* the latter third of the last whorl is smooth, the costæ disappearing.

Mitra (Costellaria) vanattai n. sp. Pl. XXI, fig. 28.

Shell rather slender, solid, brownish olive, with a wide dark-brown band below the periphery, and a light brown line at the shoulder, the base brown. Surface rather glossy, sculptured with rounded longitudinal ribs, as wide as the smooth concave intervals, 14 in number on the penultimate whorl, obsolete on the latter half of the last whorl; the attenuated base sculptured with spiral cords, the largest continuous with the upper plait of the columella, those below it (about 4) progressively smaller; a few small spirals above the large cord. Whorls remaining 8 (the apex being eroded), somewhat convex. Aperture bluish and finely lirate deep within, purple brown toward the white-bordered thin lip. Columella with 5 plaits, the upper strong, not grooved. Length 17, diam. 7, longest axis of aperture 8 mm.

Hirado, Hizen (Mr Y. Hirase). Types No. 80,476, from 688*b* of Mr. Hirase's collection.

This species was sent with the preceding, from which it is easily separated by the want of spiral sculpture between the ribs. Somewhat allied to *M. semisculpta*, but it differs in the smooth intervals. *M. analogica* Reeve has fewer plaits, according to the description.

MURICIDÆ.

Tritonidea submenkeana n. sp. Pl. XXI, fig. 24.

Shell short-fusiform, very solid and strong. Sculptured with longitudinal ribs, 12 to 15 in number on the last whorl, the last rib very much larger, forming a large, swollen varix behind the lip; crossed by spiral cords which are low in the intercostal spaces but rise and widen into transverse, oblong, glossy tubercles where they cross the ribs; the penultimate and earlier whorls having three such spiral cords, the last whorl with ten (counted just behind the outer lip); the intervals between the spiral cords everywhere densely, finely striate. Surface lustreless, black, the intervals between ribs and a peripheral belt largely white; the tubercles of the subsutural cord are mostly brown, the others chiefly black. Whorls about 8, but slightly convex, the spire being rather straightly conic; last whorl impressed below the suture, concave below the periphery, produced and spirally striated anteriorly. Aperture less than half the length of the shell, blue-white inside, the lip beveled, with a brown spot at the termination of each spiral cord, thickened within and contracted by six rounded teeth, the upper one more widely separated than the others, the second from above largest. Columellar margin concave above with a pliciform tooth near the posterior angle, straightened and rather wide below, bearing five or six transverse tubercles. Length 15, diam. 7, longest axis of aperture 7.5 mm.

Hirado, Hizen, western Kiusiu (Mr. Y. Hirase). Types No. 80,538 Coll. A. N. S., from 1,037 of Mr. Hirase's collection.

This little black-and-white species groups with *T. menkeana* Dkr., a shorter shell with similar coloration. The unusual prominence of the tubercles on the columellar lip, and the sculpture of ribs tuberculate at the intersections of spiral cords, give it much the appearance of a *Sistrum*.

PURPURA.

The *luteostoma* group of *Purpura* was too much lumped in my Catalogue of Japanese Marine Mollusks. From a renewed study of them, with much more material, it seems that the following four Japanese forms are recognizable: *P. luteostoma* (Chemn.) Dillwyn, *P. bronni* Dkr., *P. clavigera* Küster, *P. tumulosa* var. *problematica* Baker (= *tumulosa* Lischke not Reeve). I formerly followed Mr. E. A. Smith[3] in referring the latter to *P. alveolata* Reeve; but I am now convinced that *alveolata* is, as Reeve stated, a Panamic species. We have specimens from Panama in our collection exactly like his figure.

Mr. Hirase sends the Californian species *P. saxicola* Val. from Kisennuma, Rikuzen, on the east coast of Hondo.

[3] *P. Z. S.*, 1879.

Euthria hokkaidonis n. sp. Pl. XIX, fig. 17.

Shell slender, fusiform, moderately solid, yellowish or purplish ashen. Surface lustreless, sculptured with slightly oblique longitudinal rounded folds as wide as their intervals, 13 or 14 in number on the penultimate whorl, wanting on the base of the last whorl, where they disappear just below the periphery; crossed by spiral cords alternating with threads or striæ, of which there are usually two in each interval; the coarser cords about 5 in number on the whorls of the spire, slightly widening as they cross the longitudinal folds; the spirals alone developed on the base. Spire high; whorls about 9, very convex, separated by deep sutures; the last whorl concave below, produced in a slender, somewhat recurved rostrum; siphonal ridge convex. Aperture small, ovate, acuminate above, livid dull purple inside, with 8 to 10 acute folds within the thin-edged outer lip; canal short and open.

Length 22, diam. 8.5, length of aperture 10 mm.

Length 22, diam. 8, length of aperture 9 mm.

Nakauta, prov. Teshio, Hokkaido (Mr. Y. Hirase). Types No. 80,394, from No. 102 of Mr. Hirase's collection.

Apparently related to *E. fuscolabiata* E. A. Smith, from which it differs conspicuously in the much more slender figure.

COLUMBELLIDÆ.

Columbella misera Sowerby. Pl. XXI, figs. 37, 38.

C. miser Sowb., Thes. Conch., I, p. 129 *bis*, Pl. 38, fig. 111.

This species is figured to illustrate its difference from the following. It was taken in some numbers at Kamakura, province Sagami (below the mouth of Tokyo Bay), by Mr. Frederick Stearns. It is very strongly ribbed, especially on the spire, the ribs being about half the width of the interstices, about 11 or 12 in number on the penultimate whorl, or on the last, when they are not obsolete on its latter part, which is frequently the case. On the front of the last whorl these ribs extend well over the periphery, but they become much shorter on its latter half, or wholly obsolete. The base is sculptured with coarse spiral cords, which become increasingly weaker and obsolete as they approach the periphery. *Color white, with one or two dark brown spots on each rib* and a checkered striped basal zone; the back of the last whorl irregularly striped or reticulate; a white zone, usually brown-dotted on each rib, revolves below the suture. The form varies widely. Alt. 11, diam. 5.2 mm; alt. 12, diam. 6 mm.

Figured specimens are No. 70,765 Coll. A. N. S. P., from Kamakura, Sagami.

Columbella misera var. **polynyma** Pils. Pl. XXI, fig. 39.

This vol., p. 196. Types No. 80,556 Coll. A. N. S. P., from No. 1,097 of Mr. Hirase's collection. Study of more specimens causes me to doubt whether the characters of this form are constantly different enough from *misera* to require specific rank. The following variety connects them to some extent.

Columbella misera var. **californica** Reeve. Pl. XXI, fig. 36.

Columbella californica Reeve, Conch. Icon., VI. fig. 165 (1859). Kobelt, Conchyl. Cab., p. 59, Pl. 8, figs. 3, 4. Not *C. californiana* Gaskoin, P. Z. S., 1851, p. 12.

Specimens agreeing exactly with Reeve's figure were taken by Mr. Hirase at Hirado, Hizen. They are larger than *C. misera*, but agree with that in sculpture, except that there are one or two more ribs to a whorl. The coloration is much darker. There is a white subsutural zone pied with black, and a white basal area striped with black-brown; the intermediate space being more or less suffused with rich brown and copiously lineated with black-brown. The ribs are black below the subsutural zone. Whorls over seven. Alt. 13.5, diam. 6.5 mm.; alt. 14, diam. 6 mm.

Prof. von Martens has quoted this race as a synonym of his *C. japonica*, but I think incorrectly. It is much nearer the true *misera*, and in my opinion is a southern variety of that species. The name given by Reeve is unfortunate, as it is not a Californian species. The specimen figured is No. 80,597 Coll. A. N. S. P., from No. 1,230 of Mr. Hirase's collection

C. misera inhabits the ocean coast of Hondo; *C. misera* var. *polynyma* the opposite shore of the same island, and both *C. misera* var. *polynyma* and *C. misera* var. *californica* occur in southwestern Kiusiu.

FASCIOLARIIDÆ.

Peristernia ustulata var. **luchuana** Pils. Pl. XIX, fig. 18.

See p. 197. Type is No. 80,418 Coll. A. N. S. P., from No. 298 of Mr. Hirase's collection.

P. crocea Gray, *scabrosa* Reeve, *xanthostoma* Nutt. and various other forms of the Polynesian *chlorostoma* Sowb. are all markedly shorter shells. The variety of *scabrosa* figured by Kobelt (Conchyl. Cab. *Turbinella,* Pl. 23, f. 4, p. 96) may possibly be the same, but it is nameless.

BUCCINIDÆ.

Chrysodomus intersculptus var. **frater** Pils. Pl. XX, fig. 21.

See p. 197. Type is No. 80,379 Coll. A. N. S. P., from No. 59 of Mr. Hirase's collection.

Buccinum Hirasei n. sp. Pl. XX, fig. 22.

Shell solid, turreted, partly covered with an olive-brown cuticle; composed of about 8 whorls, which are convex at the periphery, contracted below, and channeled above; the channel rather wide, flat, bounded by a strongly elevated, slightly uneven carina. Sculpture of faint growth-lines and a few low spiral cords, hardly noticeable on the last whorl. Aperture slightly ovate, angular at the termination of the carina, the basal notch not very deep. Outer lip smooth, not thickened, somewhat expanded. Operculum unknown.

Length 104, diam. 43, longest axis of aperture 37 mm.

Kizennuma, Rikuzen (Mr. Y. Hirase, No. 55*b*).

This magnificent species is known to me by the single specimen figured, which was collected dead. The outer lip is broken above the middle, so that its true outline in that part is not given in the figure. The cuticle has nearly all been lost, and the shell is overgrown with *Polyzoa, Spirorbis,* etc.

The conspicuous channel at the suture is formed almost exactly like that of *Chrysodomus pericochlion* (Schrenk), a species occurring with *B. Hirasei* at Kizennuma. The similarity is so great that I have figured Schrenk's species for comparison.

Chrysodomus pericochlion (Schrenk). Pl. XX, fig. 23.

The specimen here figured is longer and less inflated than the original type of the species as figured by Schrenk. The dark olive cuticle, wanting from the base of the shell, resembles that of *Buccinum Hirasei,* and reminds one of the cuticle of such fresh-water snails as *Viviparus* or *Campeloma.*

CERITHIIDÆ.

CLAVA Martyn.

This genus has been used to cover certain species formerly referred to *Potamides*, by Jousseaume in 1884,[4] and by Dollfus and Dautzenberg in 1899,[5] and for the group long known as *Vertagus* by Dall in 1892.[6] The latter usage I find to be correct. In the first volume of the *Universal Conchology* Martyn introduces *Clava* for the *Cerithiidæ* known to him—a group which had previously been referred to *Murex* by Linnæus. He gives the following species:

Clava rugata Martyn (= *Cerithium lineatum* Lam.).
Clava herculea Martyn (= *Cerithium ebeninum* Brug.).
Clava maculata Martyn (= *Cerithium maculosum* auct.).
Clava rubus Martyn (= *Cerithium echinatum* Lam.).

In following volumes of the same work, Martyn adds still other forms of *Clava*. But it is obvious that a type for the genus must be selected from species contained in his first volume. Now the *C. herculea* of his list was made type of the genus *Pyrazus* by Montfort in 1810,[7] under the name *Pyrazus baudini* Montf. *C. rubus* falls into *Cerithium* as now restricted.[8] This leaves *C. maculata*[9] and *C. rugata* to bear the name *Clava*. The two species are not closely related, and the latter may be considered type of Martyn's genus. The name *Vertagus*, used for this group by many authors, had no standing in binomial nomenclature until long after the foundation of *Clava*.

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[4] *Bull. Soc. Zool. de France*, IX, 1884, p. 191.

[5] *Journ. de Conchyl.*, 1899, p. 2.

[6] *Trans. Wagner Free Institute of Science*, III, p. 290.

[7] *Conch. Syst.*, II, pp. 458, 459.

[8] *Cerithium* was established by Bruguiere to contain species of *Vertagus* and *Potamides* of authors, as well as the forms to which it is now restricted.

Clava rubus of Martyn is the well-known *Cerithium echinatum* of Lamarck, which name it must replace. It is not the *Cerithium rubus* of English monographers or of Tryon, who followed their error. Kobelt, in his monograph in the new edition of Chemnitz's *Conchylien Cabinet*, p. 213, quotes "*C. rubus* Pilsbry, *Manual*, IX, p. 103, Pl. 23, fig. 9," as a synonym of *C. serratum* Wood. I was not responsible for volume IX of the *Manual*, my work beginning in volume X. With a "?" he also quotes "*Clavus rubus* Martyn." But Martyn's *Clava rubus* was a totally different shell, the *C. echinatum* of authors, a common Polynesian species. The failure on the part of monographers to recognize this fact was due to want of care; neither the *Universal Conchology* nor Chenu's reprint have been consulted by them.

[9] *C. maculata* is the "*C. maculosum*" of English monographers and of Tryon; another curious error.

No species of the type proposed by Dr. Jousseaume and Messrs. Dollfus and Dautzenberg was contained in Martyn's original list. Their use of the name *Clava* is therefore without proper foundation, while Dall's course is clearly supported by the evidence of Martyn's original work.

The *Vertagus pfefferi* of Dunker is not a *Vertagus* or *Clava*, but a true *Cerithium*, which I have received from Hirado, prov. Hizen, Japan (collected by Mr. Hirase), and from Hong Kong (B. Schmacker). It is very close to *C. granosum* Kiener (not of Searles Wood, 1848), which was described from the Red Sea, and has been reported by Lischke (*Jap. Meeres-Conchyl.*, I, p. 68) from Nagasaki. *C. mitræforme* Sowb. seems to differ but little, if at all, and *C. eximium* Sowb. and *rubus* of Sowerby and Tryon[10] may be the same thing. As there is great uncertainty about the species of Kiener and Sowerby, I prefer to use the name given by Dunker, based upon Japanese specimens, and with a good description and figures, for the Japanese form.

Cerithium chemnitzianum n. sp. Pl. XIX, figs. 14, 15.

Shell oblong-conic, strong, pale yellow, sparsely maculate and densely dotted with rich brown. Sculptured with many very low spiral cords which are weakly granose, the grains irregularly alternating brown and white; the upper two cords with stronger grains. There are about 10 of these cords on the latter part of the last whorl, 4 on the penultimate, and 3 on each of the earlier whorls. The intervals between cords are densely striate spirally, the striæ usually very unequal, a median one generally larger, sometimes nearly as large as the primary cords, and brown-dotted. Outlines of the spire convex below, becoming straight above. Whorls remaining 8 (the apex being eroded), the upper ones flattened, the last three somewhat convex just below the sutures, the last whorl having a very strong, tumid, oblique varix on the back, and another less elevated one strengthening the outer lip. Aperture slightly oblique, the base being a little advanced, white within; outer lip strongly arched, almost forming a semicircle. Columellar

[10] That the English monographers and Tryon should have identified this small species as Martyn's *Clava rubus* is inexplicable. *Murex serratus* of Wood, in the *Index Testaceologicus*, Pl. 28, fig. 158, is a much reduced and poor figure of the true *C. rubus* Martyn; but *C. serratum* of the English and German monographs is quite another thing.

lip calloused, bearing a strong entering callous ridge above. Canal very short, deep and narrow.

Length 27, diam. 13.5, longest axis of aperture 11.5 mm.

Length 29, diam. 14, longest axis of aperture 11.5 mm.

Loo Choo Islands (Mr. Y. Hirase). Types No. 80,631 Coll. A. N. S. P., from No. 279 of Mr. Hirase's collection.

The sculpture is much more feeble than in *C. morus* or its immediate allies, though some forms referable to *morus* resemble this species in form.

The figure of *C. janellii* var. in the zoology of the *Astrolabe et Zelée, Atlas,* Pl. 24, fig. 22, resembles *C. chemnitzianum* somewhat, but differs in the plicate spire. In the monographs by Reeve, Tryon and Kobelt I fail to find anything much like the present species. This shell is named for the author of the most extensive shell iconography of the eighteenth century, a work of utility up to this day. Would that A. Adams, a hundred years later, had defined his species half as well! is one's thought on working with Japanese mollusks.

LITTORINIDÆ.

Echinella cumingi var. **luchuana** Pils. Pl. XIX, fig. 16.

See p. 198. Types are No. 70,962 Coll. A. N. S. P.

This variety resembles *Tectarius spinulosa* Phil. (Abbild. III, *Littorina,* Pl. 6, f. 24), but that is *imperforate,* while this has an open, cylindrical umbilicus.

PYRAMIDELLIDÆ.

Syrnola bacillum n. sp. Pl. XXI, fig. 25.

Shell slender, rod-like, marbled reddish-brown and white, with a narrow band of alternate brown and white spots revolving midway between sutures and on the middle of the upper surface of the last whorl, which has a white peripheral belt; this coloring sometimes very faint. Nuclear whorl standing obliquely on edge, the very short spire inclined downward; subsequent whorls 12½ or 13, flat, separated by deeply cut sutures, sculptured with faint growth-lines and an impressed line revolving below the suture; some very faint spirals showing elsewhere in certain lights. Periphery rounded, the base convex, subperforate. Aperture small, narrowly ovate; columella bearing a single strong fold.

Length 9.7, diam. 2, longest axis of aperture 2 mm.; diam. of the upturned apical whorl .27 mm.

Hirado, Hizen (Mr. Y. Hirase). Types No. 80,605 Coll. A. N. S. P., from No. 1,239 of Mr. Hirase's collection.

A very narrow species, with a particular style of coloration, which at times, however, is very faint. The widely distributed *Syrnola brunnea* also occurs at the same locality. *S. aciculata* A. Ad., of which I have compared specimens from Fiji, is a larger species with more convex whorls.

TURBONILLIDÆ.

Turbonilla varicifera Pils. Pl. XXI, fig. 27.

See p. 198. Types are No. 80,603 Coll. A. N. S. P., from No. 1,238 (part) of Mr. Hirase's collection.

EULIMIDÆ.

Eulima dunkeriana n. sp. Pl. XXI, fig. 30.

A glossy, white, straight species, remarkably thick above, being thus somewhat cylindric. Whorls $9\frac{1}{2}$, a trifle convex, the linear suture being margined below (at least on the upper half of the shell) with a translucent band (sometimes enclosing a white band), one-fourth to one-third the width of the whorl, the lower margin of which, in some lights, looks like the suture itself, though there is no impression at that place. At the last half-whorl there is an impressed varix-line; another in line with it is on the preceding whorl, while the next earlier whorl shows a similar impression somewhat in advance of these. On another specimen about 1 mm. shorter, and evidently not full grown, there is on the last whorl a single varix-line. The aperture is narrowly and acutely ovate; lip simple, a little obtuse. Length 11.2, diam. 2.6, longest axis of the aperture 3.2 mm.

Hirado, Hizen (Mr. Y. Hirase). Types No. 80,637 Coll. A. N. S. P., from No. 1,222 of Mr. Hirase's collection.

Close to *E. philippiana* (Dunker),[11] which was taken at Kamakura by Mr. Frederick Stearns; but *E. dunkeriana* differs in the much broader form. *E. philippiana* has not been well figured. A specimen from Kamakura before me has an impressed varix-line near the end of the penultimate whorl, and only falling a little

[11] Erroneously referred to the genus *Eulimella* by Dunker.

short of corresponding with the position of the peristome; another on line with it is upon the preceding whorl; the next earlier whorl has a varix-line near its beginning, almost a whorl being thus without a varix. A young shell, 6 mm. long, has one varix-line on the back of the penultimate whorl. *E. philippiana* measures, alt. 10.2, diam. 2.15, longest axis of aperture 2.67 mm. Dunker gives alt. 11, diam. 2 mm. for the type.

Evidently these species have resting stages at irregular intervals, and the varix-lines are inconstant in position and number.

Both of these species are remarkable for the thickness of the upper part of the spire, though this feature is more exaggerated in *E. dunkeriana*.

Eulima luchuana n. sp. Pl. XXI, fig. 21.

Shell white and glossy, conic, curved slightly to the right, that margin being about straight while the left side is a little convex, regularly tapering, 9½ whorls remaining (the apex being decollate), slightly convex, the penultimate whorl having an impressed varix-line at its last sixth, the preceding whorl with one on line with the peristome, the next earlier whorl with a varix-line corresponding in position to that on the penultimate whorl; the varices thus being all on the right or incurved side. Aperture ovate-acuminate, the lip a little obtuse.

Alt. 12, diam. 3.85, longest axis of aperture 4.15 mm.

Loo Choo Islands (Mr. Y. Hirase). Types No. 80,628 Coll. A. N. S. P., from No. 1,275 of Mr. Hirase's collection.

The aperture is longer than in *E. nitidula* A. Ad., which, though a smaller species, is described as having 11 whorls.

Assiminea angustata n. sp.

Shell minute, imperforate, or nearly so, long ovate-conic, solid, red-brown, glossy and smooth. Whorls about 5½, rather flattened, the last one convex. Aperture small, rounded-ovate, oblique; peristome simple, the columellar and parietal margins somewhat thickened. Length 3, diam. 1.7, longest axis of aperture 1.2 mm.

Rishiri, Kitami (Mr. Y. Hirase, No. 1,277 of marine mollusk list).

Unusually lengthened for *Assiminea*, but with the color and texture of that genus, though it may possibly be Rissoid.

NERITIDÆ.

Nerita martensiana n. sp.

Shell globose, small, solid, rather bright sulphur yellow, paler and somewhat mottled with gray or blackish toward the aperture. Surface dull, sculptured with low, rather coarse spiral cords, about 15 on the last whorl, the upper one appressed against the preceding whorl. Spire short, whorls about 3, the last a little depressed below the suture, which is bordered below by a somewhat more prominent cord. Aperture semicircular, yellow or whitish; lip-rib smooth, with a small tubercle above, and another well within near the base of the columella. Columellar area white or yellowish, flat and smooth, the outer border well defined; edge of columella straight, with two or three low, subobsolete teeth, the upper one strongest.

Alt. 10, diam. 9.5 mm.

Loo Choo Islands (Mr. Y. Hirase). Types No. 80,489 Coll. A. N. S. P., from No. 729 of Mr. Hirase's collection.

Small as this species is, the specimens are apparently adult. The smooth columellar area, with well-defined outer margin, weak denticulation and smooth rib within the outer lip are its more prominent characters. I find no species agreeing with these specimens in the monographs, the best of which is that by Prof. von Martens in the new edition of Chemnitz.

Nerita helicinoides var. **tristis** nov.

Shell black with some white spots along the basal margin, and sometimes a few angular pink and white spots elsewhere. Columella three-notched in the middle; area smooth, yellow-tinted in the middle; lip-rib weakly crenulate, a small denticle near its upper end.

Alt. 13½, diam. 11½ mm.

Loo Choo Islands (Mr. Y. Hirase, No. 218). Types No. 80,406 Coll. A. N. S. P.

This variety is like the typical form in the denticulation of columella and lip. In var. *lævilabris* Pils. the lip-rib is smooth throughout, and the columellar denticles very weak; these characters being constant in a large number of specimens.

N. helicinoides is apparently closely related to the small form of *N. striata* Burrow described by Prof. von Martens in the new edition of *Chemnitz*, p. 39, Pl. 7, figs. 19, 20.

TROCHIDÆ.

Cantharidus hirasei Pils. Page 199. Pl. XXI, fig. 32.

Cantharidus bisbalteatus Pils. Page 199. Pl. XXI, fig. 33.

Clanculus gemmulifer Pils. Page 200. Pl. XXI, fig. 34.

Clanculus hizenensis Pils. Page 201. Pl. XXI, fig. 35.

Some of A. Adams' blanket "descriptions" might cover these species, but none of them indicate the *specific characters* of either of them. The sane judgment of scientific malacologists now demands that a description shall describe.

TURBINIDÆ.

Leptothyra rubra var. **lævicostata** nov.

Shell depressed-globose, coral-red, with pale and red dots alternating on the ribs. Whorls $4\frac{1}{2}$, the last deeply descending anteriorly. Sculpture of about 8 rather strong, almost smooth spiral ribs above and upon the rounded peripheral region, with one or several fine threads in some of the interspaces; 8 to 10 smaller, closer smooth ribs upon the rather flattened base. Alt. hardly 4, diam. 5 mm.

Northern shore of province Tango, western side of Hondo (M. R. Gaines). Types No. 70,794 Coll. A. N. S. P.

Specimens from Mr. Hirase, taken at Hirado, Hizen, vary from coral-red to almost purple, and some of them are rather larger with the spire elevated, the largest measuring alt. 5.2, diam. 5.5 mm.

This form differs from *L. rubra* (Dkr.) in the smoothness of the spiral ribs, which are not rougher than in the Mediterranean *L. sanguinea* (L.), and in the smaller size, *rubra* measuring, alt. scarcely 6, diam. 6 to $6\frac{1}{2}$ mm. In *L. sanguinea* the ribs of the base are not noticeably smaller, as they are in all of the Japanese *Leptothyras* I have seen. Perhaps this variety is what Dunker and others have reported from Japan as *sanguinea* L.

ACMÆIDÆ.

Acmæa heroldi var. **signata** Pils. Pl. XIX, figs. 10, 11.

See p. 202. Types No. 80,497 Coll. A. N. S. P., from No. 748 of Mr. Hirase's collection.

SOLENIDÆ.

Solen roseomaculatus n. sp. Pl. XIX, fig. 13.

Shell small, thin, moderately curved, the upper and lower margins parallel, both ends truncated, with rather rounded angles; compressed, open at both ends, glossy and smooth except for faint growth-striæ. White with very irregular, more or less confluent purplish-roseate maculation throughout, the spots coarser toward the distal end. Beaks roseate. Anterior end obliquely truncate, the margins narrowly expanded or flaring, thickened within. A single prominent, erect tooth in each valve, that in the right valve anterior to the other and compressed, that in the left triangular, being buttressed posteriorly.

Length 31, alt. 6.3, diam. 3.8 mm.

Hirado, Hizen, western Kiusiu (Mr. Y. Hirase). Types No. 80,565 Coll. A. N. S. P., from No. 1,044 of Mr. Hirase's collection.

This rose-variegated little *Solen* is curved like an *Ensis*, and has some similarity to *S. pictus* Philippi,[12] *S. vaginoides* Phil.[13] *non* Lam. = *S. philippianus* Dkr.[14] and *S. aspersus* Dkr.[15] *Solen pictus* is comparatively shorter and markedly inflated or cylindric, while the present Japanese species is strongly compressed. *S. philippianus* measures 66 by a little over 10 mm. ("2″ 8‴ lang, und wenig über 5‴ hoch"), and is thus a narrower shell, and it is more attenuated anteriorly, with smeared coloration, according to the figure. *S. aspersus* is decidedly more slender, and anteriorly below it is more square-cornered. The proportions of the three species are as follows, the altitude and diameter being compared with the length:

	Length.	Alt.	Diam.	
S. roseomaculatus, ...	1	$\frac{1}{5}$	$\frac{1}{8}$	of the length.
S. philippianus,.	1	$-\frac{1}{6}$		" "
S aspersus, ...	1	$\frac{1}{7}$	$-\frac{1}{10}$	" "
S. pictus, ...	1	$\frac{2}{9}$	$\frac{1}{5}$	" "

[12] Philippi, *Zeitschr. f. Malak.*, 1848, p. 174. Habitat unknown. It has not been figured, to my knowledge.

[13] Philippi, *Abbild. u. Beschreib.*, etc., I, *Solen*, Pl. 1, fig. 3. From New Holland.

[14] Dunker, *Proc. Zool. Soc. Lond.*, 1861, p. 420, under *S. aspersus*.

[15] Dunker, *l. c.*, Australia. The type has been figured in *Conch. Icon.*, XIX, *Solen*, Pl. 7, fig. 33*a*.

PETRICOLIDÆ.

Petricola cyclus Pils. Pl. XIX, figs. 3, 4.

See p. 204. Types are No. 80,580 Coll. A. N. S. P., from No. 1,199 of Mr. Hirase's collection. It has some merely superficial resemblance to *P. typica* Jonas.

Petricola cyclus var. **sculpturata** Pils. Pl. XIX, fig. 7.

See p. 205. Types are No. 10,130 Coll. A. N. S. P., from Puttalam, Ceylon.

VENERIDÆ.

Venus Hirasei Pils. Pl. XIX, fig 1; Pl. XX, fig. 20.

See p. 205. Types No. 80,447 Coll. A. N. S. P., from No. 492 of Mr. Hirase's collection. It is curiously like the Panamic *V. columbiensis* Sowb., but differs in having fewer ribs separated by much wider intervals, and a deeper, narrower pallial sinus. The cardinal teeth are more deeply bifid than in *V. columbiensis.* The largest specimen I have seen measures, length 52, alt. 44, diam. 33½ mm. It is from Oyama, Tsushima.

Tapes platyptycha Pils. Pl. XIX, fig. 6.

Page 206. Types are No. 81,218 Coll. A. N. S. P., from No. 1,196 of Mr. Hirase's collection.

Tapes phenax Pils. Pl. XIX, fig. 5.

Page 207. Types are No. 80,436 Coll. A. N. S. P., from No. 432 of Mr. Hirase's collection

DONACIDÆ.

Donax kiusiuensis Pils. Pl. XX, fig. 19.

Page 207. Types are No. 80,505 Coll. A. N. S. P., from No. 847 of Mr. Hirase's collection.

TELLINIDÆ.

Tellina (Merisca) pristiformis n. sp. Pl. XIX, fig. 8.

Shell equilateral, subtriangular, slightly inequivalve, the posterior end being bent to the right; moderately convex, solid, white. Surface dull and lustreless, sculptured with densely crowded fine, concentric lamellæ, a little stronger and more spaced toward the two ends; the intervals sculptured with fine, subobsolete, radial striæ, which are fainter in the middle, and often hardly perceptible anywhere, even with a lens. Beaks somewhat prominent, small and in contact. Anterior end rounded, the slope above straight; posterior slope straight or slightly convex, finely serrate; the posterior end narrowly subrostrate and biangular, the right valve having two prominent posterior keels, the space between them concave, left valve with one posterior keel, a narrow furrow close before it, with a slighter second depression, the basal margin well rounded, ascending and sometimes slightly sinuous behind. Lunule lanceolate, very deeply cut, bounded by acute ridges, that of the right valve rising well above the left, and with a wider excavation. Area also deeply excavated, bounded by keels, the ligament prominent. Interior white, the hinge strong, with two cardinal teeth in each valve, the left anterior tooth and the right posterior bifid. Left valve without laterals, right valve with low, distant anterior and posterior lateral teeth. Hinge-line straight behind the beak, concave in front. Pallial sinus very large, reaching to within a millimeter or two of the anterior adductor scar, confluent with the pallial line below for about half its length. Scars of the cruciform muscle distinct.

Length 38, alt. 29.5, diam. 11.5 mm.

Inland Sea of Japan. Types No. 71,029 Coll. A. N. S. P.

This species is closely related to *T. pristis* Lam. and *T. concentrica* Gld. It has a wider lunule than the former, its bounding keels without the irregularity, "saw" or serration seen in *T. pristis.* The posterior area is more deeply excavated, the posterior keel of the right valve is stronger, and the end is much more bent to the right. The hinge-plate is wider, and the anterior lateral tooth is further removed from the cardinals. Finally, the dorsal slopes are steeper, meeting at a smaller angle, and hence the whole outline is more triangular. In *T. concentrica* Gld. (Fiji Islands) the form is more elongate, the lunule and posterior area far less impressed, and the interior is more glossy, with shallower, less distinct muscular scars, and the shell is thinner. *T. diaphana* Desh. differs by having the pallial sinus abut against the anterior adductor scar, according to Deshayes' description. *T. siamensis* v. Martens is a longer, less high species, by the description. It has not been figured, so far as I can learn, and is doubtfully distinct from *T. diaphana* Desh.

ANATINIDÆ.

Anatina impura Pils. Pl. XIX, fig. 9.

Page 208. Types are Nos. 68,536 and 70,812 Coll. A. N. S. P.

LIMIDÆ.

Lima hians var. **hirasei** Pils. Pl. XIX, fig. 12.

Page 209. Types No. 80,525 Coll. A. N. S. P., from No. 901 of Mr. Hirase's collection.

Closely allied to *L. hians* Gm. of Europe, but the sculpture is finer, the gape of both ends less widely open, and the anterior rib inside is not so strong.

ARCIDÆ.

Arca nipponensis Pils. Pl. XIX, fig. 2.

See p. 209. Types are No. 79,009 Coll. A. N. S. P.

Land and Fresh-water Species.

PUPIDÆ.

Buliminus reinianus var. **hokkaidonis** nov.

Similar to *reinianus* except in being shorter and broader, with very obtuse apex, the upper part of the spire broader. Whorls 8. Length 23, diam. above aperture 8, longest axis of aperture 9 mm.

Kayabe and Shukunobe, prov. Ojima, Hokkaido.

Typical *B. reinianus* is not known from Hokkaido Island. I now believe that it will be difficult, if indeed practicable or desirable, to distinguish *extorris* or *omiensis* as races distinct from the variable *reinianus*, though typically the forms are separable. There is also a rather small and more striate form of the species occurring at Okinoshima and some other places in Shikoku Island, but I have not seen enough specimens to be satisfied that it requires varietal distinction.

HELICIDÆ.

Mandarina mandarina var. **ponderosa** nov.

Shell large and very heavy, reddish-brown or purple-black with a light umbilical patch; whorls $5\frac{1}{2}$, the last one *distinctly carinated* at the periphery. Surface coarsely decussate, the impressed spiral lines being much stronger than in the typical form. Alt. 21, diam. 28 mm.; alt. 19, diam. 26 mm.

Ogasawara (Bonin) Islands (Mr. Y. Hirase). Types No. 80,812 Coll. A. N. S., from 467*b* of Mr. Hirase's collection.

As yet we know nothing of the distribution of species on the several islands of this little group, the investigation of which will be of the greatest interest. We look to Mr. Hirase to throw light upon it.

Trishoplita dacostæ var. **awajiensis** nov.

Shell depressed-*conoid*, thin, hardly glossy, corneous with a faint brown tint, often in streaks, paler or a little whitish below the sutures. Spires somewhat elevated; whorls 5¾, the last obtusely subangular in front. Sculpture of slight, rather irregular growth-striæ, a strong lens showing some almost obsolete spiral striæ near the umbilicus. Aperture oblique, short-oval, almost round, a little excised by the parietal wall. Peristome thin, narrowly expanded and subreflexed. Alt. 6.2, diam. 9 mm.; width of umbilicus about 1 mm.

Anaya, Awaji Island (Mr. Y. Hirase, No. 643).

This form is duller, more conoidal, with the last whorl more depressed than *T. goodwini* var. *kyotoensis*. It is smaller than *T. dacostæ*, with the aperture less rounded. It is the first *Trishoplita* known from Awaji Island.

Trishoplita goodwini var. **strigata** nov.

Shell similar in general characters to *T. goodwini*, but rather faintly streaked obliquely with brown on a whitish corneous ground, usually whitish below the suture. Finely obliquely striate, and *densely decussate* by close spirals. Whorls 5¾ to 6. Alt. 9½, diam. 13, width of umbilicus 1½ mm.

Hirado, Hizen, in western Kiusiu (Mr. Y. Hirase). Type, No. 78,844 Coll. A. N. S. P., No. 344 of Mr. Hirase's collection.

This form was recognized as somewhat different from the typical *T. goodwini* of Hondo, when received from Mr. Hirase about a year ago; but I did not then think it desirable to distinguish it by name. Since such forms of *goodwini* as *tosana* and *dacostæ* have been so distinguished, it would seem advisable to recognize this also. Upon the whole, it is well to have names for these subspecies, which have become differentiated in various areas of the empire. *T. goodwini* var. *strigata* differs from *tosana* and *dacostæ* by its decussate surface.

ZONITIDÆ.

Kaliella subcrenulata n. sp.

Shell narrowly perforate, depressed-trochiform, pale brown, somewhat translucent. Sculpture of very fine, close, thread-like striæ and subobsolete spiral striæ; the base smooth. Spire conic, the apex obtuse. Whorls 4, nearly flat, the last acutely carinate in the middle, the carina smooth-edged; base very convex. Aperture narrow, somewhat rhombic; peristome simple. Alt. 1.5, diam. 2.4 mm.

Kochi, Tosa, Shikoku Island (Mr. Y. Hirase).

Similar to *K. crenulata* Gude, but much more depressed. It occurred with specimens of *K. crenulata* (Gude), and an elevated variety of *K. multivolvis* Pils.

K. ruida Pils. is a larger and more coarsely sculptured but evidently allied species.

Kaliella lioderma n. sp.

Shell perforate, pyramidal with flattened base, obtuse apex and straight lateral outlines; pale yellowish-corneous. Whorls 7, rather convex, the last acutely carinate, somewhat convex below. Surface glossy, *smooth* except for slight growth-striæ. Aperture basal, rhombic, nearly twice as wide as high; peristome simple, the margins remote, the columellar margin reflexed. Alt. 2.5, diam. 2.2 mm.

Kashima, Harima (Mr. Y. Hirase).

More elevated than *K. crenulata*, and distinguished by its plain, smooth surface.

Kaliella harimensis n. sp.

Shell perforate, obtusely conoidal, fragile, amber colored, translucent. Whorls 5, *convex*, slowly increasing, the nucleus rather large; last whorl obtusely subangular in front, elsewhere rounded at the periphery, the base convex. Sculpture of extremely fine, densely crowded, thread-like striæ above, giving the surface a somewhat silken lustre; almost obsolete on the glossy base, which shows weak spiral striæ near the middle. Aperture truncate-crescentic, the peristome thin, a little reflexed at the perforation. Alt. 2, diam. 2½ mm.

Kashima, Harima (Mr. Y. Hirase, No. 655).

This species is much more depressed than the allied *K. pagoduloides* Gude. It has not the peripheral keel of *K. fraterna* Pils.

REALIIDÆ.

Omphalotropis japonicus n. sp.

Shell narrowly umbilicate, acutely ovate-conic, rather thin, yellowish brown; surface glossy and smooth. Spire straightly conic, the apex rather acute. Whorls 6, convex, the last with a strong basal keel around the umbilicus. Aperture slightly oblique, ovate, the outer and basal margins of the peristome a trifle expanded, columellar margin reflexed. Length 5.3, diameter 3.5, length of aperture 2.5 mm.

Kashiwashima, Tosa, Shikoku Island (Mr. Y. Hirase, No. 588).

This is, I believe, the first *Omphalotropis* found in Japan.

AMNICOLIDÆ.

Bithynia striatula var. **japonica** nov.

Shell pale amber tinted or corneous, glossy, similar to *B. striatula* of China, but differing in sculpture, the spiral ridges being much stronger; 3 or 4 large and irregularly spaced ones above the periphery, those on the base smaller and closer. Alt. 10 (specimens with the early whorls lost by erosion), diam. 6.5 mm.; longest axis of aperture 5 mm.

Manabe, Hidachi (type locality), and Osaka (Mr. Y. Hirase).

Types No. 80,683 Coll. A. N. S., from No. 152 of Mr. Hirase's collection.

Specimens from Osaka have less strong sculpture than those from the province Hidachi, though it is still stronger than in any Chinese specimens of *B. striatula* in the series before me. The peristome is rather less expanded, too, though well thickened in adults, and either black (Manabe) or pale (Osaka). *B. striatula* has already been reported from Japan by Prof. von Martens,[16] who in 1860 found it at Yokohama, on the muddy bank of the small river, at the first bridge, in quite fresh water. I suppose it was this strongly sculptured form which he found. The Vega Expedition collected shells identified by Westerlund as *B. striatula* at Jokogava (near Tokyo), and at Lake Biwa (*Vega Exp.*, IV, p. 182). In China the species is widely diffused, from the Yangtse to the Amur drainages; and Pére Heude[17] has split it into some four species. Of

[16] *Sitzungsber. naturf. Freunde zu Berlin*, 1877, p. 114. *B. striatula* was described from Chusan, as *Paludina (Bithinia) striatula* Bens., *Journ. Asiat. Soc. Beng.*, XXIV, 1885, p. 131. Schmacker found it at Shanghai.

[17] *Mémoires concernant l'Hist. Nat. de l'Empire Chinois*, pp. 171, 172.

these his *B. chinensis* seems to me to be typical *B. striatula*, while *B. spiralis* is a more slender, *B. scalaris* a stouter form, perhaps not more than varietally distinct. *B. striatula* Bens. of Heude is a strongly keeled form, certainly not the typical *striatula* of Benson. His identification of it was possibly due to a remark of von Martens in *Jahrb. D. Mal. Ges.*, II, 1875, p. 133.

I have no great faith in the distinctness of any of these supposed species; but if several Chinese forms are to be distinguished, the Japanese shells evidently deserve at least varietal rank. They are nearer *B. striatula* Heude *non* Benson than to any other of the Chinese varieties.

SPHÆRIIDÆ.

Sphærium inutilis n. sp.

Shell oval, much inflated, thin, equilateral, grayish-brown, with a pale basal zone; glossy, minutely striate; anterior end curved in a semicircle; posterior end a little more obtuse, though still well curved. Beaks small, projecting, "calyculate," or tipped with a distinctly demarked protoconch. Interior bluish-white; cardinal teeth subobsolete, extremely compressed, parallel with the hinge-line, divided in the right valve, single in the left; lateral teeth moderately strong, double in the right, single in the left valve. Length 10, alt. 8.6, diam. 6.2 mm.

Nishigo, Uzen (Mr. Y. Hirase).

Three species of *Sphærium* are now known from Japan: *S. japonicum* Westerlund,[18] *S. heterodon* Pilsbry,[19] and the present species. All belong to the subgenus *Calyculina*. *S. japonicum* is an elongate "subtrapeziform" species. *S. inutilis* differs from *S. heterodon* in having higher beaks, a more curved hinge-line, rounded ends and it is more globose.

No *Pisidium* or *Cyrena* is yet known from Japan proper, although the latter genus occurs in the middle group of the Loo Choo Islands.

CYRENIDÆ.

Corbicula sadoensis n. sp.

Shell triangular-oval, moderately inflated, solid; glossy, nearly black in adults, sculptured with very close, irregularly raised and

[18] *Calyculina japonica* West., *Nachr'bl. d. D. Malak. Ges.*, 1883, p. 58 (April); *Vega Exp.*, IV, p. 216, Pl. 6, fig. 31, from Jokogava, near Tokyo.

[19] *Catal. Mar. Moll. Jap.*, p. 159, Pl. 3, figs. 15, 16, 17, from Hizen, in Kiusiu.

thread-like concentric striæ. Beaks moderately raised and full, deeply eroded in adults. Interior whitish, or light violet outside of the pallial line. Hinge rather narrow, the cardinal teeth slightly grooved at their summits; anterior and posterior laterals of equal length, single in the left, double in the right valve. Length 33, alt. 27, diam. 18 mm.

Sado, Japan (Mr. Y. Hirase).

It fills me with sadness to add another *Corbicula* to the Japanese fauna, but these specimens cannot without violence be referred to any of those known. *C. martensi* Clessin is perhaps the nearest, but *sadoensis* is more transverse, the lateral teeth diverge at a wider angle, and the striæ are far closer. The very close, comparatively fine striation is the chief differential character of the species, distinguishing it from all the other forms.

Corbicula awajiensis n. sp.

Shell oval, compressed, the diameter about half and the alt. three-fourths the length, bright yellowish green, with buff spots and patches toward the beaks; strongly and regularly ribbed concentrically. Beaks rather low, not projecting much, eroded and deep violet. Nearly equilateral, the anterior end sometimes slightly narrower, the two ends about equally rounded, upper and lower margins equally and similarly curved. Interior dark violet, with a darker, often light-bordered spot under the beaks. Hinge delicate, the cardinal teeth small; anterior and posterior laterals of about equal length, somewhat curved, very strongly crenulate, double in the right, single in the left valve. Length 16, alt. 12, diam. 8½ mm.

Noda, Awaji (Mr. Y. Hirase).

The valve-margins viewed from within are seen to form a symmetrical oval figure, the upper and lower borders having almost exactly the same curvature, and the anterior and posterior ends being about equal. There is no suggestion of the subtriangular shape of most Japanese species of *Corbicula*. The beaks are low and the sculpture strong and regular. It is a small species, the first known from Awaji Island, and seems quite distinct from any other.

EXPLANATION OF PLATES XIX, XX, XXI.

PLATE XIX (figures natural size), Fig. 1.—*Venus hirasei*, pp. 205, 400.
Fig. 2.—*Arca nipponensis*, pp. 209, 402.
Figs. 3, 4.—*Petricola cyclus*, pp. 204, 400.
Fig. 5.—*Tapes phenax*, p. 207.
Fig. 6.—*Tapes platyptycha*, p. 206.
Fig. 7.—*Petricola cyclus* var. *sculpturata*, p. 205 (Ceylon).
Fig. 8.—*Tellina pristiformis*, p. 400.
Fig. 9.—*Anatina impura*, pp. 208, 402.
Figs. 10, 11.—*Acmæa heroldi* var. *signata*, p. 202.
Fig. 12.—*Lima hians* var. *hirasei*, pp. 209, 402.
Fig. 13.—*Solen roseomaculatus*, p. 399.
Figs. 14, 15.—*Cerithium chemnitzianum*, p. 393.
Fig. 16.—*Echinella cumingi luchuana*, pp. 198, 394.
Fig. 17.—*Euthria hokkaidonis*, p. 389.
Fig. 18—*Peristernia ustulata* var. *luchuana*, pp. 197, 390.

PLATE XX (fig. 19 much enlarged, the others natural size), Fig. 19.—*Donax kiusiuensis*, p. 400.
Fig. 20.—*Venus hirasei*, p. 400.
Fig. 21.—*Chrysodomus intersculptus* var. *frater*, pp. 197, 391.
Fig. 22.—*Buccinum hirasei*, p. 391.
Fig. 23.—*Chrysodomus pericochlion*, p. 391.

PLATE XXI (figures much enlarged), Fig. 24.—*Tritonidea submenkeana*, p. 387.
Fig. 25.—*Syrnola bacillum*, p. 394.
Fig. 26.—*Daphnella fragilis* var. *articulata*, p. 385.
Fig. 27.—*Turbonilla varicifera*, pp. 198, 395.
Fig. 28.—*Mitra vanattai*, p. 387.
Fig. 29.—*Eulima luchuana*, p. 396.
Fig. 30.—*Eulima dunkeriana*, p. 395.
Fig. 31.—*Mitra hizenensis*, p. 386.
Fig. 32.—*Cantharidus hirasei*, p. 199.
Fig. 33.—*Cantharidus bisbalteatus*, p. 199.
Fig. 34.—*Clanculus gemmulifer*, p. 200.
Fig. 35.—*Clanculus hizenensis*, pp. 201, 398.
Fig. 36.—*Columbella misera* var. *californica*, p. 390.
Figs. 37, 38.—*Columbella misera*, p. 389.
Fig. 39.—*Columbella misera* var. *polynyma*, pp. 196, 390.

THE LAND MOLLUSKS OF THE LOO CHOO ISLANDS: CLAUSILIIDÆ.

BY HENRY A. PILSBRY.

Seven or eight years ago, at the time of my first studies upon Japanese mollusks, only two species of *Clausilia* were known from the Loo Choo Islands: *C. valida* Pfeiffer,[1] described from specimens collected by Largilliert, and *C. præclara* Gould,[2] collected by William Stimpson, naturalist of the U. S. North Pacific Exploring Expedition, under Commanders Ringgold and Rodgers.

Mr. Frederick Stearns brought a third species, taken on Okinawa, which I described in 1894 as *C. Stearnsii*,[3] and a fourth was sent in 1900 by Mr. Hirase, *C. hyperoptyx*,[4] from the same island.

Two other species, *C. Bernardii* Pfr. and *C. ptychochila* Bttg., supposed to be from Siam and China respectively, seem from their characters to be so near Loo Chooan species that I think their formerly assigned habitats were probably erroneous, and that both really came from the Loo Choo Islands. Acting upon this hypothesis, I provisionally include them in the following account.

Through the researches conducted by my esteemed correspondent, Mr. Y. Hirase, the number of species known from these beautiful and interesting islands has now been increased to eleven,[5] not counting the two species of doubtful provenance alluded to above.

Up to this time we have received species from only three islands: Yayeyama in the southwestern group, Okinawa or Great Luchu in

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[1] *Zeitschr. f. Malak.*, 1849, p. 106; *Mon. Hel. Viv.*, III, p. 591. Küster, *Conchyl. Cab.*, *Clausilia*, Pl. 23, figs. 1–3, figures of Pfeiffer's type.

[2] *Proc. Bost. Soc. Nat. Hist.*, VI, p. 425, February, 1859; *Otia Conch.*, p. 103. The name *præclara* being preoccupied in *Clausilia*, Pfeiffer changed it to *C. excellens*, *Jour. de Conchyl.*, p. 268 (1861), basing the new name on Gould's description.

[3] *Nautilus*, VIII, p. 47 (August, 1894); *Catal. Mar. Moll. Jap.*, Appendix, p. 163, Pl. 1, fig. 12.

[4] These *Proceedings*, 1900, p. 446, Pl. XIV, figs. 12–14.

[5] This includes the species of Oshima, as this island belongs both geographically and faunally to the Loo Choo group. Being politically a part of Kagoshima Ken or prefecture, it is not usually considered by the Japanese to be one of the Loo Choo group, which in ordinary parlance includes merely the Central and Further groups of islands, belonging to Okinawa Ken.

the central group, and Oshima in the northeastern group. There can be no doubt that when other islands are explored many more species will be brought to light, and our zoögeographic knowledge correspondingly expanded.

The known species fall into five subgenera or sections: *Stereophædusa*, *Luchuphædusa*, *Hemiphædusa*, *Tyrannophædusa* (?) and *Zaptyx*. Of these, the section *Luchuphædusa*, comprising about half the species now known, has been found nowhere but on these islands. *Zaptyx* extends into the southernmost provinces of Kiusiu, in the neighborhood of Kagoshima Bay; and probably borne by the "Kuro Shiwo" has reached Hachijo, an islet a hundred miles off Izu province; but a Loo Chooan origin of the group seems probable. *Stereophædusa* and *Hemiphædusa* range further, being common throughout Japan, and the latter group is widespread on the Chinese mainland; but the species of the Loo Choo Islands belong to a special group of *Hemiphædusa* which has not been found elsewhere. The single species referred doubtfully to *Tyrannophædusa* has no close relatives, but seems nearer to Japanese than to any Chinese species known to me. The sections *Euphædusa* and *Megalophædusa*, so characteristic of Japan, are wanting in the Loo Choos, so far as present information goes; and *Reinia* has not been found. So much for the distribution of the groups. Descending to *species*, we find not one common to the Loo Choo Islands and any other land.

The general affinities of the *Clausilia* fauna, we may conclude, are closest with Japan, though the endemic element is so strong that no relationship at all intimate can be claimed. No characteristic Formosan forms of *Clausilia* have been found in the Loo Choo group.

Section STEREOPHÆDUSA Bttg.

Clausilia valida Pfr.

Originally described from the "Liew Kiew" Islands, this species is known from Okinawa Island only. It has been collected there by the Japanese collectors sent by Dr. Adolph Fritze in 1891, by Mr. Frederick Stearns about the same time, and has also been taken by Mr. Hirase's collector. The typical form is uniform brownish yellow.

The chestnut-banded form with the coarse sculpture of the type has been named var. *fasciata* by Mr. E. R. Sykes.[6]

Another banded variety may be called var. *perfasciata.* It is similar to *C. valida fasciata* Sykes, but larger, the broad *purple*-brown band more strongly contrasted with the whitish or pale buff bands above and below it; aperture longer, more piriform. The sculpture is perceptibly finer than in *valida.* The types of this form are from the province Kunchan, Okinawa Island (No. 633 of Mr. Hirase's collection).

A third form of the species, var. *striatella,* nov., has the coloring of var. *fasciata,* but darker on the last two whorls, with the same rather wide aperture, dusky purplish within; but the surface is far more finely striated, there being fully twice as many striæ as there are in *valida.* The size is about the same.

Length 28, diam. 6 mm., 7⅓ whorls remaining.

Length 25½, diam. 6⅓ mm., 6½ whorls remaining.

The types are 79,116 Coll. A. N. S. P., from 462 of Mr. Hirase's collection, labeled "Loo Choo."

Clausilia Stearnsii Pilsbry.

The types were taken on Okinawa by the collector sent by Mr. Frederick Stearns in 1891–2. They measure, length 26 to 31, diam. 5 mm. Specimens sent this year from Yayeyama by Mr. Hirase (No. 622) measure 26–28 by 5 mm. Others sent from "Loo Choo" are more slender, length 25–25½, diam. 4⅓ mm., with 12 whorls and a less distinct lunella than the types.

C. Stearnsii is very distinct by its receding inferior lamella and the development of a lunella, both being characters unlike most other species of *Stereophædusa.*

Section LUCHUPHÆDUSA nov.

Clausilium wide, *truncate* or *notched distally,* and with a thickened lobe or finger-like process on the columellar side of the apex, standing at nearly a right angle with the body of the plate.

Shell fusiform, the right margin of the peristome usually crenate, outer margin excavated above to form a sinulus; superior lamella marginal, projecting, continuous with the long spiral lamella;

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[6] *The Conchologist,* II, p. 118. Figure 52 of Sowerby's monograph in the *Conchologia Iconica,* XX, evidently is intended to represent one of the specimens mentioned by Mr. Sykes.

inferior lamella strongly spiral within, calloused below; subcolumellar lamella *dilated adjacent to the very long and strong lower palatal plica,* which is united with the lunella, when that is present; principal plica long; upper palatal plica developed, sometimes coalescent with the lunella.

The shell in this section is similar to that of the group of *C. ptychochila* in general characters, but differs in the dilation of the subcolumellar lamella and in the much higher, simple spiral plate of the inferior lamella within the last whorl. Like the group mentioned, its peculiarities are an exaggeration of the *platydera* group of *Hemiphædusa,* which may be looked upon as a sort of unspecialized branch of the common stock. The clausilium, however, is so peculiar and unlike any Phædusoid group hitherto known, that the erection of a new section is required. The lamellæ and plicæ are all very strongly developed within, and the former are unusually long, passing the ventral position.

Luchuphædusa has much in common with the section *Emarginaria* Bttg. of the German upper Miocene, in which a similar emarginate or notched clausilium and the same interlamellar plication is developed; but the Miocene forms retain a primitive structure of the palatal region, where several plicæ are developed, while *Luchuphædusa* is very highly specialized there. The resemblance is partially due to convergent evolution.

Key to species of Luchuphædusa, by external characters.

1.—Right margin of the peristome crenulate:
- *a.*—Aperture narrow, the sinulus strongly developed; principal plica reaching to the lip; last whorl strongly compressed (Oshima).
  - *b.*—Subcolumellar lamella wholly immersed (though the lip is crenate at its position), . . . *C. oshimæ.*
  - *b'.*—Subcolumellar lamella emerging to the lip-edge, *C. pseudoshimæ.*
- *a'.*—Aperture moderately wide, of normal proportions, piriform-ovate; principal plica immersed, as usual.
  - *b.*—Rather large, the broad right lip deeply plicate; length about 23 mm. (Okinawa), *C. callistochila.*
  - *b'.*—Small, length about 12 mm.: the right lip narrow and not very strongly crenate (Oshima), *C. mima.*

2.—Right margin of the peristome smooth; aperture semicircular; inferior and subcolumellar lamellæ emerging to the lip-edge; length 30–34 mm. (Oshima), ... *C. nesiothauma.*

All of the species of this section are new, and from the two islands Okinawa and Oshima.

Clausilia callistochila n. sp. Pl. XXII, figs. 1, 2, 3.

Shell thick and strong, pale brown, or green from adhering algæ, rimate, turreted, the upper third of the length attenuated, with slightly concave outlines, the lower two-thirds rather swollen, the penultimate whorl widest, the last half of the last whorl contracted, compressed laterally. The apex is obtuse. Whorls $11\frac{1}{2}$, the early ones worn smooth, the rest closely rib-striate, the riblets on the last whorl coarser and more widely spaced, somewhat undulating and irregular. Aperture vertical, rhombic-piriform, with distinct sinulus, the peristome expanded and reflexed, thick, white, the left margin wide and thick as far up as the sinulus, where it is abruptly excavated; *right margin, from the superior lamella to the base, deeply cut into rounded entering wrinkles*, which deeply crenulate the lip-edge. Superior lamella subvertical, rather thick, emerging to the margin, continuous with the high, long and strongly developed spiral lamella. Inferior lamella subhorizontal, strongly approaching the superior lamella within, heavy, not reaching the lip-margin, very strongly spiral inside. Subcolumellar lamella emerging to the lip-edge, where it forms one of the series of lip-folds. Principal plica strong and nearly a whorl long, reaching nearly to the lip; extending inward far beyond the lunella. Upper palatal plica long, converging inwardly toward the principal plica; lunella short and *very obliquely running inward*, arising below from a *very strong and high, angularly bent, long, lower palatal plica.*

Clausilium (Pl. XXII, fig. 4) broad, irregularly curved, abruptly truncate below, slightly thickened along the palatal margin, the apical end of the columellar margin much thickened, bent nearly at a right angle with the rest of the surface, producing a blunt tooth or lobe.

Length 24, diam. $5\frac{3}{4}$, longest axis of aperture $5\frac{3}{4}$ mm.

Length $22\frac{3}{4}$, diam. $5\frac{3}{4}$, longest axis of aperture 6 mm.

Province Kunchan, Okinawa (Mr. Y. Hirase, No. 634).

An extraordinary species, not only by the interpalatal lamellæ which deeply crenulate the lip, but also by the long and high lower palatal fold and very oblique lunella; the two united in such fashion as to make the figure of an almost prostrate letter λ, reminding one of the lunella of some of the *C. platydera* group of

Hemiphædusa, but unlike that group, an upper palatal plica is developed. The clausilium is very peculiar.

Clausilia nesiothauma n. sp. Pl. XXII, figs. 19, 20, 21.

Shell large, fusiform, rather obese below, moderately tapering above, fleshy-whitish, the surface lustreless and (where not overgrown with algæ or worn smooth) sculptured with moderately coarse, somewhat waved rib-striæ, branching or with intercalated striæ on the upper half of the last whorl. Apex small, the first whorl rapidly enlarging, sometimes self-amputated and plugged. Whorls 10, the last tapering below, having a broadly rounded basal crest running to the lower angle of the aperture. Aperture vertical, *semicircular* in general contour, obtusely angular at the sinulus and at the foot of the columella; the inner margin being straightened, the outer rounded. Peristome white, the outer and basal margins flaring, broadly reflexed, the inner margin sloping, emarginate at the termination of the superior lamella, arcuate along the interlamellar space, then straightened. Superior lamella strong, slightly oblique, marginal, continuous with the spiral lamella. Inferior lamella very strong, calloused and thick, forming a squarish columellar fold, abruptly lower or sometimes bifid where it extends upon the peristome. Subcolumellar lamella emerging, very strong and prominent, extending to the lip-edge. Principal plica about one-third of a whorl long, lateral in position. Lunella arcuate, its upper end curving well inward (being completely united with, and curving into, a short upper palatal plica); below, the lunella becomes strong and high, and joins the middle of an extremely strong, long, arched lower palatal fold, the summit of which curves downward and almost meets a broad, erect plate which at this point rises from the subcolumellar lamella. The lower end of the lower palatal plica is visible from the aperture, in a front or slightly oblique view. The inferior lamella is continued inward as a strongly spiral erect plate, rather distant from the spiral lamella on the dorsal side, but approaching it and becoming rather abruptly lower ventrally, both penetrating to beyond the middle of the ventral side. The subcolumellar lamella inward from the expansion toward the lower palatal plica, is slightly sigmoid, and not parallel inside with the inferior lamella.

Clausilium (figs. 15, 16) rather broad in the middle, slightly tapering toward each end, the lower end abruptly truncate, emarginate or notched, a somewhat thickened, finger-like and more curved process extending downward on the columellar side; proximal end passing gradually into the rather broad filament.

Length 34, diam. 7.8, longest axis of aperture 9.4 mm.

Length 30.5, diam. 7.5, longest axis of aperture 9 mm.

Oshima (Mr. Y. Hirase, No. 652).

Readily known by its large size and the peculiar shape of the aperture.

Clausilia oshimæ n. sp. Pl. XXII, figs. 5, 6.

Shell fusiform, the upper third slender and somewhat attenuated, the lower half rather swollen; penultimate whorl widest. Very solid and strong. Pale brownish, more or less eroded. Closely and rather strongly striate. Apex small, the first whorl rapidly increasing, next three or four whorls very slowly widening; whorls about 11½, the last whorl tapering, *laterally compressed*, flattened, having a shallow pit behind the middle of the outer lip, rounded at the base. Aperture ear-shaped, oblique, produced in *a deep retracted sinulus above.* Peristome reflexed, thickened, a slight ridge running behind the outer lip parallel with it; outer lip obtusely toothed at the termination of the principal plica, thin above, rather broad below the tooth. Inner lip projecting in the middle, *cut into six or eight rounded, unequal interlamellar folds,* and similarly or more weakly crenate to or below the subcolumellar lamella. Superior lamella vertical, emerging beyond the general level of the peristome, continuous with the spiral lamella. Inferior lamella very prominently projecting into the aperture, subhorizontal and somewhat thickened below. *Subcolumellar lamella wholly immersed,* but replaced on the lip by rugæ occupying its place. *Principal plica very long, reaching to the lip* and running inward over a whorl; very strong. Upper palatal plica short, weak and lateral; lower palatal plica very strong and long, its lower end visible within the aperture, in an oblique view. Lunella apparently wanting. Within, the inferior lamella is a very high, strongly but somewhat irregularly spiral plate; the spiral lamella is also very high, almost touching the principal plica; and both lamellæ penetrate far past the ventral side. The subcolumellar lamella is short as usual, but strong near its deeply immersed lower end.

Length 22.5, diam. 4.5, longest axis of aperture 5.6 mm.

Length 21, diam. 4.5, longest axis of aperture 5 mm.

The clausilium (Pl. XXII, figs. 12, 13, 14) is strongly curved below, and becomes very thick toward the apex. The distal end has two apices separated by a notch, the outer one conic and rather broad, the inner blunt and bent nearly at a right angle with the body of the plate.

Nase, Oshima (Mr. Y. Hirase, No. 653*a*).

This exceedingly peculiar species has the crenulate right lip of most of its group, but it differs from all known species except the next in the great development of the posterior bay or "sinulus" of the aperture. It is difficult to gain a correct conception of the closing apparatus, so contracted is the cavity of the last whorl by the enormously developed lamellæ and plicæ. The deeply immersed subcolumellar lamella is a prominent feature, differentiating *C. oshimæ* from *C. pseudoshimæ;* but as I have remarked above, this is masked by the sulcation of the lip, by which rounded lamellæ are produced in the subcolumellar position.

Clausilia pseudoshimæ n. sp. Pl. XXII, figs. 7, 8, 9, 10.

Shell very similar externally to *C. oshimæ;* a little smaller; aperture and lip the same, except that *the subcolumellar lamella emerges to the lip-edge.* Internal structure the same, except that the spiral trend of the inferior lamella, as seen from the back in an opened shell, is made irregular by two prominent angles; there is a rather long, latero-dorsal, upper palatal plica opposite the great lateral dilation of the inferior lamella. The very long lower palatal plica gives off *a very short and extremely oblique lunella in a ventral position,* where the clausilium lodges. The clausilium (Pl. XXII, fig. 11) has two subequal blunt apical points, separated by a rather wide notch.

Length 19.3, diam. 4, longest axis of aperture 5 mm.

Length 17, diam. 4, longest axis of aperture 4.7 mm.

Furuniya, Oshima (Mr. Y. Hirase, No. 653*b*).

Strikingly like *C. oshimæ* in general aspect, yet readily distinguishable by a number of important internal characters. On cutting the shell it is found to be decidedly less strong than in the other species. The clausilium lodges in a ventral position. The form of the basal lip is poorly represented in fig. 8. The other figures show it correctly.

Clausilia mima n. sp. Pl. XXIII, figs. 37, 38, 39.

Shell small, fusiform, rather obese, but rapidly tapering and conspicuously attenuated above; thin and not very strong, pale brown, densely and finely rib-striate. Whorls 8½ to 9, convex, the apex rather large, next three or four whorls widening but little; last half of the last whorl much contracted, flattened. Aperture somewhat oblique, small, piriform, with moderately well-defined sinulus. Peristome reflexed, slightly thickened, the outer margin excavated above, the upper and right margins more or less crenulate, the crenulation varying from strong to subobsolete in different specimens. Superior lamella vertical, emerging a little beyond the general level of the peristome, slightly wider or bifid at the margin; continuous with the spiral lamella. Inferior lamella forming a rather strong subhorizontal fold within, not emerging to the peristome. Subcolumellar lamella emerging, marginal. Principal plica about a half whorl long, extending from the dorsal to the middle of the ventral side. Upper palatal plica lateral, arcuate, converging inward toward the principal plica, the outer end contiguous to the lunella, the upper end of which curves toward and is almost united with it. Lunella lateral in position, oblique, weak above, strong below, where it unites with the middle of a long, very strong and angularly bent lower palatal plica. The subcolumellar lamella is abruptly and strongly dilated in the region of the lower palatal plica, and is bent over toward it; beyond this dilation it curves abruptly and ascends the internal column in the usual manner, expands again and turns toward the right, parallel to the other lamellæ upon the roof of the penultimate whorl. The inferior lamella within the last whorl is stout, high, very strongly spiral, and with the spiral lamella continues inward past the ventral side, upon which the three lamellæ run parallel.

Length 13½, diam. 3½ mm.

Length 11½, diam. 3 mm.

Clausilium (Pl. XXII, figs. 17, 18) broad, strongly curved, broadly rounded along the outer margin, truncate at the apex, and produced on the columellar side into a long finger-like process.

Oshima (Mr. Y. Hirase, No. 654).

Much smaller than other species of the section, and strongly attenuated above, like *C. brevior* v. Mart. The process of the clausilium is also longer, and the whole plate is strongly twisted spirally.

Section HEMIPHÆDUSA Bttg.

Group of C. ptychochila.

In this group the right lip or interlamellar space is more or less crenate; the superior and subcolumellar lamellæ are marginal, the inferior lamella somewhat receding, thickened below, strongly sigmoid within, and in the middle of the dorsal aspect it is low, wide and bifid, as if composed of two cords twisted round one another. The lower palatal plica is very strong, elevated in the middle where the lunella joins it, the latter being very strong below, weak above. The clausilium (Pl. XXIII, figs. 26–29) is wider in the middle than in *Hemiphædusa*, tapering above and below, strongly curved toward the thickened, obtuse apex, and with the lateral margins bent nearly at right angles with the rest of the plate, forming a sort of spout-like distal extremity (Pl. XXIII, figs. 27, 28).

This group is probably entitled to separate sectional rank. It is related to the Japanese group of *C. platydera*, but differs in the form of the inferior lamella within the last whorl, and in the clausilium.

Key to species.

1.—Inferior lamella thickened but simple below:
- *a.*—Surface strongly ribbed; subcolumellar lamella somewhat dilated in the part adjacent to the lower palatal plica, *C. Bernardii.*
- *a'.*—Surface more finely costulate:
  - *b.*—Lunella becoming very weak and curving inward above, strong and high below; subcolumellar lamella not dilated near the lower palatal plica; upper palatal plica weak, . . *C. crenilabium.*
  - *b'.*—Lunella straight; shell more obese, *C. ptychochila.*

2.—Inferior lamella bifid below, ... *C. excellens.*

Clausilia Bernardii Pfr. Pl. XXIII, figs. 30, 31, 32.

C. Bernardii Pfr., Journ. de Conchyl., IX, 1861, p. 267, Pl. 15, figs. 1, 2; Monogr. Hel. Viv., VI, p. 426.

This species was described as from Siam. It has not been found by any later collectors in that region, and there are grave reasons for considering the locality erroneous.

The original specimens from Bernardi's collection were distributed to Pfeiffer, the Academy of Natural Sciences of Philadelphia, and perhaps to other collections; and I suppose the figured type is preserved in the collection of the *Journal de Conchyliologie* in Paris.

Upon examining the species, I find that it is very closely related to my *C. crenilabium* of Kunchan, Okinawa; in fact, so intimately, that I have no doubt that *C. Bernardii* really came from Okinawa or some other island of the Loo Choo chain. No species of the same group has been found in China, Tonquin or elsewhere on the mainland, and it is apparently a local group, specialized on these islands.

The source whence Bernardi procured his specimens is not stated, but it is significant that in the same volume of the *Journal* several species from Japan and the Loo Choo Islands, collected by a French naval officer, M. Thomas, are described. Probably *C. Bernardii* was one of the species taken by him in Loo Choo.

C. Bernardii differs from *C. crenilabium* in having the surface-sculpture very much coarser. The lunella is very strong below, where it joins the middle of an elevated conic lower palatal fold, the apex of which overhangs or curves downward in the middle. Above, the lunella rapidly weakens, and curves backward into the low upper palatal fold, which also has a low continuation on the other side—apertureward—of the lunella. The projecting squarish inferior lamella is much thickened below, and within the last whorl it has the peculiar shape seen in *C. crenilabium*, the spiral portion being superposed at the side of, rather than continuous with, the externally visible part of the inferior lamella. It is very strong, somewhat expanded in the region of the lunella. The spiral and inferior lamellæ are of equal length, and continue inward past the ventral position, to a point in line with the superior lamella. In *C. crenilabium* both lamellæ extend further inward, and the spiral lamella is decidedly longer than the other. The crenulation of the interlamellar space is coarser in *Bernardii* than in *crenilabium*. There are 11 whorls, the upper ones more attenuated than in *crenilabium*, and the color is corneous-white, not brownish.

The clausilium of *C. Bernardii* is shaped almost exactly as in *C. crenilabium*, broad in the middle, tapering and strongly curved toward the apex, which is obtuse, slightly thickened and spout-like, from having the lateral edges of the tapering portion abruptly bent toward the convex side of the clausilium. The palatal margin is especially widely reflexed and flattened.

Clausilia ptychochila Boettger. Pl. XXIII, figs. 40, 41, 42.

Clausilienstudien, p. 66 (1877); Jahrb. d. D. Malak. Ges., V, p. 57, Pl. 3, fig. 8 (1878).

The habitat of this species is unknown. It was described from a single specimen, supposed to be from China, but without record of locality. From its characters I think it will be found on Okinawa or some neighboring island.

The type measures, length 24½, diam. 6½, length of aperture 6½, width 4½ mm. It is swollen-fusiform, densely costulate and whitish-corneous, the spire concavely attenuated. Whorls 11. The aperture is rhombic-piriform, peristome much thickened, sinuate and appressed above. There is a groove separating the superior lamella from the *numerous folds which corrugate the interlamellar space.* The inferior lamella is callous below. "The small upper and the longer lower palatal plicæ are united with the short, straight lunella, which at its base gives off a distinct branch backward." The clausilium has not been described.

Boettger's description and figures show this to be a species closely related to *C. crenilabium* and *C. Bernardii.* It differs from the former in being more inflated, with the lunella apparently straight, not curving inward above, and nothing is said to indicate that the lower palatal plica has the great height at its junction with the lunella and the strong development seen in *C. crenilabium.* It is apparently more finely sculptured than *C. Bernardii.* Further collections are needed to determine whether these three species are constantly distinct or united by intermediate examples. Numbers of specimens of *C. Bernardii* and *C. crenilabium* show no tendency toward intergradation, and with present knowledge I would not feel justified in uniting the three species.

Dr. von Möllendorff has placed *ptychochila* in the synonomy of *excellens* (*Jahrb. D. Mal. Ges.*, X, p. 269). This union is inadmissible.

Clausilia crenilabium n. sp. Pl. XXIII, figs. 23, 24, 25, 33.

Shell thick and strong, brownish buff, rimate, turreted, attenuated above, moderately swollen below, the last whorl contracted, penultimate whorl widest. Whorls about 11½, slightly convex, sculptured with close, regular and rather fine rib-striæ, coarser on the last whorl. Aperture vertical, rhombic-piriform, the peristome white, reflexed, somewhat thickened, the outer lip excavated above to form an indistinct sinulus; *the upper margin to the right of the superior lamella is cut into 3 to 5 entering folds*, deeply crenulating the lip-edge; *the rest of the right margin is weakly and irregularly subcrenulate.* Superior lamella strong, slightly oblique, attaining the margin, continuous with the long and high spiral lamella. Inferior lamella strong, approaching the superior, not reaching upon the lip, very heavy and callous below, strongly spiral and with a superposed callus within. Subcolumellar lamella emerging. Principal plica rather long and strong, visible within the aperture, extending inward slightly beyond the latero-ventral lunella. Upper palatal plica small and low, united with the lunella. Lower palatal plica short and high, angularly elevated and overhanging downward in the middle, where the strong lunella joins it.

Clausilium (Pl. XXIII, figs. 26–29) well curved, wide above, the lower half tapering, narrow, terminating in a blunt apex, which is channeled and spout-like outside. Columellar margin thickened near and at the apex; palatal margin sinuous, bearing a sharp, high, keel-like thickening on the outside along its lower half; proximal end emarginate on the columellar side of the filament.

Length 32, diam. 7, longest axis of aperture 7.8 mm.

Length 30, diam. 7.3, longest axis of aperture 8.3 mm.

Length 26, diam. 6.3, longest axis of aperture 7 mm.

Kunchan, Okinawa (Mr. Y. Hirase, No. 632*a*).

This species differs from *C. callistochila* in the weak crenulation of the right lip, shorter principal plica, shorter and differently shaped lower palatal plica, the smaller upper palatal, which is united with the lunella, and especially in the different form of the clausilium.

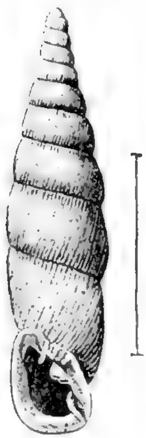
Specimens No. 632*b* of Mr. Hirase's collection, also from Kunchan, the northern province of Okinawa, are green from adhering algæ, evidently having lived in a moist place. The crenulation of the lip is much less marked, there being but one or two interlamellar folds close to the superior lamella; the lower palatal fold and lunella are shortened, forming a sort of triangular buttressed pyramid; the lunella is very low above, and curves into a subobsolete upper palatal fold. The clausilium is the same as in the typical form. The tip of the spire is sometimes lost.

Length 28, diam. 6.3, longest axis of aperture 7.2 mm.

Length 28.7, diam. 6, longest axis of aperture 7.2 mm.

Clausilia excellens Pfeiffer. Pl. XXIII, fig. 43.

This species was originally described by Gould as *C. præclara*, but this name being preoccupied it was changed by Pfeiffer to *C. excellens*. The species was known to Pfeiffer by Gould's description only.[7] Through the kindness of Prof. William H. Dall I am able to give a figure of the type specimen, from Loo Choo, in the National Museum.



It differs from *C. crenilabium* in the slightly stronger striation and the better development of the interlamellar crenulation; and from *C. crenilabium*, *ptychochila* and *Bernardii* in the grooving of the top of the inferior lamella, which is almost bifid. In *C. crenilabium* and *C. Bernardii* the inferior lamella is only bifid far within, in a dorsal position, as shown in Pl. XXIII, fig. 25. In *C. excellens* this bifid structure has apparently moved downward to the lower end of the lamella.

The clausilium of *C. excellens* is still unknown, as the type specimen has not been opened; and the subgeneric position of the species cannot, therefore, be considered certain. It may possibly be a *Luchuphædusa*.

Group of C. munus.

A group of uncertain systematic position, probably referable to *Tyrannophædusa* rather than to *Hemiphædusa*; but more material and further study is needed to determine to what extent *Hemiphædusa* is heterogeneous, and how it may best be subdivided. The heavy thickening of the distal end of the clausilium on the columellar side, and its short form, remove the species described below from *Hemiphædusa*, but it differs from the typical forms of *Tyrannophædusa* in the comparatively few-whorled shell and in details of the palatal armature.

[7] See p. 409, footnote No. 2. There is a very poor figure of *C. excellens* in the *Conchologia Iconica*, XX, Pl. X, fig. 89.

Clausilia munus n. sp. Pl. XXIII, figs. 34, 35, 36.

Shell rather small, fusiform, slender and much attenuated above, rather obese below; brown and glossy when unworn, but often lustreless and more or less eroded. Finely and closely striate, the later half of the last whorl much more coarsely so. Whorls 9 to 9½, rather convex, the penultimate whorl widest, the last whorl contracted, tapering. Aperture rhombic-ovate, the peristome whitish, reflexed, moderately thick, slightly emarginate at the position of the superior lamella. Superior lamella vertical, reaching the margin, continuous with the spiral lamella. Inferior lamella immersed, receding, not visible in a front view, but seen by looking obliquely into the aperture; almost straightly ascending inside. Subcolumellar lamella emerging to the lip-edge, with a groove on each side. Principal plica nearly a half whorl long, its end visible within the throat from the aperture, extending inward slightly beyond the closing apparatus. Upper palatal plica short, converging a little inwardly toward the principal plica; not connected with the arcuate, oblique, rather strong lunella, the lower end of which curves inward somewhat.

Length 15, diam. 3.5 mm.

Length 13.5, diam. 3.6 mm.

Length 13, diam. 3 mm.

Clausilium rather broad and short, tapering to a mucronate apex, heavily thickened on the columellar side at and near the apex, nearly straight, curved only near the filament, where it is abruptly narrowed, and deeply excavated or emarginate on the columellar side.

Oshima (Mr. Y. Hirase, No 646).

In general form this species resembles *C. brevior* and *C. awajiensis*. It differs from the latter in the wider peristome, in having the lunella free from the upper palatal plica, and in the shape of the clausilium, which in this species resembles that of *Tyrannophædusa*, it being shorter and broader than in *Hemiphædusa*, and strongly thickened toward the apex, along the columellar side.

Section ZAPTYX Pilsbry.

Vide these *Proceedings* for 1900, pp. 446, 672.

Clausilia hyperoptyx Pilsbry.

This species was sent by Mr. Hirase as from "Loo Choo"—that is, I suppose, Great Loo Choo (Luchu), Nawa, or Okinawa Island. A further lot, No. 457*b*, has been sent from Yayeyama.

EXPLANATION OF PLATES XXII AND XXIII.

PLATE XXII, Figs. 1–3.—*Clausilia callistochila.*

Fig. 4.—*Clausilia callistochila.* Clausilium, showing form of the apex.

Figs. 5, 6.—*C. oshimæ.* *I*, inferior lamella; *P*, lower end of the lower palatal plica; *S*, subcolumellar lamella; *Sp.*, spiral lamella; *Sup.*, superior lamella.

Figs. 7–10.—*C. pseudoshimæ.*

Fig. 11.—*C. pseudoshimæ.* Clausilium, turned to show form of the apex.

Fig. 12.—*C. oshimæ.* Clausilium, interior face; 13, profile from columellar side; 14, inner face, turned to show form of the apex.

Fig. 15.—*C. nesiothauma.* Clausilium, interior face; 16, the same, turned to show form of the apex.

Fig. 17.—*C. mima.* Clausilium, turned to show form of the apex; 18, interior face of the same.

Figs. 19-21—*C. nesiothauma.* Fig. 20 showing the spiral and inferior lamellæ, and on the left side part of the lunella and lower palatal plica, with the dilated portion of the subcolumellar lamella.

PLATE XXIII, Figs. 23–25.—*C. crenilabium.* *I*, inferior lamella, *L*, lunella; *P*, lower palatal plica; *S*, subcolumellar lamella.

Fig. 26.—*C. crenilabium.* Clausilium, seen in profile from the columellar side; 27, apical view; 28, interior face; 29, the same turned to show shape of the apex.

Figs. 30–32.—*C. Bernardii.*

Fig. 33.—*C. crenilabium.*

Figs. 34–36.—*C. munus.*

Figs. 37–39.—*C. mima.*

Figs. 40–42.—*C. ptychochila* (copied from Boettger).

Fig. 43 —*C. excellens* (type specimen of *C. præclara* Gld., drawn by Dr. J. C. McConnell).

A STUDY OF AN ANT.

BY ADELE M. FIELDE.

The colonies of *Stenamma (Aphænogaster) fulvum* Mayr, subspecies *aquira* Buckley, variety *piceum* Emery, a Myrmicid ant found commonly in the neighborhood of Wood's Hole have varied in the numbers of their inmates from a few individuals to many thousands. The nests are near the surface, in mellow soil, by roadsides, in meadows, and in woods, and are usually near, among, or under loose stones.[1]

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[1] Unless otherwise indicated the ants under observation were kept in the portable nests described by the author in Vol. 2, No. 2, of the *Biological Bulletin*. The species mentioned in this paper were identified for the writer by Prof. William Morton Wheeler, of the University of Texas. The colonies under inspection were kept at the Marine Biological Laboratory at Wood's Hole, Mass., from July to the end of September, 1900, and in New York City from then until the first of June, 1901, when they were carried back to Wood's Hole. The temperature of the room in which they were kept in New York varied from 40° to 90° F., or 5° to 35° C., and this variation often occurred during single days. The word *day* is used throughout this narrative as representing a period of twenty-four hours' duration. The use of Petri double-dishes in the study of living ants was suggested to the author by Prof. Wheeler. Those referred to in this study were about 100 millimeters in diameter and 10 mm. deep on the inside. The cell formed by the double dish was set upon a disk of card-board, covered with white Turkish towelling, to which a tiny patch of black silk was attached. The Petri cell was set upon this disk, which was wider than itself, and the cell was covered with another disk of thick dark blotting paper. Within the cell were two sections of very fine-meshed sponge about 6 mm. thick, covering one-third the floor of the cell, and so placed as to leave a passageway for the ants between the sponge and the cell-wall, and also a triangular space where the ants could settle between the sponges and above the black patch. The sponges were kept saturated with water, to give drink to the ants and moisture to the air, and to prevent the hiding of the eggs in the interstices of the sponge. Care was taken that the sponges should not overflow and inundate the young.

Particles of food, from three to six kinds, known to be acceptable to the ants, were constantly provided, and laid on that part of the floor farthest from the sponges. The air, the water, and the food were kept always fresh and clean. The sponges were dipped in alcohol and well rinsed once a week.

The cells were set upon the shelves of a dark, well-aired cupboard, with the food-side of the cell toward the source of light. Not more than seven ants were permanently housed in a single cell. Among the ants kept several months in this manner there were scarcely any deaths from natural causes, The workers are brown in their general color, and are from four to seven millimeters in length, and, although they are apparently alike in all except size, they are here referred to as majors, minors and minims, the majors being from six to seven millimeters long, the minors from five to six, and the minims from four to five. When the colony moves the majors do the main part of the work of transporting the inert young, and they often seize, lift and carry to the new abode such ants as adhere too persistently to the old habitation. The minors appear to do a large part of the scouting and purveying. The minims are greatly devoted to the care of the eggs, larvæ and pupæ. All assiduously serve the queen, and all engage in battles with enemies.

The queens are from seven to eight millimeters in length without their wings, and are redder than the workers. The kings are from six to seven millimeters long, with the wings projecting another millimeter beyond the end of the body, and are jet black in color.

The workers are efficient fighters, and at close quarters will kill *Formica fusca*, double their bulk. They evince extreme hostility not only to ants of other species, but to those of other or alien colonies of their own species and variety. In this paper the term *alien* is used to denote a different colony of the same species and variety. Queens of different colonies, when placed together in a nest or a Petri cell, ostracize each other, remaining as far apart as possible. If forced into close quarters, they interlock mandibles and push and pull one another until one dies. An alien queen, introduced into and unable to flee from a queenless colony, is attacked by its workers, and though she may make a brave fight, is eventually killed. When a queen is alone she will sometimes fight in defense

and after a day or two of quiet residence in this abode they showed little disposition to leave it, but carried on their normal occupations with an appearance of contentment.

In cleaning the cell, the cover was gently removed in a dim light, the left hand was placed snugly over the part of the cell occupied by the ant family, and the ants stayed in the agreeable warmth and darkness thus provided for them while the unoccupied part of the cell was cleaned. By externally covering any portion of the cell floor with the black patch, and setting the cell in a dim light, the ants were made to move to the selected site without serious disturbance or loss of eggs.

For prolonged observation of the ants I used a weak light, natural or artificial, hand lenses, and a background, under the glass floor, of whatever color best showed the object.

of her eggs, larvæ and pupæ; but if there be workers belonging to her, she retires to a place of safety, and remains there until the fracas subsides and the workers seek her out.

Workers from different colonies shut into the same nest will fight until but one party remains. I put into a Janet nest, which one colony had occupied for a week, another colony that had for two weeks been in a Lubbock nest. The following day the Lubbock colony was congregated with a mass of its young in three stages in the food-room; the Janet colony was likewise congregated with its young in the adjoining nursery, and a battle was raging between groups of two, of three, of four and of five, the attacks being always upon single ants. A day later eighty ants had been slain, and the warfare continued. On the fifth day the young of both colonies had all been brought together into the nursery and the victorious remnant of the Janet colony was alone with its spoils.

When a single alien *Stenamma fulvum piceum* is introduced into a colony, it at once exhibits signs of terror, endeavors to flee or to hide, and keeps apart from the habitants; but sooner or later an inmate comes upon it, and though it may slay its opponent in a duel or two, it is sure to be destroyed, as no *Stenamma fulvum piceum* code of honor intervenes against an attack of many upon one.

Long-continued isolation does not abate the hostility of *Stenamma fulvum piceum* to an alien. I have tried many experiments with queens that had lived solitary for several months, introducing to their respective domiciles alien workers of all ages, from long mature adults to callows just beginning to walk, and I have but rarely succeeded in effecting a reconciliation between the two. The hostility of the worker to the queen was usually as marked as was that of the queen to the worker. The few cases in which affiliation was induced were all between the queen and very young callows, whose impudence appears sometimes to be condoned by their elders. An instance of this toleration was given by a queen and one major worker that had been isolated in a Petri cell for more than three months. After killing several older callows, introduced one by one, they had permitted an alien minim, introduced when but a few hours old, to remain with them. Five days later I introduced two sisters of their adopted young worker, the newcomers being minims about twenty days old. These newcomers at once attacked the queen and the major. The major acted solely on the defensive. Curling her abdomen in, and sitting on the small of her back, with her tough thorax presented to her small enemy, she permitted much nabbing of her body and much pulling of her limbs, making no retaliation. The queen, on her part, caught her little adversary by its antenna and held it firmly and quietly for some minutes, then released it and stood head to head with it without nipping it. The whole conduct of the adults was like that often seen in big dogs that are playing with obstreperous puppies. It appeared as if the adults liked their adopted callow and were unwilling to harm its sisters. The three callows perfectly affiliated from the start; but the newcomers often renewed their attacks on the queen and the major, and after some hours were killed by the adults. The adopted callow continued to live in that cell.

The kings of different colonies are indifferent or friendly to one another, and they have no steady foes either in their own or other households of their kind. They are the only active representatives of their colony that are ever cordially received in any other colony, and strong inducements are apparently offered for their permanent residence among the aliens. I have seen two workers, one on either side of an alien king, holding to his wings and gently conducting him through the grass to the entrance of their domicile; and I have repeatedly seen the workers capture, lift and carry alien kings home with them. If, about swarming time, an alien king is dropped into one of my glass nests, the workers seize him by his wings and forcibly detain him among them. If he later wanders away, they follow, lift and bring him back. The kings are much petted by the workers; their bodies are licked clean, their wings are straightened and smoothed, and their heads are patted with the antennæ. If the colony is forced to change its place of residence the kings are picked up by the small of the back and carried to the new abode. Young winged queens manifest great friendliness toward alien kings. Probably cross-fertilization is common if not universal.

Stenamma fulvum piceum of the same colony, queens, kings and workers, generally live amicably together. The queen is followed, tended, licked and patted, and is the evident centre of attraction in the group.

Colonies captured and confined in my nests just before swarming time, within a few days divided into as many groups as there were queens, the queens disposing themselves as far apart as the limits of the nest permitted. When a queen was then removed by me, the workers at once carried the young and settled down by another queen.

A wingless queen, after wandering for some days alone in a Lubbock nest, cleared an irregularly oval space about three centimeters long and two centimeters wide, building a smooth solid wall with the particles of earth that she removed from her floor. The wall was compact and vertical, and for more than half the circumference of the structure extended a distance of five millimeters from the floor to the glass roof. She worked industriously for several days on this structure and then laid an egg, which she lifted and carried between her mandibles whenever light was admitted to her dwelling. The day after the laying of the first egg, a visitor lifted the glass roof of the nest and spoiled her work. I then marked her, using a fine camel's-hair brush and dotting the top of her abdomen with a fleck of quickly drying varnish into which water colors had been rubbed, and I then returned her to her own colony, from which she had been absent three weeks. The first worker that she there met stood head to head with her for some minutes, while the two tapped each other with antennæ and the worker regurgitated food to the queen. Other ants greeted her with the same ordinary signs of satisfaction. Nine queens taken on their emergence from the nest at swarming in September and placed in Petri cells, each with an alien king, retained their wings from two to three months, and only one of them laid eggs before shedding her wings. One of my queens shed her wings the day she was captured, and another retained hers nearly four months. One laid her first egg twenty-seven days after swarming in September, and one laid no eggs until January, one hundred and six days after swarming. None of the score of queens that I have isolated at their swarming with alien kings has failed sooner or later to lay eggs.

The eggs are deposited one at a time, without regularity in the intervals. Only once have I known so many as six to be deposited in a single day, one or two a day being the ordinary number. If the queen is agitated or troubled she ceases from egg-laying, sometimes for many days together. Some of the queens in my Petri cells have averaged more than one egg a day during every month from September to the following July, and they and their workers appear to be in good health, though they have had during the winter no respite from the labor of rearing the young.

The eggs laid by the queens are visible to the unassisted eye, are a pearly translucent white, and are oblong in shape, the thickness being about half the length, which is half a millimeter. When the queen is about to deposit an egg, workers stand about her, as if aware of a new duty, and they pick up the egg as soon as it is deposited and add it to the packet, which is constantly tended, kept clean, watched over and carried about by the workers. The egg-packet, after being carried about for some time by one worker, is passed over to another, who appears to assume the burden eagerly. If the queen is alone she takes care of her own eggs.

In order to ascertain the time of incubation, I placed queens each in a clean Petri cell, some with workers, some without workers, and cleaned each cell daily until the first egg was deposited in it. I examined the cell two or three times a day, and recorded the time of deposit of the first egg and of a few succeeding ones. In some cases I removed the queen after a few eggs had been deposited, leaving the eggs to the care of the workers alone. I counted the eggs daily to see that there was no diminution in their number, and I cast out from my calculations all cases in which there was a diminution of the number of eggs during the time of my observations. I was also careful that there should be no manipulation nor disturbance of the eggs except by the ants themselves. The eggs recorded were laid between the 7th of October and the 8th of the following May, and were laid by ten different queens. Twenty-two simultaneous or successive broods were thus observed, with the result that in two cases the first larva appeared on the eighteenth day after the laying of the first egg; in nine cases on the nineteenth day; in ten cases on the twentieth day; in one case on the twenty-first day. The time of incubation was not influenced solely by temperature, for eggs laid by different queens on the same day did not invariably hatch on the same day. In six of the twenty-two broods two eggs were deposited by the same queen on the first day, and these six broods each produced its first two larvæ within the same day. Furthermore, the appearance of larvæ succeeding the first in each brood corresponded closely with the times of the deposit of eggs succeeding the first laid. Various broods, removed to weak alcohol or hot water and examined under a lens, showed the larva well formed in the egg at about the seventeenth day and no earlier. Broods in which the first larva appeared on the nineteenth day were immersed in alcohol and examined under a lens, and they always showed earlier, but never later, stages of larval existence; while broods in which no larva had appeared on the twentieth day showed, when examined in like manner, a larva perfectly formed within the egg membrane. I therefore conclude that the period of incubation varies between seventeen and twenty-two days, with nineteen days as the common period. The variation in the period of incubation bears no fixed relation to the size of the future adult. Eggs of different periods of incubation followed to the adult form were found to produce the same sort of worker.

My ants have furnished no evidence that they ever devour the eggs, larvæ or pupæ of their own colony. One worker, isolated in a Petri cell twenty-one days without food, died leaving five eggs intact during the last sixteen days of her starvation. In all the score of Petri cells in which I have for months watched the condition and counted the numbers of the eggs, no diminution of them could be logically charged to the mature ants, whose skill and diligence in keeping them clean, safe, dry and in humid darkness, merits high renown.

The feeding of the larva, which is bent nearly double in the egg, with regurgitated food begins as soon as it straightens itself and protrudes its mouth. When the larvæ begin to appear in the egg-packet, the workers lift the packet and hold it free and still, while one of their number holds a translucent white globule of regurgitated food to the larval mouth projecting from the surface of the egg-packet. I have repeatedly seen the workers thus feeding the very young larvæ, a single globule of regurgitated food serving for a meal of which four or five larvæ successively partook.

When the larva first emerges, its length is nearly double that of the egg. When well fed its growth is rapid and in a day or two its length is three or four times that of the egg. When about two millimeters long it is usually removed from the egg-packet and laid on the floor, or associated with others of its size in a separate bundle, the individuals being fastened together by the hooks on their surfaces, as the eggs were by their sticky shells. The habit which is observable in *Stenamma fulvum piceum*, in common with some other species of ants, of assorting the young in accordance with the size and form, doubtless economizes labor and also tends to the preservation of the young. The flexible neck of the larva enables it to reach to a distance equal to a quarter of its body-length, and to fix its mouth upon anything edible that is within its reach. I have observed a gradual diminution of the eggs in every cell where the smallness of the working force prevented that segregation of the larvæ and that assortment according to size which prevails in large communities; and I have also, in such circumstances, seen full-grown larvæ, and even pupæ, fall victims to the voracity of the unfed younger larvæ.

The older larvæ are often fed when lying upon their backs, the ventral side serving as a place of deposit for food reached by the curving of the neck, as described for *Ponera coarctata* by Prof. Wheeler in the *Biological Bulletin*, Vol. 2, No. 2. But this feeding posture is with *Stenamma fulvum piceum* scarcely more common than are others. Sometimes one larva is used as a table, not only for its own feeding, but for the feeding of two or three other larvæ that are inclined against its sides to take their portion of the same morsel. I have also seen five larvæ set on end around half the abdomen of a bisected house-fly, feeding voraciously from its interior, like pigs around a trough. Sometimes the larva is laid with its ventral side against a succulent portion of the insect, and is left there to take its fill; sometimes it has a portion of meat held to its mouth and forcibly removed as soon as it has had a brief repast, and sometimes a worker stands with her head over that of the larva and allows it to take food from her crop in a manner resembling that in which a mother-pigeon feeds her young. In my nests the very young larvæ have been fed solely upon regurgitated food. The older larvæ have been given particles of flies, mealworms, roaches, beetles, spiders, sponge-cake, white bread moistened with sweetened water, and of dried yolk of hens' eggs. They have also fed upon fragments of ants of other species, on pupæ of alien colonies, and on the pupæ and larvæ of *Cremastogaster lineolata* and of *Lasius umbratus*.

Larvæ deprived wholly of insect food did not during a period of one hundred days produce one pupa. But larvæ grew from the egg to nearly full size without insect food, and one pupa, that later on became a minim, had no insect food during the last twenty-two days of its larval stage. The adult ants appear able to live on indefinitely without insect food; but there is a noticeable diminution in the number of eggs laid by the queen, and in the number of the larvæ simultaneously fed by the workers. I have seen no instance of the eating of members of their own colony by these ants, nor of their feeding their larvæ upon dismembered kin. But they will eat and feed to their larvæ the flesh of dismembered alien callows, and probably thickness of integument is all that protects alien adults from being commonly used as food.

The responsibility taken by the workers in the care of the young may have brought about an incapacity on the part of some of the queens to regurgitate food, and may have disabled them for solitary rearing of the larvæ.

Two sister queens that were taken at swarming on September 17, lived each with a king of another colony until the death of both kings, when I placed them, on November 13, together without workers in a Petri cell where they lived until the following June. The first egg was laid on December 8, and the first larva appeared on December 28, when there were fifteen eggs, cared for by both queens. The queens continued to lay eggs, and young larvæ frequently appeared among the eggs, but no larva lived longer than two or three days. Up to April 28, four months after the appearance of the first larva, no larva had been reared in this cell, although more than one brood had meantime been successfully reared in all similar cells where the queens were assisted by workers. I then thoroughly cleaned the cell and replaced the two queens. That same evening two eggs were deposited, and when, on May 7, the eggs had been increased to eleven, I put in two full-grown alien larvæ, and later on a white pupa, all of which were accepted by the queens. On May 24 the pupa became a minor ant, and at once began to assist the queens in the care of the eggs. On May 25 two new larvæ were to be seen among the eggs, and these larvæ continued to grow and live. The two introduced larvæ also thrived, and on June 10 the two queens and three callows were together engaged in tending a promising group of larvæ, the first that were reared from eggs in this cell.

Three solitary widowed queens of the five in my Petri cells, during four or more months after beginning to lay eggs, failed to rear any larvæ, although other queens to the number of seven, at the same time and in exactly similar conditions, with the exception of having worker-assistants, all reared one or more broods. The fourth solitary queen brought up a single male, I myself having given her much help in the feeding of one larva, the sole survivor among many that appeared and perished during four months. The fifth solitary queen had the assistance of workers in rearing her first larvæ, and later on when the workers were removed, she indisputably fed and reared larvæ all the way from the egg upward.

The length of the larval period has, in my nests of *Stenamma fulvum piceum*, as is generally thought to be the case with other ants, been apparently dependent on the amount and quality of the food-supply. Between October 27 and May 9 I recorded the beginning and end of the larval stage of twenty-six larvæ from queens' eggs. There was one of twenty days, one of twenty-one, one of twenty-two, three of twenty-four, one of twenty-five, one of twenty-six, one of twenty-seven, four of twenty-eight, one of twenty-nine, three of thirty, one of thirty-one, two of forty-two, one of fifty-three, one of eighty-four, three of ninety-three, and one of ninety-seven days' duration. All the larval periods shorter than forty-three days were in domiciles where the queen was present, and all over forty-three days were in cells where the larvæ were reared by workers alone. The assiduity of the worker is even obviously greater when the queen is present. The shortest period recorded was that of the larva in whose feeding I myself assisted the queen.

The length of the larval period does not determine the sex nor the size of the ant. In the cases above recorded, one larva having a period of twenty, one of thirty and one of ninety-three days all ultimately became males. One larva with a period of twenty-four, one of ninety-three and one of ninety-seven days all ultimately became minims. The only queen hatched in my nests had a larval period of fifty-three days. A queens'-egg-larva now under the care of three workers in one of my Petri cells has been in the larval stage a hundred and forty days.

From four to eight days previous to emergence from the larval stage, the larva expels the contents of the alimentary canal, ceases to feed, and changes in color from translucent white with a brown core to creamy and more opaque white. Deprivation of food for some days will cause any half-grown larva to make these preparations for becoming a pupa, and minims can be reared at will.

The larvæ are kept resplendently clean by the licking given by the workers. In my nests the workers appeared to learn a use for the sponge, and when I at various times soiled a larva with stale insect juices, they rubbed it upon the sponge to clean away what they apparently disliked to lick off.

Either majors, minors, or minims alone can feed larvæ, but in my Petri cells, where food is always near, they have rarely reared more than three larvæ to each adult worker. A minim alone with a queen reared three larvæ simultaneously, and five majors together reared sixteen. The anxiety which impels the nurses to lift the immature young whenever the cell is uncovered probably hinders their rearing large numbers in these abodes. When disturbed, the workers first lift the oldest in the nest, the pupæ, the larvæ or the egg-packet. This order is also followed by the solitary queens.

After the larvæ are large enough to be removed from among the eggs of a packet and to lie separately on the floor, they are so fed as to bring them to about the same size. As the eggs are laid rather regularly, one or two a day, and are nearly equal in their periods of incubation, the larvæ, if evenly fed, would reach the pupa stage one by one. But great natural possibilities of shortening or prolonging the larval period by increase or diminution of the supplied nutriment, and the method of feeding the larvæ so unequally as to keep them nearly equal in size, causes the normal nest to be at times without pupæ, and at times to be destitute of advanced larvæ. I have observed in natural nests, and also in my artificial nests, that at times there are a great number of larvæ and no pupæ, and at times countless pupæ with no advanced larvæ.

The larvæ grow to the length of the pupæ perfected within their integument, varying from two to five millimeters. When the thin, transparent-white integument bursts, the ants clean the snow-white naked pupa, and constantly watch over and tend it. Its first color appears in the eye-spots, which are grayish on the third day and brown on the fifth. On the tenth day, with the utmost regularity, there is a deposit of pigment on the dorsal side of the largest segments of the abdomen, and this color spreads and deepens until, on the twelfth day, the sex of the future ant can thereby be foretold, the worker-pupa being yellowish all over, the male-pupa gray-bodied with white limbs, the queen-pupa mottled brown and orange with yellowish limbs. Two days later the worker-pupa acquires the rich dark amber color which it retains as a callow; the slate color of the male-pupa deepens to black, and the queen-pupa has the tints of an adult queen. The length of the pupa-stage was ascertained by me for seventy-three pupa, all presumably the issue of queens' eggs, in fifteen different habitations, between January 5 and May 27. I took the time from emergence from the larval sheath to the assumption of the standing posture as the period of pupa-existence. Forty-four of my number proved to be minims, and of these two became such on the fourteenth day, twenty-three on the fifteenth day, and nineteen on the sixteenth day.

Fourteen became minors, and of these eleven became such on the seventeenth day and three on the eighteenth day.

Ten became majors, and of these five became such on the nineteenth day, four on the twentieth day and one on the twenty-first day.

The pupa-stage of the sixty-eight workers varied, therefore, between thirteen and twenty-two full days; but the minims may be said to have a pupa-period of about fifteen days, the minors a pupa-period of about seventeen days, and the majors a pupa-period of about nineteen days.

Four of the seventy-three pupæ became kings, and of these one became such on the eighteenth day, two on the nineteenth day and one on the twentieth day.

One only became a queen. She was a pupa nearly seventeen days, and died soon after beginning to walk about among the three workers that reared her from a queen's egg.

Of some hundreds of larvæ that have successfully been reared to the pupa-stage by my captive ants, not more than ten have failed to safely pass the pupa-stage and to live on as ants. The small proportion of deaths among the ant-children, in so unnatural an environment as is created by a glass nest and a human purveyor, surely indicates a more than human skill on the part of the adults in their care of the offspring, or else wonderful tenacity of life on the part of the young ants.

The workers care for the pupæ with the same assiduity that distinguishes their attention to the eggs and the larvæ, but this attention does not appear to be necessary to the survival of the pupæ. I isolated ten pupæ in a Petri cell, having the same warmth, moisture, and general environment as had those pupæ remaining under the care of the workers, and although half of them were taken from their nurses before any color had been deposited in their integuments, every one of them came safely to the adult-stage. When, as callows, they were one by one returned to their adult kin, they received such an extraordinary amount of licking as to suggest the well-known theory that the pupæ exude a substance which is liked by the ants, and that the attention of the latter to the pupæ is not wholly altruistic.

These ants are very cleanly. In every nest where I have long kept them they have chosen a fixed place for the throwing of refuse, as remote as possible from the inert young.

They carry morsels of food and lay them on the sponges, as if with intent to moisten edibles that are too dry for their eating.

They follow their usual occupations both by day and by night. Individual ants rest sometimes for hours, standing motionless and apparently asleep. I have seen a worker spend more than an hour upon her toilet, combing or licking every part of her body as far as she could reach. Much willing service is renderd by the adults to each other in the cleaning of their integuments. I saw one worker hold another by a foot, apparently insisting upon such service, which was rendered at intervals and was renewed only when a limb was again nipped, during forty minutes. On the final release of the operator the two ants turned mouth to mouth and one regurgitated food to the other.

The muscular endurance of these ants seems to be great. They will fight with no cessation during several hours, holding an enemy by a limb or mandible. When the fight is a duel, the stronger ant, or the ant that first succeeds in nipping a leg or an antenna, thereby drags its opponent over objects, itself keeping the higher ground, until the limb is severed. In the Lubbock nests, the stronger fighter always threw the weaker into the moat, either before or after the death of the unfortunate. When a battleground presents a precipice, the attempt to push the enemy over it is always noticeable. The successful use of the sting does not appear to be fatal to an ant-enemy, although it gives pain in the human hand for an hour or more.

Notwithstanding the general harmony and mutual helpfulness in a colony of *Stenamma fulvum piceum*, the ants have their individual quarrels. Three queens had lived by themselves serenely in a Petri cell for five months, giving common care for four months to their single group of eggs, when two of the queens began a tug of war, standing head to head, one holding the other by a mandible, and dragging or pushing her over and around the sponges. Uncovering the cell, watering the sponges, introducing an alien worker caused no cessation of the fray. The third queen, distinguished from the other two by a fragment of wing on one side, made frequent excursions to inspect the two belligerents, and then returned quickly to continue her care of the eggs. The battle persisted, with brief intervals, for four days, and then one of the two combatants was left on the side of the cell opposite the eggs, and there she remained in isolation for the ensuing ten days. I several times lifted her and placed her close to the other two queens and the eggs, but every time her wingless enemy seized her by the small of her back, carried her across the cell, and cast her down in the place for refuse, or else attacked and drove her back to her place of banishment. On the eleventh day the banished queen was permitted to return to her two sister queens and the eggs, but she died on the following afternoon.

One who watches the proceedings of these ants through many months finds numerous occasions when the sequence of events strongly suggests a designed punishment of individual offenders in the colony. Twice I have seen an assembly of older ants, its members ranged at nearly equal distances, forming a circle with all heads toward the centre, remaining motionless except in vibrations of the antennæ or a curious shaking of the abdomen, certainly for some hours, and probably for some days. These assemblages were each succeeded by an execution. In the one case an ant was torn asunder and cast in the kitchen-midden. In the other case one ant was dismembered, and another ant picked up the head and thorax of the dismembered victim and carried it about in the food-room. She was carrying it at all the many times when I looked at her during the succeeding three days. Of course, the sequences noted may have been merely double coincidences in two unusual proceedings of the ants.

Both majors and minors among the *Stenamma fulvum piceum* sometimes lay eggs, especially when no queen is present in their habitation. The number of eggs laid is sometimes considerable. I have seen as many as three hundred at once in a nest of fifty workers from which a queen had been for several months absent. One of my Petri cells, in which the eggs of five isolated workers came to the larval stage, indicated that the time of incubation of these eggs may be the same as for queens' eggs, eighteen or nineteen days. The first egg was laid on February 21, the second on February 23, and the eggs were gradually increased to ten. The first larva appeared on the 12th and the second on the 14th of March.

The larval period of workers'-egg-larvæ under the care of workers alone, appears to be much longer than for the queens'-egg-larvæ under the care of queens alone, or under the care of queens and workers, or under the care of workers alone. Judging from data recorded from five groups of isolated workers that have been rearing their own progeny in my nests during ten months, I think these larvæ sometimes take more than two hundred days in their growth from egg to pupa.

The workers' eggs are about half as large as are the queens' eggs; the larvæ on issuing from the eggs are but half as large as those issuing from queens' eggs; the pupæ are also much smaller than are those of males produced from queens' eggs, and the adult males are dwarfs, being from four to five millimeters in length of body, without the wings.

A colony captured by me on July 13, 1900, lost its only queen on August 25. It was transferred from a Janet to a new, clean Fielde nest on September 6, and after that date had no communication with any other nest. Between the 17th of the following February and the 7th of June, 1901, twelve dwarf males were successively produced. No ants of any other sort were during four months produced in this queenless colony. All twelve of these dwarf males, with the utmost regularity, showed eyespots and ocelli of pale gray on the third day of pupal existence, and the color deepened to black on the fifth day. On the tenth day the dorsal side of the abdomen became grayish, and on the twelfth day the head, thorax and abdomen were slate color, while the limbs remained white. Thereafter the color deepened to black, and in each of the twelve cases the pupa became an ant on the seventeenth day.

Four of these dwarf males, that remained during their natural lives with their worker-progenitors, lived respectively fifteen, thirty-two, thirty-four and forty-five days.

The food which the *Stenamma fulvum piceum* were seen to eat in captivity was, in the order of their apparent preference, fragments of flies, roaches, mealworms, beetles and spiders; morsels of sponge-cake, white bread moistened with sweetened water or white syrup; apple, banana, boiled sweet-potato; fat of boiled fresh beef; soft gum-drop, almond paste, pie crust, hickory nut and honey. They showed no lively interest in other than insect food of which they had been for some days deprived. They appeared to avoid all raw or cooked meats other than particles of fat. Their liking for a varied diet and their attention to unusual delicacies indicate a highly developed sense of taste.

Though the attitude ordinarily assumed in eating is that of standing on all six legs and lapping the food, I have twice seen an ant stand on four legs, using the front feet to hold an insect-egg to its mouth, suggesting the posture in which a squirrel commonly eats nuts.

The amount of food required to sustain life must be small. I isolated sixteen workers in groups in clean Petri cells, containing nothing but sponges that were frequently cleaned with ninety-five per cent. alcohol and then saturated with water. Of these ants one lived five days, five lived six days, two lived seven days, one lived eight days, three lived nine days, one lived twelve days, one sixteen days, one twenty-one days, and one thirty-four days without visible food. That these ants died from starvation and not from other cause was indicated by the control experiments in which other ants similarly placed, but with a supply of food, continued to live on for months. The ability of *Stenamma fulvum* to endure starvation is, however, exceeded by the less active *Formica fusca* and the sluggish *Ponera coarctata*, one of the former having lived in my Petri cell forty-one days, and one of the latter forty-three days, without visible food. *Formica sanguinea* shows lesser tenacity of life, as none of several subject to the same experiment lived more than six days.

The *Stenamma fulvum piceum* also meet extreme cold with impunity. At about 50° F., or 10° C., they become sluggish, remaining almost or quite motionless in their usual attitudes. I froze a two-queen colony for twenty-four hours, the thermometer going down to 23° F., or 5° C. On gradually thawing the ants, all survived, including callows but two days old, and the frozen pupæ, larvæ and eggs developed perfectly later on. Another small colony was frozen continuously for five days, the thermometer going down to 15° F., or 10° C. The queen and all the workers survived thawing, but a fifth of the workers died soon after, and the queen, who had previously laid eggs almost daily for five months, laid no egg thereafter for eighteen days.

It is probable that these ants, being highly thermotactic, seek the deeper, warmer recesses of their nests in the ground in autumn, and there hibernate until the warmth of spring draws them toward the surface.

The color of these ants manifestly deepens with age. The newly hatched callows are translucent amber. The brown tint of the adult first begins to appear on the dorsal side of the largest segments of the abdomen. Some of the majors have already this beginning of brown coloration before they pass the pupa stage. The head, which is throughout life darker than the thorax, takes on color next after the abdomen. In three or four months the young worker has the color of an adult, but very old ants, queens as well as workers, attain deeper shades of brown with passing years. The males are fully colored, a glossy jet black, even before leaving the pupa stage.

I have not yet the data from which to draw conclusions concerning the longevity of queens and workers, though I have those in my nests that are certainly over one year old. The shorter-lived males have furnished me the following record relating to their longevity:

Longevity Table for 20 males, presumably the issue of queens' eggs.

a. Swarmed September 17 from roadside colony, isolated with queen of another colony in a Petri cell, lived . . . . 5 days.

b. Swarmed September 17 from roadside colony, isolated with queen of another colony in a Petri cell, lived	7 days.
c. Swarmed September 17 from roadside colony, isolated with queen of another colony in a Petri cell, lived	13 "
d. Swarmed September 17 from roadside colony, isolated with queen of another colony in a Petri cell, lived	20 "
e. Swarmed September 17 from roadside colony, isolated with queen of another colony in a Petri cell, lived	20 "
f. Swarmed September 17 from roadside colony, isolated with queen of another colony in a Petri cell, lived	102 "
g. Captured September 11 from nest in woods, isolated with queen of another colony, lived . . .	18 "
h. Captured September 11 from nest in woods, isolated with queen of another colony, lived . . .	19 "
i. Captured September 11 from nest in woods, isolated with queen of another colony, lived	19 "
j. Captured September 11 from nest in woods, isolated with queen of another colony, lived, ...	40 "
k. Hatched in Fielde ant-house, November 22, lived with his sister-workers, no queen, lived . . .	14 "
l. Hatched in Fielde ant-house, November 22, remained there with queen-mother and workers, lived . .	24 "
m. Hatched in Fielde ant-house, November 22, domiciled with sister-workers, no queen, lived . .	40 "
n. Hatched in Fielde ant-house, November 27, domiciled with sister-workers, lived	42 "
o. Hatched in Fielde ant-house, November 27, remained there with mother-queen and workers, lived	72 "
p. Hatched in Fielde ant-house, December 1, domiciled with sister-workers, no queen, lived . . .	87 "
q. Hatched in Fielde ant-house, December 1, remained there with mother-queen and workers, lived .	100 "

The king that lived longest, having been taken at the swarming, must have lived considerably more than 102 days, and his residence with a queen did not manifestly shorten his days.

The history of this little pair illustrates interesting traits of these ants. The two were taken from different colonies on a sunny morning after heavy rain, September 17, 1900. They were immediately placed by themselves in a Petri cell, and were at once friendly. The courtship or honeymoon was distinguished by mutual devotion. The one was rarely beyond the touch of the other, and the satisfaction of the two in their companionship was apparently equal. If the queen moved the king usually followed. If the king failed in constancy of attention to her, the queen approached and by a side stroke of her antenna made him aware of herself. This queen was exceptional in retaining all her wings until after she deposited her first two eggs, on the 15th of November, two months after swarming. She had laid twenty-eight eggs before she lost the wings of one side, on December 7, and she laid many more before her last wing fell off in January.

From the time of first egg laying, the king and queen both watched over the eggs, one of them remaining on guard when the other went to the opposite side of the cell to eat. The king watched over the eggs in the absence of the queen, but he never lifted them nor carried them about as did the queen.

On the death of the king, December 28, after more than a hundred days of wedlock, as he lay prone on his back with outspread wings, the queen piled her twenty eggs upon him, and hung over the body persistently. On ensuing days I separated the body, the queen and the eggs, first by a distance of a half-inch, then of an inch, then of two inches, then of three inches, and in a few hours after each separation the queen had brought the body and the eggs again together and stood with her head lowered over them, her mouth usually near the king's mouth. On the fifth day after his death, I moved his body to the opposite side of the cell, and separated it from the eggs by an intricate route between the sponges. The distracted queen at once set out in search of her treasures, and in her efforts during the next two days to bring the body and the eggs together, she so scattered the eggs that, fearing the loss of them, I took out the shriveled body, collected the eggs, and left the queen alone with them in a cleaned cell.

Two males, one the issue of a workers' egg, the other of a queens' egg, were later on introduced separately into her cell, and were killed and dismembered by her.

The queen continued to lay eggs, and the eggs at frequent intervals produced larvæ, but this queen was evidently unable to feed her young larvæ, and I had no workers of her own colony to offer her. Up to the end of May, 1901, she continued to lay eggs and the young larvæ continued to perish. Meantime two of her eggs, given on January 31 to the care of three alien workers living in a cell by themselves, had produced one queen and one king.

After four months of failure had sufficiently shown the inability of this queen to alone rear her larvæ, I attempted to reconcile her to alien helpers, putting in at different times from other colonies five young workers of ages varying from a few days to a few hours, and all were killed by her, or were removed on account of endangering her life. One callow minor, after having been nine days in the cell with the queen, nipped her so viciously and tenaciously that I could release her only by decapitating her enemy. The mutual fear and hostility of the queen and the alien workers, with the common desire to possess and care for the eggs, always resulted in the scattering and eventual loss of the eggs.

However, two other alien workers, one minor and one minim, introduced into the cell when but a few hours old, after several days' residence with the queen and numerous timid tentative approaches, perfectly affiliated with her. She laid no eggs thereafter until the ninth day in an eggless cell, and then she continued to lay an egg or two daily, to be picked up and taken care of by her adopted callows. Two white pupæ were also introduced into the eggless cell and there became ants, and in June the long solitary and childless queen had four devoted workers caring for her own young larvæ.

Ants have great aptitude in the recognition of their kin of the same colony. A colony found in the woods just previous to its swarming, on September 7, 1900, was divided and placed in two nests, *C–c* and *C–d*, each with one queen. After eight months of separation, ants brought together from the two nests perfectly and immediately affiliated.

Sister-queens of this colony, kept apart in Petri cells with a few workers to June 17, 1901, were after nine months' separation from their colony, received back with distrust. They were nabbed and held by the workers, but they were themselves quiescent. The attacks of the workers were hesitating and tentative, and after they had passed their antennæ over the whole body of the visiting queen, they left her alone. After a few hours in the nest, she was beside her former associate, and the workers were gathered around the two in the manner usual with colonies that have two esteemed queens.

That the recognition of the ants is not personal is proven by the following fact: Workers hatched in nest *C–e* during the first half of November, 1900, were isolated in nest *A–a*, while workers hatched in nest *C–d* during the same period of time were isolated in nest *A–b*. The two sections *C–e* and *C–d* had each its own queen, workers and young, and there was no communication between the two nests after the division of the original colony on September 7. Between nests *A–a* and *A–b* there was no communication, and these two nests contained workers only. The workers of nest *A–a* had never during their active lives met those in *A–b* nest until six months after they all became ants, when I put them together in a Petri cell. There was at first an exhibition of mutual distrust, and even of animosity, which gradually disappeared when the antennæ had been passed over the bodies of the strangers, and in a half-hour all were amicably congregated in a single group.

These ants have a habit of bringing their bodies to a low level, stretching their legs wide asunder, and creeping slowly up to an object of suspicion, in a manner that is quite catlike in its stealthiness; and this mode of approaching was often used toward the strangers, after the antennæ had once touched.

I also transferred pupæ from *C–d* nest to the care of queens of other colonies, and left them there in the care of aliens until they became ants and reached the age of about sixteen days. On returning these callows to the *C–d* nest, which they had left as pupæ, they exhibited great fear of their relatives and hosts, sought to stay in parts of the nest most remote from the resident community, hid themselves, and showed all the trepidation usual in ants that are put into a nest of aliens. On the other hand, the resident ants made no unfriendly demonstrations toward the newcomers, and after these callows were forced into association with them by confinement with a few of the adults in a small space, the callows lost their fears and thereafter mingled freely and happily with all in the nest. In less than a day they were incorporated in the community where they accomplished their larval career.

Callows of the same stock, *C–d*, of the same age and the same rearing as the above, were introduced the same day into an absolutely alien community, *B–b*, were instantly attacked, and were dismembered and then fed to the larvæ or eaten by the ants.

Four adult workers, two majors and two minors, that I took in August, 1900, from an apple-core by the roadside and isolated in a Petri cell, on December 4 killed two alien callows that had just come from the pupa-stage in *C–d* nest. The next day they received three amber pupæ from *C–d* nest, and one of these pupæ that same day became an ant, and of it the adult ants appeared to be very fond. On the 6th and 8th of December they killed two of its sisters, introduced when but a few hours old into their cell. On December 9, when the callow hatched in this cell was four days old, I put in an ant only seven hours old, also from the *C–d* nest. The four-day-old callow was the first to meet the baby ant in the Petri cell. It licked its junior from end to end, and when the adults repeatedly approached and snapped with their mandibles at the latest comer, the older callow stood over and appeared to wittingly protect the younger. It then picked up the baby ant, which was a minim quite as large as itself, and carried it into the shade of the sponge where two pupæ were attended by the adult ants. There it stood between the adults and the baby, giving attention alternately to it and to the pupæ, and often touching the adults with its antennæ, until after many minutes the adults left all to its care. From that time the adults showed no further hostility toward the younger minim, and it continued to live in that cell.

While it is generally true that *Stenamma fulvum piceum* will capture and care for the eggs, larvæ and pupæ of alien colonies, they do not invariably rear these to adult life.

A queen alone will not usually accept any worker from an alien colony, but persistent effort may induce her to accept a very young worker.

A queen alone with her eggs will not usually accept alien pupæ. She carries them away and casts them in her rubbish heap. But if alien larvæ are introduced she will accept them, and then she will later on accept pupæ from the same stock. She will at any time accept alien eggs.

Queens assisted by numerous workers will receive alien eggs, larvæ or pupæ, separately or together, the workers assuming immediate charge of them.

I have seen queenless workers break up and feed alien pupæ to the larvæ they were rearing, but when they had no larvæ they took excellent care of pupæ from the same alien stock. As one pupa will furnish an ample meal to a great number of larvæ, there may be much economy in thus utilizing an alien pupa that appears unseasonably in their nursery.

An explanation of the somewhat erratic behavior of the ants toward alien young will be suggested in a subsequent paragraph.

In many of the experiments made to test the power of these ants in recognizing those of their own colony, I used a small number of ants in each cell, and, without marking the ants, I could, by choosing those of one shade from one colony and those of another shade from another colony, always identify the colony to which any ant used in the experiment had originally belonged, and could invariably return her to her own.

The power of *Stenamma fulvum piceum* to recognize another of her own colony is not destroyed by freezing and thawing either one or both of the individuals.

Neither is it destroyed by merging one or both for an instant in alcohol, in diluted oil of anise-seed or of bergamot, in tincture of valerian or of asafœtida. The adult workers will survive dipping in eighty per cent. alcohol or in the above-mentioned oils and tinctures duly diluted. On returning the dipped workers to their colony they are not attacked as are aliens, though they may be for a time avoided, and on recovering from the bath they join their comrades in the common vocations of the nest.

I repeated one of the experiments of Bethe and obtained with my ants results similar to his. When I mashed ants of colony *C–e* and with the juices thus obtained smeared ants of the alien colony *B–b*, the *C–e* colony received the smeared ants without hostility, and the smeared ants exhibited the trepidation usual at finding themselves in an alien nest. Likewise, ants from the *C–e* colony, freshly smeared with the juices of *B–b* ants, were not attacked in the *B–b* nest, but they were evidently terrified in being there.

I then smeared a small number of *B–b* ants with the juices of *C–e* ants, and put them into a new Petri cell with an equal number of unsmeared *C–e* ants; and I smeared a small number of *C–e* ants with the juices of *B–b* ants and put them into a new Petri cell with an equal number of unsmeared *B–b* ants. In no case did the unsmeared ants attack the ants that had been merged in the juices of their kin; but the smeared ants attacked the unsmeared ants as they commonly attacked aliens. The smeared ants never attacked each other.

After a worker had been smeared in the juices of ants of an alien colony and then isolated for about thirty hours it was returned to its colony, and every worker that touched it with the antennæ started back in alarm, but it was not attacked nor harmed. The juices probably wore off gradually, since smeared workers returned to their colony after one week of isolation were received with no sign of distrust.

A queen that had for over three months peacefully shared the cell and labors of a sister-queen and five workers was smeared with the juices of aliens and at once returned to the cell. She was immediately attacked by the workers as if she were an alien. She evinced dread and submission in the usual manner of these ants by cowering low, tightly shutting her mandibles, folding her antennæ and holding them close down upon her head. Three workers together attacked her, but the attacks were intermittent, and she soon crept up to her sister-queen. The queen prodded he curiously with the ends of the antennæ and showed no animosity. Then a worker came and nabbed her in places and licked her in places, as though she was a composite of alien and kin. She was kept aloof from the group for a day or two and then resumed without harm her former associations.

Workers merged in alien juices were likewise attacked on being restored to their kin, but the attacks were not persistent and none were slain. The losses of life or limbs all occurred through the attacks of the smeared workers upon the aliens, among whom they were as wolves in sheep's clothing. The smeared ants, in spite of their disguise, must have retained some evidences of their lineage which protected them from extreme violence.

When two parties, each consisting of several workers that had been merged in the juices of the kin of the other party, were placed together in a new Petri cell, there were no violent attacks from either side during the first two or three days. A tendency to congregate according to colony showed itself from the beginning, but by keeping the cell clean and preventing separate settlement of the two parties I secured the safety of both for eight days. When I put in larvæ there was strife for its possession, and at the end of three weeks the only survivor of one party defended the larvæ against the sole survivor of the other party that, with but five legs and a single antenna, still made stealthy approaches toward the coveted young.

My observations of *Stenamma fulvum piceum* sustain the usual view that ants have an inherent and hereditary odor, or something akin to odor, whereby they are identified as friends or enemies, and that they impart this odor to places which they frequent. All the phenomena that I have observed in the lives of *Stenamma fulvum piceum* indicate that the distinctive odor may appear first in the larvæ, and a little less faintly in the pupæ; that it intensifies with age as does the color; that the sensitivity of the queen to this odor is greater than is that of the workers; that any distinctive odor to which an ant is accustomed and with which it associates security and satisfaction is attractive to it, while ant-odors to which it is unaccustomed excite alarm and hostility in proportion to their strangeness. For such causes, ants that have come from the eggs of colony *M* and in their pupa-stage were transferred to colony *N*, while they affiliate perfectly with the *N* ants that they live among, quickly recognize the odor of the *M* ants because it is their own. As to the origin of the distinctive colony odor, it appears possible that it may be traced to a king.

Among *Stenamma fulvum piceum* there are differences in individual traits. Some are more truculent than are others of their sex, age and size; or are more assiduous in their attention to the young; or more devoted to the queen or the males; or more gregarious in habit; or more attached to the home; or more hostile toward aliens. Every characteristic of a typical *Stenamma fulvum piceum* appears strongly in certain individuals and is comparatively weak in others.

The increasing tameness of my captive ants has been observable. After some months of acquaintance, these Myrmicid ants have wholly ceased to sting me when I handle them.

So domesticated have they become in their artificial nests that they rarely run outside their houses when uncovered, and the accustomed routine of cleaning their dwellings agitates them scarcely at all.

CRYSTALLINE AND CRYSTALLOIDAL SUBSTANCES AND THEIR RELATION TO PLANT STRUCTURE.

BY HENRY KRAEMER, PH.D.

Nägeli and Schwendener,[1] in the preface to their chapter on morphology, give us probably the most comprehensive idea of the scope of the subject. They say: "Zur Morphologie im weiteren Sinne des Wortes gehört die ganze Lehre vom Aufbau der Oganismen aus den Elementen, woraus sie bestehen—von den Micellen, welche die Bausteine der Zellen bilden, bis hinauf zu den Einheiten der höchsten und letzten Ordnung, welche den vielfach gegliederten Bau der höhern Gewächse zusammensetzen. Die Morphologie hat zu ermittelen, unter welchen bestimmten Form— und Lagerungsverhältnissen die Micellen und Micellarschichten sich vereinigen, um die Zelle und deren Theile zu bilden und während des Wachsthums weiter aufzubauen; sie hat hierauf die Zelle als gegeben zu betrachten und zu untersuchen nach welchen Gesetzen die Vermehrung derselben erfolgt, wie gleichsam Zelle auf Zelle gesetzt wird, um die grossen Complexe zu bilden, die wir als Organe kennen; sie hat ferner dir Differenzierungen zu verfolgen, welche in solchen Zellencomplexen nachträglich stattfinden, und endlich auch die Entwicklung neuer Organe aus schon vorhandenen, sowie die Natur und Stellungsverhältnisse derselben in Betracht zu ziehen."

As a result of having given considerable attention to what might be termed the morphology of plant constituents and having made a number of observations while trying to produce artificially from chemical solutions crystalline and crystalloidal substances resembling those formed naturally in the plant, such as calcium salts, inulin, hesperidin, etc., a number of questions have arisen in the author's mind concerning morphological development which are set forth in this paper.

Sphere-crystals are spherical aggregates of crystals with sharp

[1] *Das Mikroskop*, von Carl Nägeli und S. Schwendener. Zweite Auflage. Leipzig: William Engelmann, 1877, p. 532.

angular contours which are made up of but one substance, the molecule of which is simple, or at least not very complex. This class includes carbon compounds as well as inorganic substances. Of these may be mentioned calcium phosphate, calcium carbonate, calcium oxalate, amygdalin, strychnine, berberine, etc. Some of these compounds are soluble in water while others are not, hence we may say that there are both soluble and insoluble sphere-crystals. As examples of the former may be mentioned the glucosides and alkaloidal salts, while as examples of the latter we have calcium phosphate and oxalate, the alkaloids, etc.

The spherites resemble somewhat the sphere-crystals, but are distinguished from them by the fact that they have a more complex composition and the individual crystals have either a somewhat rounded outline or are imbedded in colloidal substances in which the crystalline or crystalloidal character is more or less obscured and hence with difficulty discerned.

The spherites also admit of a classification into soluble and insoluble bodies. The soluble spherites, or those directly soluble in water, include hesperidin, inulin and allied carbohydrates, and their crystalline character is most apparent when the specimens are dehydrated with alcohol.

The insoluble spherites are not directly soluble in water, but may be rendered so by treatment with certain reagents. These include starch and the fundamental substances entering into the composition of the cell-wall. The spherite character of these substances is not at once apparent, but can be demonstrated by the use of reagents which cause a swelling of the substances in the starch-grain or in the cell-wall. In a paper[2] communicated to the Society

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[2] See also *Journal of American Chemical Society*, 1899, p. 650, and *American Journal of Pharmacy*, 1899, p. 174. The following are the reagents that were used :

(1) Chloral iodine + iodine solution ; of each 5 parts.
(2) Chlor-zinc-iodide solution.
(3) Chromic acid solution (15 per cent.).
(4) Calcium nitrate solution (30 per cent.).
(5) Chloral solution (saturated), water and glycerin ; of each 5. parts. To this solution as much iodine is added as the solution will take up.
(6) Saliva.
(7) Silver nitrate (2 per cent.).
(8) Sulphuric acid (C. P. acid 90 parts and water 10 parts).
(9) Taka-diastase (saturated solution).
(10) Sodium acetate solution (50 per cent.).
(11) Potassium hydrate solution ($\frac{1}{10}$ of 1 per cent.).

of Plant Morphology and Physiology, 1899, the author enumerated the substances which could be used to bring out the spherite structure in the starch-grain. The same kind of reagents, but in stronger solutions, may be used to bring out the spherite structure in the wall of thickened parenchyma cells, as endosperm, or lignified cells, as stone cells. In cases where the cell-wall has been metamorphosed into mucilage, simple treatment with water, as has also been shown with the starch-grain, is sufficient to bring out the structure.[3] The reason that this structure is not apparent under natural conditions is because the refractive properties of the crystalloidal substance so nearly resembles that of the associated colloid. The use of certain reagents, however, which are more or less penetrating in their action, cause an imbibition of water by the colloidal portions with consequent swelling of the grain, or cell-wall, and a contrast in refractive power with the more insoluble and hence unaffected crystalloidal substances.

Sphere-crystals are further distinguished from spherites in that the latter are capable of taking up or holding certain coloring principles, as safranin, gentian violet, etc. It is questionable, however, if the crystalloids contained in the spherite take up the coloring matters, it being probable that the colloid associated with the crystalloid is the portion that is colored, as I have already shown in my studies on the structure of the starch-grain.

In the cell-wall the crystalloids occur in very close radial and tangential rows and constitute by far the greater proportion of the wall. In the starch-grain, on the other hand, there is apparently a greater preponderance of colloidal matter which takes up certain stains. This layering, which is well marked in the starch-grain, is scarcely distinguishable in the cell-wall. The reason that it is not so well marked in the cell-wall is because of the difference in amount of the crystalloidal and colloidal substances, the close arrangement of the crystalloids and also the difficulty of obtaining uniform microscopical sections, as can be readily obtained with the starch-grain.

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(12) Potassium nitrate solution (saturated).
(13) Tannin solution.
(14) Potassium phosphate solution (saturated).
(15) Hydrochloric acid (5 per cent.).
(16) Water between the temperatures of 50° C. and 70° C.

[3] This would tend to show that the crystalline structure is not due to the precipitation of substances by the reagents used.

The structure, as well as the mode of formation, of spherites and sphere-crystals is apparently the same. The mode of formation is, furthermore, apparently the same whether observed in nature or as carried on artificially. The different stages in their natural formation can be followed comparatively easily in those parts of plants containing hesperidin (as the epicarp of citrous fruits) or inulin (as roots of artichoke, etc.). It is interesting to compare these crystals or spherites with those formed artificially by evaporation of solutions of inulin or hesperidin. It is also instructive to compare the natural oxalates, phosphates, and carbonates of calcium with those formed artificially by precipitation of soluble calcium salts with alkaline oxalates, phosphates or carbonates.

After a comparison of the artificially produced spherites or sphere-crystals with those formed naturally in the plant, one cannot but conclude that there is a play of similar forces in their formation.

Furthermore, if we examine the crystal masses remaining in a watch-crystal after the spontaneous evaporation of solutions of various substances, under varying conditions of temperature, etc., we observe not only the formation of crystals which resemble those produced in the plant cell, but other rather striking forms of combination which are very suggestive indeed; leading one to a comparison of the arrangement of the products of crystallization with the apparent multiplicity of forms found in plant life. Indeed, the arrangement of the crystals in such a watch-crystal reminds one of the appearance of our woods in winter, when the absence of leaves permits the observance of fundamental lines of development in shrubs and trees.

If we take an alum solution (such as a Delafield's Hæmatoxylon Solution), dilute it with water and allow it to evaporate spontaneously in a watch-crystal, the result will be the formation of concentric rows of acicular crystals which show an analogy to the structure of the wheat starch-grain after treatment with the reagents mentioned.

The crystalline residue from a cocaine solution resembles a group of sclerenchyma cells in transverse section, the individual sphere-crystals resembling single cells, the portion corresponding to the wall being made up of radiating acicular crystals which even join with those of the adjoining sphere-crystals. The latter arrangement may be likened to the pores in such thickened cell-walls.

A resemblance to the wavy contour of the walls of transverse sections of epidermal cells is exhibited in the residue formed by the evaporation of brucine solutions.

The infoldings in the parenchyma cells in pine stems and leaves is exemplified in the arrangement of the crystals which result from the evaporation of solutions of amygdalin.

From solutions of caffeine hydrobromate there separate crystals which in abundance and in arrangement resemble a dense mycelial development of penicillium with conidia.

The crystalline residue from solutions of berberine shows a marked resemblance to the outer morphology of certain Lycopodiums, species of *Juniper* and other similar arborescent plants. Illustrations of this kind could be multiplied which would tend to show a relationship between the form of crystalline groups and the ultimate arrangement of the substances entering into the composition of the plant.

The chemist has considered but one phase of the subject of crystallization, namely, the form and nature of individual crystals. The botanist, however, until recently has considered the aggregation of morphological units, as is evidenced in his studies on the outer and inner morphology of plants. But as the form and nature of the individual units are seen to depend more or less upon the nature of the substances comprising them, it becomes of fundamental importance to study the composition of these units in their relation to form and structure.

In the case of inorganic bodies chemical as well as physical tests are necessary to prove the identity of a substance. In the organized, or organic, world it has been impossible to define a species or designate the limitations of a species because our studies have been directed almost entirely to the outer morphology of individuals rather than to the study of the substances which, grouped together, form these individuals and the physical and chemical forces underlying their structural arrangements.

The same substance may under different conditions develop different outer forms, as, for example, alum may crystallize in monoclinic prisms, hexagonal prisms, or in arborescent forms or sphere-crystals. Chemical tests are necessary to prove the identity of the substance in these various forms.

Not all substances, however, show this tendency to variation in form of crystals, as, for example, caffeine, berberine, and still other substances which show a tendency to uniformity in general outline.

If, then, there is so much variation in the form and arrangement of crystals of the same substance when artificially formed, to what extent may not variation in form take place in bodies of complex composition and therefore influenced by complex attractions and repulsions? Now while we see in the crystal a decided tendency to uniformity of structure under similar conditions, yet, admitting of modifications under varying conditions, we must allow that in organized structures this tendency to uniformity is modified over and over again.

In the plant world similar variations are observed, not only in forms of the elements (roots, stem, leaves, flowers, fruits and seeds) comprising the individual, but also in cell-contents. In some so-called species individuals vary greatly as regards form of elements, as in oaks, violets, etc. In others a constancy is observed, as in *Erythronium.* In still others a variation in the form assumed of some of the cell-contents is observed, as in the crystals of calcium oxalate in *Datura stramonium*,[4] while in other crystals a constancy of form is observed, as with calcium oxalate in the genus *Viola.* Even in the study of starch-grains one observes a constancy in the form of the grains in all plants. There is, however, a sufficient modification in some of the grains in the reserve underground parts of such plants as potato, maranta, etc., to justify one in pronouncing on the origin of the starch. The same may be said of other substances, as calcium oxalate, inulin and other carbohydrates, etc.

The selection of certain constant forms of cell-contents or of cell-walls would appear to be of as much, or greater, importance in designating the limitations of a species as the outer form of elements, which it is evident are dependent upon the arrangement of aggregates of substances making up the individual. As this arrangement is due, on the one hand, to the chemical factors, food

[4] The author, *Proc. Amer. Assoc. for Adv. of Science*, 1899; see also *Bulletin of Torrey Botanical Club*, 1899.

and air, and, on the other, to the physical factors, light and temperature, variations are bound to occur. If, however, these variations are constant for a series of successive generations and can be demonstrated in cell-contents, cell-walls and cell-functions, then a species has been formed, but not otherwise.

In the inorganic world, as we well know, physical and chemical tests both are oftentimes necessary to prove the identity or specific nature of a substance. Likewise in the biological world physical and chemical tests of cell-contents, cell-walls and the products of cell-function are necessary to establish the specific character of an individual.

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THE NASAL PASSAGES OF THE FLORIDA ALLIGATOR.

BY ALBERT M. REESE, PH.D.

The material upon which the following work was done was received by the writer from southern Georgia, about the first of August, whence it had been sent by express to Baltimore.[1] It consisted of about thirty eggs of *Alligator mississippiensis*, most of which contained embryos in an advanced stage of development. These embryos were fixed in Kleinberg's dilute picro-sulphuric mixture, giving a fair fixation, and were stained in borax carmine and Lyon's blue. Serial sections were cut through the head in transverse, horizontal and sagittal planes. Although the structure of the nasal cavity, even of so advanced an embryo, cannot be taken to represent that of the adult, there have been so few figures of this character published that the following account may be of interest.

As may be seen from Plate XXIV, figs. 1*a* and 1*b*, the embryo is in an advanced state of development, and already shows distinct reptilian characters. The first series of sections (figs. 2*a–l*) was cut at right angles to the long axis of the snout of the embryo (fig. 1*b*, *x–y*), or rather it was intended to be an exactly transverse series but, by faulty orientation, the sections were so cut that the right side is inclined, somewhat, toward the base of the snout. This departure from the exact transverse position is the cause of the lack of symmetry in the two sides of the nasal cavity, as seen in this series of sections. Fig. 2*a* represents a section through the tip of the upper jaw. On the left it passes through the extreme edge of the wall of the nasal cavity, while on the right side, which is nearer the base of the snout, it cuts through the right nasal aperture, *r.n.a.* Near the centre of the section is seen the extreme tip of the nasal cartilage, *n.c.* The body wall, *b.w.*, in this section, as in all following sections, is represented by a heavy black line.

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[1] *American Naturalist*, Vol. XXXV, No. 411, pp. 193–195.

Fig. 2*b* is somewhat further from the tip of the snout and cuts through the extreme point of the lower jaw, *l.j.* On either side of the large, median, nasal cartilage, *n.c.*, is seen the nasal canal, *l.n.c.* and *r.n.c.* On the left, the canal is, at this point, somewhat circular in cross section, while on the right, which, it will be remembered, is nearer to the base of the snout, the canal is more elongated in a dorso-ventral direction. The walls of the nasal passages are lined with cilia, and are, in most places, many cells thick. On account of the low magnification used, no attempt has been made to represent the cilia and cell outlines in these figures. The collections of cells, *t.r.*, in this and the following sections are the rudiments of the teeth. At the point represented in fig. 2*c*, the nasal cartilage, *n.c.*, has increased considerably in extent and almost completely surrounds the nasal passages on each side. In this and the following two sections, the plate of cartilage, *b.*, which lies ventral to the nasal passage on each side, seems no longer to be continuous with the vertical septum, *s.*, as in the preceding figure, although it is still in close contact with it. The nasal canals are drawn out, in this section, in a ventro-lateral direction, until their passages are reduced to mere slits. The passage on the right is drawn out, laterally, toward a small group of cells, *r.n.g.*, the apparent rudiment of one of the nasal glands. The teeth rudiments, *t.r.*, are seen in both upper and lower jaws, in the former of which they are very large, in proportion to the size of the jaw. The cartilages of the lower jaw are seen on each side, *m.c.*

In fig. 2*d* the nasal canals are still more closely invested by the nasal cartilages. On the right, the section passes through the opening of the right nasal gland, *r.n.g.*, into the nasal passage of the corresponding side. On the left side of the section is seen the left nasal gland, *l.n g.*, cut in front of its opening into the nasal passage, that is, between this opening and the tip of the snout. In all the following figures *anterior* will mean toward the tip of the snout, *posterior* will mean toward the base of the snout or of the head.

Fig. 2*e* is a short distance posterior to the last figure. On the right it passes through the extreme anterior edge of the right eye, *e.*, while on the left the section is anterior to the eye. The nasal cartilage, *n.c.*, on the right, completely encloses the nasal passage of that side, and thus lies between that passage and its nasal gland. The section is cut posterior to the opening of the right nasal gland, *r.n.g.*, into the right nasal passage, *r.n.c.* The left side of the section passes through the opening of the left nasal gland, *l.n.g.*, into the left nasal passage.

In the next section (fig. 2*f*) the complexity of the nasal apparatus has, apparently, considerably increased. In the first place, the ventral portions of the nasal cartilage, which, anterior to this point, formed a more or less complete wall ventral to the nasal passages, have disappeared, and on the right the dorsal portion of the cartilage has separated from the median, *s.*, and is now represented by a short straight piece, *n.c'.*, and a long curved piece, *n.c.*, enclosing a part, *c.*, of the right nasal passage. On the left the dorsal wall of cartilage is still connected with the median septum. The nasal passages are here of quite different shape from what they were in the preceding section. They are still more elongated in a dorso-ventral direction, and that on the right, which is nearer the base of the snout, is cut at the point, *v.p.*, at which it opens ventrally into the narrow ventral passage, which, in turn, leads posteriorly to open at the posterior nares. *d.* represents a narrow diverticulum, projecting in a ventro-lateral direction, which may be followed almost to the posterior end of the large dorsal passage. A large branch of the main nasal passage, *r.n.c.*, is represented at *c.*, and the following section passes through the point at which this lateral passage opens ventrally into the main passage.

On the left side of the section is seen the left nasal gland, *l.n.g.*, cut posterior to its opening into the left nasal passage. On either side of the ventral end of the median cartilage, *s.*, is seen a small collection of cells, *j.*, which, according to Röse, is the rudimentary Jacobson's organ. These two collections of cells, which will be spoken of as "Jacobson's organ," extend from this point posteriorly for a considerable distance, as two solid rods of cells; they then become hollowed out to form tubes, which soon open ventrally into the ventral nasal passages, *v.p.*, as will be shown in one of the following figures. The section represented in fig. 2*f* passes near the extreme anterior end of Jacobson's organ.

In fig. 2*g*, which is only a short distance posterior to the one just described, Jacobson's organ is still seen as two solid rods of cells. On the right, the ventral nasal passage, *v.p.*, is cut posterior to its opening into the main nasal passage and is hence seen as an independent, circular passage. On the left, the section passes through the opening of the left ventral passage, *v.p'.*, into its adjacent main nasal passage. The ventro-lateral diverticula, *d.* and *d'.*, are seen on either side. The right side of the section passes through the opening of the cavity *c.* into the ventral part of the right nasal passage, *r.n.c.*, while on the left the corresponding cavity, *c'.*, is cut anterior to its opening and is surrounded on all sides by the nasal cartilage. In the preceding section the cavity *c.* was cut posterior to the region at which it was completely surrounded by cartilage.

In fig. 2*h* the nasal cartilages have about the same outline as in the figure just described, the sections represented by these two figures being close together. Jacobson's organ, *j.*, has increased somewhat in size, but there is still no trace of a cavity in either part. Both ventral nasal tubes, *v.p.*, are now entirely distinct from the main nasal cavities and are somewhat circular tubes lined with columnar cells. On the left the side cavity, *c'.*, is still surrounded by cartilage, being again cut anterior to its opening into the left nasal passage, *l.n.c.*, while on the right of the section, at the point *c.*, the side cavity is seen to open dorsally into the main nasal cavity. The relation of this side cavity to the main nasal cavity is made plain by reference to fig. 3*a*, which represents a section cut in the plane *a–b*, fig. 1*b*. The section passed through the dorsal part of the nasal cavities, cutting the cavity on the right so far dorsally that but little indication of the side cavity, *c.*, is evident. It is plain, from this figure, that what has been called a side cavity, *c'.*, is merely the posterior end of the main nasal cavity which has bent around until it projected outward and forward, and thus gave the idea, in transverse section, of a distinct offshoot from the main nasal cavity, *l.n.c.* Fig. 3*a* shows how the nasal cartilage, *n.c.*, pushes in between the cavity *c'* and the main cavity, *l.n.c.*, giving the impression, in transverse section, that the cavity *c'* is completely surrounded by cartilage. In a section ventral to this one, what has been called the main nasal cavity, *l.n.c.*, is seen to extend somewhat further toward the brain, *br.*, and in that way the cavity *c'.* is made to appear more like a branch of the main cavity than simply a forward bending of the larger cavity. This posterior extension of the main nasal cavity is shown in fig. 2*i*, *l.n.c.* Fig. 3*a* shows that the median nasal cartilage, *s.*, extends back between the eyes, and becomes continuous with the cartilage surrounding the brain. It is somewhat swollen at a point about half-way between the nasal cavities and the brain.

The section represented in fig. 2*i* passes through the extreme posterior part of the main nasal cavities, *l.n.c.* and *r.n.c.*, and cuts the ventral canals, *v.p.*, posterior to the point at which Jacobson's organ opens into them. The way in which this takes place will be described later. The lateral parts, *n.c.*, of the nasal cartilages have diminished considerably in size, and now lie much nearer to the median cartilage, *s.* This section passes through the anterior ends of the two olfactory lobes, *o.l.*

In fig. 2*j* is represented a section cut posterior to the nasal cavity, so that neither of the main or dorsal nasal chambers are seen. The ventral passages, *v.p.*, have about the same size and position as in the preceding figure, while the lateral cartilages, *n.c.*, are reduced to mere rods, lying close against but not fused with the median cartilage, *s.* A short distance posterior to this point these cartilages end.

The section seen in fig. 2*k* is some distance posterior to the one just described, and shows how the ventral canals, *v.p.*, unite to form a single median canal, before they open posteriorly as the posterior nares.

This section does not cut the lateral parts of the nasal cartilage, but the median septum, *s.*, is seen extending dorsally, *b.c.*, on either side of the olfactory lobes, *o.l.* The outlines of the muscles of the eyes are shown in this as well as in the following figure by dotted lines, *m.*

Fig. 2*l* is somewhat posterior to fig. 2*k*, and passes through the opening of the ventral passages, the posterior nares, *p.n.* The other points brought out in this figure are about the same as in fig. 2*k*, and need no further description.

Fig. 4*a* represents, under a much higher magnification, a part of one of the sections of the series that has just been described. The ventral end of the median cartilaginous septum is shown at *s.*, and the ventral ends of the right and left nasal passages are seen at *r.n.c* and *l.n.c.* The walls of these passages are made up of one or more layers of cubical or columnar ciliated cells. The ventral passages, *v.p.*, are lined with similar cells, except that no cilia could be made out. On the left is seen, dorsal to the left ventral passage, the tubular organ of Jacobson, *j.*, which is cut anterior to its opening into the ventral passage, *v.p*; its cavity is small, in cross section, and only extends for a short distance anteriorly, the greater part of the organ being a solid rod of cells without any visible cavity. On the right side of the figure, which, it will be remembered, is posterior to the plane of the left side, is seen the opening of Jacobson's organ, *j.*, into the right ventral canal, *v.p.* The united cavities of the ventral canal and Jacobson's organ have a sharply triangular outline, which is maintained for a considerable distance posterior to the point at which they first come together. The walls of the organ are of about the same structure as those of the ventral passages. For the sake of simplicity the mesoblast cells in this and in all of the preceding sections have not been represented. They are typical mesoblast cells and surround numerous blood vessels.

Fig. 5*a* represents a sagittal section of an embryo of the same stage of development as the one represented in fig. 1*a*. The section is nearly, but not exactly, in the median plane, so that some of the organs are cut medianally while others are cut to one side of the median plane. The general outline of the head is well shown and the relative positions of the main regions can be seen. The brain, *br.*, and spinal cord, *s.c.*, are represented in the heavier shading; the cartilaginous parts, including the vertebral column, *v.c.*, in the lighter areas. The great size of the nasal cavity is due to the fact that the section passes through one of the main nasal passages in the plane of its greatest diameter, fig. 2*f*. The other parts of the head will be easily understood by reference to the letters. As in the previous sections, the mesoblast has been omitted for convenience and simplicity.

Lettering of Figures.

b.—Basal plate of cartilage.
b.c.—Cartilage around the brain.
br.—Brain.
b.w.—Body wall.
c.—Lateral part of nasal canal.
d.—Diverticulum of nasal canal.
e.—Eye.
h.—Hypophysis.
j.—Jacobson's organ.
l.—Lens.
l.j.—Lower jaw.
l.n.c.—Left nasal canal.
l.n.g.—Left nasal gland.
m.—Muscle of the eye.

m.c.—Cartilage of lower jaw
n.c.—Nasal cartilage.
o.—Œsophagus.
o.l.—Olfactory lobes.
p.n.—Posterior nares.
r.n.a.—Right nasal aperture.
r.n.c.—Right nasal canal.
r.n.g.—Right nasal gland.
s.—Nasal septum.
s.c.—Spinal cord.
t.—Tongue.
ta.—Trachea.
t.r.—Tooth rudiment.
v.c.—Vertebral column.
v.p.—Ventral passage.
x.—Septum projecting back between main nasal canal and its side branch.

EXPLANATION OF PLATE XXIV.

(*All sections were drawn with a Zeiss Camera.*)

Fig. 1*a*.—Side view, from a photograph, of an embryo of the stage represented in the sections. The yolk is not represented, but the cut stalk may be seen projecting from the abdominal wall just anterior to the hind legs (mag. $\frac{4}{3}$ diam.).

Fig. 1*b*.—This is merely an outline drawing of the preceding figure to show the planes of the sections represented in the following figures.

Fig. 2*a*.—Transverse section through the tip of the snout. The section is so near the tip of the snout, that it does not cut the lower jaw (mag. 4 diam.).

Fig. 2*b*.—Transverse section posterior to fig. 1*a*. It passes through the extreme tip of the lower jaw (mag. 4 diam.).

Fig. 2*c*.—Transverse section still further toward the base of the snout. The details of the figure will be understood from the lettering (mag. 4 diam.).

Fig. 2*d*.—Transverse section posterior to the preceding (mag. 4 diam.).

Figs. 2*l* to *h*.—Transverse sections posterior to the preceding, passing through the right eye, but anterior to the left eye (mag. 4 diam.).

Fig. 2*i*.—Transverse section passing through the extreme posterior part of the main nasal passages (*l.n.c.* and *r.n.c.*). The section passes through the anterior edge of the left eye and through the anterior ends of the olfactory lobes (mag. 4 diam.).

Fig. 2*j*.—Transverse section just beyond the posterior end of the main nasal cavities. It passes through the extreme posterior ends of the lateral nasal cartilages (*n.c.*) (mag. 4 diam.).

Fig. 2*k*.—Transverse section through the point where the two ventral canals (*v.p.*) unite to form a single large median canal. The section passes through the eyes at about their central points, and shows the sets of muscles by which their motion is controlled. The lower jaw is cut at the point at which it becomes continuous with the neck, which accounts for the break in the ventral side of this and the following figure (mag. 4 diam.).

Fig. 2*l*.—Transverse section, a short distance posterior to the one immediately preceding, passing through the posterior nares (*p.n.*), and through the upper end of the trachea (*ta.*) which appears in the figure to be three distinct cavities (mag. 4 diam.).

Fig. 3*a*.—Horizontal section through the plane *a–b*, fig. 1*b*. Shows the general anatomy of the head as seen in horizontal section, and especially the way in which the main nasal passages (*l.n.c.* and *r.n.c.*) curve outward and forward, as has been above described (mag. 4 diam.).

Fig. 4*a*.—Transverse section, under a much greater magnification, to show the structure and position of the paired Jacobson's organ (*j.*) (mag. 18 diam.).

Fig. 5*a*.—Sagittal section of the head of the embryo under consideration. The section is not exactly in a median plane, so that some of the unpaired organs are cut medianally while others are not (mag. 4 diam.).

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ADDITIONS TO THE JAPANESE LAND SNAIL FAUNA, IV.

BY HENRY A. PILSBRY.

In the present communication the description of Japanese *Clausiliidæ* is continued, and that of the *Pupidæ* begun. The genesis of *Balea*-like forms in Japan is considered in some detail, together with various other divergent branches from the Euphædusoid phylum.

For most of the material described I am indebted to the liberality of Mr. Y. Hirase, a corresponding member of this Academy.

Mr. E. R. Sykes also has entrusted to me certain specimens collected in Japan by Dr. Hungerford, many years ago, representing species described but not figured by Dr. O. von Möllendorff; and I have included herein some account of such of these as are closely related to my new forms. My thanks are due to both of these co-workers for their kind assistance.

Section ZAPTYX Pils.

Proc. A. N. S. P., 1900, p. 672.

This strongly differentiated group has hitherto been known from southern Kiushiu and the Loo Choo Islands only; but a representative has now been found to the north and east in an island belonging to the province of Izu. I have attempted below to explain its presence there.

Typical *Clausilia* (*Zaptyx*) *Hirasei* occurs at Kagoshima, the type locality, and on Sakura Island in Kagoshima Bay. A more slender form, of a richer, darker brown color, but the same internal structure, has been sent by Mr. Hirase (No. 557) from Kikai,[1] Osumi, at the head of Kagoshima Bay. Many specimens are very small, length $7\frac{1}{2}$ mm., but others reach $10\frac{1}{2}$ mm. in length. As the shell is quite slender, this is one of the smallest Clausilias

[1] In treating of *Eulota connivens*, Proc. Malac. Soc. Lond., IV, p. 77, Mr. Gude has confused this locality with the island Kikai-ga-shima, of the Oshima group, south of Kiushiu. This island is in the Loo Choo group, broadly speaking, but belongs for administrative purposes to Kagoshima Ken or prefecture.

known, as well as one of the most complicated in internal structure.

Clausilia hachijoensis n. sp. Pl. XXVII, figs. 39, 40.

Shell fusiform, rimate, rather thin, of a dark, rich brown color; rather weakly wrinkle-striate, the latter part of the last whorl distinctly and sharply striate. Whorls 8 to 8½, slightly convex, the apex obtuse, the last whorl somewhat flattened laterally, and gibbous or sack-like below. Aperture trapezoidal-piriform, the peristome continuous, brown, narrowly expanded and subreflexed. Superior lamella rather small, compressed, vertical, distant from the spiral lamella. Spiral lamella short, lateral, not reaching a ventral position, a short *lamella fulcrans* lying parallel to it. Inferior lamella receding, immersed, visible in an oblique view in the aperture, moderately spiral within; subcolumellar lamella either emerging or immersed. Principal plica *short* and lateral, one or two short sutural plicæ lying above it; *upper palatal plica exceedingly short* and joining the lunella. Lunella lateral, rather long and straight.

Clausilium strongly curved throughout, the apex rounded, straightened or slightly emarginate on the palatal side, near the apex.

Length 10, diam. 2⅓ to 2½ mm.

Bachijo (or Hachijo) Island, prov. Izu (Mr. Y. Hirase, No. 638).

This species is about the size of the largest specimens of *C. Hirasei* and *C. hyperoptyx*, but is a trifle wider. It differs from both in wanting a parallel lamella, and the upper palatal plica is extremely short, a mere dilation of the upper end of the lunella. In *C. Hirasei* it stands free of the lunella, and in *C. hyperoptyx* is united with it and is much longer. The principal plica is shorter than in the other two species. The clausilium is much more curved than in either of these species, and its apical end has a somewhat different shape.

The specimens were sent with *C. Tryoni*, an *Euphædusa* much resembling this species in size and color.

Bachijo or, as most charts spell it, Hachijo (or sometimes Fatsizio) Island lies in the Pacific just above the 33d parallel N. lat., and near 140° E. long. It is somewhat over 100 miles from the nearest mainland, and is about twenty-one miles long by seven and a half wide. A chain of islets reaches northward to the Sagami Sea; but I am disposed to believe that its molluscan fauna has been derived chiefly from the islands south of Kiushiu by means of drift, as it lies directly in the Kuro Shiwo, or "Black Current," and *Zaptyx*, the group to which *C. Hachijoensis* belongs, is distinctly a southern group, unknown in Hondo Island. Small islets at wide intervals are scattered down to the Bonin (Ogasawara) group, but they rise from a submarine ridge in the sea bed between 1,000 and 2,000 fathoms depth.

The two species of *Clausilia* here described and *Clausilia* (*Reinia*) *variegata* var. *nesiotica* Pils. are the first land shells known from the island.

Section EUPHÆDUSA Böttger.

Clausilia Tryoni n. sp. Pl. XXV, figs. 1, 2, 3.

Shell small, rimate, thin, fusiform, dark purplish brown, glossy. finely striatulate, the last whorl more coarsely rib-striate. Whorls 8, rather convex, the apex obtuse, next three or four whorls attenuated, the last whorl flattened on its last half. Aperture piriform, the peristome rather thin, narrowly expanded and subreflexed, continuous, adnate or very shortly free above, deeply emarginate at the position of the superior lamella. Superior lamella thin but high, continuous with the spiral lamella. Inferior lamella rather small, weak below, though emerging nearly to the lip-edge, rather abruptly becoming stronger and converging toward the superior lamella within, strongly spiral. *Subcolumellar lamella emerging. Principal plica short,* its lower end visible from the aperture, deep within the throat, the other end extending past the palatal plicæ to a lateral position. *Upper and lower palatal plicæ small, oblique and parallel,* lateral in position, the lower one smaller. *There is no trace of a lunella.* The inferior and spiral lamellæ are of equal length within, and reach to the middle of the ventral side.

The clausilium is broad, strongly curved, a little pointed or tapering toward the apex, and very slightly thickened there.

Length 11½, diam. 3 mm.

Bachijo (Hachijo) Island, prov. Izu (Mr. Y. Hirase, No. 638).

This pretty little *Euphædusa* was sent with *Clausilia* (*Zaptyx*) *hachijoensis,* which it resembles in size and color. It will be known by the unusually strong superior lamella, emerging subcolumellar lamella and total absence of a lunella, the two palatal folds being small, remote and parallel. The clausilium though wide is a little tapering below, and less thickened at the apex than in most of the related species.

There is some variation in sculpture, one specimen being densely and rather sharply striate, while the others are smoother.

Group of C. Hungerfordiana.

Shell with the ordinary slender contour and piriform aperture of *Euphædusa. Superior lamella wanting,* or represented merely by a slight thickening of the lip-edge. Inferior lamella rather strongly developed. Lunella subobsolete or wanting; palatal plicæ 2; the principal plica short. Shell usually variegated with white streaks.

This new "*Formenkreis*" contains two species, both Japanese.

Clausilia Hungerfordiana Mlldff. Pl. XXV, fig. 4.

Von Möllendorff, Journ. Asiatic Soc. of Bengal, LI, Pt. 2, No. 1, p. 2, Pl. 1, fig. 1 (July, 1882).

The specimen figured is from Hungerford's collection, and is now in that of Mr. E. R. Sykes. It is slender, thin, conspicuously streaked and maculate with buff-white on a brown ground. It is finely, rather irregularly striatulate, the striæ becoming coarser and distinct on the back of the last whorl. The superior lamella is represented by a slight thickening of the lip-margin. Inferior lamella strong. Subcolumellar lamella very deeply immersed. The rather short principal plica is lateral, the lunella subobsolete, upper and lower palatal plicæ being developed.

Length 12, diam. 2.5 mm.

Nara, Yamato.

Thus far known from the type locality only, a town lying east from Osaka, in northern Yamato.

Clausilia monelasmus Pils. Pl. XXVII, fig. 5.

Pilsbry, Proc. A. N. S. Phila., 1900, p. 674, Pl. 24, figs. 4–6; Pl. 25, figs. 26–29.

The specimen here figured has the inferior lamella more receding than in the type, and the shell is variegated with white.

It is evident that this is a northern species very closely related to *C. Hungerfordiana*, from which it differs in being smaller and more graceful, decidedly more attenuated above, with much stronger striation. There is no trace of a lunella. It is from Hokkaido Island, while *C. Hungerfordiana* is from southeastern Hondo. Perhaps northern Hondo will supply specimens of intermediate character.

The shell figured is 10 mm. long.

Group of C. euholostoma.

Shell shorter than in normal *Euphædusæ*, the whorls reduced to 7–7½; *aperture broad, squarish-oval*, scarcely narrower above than below; peristome continuous, the broadly arched parietal margin in part adnate, though distinct. *No superior lamella.* Inferior lamella strong; spiral lamella and principal plica very short; no lunella; upper and lower palatal plicæ developed. Clausilium Euphædusoid.

The single species of this group approaches *Reinia* in contour, but, like the preceding group, the superior lamella is obsolete and the inferior lamella strong.

Clausilia euholostoma Pils. Pl. XXV, figs. 6, 7, 8.

Pilsbry, Nautilus, XIV, p. 108 (January 1, 1901).

Shell rimate, slenderly pupiform, brown, finely striate. Apex rather acute; spire rapidly tapering above; whorls 7–7½, quite convex, the last two forming much more than half the shell's length, and of about equal diameter. Aperture of a *broad, squarish-oval form, scarcely narrower above* than below; peristome white, reflexed, continuous, the strong *parietal margin arcuate* and in part adnate. *Superior lamella wanting. Spiral lamella reduced to a short plate* deeply immersed, developed in a lateral position. Inferior lamella appearing in a front view as a strong triangular plate, strongly spiral within. Subcolumellar lamella very deeply immersed. *Principal plica reduced to a short fold*, lateral in position and about twice as long as the small upper and lower palatal plicæ. No lunella. Clausilium very similar to that of *C. comes*,[2] but the palatal margin is more straightened near the apex, and the columellar margin is more strongly notched near the filament.

Length 8.6, diam. 2.4 mm.; length of aperture 2.3 mm.

Length 7.3, diam. 2.2 mm.; length of aperture 2 mm.

[2] See these *Proceedings* for 1900, Pl. XXV, figs. 35, 36.

Mikuriya, prov. Suruga (Y. Hirase). Types No. 79,724 Coll. A. N. S. P., No. 563 of Mr. Hirase's collection.

This species is one of the most extraordinary modifications of the Euphædusan stock yet known. The large aperture resembles in form that of no other *Clausilia* known to me, and shows but one lamella, the inferior; the superior lamella being wholly atrophied, and the spiral lamella and principal plica reduced to short laminæ in the region where the clausilium lodges. There is no trace of a lunella. The clausilium remains well developed, is slightly thickened distally, and has all the characters of that of *Euphædusa.*

In the strong development of the inferior lamella, *C. euholostoma* resembles *C. Hungerfordiana* Mlldff. and *C. monelasmus* Pils., which are likewise deficient in the superior lamella. *C. euholostoma* agrees with the typical forms of *Reinia* in having the aperture wide above, not piriform as in the group of *C. Hungerfordiana.* It is intermediate between the two groups in number of whorls and in general contour.

Section REINIA Kobelt.

Reinia Kob., Jahrb. d. D. Malak. Ges., III, 1876, p. 34, proposed as a section of *Balea ;* type *Balea variegata* A. Ad.

The type of *Reinia* is a small tapering-pupoid species, with *discontinuous peristome,* the aperture being Buliminoid, deficient in lamellæ and *without plicæ, lunella or clausilium.* It was included by Böttger next to *Balea;* but that group as usually constituted consists of no less than three series of species, each totally distinct and unrelated.

It was Dr. O. von Möllendorff who with keen insight first pointed out the fundamental distinction between *Balea* and *Reinia.*[3] He recognized in the Chinese *C. eastlakeana* a less modified form of *Reinia,* and after discussing the characters of the group, declared it to be related to the eastern Asiatic group *Phædusa.* The relation of *Reinia* to *Phædusa,* von Möllendorff further held, is comparable to that of *Alopia* to the true *Clausilia* of Europe: "Phylogenetisch dürfte *Reinia* als der lebende Rest der Vorfahren der heutigen *Phædusa*-Arten aufzufassen sein, wie

[3] Jahrb. d. D. Malak. Ges., X, p. 262–265, 1883, under description of *C. eastlakeana,* a species from Fu-dshow, on the island Nan-tai, province of Fu-dshien, southern China.

die Baleo-Clausilien die direkten nachkommen des Prototyps der Europäischen Clausilien sind."[4]

The conclusion that *Reinia* stands in close relationship with *Phædusa,* and has nothing to do with *Balea,* was forced upon me by the study of a series of Japanese species, before I knew that von Möllendorff, nearly twenty years ago, had been led to the same result by the structure of a Chinese form. Only in one point of view the data before me seem to modify the ideas of the German savant: the Japanese series establishes such a connection between *Reinia* and *Euphædusa* that the descent of the former from the latter is strongly indicated. *Reinia is not a primitive Phædusa, but a degenerate one.* I regard *Reinia variegata* as the secondarily simplified end of a series leading from typically Euphædusoid ancestors, just as *Balea perversa* is a secondarily simplified, and not a primitive, *Clausilia.* The east Asiatic series leads from forms with many whorls, well-developed clausilium, lamellæ and folds, and continuous peristome, to those with few whorls, no clausilium, the lamellæ and plicæ reduced and in part lost, and the peristome adnate above and finally interrupted. Böttger has demonstrated that the older tertiary *Clausiliidæ* of Europe had a narrow clausilium and the superior lamella was continuous with the spiral lamella; the widening of the clausilium and separation of the superior and spiral lamellæ being modern characters. Now *Reinia* and its nearest allies have the spiral and superior lamellæ interrupted, and the clausilium when developed is of the very broad type. These considerations seem to render the hypothesis that *Reinia* is a primitive *Phædusa* quite inadmissible.

The chief characters of *Reinia* and the Euphædusoid forms leading toward it, are stated in the following table:

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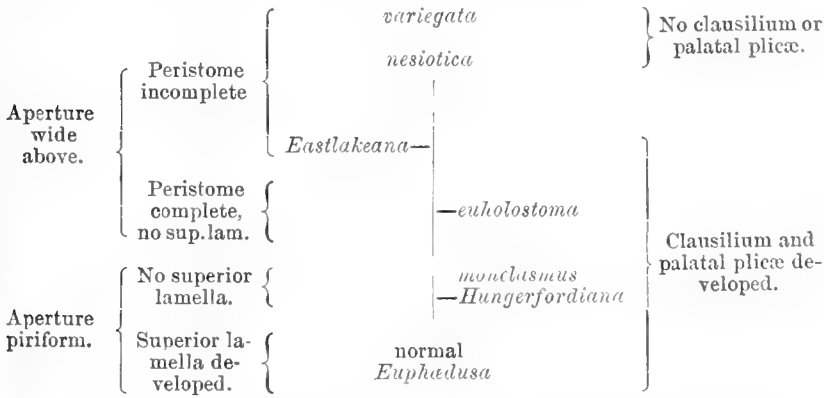
[4] *L. c.*, p. 265.

Species.	Whorls.	Peristome.	Sup. lamella.	Spiral lamella.	Inf. lamella.	Lunella.	Princ. plica.	Pal. Plicæ.	Clausilium.
Variegata	6	incomplete	minute, not marginal	short, dorsal	receding, dorsal	none	none	none	none
Nesiotica	$6\frac{1}{2}$	"	"	dorso-sublateral	receding, sublateral	"	"	"	"
Eastlakeana	7	"	small, submarginal	lateral	lateral	"	short	2	euphædusoid
Euholostoma	$7-7\frac{1}{2}$	complete	none	short, lateral	strong, lateral	subobsolete	very short	2	"
Monelasmus	$8\frac{1}{2}$	"	"	strong, lateral and ventral	strong, latero-ventral	none	short, latero-dorsal	2	"
Hungerfordiana .	9	"	"	"	"	"nearly obsolete"	"	2	"

The interrelations of the above species are further illustrated in the following diagram, the median portion of which shows the probable phylogeny of the forms under consideration:



It will be seen from the table and diagram that no sharp line can be drawn between *Reinia* and *Euphædusa*. The number of whorls varies, by easy stages; the form of the aperture is not correlated with other characters; and upon the whole, it is obvious that we have to deal with forms in various stages of change and of degeneration of the closing-apparatus, from an Euphædusoid ancestor. In fact, it is not quite certain that they had a single common progenitor; they *may* be descendants from three species of *Euphædusa;* but however this may be, it is obvious that the original stock, whether one or three, belonged to the *aculus* group of *Euphædusa;* and some apparently trivial features of the whole series, such as the peculiar coloration, give me reason to believe that the phylogeny indicated above is not far wrong.

Clausilia (Reinia) variegata (A. Ad.). Pl. XXV, figs. 11, 12.

Balea variegata A. Adams, Ann. and Mag. Nat. Hist. (ser. 4), I, p. 469 (1868); Kobelt, Fauna Jap., p. 63, Pl. 9, fig. 20 (1879); Martens, Sitzungsber. Ges. Naturforsch. Freunde zu Berlin, 1877, p. 105.

The shell is sinistral, rimate, thin, tapering-pupiform, the last whorl widest; *streaked with opaque buff* on an olivaceous or brownish corneous ground, and more or less marked with spiral lines of the darker color. The surface is irregular striatulate, the last half of the last whorl being striate. *Whorls 6,* convex and regularly increasing. The aperture is broadly ovate, with white, reflexed peristome; the right and left margins scarcely converging above, *widely separated*, connected by a *thin, adnate parietal callus*. The superior lamella is minute, short and removed from the edge of the parietal callus. It is widely separated from the rather short, spiral lamella. Inferior lamella receding, small, becoming higher inside, extending to a dorsal position. Subcolumellar lamella very deeply immersed, a long pit between it and the inferior lamella. There are no plicæ. Clausilium wanting. Length 8.3, diam. above aperture 2.6, length of aperture 2.8 mm.

Tago (A. Adams) (Tako, in western Shikoku, province of Iyo); Uweno, near Tokyo, and Ujeno (Hilgendorf); Tokyo (Dönitz); Takasaki, prov. Kozuke (Y. Hirase, No. 525).

This species was found by Hilgendorf under the bark of trees, by Dönitz in hollow trees. It is viviparous, one specimen I opened containing a young shell.

Clausilia Eastlakeana Mlldff., of which I have specimens from the original locality, is undoubtedly nearer *variegata* than any Japanese species, having the same discontinuous peristome; but it has longer, stronger lamellæ, palatal plicæ and an Euphædusoid clausilium.

Clausilia (Reinia) variegata var. **nesiotica** nov. Pl. XXV, figs. 9, 10.

Whorls $6\frac{1}{2}$; striation stronger than in *variegata*, the last whorl with fine incised spiral striæ. Inferior and spiral lamellæ decidedly more strongly developed.

Length 8.3–9.5, diam. 2.7 mm.

Hachijo Island, off Izu (Mr. Y. Hirase, No. 525*b*).

This insular race has slightly less degenerate lamellæ than the typical form from Hondo. Some specimens from the outlying Ogasawara (Bonin) Islands, Mr. Hirase's No. 469, apparently belong here, though as only young ones have been received, I am not certain of them.

Section TYRANNOPHÆDUSA Pilsbry.

This section is not allied to *Euphædusa*, as I formerly supposed, but to *Hemiphædusa*, with which it agrees in the receding inferior lamella, straightly ascending within, and remote from the superior lamella. Whether it will stand as a separate section, or become a subordinate group of *Hemiphædusa*, depends upon the emphasis placed upon the different form of the clausilium. *Hemiphædusa* now comprises various shell-forms, especially among Chinese species, and will probably require to be more or less subdivided.

As the figure of *C. mikado* Pils. was on too small a scale to show the form of the spire well, I give here an enlarged outline, Pl. XXVII, fig. 35.

Clausilia iotaptyx Pilsbry. Pl. XXVII, fig. 38.

These *Proceedings* for 1900, p. 674.

The reference to plate in my former paper should read *Pl. XXIV*, not "Pl. XXV." In the description, p. 675, eighth line from top, the lunella was stated to be "lateral," whereas it is, in fact, nearly *ventral.* The same correction should be made in the third line from bottom of same page.

The systematic position of this species was left in doubt in my former paper; but further study inclines me to place a good deal of weight upon the characters of the clausilium in deciding on the classification of any Phædusoid species; and this would throw *C. iotaptyx* into my section *Tyrannophædusa.* The definition of that group must then be extended to include species with fewer whorls, but having the same type of closing apparatus. As in *C. mikado*, the upper half of the shell is attenuated.

Clausilia iotaptyx, var. clava Pilsbry. Pl. XXVII, figs. 36, 37.

Pilsbry, Nautilus, XIV, p. 108 (January, 1901).

Much smaller than *C. iotaptyx*, but similar in form; whorls 11½–12, the first globose, following 7 or 8 attenuated, last 3 swollen and forming more than half the length of the shell, the last whorl tapering below, impressed at the position of the principal plica, more or less distinctly ridged behind a wide shallow constriction behind the lip. Finely striate where not eroded; whitish or dirty buff, and lustreless. Aperture as in *C. iotaptyx*, but the subcolumellar lamella is sometimes wholly immersed. Closing apparatus more lateral than in *iotaptyx*, the upper palatal plica strong but short, lower plica shorter, connected with a rudimentary, straight lunella, which does not reach the upper palatal fold.

Alt. 12, diam. 2.8 mm.

Alt. 11.5, diam. 2.5 mm.

Senzan, Awaji Island (Y. Hirase). Types No. 79,723 Coll. A. N. S. P.; from No. 292 of Mr. Hirase's collection.

This insular subspecies has one-half to one whorl more than the typical form from Omi province, although it is much smaller; the spire is somewhat more slender, and the lunella is comparatively degenerate.

Section HEMIPHÆDUSA Bttg.

Group of C. validiuscula.

Clausilia gracilispira Mlldff. Pl. XXVII, figs. 27–31.

Von Möllendorff, Journ. Asiatic Soc. of Bengal, LI, Pt. 2, No. 1, p. 5, Pl. 1, fig. 3 (July, 1882); LIV, Pt. 2, No. 1, p. 63 (1885).

Two specimens labeled as this species were transmitted to me by Mr. E. R. Sykes. They formed part of Brigade-Surgeon Hungerford's collection, and were taken by him near Kobi, Japan, about twenty years ago.

One of the specimens is slightly stouter and reddish, the other more slender and pale yellowish green. I shall refer to them as the reddish and the green examples.

The green specimen (Pl. XXVII, figs. 27–29) is slender, much attenuated above, and has 9½ convex whorls. It is rather strongly, regularly striate. The last whorl is somewhat cylindric, and on its last half the space above the position of the principal plica is distinctly swollen. The aperture is decidedly oblique and ovate; and from its obliquity appears abnormally short in the figures, from being foreshortened. The peristome is rather widely reflexed, shortly free, a little emarginate above, and viewed from the base, it is seen to be *distinctly notched to the right of the superior lamella.* The superior lamella is marginal and slightly projecting, rather short, and *distinctly flat-topped;* continuous with the spiral lamella. The inferior lamella is very receding, hardly visible in a front view. Within it ascends straightly, is rather stout, and terminates below in a perceptible "knot" or callous thickening. The subcolumellar lamella is very deeply immersed, not visible within the mouth. Both spiral and inferior lamellæ ascend to a ventral position, the former being higher in the region where the clausilium lodges. The principal plica is visible within the aperture, and penetrates to a lateral position, being thus fully a half-whorl long. Below it there are four plicæ, the upper and lower well developed; two very short, indistinct, minute callous nodules or plicæ lying between them.

The clausilium (Pl. XXVII, figs. 30, 31) is parallel-sided, acuminate below, abruptly and deeply emarginate above on the columellar side of the filament.

Length 10, diam. 2 mm.

This specimen agrees with von Möllendorff's description of *C. gracilispira* in color and form, but differs in having fewer whorls, 9½ instead of 10–11, and in having two minute intermediate palatal plicæ instead of only one. Moreover, the lip is rather broadly reflexed, not merely "*breviter expansum.*"

The reddish specimen (Pl. XXVII, figs. 32–34) is wider than the green, with the space above the principal plica very convex (fig. 34). Whorls 9½. The aperture is less oblique than in the green specimen, but otherwise similar; the oblique flattening of the top of the superior lamella, and the notch in the peristome to the right of it being well marked. Internally it is similar to the green specimen except in the following respects: the spiral and inferior lamellæ are longer, ascending almost past the ventral position; and between the upper and lower palatal plicæ there is one very low, nodule-like callus or intermediate plica.

Length 10, diam. 2.2 mm.

This specimen agrees with von Möllendorff's description in having an identical palatal armature. In color and general appearance it is a good deal like *C. aurantiaca* var. *Erberi* Bttg. I did not examine the clausilium. The rather peculiar form of the superior lamella, in a front view, is the same in the two specimens; and when the intermediate palatal plicæ are so reduced as in these shells, I am disposed to believe that the differences above recorded are not of specific value.

It is obvious, however, that more material is needed to satisfactorily elucidate the characters of the species.

Group of C. sublunellata.

This group was defined by von Möllendorff in 1885. It is characterized by the palatal armature, the species examined by him having " below the principal plait, first an upper palatal, after this a very short second one, and then a short, straight lunella, which in some forms is somewhat obsolete, but always discernible."

In my opinion the group should be enlarged to include species which have below the principal plica or plait, one upper palatal plica, followed by a straight lunella, or a short, low callous nodule representing the lunella. There is no lower palatal plica, nor inward curve of the lower end of the lunella, representing such plica.

Since the lunella is a secondary evolution-product, formed by the coalescence of primitive palatal plicæ, it is natural that species representing certain intermediate stages should occur.

Clausilia micropeas Mlldff. Pl. XXVIII, figs. 41, 42, 43.

Von Möllendorff, Journ. Asiatic Soc. Beng., LI, Pt. 2, No. 1, p. 12; LIV, Pt. 2, No. 1, p. 64.

A specimen from Hungerford's collection, doubtless one of the original lot, was kindly lent me by Mr. E. R. Sykes. On account of its relationship with the following species, figures and descriptive notes are here given. It has not before been figured.

The pale buff, slender shell is attenuated above, and consists of nearly 9, moderately convex whorls. It is delicately costulate-striate. The aperture is piriform-ovate, with moderately reflexed lip, which is quite deeply emarginate above. The superior lamella is vertical, rather slender and high, marginal, and continuous with the spiral lamella. The inferior lamella is deeply receding, not visible from in front. Within it ascends straightly. The subcolumellar lamella is wholly immersed. Within, the spiral and inferior lamellæ are of equal length, ascending to a point on the ventral side just above the superior lamella. The principal plica is rather short, not quite a half-whorl long, its lower end visible deep within the throat, whence it extends almost past a strictly lateral position. Below it there is a rather long upper palatal plica, and then a very low, rather wide and straight lunella. No lower palatal plica.

The long, narrow clausilium (Pl. XXVIII, figs. 44–46) is parallel-sided, slightly acuminate below, and not emarginate posteriorly.

Length 10.5, diam. 2 mm.

In this specimen the lunella is apparently better developed than in that opened by Dr. von Möllendorff, who in his first description states that there is a short upper palatal plica and sometimes a second punctiform one, the latter evidently being the vestige of a lunella. In his second article he finds "that there is an indication of a lunella below the second (generally punctiform) palatal plait.'' In the specimen before me, the structure is clearly as described above and figured on my plate. When low, ill-developed or "punctiform," these palatal structures are doubtless subject to a somewhat wide range of variation, although the difference between a "punctiform plica with the indication of a lunella," and a "low, ill-defined lunella" occupying the same position, appears greater in the statement than the structure itself.

Compared with *C. perpallida*, this species differs in having the principal plica longer, and the superior lamella a little more prominent. The striation is also a trifle coarser, and the form more cylindric, less tapering. These differences do not seem to me to be of specific importance.

Clausilia micropeas var. **perpallida** Pilsbry. Pl. XXVIII, figs. 50, 51, 52.

C. perpallida Pils., Nautilus, XIV, p. 108 (January, 1901).

Shell rimate, slenderly fusiform, finely and distinctly striate, pale corneous. Apex obtuse, the first whorl globose; spire somewhat attenuated above. Whorls $9\frac{1}{2}$, convex, the sutures impressed, last whorl but slightly narrower than the penultimate, somewhat compressed. Aperture piriform, slightly oblique, with rather distinct, slightly retracted sinulus. Peristome somewhat thickened, reflexed, continuous. Superior lamella vertical, continuous with the spiral lamella, arising at the edge of the parietal lip. Inferior lamella deeply receding, visible only in an oblique view, within straightened and thickened below. Both the spiral and the inferior lamellæ penetrate inwardly to a fully ventral position, and are of about equal length; the former becoming very high for a short distance, just within the position of the palatal armature. Subcolumellar lamella is deeply immersed and either not visible within the aperture, or showing the end only in an oblique view. Principal plica less than a half-whorl long, the end visible within the aperture, inner end extending a little beyond a short, slightly curved, or forwardly diverging lateral upper palatal plica; below this, and not connected with it there is a low callous pad representing the lunella; no lower palatal fold. Clausilium long, slender and parallel-sided, somewhat acuminate toward the apex, tapering to the filament, the sides and apex thin; in profile seen to be curved, bow-like.

Length 11.4, diam. 2.6 mm.

Nishigo, province Uzen (Mr. Y. Hirase). Types No. 79,725 Coll. A. N. S. P., from No. 460*b* of Mr. Hirase's collection.

Distinguished by the pale color, subobsolete lunella, and absence of any lower palatal plica. It is closely related to *C. micropeas*, from which the shorter principal plica separates it.

Clausilia micropeas var. **hokkaidoensis** Pilsbry. Pl. XXVIII, figs. 47, 48, 49.

C. hokkaidoensis Pils., Nautilus, XIV, p. 108 (January, 1901).

Shell similar to var. *perpallida* except in the following characters: it is of a light brown color; the spire is a little less attenuated above; the peristome and superior lamella are thinner; the spiral and inferior lamellæ penetrate somewhat deeper; and the lunella is more distinctly developed, narrow and straight, extending downward to the position of the (wanting) lower palatal fold. Whorls $9\frac{1}{2}$.

Length 11.2, diam. 2.3 mm.

Length 10, diam. 2.2 mm.

Kayabe, Ojima, Hokkaido Island. Types No. 79,321 Coll. A. N. S. P., from No. 546*b* of Mr. Hirase's collection.

This is the *Hemiphædusa* referred to in these *Proceedings* for 1900, p. 674, as occurring with *C. monelasmus*. I at first considered it specifically distinct, but am now disposed to look upon it as merely a northern race of *C. micropeas* of Hondo Island. It tapers more than *C. micropeas* which has a somewhat cylindric contour.

Group of C. awajiensis.

Clausilia harimensis Pilsbry. Pl. XXVI, figs. 16, 17, 18.

Pilsbry, Nautilus, XIV, p. 108.

Shell rimate, slender, gradually tapering to a rather acute apex, light brown, finely and weakly striate, more strongly and regularly so on the last two whorls, especially the last one. Spire gradually tapering, the last two whorls of about equal size. Whorls slightly over 9, moderately convex. Aperture trapezoidal-piriform, sinulus well developed; peristome thin, whitish, narrowly reflexed, continuous, emarginate at the position of the superior lamella. Superior lamella marginal, rather high but slender, oblique, disconnected from or subcontinuous with the spiral lamella. Spiral lamella ascending to a merely ventral position, very high inside. Inferior lamella deeply immersed, visible in an oblique view only, straightened inside, thickened below. Subcolumellar lamella immersed, the end visible in an oblique view, but usually a weak continuation reaches to the edge of the peristome. Principal plica a half-whorl long, the lower end visible within the aperture; extending inward beyond the lunella. Upper palatal plica short, joined in the middle to the narrow, well-developed lunella, which descends obliquely, and curves backward below; the recurved lower end representing a lower palatal fold. Clausilium (Pl. XXVII, figs. 19, 20, 21) narrow, parallel-sided, abruptly curved where it passes into the wide filament, straightened toward the rounded, hardly angular apex; columellar side emarginate at the origin of the filament.

Length 11.5, diam. 2.8 mm.

Kashima, Harima (Mr. Y. Hirase). Types No. 79,133 Coll. A. N. S. P.

Allied to *C. awajiensis* Pils., but that species is far more obese, with tapering, compressed last whorl.

Clausilia perignobilis n. sp. Pl. XXVI, figs. 13, 14, 15.

Shell rimate, fusiform, attenuated above, moderately swollen below, pale brown, densely and finely striate. Whorls about 10, moderately convex, the early ones corneous, forming a slender apical portion, the last whorl somewhat compressed laterally. Aperture trapezoidal-piriform, slightly oblique, the sinulus somewhat retracted; peristome whitish, more or less emarginate above, very narrowly reflexed. Superior lamella small, vertical, reaching the margin, continuous with the spiral lamella. Inferior lamella very deeply receding, hardly visible from the mouth except in an oblique view. Subcolumellar lamella emerging, usually distinct to the lip-edge. Principal plica fully a half-whorl long, visible in the aperture, and extending inward beyond the upper palatal plica. Lunella lateral, oblique, shaped like the letter J, the lower end curving inward, the upper end joining the middle of a rather short upper palatal plica, which converges inwardly toward the principal plica.

Length 14.5, diam. 3 mm.; longest axis of aperture 3.2 mm.

Length 12.3, diam. 2.7 mm.

Length 12.3, diam. 3 mm.

Okinoshima, Tosa, Shikoku Island (types No. 80,843 Coll. A. N. S. P., from No. 584 of Mr. Hirase's collection).

I at first identified this species with *C. ignobilis* Sykes,[5] described from Kinnayama, Shikoku Island, but upon requesting a comparison with the type of that species, Mr. Sykes noted several important differences. The first two or three whorls in *C. ignobilis* are much larger, not so slender and pointed as in *C. perignobilis;* and the lunella is bow-shaped, as in *C. shikokuensis*, not J-shaped.

In other words, the lunella in *ignobilis* and *shikokuensis* unites with the lower, outer end of the upper palatal plica, curving gradually and imperceptibly into it, the united plica and lunella having the shape of a drawn bow, while in *C. perignobilis* the lunella unites with the middle of the upper palatal plica, like the letter J.

In *C. perignobilis* the spiral and inferior lamellæ are both high and lamellar within, of equal length, attaining barely a ventral position. The inferior lamella ascends rather straightly, and is not spiral, seen from the back in a broken specimen, but is rather thick. It gives off a branch toward the superior lamella, on the parietal wall.

Clausilia perignobilis var. **kochiensis** nov.

Similar to *C. perignobilis* Pils., from which it differs in the more robust, broader contour, more widely reflexed peristome and coarser striation of the latter part of the last whorl.

Length 15.5, diam. 4 mm.

Length 13.6, diam. 3.8 mm.

Kochi, province of Tosa, Shikoku Island (Mr. Y. Hirase, No. 657*b*).

The *J*-shaped lunella has the form of that of *C. perignobilis.*

Section STEREOPHAEDUSA Bttg.

Clausilia japonica var. **perobscura** nov.

Similar to *japonica*, but of a very dark, almost blackish, brown color, and sculptured with much coarser, more widely spaced rib-striæ. Suture with a whitish margin below. Lower palatal fold very small.

Length 25, diam. hardly 6 mm. Whorls 11.

Shirono, Buzen (Mr. Y. Hirase).

It occurred with, or at least was sent with, a rather obese form

[5] Proc. Malac. Soc. Lond., I, p. 261, and these *Proceedings* for 1900, p. 682, footnote.

of *C. japonica*, having the usual fine, sharp striation of that species.

Section MEGALOPHÆDUSA Boettger.

Clausilia Hiraseana Pilsbry. Pl. XXVI, figs. 24, 25, 26.

Shell rimate, strong, the last two whorls of about equal diameter, and forming half the shell's length, those above rapidly diminishing, the lateral outlines becoming somewhat concave toward the apex, the earlier three whorls being of about equal diameter; dark reddish brown, with a pale band below the suture, the earliest whorls white. Surface usually with a brilliant gloss, *sculptured with coarse, strong, slightly waved or uneven ribs*, which occasionally anastomose or branch, and become finer on the upper, imperceptible on the earliest whorls. Whorls 11½ to 12, but several are self-amputated in old individuals; they are convex and parted by well-impressed sutures. The last whorl, viewed dorsally, is narrower than the swollen preceding whorl, and is rather compressed, hardly convex. Aperture rhombic-ovate, vertical; peristome continuous, reflexed, flesh-tinted, whitish at the edge. Superior lamella small, marginal, oblique, continuous with the spiral lamella. Inferior lamella low and receding, within rather straightly ascending and strongly thickened below. Subcolumellar lamella deeply immersed, not visible in a front view, but its end may be seen by looking obliquely into the aperture. Principal plica short, its lower end visible deep within the aperture, upper end scarcely extending inward beyond the palatal armature. Palatal plicæ or folds lying a little dorsal of a lateral position, four in number, equidistant, all strongly developed though short; the upper fold a little longer, diverging from the principal plica, the lower (fourth) fold slightly longer than the two median, and a little arched upward in the middle. No lunella.

Clausilium evenly and rather strongly arcuate, long and rather narrow, parallel-sided. The apex is slightly acuminate on the columellar side, being rounded and strongly thickened; on the palatal side straightened, a little concave (Pl. XXVI, figs. 22, 23).

Length 27 to 29½, diam. 6 mm.

Okinoshima, province Tosa (Y. Hirase).

A fine, handsome species, easily known by its strong sculpture, which finds no parallel among known Japanese *Clausiliidæ*. It is allied to *C. Fultoni* Sykes, described from Kinnayama, Shikoku Island, a species with fine striation.

Family PUPIDÆ.

Bifidaria armigerella var. **luchuana** nov. Pl. XXVIII, fig. 54.

Shell similar to *B. armigerella* (Reinh.), but with an infra-parietal lamella developed. Length 2.25, diam. 1.2 mm.

Kunchan, Okinawa (types No. 80,992 Coll. A. N. S. P., from No. 619*b* of Mr. Hirase's collection), and Yayeyama (No. 619 of Mr. Hirase's collection).

The type lot contains one sinistral specimen. *B. armigerella* (Reinhardt) is described and figured as with but two teeth on the parietal margin, evidently the angular and parietal lamellæ. It is from Misaki, in the province of Sagami.

Vertigo Hirasei Pilsbry. Pl. XXVIII, fig. 53.

Pilsbry, Nautilus, XIV, p. 128 (March 1, 1901).

Shell very minute, openly rimate, ovate, brown, glossy, somewhat transparent, faintly striatulate. Whorls 4½, the last a little contracted and straightened near the aperture. Aperture truncate-ovate; peristome thin, hardly expanded, the outer margin straightened but not inflexed to form a sinulus, although it projects forward in a slight point or angle, visible when viewed in profile. Parietal wall bearing a rather strong lamella in the middle; columella with a somewhat smaller lamella; palatal plicæ two, near together, the lower larger, elongated, the upper tubercular, sometimes obsolete.

Alt 1⅔, diam. 1 mm.

Yanagawa, province Chikugo, Kiushiu Island (Mr. Y. Hirase).

Types No. 79,738 Coll. A. N. S. P., from No. 570 coll. Hirase.

Belonging to the *V. modesta* group, this species is smaller than its allies. As in some forms of *V. modesta*, the upper palatal fold is sometimes obsolete. The only other Japanese *Vertigo* described, to my knowledge, is *V. hydrophila* (Reinh.), from the opposite end of the empire, Hakodate, Hokkaido Island. Reinhardt's species belongs to the group of *V. ovata*, and has five or six teeth. It is about the size of *V. Hirasei*, measuring 1¾ by 1 mm.

REFERENCE TO PLATES XXV, XXVI, XXVII, XXVIII.

PLATE XXV, Figs. 1, 2, 3.—*Clausilia* (*Euphædusa*) *Tryoni*. Hachijo Island.

Fig. 4.—*Clausilia* (*Euphædusa*) *Hungerfordiana*. Nara, Yamato.

Fig. 5.—*Clausilia* (*Euphædusa*) *monelasmus*. Kayabe, Ojima.

Figs. 6, 7, 8.—*Clausilia* (*Euphædusa*) *euholostoma*. Mikuriya, Suruga.

Figs. 9, 10.—*Clausilia* (*Reinia*) *variegata* var. *nesiotica*. Hachijo Island.

Figs. 11, 12.—*Clausilia* (*Reinia*) *variegata* A. Ad. Takasaki, Kozuke.

PLATE XXVI, Figs. 13, 14, 15.—*Clausilia* (*Hemiphædusa*) *perignobilis*. Okinoshima, Tosa.

Figs. 16, 17, 18.—*Clausilia* (*Hemiphædusa*) *harimensis*. Kashima, Harima.

Figs. 19, 20, 21.—*Clausilia* (*Hemiphædusa*) *harimensis*. Clausilium. Fig. 19, profile view from columellar side; fig. 20, view of interior face, tilted to show shape of the apex; fig. 21, the same, showing posterior emargination, the apical end foreshortened.

Figs. 22, 23.—*Clausilia* (*Megalophædusa*) *Hiraseana*. Clausilium. Fig. 22, showing shape of apex; fig. 23, shape of posterior end, the apical end foreshortened.

Figs. 24, 25, 26.—*Clausilia* (*Megalophædusa*) *Hiraseana*. Fig. 26, natural size.

PLATE XXVII, Figs. 27, 28, 29, 30, 31.—*Clausilia* (*Hemiphædusa*) *gracilispira*, green specimen. Fig. 30, showing form of the apex of the clausilium; fig. 31, the posterior emargination.

Figs. 32, 33, 34.—*Clausilia* (*Hemiphædusa*) *gracilispira*, reddish specimen.

Fig. 35.—*Clausilia* (*Tyrannophædusa*) *mikado*.

Figs. 36, 37.—*Clausilia* (*Tyrannophædusa*) *iotaptyx* var. *clava*.

Fig. 38.—*Clausilia* (*Tyrannophædusa*) *iotaptyx*.

Figs. 39, 40.—*Clausilia* (*Zaptyx*) *hachijoensis*.

PLATE XXVIII, Figs. 41, 42, 43.—*Clausilia* (*Hemiphædusa*) *micropeas*.

Figs. 44, 45, 46.—*Clausilia* (*Hemiphædusa*) *micropeas*, Clausilium. Fig. 44 showing shape of apex; fig. 45, profile from columellar side; fig. 46, shape of posterior end, the distal end foreshortened.

Figs. 47, 48, 49.—*Clausilia* (*Hemiphædusa*) *micropeas* var. *hokkaidoensis*.

Figs. 50, 51, 52.—*Clausilia* (*Hemiphædusa*) *micropeas* var. *perpallida*.

Fig. 53.—*Vertigo Hirasei*.

Fig. 54.—*Bifidaria armigerella* var. *luchuana*.

BIOGRAPHICAL NOTICE OF ROBERT HENRY LAMBORN.

BY CARRIE B. AARON.

At Hornblue Hill, Chester county, Pa., not far from the historic Kennett, whose beauties have been the theme of Bayard Taylor's pen, Robert Henry Lamborn was born, October 29, 1835.

His boyhood was spent in the home of his fathers, and he was thus surrounded by the advantages of inherited prosperity. His father was a member of the Society of Friends, and was an intelligent man of refined tastes, a close observer, a bright conversationalist and a wide reader. The son inherited his prepossessing appearance, courteous manner, dignified bearing and agreeable disposition.

Young Lamborn's education was given a scientific turn by the influence and patronage of his uncle, Jacob Pierce, who served as Librarian of the Academy of Natural Sciences of Philadelphia from December, 1817, to December, 1826, and who, in the early days of the institution, had, at one time, all its collections stored in one of his spare back rooms. No doubt the youth received his first inspiration for "collecting" while in such environment.

After receiving a common-school education and a special training at the Polytechnic College in Philadelphia, he determined to continue his studies in civil engineering abroad. He secured means to do so by the publication of original essays on the metallurgy of copper, silver and lead,[1] works which, although long superseded, were considered ably written and used as text-books both here and abroad. He became a student of the Royal Saxon Mining Academy of Freiberg, and the School of Mines in Paris, graduating from the University of Giessen, from which he later received the degree of Doctor of Philosophy.

Soon after the outbreak of the Civil War, Dr. Lamborn returned from Europe and joined the army, serving with the Anderson

[1] *A Treatise on the Metallurgy of Copper*, J. Weale, London, 1860, and *A Treatise on the Metallurgy of Silver and Lead*, J. Weale, London, 1861.

Cavalry at the Battle of Antietam, under Captain Palmer. He became captain on the staff of Gen. John F. Reynolds in 1862.

After the war he was twice elected City Surveyor of Trenton, N. J. He was engineer in charge of fuel and iron rails on the Pennsylvania Railroad when coal was displacing wood as fuel for engines, and steel was finally supplanting iron. He was Secretary of the American Iron and Steel Association at the period of its development into an institution of national importance, and when the publication of iron and steel statistics became a necessity. He was Secretary, Treasurer and Director of the first railroad to connect the Mississippi river and Lake Superior, and founder, Treasurer and Director of the Western Land Association, which began the building up of Duluth when the town consisted of but seven houses. He was made President and Director of the National Land Improvement Company. He participated in founding the towns of Colorado Springs and Manitou, and in colonizing the country at the base of Pike's Peak.

Early in his career, while residing in Pittsburg, where he was appointed the first chemical expert for the Pennsylvania Railroad, Dr. Lamborn became acquainted with Mr. Andrew Carnegie and others who have done so much for the development of the industrial resources of western Pennsylvania, with whom he maintained a life-long friendship. Mr. Carnegie writes of him: "As a young man he was thoroughly practical, quiet, reserved, dignified, eminently scientific. . . . . He wore kid gloves, which were then rare in western Pennsylvania; this fact rendered him somewhat an object of suspicion at first, something rather effeminate; one had only to know him to see how he survived his kid gloves. Year after year he gained more and more the respect and confidence of all of us, and finally became a friend and one of the circle whose loss was deeply deplored."

Dr. Lamborn, as General Manager of various Western railways, introduced the first coke blast furnaces and the first Bessemer steel ingot and rail works west of the Missouri river.

While engaged in extensive railroad and mining interests, he lost no opportunity of studying the cliff dwellers and other primitive inhabitants, making at the same time collections of pottery and ethnological objects which he presented to various institutions.

While in Mexico he devoted much attention to the art of that country, subsequently publishing his observations in 1891 under the title, *Mexican Paintings and Painters*, Bouton, N. Y. The Lamborn Collection in Memorial Hall, Philadelphia, contains the material secured in Mexico, as well as many specimens gathered in Europe to illustrate the history of civilization in the Italian Peninsula, beginning with relics from the prehistoric Terra Mane period and from the almost prehistoric Etruscan times.

While engaged in building the Lake Superior Railroad, Dr. Lamborn suffered so from the attacks of countless mosquitos, that he became interested in extermination of the insect, and later offered prizes for the three best essays on the subject. These were published under the title *Dragonflies vs. Mosquitos: The Lamborn Prize Essays*, D. Appleton, New York, 1890.

As a beekeeper Dr. Lamborn will long be remembered by many friends who had received from him colonies of Italian bees. He enjoyed the careful study of the social organization of a hive, his special interest being the development of a stingless bee. While intent upon these investigations his identity as a railroad magnate would be quite lost under his bee hat and veil.

While the name of Robert H. Lamborn will not be found recorded among those of the great scientists of the world, his environments, the natural bent of his mind, his broad views of life, together with an executive and business ability far beyond the average, constituted a unique personality. His interests in mining and metals and the demands of business made him a constant traveler over large areas. It was thus impossible for him to give the sustained attention necessary to effectively cultivate the many subjects of natural history which he loved, and in which he might have become eminent if his interests had been more concentrated.

Philadelphia was his favorite city. During the last years of his life he retained here a domicile, and would probably have made his home here had his life been prolonged.

Dr. Lamborn expressed his opinions of the unequal distribution of wealth in a manner which showed his altruistic notions as to the power and influence of money when used productively. He believed that great fortunes should be regarded as capital in trust for the permanent benefit of society, and that the owner of a large amount of money could erect no better monument to himself, than by systematically employing a great number of persons with the aim of improving their social conditions. He was opposed to indiscriminate charity, regarding it as one of the causes of pauperism and the natural demoralization which is the usual result of receiving something for nothing.

That Dr. Lamborn recognized the institutions which foster the various branches of science as fitting beneficiaries of his wealth was evidenced by the placing of his collections of archæological books, ethnological objects, Etruscan relics, Mexican pottery, etc., where, free to the public, they may be used for reference and instruction as additions to the educational resources of the several repositories. He advocated the opening of all museums, parks, art galleries and places of healthful recreation to the public on Sunday, that all might be brought in contact with the beautiful in nature and with man's best handiwork. He placed none of his collections in any museum which exacted an admission fee.

Although Dr. Lamborn was a man of large means, he frequently suggested money-making schemes to young people whom he wished to employ, by offering work on a profit-sharing basis, his object being to engage the earnest attention of students and to develop a love of research, ends more likely to be secured by copartnership than by patronage. As an incentive to study, he frequently offered prizes of money for the investigation of various scientific questions, his interest being especially in the direction of the cultivation of bees and flowers.

Shortly before his death Dr. Lamborn placed a sum of money with the President of Swarthmore College to be paid in prizes for the two clearest and most useful essays upon the theme, "What important inventions, discoveries, observations, ideas or acts tending to advance civilization have been contributed by members of the Society of Friends, or by persons descended from members of that Society, or by persons guided or employed by such members, with an estimate of the number of members composing the Society each twenty years since its foundation." Some essays were written in response but have not been published.

During the greater part of his active life Dr. Lamborn was conscious of the existence of organic cardiac weakness, which, it is believed, deterred him from marrying, and resulted in his sudden death in New York, after a slight, apparently trivial, indisposition, January 14, 1895.

Dr. Lamborn's success in life was due to his persistent efforts to master difficulties, the possession of the loftiest aims and an invincible purpose of acting for the right.

All knowledge which he acquired by personal research or through his patronage of students he cheerfully gave to the world. Science has been enriched by his benefactions to the several institutions in which his library and collections have been placed.

His special interest in the Academy of Natural Sciences of Philadelphia, his devotion to its objects and his approval of its administration have been most practically indicated by the terms of his last will which left to the Society without conditions his entire estate for the advancement of its work in biology and anthropology. Although, because of a legal technicality—a question of domicile and a provision of New York law which seems to have been framed solely for the benefit of lawyers—his benevolent intention has not been entirely fulfilled, the portion of his estate of which the Academy has become possessed by an agreement with the heirs-at-law, forms a most important addition to its resources and will enable the Society to effect such development in the departments indicated as will constitute a lasting memorial of its generous benefactor, who, by the magnitude of his gift, stands first among the many earnest men devoted to the advancement of knowledge who have substantially manifested their interest in its well-being.

Miss Anna Wharton, in the following ode, has briefly given expression to the feelings of many who hold Dr. Lamborn in grateful and appreciative memory:

Esteem he won from many loyal friends,
To whom his well-stored mind and humor keen,
His generous heart, where kindly traits convene,
Had drawn him by that bond which nothing rends.
And now where his remembered image blends
With thronging shadows of the world unseen,
That honored figure of the stately mien
Is crowned with light which grateful memory lends.

His life so full of thought and effort high,
Brought that success which is to sloth unknown,
But as he had not formed that dearer tie
Which makes a home and kindred of one's own,
There at the last no helping hand was nigh,
No love to soothe him, and he died alone.

August 6.

Mr. Benjamin Smith Lyman in the Chair.

Seven persons present.

A paper entitled "Notices of New Land Snails from the Japanese Empire," by Henry A. Pilsbry, was presented for publication.

The death of D. Calvin Mensch, M.D., Ph.D., a member, July 30, and of Charles Mohr, a correspondent, July 17, 1901, were announced.

August 20.

Mr. Arthur Erwin Brown, Vice-President, in the Chair.

Seven persons present.

Papers under the following titles were presented for publication:

"A New Species of Coluber from Western Texas," by Arthur Erwin Brown.

"Peculiarities of the Terrestrial Larva of the Urodelous Batrachian Plethodon cinereus," by Thomas H. Montgomery, Jr.

The death of Louis Schneider, a member, August 14, 1901, was announced.

August 27.

Mr. Benjamin Smith Lyman in the Chair.

Seven persons present.

Thomas Lauder Brunton, of London, was elected a correspondent.

The following were ordered to be printed:

A NEW SPECIES OF COLUBER FROM WESTERN TEXAS.

BY ARTHUR ERWIN BROWN.

On June 18 a large and handsome *Coluber* was received at the Zoological Gardens from Mr. E. Meyenberg, a resident collector of the Society at Pecos, Texas, which both in color and scutellation differs greatly from any species of the genus previously collected in the United States.

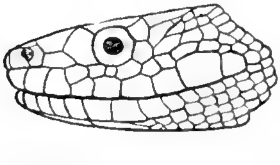
The locality of its capture was given by Mr. Meyenberg as the Davis Mountains, fifty miles southwest of Pecos, near the head of Toyah creek.

As it seemed unlikely that so large and striking a snake could have hitherto escaped notice in a region comparatively well known to collectors, description of the species was withheld and a liberal reward was offered for additional specimens, the fortunate result of which has been the receipt on August 13 of two younger, living snakes from the same locality, presenting similar characters, and a fourth specimen on August 16.

All doubt as to the fixed characters and the place of origin of these snakes being removed, the species is here described:

Coluber subocularis sp. nov. Plate XXIX.

Specific characters: Head broad and flat on top. Body stout. Tail short. Rostral broad and low. A row of small accessory plates below the eye and preocular. Preocular in contact with the frontal. Temporals small and numerous. Scales in 31–35 rows. Anal divided. Body color yellow, with a series of black H-shaped dorsal blotches with pale centres, the lateral arms being continued by a paler shade, and forming a pair of longitudinal stripes. Head and belly unmarked.



Type specimen. No. 13,733 Academy Collection, from the Davis Mountains, Jeff. Davis county, Texas.

In the type specimen, which is adult, the head is broad, flat on top and distinct from the neck, which is rather slender; the body is stout and the tail a little less than one-eighth of the total length.

Rostral nearly twice as broad as high, barely visible from above. Internasals narrow in front, half the length of prefrontals. One pair of prefrontals. Frontal rather broad behind, one-third longer than its greatest breadth, the anterior corners cut off to form an oblique suture with the preocular. Suture between the parietals equals the length of the frontal, or the distance between the frontal and rostral. Two large nasals, the nostril between them, situated high up and directed rather upward. Loreal longer than high, its upper border sloping downward and backward. One large preocular, reaching the frontal. In each of the specimens a row of two or three small accessory plates more or less completely separates the eye, the preocular and the hinder end of the loreal from the labials, but they present variations in detail. The type has 9 upper labials on one side, and there are three accessory plates, the first lying on the 3d and 4th, the second on the 4th and 5th, and the third on the 5th labial; on the other side there are 11 labials, the first accessory lying on the 4th and 5th, the second on the 5th and 6th, and the third on the 6th, the labials being wholly excluded from the orbit on both sides. The largest of the smaller specimens has 10 labials on each side, and the accessory plates are as in the type. In the third specimen there are 11 labials on each side, on one of which only the two anterior accessory plates are present, and the sixth labial enters the orbit behind them; on the other side, the 6th labial also reaches the eye, and all three accessory plates are present, but the two hinder are small and are pushed forward. In the smallest specimen the labials on one side are 10, the first and second accessory plates only are present, permitting the fifth labial to enter the eye; on the other side, the labials are 11, and the three plates completely shut out the labials, as in the type and the second specimen. Three postoculars, the inferior extending forward under the eye. The temporals are small and irregular, from 3 to 5 in the first row. Lower labials 14, the hinder ones small and scale-like. Five lower labials in contact with the anterior chin shields; the hinder pair shorter and widely separated.

Scales in 33 rows, with two pits; the outer row very slightly enlarged; 27 to 29 rows faintly keeled.

Ventrals 270; anal divided; subcaudals 70 pairs.

Total length 1,590 mm. (tail 190).

Color bright yellowish buff, with an orange tinge anteriorly; head more ashy, without markings on top or sides. Two very distinct black stripes, two or three scales wide, separated by three and two half rows, begin on the neck and run back to the tail, becoming blackish brown posteriorly. At intervals of about eight scales they are connected by narrow crossbars of the same color, the first of which is about three inches behind the head. The stripes are at first jet black, but after a short distance the portion midway between the crossbars fades to maroon, leaving the black sections outlined as a series of H-shaped dorsal blotches, the centres of both the crossbars and the lateral arms being paler. There are 24 of these spots on the body and 8 on the tail, where they lose much of their characteristic shape. On each side is a row of ill-defined, cloudy spots, rather higher than long, extending to the ends of the ventrals; they mostly alternate with the dorsal spots, but an occasional one is opposite. Traces of a short, broken black line on the sides of the neck suggest a second stripe parallel to that on the back. Belly white with a faint yellowish tinge, unmarked, except for a dusky shade on the suture between the subcaudals, and a cloudy spot on the hinder margin of each scutum on the anterior half of the tail. Chin and throat pure white.

The above color description was taken from the type in life, when freshly caught, but much of the intensity has already faded, after two weeks' immersion in spirits.

The largest of the three specimens now living in the Zoological Society's collection measures 915 mm. (tail 125). It has 35 rows of scales, of which about 15 are very faintly keeled. As nearly as it is possible to count them in a living snake, the ventrals are about 240; subcaudals about 77. There are 25 dorsal spots and 8 on the tail, and the body color is paler and more ashy than in the type.

The third specimen is 684 mm. long (tail 98); the scales are in 31 rows, about 13 of which are faintly keeled; ventrals about 245; subcaudals about 68. The color is similar to the last described, but there is a small dusky spot at each of the anterior and lateral angles of the frontal plate. There is the same number of dorsal spots as in the type.

The fourth example is 472 mm. long (tail 67); scales in 31 rows, of which 15 are keeled; ventrals about 240; subcaudals about 63. The color is very similar to the type, but less intense, and there are but 20 dorsal spots on the body, with 8 on the tail.

In all the young individuals the light portion of the dorsal stripes, continuing the lateral arms of the H-shaped spots, is less distinct than in the adult, and the whole under surface is pearly white, with indications of the cloudy markings under the tail; the carination of the dorsal scales is so indistinct that it is hard to determine its exact extent.

The bright colors and the strong contrasts shown in life by the adults, render this one of the most beautiful of North American snakes. The pattern on the dorsal region is simply the extreme development of the tendency toward longitudinal extension of the corners of the spots, which is shown at times in some other species, such as *C. obsoletus confinis*, which occasionally exhibits even the neck-bands. It is also suggested on the forepart of the body in *C. lineaticollis* Cope, but from these it differs widely in scutellation, and its real relations are with the section of *Coluber* represented by the Mexican *C. triaspis* and *C. mutabilis*, which tend in the direction of the nearly related genus *Pityophis* through *P. vertebralis*, from which, however, it is abundantly distinguished by the generic characters and by the curious fact that the color shading is completely reversed, the spots in *C. subocularis* being black anteriorly and fading toward the tail, while in all species of *Pityophis* the exact opposite occurs.

NOTICES OF NEW LAND SNAILS FROM THE JAPANESE EMPIRE.

BY HENRY A. PILSBRY.

Continuing his zoological researches in the islands south of Kiusiu, Mr. Hirase has had the two principal islands of the "Northeastern group" of the Loo Choo chain explored for land snails. These islands, Tane-ga-shima and Yaku-no-shima (Yaku-shima), belong politically to the Province of Osumi, and hence in Japan are not ordinarily included in the Loo Choo Islands. I shall discuss their faunal relations more fully at another time, but it may be said here that while there is one species of land snail, *Trochomorpha Gouldiana* Pils., identical with a species of Oshima, the rest of the fauna, though composed almost wholly of endemic species, is more nearly related to that of Kiusiu than to the Loo Choo fauna proper.

CYCLOPHORIDÆ.

Spiropoma Nakadai n. sp.

Shell discoidal, with very wide, bowl-shaped umbilicus, and nearly flat spire, except that the first whorl projects when not worn; solid, yellowish-brown, rather dull, sculptured with slight growth-lines only. Whorls 4½, convex, the last one very deeply descending in front. Aperture quite oblique, nearly circular, the peristome built forward, becoming free from the preceding whorl, and a little contracted. Diam. 10, alt. 4.8 mm.; diam. 9, alt. 4.7 mm.

Tane-ga-shima (Mr. Y. Hirase, No. 658).

In the larger *S. japonicum* the last whorl descends much less in front; the peristome is expanded and not so much, usually not at all, built forward. It is named for Mr. Nakada, an earnest and successful collector for Mr. Hirase.

Spiropoma is a new name recently substituted for *Cœlopoma*, which was found to be preoccupied.

Pupinella rufa var. **tanegashimæ** nov.

Smaller than *P. rufa* from Hondo, Awaji or Kiusiu, or the Tsushima or Iki forms; whorls 6; peristome very heavy. Alt. 9.5, diam. above aperture 4.3 mm.; alt. 8.3, diam. 4 mm.

Pupinella Funatoi n. sp.

This species differs from *P. rufa* in being much smaller, with only 5½ whorls, the spire more abruptly tapering above; more solid; darker colored. The aperture is vertical, the lower margin not in the least carried forward as it is in *P. rufa*. The whole peristome is exceedingly thick and strong, with an inner elevated rim about the orifice. The posterior orifice is not channel-like; and the columellar orifice is a small slit, which does not deeply penetrate the lip, as it does in *P. rufa*. A glossy callus spreads much further up on the ventral face of the whorl than in *P. rufa*. Length 7½, diam. above aperture 3½ mm.

Tane-ga-shima (Mr. Y. Hirase, No. 665*a*).

It seems curious that there should be a slightly differentiated race of the widespread *P. rufa*, and a well-characterized species of the same genus, on so small an island as Tane-ga-shima. This species is named for Mr. Funato, one of the efficient assistants who have enabled Mr. Hirase to make such notable additions to our knowledge of Japanese mollusks.

Diplommatina tanegashimæ n. sp.

Shell small, obese, pupiform, light red, composed of 5½ convex whorls, the penultimate whorl widest, those above tapering regularly; last whorl much contracted. Sculpture of widely spaced, delicate riblets on the spire, the last two whorls with very much finer, far closer rib-striæ. Aperture circular, the peristome expanded, thickened within, slightly duplicate. Columellar tooth strong and acute; palatal plica short, distinct, situated above the columella. Length 2.6, diam. 1.6 mm.

Tane-ga-shima (Mr. Y. Hirase, No. 668).

Somewhat allied to *D. saginata*, of Oshima.

HELICINIDÆ.

Helicina yaeyamensis n. sp.

Shell very small for the genus, thin, rather pale red, dull, faintly marked with growth-lines, and a few spiral striæ are usually developed; shaped like *H. verecunda*. Whorls 4½, convex, the last rounded at the periphery, a little compressed above and below. Aperture oblique, semicircular, the outer lip simple, unexpanded, *not thickened.* Umbilical callus whitish, rather large and densely pitted. Alt. 2.2, diam. 3.3 mm.

Yaeyama, in the southwestern group of the Loo Choo Islands (Mr. Y. Hirase, No. 624). Types No. 80,967 Coll. A. N. S. P.

About half the dimensions of *H. verecunda* of Okinawa, but with the same number of whorls, and a simple, unexpanded lip. I at first supposed the specimens were young, but the receipt of a second lot from Mr. Hirase, agreeing in size and other characters with the first, indicates that they are full grown.

ZONITIDÆ.

Microcystina Hiraseana n. sp.

Shell trochiform, with minute, nearly covered perforation; brown, glossy and smooth, slightly transparent. The periphery has a narrow, acute, projecting keel, visible in the suture above. Spire conic, the apex obtuse. Whorls 5¼, quite convex; base convex, narrowly impressed in the centre. Aperture shaped like a crescent with truncate ends, slightly oblique; peristome simple and acute, the columellar margin reflexed at the perforation, thickened within with a white callus, sometimes sinuous. Alt. 3, diam. 3.5 mm.

Tane-ga-shima (Mr. Y. Hirase, No. 667).

This species resembles *M. ceratodes* (Gude) in general features, but is more elevated, with more exserted keel, a less varnish-like gloss, and more closely coiled whorls.

Macrochlamys tanegashimæ n. sp.

Shell small, depressed, minutely perforate, smooth and glossy, rich brown, somewhat translucent. Spire low-conoidal, obtuse at the apex. Whorls 4½, moderately convex, rather closely revolving, appressed at the suture, which appears margined; the last whorl nearly double the width of the preceding, rounded at the periphery, moderately convex beneath. Aperture crescentic, slightly oblique, the lip simple and thin, abruptly reflexed at the columellar insertion. Alt. nearly 2, diam. 3.8 mm.

Tane-ga-shima (Mr. Y. Hirase, No. 666).

About the size and general appearance of the shell I called *Vitrea harimensis*, but which I subsequently decided to be young

Macrochlamys Doenitzi (Reinh.); but the species from Tane-ga-shima has a narrower umbilical perforation, and the spire is more developed, with an additional whorl.

CLAUSILIIDÆ.

Clausilia oscariana n. sp.

Shell fusiform, rather slender, not subject to truncation, brown, finely striate, the last whorl more coarsely so. Whorls $10\frac{1}{2}$ to $11\frac{1}{2}$, the upper part of the spire decidedly attenuated. Aperture piriform, the peristome thickened and reflexed, with several more or less distinct folds on its face, adjacent to the subcolumellar lamella. Superior lamella rather small, oblique, not connected with the spiral lamella. Inferior lamella deeply receding, straightened and subvertically ascending within. Subcolumellar lamella emerging. Principal plica long. Lunella curved inward above, straightened and connected with a short palatal plica below, being thus shaped like an inverted letter J. Length 12–14.5, diam. 2.8–3.3 mm.

Fukuregi, Province of Higo, Kiusiu (Mr. Y. Hirase, No. 674).

This *Hemiphædusa* belongs to the group of *C. plicilabris* A. Ad. (*bilabrata* Smith), but this is a much smaller species and differs in various structural characters. It is named in honor of Dr. Oscar Boettger, the acute and lucid master in the study of *Clausiliidæ.*

Clausilia higoensis n. sp.

Shell fusiform, very much attenuated above, brown, finely striate, the last whorl tapering. Whorls 10, the last more coarsely striate dorsally, having a low, inconspicuous wave or prominence behind the outer lip. Aperture piriform, the peristome slightly reflexed, somewhat thickened. Superior lamella rather small, oblique, marginal, continuous with the spiral lamella. Inferior lamella deeply receding, rather straightly ascending inside. Subcolumellar lamella immersed, or nearly emerging. Principal plica extending beyond the lateral lunella. Lunella strongly curved inward below, straightened above, where it joins the middle of a short, oblique upper palatal plica. Length 14–15, diam. 3.7–3.8 mm.

Midumate, Province of Higo, Kiusiu (Mr. Y. Hirase, No. 677).

A species of the Hemiphædusan group of *C. awajiensis, perig-*

nobilis, etc., more attenuated above than any of the known species except *C. awajiensis*, which is a more obese form with narrow lip and emerging subcolumellar lamella.

Clausilia ischna n. sp.

A slender and elongate member of the group of *C. awajiensis*, the length five times the greatest diameter; rather thin, brown, with about 11½ whorls; finely striate. Aperture small, the peristome reflexed, rather narrow. Superior lamella compressed, oblique, continuous with the spiral lamella. Inferior lamella very deeply receding. Subcolumellar lamella deeply immersed. Lunella curved inward below, straightened above, and connected with a short, oblique upper palatal plica, being shaped like the letter *J*. Length 16.5, diam. 3 to 3.3 mm.

Kochi, Tosa (Mr. Y. Hirase, No. 657*a*).

More slender than any other known species of the group of *C. awajiensis.*

Clausilia ischna var. **neptis** nov.

Paler, nearly corneous or whitish; less slender, the last whorl more coarsely striate; peristome broader; sinulus more retracted. Whorls 11. Length 15.5 to 16.5, diam. 3.5 mm.

Occurred with the preceding.

Clausilia tanegashimæ n. sp.

Fusiform, rather slender, obsoletely marked with growth-lines, the last whorl striate, pinched up in a rather acute strong wave behind the peristome. Whorls 10½. Aperture ovate, the peristome well expanded. Superior lamella small, oblique, marginal. Inferior lamella receding, not visible from in front. Subcolumellar lamella emerging. Lunella curved inward above, straight below, its lower end joined to a lower palatal plica near its inner end. Length 18½, diam. 4⅓ mm. or smaller, length 16½ mm.

Tane-ga-shima (Mr. Y. Hirase, No. 662).

The *Hemiphædusæ* of the northeastern Loo Choo Islands belong to several groups special to those islands. The group of *C. tanegashimæ* has the internal structure of the *plicilabris* group, but there is a strong wave or crest behind the outer lip parallel with it. The shell is very solid and strong.

Clausilia ptychocyma n. sp.

Obesely fusiform, nearly smooth except the last whorl, which has a wave-like ridge and several strong wrinkles behind the lip. Whorls about 8½. Aperture squarish-ovate, the peristome thick, narrowly reflexed. Superior lamella small and obtuse. Inferior lamella very deeply receding. Subcolumellar lamella immersed. Lunella very low, narrow, straight above, curved inward and meeting the outer end of a short lower palatal plica below. Length 11, diam. 3 mm.

Tane-ga-shima (Mr. Y. Hirase, No. 664*a*).

Clausilia ptychocyma var. **yakushimæ** nov.

Wrinkles on the latter part of the last whorl more numerous and less prominent; superior lamella often subobsolete; subcolumellar lamella less deeply immersed, or emerging. Lunella more distinct.

Yakushima (Mr. Y. Hirase, No. 664*b*).

The following species belong to another group of *Hemiphædusa*, characterized by the very strongly spiral inferior lamella.

Clausilia entospira n. sp.

Fusiform, rather slender, yellowish, smooth, the latter half of last whorl coarsely striate, whorls about 8½, moderately convex. Aperture small; peristome narrowly reflexed, very much thickened, flattened. Superior lamella small, remote from the spiral lamella. Inferior lamella forming a prominent, heavy fold rather deep within the mouth, strongly spiral within the last whorl. Subcolumellar lamella immersed. Lunella very strong, strongly curved inward below, straight above. No palatal plicæ except the principal plica. Length 10, diam. 2½ mm.

Tane-ga-shima.

Clausilia pinto n. sp.

Shell small, fusiform, dull brownish-olive, nearly smooth. Whorls 8, moderately convex. Aperture small, squarish-ovate; peristome thick, expanded, subreflexed. Superior lamella small, vertical, marginal, barely continuous with the spiral lamella. Inferior lamella very deeply receding, straightened within the last whorl. Subcolumellar lamella emerging. Lunella connected above with the middle of a short upper palatal plica, strongly curving inward at its lower end, being shaped like the letter J. Length 9.3, diam. 2.4 mm.

Tane-ga-shima (Mr. Y. Hirase, No. 663).

This species looks like a *Zaptyx*, but wants the accessory lamellæ and plicæ of that group. I am disposed to consider it a degenerate member of that subgenus. Otherwise, the receding inferior lamella would cause it to be ranked as a *Hemiphædusa*.

Clausilia (Stereophædusa) stereoma n. sp.

Excessively strong, glossy, olive-yellow, weakly striate; very obese below, the upper third very much attenuated, latter half of the last whorl compressed. Whorls about 8½. Aperture piriform, the peristome thickened, narrowly reflexed. Superior lamella rather small, continuous with the spiral lamella; inferior lamella forming a strong, subhorizontal fold; subcolumellar lamella emerging. Principal plica rather short, lateral; upper and lower palatal plicæ of moderate length, oblique, two minute palatal plicæ between them. Length 21½, diam. 6 mm.

Yaku-shima (No. 670 of Mr. Hirase's collection).

Specimens from Tane-ga-shima, which may be called var. *cognata*, are referable to the same species. They are a little larger, reddish-brown, perceptibly thinner than the types though still very strong, and with 9½ whorls (No. 661 of Mr. Hirase's collection).

There is also a well-marked variety found on Yaku-shima, much smaller, length 14½ to 17 mm., more slender, but the color of the type. This may be called var. *nugax*.

These forms closely resemble *C. brevior* v. Mart. in the obese contour, very much attenuated above; but they are excessively strong, while *brevior* is thin. One species of the *brevior* group occurs in southeastern Kiusiu, *C. Addisoni* Pils. This was originally described as a variety of *C. brevior*, but on opening additional specimens I find that there is a more or less distinct, straight lunella between the second and lower palatal plicæ, not present in *C. brevior*. Moreover, *C. brevior* seems to be widely separated geographically from *Addisoni*. I think therefore that the latter will stand as a distinct species.

PECULIARITIES OF THE TERRESTRIAL LARVA OF THE URODELOUS BATRACHIAN, PLETHODON CINEREUS Green.

BY THOMAS H. MONTGOMERY, JR., PH.D.

To the writer's knowledge no description has been published of the larval stage of this strictly terrestrial species, which occurs through the United States of America east of the Mississippi river. Cope[1] states: "Its habits are entirely terrestrial, as it is never, even in the larval stage, found in the water. It is abundant under stones and logs in the forests everywhere, and does not occur in open fields. The eggs are laid in a little package beneath a stone in a damp place. When the young emerge they are provided with branchiæ, but these soon vanish, and they are often found in this young stage apparently quite developed." I have collected several hundred individuals near West Chester, Pa., at all seasons of the year, and have never found them in streams or boggy places, but most generally in woods on hillsides at varying elevations above water-courses, sometimes several hundred feet from any water, and occasionally in open fields and hillsides which in the summer season become very dry. For the most part they are found beneath wood and stones, and even in mid-winter may be found in these places, though at that time generally deeper in the ground than in summer.

This being, then, such a strictly terrestrial species, it was to be anticipated that its larval stage would show deviations from the larvæ of the other *Urodelea* which develop in the water. In July of the present year I found five eggs of *Plethodon cinereus* under a stone, and curled around them, on guard, an adult which dissection proved to be a female; these ova were larval stages, and the examination of them showed many interesting modifications, as follows:

The eggs are relatively very large for the size of the species, and each enclosed in gelatinous envelopes. Active movements of the heads and tails of the larvæ could be observed within the innermost membrane. But the striking peculiarity, even to the naked eye,

[1] "The Batrachia of North America," *Bull. U. S. Nat. Mus.*, No. 34, 1889.

is a large, nearly spherical yolk-mass around which the larva is curled, or rather into which it is pressed by the tension of the egg-envelopes. Plate XXX, fig. 1 shows a larva freed from its envelopes before killing so that it had straightened out; and fig. 2, an older larva, similarly treated, but which had still retained much of its normal position. The surface of the yolk-sphere is well supplied with blood-vessels, as shown in fig. 1, an antero-ventral one being particularly prominent. The figures show that there are three pairs of gills present (in fig. 2 only one gill is shown on the right hand, for the sake of clearness); and in the older larva the gills are of great size, much branched, the first the smallest, the second largest, lamellar and richly vasculated. The fore and hind limbs are already well marked, the toes on both faintly outlined; but most remarkable is the fact that the posterior limbs are larger than the anterior, which might indicate that the former develop first, in contradiction to what is known of other *Urodelea*. The head, the limbs, and all the trunk region of the embryos, except the end of the tail, are dorso-ventrally flattened, due undoubtedly to pressure against the yolk-sphere, but become more cylindrical after removal from the egg-envelopes. The head and trunk are pigmented with dark-brown chromatophores, which in the trunk region are arranged metamerically, while the yolk-sphere is not pigmented and of a yellow color; and as the figures show, the eyes are very large. A mouth was present in both cases, but there appeared to be no sucking disks upon the lower side of the head.

In fig. 3 is shown a camera drawing of a section through a stage somewhat younger than that of fig. 1; this section was made through an embryo curled closely around the yolk-sphere, in such a manner that the anterior region of the head, shown on the upper side, is cut medially, while a portion of the bend of the trunk, seen on the right-hand lower side, is cut obliquely. This figure is to illustrate the relations of the intestine to the yolk-mass. The mouth (*Mo.*) leads through the pharynx (*Ph.*) and œsophagus (*Œs.*) to the stomach (*St.*), and posteriorly to the latter is a short diverticulum (*D.*). The small intestine (*Int.*) is seen to be tubular in its proximal portion, but more distally to pass over into the wall of the yolk-mass (*Yk.*). The yolk-mass of this stage is seen to be composed of large yolk-cells, the boundaries of which are very distinct. In this fig. 3 the relative dimensions of yolk-mass to the body are not shown, since the head hides a part of the yolk-mass, and since the head is cut obliquely and so appears larger than it would be in strictly median section.

But the relations of the intestine to the yolk-mass are more clearly shown in the camera drawings 4 and 5, which are dorsal portions of cross-sections of the larva shown in its entirety in fig. 1. Fig. 4 is in a plane behind the gill region, and shows how the intestine (*Int.*) is connected with the yolk-sphere (*Yk.*). The epithelium of the intestine, the nuclei of which are shown as black spots, expands ventrally into the yolk-sphere on the dorsal aspect of the latter. The epithelium of the intestine ends abruptly against the peripheral layer of the yolk-sphere, and does not pass over into it gradually. The nuclei of the yolk-sphere are much smaller and peripherally placed, and in places are found small clusters of nucleated cells. The yolk-mass of this larva shows that the cell boundaries of the yolk-cells have disappeared, and consequently the latter are undergoing regressive changes; the yolk appears as a mass of globules of different volumes suspended in a structureless fluid and without nuclei. Fig. 5 represents the dorsal half of a cross-section through the same larva, in a plane about half-way between the anterior and posterior limbs. In this region there is no tubular intestine, nor any open groove of intestinal epithelium upon the yolk-sphere, the entoderm being represented simply by the yolk-sphere (*Yk.*), the small nuclei of which are on its periphery.

These sections make clear the nature of the yolk-mass, and its relation to the intestine. From the mouth to the commencement of the small intestine the alimentary tract is tubular, and has the same appearance in its epithelial lining as in like stages of other *Batrachia;* the same is true also for the rectal region of the alimentary tract, which is likewise tubular. But the middle region of the intestine is composed of the yolk-mass, which in the earlier stage shown in fig. 3 is made up of large yolk-cells, and in the latter stage of figs. 4 and 5 of a mass of yolk-globules with a peripheral layer of small nucleated cells. Accordingly the large yolk-sphere is not a yolk-sac, since it is an integral part of the intestine.

The larva shown in fig. 1, of which figs. 4 and 5 represent sections, is in quite an advanced stage. Externally can be seen the gills and both pairs of limbs. The sections show that pronephroi are present in the anterior trunk somites, and metanephroi (*M. T.*, fig. 5) in the posterior somites. There is a cartilaginous brain capsule, cartilaginous vertebral arches (*V. C.*, figs. 4 and 5), and cartilages for the bones of the limbs. The notochord (*N. C.*) is undergoing degeneration; the somatic mesoderm (*So. M.*) is divided into its various components—muscle somites, sclerotom, etc. The segmental ducts (*S. D.*) extend posteriorly and open into the rectum. The cœlom (*C.*) is large, the median mesenteries well formed (*M.*), the liver (*L.*) and hepatic ducts present. The epidermis (*Ect.*) is thick and glandular on the dorsal side of the body, and the genital ridges (*G. R.*, fig. 5) developed. All these points show an advanced stage of development, which makes it the more remarkable that the middle intestine should be represented by a large yolk-sphere.

The sides and ventral aspect of the yolk-sphere are covered with a very thin envelope composed of three cell layers closely apposed, the flattened ectoderm (*Ect.*, figs. 4, 5), the somatic mesoderm (*So. M.*) and the sphlanchinic mesoderm (*Sp. M.*). The fact that the body wall is excessively thin upon the ventral side of the yolk-sphere, would show perhaps that this wall had extended around the yolk not until late in the development. The blood-vessels of the yolk-sphere have their position in the mesodermal layers.

In conclusion, we find the principal modification of these larval stages to consist in the presence of a large yolk-sphere, which is an integral part of the mid-gut, while the anterior and posterior portions of the gut are tubular. Peculiar also is the great size of the posterior limbs and of the gills (fig. 2), and the continuance within the egg-envelopes after a time when in other *Urodelea* the larva has emerged from them. All these modifications must be referred to the terrestrial life; and the great size and long continuance of the yolk-sphere may be accredited the value of a source of nourishment. A life under still dryer surroundings, and longer life within the egg-envelopes necessitating a larger yolk-sphere, might lead to the formation of a yolk-sac in the strict sense by the holoblastic cleavage becoming mesoblastic. The case of *Plethodon cinereus* is but another to show how readily developmental processes become modified by change of the environment, and how much care must be used in interpreting them in the search for affinities.

A number of cases are known in the *Anura* of terrestrial larvæ with a large yolk-sphere, which have been collected together in a contribution by Miss L. V. Sampson,[2] but terrestrial development in the *Urodelea* appears to be much less frequent. In the Cæcilian genus, *Ichthyophis*, the embryology of which has been carefully studied by the Sarasins,[3] there is a large yolk-sphere, which at first becomes segmented only peripherally and not until much later through its entire mass, so that here the development is at first mesoblastic much as in a Sauropsidan. That may perhaps be found to be the case in *Plethodon* also when its early cleavage is studied. In *Ichthyophis* the intestine lies at first as a straight open groove upon the yolk (cf. the chapter in the Sarasins' monograph, *Das Schicksal des Dotters*); then the yolk bends into a number of lobes, which later become elongated and entirely covered by the body wall. The intestinal groove of *Ichthyophis* is supposed by these investigators to become a closed tube without growing round the yolk-mass, but they did not have the necessary stages to show the final fate of the yolk. The Sarasins laid particular stress upon the peculiar development of the *Cæcilia* in discussing their relationships, as, *e.g.*, in allying them with *Amphiuma*, which Hay[4] has shown to have quite a similar development. But the fact that *Amphiuma*, the *Cæcilia* and *Plethodon* show great similarity in their development, might prove rather that the formation of a large yolk-mass with the embryo curled around it may be merely the consequence of terrestrial development, and the similarity express rather a case of convergence than of phyletic affinity. The relationships of the *Amphibia* must be shown from comparative anatomical standpoints, and not from the larval development which obviously may be easily modified by change in environment, as is particularly well shown in the *Anura*. Brauer, who studied the development of the Cæcilian genus *Hypogeophis* from the Seychelles, where it lives wholly terrestrial, concludes:[5] "Wenn auch kein Zweifel darüber aufkommen kann,

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[2] "Unusual Modes of Breeding and Development Among Anura," *American Naturalist*, 34, 1900.

[3] "Ergebnisse naturwissenschaftlicher Forschungen auf Ceylon," Wiesbaden, 1887–1890.

[4] "Observations on Amphiuma and Its Young," *American Naturalist*, 1888.

[5] "Beiträge zur Kenntniss der Entwicklungsgeschichte und der Anatomie der Gymnophionen," *Zool. Jahrb.*, 10, 1897.

dass die grosse Dottermasse bei den untersuchten Gymnophionen erst secundär erworben ist, nachdem die Entwicklung nicht mehr im Wasser ablief, sondern ganz auf dem Lande, ... so ist deshalb auch die Annahme, dass die Entwicklung durch die grössere Dottermasse derart modificirt sei, dass ein Vergleich mit den übrigen Amphibien nicht berichtigt sei, meiner Ansicht nach nicht zutreffend. . . . . Aus diesen Betrachtungen ergiebt sich somit, dass der Keim der Cöcilien im Wesentlichen denselben Bau am Ende der Furchung hat wie der übrigen Amphibien und dass die scheinbar meroblastische Furchung in Wirklichkeit nur eine durch den grössern Dottergehalt bedingte Variation der inäqualen Furchung anderer Amphibien ist."

The only other case known to me of a Urodele with terrestrial development (except the European viviparous *Salamandra maculosa*) is that of the Californian *Autodax lugubris*, as described by Ritter and Miller.[6] In this species the eggs are laid attached by pedicels to stones on the land, there is a large yolk-sphere, large gills, and apparently quite close similarity to the larval stages of *Plethodon*.

[6] "A Contribution to the Life History of *Autodax lugubris* Hallow.," *American Naturalist*, 33, 1899.

CYMBULIOPSIS VITREA, A NEW SPECIES OF PTEROPOD.

BY HAROLD HEATH AND M. H. SPAULDING.

On the 27th of December, 1900, a large number of individuals of the species about to be described were taken at or near the surface of Monterey Bay, California, and twice since that time great shoals have been noted in the same locality. With the use of formalin, formalin-alcohol and picro-formalin their natural appearance and structure have been preserved with exquisite fidelity, and will be more fully discussed in a later paper.

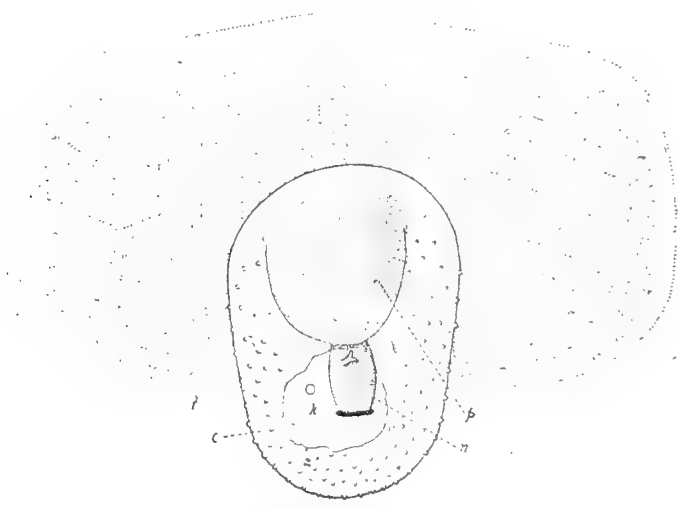
This species falls naturally into the genus *Cymbuliopsis* proposed by Pelseneer[1] which was made to embrace the two species *C. ovata* and *C. calcola*, but differs from these in several important respects. The "shell" or casque (Peck),[2] slightly asymmetrical, possesses the characteristic slipper form and bears on its external surface numerous small rounded tubercles which become smaller and more closely grouped together near the posterior-dorsal surface. Its aperture is large, unarmed and much wider than in *C. ovata*, but is almost identical with that of *C. calceola*, and as in the latter, its large cavity extends to the dorsal extremity. The maximum length of the casque is 4 cm., with a width of 2.5 cm.

The broad, perfectly symmetrical flattened proboscis constituting the head region is in contact with the upper surface of fin, yet free from it to a point immediately in front of the central nervous system. Its edges are grooved and lead into the wide funnel-shaped mouth and œsophagus. Dorsal to the latter and symmetrically placed are the tentacles having the form of small knob-like projections, each of which is supplied with a strong nerve from the cerebral ganglia. Peck noted the occasional absence of these

[1] Report on the Pteropoda collected by H. M. S. Challenger during the years 1873–1876, Part LXV, p. 96. *Vide* also *The Nautilus*, III, p. 30, 1889, where Dall shows *Cymbuliopsis* to be identical with his earlier genus *Corolla*.

[2] Peck, J. I., "On the Anatomy and Histology of Cymbuliopsis calceola," *Studies from the Biological Laboratory, Johns Hopkins University*, Vol. IV, No. 6.

structures in *C. calceola*, but it was found to be present in each of the fifty specimens of *C. vitrea* examined on this point. The œsophagus leads directly backward into the visceral mass, where it joins the relatively voluminous stomach provided with five large and several small teeth. The intestine makes one turn on the ventral surface of the stomach and opens into the mantle cavity slightly to the left of the median line. The remainder of the visceral mass is composed of the large liver and the gonad, which has the form of a thin sheet investing the surface of the visceral mass except at its forward extremity, where the albumen gland and seminal receptacle are situated.



Cymbuliopsis vitrea, ventral view, natural size. *C.*, casque or "shell;" *f.*, foot or fin; *k.*, kidney within mantle cavity represented by stippled line; *n.*, nucleus or visceral mass, showing termination of intestine and pigmented cap; *p.*, pallial gland.

The mantle cavity is placed on the ventral side of *Cymbuliopsis*, and anterior to the visceral mass a portion of the bounding epithelium is modified into the pallial gland. This is crossed by one complete and two incomplete transparent bands. Peck states that the pallial gland is "almost symmetrical in this genus, being twisted somewhat to the right, but the asymmetry was not marked."

In *C. vitrea* the asymmetry is not especially apparent, but it is twisted in the reverse direction to that described and figured by

Peck, and it also differs in being relatively larger and much nearer the anterior margin of the casque. Beyond the pallial gland the mantle cavity narrows and again enlarges to form the space surrounding the visceral mass, kidney and heart. Peck's figure of *C. calceola* represents the foot as extending to the anterior border of the casque, while in *C. vitrea* this organ is relatively much larger and projects beyond the shell almost half its width. Three sets of muscles operate it as in the other species of the genus, and a large number of pigment spots, probably sensory in function, are scattered along its margin.

September 3.

Mr. Arthur Erwin Brown, Vice-President, in the Chair.

Eight persons present.

A paper entitled "On the Probable Age of the Alabama White Limestone," by Thomas L. Casey, was presented for publication.

The death of Adolf Eric Nordenskiold, a correspondent, was announced.

September 10.

The President, Samuel G. Dixon, M.D., in the Chair.

Ten persons present.

September 24.

Mr. Arthur Erwin Brown, Vice-President, in the Chair.

Twelve persons present.

A paper entitled "Further Study of an Ant," by Adele M. Fielde, was presented for publication.

The following was ordered to be printed :

ON THE PROBABLE AGE OF THE ALABAMA WHITE LIMESTONE.

BY THOMAS L. CASEY.

The Jackson stage of the marine Eocene may, and probably does, offer several lithological characters in common with the Vicksburg, but in the nature of its fossils it differs so profoundly that it is impossible to conceive of aught else than the lapse of a greatly prolonged time interval between the two horizons. Among some 240 species of the Jackson group I collected at Moody's Branch and at Montgomery, La., and the bluffs below, I am unable to recognize more than eight or ten which are unmistakably identical with any of a still larger series which I have found in the Vicksburg beds during a residence of nearly two years. It is true that there are quite a number of Vicksburg species so closely related to analogues of the Jacksonian as to conclusively indicate a direct descent from the latter, but many of these species belong to that class which, from the isolation of their environment, are peculiarly slow in evolutionary changes, such, for example, as *Dentalium* and *Cadulus* and some of the small bivalves, which from their frailness must live very secluded lives.

The fact which most distinctly proclaims the revolution of environmental conditions that must have been brought about during the interval in question, and the probably great lapse of intervening time, is that so many highly characteristic Eocene forms, such as *Venericardia planicosta, Verticordia eocense, Calyptraphorus, Pseudoliva, Capulus, Volutilithes, Papillina, Lapparia,* and other mollusks, besides a number of very characteristic Turbinolid corals, completely disappear and leave no descendant in any way related to them, for there are no species occurring in the Vicksburg strata which recall any of these forms. And again, there are many distinct types in the Vicksburgian, such as *Tritonopsis* and *Lyria costata,* the ancestry of which cannot be satisfactorily traced from the Jackson, and which must have required a long time for their evolution. In addition to these facts, there are several broad and striking differences between the two faunas, such, for example, as the great abundance of Bryozoa in the Jackson and the insignificant representation of this great class of animal life in the Vicksburg.

Because of the existence of most of these Eocene forms in the Red Bluff bed, I am inclined to consider that horizon more closely related to the Jackson than to the Vicksburg, in spite of the greater proportion of its species which have been identified with the Vicksburgian. It is possible, also, that many of these supposedly identical forms may prove to be more or less well marked subspecies, and not exactly the same as their Vicksburgian successors. However, not having visited the Red Bluff deposit as yet, it would be unreasonable to pass any definite opinion on this point.

If my memory serves, Mr. Vaughan informed me some time ago that he had found *Alveinus minutus* at Claiborne, Alabama. This species literally swarmed throughout the Jackson stage, and, in fact, is one of the most characteristic upper Eocene species, but no trace of it or of any allied species has occurred in either horizon at Vicksburg, even upon diligent special search on the part of the writer and careful washing of considerable quantities of marl from various parts of the beds. The discovery of a species of this genus in the Oligocene of Florida by Dr. Dall is therefore the more surprising.

As a broad statement, therefore, it may be said that the divergence of the Jackson and Vicksburg faunas is so radical as to abundantly justify the assignment of them to different epochs of the Tertiary—the Eocene and the Oligocene.

It is here necessary to discuss the distribution in time of the two species, *Orbitoides mantelli* and *Pecten poulsoni*, before alluding to the White Limestone of Alabama, for these two species seem to have been regarded, especially by Hilgard, as the conclusive earmarks of the Vicksburg formation. This is an error which has caused much misapprehension, for there is abundant testimony to prove that they both persist through such an extended range in time as to deprive them of any such value.

As for *Orbitoides mantelli*, I personally collected in two partial days at Moody's Branch, and a portion of a day at Montgomery, La., with subsequent washing of a little marl, seventeen specimens, some of which represented large and well-developed individuals. This species was therefore at least tolerably abundant throughout the Jackson stage, and was probably in existence long before.

At Vicksburg there are two distinct horizons, as recognized by Meyer,[1] but very inadequately and in part erroneously elucidated by Hilgard. The lower Vicksburgian consists of alternate thin strata of gray sands, sandy clays and variably, but usually loosely, compacted white or gray limestone. The upper consists of a much thinner bed of more or less red-brown marl, often indurated into nodular masses, or subindurated, and without trace of limestone, having rarely, however, thin layers of glauconitic sands and comminuted shells, in which entire specimens when found are generally much distorted by pressure.

The faunas of these two beds differ very markedly, and there are probably not one-half of the species of either common to the two. One of the chief points of distinction resides in the fact that *Orbitoides mantelli* is virtually altogether wanting in the lower or limestone bed and is abundant and fully developed in the upper or marl bed. As this species existed in Jacksonian times, however, it seems as though it must certainly occur in the lower Vicksburg limestone, but at any rate it is so rare that I have never observed a specimen. The incongruity, therefore, of calling the Vicksburg limestone an Orbitoidal limestone is sufficiently evident; possibly the error occurred by reason of the washing down into the ravines of some material from the upper marls. It is consequently certain, from the facts above mentioned, that *Orbitoides mantelli* and its varieties existed through a considerable portion of the entire duration of our early middle Tertiary, including and subsequent to the Jackson stage, and that it became alternately abundant or semi-extinct according as surrounding conditions favored or retarded its development.

In regard to *Pecten poulsoni*, it is only necessary to refer to the report on the Coastal Plain of Alabama, by Dr. E. A. Smith, where, on page 237, this species will be found listed with the Bashi fossils of the Lignitic stage. As there is no more reason to doubt the correctness of this identification than there is to doubt the identity

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[1] The two lower horizons of Meyer constitute, in my opinion, but one.

of the Vicksburg forms with the species in question, it will be readily perceived that *Pecten poulsoni*, because of its extended duration in time, is deprived of any decisive value as a criterion. Besides this, however, I find that there are at Vicksburg two well-defined subspecies, or perhaps closely allied distinct species, one characterizing the lower and the other the upper horizon, which have been indiscriminately alluded to as *poulsoni* for many years; it is quite possible that neither of them is exactly the same as that species, which was apparently described originally from the White Limestone itself.

On the Tombigbee river, near St. Stephens, and on the Alabama river, near Claiborne, there appear more or less conspicuous bluffs composed of a white limestone, which has been designated the Alabama White Limestone. The lower portion of the bluff at St. Stephens has been considered to be Jacksonian, while the upper part, which is apparently a conformable continuation, although differing noticeably in lithological character, has been identified as Vicksburgian, primarily because the limestone here becomes orbitoidal, and, secondarily, because it also contains a few fossils, especially *Pecten poulsoni*, which bear a strong resemblance to species occurring at Vicksburg. In accepting this as a fact we are forced to admit that two horizons, differing at least quite as radically in their fauna as any other two consecutive stages of the American Tertiary, are here conformably united in a continuous bluff of limestone. This would seem to be incongruous and highly improbable on general reasoning, but in my opinion it is not a correct statement of the case, and the above discussion of *Orbitoides* and *Pecten poulsoni* renders it quite unnecessary to form any such conclusion. It seems much more probable that the entire White Limestone of Alabama, including the coral limestone, is intermediate in age between the Claiborne and Jackson stages.[2] I feel the more confident in this statement on again con-

[2] The examples of *Orbitoides* contained in a specimen of the White Limestone from Clarke county, Ala., from the first bed above the Claiborne sand, which I have before me, differ very much from those occurring at either Jackson or Vicksburg in their much larger size; in fact they would almost appear to constitute a distinct species, and in any event they represent the maximum development of the genus in the Southern Tertiary. The Jackson and Vicksburg form is a degradational type derived from the White Limestone, and, as the White Limestone form is the one which was originally published under the name *mantelli*, it is the Vicksburg modifica-

sulting the report of Dr. Smith, where, on page 109, it is said that *Venericardia planicosta* was found by Mr. Aldrich in the upper part of the limestone near Claiborne, which is presumably the orbitoidal part, and this at once proves that it cannot at least be Vicksburgian. If this is not conclusive, however, it can be supplemented by another significant remark, made by Mr. Cunningham on page 254 of the same report, to the effect that the orbitoidal or upper portion of the White Limestone contains large numbers of "minute coralline branches." These are exceedingly abundant in the fauna of the Moody's Branch beds of the Jacksonian, and constitute one of its conspicuous features, but they are completely unknown from either the lower or upper horizons of the Vicksburgian.

It is probable that the uplift of the true Vicksburg beds was very limited in geographical extent, and confined to the vicinity of the capes or elbows of the coast separating, on both sides, the Bay of Mississippi from the ocean to the south, and that the so-called Vicksburg localities in eastern Mississippi are to be viewed with suspicion. It will require something more than *Dentalium mississippiense*, *Pecten poulsoni* and *Orbitoides mantelli* to prove them even approximately synchronous, as these classic species are all noticeably extended in vertical range.

Mr. D. W. Langdon enumerates[3] the fossils collected by him at Byram Station, on the Pearl river. They are all Vicksburgian with the exception of *Capulus americanus*, which is Jacksonian. As this species has never been found at Vicksburg, the presumption is that the Byram beds are older than the true Vicksburgian, and this is further borne out by the fact, which I have noted from personal observation, that the Byram deposit contains, besides the species quoted by Mr. Langdon, a considerable number peculiar to it and apparently occurring nowhere else. The evidence adduced by Mr. Langdon would seem to show that there is a notable thickness of marine, though scarcely fossiliferous, deposits between the true Jackson and Byram, and it is probable that during this interval the Red Bluff

tion which must be considered to be undescribed. In the Lower Claiborne at Natchitoches, La., another form of *Orbitoides* occurs, which is smaller and thicker than that of Jackson and Vicksburg and probably specifically different.

[3] *Amer. Jour. Sci*, XXXI, p. 205.

beds were formed. The order of emergence of the various deposits—which were all more or less local—may therefore be stated to be: (1) Jackson stage, (2) Red Bluff substage, (3) Byram substage, and (4) Vicksburg stage. The *Scobinella cœlata* mentioned by Mr. Langdon among the Byram fossils, is not exactly the same as the form described from Vicksburg under that name, but is a very well-marked variety or subspecies, related, in fact, more closely to the form occurring at Red Bluff. The degenerative Vicksburg modification, strangely enough, appears to be entirely wanting in the lower—limestone—horizon, but is sufficiently common in the upper marls, as in the case of *Orbitoides mantelli* alluded to above.

October 1.

Mr. Arthur Erwin Brown, Vice-President, in the Chair.

Nine persons present.

Papers under the following titles were presented for publication:

"A New Species of Clavilithes from the Eocene of Texas," by C. W. Johnson and A. W. Grabau.

"New Mollusks of the Japanese Empire," by Henry A. Pilsbry.

"A Quick Method of Testing for Gold," by Edward Goldsmith.

October 8.

The President, Samuel G. Dixon, M.D., in the Chair.

Fourteen persons present.

October 15.

Mr. Arthur Erwin Brown, Vice-President, in the Chair.

Thirteen persons present.

October 22.

The President, Samuel G. Dixon, M.D., in the Chair.

Miss Nichols requested permission, which was granted, to withdraw her paper entitled "The Spermatogenesis of Oniscus asellus Linn," presented for publication July 16, 1901.

October 29.

The President, Samuel G. Dixon, M.D., in the Chair.

Twenty-one persons present.

Henry Fox and Howard Crawley were elected members.

The following were ordered to be printed :

FURTHER STUDY OF AN ANT.

BY ADELE M. FIELDE.

Argument.—That *Stenamma fulvum piceum*[1] is the bearer of three distinct odors, perceived through the three distal segments of her antennæ: (*a*) A scent deposited by her feet, forming an individual trail, whereby she traces her own steps, discerned through her tenth segment; (*b*) an inherent and inherited odor, manifested over her whole body, identical in quality for queens and workers of the same lineage, a means for the recognition of blood-relations, discerned by contact of the eleventh segment; (*c*) a nest-smell, consisting of the commingled odors of all animate members of the colony, diffused by them in air or ether, constituting an aura whereby they distinguish their nest from those of aliens and discerned through the twelfth, the distal, segment.

That her behavior is influenced by a sensory memory; and that while, without experience or instruction, she capably constructs the dwellings of her species and tends the young, her criterion of a nest-aura is established solely by association, and may be changed many times during her life.

That her care of the young is a reflex from the eighth and ninth segments of her antennæ; and that she receives an immediate reward for her labor in the sustenance thereby obtained.

That the gregarious habit of the ant is a conjoint result of the reflexes from the five distal segments of her antennæ.

An Oriental folk-story ascribes to the ant a keen sense of smell,[2] and Occidental biologists grant its possession of this faculty.

I have recently carried on experiments,[3] using the maze herein described, whereby I believe it to be shown that *Stenamma fulvum piceum, aided by a sensory memory, finds her way by means of an individual scent deposited from her feet, and that her perception of this scent is through the tenth segments of her antennæ.*

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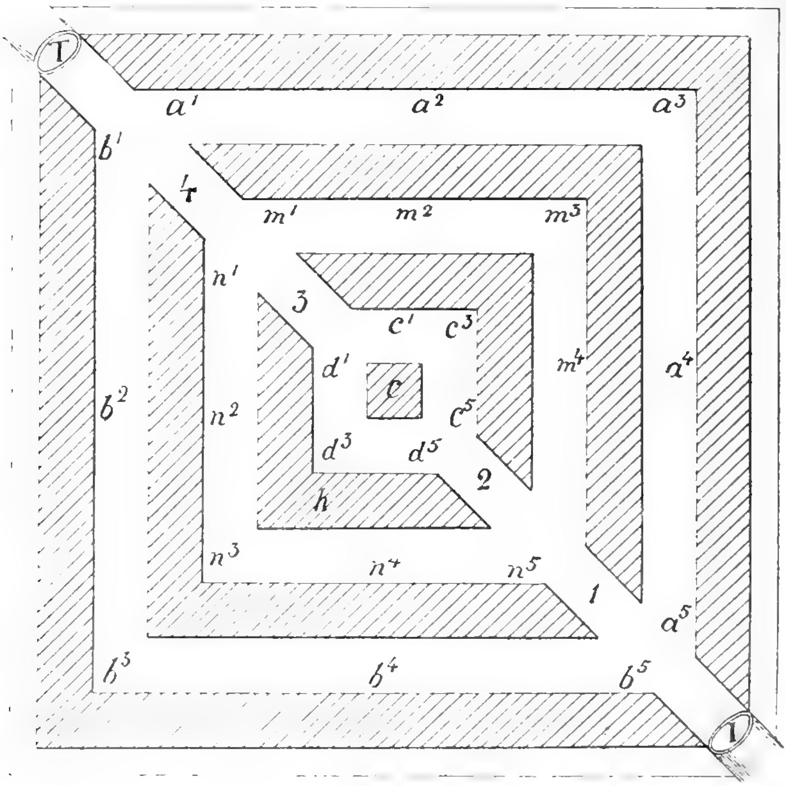
[1] *Stenamma* (*Aphænogaster*) *fulvum*, Mayr; subspecies *aquia*, Buckley; variety *piceum*, Emery.

[2] "The Origin of Ants," in *Chinese Nights' Entertainment*, by A. M. Fielde: G. P. Putnam's Sons, 1894.

[3] At the Marine Biological Laboratory, Woods Hole, Mass., May to October, 1901.



THE MAZE.

The floor of the maze was a pane of clear glass laid upon white cardboard, upon which the runs were indicated by letters and figures. The runs were twelve millimeters or a half inch wide, and were separated by walls twelve millimeters high and twelve millimeters thick, built of strips of glass closely joined to one another and to the floor by LePage's liquid glue, and dried during several months before the maze was used in experiment. The walls were topped by a layer of cotton wadding which was removed and renewed whenever the maze was cleaned for a new experiment. The roof, laid upon the wadding and closing the maze at the top, was a square of thin clear glass diagonally divided across a^3–b^3, for convenience in uncovering only half the maze at a time. Effort was made to secure the same degree of light, warmth and humidity in every part of the maze.

At *I* a straight glass tube seven centimeters long communicated with a small nest in which the ant household used in the experiment had been long established. The tube *I*, as well as the nest, was completely darkened, and was opposite the source of light.

At *T* a glass tube, bent upward at its outer end, gave ingress to the ants from my hand and was stopped by a plug of cotton when not in use.

The distance from *T* to *I* was twenty-one centimeters, a little more than eight inches.

I placed some hundreds of pupæ at the *T* corner, and taking marked and unmarked ants from the nest *I*, introduced them to the maze through the tube, *T*. In no case, except when manifestly lost, did any ant carry[4] in a pupa without having first made the journey without a burden. Sometimes an ant traversed more than one run before she began the labor of carrying in, and if she afterward used more than one of the runs she never used other than those she had previously traversed, no matter how many of her fellow burden-bearers were travelling the other routes. If the glass floor was clean she apparently had greater difficulty in establishing her trail than when the floor was covered by wood or by earth. In the first case, she would go a short distance, as from *T* to a^2 or n^2, and return, and then would prolong her next journey as far as a^3 or n^3, and she might make many excursions from *T* over the same path before she discovered the entrance to the nest at *I*. When the floor was covered with earth a single trip often sufficed, and she began to carry in when on her second excursion from *T*. The structure of the ant's feet adapts them to the partial clasping of particles of earth, and it may be that pressure assists in the deposit of the scent.

Having begun to carry in, an ant usually continued her work incessantly, making from thirty-seven to seventy round journeys in an hour. No burden-bearing ant ever made a loop in her own trail. The shortest run, *c–d*, was not oftenest taken, but no ant ever carried in by a route longer than a single run, *a*, *m*, *c–d*, *n* or *b*.

The *c–d* run virtually counted as but one, for when any ant had made the *c* or the *d* passage, she afterward used either side of the central block *e* with little hesitation.

There was no evidence that any ant was influenced by the fact that the *c–d* run was shortest, and that there were certain advantages in following a straight line; but we should not therefore hastily declare that ants have no reasoning power. The Chinese, for reasons well known to themselves, generally make their roads crooked.

The ingoings and returns of several marked ants during one

[4] The ants withdraw their young from currents of air even more quickly than from light. If the ants huddled upon the pupæ, making their own bodies a screen from the light, they were impelled by my gently blowing into the tube *T* to search for a tranquil refuge in the nest.

hour were recorded. *Dot One* made seventy-two journeys, going in and returning by the *c–d* run. Deviations, apparently caused by pressure or by momentum, were sometimes made on departing from *T* or from *I*, but she never deviated from her trail more than four times her own length without discovering her error and retracing her path into the *c–d* run.

Dot Two made sixty-one round journeys by the *c–d* run. Other ants were at the same time going in and returning by the same and by other routes.

Dot Three made forty round trips. The first fourteen were all by the *n* run. She was then carried, apparently by her own momentum under a heavy burden, into the *a* run, and there wandered to and fro, utterly lost, notwithstanding the frequent passing of her comrades. She eventually made her way by the *a* run into *I*. Somewhat later, under similar momentum, she likewise floundered through *c–d*, and then at intervals she afterward, with no hesitation, four times took the *c–d* route to *I*. All her other ingoings and all her returns were via the *n* run. A few hours later, when I again set the ants to work, *Dot Three* again took the *n* route, and in an hour made forty-eight round trips thereby. A few times she made impetuous starts into other runs, but she every time retraced her steps and followed her best-known path. I then removed her to a Petri cell, closed the entrances to all runs other than *c–d* and *m*, and put several unmarked ants to the work of carrying in pupæ. During that afternoon and the succeeding forenoon, these ants made over three hundred round trips through *m* and *c–d*. When these two runs had thus been thoroughly scented by other ants, and while their trails were yet fresh, I unclosed all the runs and put *Dot Three* in through *T*. After an absence of nineteen hours, she made her first trip, without a burden, through *n*, and then resumed the carrying in of pupæ, making fifty-four round journeys in an hour, going in forty-eight times by the *n* run and six times by the *c–d* run, and returning fifty-two times by the *n* run and twice by the *c–d* run. Not once did she enter the *m* run, which had during the previous hour been traversed hundreds of times by her comrades.

The following day, no use having been made of the maze in the interval, I again put *Dot Three* in at *T*. She at once went, without a burden, through *a*, and returned through *n*. During the next hour she made forty-six burden-bearing journeys through *n*, returning forty-five times through *n* and once through *c*. She undertook to carry in a larva larger than herself and, after protracted and ineffective effort, dropped it at n^1, returned, and then carried in a very small larva. On subsequent journeys she repeatedly passed over or close beside the dropped larva, but she seemed to be aware that it had proven too heavy for her, and did not renew her attempt to lift it.

I then, during her absence in the nest, removed the earth over a space of one centimeter from the floor at n^2, and washed the glass floor and the neighboring walls and roof. On her return she crossed the space unhesitatingly to the pupæ pile at *T*, made two burden-bearing journeys, one *via c*, one *via a*, with both returns *via n*. She then came and examined the cleaned space, burrowed in the bank at its sides, went to and fro several times over it, and resumed her carrying in through this *n* run.

Dot Four having first made without a burden excursions through the *b*, *c*, *n*, *m* and *a* runs, made fifty-five consecutive burden-bearing journeys, going in forty-five times by the *a*, twice by the *m*, four times by the *c–d*, and four times by the *n* run. Her returns were forty-nine times by the *a*, once by the *m*, twice by the *c*, and three times by the *n* run. The *b* run was not again entered. I then isolated her in a Petri cell, and two days later, having stopped the *a* run with plugs of cotton, I returned her to the maze through *T*. She at once tried to enter *a*, pushing at the cotton and endeavoring to creep under or over it. Finding it impassible, she made several journeys through *m*. I then isolated her two days more, unstopped *a*, and returned her to the maze through *T*. She resumed her route through *m*, and made six round trips by that run which she had used while *a* was stopped, then she made a return through *a*, her older path, and from that time all her ingoing journeys and returns were made by that route.

Dot Five made sixty round trips, of which twenty-eight ingoing journeys were made by the *m*, thirty-one by the *a*, and two by the *c–d* run. Of her returns fifty-two were made by *c–d* and nine, at intervals, by *m*. When she had passed thirty-seven times through *m*, I laid across its floor, at m^2, while she was at *T*, a strip of paper one centimeter wide. As soon as she reached it she turned back with her burden and went in by *c–d*, returning as usual by *c–d*. Twice more she likewise came to the paper, and although several other ants had meantime passed over it, she retraced her steps into *c–d*, and thereafter made no more excursions into *m*, going always through *c–d*.

Dot Six entered the maze at *T*, made her first round trip, without a burden, through *m*, then took a false start into *c–d*, wandered there, reached *2*, returned to m^1 and followed the *m* run to the nest. Thereafter she made nineteen journeys, going in fifteen times through *m* and four times through *n*, and returning once through *n*, and eighteen times through *c–d*. I then put a barrier across *2*, expecting her to turn back and take the *m* or *n* route, but in returning on her trail she discovered what neither the ants nor I had before observed, a small hole in the glass wall at *h*, and through this hole she reached *n*. After that her journeys, made with no hesitation, were as follows:

Ingoing.			Returning.		
1	via	*n*	1	via	*n*
2	"	*d–h–n*	2	"	"
3	"	"	3	"	"
4	"	*n*	4	"	"
5	"	"	5	"	"
6	"	*d–h–n*	6	"	"
7	"	"	7	"	*n–h–d*
8	"	*n*	8	"	"
9	"	*d–h–n*	9	"	"
10	"	*n*	10	"	"
11	"	*d–h–n*	11	"	"
12	"	*n*	12	"	"
13	"	*d–h–n*	13	"	*n*
14	"	*n*	14	"	"
15	"	"	15	"	*n–h–d*
16	"	*d–h–n*	16	"	"
17	"	"	17	"	"
18	"	"	18	"	"
19	"	"	19	"	"
20	"	*n*	20	"	"
21	"	"	21	"	"
22	"	*d–h–n*	22	"	*n*
23	"	"	23	"	"
24	"	"	24	"	"
25	"	"	25	"	*n–h–d*

After *Dot Six* had several tens of times passed through the hole in the wall, I stopped the runs from *c–d* at *2* and at *3*, enclosing two burden-bearing ants and a dropped pupa. The two ants had trails directly to *I*, and when they found themselves unable to proceed through *2* they turned back and repeatedly explored all parts of *c–d*. It was plain that the trail of *Dot Six* through the hole gave them no guidance. At last one of the two ants found the hole, passed through it, made her way in, returned and carried in the dropped pupa, passing the hole the second and third times with no hesitancy. The trail of this ant, added to that of *Dot Six*, apparently gave no clue to the remaining ant, for she continued to hunt for an exit until she, too, finally found the hole for herself, and went through it to I. During succeeding hours, after *2* and *3* were unstopped, no more than the three ants, including *Dot Six*, ever used the hole as a passageway.

While the ants were carrying in pupæ, one of the two queens in the nest twice came out to the *T* corner, examined the pupæ pile and went back, but no worker changed her route to follow that of the queen.

It is evident from the foregoing records, giving examples taken from among many made, that the ant followed her own trail, taking it in either direction with equal facility. She was doubtless influenced in her course by the topography of the ground. *Dot Seven* always went in through the *b* run, passing close to the outer wall at b^5. On returning she usually mounted a corner of the inner wall near b^5 and scrambled down its vertical face. The latter route was feasible for a return journey, but impracticable for her when she carried a burden.

When the ants regularly took one route for the outgoing and another for the ingoing trip, they appeared to follow the line of least resistance, or to be influenced by convenience. I have repeatedly seen ants change their customary route when they found their progress hindered by other ants that were taking the same or the opposite course. When ants journey in numbers they go by one route and return by another, as human throngs divide, for mutual advantage, into two processions for crossing a bridge, one moving to the right, the other to the left.

The ants cannot follow the trail of a foe. An intruder whose aura has alarmed the colony may pass close to a resident, alert on the warpath, and the resident will run to and fro with no clue to the exact location of the enemy until the touch of an antenna reveals it.

Bethe holds that there is a polarization of the scent,[5] showing

[5] Albrecht Bethe, *Dürfen wir den Ameisen und Bienen physchische Qualitäten zuschreiben.* Pflüger's Archiv, Vol. 70, Jan., 1898.

the ant the direction toward or away from the nest. He caused ants to make a path across a board, a section of which could be made to revolve 180°. When the section was reversed, an ant reaching the section from either direction was unable to directly proceed. If the section was not reversed until the ant was upon it, the ant would continue its way across the section, but on coming to the end of the section would stop and give evidence of having lost its trail.

Perhaps by reversing the section the continuity of the individual trail was broken, the ant being therefore unable to directly proceed. My experiments show that the theory of polarization of the scent is untenable. *Dot Five*, after establishing her trail, made, in thirty minutes, twenty-eight round trips through *a*. During her absence in the nest, at the end of every ingoing journey, I changed the relative position of at least three centimeters of earth forming her path, and I gradually extended the displacements as far as from a^1 to a^5, being careful to make the road level and quiet before her return. Not once did she hesitate or wander during all these journeys, although in the twenty-eight stirrings every millimeter of her trail had been displaced. Other ants were equally able to follow their trail over displaced portions of their path.

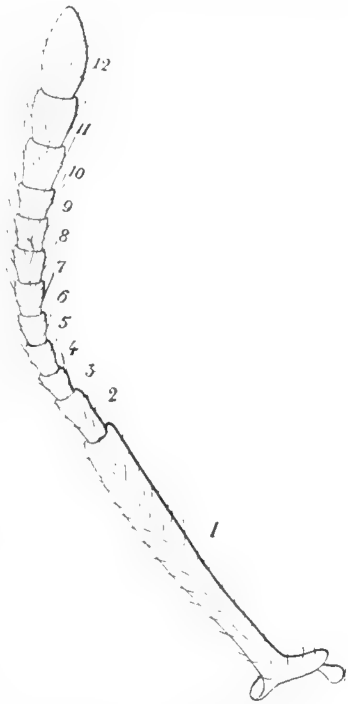
I also caused many marked ants to make trails over strips of wood covering the floor of the runs, and after the trails were established I turned the strips end for end, being careful to replace them so exactly that the continuity of the individual trail should not be broken. In no case did an ant give sign of having lost her trail. The advance of the ant over the reversed trail was unhesitating even when the reversed strip was so much as eight centimeters in length.

A layer of washed earth[6] a millimeter or two in depth may be sprinkled upon the trail without destroying it, as does a thicker layer. The thin layer is doubtless pervious to the scent. The trail may also be moistened for a distance of several centimeters without destroying its continuity. But, as Bethe has pointed out, the ant can be thrown off its trail by wiping the floor on which the scent is laid, or by covering it with a strip of wood or of paper

[6] Earth taken from any *Stenamma fulvum piceum* nest, well washed in running water and then dried.

from five to ten millimeters wide. The action of the ant when the scent is obscured proves that her trail is individual, and that it is under foot. She does not more readily pass the point of obscuration on account of it having been previously traversed by her comrades. Her action is the same whether she be the first to arrive at the newly-laid flooring or whether many ants have crossed it before her.

The power of perceiving the individual trail lies in the tenth segments of the antennæ. When deprived of this segment the ant is no longer able to find her way in with the pupæ, but wanders about helpless and bewildered. Ants deprived of nearly all of the eleventh and all of the twelfth segments continued to carry the pupæ through the runs of the maze, though with diminished physical vigor. The ant could pick up her scent so long as a tenth segment was intact, and no longer. For experiments in following the trail, I selected ants that had been previously distinguished by diligence in the carrying in of pupæ and later on set them to work with clipped antennæ.[7]



LEFT ANTENNA OF STENAMMA FULVUM PICEUM.

That *memory plays a part in the journeys as well as in other proceedings of the ant,* is shown by experiments made by me in gradually increasing the width of

[7] For removing the whole or any part of the antennæ of the ants used in the experiments described in this paper, the antennæ were clipped with sharp scissors, the wound was merged for five seconds in eighty per cent. alcohol to coagulate the blood ; the ant was isolated upon a wet sponge in a Petri cell, without food, for a day, and was thereafter daily placed upon some acceptable food, such as moistened sponge cake, soft pie crust, or bread touched with honey. No insect food was given, and the cell was kept very clean. After fifteen days or longer about forty per cent. of the ants recov-

strips of paper or of wood-shavings laid over the trail. When the ant had well established her trail across the paper or shaving I could sometimes in her absence change it, replacing it exactly by a new one of the same color and material, and I have gradually increased its width from five millimeters to fifteen, or from one to three times her length, without causing the slightest distraction of the ant from her steady journeys to and fro over it.[8] This proves that the ant does not smell her way at every point, and that familiarity with certain objects under her feet is gradually acquired. A dissimilar object, or an old object in a different place, never failed to distract the ant. The frequent placing of new objects upon her path, or repeated interruptions of her work, always caused her to change her route or to abandon her work.

Many ants, where records were kept, gained speed in the carrying in of pupæ, the number of journeys accomplished during an hour increasing always with experience of the runs, unless special hindrances occurred. If there be no greater stimulus in the greater amount of scent laid down, the gain in speed must arise from added familiarity with the road.

I occasioned one of my colonies to move from a Lubbock nest to its annex over a bridge eight inches long, once or twice a day during ten days, and the colony gradually reduced the time required for a complete change of location from over an hour to twenty minutes.

When an ant discovers a barrier across one of the runs in the maze, she does not more than two or three times follow her trail to the barrier, but altogether changes her route. In the change she does not merely cut off the loop in her own path, but she frequently takes a different direction.

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ered from shock-effect and by their activities indicated their readiness for use in experiment. Before their recovery the ants were listless and abnormally irritable; and they attacked with self-destructive violence any moving thing that touched them. One antenna performs all the functions of a pair. In examining hundreds of ants, I found many with a single antenna, or with one antenna and the long proximal joint of the other, and these ants, including queens so maimed, were living normal lives. But I never found in its native nest any antennaless ant. The sense of taste is not lost with the antennæ. Ants kept without food for three days lapped honeyed cake with evident relish immediately after they were deprived of their antennæ. Their sensitivity to light, heat and humidity also remains unimpaired. No part of an antenna that had been clipped was regenerated during three subsequent months that I kept the clipped ants under my observation.

[8] My best results were in using moistened brown blotting paper, care being taken that its edges across the path should be exactly even with the surface of the earth covering the floor.

The aptness of these ants to seek a new domicile whenever their nest is disturbed is perhaps correlated with the necessity of maintaining associations which give efficiency to a sensory memory.

Three worker-ants, without kindred, have lived in one of my Petri cells more than a year. They are perfectly at home in any new similar cell to which I transfer them. This surely indicates that they have become acquainted with their environment through other senses than that of smell.

Beside the scent whereby the ant lays her individual trail, every *Stenamma fulvum piceum has an odor manifest in all parts of her animate body, and discerned by herself and by other ants through the eleventh segments of the antennæ.*

It is improbable that the environment of the ants impart to them their odor. I found beside an old stone fence a colony rearing young under loose stones fifty yards apart. Workers taken from the discovered extremes of this colonial manor affiliated perfectly. From a space no larger than a quart-pot I took thirteen deälated queens in September, and eleven more the following June. Queens and workers of this colony met one another amicably after a full year of separation, although the one had spent that time in native soil, while the other had endured vicissitudes of travel, living in a glass house, feeding on human confections, and drinking water containing unlike mineral ingredients. I am also acquainted with two colonies whose swarming exits are but two yards apart, and these two colonies evince the intensest hostility to one another.

From among more than a hundred experiments that I have made, all yielding corroborative results in a study of the ant-odor, I give but a few examples:

The ant has an inherent odor. A callow five days old, that had been isolated nine days before emergence from the pupa-stage, was attacked and killed by the first ant it ever met, a callow of another colony.

Ants reared all the way from the larval stage without ant-nurses attract or repel other ants.

Ants were reared without ant-nurses, in sequestered groups, from pupæ of the same colony. When these ants were twenty days old the groups were united, and the ants at once affiliated.

Young ants, reared in an alien group, were returned to their blood-relations. They were repeatedly dragged away from the nursery and were kept on probation until their personal odor was ascertained, and were within a day received into full association with their kindred.

A queen of colony D with four workers that she had reared from larvæ of the C colony, together reared three callows from pupæ of the E colony. When the callows were twenty days old, I put them in a Petri cell with adults of the E colony. The callows attacked the adults as with intent to kill, but they met with great toleration, and within a day all the inmates of the cell were living together in unity. In every case where callows were returned from among aliens to their own stock, the action of the adults bore a strange similitude to patient and forbearing discipline directed toward the reclamation of wayward offspring.

In a nest containing a queen and workers of colony C, I put a few young ants that had been reared in another section of the C colony from pupæ of the E colony. The young ants showed no fear of their new host, and were received with but slight sign of suspicion. They were treated as are alien ants smeared with the juices of kindred.[9] But the superficial gloss did not long deceive, and at the end of the second day the young ants had all been killed and dismembered. Incorporation into one section of a colony never gave permanent safety in another section of the same colony that I had divided.

Workers of colony D alone reared four callows from pupæ of colony C. I segregated these callows and introduced to their cell four adults from another section of colony C. The adults immediately attacked the callows, indicating that they were overlaid with the odor of the workers that had fostered them; but the inherent odor of the callows was also influential, for none were killed, and the next day all the eight ants were clustered serenely in one group.

The odor is inherited through the queen. Five queens of the C colony, each sequestered with a few of her workers, reared from her own eggs several young ants. I am uncertain whether the five kings associated with these queens were of different colonies. The issue of any one queen would live in amity with the issue of

[9] "A Study of an Ant," A. M. Fielde, *Proceedings of the Academy of Natural Sciences of Philadelphia*, September, 1901.

any other one of these queens, and all of the young ants would congregate around any one of the sister-queens.

Queens of the same colony have the same odor. Two queens, each having a similar mixed family made up of her own and a different stock, were interchanged with no disturbance of the domestic life in either nest.

Isolated queens of colony D reared each a few workers from pupæ of the C colony. The workers so reared would live amicably with any sister of the queen that reared them and also with one another.

A colony C queen and her issue reared two ants from pupæ of the E colony. When the two ants were a month old they were removed from the fostering family and were introduced into a cell containing a queen and adult workers of the C colony all deprived of the smell-sense. The young ants at once snuggled the queen and affiliated with the adults. They manifestly found in this sister-queen and her workers the exact odor to which they were accustomed.

I took two queens of the C colony and segregated each with pupæ of the E colony. After the pupæ had become ants fifteen days old, an exchange of queens caused no demonstration of surprise or of hostility.

The inherent odor of the queens and that of the workers in the same colony is of like quality, though the odor of a queen is probably stronger than that of a worker.

The behavior of kings in the nests proves them to be unable to distinguish between queens and large workers.

Workers removed from the C colony and segregated when eight days old received amicably, after nine months of separation, the two sister-queens in whose nests they had spent the first few days of active life. Unless their own odor was similar to that of these queens they must have had a personal memory of them. These workers rejected queens of another colony.

I isolated queens of the C colony and caused each to rear four callows from pupæ of the E colony. When the callows were sixteen days old I introduced into every queen's cell two colony C adults deprived of smell-sense. These adults were all received amiably by the callows, indicating that they had the same sort of odor as had the queen.

Ants hatched and reared to the age of twenty days with no association with any other ant received and affiliated with a queen of their lineage, though with some tentative nabbing.

Into a cell containing eight workers, of which equal numbers had been together reared from pupæ of two colonies, C and E, I introduced a C colony queen deprived of smell-sense. She was dragged away from the larvæ pile, but was not injured, and in six hours she was a fully accepted member of the mixed group.

Probably the odor discerned by the ants is something different from any discovered by human nostrils.

The odor preferred by the individual ant is determined by association, naturally during the first few days of its active life. Callows no more than three days old, having spent these days with a queen alone, with workers alone, or with both queen and workers, will thereafter withdraw from or fight any queen or worker belonging to any colony other than their own ancestral one, or those represented in their earliest nurses.

Pupæ of the E colony were isolated the last thirteen days of their pupa-stage, and their first meeting with any ant was when they were two days old, and was with a queen of the C colony. Within an hour the queen and the callows had perfectly affiliated. This queen had not been deprived of smell-sense; but during the long isolation of the pupæ, the E colony odor that earlier overlaid them had doubtless been dissipated, and they therefore presented to her nothing stronger than their own inherent odor as callows. Young callows from pupæ that have been isolated during the whole or nearly the whole pupa-period are safe in any colony. The immediate affiliation of these callows with an alien queen is the point to be here observed.

I sequestered pupæ from colony C and isolated the emerging unlicked callows. When these unnursed callows were two days old I put them into a Petri cell with a colony E queen and workers deprived of the smell-sense. The callows made no attack on the alien adults, but congregated beside the queen or workers as amicabiy as if all were of their own lineage. But callows likewise sequestered, isolated and reared to five days old with no association with other ants, could not be induced to affiliate with aliens. They established for themselves a criterion of correct odor, and withdrew from or seized any ant varying from their standard.

Queens and workers will usually live peaceably with any ant that they have reared from the pupa, and they may be caused to rear successive broods of unlike lineage, or to rear at one time a brood from eggs, larvæ or pupæ of diverse stock. But both queens and workers appear to be less at ease and to filiate less closely with such associates than with those of their own line, unless they greatly outnumber the introduced members of their group. If pupæ of alien stock are given to them in large numbers, shortly before the pupæ become callows, many of the callows are immediately killed. I segregated three groups, each consisting of a colony C queen and seven adult workers, and gave to each group eight pupæ from colony E. In two of these groups the pupæ all became callows within four days and all were killed. In the third group the pupæ were younger, none became active before the seventh day after being introduced, and five were permitted to live. These five callows had doubtless, during their longer residence in the group fostering them, been overlaid with the odor of the C colony, and therefore when they became active they bore an odor inoffensive to their adult companions. They were doubtless smeared with the odor of their hosts.

I have repeatedly seen a queen, with numerous workers of alien stock, flee from the group of ants that I had induced her to rear in her own nest. She had been unable to lick so many pupæ into her own likeness.

Ants remember, or are for some time positively chemotropic to, the odor to which they were earliest accustomed. An isolated queen of the D colony first reared four workers from larvæ of the C colony, and later on this mixed group reared three callows from pupæ of the E colony. When these callows were fifteen days old I removed them to the E colony, where they were happily domesticated five days. I then sequestered them in a Petri cell, and found that they instantly affiliated with either the D colony queen or the C colony workers that had earliest fostered them. They also affiliated with C colony adults deprived of the smell-sense.

Two queens of the C colony separately reared eight callows from pupæ of the E colony. When the callows were from eight to fifteen days old, I put the two queens into one Petri cell and the eight callows into another, and kept the C and E ants thus apart for thirty days. I then reunited the queens and the young ants and they again filiated, with no sign of distrust or aversion.

An artificially mixed group, now in my possession, was created partially by design and partially by incident, and it curiously illustrates my theme. As mentioned by Dr. W. M. Wheeler,[10] *Stenamma fulvum piceum* sometimes feed their larvæ upon pieces of the pupæ of *Cremastogaster lineolata.* Desiring to know whether these ants would, when without larvæ, themselves devour the Cremastogaster pupæ, I gave a goodly number of such pupæ to each of several groups of Stenammas living in Petri cells. In every group of Stenammas some portion of the Cremastogaster pupæ was adopted and taken care of, at least during several days. In one group only, three of the Cremastogasters were brought to the active stage, and continued to live with the Stenammas and to share their labor of rearing a single introduced male pupa. Probably these three Cremastogaster pupæ were so long in the care of the Stenammas that they were overlaid or smeared with the Stenamma odor before they became animate, and that their inherent odor was therefore obscured. Their own standard of congenial odor would, by earliest impression, be that of the Stenamma group. These Stenammas, which were of the C colony, had previously reared four workers from pupæ of the E colony, and I had removed these workers from their cell before the Cremastogaster pupæ therein had become active. The four workers had meantime been segregated in another cell. When the Cremastogasters were about twelve days old, I returned the E Stenammas, after an absence of twenty days, to the C Stenamma cell. They were cordially received by, and at once filiated with, their foster C queen and workers, and they made no attack on the previously unknown Cremastogasters. But the little Cremastogasters attacked them frequently, until, in the course of a day or two, experience had shown them the futility of attempts on the life of newcomers so much stronger than themselves. *Cremastogaster lineolata* introduced from outside were killed under attacks from all the ants in this mixed group.

That *there is a relationship between the inherent odor of the ant and its color,* which gradually deepens with age, and that the odor of the queen is stronger than is that of her workers, is shown by the following experiment. I brought a colony from the woods, placed it in its native earth upon a Lubbock nest, and sequestered

[10] "Habits of Ponera and Stigmatomma," *Biological Bulletin,* Vol. 2, No. 2.

many of its pupæ. I then segregated all callows that appeared on the same day among the pupæ, and in my experiment used none that had been nursed by any ant during the last three days of the pupa-stage, or that had ever met any ant other than those of her own age and lineage. When the callows were from sixteen to twenty days old, I introduced into a Petri cell containing several of the segregated callows single ants from among their blood-relations in the Lubbock nest. Ants of about their own age were always received with little attention and no nabbing; older workers with considerable attention and occasional nabbing; and very old workers or queens were attacked and pulled about by as many as three or four callows at once. The amount of excitement produced by the newcomer, and the number of attacks made upon her person, bore a direct ratio to the depth of her color. When an old worker had first been introduced and domiciled, the introduction of a second adult caused little excitement; but that of a queen called forth all the usual demonstrations of interest or distrust. If a queen was first introduced and domesticated, then the introduction of an old worker was an unimportant event. A second queen or a second adult was always received with lesser attention. I therefore think that the ants discriminate not only in regard to the quality of the odor presented, but also as to its intensity, and that the queen presents the ancestral odor in a more concentrated form than do her workers. None of these introduced ants attacked the callows, and all callows affiliated with the introduced ants within a day; but the fighting instinct of the callow is evidently aroused, not only by ant-odors to which it is unaccustomed, but by an intenser expression of its own inherent odor. If the older ants bore an adventitious odor through association with aliens reared in their nest, then the young ants would have borne the same odor and would have offered the same reason for attack.

With the purpose of ascertaining whether the odor of the ant was perceptible to other ants when deposited upon inanimate objects, I took a new unused maze and smeared the floor and walls of the *a* and the *n* runs with the juices of kindred queens and workers, and the *m* and *b* runs with the juices of aliens, leaving the *c* and *d* runs unsmeared. This smearing did not manifestly influence the ants in their choice of a route in carrying pupæ from *T* to *I*.

I then laid upon the floor of the *a* and *n* runs earth newly taken from their own E nest, and upon the *m* and *b* runs earth newly taken from the nest of aliens, making the earth from the two nests to meet in the middle of the passages, *1, 2, 3, 4* Into *c–d* I put washed earth. Immediately after such distribution of the earth I put many ants from the E nest into the maze at *T* upon the pupæ pile, and recorded the number of journeys made through each run. Fully half the journeys were made upon the earth from the alien nest.

I then closed the *a* and the *n* runs and sent many ants of colony C over the *m* and *b* runs. While the trails were yet fresh, I removed the C ants and their nest, and gave the maze over to the E colony. The E ants in no wise avoided the *m* and *b* runs that had just been used by the C ants, but they traversed them as often as they traversed the runs through which no aliens had passed. Variations and repetitions of this experiment gave results always similar. I therefore think that the odor of the ant is discernible to other ants only when it is either perceived upon or is immediately disseminated from the living body of the ant. This view is sustained by the fact that alien pupæ placed in the nest just before they emerge from the pupa-stage are at first accepted by the ants, and are nevertheless often killed as soon as they cease to be inert.

I have found that the ant's power of perceiving this odor lies in the eleventh segments of her antennæ. The contact of these segments with any part of the body of another ant is followed by reflexes denoting either satisfaction or repugnance. When the ant is deprived of these segments by a cut across the tenth segment, she no longer discriminates between friend and foe. Deprived of these segments, marked ants of two or of five colonies lived peaceably together or fought one another with absolute impartiality. Forel discovered that ants of alien colonies ceased from hostile demonstration when deprived of the antennæ; but in my experiments this effect is as complete when no more than the two distal segments are removed. The removal of the twelfth segment alone is not effective, and as the segments telescope each into its proximal neighbor, the destruction of the tenth is necessary for the complete removal of the eleventh.

A healthy ant, with or without antennæ, will fight a dead ant, kindred or alien, if the dead ant be made to simulate an attack upon the live ant; and an ant will sometimes continue a battle when all of its body except the head and one pair of legs has been clipped off. I have seen an ant, deprived of the smell-sense, continue through eighteen hours its grip upon an adversary's antenna. An antennaless ant will fight with energy and endurance, the difference between its battles and those of a whole ant being in that it fights indiscriminately the ants of its own and other colonies. In the complete ant the odor appears to modify, control or determine the fighting reflex.

In all cases of transfer from one kindred group to another there are evidences that the whole ants discern differences in the individuality of their companions whether queens or workers. Every newcomer is examined, sometimes from end to end, by touches of the antennæ; there is often much hesitating and tentative nabbing of an ant that is ultimately received into full fellowship, and two or three impetuous onsets often precede complete filiation.

In determining through their actions the affinities and repulsions of the ants, I have considered final relationships more important than first behavior.

The removal of the antennæ does not destroy the odor of the ants so maimed, for neither their enemies nor their kindred change on this account their usual behavior toward them. But the excision of these prominent organs reduces greatly their liability to seizure.

The commingled odors of all the ants in the nest constitutes what Bethe calls the Neststoff, or what I shall call the aura of the nest. It is diffused in air or ether from the animate occupants of the nest, and it is discerned by the ant through the twelfth, the distal, segments of her antennæ.

By this aura every ant recognizes its own abode and distinguishes it from the abode of other colonies. The aura of the nest may be superadded to, but does not extirpate, the individual scent nor the inherent body odor.

The creation of a new nest-aura is always possible through the gradual admixture of different odors produced by and disseminated from living ants reared from eggs, larvæ or pupæ of alien colonies.

Any ant bearing the preponderating odor is apt to gain easy admission to the nest. The countless variations observed in the treatment of newcomers are due to the infinitely variable proportions in the odors borne by the ants. If an ant permanently bears an odor which is a component of the aura, she may be eventually accepted as an associate. If, in a group of ants reared in equal numbers from the pupæ of two colonies, C and E, I introduce an ant, deprived of smell-sense, from either the C or the E colony, the fearless newcomer is received with excitement and alarm and may be attacked with violence. But the attack is never fatal, and the blood-relative of half the group is eventually permitted to remain peacefully in the nest. When a whole ant from either C or E colony is introduced, the newcomer manifestly discerns an unfamiliar aura and either flees or else fights to a fatal end.

The sensitivity of the normal ant to the aura of an alien nest causes her to flee from it when escape is possible, and to endeavor to hide herself when she cannot escape. I have deprived many ants of the distal segments of the antennæ, and have found that on complete recovery from shock-effect their behavior was to be distinguished from that of normal ants by the absence of an exhibition of alarm when introduced into the nest of aliens. Such maimed ants do not flee, nor do they endeavor to hide, nor do they hesitate in close approach to a dense swarm of aliens. Their conduct when introduced into the nests of other colonies is strikingly different from that of the whole ant. Their action, whether in their own or an alien nest, evinces unconsciousness of the aura that determines the advance or retreat of the whole ant, or causes it, with uplifted and waving antennæ, to pursue an object that is beyond its reach. Callows reared from the third day of the pupa-stage with no association with other ants until the tenth day of active life, had then established their own aura, without the presence of a queen, and manifested alarm at the introduction of aliens.

If the subtile aura of the nest, imperceptible as it is to human nostrils, is diffused by a vibration in the body of the living ant which it envelops, the aura should be strongest where the greatest number of ants have longest lived. Its allurement in the air or ether may be what sometimes causes an ant to return to an old and empty habitation, and to carry back pupæ that have already been transported to a newly occupied nest.

The excitement occasioned by the intrusion of an alien among ants that are a few millimeters from the point at which the alien passes, indicates that the aura borne by the introduced ant extends at least a few millimeters from its body. The behavior of the resident ants shows that the aura pervades the air or the ether, and gives intimation of the presence of the intruder without denoting her exact location.

The aura of an ant of the same colony appears often to determine the route of a companion not within touch of the antennæ, when burdens are being carried into the nest.

The distance to which the nest-aura is diffused may depend upon the number and quality of the living inmates.

Before an ant is five days old it has all its reflexes established, and appears to have sprung as from the head of Jove, full grown and completely accoutred, into active existence.

Callows that became such in the *T* corner of the maze straightway found a way into the nest, and commenced the carrying in of the inert young.

Callows less than five days old, that had never seen a queen, nor adults, nor earth, were transferred from their Petri cell to a handful of their ancestral soil, and they immediately built a nest with runs and recesses such as are made by experienced workers of their kind.

Prolonged captivity in a glass house does not diminish their ability to use earth in nest-making. I transferred to the earth on a Lubbock nest, when they were nine months old, some queenless ants that had always lived without earth in one of my artificial nests, and gave them a few larvæ and pupæ. Within ten hours they had made as perfect runs and recesses as any ever constructed by their species, and had disposed the young in the same manner as do their free congeners.

The unremitting attention habitually given by the workers to the young is hardly demanded by the necessities of the latter. I segregated eggs, larvæ and pupæ, and found that eggs untouched during several days bring forth normal larvæ; that with no attention from the ants the full-grown larva may successfully become a pupa; and that the whole pupa-stage may be safely passed with no more tending than such occasional changes of position as will prevent the growth of mould. *Penicillium crustaceum*[11] grows to ripeness, in either darkness or light, upon eggs, larvæ or pupæ, if left for a few days unattended in the humid atmosphere required by

[11] The moulds here mentioned were identified for me by Dr. George T. Moore, of Dartmouth College.

the ants, and its sprouting spores may be seen on their surfaces under a magnification of about five hundred diameters. If the spores are left undisturbed they cover the young with a delicate dense white coat that becomes sage-green with the ripening of the new spores. It appears probable that the ants find nutriment in the new mycelium of the mould, from which they relieve the young by licking them frequently and thoroughly. If the surfaces of the ant-children be a kitchen-garden spontaneously supplying the nurses with aliment, then these ants enjoy an economic independence surpassed only by that of an ideal creature that could lay eggs sufficient for its own nourishment.

This delicate mould does not grow upon the bodies of dead ants, but is there replaced by *Rhyzopus nigricans*, with long and spreading hyphæ, and in this may lie the cause for the carrying off and casting away of all ants that die or are killed in the nest.

So long as the eighth and ninth segments of the antennæ are uninjured, the ant may continue to lift and care for the eggs, larvæ or pupæ, but after the removal of these segments she loses all interest in the young and performs no further work in the nursery. I proved this to be true in several colonies. In my colony B, which had been queenless during many months, the workers had been singularly devoted to the larvæ and pupæ from their own eggs,[12] and from among these ants I selected several that never failed to lift a larva when the cover of their Petri cell was taken away. Some of these assiduous nurses took all usual precaution for the safety of their young so long as the eighth segments of the antennæ were uninjured, but none lacking the eighth segment ever gave heed to nursery duties of any sort. From none of the other ants could I secure any attention to the young after the excision of the ninth segment.

Marked ants of two hostile colonies, when clipped across the tenth segment, associated freely and amiably with one another during several days in the care of pupæ belonging to one of the two colonies. A whole queen resident in the small nest appeared unable to tolerate the alien odor among the nurses, and often withdrew from the ever-alluring pupæ pile where they congregated. When the callows appeared, the queen aggressively took her place

[12] One of these worker's-egg-larvæ, separately reared, was one hundred and forty days in the larval stage.

among the young, and drove the alien nurses out from the nursery to the food-room, where they remained until I removed them. The queen's clipped workers continued to tend the young in the manner of whole ants.

On clipping the antennæ to the seventh segment, the middle of the segmented portion below the elbow, the ants lose all community of interest. In one of my large nests,[13] used as a *hotel des invalides*, the ants never congregate, but stand separately and sometimes almost equidistant throughout the three rooms. The gregarious habit is probably a conjoint result of the reflexes from the five distal segments.

The instinct of following or huddling, common in young animals, is manifest in this ant during the first hours of its activities, when it keeps close to any accessible queen or worker.

The huddling instinct is apparently strong in its relation to ants of the same or lesser age. I isolated pupæ during the whole pupa-stage, thus freeing them, in their casting off of both the larval and the pupal integument, from all except the inherent odor, and I found that the callows huddled as soon as they were able to walk toward one another. The isolation of such callows for twelve days or longer did not diminish their tendency to huddle with ants of their own age or with younger ones of the same lineage. But from the twelfth to the twentieth day of isolation there was a marked diminution of the disposition to follow the queen and to huddle with adults. Dr. Edward Thorndike says[14] that "if chicks do not have a chance to follow a hen in the first ten or twelve days they will not go near one if they have a chance." I have found no limit to the age at which a worker will follow a queen, but the attraction exercised by the queen is apparently due solely to association. When she or her kind has not been known during ant-infancy, her acquaintance is made with caution and reserve, if not with signs of distrust or dislike.

The ants appear to exhibit personal likings, aversions, affinities and antipathies. They seem to make and to keep individual acquaintances. They exhibit true social proclivities, and they manifest a possibility of surmounting race prejudices. Living mainly in darkness, they receive impressions through the antennæ

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[13] "Portable Ant-Nests," *Biological Bulletin*, Vol. 2, No. 2.
[14] "The Human Nature Club," p. 26, *Chautauqua Press*, 1901.

rather than through the eyes, and they suggest the idea that the sense of smell may be as efficient as that of sight in appropriately connecting a creature with its environment.

I have observed that these ants, like the Termites, are able to carry water for domestic uses. They probably lap the water into the pouch above the lower lip and eject it at its destination. A hundred or two of ants that I brought in and left in a heap of dry earth upon a Lubbock nest, during the ensuing night took water from the surrounding moat, moistened a full pint of the earth, built therein a proper nest, and were busy depositing their larvæ in its recesses when I saw them on the following morning.

NEW LAND MOLLUSKS OF THE JAPANESE EMPIRE.

BY HENRY A. PILSBRY.

Eulota (Plectotropis) shikokuensis n. sp.

Shell openly umbilicate, rather thin, reddish-brown, low-conic above, convex beneath, irregularly striate, and covered with short, triangular cuticular scales, a series of longer ones along the periphery. Whorls $5\frac{3}{4}$ to 6, slightly convex, the last carinated at the periphery, more or less deflexed in front. Aperture very oblique, subcircular, the peristome narrowly reflexed, dilated at the columella, the ends approaching.

Alt. 8, diam. 14 mm.

Alt. 7, diam. $12\frac{1}{2}$ mm.

Yoshida, Prov. Iyo. Type No. 81885, Coll. A. N. S. P., from No. 694 of Mr. Hirase's collection.

Similar in contour to *trochula*, of Tsu-shima. The cuticular scales are less densely crowded than in *scepasma*.

Eulota mercatoria var. **dæmonorum** nov.

Shell solid, with well-elevated spire and rounded periphery, slightly plicatulate above, as in *mercatoria*, from which it differs in the straighter, slightly bent forward, basal lip, with an impressed line or two behind it, as in *E. caliginosa*.

Alt. 27, diam. 36 mm.; whorls $6\frac{1}{3}$.

Alt. $20\frac{1}{2}$, diam. 29 mm.; whorls $5\frac{3}{4}$.

Kikai, Osumi (Mr. Y. Hirase, No. 683). It occurs fossil with a form of *Eulota luhuana*, a large form of *E. sieboldiana*, *Cyclophorus turgidus*, and fragments of a *Clausilia*, in a calcareous deposit consisting largely of foraminifera.

Eulota (Plectotropis) omiensis n. sp.

Shell small, openly umbilicate, low-conic above, convex beneath, carinate at the periphery, brown. Surface of the last whorl shaggy with triangular cuticular scales, large for so small a shell, and longer at the periphery. Whorls $4\frac{1}{2}$, convex, those of the spire roughly striate, the last slightly and slowly descending in front. Aperture oblique, subcircular, the parietal wall excising about one-fourth of the circle. Peristome thin, narrowly expanded throughout, more dilated at the columellar insertion.

Alt. 3½, diam. 7½ mm.

Itanami, Omi (Mr. Y. Hirase, No. 752).

Much like *E. lepidophora* var. *tenuis* Gude, but with fewer whorls and more shaggy, large-scaled cuticle.

Ganesella fausta n. sp.

Shell resembling *G. pagodula* Ehrm. in contour; umbilicate, very glossy, light chestnut colored. Sculpture of faint growth-lines and excessively fine, subobsolete spiral striæ. Spire high, convexly conic. Whorls 5½, convex, the last rounded at the periphery, very slightly descending in front, a trifle constricted behind the lip. Base convex, impressed in the middle. Aperture less oblique than in *G. pagodula*, rounded, the parietal wall excising slightly less than a third of the circle; peristome narrowly expanded, the outer lip hardly reflexed, columellar margin dilated above, half covering the umbilicus. Columella subvertical above.

Alt. 13½, diam. 12½ mm.

Mikuriya, Suruga (Mr. Y. Hirase, No. 734).

This form differs from *G. pagodula* in its smaller size, fewer whorls, dark color and glossy surface, the hollow axis and different form of the columella. I do not think it directly related to *G. pagodula*. The two species are apparently independent offshoots from the *G. japonica* stock.

Ganesella Adelinæ n. sp.

Shell pyramidal, narrowly umbilicate, thin, pale yellow or rose-whitish, with three equidistant blackish chestnut bands; the first above the middle of the upper surface of the last whorl, the second at the periphery, the space between these two varying from light red-brown to almost as dark as the bands themselves, which are then confluent; the third band is wider, in the middle of the basal surface; the interior of the umbilicus also dark. Surface rather glossy but with a dull "bloom" as in some forms of *G. Largillierti*, having slight wrinkles of growth and fine, subobsolete, spiral striæ. Spire straightly conic, the apex obtuse, whorls 6 to 6⅓, slightly convex, the last angular at the periphery, moderately convex beneath, but slightly descending in front. Aperture wide, semicircular, banded within, somewhat oblique; peristome thin, narrowly expanded throughout, white-edged, the columellar margin dilated, purple-black, partially covering the umbilicus.

Alt. 26½, diam. 25 mm.

Alt. 24, diam. 22½–23½ mm.

Oshima (Amani-Oshima), Mr. Y. Hirase, No. 352.

This charming species is closely related to *G. Largillierti* of Okinawa, and has also some superficial resemblance to *Eulota callizona* var. *Dixoni.* It differs from the former in the larger umbilicus and the pyramidal rather than turbinate contour.

A specimen I dissected has the exceedingly long kidney and characteristic genitalia of *Ganesella.* As its close relationship to *Largillierti* is obvious, that species can no longer be placed in *Eulota,* as some authors have done.

Trishoplita hilgendorfi var. **tenuis** nov.

Closely resembling *T. hilgendorfi* (Kob.), this form differs in being thinner with perceptibly larger aperture, and the surface is seen under a lens to be finely decussate, the fine growth-wrinkles being cut into spiral series of long granules. Pale corneous-brown, with inconspicuous darker streaks.

Alt. 9½, diam. 14–15 mm.

Ibuki, Omi (Mr. Y. Hirase, No. 310*c*).

Trishoplita collinsoni var. **okinoshimæ** nov.

Similar to var. *casta,* but not papillose, distinctly decussate, especially beneath, with a reddish-chestnut band at the slightly angular periphery. Whorls 5¾ to 6.

Alt. 10½, diam. 15 mm.

Alt. 9, diam. 13½ mm.

Okinoshima, Tosa. Type No. 81,884, Coll. A. N. S. P., from No. 691 of Mr. Hirase's collection.

Kaliella præalta n. sp.

Shell perforate, pyramidal, pale brown, the surface glossy and smooth. Spire very high, straightly conic, the apex obtuse, *whorls 9,* convex, the last angular at the periphery, convex beneath. Aperture semicircular, the lip thin as usual, columella vertical, triangularly dilated above.

Alt. 4, diam. 2½ mm.

Ryozen, Omi (Mr. Y. Hirase, No. 743).

This species is distinguished among the crowd of Japanese Kaliellas by its high, pyramidal contour and numerous whorls. In outline it resembles *Buliminopsis turrita* (Gude). It has not the minute vertical striation of most species of the genus.

Kaliella kyotoensis n. sp.

Shell imperforate, obtusely pyramidal, the apex obtuse; thin, yellowish brown, smooth but rather dull, more glossy beneath. Whorls 6, very convex, the last rounded at the periphery and beneath, impressed around the axis. Aperture lunate, chiefly basal; peristome thin and acute, abruptly reflexed over the umbilical perforation.

Alt. 3, diam. 3 mm.

Kyoto (Mr. Y. Hirase).

Much larger than *nanodes*, *pagoduloides* or *harimensis*, and well rounded at the periphery.

Kaliella modesta n. sp.

Shell minutely perforate, similar to *K. pagoduloides*, but less elevated and larger. Whorls $4\frac{3}{4}$, very convex, the last rounded at the periphery, impressed in the centre beneath. Sculpture of excessively fine, close, subobsolete striæ, the base most minutely striate spirally. Aperture lunate.

Alt. 2.4, diam. 2.7 mm.

Oshima, Prov. Higo (Mr. Y. Hirase).

Kaliella nahaensis (Gude).

Naha (or Nafa), in southern Okinawa, on the west side. A new variety of this species is represented by specimens sent by Mr. Hirase from Kunchan, the northern province of Okinawa. It differs from *nahaensis* in being slightly smaller, with decidedly sharper striation; and may be called var. *kunchana*.

Alycæus satsumana n. sp.

Shell with the general form of *A. melanopoma*, red-brown becoming pale-brown beneath. Whorls $3\frac{1}{2}$, the first smooth and projecting nipple-like, the next spirally striate, the last $1\frac{1}{4}$ whorls costulate, the riblets narrow, rather widely spaced and accompanied by spiral striæ on the first half of the last whorl, which then becomes more swollen and sculptured with crowded riblets. At the end of the swollen portion the sutural process is given off. This is rather long and lies backward in the suture; the whorl is then rather strongly constricted and almost smooth, the riblets reappearing behind the lip. Aperture oblique, circular, peristome narrowly reflexed and doubled. Operculum thin, reddish-corneous, smooth externally.

Alt. 2.3, diam. 3.7 mm.

Kagoshima, Satsuma, Kiusiu (Mr. Y. Hirase, No. 704).

The "neck" is more constricted than in *A. melanopoma*, and the operculum is thin. It differs in sculpture from the other Japanese species of *Alycæus*, which are all a good deal alike in form.

Cyclophorus turgidus var. **angulatus** nov.

Substance of the shell roseate; thick and strong, distinctly angular or cariuated at the periphery; interior orange or orange-red. Whorls 5.

Alt. 23½, diam. 29 mm.

Alt. 16, diam. 20 mm.

Loo Choo (Mr. Y. Hirase, No. 713).

A QUICK METHOD OF TESTING FOR GOLD.

BY E. GOLDSMITH.

The volcanic rocks of the crater in which the towns of Cripple Creek and Victor, Colo., are built, according to Mr. Moore, the chief mining engineer of the district, all contain gold. The rock mined, however, is thrown on the dump and many thousands of tons, not worked for the gold at present, are piled up outside the mines.

The vein gold, in the form of sylvanite, telluride, and probably calaverite, is separated by hand from the gangue or rock and sent to the smelters for reduction. A specimen was secured from a depth of about 800 feet below the surface. Its general appearance was not very promising, inasmuch as the minerals were so finely divided that a mechanical separation for a test seemed to involve a waste of time. Separation, melting and cupellation are practiced extensively and are well known. A quicker and simpler method for at least a qualitative determination of the gold in the rock can, I think, be devised. Since these and other gold compounds are very fusible, it seemed probable that the small particles of the gold salts may be fused together before the blowpipe in the rock, and by shaking and driving with the pointed flame larger globules may be formed. This proves to be the case. During the process the tellurium and selenium, if present along with other volatile bodies, are roasted, *i. e.*, oxydized and expelled. The flame is bluish green. After the volatile substances are thus removed dark-colored globules project upward on the surface of the rock-splinter, which was about one inch long and a quarter of an inch thick. To clean these under the flame I covered the whole surface with cyanide of potassium, a reducing fire finishing this part of the work.

The rock-splinter was disintegrated; it broke easily and the globules of dark metal could be picked up with the pointed pincette or separated with a knife. These were put into the agate mortar and pressed and rubbed with the pistil to thin plates. A little nitric acid was added and rubbed, then poured into a capsule; a second dose of nitric acid was given and worked as before. The gold appeared now, after washing with water, in its bright yellow color. The acid solution, after settling, poured cleanly into a test-tube, gave with a few drops of hydrochloric acid the well-known white precipitate of chloride of silver soluble in ammonia.

The gold was, as may be expected, in very thin plates, and, although not absolutely pure, showed the two distinct colors of the metal—the fine yellow by reflected light, and the violet color when a ray of ordinary light passed through it and was observed under the microscope by sunlight. By artificial light the color is modified to a greenish tint. The test of a gold-containing mineral in a rock, as described above, can be made within ten minutes. The microscopic part of the test is, of course, unnecessary, as the gold can be seen as readily without it after the treatment with nitric acid.

The ease and quickness of this blowpipe process and the little preparation required may recommend it to prospectors for gold ore, who, we are well aware, often overlook gold-containing minerals in the absence of an easy and simple test. The above-described method, if followed, may be found helpful, inasmuch as no new instrument or apparatus is required.

The finely and sparsely distributed gold compounds in the Cripple Creek volcanic rock have a similarity in appearance to common pyrites. In volcanic rocks, therefore, wherein both minerals may occur, the gold and iron compounds present can only be determined by the application of the proper tests.

NOVEMBER 5.

Mr. ARTHUR ERWIN BROWN, Vice-President, in the Chair.

Twenty-seven persons present.

A paper entitled "An Ecological Sketch of the Flora of Jamaica," by John W. Harshberger, was presented for publication.

Fasciolaria gigantea, subsp. reevei.—DR. H. A. PILSBRY exhibited specimens from Little Sarasota Bay and Clearwater Harbor, Fla., the former collected by Mr. Henry Hemphill, the latter by Dr. J. W. Velie, who in sending a specimen to the Academy had directed attention to the peculiarities of the form. Dr. Pilsbry stated that the specimens are referable to the form described by Philippi[1] as *Fasciolaria reevei* Jonas. That form has been lost sight of by later observers. Those authors who have noticed it have considered it to be a synonym of *F. princeps*, a species of the Panamic zoölogical province, from which it differs in the gradual decrease in prominence of the sculpture with age and the smooth operculum. It seems to be a local subspecies of *F. gigantea*, differing from that by its much smaller size, the obsolescence or absence of nodes on the last whorl, the longer and narrower anterior portion, etc. The shell reaches a length of 24 cm., and is covered with a dark cuticle, blackish-chestnut on the last whorl, yellowish-chestnut on the spire. Under this cuticle and in the mouth the shell is pale salmon-pink. Fine liræ may usually be felt deep in the aperture, but they are not colored as in *F. princeps*.

NOVEMBER 12.

Mr. ARTHUR ERWIN BROWN, Vice-President, in the Chair.

Twelve persons present.

NOVEMBER 19.

Mr. ARTHUR ERWIN BROWN, Vice-President, in the Chair.

Twenty-two persons present.

A paper entitled "Some Arachnida from New Mexico," by Nathan Banks, was presented for publication.

[1] *Abbildungen und Beschreibungen neuer oder wenig bekannter Conchylien*, III, p. [121], *Fasciolaria*, Pl. 3, fig. 2 (September, 1850).

NOVEMBER 26.

The President, SAMUEL G. DIXON, M.D., in the Chair.

Twenty-one persons present.

Papers under the following titles were presented for publication:

"Cockscomb Fasciation of Pineapples," by John W. Harshberger.

"Myctophum phengodes in the North Atlantic," by H. W. Fowler.

"New Land Mollusks of the Japanese Empire," by Henry A. Pilsbry.

The death of THOMAS MEEHAN, Vice-President of the Academy, on the 19th inst., having been announced, the following minute was unanimously adopted:

THE ACADEMY OF NATURAL SCIENCES OF PHILADELPHIA is again called on to record its sense of loss in the death of one of its oldest and most devoted associates. Since Mr. Meehan's election to membership forty-one years ago he never neglected an opportunity to manifest his interest in the society, and for much the greater part of that period he gave freely of his time, means and best thought for the increase of its prosperity. His special care for the welfare of the Botanical Department was manifested with singular devotion until physical exertion was no longer possible, and the Academy is well aware that the present prosperous condition of the herbarium is mainly due to his intelligent efforts.

While his extraordinary accuracy as an observer and his clearness as a recorder of natural phenomena place a high value on his scientific work, he was personally endeared to his fellow-members by unfailing courtesy, integrity and generosity. Their regard enables them to appreciate the more fully the loss sustained by his wife and family, to whom they tender this assurance of their heartfelt commiseration.

John M. Macfarlane, D.Sc., was requested to prepare a biographical notice of Mr. Meehan, to be read at a meeting of the Academy and published in the *Proceedings.*

Messrs. Roswell C. Williams, Jr., Henry C. Savage, William B. Davis and S. Harbert Hamilton were elected members.

T. D. A. Cockerell, of East Las Vegas, N. M., was elected a correspondent.

The following were ordered to be printed:

AN ECOLOGICAL SKETCH OF THE FLORA OF SANTO DOMINGO.

BY JOHN W. HARSHBERGER, PH.D.

The island of Santo Domingo (Hispañola of Columbus) is politically divided into an eastern and a western portion. The eastern section, by far the largest, comprises the Republic of Santo Domingo, and the western area, the smallest, is dominated by the blacks of the Haitian Republic. The island of Santo Domingo is one of extreme fertility. Columbus, and travelers since, speak in the highest terms of the rare beauty and natural grandeur of the island, which has been called without exaggeration "The Queen of the Antilles."

TOPOGRAPHY.

Hispañola by nature is the geographic centre of the Greater Antilles. Thomas Jefferys in 1760 said: "Its situation with respect to the rest of the Antilles is the most advantageous imaginable, as it stands, you may say, in the centre of this great cluster of islands, and looks as if intended by nature to give laws to them. The other three great Antilles lie in such a manner as to prove its superiority, and their own dependence; for it has three points of land corresponding respectively to each island" (Puerto Rico, Cuba, Jamaica). Santo Domingo excels Puerto Rico, Cuba and Jamaica in altitude, diversity of configuration, picturesque aspect and natural fertility. It is continental in its topographic make-up, being the radiating centre of the great Antillean uplift. The outline of Hispañola is the most irregular of all the Greater Antilles, its periphery being nearly a thousand miles, its length 400 miles, and its breadth 160 miles. The great Gulf of Gonaives is enclosed by the western peninsulas, and is an immense semicircular bay with a coast line of two hundred miles. Samana Bay on the northeast, Barahona Bay on the south coast and Manzanilla Bay on the north are also conspicuous indentations. Approached from the ocean, the island presents a huge mass of mountains rising precipitously from the sea, extending in all directions and apparently jumbled up in hopeless confusion. The mountains consist of lofty forest-covered peaks, resembling the Alleghenies, the Alps or the Pyrenees, but with this difference, that they are always without snow. There are four ranges of mountains which run in a general east-and-west direction, as follows: The northern fragment is the Monte Cristi Range; the main orographic section, the Sierra Cibao, consists of lofty mountains, with the third range as an outlier toward the southwest, and the fourth mass is formed by the tall mountains of the southwestern peninsula. Between these ranges lie extensive fertile valleys, threaded by streams of limpid water. Many of these streams debouch on the plains which fringe the sea-coast, and irrigate those coastal areas which are more or less arid in condition, being shut off from the prevailing winds and rains by lofty mountain summits. There are many central valley plains in the island. The largest of these, lying between the Monte Cristi Range and the Cordillera Cibao, extends from the sea at the Haitian border to Samana Bay, its eastern prolongation. The western portion, watered by the Yaqui, is an arid region covered by chaparral, where arborescent opuntias and cereuses abound. The windward area, or eastern division, watered by the Yuna, is covered by beautiful deciduous plants. South of the Cibao Range is the extensive plain of Seylo, covered in part by open prairie and forest. The terraced Caribbean coast supports a belt of forest averaging twelve miles in width. The tension line between coastal forest and inland prairie is parklike in aspect, carpeted by green grass and dotted by clumps of trees. At Azua, the whole neighborhood is barren, dry and thorny. The only lakes are salt, occupying the east-and-west depression which separates the southern peninsula of Haiti from the main portion of the island. This basin, formerly an oceanic inlet, is said to be inhabited still by sharks, porpoises and even crocodiles.

The configuration of the Haitian division of the island appears an agglomeration of mountains, hills and valleys most irregular in form. There are precipices, deep hollows, vales apparently without outlet, but with water glistening below. The whole of the Republic is more or less mountainous. The La Haute Mountains are most noted and they form a continuation of the great axial sierra of the island. There are many beautiful slopes and valleys.

Those of Port-au-Prince, Gonaives, Artibonite, Arcahaie, Port Margot, Léogane, Aux Cayes being the most famous. Three large islands are attached to the Haitian coast—Tortuga on the north, Gonave on the west are noted for their mahogany trees; L'Ile-a-Vache on the south coast lies in a sound of the same name.

Climate.

The dry season covers the period of the year from October to April, when the temperature is some 10° lower than during the so-called rainy season, which lasts from April to October, when rains fall, as a rule, late in the afternoons or evenings. In general, the climate of the island of Santo Domingo is most diversified, presenting wide extremes of moisture, aridity and temperature. At the sea-level, in sheltered places, the heat is intense, but as one ascends the mountains of the interior the heat of the seaboard becomes moderated. At 1,600 feet, European and American travelers complain of cold at night, although there the mercury never falls below 45°. Rain is almost lacking on the lower slopes of sheltered mountains, but above 2,000 feet rains and dews are copious. The nights are from 10° to 20° cooler than the days.

Ecology.

The information for the following ecologic sketch was obtained from three sources: (1) The observations of the writer made upon the flora of Haiti during July, 1901, when he visited the island, stopping at four ports, viz., Cape Haitien, Port-au-Prince, Aux Cayes and Jacmel; (2) The information gleaned by conversation with inhabitants of the island familiar with its vegetation; (3) A careful perusal of Tippenhauer's book, *Die Insel Haiti*. It is impossible to give a detailed sketch of the phytogeography of the island of Hispañola. It seems, therefore, best to assemble the species in an ecologic manner as a basis for a future work upon this rich and most luxuriant insular vegetation.

Hydrophytes.—Living along shore in the bays and shallow estuaries is found an abundant mangrove vegetation. In Port-au-Prince Bay, at Cape Haitien, at Aux Cayes, are found extensive mangrove swamps and islands. The three trees concerned in forming the mangrove association are *Rhizophora mangle* L., *Avicennia* *officinalis* L. and *Laguncularia racemosa* Gaertn. *Pistia stratiotes* L. floats in the fresh-water streams of the island, or loosely attached to the soil along their banks. *Sagittaria lancifolia* L. may also be classed as a hydrophyte.

Mesophytes.—The plants composing the vegetation of a tropical forest are in superimposed layers, or stories. The different levels at which tropical plants grow is in direct response to the environmental conditions of light and moisture. These storied layers may be termed vegetal strata. It may be stated, in this connection, as axiomatic, that in a tropical forest, when one ascends from the ground to the crown of the dominant forest trees, as the light increases the moisture content of the air decreases. On the ground in the forest, mosses, ferns and fungi abound in the deep shadow and growing in the mould arising from fallen leaves and rotting wood. In the forests, on the trees, ferns, aroids and orchids are found, while serpent-like lianes clamber from limb to limb and from tree to tree, until they reach abundant light in the crowns of the trees above. Epiphytes and parasites, more or less xerophytic in habit, are found in the tops of the dominant species of trees.

Forest Vegetation.—The richness of the tropical flora and the lush growth of the vegetation in general is most marked in those situations that are exposed to the copious rains that fall during the summer months. The drenching rainfall, the richness of the soil in the mountain valleys and coastal plains are such as to encourage to the highest degree a luxuriant fern and arboreal vegetation. Along the banks of streams occur *Bambusa vulgaris* Schrad., *Heliconia* sp., *Amomum* sp., and of the palms, *Oreodoxa oleracea* Mart., *Thrinax argentea* Lodd, *T. parviflora* Sw., *Acrocomia sclerocarpa* Mart., *Euterpe oleracea* Engelm.

The component vegetation of damp woods consists of *Musa sapientum* L., *M. coccinea* Andr., *Heliconia bihai* L., *H. psittacorum* L., *Arundo occidentalis* Sieber, *Canna edulis* Ker-Gawl, *Swietenia mahagoni* Jacq., *Hæmatoxylon campechianum* L., *Maclura tinctoria* D. Don., *Cedrela odorata* L., *Artocarpus incisa* L., *Chrysophyllum cainito* L , *Catalpa longissima* Sims, *Sloanea dentata* L., *Swartzia tomentosa* D.C., *Ilex obcordata* Sw., *Cecropia peltata* L., and other arborescent species. The larger trees are draped by lianes of the following species: *Passiflora cærulea* L., *P. lauri-*

folia L., *P. perfoliata* L., *Aristolochia arborescens* L., *Entada scandens* Benth., *Philodendron lacerum* Schott. and *Vitis caribœa* D.C.

Savanna Vegetation.—The green covering of the open park-like areas, or savannas, consists of grasses and other herbaceous plants. The grasses are of most interest from an economic standpoint and should be mentioned first. The following seem to be the chief components of the grassy stretches of savanna land: *Paspalum platycaule* Poir, *P. distichum* Linn., *P. virgatum* Linn., *P. paniculatum* Linn., *Chloris ciliata* Sw., *C. cruciata* Sw., *C. barbata* Sw., *Panicum colonum* Linn., *P. maximum* Jacq., *P. hirsutum* Sw., *Andropogon saccharoides* Sw., *A. gracilis* Spreng., *A. fastigiatus* Sw., *A. bicornis* L., *A. leucostachys* H. B. and K., *Eragrostis ciliata*, with herbaceous plants, *Desmodium axillare* D. C. and *Boerhaavia erecta* Linn.

Epiphytes.—The large trees, such as the figs, the mahogany, the silk cotton, are loaded down with a considerable number of epiphytes belonging to the orchid, fern, cactus and aroid families. Foremost among these air-dwellers are two members of the natural order Cactaceæ, viz., *Cereus triangularis* Mill and *Rhipsalis cassytha* Gaertn., which live in the crotches or attached to the upper side of the limbs of tropical forest trees. Here are seen, also, *Philodendron lacerum* Schott., *Polypodium aureum* L., *Vittaria lineata* Swartz, species of *Epidendrum*, and the following plants of the genus *Tillandsia: T. angustifolia* Sw., *T. complanata* Benth., *T. bulbosa* Hook., *T. compressa* Bert., *T. excelsa* Griseb., *T. fasciculata* Sw., *T. flexuosa* Sw., *T. laxa* Griseb., *T. pruinosa* Sw., *T. setacea* Sw., *T. usneoides* Linn.

The aerial life, therefore, seems to be of incontestible value to these plants. Here they are installed in a position which offers the largest amount of sunlight, and this advantage of increased illumination seems to outweigh any disadvantage which the species might have in running a constant risk of death by desiccation.

Parasites.—There are a number of true parasites to be found attached to and living upon the trunk and limbs of various tropical forest trees. Parasites of the genus *Phoradendron*, with rounded or four-cornered stems, opposite or whorled, palmately veined, leathery leaves, are among the most prominent. The following species of the genus have been recorded as occurring in the island: *Phoradendron berterianum* Nutt., *P. flavescens* Nutt., *P. schottii* Nutt., *P. rubrum* Nutt. The genus *Dendrophthora* (formerly included in *Arceuthobium*) consists of parasites, that are represented in the Santo Domingan flora by *Dendrophthora cupressoides* Eichl., *D. gracile* Eichl., *D. opuntioides* Eichl.

Xerophytes.—The writer has briefly alluded to the stretches of country that may be said to be of arid nature in referring to the topography of Santo Domingo. These desertic areas are usually found on the slopes of mountains and in valleys that are sheltered by their position from the prevalent summer rains. These rains may be denominated trade-wind rains, because they owe their origin to the strong evaporation of water within the zone of the trades. If the trade wind encounters a mountainous island, or a bald continental coast, the ascent of air over such obstructions cools it, and the water in the clouds, thus formed, descends as rain. For this reason the windward slopes of Santo Domingo are well watered, while the leeward slopes are comparatively dry. Again, if the trade winds blow over a land of moderate elevation no precipitation occurs, but the winds reduce its surface to a dry desert by depriving it of moisture. In the Republic of Haiti, as well as in that of Santo Domingo, there are many arid situations which owe their barrenness to just such causes. Consequently in such arid districts we naturally look for a xerophytic flora. The species which exist in such situations are the following: *Opuntia tuna* Mill., *O. spinossissima* Mill., *Cereus moniliformis* D.C., *C. grandiflorus* Mill., *Nopalea coccinellifera* Salm Dyck, *Mammillaria simplex* Haw., *Melocactus communis* Link and Otto, *Pereskia aculeata* Mill. To this list of succulents belonging to the cactus order should be added several other fleshy plants, viz., *Agave sobolifera* Salm Dyck and *Aloe vulgaris* Lam. The arid hillsides are generally covered, in addition to the xerophytes mentioned above, with thickets of *Acacia farnesiana* Willd., *A. sphærocephala* Cham. and Schlecht., the mezquite, *Prosopis juliflora* D. C., *Yucca aloifolia* Linn. and *Yucca gloriosa* Linn.

The native flora has been undisturbed on the slopes of the higher mountains inland. Some of the most valuable timber trees have been removed, but cutting them has rather improved the botanical interest of the country, because the smaller plants have thus had a chance to grow. Around the dwellings, however, and in the cultivated valleys, great changes have been worked in the flora. The indigenous plants have been slowly replaced by introductions from tropical and temperate climes.

A typical valley which has been modified by human agency was visited by the writer near the town of Cape Haitien, on the north coast of the island. A description of the flora of this valley will serve to illustrate the influence of cultivation upon the primitive surroundings. The ravine in question is situated just back of the town of Cape Haitien, between the mountain of the cape and the main range to the south and southwest. A mountain stream of limpid water runs down through the depression, and a bridle path winds its way to the top of the hills overlooking the sea. Both banks of the brook are covered with arborescent vegetation, except where the gardens of houses are found, or where banana plantations are made. The following trees are met in the rich soil of the valley: The bread-fruit, *Artocarpus incisa* Linn.; the star-apple, *Chrysophyllum cainito* Linn.; the mango, *Mangifera indica* Linn.; the banana, *Musa sapientum* Linn.; the bamboo, *Bambusa vulgaris* Schrad.; the coffee, *Coffea arabica* Linn.; the guava, *Psidium guajava* Linn.; the trumpet tree, *Cecropia peltata* Linn.; the chocolate, *Theobroma cacao* Linn.; the alligator pear, *Persea gratissima* Gaertn. The banana fields are planted on the steep declivities and consist of a pure growth without the admixture of coffee plants and chocolate shrubs. Along the roadside are found the following: *Adiantum pedatum* Linn., *Asplenium pellucidum* (?), *Argemone mexicana* Linn., *Lepidium virginicum* Linn., *Mimosa pudica* Linn., *Momordica charantia* Linn., *Hibiscus trilobus* Aubl.

An occasional small maize field is interspersed with banana plantations. The gardens of the houses along these roads are not rich in species or in showy plants. Most of them suffer from neglect. There is an apparent poverty of decorative plants and a great uniformity is noticeable in the garden plants of adjacent properties. A list of a few garden plants may here be given: *Musa sapientum* Linn., *Hibiscus esculentus* Linn., *H. sabdariffa* Linn., *Lycopersicum esculentum* Mill., *Solanum melongena* Linn., *Cucurbita pepo* Linn., *Gynandropsis pentaphylla* D. C., *Capsicum annuum* Linn., *C. baccatum* Linn., *Zingiber officinale* Rosc., *Dioscorea alata* Linn., *Punica granatum* Linn., *Fragaria vesca* Linn.

Near Port-au-Prince a hillside was visited which supported an almost pure growth of lignum vitæ, *Guaiacum officinale* Linn.; the mezquite, *Prosopis juliflora* D. C., and the acacias, *Acacia sphærocephala* Cham. and Schlecht., *Acacia farnesiana* Willd., while on rocky outcrops in open places in these woods was found a growth of yuccas, probably *Yucca aloifolia* Linn.

This brief sketch of the ecology of the flora of Santo Domingo suffices to show that an interesting and profitable field of investigation lies at the doors of the American botanist. The West Indies, in their varied topographical configuration, are especially adapted for philosophical inquiry into the causes which have influenced the distribution of plants on the North American continent. The writer believes, since his visit to Haiti and Jamaica, that the solution of this phyto-geographic problem will follow a careful biological survey of the fauna and flora of the Greater and Lesser Antilles.

NEW LAND MOLLUSKS OF THE JAPANESE EMPIRE.

BY HENRY A. PILSBRY.

Alycæus tanegashimæ n. sp.

Shell similar in shape to *A. harimensis.* Pale brown, the early whorls orange-red, or uniform whitish-corneous. Whorls 3⅓, the last slowly descending, moderately constricted, then swollen again. Sculpture of crowded rib-striæ, finer at the constriction; no spiral striæ. Aperture very oblique, circular, the peristome double. Operculum nearly smooth, the edges of the whorls slightly projecting.

Alt. 1.7. diam. 3 mm.

Tane-ga-shima, Osumi (Mr. Y. Hirase, No. 723).

Closely related to *A. harimensis,* but that is a much larger species.

Carychium pessimum n. sp.

Shell very minute, corneous-white, fusiform-conic, minutely striate. Whorls 4¾, convex. Aperture ovate, the peristome well expanded, very much thickened within, with a strong tooth-like prominence just above the middle of the outer lip, marked by a groove behind the lip. Columella truncate below, the columellar lamella small, receding.

Length 1.8 mm.

Tane-ga-shima, Osumi (Mr. Y. Hirase, No. 729).

This species is smaller and less conically tapering than *C. noduliferum* Reinh. The columellar lamella is smaller, much less prominent than in either *C. noduliferum* or *C. cymatoplax.*

Macrochlamys dulcis n. sp.

Shell depressed, brownish-yellow, rather transparent, *narrowly perforate.* Surface *brilliantly glossy,* weakly marked by growth-lines, and under a strong lens seen to be engraved with *excessively fine, crowded spiral lines,* which are obsolete on the upper and peripheral portions of the last whorl. Spire a little convex, narrow. Whorls 4½, slowly widening, the last very wide, concave at the suture, rounded peripherally and less so beneath, narrowly impressed around the umbilical perforation. Aperture large, but slightly oblique, very broadly lunate; peristome simple, a little retracted at the upper insertion, basal margin straightened, the columellar margin short, subvertical, dilated.

Alt. 6, greater diam. $11\frac{1}{2}$, lesser 10 mm.

Nachi, Prov. Kii (Mr. Y. Hirase, No. 785).

Well marked by the narrow perforation, small spire, sculpture and the shape of the aperture. *M. perfragilis* Pils. of Kunchan, Okinawa, is a closely related species, differing in the much larger size, smaller perforation, etc.

Eulota (Plectotropis) pannosa n. sp.

Shell similar to *trochula* A. Ad. in general shape; light brown, somewhat translucent. Surface slightly shining, sculptured with very minute spiral striæ under sparsely scaly oblique cuticular striæ, with, at the periphery, a long, ragged fringe of flattened filaments, triangular at their bases. Spire low-conic. Whorls slightly over 6, slowly and regularly increasing, a little convex, acutely carinate peripherally, convex beneath, being elevated and subangular around the deep, broadly open umbilicus; the last whorl very slightly descending in front. Aperture oblique, the peristome hardly expanded above, thickened within and expanded and somewhat reflexed below.

Alt. $8\frac{1}{3}$, diam. (exclusive of fringe) 17 mm.; width of umbilicus (from suture to suture) $4\frac{1}{2}$ mm.

Atsumi, Prov. Uzen (Mr. Y. Hirase, No. 773).

This species differs from *E. trochula* in being much more angular around the umbilicus, *trochula* being rounded there. *E. vulgivaga* is a more solid shell, with the umbilicus wider and the base more convex.

Eulota (Plectotropis) deflexa n. sp.

Shell small, biconvex, widely and openly umbilicate, brown. Surface dull, sculptured with subobsolete, fine spiral striæ and slight spaced growth-wrinkles, bearing a few cuticular threads and scales above, more numerous short scales beneath, with a peripheral fringe of flattened, ragged filaments. Spire low-conic. Whorls $5\frac{1}{3}$, the first $1\frac{1}{2}$ convex, following whorls less so, the last whorl acutely carinate, descending near the aperture for some distance and rather deeply below the keel; the base convex, subangular around the umbilicus. Aperture oblique, rounded, the peristome arcuate, unexpanded and thin above, narrowly expanded and subreflexed below the periphery, the margins approaching, separated by the nearly straight parietal margin, which forms less than one-fourth the total circumference of the peristome.

Alt. 5.5, diam. 10.8 mm.; width of umbilicus (from suture to suture) 3 mm.

Tobishima, Prov. Ugo (Mr. Y. Hirase, No. 774).

This species is related to *Eulota* (*Plectotropis*) *æmula* Gude, but it is smaller with fewer whorls, the last descending in front and with a developed, though usually incomplete, peripheral fringe. *E. deflexa* is also less conic above, and the nepionic 1½ whorls project somewhat.

Eulota (Ægista) aperta var. **cavata** nov.

Larger and more elevated than *aperta*, with 6½ to 6¾ whorls, the umbilicus larger, more widely open. Aperture more oblique, the basal margin more deeply arcuate.

Alt. 9, diam. 16, width of umbilicus 6 mm.

Alt. 8, diam. 17, width of umbilicus 6½ mm.

Tomisato, Kii (Mr. Y. Hirase, No. 761).

This form approaches *E.* (*Ægista*) *kobensis* somewhat, but that is still more open beneath, with the aperture more elliptic. Some specimens from Gojo, Yamato (Mr. Hirase's No. 567), are to some extent intermediate between *aperta* and *cavata* in shape, as they are in geographic position.

Trishoplita Hilgendorfi var. **chikubashimæ** nov.

Shell smaller and thinner than *hilgendorfi* from the top of Mt. Ibuki, Omi; very densely and minutely but subobsoletely granulose; angular at the periphery in front, the umbilicus smaller. Spire conic; whorls 5 in small, 5½ in large specimens. Aperture rounded-lunate, the peristome thin, expanded.

Alt. 7½, diam. 10½ mm.

Alt. 7, diam. 9½ mm.

Alt. 6, diam. 8½ mm.

Chikubashima, an island in Lake Biwa (Mr. Y. Hirase, No. 746).

In describing *T. Hilgendorfi* var. *tenuis* in these *Proceedings*, p.

547, I neglected to state that while *Hilgendorfi* occurs at the top of Mt. Ibuki, the var. *tenuis* is found in a valley below.

Trishoplita tosana var. **anozona** nov.

Shell thin and glossy like *tosana*, and resembling that species in shape and the size of the umbilicus, but differing from it in wanting a pale zone below the suture. It has a narrower umbilicus than *T. Hilgendorfi* var. *tenuis*.

Alt. 8½, diam. 13 mm.

Alt. 7, diam. 11½ mm.

Akasaka, Mino (Mr. Y. Hirase, No. 751*b*).

Still another form of this terrible genus, which I will call *T. tosana* var. *rufa*, occurs at Kashima, Harima. It resembles *anozona*, but is dull, russet-colored, densely striate spirally beneath, subangular at the periphery in front. Whorls 5½ to 5¾, the spire conic.

Alt. 8, diam. 11½ mm.

Chloritis Hirasei n. sp.

Shell openly umbilicate, depressed, thin and fragile, flattened above, the earlier whorls a trifle sunken; pale brown. Surface lustreless, densely beset with delicate hairs arranged in oblique sweeps. Whorls 4½, the last wide, rounded at the periphery and beneath, hardly descending in front. Aperture lunate, the peristome thin, a little expanded, somewhat dilated at the columellar insertion.

Alt. 8½, greatest diam. 17½, width of umbilicus 2⅔ mm.

Kurozu, Prov. Kii (Mr. Y. Hirase, No. 786).

This species is larger and flatter than *C. fragilis* Gude, with more densely placed hairs, and a much wider umbilicus. *C. oscitans* v. Mart., a form of which Mr. Hirase sends from Mikuriya, Prov. Suruga, is a smaller, almost imperforate species, the most northern of its genus. No exact locality has hitherto been reported for von Marten's species. *C. eucharistus* Pils., of Oshima, also brought to light by Mr. Hirase, is the finest *Chloritis* of the Japanese Empire, these four species being all known from Japan to this time.

Ganesella tanegashimæ var. **dulcis** n. var.

Similar to the type except in color, the shell being of a very dark and beautiful chestnut color, with a blackish peripheral band. The interior is purple with a bluish gleam, and the lip purple.

Alt. 18½, diam. 26 mm.

Tane-ga-shima.

Only two living specimens of this superb variety were taken. Dead shells are reddish rather than chestnut.

Ganesella selasia n. sp.

Shell *umbilicate, trochiform,* brown or corneous-brown, *very glossy,* striatulate, finely malleate in places. Spire conic; whorls 5¾, convex, slowly increasing, the last depressed, subangular at the periphery, somewhat convex below, slightly descending in front, narrowly constricted behind the lip. Aperture oblique, somewhat triangular, the peristome thin, arcuate and narrowly expanded above and outwardly, the basal margin straight or sinuous, reflexed, thickened (like a low, wide tooth) within; columellar margin short, dilated.

Alt. 11½, diam. 16, width of umbilicus 1½ mm.

Alt. 11½, diam. 15, width of umbilicus 1⅓ mm.

Nachi, Prov. Kii (Mr. Y. Hirase, No. 788).

The glossy surface, narrow whorls and open umbilicus separate this from all forms of *G. japonica.*

Ganesella cristata n. sp.

Shell *imperforate,* globose-trochiform, pale russet, with a faint brown line at the periphery, a pale line below it. *Surface very obsoletely and indistinctly papillose, somewhat dull.* Spire a little convexly conic. Whorls 5¾ to 6⅓, convex, the last rounded peripherally. Abruptly descending in front, *expanding in a conspicuous ridge or crest and then strongly contracted* behind the lip. Aperture oblique, somewhat triangular, the upper and outer margins expanded, thickened within, basal margin straightened, reflexed, indistinctly toothed or thickened within; columellar margin short, abruptly expanded over and covering the umbilicus.

Alt. 14, diam. 16 mm.

Alt. 11½, diam. 15 mm.

Nachi, Prov. Kii (Mr. Y. Hirase, No. 783*b*).

The absence of spiral lines on the slightly dull, silken surface, the closure of the umbilicus, and the crest behind the lip all mark this as a species distinct from the *G. japonica* series. The smaller specimens are obtusely subangular in front.

Ganesella japonica var. **granulosa** nov.

In this race the shell is trochiform, umbilicate, strongly carinate at the periphery, irregularly wrinkle-striate, minutely, very obsoletely granulose, with some faint spiral lines or none. It is light brown, not corneous or corneous-brown, as in *japonica*. Two forms have been received, a larger and smaller.

Alt. 14, diam. 19 mm. (large form, No. 513*b* of Mr. Hirase's Coll.).

Alt. 13, diam. 14½ mm. (small form, No. 513*c* of Mr. Hirase's Coll.).

Alt. 11, diam. 15 mm. (small form, No. 513*c* of Mr. Hirase's Coll.).

Ibuki Mountain, Prov. Omi. The small form occurs also at Kyoto.

Ganesella japonica var. **carinata** Pilsbry and A. Gulick, nov.

This is a large, very strongly carinate shell, openly umbilicate, yellowish-corneous, and finely striate spirally like *G. japonica*. Whorls 5½ to nearly 6.

Alt. 18, diam. 26 mm.

Alt. 16, diam. 23 mm.

Ibuki, Omi (Mr. Y. Hirase, No. 513*a*). Types No. 79,202, Coll. A. N. S. P.

This is apparently the "*Helix patruelis* Ad.," "*H. tabuensis* Ancey," of authors; but after a careful examination of the evidence, a year or two ago, Mr. Gulick and I concluded that it could not be identical with the form described by Adams and renamed by Ancey. It is apparently an independent local mountain race of *G. japonica*.

The sculpture, paler color, and less trochiform shape separate it from the large form of *G. japonica granulosa*, which is apparently a parallel modification of the papillose or granular type of the *G. japonica* stock.

SOME ARACHNIDA FROM NEW MEXICO.

BY NATHAN BANKS.

The following list of New Mexican Arachnida is based chiefly on material collected during the past few years by Prof. T. D. A. Cockerell. A few species were collected by his wife and son. Prof. C. H. T. Townsend, when connected with the New Mexico Agricultural Experiment Station, collected and sent to me a small lot of spiders from the vicinity of Las Cruces. The late Mr. Hugo Soltau sent me a very interesting collection from Albuquerque, containing a number of forms not taken by others. I have added the few species recorded by other writers from New Mexico, but not seen by me.

The total sums up to 148 species, nineteen of which appear to be new and are here described. The leading groups may be tabulated as follows:

Araneida,	123
Phalangida,	6
Pseudoscorpionida,	3
Scorpionida,	2
Solpugida,	3
Acarina,	11
Total,	148

The spiders are included in seventeen families; the leading family in point of numbers is the Attidæ with twenty-two species; the others are: Thomisidæ with sixteen, Theridiidæ with sixteen, Epeiridæ with thirteen, and the Lycosidæ with ten species. Of especial interest are the species of *Pachylomerus*, *Meriola*, *Corinna*, *Oxyopes*, *Fuentes* and *Taracus*. The list shows many northern as well as southern forms. The species of Northern distribution are mostly from Beulah and Las Vegas. The Southern forms come mostly from Mesilla and Las Cruces. Of the species of northern distribution, many of which occur across the northern part of our country, attention may be drawn to the following forms:

Drassodes robustus, Pœcilochroa montana, Gnaphosa conspersa, Titanœca americana, Grammonota pictilis, Tetragnatha extensa, Epeira aculeata, Xysticus montanensis, Lycosa modesta, Pardosa glacialis, Icius similis, Habrocestum oregonense and *Phalangium cinereum.* These species ally the fauna very strongly to that of Colorado.

The Southern element contains several species not previously known from north of the Mexican boundary. The most characteristic of these species are *Physocyclus globosus, Gnaphosa distincta, Syspira* sp., *Dictyna texana, Epeira nephiloides, Epeira oaxensis, Ebo mexicana, Olios fasciculatus, Phidippus bicolor, Sadala distincta, Ammotrecha peninsulana* and *Lithyphantes fulvus.* There does not appear to be any particular connection between this fauna and that of Arizona, although, of course, there are a number of forms common to both. These forms are such as are rather widely distributed in the West. Of the six harvest-men, one is a northeastern form, one a northwestern one, two are typical Colorado species, and two are known chiefly from New Mexico. Of the three Pseudoscorpions, one is a typical Colorado species and two are California forms.

The collection, as a whole, contains few bright-colored species, and none are of very large size. In fact, many of the specimens are smaller than those from more northerly regions.

Mr. Cockerell gives the following notes on localities:

(1) The Mesilla Valley, about 3,800 feet, includes Mesilla Park and Mesilla (collections by Cockerell) and Las Cruces (collections by Townsend; a few specimens by Cockerell). These places are all close together, and are in the Middle Sonoran zone.

(2) Organ Mountains; collections at La Cueva and Fillmore Cañon by Townsend, and at Dripping Spring by Cockerell. These mountains may be considered Upper Sonoran; they form the eastern boundary of the Mesilla Valley.

(3) White Mountains; collections by Townsend. This includes the localities cited as Ruidoso creek and Eagle creek. The mountains form an isolated range of considerable altitude, and possess some endemic mollusca, at least.

(4) Albuquerque; collections by Soltau. This is Upper Sonoran.

(5) Las Vegas; collections by Cockerell. This has an altitude of about 6,400 feet, and is Upper Sonoran, tinged with Transi-

tion. Las Vegas Hot Springs (collection by Cockerell) is more decidedly Transition.

(6) Santa Fé (collections by Cockerell) is Transition. Altitude 7,000 feet.

(7) Beulah, Sapello Cañon (collections by Cockerell), is in the Las Vegas range, and has an altitude of about 8,000 feet. This belongs to the Canadian zone; the only other arachnids of this zone listed are some from the White Mountains.

(8) Top of range between the Sapello and Pecos rivers, about 11,000 feet; collection by Cockerell. This belongs to the Hudsonian zone.

THERAPHOSIDÆ.

Eurypelma steindachneri Ausserer.

Eurypelma steindachneri Ausserer, Verh. zool.-bot. Ges. Wien, 1875, p. 199.

A male and young female, collected by Prof. Townsend, without definite locality. Mr. Cockerell states that it is common in the Mesilla Valley.

Pachylomerus modestus n. sp.

Cephalothorax and mandibles shining black; abdomen dull black above, no markings; sternum and coxæ yellow-brown; legs blackish, tarsi paler; tibia and tarsus of palpus pale; spinnerets pale. Cephalothorax broad, truncate in front, surface finely and uniformly granulate, from the eye-region backward there are two submedian lines. Posterior eye-row procurved; the P.M.E. fully three times their diameter apart, and touching the slightly larger P.S.E.; anterior eye-row strongly procurved, the A.M.E. equal to the P.M.E., rather more than their diameter apart, closer to the much larger A.S.E. Dorsum of abdomen corrugate. Tibia of male palpus about three and one-half times as long as broad, somewhat swollen below at base, palpal organ of usual form, the stylet very long, curved before middle and again at tip. Eight short spines in the inner row on the inner side of tibia I.

Length 12 mm.

One male, collected by Townsend, probably near Las Cruces.

FILISTATIDÆ.

Filistata hibernalis Hentz.

Filistata hibernalis Hentz, Jour. Bost. Soc. N. H., IV, p. 227 (1843).

Several females from Albuquerque (Soltau), and two males from Prof. Townsend, without definite locality. The male (as *T. capitata*) is recorded by Dr. Marx.

SCYTODIDÆ.

Scytodes thoracica (Latreille).

Aranea thoracica Latreille, Tabl. Meth. des Ins., p. 134 (1804).

Dr. Marx identifies this among material sent him by Prof. Townsend.

Loxosceles unicolor Keyserling.

Loxosceles unicolor Keyserling, Verh. zool.-bot. Ges. Wien, 1887, p. 474.

Described from New Mexico, and I have one specimen collected by Prof. Townsend; also recorded by Dr. Marx.

PHOLCIDÆ.

Psilochorus pullulus (Hentz).

Theridion pullulum Hentz, Jour. Bost. Soc. N. H., VI, p. 282 (1850).
Pholcus cornutus Keyserling, Verh. zool.-bot. Ges. Wien, 1887, p. 208.

Two males from Albuquerque; the species appears to be moderately common in the Southwest.

Physocyclus globosus (Taczanowski).

Pholcus globosus Taczanowski, Horæ Soc. Entom. Ross., Vol. X, p. 105 (1874).
Pholcus gibbosus Keyserling, Verh. zool.-bot. Ges. Wien, 1877, p. 208.

One female from Mesilla Park, April; young from Las Cruces.

DRASSIDÆ.

Prosthesima atra (Hentz).

Herpyllus atra Hentz, Jour. Bost. Soc. N. H., V, p. 455 (1846).

Several examples from Albuquerque (Soltau) and from first Ruidoso camp, Eagle creek, White Mountains, third week in August.

Prosthesima cockerelli n. sp.

Cephalothorax nearly uniform pale yellowish-brown, a black marginal line and around anterior eyes black; the mandibles and sternum more red-brown; the legs pale yellow-brown, the tibiæ and beyond of anterior legs more red-brown; abdomen gray above, blackish on sides and behind, below more yellowish; spinnerets pale; epigynum red-brown; the male with a yellow shield on base of abdomen above. The cephalothorax is quite narrow in front; posterior eye-row nearly straight; P.M.E.

round, fully diameter apart, about same distance from the equal P.S.E.; A.M.E. much larger than P.M.E., much less than diameter apart, and much closer to the rather smaller A.S.E. Mandibles rather long. Legs of moderate length, tibiæ I and II with one spine below at middle and a pair at tip, these metatarsi with a pair near the base; tarsi and metatarsi slightly scopulate; one spine above on base of tibia III. Sternum narrowed in front, pointed behind. Abdomen quite large, depressed, nearly twice as long as broad, with some stiff black hairs at base; the epigynum shows a broad area divided in front, and behind enclosing a triangular septum. The tibia of male palpus shows on the outer side a slender projection, the tip of which is slightly recurved.

Length ♀ 10 mm., ♂ 8 mm.

Several specimens from Mesilla Park (Cockerell).

Prosthesima blanda Banks.

Prosthesima blanda Banks, Proc. Acad. Nat. Sci. Phila., 1892, p. 18.

Two specimens (one immature) from Albuquerque. Previously known from Ithaca, N. Y., and Colorado.

Drassodes robustus (Emerton).

Drassus robustus Emerton, Trans. Conn. Acad. Sci., VIII, p. 15 (1890).

Several specimens, none quite adult, from Albuquerque, also Las Vegas, February. They agree with Colorado specimens, and there is no probability that an adult would show a different vulva. This species extends across the country from New Hampshire to Washington.

Pœcilochroa montana Emerton.

Pœcilochroa montana Emerton, Trans. Conn. Acad. Sci., VIII, p. 11 (1890).

One female from first Ruidoso camp, White Mountains, latter half of July. A sub-boreal species, known from New Hampshire, northern New York, Colorado and Washington.

Gnaphosa conspersa Thorell.

Gnaphosa conspersa Thorell, Bull. U. S. Geol. Surv. Terr., III, No. 2, p. 489 (1877).

One female from Beulah.

Gnaphosa distincta Banks.

Gnaphosa distincta Banks, Proc. Calif. Acad. Sci., 3d Ser., Zool., Vol. I, p. 222 (1898).

Two specimens from the White Mountains appear to belong to this Mexican species, not previously recorded from the United States.

Gnaphosa hirsutipes n. sp.

Cephalothorax pale yellow-brown, darker around eyes, margin black, at base of pars cephalica are two oblique blackish spots, more or less distinct. Mandibles and sternum red-brown, the latter with dark margin. Legs pale yellow-brown, the tarsi rather darker. Abdomen uniform light brown above, below rather paler, spinnerets yellowish; epigynum reddish. Posterior eye-row slightly recurved, P.M.E. oval, oblique, at hind ends about their short diameter apart, nearly twice as far from the slightly larger P.S.E.; anterior eye-row shorter, straight; A.M.E. no larger than P.M.E., about diameter apart, and plainly closer to the slightly larger A.S.E. Legs short and stout, quite thickly clothed with fine hairs, very few spines, none under tibia I, one at tip under metatarsus I, a fine one at tip of tibia II, and one at tip of metatarsus II. Sternum short and broad, truncate in front, rounded behind; abdomen depressed, one and one-half times longer than broad, truncate at base where there are many stiff hairs. The epigynum shows a cavity, narrow behind; the anterior part mostly filled by a broad, tapering septum.

Length 8 mm.

Two females from Albuquerque (Soltau).

Micaria albocincta n. sp.

Cephalothorax uniform dark red-brown; mandibles nearly black; sternum black; legs yellow-brown, tips of tarsi yellow, femora I and II dark brown, base of femur III also dark; abdomen black, covered with iridescent scales, a narrow median white band extending well down on each side, and an indistinct one near base. Cephalothorax moderately slender; P.M.E. round, nearly twice their diameter apart, slightly more than the diameter from larger P.S.E.; A.M.E. a little larger than P.M.E., scarcely the diameter apart, closer to the equal A.S.E.; quadrangle of M.E. higher than broad. Tibiæ I and II each with a pair of spines at base, a pair at middle, and a single one at tip, none on metatarsi; metatarsi and tarsi beneath with scant scopula of clavate hairs. Abdomen fully twice as long as broad, not constricted in middle.

Length 5.7 mm.

One specimen from Beulah (Cockerell); another from top of Las Vegas range, 11,000 feet, last of June.

CLUBIONIDÆ.

Chiracanthium inclusum (Hentz).

Clubiona inclusa Hentz, Jour. Bost. Soc. N. H., V, p. 451 (1846).

Some immature specimens from Mesilla Park (Cockerell).

Anyphæna sp.

One immature specimen from Mesilla Park, January, and another from Mesilla.

It has a black clypeus and black mandibles, a brown stripe on each side of the cephalothorax, broadest behind; and two rows of connected spots on the dorsum of abdomen, united behind. It is possibly *A. futilis* Banks, a Mexican species.

Gayenna marginalis n. sp.

Cephalothorax yellowish, margin black, two black stripes above, not reaching hind margin, and two within these near eyes, eyes on black spots; mandibles pale yellowish; legs yellowish, femora with three incomplete narrow black rings, two on the tibiæ, and some spots on the hind pairs of metatarsi. Sternum pale, margined with brown; abdomen pale gray, quite densely marked above with pale brown spots, those on the sides being oblique dashes; venter with a dark stripe each side, and a broader median one, all ending at the ventral furrow. P.M.E. scarcely their diameter apart, barely closer to the rather smaller P.S.E.; A.M.E. much smaller, not one-half their diameter apart, and fully as close to the subequal A.S.E. Tibia I below with five spines in front and four behind; tibia II with four in front and three behind; metatarsi I and II with three pairs beneath.

Length 6 mm.

One female from near Beulah, March, 8,000 feet altitude (Cockerell).

Meriola inornata n. sp.

Cephalothorax, mandibles and sternum dark red-brown; legs pale yellowish, fore pairs little, if any, darker; abdomen above and below pale yellowish, a faint basal brown spear-mark. Cephalothorax and sternum rugosely granulate; posterior eye-row nearly straight, P.M.E. about their diameter apart, no closer to the rather smaller P.S.E.; A.M.E. equal to P.M.E., nearly their diameter apart, much closer to the nearly equal A.S.E.; quadrangle of M.E. a trifle broader than high. Mandibles large and slightly porrect; sternum truncate in front; hind coxæ widely separated. Legs quite long and slender, no spines, but with many hairs; beneath on tibiæ, metatarsi and tarsi are rows of serrated, semi-clavate hairs, each arising from a pointed granule; these are most evident on anterior legs. Abdomen slightly depressed, about one and one-half times as long as broad, nearly truncate at base. The epigynum shows two elliptical approximate marks beneath the surface, in each outer posterior corner is a black circular cavity, between them are two smaller black dots from which lines extend to the furrow.

Length 3.5 mm.

One female from Albuquerque (Soltau).

Thargalia modesta n. sp.

Cephalothorax pale reddish yellow, black around the eyes; mandibles and femora like cephalothorax, rest of legs pale yellowish, except the fourth pair, which have the tibiæ and metatarsus brown, the former pale on base and tip; sternum brown; venter black; palpi pale yellow; abdomen black, with black hairs and scales, a white band at base, a spot each side behind this band, and a narrow white band before the middle. Cephalothorax quite long and slender, about the length of tibia plus patella IV; head not elevated. Posterior eye-row procurved; P.M.E. round, nearly twice their diameter apart, over diameter from equal P.S.E.; anterior row shorter, nearly straight, A.M.E about their diameter apart, closer to the equal A.S.E., S.E. about diameter apart and subequal; quadrangle of M.E. much higher than broad, broader behind than in front. Abdomen scarcely longer than the cephalothorax, broadly rounded behind, with a horny shield at base.

Length ♀ 6 mm.

One female from Albuquerque (Soltau).

Thargalia sp.

One immature specimen from Dripping Springs, Organ Mountains, in April. Probably represents an undescribed species.

Corinna bicalcarata Simon.

Corinna bicalcarata Simon, Ann. Soc. Ent. Belg., 1896, p. 416.

One female from Las Cruces. It was described from Arizona.

Phrurolithus sp.

Two specimens, both females, from the White Mountains, first Ruidoso camp, latter half of July. Very near *P. pugnatus* Emer., and quite possibly identical; a male from Las Vegas, February.

Syspira sp.

One immature specimen from a deep hole in the ground, January 24, at Mesilla Park. Like *S. tigrina* but paler, yet may be identical; both of the described species come from Lower California, and this is the first record of the genus in our country.

AGALENIDÆ.

Agalena longistylus n. sp.

Cephalothorax pale yellowish, with a brown stripe each side, broadest behind, leaving a pale median area, narrower behind; side margins narrowly brown; eyes on black spots; mandibles yellowish brown; sternum yellowish, broadly margined with brown; legs pale yellowish, femora marked with oblique brown spots, tibiæ and metatarsi brown at tips; abdomen brown, a broad pale area above, enclosing a brown basal spear-mark; venter yellowish brown, a brown line on each side; upper spinnerets brown, last joint long and slender like that of *A. nævia*. Structure similar to *A. nævia*, but the stylet of the male palpus is very much longer, making two full circles, the outside process is proportionally larger and sharper pointed, the tibia extends over the base of tarsus as in *A. nævia*.

Length ♂ 7 mm.

One male from first Ruidoso camp, White Mountains, August 10 (Townsend).

Agalena nævia Hentz.

Agalena nævia Hentz, Proc. Bost. Soc. N. H., Vol. V, p. 465 (1847).

One small male from Eagle creek, White Mountains, August. The stylus is of the usual length, a trifle more than one circle; the femora are unmarked.

Cicurina arcuata Keyserling.

Cicurina arcuata Keyserling, Verh. zool.-bot. Ges. Wien, 1884, p. 460.

One female from Las Vegas Hot Springs, January.

DICTYNIDÆ.

Dictyna arundinacoides Keyserling.

Dictyna arundinacoides Keyserling, Verh. zool.-bot. Ges. Wien, 1883, p. 665.

Several specimens from Beulah. A pair from top of Las Vegas range, 11,000 feet, last of June.

Dictyna texana Banks.

Dictyna texana Banks, Proc. Calif. Acad. Sci. (3), Vol. I, p. 233 (1898).

Two immature specimens from Mesilla Park

Dictyna sp.

One female of a small species from Las Cruces. It is much like *D. sublata*, but different.

Titanœca americana Emerton.

Titanœca americana Emerton, Trans. Conn. Acad., VII, p. 453 (1888)

One broken specimen from Las Vegas, at the limestone ledges by Gallinas river, January. Does not appear to differ from Eastern form.

Lethia trivittata n. sp.

Cephalothorax dark red-brown, with three stripes of white hairs on the head uniting behind at the dorsal groove; mandibles red-brown; sternum and legs more yellow-brown, paler toward tips; abdomen grayish white above, with a broad median brown stripe with serrated margins. Legs quite long and hairy, no spines; mandibles of male long and slightly concave; palpus of male short, the tibia with a plate-like projection below near the tip, palpal organ simple, a long stylet on outer side, bent over at tip; epigynum shows two transverse cavities in front, and two smaller oblique cavities behind. Posterior eye-row straight, P.M.E. fully their diameter apart, about as far from the equal P.S.E.; A.M.E. equal to P.M.E., about their diameter apart, and closer to the equal A.S.E.; quadrangle of M.E. broader than high.

Length ♀ 6 mm.; ♂ 4.2 mm.

One pair from Albuquerque (Soltau).

THERIDIIDÆ.

Theridium neomexicanum n. sp.

Cephalothorax pale yellowish, with a marginal black line, head with four reddish brown lines, converging back from the eyes and uniting at dorsal groove; mandibles and sternum pale yellowish; legs pale, tips of patellæ and tibiæ, and sometimes of metatarsi, reddish; abdomen white, a few scattered black dots on dorsum, and two larger black spots above the spinnerets. Cephalothorax of usual shape; P.M.E. rather large, a little less than diameter apart; the A.M.E. smaller, fully diameter apart; quadrangle of M.E. forming a square. Legs of moderate length, metatarsus I a little longer than tibia I. Sternum triangular, the sides slightly rounded. Abdomen (when full of eggs) globular, higher than long; the epigynum shows as a simple median black opening.

Length 4 mm.

Two females from Las Cruces (Cockerell).

Theridium differens Emerton.

Theridium differens Emerton, Trans. Conn. Acad., VI, p. 9 (1882).

A young male from Mesilla Park, November 30, appears to belong to this species (Cockerell).

Steatoda grandis n. sp.

Cephalothorax and mandibles uniform dark red-brown; legs a brighter red-brown, still paler on the tarsi, tips of tibiæ plainly darker; sternum black; abdomen black above, with a narrow white line around base, extending back about one-third the distance to tip; venter pale, with a black mark similar in shape to that of *S. borealis*, but heavier. The posterior eye-row is straight, the P.M.E. fully their diameter apart, rather closer to the slightly larger P.S.E.; the A.M.E. much larger than the P.M.E., about one-half their diameter apart, and still closer to the much smaller A.S.E., the latter nearly touching the P.S.E. The epigynum shows a nearly circular, depressed corneous lid, with a small transverse opening behind. The legs are of moderate length, but rather large and stout.

Length 7.5 mm.

One female from Albuquerque (Soltau). It has much resemblance to the common *S. borealis*, but is larger and heavier; this is particularly noticeable in the size of the legs.

Steatoda borealis (Hentz).

Theridium borealis Hentz, Jour. Bost. Soc. N. H., VI, p. 274 (1850).

One from first Ruidoso camp, White Mountains, latter half of July.

Lithyphantes fulvus Keyserling.

Lithyphantes fulvus Keys., Die Spinn. Amer., Theridiidæ, p. 142, 1884.

One immature specimen from Las Cruces (Cockerell).

Lithyphantes corollatus (Linné).

Aranea corollata Linné, Syst. Nat., Ed. X, i, p. 621 (1758).

A female from Las Vegas (Cockerell), and a pair from Prof. Townsend.

Lathrodectus mactans (Fabricius).

Aranea mactans Fabricius, Entom. Syst., II, p. 410 (1793).

An adult female from Mesilla Park in April, also young from Las Cruces (Cockerell); one female from Las Vegas Hot Springs, January. It is also found commonly at Santa Fé (Cockerell, Bull. 15, N. M. Agr. Exp. Sta., p. 81).

Euryopis funebris (Hentz).

Theridium funebris Hentz, Jour. Bost. Soc. N. H., VI, p. 276 (1850).

Several specimens from Beulah.

Grammonota pictilis (Cambridge).

Erigone pictilis Cambridge, Proc. Zool. Soc. London, 1875, p. 396.

Three females and a male from Albuquerque; do not appear to differ from Eastern specimens.

Ceratinella occidentalis n. sp.

Cephalothorax uniform dark red-brown, shining; abdomen dull gray, with a dark red-brown dorsal shield, containing four black submedian impressions forming a trapeze; sternum red-brown; mandibles paler red-brown, fang black in middle; legs pale reddish, the patellæ paler, especially from beneath; abdomen with many small dark pits from which arise hairs. Cephalothorax rather short and broad; P.M.E. fully one and one-half their diameter apart, and as far from the equal P.S.E.; A.M.E. small, close together, farther from the larger A.S.E. Sternum broad, broadly truncate between hind coxæ which are widely separated. Abdomen with a large rounded dorsal shield, about one-third longer than broad, and rather pointed behind; on the venter there is a somewhat semicircular shield each side of the epigynum, another in front of the spinnerets, and several corneous dots as follows: Two behind epigynum, two in front of the anal plate, and a series each side, of which the basal one is the largest. Legs hairy, without spines.

Length 1.6 mm.

Two females from Beulah, March, 8,000 feet altitude (Cockerell).

Tmeticus sp.

One specimen, a male from Eagle creek camp, White Mountains. In many respects similar to *T. perplexa*, but different; not in very good condition.

Tmeticus brevipalpus n. sp.

Cephalothorax yellowish brown, more or less mottled with dull black, eyes on black spots; mandibles more red-brown; legs pale yellowish; sternum dark brown; abdomen black, with some small scattered white spots above. Cephalothorax rather broad, head slightly elevated; posterior eye-row nearly straight; P.M.E. about their diameter apart, and about as far from the equal P.S.E.; A.M.E. smaller, about diameter apart, and rather farther from the larger A.S.E.; quadrangle of M.E. broader behind than in front, and a little higher than broad. Mandibles vertical, slightly diverging, unarmed. Sternum very broad, rounded behind. Legs long, with many hairs, but few spines; metatarsus I scarcely as long as tibia I. The tibia of palpus shows above two projections, a long one at tip and a smaller one toward base. Stylet long and curved once around the tip.

Length 2 mm.

One specimen from the White Mountains (Townsend).

Tmeticus perplexus (Keyserling).

Erigone perplexa Keyserling, Die Spinn. Amer., Therid., II, p. 190, 1886.

Tmeticus pectinatus Emerton, Trans. Conn. Acad., IX, p. 409, 1894.

One male from Albuquerque.

Linyphia communis (Hentz).

Linyphia communis Hentz, Jour. Bost. Soc. N. H., VI, p. 280 (1850).

One female from La Cueva, Organ Mountains, in August; another from one-half mile below first Ruidoso camp, White Mountains, August 8, by sweeping.

Linyphia phrygiana Koch.

Linyphia phrygiana Koch, Die Arach., III, p. 83, 1836.

Several specimens from top of Las Vegas range, 11,000 feet, last of June.

Microneta soltaui n. sp.

Cephalothorax and legs yellowish, the mandibles and sternum often more brownish, eyes on black spots, femora of male more reddish; the abdomen is gray above and below, spinnerets yellowish. Posterior eye-row is slightly procurved, P.M.E. about diameter apart, rather closer to the equal P.S.E.; A.M.E. small, close together, much farther from the much larger A.S.E. which are some larger than the P.S.E. to which they are closely approximated; quadrangle of M.E. much higher than broad, broader behind than in front. Mandibles divergent, no teeth in front. Tibia of male palpus swollen below, above, as well as the patella tipped with several strong hairs; tarsus broad, rather angular above near base; the palpal organ broadest near tip; a dark piece extending across the base, close to the surface, tapering and twisted, but little curved; a large and prominent hook on inner face, curved and twisted at the tip where it is bifid. The epigynum is prominent and triangular in form, with a small median finger behind.

Length ♂ 2.4 mm.; ♀ 2.8 mm.

Several specimens from Albuquerque (Soltau).

TETRAGNATHIDÆ.

Tetragnatha extensa (Linné).

Aranea extensa Linné, Syst. Nat., Ed. XII, p. 621 (1767).

One pair from Beulah, and a male from the White Mountains, Eagle creek camp, third week in August.

Tetragnatha laboriosa Hentz.

Tetragnatha laboriosa Hentz, Jour. Bost. Soc. N. H., VI, p. 27 (1850).

Several specimens from Las Cruces; one from one-half mile below first Ruidoso camp, August 4, by sweeping.

Eugnatha pallida Banks.

Tetragnatha pallida Banks, Proc. Acad. Nat. Sci. Phila., 1892, p. 51.

One male from Beulah.

EPEIRIDÆ.

Argiope transversa Emerton.

Argiope transversa Emer., Trans. Conn. Acad., VI, p. 330, 1884.
Epeira fasciata Hentz, Jour. Bost. Soc. N. H., V, p. 468 (1847).

One fine specimen from Las Vegas, September (Miss Ada Springer).

Argiope aurantia Lucas.

Argiope aurantia Lucas, Ann. Soc. Entom. France, 1833, p. 86.
Epeira riparia Hentz, Jour. Bost. Soc. N. H., V, p. 468 (1847).

One specimen collected by Prof. Townsend.

Gasteracantha cancriformis (Linné).

Aranea cancriformis Linné, Syst. Nat., Ed. XII, p. 1037 (1767).

Recorded from New Mexico by Dr. Marx, in his Catalogue. Mr. Cockerell says he has never seen it, so far as he can remember.

Epeira placida Hentz.

Epeira placida Hentz, Jour. Bost. Soc. N. H., V, p. 475 (1847).

Two females from one-half mile below first Ruidoso camp, White Mountains, August, by sweeping. They are not quite adult, and differ considerably from the usual form. There are no stripes on the cephalothorax; the abdomen is light chocolate-brown, with some white marks in front and where the stripe should be, behind there are two black spots each side. The spinnerets are black, with the usual two spots each side. Structurally there are no differences from the Eastern specimens, but the male might show differences in the palpus. *E. placida* has not previously been recorded from the West.

Epeira oaxensis Keyserling.

Epeira oaxensis Keyserling, Sitzungsber. Isis, Dresden, 1863, p. 121.
Epeira vertebrata McCook, Proc. Acad. Nat. Sci. Phila., 1888, p. 196.

Several specimens from Las Cruces, September 6 (Cockerell), and Eagle creek camp and Ruidoso creek, White Mountains, third week in August. An abundant species in the extreme Southwest and in Mexico.

Epeira aculeata Emerton.

Epeira aculeata Emerton, Bull U. S. Geol. Surv. Terr., III, No. 2, p. 528 (1877).

A few specimens from Beulah (Cockerell). A species common in the foothills of Colorado.

Epeira labyrinthea Hentz.

Epeira labyrinthea Hentz, Jour. Bost. Soc. N. H., V, p. 471 (1847).

Three specimens from Eagle creek camp, White Mountains, August.

Epeira displicata Hentz.

Epeira displicata Hentz, Jour. Bost. Soc. N. H., V, p. 476 (1847).

One specimen swept from Solidago patch on Ruidoso side of divide, about 200 feet below top of divide, White Mountains, August 17.

Epeira trivittata Keyserling.

Epeira trivittata Keyserling, Sitzungsber. Isis, Dresden, 1863, p. 95.

Recorded by McCook from New Mexico; one specimen collected by Prof. Townsend, and one each from Mesilla Park and Ruidoso creek.

Epeira nephiloides Cambridge.

Epeira nephiloides Cambridge, Biol. Cent.-Amer. Arach.-Aran., I, p. 32 (1890).

Dr. Marx records a specimen from Fort Canby.

Epeira gemma McCook.

Epeira gemma McCook, Proc. Acad. Nat. Sci. Phila., 1888, p. 193.

A female from Rio Ruidoso, 200 feet above first Ruidoso camp; a large female from East Las Vegas.

Epeira trifolium Hentz.

Epeira trifolium Hentz, Jour. Bost. Soc. N. H., V, p. 471 (1847).

Several from top of ridge near Eagle creek, White Mountains, August, September.

Epeira mœsta Keyserling.

Epeira mœsta Keyserling, Die Spinn. Amer., IV, p. 108 (1892).

Dr. Marx had a specimen from New Mexico, without more definite locality.

THOMISIDÆ.

Xysticus bicuspis Keyserling.

Xysticus bicuspis Keyserling, Verh. zool.-bot. Ges. Wien, 1887, p. 478.

One male from Dripping Springs, Organ Mountains, and a female from Las Cruces, which probably belongs to the male. The epigynum consists of a simple transverse elliptical cavity without any indentation.

Xysticus montanensis Keyserling.

Xysticus montanensis Keyserling, Verh. zool.-bot. Ges. Wien, 1887, p. 479.

Xysticus pulverulentus Emerton, Trans. Conn. Acad., IX, p. 417, 1894.

One female from Beulah; it may possibly be a different species, but the differences are so slight that, in the absence of males, I refer it to this species. The epigynum has the same general shape, but is longer.

Xysticus emertoni Keyserling.

Xysticus emertoni Keyserling, Die Spinn. Amer., I, Latr., p. 39 (1880).
Xysticus elegans Keyserling, *ibid.*, p. 31.

A female from Beulah and a male from Las Vegas Hot Springs appear to belong here. The male is like males from New England, which both Emerton and myself consider *X. elegans.* The female is not, however, so certain.

Xysticus cunctator Thorell.

Xysticus cunctator Thorell, Bull. U. S. Geol. Surv. Terr., III, No. 2, p. 495 (1877).
Xysticus quinquepunctatus Keyserling, Die Spinn. Amer., I, Latr., p. 12 (1880).

Several specimens from Albuquerque (Soltau), and Beulah and Mesilla Park (Cockerell). This gives the species a vertical range from 3,800 feet to 8,000 feet.

Xysticus gulosus Keyserling.

Xysticus gulosus Keyserling, Die Spinn. Amer., I, Latr., p. 43 (1880)

One young female from summit of range between the Pecos and Sapello rivers, August (Cockerell); adult female from Las Vegas, February.

Coriarachne versicolor Keyserling.

Coriarachne versicolor Keyserling, Die Spinn. Amer., I, p. 53 (1880).

An immature male from Mesilla.

Misumena oblonga Keyserling

Misumena oblonga Keyserling, Die Spinn. Amer., I, Latr., p. 79 (1880).

One female from Mesilla Park.

Misumena vatia (Clerk).

Araneus vatia Clerk, Sven. Spindlar, p. 128 (1757).

A few from top of ridge near Eagle creek, White Mountains, August and September; also from Eagle creek camp.

Misumena sp.

Three immature specimens of a species new to the United States, but may be young of some Mexican form. It has the anterior legs evenly sprinkled with red dots, and many similar dots on cephalothorax and dorsum of abdomen; the cephalothorax has a dark stripe on each side.

Taken in White Mountains, one-half mile below forks, August 6, sweeping; another, nearly adult, from one-half mile below first Ruidoso camp, August 4, by sweeping.

Ebo mexicana Banks.

Ebo mexicana Banks, Proc. Calif. Acad. Sci., 3d Ser., Zool., Vol. I, p. 265 (1898).

Several specimens from Mesilla Park, January. Among them is the male, not previously known; it is a little smaller than the female, but marked like it. Previously recorded only from Hermosillo, Mex., but I have some specimens from El Paso, Tex.

Thanatus coloradensis Keyserling.

Thanatus coloradensis Keyserling, Die Spinn. Amer., I, Laterigradæ, p. 206 (1880).

A pair from Las Cruces (Townsend). Readily separated from *T. rubicundus* by the fact that the eyes of the anterior row are of equal size; in the latter species the side eyes are much larger than the median ones.

Thanatus rubicundus Keyserling.

Thanatus rubicundus Keyserling, Die Spinn. Amer., I, p. 204 (1880).

Two specimens from Beulah.

Tibellus duttoni (Hentz).

Thomisus duttoni Hentz, Jour. Bost. Soc. N. H., V., p. 488 (1846).

Several specimens from Albuquerque (Soltau), and Mesilla Park and Beulah (Cockerell); young from Las Vegas.

Philodromus alaskensis Keyserling.

Philodromus alaskensis Keyserling, Verh. zool.-bot. Ges. Wien, 1883, p. 674.

An immature specimen from Las Vegas (Cockerell).

Philodromus spectabilis Keyserling.

Philodromus spectabilis Keyserling, Die Spinn. Amer., I, p. 210 (1880).

Several specimens, mostly immature, from Mesilla Park, in January.

Philodromus inquisitor Thorell.

Philodromus inquisitor Thorell, Bull. U. S. Geol. Surv. Terr., III, 2, p. 502 (1877).

One female from top of Las Vegas range, 11,000 feet, last week in June.

SPARASSIDÆ.

Olios fasciculatus Simon.

Olios fasciculatus Simon, Act. Soc. Linn. Bord., XXXIV, p. 307 (1880).
Olios giganteus Keyserling, Verh. zool.-bot. Ges. Wien, 1883, p. 681.

An immature specimen from La Cueva, Organ Mountains, September.

Olios abnormis Keyserling.

Olios abnormis Keyserling, Verh. zool.-bot. Ges. Wien, 1883, p. 679.

The species was described from Santa Fé, N. M.

Olios concolor Keyserling.

Olios concolor Keyserling Verh. zool.-bot. Ges. Wien, 1883, p. 682.

This species was described from Punta del Aqua, N. M.

CTENIDÆ.

Ctenus hibernalis Hentz.

Ctenus hibernalis Hentz, Jour. Bost. Soc. N. H., IV, p. 393 (1843).

This is recorded from New Mexico in Dr. Marx's Catalogue.

LYCOSIDÆ.

Lycosa helluo Walckenaer.

Lycosa helluo Walckenaer, Ins. Apt., I, p. 337 (1837).
Lycosa babingtoni Blackwall, Ann. Mag. Nat. Hist., XVII, p. 30, (1846).
Lycosa nidcola Emerton, Trans. Conn. Acad., VI, 482 (1885).

One female and several young from Albuquerque; apparently identical with Eastern specimens.

Lycosa modesta (Thorell).

Tarentula modesta Thorell, Bull. U. S. Geol. Surv. Terr, III, No. 2, p. 520 (1877).

Several specimens from Beulah.

Lycosa coloradensis Banks.

Lycosa coloradensis Banks, Jour. N. Y. Ent. Soc., 1891, p. 50.

Two specimens from Las Cruces, not quite adult.

Lycosa sp.

Two immature specimens from Las Vegas, limestone ledges by Gallinas river. The cephalothorax is dark brown, with three pale stripes, the median the broadest, and of nearly equal width from eye-region to tip; sternum dark; coxæ pale, legs more or less marmorate above with brown, the hind tibia broadly banded at base and tip with black; abdomen discolored.

Lycosa caroliniensis Hentz.

Lycosa caroliniensis Hentz, Jour. Bost. Soc., Nat. Hist., IV, p. 230 (1843).

One adult male, fully colored, from Eagle creek canon, White Mountains, August 15; under a log.

Trochosa parva Banks.

Trochosa parva Banks, Jour. N. Y. Ent. Soc., 1894, p. 52.

Several examples from Albuquerque (Soltau), Beulah (Cockerell), and Eagle creek camp, White Mountains, third week in August.

Trochosa cinerea (Fabricius).

Araneus cinereus Fabricius, Entom. Syst. II, p. 423 (1793).

A female from Las Cruces, September 2; at light.

Trochosa sp.

One female of a pale species from Albuquerque. It is apparently new, but does not show any marked characters in this sex.

Pardosa glacialis (Thorell).

Lycosa glacialis Thorell, Öfv. K. Vetensk.-Akad. Förh., 1872, p. 159.
Lycosa concinna Thorell, Bull. U. S. Geol. Surv. Terr., III, No. 2, p. 506 (1877).

One male and several young from Albuquerque, and adults from summit of range between the Pecos and Sapello rivers, August, July.

Pardosa sternalis (Thorell).

Lycosa sternalis Thorell, Bull. U. S. Geol. Surv. Terr., III, No. 2, p. 504 (1877).
Pardosa luteola Emerton, Trans. Conn. Acad., IX, p. 427, 1894.

One male from the White Mountains.

OXYOPIDÆ.

Oxyopes pictipes n. sp.

Cephalothorax uniform gray-brown on sides and in front, eye-region black, above a broad pale area, broader in front than behind, with a narrow median extension forward to the eyes, and each side at base of pars cephalica is a short extension, in front on the clypeus is a small median pale spot; mandibles dark brown; palpi pale, banded with black; legs pale, a longitudinal black line beneath on the femora of anterior pairs, apical halves of all femora mostly black, patellæ mostly black, bands on middle and apex of tibiæ, and on base, middle and apex of metatarsi, black. Sternum pale; coxæ dark; venter mostly black; dorsum of abdomen pale, nearly interrupted beyond middle by an extension upward of the black sides. Head of the cephalothorax rather high, sloping off gradually behind. Posterior eye-row procurved; P.M.E. about twice their diameter apart and fully as far from the equal P.S.E.; eyes of second row larger than P.M.E., about twice their diameter apart, closer to the P.S.E.; eyes of first row very small, and directly below the second row. Abdomen rather short, and acute at tip. Legs of moderate length.

Length 7 mm.

One specimen from Albuquerque (Soltau).

Hamalatiwa grisea Keyserling.

Hamalatiwa grisea Keyserling, Verh. zool.-bot. Ges. Wien, 1887, p. 458.

Dr. Marx determined this in the material Prof. Townsend sent him.

ATTIDÆ.

Phidippus opifex McCook.

Phidippus opifex McCook, Proc. Acad. Nat. Sci. Phila., 1878, p. 276.

One male from Las Cruces. *Parnænus* (?) *griseus* Peckham, recently described from the same locality, is probably this species.

Phidippus bicolor Keyserling.

Phidippus bicolor Keyserling, Verh. zool.-bot. Ges. Wien, 1884, p. 496.
Phidippus ardens Peckham, Trans, Wisc. Acad. Sci., XIII, 288 (1901).
Phidippus californicus Peckham, *ibid.*, p. 289.

A few specimens from Las Cruces, September 6; La Cueva, August; Fillmore Cañon (near the falls), Organ Mountains; White Mountains, September 11; and limestone ledges by Gallinas river near Las Vegas. I have also seen the species from Arizona (Yuma). Peckham describes the sexes as separate species, although noting the possibility of their identity. Keyserling's specimen came from Utah.

Phidippus comatus Peckham.

Phidippus comatus Peckham, Trans. Wisc. Acad. Sci., XIII, p. 291 (1901).

Described from Las Vegas.

Phidippus tyrellii Peckham.

Phidippus tyrellii Peckham, Trans. Wisc. Acad. Sci., XIII, 296 (1901).

A few specimens from Beulah, August, and Eagle creek, White Mountains. A very pretty species in the male sex. I also have it from Bear, Idaho.

Dendryphantes octavus (Hentz).

Attus octavus Hentz, Jour. Bost. Soc. N. H., V, p. 365 (1846).

Several specimens from Las Cruces (Cockerell) and first Ruidoso camp, White Mountains, latter half of July.

Dendryphantes nubilus (Hentz).

Attus nubilus Hentz, Jour. Bost. Soc. N. H., V, p. 358 (1846).

Several examples from under bands on apple and pear trees at Mesilla Park, January (Cockerell). The bands were those which had been put on to catch the larvæ of the Codling Moth.

Dendryphantes vitis Cockerell.

Dendryphantes vitis Cockerell, The Entomologist, 1894, p. 207.

Described from Las Cruces, April; also occurs at Mesilla Park, under bands on apple and pear trees (Cockerell).

Philæus rimator (Walckenaer).

Attus rimator Walckenaer, Ins. Aptères, I, p. 446 (1837).
Phidippus auctus Koch, Die Arachn., XIII, p. 148, 1845.

One female on *Larrea* at Mesilla Park, January 22.

Sadala distincta Peckham.

Sadala distincta Peckham, Trans. Wisc. Acad., VII, p. 53 (1888).

Recorded from New Mexico in Dr. Marx's Catalogue; described from Mexico.

Plexippus paykulli (Aud. et Sav.).

Attus paykulli Audouin et Savigny, Descrip. Egypte, XXII, p. 172 (1827).

I have seen a few specimens from New Mexico, without definite locality.

Marptusa californica Peckham.

Marptusa californica Peckham, Trans. Wisc. Acad., VII, p. 81 (1888).

Young specimens from Mesilla Park (Cockerell), and also from Prof. Townsend.

Icius neomexicanus n. sp.

Cephalothorax reddish, eyes on a black band, two indistinct dark spots in middle of eye-region, a white stripe each side below eye-region and extending backward, lower sides black, some golden hairs around the anterior eyes; mandibles reddish; sternum red-brown; femora red-brown, rest of legs clear pale yellow, except the patella, tibia and metatarsus of leg I, which are red-brown like the femora; abdomen reddish brown above, with faint indications of a few black spots, the sides of the abdomen are distinctly white, the venter nearly black, spinnerets black. Cephalothorax low and rather long; the eye-region scarcely as broad behind as in front, eyes of second row rather closer to laterals of first row than to third row; the anterior row is curved, the top of laterals being even with top of median eyes, the latter are very large, close together and close to the anterior margin, so that the clypeus is extremely narrow. The mandibles are small and vertical; leg I much thickened, tibia and metatarsus I with two pairs of spines below; tibia III with a spine near base below, and a pair at tip; tibia IV with one at tip; metatarsi III and IV with several spines grouped at tip. Anterior coxæ separated by more than width of lip, hind coxæ nearly touching, the sternum much longer than broad. Abdomen about once and two-thirds as long as broad. The tibia of male palpus has a stout curved hook on outer tip; the palpal organ is tipped with three short black stylets, all of them only visible directly from below.

Length ♂ 3.8 mm.

One male from Beulah, 8,000 feet (Cockerell).

Icius peckhamæ Cockerell.

Icius peckhamæ Cockerell, Can. Entom., 1897, p. 223.

Several specimens from Mesilla Park. It is often found on fruit trees in the orchards.

Icius similis Banks.

Icius similis Banks, Can. Entom., 1895, p. 100.

Some immature examples from under bands on apple and pear trees, Mesilla Park (Cockerell).

Icius piraticus Peckham.

Icius piraticus Peckham, Trans. Wisc. Acad., VII, p. 49 (1888).

One male from San Augustine (Cockerell).

Fuentes vittata n. sp.

Cephalothorax blackish in eye-region and on sides, red-brown in thoracic part; sparsely clothed with white hair, and longer black ones; clypeus densely clothed with hair; many long black hairs above first row of eyes; dorsum of abdomen brown, rather mottled, with a whitish tapering stripe from base to tip, its sides ragged but distinct; on lower posterior sides a few pale oblique spots; venter pale brown; mandibles and sternum red-brown; leg I mostly red-brown, metatarsi and tarsi paler, other legs pale yellowish, all banded, especially above with blackish; these bands principally at tips of femora, middle of patellæ, base and middle of tibiæ and base and tip of metatarsi. Cephalothorax rather long and flat; first eye-row like that of *F. pertinax,* the second, however, is full as near to the dorsal as to lateral eyes. Legs moderately slender, and well spined; metatarsi III and IV spined along their length; leg I much enlarged, except the metatarsi and tarsi; three pairs of spines under tibia I, two pairs under metatarsus I; tibia and patella I rather more hairy than the other joints; coxæ I separated by width of lip. Abdomen nearly twice as long as broad, tapering behind, somewhat depressed. The epigynum shows a broad tapering cavity, limited behind by two approaching corneous pieces, leaving a median emargination.

Length 6 mm.

Two females from Albuquerque (Soltau). Readily known from our two other species by its coloration as well as the structure of the vulva.

Pellenes oregonense Peckham.

Habrocestum oregonense Peckham, Trans. Wisc. Acad., VII, 1888, p. 66.

One male from Las Vegas Hot Springs. It is much rubbed, but the male palpus agrees with Peckham's figure.

Pellenes hirsutum Peckham.

Habrocestum hirsutum, Peckham, Trans. Wisc. Acad., VII, p. 64, (1888).

Prof. Peckham so named a specimen sent him by Prof. Townsend from Las Cruces.

Pellenes cockerelli n. sp.

Cephalothorax above black, with black hair, a narrow white stripe each side arising above the lateral eyes and running just below the dorsal eyes back and then down to the hind margin, below this is a black stripe, and the lower sides are clothed with white hair; between the M.E. and on the anterior part of the eye-region is a median white line; the male shows a more distinct pale V-mark connecting the dorsal eyes; clypeus with white hair; mandibles reddish, with some white hair on basal part; all legs pale in both sexes, dotted and mottled with dark brown, more densely so on the hind pairs, all with black hairs and white scales; patella I of male paler than the tibia, patella III not modified; male palpus short, patella and base of tibia very pale, beyond very dark. Abdomen gray above and on the sides, clothed with white hair, with two broad black submedian stripes from base to tip, in the male broader and nearly connected behind, in the female interrupted behind by a prominent oblique white mark on each side; venter dark, with two pale submedian lines on basal part.

Length ♀ 7 mm.; ♂ 5 mm.

One pair from top of Las Vegas range, 11,000 feet; last week in June.

Pellenes klauserii Peckham.

Pellenes klauserii Peckham, Bull. Wisc. N. H. Soc., Oct., 1900,[1] p. 216.

Peckham describes this from two males from New Mexico, without more definite locality. The figure of the palpus looks much like that of *P. cockerelli*, but the description does not apply.

Pellenes birgei Peckham.

Pellenes birgei Peckham, Bull. Wisc. N. H. Soc., Oct., 1900, p. 217.

Described from one male from Mesilla Park.

Pellenes politus Peckham.

Pellenes politus Peckham, Bull. Wisc. N. H. Soc., Oct., 1900, p. 223.

Described from two females from New Mexico, without more definite locality; quite probably they are females of *P. klauserii*.

Pellenes cognatus Peckham.

Pellenes cognatus Peckham, Bull. Wisc. N. H. Soc., Oct., 1900, p. 224.

Peckham records one female from New Mexico.

Pellenes sp.

A male, one moult from maturity, from Ruidoso creek, one-half mile below forks, August 6, sweeping. It has black legs, with the bases of all femora pale; the palpi pale, with a large black spot on the patella; the abdomen is black, with a few small white spots.

Sassacus popenœi Peckham.

Sassacus papenhœi Peckham, Occ. Pap. Wisc. N. H. Soc., Vol. II, No. 3, p. 177 (1895).

Two young specimens; one from Prof. Townsend, the other under bands on apple and pear trees, Mesilla Park (Cockerell).

Homalattus cyaneus (Hentz).

Attus cyaneus Hentz, Jour. Bost. Soc. N. H., V, p. 365 (1846).

One from Mesilla Park, January 23, on *Larrea* (Cockerell).

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[1] Dated October, 1900, but not distributed till July, 1901; paper not completed till early in 1901.

PHALANGIDA.

Homolophus biceps (Thorell).

Mitopus biceps Thorell, Bull. U. S. Geol. Surv. Terr., III, No. 2, p. 525 (1877).

Several specimens from Beulah, Eagle creek, White Mountains, and ridge between Sapello and Pecos rivers, 11,000 feet. This is a common species in Colorado. In New Mexico it appears to belong to the Canadian and Hudsonian zones.

Trachyrhinus marmoratus Banks.

Trachyrhinus marmoratus Banks, Jour. N. Y. Entom. Soc., 1894, p. 145.

Described from Santa Fé; also found at Las Cruces, September (Cockerell).

Liobunum townsendi Weed.

Liobunum townsendi Weed, Amer. Nat., 1893, p. 295.

Described from Las Cruces (Townsend). Specimens have been examined from Las Cruces, Beulah, and various places in the White Mountains, some under logs and rocks, July, August and September. By far the most abundant Phalangid.

Taracus packardi Simon.

Taracus packardi Simon, C. R. Soc. Ent. Belg., 1879, p. lxxiv.

A pair from Beulah (Cockerell). Described from Colorado, but not taken by recent collectors. It is one of the rarest and most interesting of our "daddy-long-legs."

Phalangium cinereum Wood.

Phalangium cinereum Wood, Comm. Essex. Inst., VI, p. 25 (1868).

One specimen from Raton, Colfax county (Cockerell). Not previously known from the West; a common species in the extreme northeastern States. The specimen was taken on the railroad track at Raton station, and may possibly have been introduced with freight in some way.

Sclerobunus robustus (Packard).

Scotolemon robustus Packard, Bull. U. S. Geol. Surv. Terr., III, p. 164, (1877).

Specimens come from Beulah (Cockerell), from Eagle creek camp, White Mountains, August 21, in dead, rotten, wet pine log, and ridge of Eagle creek camp, White Mountains, under log, August. It belongs to the Canadian zone, both in New Mexico and Colorado.

PSEUDOSCORPIONIDA.

Chelanops validus Banks.

Chelanops validus Banks, Jour. N. Y. Ent. Soc., 1895, p. 7.

Two specimens from Mesilla. They are larger, but differ little in structure from the Lake Tahoe specimens.

Chelanops grossus Banks.

Chelanops grossus, Banks, Can. Entom. 1893, p. 65.

Two specimens from Eagle Creek, White Mountains; the fingers are a trifle longer than in Colorado specimens.

Chelifer scabrisculis Simon.

Chelifer scabrisculis Simon, Ann. Soc. Ent. France, 1878, p. 154.
Chelifer degeneratus Balzan, Ann. Soc. Ent. France, 1891, p. 532.

Three specimens from Eagle creek, White Mountains; they are like specimens that I have seen from Utah.

SCORPIONIDA.

Vejovis punctipalpi Wood.

Vejovis punctipalpi Wood, Proc. Acad. Nat. Sci. Philad.,1863, p. 109.

One from Mesilla, June, and a young one from La Cueva, Organ Mountains, August 30, under a rock.

Centrurus carolinianus (Beauvois).

Scorpio carolinianus Beauv., Ins. rec. Afr. Amer., p. 190, 1805.

One immature specimen from Las Vegas (Cockerell).

SOLPUGIDA.

Eremobates sulphurea (Simon).

Datames sulphurea Simon, Ann. Soc. Entom. France, 1879, p. 142.

One male from San Augustine, eastern base of Organ Mountains. Two females, one from Las Cruces, September 3, the other from Las Vegas, June 29, 1899 (W. Porter and M. D. Cockerell).

Eremobates californicus (Simon).

Datames californica Simon, Ann. Soc. Entom. France, 1879, p. 143.

One male from Mesilla valley is probably this species.

Eremobates pallipes (Say).

Galeodes pallipes Say, Long's Exped. Rocky Mts., Philad., 1823, Vol. II.

One specimen from Aztec, San Juan county, October (C. A. Grommet), appears to be this species.

Ammotrecha peninsulana (Banks).

Cleobis peninsulana Banks, Proc. Calif. Acad. Sci. (3), Zool., I, 290, 1898.

One specimen from La Cueva, Organ Mountains, September 2, at light in tent running over the blanket; another from Las Vegas Hot Springs, January.

ACARINA.

Trombidium gemmosum n. sp.

Body above densely clothed with short, thick, but scarcely clavate, hairs; below with short, stiff, pointed bristles; legs and palpi with fine slender hairs. Body once and one-half as long as broad, broadest in front, plainly constricted near middle above the third legs, the dorsum with several small impressed spots. Legs very short; leg I about as long as width of body, last joint but little swollen, no longer than preceding joint; fourth legs not reaching beyond tip of body. Palpi short; second joint much swollen above, below with long hairs; third rather longer than broad and plainly narrower at tip; fourth quite long, ending in a long stout claw; fifth, or thumb, clavate, hardly reaching beyond the claw, with short, simple hairs. Color red.

Length 2.4 mm.

Several specimens from Las Vegas in January (Cockerell), one from Eagle creek, White Mountains (Townsend). Closely related to *T. scabrum*, but with shorter legs, and shorter terminal joint to leg I. Mr. Cockerell states that this species is extremely abundant at Las Vegas.

Trombidium magnificum Le Conte.

Trombidium magnificum Le Conte, Proc. Acad. Nat. Sci. Philad., 1853, p. 145.

I have seen specimens from several parts of southern New Mexico.

Rhyncholophus sp.

Several specimens from Beulah. Very similar to *R. simplex*, but, I think, different.

Tetranychus bimaculatus Harvey.

Tetranychus bimaculatus Harvey, Rept. Me. Exp. Sta., f. 1892 (1893), p. 133.

Specimens from Mesilla Park on violet leaves (in cultivation) appear to belong to this common species. They were found by

Mr. Fabian Garcia, and the species was doubtless imported with the violets.

Tetranychus desertorum Banks.

Tetranychus desertorum Banks, Bull No. 8, Tech. Ser., Div. Entom., U. S. Dept. Agric., p. 76 (1900).

Described from specimens from Mesilla Park on *Larrea tridentata* and *Phacelia crenulata*. The latter, at least, were probably collected by Prof. J. D. Tinsley. Mr. Cockerell says the *Phacelia* was doubtless *P. intermedia* Wooton, until recently confused with *P. crenulata.*

Bryobia pratensis Garman.

Bryobia pratensis Garman, 14th Rept. State Entom. Ill, p. 73 (1885).

Prof. Cockerell has seen it from various parts of the Territory—Mesilla, Mimbres, etc.

Argas sanchezi Neumann.

Argas sanchezi Neumann, Mém. Soc. Zool. France, 1896, p. 16.

I have seen specimens from Deming.

Ixodes diversifossus Neumann.

Ixodes diversifossus Neumann, Mém. Soc. Zool. France, 1899, p. 136.

Described from two specimens taken from *Procyon lotor* from New Mexico; I have not seen it.

Dermacentor reticulatus (Fabricius).

Acarus reticulatus Fabricius, Ent. Syst., IV, p. 428, 1794.

Recorded by Neumann from the Territory; it is moderately common in the Western States.

Boophilus annulatus Say.

Ixodes annulatus Say, Journ. Acad. Nat. Sci. Philad., II, 1821, p. 75.
Ixodes bovis Riley, Spec. Rept. U. S. Dept. Agric., 1869.

Neumann records the well-known cattle-tick from New Mexico. Mr. Cockerell has not met with it.

Lælaps sp.

An undescribed species was taken under a rock at Las Vegas, April 7, in company with *Lasius interjectus.*

EXPLANATION OF PLATE XXXIII.

Fig. 1.—*Pachylomerus modestus*, palpus.
Fig. 2.—*Prosthesima cockerelli*. vulva.
Fig. 3.—*Prosthesima cockerelli*, palpus.
Fig. 4.—*Gnaphosa hirsutipes*, vulva.
Fig. 5.—*Thargalia modesta*, vulva.
Fig. 6.—*Meriola inornata*, vulva.
Fig. 7.—*Tmeticus perplexus*, palpus.
Fig. 8.—*Microneta soltaui*, palpus.
Fig. 9.—*Lethia trivittata*, vulva.
Fig. 10.—*Lethia trivittata*, palpus.
Fig. 11.—*Ceratinella occidentalis*, venter.
Fig. 12.—*Ceratinella occidentalis*, vulva.
Fig. 13.—*Microneta soltaui*, vulva.
Fig. 14.—*Tmeticus brevipalpus*, palpus.
Fig. 15.—*Xysticus bicuspis*, palpus and vulva.
Fig. 16.—*Pellenes cockerelli*, palpus.
Fig. 17.—*Pellenes cockerelli*, vulva.
Fig. 18.—*Phidippus tyrelli*, palpus.
Fig. 19.—*Xysticus montanensis*, vulva.
Fig. 20.—*Fuentes vittata*, vulva.
Fig. 21.—*Icius neomexicanus*, palpus.
Fig. 22.—*Gayenna marginalis*, vulva.

A PECULIAR CONDITION OF ŒDOGONIUM.

BY IDA A. KELLER.

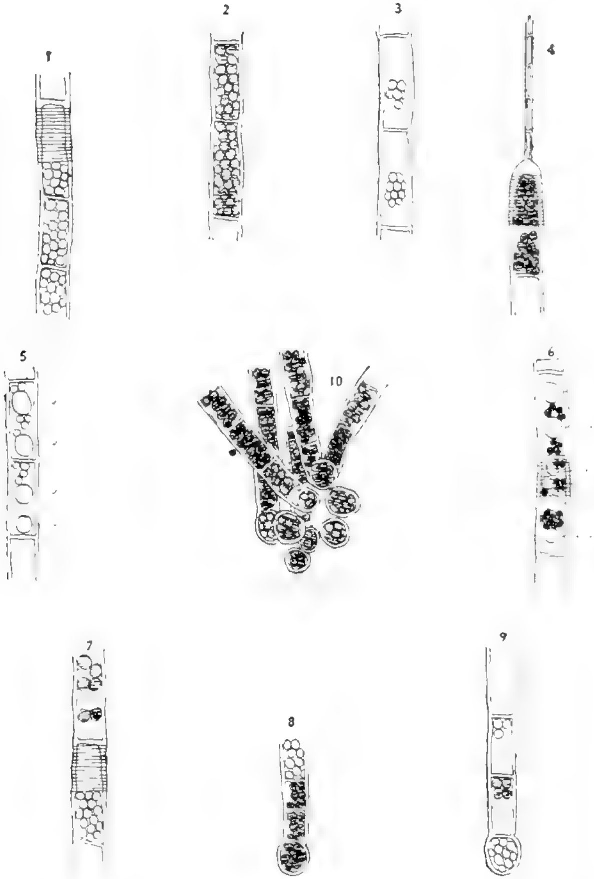
For several years I have kept a jar of water at my window, in which I have found interesting things at different times. Last fall there was a luxuriant growth of a dense green mat, which turned out to be a species of *Œdogonium.* Later on, as the color gradually disappeared, I took for granted that the plant was about to die, and gave it no further attention. The next time I happened to observe the jar the alga seemed to have been replaced by a heavy growth of the mycelium of some fungus. This remained in a thriving condition all winter, and proved on examination, to my great surprise, not to be a fungus at all, but the *Œdogonium* which had lost its chlorophyll. In all other respects the alga was apparently in a perfectly healthy condition, its filaments were rooted fast to pieces of rock which were in the bottom of the jar, the cells showed absolutely no signs of decomposition—furthermore, they were remarkably well packed with granules which turned out to be starch.

This phenomenon seemed to me an unusual one. I know of no alga which continues to live after it loses its chlorophyll, nor can I recall any parallel case among the higher plants—a water-plant which ceases its assimilating activity, full of the most attractive bait for bacteria, in nowise protected from them, and yet of sufficient vitality to withstand all attacks of these ever-present enemies.

The condition of the plant in May may be summed up as follows: The filaments are rooted to pieces of rock. To the naked eye they seem perfectly colorless and form a dense tuft of white threads. Fig. 1 represents a typical case. It shows absolutely no sign of chlorophyll and is full of starch.

In fig. 2 I have represented what may be regarded as a transition stage. It is also full of starch, but the cell has a faint greenish tinge. It is impossible to say whether the plant is just regaining its chlorophyll or whether it is just losing it.

The condition of a dead cell is represented in fig. 3. Here the protoplasm is contracted, and the starch granules are lumped together in the centre of the cells, in striking contrast to the case represented in fig. 1.



Microscopic examination further showed that green threads were interspersed here and there among these white filaments ; one of these is shown in fig. 4, the green color being indicated by shading. I regret not having made the examination sooner, since it would then have been possible for me to say whether or not the green color is newly acquired. It seems quite probable that some of the threads remained green over the winter, but, being few, they were not noticeable to the naked eye.

The quantity of starch in the bleached cells varied considerably. The extreme condition, on the one hand, where the cells were quite full of starch, as in fig. 1, is markedly different from the rather starved condition of figs. 5 and 6. In the latter cases the cells are doubtless still alive, but they contain comparatively little starch and great vacuoles. The vacuoles are well brought out on treating the cells with iodine (fig. 6).

The plant, as a whole, is certainly in a living and, I believe, actively growing condition, and it looks as though it were regaining its normal activity. Extremes and transitions, as regard the quantity of chlorophyll present, can easily be observed. Comparisons of figs. 1, 7, 9 and 2 will illustrate this point. Fig. 1 shows the perfectly bleached cell, figs. 7 and 9 show cells containing a little chlorophyll, while fig. 4 represents the deep green cell, which consists of one large mass of connected chromatophores. Furthermore, such cases as that of fig. 2, which I mentioned above, were to be found where the whole cell was colored, but the green tinge a very faint one.

The filaments come singly or in groups from basal cells (figs. 8, 9 and 10). In many cases these basal cells are green, while the remainder of the filament may be either green or bleached. Fig. 9 represents a case where the basal cell is white.

The normal state of affairs is the following: The vegetative condition finally results in the formation of oögonia. These are the only portions of the plant which survive the winter, and are protected from cold and moisture by their thick cell walls.[1] In this instance the oögonia were not formed, and the food which the plant had stored up for this normal function remained in the form of starch. Naturally it will be of interest to find out if the plant will again resume its assimilating activity. It would also be of interest to determine if the plant behave similarly out of doors, which it might well do under the conditions of a mild winter or in protected places. At all events, the fact that the plant continues to live in its present ghostlike condition seems an interesting revelation, so far as the physiology of algæ is concerned.

In Leunis' *Synopsis der Botanik*[2] I found the following state-

[1] Luerssen, *Grundzüge der Botanik*, p. 191.
[2] Leunis, *Synopsis der Botanik*, Bd. III, pp. 163, 164.

ment, which seems of interest in this connection. Of *Œdogonium capillare* this author says: "It is a form frequent in stagnant waters, and forms when the water disappears a felt-like mass, the so-called 'Meteor Papier' (Meteor Paper). Such masses are also found on meadows which have been submerged for some time, the so-called Wiesentuch, Wiesenleder (meadow cloth, meadow leather). The same formations have been repeatedly found on meadows along the River Oder after floods and are called Oder Haut (Oder skin). A piece which was examined in 1736 by Ehrenberg, and one observed by Cohen in 1849, consisted principally of *Cladophora fracta* and diatoms." In commenting on this phenomenon Leunis makes the following statement : "This comparatively rare formation is the result of a number of conditions—appearance of vigorous algoid growth, rapid evaporation of water in consequence of sunshine and high temperature, and a soil which does not long retain its moisture, so that the Confervæ are not decomposed."

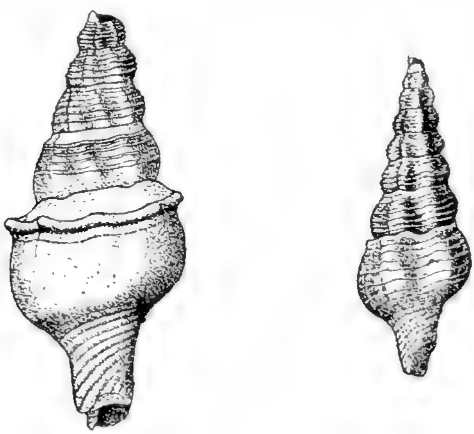
The condition described by Leunis resembles the one I have just observed in the fact that in both cases the alga is bleached and not decomposed. It differs from it, however, in the fact that in drying all activity is forced to cease, while the plant under consideration continues its existence in its normal medium ; and it is this, together with the fact that decomposition does not set in, which makes this condition of *Œdogonium* a very remarkable one.

A NEW SPECIES OF CLAVILITHES FROM THE EOCENE OF TEXAS.

BY C. W. JOHNSON AND A. W. GRABAU.

Clavilithes chamberlaini n. sp.

The spire of this species is long and slender, as in *C. kennedyanus* Harr., with which the early whorls of the shell agree pretty well. Only a portion of the protoconch has been observed, but it is apparently of the same character as that of the American species of this genus generally, unless more slender than the normal. The spire contains about seven ribbed whorls; the suture is moderately depressed; the ribs are swollen near the middle, but



become obsolete toward the suture; they are at first more than their width apart, but later become broader and the interspaces correspondingly narrower. A subsutural band occurs, and is quite strongly marked on the later ribbed whorls, indicating a pronounced posterior canal at this stage.

Spirals on the first five whorls, single, coarser in the centre, but becoming finer toward the sutures; interspiral spaces broader than the spirals. Intercalation of secondary spirals begins on the sixth whorl. On the seventh whorl the ribs become broad and ill defined, tending toward obsolescence. Before they have quite disappeared, a sutural shelf sloping somewhat outward and bordered by a slightly outward projecting margin appears; this very soon develops into a serrated flange. At the same time the whorls become almost smooth, the spirals usually only occurring on the narrowed anterior portion or canal of the body whorl. Length of the adult specimen figure 39 mm., diameter 18 mm.

This is a parallel species to *C. scalaris* Lam. of the Paris Basin (Calcaire Grossier) and *C. longævus* Sol. of the London Clays (Barton Beds). Compared with *C. humerosus* variety *texanus* Harris it has more ribs on the spire, which are more regular and bulging, stronger spirals and the well-marked serrated flange. It also differs somewhat in outline, the last whorl being broader than the corresponding one of *texanus*. It differs from its European parallels in many features, chief of which are the protoconch, the long-ribbed spire, the character of the sutural shelf and flange, and other points readily seen on comparison.

From the Lower Claibornian Eocene, Bald Mound, nine miles southeast of Jewett, Leon county, Tex.

Type No. 9,409, "Isaac Lea Collection of Eocene Mollusca," Academy of Natural Sciences of Philadelphia. This species is respectfully dedicated to Rev. L. T. Chamberlain, D.D., Curator of the Isaac Lea Collection.

DECEMBER 3.

The President, SAMUEL G. DIXON, M.D., in the Chair.

Ten persons present.

A paper entitled "A New Species of Ophibolus," by Arthur Erwin Brown, was presented for publication.

The death of Herman Strecker, a member, was announced.

Lodel Creek and Skippack Creek.—MR. BENJAMIN SMITH LYMAN remarked that on October 26, 1901, the Mineralogical and Geological Section of the Academy of Natural Sciences made an excursion to Fisher's quarry, some twenty yards south of Lodel creek (on the U. S. Geological Survey's topographical sheet incorrectly called Landis brook, which is really the name of the next stream to the north). The quarry is near a small highway bridge, one mile northwest of Grater's ford, on the Perkiomen railroad. The rockbeds of the quarry belong to the American New Red, and, as observed in 1889, at the time of the State Geological Survey, show the following section from above downwards:

Dark red, rather soft shales, about	5 feet.
Dark dull red, rather hard, thin-leaved shales, with fossil impressions and calcareous seams, about	4 "
In all, about	9 "

The shales are close within the upper limit of the beds marked on the State Geological map of Bucks and Montgomery counties as the Lansdale shales. They dip here 13° N. 30½° W. (true bearing).

The excursion party was so fortunate as to find a large slab of the stone of irregular shape, about five feet long by three feet wide and perhaps five inches thick, that proved to be particularly rich in interesting impressions. The whole of one side was covered with unusually perfect ripple marks, of about three-quarters of an inch in amplitude. In spite of the ripples, somewhat indistinct traces of two Dinosaur tracks, with three forward-pointing toes, could be discerned, each track about six inches in extreme length and about three inches in width. The two tracks are in line, and about twenty inches apart, centre to centre, evidently formed by one animal moving forward. The hinder track seems to have, at a couple of inches in front of it and a little to the right, a small track, as if of the forefoot of the same animal. The forward track is too near the edge of the slab to have that accompaniment. At twenty inches back of the foremost toe-point of the hinder track there appears at the other edge of the slab to be the toe-point of another track, and a couple of inches in front of it perhaps very indistinct traces of the small forefoot. Other less distinct footmarks can be perceived to the left of this principal line of tracks.

On lifting up the slab, however, it was found that the other side had, in the absence of ripple marks, the cast of a number of other Dinosaur tracks of about the same size, and likewise two or three in succession at the same distance apart, and more distinctly accompanied by the impression of the small forefoot. In addition there are a number of smaller tracks, about half an inch across, that appear to be the footmarks of Labyrinthodonts. A few other less perfect impressions of ripple marks, raindrops and footmarks were found by the party in other parts of the quarry.

At the meeting of the Section on October 28, Messrs. Woolman and Lyman were appointed a Committee to revisit the quarry, and, if possible, send the slab to the Academy for preservation, which was accordingly done on the 2d of November, Mr. Uselma C. Smith kindly aiding in the work. It was found, however, on arriving at the quarry, that the ripple marks had in great part been broken off from the slab by the members of the previous excursion party, and the best of the tracks also removed from the other side. Nevertheless, a number of tracks as well as a considerable extent of the ripple marks were still left, and the slab was taken. Another slab of equal surface and like shape was found, and on turning over, proved to be the mate of the other, and to have a complete and perfect cast of the ripple marks, as well as some similar tracks on the other side. The uninjured slab was also taken and sent to the Academy. Mr. Josiah H. Fisher, the owner of the quarry, readily and freely made a gift of the specimens, with admirable public spirit.

A couple of smaller slabs showed very good ripple marking. One of them, of irregular shape, about eleven inches long by nine wide, and half an inch thick, has, on one side, shallow ripple marks of about two and a half inches in amplitude; and, on the other side, ripple marks of about the same dimensions, but surmounted by what seem to be smaller ripple marks of about half an inch in amplitude, or perhaps rillmarks: but may possibly be very confused impressions of *Dendrophycus*. It appears, however, to be an interesting example of more than usually complicated ripple marking. The slab has also very perfect worm tracks, and several sun cracks. At the original examination of the quarry, in 1889, all the above-mentioned kinds of impressions were found, except the Dinosaur tracks; and, in addition, impressions of a plant were collected that may be a *Baiera*.

The excursion party of October 26 also, on the way home, visited a quarry on the roadside, on the southeast side of Skippack creek, about three-eighths of a mile southwest of the main road between Collegeville and Norristown, near a mill across the creek. The quarry is in dark red, hard, shaly sandrock of what is marked on the State Geological map of the two counties as Gwynedd shales, some 900 feet geologically below their top. The dip here is about 12° northwesterly. Here a large fossil Cycad leaf was found, about twenty-one inches long by eight inches wide. It is expected that this block will also be brought to the Academy. It may be, as Miss Walter suggests, *Pterophyllum spatulatum*.

The party thence proceeded southward to Eagleville, on the top of a hill of the Gwynedd shales. These comparatively hard dark shales all along their outcrop make prominent hills, with the lower lands formed on the southeast of them by the softer and in greater part red, but further south gray, Norristown shales, and on the northwest by the likewise softer and almost universally bright red Lansdale shales, succeeded northward by the harder and in great part greenish or blackish Perkasie shales, again with higher hills, and yet further north by the softer red Pottstown shales. This succession of beds of distinct character, with their outcrop of special topographical character extending throughout the two counties, all conforming uniformly to several variations of structure, with corresponding curves in the strike of the beds and everywhere with correspondence in the dips, and with no evidence whatever of any repetitions of the same sets of beds (except near the great Buckingham Mountain fault), is convincing proof that there is no overthrust fault parallel to the strike that could diminish the apparent total thickness of the beds. Such a fault, indeed, would have to be of wonderful shape, in conformity to a somewhat complicated folding of the beds. It is, moreover, in the highest degree improbable that such faults, the result of excessive horizontal pressure, with beds of great stiffness and cohesion, necessarily causing extremely steep and overturned dips, could occur in a region of gentle dips and mainly soft beds.

The foot tracks, ripple marks, raindrop impressions and sun cracks found at Fisher's quarry, the Cycad leaves and the raindrop impressions at the Skippack quarry, and other impressions and sun cracks at many other points in the New Red of this region, show clearly that the rocks were laid down in an estuary that was shallow through a great part of the process, if not throughout. There must have been submergence to correspond with the accumulating beds, and doubtless caused by their weight upon this portion of the earth's crust. As the sedimentary material has plainly come from both sides of the narrow estuary, the accumulated thickness of the beds must have been far greater, perhaps six times greater, than it would have been with equally far-reaching and rapid drainage on the single shore of an ocean where the sediments would be carried three times as far from land. This consideration may make belief in the thoroughly demonstrated great thickness of the New Red in Montgomery county a little easier to those, if any there be, who still fondly cling to the old purely conjectural estimates.

DECEMBER 10.

The President, SAMUEL G. DIXON, M.D., in the Chair.

Twelve persons present.

Papers under the following titles were presented for publication:

"Additions to the Japanese Land Snail Fauna, V," by Henry A. Pilsbry.

"Catalogue of the Clausiliidæ of the Japanese Empire," by Henry A. Pilsbry.

DECEMBER 17.

Mr. CHARLES MORRIS in the Chair.

Twelve persons present.

The deaths of William F. Norris, M.D., and Rush S. Huidekoper, M.D., members, were announced.

DECEMBER 24.

Mr. CHARLES MORRIS in the Chair.

Seven persons present.

Papers under the following titles were presented for publication:

"On the Common Brown Bats of Peninsular Florida and Southern California," by S. N. Rhoads.

"New Land Mollusca of the Japanese Empire," by Henry A. Pilsbry.

"Description of New Helicoid Land Shells from Japan," by G. K. Gude.

The death of Edward Lewis, a member, was announced.

DECEMBER 26.

The President, SAMUEL G. DIXON, M.D., in the Chair.

Twenty-three persons present.

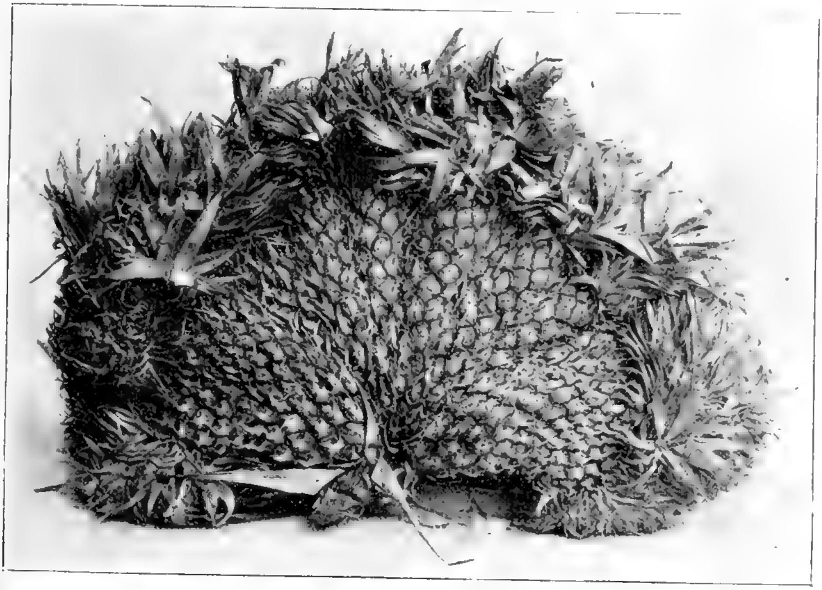
New Year's Eve (December 31) falling on Tuesday, the meeting, under the By-Laws, was held on the preceding Thursday.

The following were ordered to be printed:

COCKSCOMB FASCIATION OF PINEAPPLES.

BY JOHN W. HARSHBERGER, PH.D.

A remarkable case of fasciation, probably one of the most striking of that teratological condition known to botanists, is one recently found by the writer in the pineapple, *Ananassa sativa*. The fruit of the pineapple plant is a multiple one, formed from many spicately arranged flowers and their bracts consolidated into one mass upon a succulent, fleshy axis. Ordinarily, only a single, conical fruit with its tuft of green, sterile, bract leaves is borne at the summit of the plant, surrounded at the base by the large, leathery, awl-pointed, spirally-arranged, sword-shaped, vegetative leaves. In teratological specimens, shipped to Philadelphia from Jamaica and displayed in the windows of prominent fruiterers, several pineapples produced on a single plant were found united by congenital growth into a fan-like mass. One of the most



striking of these, presented to the writer by Henry Hallowell & Son, was an almost completely open fan, the individual fruits being arranged in a semicircular manner, as shown in the accompanying figure, reproduced from a photograph of one of the largest fasciated specimens. These fasciated pineapples, known to the trade as "Freak" or "Cockscomb Pineapples," seem to be not at all uncommon. Henry Hallowell & Son had at least a dozen or more specimens, besides the one presented to the writer. The smallest of these consisted of two united pineapples, and the largest (twenty inches across, twelve inches high) showed the union of a dozen or more. The fasciated fruits in nearly all instances were arranged regularly side by side; in some illustrations, however, one or two fruits crowded out of the fan-shaped mass during growth projected in several directions, so that the combined mass consisted of an irregularly disposed row of united pineapples. A stem, one to two inches in diameter, common to all of the united fruits, was present in all the cases examined.

Apparently from a count of the more concave, flat side of the monstrosity shown in the plate, there were ten pineapples united together, as outlined by the deep grooves which ran between them. On the other, more convex face, twelve united masses were discernible, all arising from a common stalk one and a half inches in diameter, with a number of lanceolate, involucral leaves about six to eight inches long at the base of the clustered fruits. A count, however, of the tufts of crown leaves would indicate, if each fruit in the bunch had only one crown tuft, that many more fruits than ten or twelve were aggregated together. The coronal tufts of leaves form a continuous growth over the entire top of the fasciation, as shown in the plate. It was difficult to count the tufts therefore, on account of their massing together, but the most careful count possible under the circumstances gave fifty tufts as the result of the enumeration. It seemed hardly likely, however, that the fasciated mass consisted of that many fruits, and to decide the matter a section was made through the monstrosity by means of a saw, and such a section showed twenty distinct upward projecting divisions of the fleshy fasciation. Whether each division represented a fruit, it was not possible to determine by the examination.

The monstrosity, which had a pleasant pineapple aroma, was succulent, but very fibrous, with many fibres radiating from the common stalk and running to the semicircular summit of the edible mass. The flavor was quite good, although the specimens tried lacked the juiciness of the finer Ripley pines, and reminded one of the taste of the inferior grades of Cowboy pineapples raised in Jamaica and consumed by the negroes of that island.

The ripened individual flowers of the fasciated pineapples were apparently normal, consisting of the succulent inferior ovary, succulent sepals and fleshy base of the subtending bract. The succulent, diamond-shaped floral masses were flattened laterally, or became mere vestigial structures, wherever they had been pressed together by the union of the pineapples of which the monstrosity was composed.

One is tempted to theorize with these unique specimens taken into consideration, for fasciation appears in plants subjected to conditions of nourishment above the normal, occasionally as a result of disease or injury. Did these factors influence the production of fasciated pineapples in Jamaica? Who can say!

A NEW SPECIES OF OPHIBOLUS FROM WESTERN TEXAS.

BY ARTHUR ERWIN BROWN.

Ophibolus alternus sp. nov. Plate XXXIV.

Maxillary teeth 13; mandibular 14–15. Body moderately slender; head distinct, muzzle contracted; eye rather large. Rostral low and broad, barely visible from above; internasals about half the length of prefrontals; frontal a little longer than the suture between parietals, longer than the snout; parietals large, wide in front, narrow behind; nasals 2, the nostril between them; loreal small, longer than high; preocular 1; postoculars, 2 on one side, 3 on the other; temporals, 2–3 on one side, 3–4 on the other; upper labials 7, third and fourth in orbit; lower labials 11. Posterior chin shields a little shorter than the anterior, not separated by scales. Scales smooth, with two inconspicuous pits, in 25 rows. Ventrals 217; anal entire; subcaudals 60 pairs. Total length 710 mm. (tail 115).

The ground color is slate gray, crossed on the back, at intervals of 3 to 5 scales, by bands of black which are alternately wider and narrower, the wide ones covering from 2 to 3 scales on the middle of the back, and more or less divided transversely on their centres with scarlet. The narrow bands are about one scale wide and wholly black, occasionally broken through by the ground color. On the neck the bands are narrower and less defined, while the red is more pronounced on the posterior part of the body. There are nineteen red and black bands on the body, and an equal number of the intermediate black ones. On the tail there are 5 bands, which form quite distinct rings, on the last two of which the red is absent. The head, including the labials, is dark gray with small dark mottlings, not well defined, and a narrow black streak from the postoculars to the angle of the mouth. Ventral surface grayish white, heavily blotched with black, into which the black portion of the cross bands runs.

Type, No. 14,977 Academy Coll. From the Davis Mountains, Jeff Davis county, Texas. Collected by E. Meyenberg.

The snake here described was received alive at the Zoological Gardens, on October 22, and came from the same locality and collector as the lately described *Coluber subocularis*. In proportions and scale formula it comes nearest to *O. zonatus* Blain. (= *O. pyrrhomelas* Cope), but the head is narrower, the snout more contracted and there are two more rows of scales, while the peculiar disposition of the dorsal cross bands is quite unlike any *Ophibolus* previously known. The species is perhaps intermediate between *O. zonatus* and *O. leonis* Gunth., the type of which came from Nuevo Leon, Mexico.

NEW LAND MOLLUSCA OF THE JAPANESE EMPIRE.

BY HENRY A. PILSBRY.

Eulota (Ægista) aperta var. **trachyderma** Pils. and Gude, nov.

Resembling *E. aperta* in general characters, but smaller, more depressed, less distinctly angular at the periphery in front; whorls $5\frac{1}{2}$ to $5\frac{3}{4}$; base a little more widely umbilicate. Surface densely clothed with short, crowded, thread-like cuticular processes, visible only under a lens, and in large part rubbed off of most specimens. Peristome thin, expanded, narrowly reflexed below.

Alt. $6\frac{3}{4}$, diam. 12 mm.

Alt. 5, diam $10\frac{1}{2}$ mm.

Ikoma, Kii. Types No. 82,464, Coll. A. N. S. P, from No. 787 of Mr. Hirase's collection.

Eulota (Euhadra) luhuana var. **pachya** nov.

A fossil form characterized by the thickness of the large shell, the somewhat swollen latter third of the base, which is also swollen immediately around the umbilicus. The peristome is very thick and heavy, especially along the columellar margin. Traces of a reddish band above the periphery, and copious opaque-white streaks and flecks are visible on some specimens. The type measures, alt. 23, diam. 46 mm.

Kikai-ga-shima, Oshima group, Osumi. Types No. 81,921, Coll. A. N. S. P., from No. 682 of Mr. Hirase's collection.

Eulota luhuana var. **nesiotica** nov.

In this race the shell is rather small, comparatively smooth and glossy, with slightly flattened base, passing into the umbilicus in a regular curve, not in the least angular. Umbilicus much smaller than in any other known form of *luhuana*, rapidly contracting within. Yellow, either uniform or with reddish-brown bands according to the formulæ 00300, 00340, 00345.

Alt. $22\frac{1}{2}$, diam. 35, diam. of umbilicus 3 mm.; whorls $6\frac{1}{3}$.

Alt. $20\frac{1}{2}$, diam. $30\frac{1}{2}$, diam. of umbilicus $2\frac{2}{3}$ mm.; whorls 6.

Tane-ga-shima, Osumi (Mr. Y. Hirase, No. 73*b*).

The absence of any trace of angulation around the umbilicus, and the small size of the latter, give this race an appearance of distinctness.

Clausilia ducalis Kobelt.

This magnificent species was described from a specimen of unknown locality further than the indefinite "interior of Nippon" which served as habitat for Rein's Japanese collection. The type is described as yellowish horn-colored, and 36 mm. long, 8 wide, the aperture 9 mm. long. Mr. Hirase has lately sent specimens from Miya-mura, in Hida Province, which agree with *ducalis* in the brilliant gloss and large apex, but have the last two whorls dark vinaceous-brown, with a yellow sutural border and sprinkled with fine yellow dots; the two next earlier whorls are rather bright yellow, still earlier ones are worn.

Length $32\frac{1}{2}$ to $34\frac{1}{2}$, diam. 8 mm.

It is a magnificent species.

At Kiyomi-mura, Hida, an interesting variety occurs, the shell being longer and narrower, less glossy, the surface more striate, last whorl more cylindric. Color light olivaceous yellow.

Length 35, diam. $6\frac{1}{2}$ mm.; whorls $11\frac{1}{2}$.

This race I call var. *dorcas*. Some specimens are shorter, length $28\frac{1}{2}$, diam. $6\frac{1}{2}$ mm.; whorls 10.

Truncatella kiusiuensis n. sp.

Shell nearly cylindric, slightly tapering, pale red, composed of $4\frac{1}{2}$ whorls, the upper one truncate and plugged. Sculpture of strong, regular, nearly straight ribs, about 20 on the last whorl. There is *a high, narrow rib* behind the outer and basal lips, and a rounded rib or prominence around the umbilical region. Aperture oval; the inner lip covered with a heavy callus.

Alt. 7, diam. 2.6 mm.

Hirado, Hizen (Mr. Y. Hirase, No. 844*a*). Also Tane-ga-shima (Hirase, No. 811*c*).

This is one of the few Old World species of *Truncatella* in which there is a rib or crest behind the lip. It differs in this respect from *T. valida* Pfr., which is found in Okinawa or Riukiu Island. The latter is also larger and has more numerous, smaller ribs.

Truncatella Pfeifferi Martens is the only species of the genus hitherto reported from Japan. It was described from a specimen or specimens in the Leyden Museum, collected by Siebold, and bearing the locality "Japan." It has not been figured, but from the description it differs from *T. kiusiuensis* in being shorter and wider, with the ribs disappearing on the last whorl. No crest or rib behind the lip is mentioned.

DESCRIPTIONS OF NEW HELICOID LAND SHELLS FROM JAPAN.

BY G. K. GUDE.

Chloritis (Trichochlorites) pumila n. sp.

Shell imperforate, depressed, dark corneous. Spire flat, apex obtuse, suture impressed. Whorls 4¼, convex, increasing slowly at first, the last widening rapidly; very densely covered with very short bristles, arranged in oblique rows. Last whorl scarcely descending in front, inflated below. Aperture a little oblique, rounded lunate, peristome thin, straight; margins distant, united by a thin callus on the parietal wall. Columellar margin dilated above, completely covering the umbilicus.

Diam. maj. 12, minor 10.5; alt. 9 mm.

Hab.—Mikuriya, Suruga (Hirase, No. 735). Type in my collection.

This makes the third species of *Chloritis* recorded from Japan. It differs from both *C. oscitans* and *C. fragilis* by its smaller size, by the completely covered umbilicus and by the bristles being shorter, stiffer and much more crowded. In the shape of aperture it is nearest to *C. oscitans*.

Eulota (Ægista) mimuloides n. sp.

Shell rather narrowly umbilicated, depressed conoid, ruddy corneous, paler below. Spire depressed, apex obtuse, suture linear. Whorls 5, closely coiled, increasing very slowly, somewhat flattened above, rounded below, with a thin deciduous cuticle, which is densely covered with short silky processes, like adnate hairs. The last whorl angulated at the periphery, scarcely descending in front. Aperture oblique, subcircular, peristome not thickened, a little expanded; margins distant, columellar a little dilated above. Umbilicus rather narrow.

Diam. 7.5, alt. 4.25 mm.

Hab.—Itanami, Omi (Hirase, No. 753).

Allied to *Ægista mimula*, but it is smaller, the spire is more depressed, the whorls are more closely coiled, the last is less ample, the umbilicus narrower, and the cuticular processes are more crowded and smaller.

ON THE COMMON BROWN BATS OF PENINSULAR FLORIDA AND SOUTHERN CALIFORNIA.

BY S. N. RHOADS.

Examination of a series of skins and skulls and alcoholic specimens of the Florida Brown Bat, in the author's collection and in the museum of the Academy of Natural Sciences of Philadelphia, shows constant racial differences from typical *Eptesicus fuscus* of Philadelphia county. These differences are similar and in the same degree and direction as those separating the two forms of Red Bat inhabiting the regions named. The Florida race may be distinguished as follows:

Eptesicus fuscus osceola subsp. nova.

Type No. 875, ad. ♂, in Coll. of S. N. Rhoads. Taken April 29, 1892, at Tarpon Springs, Fla., by W. S. Dickinson.

Description.—Similar in size and cranial characters to *fuscus;* colors deeper and darker, being of slightly varying shades of *cinnamon* brown as contrasted with the bistre and sepia of *fuscus.* This character is uniform in a series of eight dry skins which have never been immersed in a liquid preservative, and is peculiar to them in a comparison with a similar series of fifteen topotypes of *fuscus.*

Measurements of type, made by collector from fresh specimen: Total length 101 mm.; tail 38 mm.; hind foot $9\frac{1}{2}$ mm. Average measurements of four topotypes, 113–44–10.6.

The skull of type indicates it to be an old adult, quite as large as adult skulls of *fuscus,* but the measurements given by the collector are less than a normal average. This average corresponds closely with that of ten specimens of *fuscus* from Sing Sing, N. Y., as given in Miller's monograph of North American *Vespertilionidæ.*

Whether this subspecies is found outside the limits of peninsular Florida I am unable to state. As Miller classes the *Eptesicus* from Alabama, Georgia and Mississippi examined by him under *fuscus,* I conclude that *V. caroliniensis* of Geoffroy cannot apply to the Florida race.

In Miller's monograph, above cited, all the California *Eptesicus* examined by him are classed under *fuscus*. A specimen in the author's collection from the San Bernardino Valley, near San Bernardino, indicates a phase of coloration separating it from typical *fuscus*, in a manner such as might be reasonably predicted by any one having a knowledge of the climatic effect of this locality upon other mammals thus living on the outskirts of the Mojave Desert region. It is quite probable that Mr. Herron collected this specimen on his ranch, a few miles west of San Bernardino, or in one of his eastern trips into the edge of the desert. The exact locality is not stated on the label. The specimen may be thus characterized:

Eptesicus fuscus bernardinus subsp. nova.

Type No. 1,247, ad. ♂, Coll. of S. N. Rhoads. Taken by R. B. Herron, May 26, 1893, in the "San Bernardino Valley" (near San Bernardino), Cal.

Description.—Size and cranial characters as in *Eptesicus fuscus typicus.*

Color.—Pallid bistre above, brownish drab below; the hairs below being unicolor nearly to their roots, and those above darkening slightly only in the basilar fourth of their length. In *fuscus* the upper body hairs are darkly sooty for more than half their basilar length, the brown tips not concealing the dark under-fur. Wing membranes and ears in *bernardinus* very dark.

Measurements of type: Total length 114 mm.; tail 51 mm.; hind foot ?; alar extent 304 mm. These measurements were made by the collector before skinning the specimen.

A series of four specimens from the same collector taken in the "San Bernardino Mts." in September, 1893, shows that the mountain form is inseparable from *fuscus*; one of these, however, is a perfect intergrade. *Bernardinus* differs from *peninsulæ*, O. Thomas, from southern Lower California, in its large size; *peninsulæ* appearing to be a distinct species.

MYCTOPHUM PHENGODES IN THE NORTH ATLANTIC.

BY HENRY W. FOWLER.

Myctophum phengodes (Lütken).

S.[copelus] phengodes Lütken, Kongel. Dansk. Vidensk. Selsk. Skrift. (København), 6e Ræke, VII (1890–94), 1892, p. 253, fig. 11.

No. 7,987. From the Atlantic Ocean, in 60° N. Lat., between Greenland and North America. Dr. I. I. Hayes.

Form of the body of the fish elongate and compressed, and much as in Goode and Bean's figure (No. 84) of *Myctophum remiger.* The greatest depth of the body is about the pectoral region, and it is contained in the body (excluding caudal) about 4 times.

The head is rather large and about $3\frac{3}{4}$ times in the body (without caudal), blunt and compressed. Eyes large and anterior in position, about $2\frac{1}{2}$ in the head, and while less than the greatest posterior part of the interorbital region they are larger than the least, or anterior, width of the same. Mouth large, the distal expanded extremity of the maxillary posterior to the eye for nearly the length of the snout, and the mouth-cleft itself occupies $\frac{2}{3}$ the length of the head. Margin of the preoperculum slopes slightly posteriorly and forms a slightly convex curve which bulges posteriorly. Nostrils directly anterior to the eye and placed laterally upon the blunt snout. Pseudobranchiæ large. Gill-rakers long and slender upon the first arch, some longer than the gill-filaments. Tongue narrow, knobbed, and free anteriorly. Minute villose teeth upon the jaws.

Origin of the D. nearer the tip of the snout than the base of the caudal. Base of D. a little more than $\frac{1}{2}$ the base of the A. Base of last D. ray over the origin of the A. The P. are long and pointed, and with their tips extending nearly to the anus and almost to the medio-lateral photophores. Origin of the V. a little anterior to the origin of the D. and the tips of the fin extending to the origin of the A. Adipose D. a little nearer the base of the caudal than the base of the last D. ray, though the posterior margin of its own posterior moiety is anterior to the base of the last

A. ray. The least depth of the caudal peduncle is equal to the anterior interorbital region.

The photophores are as follows: 3 mandibulars on each side of the mandibles; 2 operculars near the lower part of the margin of the preoperculum; 5 thoracic on each side; 4 ventrals on each side; 8 anals, a gap, then 9 more, in all 17 on each side; 3 pectorals on each side; 1 antero-lateral on each side a little posterior, though above, the bases of the V., but nearer to the latter than to the lateral line; 3 medio-laterals on each side, forming an oblique series on each side, the lower a little anterior to the last ventral photophores, and the uppermost immediately below the lateral line and in advance of the first anal photophore; a single photophore, the postero-lateral, almost on the lateral line and above and anterior to the eighth anal photophore; 2 caudals upon each side inferiorly, and a single supercaudal at the origin of the rudimentary caudal rays. The caudal, though somewhat damaged, was forked, the lobes most likely rounded, and the lower a trifle the larger. The lateral line consists of a single well-developed pore on each scale of its course, which is superior, and parallel with the dorsal profile of the back. Scales 42 (?). Radii of D. 12. Radii of A. 22.

My first impression was to regard this specimen as *Myctophum remiger* Goode and Bean, but a careful examination has revealed the facts mentioned above; and if, as Goode and Bean contended, "the arrangement of the luminous spot is of the greatest value in the classification of these fishes," there can be no reasonable doubt that it is Lütken's *Scopelus phengodes.*

Although the localities where Lütken obtained his examples were all in southern latitudes, and very remote from that where the present example was taken, I identify it with the above species without any hesitation, as it agrees perfectly with the essential characters given. Specimens from widely remote localities in the case of deep-sea and oceanic fishes do not always necessarily form a barrier to their identity as one and the same species.

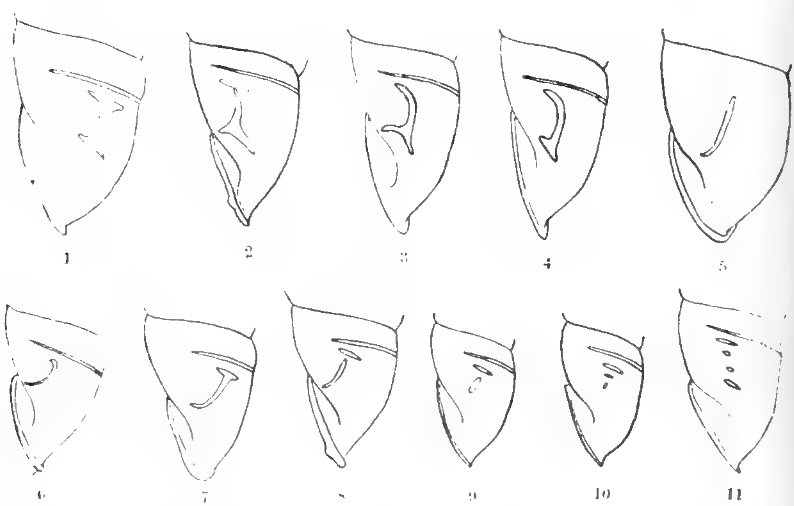
That *M. phengodes* and *M. remiger* are allied is also evident by their long P., the large eye and shape of the head, as seen on comparison with an example of the latter species.

The example described above is in the collection of the Academy of Natural Sciences of Philadelphia. It po ssesses a median infero-caudal photophore.

ADDITIONS TO THE JAPANESE LAND SNAIL FAUNA.—V.

BY HENRY A. PILSBRY.

The description of Japanese *Clausiliidæ* is resumed in the present paper. Enough material is now at hand to permit some work looking beyond merely descriptive treatment, while every sending from Mr. Hirase adds to the data on one or another of the problems presented by these intricately constructed creatures. I have below considered the evolution of the "lunella," as shown in some newly discovered species of *Stereophædusa*, in which young shells show a series of distinct palatal folds, like the European tertiary *Clausiliidæ* and the more primitive forms of Eastern Asia, while old shells have a true lunella. A similar transformation has likewise been observed in a *Megalophædusa* just received. The evidence indicates that the lunella has been independently acquired, in different phyla, by a process of parallel evolution.



Diagrams showing chief modifications of the palatal armature in *Hemiphædusa*: Fig. 1, *C. aulacophora*; fig. 2, *C. crenilabium*; fig. 3, *C. attrita*; fig. 4, *C. hakonensis*; fig. 5, *C. hyperolia*; fig. 6, *C. shikokuensis*; fig. 7, *C. perignobilis*; fig. 8, *C. munus*; fig. 9, *C. micropeas*; fig. 11, *C. gracilispira*.

I must again express my deep obligation for material to Mr. Y. Hirase, of Kyoto, Japan. His tireless researches, critical eye for detecting species, and exactness in recording localities are worthy of high commendation. Without these qualities the new and relatively exact literature of Japanese land mollusks would not exist.

Section HEMIPHÆDUSA Boettger.

The system of groups set forth by Dr. Boettger in the *Clausilienstudien*, while sufficient at that time, is quite inadequate for the classification of the great number of Chinese and Japanese species now known. For Japanese species my studies lead me to adopt the arrangement offered below. The clausilium in all the groups is rounded or tapering at the end, and not thickened or only slightly so.

a.—Inferior lamella spirally ascending within, visible in a front view, receding less deeply than in other *Hemiphædusæ;* shell rather large; superior lamella continuous with the spiral.

b.—Interlamellar space corrugated; lunella united to the middle of a lower palatal plica, contiguous to or united with an upper palatal plica near the middle (fig. 2). Clausilium tapering below, recurved and spoutlike at the apex, ... *Group of C. ptychochila.*

b[1].—Interlamellar space smooth; lunella curving inward above, united below to the middle of the lower palatal plica (figs. 3, 4). Clausilium narrowly tongue-shaped, *Group of C. platyauchen.*

a[1].—Inferior lamella receding, inconspicuous or not visible in a front view.

b.—Several palatal plicæ; no lunella (fig. 11), *Group of C. validiuscula.*

b[1].—A short or rudimentary lunella below one or two palatal plicæ; no lower palatal plica (figs. 9, 10), *Group of C. sublunellata.*

b[2].—A lunella developed.

c.—No palatal plicæ; plica principalis subobsolete or wanting; superior lamella separated from the spiral lamella (fig. 5), . *Group of C. hyperolia.*

c[1].—Superior continuous with the spiral lamella; principal plica well developed; an upper palatal plica present. Clausilium *curved*, concave on the inner face.

d.—Lunella bow-shaped (fig. 6) or J-shaped (fig. 7), united to the upper palatal plica, curved inward below; superior and spiral lamellæ united, *Group of C. awajiensis.*

d^2.—Lunella slightly curving inward below, not united above with the upper palatal plica (fig. 8). Clausilium rapidly tapering to the mucronate apex, ... *Group of C. munus.*

d^1.—Lunella straight, joined to the middle of the upper and lower palatal plicæ, like the letter I (fig. 1), . . . *Group of C. aulacophora.*

c^2.—Superior and spiral lamellæ contiguous or separated; lunella curving inward below, joining the short palatal plica above. Clausilium unusually straight and flat, rounded at the apex, *Group of C. Pinto.*

A somewhat different sequence of groups would result from using the characters of the clausilium for the primary divisions, but while probably more natural, such an arrangement would be more difficult in practical use. The clausilium is variously specialized in the groups of *C. ptychochila, C. munus* and *C. Pinto,* much alike in the other groups. The only species, so far as I know, not provided for in the above key is *C. platydera,* which belongs without doubt to the *platyauchen* group, but has the receding and straightened inferior lamella of the other division; but there are also some forms partially intermediate between the groups of *C. validiuscula, C. sublunellata* and *C. aulacophora,* and further knowledge will doubtless reveal various other intermediate species. The group of *C. validiuscula* is probably a composite one.

Group of C. sublunellata.

Clausilia sericina var. **rhopalia** nov.

Shell rimate, fusiform, rather obese below, the upper half attenuated; pale yellow; very finely striate throughout, the sculpture not coarser on the last whorl. Outlines concave above, the apex obtuse. Whorls 10, moderately convex, the last compressed laterally. Aperture ovate, somewhat oblique; peristome continuous, white, reflexed and thickened, the upper margin in contact with preceding whorl. Superior lamella oblique, marginal, continuous with the spiral lamella which ascends to the middle of the ventral side. Inferior lamella thick and forming a rather conspicuous fold deep in the aperture, straightly ascending within, and penetrating as far as the spiral lamella. Subcolumellar lamella deeply immersed, terminating about a half whorl within. Principal plica visible deep in the throat, ascending to a lateral position. Upper palatal plica narrow, oblique, lateral, well separated from the straight, oblique, low and narrow lunella. Lower palatal plica subobsolete or wanting.

Length 18.3, diam. 4.3 mm.

Length 17, diam. 4.3 mm.

Clausilium very narrow, parallel-sided, a little excised on the palatal side of the apex.

Mikuriya, Suruga. Types No. 82,298 Coll. A. N. S. P., from No. 736*b* of Mr. Hirase's collection.

This somewhat club-shaped form is noticeable for its fine striation and pale color. The narrow lunella is longer than in other species of the group which I have seen. *C. sericina*, which has not been figured nor very fully described, seems to be its nearest relative.

Group of C. awajiensis.

This group comprises *Hemiphædusæ* in which the lateral or latero-dorsal lunella is J-shaped or bow-shaped, its upper end being united to the middle, or sometimes to the lower end, of a short upper palatal plica, the lower end curving inward. The clausilium is typical of *Hemiphædusa*, being parallel-sided, not oblique or thickened at the distal end, and usually it is emarginate on the columellar side of the filament.

The species are numerous on Shikoku Island, and will probably prove difficult to limit when more localities are explored and further slightly differentiated races come to light. Others are known from Awaji, western Nippon and Kiushiu. None have come to my hands from middle or northern Nippon, or from Yesso.

Species with J-shaped lunella: *C. awajiensis* Pils., *C. perignobilis* and var. *kochiensis* Pils., *C. ischna* and var. *neptis* Pils., *C. subaurantiaca* Pils., *C. harimensis* Pils. and *C. higoensis* Pils.

Species with bow-shaped lunella: *C. ignobilis* Sykes, *C. shikokuensis* Pils.

Clausilia higoensis Pilsbry. Pl. XXXV, figs. 1, 2, 3, 4.

Pilsbry, these *Proceedings* for 1901, p. 499 (October 2, 1901).

Distinct by its inflated shell, attenuated above, and with a more or less developed wave or crest behind the outer lip. In some specimens this is strongly developed (Pl. XXXV, fig. 3), much as in

C. oxycyma; in others (fig. 4) it is hardly noticeable; but there are intermediate specimens.

The type locality is not Midumate, as at first announced, but Minamata, Higo. The specimens figured are from that place. Perfectly similar forms have been sent from Togo, Satsuma, No. 760 of Mr. Hirase's collection.

Clausilia ischna Pilsbry. Pl. XXXV, figs. 15, 16.

Pilsbry, these *Proceedings* for 1901, Vol. LIII, p. 500 (October 2, 1901).

Shell rimate, fusiform, *very slender, the length about five times the diameter*, attenuated above, brown or pale brown, somewhat glossy, finely striate, more coarsely so behind the lip. Whorls 11½, moderately convex, the last somewhat flattened above, having a low swelling some distance behind the lip, a little produced forward. Aperture piriform, small, slightly oblique. Superior lamella rather strong, marginal, slightly oblique, continuous with the spiral lamella. Inferior lamella receding, not visible in a front view, but in oblique view seen to be quite strong; straightly ascending within the last whorl, and giving off a distinct branch toward the spiral lamella; its spiral portion weak, shorter and much lower than the spiral lamella, reaching inward to a ventra position. Subcolumellar lamella deeply immersed, its lower end barely visible or not visible within the aperture. Principal plica visible in the throat, extending inward a little past a lateral position. Lunella lateral, straight and joining the middle of a very short upper palatal plica above, curving strongly inward below. Peristome reflexed, continuous, emarginate at the termination of the superior lamella.

Clausilium long and parallel-sided, deeply emarginate on the columellar side of the filament.

Length 16.5, diam. 3.3, length of aperture 3 mm.

Length 15.7, diam. 3 mm.

Kochi, Tosa, Shikoku Island (Mr. Y. Hirase, No. 657*a*). Types No. 81,580 Coll. A. N. S. P.

The somewhat stouter, paler var. *neptis* is similar to *C. ischna* internally.

This species is more slender than any other known member of the group of *C. awajiensis*, and has more whorls. The closing apparatus is similar to that of several other species of the group. It differs from *C. subaurantiaca* from Deyai, Nagato, in the following respects: The surface is more coarsely striate; the last whorl does not have a convex belt above the position of the principal plica, and has more of a swelling on its latter portion; the spire has one more whorl. It remains to be seen whether intergrades exist between this species from Shikoku and *subaurantiaca* from the Province of Nagato in western Nippon. They are certainly closely related.

Group of C. Pinto.

Small, solid *Hemiphædusæ* with the clausilium unusually straight and flat, rounded or a little tapering at the apex, abruptly bent near the filament and emarginate or excised on the columellar side thereof. Superior lamella contiguous to or separated from the spiral lamella, which is short, barely reaching the ventral side. Inferior lamella deeply receding, straightened and strong inside.

This group has some affinity to *Zaptyx* in both shell and clausilium, but it has not the accessory lamellæ and plicæ of that section. It is not closely related to other Hemiphædusan groups.

Two species, from the islands Tane-ga-shima and Yaku-shima, are known: *C. Pinto*, in which the last whorl is normal, and *C. ptychocyma*, which has a wave or crest and several strong wrinkles behind the outer lip.

Clausilia Pinto Pilsbry. Pl. XXXV, figs. 12, 13, 14.

Pilsbry, these *Proceedings*, Vol. LIII, p. 501 (October 2, 1901).

Shell very small, fusiform, solid and strong, flesh-colored, weakly marked with slight growth-wrinkles, eroded in irregular spots. Spire regularly tapering to a rather small apex. Whorls about 8, the last without crest or other conspicuous sculpture behind the lip. Aperture small, squarish-ovate, the lip somewhat reflexed, very thick, white, hardly free above. Superior lamella marginal, contiguous to the spiral lamella, which penetrates barely to the ventral side. Inferior lamella very deeply receding, high and stout within the last whorl, subvertically ascending, a trifle sinuous, extending inward as far as the spiral lamella. Subcolumellar lamella emerging. Principal plica less than a half whorl long, extending shortly beyond the lunella. Lunella lateral, straight and joining a short upper palatal plica above, curving well inward and ending in a slight nodule below.

Length 9.5, diam. 2.6 mm.

Length 8.5, diam. 2.3 mm.

Clausilium (Pl. XXXV, fig. 13) remarkably straight, rounded at the apex, abruptly bent near the filament, and very deeply excised on the columellar side of the latter.

Tane-ga-shima, Osumi, in the northeastern group of the Riukiu Islands. Types No. 82,553 Coll. A. N. S. P., from No. 663 of Mr. Hirase's collection.

A smaller species than *C. ptychocyma*, with the last whorl plain and normal, not strongly sculptured, as *C. ptychocyma* is. The solid, smoothish shell, short spiral and columellar lamellæ, and peculiarly flat clausilium are the same in both species.

At the time I wrote a preliminary account of the Tane-ga-shima and Yaku-shima snails these points of relationship were not appreciated, and I took a wrong view of the affinities of *C. pinta*.

Clausilia ptychocyma Pilsbry. Pl. XXXV, figs. 7, 8, 9.

Pilsbry, these *Proceedings* for 1901, Vol. LIII, p. 501 (October 2).

Shell obesely fusiform, rather acutely tapering above, buff or in part pale reddish, extremely solid and thick, weakly striate, almost smooth. Whorls 9, the latter part of the last whorl having a strong wave or crest, accompanied by several smaller but strong wrinkles, behind and parallel to the outer lip. Aperture small, squarish-ovate, the peristome slightly expanded, thick, hardly free above. Superior lamella low and small but stout, separated from the spiral lamella, which runs inward barely to the ventral side. Inferior lamella very deeply receding, strong and obliquely ascending inside, penetrating as far as the spiral lamella. Subcolumellar lamella immersed, its lower end visible in an oblique view in the aperture, sometimes very weakly emerging. Principal plica rather short, visible deep in the throat and extending shortly past the lunella. Lunella lateral, weak, straight above, curving inward below and joining or contiguous to a very short, nodule-like lower palatal plica.

Length 11, diam. 3 mm.

Clausilium (Pl. XXXV, fig. 10) parallel-sided, remarkably straight in profile, tapering on both sides and slightly acuminate below, excised on the columellar side of the filament.

Tane-ga-shima, Osumi. Types No. 81,932, Coll. A. N. S. P., from No. 664*a* of Mr Hirase's collection.

An exceedingly solid little Clausilia, quite unlike *C. tanegashima* in its immersed or nearly immersed subcolumellar lamella, and especially in the clausilium, which is unusually straight and not in the least oblique at the apex.

Clausilia ptychocyma var. **yakushimæ** Pilsbry. Pl. XXXV, fig. 11.
Pilsbry, *l. c.*

Yaku-shima, Osumi. Types No. 81,934 Coll. A. N. S. P., from No. 664*b* of Mr. Hirase's collection.

Section TYRANNOPHÆDUSA Pilsbry.

Clausilium obliquely truncate distally, the columellar side of the apex slanting, strongly thickened along the inner face. Shell having the superior and spiral lamellæ contiguous or separated, the inferior lamella deeply receding, straight or obliquely ascending inside; spiral and columellar lamella usually continued within past the ventral side; lunella united to both upper and lower palatal plicæ or separated from the upper plica, usually latero-ventral or ventral in position. Type *C. mikado* Pils.

The characters of this section were only imperfectly perceived when it was originally proposed last year. Further investigation shows it to be quite distinct from *Hemiphædusa* (which resembles it in the receding inferior lamella), by the oblique and thickened end of the clausilium. Moreover, the lamellæ extend further inward, the closing apparatus retreats more deeply; there is often a crest on the neck parallel to the outer lip, and in some species the lip is plicate in the subcolumellar region, and there may be interlamellar folds.

The section includes three groups of species, distinguished as follows:

a.—A strong crest behind the outer lip, *Group of C. tanegashimæ.*
a[1].—No distinct crest.
  b.—Lunella curving inward above (concrescent with the outer end of the upper palatal plica), *Group of C. bilabrata.*
  b[1].—Lunella straight; together with the palatal plicæ forming an I-shaped barrier, or separated from the upper palatal plica, ... *Group of C. mikado.*

Group of C. bilabrata.

Tyrannophædusæ of ordinary form, with the clausilium oblique and thickened at the apex, excised on the columellar side of the filament. Superior and spiral lamellæ separated or nearly so, the spiral and inferior extending inward to or past the ventral side.

Inferior lamella obliquely or somewhat spirally ascending within. Subcolumellar lamella emerging, usually in a group of lip-folds.

Lunella ventral or lateral, rather straight above, united below to a lower palatal plica. No upper palatal plica.

The oblique end of the clausilium, disconnected superior and spiral lamellæ, and frequent development of a group of lip-folds are the chief characters of this group. It differs from the *mikado* group by the absence of an upper palatal plica and the discontinuous superior and spiral lamellæ. The plication of the lip in the region of the inferior and subcolumellar lamellæ varies from strongly developed to obsolete in each of the species known among individuals from most localities.

a.—Peristome notched on the left side of the superior lamella. Shell obese below, the upper, attenuated portion thick, apical whorl large; length about 15 mm., . *C. surugensis.*

*a*¹.—Peristome not notched or emarginate near the superior lamella.

b.—Early whorls almost always self-amputated in adults. Length 17–25 mm., dependent upon the number of whorls retained, as well as upon the size of the individual; diam. 4½–6 mm., ... *C. bilabrata.*

*b*¹.—Apex entire; shell slender, acutely tapering above, the first whorl minute; length 12–15, diam. 3–3½ mm., *C. Oscariana.*

Clausilia bilabrata Smith. Pl. XXXVI, figs. 17–21.

Clausilia bilabrata E. A. Smith, Quarterly Journ. of Conchology, I, p. 120. Boettger, Jahrb. d. D. Malak. Ges., 1878, p. 103, with var. *ptycholæma*, Pl. 4, fig. 6. Kobelt, t. c., p. 96, Pl. 9, fig. 12. Möllendorff, Nachr'bl. d. D. Malak. Ges., 1900, p. 109.

As no good illustration of this species has appeared, it is figured here for comparison with the two new forms of the same group, and to show the local variations.

The shell is strong, almost always truncate and plugged in adults, 7 to 10 whorls usually remaining. It varies in color from straw-yellow to rather dark brown. It is very finely striate, attenuated above, the last whorl laterally compressed. Aperture ovate, the peristome reflexed and well thickened, very shortly free above, usually but not always corrugated by several or many folds grouped around the subcolumellar lamella. The superior lamella is marginal, rather small, and separated from or sometimes almost continuous with the spiral lamella, which penetrates past the ventral side. The inferior lamella recedes very deeply, is not visible from the mouth, except for a slender continuation across the lip parallel with the subcolumellar lamella in most specimens, but often wanting. It ascends rather straightly but obliquely inside, and continues inward as far as the spiral lamella. The principal plica is almost a whorl long, approaching the aperture, and continued within past the ventral side. The lunella is latero-ventral or almost ventral, oblique, almost straight, but curved a trifle inward above, and connected with a strong lower palatal plica very near its inner end.

The clausilium (Pl. XXXVI, figs. 20, 21) is parallel-sided, very obliquely cut off and thickened on the columellar side of the apex. It is deeply emarginate or excised on the columellar side of the filament.

I have received specimens from the following localities: Nippon —Kobé, Setsu; Takaya, Bitchu; Toyonishikami, Nagato. Senzan, Awaji. Shikoku: Ushirogawa and Okinoshima, Tosa. Kiushiu: Fukuregi and Yatsushiro, Higo.

The distribution of *C. bilabrata* includes southwestern Nippon, Awaji and Shikoku Islands, Kiushiu and the Iki Islands; the latter locality on the authority of Dr. O. von Möllendorff, who records specimens collected by Fruhstorfer.

While there is some variation from place to place, I do not see grounds for the definition of any races or subspecies, except the variety defined by Boettger, which I have not seen. The degree of plication of the right margin of the peristome is subject to wide individual variation in *C. bilabrata*, *C. Oscariana* and *C. surugensis*.

Specimens from Kobé are pale colored, retain 7½–9 whorls, and either have the right margin plain, except for the emerging inferior and subcolumellar lamellæ (fig. 17), or many-folded (fig. 19). They measure between, alt. 22.5, diam. 5.5 mm., whorls 9, and alt. 20, diam. 4.8 mm., whorls 8. At Takaya, Bitchu, the shells are larger, and vary from a single emerging lamella, the subcolumellar, to three or four folds. Alt. 25, diam. 5.8 mm., whorls 8½; alt. 21, diam. 6 mm., whorls 7½. They are corroded, and more or less clothed with green algæ on the back (figs. 23, 24).

Toyonishikami, Nagato. Dark reddish-brown, with the lunella decidedly *latero*-ventral, and the principal plica shorter; lip with numerous folds. Alt. 23.5, diam. 5.6 mm., whorls 9½.

Senzan, Awaji. Like Kobé shells, but sometimes smaller. Alt. 20, diam. 5 mm., whorls 8; alt. 17, diam. 4.5 mm., whorls $7\frac{1}{2}$.

Okinoshima, Tosa. Specimens like those from Kobé, but the lip is sometimes appressed, not free above, and the superior lamella scarcely marginal. Plication of the subcolumellar region variable.

Ushirogawa, Tosa. Slightly smaller than Kobé shells and, like the preceding lot, more opaque, the lunella not visible from the outside.

One specimen, sent at a different time from this locality (Pl. XXXVI, fig. 22), retains the apex perfect, is reddish-brown, slightly translucent, and has a much shorter principal plica, extending but a short distance beyond the lunella. There are 13 whorls, the earlier ones translucent-white. Length 25.5, diam. 5.9 mm.

Fukuregi, Higo, Kiushiu. Rather small, with few or many subcolumellar plications. Alt. 19, diam. 5 mm., whorls 9.

Yatsushiro, Higo. Larger than the preceding; peristome often somewhat more solute than in Kobé shells, and the mouth a little narrower. Alt. 2.4, diam. 5 mm., whorls $10\frac{1}{2}$; alt. 21, diam. 5 mm., whorls $8\frac{1}{2}$.

Clausilia plicilabris var. **ptycholæma** Boettger.

"Shell larger, more distinctly striate, the last whorl more strongly rib-striate. Aperture longer, the peristome less calloused and reflexed. Length (decollate) $20\frac{1}{2}$–$27\frac{1}{2}$, diam. $5\frac{1}{2}$–$6\frac{3}{4}$ mm."

"Seluchi, between Hiuga and Bugo" (Rein).

Clausilia Oscariana Pilsbry. Pl. XXXVI, figs. 30, 31.

Pilsbry, in these *Proceedings* for 1901, Vol. LIII, p. 499 (October 2, 1901).

Shell rimate, fusiform, rather acutely attenuated above, the early whorls retained in adults; dingy brown; finely striate. Whorls $10\frac{1}{2}$ to $11\frac{1}{2}$, slightly convex, the last perceptibly constricted behind the lip. Aperture ovate-piriform, the sinulus a little retracted; peristome very shortly free above, not emarginate at the position of the superior lamella, reflexed and thickened, *crossed by several folds (sometimes subobsolete) in the vicinity of the subcolumellar lamella.* Superior lamella marginal, rather low, slightly oblique, *widely separated from the spiral lamella,* the latter reaching a ventral position within. Inferior lamella very deeply receding, scarcely visible from the mouth, extending inward nearly as far as the spiral lamella. Subcolumellar lamella emerging to the lip-edge, several folds usually grouped around it. Principal plica strong, reaching from the dorsal to the ventral side. Lunella lateral, strong, slightly curving inward above, united below to the lower palatal fold near its inner end.

Length 14.7, diam. 3.5 mm.

Length 12, diam. 3 mm.

Fukuregi, Province Higo, Kiushiu. Types No. 81,930 Coll. A. N. S. P., from No. 674 of Mr. Hirase's collection.

Related to *C. bilabrata* Smith, but only about half as large, with fewer whorls, not subject to truncation, and more attenuated above. The lunella is more lateral. In *C. surugensis* the spire is much less slender. Named in honor of Dr. Oscar Boettger.

Clausilia surugensis n. sp. Pl. XXXVI, figs. 25, 26, 27.

Shell rimate, *obese below, attenuated above,* whitish under a pale brownish-yellow cuticle, which is mainly eroded from the specimens examined; finely striate. Whorls 10, the first rather large, next three or four scarcely increasing in diameter, the last two or three whorls quite swollen. Aperture piriform with rather distinct sinulus, peristome narrowly reflexed and thickened, varying from nearly smooth to *densely plicate along the columellar margin; notched to the left of the superior lamella.* Superior lamella rather small, a more or less distinct groove on each side of it, and a very small fold or lamella close to it on the left; not continuous with the spiral lamella, the latter continued inward past the ventral side. Inferior lamella very deeply receding, strongly spiral within, continuing inward as far as the spiral lamella. Subcolumellar lamella emerging. Principal plica a half whorl long, extending from a dorsal to a ventral position. The lunella is subventral, curves inward above, and is weakly united with, or slightly separated from, the middle of a rather long, oblique, lower palatal plica.

Length 15, diam. 3.7 mm.

Length 14.3, diam. 3.8 mm.

Clausilium (Pl. XXXVI, figs. 28, 29) oblique and somewha thickened at the apex, a little excised or emarginate on the columellar side of the filament.

Mikuriya, Suruga. Types No. 81,902 Coll. A. N. S. P., from Mr. Hirase's No. 688.

This species is much smaller than *C. bilabrata*, which is not known from so far north or northeast. It is more attenuated above, and the peristome is notched on the left side of the termination of the superior lamella.

Group of C. tanegashimæ.

Solid and strong *Tyrannophædusæ* with the clausilium oblique and thickened distally, the superior lamella separated from the spiral lamella, which penetrates past the ventral side, accompanied by the inferior lamella; lunella subventral; subcolumellar lamella strongly emerging. There is *a strong ridge or crest behind the outer lip*, parallel with it.

Similar to the group of *C. bilabrata* in internal structure, but differing in the crest behind the lip. Species are known from the northeastern group of Riukiu Islands, and from southern Kiushiu. Species two: *C. oxycyma*, with a distinct upper palatal plica developed, length 14 mm., and *C. tanegashimæ*, which has the upper palatal plica represented only by an inward bend of the upper end of the lunella, length 16–18½ mm.

Clausilia oxycyma n. sp. Pl. XXXVII, figs. 35, 36, 37, 38.

Shell rimate, fusiform, rather slender, attenuated above, glossy, rather dark red-brown when unworn; finely striate, a little more coarsely so on the last whorl. Whorls 9¾ to nearly 11, moderately convex, the last three whorls of almost equal diameter, last whorl compressed laterally, tapering, rising into *a strong, rather acute ridge or crest a short distance behind the lip* and parallel with it. Aperture piriform, slightly oblique, brown within; peristome narrowly reflexed, continuous, white, scarcely emarginate at the position of the superior lamella. Superior lamella small, marginal, slightly oblique, *not continuous with the spiral lamella.* Spiral lamella very high within, of equal length with the inferior lamella, both continuing past a ventral position. Inferior lamella very deeply receding, twisted within. Subcolumellar lamella emerging to the lip-edge, bounded by grooves. Principal plica strong, reaching from the dorsal to the ventral side. Lunella latero-ventral, oblique, joining the middle of strong, rather long, oblique, upper and lower palatal plicæ.

Length 14, diam. 3 to 3½ mm.

Clausilium (Pl. XXXVII, figs. 41, 42) moderately curved, the distal end very oblique and thickened on the columellar side, the proximal end emarginate on the columellar side of the filament. The middle of the palatal margin projects.

Kagoshima, Satsuma, in southern Kiushiu. Types No. 81,925 Coll. A. N. S. P., from Mr. Y. Hirase's No. 695.

Similar to *C. tanegashimæ* and *C. ptychocyma* in the strong crest behind the outer lip, but different from both in palatal armature. No other Japanese species has any similar structure of the last whorl.

Clausilia tanegashimæ Pilsbry. Pl. XXXVII, figs. 32, 33, 34.

Pilsbry, these *Proceedings* for 1901, Vol. LIII, p. 500 (October 2).

Shell fusiform, rather acutely tapering above, very solid, somewhat glossy, brown, very weakly striate except the last whorl. Whorls about 10½, moderately convex, the last having a *strong, acute ridge or crest* a short distance behind the outer and basal lips. Aperture ovate-piriform. the sinulus a trifle retracted; peristome reflexed, somewhat thickened, very shortly free or almost adnate above. Superior lamella small, vertical, marginal, widely separated from the spiral lamella, the latter extending inward past the ventral side. Inferior lamella emerging in a slender cord parallel to the subcolumellar lamella, otherwise very deeply receding, within very strong and obliquely ascending, penetrating as far as the spiral lamella. Subcolumellar lamella emerging to the lip-edge, bounded by grooves. Principal plica about a half-whorl long, extending from a dorsal position (visible within the throat) to just past the lunella. Lunella well developed, subventral, somewhat curved inward above, connected below with the inner end of a long oblique lower palatal plica.

Length 18.5, diam. 4.2 mm.

Length 16, diam. 4 mm.

Length 16.2, diam. 3.7 mm.

The clausilium (Pl. XXXVII, figs. 39, 40) is similar to that of *C. bilabrata*, being oblique and thickened at the apex, and excised on the columellar side of the filament.

Tane-ga-shima, Osumi, Northeastern Group of the Riukiu Islands.

Types No. 81,933 Coll. A. N. S. P., from No. 662 of Mr. Hirase's collection. Also occurs on Yakushima, No. 662*b* of Mr. Hirase's collection.

This is a much larger species than *C. ptychocyma*, with emerging subcolumellar lamella and sharper, higher crest behind the outer lip. *C. oxycyma* scarcely differs from *tanegashimæ* externally except in its smaller size, but it has a well developed upper palatal plica, which is represented in *tanegashimæ* by only a short inward bend of the lunella. The palatal margin of the clausilium is straight in *C. tanegashimæ*.

Specimens from Yaku-shima agree with those of Tane-ga-shima in solidity and size. The lunella is low above and its inward bend above, though low, is rather pliciform. I did not receive these specimens until recently, or I would have named the species differently, since it proves to extend beyond Tane-ga-shima.

Group of C. mikado.

This group is well developed in the provinces about the upper (eastern) end of the Inland Sea. Probably *C. plicilabris* A. Ad., described from Tanabe, Kii, will prove to belong here, near *C. aurantiaca* and the following species. I formerly thought it might be identical with *C. bilabrata* Smith.

Clausilia orthatracta n. sp. Pl. XXXVII, figs. 44, 45, 46.

Shell rimate, slenderly and straightly fusiform, rather solid, of a pale brown tint. Surface lusterless, finely striate, the striæ perceptibly coarser, though still fine and close, on the latter part of the last whorl. The upper whorls are almost smooth from wear in the specimens seen. Spire nearly straight-sided, attenuated and nearly cylindric above, the apex rather large. Whorls 12, the earlier convex, the later ones flattened, last whorl compressed laterally, noticeably constricted behind the lip, especially near and at the base; and there is generally a stronger riblet where the expansion of the lip begins (fig. 45). Aperture oblique, retracted at the base and sinulus, piriform and small. The peristome is continuous and stands forward free from the preceding whorl; is white, thickened, expanded and reflexed, weakly emarginate at the position of the superior lamella or not noticeably so. Superior lamella marginal, oblique, continuous with the spiral lamella, which is low at first, but rises high in the region of the closing apparatus, and penetrates inward past the aperture to a lateral position on the left side. The inferior lamella recedes deeply, though the lower end continues to the lip-edge. It is straightened within, and penetrates nearly or quite as deeply as the spiral lamella. The sub-columellar lamella emerges to the lip-edge, is bounded by grooves, and there is sometimes some weak crenation of the lip below it. The principal plica approaches the lip, and is about one whorl long. The narrow, straight lunella stands in a ventro-lateral position, and is connected above and below with short but higher upper and lower palatal plicæ (fig. 46).

Length 16, diam. nearly 3, length of aperture 3 mm.

Length 15, diam. 3, length of aperture 3.2 mm.

The clausilium (fig. 43) resembles that of *C. oxycyma;* the palatal edge being a little swollen in the middle. The distal end is oblique and strongly thickened, as usual.

Akasaka, Province Mino, Japan. Types No. 82,273 Coll. A. N. S. P., from No. 748 of Mr. Hirase's collection.

This *Tyrannophædusa* stands between *C. aurantiaca* Bttg. and *C. iotaptyx* Pils. It is more slender than either, and differs from them in the shape of the spire and the relatively smaller aperture.

Compared with *C. aurantiaca* var. *hypoptychia* Pils., the present species is seen to differ in the straighter lateral outlines and larger apex.

Section STEREOPHÆDUSA Bttg.

This section comprises four groups of species: The group of *C. valida*, restricted to the middle Riukiu Islands;[1] the group of *C. japonica*, known from Nippon and Shikoku; the group of *C. brevior*, now known from Nippon, Kiushiu and the Riukiu Islands, and the group of *C. entospira*, containing a single species from Tane-ga-shima.

The group of *C. japonica* includes the following large species:

1. *C. japonica* Crosse. Synonyms of the typical form are *C. kobensis* Smith and *C. nipponensis* Kobelt. There cannot be much doubt that *C. eurystoma* v. Mart. is a pathologic individual of the same.

   A var. *pallens* has been distinguished by von Möllendorff, and I have defined var. *interplicata*. There remain several other more or less well-marked races, which it seems to me inadvisable to name until their distribution can be more fully studied. In Idzumo Province a large, dark race occurs, which

[1] These *Proceedings* for 1901, Vol. LIII, p. 410.

agrees with *C. Hilgendorfi* v. Mart. in everything except the sutural plica which is said to characterize that species.

2. *C. Hilgendorfi* v. Mart. Probably a subspecies of *C. japonica.*
3. *C. oostoma* v. Möll. I have considered my *C. japonica* var. *surugæ* to be this species. The latter has a synonym, *C. eurystoma* subsp. *brachyptychia* Mlldff.
4. *C. subjaponica* Pils.

The group of *C. brevior* consists of smaller species, of which the first two, from the middle part of Nippon, have no lunella, while in *C. Stearnsii, Addisoni, Jacobiana* and *hondana* a lunella is developed, at least in some individuals.

5. *C. brevior* v. Mart. Includes *C. tetraptyx* Mlldff.
6. *C. nikkoensis* Mlldff.
7. *C. hondana* Pils.
8. *C. Stearnsii* Pils.
9. *C. Jacobiana* Pils.
10. *C. Addisoni* Pils.
11. *C. stereoma* Pils. with varieties *nugax* and *cognata.*

I have elsewhere described and figured *C hondana* and *C. Stearnsii. C. nikkoensis* I have not yet seen. The other species of the *brevior* group are described below.

In the typical *Stereophædusæ* there are either several palatal plicæ, or only the upper and lower. In *C. hondana, Addisoni, Stearnsii, Jacobiana* and *stereoma* a low, straight lunella stands between the upper and lower plicæ. This lunella, in fully adult individuals, is a smooth ridge, without higher points or irregularities; but in some individuals, viewed from the outside, a row of short light markings is seen, as though a series of palatal plicæ stood in place of the lunella. When this is not obvious from the outside, it appears when the shell-wall and lunella are viewed by transmitted light. This indicates local differences in the substance of the shell, affecting its refracting qualities; and it occurred to me that a row of plicæ is first formed, and subsequently the spaces between them are filled in. Upon examining specimens of *C. Jacobiana* not quite mature, in which the peristome was not fully formed, I found that this was what actually takes place. Such shells have no lunella whatever, but in its place a series of four or five short plicæ (Pl. XXXIX, fig. 68).

These facts indicate that the ancestral *Stereophædusæ* had a palatal armature of short palatal plicæ, precisely similar to the structure still extant in certain other groups, *Megalophædusa* for instance. This became modified in two modes: (1) The intermediate plicæ degenerated, resulting in such forms as typical *C. japonica*, in which only the upper and lower plicæ remain, or (2) the intermediate plicæ coalesced to form a lunella.

That the loss of an even series of plicæ has been a very recent one in *Stereophædusa* is indicated by several facts. In species which normally have but two palatal plicæ sometimes individuals or races occur in which small intermediate plicæ are developed;[2] and in species with a lunella, the earlier structure of a row of plicæ is perfectly developed in the stage of growth immediately preceding the adult stage.

Incidentally I may observe that the perplexing structural variation I formerly recorded in describing *C. hondana* is at least partially explained by what I find to occur in the *Stereophædusæ* of Kiushiu and Tane-ga-shima. I was dealing with a small series of shells, part of which were not absolutely mature.

Clausilia brevior v. Martens. Pl. XXXVIII, figs. 47, 48, 49, 50, 51.

Von Martens. Sitzungsberichte der Ges. Naturforsch. Freunde in Berlin, 1877, p. 109. Kobelt, Fauna Moll. Extramar. Jap., p. 78, Pl. 9, fig. 4 (bad).

C. tetraptyx v. Möllendorff, Journ. Asiatic Soc. Beng., LI, p. 7, Pl, 1, fig. 7 (1882); 1885, p. 61.

This species is not recognizably figured in Kobelt's work. For the purpose of more exact comparison with *C. Addisoni*, a fuller account of the species than has been published is given below.

The shell is *thin*, obesely fusiform, *much attenuated* and concave-sided near the apex, the last three whorls inflated, the last half of the last whorl more or less compressed, often conspicuously narrower than the preceding whorl, as in the "*nipponensis*" form of *C. japonica*. Pale yellowish brown; sharply, very obliquely striate or rib-striate. Whorls about $9\frac{1}{2}$, the apex minute, but the following whorl disproportionately large; next few whorls very slowly increasing. Aperture squarish-ovate, the peristome expanded, somewhat reflexed, thickened and white, hardly free above, the upper margin parallel to the sutures. Superior lamella thin and high, marginal, continuous with the spiral lamella which

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[2] The evidence of this will be presented in a future paper dealing with the *C. japonica* group of *Stereophædusa*.

penetrates to or past the middle of the ventral side. Inferior lamella approaching the superior, forming a strong, subhorizontal fold; inside it ascends with a broad spiral trend, and penetrates nearly or quite as far as the superior lamella. The subcolumellar lamella emerges to the lip-edge. The principal plica is visible deep in the throat and ascends to a latero-ventral position. Palatal plicæ three or four, the first and fourth long, oblique; the second shorter; third very small or wanting, leaving a space.

Length 14 to 17, diam. 4 mm. (Von Martens' type).

Length 17.2, diam. 4.3 mm.; length 14, diam. 4 mm.; length 13.4, diam. 3.5 mm.; specimens from Tokyo.

Length 14.5, diam. 4.1 mm.; length 12, diam. 3.5 mm.; specimens from Nikko.

Length 17, diam. 3.7 to 4 mm.; specimen from Numazu, Suruga.

Clausilium (Pl. XXXVIII, figs. 52, 53) short and wide, broadest below, strongly arcuate, a little tapering and thickened at the apex, somewhat excised on the columellar side of the filament.

Misaki, Sagami, at the mouth of the Bay of Tokyo (Hilgendorf, type locality); Ashima, Izu (Hirase); Yokohama (B. Schmacker); Tokyo (F. Stearns); Nikko, Shimotsuke (Loomis); Fujisawa (Hungerford, type locality of *C. tetraptyx*); Numazu, Suruga (Hirase).

The small size for a *Stereophædusa*, strongly attenuated early whorls, and thin shell are the more prominent differences between *C. brevior* and other species of the group.

The area of distribution so far indicated is a rather restricted district in middle Nippon. Mr. Hirase's fruitful researches in the southwestern half of Nippon and in Shikoku have not revealed the species there; nor has it yet appeared from as far north as the Province Uzen, whence a considerable number of small species have been sent. It seems to be a very abundant shell in the region about Tokyo Bay.

The variety *tetraptyx* Mlldff. is a little darker brown, the peristome brown-tinted, at least in part, the palatal plicæ slightly longer than in typical *brevior;* but in the lot of some hundreds of specimens I have seen, these characters, except as to the tint of the lip, vary by insensible degrees, so that I do not see that *tetraptyx* has a valid claim to varietal distinction. One of the original specimens of *tetraptyx*, collected by Hungerford, is before me, kindly lent from the collection of Mr. E. R. Sykes.

Clausilia Addisoni Pilsbry. Pl. XXXVIII, figs. 56, 57.

> *C. brevior* var. *Addisoni* Pils., these *Proceedings* for 1900, p. 677 (January 28, 1901). *C. Addisoni* Pils., t. c., p. 502, under *C. stercoma*.

Shell obesely fusiform, much attenuated and with concave outlines above, inflated below, the last whorl narrower and tapering. Light brown or corneous. Rather strongly and coarsely striate, more coarsely so on the last half whorl. Aperture squarish-ovate, the lip reflexed, somewhat thickened, white. Lamellæ about as in *C. brevior*. The subcolumellar lamella barely emerges or is continued to the lip-edge. The three palatal plicæ are slightly shorter than in *C. brevior*, and there is a very low, subobsolete, straight lunella, or at least a low callous deposit between the second and the lowest plicæ, and connected with the latter.

Length 18, diam. 4.2 to 4.7 mm., whorls $9\frac{1}{2}$.

Length 16, diam. 4.5 mm., whorls 9.

Ari-mura, a village on the southern side of Sakura Island, in Kagoshima Bay (Addison Gulick); Kagoshima and Kajima, Satsuma (Mr. Hirase); Isshochi, Higo (Hirase); all in southern Kiushiu.

This form is very much like *C. brevior*, of which I at first considered it a variety. It is slightly stronger, larger than any but the largest specimens of *brevior*, and differs in having a callous pad or rudimentary lunella above the lower palatal fold, and in the decidedly coarser striation. The clausilium is thicker at the apex, and the palatal side is more convex (figs. 54, 55).

Geographically it is very widely separated from all parts of the range of *C. brevior;* and as Mr. Hirase has not found either species at any of the multitude of intermediate localities explored by him or his collectors, it seems unlikely that there are any connecting forms in the intermediate territory—the southwestern half of Nippon and northern Kiushiu.

It is named in compliment to Mr. Addison Gulick, formerly of Osaka.

Clausilia Jacobiana n. sp. Pl. XXXIII, figs. 58–62; Pl. XXXIX, figs. 66–69.

Shell thin, brown, rimate, fusiform, the upper half rapidly tapering, several earlier whorls attenuated, the penultimate whorl swollen, latter half of the last whorl compressed. Surface glossy, sculptured with strong, threadlike oblique striæ, 3 or 4 earlier whorls smooth, usually worn or eroded. Whorls 9 to 9½, *quite convex*, and separated by deeply impressed sutures. Aperture slightly oblique, ovate-piriform, the peristome very shortly free above, expanded and reflexed, whitish, slightly emarginate at the position of the superior lamella, the sinulus a little retracted. Superior lamella slender, vertical, continuous with the spiral lamella, which extends inward to the middle of the ventral side. Inferior lamella forming a rather small but subhorizontal fold, not reaching out upon the lip, extending inward as far as the superior lamella. Subcolumellar lamella varying from barely immersed to rather weakly emerging. Principal plica a half-whorl long, extending from a dorsal position (visible deep in the throat) to a latero-ventral position. Upper and lower palatal plicæ rather short, lateral. Below the upper palatal plica there is a delicate second plica, from the outer end of which a low straight lunella runs to the lower palatal plica.

Length 15.5, diam. 3.6 mm.; length 13.6, diam. 3.5 mm.

The clausilium (Pl. XXXIII, figs. 61, 62) has the general shape and curvature of that of *C. brevior* and *Addisoni*, but differs from both in having the apex more pointed, and it is more concave on the palatal side of the apex. The end is also more thickened than in *C. brevior*.

Tane-ga-shima, Osumi. Types No. 82,277 Coll. A. N. S. P., from No. 754 of Mr. Hirase's collection. Also Yaku-shima, No. 778 of Mr. Hirase's collection.

This species is related to *C. Stearnsii* Pils. of Okinawa and *C. Addisoni* Pils. of southern Kiushiu. It is much more slender than the latter, with more convex whorls and a more pointed clausilium. *C. Stearnsii* is a longer species, in which the early whorls are not so attenuated. These three species have a low and more or less well-developed lunella when adult, a structure occurring also in some specimens of *C. hondana*, but otherwise unknown in the *Stereophædusæ* of Nippon. In immature shells a row of short palatal plicæ stands in place of the lunella (fig. 68).

This *Clausilia* has the thin shell of the other species of the *brevior* group, while all other *Clausiliæ* known from Tane-ga-shima are extremely thick and strong.

It is named in honor of Dr. Arnold Jacobi, author of excellent papers upon the soft anatomy of Japanese snails, the faunal relationships of Japan, etc.

The specimens from Yaku-shima are more solid than those from Tane-ga-shima, and the palatal armature seems to be less developed, the lunella being less distinct or absent. There are three palatal plicæ below the principal plica, the first, second and lowest. The sculpture and shape are not noticeably different, the largest and smallest sent measuring:

Length 13.8, diam. 3.3 mm.

Length 11.3, diam. 3 mm.

Clausilia stereoma Pilsbry. Pl. XXXIX, figs. 70, 71.

Pilsbry, these *Proceedings* for 1901, Vol. LIII, p. 502, with varieties *nugax* and *cognata* (October 2, 1901).

Shell rimate, *obesely* fusiform, the spire tapering rapidly, its *upper fourth very slender; thick and extremely strong;* olive yellow, glossy; the spire distinctly striate, last two whorls smoother except near the suture. Whorls about 8½, convex, the penultimate whorl swollen, latter half of the last whorl compressed, tapering. Aperture ovate, vertical, flesh-tinted within; peristome white, reflexed and thickened within, continuous, though almost in contact with the preceding whorl above. Superior lamella rather slender, oblique, continuous with the spiral lamella. Inferior lamella strong, subhorizontal, approaching the superior lamella, strongly spiral within, both spiral and inferior lamellæ penetrating to the middle of the ventral side. Subcolumellar lamella emerging but not extending to the lip-edge. Principal plica very short, lateral; palatal plicæ four, the upper one long, converging inwardly toward the principal plica, the lower plica shorter, strong, a little curved; two intermediate plicæ minute, punctiform, hardly perceptible.

Length 21½, diam. 6 mm.

Length 19½, diam. 5½ mm.

Clausilium very short and broad, acuminate and thickened distally, very strongly arcuate (Pl. XXXIX, figs. 63–65).

Yaku-shima, Osumi, in the Northeastern Group of the Riukiu Islands. Types No. 81,737 Coll. A. N. S. P., from No. 670 of Mr. Hirase's collection.

This fine species is the most solid and strong *Stereophædusa* known. The obese lower whorls and strongly attenuated spire show relationship to *C. Addisoni* Pils. of Kiushiu, and *C. brevior* v. Mart. of middle Nippon—both comparatively thin shells. The two intermediate palatal plicæ are likely to prove inconstant.

Clausilia stereoma var. **nugax** Pilsbry. Pl. XXXIX, figs. 78, 79.

Much smaller and more slender than the type, which it resembles in color and sculpture. Very solid.

Length 13½ to 14½, diam. 4 mm.

Length 16½, diam. 4¼ mm.

Also from Yaku-shima, probably from a different locality. Types No. 81,576 Coll. A. N. S. P., from No. 671 of Mr. Hirase's collection.

Clausilia stereoma var. **cognata** Pilsbry.

Rich reddish-brown, thinner than the types, though still very strong, with about 9 whorls. Palatal plicæ four or five, the intermediate ones very small.

Length 23½, diam. 6½ mm.

Length 22, diam. 6½ mm.

Length 21⅔, diam. 6⅓ mm.

Tane-ga-shima. Types No. 81,578 Coll. A. N. S. P., from No. 661 of Mr. Hirase's collection.

As in the type, the palatal plicæ are often visible through the shell, and from the outside appear longer and more prominent than they are found to be on opening the shell.

Group of C. entospira.

Shell thick, small, the inferior lamella thick and squarish below (not forming a spiral fold on the columella, as in other *Stereophædusa*), very strongly spiral within; a stout, lunate lunella developed, but no palatal plicæ except the principal one. Clausilium very strongly arcuate, slowly and much tapering below to the subacute, thickened apex, wide above, deeply emarginate on the columellar side of the filament.

The single species known of this very distinct group has obviously arisen from the Stereophædusan stock; but it is more specialized than any other known member of *Stereophædusa*, both in palatal armature and clausilium.

Clausilia entospira Pilsbry. Pl. XXXIX, figs. 72–75.

Pilsbry, these *Proceedings*, Vol. LIII, p. 501 (October 2, 1901).

Shell rather obesely fusiform, attenuated, with somewhat concave outlines above, extremely thick and strong, nearly smooth, glossy, the latter half of the last whorl becoming coarsely striate; flesh-colored with buff patches and streaks, eroded in spots. Whorls about 8½, convex, the last tapering below. Aperture long-ovate, the peristome slightly reflexed, very much thickened within, shortly free above. Superior lamella small but rather stout, marginal, very widely separated from the spiral lamella, which is quite small, short and latero-ventral. Inferior lamella receding, in oblique view (fig. 72) appearing very prominent and squarish; *very strongly spiral within*, heavily thickened at the lower end, ascending merely to a lateral position. Subcolumellar lamella immersed, interrupted within. Principal plica slender, short and low, lateral. Lunella latero-ventral, oblique, curved, running inward below, tapering at the ends, *excessively thick and strong* in the middle. No palatal plicæ

Length scarcely 10, diam. 2.4 mm.

Clausilium (Pl. XXXIX, figs. 76, 77) moderately long, but being strongly curved near the middle, nearly at a right angle, it appears short; distal half rapidly tapering, straight along the palatal, convex at the columellar side, thickened at the apex. Proximal half rather wide and parallel-sided; deeply excised on the columellar side of the filament.

Tane-ga-shima, Osumi, one of the Northeastern Group of the Riukiu Islands. Types No. 82,558 Coll. A. N. S. P., from No. 663*a* of Mr. Hirase's collection.

A few examples were with the specimens of *C. Pinto*. Mr. Hirase remarks that it is very rare. It is an excessively peculiar species, and I was formerly at a loss as to its affinities. The broadly spiral trend of the inferior lamella, which is moreover very short within, the weak, short spiral lamella and principal plica and the peculiar lunella are a combination of features unlike any Oriental species known to me. The squarish lower end of the inferior lamella is sometimes visible in a front view (fig. 74), but in other specimens it *recedes, and is seen only in oblique* view (figs. 72, 73). The clausilium is quite unlike that of any other known Japanese species. The lunella might almost as well be considered a greatly developed lower palatal plica, as it is no doubt in part homologous with that.

The shell is excessively solid and thick, stronger in fact than any other species of such diminutive stature known to me; but unusual solidity is a characteristic of the Clausiliæ of Tane-ga-shima and Yaku-shima, common to the *Stereophædusæ*, *Hemiphædusæ* and *Tyrannophædusæ* alike, and clearly to be correllated with some factor in the environment acting upon the entire series.

EXPLANATION OF PLATES XXXV-XXXIX.

PLATE XXXV (HEMIPHÆDUSA). Figs. 1-6.—*Clausilia higoensis.* Types.
Figs. 7-10.—*Clausilia ptychocyma.* Type.
Fig. 11.—*Clausilia ptychocyma* var. *Yakushimæ.* Type.
Figs. 12-14.—*Clausilia Pinto.* Type.
Figs. 15, 16.—*Clausilia ischna.* Type.

PLATE XXXVI (TYRANNOPHÆDUSA). Figs. 17-21.—*Clausilia bilabrata.* Specimens from Kobé, the type locality.
Fig. 22.—*Clausilia bilabrata.* Specimen retaining the apical whorls, from Ushirogawa, Tosa, No. 81,926 Coll. A. N. S. P.
Figs. 23, 24.—*Clausilia bilabrata.* Specimens from Takaya, in which the surface is corroded, covered with algæ dorsally. No. 79,719 Coll. A. N. S. P.
Figs. 25-29.—*Clausilia surugensis.* Types.
Figs. 30-31.—*Clausilia Oscariana.* Types.

PLATE XXXVII (TYRANNOPHÆDUSA). Figs. 32-34.—*Clausilia tanegashima.* Type.
Figs. 35-38.—*Clausilia oxycyma.* Types.
Figs. 39, 40.—*Clausilia tanegashima.* Clausilium.
Figs. 41, 42.—*Clausilia oxycyma.* Clausilium.
Fig. 43.—*Clausilia orthatracta.* Clausilium.
Figs. 44-46.—*Clausilia orthatracta.* Type.

PLATE XXXVIII (STEREOPHÆDUSA). Figs. 47, 48.—*Clausilia brevior.* Specimen from Coll. E. R. Sykes
Figs. 49-53.—*Clausilia brevior.* Specimens from Tokyo. No. 18,801 Coll. A. N. S. P.
Figs. 54-57.—*Clausilia Addisoni.* Types.
Figs. 58-62.—*Clausilia Jacobiana.* Tanegashima, Osumi.

PLATE XXXIX (STEREOPHÆDUSA). Figs. 63-65.—*Clausilia stereoma.* Clausilium, Fig. 64, from the columellar edge.
Figs. 66-69.—*Clausilia jacobiana.* Fig. 68 represents the palatal armature of an immature shell.
Figs. 70, 71.—*Clausilia stereoma.* Type.
Figs. 72, 73.—*Clausilia entospira.* Fig. 72 is an oblique view in the aperture, from below and the left side.
Figs. 74-77.—*Clausilia entospira.* Type. Figs. 76, 77 reconstructed from a broken clausilium.
Figs. 78, 79.—*Clausilia stereoma* var. *nugax.* Type.

CATALOGUE OF THE CLAUSILIIDÆ OF THE JAPANESE EMPIRE.[1]

BY HENRY A. PILSBRY.

The general sequence of species in the following list is from primitive to specialized forms; but this end is only imperfectly attained, as there are several highly specialized groups terminating wholly independent phyla, making a serial arrangement quite arbitrary. The forms with narrow clausilium and several palatal plicæ in place of a lunella are the more primitive, retaining the structure of early Tertiary groups. *Megalophædusa* and the typical *Hemiphædusæ* are of this kind. *Zaptyx, Luchuphædusa* and *Tyrannophædusa* seem to be three independent specializations from an early Hemiphædusan stock. *Stereophædusa* stands a little more remote; while *Pseudonenia, Euphædusa* and *Reinia* probably separated from the pro-Hemiphædusan stock at a still earlier period.

The East Asiatic *Clausiliidæ* are much more closely related to early Tertiary than to modern European groups. The evidence indicates that, like the Belogonous *Helicidæ*, a common stock of *Clausiliidæ* spread over Asia and Europe, *at least* as early as the Eocene. Subsequent evolution has been along independent lines in the East and the West; and just as I have demonstrated in the *Helicidæ*, the European stock has forged ahead, while the Oriental looks backward, many a group retaining old characters.

Ninety-three well-established species of *Clausilia* are now known from Japan, more than half of them first described in this journal. Of this number forty-four were brought to light by Mr. Hirase. The localities of many others, previously uncertain, have been ascertained from specimens collected by him. In addition to these species, thirty-five subspecies or varieties have been described. The list of species is encumbered with eleven additional specific names, standing for forms so inadequately described that their relationships with other species are not ascertainable from published

[1] Exclusive of Formosa.

data, though part of them can be identified specifically when specimens *from the original localities* come to competent hands.

Section MEGALOPHÆDUSA Bttg.

C. MARTENSI 'Herklots' v. Mart. (= *C. yokohamensis* Crosse and *C. Reiniana* var., Kob., Jahrb. iii, Pl. 5, f. 8). Yokohama (Crosse); Hakone Mountains (Schmacker); Mikuriya, Suruga; Gojo and Kambe, Yamato; Kobé, Setsu; Kashima, Harima.

Form TINCTILABRIS Pils. Nachi and Tomisato, Kii (Hirase).

Var. REINIANA Kobelt. Ibuki, Omi (Hirase); Aichi (U. S. Nat. Mus.).

C. MITSUKURII Pils. Tomisato, Kii.[2]

C. DUCALIS Kob. "Interior of Nippon" (Rein); Miya-mura, Hida (Hirase).

Var. DORCAS Pils. Kiyomi-mura, Hida (Hirase).

C. VASTA Bttg. Nagasaki (Rein, Schmacker); Seluchi (Rein); Fukuregi, Higo (Hirase).

C. FULTONI Sykes. Shikoku: Kinnayama, type locality; Ushirogawa, Tosa; Nametoko, Iyo; Goto, Uzen (Hirase).

C. HIRASEANA Pils. Okinoshima, Tosa, Shikoku (Hirase).

Section HEMIPHÆDUSA Bttg.

Group of C. validiuscula.

C. DECUSSATA v. Mart. Tsukuba-san, a mountain in Hitachi Province, north of Tokyo (Hilgendorf). A species of uncertain position in the system.

C. VALIDIUSCULA v. Mart. Seluchi, Kiushiu (Rein).

Var. BILAMELLATA Bttg. "Seluchi, between Hiuga and Bugo" (Rein).

C. INTERLAMELLARIS v. Mart. Kiushiu.

C. ÆTHIOPS Mlldff. Near Nagasaki, Kiushiu.

C. VIRIDIFLAVA Bttg. "Interior of Japan," "Kiushiu" (Rein).

[2] Smaller than *Martensi*; somewhat Buliminus-shaped. Whorls 9½, the upper ones not amputated. Aperture about as in *Martensi*. Length 29, diam. 8 mm.

C. HICKONIS Bttg "Interior of Nippon" (Rein).

Var. BINODIFERA Bttg. "Interior of Nippon" (Rein).

C. NOLANI Pils. Fukura and Ikari, Awaji (Hirase).

C. GRACILISPIRA Mlldff. Near Kobé, Setsu.

C. CARYOSTOMA Mlldff. Kobé, Setsu.

Var. JAYI Pilsbry. Jo, Kii (Hirase).

C. TOSANA Pils. Ushirohawa, Tosa, and Nametoko, Iyo,[3] Shikoku Island.

C. GRACILE Pils. Nachi, Kii (Hirase, No. 794).

Group of C. sublunellata.

C. SUBLUNELLATA Mlldff. Nikko Mountains (Hungerford).

C. HETEROPTYX Pilsbry. Tomisato and Nachi, Kii (Hirase).

C. OPEAS Mlldff. Nikko Mountains (Hungerford).

C. MICROPEAS Mlldff. Nikko (Hungerford); Mikuriya, Suruga (Hirase).

Var. PERPALLIDA Pils. Nishigo, Uzen.

Var. HOKKAIDOENSIS Pils. Kayabe, Ojima, Hokkaido.

C. SUBULINA Mlldff. Nikko Mountains and Lake Chusenji, Shimotsuke.

Var. LEUCOPEAS Pilsbry. Ikoma and Samotonakamura, Kii (Hirase).

C. SERICINA Mlldff. Lake Chusenji, Shimotsuke and Yumagaaishi (Hungerford).

Var. RHOPALIA Pilsbry. Mikuriya, Suruga (Hirase).

Group of C. hyperolia.

C. HYPEROLIA v. Mart. Uweno, near Yeddo (Hilgendorf, type locality). Oshima, Izu; Mikuriya, Suruga (Hirase).

Var. RECTALUNA Mlldff. Kamatokogiro.

Var. APTYCHIA Mlldff. Hakone and Chusenji.

Var. PLANULATA Mlldff. Kobé.

Group of C. awajiensis.

C. AWAJIENSIS Pils. Fukura, Awaji.

C. HARIMENSIS Pils. Kashima, Harima; Shirono, Buzen.

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[3] In the specimens of *C. tosana* from Nametoko, Iyo, the intermediate palatal plicæ coalesce to form a somewhat I-shaped lunella. They are a transition form to the group of *C. aulacophora*.

C. PERIGNOBILIS Pils. Okinoshima, Tosa; Dogo, Iyo.

C. KOCHIENSIS Pils. Kochi, Tosa; Minamata and Yatsushiro, Higo; Togo, Satsuma. (*C. higoensis* Pils. is a synonym.)

C. SUBAURANTIACA Pils. Deyai and Toyonishihami, Nagato.

C. ISCHNA Pils. Kochi, Tosa, Shikoku Island.

Var. NEPTIS Pils. Kochi, Tosa.

C. IGNOBILIS Sykes. Kinnayama, Shikoku.

C. SHIKOKUENSIS Pils. Ushirohawa, Tosa, Tairiuji, Awa, and Nametoko, Iyo, Shikoku Island.

C. STRICTALUNA Bttg. Nagasaki (Lischke).

Var. MAJOR Bttg. Seluchi, between Hiuga and Bugo (Rein).

Var. NANA Mlldff. Nagasaki.

Group of C. aulacophora.

C. AULACOPHORA Pils. Fukura, Awaji (*C. breviluna* Mlldff.).

C. PIGRA Pils. Kashima, Harima (Hirase).

Group of C. platyauchen.

C. PLATYAUCHEN v. Mart. (*C. fusangensis* Mlldff.). Tsukuba-san, a mountain north of Tokyo (Hilgendorf, type locality); Lake Chusenji (Schmacker); Nishigo, Uzen; Mikuriya, Suruga (Hirase); Prov. Suruga (F. Stearns); Prov. Yamato (Rein).

C. ATTRITA Bttg. Japan (Rein); Ibuki, Omi, and Kiyomimura, Hida (Hirase).

Var. INFAUSTA Pils. Nachi, Ikoma, and Jo, Prov. Kii (Hirase).[4]

C. HAKONENSIS Pils. Hakone Mountains (B. Schmacker); Oshima, Izu (Hirase).

C. SCHMACKERI Sykes. Kinnayama (Sykes); Kochi, Tosa (Hirase); Shikoku Island.

C. BUSCHII Küster. Japan (Siebold). Position uncertain.

C. PLATYDERA v. Mart. Kobé (Schmacker); Prov. Yamato, at Gose, Matsunotoge, Kambe and Nara, and Hieisan, west of Lake Biwa (A. Gulick!).

Var. LAMBDA Bttg. Japan (Rein); Nohara, Yamato (Hirase).

[4] Somewhat smaller than *attrita*: the subcolumellar lamella immersed, inferior lamella continued inward decidedly farther than the spiral lamella. Other characters substantially as in *attrita*.

Var. KIIENSIS Pils. Kurozu, Nachi and Tomisato, Prov. Kii (Hirase).[5]

Group of C. ptychochila.

C. BERNARDII Pfr. [Siam ? Riukiu Islands ?]
C. CRENILABIUM Pils. Prov. Kunchan, Okinawa (Hirase).
C. PTYCHOCHILA Bttg. [China ? Riukiu Islands ?]
C. EXCELLENS Pfr. (*C. praeclara* Gld. preoc.). Okinawa (U. S. N. P. Exp.).

Group of C. Pinto.

C. PINTO Pils. Tane-ga-shima, Osumi (Hirase).
C. PTYCHOCYMA Pils. Tane-ga-shima, Osumi (Hirase).
Var. YAKUSHIMÆ Pils. Yaku-shima, Osumi (Hirase).

Group of C. munus.

C. MUNUS Pils. Oshima, in the Riukiu Islands (Hirase).

Section ZAPTYX Pilsbry.

C. HIRASEI Pils. Kagoshima and Sakura Island, Satsuma (Hirase).
Var. KIKAIENSIS Pils. Kikaigashima, Osumi (Hirase, Nos. 557, 557*b*).
C. HYPEROPTYX Pils. Okinawa; Yaeyama (Hirase).
C. HACHIJOENSIS Pils. Hachijo Island, Izu.

Section TYRANNOPHÆDUSA Pilsbry.

Group of C. mikado.

C. MIKADO Pils. (*C. omiensis* Mlldff.). Ibuki, Omi, and Akasaku, Mino (Hirase).
C. IOTAPTYX Pils. Ibuki and Ryozen,[6] Omi (Hirase).
Var. CLAVA Pils. Senzan, Awaji; Ikoma, Kii (Hirase).
C. ORTHATRACTA Pils. Akasaka, Mino (Hirase).

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[5] Smaller than *platydera*; more swollen below and more attenuate above. Whorls 8½–10. Length 16–17, diam. 4⅓ mm.

[6] Specimens of *C. iotaptyx* from Ryozen, Omi, have 12 to 13 whorls, but otherwise are like the types from Ibuki, Omi. The shells from Ikoma, Kii, are somewhat intermediate between *iotaptyx* and *clava*, but nearer the latter.

C. AURANTIACA Bttg. "Interior of Nippon" (Rein); Kobé (Schmacker); Nachi, Kii, Ikari, Awaji, and Suimura, Awa (Hirase).

Var. HYPOPTYCHIA Pils. Kashima, an island near Tanabe, Kii (Hirase).[7]

Var. ERBERI Bttg. (*minor* Mlldff.). Nara, Nohara and Gojo, Yamato; Chikubushima, in Lake Biwa; Kashima, Harima; Tomisato, Aiga, and Kurozu, Kii (Hirase).

Group of C. bilabrata.

C. PLICILABRIS A. Ad. Tanabe, Kii. (Subgeneric position doubtful.)

C. BILABRATA Smith. Kobé, type locality; southern half of Nippon; Shikoku, Kiushiu and Iki Islands.

Var. PTYCHOLÆMA Bttg. "Seluchi, between Hinga and Bugo" (Rein).

C. OSCARIANA Pils. Fukuregi, Higo, Kiushiu (Hirase).

C. SURUGENSIS Pils. Mikuriya, Suruga (Hirase).

Group of C. tanegashimæ.

C. OXYCYMA Pils. Kagoshima, Satsuma, in southern Kiushiu (Hirase).

C. TANEGASHIMÆ Pils. Tane-ga-shima and Yaku-shima, Osumi (Hirase).

Section LUCHUPHÆDUSA Pilsbry.

C. CALLISTOCHILA Pils. Prov. Kunchan, Okinawa (Hirase).

C. MIMA Pils. Oshima, Riukiu Islands (Hirase).

C. NESIOTHAUMA Pils. Oshima, Riukiu Islands (Hirase).

C. OSHIMÆ Pils. Nase, Oshima (Hirase).

C. PSEUDOSHIMÆ Pils. Furuniya, Oshima (Hirase).

Section STEREOPHÆDUSA Bttg.

Group of C. valida.

C. VALIDA Pfr. Okinawa.

Var. FASCIATA Sykes. Okinawa.

Var. PERFASCIATA Pils Prov. Kunchan, Okinawa.

Var. STRIATELLA Pils. Okinawa.

[7] Larger than *aurantiaca*, with narrower, less developed lip, more whorls, and several plicæ in the subcolumellar region.

Group of C. japonica.

C. JAPONICA Crosse. Middle and southern Nippon; Awaji and Shikoku Islands. (Includes *C. kobensis* Smith, type loc. Kobé; *C. nipponensis* Kobelt; and *C. eurystoma* v. Mart., type loc., Tsukuba-san, a mountain north of Yeddo, in Hitachi Province, Hilgendorf.)

Var. PALLENS Mlldff. "Koma-kasunga."

Var. PEROBSCURA Pils. Shirono, Buzen (Hirase).

Var. INTERPLICATA Pils. Nishigo, Uzen; Takeya, Idzumo; Ryozen, Omi (Hirase).

C. HILGENDORFI v. Mart. Prov. Idzumo (Hilgendorf).

C. OOSTOMA Mlldff. Hakone (? *C. japonica* var *surugæ* Pils. + *C. eurystoma* subsp. *brachyptychia* Mlldff., both from Mikuriya, Suruga; also occurs at Kashiwa, Awaji).

C. SUBJAPONICA Pils. (= *C. fultoni* subsp. *clavula* Mlldff.). Ibuki, Omi; Tomisato, Kii (Hirase).

Group of C. brevior.

C. BREVIOR v. Mart. (*C. tetraptyx* Mlldff.). Misaki, Sagami (Hilgendorf); Yokohama (Schmacker); Tokyo (Stearns); Nikko, Shimotsuke (Loomis); Oshima, Izu, and Goto, Uzen (Hirase).

C. NIKKOENSIS Mlldff. Near Nikko (Eastlake).

C. HONDANA Pils. Coast of Prov. Suruga (F. Stearns).

C. JACOBIANA Pils. Tane-ga-shima and Yaku-shima, Osumi (Hirase).

C. ADDISONI Pils. Provinces Satsuma and Higo, Kiushiu.

C. S EARNSII Pils. Okinawa; Yayama (Hirase, Stearns).

C. STEREOMA Pils. Yakushima, Osumi, south of Kiushiu.

Var. COGNATA Pils. Tane-ga-shima, Osumi, south of Kiushiu.

Var. NUGAX Pils. Yaku shima.

Group of C. entospira.

C. EN:OSPIRA Pils. Tane-ga-shima (Hirase).

Section PSEUDONENIA Boettger.

C. SIEBOLDI Pfr. Kashiwashima, Tosa; Toyonishikami, Nagato; Sasebo, Hizen; Yatsushiro, Higo (Hirase).

Section EUPHÆDUSA Boettger.

Group of C. jos.

C. SUBGIBBERA Bttg. Japan.
C. EXPANSILABRIS Bttg.
Var STROPHOSTOMA Bttg. Interior of Nippon (Rein).
Var. NANA Bttg. Interior of Nippon (Rein).
C. ONCAUCHEN Mlldff. Tsu-shima (Fruhstorfer).

Group of C. shanghaiensis.

C. ACULUS Bens. Nagasaki (Rein); also China.
C. DIGONOPTYX Bttg. "Interior of Nippon" (Rein); Manabe, Hitachi; Takasaki, Kozuke; Yamaguchi, Tajima; Nishigo, Uzen.
C. TAU Bttg. (*C. proba* Mlldff., 1885, not A. Ad.). Kyoto (Rein, Hirase); Nohara and Gojo, Yamato; Takasaki, Kozuke (Hirase); Tokyo; Yokohama.
C. COMES Pils. Kashima, Harima (Hirase).
C. TRYONI Pils. Hachijo Island, Izu (Hirase).

Group of C. Hungerfordiana.

C. HUNGERFORDIANA Mlldff. Nara, Yamato.
C. MONELASMUS Pils. Kayabe, Ojima, Hokkaido.

Group of C. euholostoma.

C. EUHOLOSTOMA Pils. Mikuriya, Suruga (Hirase).
C. HOLOTREMA Pils. Nachi, Kii (Hirase).[8]

Section REINIA Kobelt.

C. VARIEGATA (A. Ad.). "Tago" (A. Ad.); Uweno, near Tokyo; Tokyo; Takasaki, Prov. Kozuke; Hirado, Hizen.
Var. NESIOTICA Pils. Hachijo Island, Izu.

[8] *C. holotrema* resembles *C. euholostoma*, but is larger, purplish-brown with a yellow belt below the sutures, the base yellowish. Principal and palatal plicæ longer. Whorls 8½. Alt. 12, diam. 3.2 mm.

Species of unknown subgeneric position.

The following forms have been too imperfectly characterized to permit their reference to subgeneric groups:

C. CINCTICOLLIS Ehrmann. Province Tosa, Shikoku.

C. CRASSILAMELLATA Ehrmann. Province Tosa, Shikoku.

C. GOULDII A. Adams. Tago.

C. IJIMÆ Ehrmann. Province Tosa, Shikoku.

C. LIRULATA A. Adams. Mososeki.

C. NODULIFERA v. Mart. Nippon, probably from near Yeddo (Dönitz). Based upon a single, perhaps abnormal, specimen.

C. PINGUIS A. Adams. Kino-o-sima.

C. PROBA A. Adams. Kino-o-sima.

C. SPRETA A. Adams. Tago.

C. STENOSPIRA A. Adams. Kino-o-sima.

C. STIMPSONI A. Adams. Tsu-sima and Awa-sima.

APPENDIX.

The following species have been received since the preparation of the foregoing list, bringing the number of recognized species to 99, with 37 subspecies or varieties; exclusive of 11 species of indeterminate position, enumerated above.

Section HEMIPHÆDUSA Bttg.

C. SUBIGNOBILIS Pils.[9] Hirado, Hizen (Y. Hirase).

C. TANTILLA Pils.[10] Goto, Uzen (Y. Hirase).

[9] *C. subignobilis* n.sp. Rather stout, fusiform, light brown, lightly striate, composed of 9½ whorls. Spire strongly attenuated above, the apex small. Aperture subtrapezoidal, the lip reflexed and thickened. Superior lamella rather small, inferior very deeply receding, subcolumellar emerging. Principal plica rather short. Lunella lateral, arcuate or bow-shaped. Length 15, diam. 3.3 mm. Like *C. ignobilis* Sykes, but with smaller early whorls.

[10] *C. tantilla* n.sp. Small, brownish, fusiform, striatulate, the last whorl distinctly striate; whorls 8, the second rather large. Aperture small, squarish-ovate, the lip well reflexed, somewhat thickened. Superior lamella small, inferior deeply receding, subcolumellar either immersed or emerging. Lunella oblique, united above with the middle of a short upper palatal plica. Length 9.5, diam. 2.5 mm.

C. AULACOPOMA Pils.[11] Hirado, Hizen (Y. Hirase).
C. BIGENERIS Pils.[12] Goto, Uzen (Y. Hirase).

Section TYRANNOPHÆDUSA Pils.

C. DALLI Pils.[13] Tairiuji, Awa, Shikoku Island (Y. Hirase).

Section STEREOPHÆDUSA Bttg.

C. UNA Pils.[14] Goto, Uzen (Y. Hirase.)

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[11] *C. aulacopoma* n.sp. Fusiform, slowly tapering above to a subacute apex, light reddish brown, weakly striatulate, the last whorl somewhat produced forward. Whorls 9½. Aperture piriform, the lip well reflexed, thickened. Superior lamella low; inferior deeply receding; subcolumellar emerging to the lip-edge. Principal plica long. Upper palatal plica short, joined in the middle to the lunella, which is curved inward below (j-like), with a nodule at its inner termination. Clausilium somewhat spout-like distally, but wider there than in species of the *ptychochila* group.

[12] *C. bigeneris* n.sp. About the size and shape of *C. ignobilis;* pale-brownish, faintly striate. Subcolumellar lamella immersed; lip broadly reflexed. Principal plica rather short, dorsal and lateral; upper palatal plica oblique, almost joined in the middle to a long, slender lunella, the lower end of which curves far inward. Length 14 3, diam. 3.5 mm.

[13] *C. Dalli* n.sp. With the general form of *C. mikado,* the aperture is much as in *C. iotaptyx.* Whorls 14 to 16. The subcolumellar lamella emerges strongly, and sometimes the lip is puckered above it. Lunella as in *C. bilabrata.* Length 18.5, diam. 4 mm. This exceedingly peculiar many-whorled Clausilia belongs to the group of *C. bilabrata* by its palatal armature, but in contour it resembles species of the group of *C. mikado.*

[14] *C. una* n sp. General contour of *C. oostoma* Mlldff., pale yellowish-corneous, striate. Whorls 11½. Entire interlamellar margin of the lip closely and deeply plicate. Upper palatal plica short, oblique; lower long and arcuate, a short, rudimentary lunella rising from it. An extraordinary *Stereophædusa,* with interlamellar plication like *Luchuphædusa callistochila.*

ZYGEUPOLIA LITORALIS, A NEW HETERONEMERTEAN.[1]

BY CAROLINE BURLING THOMPSON, PH.D.

I. INTRODUCTION.

At the end of August, 1899, four specimens of *Zygeupolia litoralis* were discovered by the writer at Wood's Hole, Mass. The following summer the worms were found in great abundance in the same locality, and from fifty to one hundred specimens were obtained.

The work on this paper has been mostly done in the Zoological Laboratory of the University of Pennsylvania, under the direction of Prof. E. G. Conklin and Asst. Prof. T. H. Montgomery, Jr., and it is a pleasure to express my thanks to both for their interest

[1] Contribution from the Zoological Laboratory of the University of Pennsylvania.

and generous assistance. To Dr. Montgomery, who has more directly supervised my work and kindly helped me in many ways, I am especially grateful. I would also thank Dr. C. O. Whitman for the courtesies extended me at the Marine Biological Laboratory at Wood's Hole, and I am indebted to Dr. Wesley R. Coe for many kindnesses.

METHODS.—Owing to the great contractility of the Nemerteans, it is best to use some stupefying agent before fixation, otherwise the specimen becomes so twisted that it is unfavorable for sectioning. After removing the slime sheaths with a needle, the worms were usually placed in a shallow dish of sea-water, and crystals of magnesium sulphate were slowly added. If dropped in too quickly they will irritate the worms and fragmentation will occur. In this solution the worms were left until they ceased to respond when touched, the time varying from one and a half to three hours, according to the amount of the sulphate. When the worms were sufficiently relaxed the water was drawn off, and the killing fluid added; or they were lifted out of the water with brushes and placed in the fixative.

The fixatives used are (1) corrosive sublimate, a concentrated solution in fifty per cent. alcohol, for thirty minutes; an excellent general fixative, and one that has been extensively used in this work. (2) Gilson's mercuro-nitric mixture, formula according to Lee (1896), for about half an hour; to be highly recommended, especially for the structure of gland cells and connective tissue. (3) Flemming's fluid (chromo-aceto-osmic acid), for twenty-four to sixty hours; especially good for nerve tissue and cilia. (4) Flemming's fluid (stronger mixture), for forty-eight hours, followed by pyroligneous acid for twenty-four hours. After employing this method the material may be sectioned and mounted without staining. It is excellent for tracing nerves, and for the gross anatomy of most parts, but it is not adapted for histological or cytological details, except for cilia. Specimens fixed in this way may afterward be stained with iron-hæmatoxylin, but the results are not so good as when Flemming's fluid alone is used. (5) Ninety-five per cent. alcohol; a good fixative, except for the body epithelium.

The stains used are Ehrlich's hæmatoxylin, undiluted, fifteen minutes to one hour, washed with alcohol containing a few drops of ammonia and followed by eosin in concentrated aqueous solution, three to five minutes. This is the stain that has been most used, and is a very satisfactory one. The longer time in hæmatoxylin is best for nerve fibrous tissue and epithelial structures. The Biondi-Ehrlich mixture, three hours, has been employed, but is not very satisfactory except for connective tissue. The iron-hæmatoxylin method together with Bordeaux red is an excellent stain after a Flemming fixation, and the Hermann triple stain—saffronin twenty-four hours, gentian violet six minutes, iodine three hours—has also been used.

Habitat.—*Zygeupolia* was found at Wood's Hole, in a sandy beach of limited extent, bordering on a little arm of Buzzard's Bay that is separated from the main bay by the point of land known as Penzance. Here, just in the angle made by the bay shore and Penzance, the sand has drifted in, replacing the usual stony or pebbly beach; and in this small area, which is uncovered at low tide, are found, together with many other marine worms, especially Annelids, several genera and species of Nemerteans. Both *Cerebratulus leidyi* Verr. and *C. lacteus* Verr. occur there, but the latter not abundantly; *Micrura cæca* Verr., *Cephalothrix linearis* Oers. and *Carinoma tremaphoros* Thomp. With such a rich supply of material in a spot very convenient to the Marine Biological Laboratory, it seemed unprofitable at that time to work over any other localities, so I am unable to say anything in regard to the distribution of *Zygeupolia*. Dr. Coe found this genus last summer in Quisset Harbor, about two miles farther north on Buzzard's Bay, in a very similar habitat.

When the sand, either above or below the low-water mark, is turned over, *Zygeupolia* may be found, usually about a foot below the surface. The turning up of the sand frequently breaks the worm, but a number of perfect specimens have been preserved.

The Living Worm.—In life the worms vary considerably in length, chiefly owing to different states of contraction, so that it is difficult to say accurately what the true length is. The same worm seems to have two normal states, beside that of actual contraction. The first is that of comparative rest, seen in Pl. XL, figs. 5, 6, which are sketches from living worms. In this condition, as when lying undisturbed in a dish of water, the average length is from 6–8 cm. But when in motion, crawling along the sides of the dish, the worm becomes greatly extended, so that the individual that in rest measured 6–8 cm. may now be 10–12 cm. or longer.

A change in color accompanies the elongation. At rest the body has a decidedly pink color; in extension the body is more transparent and dull brownish. This may be seen by comparing the extended worm in fig. 4 with figs. 5 and 6. As the pink color is most pronounced in the contracted condition, becomes less so at rest and disappears in extension, it is probably due to muscular contraction. The width varies in different specimens from $1\frac{1}{2}$–3 mm.; it also varies in the same specimen according to the state of contraction.

In the living worm, Pl. XL, figs. 4, 5, 6, four different regions may be distinguished: (1) the head, (2) the anterior part of the body, (3) the posterior part of the body, and (4) the caudicle.

The head is about 6 mm. long, not separated from the body, pure white and tapering to a very fine point. There are no lateral slits, the ciliated pits of the cerebral organs opening directly to the exterior. The mouth is a very small round opening on the ventral surface. The shape and color of the head, together with the absence of lateral slits, are good criteria for determining the genus.

The anterior part of the body is the region extending from the mouth to the beginning of the lobed middle intestine. The length is from $1\frac{1}{2}$–$3\frac{1}{2}$ cm., and the color varies from pale yellow to pinkish. It is rounded and more or less swollen, owing to the presence there of the greater part of the proboscis.

The posterior part of the body is the most extensive. It is somewhat flattened in life but is always rounded in preserved specimens. The color varies from rose color to pale yellow, light brown and chocolate brown. A pinkish median line on the dorsal surface represents the rhynchocœl; the alternating cross lines of light and dark on each side of the median line, fig. 5, are the gonads and intestinal cæca respectively.

A series of observations were made to ascertain if there are any appreciable color variations corresponding with sexual maturity or difference of sex. The conclusions reached are (1) that there is no difference in the color of sexually mature and immature individuals, except that the increased size of the gonads in the mature specimen causes the cross lines mentioned above to be more pronounced; (2) that the general color of the body is the same for males and females; (3) that the color of the intestinal cæca is dependent upon the amount and character of the food contents. The intestine in freshly taken worms is much darker in color than in specimens that have been kept in an aquarium for several days without food.

The caudicle in life appears as a slender white thread at the posterior end of the body, figs. 4, 5, 6. It is usually much twisted and is easily broken off. It should be mentioned here that in none of the four specimens that were first obtained in 1899 was the caudicle preserved, so that the presence of this appendage is not mentioned in my preliminary note, Thompson (1900 *a*).

The white spots in the posterior part of the worm, slightly exaggerated in fig. 6, are parasites and will be described under that heading.

On account of its transparency the living worm is a most favorable and interesting object for study with the low powers of the microscope. It should first be slightly stupefied to prevent excessive movements and contractions, so that when it is placed on the slide with a few drops of sea-water and covered, the muscles relax and it lies quietly there, fully extended. With a magnification of about 70 diameters, it is possible to study the brain lobes and commissures, the cerebral organs, the blood vessels of the head, the proboscis and rhynchodæum, the alimentary system and the gonads. In only two cases could the nephridia be distinguished, but nothing was determined as to their structure. Several attempts were made to study the worm by treatment with methylen blue, after the method of Bürger (1891, p. 327, footnote), but without success.

The results obtained from the study of the organs in life will be incorporated in the several sections relating to the different organ systems.

II. Anatomy.

Body Wall.—*a. Body Epithelium.*—The body epithelium, fig. 2, is a high one-celled layer, consisting of ciliated supporting cells, *S. C.*, and gland cells, $Gl._1$, $Gl._2$, resting upon a basement layer, *B.L.* Interstitial connective tissue cells are always present in varying numbers between the bases of the epithelial elements.

The supporting cells, fig. 14, are about .035 mm. in height, broad at the free distal ends where the cilia are borne, and tapering proximally to a slender stalk, *st.*, which constitutes about two-thirds of the length. In fig. 15, drawn from a sublimate preparation, the stalk is somewhat shrunken and appears less than half the length of the expanded distal part; in fig. 14, a Flemming's fluid preparation, the stalks are relatively longer, and probably more as they appear in life. The oval nucleus, *N.*, lies in the tapering part of the cell, just above the stalk. The chromatin forms a prominent reticulum.

The cilia, *Cil.*, are about as long as the expanded distal part of the cell. Each cilium is composed of several parts. The basal knob, fig. 14, *b.k.*, rests on the distal surface of the cell, and is connected by a fine thread with a second smaller granule, the upper knob, *u.k.*, which bears the terminal hair of the cilium. The cilium is continued into the cytoplasm by a line of very fine granules, fig. 14, *x.*, which seem to reach the nucleus. This, however, can only be seen with a very high magnification.

The gland cells are abundant in the body epithelium, and are uniformly distributed throughout the body. Two types may be distinguished, in the first the secretion stains with eosin, fig. 2, $Gl._1$, in the second with hæmatoxylin, fig. 2, $Gl._2$. In both types a delicate cell membrane is present, the nucleus is small and lies at the base of the cell embedded in cytoplasm. The relative amounts of cytoplasm and secretion depend upon the phase of the cell. In fig. 2 the blue-staining cell on the left contains less secretion and more cytoplasm, and is therefore in an earlier phase than the blue-staining cell to the right. In like manner, the red-staining cell on the right of the figure contains less secretion and is in an earlier stage than the red-staining cell on the left. The red-staining secretion is homogeneous, evidently fluid or viscous; the blue-staining secretion apparently contains flaky masses within a fluid. The latter cells are more apt to assume the flask-like shape, the former are oftener rod-shaped. Cells are frequently found with the secretion entirely discharged from the delicate cell membrane, the nucleus remaining at the base.

The basement layer, fig. 2, *B.L.*, separates the epithelial cells from the underlying musculature. It is not a true basement membrane, being not the product of the bases of the epithelial cells, but a formation from the interlacing fibres of connective tissue cells. The nuclei of the component connective tissue cells are seen with difficulty, but occur here and there embedded in the fibres. With a low power the basement layer has a homogeneous, rather gelatinous appearance, but with higher magnification its true fibrous structure is seen. The average height of the basement layer in the head region is about .006 mm., but it is not a layer of uniform thickness, for its outer surface is thrown into a series of small elevations and depressions. The ridges on the surface bear the stalks of the supporting cells, while the gland cells are inserted into the pits or depressions. The basement layer does not stain with hæmatoxylin-eosin, but takes a faint pink with the Biondi-Ehrlich stain.

An epithelial musculature of circular muscle fibres, fig. 2, *Ep.m.*, is present immediately beneath the basement layer. It is especially well developed in the head region, consisting of a number of fibres like those of the body wall. Posterior to the œsophageal region the epithelial muscle layer becomes very thin and finally disappears, but reappears at the posterior end of the body.

b. The Cutis.—The cutis is defined by Bürger (1895) as the subepithelial glandular layer, usually containing numerous muscle fibres, which is found in the Heteronemerteans.

In *Zygeupolia* any distinction between the outer longitudinal muscle layer and the cutis would be merely an artificial one. The fibres of the outer longitudinal muscle layer extend from the circular layer out to the epithelium of the body wall, and although subepithelial gland cells are present, frequently in great numbers, they are not restricted to the peripheral portion of the layer, but often extend in as far as the circular muscle. It is thus evident that in *Zygeupolia* the term cutis is synonymous with outer longitudinal muscle layer. In this respect *Zygeupolia* differs greatly from the genus *Eupolia*, in which a cutis distinct from the outer longitudinal muscle layer is present.

The finer structure of the cutis, or of the outer longitudinal muscle layer, may be seen in fig. 2. Each longitudinal muscle fibre, *L.M.f.*, is surrounded by a sheath of connective tissue, composed of the slender processes of the connective tissue cells which are present between the muscle fibres. These cells are greatly branched, their nuclei, *Cn.T.N.*, are oval, and contain a small amount of chromatin. Slender radial muscle fibres, *r.m.f.*, traverse the cutis, and here and there detached circularly running fibres, *M.s.*, occur.

The subepithelial gland cells, or, as Bürger terms them, the cutis gland cells, are present throughout the body in the outer longitudinal muscle layer. Two, and possibly three, types of glands may be distinguished.

The first type is a multinucleate structure, fig. 2, *Cu. Gl.*$_2$, staining with hæmatoxylin. Such a gland is the probable result of the fusion, phylogenetically, of several simple cells. The proximal portion resembles a bunch of grapes, each grape representing a cell with its nucleus ; the distal part is a long, slender duct, opening to the exterior between the epidermal cells. The length of the blue-staining cells varies in different parts of the body. In the head region, fig. 2, they are very long, extending in from the epithelium nearly to the rhynchodæum. In the posterior part of the body, fig. 15, *Cu. Gl.*$_2$, their length has diminished more than one-half.

The second type is a cell, staining red with eosin, having the shape of a very slender flask with a long neck, figs. 2, 15, *CuGl.*$_1$. Only one nucleus is present, at the basal end of the cell, and a delicate cell membrane may be distinguished.

Two quite distinct appearances have been observed in the red-staining cells. These may be morphologically different cells, or merely phases of the one type. In the one, figs. 2, 15, *Cu. Gl.*$_1$, the granules are very fine, close together, and stain a rose red; in the other, fig. 15, *Cu. Gl.*$_{11}$, the granules are large, rounded and a brighter, more metallic red. The facts that no transition stages have been observed, and that the two varieties have a slightly different distribution, may indicate that they are morphologically different.

The distribution of the cutis gland cells is a point of some interest and, so far as I am aware, has not been worked out in any detail among the other Nemerteans. In certain parts of the body the gland cells are aggregated into very prominent zones, and it seems probable that these glandular areas have some important physiological function, which is as yet undetermined, aside from the usual one of producing the slime sheath for the body.

Diagram 1 illustrates the distribution of the cutis gland cells.

It is seen here that the most anterior part of the head is entirely free from cutis gland cells, but that about 0.5 mm. behind the tip the blue-staining cells are very abundant, distributed uniformly on all surfaces of the body. The red-staining cells occur in small numbers and are mostly on the ventral surface; they are of the finely granular variety. From the mouth back to some distance behind the nephridia the blue-staining cells are quite numerous, interspersed with the red-staining cells. Just behind the great rhynchocœlomic expansion, where the circular muscle of the body wall is considerably thickened, comes a region that might properly be called a *glandular zone*, *Gl. Z.*, owing to the enormous increase in the number of the cutis gland cells. The whole outer longitudinal muscle layer is so crowded with them that in a cross section the muscle fibres seem nearly obliterated. The cells increase also in size, or perhaps are more distended with secretion. The blue-staining cells are more abundant than the red. This zone extends backward for about 3 mm., then suddenly ends, just in front of the two lateral grooves, *L. G.*

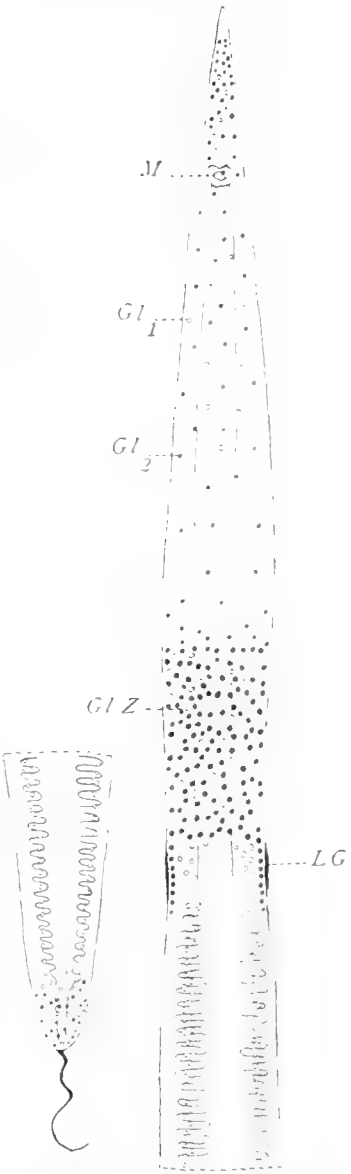

Diagram 1.—The head and part of the body of *Zygeupolia*, illustrating the distribution of the cutis gland cells.—The outline of the alimentary tract is given as a means of orientation. $Gl._1$, red-staining cutis gland cell; $Gl._2$, blue-staining cutis gland cell; *Gl. Z.*, glandular zone; *L. G.*, lateral groove; *M.*, mouth.

In the lateral groove region, fig. 23, $Cu. Gl._1$, $Cu. Gl._2$, the blue cells are confined to two tracts, one on each side of the body, above the lateral nerves. The red-staining cells are in four tracts, dorsal and ventral to the blue tracts. The red-staining cells in this region and in the preceding *glandular zone* are of the coarse granular variety.

After the beginning of the middle intestine and its pouches, the blue-staining cells are no longer present, except at the most posterior end of the body. The four tracts of red-staining cells, however, continue along the entire length of the intestine. Owing to the increased size of the intestinal cæca and the gonads, the body wall is stretched and the muscular layers are thin, so that the red gland cells can reach down only a short distance, and are consequently short, often appearing more like epithelial cells.

At the extreme posterior end of the body both red and blue cells are present in great numbers all around the body. The red cells are the more abundant, and are considerably larger than the blue (see fig. 15). Both fine and coarse varieties occur.

There is no cutis in the caudicle, so that cutis gland cells are necessarily absent.

c. The Body Musculature.—The entire region of the head in front of the brain, Plate XLI, fig. 18, from the epithelium, *Ep.*, in to the rhynchodæum, *Rd.*, is made up of longitudinal muscle fibres, *L.M.*, with interlacing radial muscle fibres, *r.m.f.* Except for the cerebral nerves, *C.N.*, and the cutis gland cells, $Cu.Gl._2$, and probably some very fine blood lacunæ, no other organs are present. The wall of the rhynchodæum, which will be described under that heading, contains four stout bundles of longitudinal muscle, *Rd.M.*

Just anterior to the attachment of the proboscis to the body wall, the inner ends of the radial fibres interlace more closely about the rhynchodæum, until a ring of circular muscle, fig. 18, *C.M.*, is formed, which becomes the circular muscle of the proboscis sheath. Behind the attachment of the proboscis, fig. 19, *y.*, the outermost circular fibres separate off from the rest, thus forming the circular muscle of the body wall, fig. 19, *C.M.*, outside the proboscis sheath. The longitudinal fibres lying between, fig. 20, *i.L.M.*, represent the beginning of the inner longitudinal muscle.

Both dorsal and ventral brain lobes, fig. 19, *D.L.* and *V.L.*, lie outside the circular muscle, *C.M.*, in the outer longitudinal layer; but the cerebral organs, fig. 21, *C. Org.*, which are directly behind the dorsal lobes and receive their nerve supply from them, lie within the circular muscle, in the inner longitudinal layer. At the posterior end of the dorsal lobes the following changes may be noted. The circular fibres, figs. 19, 20, *C.M.*, at first all run along the inner surface of the end of the dorsal ganglion and beginning of the cerebral organ, then a few fibres bend out and curve around the sense organ on its outer side, until finally all the muscle fibres lie on the outside of the cerebral organ, fig. 21, *C.M.* The ventral ganglia lie as before, outside the circular muscle.

Just in front of the mouth a strong band of muscle, fig. 21, *H.M.*, runs from side to side, beneath the rhynchocœl and above the median blood vessel.

In the œsophageal region, fig. 22, there is nothing unusual in the structure of the muscle layers; the outer longitudinal, *o.L.M.*, is the thickest, and next the circular, *C.M.* This arrangement continues past the nephridia into the region of the expanded rhynchocœl, where all layers of the body wall are greatly stretched, and consequently very thin.

A short distance anterior to the middle intestine the rhynchocœlomic dilation ceases and the diameter of the rhynchocœl is about equal to that of the œsophageal region, while its walls are frequently folded and constricted. In this part of the body the circular muscle of the body wall becomes greatly thickened (see Plate XLIV, fig. 62, *C.M.*).

Inner Circular Muscle.—Fig. 23, Plate XLI, is a cross section of the body just anterior to the beginning of the middle intestine. The diameter of the body is less than in the œsophageal region (cf. fig. 22), and much less than in the great expanded portion which is not figured. The outer longitudinal muscle in fig. 23 needs no description; the circular muscle is relatively thicker than in the anterior part of the body, but not greatly enlarged. The circular muscle of the proboscis sheath has increased greatly in size and some of its outer fibres run ventrally, making a band of circular muscle, *i.C.M.*, that encircles the stomach, *S.* Other fibres, apparently from the circular muscle of the body wall, join with these, running dorso-ventrally, and crossing the inner longitudinal layer dorsally and ventrally. In short, *an inner circular muscle layer is here present; and muscular crosses occur between it and the outer circular layer, both dorsally and ventrally* (see fig. 23, *D.m.cr.*, *V.m.cr.*). A few sections posterior to the one figured in fig. 23, the inner circular muscle layer suddenly ends and the first pair of cæca of the middle intestine appear. On examining the sections anterior to fig. 23, it is found that the inner circular muscle extends forward for about 1.8 mm. as a very thin layer of a few fibres (see Plate XLII, fig. 30, *i.C.M.*), the thickened region, as in fig. 23, only extending over a few sections.

At its beginning the inner circular muscle, as seen in cross sections, measures about .006 mm. dorso-ventrally; over the greater part of its extent the measurements range from .012–.017 mm.; then suddenly increase from .023 to .06 in about five sections of 6μ each; finally just before the end, fig. 23, the layer is .087 mm. thick.

The inner circular muscle encloses a band of longitudinal muscle fibres on the dorsal side of the stomach, below the rhynchocœl, Plate XLII, figs. 23, 30, *i.L.M.*

The fibres of the inner circular muscle layer are direct continuations of fibres from the circular layer of the proboscis sheath. Furthermore, in the anterior part of the layer, the fibres come from the inner surface of the proboscis sheath, bend out, cross the outer fibres and then continue down around the stomach. This bending out and crossing is shown in fig. 30, *z.* In a more posterior position, the inner circular layer becomes thicker and consists of fibres from the outermost part of the proboscis sheath, together with fibres from the circular muscle of the body wall. It is thus seen that the partial origin of the inner circular muscle layer of *Zygeupolia* from the proboscis sheath circular muscle is beyond a doubt.

An inner circular muscle layer has not been heretofore described, as such, for any Heteronemertean. I have found a very similar layer in *Micrura cæca*, with a considerable thickening at the posterior end, but this has not been mentioned in any published work, so far as I am aware. Coe (1901) describes in *Micrura alaskensis* a structure that might properly be called an inner circular muscle layer. He says, p. 72: "The delicate layer of circular and longitudinal muscular fibers which surrounds the epithelial lining of the esophagus in most of the Heteronemerteans becomes remarkably developed in this species. At the very posterior end of the esophagus—just anterior to the first intestinal pouches—the circular muscles of the esophagus increase so greatly in number that they form a most conspicuous layer. In the region of its maximum development this layer becomes nearly half as thick as the circular layer of the body walls in the same section. In no other species of the Lineidæ has this muscle been found of even approximately this thickness. Its fibers connect in part with the circular layer of the body walls and to a lesser degree with the circular muscles of the proboscis sheath. But few fibers lie on the dorsal wall of the esophagus, so that this organ is largely bound up with the proboscis sheath in a continuous layer of muscles, and one cannot fail to see the striking resemblance between this circular layer and the inner circular muscles that are so highly developed in precisely the same region in *Carinoma*."

Since, as Dr. Coe says, the resemblance between this muscular layer and the inner circular layer of *Carinoma* is so striking, why should we not regard them as one and the same structure, that is, as homologous? In what particulars do they differ?

Bürger (1895), p. 234, gives the following definition for the inner circular muscle layer of the Protonemerteans and *Carinoma*. "Die Leibesmusculatur. Zu dieser rechne ich einen aus Ringfibrillen zusammengesetzten Muskelschlauch, welcher bei den Protonemertinen, vor allem bei *Carinina grata* und *Carinella polymorpha*, *superba* und *linearis*, und unter den Mesonemertinen bei *Carinoma armandi* um Vorderdarm und Rhynchocölom entwickelt ist, diese beiden Hohlcylinder einschliessend. Diesen Muskelschlauch nenne ich die innere Ringmuskelschicht." Bürger also states that the fibres of the inner circular muscle differ in no way from those of the body wall.

Bürger further speaks, p. 235, of the crossing of fibres that frequently occurs in the dorsal and ventral median line of the body, between the inner circular and the outer circular layer of the body wall. "Eine sehr merkwürdige Erscheinung wird dadurch hervorgerufen, dass die innere Ringmuskelschicht in Beziehung zur äusseren Ringmuskelschicht, also der Ringmuskelschicht des Hautmuskelschlauchs tritt. Das geschieht, indem dorsal und ventral in der Medianebene des Thierkörpers von links und rechts Muskelfasern aus dem Verbande beider Ringmuskelschichten heraustreten, und, die Längsmuskelschicht des Hautmuskelschlauchs durchdringend, die von der einen Ringmuskelschicht kommenden über Kreuz an die andere hinantreten."

The definition, then, of the inner circular muscle is a layer of circular muscle fibres that encloses the rhynchocœl and anterior intestine, the individual fibres being just like those of the body wall.

Since there is a common agreement with Bürger's definition among the three muscle layers under discussion, namely, that in *Micrura alaskensis*, that in *Zygeupolia*, fig. 23, *i. C. M.*, and that in *Micrura cæca;* and furthermore, since all three layers have muscular crosses between themselves and the circular muscle of the body wall, I can see no reason why each should not with all propriety be termed an inner circular muscle layer, homologous with that of the Proto- and Mesonemerteans.

The only difference between the inner circular muscle layer of *Zygeupolia* and that of the Carinellas and *Carinoma* is in the amount of surrounding connective tissue, the body "parenchym" of Bürger. In *Zygeupolia* this tissue is present only around the blood vessels, so that the inner circular muscle layer adjoins the inner longitudinal muscle layer, except where the blood vessels intervene. In this particular *Zygeupolia* resembles *Carinina*, for in *Carinina* the inner circular muscle borders directly on the longitudinal muscle, and there is no intervening layer of "Leibesparenchym."

The presence of the inner circular muscle layer and the muscular crosses in *Zygeupolia* and *Micrura* is important when viewed from a phylogenetic standpoint. This peculiar region of the body, just in front of the middle intestine, is by far the most interesting part of the whole trunk, for it has unaccountably remained in a primitive condition, as comparison with other Nemerteans will show.

Diagram 2 is a representation of the stages, illustrated by living, more primitive genera, through which the inner circular muscle of *Zygeupolia* and *Micrura* may have passed. A, represents the most primitive condition, found in *Carinella annulata*, in which the inner circular muscle is a thin layer of uniform thickness, extending throughout the body; in B, *Carinella polymorpha*, the muscle is co-extensive with the body, but is thickened in a certain region; in C, *Carinella linearis*, the muscle ends shortly behind the thickened region; in D, *Carinoma*, the muscle ends

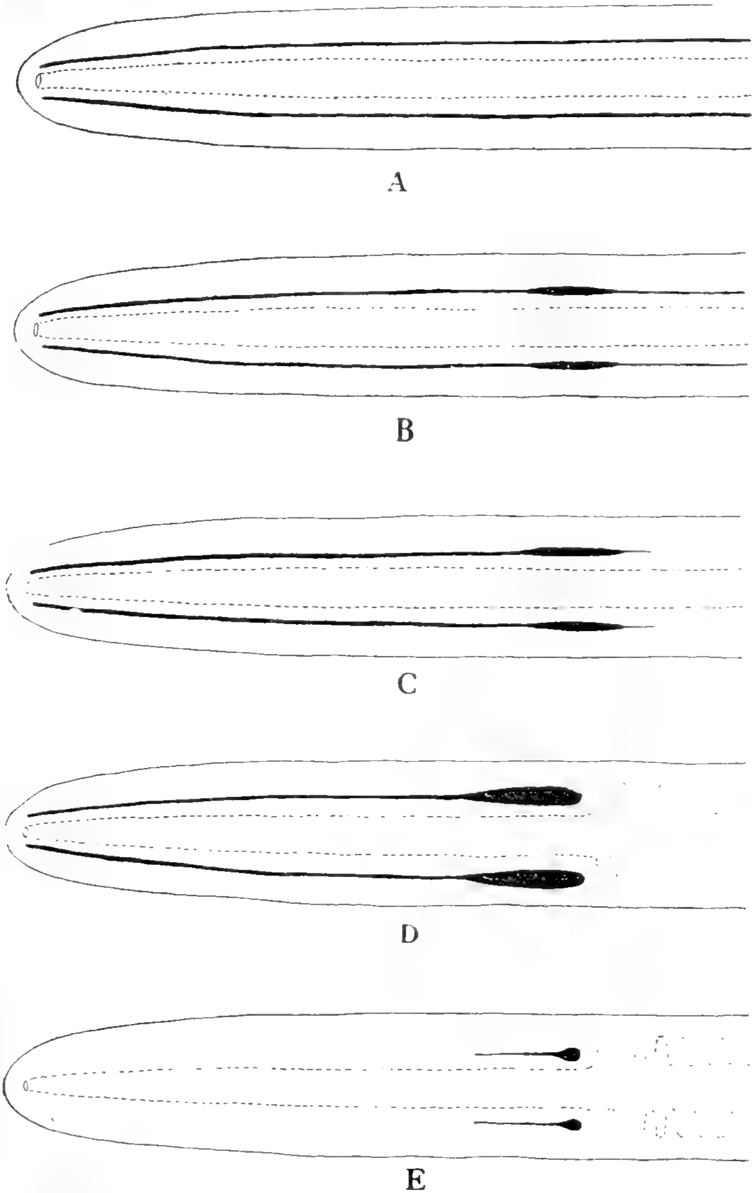

Diagram 2.—Showing the comparative extent of the inner circular muscle layer in certain Nemerteans.—A, *Carinella annulata ;* B, *Carinella polymorpha ;* C, *Carinella linearis ;* D, *Carinoma ;* E, *Zygeupolia* and *Micrura cæca.* The heavy lines represent the extent of the inner circular muscle, the broken lines the outline of the alimentary tract.

with an enormous thickening just in front of the middle intestine; E, shows the condition in *Zygeupolia* and *Micrura*. In the last two forms the inner circular layer is absent from the entire œsophageal region, and is represented merely by the thickened part in front of the middle intestine, and a short, thin, anterior extension of this.[2]

In this connection it is interesting to note that in *Cephalothrix aliena*, a new species from the Maldive Islands recently described by Punnett (1901 *a*), a very delicate inner circular muscle layer is present in the œsophageal region.

From the facts just enumerated it is evident that the inner circular muscle of the Heteronemerteans may be regarded as the remnant of a layer once continuous throughout the body.

The accompanying table shows the comparative extent of the inner circular muscle layer in the different genera in which it occurs.

The second part, relating to the muscular crosses between inner and outer circular layers, shows that there is great variation in this respect in the genus *Carinella*.

[2] The facts in regard to the distribution and structure of the inner circular muscle in the genus *Carinella* have been obtained from Bürger's monograph.

	Inner Circular Muscle.		Crosses between Inner Circ. Muscle and Outer Circ. Muscle.	Position of Crosses.
	Structure.	Extent.		
Carinina grata,	thicker in nephridial region	throughout body (?)	ventral cross only	in region posterior to nephridia
Carinella— a. *superba*,	uniform thickness	throughout body	dorsal and ventral	throughout body
b. *annulata*,	uniform thickness	throughout body	dorsal only	throughout body
Carinella banyulensis,	thinner in nephridial region	throughout body	dorsal cross only	in nephridial region
Carinella rubicunda,	thinner posterior to nephridial region	throughout body	wanting	
Carinella polymorpha,	thicker in nephridial region, very thin posterior to nephridia	throughout body	dorsal cross faint, ventral cross wanting	throughout body
Carinella linearis,	thicker in nephridial region, thin posterior to nephridia	from the mouth to nephridia, and a short distance behind them	wanting	
Callinera bürgeri Berg.,	thinner behind "rhynchocœl muscle sack"	from the mouth to close behind the "rhynchocœl muscle sack"	wanting	
Hubrechtia,	uniformly thin	throughout body (?)	wanting	
Carinoma,	great thickening at nephridia	from mouth to end of nephridial region	dorsal and ventral	from the mouth to end of nephridial region
Cephalothrix aliena Punnett,	very thin, delicate layer	œsophageal region only	(?)	
Zygeupolia,	absent in œsophageal region, appears as a thin layer about 2 mm. anterior to middle intestine, very thick at posterior end	extends forward for 2 mm. just anterior to middle intestine	dorsal and ventral	at posterior end of the inner circular muscle
Micrura,	absent in œsophageal region, appears as a thin layer a short distance in front of the middle intestine, quite thick at posterior end	extends forward a short distance in front of middle intestine	dorsal and ventral	at posterior end of the inner circular muscle

The question now arises, can the so-called "œsophageal muscle" (Darmmusculatur, Bürger) be correlated in any way with the inner circular muscle?

Bürger (1895), p. 257, speaks of a musculature ("Darmmusculatur") that is developed in the Meso-, Meta- and Heteronemerteans around the posterior part of the œsophagus, consisting of both longitudinal and circular fibres, the fibres being more slender than those of the body wall.

On p. 237 the same writer says that the dorso-ventral fibres that occur so frequently between the intestinal cæca, and also in the anterior part of the body, may be regarded as parts of a formerly continuous inner circular muscle layer. "Wir können die dorsoventrale Musculatur als eine innere Ringmuskelschicht, welche in lauter, in gewissen Abständen aufeinanderfolgende Ringe zerlegt wurde, vorstellen." He adds that sections of *Eupolia* and *Lineus geniculatus*, the latter figured on Taf. 20, Fig. 7, strengthen this opinion. In *L. geniculatus* the dorso-ventral fibres have bent around the intestine, on its dorsal as well as on its ventral face, making a continuous ring of circular muscle, and a crossing between these fibres and the circular muscle of the body wall takes place in the median ventral line.

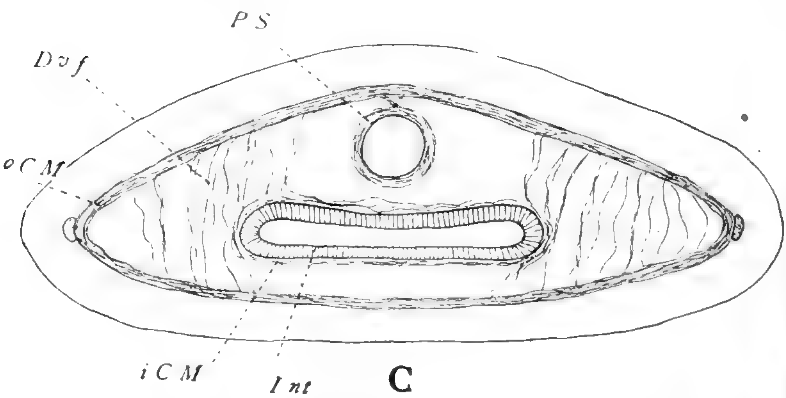

Diagram 3.—Cross section through the body of *Cerebratulus lacteus*, illustrating the deflection of the dorso-ventral muscle fibres into the inner circular muscle layer around the intestine.—*P.S.*, proboscis sheath; *o. C.M.*, outer circular muscle; *Int.*, intestine; *i. C.M.*, inner circular muscle; *Dv.f.*, dorso-ventral muscle fibres.

From my own observations upon *Cerebratulus lacteus*, *Lineus lacteus* and a *Lineus* sp., all preparations kindly lent by Dr. Montgomery, I find there is frequently quite a considerable layer of circular muscle fibres beneath the intestine, and also on its dorsal side. These fibres may be almost invariably traced out of the circular sheath around the intestine into dorso-ventral fibres coming from the circular muscle of the body wall, or else into the circular muscle of the proboscis sheath. This is illustrated by Diagrams 3 and 4. The same is true in regard to the scattered fibres occa-

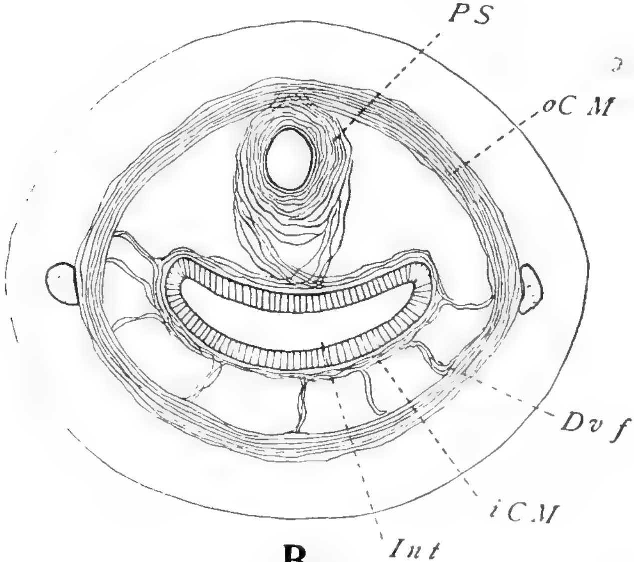

Diagram 4.—Cross section through the body of *Lineus* sp.; illustrating the deflection of the dorso-ventral muscle fibres into the inner circular muscle layer around the intestine.—*P.S.*, proboscis sheath; *o.C.M.*, outer circular muscle; *Int.*, intestine; *i.C.M.*, inner circular muscle; *Dv.f.*, dorso-ventral muscle fibres.

sionally found above or below the œsophagus in *Zygeupolia*, which come from the body wall or the proboscis sheath, see Diagram 5.

It therefore seems that, if we accept the view of Bürger that the dorso-ventral fibres are derived from an original inner circular muscle layer, we may profitably go a step farther and say that the " Darmmusculatur " or " œsophageal muscle," found around the dorsal as well as the ventral side of the œsophagus, is derived from the dorso-ventral fibres which have turned aside from their dorso-ventral course and have curved around the œsophagus so as to partially encircle it. If this is accepted we may then say that the " œsophageal muscle " is secondarily derived from the inner circular muscle, two steps being involved in the phylogeny: first, the inner circular layer breaks up into detached groups of dorso-ventral fibres, then the latter turn out of their course and bend around the intestine to form the encircling "œsophageal muscle."

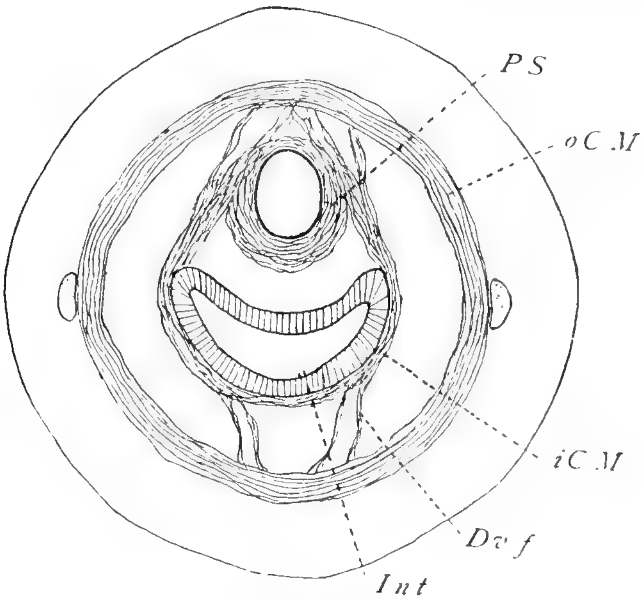

Diagram 5.—Cross section through the body of *Zygeupolia*, illustrating the deflection of the dorso-ventral muscle fibres into the inner circular muscle layer around the intestine —*P.S.*, proboscis sheath; *o.C.M.*, outer circular muscle; *Int.*, intestine; *i.C.M.*, inner circular muscle; *Dv.f.*, dorso-ventral muscle fibres.

This view is foreshadowed by Hubrecht (1887), p. 71, where he says: "I will not at present attempt to decide whether any of the muscular layers of the œsophagus, noticed both in *Eupolia* and *Cerebratulus*[3] (Pl. VI, fig. 9, *œ.m.*; Pl. XIII, fig. 6, *mto.*), may also be looked upon as derivatives of this inner circular layer . . . .;" and "Here, too [alluding to the Schizonemerteans], I would be tempted to hazard a comparison between the absent inner circular layer and the musculature of the proboscis sheath."

To briefly summarize my views in regard to the presence and

[3] The *Cerebratulus* here alluded to is *C. corrugatus* = *Lineus corrugatus*, described by M'Intosh (1879).

origin of the inner circular muscle layers in the Heteronemerteans: (1) the more or less delicate layer of circular muscle fibres encircling the alimentary tract in the œsophageal region of *Zygeupolia* and *Micrura* is a primitive structure, the remnant of a once extensive layer; (2) further investigation will probably demonstrate the presence of similar primitive remnants of an inner circular muscle layer in other Heteronemertean genera; (3) the "œsophageal muscle" fibres that frequently encircle the alimentary tract in the higher Lineidæ are continuations of deflected dorso-ventral muscle fibres. They are not primitive but of more recent structure, secondarily derived from the inner circular muscle layer by a breaking down of the latter into groups of dorso-ventral fibres.

The inner circular muscle layer ends with its great thickening just in front of the beginning of the middle intestine, so that posterior to this region the body musculature consists of the usual three layers—outer longitudinal, circular and inner longitudinal (see figs. 24, 25, 26)—which are very thin in the region of the gonads.

Histology of Muscular System.—Very little need be said in regard to the histology of the muscle. Each muscle fibre, as Bürger first demonstrated in 1890, is a single cell. The nuclei are long and stain deeply.

In Plate XL, fig. 13 is shown a portion of the circular muscle layer from the posterior end of the body, drawn from a section stained with iron-hæmatoxylin. At regular intervals, dark areas, *contr.*, are seen, alternating with light areas. The dark portions represent the most contracted part of the layer, the light a region of less contraction, or of rest. In the middle of the light areas, very faint indications may be seen of a smaller region of contraction. The contraction caused by fixation has evidently occurred in waves, as the regular intervals show. These contracted areas were first noticed in the Nemerteans by Hubrecht (1887).

Wagener (1863) describes "striated" muscle from a Nemertean, the genus of which is not mentioned. He says the striated areas ("Querstreifungen") alternate with thinner, lighter parts, and that the cross-striping merges into a non-striated portion. A fibre separated from the bundle has a series of swellings ("Anschwellungen") on its surface. Wagener's Fig. 1, Taf.

IV, shows that what he regards as cross striations are evidently merely swollen, *i.e.*, contracted areas of the fibres.

2. THE NERVOUS SYSTEM.—*a. Anatomy.* — Bürger (1895) divides the nervous system of the Nemerteans into a central and a peripheral system. The former comprises the brain and lateral nerve chords, which have a thick investing layer of ganglion cells; the latter, all other nerves and nerve layers, provided with a thick ganglion cell envelope. Montgomery (1897 *b*), p. 382, includes in the central nervous system all parts provided with ganglion cells, namely: "(1) the dorsal and ventral brain lobes and commissures; (2) the lateral nerve chords . . . ; (3) the paired œsophageal nerves; (4) the longitudinal nerves of the proboscis . . . ; (5) the dorsal, unpaired, larger median nerve of the body wall; and probably also (6) the lesser, unpaired median nerve."

The anatomy of the brain of *Zygeupolia* may be readily studied in life from a specimen compressed beneath a cover glass, for the head is so transparent that the parts are easily distinguished (see figs. 1, 16). The brain lies about 4 mm. behind the tip of the head, directly in front of the mouth, encircling the rhynchocœl, and consists of four lobes or ganglia of about equal size, two dorsal and two ventral. Viewed from the dorsal surface, the dorsal lobes, fig. 16, *D.L.*, are most prominent, and at their posterior ends are situated the pear-shaped cerebral organs, *C. Org.*, which are about one-third the length of the dorsal lobes and about one-half their width. The dorsal lobes are connected above the rhyn chocœl by a slender commissure, which is very difficult to see in life, figs. 1, 16, *D. Comm.*, but is easily made out from sections. Its dorso-ventral measurements vary in different specimens from .04–.07 mm., probably owing to different states of contraction, or to the plane of the section. In the sections of one specimen, fig. 19, the dorsal commissure appeared to be composed of fibres coming from both dorsal and ventral lobes, an unusual condition, and one not previously described in Nemerteans, so far as I am aware. The ventral lobes are united by a stout commissure, about 14 mm. measured dorso-ventrally, that in life may be plainly seen, figs. 1, 16, shining through the rhynchocœl, which lies above it, and extending backward posterior to the dorsal commissure. Measured from side to side, both commissures are short, owing to the close proximity of the brain lobes. The dorsal and ventral lobes of each side are connected anteriorly, as may be seen from sections, but the connection ends just posterior to the end of the ventral commissure, and from this point backward the dorsal and ventral lobes are quite separate. In life the ganglion cell layer appears distinct from the fibrous core of the brain and lateral chords, the former as a greenish-yellow investing layer, the latter as a clear silvery-gray central mass.

From sections it may be seen that both dorsal and ventral lobes are continued forward into the tip of the head as numerous slender nerves, which are approximately represented in Plate XL, fig. 1. No especial nerve endings have been observed. The dorsal lobes terminate as such just in front of the cerebral organs, and from their posterior ends arise the nerves that supply the cerebral organs. Immediately in front of the cerebral organ, the dorsal lobe gives off on its dorsal side a horn or prolongation of the fibrous core surrounded by ganglion cells. This horn ends shortly and is replaced posteriorly by the cerebral organ, but there is no connection between the two structures, for the cerebral organ derives its nervous matter from the ventral part of the dorsal lobe. The cerebral organ nerve enters the cerebral organ on the ventral side and afterward branches and ramifies, so that the nervous material is well distributed throughout this sensory organ.

The ventral lobes are continued backward throughout the body and caudicle as the lateral nerve chords ("Seitenstämme"), fig. 1, *L.N.*, but do not unite posteriorly in an anal commissure.

The paired œsophageal nerves, fig. 16, *Oe.N.*, arise from the ventral lobes in the same frontal plane as the cerebral organs, but considerably ventral to them. A slender commissure, fig. 16, *Oe.N. Comm.*, is formed between them, .03 mm. behind their origin, outside the circular muscle layer, just anterior to the mouth, *M.* Behind the commissure the nerves pass through the circular and inner longitudinal muscle into the tissue around the mouth, occasionally giving off branches, and continue backward into the œsophageal region. Here they break up into numerous fine branches which ramify in the walls of the œsophagus, not only on the ventral side but also laterally, and which are very abundant on the dorsal side.

From the dorsal commissure arises the median unpaired upper dorsal nerve, first termed by Hubrecht the "Rüsselscheidennerv," later the "medullary nerve;" by Bürger denominated the "oberen Rückennerv." The dorsal nerve extends throughout the body and ends about .06 mm. in front of the anal opening. No connection could be traced between the end of the dorsal nerve and the lateral nerves, but it is probable that a delicate plexus exists. The position of the dorsal nerve is constant, just above the circular muscle in the median plane of the body. A second dorsal nerve ("Rüsselscheidennerv," Hubrecht; "unterer Rückennerv," Bürger), separates off from the first shortly after its origin, passes inside the circular muscle of the body wall and lies just above the proboscis sheath. Both nerves are of fair size, about .017 mm. in diameter in the anterior part of the body, but both become much enlarged in the region of the muscular crosses between the greatly thickened inner circular muscle and that of the body wall, Plate XLI, fig. 23. Here for a short distance the diameter of the inner nerve reaches a thickness of .03–.06 mm. There is considerable variation in the respective sizes of the two nerves in different specimens. Sometimes the upper nerve is the larger one, but more often the lower nerve attains the greater size. The greatest size observed was in a specimen whose lower dorsal nerve measured .117 mm. dorso-ventrally and .058 mm. across; the upper dorsal nerve measuring .017 mm. in both directions. This enlarged condition coincided with the thickest part of the inner circular muscle layer. The same coincidence has been noted in the Protonemerteans and *Carinoma* by Hubrecht (1887), who says, p. 80: "The fact that in this (œsophageal) region of *Carinoma* the proboscidian sheath-nerve comes into the foreground so strongly that it might easily be mistaken for the medulla, may probably be ascribed to the massive development of the inner circular muscular layer δ, which in *Carinina*, *Carinella* and *Carinoma* acts at the same time as part of the wall of the proboscidian sheath. The fact was already noticed as a peculiar feature of the species by M'Intosh (1875), when he first described *Carinoma* (under the name of *Valencinia armandi*)." Posterior to the region of the inner circular muscle the two dorsal nerves resume their normal size, and then gradually decrease until they terminate near the end of the body.

Throughout the greater part of the body the lateral nerves are connected with each other and with the upper dorsal nerve by a nervous layer of fibrous substance ("plexus" of Hubrecht, "Nervenschicht" of Bürger), situated outside the circular muscle. It is especially strong in the œsophageal part of the body, and in the inner circular muscle region, fig. 23, *n.p.* Posteriorly the layer is very thin, or may be entirely absent.

In one specimen a peculiar condition of the lateral chords was observed, Plate XLIV, fig. 62, *L.N.* A part of the fibrous substance extends toward the centre of the section in between the fibres of the circular muscle, *C.M.*: the fibres in the same radial line as the nerve are bent out of their course, and in the space thus formed is the apparent branch of the nerve, running inward. This condition was not confined to a few sections, but extended over several slides, a distance of at least 1.5 mm. It at first seemed as if a series of nerves was being given off from the inner lateral face of the nerve chord, instead of from the dorsal and ventral sides, the usual method in Nemerteans (Bürger). Several other specimens were examined, but this peculiarity was not found in them, and I am unable to account for it.

The proboscis is innervated by two slender branches that arise from the dorsal surface of the ventral commissure and immediately run dorsally into the proboscis, which is attached at this point to the body wall. The two proboscis nerves, Plate XLII, fig. 35, *P.N.*, are distinct in the anterior part of the proboscis, but in the "middle region," as will be described in that section, they become a continuous nervous layer, fig. 40, *n.p.*, separating again near the end of the proboscis into two distinct nerves, fig. 41, *P.N.*

b. Histology of Nervous System.—The brain lobes, as described by Bürger (1895) and Montgomery (1897 *b*), consist of (1) the fibrous core, (2) the inner neurilemma, (3) the ganglion cell layer, and (4) the outer neurilemma.

There is little to be said in regard to (1) and (2), as these structures in *Zygeupolia* conform to the usual Nemertean type.

In the ganglion cell layer of the brain occur the three types of nerve cells, the small, the medium-sized and the large, described by Bürger and Montgomery and denoted as I, II and III. Montgomery describes the cells of the first type, p. 385, as "densely massed together and of a shortened pyriform shape. The nucleus is very large in proportion to the cell body, in fact, nearly filling it . . . ." This description may also be applied to the cells of the first type in *Zygeupolia*, figs. 20, 9, $G. C._{I}$, which are found abundantly on the dorsal and outer lateral sides of the dorsal lobes, and on the outer lateral sides of the ventral lobes. They are very numerous around and in the cerebral organs.

The cells of the second type, figs. 20, 10, $G. C._{II}$, are elongated and pear-shaped. The cytoplasm is more abundant than in I, the nucleus is oval and centrally placed, containing relatively less chromatin than that of I. These cells are arranged usually in radiate clusters, and their distribution in *Zygeupolia* agrees with that described for other Nemerteans by Bürger and Montgomery, namely, on the ventral lobes and along the lateral chords, never in the dorsal lobes.

The cells of the third type, figs. 20, 8, $G. C._{III}$, are much larger than either I or II, but vary considerably in size. They are long, pear-shaped cells, with the greatest diameter proximally. The nucleus is large, round, and centrally placed, with a large nucleolus, and the chromatin distributed throughout the nucleus. Montgomery states that " while the cell bodies vary considerably in size, their nuclei remain of nearly uniform dimensions." These cells are found in both dorsal and ventral lobes and along the lateral chords.

A fourth type of cell has been discovered and named by Bürger (1894), namely, the colossal neurochord cells. Bürger (1899), p. 105, states: " Neurochordzellen fand ich bei allen von mir untersuchten Cerebratulen, ferner bei *Langia formosa*. Das Gehirn besitzt stets nur ein einziges Paar von Neurochordzellen, welches an der medialen Fläche der ventralen Ganglien dort gelagert ist, wo die Schlundnerven entspringen. Zahlreiche Neurochordzellen befinden sich indessen im Ganglienzellbelag der Seitenstämme . . . ." Bürger also found in the Metanemerteans *Drepanophorus* and *Prosadenoporus* one pair of neurochord cells in the brain, but none along the lateral chords. The presence of neurochord cells in *Cerebratulus lacteus* has been demonstrated by Montgomery (1897 *b*), who found that " the colossal ganglion cells (IV) of *Cerebratulus* are present in three pairs in the ventral brain lobes, and are distributed irregularly along the lateral chords, but are wholly absent in both ends of the latter (namely, in the œsophageal region and in the caudicle)."

In *Zygeupolia* a pair of large cells is found on the median sides of the ventral brain lobes, about .06 mm. behind the ventral commissure. Both cells lie in the same transverse plane. In one very favorable specimen the nerve tubule of one cell could be traced into the fibrous core of the ventral lobe. These cells are elongated, with the greatest diameter at the rounded proximal end, and surrounded by a sheath of connective tissue fibres, Plate XL, fig. 3, *Cn. T. S.* The length of the cell body is about .058 mm., the greatest width about .029 mm., the diameter of the nucleus .012 mm. The cytoplasm stains a pale violet, hæmatoxylin and eosin stain, and has a slightly granular appearance. The somewhat oval nucleus is proximally placed, the chromatin is distributed around the periphery, and one large nucleolus is present.

From the position, size and structure of these cells it seems not unfitting to term them neurochord cells.

Bürger has observed that neurochord cells occur in those forms that swim freely, and he thinks there may be some correlation between the occurrence of neurochords and the swimming habit. While it would be hasty to say that *Zygeupolia* has not the power of free swimming, it has not been observed swimming, either in nature or in captivity. In its native habitat it is always found below the surface of the sand, and while in an aquarium it never rises to the surface, but remains on the bottom, burrowing in the sand, if there is any present, and surrounds itself as soon as possible with a slime sheath to which particles of sand adhere. When placed in a shallow dish of water the head is usually kept erect and continually swaying about, but there is little or no movement of the body as a whole.

It should be mentioned here that one pair of large ganglion cells, from their structure and position evidently neurochord cells, has lately been observed by the writer in *Micrura cæca*. It is not improbable that the occurrence of these cells among the Nemerteans is more common than is generally supposed.

The outer neurilemma is but slightly developed in *Zygeupolia*. It is found around the ventral lobes, but does not occur to any extent around the dorsal lobes or along the lateral chords.

3. Sense Organs.—*a. The Cerebral Organs.*—The cerebral organs appear in life, Plate XL, figs. 1, 16, *C. Org.*, as rather pear-shaped bodies situated at the posterior ends of the dorsal brain lobes, above the ventral lobes. They are silvery gray, except the poste-

rior ends, which are dark greenish and contain large globules that have an oily appearance, the secretion from the posterior gland cells. The large blood vessels, in which the posterior ends of the cerebral organs lie, are very noticeable in life, fig. 16, *C. Org. V.* They are usually expanded, and the floating blood corpuscles may be seen even with a low power.

Each cerebral organ consists of the following parts: (1) the ciliated pit, opening directly to the exterior; (2) the ciliated canal, leading from the pit to the anterior end of (3) the cerebral organ proper.

The ciliated pit is the most anterior part of the cerebral organ. It is a flask-shaped cavity, lined with a ciliated epithelium that is differentiated histologically into several regions which will be described below. The pit opens directly on the surface of the head, there being no lateral slits, and in life is usually widely expanded, the long cilia beating vigorously. In fixed preparations the pit has a small external aperture, a narrow neck and the inner flask-shaped portion, Plate XLI, fig. 21, *Cil.P.*

The ciliated canal, *Cil. C.*, is a narrow duct, a continuation of the inner end of the ciliated pit. It extends in the transverse plane of the body from the ciliated pit to the anterior end of the cerebral organ proper, then, making a sharp turn at right angles to itself, it enters the cerebral organ and continues backward to the posterior end, where it terminates blindly.

The cerebral organ proper is a pear-shaped structure, wide at the anterior end and gradually becoming narrower at the posterior extremity. The cerebral organ nerve, which arises ventrally from the posterior end of the dorsal brain lobe, enters the anterior end of the cerebral organ on the dorsal surface, just in front of the entrance of the ciliated canal, and then ramifies throughout the organ.

The basement layer of the body epithelium is continued beneath the epithelium of the ciliated pit and forms around the cerebral organ an envelope of connective tissue, fig. 21, *Cn. T.S.*, of a thickness about equal to that of the inner neurilemma of the brain lobes. In fig. 21 the thickness of the basement layer and cerebral organ sheath is slightly exaggerated. The most anterior part of the cerebral organ is completely surrounded by muscular tissue—the inner longitudinal muscle on the inner surface, the circular muscle on the outer side.

The change in the relative position of the circular muscle in respect to the dorsal brain lobes and the cerebral organs has already been described, the circular muscle lying on the inner side of the dorsal lobe, but, with the beginning of the cerebral organs, bending out so as to adjoin their outer surfaces (cf. figs. 19 and 21).

From fig. 16 it may be seen that the cerebral organ vessels, *C.org. V.*, lateral branches from the median vessel, *M. V.*, run forward, partly encircling the cerebral organs and ending blindly near their anterior ends. The anterior part of the cerebral organ (see fig. 21, right side) is but partly surrounded by the blood vessel, while the posterior end,[4] fig. 21, left side, lies nearly free in the blood vessel, being attached at the extreme tip to the body wall. A noticeable thinning of the connective tissue envelope accompanies the increase of the surface in contact with the blood vessel, and at its posterior end the cerebral organ is covered only by a low epithelium of square flattened cells, except at the point of attachment to the muscular wall, where a small portion of the connective tissue sheath persists, fig. 21, left side.

Histology.—The epithelium of the ciliated pit consists of three sharply differentiated regions: (1) the epithelium of the outer part, or the neck of the pit; (2) the epithelium lining the median part of the pit; (3) the innermost epithelium, adjoining that of the ciliated canal. These three regions may be seen in fig. 21, *Cil.P.* The epithelial cells have the same general structure in all three regions, except that the cilia of the cells in the median part (2) are much longer. A cell from the median part (2) is shown in fig. 7. It is a slender cell, with an expanded distal end on which the long cilia, *Cil.*, are borne, and tapering into a fine stalk at the proximal basal end; the small nucleus, *N.*, lies just above the stalk. Each cilium consists of a basal knob, an upper knob and a ciliary thread.

Between the ciliated supporting cells of the outer (1) and inner (3) regions, numerous large interstitial connective tissue cells are present, and their nuclei, fig. 21, *Cn.T.N.*, are very noticeable in sections. The median (2) region is characterized by its longer

[4] The section drawn in fig. 21 is rather obliquely cut, so that on the right the plane of the section passes through the ciliated pit and the beginning of the cerebral organ, while on the left only the posterior part of the cerebral organ is seen.

cilia and the complete absence of the interstitial connective tissue cells. In a horizontal section of the ciliated pit the contrast between the three regions is very marked. In a preparation stained with hæmatoxylin-eosin, the outer and inner regions are studded with the deep-blue nuclei of the connective tissue cells, while the median region appears pink, from the cytoplasm of the supporting cells, their small nuclei being very inconspicuous.

The epithelium of the ciliated canal is a one-celled layer. The cells are much lower and wider than those of the pit and bear shorter cilia.

The anterior part of the cerebral organ proper, fig. 21, right side, is richly provided with gland cells, $Gl._1$. These are large pear-shaped bodies with long slender ducts that open into the ciliated canal. The cytoplasm is abundant, especially at the base of the cell where the large spherical nucleus is situated. The secretion is homogeneous and stains red, hæmatoxylin-eosin stain.

The posterior part of the cerebral organ, fig. 21, left side, contains other gland cells of a different character, $Gl._2$. The cytoplasm is inconspicuous, the nucleus is small, and the secretion has the form of large globules that stain a faint bluish-gray. These cells are prominent in life, evidently containing oily globules.

The cerebral organs are well supplied with nervous substance. Ganglion cells of the first type, fig. 21, $G. C._1$, are very numerous.

b. The Lateral Grooves.—The lateral grooves are two shallow elongated pits extending horizontally, one on each side of the body, above the lateral nerve chords. Each has a length of about 1.5 mm.

The grooves are constant in position in the different specimens examined, always beginning at the posterior end of the *glandular zone*, Diagram 1, *Gl.Z.* and *L.G.*, and ending about 1.5 mm. in front of the great thickening of the inner circular muscle and the beginning of the middle intestine.

The lateral grooves are distinctly seen in cross sections of this region of the body, appearing as small pits or depressions in the epithelium external to each lateral nerve chord, but they are not macroscopically distinguishable in either living or preserved specimens, although they have been repeatedly sought. The shallowness of the grooves has probably rendered them indistinguishable except by the microscope.

The lateral areas of sections of the entire body have been carefully examined, but no indication of any constantly recurring depressions could be found in any other region of the body, either anteriorly or posteriorly. Here and there, of course, as in most Nemerteans, are small depressions of the surface due to contraction and shrinkage, but their extent is very limited, and they may occur in any position, dorsal, ventral or lateral.

Fig. 62 is a cross section of a portion of the body wall through one of the lateral grooves. It shows that the lateral groove, *L.G.*, is a depression both of the body epithelium, *Ep.*, and of the outer longitudinal muscle layer, *o.L.M.* The epithelial cells in the groove are rather closely crowded together, and the individual cells are not distinguishable with the magnification used. With a higher magnification, it may be seen that the epithelium is composed of supporting cells, gland cells and interstitial connective tissue cells, just like the rest of the body epithelium. There is no differentiation of the epithelial cells in the groove. Cutis gland cells of the blue-staining type, *Cu.Gl.₂*, are present in the outer longitudinal muscle layer around the lateral nerve chord below the groove, and their ducts open between the epithelial cells of the groove.

The peculiar appearance of the lateral nerve, as shown in fig. 62, has already been discussed.

The question now to be considered is, What are the lateral grooves ? Are they the result of contraction—*i.e.*, artifacts—or are they organs of the body ?

The question whether the lateral grooves are merely contractions seems to me to be disposed of by the facts of their constant position, extent and regular occurrence in several individuals. The alternative, then, is that they are paired organs of the body ; but with what function ?

When these grooves were first observed, I believed that they were sense pits, comparable to the lateral sense organs ("Seitenorgane") of the Protonemerteans, and I hoped that further study, both upon living worms and sections, would demonstrate the presence of sensory cells and possibly of nerves.

The careful study of sections has not revealed any differentiations of the epithelial cells of the lateral groove, although no especial nerve technique, such as the Golgi or methylen blue methods, has been employed. The possibility remains that under such treatment nerves and sensory cells may yet be demonstrated.

The strongest evidence in favor of considering the lateral grooves as sense organs is the fact that dermal sense organs—aside from the well-known lateral sense organs ("Seitenorgane") of the Protonemerteans, and the frontal organs of other forms—have lately been discovered in certain Nemerteans.

In the anterior part of the body of *Parapolia aurantiaca* Coe[5] there occur paired structures, resembling the lateral grooves of *Zygeupolia*, and in the same relative position—that is, in the sides of the body posterior to the nephridia and anterior to the middle intestine. Plate XLIV, fig. 63, represents a transverse section of a part of the body wall of *Parapolia* through one of the lateral grooves. From this it may be seen that the outer longitudinal muscle, just outside the lateral nerve chord, contains an abundance of large swollen cutis gland cells, *Cu. Gl.*$_2$. These cells stain blue with hæmatoxylin and are present only in the vicinity of the lateral nerves, being absent from the rest of the cutis. The section figured shows that the "lateral groove" is elevated above the general surface level, but in other sections it is depressed into a groove.

This elevation and depression of the "groove" is interesting when one recalls that, according to Bürger (1895), the Protonemertean lateral sense organs and the Metanemertean frontal organs may be both invaginated and everted. No differentiated sense cells or nerves are distinguishable in the "grooves" of *Parapolia*.

The length of the groove of *Parapolia* is about the same as that of *Zygeupolia*, and they are probably homologous structures.

In the twelve dermal sense organs of the head, lately described by me (1900 *b*) for *Carinoma tremaphoros*, although undoubted sensory cells are present, only in one case could a nerve, running to the pit, be demonstrated.

The recent discovery of a pair of lateral sense organs in the new Heteronemertean *Micrella rufa* Punnett (1901 *b*) is of great interest and value. Punnett describes "a lateral sense organ on either side (fig. 2) shortly behind the excretory pore. In the pre-

[5] Dr. Coe has very kindly allowed me to examine the slides of his type specimen of *Parapolia* and to make drawings of the sense organs. One of these is shown on Pl. XLIV, fig. 63.

served animal it is conspicuous as a small longitudinal slit (fig. 5) about .75 mm. long on either side. It is lined with characteristic glandular epithelium, resembling that found in the head slits (fig. 6)."

These facts suggest the possibility that the lateral grooves of *Zygeupolia* may be sense organs that are either in process of formation, or that have degenerated and lost their sensory character.

There remains one other interpretation of the lateral grooves, which has been suggested by the presence of the great *glandular zone* in front of the grooves and the situation of the gonads posterior to them. The glandular zone may have a function like the clitellum of the Annelids, and the lateral grooves may be like the grooves found along the sides of the body of an earthworm, and serve to conduct the mucous secretion to the egg cells. This last hypothesis could be substantiated only by a careful study of the habits of *Zygeupolia.*

4. The Rhynchodæum.—Immediately behind the tip of the head on the ventral surface may be found a very small opening, the proboscis pore ("Rüsseloffnung"), which is the external opening of the rhynchodæum.

The rhynchodæum is the rather cylindrical cavity that extends through the head from the point of attachment of the proboscis with the body wall, Plate XL, fig. 1, *y*, forward to the proboscis pore, *P.p.*, at the tip of the head. It is the path of exit for the evaginated proboscis.

A transverse section through the rhynchodæum shows that its walls are provided with four strong bundles of longitudinal muscle, seen in Plate XLI, fig. 18, *Rd.M.*, and that it is lined with a ciliated epithelium. This lining is very delicate and liable to be torn away, and usually can be seen only at the most anterior part of the rhynchodæum. It may persist farther back, but the cilia are mostly broken off in the preparations that have been sectioned. The cilia of this epithelial lining are considerably longer than those of the body epithelium.

5. Rhynchocœl and Proboscis Sheath.—The proboscis, fig. 1, *P.*, lies in a spacious cavity, the rhynchocœl, *Rc.*, the muscular walls of which form the so-called "proboscis sheath." The rhynchocœl is closed anteriorly by the attachment of the proboscis to

the body wall, figs. 1, 16, *y*, and posteriorly ends blindly about .8 mm. in front of the anus, fig. 17, *Rc.*

In the brain region the rhynchocœl is very narrow, passing between the dorsal and ventral commissures, fig. 20, *Rc.* A constant widening of the rhynchocœl takes place in the œsophageal region, fig. 22, and the widest, most expanded part usually lies above that portion of the body extending from the nephridia to the beginning of the middle intestine (see fig. 1). At the latter point the great increase of the circular muscle layer of the proboscis sheath and of the inner circular layer causes a sudden constriction of the rhynchocœl, fig. 23. Posterior to this narrowed region, which is quite short, the rhynchocœl again widens, then gradually narrows more and more until near the end of the body the cavity is scarcely demonstrable.

The rhynchocœl is filled with a fluid in which float numerous long narrow cells, fig. 43, the "rhynchocœl corpuscles" of Bürger, "Navicula" of Quatrefages (1846) and Keferstein (1862). These cells are long and spindle-shaped, larger in the middle where the nucleus lies, and tapering to a fine point at each end. They are flattened and ribbonlike, as may be seen when the cell is twisted. Bürger (1892) has described an "attraction sphere" in the cytoplasm by the side of the nucleus. These do not appear in my preparations and, unfortunately, the rhynchocœl corpuscles were not studied in life. In one cell, however, the nuclear membrane curves in on one side, and a lighter zone in the adjoining cytoplasm may be seen, but there are no astral radiations. In another cell, fig. 43, N_1, two nuclei are present, probably the result of amitosis.

A second, smaller type of cell, fig. 42, is also found in the rhynchocœl, resembling the free corpuscles in the blood vessels. These cells are rounded, with finely granular cytoplasm and prominent nuclei.

The layers of the proboscis sheath are as follows (see figs. 20, 50):

1. The circular muscle layer, *C.M.p.s.*
2. The longitudinal muscle layer, *L.M.p.s.*
3. The basement layer, *B.L.*
4. The epithelium, *Rc.Ep.*

The muscular layers are rather thin in the head region, except when especially contracted. The basement layer is a homogeneous, gelatinous-looking, fibrous connective tissue layer, resembling that of the proboscis and body epithelia. The epithelial cells in the anterior part of the rhynchocœl, Plate XLIII, fig. 50, are not in close contact with each other and do not form a flattened endothelium. They are small, slender, pear-shaped cells, attached by their proximal ends to the basement membrane, with the nuclei at their distal ends, which project freely into the rhynchocœl. Farther back these cells become a flattened endothelium.

The dorsal blood vessel in this region is bordered on its ventral surface by numerous bundles of longitudinal muscle, evidently derived from the longitudinal muscle of the proboscis sheath.

From the end of the œsophageal region to the beginning of the middle intestine the rhynchocœl is usually greatly dilated, the proboscis is intricately coiled and much of the rhynchocœlomic fluid is centred here. Frequently the entire proboscis is drawn forward into this region, leaving the posterior part of the rhynchocœl quite empty.

The proboscis sheath in the expanded region is stretched to its greatest extent, so that it appears in cross section as an extremely thin sheet of tissue, and its component layers are scarcely distinguishable.

In the posterior part of the rhynchocœl—*i.e.*, in the part lying above the middle intestine—the circular muscle is the predominating layer in the proboscis sheath, the longitudinal muscle being represented by a very small number of fibres.

A word may be said here in regard to the comparative extent and character of the rhynchocœl and proboscis sheath in the different groups of Nemerteans, and of its position in respect to other organs.

In the Protonemerteans the rhynchocœl is short, its extent being only about one-third that of the body. It is widest in the nephridial region, then becomes constricted, owing to the thickening of the inner circular muscle, but again widens somewhat before its termination, just in front of the beginning of the middle intestine. In the words of Bürger (1895), p. 95: "Das Rhynchocölom ist vor der Nephridialregion am geräumigsten, in derselben wird es durch die mächtig angeschwollene innere Ringmuskelschicht sehr beträchtlich eingeengt und erweitert sich wieder etwas, nachdem jene abgenommen hat, hinter den Nephridien." In *Hubrechtia* the rhynchocœl is short, ending just in front of the beginning of the middle intestine. To quote Bürger again, p. 106: "Der Mitteldarm von *H.* beginnt in der hinteren Region des Rhynchocöloms. In diesem vordersten Abschnitt des Mitteldarms erscheinen die Taschen nur als flache seitliche Ausbuchtungen des sehr geräumigen centralen Darmrohres. Sobald das Rhynchocölom aufhört, verengt sich aber das centrale Rohr, und nunmehr werden die Taschen sehr umfangreich, sie erfüllen die Körper fast völlig."

Carinoma has the rhynchocœl extending throughout the body, but the character of the proboscis sheath is very diverse. In no other Nemertean is the inner circular muscle so highly developed, and as this muscle layer increases in thickness, the muscle of the proboscis sheath becomes thinner and finally disappears altogether. But with the ending of the inner circular muscle in the nephridial region, the proboscis sheath again acquires a musculature of its own. This region is also the beginning of the middle intestine—"Sowie der Vorderdarm aus dem inneren Ringmuskelschlauch herausgetreten ist, beginnt der Mitteldarm," Bürger (1895), p. 113. In *Callinera bürgeri*, Bergendal (1900 *a*), the rhynchocœl ends in the anterior part of the middle intestinal region by a great muscular swelling of its lateral and ventral walls. Bergendal, p. 314, describes this as follows: "Das Rhynchocœlom besitzt schwache Wände, bis dasselbe sich dem zweiten Drittel des Körpers nähert. Da erhält es zuerst eine sehr starke Grundschicht, die bald weiter nach hinten wieder verdünnt wird und in einen mächtigen Muskelsack eindrängt. . . . . Die dorsale Wand des Rhynchocœloms schwindet und besteht nur in einer etwas verstärkten Grundschicht. Die seitliche und ventrale Wand wird um so dicker und besteht aus sehr schönen bogenförmigen Muskelbändern . . . . diese Schicht ist beinahe so mächtig wie die halbe Dicke des Körpers."

From these data it is seen that in Nemerteans with a short rhynchocœl, the termination of the latter is near the end of the nephridial region and the beginning of the middle intestine, and usually coinciding with the thickening, when present, of the inner circular muscle. *Carinoma* is no exception to this, for we may regard its long rhynchocœl as merely a secondary development backward behind the usual point of termination. The same may be said of *Zygeupolia*. The expanded rhynchocœl is constricted in the region of the inner circular muscle at the beginning of the middle intestine, and instead of ending here, as may have been the case primitively, has secondarily developed backward through the whole length of the body.

6. THE PROBOSCIS.—The proboscis, Plate XL, figs. 1, 16, *P.*, is attached to the body wall in the brain region, just anterior to the dorsal commissure. It lies in the rhynchocœl, *Rc.*, bathed by the rhynchocœlomic fluid. The posterior end is not attached to the wall of the rhynchocœl but is entirely free, there being no retractor muscle.

In regard to its histology the proboscis may be divided into three regions, which, however, pass very gradually into one another. These parts are (1) the anterior region, which is comparatively short, being of about the same length as the œsophagus, above which it lies; (2) the middle region, comprising the greater part of the proboscis; and (3) the extreme posterior region, only a few millimeters in length.

In the following description the nomenclature of Bürger (1895) will be followed, by which in the unevaginated proboscis the layers nearest the central cavity are termed the inner layers, those toward the periphery the outer.

The Anterior Region.—This part of the proboscis is usually straight and the average diameter is 0.116 mm. A cross section, Plate XLII, fig. 35, has the following layers:

1. The outer epithelium, *o.Ep.*
2. The subepithelial layer of circular muscle fibrils, *Ep.M.f.*
3. The outer basement layer, *o.B.L.*
4. The longitudinal muscle layer, *L.M.*
5. The lateral nerves, *P.N.*
6. The inner basement layer, *i.B.L.*
7. The inner epithelium, *i.Ep.*

The outer epithelium, fig. 44, *o.Ep.*, in the most anterior part of the anterior region, consists of low, rather brick-shaped cells, in which the cytoplasm is quite abundant, and whose nuclei are large and prominent. Farther back the cells are lower and finally form a flattened endothelium, that is frequently torn away in my preparations.

Just beneath the outer epithelium is a layer of very fine muscle fibres, *Ep.m.f.*, running circularly around the proboscis. These may be termed the subepithelial circular muscle layer[6] of the proboscis. In a cross section of the proboscis, fig. 35, these fibrils are in longitudinal section, but in a longitudinal section of the proboscis, fig. 38, they are cut transversely, and it may be seen that the layer is only one fibril thick.

The basement layer, or ground substance, is a homogeneous, gelatinous-looking structure of considerable thickness. It is a product of the fibres of connective tissue cells, and their nuclei may be found scattered here and there among the fibres. The thickness varies considerably in different specimens. It may be most favorably studied in a specimen fixed with Gilson's fluid, one of the best fixatives for connective tissue. The region of the greatest thickness is always in the anterior part of the proboscis and rapidly diminishes toward the middle region.

The longitudinal muscle layer, *L.M.*, consists of bundles of fibres, about eight to ten fibres in each.

The two proboscis nerves, *P.N.*, are distinct from one another, each surrounded by a sheath of connective tissue.

The structure of the inner basement layer, *i.B.L.*, is similar to that of the outer layer but is only about one-third as thick. The inner epithelium, *i.Ep.*, is a one-celled layer. The cells are square in cross section, the cell-membranes distinct and the nuclei large and rounded. Between the epithelial cells are numerous gland cells, $Gl._2$, the contents of which stain dark blue with hæmatoxylin. The central cavity of the proboscis is quite large in this region.

The transition stages between the anterior and middle regions are characterized by the decrease in thickness and the almost total disappearance of the outer basement layer. Its diminution is coincident with the establishment of a circular muscle layer on the axial side of the longitudinal muscle. A considerable amount of connective tissue appears within the new circular muscle layer, forming the core of the papillæ into which the inner surface of the proboscis is now raised. A considerable increase in the

[6] The subepithelial muscle fibrils are not seen in fig. 44, which represents a portion of the proboscis only a few sections behind its point of attachment, but they begin a short distance farther back and form a continuous layer to the posterior tip of the proboscis.

height of the inner epithelial cells may be noticed, and gland cells are becoming more numerous.

The Middle Region.—The proboscis is usually greatly twisted and coiled, and the maximum diameter is found here, about 0.4 mm. The layers are as follows (see figs. 38, 40):

1. The outer epithelium, *o. Ep.*
2. The subepithelial layer of circular muscle fibrils, *Ep. m. f.*
3. The outer basement layer, *o. B. L.*
4. The longitudinal muscle layer, *L. M.*
5. The circular muscle layer, *C. M.*
6. The nervous plexus, *n. p.*
7. The connective tissue of the papillæ, *Cn. T.*
8. The inner epithelium, *i. Ep.*

1, 2, 3, 4 and 7 have essentially the same structure as in the transition stages. The notable features of this region are found in the circular muscle and the inner epithelium. Shortly after the appearance of the circular muscle layer, there is a crossing of the circular fibres at one point out through the longitudinal layer.

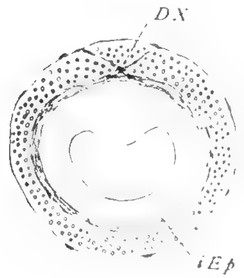

Diagram 6.—*Zygeupolia*, cross section of "middle region" of proboscis, with one muscular cross—*D.X.*, dorsal muscular cross; *i.Ep.*, inner epithelium.

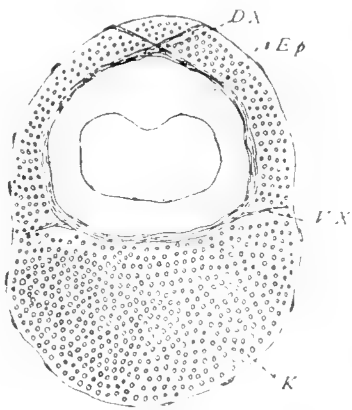

Diagram 7.—*Zygeupolia*, cross section of "middle region" of proboscis, with strong dorsal and faint ventral muscular cross—*D.X.*, dorsal muscular cross; *V.X.*, arm of ventral cross; *i.Ep.*, inner epithelium; *K.*, abnormal, enlarged region of longitudinal muscle.

The fibres of the cross are very thin, and after crossing are apparently continued as the subepithelial circular layer of fibrils before described. It is a fact worthy of note that although the crossing of the circular fibres takes place first in the middle region, the subepithelial layer of circular fibrils extends almost to the anterior end of the proboscis.

In some specimens the muscular cross is present on the dorsal surface only (see Diagram 6, *D.X.*), in others there is a weaker cross on the ventral side, fig. 40, and in still other specimens the two arms of the ventral cross are very faint, and lie about 120° apart (see Diagram 7, *V.X.*). In this latter case there is an exceptional arrangement of the longitudinal muscle fibres of the proboscis. The dorso-ventral diameter is about .145 mm., and almost one-half of the area of the proboscis is occupied by the circular muscle of the ventral side, Diagram 7, *K.* The muscle fibres have increased enormously on this side, and spaces filled with a connective tissue reticulum separate the wide part of the layer from the narrower, normal part. Through these connective tissue areas run the fibres of the ventral cross.

The lateral nerves are separate at the beginning of the middle region, but farther back they spread out into a thin nervous layer, fig. 40, *n.p.*, which forms a continuous ring around the proboscis, along the inner surface of the circular muscle.

The glandular inner epithelium of the middle region is characterized by a structure that will be termed the *glandular ridge*, Plate XLII, fig. 40, *Gl.R.* The dorsal surface bears an elevation consisting of a core of connective tissue, *Cn.T.*, which is continued throughout the middle region. The epithelium clothing the ridge is very specialized. The entire surface of the ridge is thrown into a series of lesser elevations, or knobs, covered by masses of rod-shaped bodies that are aggregated in clusters, each cluster on a small papilla. With hæmatoxylin-eosin these rods stain a bright red, and are evidently glandular secretions. Bürger (1895) has described and figured, from the probosces of living worms, very similar structures, which he has termed rhabdites. Bürger considers each rhabdite as the product of a single cell. As the red-staining bodies in *Zygeupolia* bear a close resemblance to the rhabdites of Bürger, they will receive the same term. Unfortunately the proboscis of *Zygeupolia* was not studied in life, so that the descriptions here given are based wholly on sections.[7]

[7] The best fixation for the rhabdites is 95 per cent. alcohol; their structure is also shown, but not so well, with corrosive sublimate and 50 per cent.

Fig. 36 shows a small branch of the glandular ridge, on the surface of which are several clusters of rhabdites. The section has passed through the centre of the branch, exposing the central connective tissue core, the lightly shaded area, *Cn. T.* No nuclei have been seen in the rhabdite cells, probably owing to the great number and the close proximity of the glandular secretions.

The inner epithelium of the ventral surface is of quite a different character. A certain amount of interstitial connective tissue is present at the base, but there are no elevations. The most prominent constituents of the epithelium are the large pink-staining (hæmatoxylin-eosin) gland cells, fig. 40, $Gl._1$. These cells are quite elongated, the distal ends are large, and the proximal ends are narrowed into a slender stalk. The cell body is entirely filled with the granular secretion, and the nucleus lies just above the stalk. Between the gland cells are very slender cells, somewhat resembling epithelial supporting cells in shape. The nucleus is at the base of the slender cell body, and in the distal cytoplasm may be found one, or sometimes two, rods shaped like a thorn, with flat base and pointed end. The base is embedded in the cytoplasm, the pointed ends project beyond the cell. These structures, fig. 40, *Th.*, stain a deep blue, hæmatoxylin-eosin; brownish with the Ehrlich-Biondi stain.

The Posterior Region.—The diameter of the proboscis in the posterior region, fig. 41, is constantly decreasing, until at the extreme tip it measures only .04 mm.

The outer epithelial cells, fig. 39, *o.Ep.*, like those of the extreme anterior region, are rather brick-shaped cells with abundant cytoplasm, and do not form a flattened endothelium. The muscle layers have decreased relatively to the other tissues; and instead of the nervous plexus of the middle region, there are, again, two separate lateral nerves, *P.N.* The amount of connective tissue, *Cn. T. N.*, has increased, and as the nuclei of these cells are large, with but little cytoplasm, the effect produced is that of a layer of undifferentiated tissue. The glandular ridge has disappeared, and the inner epithelium is of a uniform character, consisting of pink-staining gland cells, $Gl._1$, like those in the ventral epithelium of the middle region.

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alcohol; while they are swollen and quite unrecognizable with Flemming's fluid.

At the extreme tip of the proboscis the muscular layers almost disappear, the connective tissue cells become even more abundant, and the gland cells of the inner epithelium are replaced by low, flattened endothelial cells.

7. THE BLOOD VASCULAR SYSTEM.—The anterior part of the head of *Zygeupolia* differs from that of most Nemerteans in being quite devoid of blood vessels, and even of blood spaces that are large enough to be seen, although there is no doubt a network of capillaries too fine to be distinguishable either in life or in fixed preparations.

The blood system makes its first appearance in the brain region, just behind the insertion of the proboscis, Plate XL, fig. 16.

In the blood system the following parts may be found (see figs. 16, 17):

(1) The fine paired head vessels, *H. V.*,[3] which unite to form (2) the unpaired median vessel, *M. V.*; (3) the paired cerebral organ vessels, *C. Org. V.*; (4) the unpaired dorsal vessel, *D. V.*; (5) the paired lateral vessels of the body, *L. V.*; (6) the ventral connectives of the lateral vessels (fig. 22), *V. bl. con.*; (7) the paired dorso-lateral vessels at the posterior end of the body, derived from the forking of the unpaired dorsal vessel, *Dl. V.*, and (8) the central blood lacuna in the caudicle, *Bl. L.*

In sections of the brain region, fig. 19, *H. V.*, the head vessels appear as two irregular clefts running dorso-ventrally, one on each side of the proboscis, just behind its insertion. These narrow slits lie in the limited area between the proboscis sheath and the circular muscle of the body wall, and in the vicinity of the ventral brain commissure their ventral ends coalesce, forming an unpaired crescent-shaped vessel, the median vessel, which encircles the lower half of the proboscis sheath, fig. 20, *M. V.*

The median blood vessel extends from this point backward as far as the mouth. In its course it becomes considerably deeper dorso-ventrally, and is very noticeable in sections of this region. It assumes a horseshoe shape, with the apex pointing ventrally and the two long slender arms prolonged dorsally. In the vicinity of the cerebral organs, fig. 21, the arms are cut off by a horizontal band of muscle fibres, *H. M.*, that lies beneath the cerebral organs

[3] The reference line from *H. V.*, in fig. 16, should extend in as far as the red lines indicating the head vessel.

and the rhynchocœl, so that only the triangular middle part of the median vessel now remains.

Immediately behind the ventral brain commissure the unpaired dorsal blood vessel arises from the median vessel, figs. 16, 21, *D. V.* It passes up through the muscle layers of the proboscis sheath into the rhynchocœl, and continues in this position—on the floor of the rhynchocœl in the median line, but bounded dorsally by the rhynchocœlomic epithelium—until about the middle of the nephridial region, fig. 22. Here the dorsal vessel passes down through the proboscis sheath and out again into the tissue that is just beneath the rhynchocœl and above the alimentary canal; and this position is retained throughout the remainder of its course, figs. 23, 24.

In the anterior œsophageal region the lateral blood vessels are united beneath the œsophagus by ventral connectives. In one specimen the connectives are broad and dilated, fig. 22, *V.bl.con.*, in others they are almost entirely shrunken together. The ventral connection of the lateral trunks is continued throughout the œsophageal region, forming a network of fine anastomosing branches. It is probably further continued, in the remainder of the body, but I have been unable to follow it in my specimens.

In the œsophageal region the lateral trunks lie on the dorso-lateral side of the alimentary canal; in the middle intestinal region they have moved ventrally and lie on the ventral side of the intestine.

No connection between the dorsal vessel and the lateral trunks has been observed, except at the extreme posterior end of the body. Some little distance in front of the end of the body proper (see fig. 17) the dorsal vessel divides into two, which for a time lie side by side, their walls adjoining. They then move apart, and lie in about the same relative distance from one another as do the two ventral lateral trunks, so that in a section of this region, fig. 26, four vessels are present, symmetrically placed.

Just anterior to the anal opening the two dorsal vessels, or rather the dorso-lateral vessels, descend and unite with their ventral fellows in a large blood lacuna, fig. 27, *Bl.L.* This lacuna now occupies most of the area inside the body musculature, for the intestine curves dorsally and shortly opens to the exterior on the dorsal surface of the body. The large lacuna passes on into the caudicle, fig. 17, *Bl.L.*, and continues throughout its length. It has no definite walls, but is bounded by the muscular wall of the caudicle, on the inner surface of which are irregular groups of large mesenchym cells, figs. 27, 28, *mes.*, many of which become detached and float freely in the lacuna.

Histology.—The wall of the median blood vessel is a one-celled layer, fig. 29, of low, somewhat flattened cells that are wider than high. The nuclei are oval and rather prominent and the cytoplasm clear and hyaline. In places the wall becomes a flattened endothelium, often appearing in cross section like a thin membrane, along which the nuclei lie.

The lining of the cerebral organ blood vessels is of a similar character.

The dorsal blood vessel, as already mentioned, lies, in the anterior part of its course, in the mid-ventral wall of the rhynchocœl, and posteriorly, beneath the rhynchocœl.

Fig. 50, a section through the dorsal blood vessel shortly behind its origin, shows that the vessel is surrounded ventrally and laterally by bundles of longitudinal fibres, which are more numerous here than on the other surfaces of the rhynchocœl wall, and probably take part in the contractions of the vessel, while the dorsal surface of the vessel is bounded by the epithelial lining of the rhynchocœl, *Rc.Ep.*

The wall of the dorsal vessel consists of an endothelium, *End.*, of low, rather brick-shaped cells with large nuclei. The cells of the ventral part of the wall are very regularly arranged, Plate XLIII, fig. 50, but the regularity of the dorsal wall is interrupted by the proliferation of numerous blood-forming cells, *Bl.f.C.*, that project into the lumen of the vessel and remain for some time attached to the dorsal wall by their slender stalks.

The boundary between the dorsal wall of the blood vessel and the epithelium of the rhynchocœl is marked by a fine line, *Bl.M.*, that varies in distinctness in different preparations. After the hæmatoxylin-eosin stain it appears pink, after iron-hæmatoxylin, black, so that it is probable that a few muscle fibres are present here, forming a very delicate circular layer around the dorsal side of the vessel. This line might also represent a deeply stained connective tissue layer, but, since the dorsal vessel after leaving the rhynchocœl has a well-defined muscle sheath, it seems more likely that this is the beginning of a muscle layer.

The blood-forming cells are evidently enlarged endothelial cells, that gradually separate off and become free. At first pear-shaped, with a slender stalk, they later become rounded and are frequently amœboid in outline, fig. 51, *Bl.f. C.* The cytoplasm is finely granular in appearance and quite prominent. In the anterior (rhynchocœlomic) part of the dorsal vessel the blood-forming cells arise only from the dorsal side, but posteriorly from all sides of the dorsal vessel (cf. figs. 50, 51).

The dorsal blood vessel after leaving the rhynchocœl lies beneath it and above the intestine, figs. 22, 23, immediately surrounded by a network of connective tissue cells. The wall, fig. 51, consists of an inner endothelium, *End.*, and an outer circular muscle layer, *Bl.M.*, that in this region is continued around the entire vessel, and is not confined to the dorso-lateral surface, as in the anterior region. The muscle fibres are very fine, but are clear and distinct, and are especially well seen in tangential sections of the vessel. The endothelium, *End.*, is very irregular, being interrupted by the proliferation of cells from all sides of the vessel. In places, many consecutive sections of the vessel may be examined without finding a single true endothelial cell, while numerous blood-forming cells are present in each section. Two explanations for this are possible: either all the endothelial cells have been changed into blood-forming cells, or the endothelium has been rubbed or torn off. The latter is supported by the fact that a thin lining of cytoplasm may nearly always be seen on the inner side of the muscular layer, even though no nuclei are present.

The two dorso-lateral vessels at the posterior end of the body, figs. 26, 49, have the same histological structure as the dorsal vessel—the outer, circular muscle layer, and the inner, more or less interrupted endothelium and numerous blood-forming cells.

The lateral vessels, figs. 46, 47, *L. V.*, and their ventral connectives, *V. bl.con.*, are lined anteriorly by low, brick-shaped cells like those of the median vessel, with prominent nuclei and hyaline cytoplasm. This endothelium soon becomes more flattened and membraneous. Here and there a blood-forming cell is given off, fig. 46, *Bl.f. C.*, but there is no abundant proliferation of these cells as in the dorsal vessel. In the nephridial region the endothelium of the lateral blood vessels is discontinuous, being absent from the surfaces of the terminal bulbs. No muscular layer is present in the anterior part of the lateral vessels, the wall consisting merely of the endothelium. Outside of the membraneous endothelium, in the more posterior part of the lateral vessels, fine fibrils are seen. These may be either fine muscular fibrils, or the end processes of the branched connective tissue cells that are so numerous around the blood vessels. From their general appearance, and from the absence of muscle fibres in the more anterior part of the lateral vessels, I am inclined to regard them rather as connective tissue fibres.

8. THE EXCRETORY SYSTEM.—The paired nephridia,[9] fig. 1, *Nph.*, lie in the anterior part of the body, about 6–7 mm. behind the mouth, bordering on the ventral surface of the lateral blood vessels and running parallel with them; they are about 2.5 mm. in length, and there is no communication between the two nephridia. Each nephridium may be briefly described as a slightly convoluted tube (the main duct) that opens to the exterior by a narrow duct (excretory duct) at its posterior end, and which anteriorly gives off a number of slender, thin-walled branches (the ductules), each of these ending blindly in a group of specialized cells, known as a terminal bulb ("Endkölbchen," Bürger).

The most anterior part of the nephridial system, consisting of the terminal bulbs, fig. 47, *T.B.*, and their ductules, *Nph.d.*, is found along the ventral surface of the lateral blood vessels, *L.V.*, and their ventral connectives, Plate XLI, fig. 22, *V.bl.con.* No main duct is present in this region, and the irregular network of the fine ductules and their blind ends at first seemed a hopelessly confused mass of tissue, but by the careful study of serial sections the relative arrangement of the parts has been made out.

The terminal bulb, Plate XLIII, fig. 47, *T.B.*, is the blind enlarged end of the fine ductule, *Nph.d.*, coming from the main duct. fig. 46, *Nph.D.* Each bulb consists of a number of cells, probably eight to ten or more, but it is difficult to determine this exactly as a bulb does not always lie wholly in one section. The cells of the bulb are placed side to side about a central lumen, so that the walls of the bulb are one cell thick. The height of the cells—that is, the

[9] Several attempts were made to study the nephridia in life, but they could be seen in two specimens only. In these, merely the presence of the main duct was made out, and in one case the excretory duct. The methylen blue method, employed by Bürger (1892, p. 327, footnote) for the study of the nephridia of *Eupolia* and various Metanemerteans, was tried but without success, so that the following description is based entirely upon the study of sections.

distance from the lumen to the periphery of the bulb—is greater than their width. The peripheral ends are considerably enlarged and often irregular in outline; the luminal ends are frequently produced into long slender processes that seem to take some part in the formation of the stem of the bulb. The cytoplasm of the peripheral (proximal) end takes a bright pink, hæmatoxylin-eosin stain; the distal processes, however, stain very faintly. The nucleus is large and fusiform, but appears round in cross section, and is situated in the expanded proximal end of the cell.

After finding the terminal bulb cells so well preserved in sections, it seemed most probable that the long branches of vibratile cilia, the "ciliary flames" ("Wimperflammen," Bürger), present in the terminal bulbs of other Nemerteans, might also be found; but although they have been carefully looked for, they have not been seen. Cilia, fig. 46, *Cil.*, are found on the cells of the nephridial duct and of the ductules, and generally in a good state of preservation, so that it seems improbable that the cilia of the bulbs should have been destroyed by fixation. On the other hand, the analogy with the terminal bulbs of those Nemerteans that have been exhaustively studied is in favor of their presence in *Zygeupolia* also.

The bulbs project freely into the blood vessel all along its ventral surface, and in one case a ductule was observed that passed through the vessel, so that its bulb came to lie on the opposite, dorsal, surface. The epithelial lining of the blood vessel is frequently broken and discontinuous in the region of the bulbs, figs. 46, 47, and in no place are the bulbs covered by it, so that the ends of the bulbs are directly bathed by the blood. The absence of the blood vessel epithelium from the ends of the bulbs may facilitate the absorption of waste substance from the blood, and this may account for the disappearance of the lining from around the bulbs of the nephridia.

No internal openings between the nephridium and the blood vessel, such as Oudemans describes in *Carinoma armandi*, have been seen.

The nephridial ductules, figs. 46, 47, *Nph.d.*, the slender tubes that connect the terminal bulbs and the main duct, are very sinuous, and it is probable that several terminal bulbs may connect with one ductule. Some ductules are quite long, especially those that run along the ventral blood connectives. The wall of the ductule is a one-celled layer and encloses a narrow lumen. The cells are wider than high, with but little cytoplasm and elongated nuclei. The cell surface turned toward the lumen bears cilia. No basement membrane is present.

About 3–4 mm. behind the first appearance of the terminal bulbs the main nephridial duct begins, fig. 46, *Nph.D.* It is situated on the ventral side of the lateral blood vessel, in the angle made by the junction of the ventral connective with the lateral vessel; the main duct does not project into the blood vessel, but merely adjoins it with one surface, the other surfaces being surrounded by the fibres of the inner longitudinal muscle layer. The main duct is about 2 mm. long and composes the greater part of the nephridium. Into its anterior end for some little distance the ductules open, but behind that there are no diverticula until the excretory duct at the posterior end is reached. The main duct is thick-walled, fig. 46, and slightly convoluted throughout its length. The cells of the wall are considerably higher than wide, with quite sharply defined cell membranes. The nuclei are prominent and are situated near the outer or basal side of the cell, *i.e.*, away from the lumen of the duct. The outer surfaces of the cells are usually irregular, and often bear amœboid processes, no basement membrane being present. The surface bordering on the lumen is ciliated, and the basal knobs of the cilia are very distinct.

In the cells of the main duct and ductules of one specimen that had been fixed in a solution of sublimate in 50 per cent. alcohol, and stained with hæmatoxylin and eosin, were found numerous prominent red-staining bodies of the same size as the nucleus, but neither larger nor smaller ones. Wherever these red bodies occurred they were found one to a cell, and at first it seemed as if they were degenerating nuclei. Careful examination, however, detected the nucleus in each cell, of normal size, but staining less deeply than usual. It is possible that these bodies may be excretory masses, but their absence from the lumen of the duct and the fact that no intermediate stages in their formation have been seen would discredit this view. Bürger (1890), p. 93, describes in the nephridia of *Carinella* what may be similar masses: "Schon in den Zellen der . . . . Endkanälchen und Endkolben, fielen mir bis kerngrosse glänzende grüne Konkremente auf. Ueber ihre Natur musste ich im Unklaren bleiben; niemals beobachtete ich solche im Excretionsgefässlumen selbst."

The excretory duct, figs. 1, 45, *Exc.d.*, is the small, thin-walled tube that connects the main duct with the exterior. Its course is in a plane at right angles to the plane of the main duct, and it opens to the exterior just dorsal to the lateral nerve chord. Since the excretory duct runs in a direct line to the epidermis with but little turning or twisting, its length is merely the distance from the main duct to the surface of the body wall. The cells composing the wall are much lower than those of the main duct, and are wider than high, the height being about .006 mm. Cilia are borne on the inner surface. No basement membrane is present. The cells of the excretory duct meet those of the body epithelium at the surface of the body, there being little or no invagination of the epidermis.

A good deal of evidently foreign matter from the exterior is usually found in the excretory duct.

9. The Alimentary System.—The alimentary canal of the Heteronemerteans is usually divided into the following regions: (1) The mouth; (2) the œsophagus, or anterior intestine ("Vorderdarm," Bürger), a straight tube without lateral diverticula; (3) the middle intestine ("Mitteldarm," Bürger), with lateral outgrowths or cæca throughout its length; (4) the anal portion of the intestine ("Enddarm"), a short region where the lateral cæca ar no longer present, terminating in (5) the anal opening. Bürger (1895), p. 240, says: "Wir nennen den ungegliederten vorderen Darmabschnitt Vorderdarm, den gegliederten, welcher der mittleren und hinteren Körperregion characteristisch ist, den Mitteldarm. Wir bezeichnen ferner am Mitteldarm den röhrenförmigen Theil als axiales Rohr, die peripheren Ausstülpungen desselben als Darmtaschen."

According to Bürger, the œsophagus (Vorderdarm) has frequently two regions, an anterior and a posterior, that differ histologically from one another. In *Carinella* Bürger finds the epithelium of the anterior part of the "Vorderdarm" very rich in gland cells, while the posterior part consists mostly of supporting cells with a few scattered gland cells; and in *Cerebratulus marginatus* he finds the same differentiation of anterior and posterior parts, only in this genus the anterior glandular part is more extensive than the posterior part. Bürger's own words, p. 250, are: "Im Vergleich mit *Carinella* setzt sich das Drüsenepithel der Mundhöhle, welches dort ja ganz ähnlich wie bei *Cerebratulus marginatus* beschaffen ist, aber nur die Mundhöhle und den allervordersten Abschnitt des Vorderdarms auskleidet, bei den Cerebratulen weit nach hinten fort. . . . . Aber es fehlt auch nicht jener zweite Abschnitt des Vorderdarms bei *Cerebratulus*, welcher sich durch seine Drüsenzellen wesentlich von dem ersten unterscheidet und den Uebergang in den bei den höheren Formen durch die Darmtaschen auch morphologisch von dem vorderen Darmabschnitt differenzirten Mitteldarm bildet. . . . . Es giebt also bei *Cerebratulus*, just wie bei *Carinella*, einen äusserst drüsenreichen vorderen und einen auffallend drüsenarmen hinteren Vorderdarmabschnitt."

In *Zygeupolia* the differences between the anterior and the posterior parts of the tube-like portion of the alimentary canal (Vorderdarm) are so great that in this description the two parts will be termed respectively the œsophagus and the stomach. My reasons for this are partly for the sake of brevity and clearness, since the expressions "anterior part of anterior intestine" and "posterior part of anterior intestine" are lengthy and awkward to use; and partly to emphasize the very considerable differences in the structure of the two regions. It is my belief that while the œsophagus is evidently derived from the ectoderm, the stomach, together with the middle intestine, owes its origin to the entoderm. The term stomach is not altogether a happy one, since it at once suggests the "Magendarm" or stomach intestine of the Metanemerteans, which may have a different embryological history; and yet, on the other hand, the function of both is evidently digestive, and the resemblances in the histology very striking. Both have a truly glandular epithelium, as will be seen by comparing the section of the epithelium of the "Magendarm" of *Drepanophorus latus*, figured by Bürger (1895), Taf. 27, Fig. 17, with the epithelium of the stomach of *Zygeupolia*, Plate XLII, figs. 32, 33.

Therefore, in *Zygeupolia* the alimentary canal will be subdivided into the following regions (see fig. 1): (1) The mouth, *M.*; (2) the œsophagus, *Oes.*; (3) the stomach, *S.*; (4) the middle intestine, *M.I.*; (5) the end intestine, *E.I.* (Enddarm), and (6) the anus, fig. 17, *A.*

The mouth, figs. 1, 16, *M.*, is situated on the ventral surface of the body, shortly behind the brain, and about 5 mm. from the tip of the head. In a passive condition the mouth is a small round opening, with crinkled edges forming a kind of circular lip, but it is capable of great expansion, enabling the worm to swallow prey nearly as large as itself. The tissue immediately encircling the mouth is conspicuous in life by its greenish hue, caused by the secretions of the numerous gland cells, figs. 16, 31, *w.*, that are situated in the subepithelial tissue of the anterior œsophageal region.

A cross section of the body through the mouth opening shows that the mouth is lined with an epithelium of ciliated supporting cells resembling those of the body epithelium, but with longer cilia. No gland cells could be distinguished in the epithelium of the mouth-opening proper, nor in the cutis beneath it.

In the semi-transparent living *Zygeupolia* the œsophagus and the stomach may be easily seen under a low power in a slightly compressed specimen. The different degrees of refraction of the two parts makes them easily distinguishable. The œsophagus, fig. 1, *Oes*, appears rather light, while the stomach, *S.*, is darker, denser and of a more granular appearance. It will be seen from fig. 1 that the œsophagus is rather shorter than the stomach. These two regions do not pass gradually into one another, but there is a sudden transition which might be indicated by a straight line drawn at right angles to the long axis of the alimentary canal (see fig. 1), and sections show that there is an abrupt change in the cell elements. In life there is an appearance of a fold at the beginning of the stomach, which probably serves as a valve.

Fig. 33 is a somewhat oblique cross section of the alimentary canal through the line of division of œsophagus and stomach. The slight obliquity takes the section through both œsophagus and stomach; the œsophageal epithelium, *Oe.Ep.*, being present on the ventral surface, the stomach epithelium, *S.Ep.*, on the dorsal surface. In the upper right hand part of the figure indications of a fold, *f.*, are seen, where the œsophageal epithelium apparently passes over the stomach epithelium.

The beginning of the stomach has a constant relative position, occurring always in the same frontal plane with the anterior nephridial region (see fig. 1). This fact is helpful in trying to find the nephridia in life.

The œsophagus extends backward from the mouth a distance of about 9–12 mm., according to the size of the worm. The wall of the œsophagus, figs. 31, 33, consists of an epithelium of ciliated supporting cells, *S. C.*, and gland cells, $Gl._1$, about .023 mm. in height, very similar to that of the epidermis (cf. figs. 2 and 31). The supporting cells are like those of the epidermis, only more slender. The gland cells are flask-shaped, with finely granular contents that stain a bright pink, hæmatoxylin-eosin stain. Blue-staining gland cells are entirely absent. Both supporting and gland cells rest on a delicate basement membrane, *B.M.*, and some interstitial connective tissue cells are found between the bases of the epithelial cells.

At the extreme posterior end of the œsophagus some of the epithelial cells become much higher, but otherwise their structure is the same.

The subepithelial gland cells, that have been described above as giving the greenish color in life to the circular "lip" of the mouth, are present in great numbers immediately around the mouth, and less abundantly throughout the greater part of the œsophagus. A group of these cells, *w.*, is shown in fig. 31, from the anterior part of the œsophagus. The gland cells are large, the cell body containing a secretion that is probably fluid in life, but appears finely granular in the fixed preparations and stains rose red, hæmatoxylin-eosin stain. Some cells seem to have but one nucleus, others more than one, but the latter case may be due to the crowding together of the cells or to the presence of the adjacent connective tissue nuclei, so that this point has not been definitely settled. The ducts, *dt.*, are long and slender, and open into the œsophagus between the epithelial cells. Farther back in the œsophagus these subepithelial gland cells entirely disappear.

The inner surface of the œsophagus is usually thrown into numerous high papillæ, especially the ventral surface (see fig. 33). The papillæ are formed chiefly of longitudinal muscle fibres, but contain also connective tissue cells and the subepithelial gland cells, when they are present. The papillæ come to an end together with the œsophagus (cf. the dorsal and ventral surfaces of fig. 33).

A few isolated strands of circularly running muscle fibres, fig. 33, *M.S.*, are frequently found beneath the papillæ, partly encircling the œsophagus, but no continuous "œsophageal" muscle layer is formed. The origin of these strands has been traced in some cases to the circular muscle of the proboscis sheath, in other cases to dorso-ventral fibres coming from the outer circular muscle of the body wall.

The change between the œsophagus and stomach is not only a sudden but a very marked one (see fig. 33). Instead of the œsophagus, with its low epithelium and its great extent of surface caused by the high papillæ, there is the stomach, without folds or papillæ and consisting of a very high epithelium, about four times higher than that of the œsophagus, in which the large gland cells are the principal element. The ciliated supporting cells, *S. C.*, are present, apparently in equal numbers with the gland cells, but are so small and inconspicuous that they are easily overlooked. In fact, four specimens were studied before their presence was detected, and they were seen for the first time in an overstained specimen, where the deep blue stain taken by their cytoplasm and their ciliary bases was in strong contrast to the pink of the adjacent gland cells.

The gland cells of the stomach, fig. 32, $Gl._1$, are large, measuring .087 mm. in height and .011 mm. in width. The distal end is slightly narrowed into a neck, and the basal end into a slender process that is inserted into the basement membrane, *B.M.* The cell membrane is very distinct, and the cell body is filled with a network of cytoplasm, in which are embedded large homogeneous secretion globules that stain pink with eosin. Some slight color differences seem to indicate different phases in the secretion, and a few cells appearing lighter in color had evidently discharged most of their secretion. The rather small oval nucleus, *N.*, lies near the base of the cell, not far above the basal process.

Alternating with the gland cells are the small ciliated supporting cells, fig. 32, *S. C.* They have a small cell body, about .004 mm. in width, on a very long stalk, *St.*, the basal ends of which are inserted into the basement membrane. The cilia are short and their structure could not be determined. A surface view of these cells shows that there is one stout cilium in the middle of the cell, while the other more slender ones are arranged in a ring around the periphery of the upper surface. The stouter cilium may occasionally be seen in sections, and then appears slightly longer than the peripheral ones. A few small interstitial connective tissue cells are present among the bases of the gland and supporting cells, and are demonstrable chiefly by their nuclei.

The basement membrane of the stomach rests directly upon the inner longitudinal muscle of the body wall. The stomach is frequently greatly flattened by the pressure exerted by the expanded rhynchocœl. For the study of this region, a specimen from which the proboscis has been cast out is the most favorable.

The middle intestine, *M.I.*, according to definition, begins with the first pair of lateral intestinal cæca, but the cells that are peculiarly characteristic of the middle intestine are not found in the most anterior cæca or pouches, which are lined by cells similar to those of the stomach. In other words, the most anterior pouches of the middle intestine belong histologically to the stomach.

The transition from the gland cells and ciliated supporting cells, exactly similar to those of the stomach, that are found in the most anterior pouches, to the absorptive cells characteristic of the middle intestine is a very gradual one, and varies in different individuals. In some specimens the transition begins in the second pair of cæca, in others it takes place farther back. There is no abrupt line where gland cells end and absorptive cells begin, like the sharp line between the end of the œsophagus and the beginning of the stomach, but the gland cells and their companion supporting cells gradually become less numerous and are replaced by the absorptive cells that belong to the middle intestine. Throughout the course of the middle intestine, here and there are found gland cells, fig. 34, *Gl.*,,, just like those of the stomach and the anterior pouches.

It is the presence of these gland cells, characteristic of the stomach, in the anterior pouches and scattered through the rest of the middle intestine, that has led me to believe that probably the stomach and the middle intestine have a common origin from the entoderm. The fact that there is not a well-defined histological dividing line between the cell elements of the two regions, but a gradual replacement of the gland cells by the absorptive cells, is in confirmation of this opinion. And furthermore, to return to the differences between œsophagus and stomach, here we do find a sharply defined and sudden transition from an epithelium resembling that of the outside of the body to a truly glandular epithelium; also, the opening to the stomach provided with a primitive valvular fold. Here is certainly the division line between ectodermal and entodermal derivatives.

The characteristic absorptive cells of the middle intestine, fig. 34, *Abs. C.*, are long slender cells, about .14 mm. high, rather flattened at the base and inserted by slender lateral processes into the basement membrane, *B.M.*, and bearing several very long cilia, *Cil.*, on the distal surface. The cilia are about as long as the cell, and are inserted on a basal knob. The nucleus is rather elongate, and is situated near the base of the cell. The cell contents are of a variable nature; usually the cell is filled with a finely granular pink-staining substance, hæmatoxylin-eosin stain, in which are numerous spherical masses that stain a dark red. Other cells present a vacuolated appearance, as if filled with a foamy fluid substance. Since the function of these cells is absorption, the different appearance of the contents should correspond to the different stages in the absorptive process. Throughout the greater part of the middle intestine the cells are swollen with the food contents, and so closely pressed together that it is impossible to make out the details of a single cell. All cell walls have apparently disappeared, and the result is a chaotic mass of cytoplasm filled with globules and granules of food, bordered by cilia on the side toward the intestinal lumen, and with a row of nuclei along the base, above the basement membrane.

The gland cells that have been mentioned as occurring occasionally in the middle intestine, fig. 34, $Gl._1$, cannot be distinguished from the absorptive cells—except by their absence of cilia—in preparations stained with iron-hæmatoxylin, since with this stain both the secretion globules and the absorptive particles stain black. With the hæmatoxylin-eosin stain, however, the differences are strongly brought out, the food granules staining a brighter red, and having a different degree of refraction from that of the glandular secretion globules.

It has already been mentioned that the two anterior pouches consist of different histological elements from the subsequent ones. They are also somewhat smaller and are deflected slightly forward (see fig. 1). In the more anterior part of the middle intestine, the cæca are but little deeper than the axial part of the canal, but farther back the cæca increase in depth at the expense of the axial portion.

In the breeding season, when the gonads are swollen and enlarged, the intestinal cæca are under such pressure that their opposite walls are frequently in contact. Wilson (1900) believes that the lateral cæca do not function under these conditions, and quotes the statement of M'Intosh (1873), that "the glandular elements in the wall of the digestive tract undergo a certain amount of atrophy during the period of reproductive perfection." Wilson adds, in respect to *Cerebratulus lacteus*, p. 115: "For a long time, therefore, these intestinal pouches can function very little, if at all, and so they contribute nothing to the nourishment of the body." I should be unwilling to state that the lateral pouches in *Zygeupolia* take no part in the absorption of food, for I have found some cells of the lateral cæca that evidently contained food vacuoles, in spite of the fact that the cæcum was greatly pressed by the adjoining gonads; but the cells of the cæca are certainly under great disadvantages at this period.

Toward the posterior end of the body (see fig. 17), the lateral cæca decrease more and more in size, until finally the intestine is once more a simple tube, Plate XLI, fig. 26, *E.I.* This portion of the alimentary tract is variously termed the "anal portion of the intestine," the "end intestine" ("Enddarm," Bürger) and the "rectum" (Coe, 1895 *a*).

The end intestine, as it will here be termed, in *Zygeupolia* is about .8 mm. long. The cells are the same absorptive cells that are found in the middle intestine, with an occasional gland cell, so that histologically the end intestine is the same as the middle intestine, and may be regarded as merely the terminal portion of that region.

At the junction of the caudicle and body, fig. 27, the intestine curves dorsally and opens, by the anus, to the exterior on the dorsal surface of the body. The anal opening, fig. 17, *A.*, is small, and the edges are clothed with cilia.

10. The Reproductive System. — *Zygeupolia* is diœcious. The gonads, figs. 1, 24, 25, are found between the pouches of the middle intestine, metamerically arranged, throughout its length, the first pair of gonads occurring between the first and second pairs of intestinal cæca, and so on regularly, the gonad of one side lying between two consecutive intestinal cæca, and opposite to its fellow of the other side. Near the end of the middle

intestine, about 7 mm. anterior to the anus (see fig. 17), where the cæca become more and more shallow and finally disappear altogther, leaving the simple tube of the end intestine, the gonads terminate (cf. fig. 26).

The Testis.—The testis is a simple sac, the wall consisting of a one-celled layer of large, rather flattened cells with prominent nuclei. In cross section, Plate XLI, fig. 24, the wall of the gonad appears like a membrane, along which the nuclei are placed; in tangential section, Plate XLIII, fig. 53, the cells appear elongated, dovetailing into one another, with strong cell walls which are wavy in outline, and granular cytoplasm that stains pink with the hæmatoxylin-eosin stain. Each testis has a single duct, figs. 24, 55, *T.d.*, opening on the dorsal surface of the body, very near the side of the rhynchocœl. The duct passes dorsally from the testis through the inner longitudinal and circular muscle layers, and then expands into a bulb-like portion with slightly thickened walls, fig. 55, *b*, and again narrows before opening to the exterior. The duct meets the body epithelium at the surface, and no bending in of the latter has been observed.

The youngest male cells are found at the margin of the testis, attached by their bases to the gonad walls, figs. 24, 57. The youngest cells are the largest—.023 mm. long, .005 mm. wide. They are rather pear-shaped cells, fig. 57, with the distal end rounded and the basal end prolonged into a slender stalk. The nuclei, *N.*, are large, with a prominent chromatin reticulum and one nucleolus, *n*. The cytoplasm is finely granular and no cell membranes are present. From their size it is probable that these cells are spermatogonia. They form a layer, one or two deep, around the periphery of the testis, and are occasionally found far in toward the middle.

On the median side of the spermatogonia comes a zone of smaller cells, arranged in radial rows. These are probably spermatocytes. Many of them are in division stages, and the tiny spindles are very distinct, but are too minute for any exact study.

In the innermost part of the testis the spermatozoa, Plate XLI, fig. 24, *Spz.*, are found, and near them very small cells that are no doubt the spermatids. The spermatozoa are about .06 mm. long, and three parts may be distinguished in them, the head, the middle piece and the tail, Plate XLIII, figs. 58, 59. The head is longer than wide, and is slightly broader at its posterior end. It stains deep black with iron-hæmatoxylin, and blue with hæmatoxylin-eosin. In some iron-hæmatoxylin preparations that had been strongly destained, the head appeared ashy gray with a minute black point at the tip, fig. 58. The middle piece, *m. b.*, is a four-lobed structure. In fig. 59 there is a middle piece that has been detached from a spermatozoan and which resembles four small spheres. In side view only two of the lobes are seen. The middle piece stains black with iron-hæmatoxylin, and red with hæmatoxylin-eosin. The tail is a slender filament, in which no structure could be made out, many times longer than the head.

The Ovary.—The wall of the ovary, like that of the testis, is a flattened epithelium, fig. 54, *Gon. W.*

No ovarian duct has been found, although several specimens of different ages have been examined. It is possible that a duct may form in an older stage than those studied, but it seems more probable that the eggs are discharged by rupture of the wall. The latter view is supported by the fact of the difficulty in keeping the body wall intact while studying living females with large ova. When a perfect specimen was placed on a slide with sea water and covered, a method that was repeatedly used without difficulty for males, and for females with smaller ova, the posterior part of the body would almost invariably fragment. It was also difficult to fix and harden a mature female without rupturing the body wall. No especial importance was attached to these facts at the time, but since finding from the study of sections that there is no preformed ovarian duct, I am inclined to believe that the fragmentation observed in the female specimens was caused by the rupture of the body wall above the gonads, the break then extending farther around the body wall.

Closely pressed against the wall of the ovary and attached to it by their broad bases are the youngest egg cells.[10] Fig. 54 is a cross section of a portion of the wall of one of the youngest ovaries. Although most of the smallest ova are distinct cells, here and there several are seen, so close together that their boundaries cannot be distinguished, and it is therefore probable that the ova arise from a

[10] As all the material examined was quite advanced in age, I have had no opportunity to study the youngest stages of the ova, so that therefore the cells that are here described as the youngest are probably well on in their development.

cell syncytium. The smallest separate egg cells, $O._1$, are rather square, having as yet no stalk. The cytoplasm is clear and slightly granular, with no yolk granules, and there is a delicate cell membrane. The nucleus is round, about .0058 mm. in diameter; a small nucleolus is present, but no chromatin is demonstrable, probably on account of admixture with plastin, and the whole nucleus takes a plasma stain, pink with hæmatoxylin-eosin.

In the next stage, the young ovum, $O._2$, has lengthened, the distal end is somewhat rounded and the proximal end more slender, so that the whole cell is now pear-shaped. The proximal end constricts more and more until it becomes a slender stalk, by which the rounded distal end or cell body remains attached to the gonad wall. The nucleus has enlarged, measuring about .023 mm. in diameter, likewise the nucleolus, in which scattered vacuoles are forming. Yolk granules are beginning to appear in the cytoplasm.

After the appearance of the yolk the cytoplasm has quite a different look, being denser with the fine yolk granules scattered throughout. The nucleus of this stage, $O._3$, is much larger, .035 mm. The nucleolus has not increased much in size, but the small scattered vacuoles have fused into one large disk-shaped vacuole, *n.vac.*, at the periphery of the nucleolus.

The ovum is now surrounded by two egg membranes, the outer of which, *o. O.mb.*, is considerably thicker than the inner and stains blue, while the inner takes a faint pink, hæmatoxylin-eosin stain. The formation of the egg membranes has not been followed with any exactness, but I believe that both membranes are formed by the egg. Böhmig (1898) believes this is the case in *Stichostemma græcense.* Montgomery (1895) states that in *S. eilhardi* only the inner egg membrane is a "yolk membrane," the outer being derived from the germinal epithelium and is therefore a true chorion.

The oldest stage found, figs. 25, 52, is that of a free ovum in the centre of the gonad, no longer attached to the wall by its stalk. Both membranes are present, the outer one, fig. 52, *o. O.mb.*, being often broken and discontinuous, as if it were about to be sloughed off. This appearance, however, may be an artifact, as the specimen from which it is drawn was badly shrunken. At this stage the gonad contains twenty or more ova of equal size, in such close contact with each other that they assume a polygonal form. This is seen in fig. 56, a slightly younger stage, drawn from life. It is likely that several or many ova ripen in one gonad at once, and not one at a time as in many Nemerteans.

The cytoplasm of this oldest stage stains a bright pink with the hæmatoxylin-eosin stain, and is charged with yolk; the nucleus is very large, its diameter being about half that of the cell, the greater part of its contents still taking the plasma stain. The nucleolus is either one large rounded body, usually placed peripherally, or it is broken up into numerous small fragments, which lie around the periphery near the nuclear membrane, fig. 61, *n*. Several vacuoles of varying size are present in the nucleolus.

The attempt has been made to determine whether there is any priority in the ripening of the sexual products of either end of the body. No difference in the respective ages of the gonads of the two ends has been observed in the specimens studied. In any one immature gonad different stages may be found, the youngest cells lying peripherally, attached to the gonad wall, the older cells toward the centre and free.

11. THE CAUDICLE.—The caudicle, a term suggested by Montgomery (1897 *a*) as a translation of Bürger's "Schwänzchen," may be defined as the slender, thread-like process at the posterior end of the body of certain Heteronemerteans.[11]

The caudicle of *Zygeupolia* in life, figs. 4, 5, 6, appears as a slender white filament, and a low magnification reveals a ciliated surface and what seems to be a quite regular segmentation. A closer examination, however, shows that the apparent annular constrictions are merely the result of muscular contractions, and are constantly varying in size and position. A light area along the mid-line, bordered by denser areas, indicates the presence of a central cavity—the blood lacuna.

In connection with the caudicle, a description of the position of the organs in the extreme posterior end of the body may be of interest. The division of the dorsal blood vessel into two has already been mentioned, and the subsequent fusion of the four vessels into a central blood space; the termination of the rhynchocœl; the disappearance of the gonads and the dorsal opening of the anus. A short distance in front of the anus the lateral nerves

[11] It will be shown in the historical review of the literature of the caudicle, that the structure described as a caudicle by Montgomery (1897 *a*) is in reality a regenerating posterior end.

assume a more ventral position, finally lying on the ventral surface of the body, Plate XLI, fig. 27. In this position they pass over into the caudicle. In the caudicle, fig. 28, *C.L.N.*, the nerves lie latero-ventrally, and extend to the posterior end.

The transition from the end of the body to the caudicle is also marked by the sudden disappearance of the cutis and outer longitudinal muscle layer. This is seen in fig. 27, a slightly oblique cross section, that passes through the wall of the body dorsally and the wall of the caudicle ventrally.

A cross section through the caudicle, fig. 28, shows that it is a hollow tube with the following structure: (1) the epithelium, (2) the two lateral nerves in the epithelium, (3) the circular muscle, (4) the inner longitudinal muscle, and (5) mesenchyme cells bordering on the central blood space.

The epithelium is composed of ciliated supporting cells, fig. 12, *S.C.*, very similar to those of the body, but with a smaller cell body and longer stalk (cf. figs. 2 and 12); large gland cells, fig. 11, lying mostly on the dorsal surface, the secretion staining red with eosin, with very large nuclei at the base and abundant cytoplasm enclosing the secretion; and very numerous interstitial connective tissue cells between the bases of the epithelial cells, above the basement membrane. The epithelium of the caudicle as a whole is slightly higher than that of the body, measuring about .04 mm. in height. The nuclei of the connective tissue cells, fig. 28, *Cn.T.N.*, are so prominent and the cells so numerous that the effect is like that of undifferentiated tissue. Bürger[12] (1895), p. 239, says in this connection: "Es lässt der Reichthum an Kernen wohl keinen anderen Schluss zu, als dass die Zellelemente der Gewebsschichten und des Parenchyms des Schwänzchens im Vergleich zu denen des Körpers ganz ausserordentlich klein sind."

The lateral nerves, fig. 28, *C.L.N.*, lie in the epithelium outside the circular muscle layer, latero-ventral in position. No ganglion cells could be detected around the fibrous core. The circular muscle layer, *C.M.*, is reduced to a very thin layer of two or three fibres; the longitudinal muscle, *i.L.M.*, is also a layer of but little thickness. The central blood space, *Bl.L.*, is bordered by scattered mesenchym cells, *mes.*, large pear-shaped cells, attached at first to the muscular wall, but later floating freely in the lacuna.

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[12] For the sake of clearness the great numbers of the connective tissue cells in the epidermis are not represented in fig. 28.

It is thus seen that the caudicle of *Zygeupolia* is a structure from which many organs of the body are absent, namely: the alimentary canal, the gonads, the rhynchocœl, the outer longitudinal muscle layer and the cutis.

The significance of the caudicle, however, is not clear, and several explanations may be suggested: (1) The caudicle has remained in a simple, primitive or embryonic condition, while the rest of the body has become differentiated.

(2) The caudicle is a degenerate structure, the degeneration of certain organs having begun at the posterior end and continued gradually forward.

(3) The caudicle is a cœnogenetic structure, with a certain physiological function.

Of these views, no positive proof can be brought forward in regard to the first two. The varying complexity of the caudicles of different genera—for example, that of *Zygeupolia* and the caudicle described by Bürger (1895) for *Cerebratulus marginatus*, containing all the organs of the posterior end of the body—might support the view of degeneracy, but this argument may hardly be used until we know more of the origin and phylogeny of the caudicle.

It seems much more probable that the caudicle of the Nemerteans has arisen cœnogenetically, and an explanation of its mode of origin has been suggested by the comparison with a Rhabdocœl Turbellarian, *Macrostoma hystrix* Oe., described by Graff (1882), and figured on Taf. IV, Fig. 1. In this worm the posterior end is expanded laterally and provided with abundant gland cells, making an adhesive surface. Graff says, p. 240, the body is " hinten in einen platten spatelförmig erweiterten Schwanz ausgezogen." It would not be difficult to imagine this posterior end becoming elongated and more slender, until it is finally a thin filament. In a similar way the Nemertean caudicle may have arisen from a posterior end, originally differentiated as an adhesive surface. The observations of Johannes Müller (1854) and M'Intosh (1869) show that at the present time the end of the caudicle frequently acts as a sucker.

M'Intosh (1869) believes that the central space in the caudicle of *Micrura purpurea* is connected with the circulatory system. This, as stated above, is certainly true in *Zygeupolia*. The fact that the large blood lacuna occupies the entire space within the muscular wall of the caudicle of *Zygeupolia*, and that the mesenchym—blood-forming—cells are very abundant, suggests that one function of the caudicle may be the formation of new blood cells. This, however, also takes place throughout the blood vessels of the body. The large blood lacuna of the caudicle is probably a means of aerating the blood, making respiration another possible function of this problematical structure.

Literature of the Caudicle.—The caudicle has been known in literature under various other names, and considerable confusion has arisen from the multiplication of terms, and from the fact that the caudicle, which is an adult structure, has been confounded with the regenerating " papilla" so frequently found at the posterior end of Nemerteans that have been broken.

For this reason an account of the history and synonymy of the caudicle and the differences between the true caudicle and the regenerating posterior end will be given, at perhaps greater length than the importance of this small structure demands.

The following papers will be separated under two headings I, those describing the true caudicle; II, those in which other structures have been mistaken for the true caudicle.[13]

I. Ehrenberg and Hemprich (1831) describe the new genus *Micrura* with " anus sub cauda," and *Micrura fasciolata* nov. sp., " . . . . anus terminalis sub processu caudali parvo, albo."

Busch (1851) (cited by J. Müller, 1854) mentions and figures, Taf. II, Fig. 8, a Nemertean with a caudicle (" Schwanzanhang "). The worm is described under the name of *Alardus caudatus*.

Diesing (1851) refers to *Micrura* Hemp. et Ehr. = *Nemertes* Oersted, as with a " processu terminali postico filiformi brevissimo." He describes the new species *Meckelia Knerii* Diesing, " corpus depressum retrorsum parum augustatum processu brevissimo filiformi."

Dalyell (1853), Vol. II, (cited by Krohn, 1858), describes under the name *Gordius* four Nemerteans that would now be

[13] In this review of the history of the caudicle some of the earliest and some of the most important papers in Nemertean literature are referred to, but no attempt has been made to give a complete list of all the observations on the subject.

recognized as *Micruræ*. They are *G. viridis spinifer*, *G. purpureus spinifer*, *G. fragilis spinifer* and *G. fasciatus spinifer*.

Johannes Müller (1854) reports finding a young worm within the larva *Pilidium gyrans*, and also others in the water which have a "Schwanzanhang," and resemble the *Alardus caudatus* Busch. The latter is figured, after Busch, on Taf. IV, Fig. 2. Müller says "Mit dem Schwanzanhang kann sich das Thierchen auf dem Glase anhalten und wie festleimen und ist dann schwer von der Stelle zu bringen." He believes that the young worm within the larva, resembling the *Alardus* of Busch, is the same as *Micrura fasciolata* Ehr. et Hemp. Müller also quotes a letter from A. Krohn, dated November 19, 1851, in which Krohn speaks of finding at Naples a young worm within the *Pilidium gyrans*: "Der Leib desselben ist länglich oval, nach vorn zu etwas verschmächtigt. Mitten am hinteren Ende findet sich ein ganz kurzer cylindrischer Anhang, der durch wenige aufeinander folgende Querwülste wie gegliedert erscheint. Die Oberfläche des Leibes, so wie auch die des Anhanges ist wie bei den Turbellarien dicht mit schwingenden Cilien besetzt."

Krohn (1858), referring to the young worm within the *Pilidium gyrans*, says: "In Helgoland sah ich 1854 mehrere arten von *Pilidium*. . . . . Der Schwanzanhang wird an den mehrsten Nemertinen von Pilidien beobachtet, und wird nur selten vermisst. . . . . Die Nemertinen mit Schwanzanhang gehören zu der Gattung *Micrura* Ehr., womit *Alardus* Busch identisch ist." On p. 300, Krohn gives a list of the *Micruræ* found in the North Sea, and an account of the synonymy of the genus.

Leuckart (1858) summarizes the work done on Nemerteans. On p. 186 he mentions the "Anwesenheit eines retractilen Schwanzfadens" in a Nemertean.

Leuckart and Pagenstecher (1858) describe a new *Pilidium*, *P. auriculatum*: "Ein Schwanzfortsatz, wie er so häufig bei den in Pilidien gebildeten Nemertinen gefunden wird und nach J. Müller auch bei dem Sprösslinge eines Helgoländer *Pilidium* vorkommt, fehlt unserm Thier."

Metschnikoff (1869) mentions the presence of a caudicle on the young worm within the pilidium. This is figured on Taf. X, Fig. 15. On p. 55 he says: "Es bildet sich am Hinterrande der jungen Nemertine ein kleines konisches Schwänzchen, welches einen einfachen Auswuchs der Körperwand darstellt, und wie diese mit Flimmerhaaren bedeckt erscheint."

M'Intosh (1869) describes the following structure: "The posterior end of the body in *Micrura* (*Stylus*) requires special mention, since there is superadded a peculiar elongated and contractile style. This appendage seems to be formed by a prolongation of the cutaneous and part of the muscular (longitudinal and circular) textures of the body wall of the animal. The entire organ in contraction has a granular appearance, the coarsest granules and occasionally a few circular masses of brownish pigment, being at the tip. Within these coats is a circular chamber, which undergoes various alterations in size, and contains a transparent fluid. This cavity is not connected with the digestive tract, which opens by a terminal pore at the base of the process, nor can proboscidian discs be seen therein. . . . . its connection with the circulatory [system] appears most probable."

M'Intosh (1874) says that the genus *Micrura* has "a soft filiform caudal process, capable of attachment." He further alludes to "a pale caudal filament" and "a slender styliform process attached to the tail" which "can be elongated to an extreme degree."

Hubrecht (1887) used the term "caudal papilla" throughout his description of the caudicle.

Verrill (1893), in defining the genus *Micrura*, says: "Posterior end of the body provided with a median slender cirrus, above the anus. This genus, as here defined, differs from *Lineus* in little else than the presence of a well-marked contractile anal cirrus, which may often be distinguished even in alcoholic specimens. From *Cerebratulus*, which also has the anal cirrus, it differs in the form and muscular structure of the body posteriorly." In other parts of this work the terms "anal papilla," "caudal papilla" and "caudal filament" are indiscriminately used.

Verrill (1895) employs the expression "caudal cirrus."

Bürger (1895) describes "ein dünnes 5–15 mm. langes, meist borstenartig starres, weissliches Anhängsel," which he terms "das Schwänzchen." On p. 24, in reviewing the work of Dalyell, Bürger employs another term, saying that Dalyell "den Appendix beobachtet und gut gezeichnet hat."

Coe (1895 *a*), in regard to *Cerebratulus lacteus*, says: "The *anus* is at the end of the body, just beneath the caudal papilla."

Coe (1901) gives as one of the generic characters of *Cerebratulus*, ". . . . the posterior end extremely flattened and provided with a delicate caudal cirrus, which extends beyond the opening of the intestine."

Wilson C.B. (1900) uses Hubrecht's term "anal papilla" for the caudicle of *Cerebratulus lacteus*.

Punnett (1900) speaks of a "caudal appendage."

II. O. F. Müller (1788) describes and figures, p. 38, tab. 68, figs. 18, 20, a *Planaria filaris:* "*Planaria* linearis cauda filiformi contractili." The length of the "cauda filiformis contractilis" in fig. 20, equal to the length of the body, suggests the thought that it may be the evaginated proboscis. Bürger (1895), p. 8, says that this worm is probably a *Tetrastemma*.

Grube (1855) describes two new species of *Meckelia*. The first, *M. annulata*, resembles the *M. Knerii* Diesing. Grube thinks that the "processus terminalis" described by Diesing is more probably a regenerating end; he says: "Der processus brevissimus filiformis könnte ein reproducirtes noch junges Schwanzende sein." The second species, *M. aurantiaca*, has the following characteristics: "Der Körper verschmälert sich nach hinten sehr allmählich, und endete bei einem Exemplare in ein viel dünneres, warscheinlich vor kurzem reproducirtes Schwänzchen."

Montgomery (1897 *a*), Taf. 2, Fig. 16, has described as a caudicle what is evidently a regenerating posterior end.[14] The characters that make the structure described by Dr. Montgomery in *Cerebratulus lacteus*, and figured by him on Taf. 2, Fig. 16, a regenerating posterior end rather than a true caudicle are (1) the size, (2) the presence of the alimentary canal, (3) the presence of the outer longitudinal muscle layer, and (4) the presence of the three distinct blood vessels with definite walls.

The chief external differences between the true caudicle and the regenerating papilla of *Cerebratulus lacteus* are in size and general

[14] My attention was called to this error by Dr. Montgomery himself, who has suggested that it be rectified. Dr. Montgomery has kindly lent me his own preparations upon which the observations were made, so that I have been able to compare them with slides of my own, made from a *Cerebratulus lacteus* found in life with a good-sized regenerating papilla, which bore a short caudicle at its posterior end.

appearance. The true caudicle is slender and thread-like, contractile and usually twisted; the regenerating papilla is stouter and rod-like, and does not twist and contract like the caudicle. C. B. Wilson (1900) contrasts the two structures as follows. On p. 116, alluding to the regenerating end, he says: "Such a papilla is slender and almost pure white in colour. At first it it is difficult to distinguish it from the true anal papilla with which the body normally terminates, but it may be recognized by the fact that it always possesses a very broad base which fades gradually into the body wall, while the anal papilla is narrow and ends abruptly at the emargination."

The papilla on the *Cerebratulus* found by the writer was about 7 mm. long, light in color and rather rounded, not yet having assumed the typical flattened shape of the body. At its posterior end a short, but in all respects a true caudicle was borne. A cross section through this true caudicle shows that it consists merely of a thin body wall enclosing a central blood space. The body wall is composed of the epidermis, in which the two lateral nerves lie, and of the circular and inner longitudinal muscle layers. The blood lacuna has no definite lining, but is bordered by numerous mesenchym cells. From the caudicle of *Cerebratulus lacteus*, like that of *Zygeupolia*, the alimentary canal, the gonads and the rhynchocœl are absent.

A cross section through the regenerating papilla of my *Cerebratulus* has the same structure that is found in the section figured by Dr. Montgomery. The outer longitudinal muscle layer and the alimentary canal are present, and three blood vessels—one dorsal and two lateral—instead of the central blood lacuna. This proves finally that the structure observed by Dr. Montgomery is a regenerating posterior end and not a caudicle.

In both worms the end of the body tapers quite gradually into the regenerating portion, and it would be difficult to say where the old tissue ends and the new begins, as differentiation has evidently gone on for some time in the anterior part of the new tissue. The most posterior sections of Dr. Montgomery's worm show that a true caudicle had likewise begun to form there, but had subsequently been broken off just at its base. It is seen from the measurements of the two worms that there is an abrupt change in size between the end of the body proper and the caudicle, the caudicle measuring less than half the width of the body. The diminution in size is due to the sudden disappearance of the outer longitudinal muscle layer, and to the ending of the alimentary canal with the body.

A word must be said here in regard to the relative position of the anus and the caudicle.

Verrill (1893) states that the caudicle of the genus *Micrura* is above the anus, and Coe (1895) says the same in regard to *Cerebratulus lacteus*. From my study of sections of *Micrura cæca* and *Cerebratulus lacteus* I find that the anus undoubtedly opens dorsally *above the caudicle.* Nothing is easier than to confuse the dorsal and ventral surfaces of a living worm, but in serial sections, with definite structures for orientation, there can be no such difficulty. The anus in *Zygeupolia* likewise opens dorsally *above the caudicle,* and Bürger (1895) states that the dorsal position of the anus is usual in Nemerteans. From these data it seems likely that a thorough investigation of all species with caudicles will prove that the dorsal position of the anus is of general occurrence.

Bürger (1895), p. 238, says in regard to the caudicle of *Cerebratulus, Micrura* and *Langia:* "Morphologisch stellt das Schwänzchen nichts anderes dar als das stark und meist plötzlich verjüngte hintere Körperende, in das sich von Organen der Darmtractus, die drei Blutgefässtämme, die Genitaltaschen und die Seitenstämme fortsetzten, und in welchem wir auch alle Schichten der Körperwand bis auf die Cutis, welche gänzlich verschwunden oder in ihrer Ausbildung fast unterdrückt ist, antreffen." According to this all the organs of the posterior part of the body are represented in the "Schwänzchen," except the rhynchocœl, and even this organ, Bürger states, is present in the anterior part of the caudicle of *Cerebratulus marginatus.*

The observations of M'Intosh (1869) in regard to *Micrura purpurea,* those of Verrill (1893) on the whole genus *Micrura,* and my own upon *M. cæca* are contradictory to the above statement of Bürger. In like manner Coe's work upon the American species of *Cerebratulus* and my own upon the one species *Cerebratulus lacteus* show that the caudicles of these forms cannot be regarded as merely "verjüngte hintere Körperenden." From the very limited space devoted to the subject of the caudicle in Bürger's great monograph, it is likely that his study of this structure was hasty, and the question has arisen in my mind, could Bürger have mistaken a regenerating posterior end for a true caudicle ?

Without wishing to criticise the statement of this distinguished investigator, it seems probable that a further investigation of the caudicles of the European species of *Micrura* and *Cerebratulus* will result in an agreement with the structure of the American species.

III. Parasites.

A monocystid Gregarine in its adult form is frequently present in the middle intestine of *Zygeupolia.* Large cysts, surrounded by a thick cuticle and containing various developing stages, are also found in the intestine. From their proximity to the adult Gregarines, and from their resemblance to the stages figured by different authors, it seems likely that these are Gregarine cysts. Outside of the cyst, in the lumen of the intestine, are small amœboid masses, resembling some of the stages within the cyst. These amœboid masses also penetrate between or into the cells of the intestinal wall and probably into the gonads.

In some living specimens large white spots may be noticed among the gonads, fig. 6. They are so large that they are easily seen with the unaided eye. They appear stalked, like the ova, and have a large nucleus with one or more nucleoli. Fig. 56, a horizontal optical section drawn from life, shows one of these structures in a gonad together with several ova. In life the cytoplasm appears denser and darker than that of the small ova, and the conclusion first reached after studying these living bodies was that they were the oldest, nearly mature ova.

The examination of sections in which these large bodies are present has shown that the first conclusion was erroneous and has proved that they are the encysted stages of some parasites within the cytoplasm of the ovum. Fig. 60 is a transverse section through the body wall and the wall of the gonad, showing the cyst, surrounded by egg cytoplasm, *cy.*, and attached to the gonad wall, *Gon. W.* The cyst is surrounded by a striated cuticle,[15] *Ctl.*, and outside the cuticle is a delicate membrane staining like the cell membrane. In the cytoplasm of the base are two egg

[15] The reference line from *Ctl.*, fig. 60, only extends as far as the egg membrane, instead of to the cuticle within.

nuclei, *N*. The cytoplasm of the cyst has a very different staining reaction from that of the egg, staining a faint violet with hæmatoxylin-eosin, and having a finely granular appearance. The nucleus of the cyst, *N.par.*, is irregular in outline, in some specimens with amœboid processes. It stains homogeneously a bright red, hæmatoxylin-eosin, while the nucleoli are darker and frequently vacuolated.

The presence of the additional egg nuclei in the cytoplasm at the base of the cyst render it probable that the parasite entered the cytoplasm when the ovum was in a syncytium. The presence of the parasite may have caused an abnormal growth of the egg cytoplasm, or the latter may have merely expanded with the growth of the cyst. In its appearance the cytoplasm around the cyst is like that of the normal, uninfected eggs.

Figs. 48, 61, show two infected egg cells from a different individual, with amœboid, probably earlier stages of the parasite, *Par.* In this particular worm almost every egg has been infected.

As a rule, the gonads of the male specimens that were studied were not infected, but in a few worms the testes contained large bodies that were evidently parasites, and that resembled some of the stages found in the ovaries.

The relation, if any exists, between the amœboid masses found in the intestine and those within the egg cells has not as yet been worked out, as it is not within the scope of the present paper, but in consideration of the prominence of these parasites and of their position in the ova, this brief description has been given. If sufficient material can be obtained for the intermediate stages, this subject may later be studied in detail.

The presence of adult Gregarines in Nemerteans has been known for a long time, and they are mentioned and described by several of the earlier Nemertean writers—Frey and Leuckart (1847), Kölliker (1848) and Johnston (1865), Appendix, p. 290.

I have found no references in literature to any structures quite similar to those found in the ova of *Zygeupolia*. M'Intosh (1867) and Wheeler (1896) describe parasites that have a certain degree of likeness.

M'Intosh found adult Gregarines in *Borlasia octoculata* = *Lineus sanguineus* and *Borlasia olivacea* = *Lineus gesserensis*. Besides the adult Gregarines, M'Intosh found what he called "certain ova that accompany the Gregarines." The "ova" measured about $\frac{1}{400}$ inch in diameter and each contained an "embryo" that made evident movements. They have two coats, an inner faintly striated and an external without markings. The contained "embryo" is finely granular and has a large pale nucleus. M'Intosh regards these "ova" as altogether different from the true ova of the *Borlasia*.

Wheeler found in the body cavity of the Annelid *Myzostoma glabrum* great numbers of amœboid masses that he regards as possibly the young stages of some Gregarine. The body cavity was distended with ova, and among them occurred the parasites. He says: "In most cases the uniformly staining and rather shrunken body of the parasite was produced into a long fine point which had penetrated the cytoplasm of an ovum. In a few instances a single amœba had two points, each entering the body of an adjacent ovum (fig. 54). The cytoplasm of the ova thus attached contained large granules which took up the hæmatoxylin with avidity. These granules were larger and more numerous than those which occur in normal ova of about the same size." The amœbæ are also found outside the ova.

IV. General Conclusions.

The description of the organs of *Zygeupolia* given in the anatomical section of this paper makes it evident that this genus is a primitive one and that it has affinities with both Proto- and Heteronemerteans.

The questions now to be discussed are (1) the relationship of *Zygeupolia* to other orders, especially the Protonemerteans; (2) the position of *Zygeupolia* within its own order.

The following characters undoubtedly entitle *Zygeupolia* to a place in the order of the Heteronemerteans: the position of the lateral nerves, outside the circular muscle layer; the presence of the cutis and outer longitudinal muscle layer; the situation of the mouth behind the brain; the absence of stilets in the proboscis and of a blind intestine.

The alimentary system of *Zygeupolia* conforms with the general Heteronemertean plan, which, however, is essentially the same as that of the Mesonemerteans and such Protonemerteans as *Carinina* and *Hubrechtia*.

The blood system of *Zygeupolia* is of the Heteronemertean type, *Hubrechtia* being the only Protonemertean that approaches it in any way, namely, in the presence of a dorsal blood vessel.

In the structure of the nervous system and the cerebral sense organs *Zygeupolia* is again a Heteronemertean; but by no means the highest type of brain or sense organ is represented, *Zygeupolia* having a very simple Heteronemertean brain and cerebral sense organ.

The presence of muscular crosses in the proboscis and its general structure are further characters in common with certain Heteronemerteans.

The absence of lateral slits is a primitive character, and one common to all the Protonemerteans and to the more primitive Heteronemerteans. This character, as we know, is possessed by *Zygeupolia.* The inner circular muscle layer of *Zygeupolia* is, in my belief, a primitive character, and the short extent of the layer is explicable on the grounds that the thickened region in front of the middle intestine is only the remnant of a layer that was once continuous throughout the body.

The presence of this muscle layer in a limited region in *Micrura cæca*, and of a similar layer in *M. alaskensis*, Coe (1901), shows that an inner circular muscle layer exists in two genera of the Heteronemerteans. The dorso-ventral fibres of the Heteronemerteans, regarded by Bürger as derived from an inner circular layer, and the so-called "œsophageal muscles" ("Darmmusculatur") which, according to my view, are derived from the deflection and bending around of dorso-ventral fibres, are other evidences of the remains of an inner circular muscle among the Heteronemerteans.

The lateral grooves of *Zygeupolia*, if they are sense organs, may possibly be homologized with the side organs of *Carinella.* Their position in the median lateral line of the body, and their character as epithelial grooves, both agree with the side organs; but until their undoubted sensory character is proved, the comparison should not be emphasized.

A brief summary of the structure of *Zygeupolia* shows that it is a Heteronemertean, on account of the presence of the outer longitudinal muscle layer, the position of the lateral nerves, the structure of the alimentary system, of the blood system, of the nervous system and cerebral sense organs, and of the proboscis; while the affinities with the Protonemerteans—and certain Heteronemerteans —are in the absence of lateral slits, in the presence of an inner circular muscle layer and of crosses between this layer and the outer circular, and in the lateral grooves, if sense organs.

The general simplicity of its Heteronemertean structure and the several Protonemertean characters bring *Zygeupolia* very near to the Protonemerteans, and through *Zygeupolia* the whole Heteronemertean order is more closely connected with the Protonemerteans.

The question now arises, To which of the families of the Heteronemerteans does *Zygeupolia* belong—to the Eupoliidæ, or to the Lineidæ?[16]

The chief characteristics of the two families will now be given, according to Bürger (1895):

The Eupoliidæ.—(1) No lateral slits in the head, the cerebral canal opening directly outward or into shallow ventral furrows.

(2) No muscular crosses in the proboscis.

(3) The proboscis musculature consists of two layers, an outer circular and an inner longitudinal muscle layer.

(4) A head gland is prominent, the gland cells reaching back into the œsophageal region.

The Lineidæ.—(1) The canal of the cerebral organ opens usually, not directly outward, but into deep, or sometimes shallow, lateral slits in the head.[17]

(2) Two muscular crosses in the proboscis.

(3) The proboscis musculatur consists of three layers—longitudinal, circular and longitudinal muscle layers; if any one of these layers is absent it is the inner longitudinal one.

(4) The head gland is represented by a few gland cells, and does not extend posterior to the brain.

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[16] In my preliminary note upon *Zygeupolia* (1900 *a*) this genus is placed in the Eupoliidæ, on account of the absence of lateral slits and the supposed absence of muscular crosses in the proboscis. As I have since found muscular crosses in the proboscis, I wish to correct this error.

[17] Bürger's own words in regard to the lateral slits are here given (1895, p. 613): "Der Canal des Cerebralorgans mündet in der Regel nicht direct nach aussen, sondern in tiefe laterale horizontale Taschen, welche durch die Kopfspalten gebildet sind. Die Kopfspalten sind wechselnd tief: sie schneiden häufig bis auf das Hirn ein, aber sie sind auch, obwohl in seltenen Fällen, nur durch flache laterale Längsbuchten angedeutet."

The Lineidæ are subdivided into the Amicruræ, forms without a caudicle, and the Micruræ, forms with a caudicle.

Zygeupolia agrees with the above description of the Eupoliidæ in one point only, *i.e.*, in the absence of lateral slits in the head. The number of the muscle layers of the proboscis is the same in both, but the position of the layers is reversed in *Zygeupolia*, the longitudinal muscle being the outer; the circular, when present, the inner. It will be recalled that the circular layer is absent from the "anterior region" of the proboscis of *Zygeupolia.*

The structure of the proboscis musculature of the "middle region" in *Zygeupolia* agrees with what Bürger evidently regards as the less common condition in the Lineidæ, namely, in the absence of the innermost of the three muscle layers.

Muscular crosses are found in the proboscis of *Zygeupolia;* but this is a very variable character, for different individuals may have a dorsal and ventral cross of equal size, a strong dorsal with a faint ventral cross, or a dorsal cross only.

The absence of a definite head gland and the presence of a caudicle are common to both *Zygeupolia* and the Micruran Lineidæ.

The neurochord cells of *Zygeupolia* are an evidence of specialization, for hitherto these cells have been found only in highly organized genera.

It is evident that *Zygeupolia* agrees best with the exceptional members of the Lineidæ—*i.e.*, with those Lineidæ whose cerebral canals open directly to the exterior, and from whose probosces the inner longitudinal muscle layer is absent.

When we therefore consider the position of *Zygeupolia* in respect to the Eupoliidæ and the Lineidæ, it seems to belong entirely to neither, but to have affinities with both. It possesses the leading characteristic of the Eupoliidæ, but all the other attributes of that family are greatly modified. In general structure *Zygeupolia* comes nearest to the Micruran Lineidæ, although it is evident that it must be regarded as an aberrant member of that family.

But is *Zygeupolia* a retrograde member of the Lineidæ, or merely a more simple, primitive form in process of becoming more complex ?

It is generally accepted that the Eupoliidæ are more primitive than the Lineidæ. Now *Zygeupolia*, in the absence of the lateral slits, possesses a character that is general in the Eupoliidæ and exceptional in the Lineidæ; the number and arrangement of the muscular layers of the proboscis make a second character only occasional in the Lineidæ, and, finally, variations occur in the number of the proboscis crosses in *Zygeupolia*, a character that is constant in the Lineidæ. Therefore *Zygeupolia*, with one primitive character, a second corresponding to a reduced number of parts in the Lineidæ, and a third that varies in different individuals, is undoubtedly a form in transition from a more simple and primitive condition to a complex state. It may be regarded as the most primitive member of the Lineidæ yet described.[18]

In general external characters, *Zygeupolia* comes nearer to the genus *Micrura* than to any of the other genera of the Lineidæ. The generally small size, the body more or less rounded posteriorly and the presence of a caudicle are characters common to both. To *Micrura cæca*, *Zygeupolia* bears a most striking resemblance in size, shape and color, and the two can scarcely be distinguished except with a hand lens, which reveals the presence of lateral slits in the former and their absence in the latter.

The relation of the Heteronemerteans to the Protonemerteans is an interesting question. The position of the lateral nerve chords is relatively the same in both, the outer longitudinal muscle layer of the Heteronemerteans being merely a later formation from the ectoderm (Bürger, 1894), and the cutis glands being formed by the sinking beneath the surface of certain epithelial gland cells. Lateral slits are absent among the more simple Eupoliidæ, and I hope to have shown in this paper that an inner circular muscle layer, or its derivatives, is quite common among the Heteronemerteans.

It seems to me that the Heteronemerteans are very closely related to the Protonemerteans, the Lineidæ being connected by forms like *Zygeupolia*, the Eupoliidæ and *Hubrechtia*, and that the Metanemerteans and the Mesonemertean *Cephalothrix* are widely divergent forms.

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[18] Since the above was written the new Heteronemertean, *Micrella rufa* Punnett (1901 *b*), has been described as the most primitive member of the Lineidæ. But *Zygeupolia*, in entering the family of the Lineidæ, must assume the lowest position until an even more primitive form is discovered. Within the last few years so many new Nemertean genera have been found that we may look confidently for further additions to the group.

In regard to *Carinoma*, I agree with the view recently advanced by Bergendal (1900 *b*) that it is more of a Protonemertean than a Mesonemertean, for its points of agreement with the Protonemerteans are far more numerous than with *Cephalothrix*. Bergendal's suggestion to retain Hubrecht's broader order of the Palæonemertini, including the four families of the Carinellidæ, Carinomidæ, Hubrechtidæ and Cephalothricidæ, seems a very excellent one. This suggestion is based upon a comparative study of *Carinoma* and upon the discovery of the interesting form *Callinera bürgeri*, a true Protonemertean, in which the cerebral organs are absent.

In all zoölogy, as our knowledge advances and more and more new forms are discovered, the gaps between old and once widely separated families and groups are gradually filled and the results tend toward a more elastic and broader classification.

The view is held by some zoölogists that the Nemerteans, on account of their general uniformity, are a comparatively recent group, so that a large number of the members are probably still in existence. If this is true, we may expect some day, when our present species are better known and all the intermediate forms have been added to them, to see our existing lines of classification laid aside, and in their place one broad comprehensive group.

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EXPLANATION OF PLATES XL–XLIV.

All figures, except fig. 63, refer to *Zygeupolia.* The outlines of all figures, except figs. 1, 4, 5, 6, have been drawn with the camera lucida of Zeiss.

The following reference letters are used in the figures:

A., anus.
Abs. C., absorptive cell.
b., swollen portion of testis duct.
B.L., basement layer.
B.M., basement membrane.
Bl.M., muscle of blood vessels.
B. W., body wall.
b.k., basal knob.
Bl.f.C., blood-forming cell.
Bl.L., blood lacuna.
C., caudicle.
C. W., caudicle wall.
C.L.N., caudicle nerve.
Cn.T., connective tissue.
Cn.T.N., connective tissue nucleus.
Cn.T.S., connective tissue sheath.
Contr., contracted area.
Chr., chromatin.
Cil., cilia.
Ctl., cuticle.
$Cu.Gl._1$, red-staining cutis gland cell—coarse type.
$Cu.Gl._{11}$, red-staining cutis gland cell—fine type.
$Cu.Gl._2$, blue-staining cutis gland cell.
Cy., cytoplasm.
C.N., cerebral nerve.
C. Org., cerebral organ.
C. Org. V., cerebral organ blood vessel.
C.M., circular muscle.
C.M.p.s., circular muscle of proboscis sheath.
Cil. C., ciliated canal.
Cil.P., ciliated pit.
D. Comm., dorsal commissure.
D.L., dorsal lobe.
D.N., dorsal nerve.
D. V., dorsal blood vessel.

D.m.cr., dorsal muscular cross.
Dl. V., dorso-lateral blood vessel.
dt., duct.
E.I., end intestine.
Ep., epithelium.
Ep.M., epithelial muscle.
Ep.p.s., epithelium of proboscis sheath.
Ep.m.f., epithelial muscle fibrils.
End., endothelium.
Exc.d., excretory duct.
G.C., ganglion cell.
*G.C.*I, ganglion cell I.
*G.C.*II, ganglion cell II.
*G.C.*III, ganglion cell III.
$Gl._1$, red staining gland cell.
$Gl._2$, blue-staining gland cell.
Gl.R., glandular ridge.
Gon., gonad.
Gon. W., gonad wall.
H.M., horizontal muscle.
H. V., head blood vessel.
i.C.M., inner circular muscle.
i.L.M., inner longitudinal muscle.
i.B.L., inner basement layer.
i.Ep., inner epithelium.
i.O.mb., inner egg membrane.
I.Cœ., intestinal cæcum.
L.G., lateral groove.
L.M., longitudinal muscle.
L.M.f., longitudinal muscle fibre.
L.M.p.s., longitudinal muscle of proboscis sheath.
L.N., lateral nerve.
L. V., lateral blood vessel.
l.D.N., lower dorsal nerve.
mes., mesenchym.
M., mouth.
m.b., middle piece.
M. V., median blood vessel.
M.I., middle intestine.
M.s., muscle strand.
N., nucleus.
$N._1$, nucleus that has divided amitotically.
N.Par., nucleus of parasite.
n., nucleolus.
n.vac., nucleolar vacuole.
n.p., nerve plexus.
Nph., nephridia.
Nph.D., nephridial main duct.
Nph.d., nephridial ductule.
Oes., œsophagus.
Oe.N., œsophageal nerve.
Oe.N.Comm., œsophageal nerve commissure.
Oe.Ep., œsophageal epithelium.
Ov., ovary.
O., ovarian egg.
$O._1$, youngest ovarian egg figured.
$O._2$, slightly older than O_1.
$O._3$, slightly older than O_2.
o.O.mb., outer egg membrane.
o.Ep., outer epithelium.
o.C.M., outer circular muscle.
o.B.L., outer basement layer.
P., proboscis.
P.N., proboscis nerve.
P.S., proboscis sheath.
P.p., proboscis pore.
Par., parasite.
Rc., rhynchocœl.
Rd., rhynchodæum.
Rd.m., rhynchodæum muscle.
Rc.Ep., rhynchocœl epithelium.
Rhb., rhabdites.
r.m.f., radial muscle fibres.
S., stomach.
S.Ep., stomach epithelium.
S.C., supporting cell.
Sec., secretion.
st., stalk.
Spg., spermatogonia.
Spz., spermatozoa.
T., testis.
T.d., testis duct.
Th., secretions (?) of proboscis epithelial cells.
T.B., terminal bulb.
u.D.N., upper dorsal nerve.
u.k., upper knob.
V.Comm., ventral commissure.
V.L., ventral lobe.
V.bl.con., ventral blood connective.
V.m.cr., ventral muscular cross.
w., subepithelial œsophageal gland cells.
x., intracellular ciliary prolongations.
Xd., dorsal muscular cross of proboscis.
Xv., ventral muscular cross of proboscis.
y., attachment of proboscis to body wall.
yk., yolk.
z., bending out of fibres from inner part of proboscis sheath.

PLATE XL, Fig. 1.—Diagrammatic horizontal optical section of the anterior part of the body.

Fig. 2.—Combined drawing of parts of a cross section of the body epi-

thelium and the outer longitudinal muscle layer, from the brain region. Gilson's fluid. × 604.

Fig. 3.—Ganglion cell IV (neurochord cell), from the ventral brain lobe. × 1120.

Fig. 4.—Sketch of living worm, natural size and color. This represents the appearance of the worm in extension; the posterior end is thin and flattened and the colors are dull. The light colored median line represents the rhynchocœl.

Fig. 5.—Sketch of living worm, natural size. The worm is at rest, but not contracted, and the colors are brighter than in the extended state. The cross lines in the posterior part indicate the intestinal cæca and the gonads.

Fig. 6.—Sketch of living worm, natural size, at rest. The white spots in the posterior part represent parasites.

Fig. 7.—Supporting cell from the epithelium of the ciliated pit of the cerebral organ. × 1120.

Fig. 8.—Ganglion cell III, from the brain. × 1120.

Fig. 9.—Ganglion cell I, from the brain. × 1120.

Fig. 10.—A cluster of ganglion cells of type II, from the ventral brain lobe. × 1120.

Fig. 11.—Two gland cells from the epidermis of the caudicle, in an early phase of secretion. × 1120.

Fig. 12.—Portion of a cross section of the caudicle epidermis. × 604.

Fig. 13.—A part of the circular muscle layer from the posterior end of the body, in longitudinal section. Flemming's fluid, iron-haematoxylin. *Contr.* represents the contracted fibrillar areas which occur at regular intervals, with light non-contracted regions between. Smaller contracted streaks may be seen half-way between the larger ones. × 320.

Fig. 14.—Two supporting cells from a cross section of the body epithelium. Flemming's fluid, saffronin, gentian violet and iodine. The stalks are relatively longer than in preparations from different fixatives. *x*. indicates the intracellular ciliary prolongations. × 2200 circ.

Fig. 15.—Cells of the body epithelium and cutis gland cells, from posterior end of the body. The blue-staining cutis glands of this region are much shorter than the red-staining glands, and both are smaller than the similar glands of the anterior end. Gilson's fluid. × 604.

Fig. 16.—Optical horizontal section of the brain and mouth region. The main outlines drawn from life and diagrammatized. The blood system (in red) and the œsophageal nerve commissure are reconstructed from sections. × 29.

Fig. 17.—Optical horizontal section of the posterior end of the body and the caudicle. The main outlines drawn from life and diagrammatized. The blood system (in red) is reconstructed from sections. × 29.

Plate XLI, Fig. 18.—Part of a cross section through the head, anterior to the brain. The rhynchodæum, *Rd.*, surrounded by four bundles of longitudinal muscle, *Rd.m.*, occupies the centre of the section. From the interlacing of the radial muscle fibres, *r.m.f.*, a layer of circular muscle, *C.M.*, is formed, which becomes the circular muscle of the proboscis sheath. × 70.

Fig. 19.—Part of a cross section of the brain through the dorsal commissure, showing that the dorsal commissure in this specimen is composed of fibres coming from both dorsal and ventral lobes. The attachment of the proboscis to the body wall is also shown. × 70.

Fig. 20.—Part of a cross section of the body through the ventral brain commissure. The section is rather obliquely cut, so that the right and left sides are not quite similar. × 70.

Fig. 21.—Part of a cross section of the body through the cerebral organs. The section is quite oblique, so that its plane passes through the anterior part of the cerebral organ and the ciliated pit, *Cil.P.*, but through the posterior end of the left cerebral organ. × 70.

Fig. 22.—Part of a cross section of the body through the œsophageal region. The anterior end of the nephridial main duct, *Nph.D.*, is shown, and the large expanded ventral blood connectives, *V.bl.con.*, are very prominent. × 70.

Fig. 23.—Part of a cross section of the body immediately in front of the beginning of the middle intestine, showing the inner circular muscle layer, *i.C.M.*, and the dorsal and ventral muscular crosses, *D.m.cr.*, *V.m.cr.*, between the inner and outer circular muscle layers. The much enlarged upper and lower dorsal nerves, *u.D.N.*, *l.D.N.*, are very prominent. × 70.

Fig. 24.—Part of a cross section of the body of a male in the region of the gonads. The plane of the section passes through one of the intestinal cæca, *I.Cae.*, and the narrower part of the testis. The duct of the right hand testis is shown, *T.d.* The sexual products of this individual are only partly mature, most of the cells being in the spermatogonic stage, *Spg.* × 70.

Fig. 25.—Part of a cross section of the body of a female in the region of the gonads. The oldest ova, *O.*, are free in the centre, the youngest are attached to the wall of the gonad. Two encysted parasitic bodies, *Par.*, are present in the left-hand ovary. × 70.

Fig. 26.—Cross section through the posterior region of the body, showing the simple end intestine, *E.I.*, without lateral caeca, and the two dorso-lateral blood vessels, *Dl. V.*, that have resulted from a forking of the dorsal vessel. The gonads are absent from this region. × 70.

Fig. 27.—Cross section through the junction of the caudicle with the body; the upper part of the figure belongs to the body, the lower part to the caudicle. The different character of the walls of the two parts is very evident. The end intestine, *E.I.*, has a dorsal position, and is about to open into the anus.

Fig. 28.—Cross section through the caudicle, showing the caudicle wall and the central blood lacuna, *Bl.L.* The great numbers of connective tissue cells, *Cn.T.N.*, actually present are, for the sake of clearness, only approximately represented. × 320.

PLATE XLII, Fig. 29.—Portion of a cross section of the epithelium of the median blood vessel. × 604.

Fig. 30.—Part of a cross section of the proboscis sheath, about 1.8 mm. in front of the beginning of the middle intestine, showing the origin of the inner circular muscle layer from circular fibres of the proboscis sheath. The innermost circular fibres of the proboscis sheath bend outward at *z.* and run beneath the stomach, thus forming the inner circular muscle layer. × 240.

Fig. 31.—Part of a cross section of the epithelium of the œsophagus, from the anterior region, showing the subepithelial gland cells, *w.* × 604.

Fig. 32.—Portion of the epithelium of the stomach, from a cross section. × 604.

Fig. 33.—Half of a cross secetion of the alimentary tract through the junction of the œsophagus and the stomach. The upper part of the figure shows the epithelium of the stomach, *S.Ep.*; the lower part that of the œsophagus, *Oe.Ep.* A fold, *f.*, probably represents a primitive valve. × 320.

Fig. 34.—Part of a cross section of the epithelium of the middle intestine from the posterior region. The cilia are slightly diagrammatic, being usually massed together in fixed preparations. × 604.

Fig. 35.—Cross section through the "anterior region" of the proboscis. × 320.

Fig. 36.—Cross section through a portion of the "glandular ridge" of the proboscis, showing several aggregations of rhabdites, *Rhb.* × 604.

Fig. 37.—Tangential section of a portion of the proboscis from the "mid-

dle region," showing the longitudinal muscle, *L.M.*, with the subepithelial muscle fibrils above, running transversely. × 604.

Fig. 38.—Part of a longitudinal section of the proboscis, from the "middle region," showing the subepithelial muscle fibrils in transverse section. The outer flattened epithelium is extremely thin. × 1120.

Fig. 39.—Part of a longitudinal section of the proboscis, from the "posterior region." The outer epithelium, *o.Ep.*, is composed of cells of considerable height, with abundant cytoplasm. The subepithelial muscle fibres, *Ep.m.f.*, are thickened in this region. × 1120.

Fig. 40.—Cross section through the "middle region" of the proboscis, showing both dorsal and ventral muscular crosses, *Xd.*, *Xv.* The lateral nerves form a continuous plexus, *n.p.* The glandular ridge of the dorsal surface is very prominent, *Gl.R.* × 320.

Fig. 41.—Cross section through the "posterior region" of the proboscis, some distance anterior to its termination. The proboscis nerves are again separate, *P.N.* × 320.

Fig. 42.—Small "rhynchocœl corpuscles." × 1120.

Fig. 43.—Large cells from the fluid of the rhynchocœl, "rhynchocœl corpuscles." The two nuclei, *N.*, are probably the result of amitosis. × 1120.

Fig. 44.—Portion of a cross section of the proboscis immediately posterior to its insertion, showing the regular brick-shaped cells of the outer epithelium, *o.Ep.* The subepithelial muscle fibrils are absent from this, the most anterior, region. × 604.

Plate XLIII, Fig. 45.—Portion of a cross section through the body wall, showing the excretory duct of the left nephridium, *Exc.d.* × 128.

Fig. 46.—Portion of a cross section of the body, showing the left lateral blood vessel, *L. V.*, with the adjacent nephridial main duct, *Nph.D.*, and a ductule, *Nph.d.* × 320.

Fig. 47.—Portion of a cross section of the body, showing the right lateral blood vessel, *L. V.*, into which project two terminal bulbs of the nephridia, *T.B.* The epithelium of the blood vessel is not continued around the ends of the terminal bulbs. × 604.

Fig. 48.—Cross section of an ovum infected with a stage of a parasite older (?) than that shown in fig. 61. × 604.

Fig. 49.—Cross section of one of the dorso-lateral blood vessels. × 604.

Fig. 50.—Portion of a cross section through the anterior part of the rhynchocœl, showing the dorsal blood vessel. The endothelium, *End.*, of the ventral wall of the vessel is very distinct, but that of the dorsal wall is interrupted by the proliferation of blood-forming cells, *Bl.f.C.* × 604.

Fig. 51.—Cross section of the dorsal blood vessel after it has left the rhynchocœl. A network of connective tissue cells, *Cn.T.N.*, surrounds the blood vessel. × 604.

Fig. 52.—Cross section of the oldest stage of an immature ovum, free in the centre of the gonad. The thick outer, *o. O.mb.*, and the thin inner, *i. O.mb.*, egg membranes are shown. × 604.

Fig. 53.—Surface view of the gonad epithelium. × 604.

Fig. 54.—Portion of a cross section through an ovary, containing only young stages. $O._1$ represent the youngest ova figured, $O._2$ and $O._3$ older forms. × 240.

Fig. 55.—Portion of a cross section of the body wall, showing a testis duct, *T.d.*, with an expanded distal portion, *b.* The longitudinal muscle layers of the body wall are not indicated. × 320.

Fig. 56.—Horizontal optical section of a portion of the posterior body region. Drawn from life, showing gonads filled with ova between the intestinal cæca. The large body, *Par.*, in the middle gonad is the cyst of a parasite. × 70.

Fig. 57.—Portion of a cross section through the testis, showing the marginal spermatogonia. × 604.

Fig. 58.—Spermatozoa, the middle piece seen in side view and appearing bilobed. A minute point is present at the tip of the head. Iron-hæmatoxylin, strongly destained. × 1120.

Fig. 59.—Spermatozoan, and a detached middle piece, *m.b.*, which is four-lobed. Iron-hæmatoxylin, not strongly destained. × 1120.

Fig. 60.—Portion of a cross section through the body wall and ovary, showing an encysted stage of a parasite, *Par.* The striated cuticle, *Ctl.*, is surrounded by a delicate membrane. Two egg nuclei, *N.*, are to be seen in the cytoplasm at the base of the cyst.[19] The nucleus within the cyst, *N.Par.*, is amœboid. × 320.

Fig. 61.—Cross section of an ovum infected with a young (?) stage of a parasite, *Par.* × 604.

Plate XLIV, Fig. 62.—Part of a cross section of the body wall through one of the "lateral grooves," *L.G.* The individual cells of the groove are not clearly distinguishable with this magnification. 95 per cent. alcohol. × 320.

Fig. 63.—Portion of a cross section through the body wall of *Parapolia aurantiaca* Coe, showing the "lateral groove." The "lateral groove" is here everted, and appears as an elevation above the general surface level. The cutis glands, $Cu.\,Gl._2$ of the "groove" are large and are not found in other parts of the section. × 40.

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[19] The reference line from *Ctl.* only extends as far as the egg membrane, instead of to the cuticle within.

The following reports were ordered to be printed:

REPORT OF THE PRESIDENT.

Upon the removal of the Academy to its present location in 1876, the President, Dr. W. S. W. Ruschenberger, prepared a brief history of the institution, with a summary of its collections and publications, which appeared in the popular guide to the Museum in that year.

Subsequently throughout his term of office, Dr. Ruschenberger presented a President's annual report, the last appearing in the *Proceedings* for 1881.

His successors having discontinued this practice, there has been no summarized account of the operations of the Academy during the past twenty years, and it is my purpose to present such a *résumé* in the following pages.

During this period three members have occupied the President's chair, Dr. Joseph Leidy, Gen. Isaac J. Wistar and Dr. Samuel G. Dixon. William S. Vaux, Thomas Meehan, Henry C. McCook and Arthur Erwin Brown have served as Vice-Presidents; William C. Henzey, Isaac C. Martindale, Charles P. Perot and George Vaux, Jr., as Treasurers; George H. Horn and Benjamin Sharp as Corresponding Secretaries, while Edward J. Nolan has continued as Recording Secretary and Librarian throughout the entire period.

To the membership there have been added 505 names, while 374 have been lost by resignation or death. Among the latter are many of the Academy's staunchest supporters, to whom her present prosperous condition is largely due, and many of her most brilliant students, who by their labors have spread her reputation to all parts of the world.

During this period the regular weekly meetings of the Academy have been held, the attendance decreasing as natural history became more and more specialized. Verbal communications of importance have been made both by members and visitors, and various explorers have by request presented reports of their expeditions before the society. The specialists have continued to hold their independent meetings with most satisfactory results. Of late years, by a mutual arrangement, the several Sections have been given precedence at certain specified meetings of the Academy, with the object of bringing before the general meetings the more important communications presented at the less formal Section meetings.

With the object of fostering and encouraging small scientific organizations, especially those composed of younger students, the Academy has freely granted the use of its halls for meetings, and during the past decade the Geographical Society, Delaware Valley Ornithological Club, Philadelphia Botanical Club, Students' Mineralogical Club, Students' Entomological Society, Mycological Club, Leidy Association, Philadelphia Moss Chapter, Wood's Hole Biological Association, Odontographical and Anti-Tuberculosis Societies and Pennsylvania Audubon Society have availed themselves of this privilege, thus bringing many people in touch with the Academy and eventually adding to its membership.

Besides these organizations, a number of State and National societies have, during this period, been invited to hold their conventions in the building, notably the American Society of Naturalists, in 1891; the Pennsylvania Veterinarian Society, in 1894; and the American Ornithologists' Union, in 1899.

The *Proceedings* and *Journal* of the Academy have been issued continuously since 1881, as previously. Twenty-one volumes of the former and four of the latter have appeared, comprising in all 12,100 pages. These contain contributions not only from the members of the Academy, but from eminent scientists from various parts of America and Europe.

During the past twenty years the *Proceedings* have been sent in exchange to a constantly increasing list of scientific societies throughout the world. Beginning with the year 1900 the Academy, through its increased endowment, has been enabled to distribute the volumes to its members, a course that had long been desired. There have also been issued from the Academy and allied societies the *Transactions* of the American Entomological Society, the *Entomological News*, and the *Manual of Conchology*, while the *Nautilus* has been edited by the Conservator of the Conchological Section.

In 1885 the Committee on Lectures and Instruction established an annual series of lectures by men of eminence in various branches of science, as well as afternoon classes conducted by the Academy's professors. For both series a charge was made to cover expenses. These courses were held annually until the winter of 1896–7, when a proposition was made by the Ludwick Institute, whereby the Committee of the Academy should coöperate with the Institute in arranging courses of lectures on natural science and allied subjects, to be given in the Academy's Lecture Hall and to be free to the public, though primarily for the benefit of public school teachers, the Ludwick Institute bearing all the expenses.

Under this arrangement six to eight courses of five lectures each have been given annually by members of the Academy.

The Jessup Fund, originally established in 1860 for the assistance of young men fitting themselves for scientific work, has during the past twenty years aided many students, who have in turn rendered most important assistance to the Academy in the care and arrangement of collections. In 1888, Mrs. Clara Jessup Moore established a similar fund of $5,000 for the assistance of young women, three having up to this time profited by this endowment.

From 1890 to 1899 a medal and cash payment were annually bestowed by the Academy upon the geologist who had accomplished the most meritorious work during the year. Since then a gold medal has been awarded triennially. This award, known as the Hayden Memorial, is secured by a fund given by Mrs. Hayden in memory of her husband, Dr. F. V. Hayden.

Up to the year 1900 the Academy's growth had far exceeded its endowment. The funds at the disposal of the institution were entirely consumed in the expenses incident to supporting the museum, the publications and the library. The salaried assistance was wholly inadequate to the needs of the institution, and, as previously, most of the work of arranging and caring for the collections was performed voluntarily or by students of the Jessup Fund. Members had always been most liberal in contributing to special funds for the purchase of collections, but the Endowment Fund, owing to the broadening of the work of the Academy, became yearly less adequate.

Since 1890, however, the Academy has received liberal bequests, which have been of the utmost importance in the consummation of plans for future development.

George S. Pepper, in 1900, bequeathed to the Academy $25,000 and a percentage of his residuary estate, the amounts to be held in trust, the income only to be applied to the uses of the institution.

The James Aitken Meigs Fund was erected on the legacy of John G. Meigs, of $20,000, and the library of his son, James Aitken Meigs, M.D., a former Librarian of the Academy. Ten thousand dollars of this was left for the care and increase of the library and the remainder without condition.

From Miss Anna T. Jeanes was received the gift of $20,000, to be known as the Mary Jeanes Fund, the interest to be used for the care and increase of the museum.

In addition to amounts noted in earlier reports, $16,650 have been received from the Henry N. Johnson estate for the general purposes of the Academy.

Robert T. Lamborn, M.D., who died in 1895, bequeathed his estate to the Academy, "to be used in biological and anthropological researches, the income only to be used and the principal reinvested." A question as to the validity of the will under the New York State law having been raised by the heirs-at-law, a compromise was effected on the basis of one-half the estate coming to the Academy and the balance to them. Up to the present time $365,000 have been realized for the society. A conservative estimate places the value of the Academy's portion of the estate at half a million.

Charles E. Smith, in 1900, bequeathed his botanical books, maps, collections and one-sixth part of the sum realized from the sale of real and personal property, the interest accruing from such sum to be applied to and expended on maintenance and for no other purpose whatever. Twenty-five thousand dollars have been realized from this source to date, with the certainty of important additions in the future.

As soon as the earlier of these legacies became available, steps were at once taken to broaden the work of the institution in various directions. The *Proceedings* were distributed to members; the salaries of the scientific staff were increased; three new assistants engaged; improvements were made to the buildings; new cases were substituted for those originally erected in the museum, and important additions to the shelving capacity of the library were provided. The work of expansion is still in progress, and to understand properly the advance that has been made it is necessary to revert again to the removal of the Academy to its present quarters in 1876.

At that time only a part of the building as originally planned had been completed, and the collections and library of the Academy even then practically filled all the available space. The constant increase during the subsequent ten years caused such overcrowding that the systematic arrangement of the museum became an impossibility, and much valuable material was practically inaccessible.

In 1889 and 1891 two appropriations of $50,000 each were secured from the State Legislature. These sums, together with private subscriptions, made possible the much-needed additions to the premises. The Lecture Hall was completed the following year, and formally opened on February 22, 1892. Lectures previously given in the Library have since then been delivered in the new Hall, which has been furnished with a lantern and screen and seating accommodations for 350 persons.

The new wing of the museum was not completed until some years later and was finally opened on October 20, 1896.

Owing to the lack of funds only two floors could then be opened, and only a part of one of them was furnished with new cases. Since then, however, new cases of plate glass with oak or mahogany woodwork have almost entirely replaced the old ones on these floors, as well as in portions of the old building, and the furnishing of the third floor of the new Museum is so far advanced that it will be opened during the coming year.

In the character and care of the various collections the greatest changes have taken place, mainly since the recent increase in our endowment, though in several departments the plans were laid and work begun several years ago. The old idea of exhibiting every specimen has been dispensed with, and the need of study collections of large series of specimens has been recognized.

Large numbers of birds and mammals, especially types and unique specimens, have been unmounted and stored in moth-proof cabinets, free from light and dust, and their preservation insured. These have been arranged in the study rooms, where they can be easily examined, while still larger numbers of similar study specimens have been added by purchase and gift. A corresponding arrangement of the mollusca has also been instituted. The entire series of alcoholics has been removed from the exhibition rooms and placed in compactly arranged cases in the basement, where some 100,000 specimens are within easy reach of the student who desires to consult them, being at the same time largely shielded from the light, the great destroyer of pigment. For exhibition there is being installed by the liberality of Mr. Clarence B. Moore a series of plaster casts of snakes, colored and mounted amid natural surroundings, which are far more instructive to the general public than the alcoholics that have been removed.

In the Botanical department the modern plan of mounting the specimens upon uniform standard herbarium sheets, begun some time ago, has been finished during the present year, with the exception of certain special collections.

The museum catalogues are the work of recent years. In 1893 uniform catalogues were provided for all departments, except Entomology and Botany. In some only the accessions since that date have been entered, but in the cases of the mammals, birds, reptiles, fishes and minerals every specimen has been numbered and entered in its respective catalogue. In the case of disarticulated skeletons every bone has been numbered.

These catalogues are necessarily only accession lists, but a systematic card catalogue of the mammals has been prepared, showing at a glance exactly what the Academy possesses in this department of the museum.

The character of the exhibition specimens has also been much improved. In 1892, a taxidermist was employed and all mammals and birds since prepared for exhibition have been mounted in the most approved manner. A large number of mammals have been prepared during the past ten years, and so far as the larger forms are concerned, they have replaced the grotesque and faded stuffed specimens of earlier years, while a local collection of birds, mounted in groups, with nests and eggs, has replaced the old series.

The Academy's efforts of late years have been mainly devoted to the renovation of the museum, the increase of the collections and library, and the expansion of the publications. Nevertheless, a number of expeditions have been sent out in its interest through special subscriptions, while many private individuals have contributed results of their explorations to the institution.

Under the former head may be mentioned the expeditions to Bermuda in 1888, Mexico in 1890, under the leadership of Angelo Heilprin; the Greenland Expeditions of 1891 and 1892; Prof. Cope's trip through the fossil beds of the West in 1893, and many minor collecting trips.

Among private expeditions may be mentioned those of Dr. Benjamin Sharp to Hawaii and Alaska, Dr. W. L. Abbott to Africa, Dr. A. Donaldson Smith to Somaliland and Lake Rudolf, the Messrs. Farnum to Mongolia, while Mr. Alfred C. Harrison and Dr. H. M. Hiller are at present exploring Sumatra, partially in the Academy's interest.

Mr. Clarence B. Moore's archæological explorations in Florida and Georgia ; the exploration of the Port Kennedy fossil deposit, in the years 1894–96, under the direction of Dr. Samuel G. Dixon, assisted by Mr. H. C. Mercer; Mr. C. W. Johnson's expeditions to the Southern fossil beds, under the direction of Dr. L. T. Chamberlain, and Mr. Henry G. Bryant's expeditions to Labrador, Greenland and Alaska have also been productive of important results.

The increase in collections, especially since modern methods have been instituted in the Museum, has been so continuous and important that it is impossible even to summarize it in this brief space. Some idea, however, may be gained from the statements furnished by several special departments.

The Ornithological collection, which was formerly regarded as the Academy's most notable department, contained at the time of Dr. Ruschenberger's last report 24,000 specimens; to-day it numbers 46,000. The Conchological department since 1887 alone has added 30,000 lots to what was before regarded as the leading collection in the world. Other collections have increased at nearly the same rate, as illustrated by 6,000 additions to the department of reptiles, mainly the private collection of Prof. Edward D. Cope, and one prepared by Mr. A. E. Brown; 14,000 to the collection of butterflies; the William S. Vaux Collection of Minerals; the Isaac Lea Collection of eocene fossils, for which we are indebted to the Rev. Leander Trowbridge Chamberlain, D.D., and the Clarence B. Moore Archæological Collection.

Only passing mention has been made of the growth of the library, not because of any lack of development in this department, but because the Librarian purposes, in his annual report, to review the history of the library since the organization of the society. The development of this important section of the Academy, it will be seen, has kept pace with that of its other departments.

The present condition of the society, in its museum, its library and the work of its Publication Committee, is most encouraging, and gives every assurance of future success in maintaining the high standards established by the devoted men who have contributed so much intellectually and financially to the advancement of science.

SAMUEL G. DIXON,
President.

REPORT OF THE RECORDING SECRETARY.

The meetings of the Academy have been held during the year with three intermissions, due to the lack of a quorum on July 30, August 13 and September 17. The average of attendance at the sessions that were held was sixteen. Verbal communications were made by Messrs. Rand, Rhoads, Pilsbry, Arthur E. Brown, Harshberger, Woolman, MacElwee, Sharp, Chapman, Dixon, Roseberger, U. C. Smith, Skinner, J. Cheston Morris, T. H. Montgomery, Calvert, Conklin, Seiss, Gerson, Keeley, J. P. Moore, Goldsmith, Lyman, Keller, Murlin, Stone, Palmer, Kraemer, Crawley, S. Brown, Ravenel and McCarthy. Interesting discussion occasionally followed these communications, the substance of which was frequently embodied in the more formal papers presented later for publication, hence but few of the verbal contributions to the meetings have been prepared for the published *Proceedings.*

Seven hundred and thirty pages of the *Proceedings,* with thirty-four plates, have been issued since the last report. The fourth number, or the conclusion of the eleventh volume of the *Journal,* consisting of ninety-eight pages, copiously illustrated by text figures, was also published, the expense of printing and illustrations being defrayed by Mr. Clarence B. Moore, to whom the Academy is again indebted for this proof of his continued interest.

The Entomological Section (American Entomological Society) has published two hundred and seventy-six pages of the *Transactions* with ten plates and three hundred and twenty-eight pages of the *Entomological News* with thirteen plates.

The *Manual of Conchology* has been continued under the auspices of the Conchological Section, two hundred and seventy-one pages and sixty plates having been issued during the year.

The published contributions to science by the Academy and its Sections during the year amount, therefore, to 1703 pages and 117 plates.

The statistics of distribution are as follows:

Proceedings, delivered to members,	548
" exchanged for other publications,	574
" sent to subscribers,	40
	1,162

Journal, exchanges,	68
" subscribers,	34
	102

The published edition of the *Proceedings* is 1,500; of the *Journal,* 500.

Fifty-six papers have been presented for publication during the year, as follows: Henry A. Pilsbry, 10; Henry W. Fowler, 6; James A. G. Rehn, 4; John W. Harshberger, 4; Thomas H. Montgomery, Jr., 3; Clarence B. Moore, 2; T. D. A. Cockerell, 2; Arthur E. Brown, 2; Adele M. Fielde, 2; S. N. Rhoads, 1; Helen T. Higgins, 1; A. E. Ortmann, 1; Walter M. Rankin, 1; Edward G. Vanatta, 1; Henry Fox, 1; George and William S. Vaux, 1; Thomas Meehan, 1; Henry C. Chapman, 1; Caroline B. Thompson, 1; Ida A. Keller, 1; Henry Kraemer, 1; Benjamin H. Smith, 1; A. M. Reese, 1; M. Louise Nichols, 1; Harold Heath and M. H. Spaulding, 1; Carrie B. Aaron, 1; Thomas L. Casey, 1; C. W. Johnson and A. W. Grabau, 1; E. Goldsmith, 1; Nathan Banks, 1. Forty-seven of these have been printed in the *Proceedings,* two in the *Journal,* three were withdrawn by the authors, one was returned to the author, one was transferred to the Entomological Section, and two await action. A communication from F. Rynchowski, of Lemberg, embodying his researches on the "Electroid (Eteroid)" was, with the author's consent, referred to the Secretary of the Smithsonian Institution.

The first year of the new century sees the completion of the fifty-third volume of the *Proceedings* and the eleventh volume of the quarto or second series of the *Journal.* The first series in octavo, in eight volumes, extended from 1817 to 1842. The Academy's entire serial contributions to science, therefore, now consists of seventy-two volumes. The earlier issues, especially, formed almost the only means by which the working naturalists of America could communicate with those of kindred interests elsewhere, and much of the results of the original investigations of Say, Ord, LeSeuer, Nuttall, Maclure, Horner, Mitchell, Rafinesque, Lea, Hentz, Troost, Vanuxem, De Schweinitz and many others of the leading naturalists of America are to be found in these volumes. An index to this collection of scientific papers is manifestly desirable, and would probably be regarded by students as a valuable aid in their work. The present time is especially appropriate for its publication, because it would not only form a guide to all that the Academy has given to the world during the last century, but it would be continued without break or repetition by the proposed index to scientific literature which is about to be prepared under the auspices of the Royal Society of London, as the result of international coöperation. The compilation is recommended of an index that will be a complete and reliable guide to the contents of the Academy's serial publications, consisting of perhaps three sections devoted to author, subject and species entries. It does not seem desirable in the course of the work to attempt the decision of questions of priority or the determination of synonymy.

Fourteen members and five correspondents have been elected. The deaths of five members and six correspondents have been announced and the following members have resigned: Edw. H. Coates, Robert S Davis, Edw. Gideon, William DeCou, Vickers Oberholzer, A. H. Stewart, W. E. Barrows and Thomas Stewardson.

A severe loss was sustained in the death, November 19, of Mr.

Thomas Meehan, whose conscientious devotion to the welfare of the Academy, and especially of its Botanical department, during more than forty years of membership, is warmly appreciated by his associates. A minute embodying the Academy's sense of its loss has been published in the *Proceedings* and a biographical notice, to be read at an early meeting, is in course of preparation by Dr. John MacFarlane.

A reception was tendered to Dr. A. Donaldson Smith, to whom the Academy is indebted for valuable additions to the Museum, on his last return from Africa. The occasion was enjoyed by many who were interested in Dr. Smith's work as an explorer.

The President has appointed Mr. Clarence B. Moore as a representative of the Academy to serve on the General Committee of Arrangements for the International Congress of Americanists to be held in New York next year.

Messrs. Vaux, Nolan, Wistar, Roberts and Schaeffer have been appointed a committee to consider and report on the subject of memorial tablets to contain the names of benefactors of the Academy, and to be placed at the entrance to the Museum.

All of which is respectfully submitted,

Edward J. Nolan,
Recording Secretary.

REPORT OF THE CORRESPONDING SECRETARY.

During the past year, there have been received from ninety-five societies, museums, libraries, etc., one hundred and sixty-three acknowledgments of the publications of the Academy, and from thirty-seven societies, libraries, etc., fifty-two notices of transmission of their publications.

Fourteen applications for exchange of publications and for supplies of deficiencies, together with six circulars and invitations for the Academy to participate in congresses, etc., and five announcements of the deaths of scientific men, have also been received.

Four correspondents have been elected during the year, and the deaths of six have been recorded.

Six letters on miscellaneous subjects have been received and eleven written.

Seven hundred and one acknowledgments of gifts to the library and museum and three diplomas to correspondents have been mailed.

Respectfully submitted,

Benj. Sharp,

Corresponding Secretary.

REPORT OF THE LIBRARIAN.

The growth of the Library, as far as the ordinary current accessions are concerned, has been unprecedented during the past year. A total of 6,184 additions have been received, classified and catalogued; 4,678 of these are pamphlets and parts of periodicals, 1,380 are complete volumes, 124 maps, and one photograph.

They have been received from the following sources:

Societies,	2,293
I. V. Williamson Fund,	1,309
Editors,	861
General Fund,	846
Authors,	169
U. S. Department of the Interior,	160
Meigs Fund,	145
U. S. Department of Agriculture,	121
Wilson Fund,	37
U. S. Department of State,	16
Special Exchange,	27
Geological Survey of New Jersey,	11
Ministère des Travaux Publics, France,	11
Albert I, Prince of Monaco,	9
Pennsylvania State Library,	9
Royal Geographical Society, London,	8
Geological and Natural History Survey of Canada,	8
Library of Congress,	8
H. C. Chapman,	8
Thomas Meehan,	7
Henry G. Bryant,	7
Comité Géologique Russe,	7
Kommission zur wissenschaftlichen Untersuchungen der deutschen Meere in Kiel und der Biologischen Anstalt auf Helgoland,	7
Pauline L. Neidhard,	6
Geological Survey of India,	6
William J. Fox,	5
Department of Mines (Geological Survey), Victoria,	5
H. A. Pilsbry,	5
Biuroului Geologicu, Roumania,	5

Maryland Geological Survey, ...	4
Trustees of British Museum, ...	4
Department of Mines, New South Wales, . .	4
U. S. Treasury Department, ...	3
U. S. Commission of Fish and Fisheries, . . .	3
Conchological Section, Academy, ...	3
Geological and Natural History Survey, Minnesota, ...	3
U. S. War Department .	2
U. S. Coast and Geodetic Survey, ...	2
U. S. Board on Geographical Names, ...	2
Royal Swedish Academy of Sciences, ...	2
'sLands Plantentuin, Java,	2
Department of Mines, Nova Scotia, ...	2
Bentham Trustees, Kew Gardens, ...	2
Comission Geologica, Mexico, ...	2
Naturforschende Gesellschaft, Basel (special),	2
Académie des Science de Cracovie (special), .	2
Trustees of Indian Museum, ...	2
Botanical Survey of India,	2
Geological and Natural History Survey, Wisconsin, ...	2
Mrs. Jonas Gilman Clark,	1
Government of Uruguay,	1
Geological Survey of Michigan, ...	1
Commissioners of Inland Fisheries and Game, Massachusetts, . . .	1
Department of Agriculture, Cape of Good Hope, ...	1
Samuel G. Dixon, . .	1
Smithsonian Institution, .	1
Financial Publishing Co., Philadelphia, . . .	1
Geological Survey of Georgia, ...	1
Government of India, .	1
R. Academia di Ciencias, etc., Barcelona, .	1
E. R. Sykes, ...	1
Council of the Fridtjof Nansen Fund for the Advancement of Science, ...	1
Geological Survey of Missouri, ...	1
Bergen's Museum, . . .	1
A. W. Vogdes, . . .	1
California State Mining Bureau, ...	1
K. Akademie der Wissenschaften, Wien (special),	1
Department of Geology, etc., Indiana, . . .	1
W. N. Newton, . . .	1
Illinois State Board of Labor, ...	1
Messrs. Werner and Swasey,	1

Madras Government Museum,	1	Edward J. Nolan,	1
Home Secretary's Office, Queensland,	1	Société Hollandaise des Sciences (special),	1
Hungarian Central Bureau for Ornithology,	1	Magyar Tudomanyos Akademia (special),	1
Geological Survey of Iowa,	1	Royal Society of Denmark (special),	1
Commission des Travaux Géologiques, Portugal,	1	Geological Survey of Alabama,	1
Bernice Pauahi Bishop Museum,	1	Department of Marine and Fisheries, Canada,	1

They were distributed to the several departments of the library, as follows:

Journals,	4,866	Geography,	28
Geology,	345	Ichthyology,	21
Botany,	282	Medicine,	16
General Natural History,	146	Mammalogy,	14
Voyages and Travels,	76	Physical Science,	13
Agriculture,	67	Bibliography,	13
Encyclopædias,	47	Helminthology,	12
Entomology,	44	Mineralogy,	10
Anatomy and Physiology,	41	Chemistry,	7
Ornithology,	39	Herpetology,	6
Conchology,	34	Mathematics,	1
Anthropology,	28	Miscellaneous,	28

Fourteen hundred and seventy-two volumes have been bound, making a noticeable improvement in the library, especially in the department of periodicals. Only those who have been compelled to consult unbound sets of journals, the numbers unavoidably mixed and the indexes probably misplaced, can appreciate the comfort of working with volumes bound to date. Large appropriations for the work are still required, nearly three thousand volumes in the department of periodicals alone still requiring binding, but it is a cause of sincere congratulation that they will now be handled as rapidly as the necessary collation will permit. An important addition to the cases has been provided in the central entresol room, relieving for the present the pressure on some of the more crowded sections of the periodicals. The growth of the library in this department, as indeed in all the others, is likely to be so rapid in the future, in view of the comparatively liberal appropriations which can now be made, that the question of additional shelving and room for its accommodation will soon become a pressing one. Another important need is a case for the arrangement and storage of maps, the necessity of which was brought to the attention of the Academy as early as 1889.

Among the more important accessions of the past year have been a number of early sets of journals secured from the catalogues of second-hand dealers. As the Academy has special reason to set store by what is believed to be its well-nigh unequaled collection of journals and transactions, it is desirable that desiderata be secured as promptly as possible, as the opportunities of doing so are yearly becoming fewer because of the very liberal means at the disposal of many scientific libraries recently started and the vigor of their administration. The Academy has had the advantage of being early in the field, and, though having no means of its own for many years, the devotion of William Maclure and Thomas B. Wilson secured for it bibliographical treasures which can no longer be bought.

A list of the serials now received in exchange or subscribed for is appended.

The works on Philology have been selected from the Meigs Library and from the department of Anthropology, and now form a separate section containing 296 volumes.

The card catalogue is being carefully revised and certain unavoidable duplications and irregularities are being corrected.

A portrait of the late Thomas Meehan, in oil, by James L. Wood, was presented by Mr. Charles Roberts in May. While it has distinct value as a work of art, it forms a most desirable memorial of the senior Vice-President, whose recent death is referred to elsewhere.

Dr. John G. LeConte presented a crayon portrait of Mr. Charles E. Smith, a benefactor whose death was announced last year. The picture has been placed in the herbarium.

The present extent of the library, determined by a careful count, is as follows:

Journals	23,007
Geology	3,039
General Natural History	2,860
Botany	2,429
Voyages and Travels	1,870
Anatomy and Physiology	1,719
Entomology	1,207
Anthropology	1,120
Conchology	1,073
Medicine	903
Ornithology	863
Encyclopedias, Dictionaries, etc	816
Physical Sciences	630
Mineralogy	554
Mathematics	551
Bibliography	428
Geography	421
Agriculture	407
Ichthyology	323
Mammalogy	304
Miscellaneous	299
Philology	296
Helminthology	295
Chemistry	275
Herpetology	186
Meigs Library (miscellaneous)	1,916
Warner Library (miscellaneous)	128
American Entomological Society Library (Entomological Section)	3,160
Unbound pamphlets, 2524, forming volumes	170
	51,249

In considering the growth of the library since the last enumeration, it must be remembered that about 450 volumes, bibliographical and non-scientific, have been, by direction of the Council and the Library Committee, transferred to the Free Library.

Many of the works in the library of the Entomological Section (American Entomological Society) are duplicates, while those in the James Aitken Meigs Library are foreign to the purposes of the Academy, being retained under an agreement with the legatee.

It may not be out of place, at the beginning of the new century, to review briefly the history of the library, so as to determine with some degree of clearness what has been accomplished by this department of the Academy during its ninety years of existence.

It will be remembered that on the evening of January 25, 1812, "a meeting of gentlemen, friends of science and of rational disposal of leisure moments," was held to consider the advisability of forming a scientific society. After mature deliberation it was decided that such a society was desirable, and preliminary steps were taken toward its organization. The men who met on that occasion took themselves with entire seriousness, as is evidenced by the dignified wording of the minutes and the care with which they were kept by the first Recording Secretary, Dr. Camillus McMahan Mann. They evidently attached due importance to the formation of a library, for a committee consisting of Messrs. Troost and Shinn was appointed to consider, among other weighty matters, "which are the fittest periodical works to engage in the first instance for the accommodation of the society."

No report seems to have been received from this, the first Library Committee, but under date of March 17 of the same year, a memorandum records that "Mr. Shinn will accommodate the society with the *Mineralogical Journal* of Dr. Bruce; Mr. Speakman will furnish the *National Intelligencer;* Dr. Parmentier, the *Aurora* and a map of Switzerland; Dr. Mann, the *Monthly Magazine* for 1807. Drs. Troost and Parmentier have engaged for account of the society the *Annales de Chymie* and the *Annales des Arts et de Commerce.* Mr. Shinn is commissioned to procure for account of the society the *Archives of Useful Knowledge* of Dr. Mears, and the *Medical Museum* of Drs. Mitchell and Millar. Agreed to procure the *Repertory of Arts* from London."

On April 18, "the Secretary makes homage to the Academy of *The Bureau,* weekly newspaper recently commenced, which he has subscribed for." At the same meeting it was "referred to the Committee to purchase at least one portfolio, for the purpose of depositing extracts from newspapers announcing recent discoveries and extraordinary facts, with a view to have them afterward arranged in a proper book and inquiries instituted thereupon." The Secretary was requested "to procure a report of Prof. Davy of the London Institution's lectures lately delivered on the subject of Zoology." He was also requested "to procure report on Prof. Davy's experiments and conclusions on the subject of the oxymuriatic acid, and to require report from Dr. Mitchell at time of writing to that gentleman his letter of notification." It was ordered, Mr. Troost seeming to have dropped out, "that Mr. Shinn be requested to make his report on the periodical works eligible for the Academy, and if possible to procure the latest number of *Nicholson's Journal.*"

Then more definitely, on August 15, the Secretary was "required to obtain the following works on science: *Nicholson's Journal* from the commencement of the year 1810; a periodical work said to be conducted by Dr. Thompson, of London, from its commencement; *Repertory of Arts* from the beginning of 1810; Murray's *Chemistry,* last edition; Thompson's *Chemistry,* edition of

1810, if none since published; Davies' *Elements of Chemistry;* Tilloch's *Magazine* from the beginning of 1810; best comparative statement of the experiments relative to the oxymuriatic acid."

These are the brief records concerning the library in the earliest minutes of the Academy. It will be seen that they all relate to intentions for the future, except in the one case where the Secretary "makes homage" or presents *The Bureau*, a periodical for which he had recently subscribed, and of this, curiously enough, no record is to be found in the earliest published catalogue of the library. The list of desiderata indicates how largely the first members were concerned with physics and chemistry, subjects which now receive little or no attention in the Academy.

The growth of the library was slow until 1816, when Mr. William Maclure, who was elected President the following year, began his liberal donations, which in 1819 had reached nearly 1,500 volumes. A contemporary notice of the Academy says: "The value of these acquisitions was enhanced by the fact that they were possessed by no other institution on this side of the Atlantic. The Academy, therefore, derived from this source a prosperity and prominence which, under other circumstances, must have been extremely slow and uncertain; while science at the same time received an impulse which has never faltered and which has been subsequently imparted to every section of our country." Mr. Maclure transferred his library at New Harmony to the Academy in 1834. Dr. Pickering, then Librarian, the following year superintended the conveyance of the collection, embracing 2,259 volumes on science, literature and art, to the Academy.

A catalogue of the library was begun in the first issue of the *Journal* in 1817, and was completed in the fourth volume, published in 1824. The collection then seems to have consisted of 1,675 volumes, embracing 672 titles.

Another catalogue, published in 1836, gives the number of volumes then in the library, excluding a collection of historical documents, at 6,890, of which no less than 5,232 are thankfully credited to Mr. Maclure. The classification was practically that which is still maintained, but the collection embraced hundreds of volumes on finance, law, morals, literature, religion, amusements, military art and other subjects not at all pertinent to the Academy, and which have long since been disposed of by sale or exchange.

In a note to Morton's biographical notice of William Maclure, prepared in 1841, it is stated that the library then consisted of 7,000 volumes.

At this time certain designated books were permitted to be borrowed, but the Committee expresses grave doubt as to the advisability of continuing the practice, as serious loss of works which could not be replaced had been detected during the preparation of the catalogue of 1836. It was strongly recommended, in harmony with the desire of Mr. Maclure, that the library should be exclusively for use within the building. It was considered, however, that this was scarcely practicable until the services of a salaried Librarian could be secured.

In May, 1845, Dr. Thomas B. Wilson presented Owen's *History of British Fossil Mammalia and Birds,* and from that date until his death, March 15, 1865, more than 10,000 volumes in all branches of natural history were received from this liberal patron of the Academy. These formed the rarest and most expensive portions of the library—complete sets of early transactions and superbly illustrated monographs. Week after week the Wilson package was examined with delight, as it was sure to contain not only contributions indispensable to the workers, but also gifts of the highest artistic value, such as Gould's *Monographs,* Wolf's *Zoological Sketches,* Chenu's *Illustrations Conchyliologiques,* Reichenbach's *Xenia Orchidacea,* Lindley and Moore's *Ferns of Great Britain,* etc. Dr. Wilson's earlier contributions were placed with the society on deposit, but were given outright in 1850 on condition that they should not be removed from the building, a rule which was then extended to the entire library.

Dr. Thomas B. Wilson was not the only member of his family who took an active interest in the Academy. Between the years 1850 and 1857 his brother, Mr. Edward Wilson, residing in England, presented to the society 4,184 rare volumes and pamphlets of the last century, and after Dr. Wilson's death a valuable selection from his library was received from another brother, Mr. Rathmell Wilson. Nor did the benefit derived by the Academy from the liberality of Dr. Wilson cease at his death. He bequeathed to the society $10,000, directing that $300 of the annual income should be contributed toward the payment of the salary of the Librarian, the balance to be expended for the continuation of his subscriptions and for the purchase and binding of kindred books. By means of this fund the Academy has been enabled from time to time to add to the library many costly monographs which, until quite recently, it would otherwise have been unable to procure.

In 1850 the collection had increased to 12,057 volumes.

Apart from these gifts and others from friends of the society, the growth of the library had depended on a system of exchange with other scientific societies, begun in 1817 when the *Journal* of the Academy was first issued. This important source of supply has since been maintained, with the result of securing the earliest information regarding original research from all parts of the world. Very inadequate sums for the purchase of books were secured from time to time by subscriptions or sales of material not germane to the Academy. The historical documents received from Mr. Maclure were sold to the Historical Society of Pennsylvania in 1861 for $500. This was known as the Maclure Fund. A motion to invest the amount and expend the interest only was voted down and the entire sum was placed at the disposal of the Library Committee for the purchase of books.

The Conarroe Fund was a small amount arising from the sale of books presented by George M. Conarroe. Sums of money for special needs were frequently contributed by Mr. Joseph Jeanes and a Library Fund was started in 1860, to which twenty-seven subscribers contributed $25 each annually until 1868. Some duplicates were sold in 1870 for $100, and others were exchanged for a copy of Elliott's *Birds of North America.*

These were all helps, but a permanent endowment was sadly needed, for the income from the Wilson Bequest, after the sum toward the salary of the Librarian had been deducted, did not always yield a sufficient balance to pay the subscriptions. It can therefore be readily understood with what joy Mr. Isaiah V. Williamson's gift in 1875 of $25,000 in ground rents was received. The income only was to be expended on the purchase of scientific books, and the I. V. Williamson Fund, inaugurating a period of prosperity up to that time unknown, continues to yield an important part of the resources at the disposal of the Library Committee.

In 1882 eighteen hundred and ninety-seven volumes—1,272 on religion, history, politics, general literature, 422 duplicates and 201 on fine arts and architecture—were sold for $1,325.14 By an arrangement with Mr. George W. Tryon, Jr., one-half this sum was devoted to the Conchological Section, and the other was appropriated for binding.

The Warner Library, consisting of 1,045 volumes and 1,200 pamphlets, mostly on mathematics, came into the possession of the society in 1892, on the coming of age of Mr. Warner's daughter and heiress.

The library of James Aitken Meigs, consisting of 5,089 volumes, 1,916 of which were on other than scientific subjects, was bequeathed to the Academy by his father, John G. Meigs, who also left to the society $20,000, one-half for the exclusive use of the library. Before his death Mr. Meigs intimated his desire that even the volumes not pertinent to the Academy should be kept together as the James Aitken Meigs Library, and this desire has been so far complied with.

The first catalogue of the library was published, it will be remembered, at irregular intervals in the first four volumes of the *Journal* from 1817 to 1824. No classification is indicated in this list. The carefully compiled catalogue of 1836 is divided into broad subject sections. Dr. Fisher reports the beginning of a new catalogue in 1859, but the intention, it would appear, was not carried out. The catalogues then in use were manuscript hand-lists, arranged alphabetically for each separate department. They were not kept strictly up to date. They were added to and copied by a special clerical assistant in 1863 and 1864, and were again transcribed in 1878. They remained in use until 1885, when they were finally replaced by a card catalogue which, in a very crude form, had been begun in 1874 and completed in 1880. The numbering of the library was begun with the Conchological Department in 1869, and gradually extended, as a matter of convenience, to the other sections of the library in connection with the preparation of the card catalogue. Shelf lists of the several departments, indispensable for the proper placing of the books and in accounting for missing volumes, were also prepared.

From 1883 to 1894 much-needed clerical assistance was secured in a more or less intermittent way. The expenses were defrayed by subscriptions secured by Mrs. Annis Lea Wister and Dr. Henry M. Fisher. The old card catalogue was transcribed on regulation library cards, arranged in drawers in three sections devoted to authors, subjects and periodicals. It was begun in 1885, is the basis of the catalogue now in use and meets measurably the requirements of modern library administration. The clerk also did much good work in the endeavor to secure supplies of deficiencies from corresponding societies.

Mr. William J. Fox was appointed messenger March 26, 1888. Proving himself intelligent and trustworthy in the performance of such work as was assigned him, he was promoted to the position of Assistant Librarian in 1890, and has since been efficient in forwarding the interests of the Academy.

To provide for the supposed wants of students the experiment of keeping the library open until 10 P.M. was begun in 1873 and continued until 1876, when it was abandoned as not serving any useful end on account of the extremely limited number of members using the books in the evening.

A catalogue of duplicates was printed and distributed in 1899. A number of sales have been effected, but the larger part of the collection remains yet on hand.

Up to 1847 the library had been arranged in connection with the Museum, manifestly to the great discomfort of students who, as Dr. Zantzinger says in his report for that year, were excluded from the hall when it was open to the public. The society then occupied the building at the corner of Broad and Sansom streets (Plate C), into which it had moved from Twelfth and Sansom streets (Plate B) seven years before. During the year mentioned the books were arranged in a department expressly designed as a library and meeting room at the western end of the ground floor. The Librarian was then required to be on duty during part of the forenoon, his place being supplied in the afternoon by the Chairman of the Curators. The eastern hall, in which the collections of minerals and fossils had been arranged, was given up to the Library in 1855, and was used from 1857 as a meeting room. Finally the western section, formerly used for this purpose, was divided in two by a partition of cases erected from time to time by the liberality of Dr. Thomas B. Wilson, thus providing on the floor and gallery additional room and placing the library in the condition in which it remained until removal to the present building in 1876. The present system of alternating alcoves and study rooms with the spacious gallery above for the arrangement of periodicals is well known to all now using the library.

The accompanying plates, D, E and F, illustrate the ground-plan of the building vacated in 1876 and the present distribution and aspect of the library.

The first Librarian was John Speakman, who was elected November 29, 1814, and served until December 26, 1815, when he was succeeded in rapid succession by Caleb Richardson, Jacob Pierce, S. W. Conrad, Charles Pickering, Paul Beck Goddard, Joseph Carson, Robert Bridges, Alfred L. Elwyn, Joseph Leidy, and William S. Zantzinger. Several of these served only one or two years, Dr. Zantzinger alone reaching an incumbency of ten years. Then came Dr. James Aitken Meigs, from August, 1856, to May, 1859, and Dr. James C. Fisher, from June 28, 1859, to August 27, 1861, when he entered the army as contract surgeon and was succeeded by Dr. R. E. Griffith, who served only one year.

It was becoming hard to find any one who was willing to take the office. There were certain duties which manifestly had to be performed. As exchanges came in and the Wilson packages were delivered, the accessions must be shelved and recorded, even though they were not systematically catalogued, and some few, from time to time, had to be prepared for the binder. Dr. Robert Bridges devoted much time at irregular intervals to the latter duty, although not officially. He deserves, also, the grateful remembrance of the Academy for his supervision, in connection with Mr. William S. Vaux, of the distribution of the *Proceedings* and *Journal* to subscribers and exchanges, the editorial work being performed by Dr. Joseph Leidy, then and until his death, Chairman of the Publication Committee.

Mr. J. Dickinson Sergeant was finally prevailed on to take the Librarianship, but only on condition that an assistant should be engaged to perform the routine duties of the office. The financial resources of the Academy were not such as to permit the engagement of a trained bibliographer, and a boy was employed who owed his selection to the good offices of Mr. John Cassin. The Assistant's first record of accessions was made February 4, 1862, within a few days of the beginning of the second half century of the society's history.

Mr. Sergeant held the Librarianship until December, 1867, when the Assistant, who had in the meantime taken a degree from the Medical Department of the University of Pennsylvania, under the preceptorship of the beloved Leidy, was appointed to the office which he has held continuously ever since. If the situation be unchanged, therefore, in February of next year, he will have had the supervision of the Academy's Library, in conjunction with the Library Committee, as Assistant and Librarian for forty years. He begs to be allowed, on this occasion, to put on record his obligation to his first and only chief, J. Dickinson Sergeant, for the kindly forbearance, helpful council and unfailing courtesy and encouragement which filled the life of the boy with interest and gladness and turned the daily task which, under an unsympathetic master, might well have been irksome enough, into a labor of love. Dr. Leidy, also, was invariably helpful and encouraging, and the Librarian is unceasingly thankful that early in his life it was given to him to know, and in a measure to appreciate, the high ideals embodied in those two men.

A like acknowledgment of obligation is, in a measure, due to nearly every one with whom he has been brought into association during his forty years of service in the Academy. Only the most cordial associations are called up by the names of Lea, Wilson, Bridges, Hays, LeConte, Slack, Cassin, Tryon, Vaux, Jeanes, Allen, Horn, Redfield and Meehan, not to mention the dear friends who are still met with every day, to all of whom he is indebted for kindliness, courtesy, and forbearance. His paths have been made by them paths of pleasantness.

The Librarian hopes that he may be forgiven these personalities. It can be safely asserted that he will not have an opportunity, after an additional equal term of service, to record his obligation to his associates living and dead.

The statistics presented above show that the Academy possesses, including all the books in the building, except duplicates set apart for sale, a library of over 50,000 volumes. Their arrangement is practically what the present Librarian inherited from his predecessors in 1862. It is far from meeting the requirements of modern library classification, but in practice it has been found to be not far short of what is wanted by the worker. Books as they are received are placed under their respective headings, for the most part consecutively, a separate running number being used in each department. The subject catalogue in a measure supplies the needs of a more philosophic arrangement, and it is easy to make a memorandum of the position of books on a given subject. Still, the adoption of the decimal system of arrangement would be, in some respects, desirable; but reclassification and recataloguing will involve great inconvenience and a heavy expense, as the employment of a corps of trained assistants will be unavoidable. It may be that some one interested in the welfare of the library will volunteer to defray the cost of making such a change in the prompt way which would involve the least discomfort, or the Academy in the future may find itself in a position to make the required appropriations. Until that time arrives it is a satisfaction to know that few or no complaints are heard from the earnest workers who use the library in yearly increasing numbers, and who are intelligently informed as to what they desire in the prosecution of their work of original research.

The statistics of work and growth for the year are sufficient evidence that this department is actively benefitted by the improved financial condition of the Academy. Every book added to the shelves as the result of the judicious administration of its resources is a memorial of the liberal and enlightened men who have selected the Academy as their agent in the advancement of science.

Mr. William J. Fox has continued to render intelligent and willing assistance to the Librarian, and also in many important ways to the Recording Secretary.

All of which is respectfully submitted,

EDWARD J. NOLAN,

Librarian.

REPORT OF THE CURATORS.

The Curators are able to report many improvements in the museum and buildings of the Academy during the past year, as well as important advances in the arrangement and growth of the collections.

In the early part of the year, through the increased funds at their disposal, the services of Dr. Henry Skinner and Mr. E. G. Vanatta were secured as Assistants; Dr. Henry A. Pilsbry was appointed Special Curator of Mollusca, while Mr. Henry W. Fowler has been employed identifying, arranging and caring for the collection of fishes.

With these additions the salaried staff of the Academy is now greater than ever before, and the work accomplished during the year has been correspondingly increased.

During the summer the outside woodwork of the buildings, which has been for some time badly in need of attention, has been entirely repainted, and necessary repairs have been made to the roofs.

A number of cases have been erected for the extension of the library and for the accommodation of additions to the herbarium and the study collection of mollusks, while eighteen moth-proof tin cases have been purchased for the study series of birds and mammals, in addition to five large wooden ones uniform with those provided last year.

In the museum seven plate glass cases have been constructed from the general appropriations and the income of the "Mary Jeanes Museum Fund." Three of these are of large size, two for birds and one for mammals, and cover collectively over six hundred square feet of floor space. Two other cases have been presented by Mr. Clarence B. Moore, uniform with those already installed, to accommodate the accessions to the "Moore Archæological Collection." The large slab of fossil ferns presented by Mr. C. B. Nichols has also been enclosed in glass.

The opening of the museum on Sunday afternoons has been continued throughout the year, to the gratification of large numbers of persons who are unable to visit it on weekdays.

During the past summer the Academy has for the first time maintained a table at the Wood's Hole Biological Laboratory. It was occupied through the season by Mr. H. W. Fowler.

Much of the work accomplished during the past year in the arrangement of the collections is described in detail in the reports of the Botanical, Conchological, Ornithological and Mineralogical Sections which follow, while the more important work of other departments is briefly outlined below.

Mr. Stone has spent the greater part of the spring and summer in the arrangement of the reptiles and batrachians, with the result that all the groups not handled last year have been catalogued and systematically arranged and many unidentified specimens named.

Mr. Fowler has continued his study of, and completely rearranged and relabeled the carp-like and deep-sea fishes, the eels and their allies, and the Cyprinodonts, comprising about two-fifths of the entire collection.

During the year the whole series of alcoholic vertebrates have been carefully examined and the alcohol replenished.

The mammalian skeletons and skulls have all been relabelled with special tags and a systematic card catalogue of all the mammal collections, has been prepared by Mr. Rehn.

In the Archæological department Miss H. N. Wardle has catalogued and arranged a large number of specimens, including most of the Haldeman Collection.

Through the generosity of Dr. L. T. Chamberlain, Mr. C. W. Johnson has continued his care of the Isaac Lea Collection of Eocene Mollusca. Six hundred and fifteen species have been added during the year, mainly through exchange.

Many important additions to the collections have been received since the preparation of the last report. The Zoölogical Society of Philadelphia has presented a number of specimens, one of the most notable being a full-grown Indian Rhinoceros, which has been mounted by Mr. David McCadden, the taxidermist.

Mr. Y. Hirase, of Kyoto, has continued to add most liberally to the conchological collection, furnishing many rare and hitherto unknown species. Mr. Arthur Erwin Brown has added largely to the department of reptiles, while a fine series of Porto Rican fishes was received from the United States Fish Commission.

Dr. A. Donaldson Smith presented a number of valuable birds, mammals and mollusks secured during his recent expedition to Lake

Rudolf, Africa. Mr. Alfred C. Harrison, Jr., and Dr. H. M. Hiller, who are at present conducting an expedition in the interior of Sumatra, have generously promised to the Academy such of their collections as are pertinent to its work, a portion of the material having been already shipped.

The Curators would express the indebtedness of the Academy to the late Thomas Meehan, Dr. P. P. Calvert, Theodore D. Rand, Lewis Woolman, Charles Liebeck and other members for aid in various departments, as well as to the students of the Jessup Fund, Miss H. N. Wardle, Edward G. Vanatta, James A. G. Rehn and H. L. Viereck.

Besides the frequent consultation of the collections by visiting naturalists, specimens have been loaned for study to C. D. Beadle, E. L. Morris, W. B. Scott, G. S. Miller, Jr., M. J. Rathburn, C. H. Ball, W. B. Clark, W. D. Matthew, B. L. Robinson, E. D. Merrill, J. W. Gidley, G. C. Martin, H. M. Smith, R. Ridgway, M. W. Lyon, Jr., J. Dwight, Jr., O. P. Hay, R. Bowdler Sharpe, R. Arnold, R. H. Howe, Jr., E. A. Mearns, A. W. Evans, B. G. Wilder, D. G. Elliott and Alpheus Hyatt.

Henry C. Chapman,
Samuel G. Dixon,
Arthur E. Brown,
Henry A. Pilsbry,
Curators.

REPORT OF THE CURATOR OF THE WILLIAM S. VAUX COLLECTIONS.

The Curator of the William S. Vaux Collections would respectfully report that the specimens added have been fewer than in prior years, but have been unusually fine. Among them may be particularly mentioned a crystallized native copper from Lake Superior ; five tourmalines, including an unusually fine achroite, two showing cat's-eye reflections ; an excellent green tourmaline and rubellite, and a very remarkable opal from Australia.

Much interest has been manifested in the collections by the visitors to the museum.

Respectfully submitted,

Theodore D. Rand,
Curator.

REPORT OF THE BIOLOGICAL AND MICROSCOPICAL SECTION.

The Section has held the usual meetings during the year with increased membership. It has lost by death a valued member, Mr. David S. Holman.

The Conservator reports that the apparatus and slides belonging to the Section are in fair condition, and some progress has been made in cataloguing the latter.

Additions during the year include thirty-six slides of wood sections purchased and twenty-six volumes, principally of microscopical journals, presented by Mr. John C. Wilson.

At a joint meeting with the Biological Society of the University of Pennsylvania, the latter was represented by Prof. Conklin, who spoke upon "Fertilization and Inheritance," and the Section by Mr. Frank J. Keeley, who gave a history of the "Development of the American Microscope." Dr. Morris also spoke upon the "Theory of Vibration."

Communications have been made by Mr. Palmer on *Spirogyra* and desmids; by Mr. Keeley on rock-inclusions, various appliances of the microscope, and the Abbé diffraction theory; by Mr. Woolman on artesian well deposits, by Mr Boyer on diatoms; by Dr. Stewart on white blood corpuscles and bacteria, and by Dr. Morris on pathology.

At the meetings with the Academy Dr. Benjamin Sharp spoke upon the "Food of the Cod;" Dr. Pilsbry on the "Relationships of the Genus *Neobeliscus;*" Mr. Keeley on the "Structure of Diatoms" and "Colored Illumination," and Drs. Ravenel and McCarthy on the "Pathology and Treatment of Rabies."

The following officers were elected for the ensuing year:

Director, ...	J. Cheston Morris, M.D.
Vice-Director, ...	T. Chalkley Palmer.
Treasurer, ...	Lewis Woolman.
Conservator, ...	Frank J. Keeley.
Corresponding Secretary, . .	Silas L. Schumo.
Recorder, ...	Charles S. Boyer.

CHARLES S. BOYER,
Recorder.

REPORT OF THE CONCHOLOGICAL SECTION.

The growth of the collection of mollusks during the year has been satisfactory. The total number of accessions, 2,705, although less than in several years, comprises a large amount of material preserved in alcohol and also more species new to the collection than have been added in any year since the A. D. Brown Collection was received.

The chief accessions are as follows: Over 800 species of Japanese mollusks received from Mr. Y. Hirase, of Kyoto, Japan; a large lot of South Sea shells collected by C. D. Voy in 1872–3, and presented by Mrs. Annie P. Cope; a small series of shells from Hawaii and Torres Strait, sent to our Treasurer, Mr. Roberts, by Mr. D. Thaanum, consisting largely of species new to the collection, and a second collection from British East Africa from Dr. A. Donaldson Smith. The series of American mollusks has been increased by about 200 species from the Galapagos and Cocos Islands, collected by an expedition from Leland Stanford, Jr. University; a selected series from the Gulf of California from Mr. J. G. Malone, and a small series of C. B. Adams' Panama shells; while Messrs. E. H. Ashmun, A. C. Billups, G. H. Clapp, T. D. A. Cockerell, M. J. Elrod, J. H. Ferriss, Dr. Henry Skinner, Bryant Walker, and many others have added valuable material to the collection of United States mollusks, both dry and in alcohol. A portion of this material has been worked up by Mr. Vanatta and the Conservator in special papers.

The Academy purchased 328 species of air-breathing prosobranch snails new to the collection. Progress has been made in the rearrangement of the Pelecypoda and the alcoholic collection. The remainder of the *Bulimulidæ* and the genus *Cerion* have been revised in the progress of monographs of these groups.

The officers elected at the annual meeting, held December 5, 1901, are as follows:

Director,	Uselma C. Smith.
Vice-Director,	John Ford.
Recorder and Librarian,	Edward J. Nolan.
Corresponding Secretary,	Charles W. Johnson.
Treasurer,	S. Raymond Roberts.
Conservator,	Henry A. Pilsbry.

The continued assistance of Mr. E. G. Vanatta has largely increased the work accomplished in the department. Advice and assistance have also been rendered by Mr. C. W. Johnson and other members of the Museum Committee.

H. A. Pilsbry,
Conservator.

REPORT OF THE ENTOMOLOGICAL SECTION.

The usual meetings have been held and entomological communications of interest and scientific value have been made by members and associates. The attendance has been good, the average being fourteen persons.

Seven associates have been elected during the year.

The *Entomological News and Proceedings of the Entomological Section of The Academy of Natural Sciences of Philadelphia* has been continued with increased success. During the year the twelfth volume has been completed with three hundred and twenty-eight pages and thirteen plates.

The Section has had a very eventful year, due to the large and valuable additions of specimens to the collections of the department. Two representative collections of Hymenoptera have been presented: the Cresson Collection and the collection of Gallflies made by Mr. Homer F. Bassett, of Waterbury, Conn. The former collection contains 2,367 types and 3,511 species and the number of specimens is estimated at 87,775. The Bassett Collection contains 315 boxes, estimated to contain 6,300 specimens and over 300 types. The collection of Orthoptera made and presented to the Section by Mr. J. A. G. Rehn numbers 1,653 specimens. In addition the Academy has purchased 3,500 specimens. These collections, in conjunction with the material already in the possession of the Section, form the best museum collection of these insects in America. The Conservator has added over a thousand specimens collected in San Miguel county, N. M., during the summer. About forty species of these are new to science, and many are new to the collection. The specimens added to the cabinets during the year will number nearly 104,000.

The collections are in a good state of preservation, but additional cases are needed and more space for the department is desirable.

At the annual meeting, held December 26, the following were elected to serve as officers for the year 1902:

Director, ...	Philip Laurent.
Vice-Director, ...	H. W. Wenzel.
Treasurer, ...	E. T. Cresson.
Recorder and *Conservator*, . . .	Henry Skinner.
Secretary, ...	C. W. Johnson.
Publication Committee, ...	J. H. Ridings, C. W. Johnson.

HENRY SKINNER,
Conservator.

REPORT OF THE BOTANICAL SECTION.

The Botanical Section reports that the herbarium is in a generally satisfactory condition. Much progress has been made in the work of arrangement during the year.

About 5,500 specimens have been added to the collections, largely through purchase, the most important being a portion of the collections of Mr. A. A. Heller, from Virginia, North Carolina, Texas, Arizona, Wyoming, Idaho, Washington, Oregon and California, numbering twenty-five hundred specimens and containing about 250 types, cotypes and authentic specimens, with many from original type localities. These will add very materially to the North American series of plants.

Other purchases have been 129 specimens of Porto Rican plants from A. A. Heller, 190 specimens of Mexican plants from C. G. Pringle, 776 specimens of Canary Island plants from Dr. Theodore Bornmuller, and 250 specimens of West Australian plants from Dr. Pritzel.

Donations numbering about 2,000 specimens have been received from Col. C. A. H. McCauley, William M. Canby, Benjamin H. Smith, Uselma C. Smith, C. F. Saunders, Witmer Stone, E. G. Vanatta and Stewardson Brown.

The mounting of the general herbarium was completed in September, largely through the untiring efforts of the late Mr. Meehan, it having been his expressed desire to see this work accomplished during his life, and strangely enough it was practically the last work he was able to do in the herbarium.

In the early part of the present year the Curators had constructed eleven additional cases in the north room, which has enabled the Conservator to rearrange all the specimens of the Anthophyta in the two rooms on the library floor, the Pteridophyta being arranged for the present in the south room on the gallery floor.

All of the cases have been marked on the outside with printed labels, in brass holders with transparent fronts, greatly facilitating the reference to specimens.

The mounting of the Charles E. Smith Herbarium was completed during the year, the local material being arranged in one of the cases in the south room on the gallery floor; the balance of the specimens will be incorporated with the general collections during the coming year.

During the year much work has been accomplished on the C. W. Short Herbarium, about ten thousand sheets having been mounted, all of which will be incorporated with the general collections as rapidly as possible. It is the desire of the Conservator to push this work during the coming year, so that the many valuable specimens contained in this collection may be made available for study at as early a date as possible.

At the meeting of the Botanical Section, held on Monday, December 9, 1901, the following were elected as the officers to serve for the coming year:

Director,	Benjamin H. Smith.
Vice-Director,	Joseph Crawford.
Corresponding Secretary,	John T. Pennypacker.
Recorder,	John W. Harshberger.
Treasurer and *Conservator*,	Stewardson Brown.

Respectfully submitted,

STEWARDSON BROWN,

Conservator.

REPORT OF THE MINERALOGICAL AND GEOLOGICAL SECTION.

The Director of the Mineralogical and Geological Section respectfully reports that nine meetings have been held during the year, besides six excursions to points of geological or mineralogical interest. The average attendance at the meetings has been eight members, on the excursions thirty-two.

Additions to the Academy's collection of mineral and geological specimens include many of interest, though in number not as great as in previous years.

An elaborate paper was read before the Section by Mr. John S. Ash on the Buckingham Fault, which elicited considerable discussion, participated in by Messrs. Lyman, Woolman and others. There were read also other papers on Arizona lignite, New Jersey gravels, and on various questions relating to the geology of Pennsylvania.

Mr. Frank J. Keeley exhibited a number of rock sections prepared by himself, and made remarks upon them, particularly upon their inclusions.

The first excursion was made to Langhorne and vicinity, for the examination of the New Red Rocks in that neighborhood, and to Van Artsdalen's quarry; the second and third to the vicinity of Yardley and New Hope, the fourth to Lodel creek, near Grater's ford on the Perkiomen, and to Skippack creek. At Lodel creek a slab was obtained showing ripple marks and reptilian and amphibian footprints. The fifth was to West Chester, where the cabinet of Mr. W. W. Jefferis was inspected and also Mr. Sharpless' collection of Indian relics, after which a number of localities in the vicinity were visited. The sixth excursion was to the fossil beds in the Mattewan and other formations in the vicinity of Swedesboro and Mullica Hill.

The following officers of the Section for the ensuing year were elected:

Director, ...	Theodore D. Rand.
Vice-Director, ...	Benjamin Smith Lyman.
Treasurer, ...	Emma Walter.
Conservator, ...	F. J. Keeley.
Recorder, ...	Charles Schäffer.

Respectfully submitted,

THEODORE D. RAND, *Director*.

REPORT OF THE ORNITHOLOGICAL SECTION.

During the past year a large part of the Conservator's time has been occupied by his duties as assistant to the Curators in other departments. It has, however, been possible to make considerable progress in the rearrangement of the ornithological collections. All of the mounted water birds, with the exception of the *Anatidæ* and *Laridæ*, have been carefully examined by the taxidermist, relabeled with both common and technical names, and installed on the ornithological floor of the new building. They completely fill the large case erected last year, and show to much better advantage than they did in the old gallery. During the close of the present year three additional cases have been furnished by the Curators, which it is estimated will accommodate about one-third of the entire mounted collection. Labels for most of the remaining water birds have already been prepared, and it is expected all the new cases will be filled and the new floor opened to the public in the spring.

For the study collection eighteen moth-proof cans and three large wooden cases have been purchased, permitting the abandonment of almost all of the temporary storage boxes that we were forced to make use of some years ago. With a similar provision next year the entire collection of bird skins will be accommodated in modern cases and rendered absolutely safe from moths and dust. Considerable time has been required to effect the systematic arrangement of the skins in the new cases, but as a result they are now more accessible than ever before. The McIlhenny collection of Alaskan birds, which was formally acquired early in the year, has been incorporated with the general collection, as also a valuable local collection of water birds, the gift of Mr. H. W. Fowler.

The Delaware Valley Ornithological Club and the Pennsylvania Audubon Society have continued to hold their meetings in the building and have done a great deal to stimulate the study of birds at the Academy. Much aid has been rendered during the year to ornithologists in other institutions, both by correspondence and by loan of specimens, and many visiting naturalists have made use of the collections.

Among other important additions to the department may be mentioned a series of birds from Lake Rudolf, Africa, from Dr.

A. Donaldson Smith; a series of several hundred skulls and sterna of American birds from H. W. Fowler and Witmer Stone, and a valuable collection of nests and eggs from Robert T. Young. At the annual meeting, held December 18, 1901, the following officers were chosen:

Director, ...	Spencer Trotter, M.D.
Vice-Director, ...	George Spencer Morris.
Secretary.	William A. Shryock.
Recorder, ...	Stewardson Brown.
Treasurer and Conservator, . .	Witmer Stone.

Respectfully submitted,

WITMER STONE,

Conservator.

The election of Officers, Councilors and Members of the Committee on Accounts to serve during 1902 was held with the following result:

PRESIDENT, ...	Samuel G. Dixon, M.D.
VICE-PRESIDENTS, ...	Arthur Erwin Brown, Edwin G. Conklin, Ph.D.
RECORDING SECRETARY, . .	Edward J. Nolan, M.D.
CORRESPONDING SECRETARY, .	J. Percy Moore, Ph.D.
TREASURER, ...	George Vaux, Jr.
LIBRARIAN, ...	Edward J. Nolan, M.D.
CURATORS, ...	Henry C. Chapman, M.D., Arthur Erwin Brown, Samuel G. Dixon, M.D., Henry A. Pilsbry, Sc.D.
COUNCILORS TO SERVE THREE YEARS,	Uselma C. Smith, Charles Roberts, John Cadwalader, William Sellers.
COMMITTEE ON ACCOUNTS, . .	Uselma C. Smith, Charles Morris, William L. Baily, Harold Wingate, Lewis Woolman.

COUNCIL FOR 1902.

Ex-officio.—Samuel G. Dixon, M.D., Arthur Erwin Brown, Edwin G. Conklin, Ph.D., Edward J. Nolan, M.D., J. Percy Moore, Ph.D., George Vaux, Jr., Henry A. Pilsbry, Henry C. Chapman, M.D.

To serve Three Years.—Charles Roberts, Uselma C. Smith, John Cadwalader, William Sellers.

To serve Two Years.—Charles Schaeffer, M.D., Dr. C. Newlin Pierce, Theodore D. Rand, Philip P. Calvert, Ph.D.

To serve One Year.—Thomas A. Robinson, Charles H. Cramp, Charles Morris, Isaac J. Wistar.

CURATOR OF MOLLUSCA, . . .	Henry A. Pilsbry, Sc.D.
ASSISTANT LIBRARIAN, . .	William J. Fox.
ASSISTANTS TO THE CURATORS, .	Witmer Stone,
	Henry Skinner, M.D.,
	Stewardson Brown,
	J. Percy Moore, Ph.D.
	Edward G. Vanatta,
	Charles W. Johnson.
TAXIDERMIST, ...	David McCadden.

Jessup Fund Students, ...	J. A. G. Rehn,
	H. L. Viereck,
	Edward G. Vanatta,
	Harriet Newell Wardel.

Janitors, ...	Charles Clappier,
	John McIlhenny,
	Daniel Heckler.

ELECTIONS DURING 1901.

MEMBERS.

January 29.—William F. Dreer, James Rorer, A. Worrell Wagner.

February 26.—C. Hartman Kuhn.

March 26.—F. S. Manderson.

April 30.—Anthony W. Robinson.

May 28.—Adolph Fredholm, Ph.D.

June 26.—Henry Kraemer.

October 29.—Howard Crawley, Henry Fox, Jr.

November 26.—Roswell C. Williams, Henry Savage, William B. Davis and S. Harbert Hamilton.

CORRESPONDENTS.

Janary 29.—H. R. H. Albert I, Sovereign Prince of Monaco.

March 26.—Y. Hirase, of Kyoto, Japan; Carlos de la Torre, of Havana, Cuba.

August 27.—Sir Thomas Lauder Brunton, of London, England.

November 26.—T. D. A. Cockerell, of East Las Vegas, N.M.

ADDITIONS TO MUSEUM.

MAMMALS.

OTTO BEHR. Pine Marten, *Mustela americana ;* four Weasels, *Putorius noveboracensis ;* Rabbit, *Lepus floridanus transitionalis ;* Red-backed Mouse, *Evotomys gapperi ;* skins and skulls ; and Brewer's Mole, *Parascalops breweri ;* Short-tailed Shrew, *Blarina brevicauda ;* White-footed Mouse, *Peromyscus canadensis ;* House Mouse, *Mus musculus*, and four Weasels, *Putorius noveboracensis*, alcoholic ; all from Wyoming county, Pa.

STEWARDSON BROWN. Red Bat, *Lasiurus borealis*, Philadelphia.

HENRY C. CHAPMAN, M.D. Fœtus of *Felis domestica*, *Sus scrofa*, *Dasypus sexcinctus*, Monkey sp., and placenta of *Oryx*.

WILLIAM E. HUGHES, M.D. Collection of twenty-one mammal skins and skulls from Chihuahua, Mex.

CHARLES D. KELLOGG. Mongoose, *Herpestes griseus*, skin and skull.

PURCHASED. Collection of skins and skulls of mammals from Texas and Colorado ; skull of Black Bear, *Ursus americanus*, from Clinton county, Pa., and Virginia Deer, *Odocoileus virginianus*, male (for mounting), Wyoming county, Pa.; Florida Manatee, *Trichichus latirostris*, skeleton.

J. A. G. REHN. Five skins and skulls of Pennsylvania mammals.

SAMUEL N. RHOADS. (Collected for the Academy.) Five Field Mice, *Microtus pennsylvanicus ;* four Short-tailed Shrews, *Blarina brevicauda*, and eleven White-footed Mice, *Peromyscus leucopus*, skins and skulls.

ALFRED SATTERTHWAIT. Jumping Mouse, *Zapus hudsonius americanus* (mounted), Chester county, Pa.

MRS. CHARLES SCHAEFFER. Skin of Pocket Gopher and Shrew, British Columbia.

WITMER STONE AND J. A. G. REHN. (Collected for the Academy.) Two Red-backed Mice, *Evotomys gapperi rhoadsi*, skins and skulls, New Jersey.

ZOOLOGICAL SOCIETY OF PHILADELPHIA. Specimens prepared as indicated : Mounted : Prevost's Squirrel, *Sciurus prevosti ;* Indian Rhinoceros, *Rhinoceros unicornis*. To be mounted : Red Deer, *Cervus elaphus ;* Black-backed Jackal, *Canis mesomelas ;* Ring-tailed Lemur, *Lemur catta ;* Rufous-necked Wallaby, *Halamaturus ruficollis ;* Red-handed Spider Monkey, *Ateles paniscus*. Skins and skulls : Entellus Monkey, *Semnopithecus entellus ;* White-throated Monkey, *Cercopithecus albogularis* (no skull) ; Gray-cheeked Mangaby, *Cercocebus collaris ;* Lion-tailed Macaque, *Macacus silenus ;* Black Ape, *Cynopithecus niger ;* Silky Marmoset, *Midas rosalia* (no skull) ; Lion, *Felis leo* (male) ; Florida Otter, *Lutra hudsonica vaga ;* Bassaris, *Bassariscus astutus flavus ;* Black-backed Jackal, *Canis mesomelas ;*

Slow Loris, *Tardigradus tardigradus* (no skull); three Arizona Cottontails, *Lepus arizonæ minor;* two Spermophiles, *Spermophilus mexicanus* and *S. spilosoma;* Texan Cotton Rat, *Sigmodon hispidus texianus;* two Wood Rats, *Neotoma micropus* and *N. albigula;* Gopher, *Cratogeomys castanops;* two Kangaroo Rats, *Dipodomys ambiguus* and *D. spectabilis;* Rufous-necked Wallaby, *Halmaturus ruficollis.* Skin and skeleton: Female Buffalo, *Bison bison;* European Otter, *Lutra lutra.* Skulls: Green Monkey, *Cercopithecus callitrichus;* Rhesus Macaque, *Macacus rhesus;* Ring-tailed Coati, *Nasua narica.* Skeletons: Indian Rhinoceros, *R. unicornis;* two Spotted Hyenas, *Hyæna crocuta;* Striped Hyena, *H. hyæna;* Sacred Monkey, *Semnopithecus entellus;* Gibbon, *Hylobates lar;* Black-backed Jackal, *Canis mesomelas.* Alcoholic: two *Neotoma micropus, Tardigradus tardigradus, Dipus jaculus, Ursus arctos* (very young), two *Spermophilus mexicanus.*

A. Donaldson Smith, M.D. Collection of thifty skins and skulls of African mammals, several mounted heads and mounted Antelope.

In Exchange. Two specimens of *Chilonycteris*, from Porto Rico.

R. T. Young. Two skins of Weasel, *Putorius noveboracensis,* Princeton, N. J.

Birds.

Col. G. T. Anderson. Two bird skins from the Philippines.

Arthur Erwin Brown. Three skins of *Zonotrichia leucophys* and egg of *Corvus cryptoleucus* (?), Pecos, Tex.

J. L. Buck. Parrot skull (*Chrysotis* sp.).

Delaware Valley Ornithological Club. Three nests, two sets of eggs and three mounted birds.

H. W. Fowler. Collection of skulls and sterna, mainly of Pennsylvania birds, and collection of skins of water birds from Pennsylvania and New Jersey.

Alfred C. Harrison, Jr., and Dr. H. M. Hiller. Skin of *Ibis papillosus*, Borneo.

Susan Hayhurst, M.D. Twelve skins of Colorado birds.

Charles D. Kellogg. Several eggs of sea birds from Bird Rock.

David McCadden. Skin of Harlequin Duck, *Histrionicus histrionicus.*

Charles B. Penrose, M.D. Skin of Franklin's Grouse, *Dendragapus franklini.*

J. A. G. Rehn. Four skins of Pennsylvania birds.

Thomas A. Robinson. Case of twelve mounted birds from Africa.

A. Donaldson Smith. Collection of one hundred and twenty-nine bird skins from Lake Rudolf and vicinity, Africa.

Witmer Stone. Collection of skulls and sterna of North American birds.

H. W. Wenzel. Specimen of Hudsonian Godwit, *Limosa hæmastica* Anglesea, N. J., prepared as skin.

Robert T. Young. Collection of nests and eggs of North American birds from Nova Scotia, Pennsylvania, New Jersey, etc.

ZOOLOGICAL SOCIETY OF PHILADELPHIA. Prepared as skins: *Trichoglossis forsteni*, *Chrysotis salvini*, *Rhamphastos brevicarinatus*, *Chondestes grammacus*, *Conurus patagonicus*, *Lanius ludovicianus excubitorides*, *Ploceus baya*, *Pyrrhulopsis tabuensis*, *Amazona pretrei*. Skull and sternum: *Coscoroba coscoroba*, *Falco fusco-cærulescens*. Skeleton: *Dendrocitta vagabunda*, *Pelecanus erythrorhynchus*, *Gyps fulvus*.

PURCHASED. McIlhenny collection of Alaskan birds, three hundred and forty-seven skins.

REPTILES AND BATRACHIA.

ARTHUR ERWIN BROWN. One hundred and forty-five specimens, representing seventy-five species, of snakes and lizards; also type of *Coluber subocularis* Brown.

HERBERT BROWN. *Phyllorhynchus decurtatus*, Yuma, Ariz.

OTTO BEHR. Rattlesnake, *Crotalus horridus*, and small collection of reptiles, Wyoming county, Pa.

E. D. COPE ESTATE. One hundred and fifty specimens of reptiles and batrachia.

PHILIP LAURENT. A collection of reptiles and batrachia from Florida and several specimens from Philadelphia.

DAVID MCCADDEN. Specimen and plaster cast of *Coluber obsoletus*, Stone Harbor, N. J.

CLARENCE B. MOORE. Three casts of snakes.

MRS. SCATTERGOOD. Pine snake, *Pityophis melanoleucus*, Brown's Mills, N. J.

HENRY SKINNER, M.D. Several reptiles and batrachia from Sapello Canyon, N. M.

WITMER STONE AND J. A. G. REHN. Small collection of reptiles and batrachia from the New Jersey Pine Barrens, including *Rana virgatipes* and *Liolepisma laterale*.

ZOOLOGICAL SOCIETY OF PHILADELPHIA. *Tiliqua scincoides*, Australia.

FISHES.

CHARLES W. BUVINGER. Five jars of fishes from Atlantic City, N. J.

H. W. FOWLER. Collections from Wood's Holl, Mass., Philadelphia and New Jersey coast, and specimen of Salmon.

DAVID MCCADDEN. Specimens of Pipe fishes, *Siphostoma fuscum*.

H. A. PILSBRY. Jar of fishes from Florida.

MRS. L. J. RUSHTON. Head of Sword-fish (mounted).

J. B. SAMUEL. Bone of Sturgeon.

J. A. SCHULTZ. Mounted specimen of Grayling, Michigan.

BENJAMIN SHARP, M.D. Sand Shark, *Carcharias littoralis*, and Bill-fish, *Tylosurus acris*, Nantucket, Mass.

U. S. FISH COMMISSION. Collection of Porto Rican fishes.

E. D. COPE ESTATE. Several jars of fishes.

INSECTS, ETC.

W. M. BAKER. Larva of moth.

H. F. BASSETT. Three hundred and fifteen boxes of Cynipidæ and their galls.

FREDERICK BLANCHARD. One Coleopter.

G. W. BOCK, M.D. Thirty Hemiptera, nine hundred Coleoptera.

A. E. BROWN. One Coleopter, nine Orthoptera, three *Thelyphorus*, fifty Hymenoptera.

T. D. A. COCKERELL. Forty-three Hymenoptera, three Diptera, twenty-two Lepidoptera, three Neuroptera, one Hemipter.

EMILY COOPER. Nest of Tarantula.

E. T. CRESSON. 3,511 species of Hymenoptera—87,775 specimens, 2,367 types.

J. S. DIXON. Eight Arachnida.

S. G. DIXON. One Coleopter.

GEORGE ELLIOT. Larva of *Citheronia regalis*.

JOSEPH W. FELL. Larva of *Citheronia regalis*.

W. F. FISKE. One Lepidopter.

GEORGE FRANCK. Forty Lepidoptera.

ARTHUR FROEHL. *Dolomedes* sp.

A. HEMPEL. One hundred Neuroptera.

M. E. HOEG. Seven Lepidoptera, eleven Hymenoptera, five Coleoptera, ten Neuroptera.

HERMAN HORNIG. Two hundred and fifty Hymenoptera, thirty-five Lepidoptera.

C. W. JOHNSON. Six Diptera, two Lepidoptera.

PHILIP LAURENT. Two Orthoptera.

C. W. LENG. Six Coleoptera.

F. A. MERRICK. One hundred and twenty-nine Lepidoptera.

H. B. MEYERS. *Fenodera sinensis.*

O. C. POLING. Fourteen Lepidoptera.

CHARLES ROBERTSON. Twenty-four Hymenoptera (co-types).

J. A. G. REHN. 1,653 Orthoptera. Collection of insects from New Jersey Pine Barrens. (Collected for the Academy.)

MRS. CHARLES SCHAFFER. Nine Hymenoptera, twenty-one Diptera, three Lepidoptera, forty-seven Coleoptera, two Orthoptera, one Hemipter, ten Neuroptera.

HENRY SKINNER. Three hundred and fifty-three Hymenoptera, one hundred and seventy-two Diptera, five hundred and eighty-six Coleoptera, two hundred and fourteen Hemiptera, twenty-five Neuroptera, one hundred and seventy-four Lepidoptera, fifty-one Orthoptera.

DR. A. D. SMITH. Forty-seven Coleoptera, thirty-one Lepidoptera, two Hemiptera, two Orthoptera.

USELMA C. SMITH. Four Hemiptera.

LANCASTER THOMAS. Thirty-six Coleoptera, three Orthoptera, nine Neuroptera.

E. G. VANATTA. One thousand insects, various orders.

H. L. VIERECK. Thirty Hymenoptera.

J. L. WEBB. Two Coleoptera.

H. W. WENZEL. One hundred and forty-five Hymenoptera, eighteen Coleoptera.

W. M. WHEELER. Thirty Hymenoptera.

J. S. WHITEMAN. Three Coleoptera.

STEWARDSON BROWN. Twelve Hemiptera, one Lepidopter.

WEST INDIAN FRUIT CO. *Mygale* sp.

ZOOLOGICAL SOCIETY OF PHILADELPHIA. *Scolopendria* sp., Pecos, Tex.

RECENT MOLLUSCA.

REV. E. H. ASHMUN. Sixty-seven species of land and fresh-water shells from Idaho and Arizona.

CARL F. BAKER. Fifty-six trays of shells from the Southern States.

F. C. BAKER. Ten species of fresh-water shells from Illinois.

W. T. BENDALL. *Oxystyla undata* Brug., from New Providence, Bahama Islands.

A. C. BILLUPS. Thirty five species of land shells from Indiana.

BOTANICAL SECTION. Two species of fresh-water shells from Bethlehem, Pa. Three species of land and fresh-water shells from Bermuda.

J. H. BRITTS, M.D. Fifty-seven species of Unionidæ from Missouri.

F. W. BRYANT. Three species of California land shells.

FRED L. BUTTON. *Pecten diegoensis* Dall, from Monterey, Cal.

EMILIO F. CABADA. Twelve trays of Cuban land shells.

H. C. CHAPMAN, M.D. Five species of marine shells from Bar Harbor, Me.

GEO. H. CLAPP. Thirteen trays of American land shells.

T. D. A. and W. P. COCKERELL. Ninety lots of land and fresh-water shells from New Mexico.

O. COLLETT. Twenty-six species of shells from Ceylon, in exchange

ANNIE P. COPE. Three hundred and seventy-three trays of shells from the United States and Polynesia.

O. A. CRANDALL. *Physa rhomboidea* and *P. walkeri* Crandall, cotypes.

L. E. DANIELS. Twenty-three lots of United States land shells.

O. DEBEAUX. Six trays of Algerian land shells.

SAMUEL G. DIXON, M.D. Fifteen trays of marine shells from Cuba.

S. M. EDWARDS. *Pyramidula* from Colorado.

SIR CHARLES ELLIOTT. Six trays of marine shells from New Zealand.

M. J. ELROD. Fifteen trays of land and fresh-water shells from Montana.

J. H. FERRISS. Eighty-two lots of American land shells.

WM. H. FLUCK. Seven species of marine and fresh-water shells from Nicaragua.

JOHN FORD. Four species of shells from Florida and Pennsylvania.

H. W. FOWLER. Ten trays of marine shells from Martha's Vineyard, Mass.

L. S. FRIERSON. *Quadrula lananensis* Frierson.

MRS. E. M. GAYLORD. Two species of *Epiphragmophora* from Santa Catalina Island, California.

HAROLD HEATH. Four species of marine shells from California.

HENRY HEMPHILL. Eighteen species of California land shells.

J. B. HENDERSON, JR. Five species of land shells from Haiti.

Y. HIRASE. Eight hundred and thirty-six lots of Japanese shells.

C. W. JOHNSON. Five species of American land and fresh-water shells.

HOWARD JONES. Seven species of marine shells from New Jersey.

FAITH KEELY. Five species of marine shells from New Jersey.

R. E. B. MCKENNEY, M.D. Ten species of European land mollusks, in formalin.

R. J. KIRKLAND, M.D. *Planorbis* from Michigan.

E. J. LETSON. *Amnicola letsonæ* and *Goniobasis niagarensis.*

O. S. LEWIS. Four trays of fresh-water shells from Indiana.

H. LOOMIS. Ten species of Japanese shells.

H. N. LOWE. Four species of *Limax* and tectibranchs from Long Beach, Cal.

J. G. MALONE. Seventy-five species of marine shells from Santa Rosalia, Lower California.

GEORGE T. MARSTON. *Physa integra* Hald. from Quincy, Ill.

O. O. NYLANDER. Eighteen species of shells from Maine.

CHARLES B. PENROSE, M.D. *Pisidium* from Idaho.

H. A. PILSBRY, D.Sc. Twenty species of American land shells.

PURCHASED. Three hundred and twenty-eight species of operculate land shells.

W. M. RANKIN. Two species of land and fresh-water shells from Bermuda.

S. N. RHOADS. Forty-two trays of land and fresh-water shells from New Jersey and Pennsylvania.

S. RAYMOND ROBERTS. *Cypræa annæ* Roberts, from Hawaii.

REV. J. ROWELL. Two trays of Pacific marine shells.

W. H. RUSH, M.D. Three trays of marine shells from Honolulu.

SILAS L. SCHUMO. Three trays of marine shells from Europe.

B. SHARP, M.D. Seven trays of West Indian shells.

C. T. SIMPSON. *Pleurodonte bizonalis* from Haiti.

HENRY SKINNER, M.D. Eight species of land shells from New Mexico.

R. E. C. STEARNS. *Vivipara stelmaphora* Bgt. and *Limax maximus* from California.

STEERE EXPEDITION. Two trays of South American shells.

WITMER STONE. *Donax fossor* from New Jersey.

A. DONALDSON SMITH, M.D. Thirty-four species of shells from British East Africa.

USELMA C. SMITH. Five trays of shells.

ROBERT E. SNODGRASS. One hundred and seventy-five trays of marine shells from the Galapagos Islands.

D. THAANUM. Thirty-six trays of marine shells from Hawaii, Australia and New Guinea.

U. S. National Museum. Seven trays of land shells from Japan and Brazil.

E. G. Vanatta. Eight species of American land shells.

T. Van Hyning. Twenty-six species of American land and fresh-water shells.

J. W. Velie, M.D. Seven species of American shells.

Bryant Walker. Twenty-two species of land and fresh-water shells from Michigan.

A. G. Wetherby. Nine species of American land and fresh-water shells.

J. J. White. *Cerithium costatum* from Bahama Islands.

Wm. Wood. Six trays of shells.

Williard Wood. Two trays of shells from California.

L. Woolman. *Unio* from Greenbrier river, West Virginia.

Other Invertebrates.

Rev. E. H. Ashmun. *Helicopsyche* from Arizona.

Botanical Section. *Lingula anatina* Brug., Australia.

Stewardson Brown. *Cambarus* from Ganoga Lake, Pennsylvania.

Chas. W. Buvinger. Two jars Crustacea, Atlantic City, N. J.

H. C. Chapman, M.D. Seven jars of invertebrates from Bar Harbor, Me.

T. D. A. Cockerell. Two specimens of *Cambarus gallinus* P. and C. and *Helicopsyche* from New Mexico.

Catharine G. Dixon. *Limulus polyphemus* from Ballast Point, Fla.

J. E. Duerden. Five specimens of *Peripatus* from Bath, Jamaica.

H. W. Fowler. Two jars of invertebrates from Martha's Vineyard, Mass.

C. L. Furbush. *Hyalonema* sp., Philippines.

Y. Hirase. Six species of *Balanus* and Brachiopods from Japan.

H. W. Nagle. *Physalia* from Anglesea, N. J.

H. A. Pilsbry. Twenty-nine jars of invertebrates from Florida.

Purchased. Thirty-five trays of invertebrates, collected by C. D. Voy in the Pacific Ocean. Collection of Crustacea from Caroline Island, South Pacific.

S. N. Rhoads. Two trays of invertebrates from Cuba and New Jersey.

W. H. Rush, M.D. Two jars of invertebrates from the Pacific Ocean.

Paul Sartain, M.D. Specimen of coral.

B. Sharp, M.D. *Carcinus mœnas* L. from Nantucket.

Uselma C. Smith. *Segartia spongicola* Verr. from Spray Beach, N. J.

Witmer Stone. *Suberites* from Cape May, N. J.

E. B. Williamson. *Cambarus dubius* from Nashville, Tenn.

Fossil Vertebrates.

Edward D. Cope Estate. A small miscellaneous collection.

Mineralogical Section. Two slabs of red shale, showing Dinosaur tracks and ripple marks, from near Grater's Ford Station, Perkiomen R. R., Montgomery county, Pa.

Uselma C. Smith. Fossil Fish, Green River, Wyoming.

FOSSIL INVERTEBRATES.

REV. LEANDER TROWBRIDGE CHAMBERLAIN. Six hundred and fifteen lots from the Eocene and Oligocene of Europe.

H. C. CHAPMAN, M.D. Three species of Brachiopods from Maine and Europe.

ANNIE P. COPE. Three trays of North American fossils.

SAMUEL G. DIXON, M.D. Two trays of mollusca from Cuba.

GEORGE CUTHBERT GILLESPIE. *Baculites ovatus* Say, from Maple Shade, N. J.

C. W. JOHNSON. *Teredo* from Caloosahatchie river, Florida.

CLARENCE B. MOORE. *Exogyra costata* Say, Hoskins Landing, Miss.

JOSÉ N. ROVIROSA. *Ostrea contracta* Conr., Mexico.

JOHN TORPY. One tray of fossils from County Kilkenny, Ireland.

J. T. WALTON. Two trays of fossils from near Cardiff, N. Y.

S. WOOLVERTON, M.D. Three trays of Canadian fossils.

FOSSIL PLANTS.

PAULINE L. NIEDHARD. Several Carboniferous plants.

PLANTS.

HUGO BILGRAM. *Drachæa subsissilis*. *Physarum pallidum* and *Physarum variabile*.

BOTANICAL SECTION. One hundred and ninety specimens of Mexican plants, collections of C. G. Pringle; one hundred and twenty-nine specimens of Porto Rico plants, collections of A. A. Heller; seven hundred and seventy-six specimens of Canary Island plants, collections of Dr. Theodore Bornmüller.

STEWARDSON BROWN. Five hundred specimens of Pennsylvania and New Jersey plants.

WILLIAM M. CANBY. One hundred and thirty-nine specimens of North American plants, principally from Louisiana, Texas and Arkansas.

ZEPHANIAH HOPPER. *Leptorchis lillifolia* (L.).

E. L. MORRIS. *Batrachium hederallum*.

COL. C. A. H. MCCAULEY. Nine hundred and eighty specimens of plants from Colorado and New Mexico.

C. F. SAUNDERS. Thirty specimens of North American plants.

BENJAMIN H. SMITH. One hundred and thirty specimens of Colorado plants.

USELMA C. SMITH. Forty-one specimens of Colorado plants: twenty specimens of *Crataegus*.

WITMER STONE. Two hundred and fifty specimens of Pennsylvania and New Jersey plants.

E. G. VANATTA. Twenty specimens of Maryland plants.

CONTRIBUTORS TO FUND FOR PURCHASE OF A. A. HELLER COLLECTION. Botanical Section, Stewardson Brown, Ida A. Keller, Ph.D., Arthur N.

Leeds, Francis S. Manderson, Thomas Meehan, Adolph Miller, M.D., Silas L. Schumo, Benjamin H. Smith, William C. Stevenson, Jr.

Minerals.

Bell's Asbestos Co. Asbestos and Serpentine, Ontario.

Samuel G. Dixon, M.D. Limonite Geode, Pennsylvania; Chalcedony, Florida.

W. H. Jarman, M.D. Sulphur found at Tampa, Fla.

Frances E. Peirce. Small case of minerals.

F. Ritschl. Taraspite and Asbestos.

T. H. Ryan. Specimen of Bituminous Coal, Colorado.

J. T. Walton. Two specimens of Limonite.

S. Woolverton. Several minerals from Ontario.

William S. Vaux Collection. Specimens added by purchase.

Archæology and Ethnology.

Arthur Erwin Brown. Arrowheads and Indian Mill, Pecos, Tex.; Mexican Water Vessel, Ft. Davis, Tex.

Robert Casperson, M.D. Four Metates, Costa Rica.

Howard Eaton. Zuni Ceremonial Clothes.

Clarence B. Moore. Many additions to the Moore Archæological Collection.

Purchased. Eskimo Coat, Rattle and Boots; Beaded Saddle Bags.

F. W. Putnam. Indian Mill, Metate.

Charles G. Sower. Egyptian Mummy.

J. F. Syfrit. Eskimo Kyak Model.

PUBLICATIONS OF THE ACADEMY OF NATURAL SCIENCES OF PHILADELPHIA.

JOURNAL of The Academy of Natural Sciences of Philadelphia. 8vo. I, 1817–18—VIII, 1839–42.

JOURNAL of The Academy of Natural Sciences of Philadelphia. Second Series. 4to. I, 1847–50—XI, 1897–1901.

REPORT of the transactions of The Academy of Natural Sciences of Philadelphia, during the years 1825–1826. Submitted by S. G. Morton, M.D., Recording Secretary. Philadelphia, 1827. 8vo. Pp. 1–15.
Same, 1827–28. 8vo. 1829. Pp. 1–16.

PROCEEDINGS of The Academy of Natural Sciences of Philadelphia. 8vo. I, 1841–43—LIII, 1891.

ANNUAL REPORTS of the Treasurer have been published separately since 1890.

CIRCULAR (small pamphlet containing instructions for collecting and preparing specimens of natural history. Undated, but probably about 1830). 12mo. Pp. 1–11.

ACT OF INCORPORATION and by-laws of The Academy of Natural Sciences of Philadelphia. Philadelphia, 1836. 8vo. Pp. i–iv, 1–8. The first edition of the Act of Incorporation and Constitution was published in 1817 as part of the first number of the octavo Journal. Republished with By-Laws in Vol. VI, 1829.
Same, 1849. 8vo. Pp. 1–12.
Same, 1857. 8vo. Pp. 1–38.
Same, 1866. 8vo. Pp. 1–24.
Same, 1869. 8vo. Pp. 1–22. Issued with the Proceedings, XXI, 1870
Same, 1876. 8vo. Pp. 1–24.
Same, 1880. 8vo. Pp. 1–24.
Same, 1885. 8vo. Pp. 1–24.
Same, 1893. 8vo. Pp. 1–24.
Same, 1899. 8vo. Pp. 1–99.

LIST OF MEMBERS and correspondents of The Academy of Natural Sciences of Philadelphia, from the origin of the Society on the 25th of January, 1812, to the 1st of November, 1836. Philadelphia, 1836. 8vo. Pp. 1–16.
Same, 1841. 8vo. Pp. 1–19. Issued with Proceedings, I, 1841–43.
Same, 1848. 4to. Pp. 1–8.

MEMBERS AND CORRESPONDENTS of The Academy of Natural Sciences of Philadelphia. 1868. Philadelphia, 1868. 8vo. Pp. 1–27. Issued with Proceedings, XXI, 1870.
Same, 1877. 8vo. Pp. 1–48.
Same, 1893. 8vo. Pp. 1–62.

THE ACADEMY OF NATURAL SCIENCES OF PHILADELPHIA. 1890. 12mo. Pp. 1–11. 2 plates. Small descriptive pamphlet, issued in connection with application to the Legislature for an appropriation toward the completion of the building.

Another edition, with modifications. 1895. Pp. 1–7.

CATALOGUE OF THE LIBRARY of The Academy of Natural Sciences of Philadelphia. Philadelphia, 1837. 8vo. Pp. i–x, 1–300. The first catalogue of the library was begun in the Journal, No. 1, Vol. I, 1817, and continued in Vols II, III, IV.

GUIDE TO THE MUSEUM of The Academy of Natural Sciences of Philadelphia. 8vo. Philadelphia, 1876. Pp. 1–128.

HANDBOOK TO THE MUSEUM of The Academy of Natural Sciences of Philadelphia. Edited by J. H. Slack, M.D. 12mo. Pp. 1–116. Philadelphia, 1862.

Same, 2d edition, 1866. 12mo. Pp. 1–30.

NOTICE OF THE ACADEMY OF NATURAL SCIENCES OF PHILADELPHIA. Second edition. Philadelphia, 1831. Pp. 1–16. (The first edition was published in the American Journal of Science and Arts, XIX, pp. 88–96.)

Same, 3d edition, 1836. Pp. 1–32.

Same, 4th edition, 1837. Pp. 1–24.

A NOTICE OF THE ORIGIN, PROGRESS AND PRESENT CONDITION of The Academy of Natural Sciences of Philadelphia. By W. S. W. Ruschenberger, M.D., Surgeon U. S. Navy. (Read before the Society, February 10, 1852.) 8vo. Philadelphia. Pp. 1–78. (Contains list of members.)

Same, 2d edition, 1860. 8vo. Pp. 1–102.

ADDRESS delivered on laying the cornerstone of The Academy of Natural Sciences, May 25, 1839. By Walter R. Johnson, A.M , M.A.N.S., etc. Published by order of the Academy. Philadelphia, 1839. 8vo. Pp. 1–8. Issued with Proceedings, I, 1841–43.

DISCOURSE in commemoration of the founding of The Academy of Natural Sciences of Philadelphia. By William Parker Foulke. Delivered March 30, 1854, in the Hall of the University of Pennsylvania. 8vo. Philadelphia, 1854. Pp. 1–58.

ADDRESSES delivered on laying the cornerstone of an edifice for The Academy of Natural Sciences of Philadelphia, October 30, 1872. Philadelphia, 1873. (W. S. W. Ruschenberger, M.D., Rev. E. R. Beadle, J. Aitken Meigs, M.D., and Horatio C. Wood, M.D.) 8vo. Pp. 1–29. Issued with Proceedings, XXIV, 1872.

ADDRESS delivered on the occasion of the opening of the new lecture hall of The Academy of Natural Sciences of Philadelphia, February 22, 1892. By the Rev. Henry C. McCook, D.D., Vice-President. 8vo. Pp. 1–4.

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Zeeuwsch Genootschap der Wetenschappen. Middleburg.
Archief.

*Zeitschrift für Biologie. München.

*Zeitschrift für Krystallographie und Mineralogie. Leipzig.

*Zeitschrift für Morphologie und Anthropologie. Stuttgart.

*Zeitscrift für Planzenkrankheiten. Stuttgart.

*Zeitschrift für praktische Geologie. Berlin.

*Zeitschrift für wissenschaftliche Mikroscopie. Leipzig.

*Zeitschrift für wissenschaftliche Zoologie. Leipzig.

Zoe. San Diego.

*Zoologica. Original-Abhandlungen aus dem Gesammtgebiete der Zoologie. Stuttgart.

*Zoological Bulletin. Boston.

*Zoological Record. London.

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Proceedings.
Transactions.

Zoological Society of Philadelphia. Philadelphia.
Annual Report.

K. k. zoologisch-botanische Gesellschaft. Wien.
Berichte des Comités für ornithologische Beobachtungsstationen in Oesterreich.
Verhandlungen.

Zoologisch-zootomisches Institut. Würzburg.
*Arbeiten.

*Zoologische (Der) Garten. Frankfurt a. M.

Zoologische Gesellschaft. Hamburg.
Bericht.

*Zoologische Jahrbücher. Jena.

Zoologische Station zu Neapel. Napoli.
*Fauna und Flora des Golfes von Neapel.
*Zoologischer Jahresbericht.
Mittheilungen.

*Zoologischer Anzeiger. Leipzig.

K. zoologisches und anthropologisch-ethnographisches Museum. Dresden.
*Abhandlungen und Berichte.

*Zoologisches Centralblatt. Leipzig.

Zoologisches Institut der Universität. Wien.
*Arbeiten.

Zoologisches Museum. Berlin.
Mittheilungen.

*Zoologist (The). London.

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Species described as new are indicated by heavy-faced, synonyms by italic numerals.

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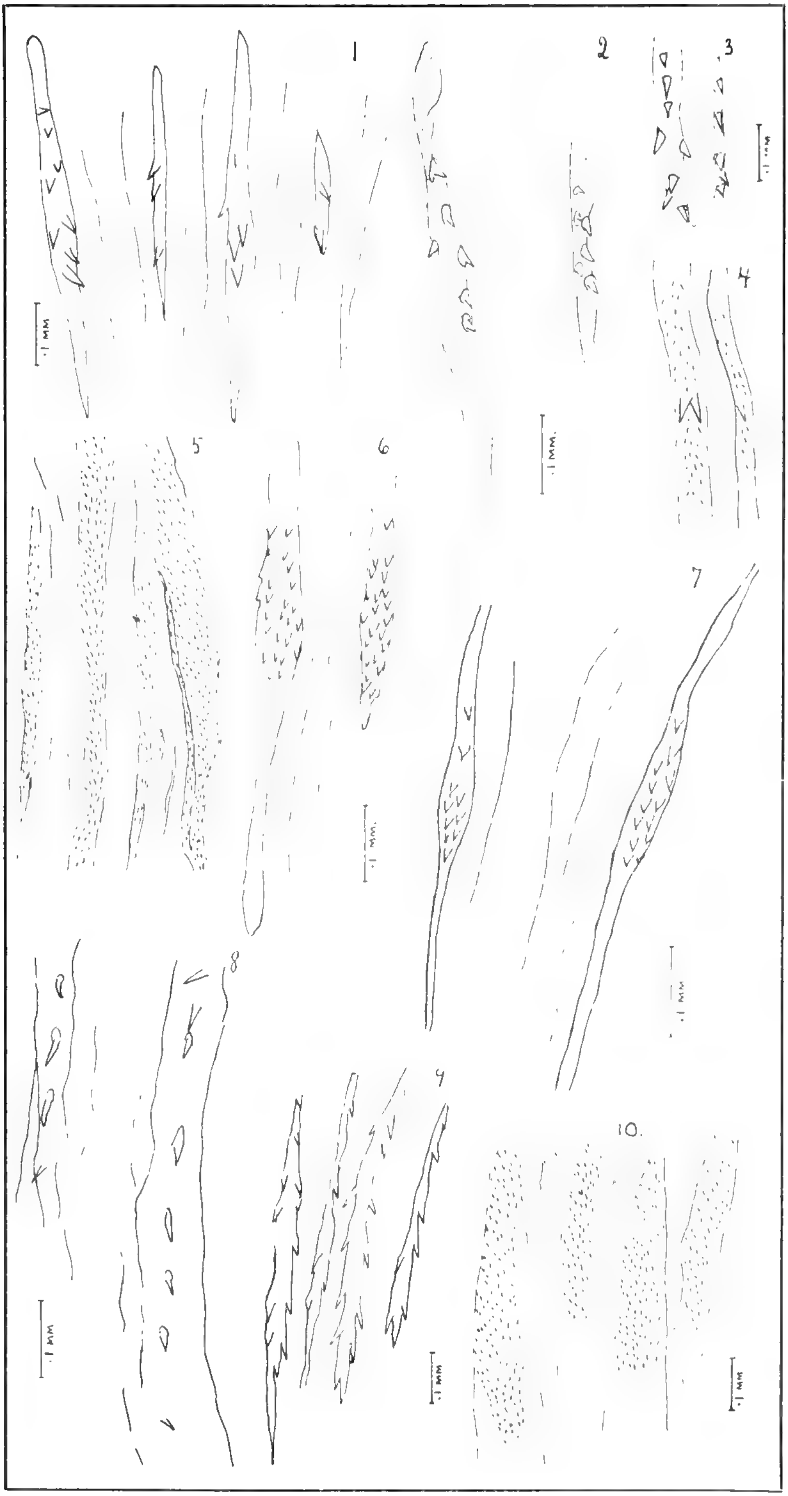
PILSBRY. CRUSTACEA OF THE NEW JERSEY CRETACEOUS.



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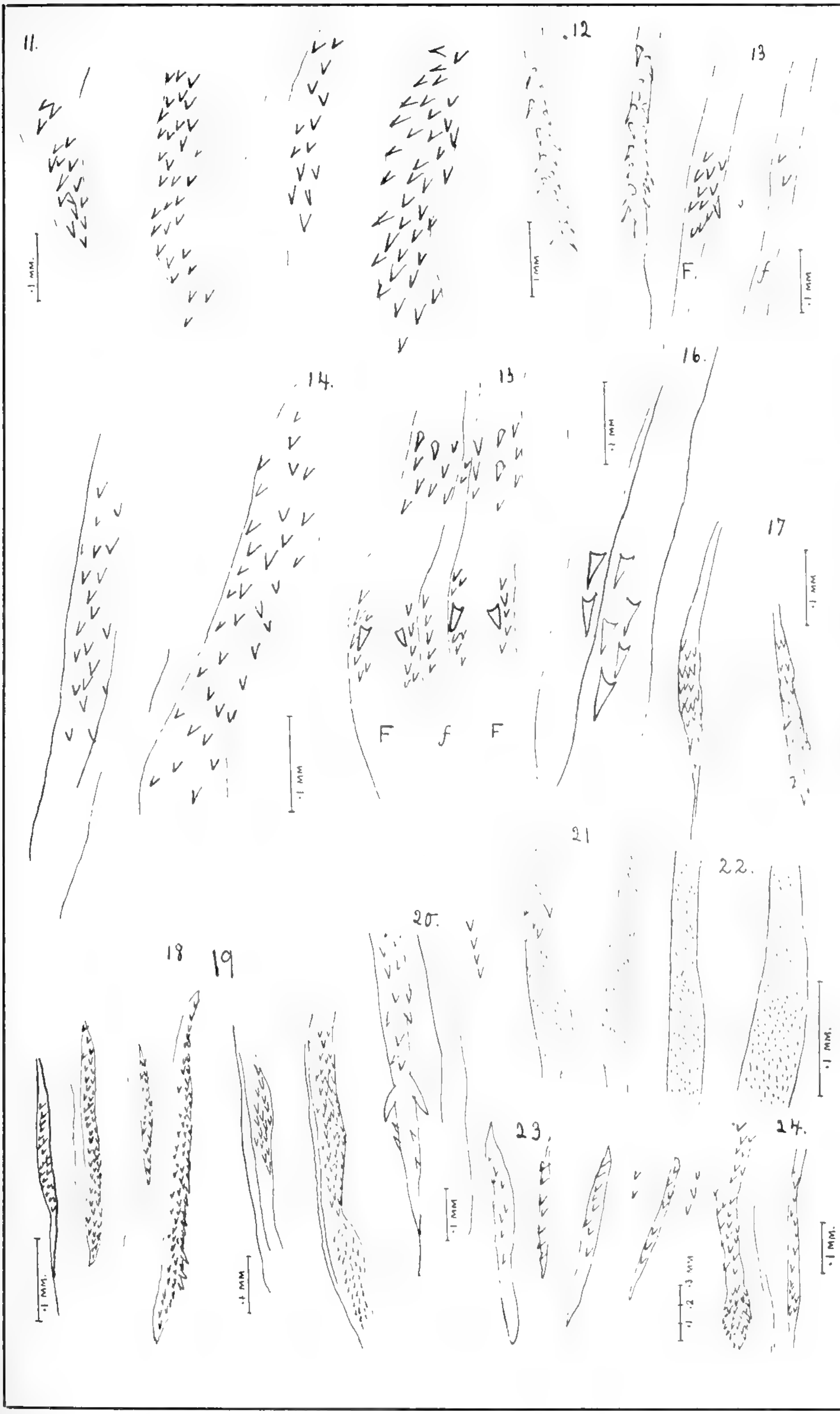

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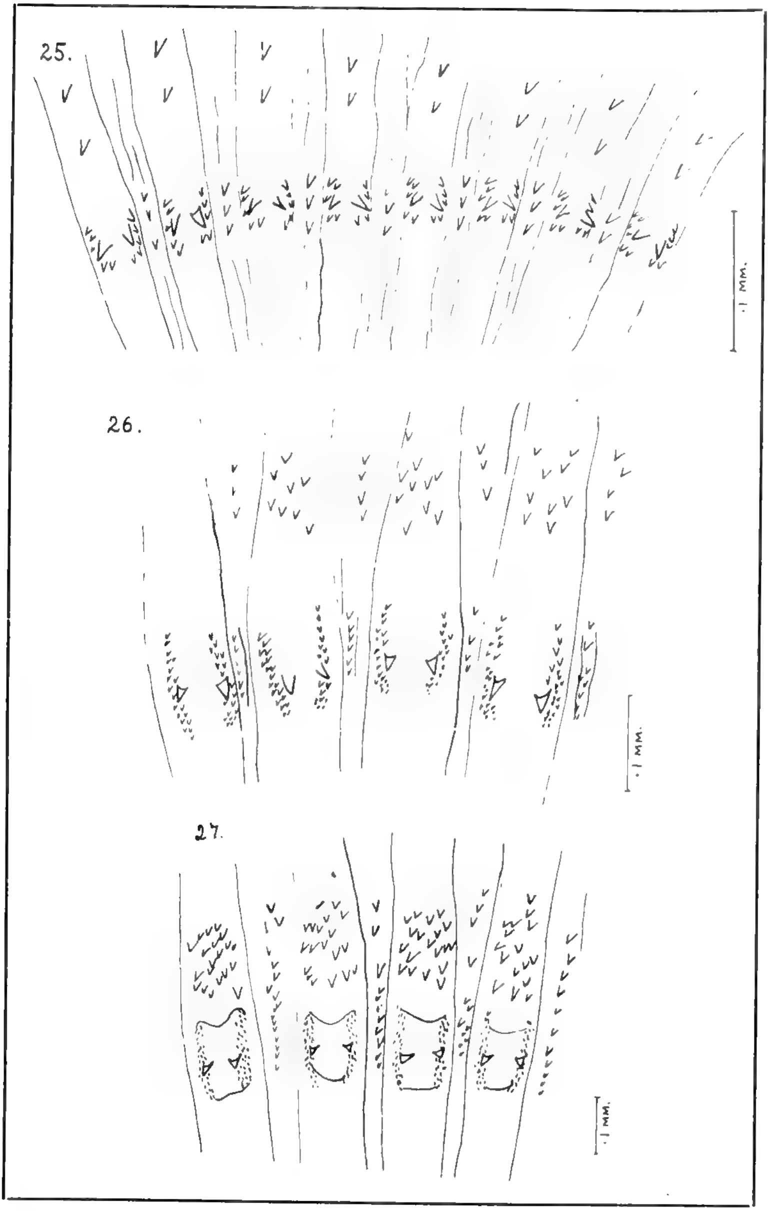

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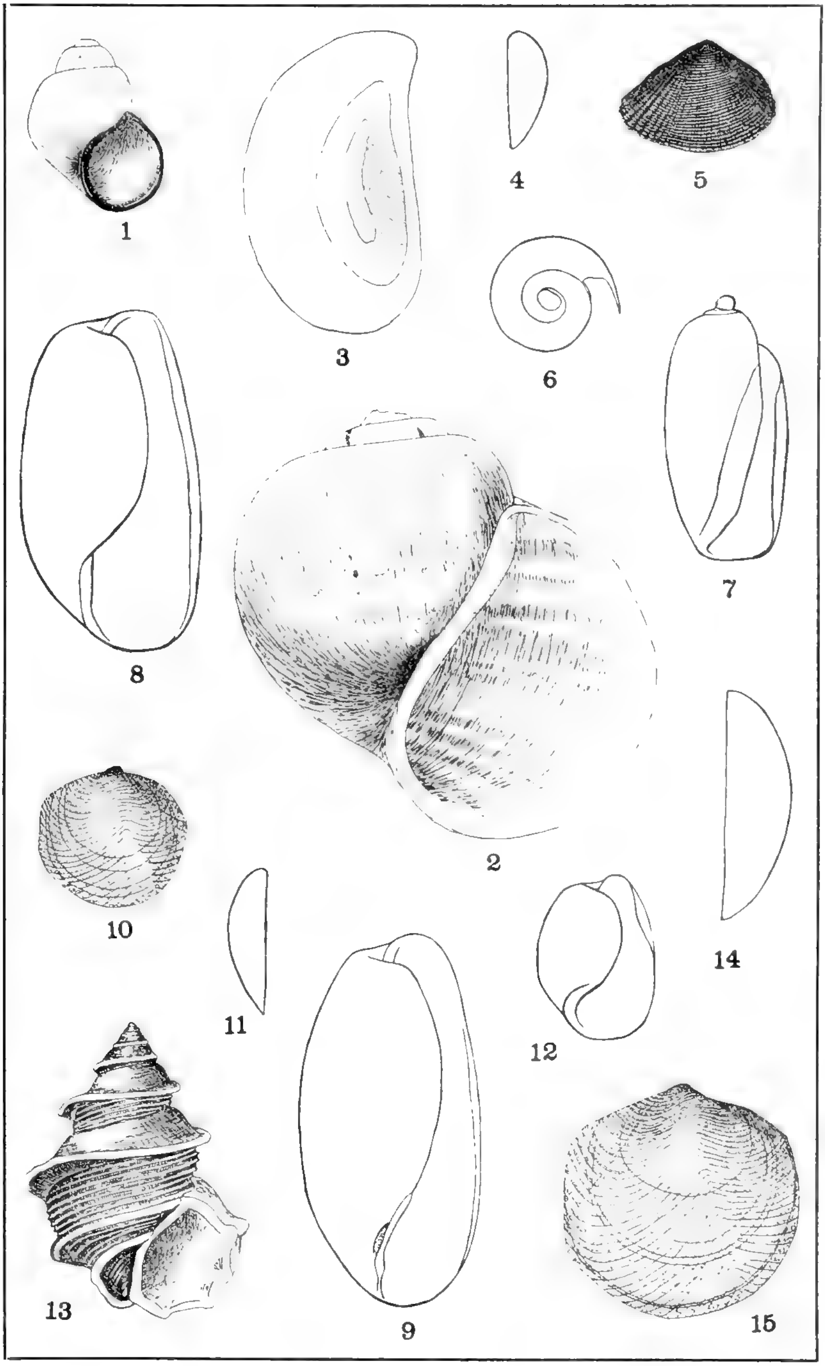

VANATTA. NEW MARINE MOLLUSKS.
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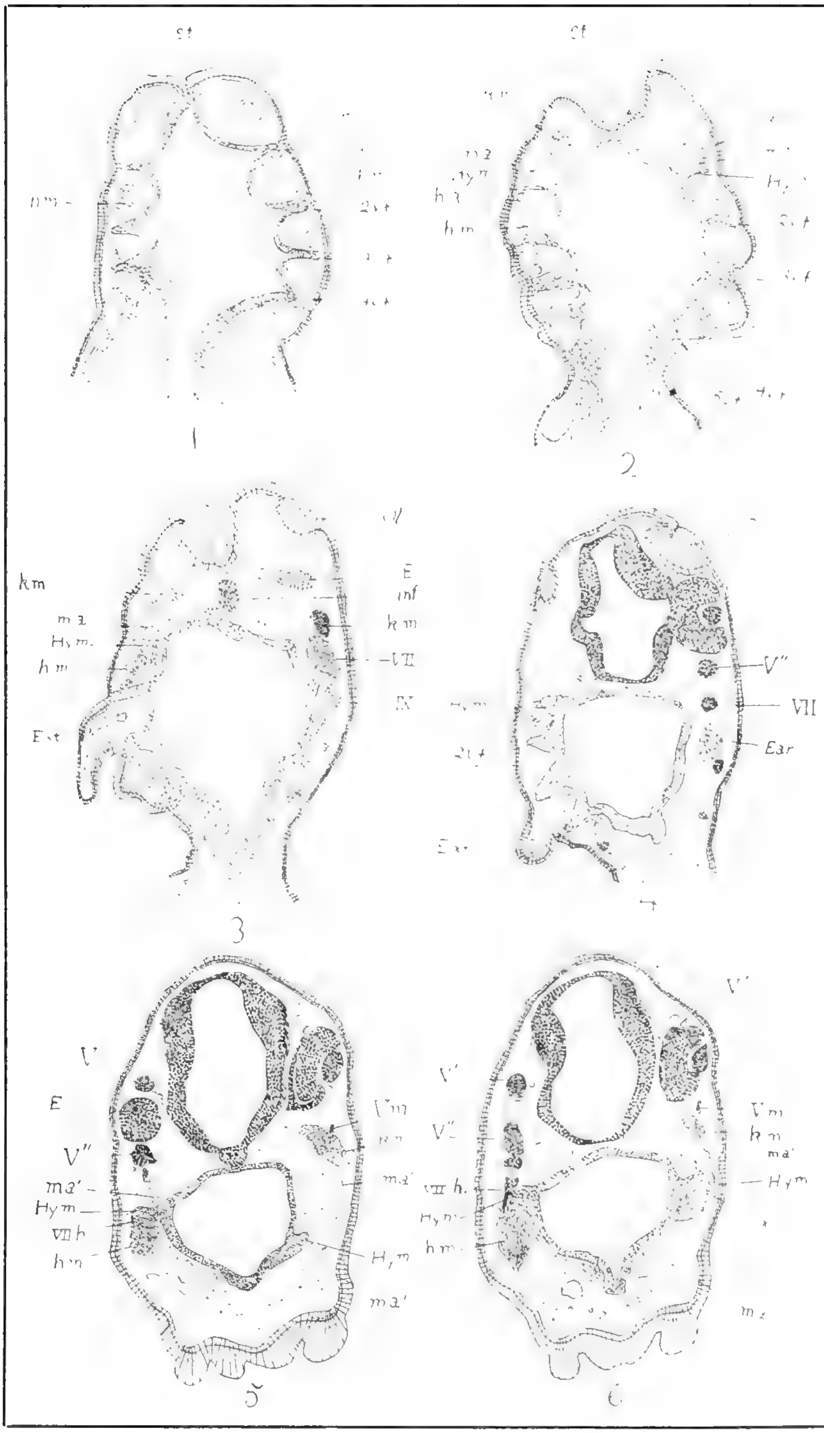
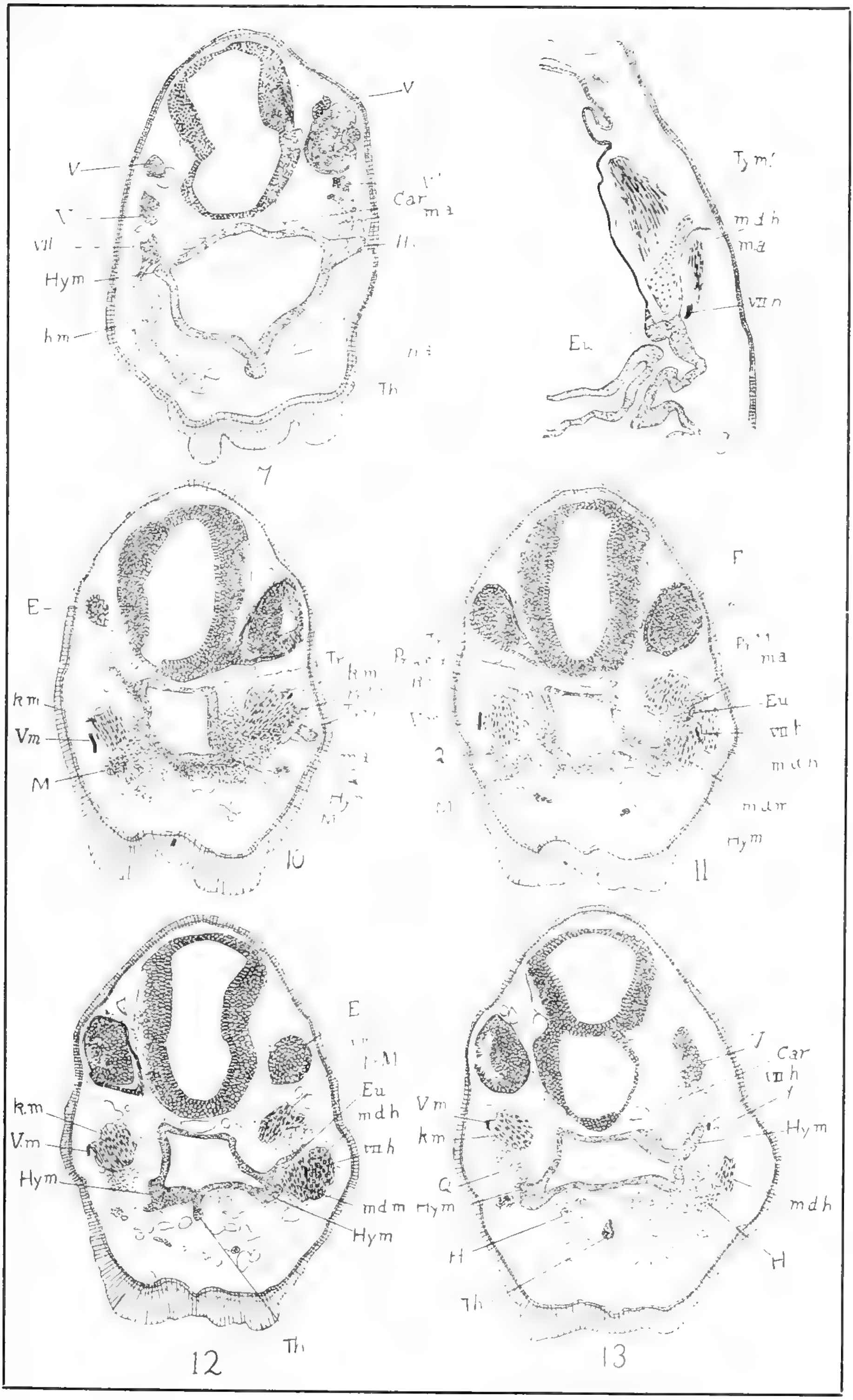


FOX. TYMPANO—EUSTACHIAN PASSAGE OF TOAD.



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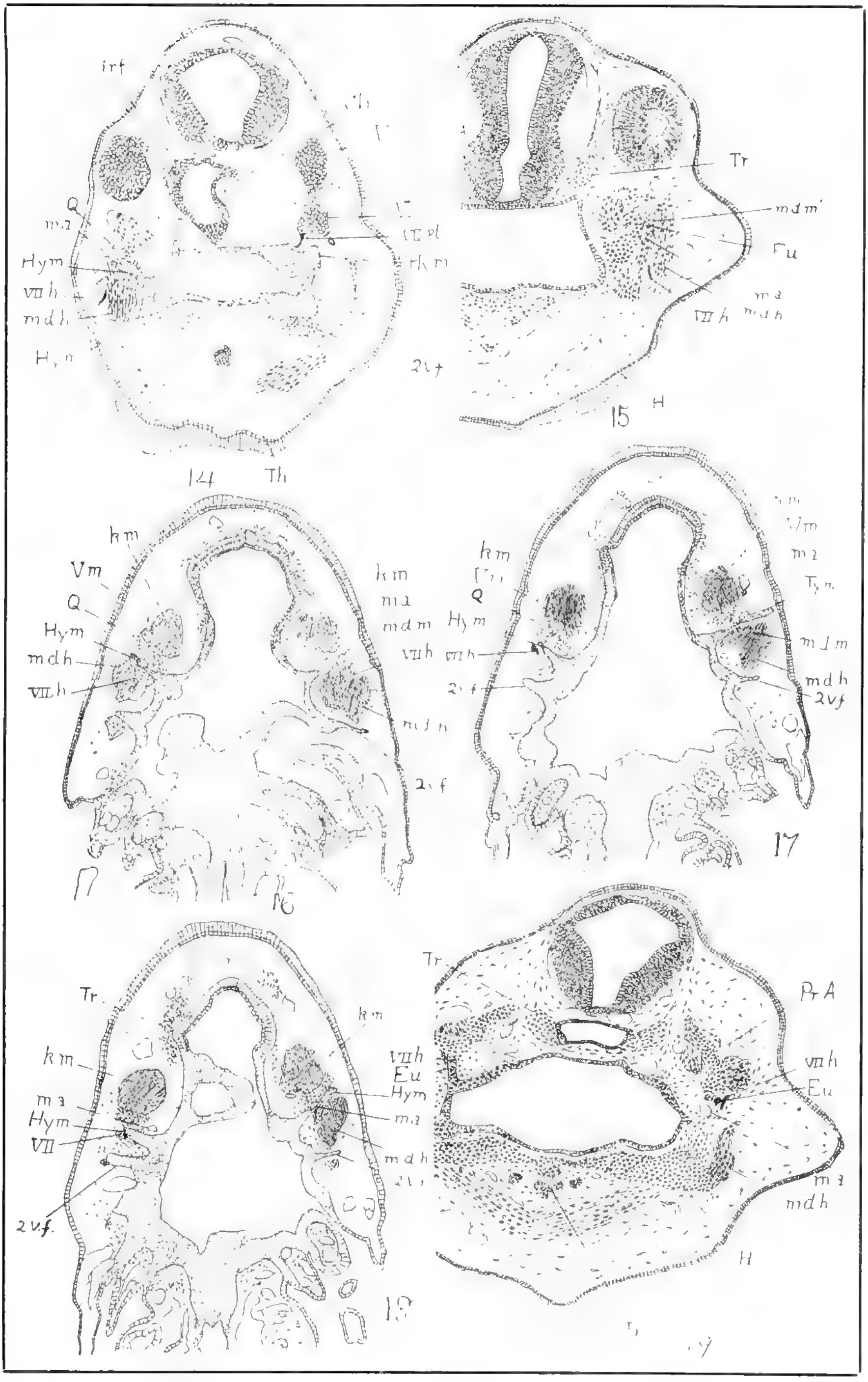

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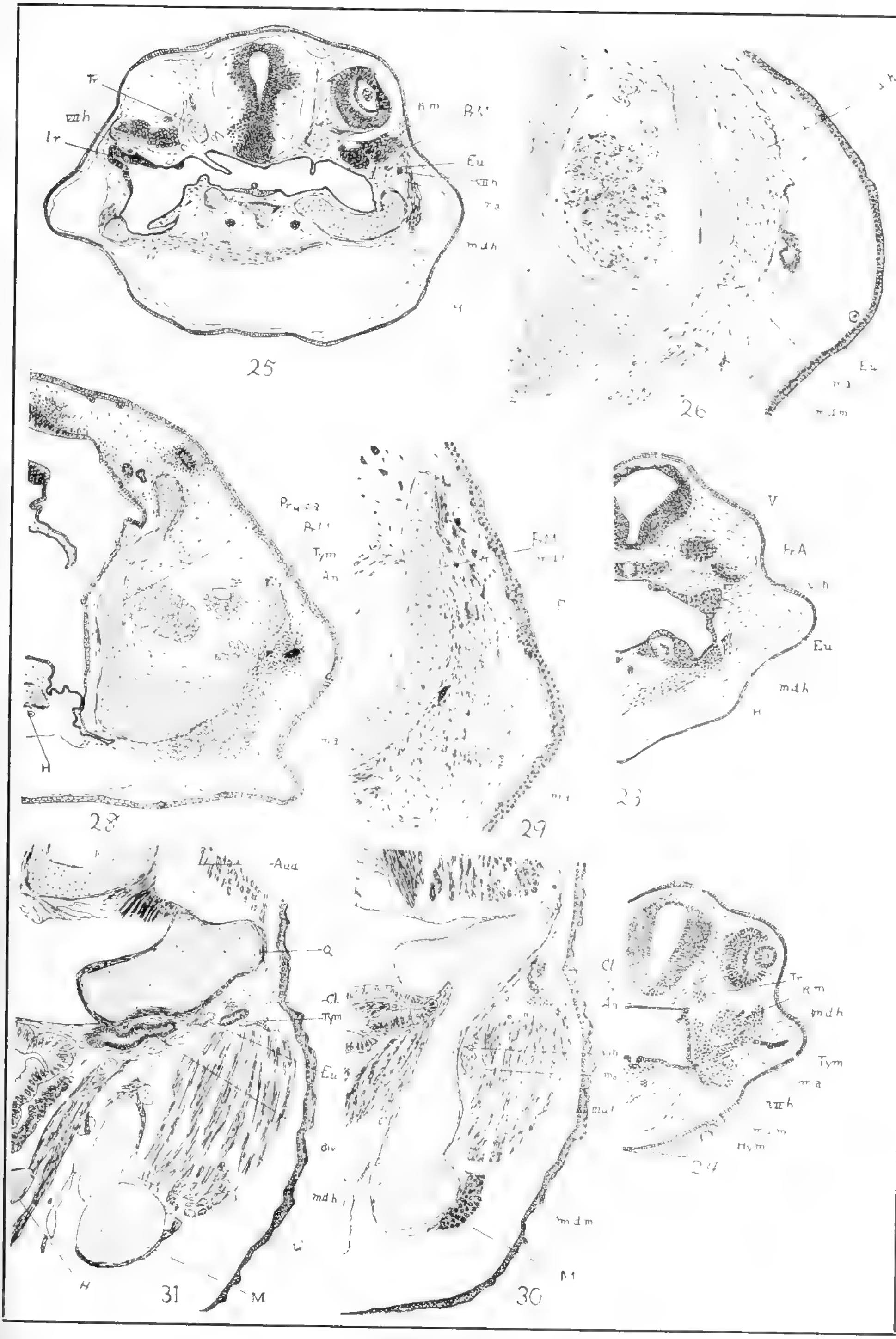

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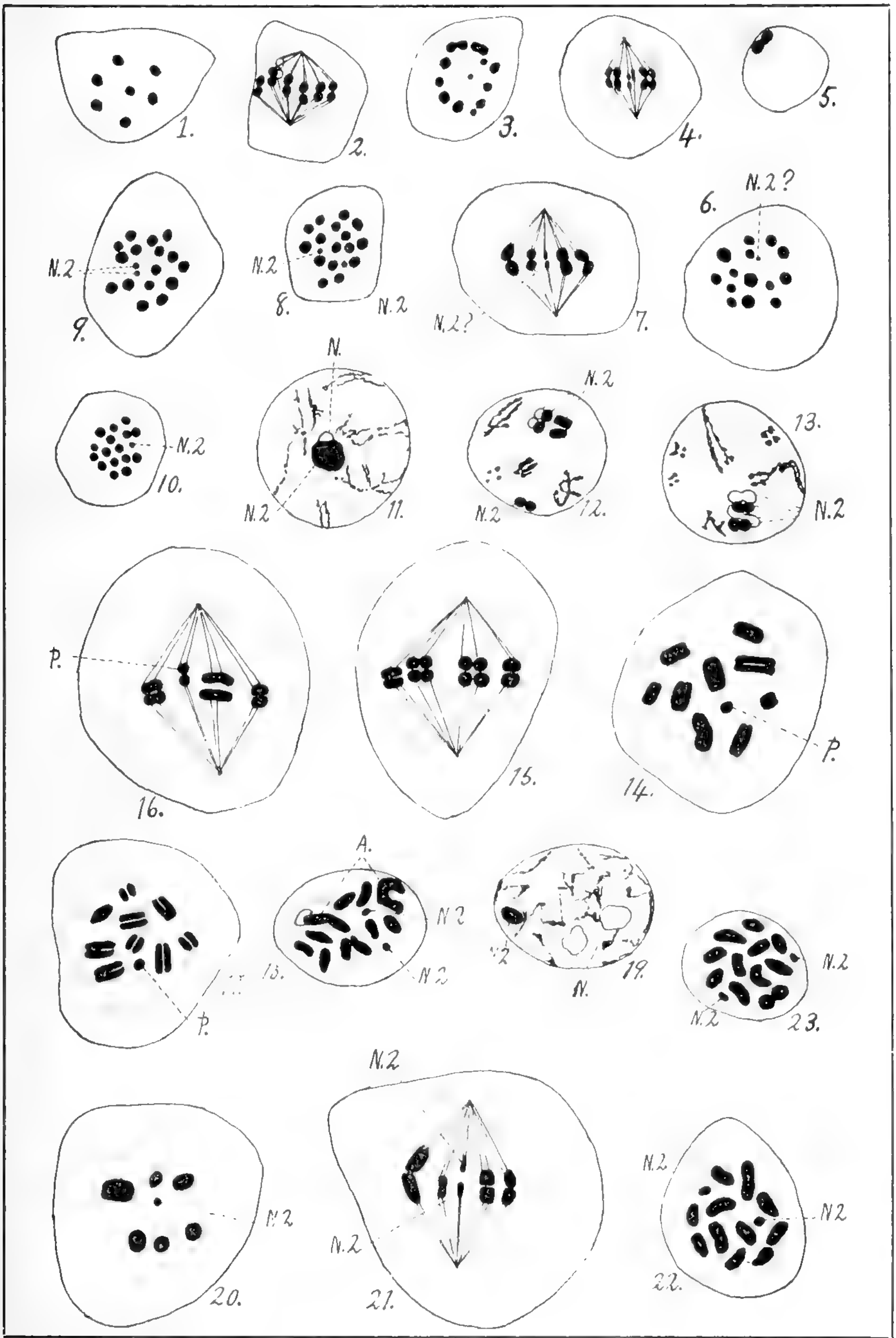
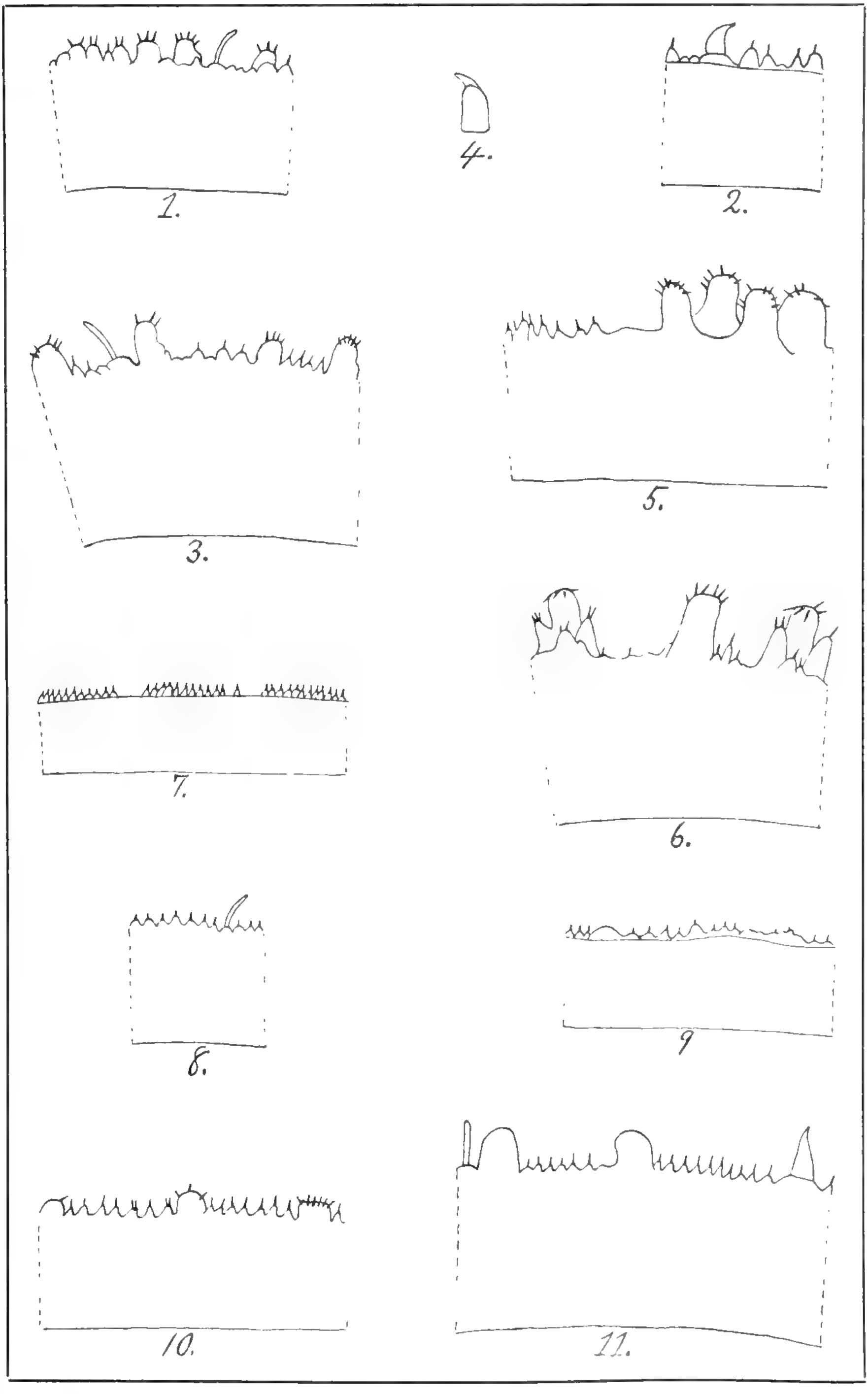


MONTGOMERY. CHROMOSOMES OF HEMIPTERA HETEROPTERA.



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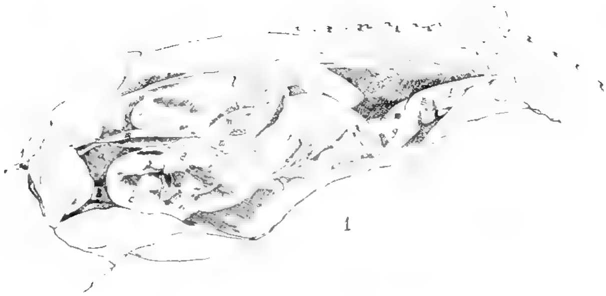

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FOWLER. TYPES OF FISHES.

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FOWLER. TYPES OF FISHES.

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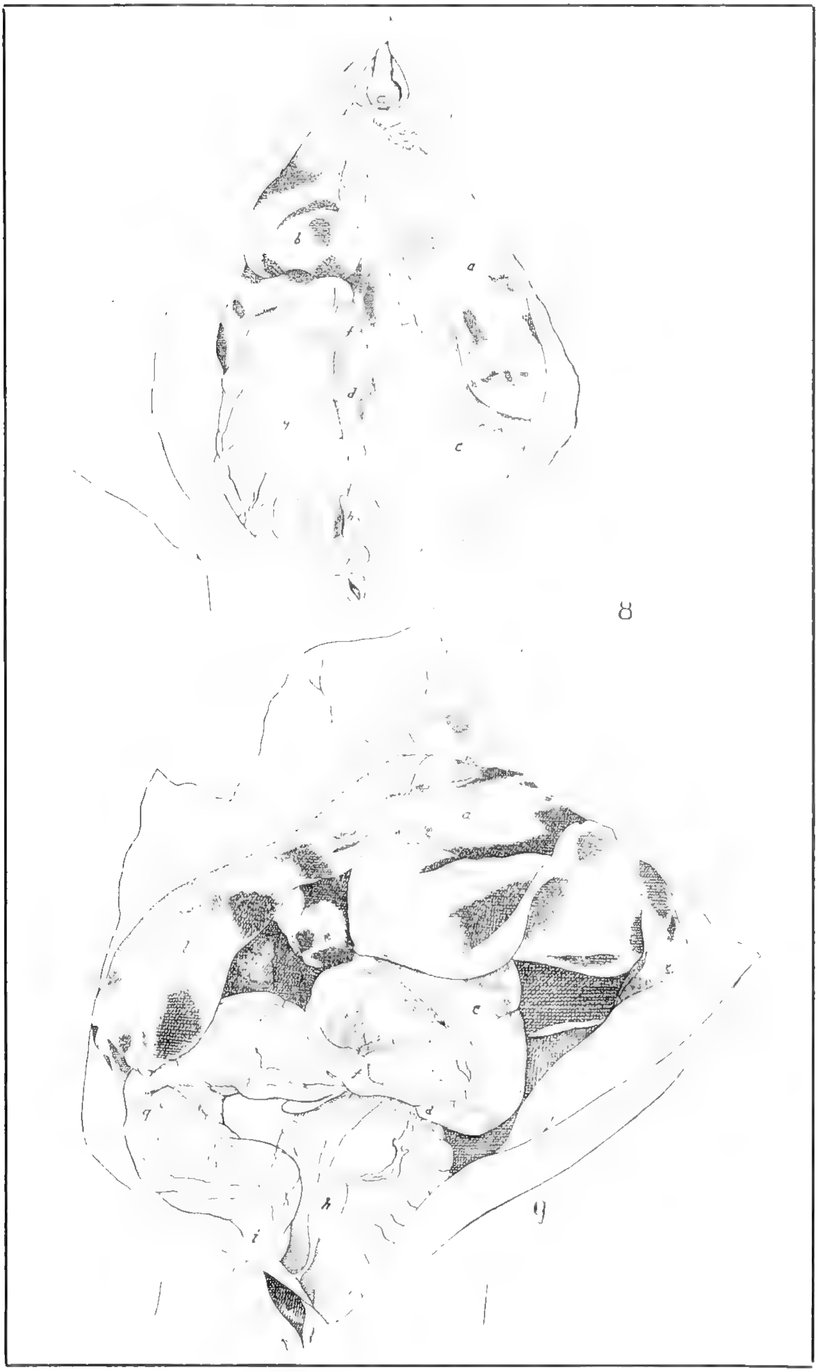

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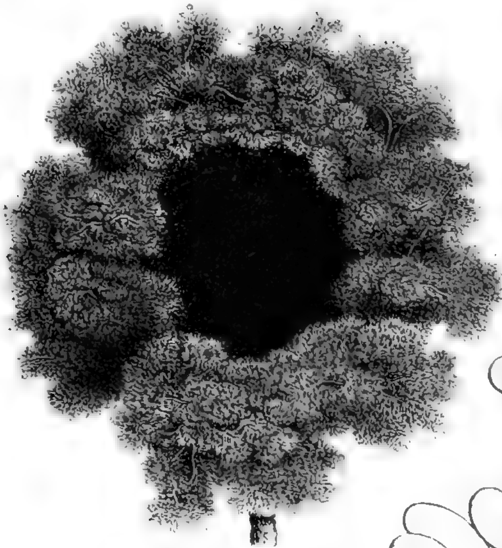
MEEHAN. BENDING OF MATURE WOOD IN TREES.

QUERCUS PALUSTRIS Q. COCCINEA.

MEEHAN. BENDING OF MATURE WOOD IN TREES.



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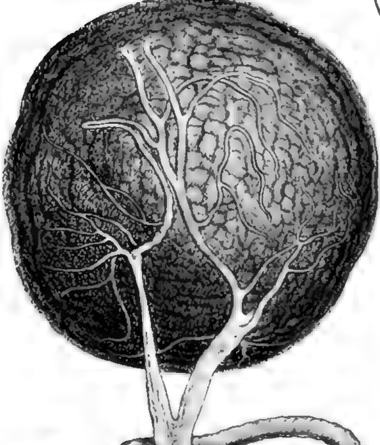
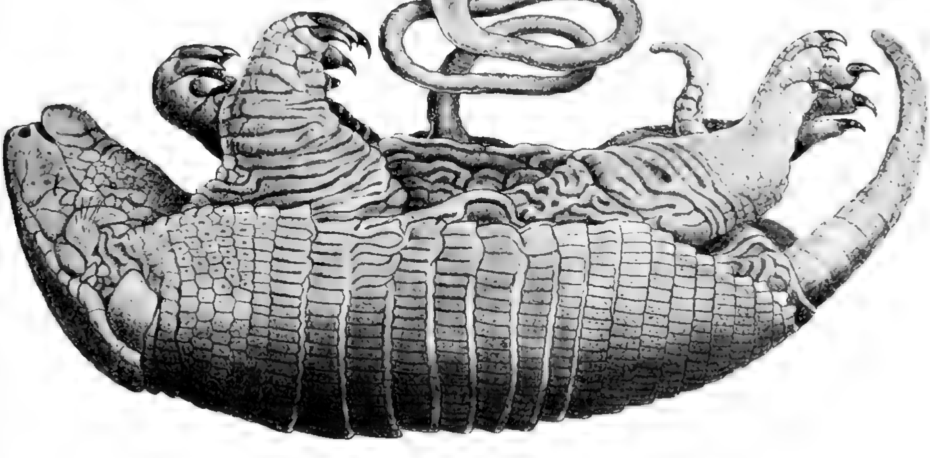

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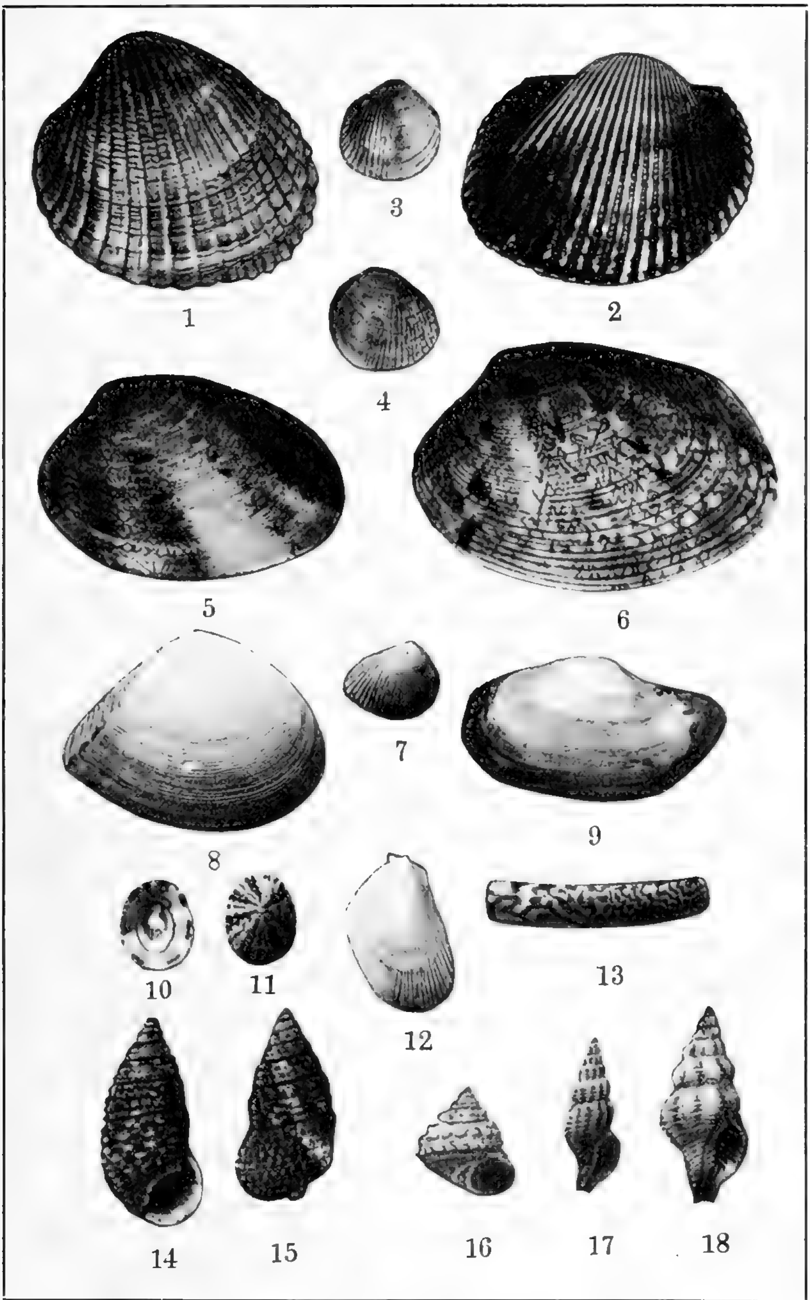
CHAPMAN ON DASYPUS SEXCINCTUS.



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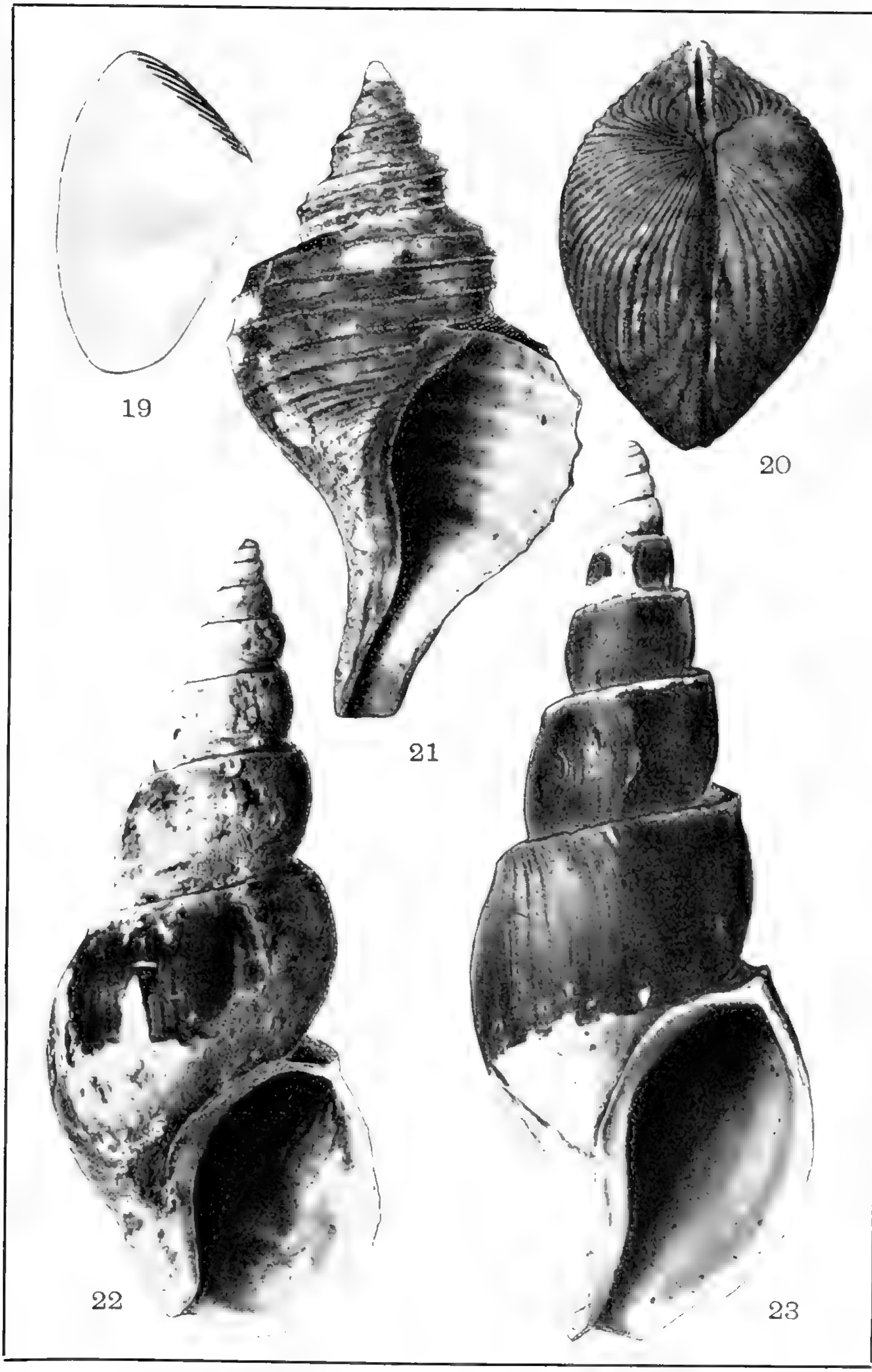

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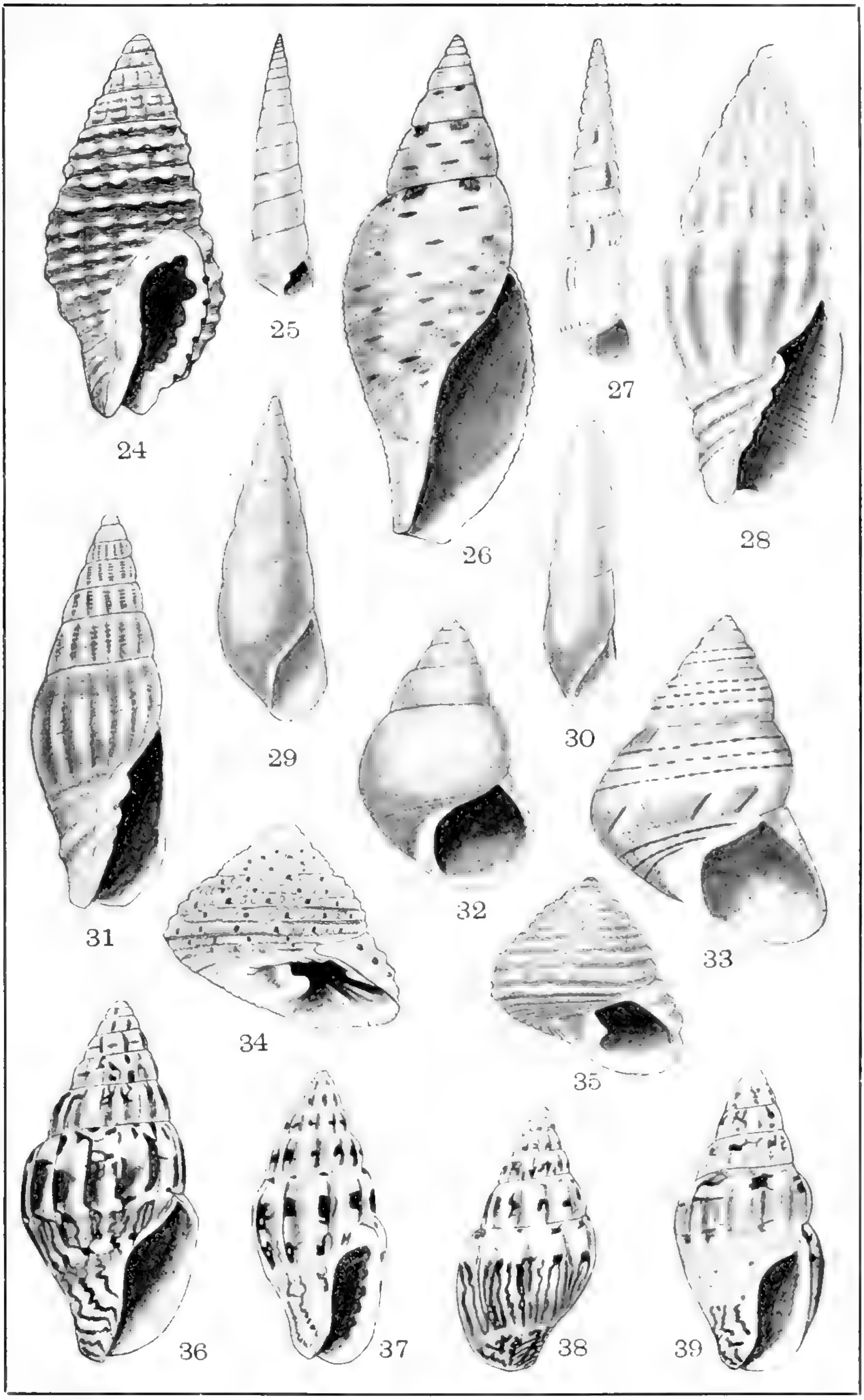

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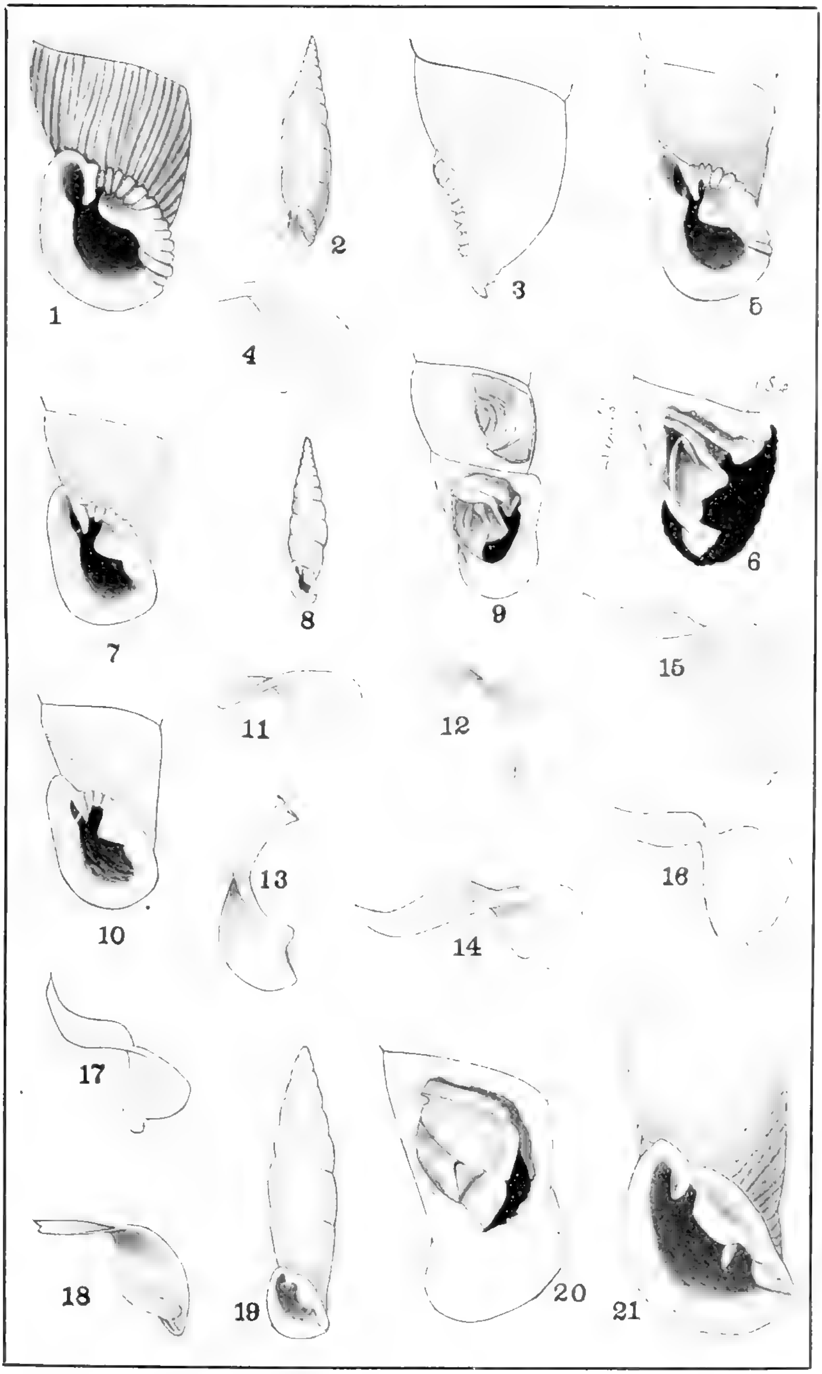

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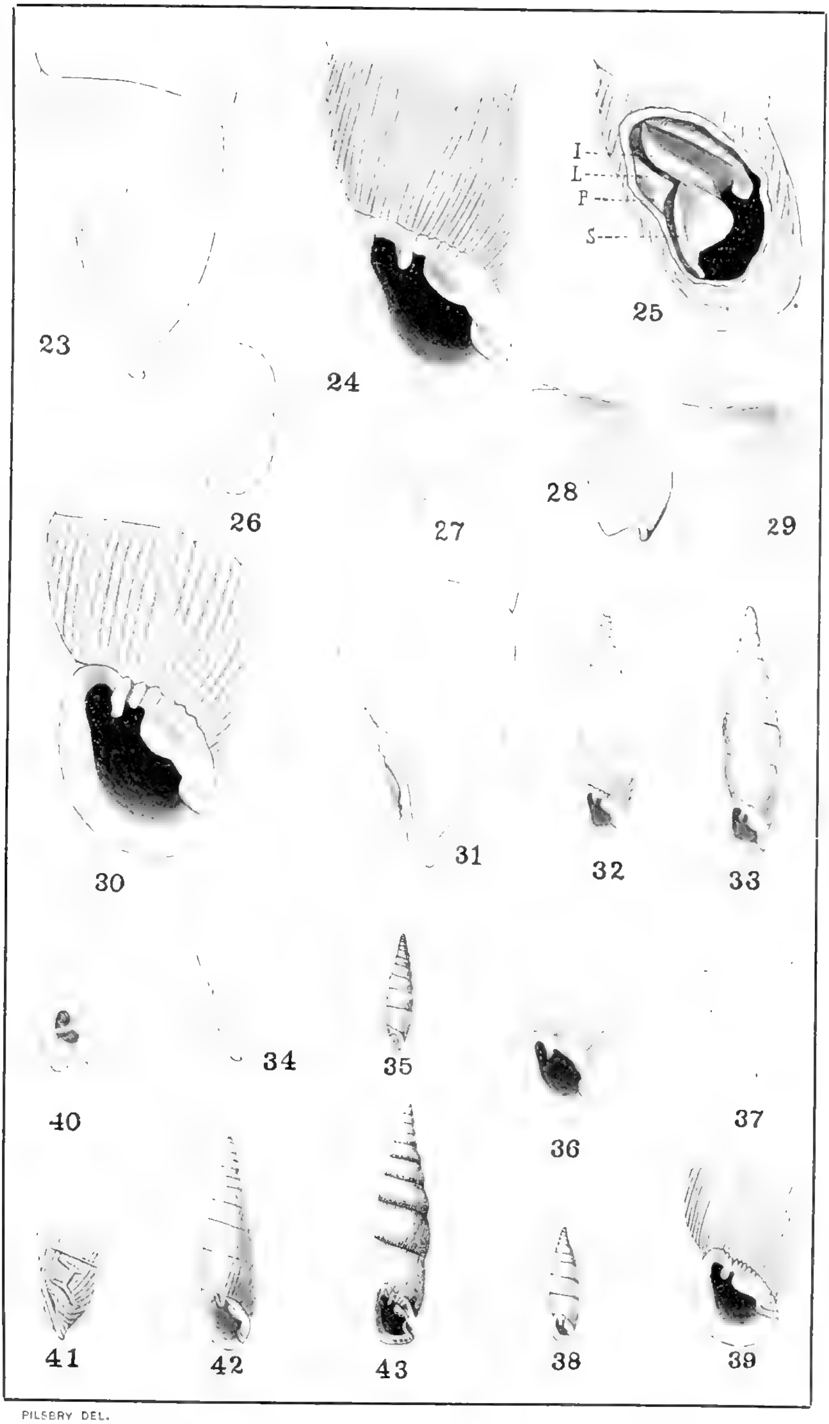
PILSBRY. CLAUSILIIDÆ OF LOO CHOO ISLANDS.



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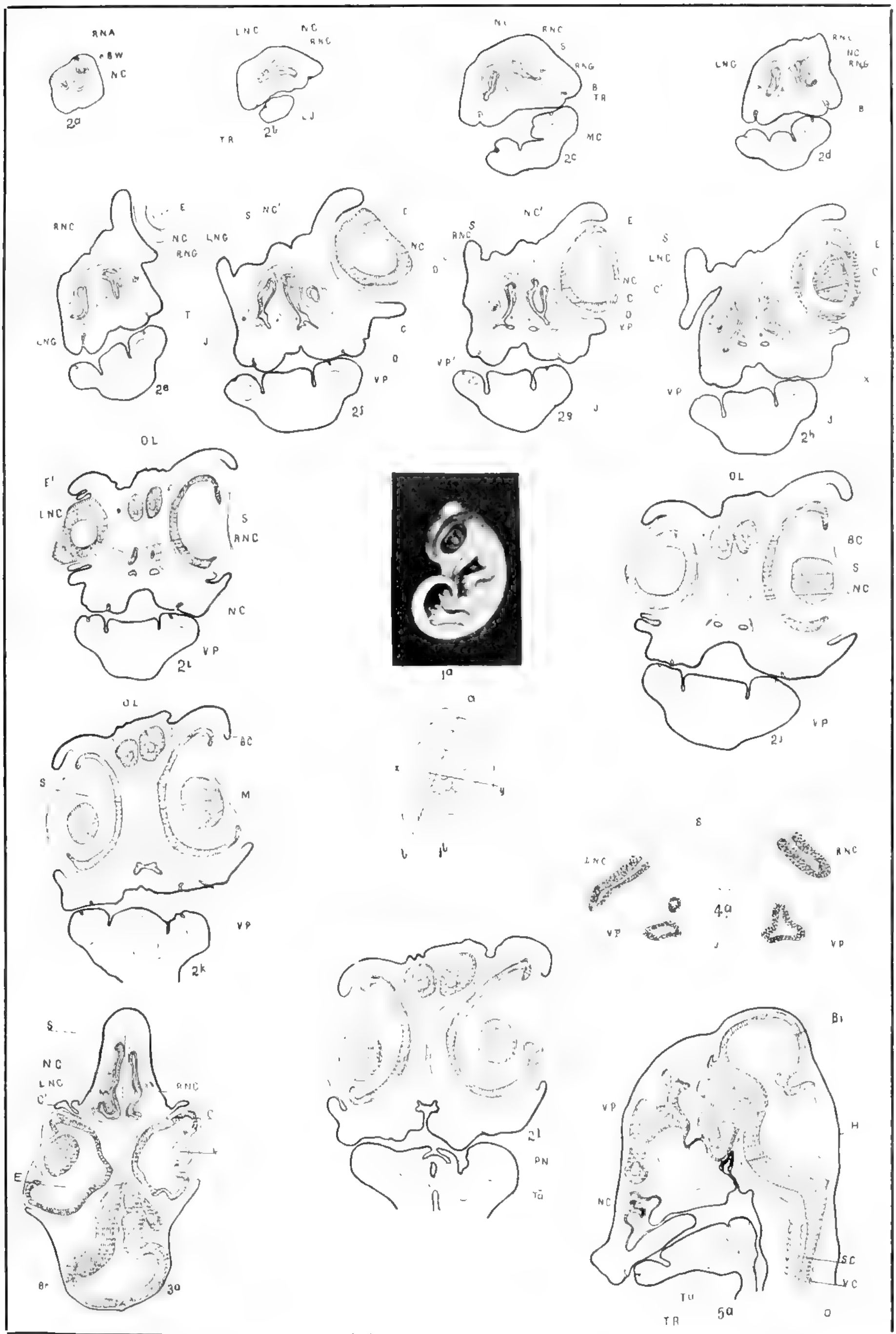

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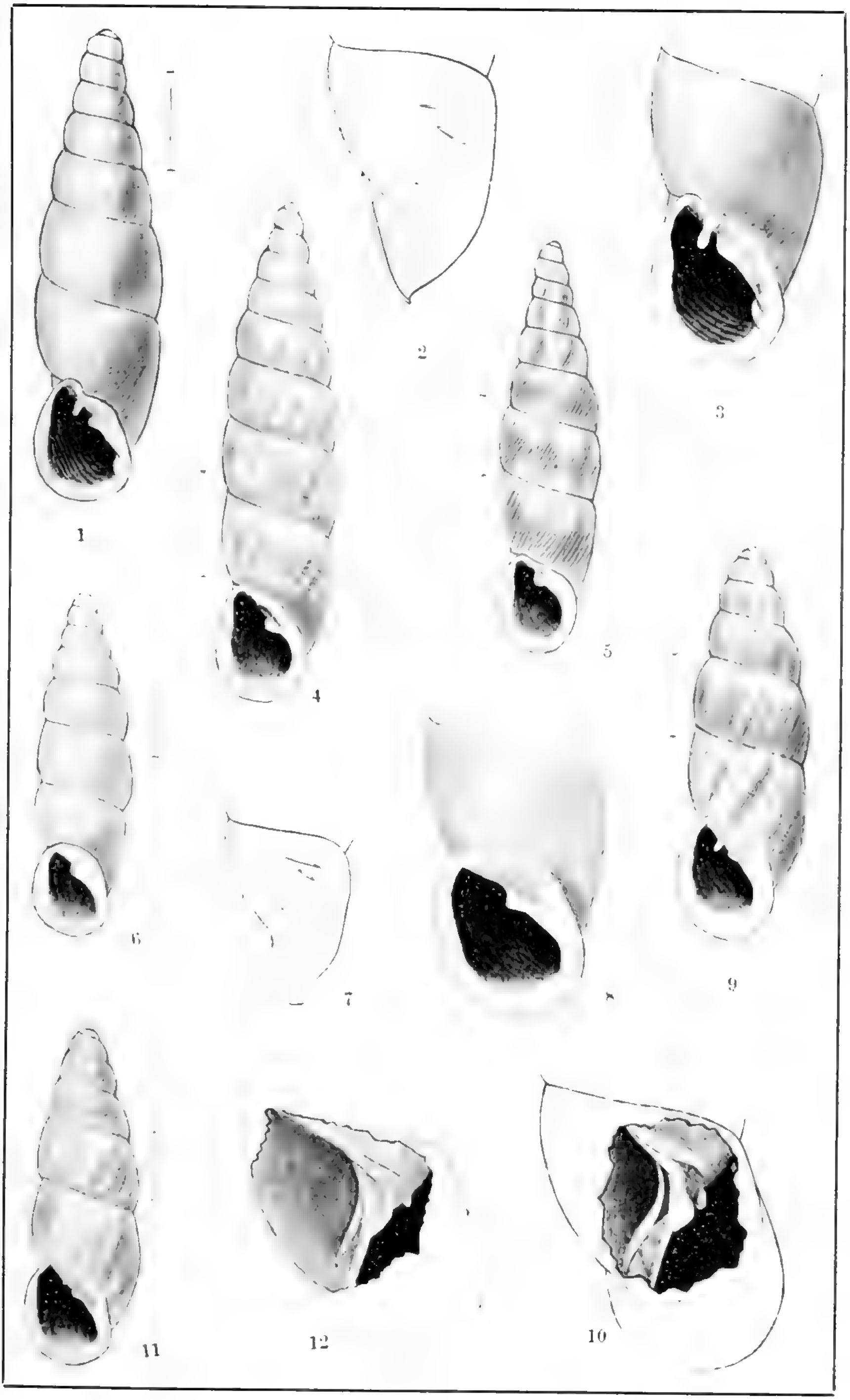

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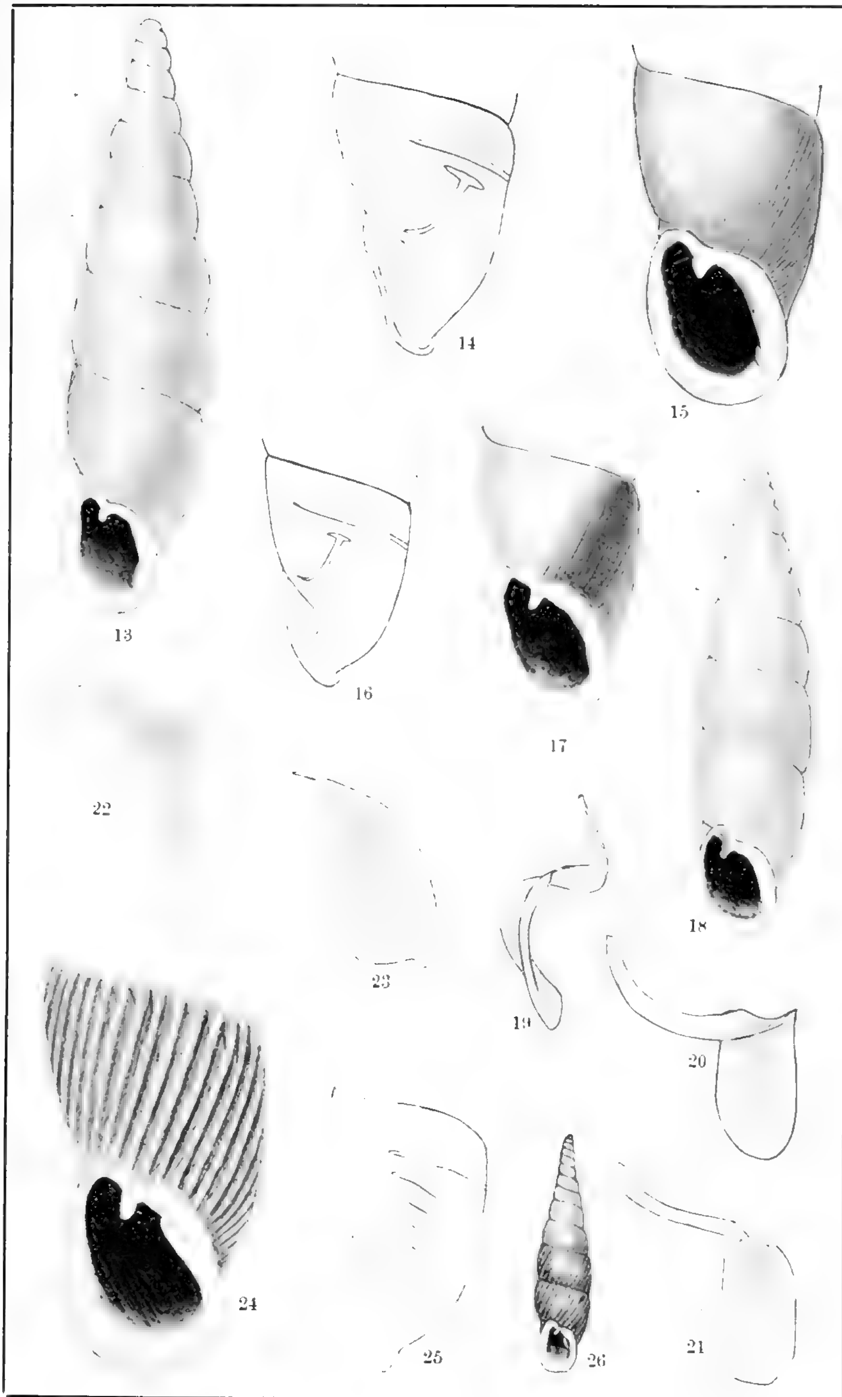

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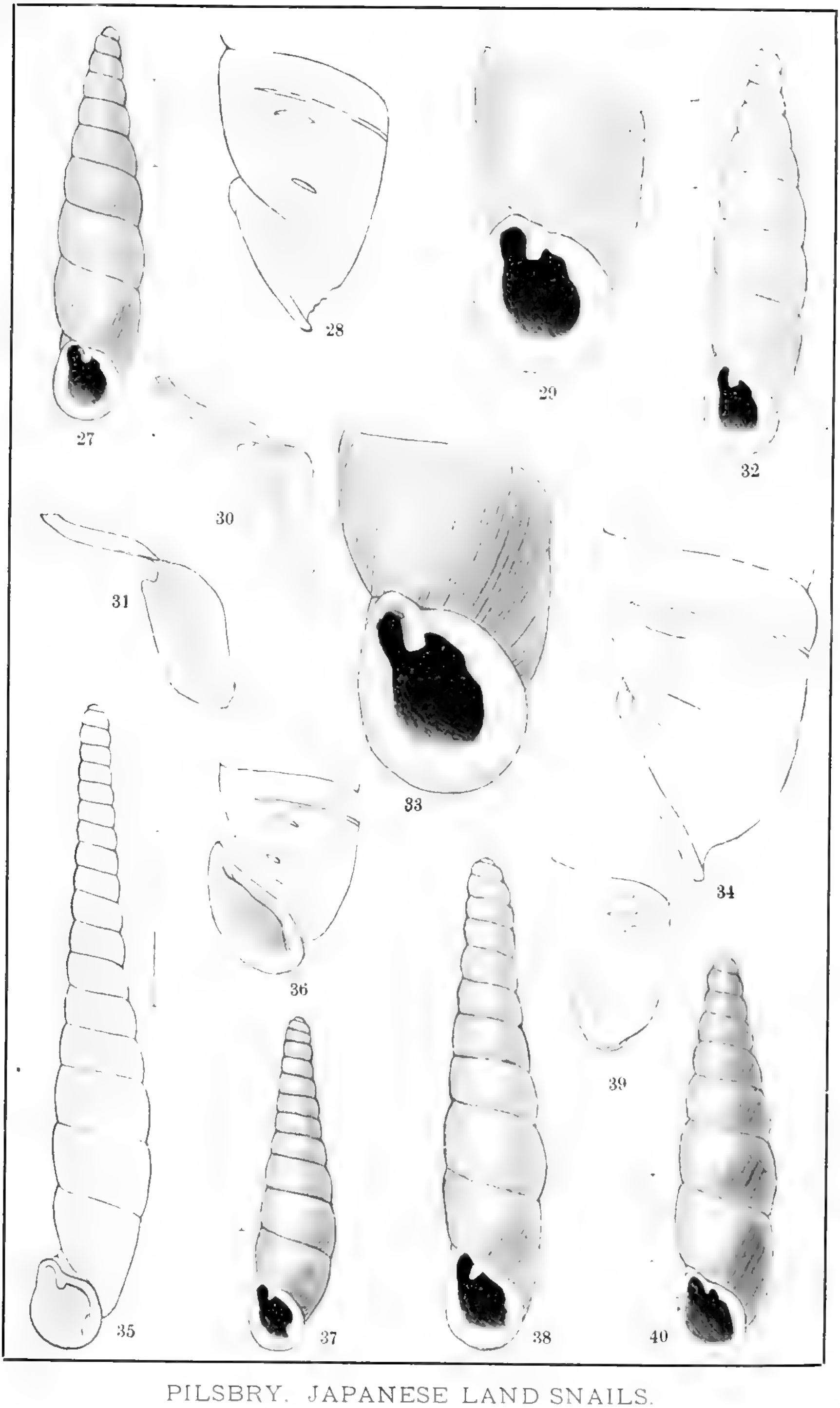

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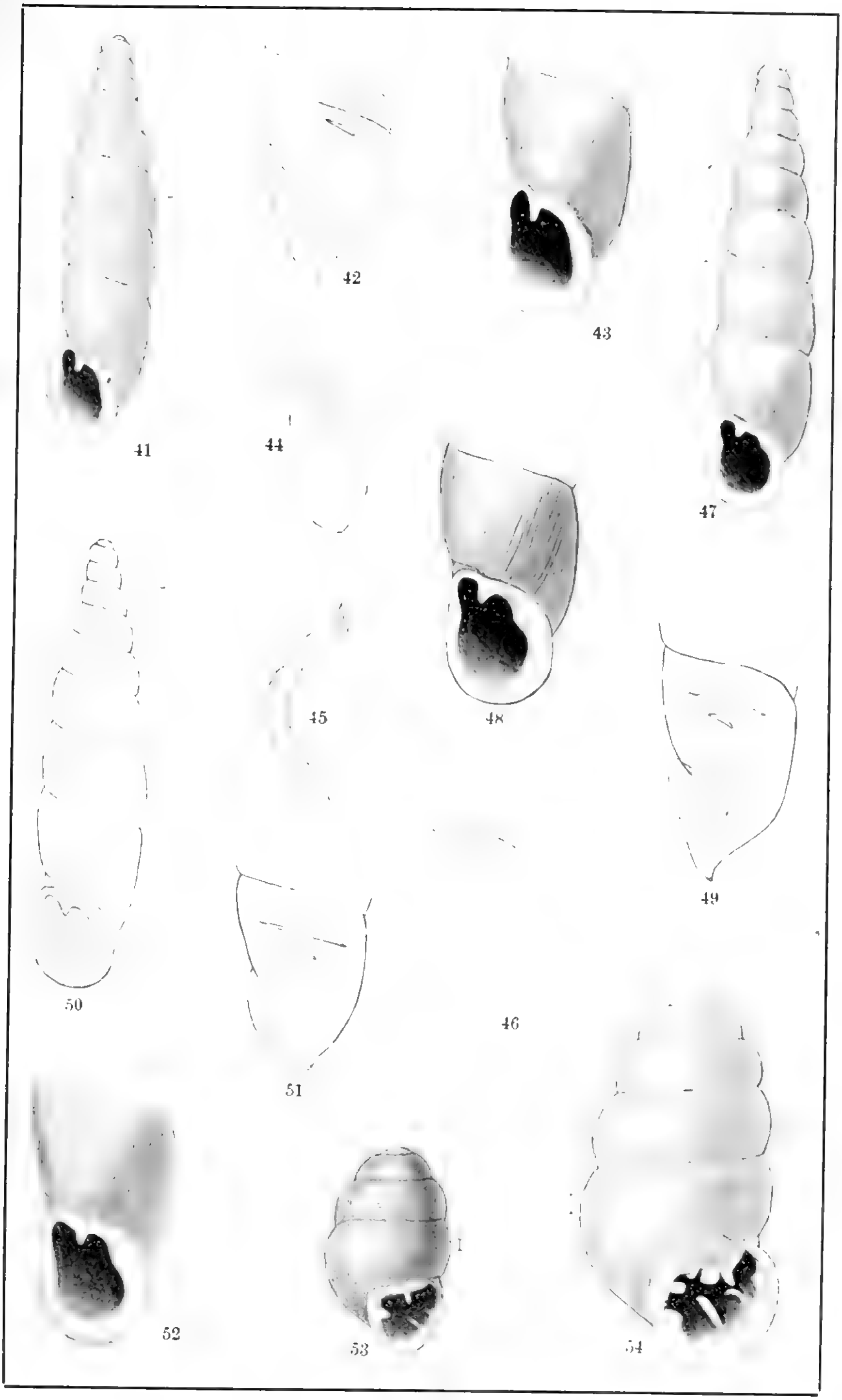

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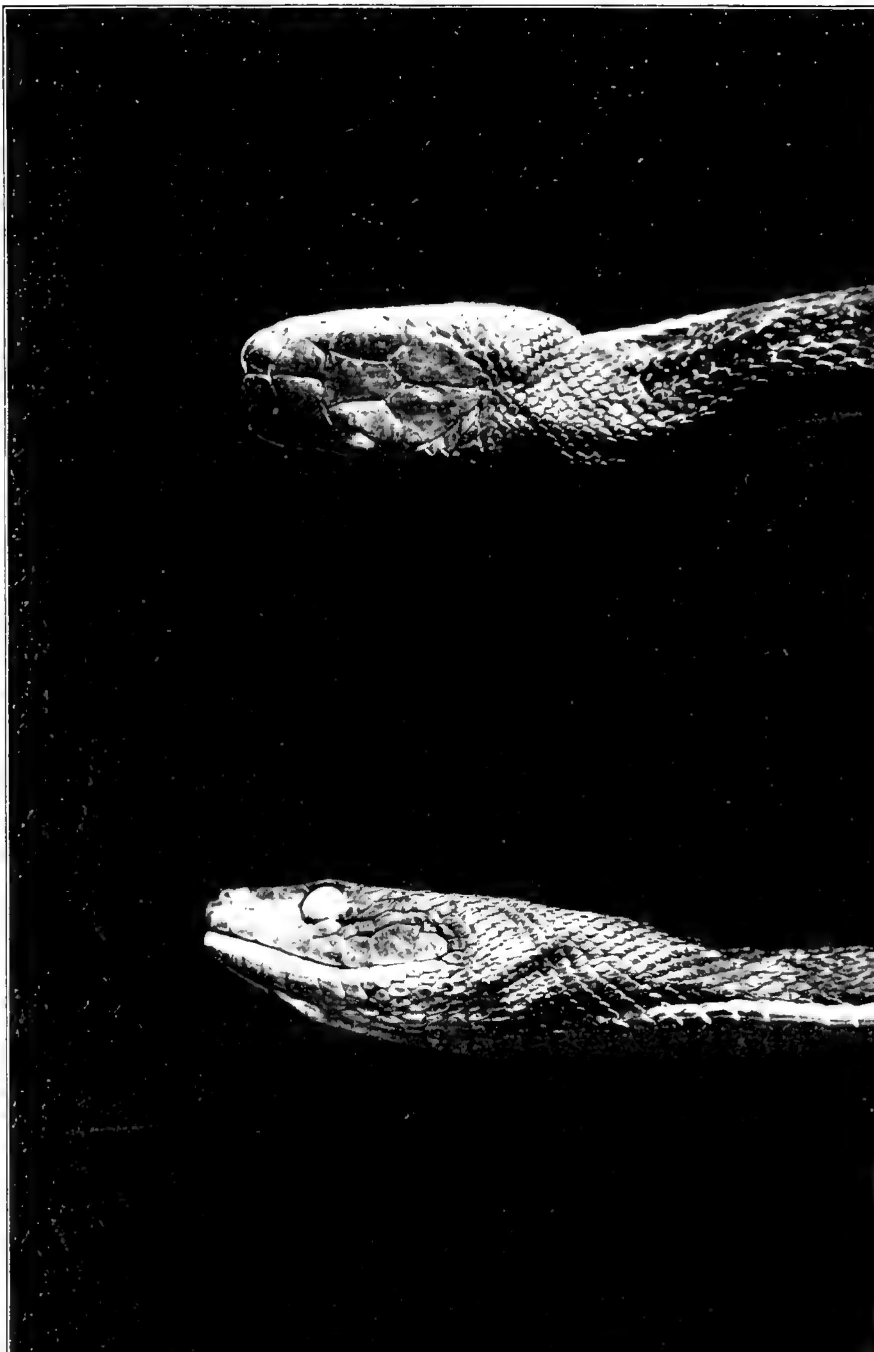

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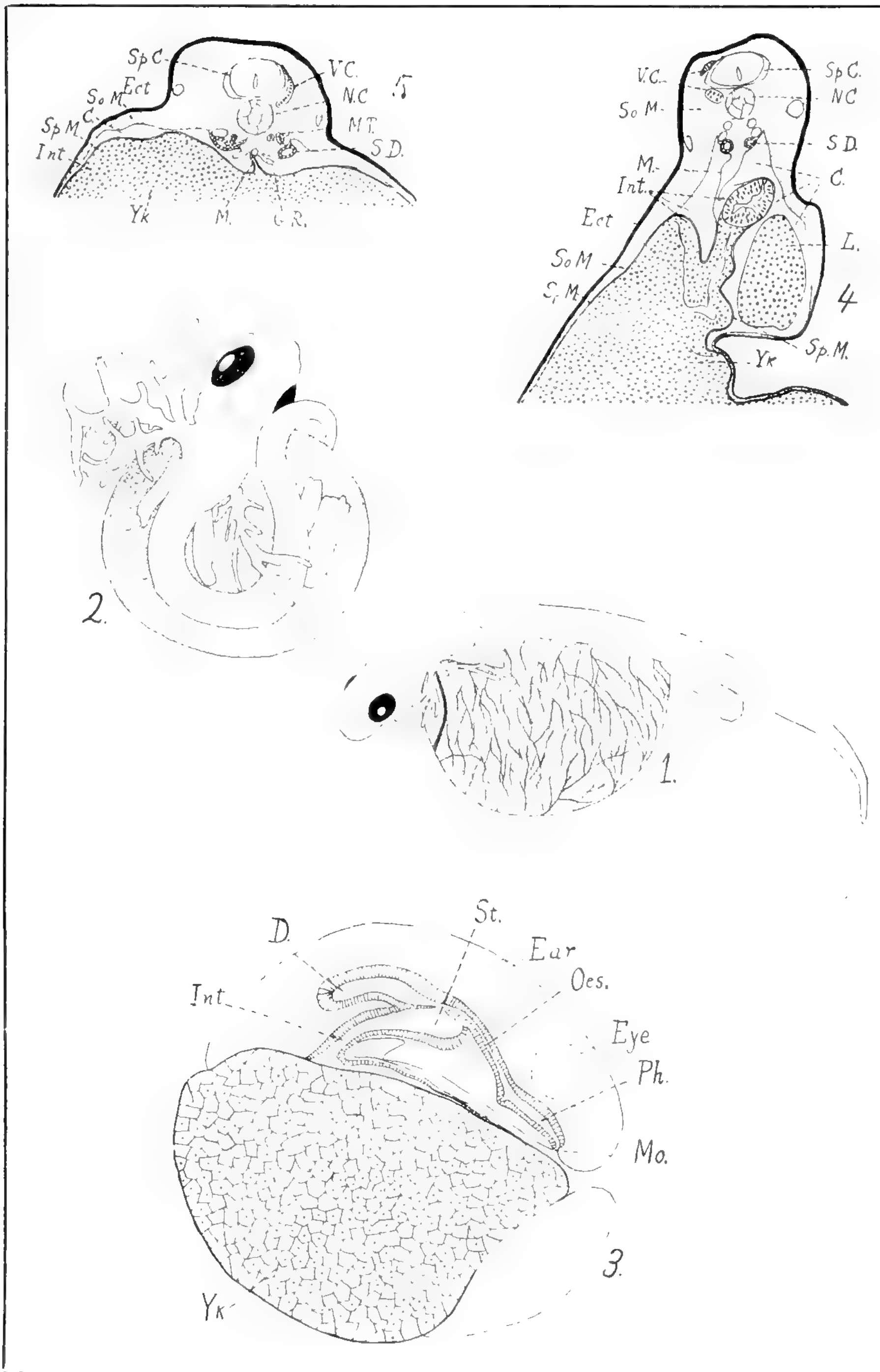
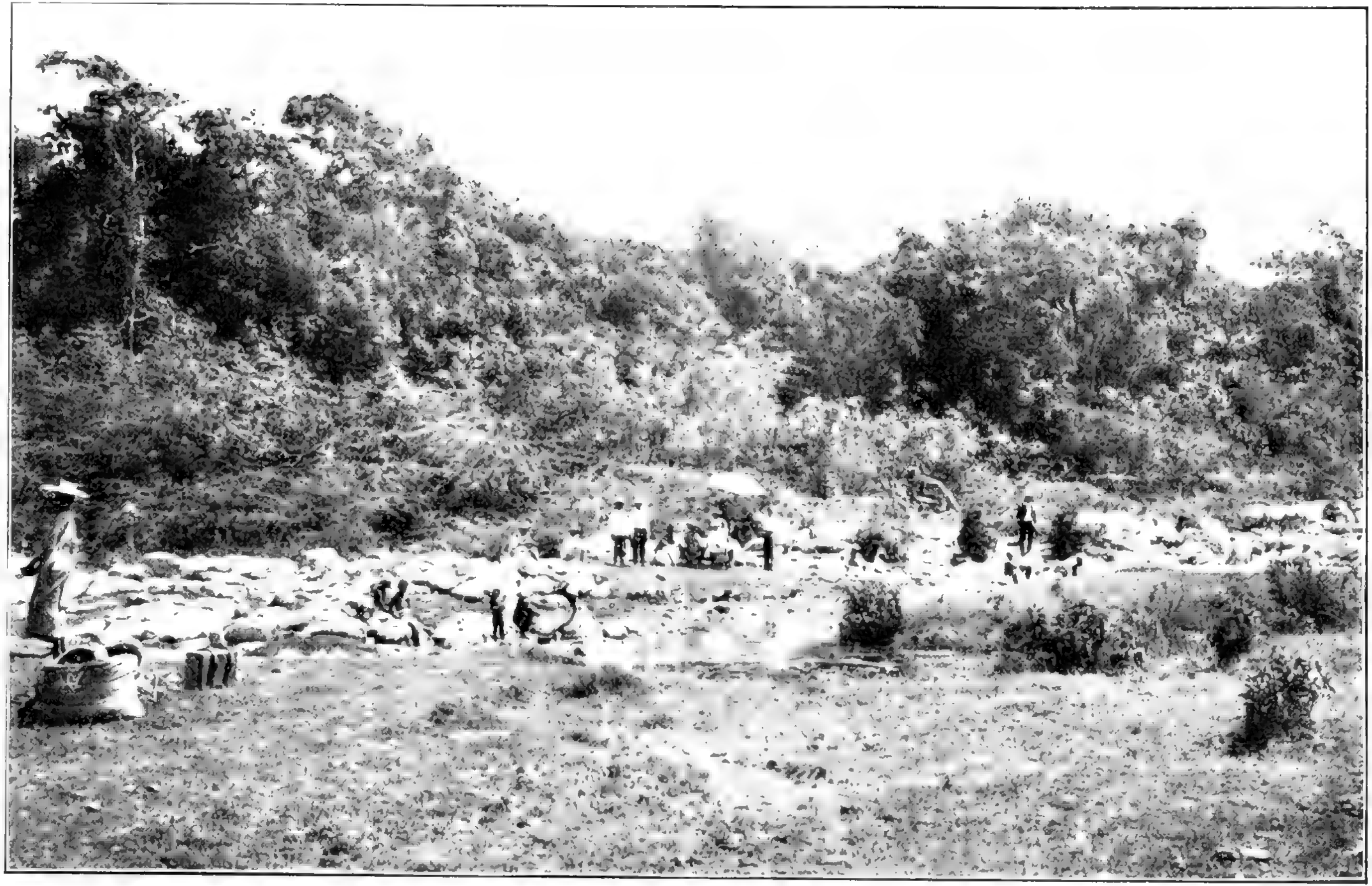


MONTGOMERY. LARVA OF PLETHODON CINEREUS.

HARSHBERGER. ECOLOGY OF SAN DOMINGO.



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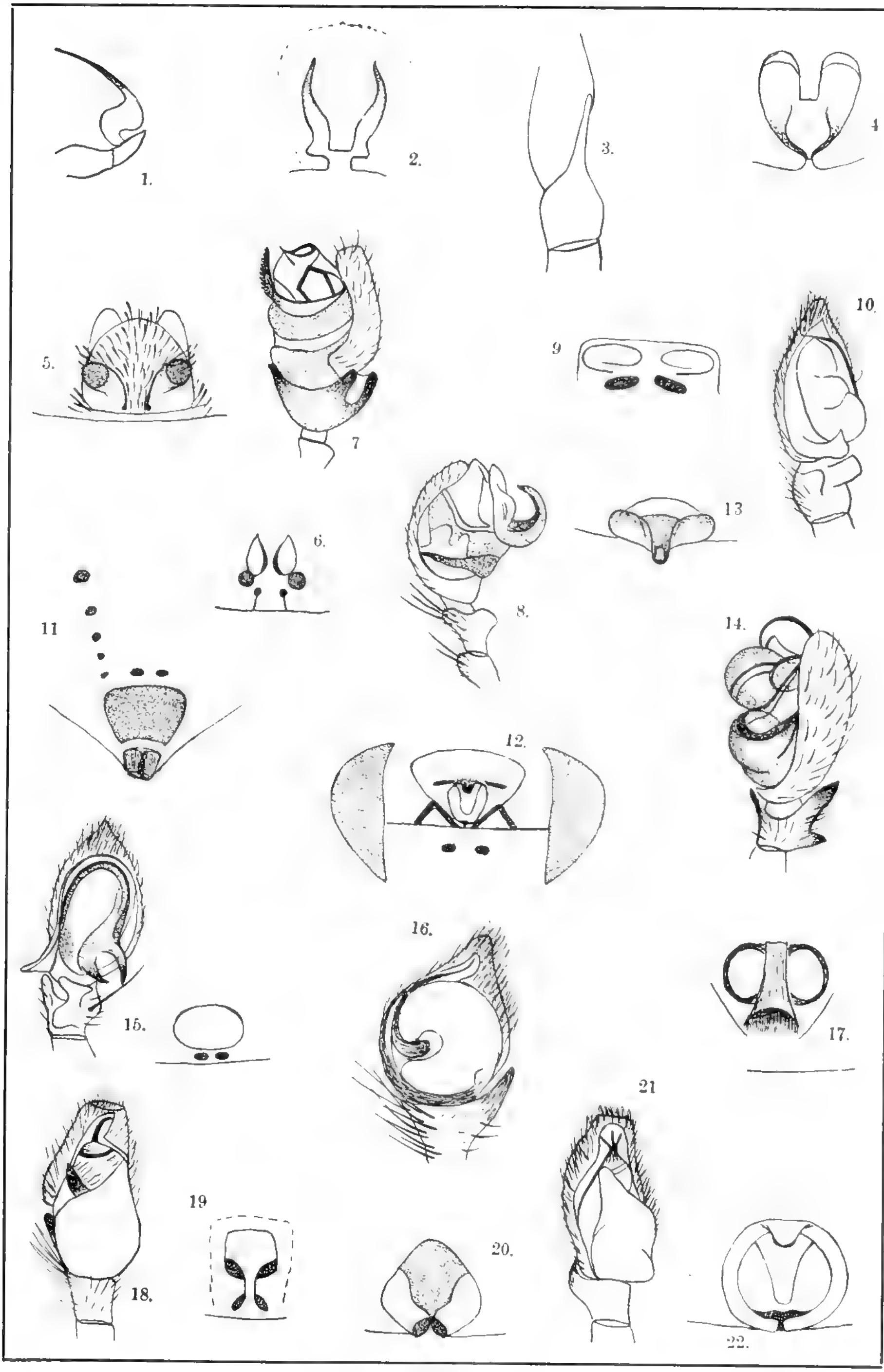

BANKS. SPIDERS OF NEW MEXICO.

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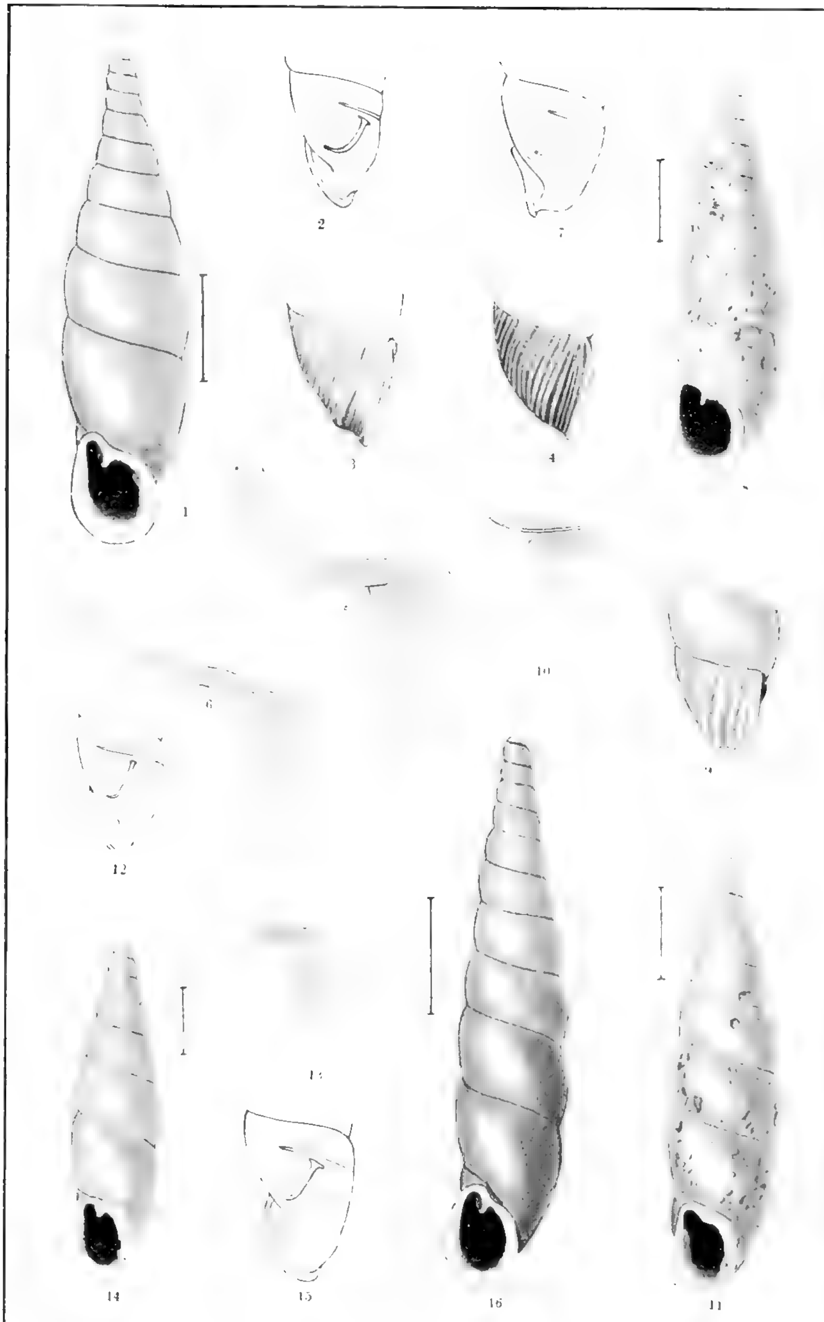

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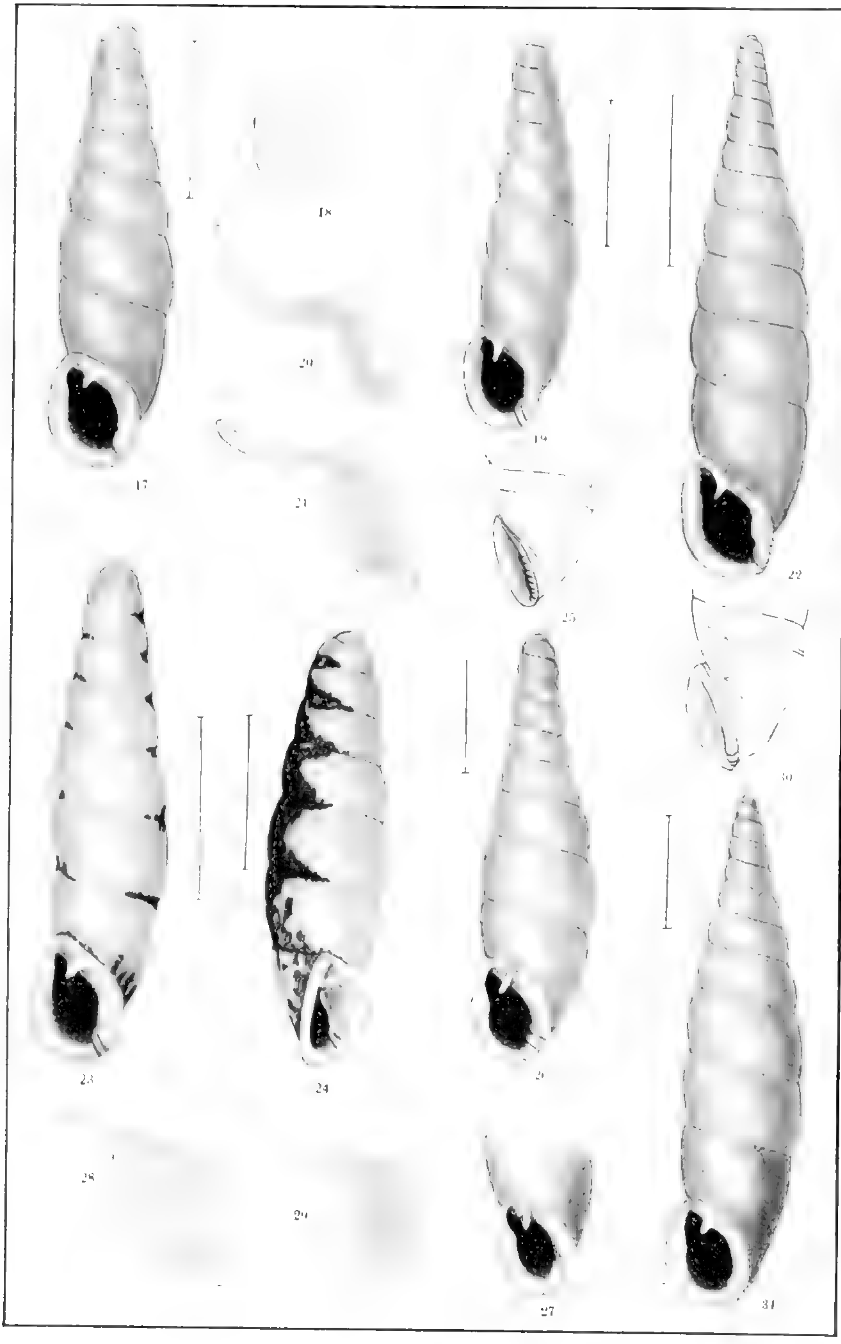

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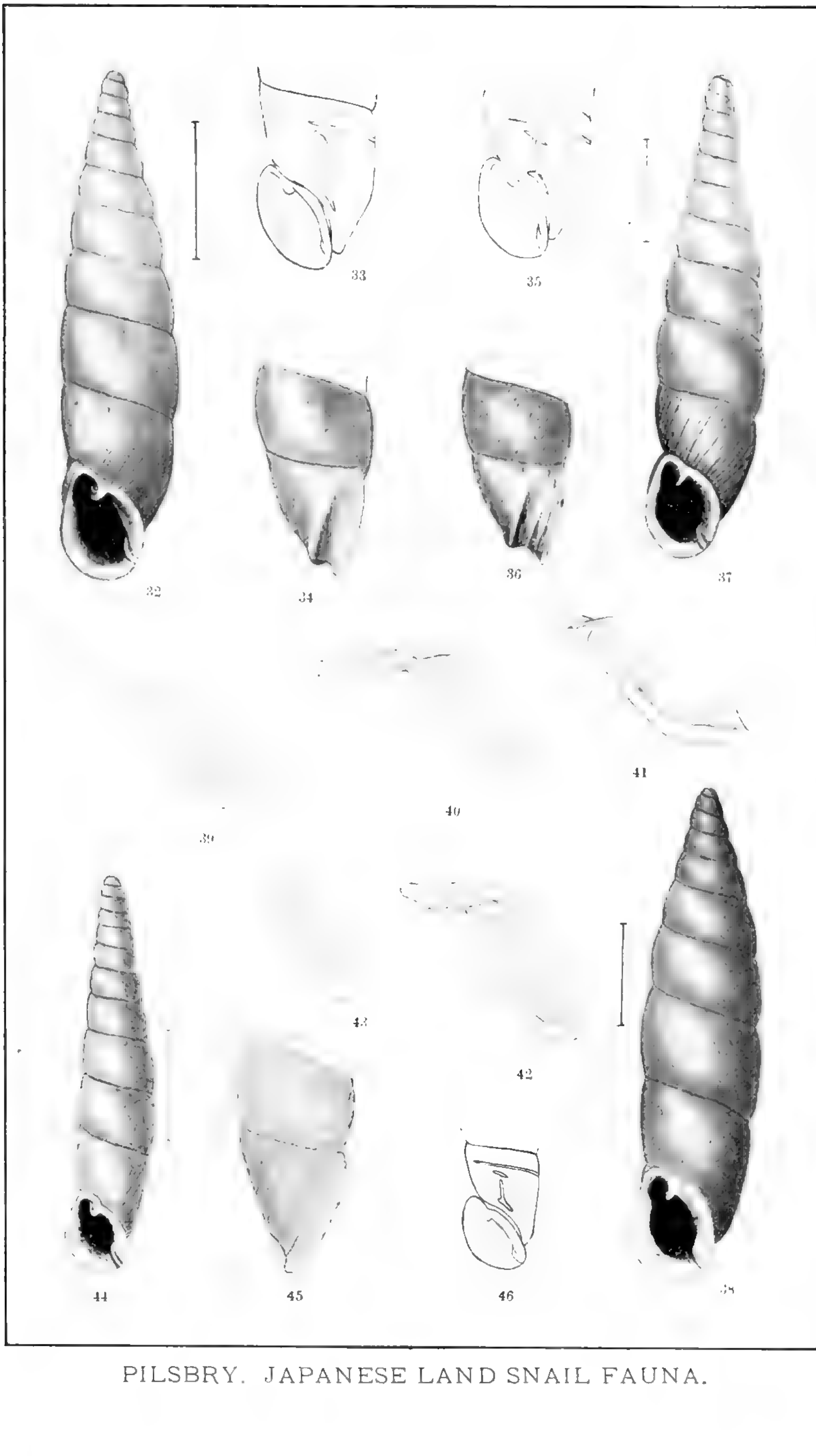

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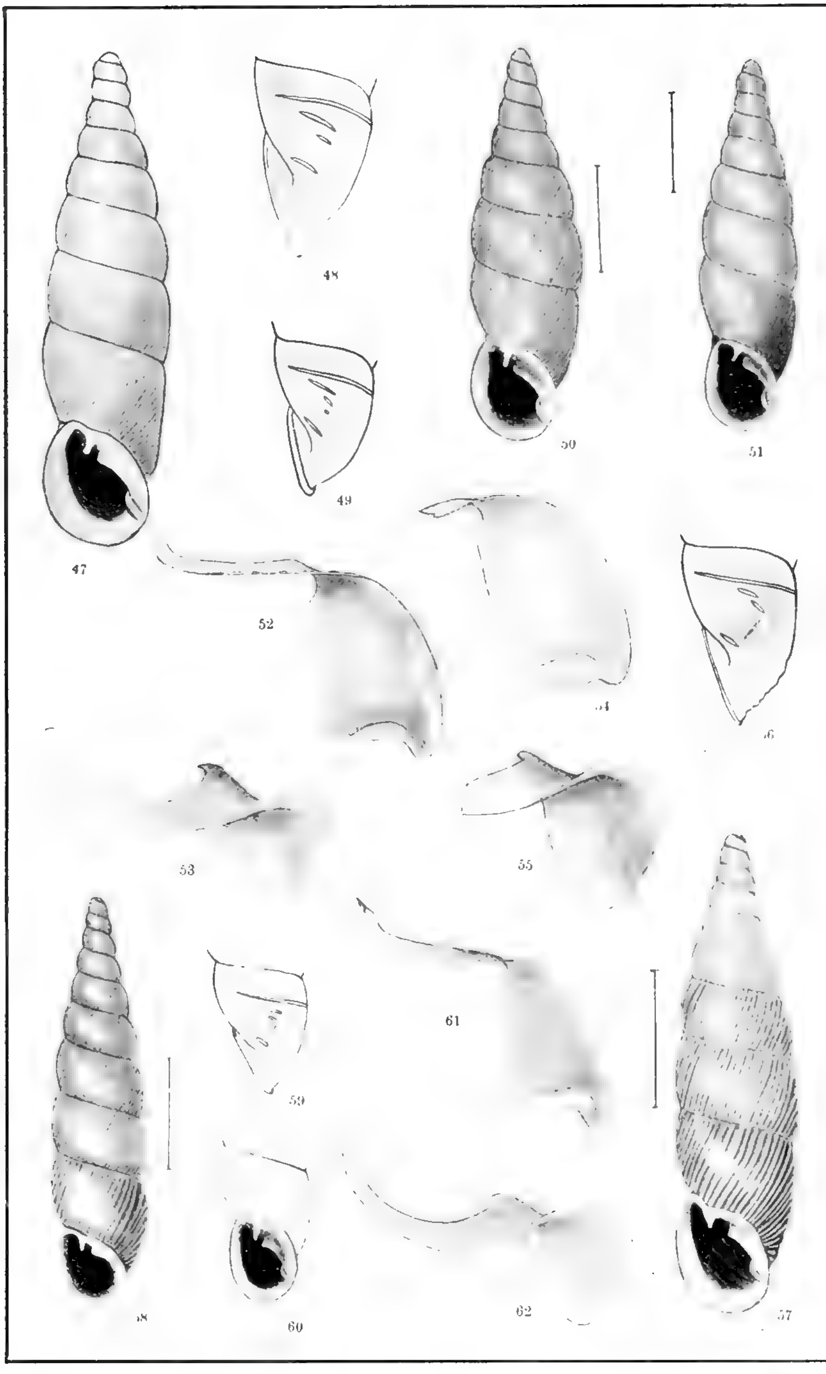

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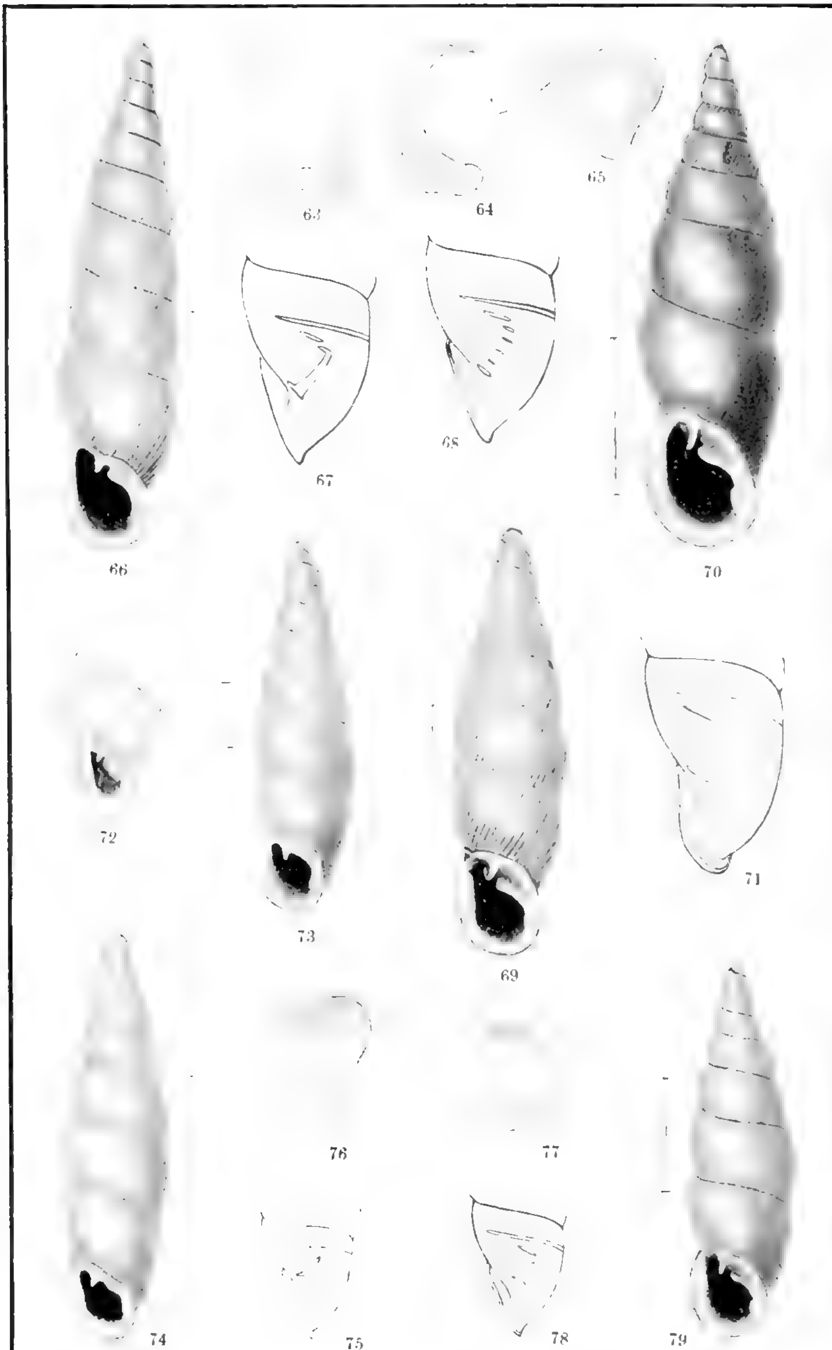

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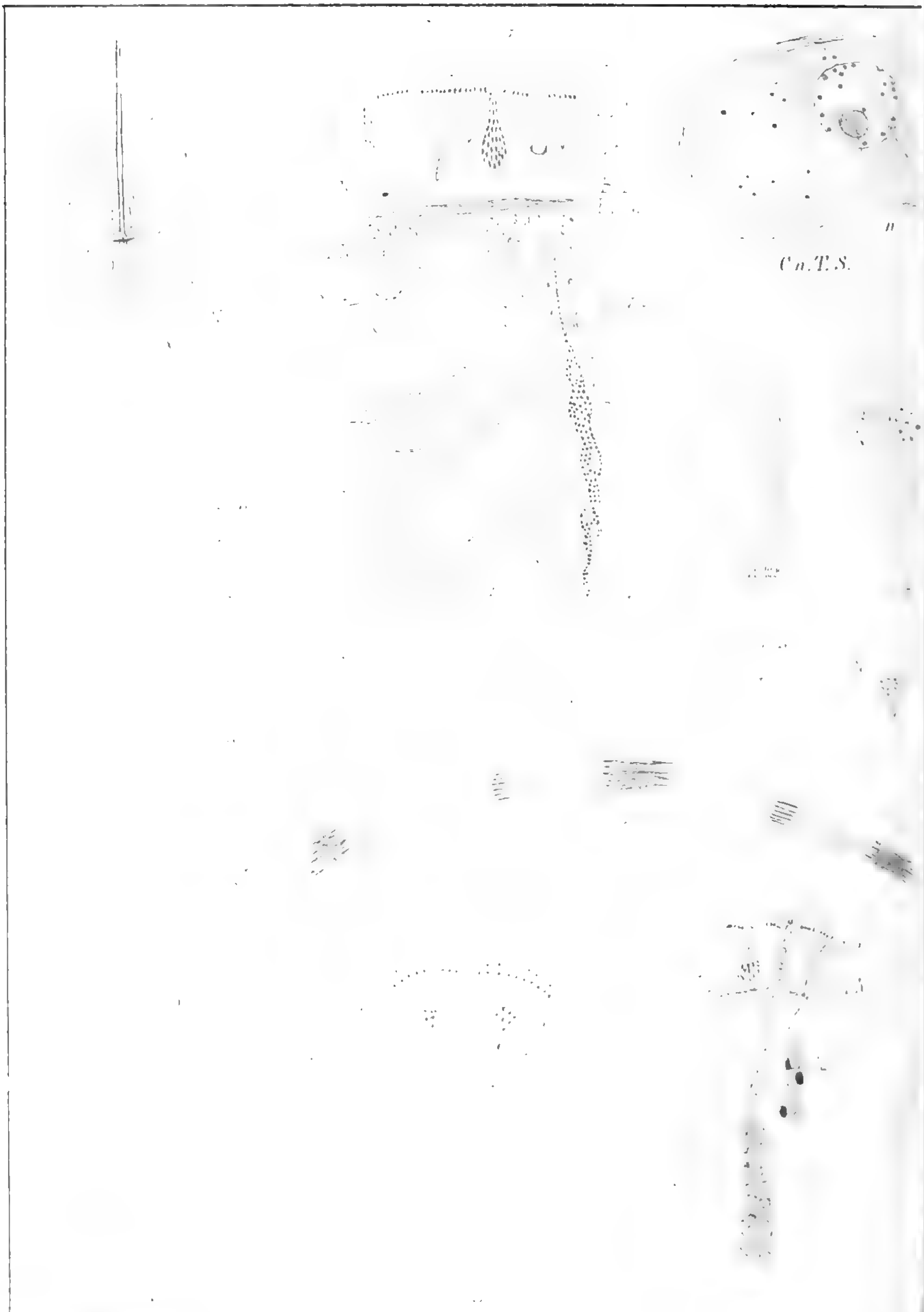

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THOMPSON ZYG

POLIA LITORALIS.

Caroline B. Thompson, del.

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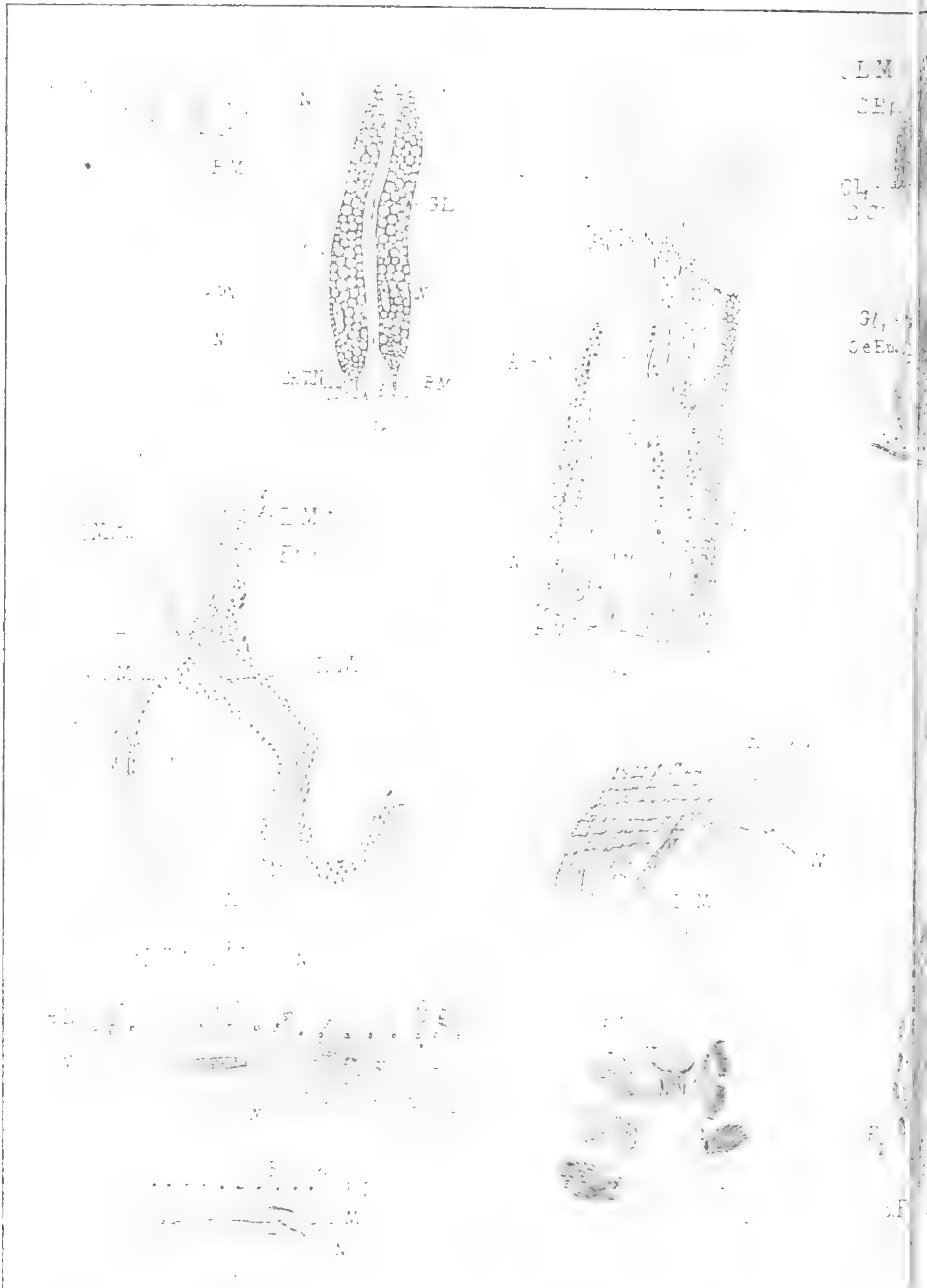

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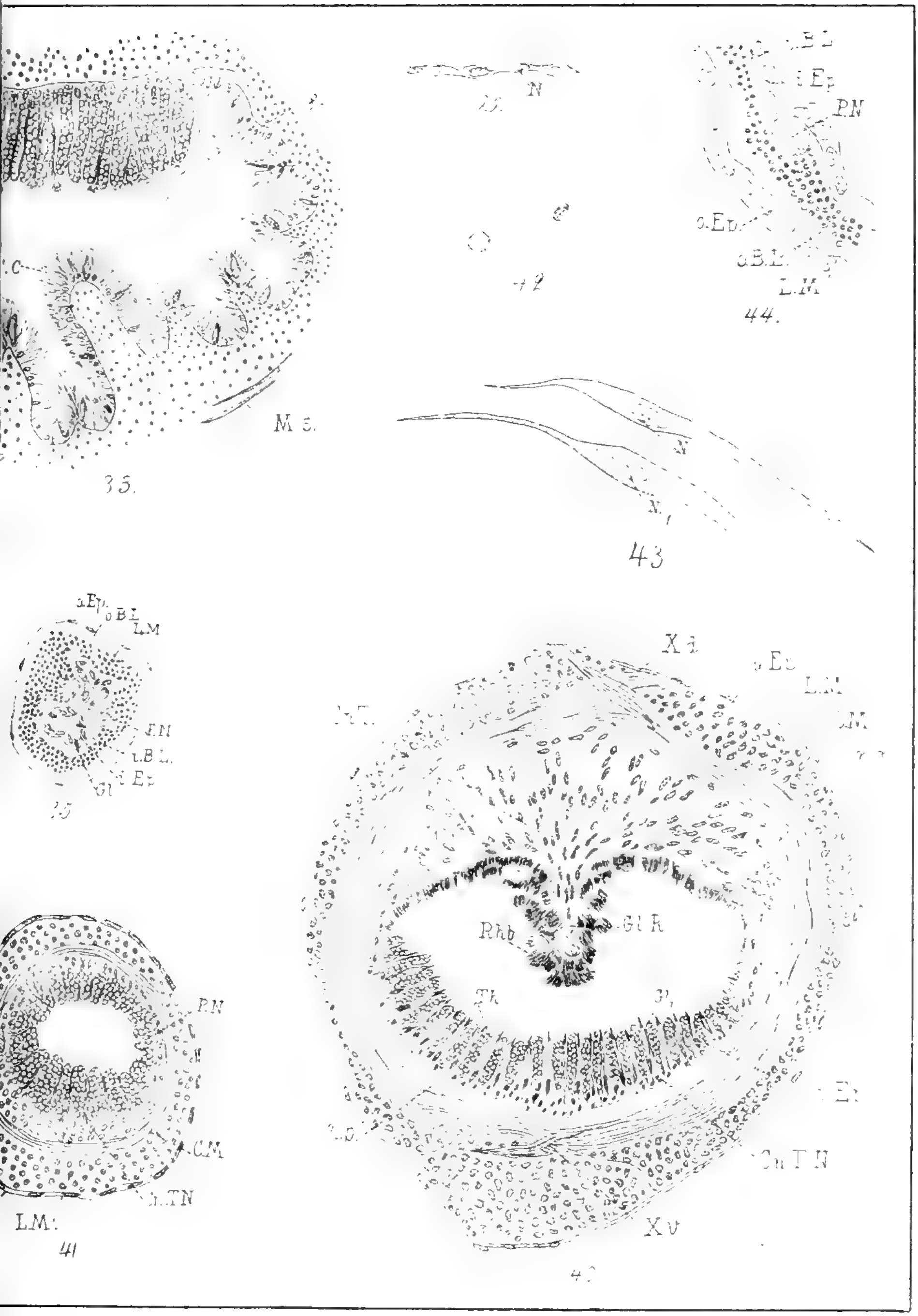

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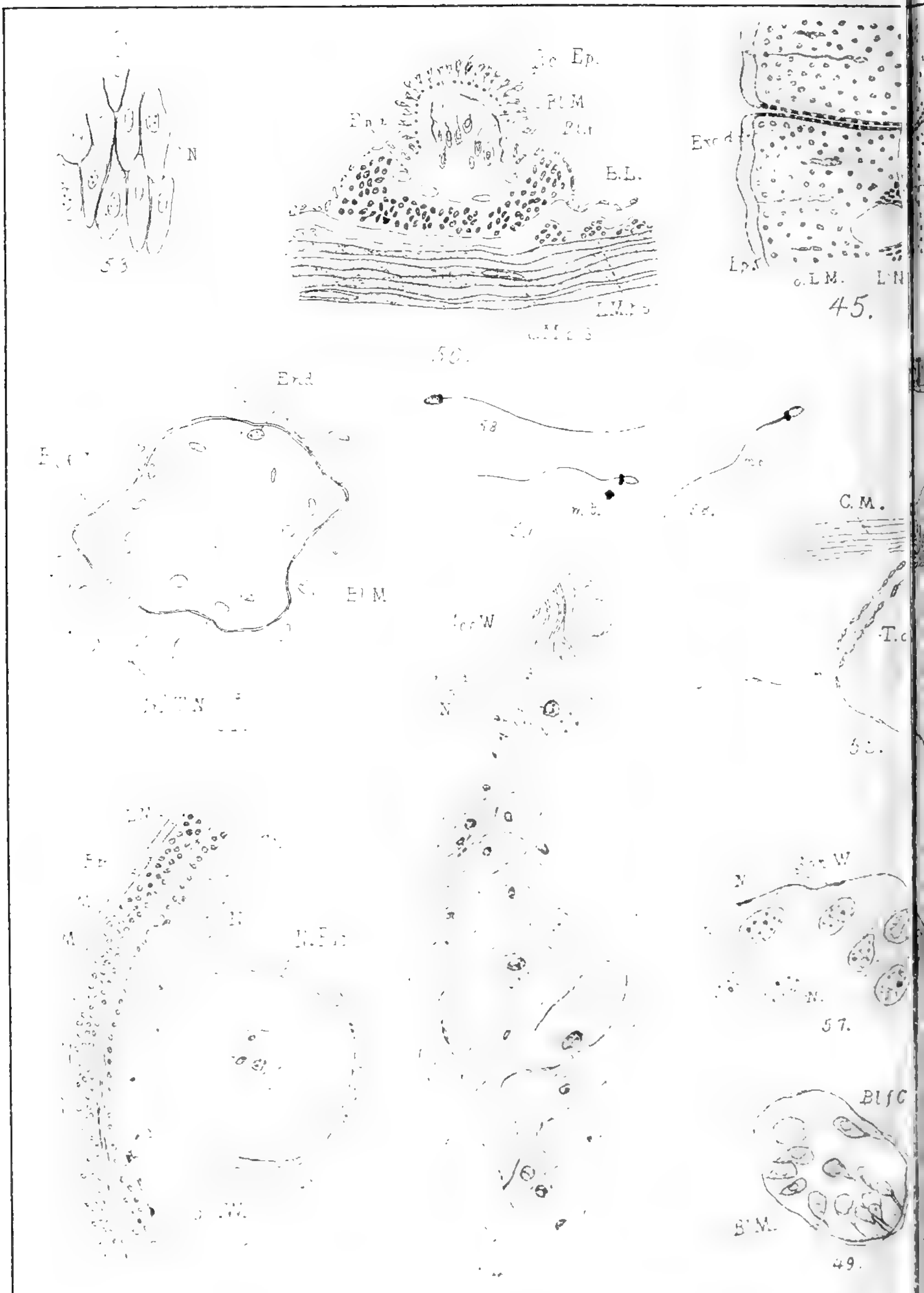

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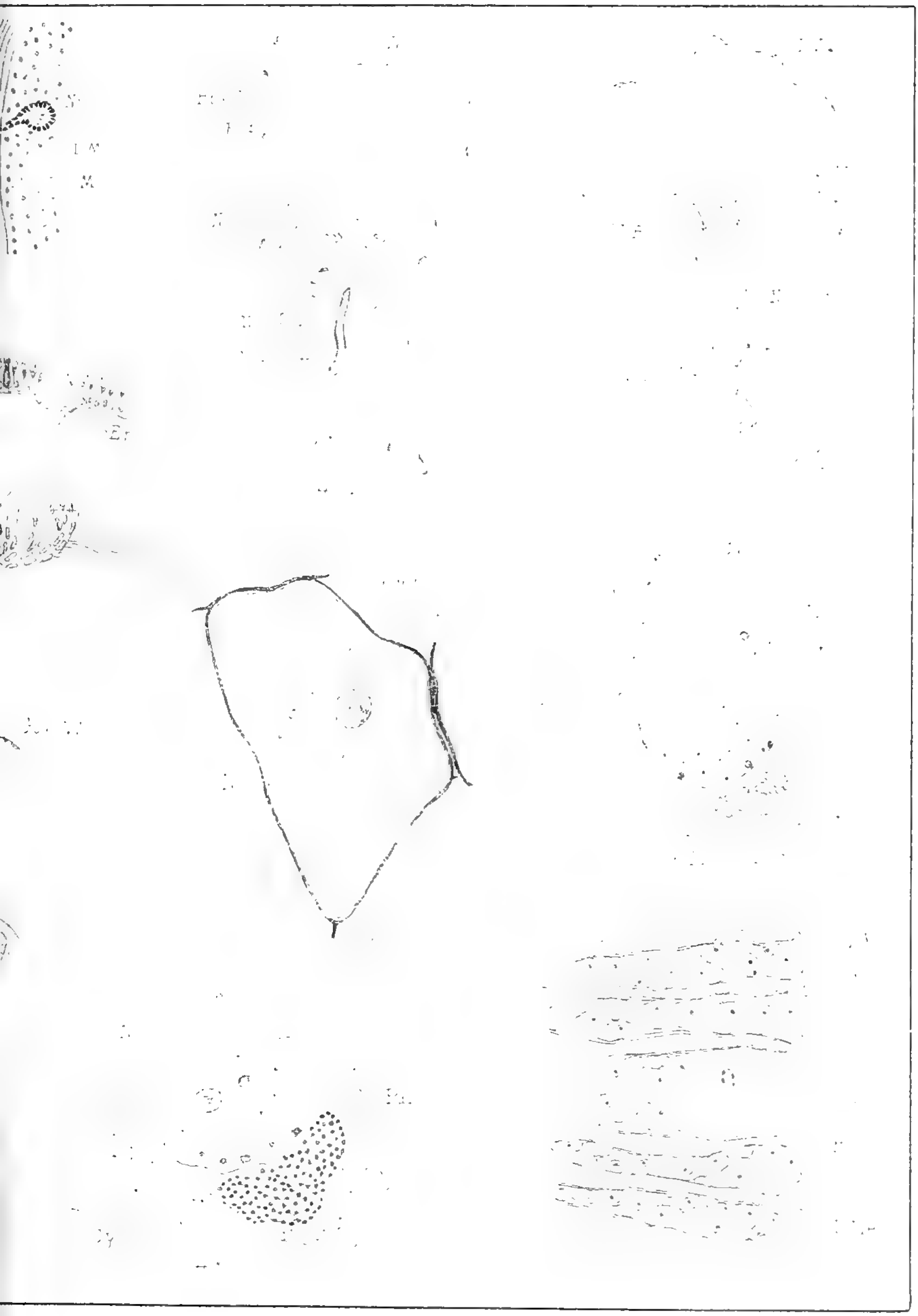

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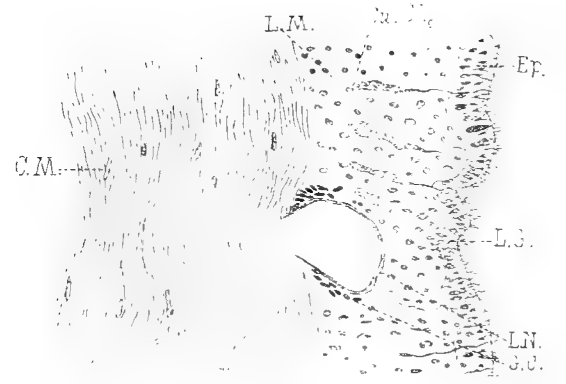

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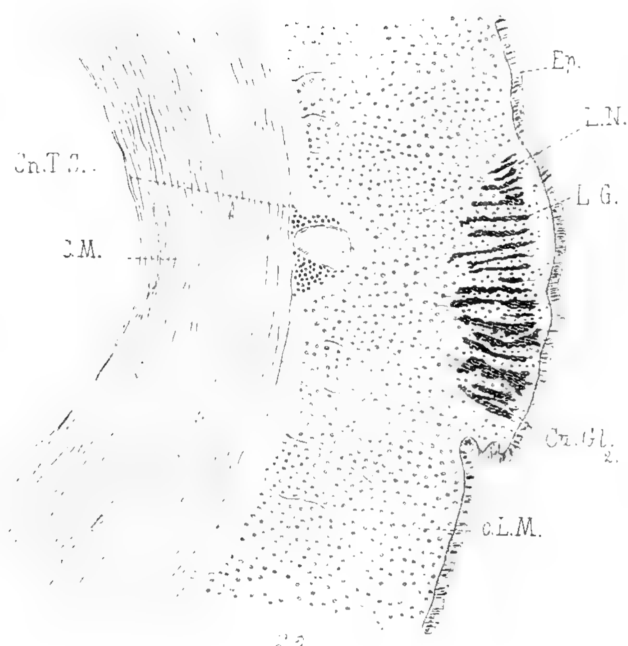

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Caroline B. Thompson, del.

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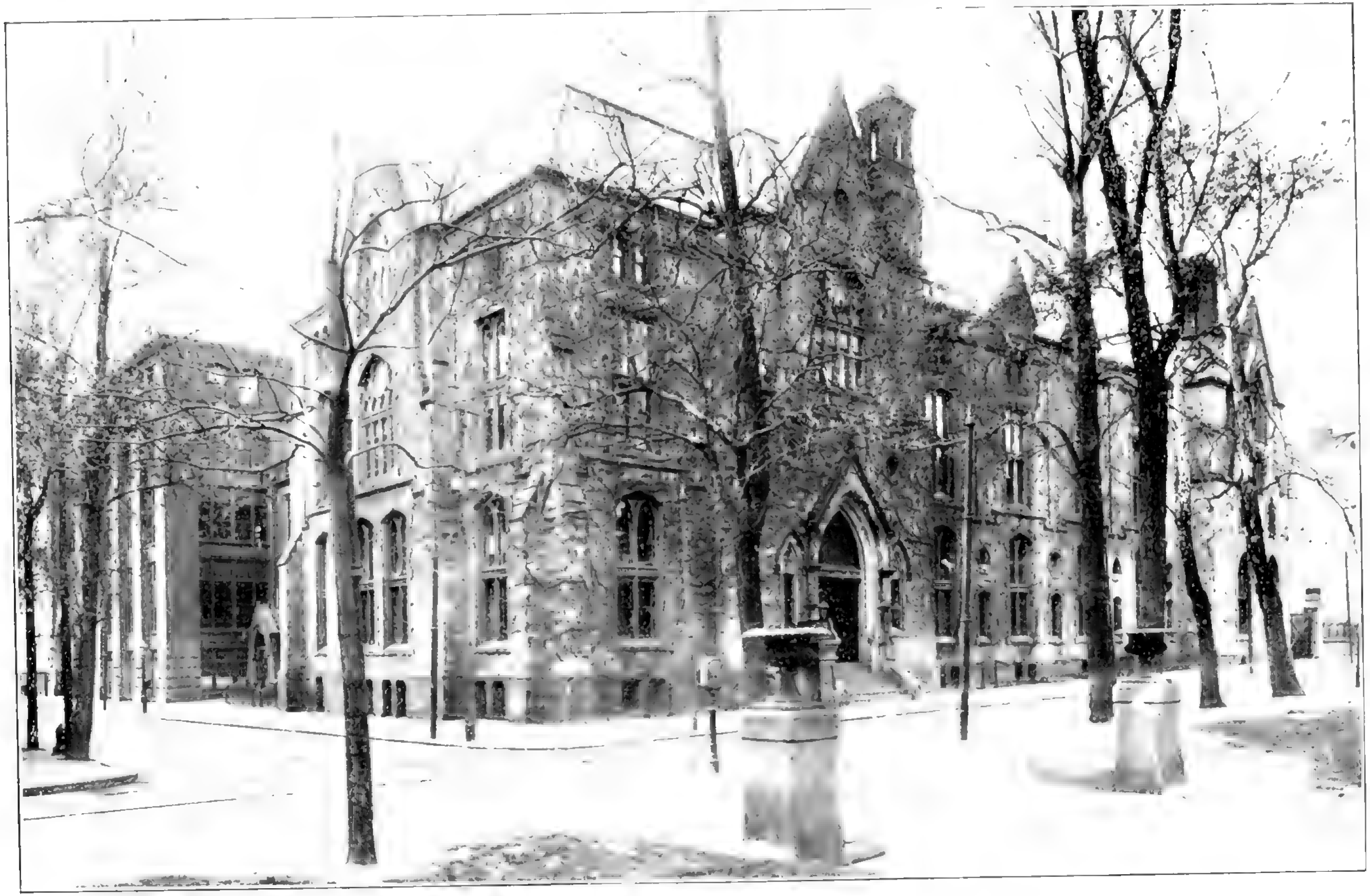
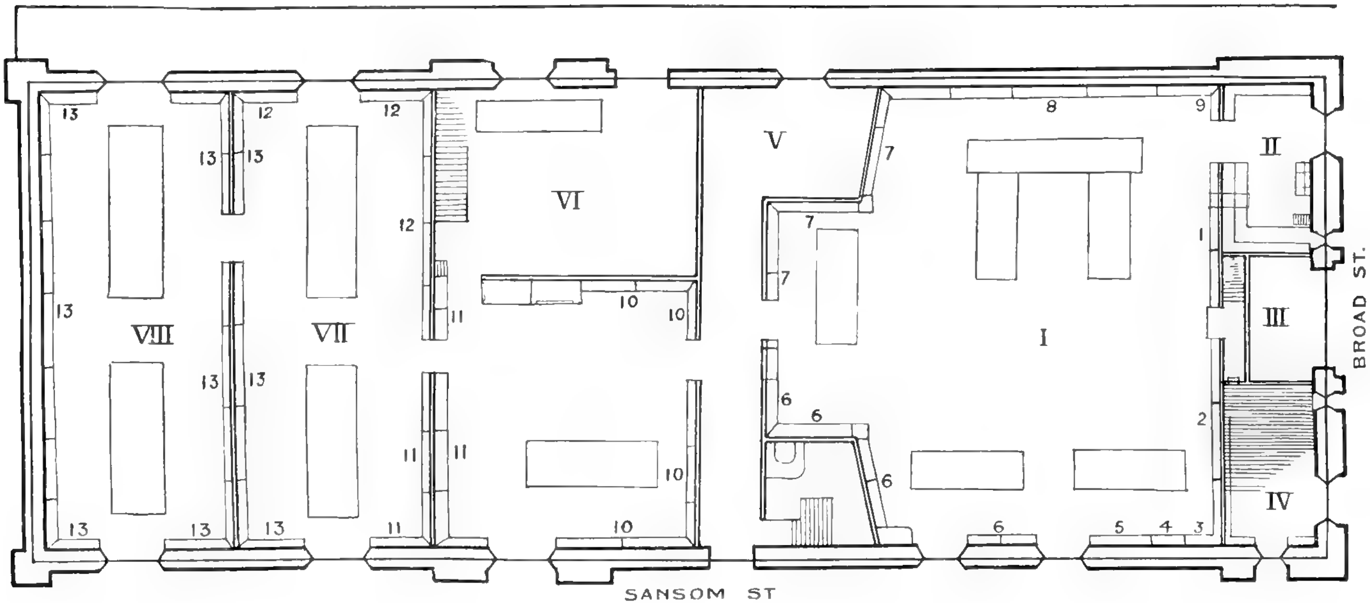


THE ACADEMY OF NATURAL SCIENCES OF PHILADELPHIA, 1901.

THE ACADEMY OF NATURAL SCIENCES OF PHILADELPHIA, 1826-1840.

THE ACADEMY OF NATURAL SCIENCES OF PHILADELPHIA, 1865.

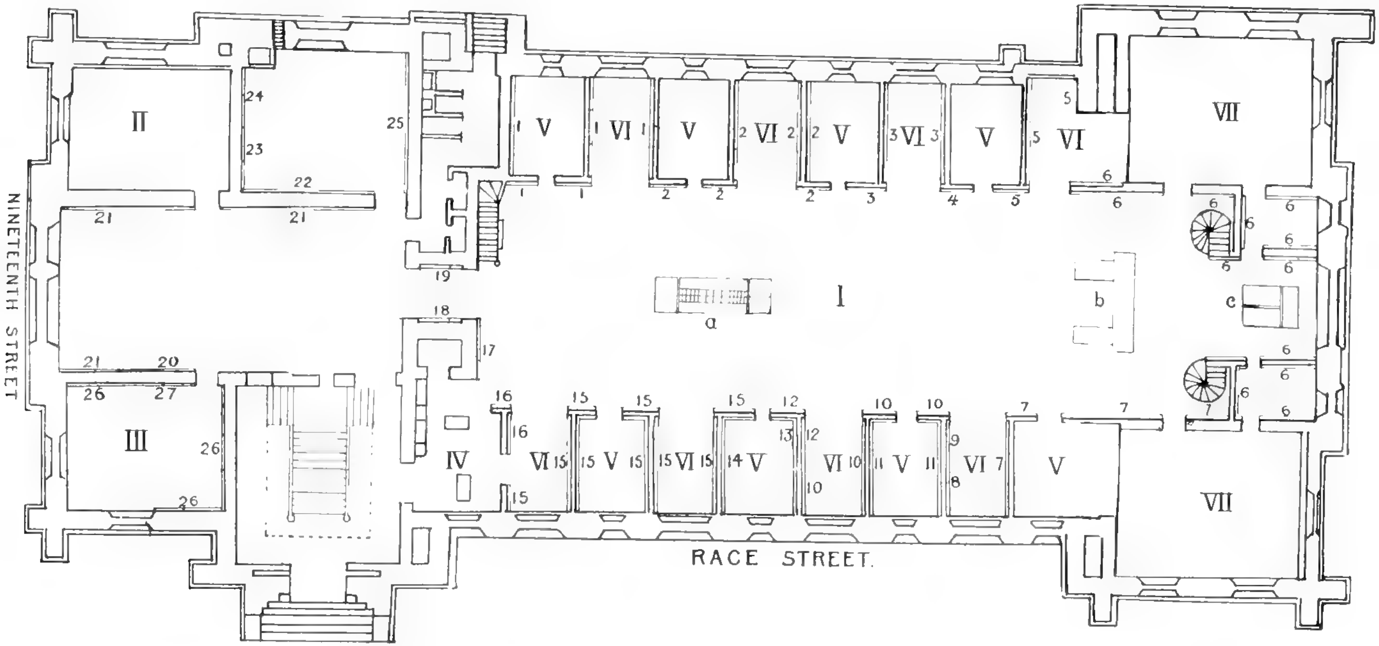


GROUND-PLAN OF LIBRARY, 1875.

I. MAIN HALL AND MEETING ROOM.
II. LIBRARIAN.
III. ENTRANCE TO MUSEUM.
IV. STORE ROOM
V. PUBLICATION ROOM.
VI. JANITOR'S ROOM.
VII. VIII. EARLIER MEETING ROOM.

1. CONCHOLOGY.
2. ENTOMOLOGY.
3. ICHTHYOLOGY.
4. HERPETOLOGY.
5. MAMMALOGY.
6. ORNITHOLOGY.
7. BOTANY.

8. GEOLOGY.
9. HELMINTHOLOGY.
10. GENERAL NATURAL HISTORY.
11. ANATOMY AND PHYSIOLOGY.
12. VOYAGES AND TRAVELS.
13. JOURNALS AND PERIODICALS.



GROUND-PLAN OF LIBRARY, 1901.

I. MAIN HALL AND MEETING ROOM.
II. PRESIDENT'S ROOM.
III. COUNCIL ROOM.
IV. LIBRARIAN'S ROOM.
V. STUDY ROOMS.
VI. ALCOVES.
VII. HERBARIUM.
a. JOURNAL TABLE AND FOLIOS.
b. PRESIDING OFFICER'S DESK.
c. CARD CATALOGUE.

1. VOYAGES AND TRAVELS.
2. GENERAL NATURAL HISTORY.
3. ANATOMY AND PHYSIOLOGY.
4. HELMIMTHOLOGY.
5. CONCHOLOGY.
6. BOTANY.
7. ENTOMOLOGY.
8. ICHTHYOLOGY.
9. HERPETOLOGY.
10. ORNITHOLOGY.
11. ENCYCLOPEDIAS.
12. MAMMALOGY.
13. PHILOLOGY.
14. MATHEMATICS.
15. GEOLOGY.
16. DICTIONARIES.
17. MINERALOGY.
18. CHEMISTRY.
19. GEOGRAPHY.
20. PHYSICAL SCIENCE.
21. ANTHROPOLOGY.
22. MISCELLANEOUS.
23. MEDICINE.
24. BIBLIOGRAPHY.
25. DUPLICATES.
26. MEIG'S LIBRARY.
27. AGRICULTURE.

JOURNALS AND PERIODICALS ARE ON THE SURROUNDING GALLERY.

MAIN HALL OF THE LIBRARY, 1900.