Bulletin of the Museum of Comparative Zoölogy

AT HARVARD COLLEGE.

Vol. LXV. No. 1.

A NEW FOSSIL CETACEAN.

By G. M. Allen.

With One Plate.

CAMBRIDGE, MASS., U. S. A.

PRINTED FOR THE MUSEUM.

August, 1921.

No. 1.— *A New Fossil Cetacean.*

By Glover M. Allen.

In the course of revising the collection of fossil mammals in the Museum, an unlabeled cranium was found, which was so largely embedded in a hard fine-grained marl, that its true nature was not at first appreciated. The specimen, after this matrix had been carefully chiseled away, proves to be of unusual interest. It lacks the vertex of the brain-case, the jugals, and most of the rostrum including the tooth-bearing parts of the maxillae and premaxillae. What remains, however, is fairly well preserved and clearly pertains to a toothed cetacean of a very primitive type, related apparently to the Eocene Agorophius, but differing in certain important details from the only known cranium hitherto referred to that genus. It is therefore doubly unfortunate that so important a specimen should be quite without record of locality, horizon, discoverer, or donor. It lay by itself in a tray without label or catalogue number, having probably been put aside just as received many years ago. The likelihood is that it was sent to Louis Agassiz in the early days of the Museum, possibly from some locality in the southeastern United States, at the time when he was planning a memoir on "Phocodon" (see Wyman, Amer. journ. sci., 1850, ser. 2, **10**, p. 230, footnote). One or two barnacle bases on the upper side indicate that it lay for a time, partly exposed, in the sea.

In the hope that there might be characteristic Foraminifera in the marly matrix, a sample from within the brain-cavity was submitted to Dr. Joseph A. Cushman, who very kindly examined it and reports that "there are a few Foraminifera contained in it, most of which are not well preserved. A few, however, seem to show that the material is probably Upper Eocene (Jackson) in age, and its general appearance would seem to indicate that it came from the Gulf Coastal Plain of the United States, probably from Alabama."

The cranium belonged to a dolphin-like animal, probably some five or six feet long. Obvious peculiarities are its relatively narrow and flattened brain-case, wide mastoid diameter, elongate flattened nasals, parietals forming part of the vertex, the relatively small and prominent occipital condyles, and the long and forward-sloping instead of vertical nasal passage with the remnant of a dorsal chamber above the main part of the nasal cavity. These characters, notwithstanding the lack of corroboration from the teeth, are sufficient to indicate its relationship to the Mesoceti as defined by Dames (1894). While it possesses several primitive features in common with Prosqualodon, its relationship is perhaps nearer to Agorophius, with both of which it may be associated in Abel's family, Agorophiidae, whose three known members, while perhaps in no case directly ancestral to the more developed Squalodontidae, yet indicate previous stages in evolution.

Though quite as primitive in many respects as Agorophius, the new fossil shows so many points of difference that it seems worthy of rank as a separate genus.

Archaeodelphis, gen. nov.

Diagnosis.— A long-beaked dolphin-like cetacean; teeth unknown, but apparently long-rooted, probably resembling those of Agorophius and Prosqualodon; nasals long, narrow, and flattened dorsally; maxillae covering the anterior three fourths of the orbital portion of the frontals; orbit large, with thickened rim and prominent postorbital process; parietals meeting across the vertex of the skull behind the orbits; zygomatic process of squamosal relatively small, with small and nearly horizontal glenoid fossa; mastoid region thickened and produced obliquely downward and backward to or beyond the posterior edge of the condyles which are small and protuberant. Palatals large, expanded anteriorly, separated medially for more than half their length at the back end and by a deep notch at the front end of their combined margin; pterygoids widely sundered, their free margins partly overarching the narial passage. A well-marked nasal chamber is present above the anterior end of the passage, and the vomer forms a cylinder that completely encloses the basal end of the mesethmoid cartilage.

The genus is based on the specimen here described.

Archaeodelphis patrius, sp. nov.

Type-specimen.— A cranium, M. C. Z. 15,749 (Cat. Fossil Mamm.) lacking the bones of the vertex, the jugals, the teeth, and all but the basal portion of the rostrum.

Locality and horizon.— Probably from Jackson formation of the Upper Eocene of the southeastern United States, possibly Alabama, as suggested by the Foraminifera from the matrix.

Description.— A striking characteristic of the dorsal aspect is the narrow rectangular outline of the nasals whose inner anterior corners seem to have been slightly produced to form a blunt median point. They completely roof over the front end of the nasal passage so that the anterior nares open forward, a primitive character common also to the Archaeoceti. At either side of the nasals appears the base of an intermaxillary, its width about equal to that of a single nasal, its termination at about five eighths the length of the nasal, where it abuts against an anterior prolongation of the frontal. Laterally the proximal end of the maxilla extends back to the level of the base of the nasals, and overspreads about three fourths of the orbital process of the frontal dorsally, reaching the edge of the orbit about half way down

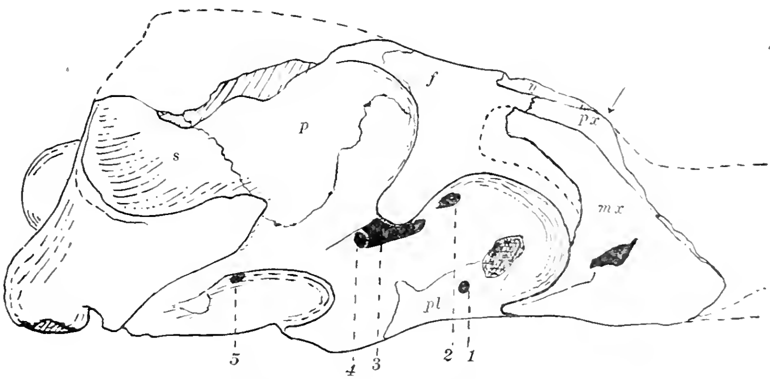


Fig. 1.— Side view of the cranium, from a photograph. *f*, frontal; *mx*, maxillary, part of base (the dotted line shows the limit of its backward extension); *n*, nasal; *p*, parietal; *pl*, palatal, ascending portion; *px*, premaxillary, basal end; *1*, sphenopalatine foramen; *2*, optic foramen; *3*, orbital fissure; *4*, foramen rotundum; *5*, foramen ovale.

on its anterior rim; below this point it forms the front portion of the orbit. Posterolaterally the frontal is produced to form a tapering supraorbital process, whose decurved point is separated from the zygomatic process of the squamosal by about one third the length of the temporal fossa. Its median portion at the point of least interorbital width shows a depression on each side of the cranial axis narrowing to a point forward, which probably received corresponding anterior processes of the parietals. In Agorophius there is also a median prolongation of the parietals fitting into a corresponding depression of the frontals but the projection is simple, not bifurcate.

Of the parietals themselves very little remains in the specimen save a portion of the lateral wing of each, (Fig. 1, *p*), whose lower boundary is faintly traceable on the inner wall of the temporal fossa, whence it extends forward as a narrowing border on the posterior rim of the supraorbital process.

In Agorophius the highest point of the dorsal profile is formed by the base of the maxillaries, back of which the summit of the skull extends on a nearly horizontal though very slightly depressed plane, to the vertex of the supraoccipital. In Archaeodelphis, on the contrary, there was obviously a gradual upward slope of the profile (Fig. 1) which, if the parietals were in place, must have been continued a slight distance to the junction with the supraoccipital, where, as in recent dolphins, the highest point of the profile must have been. This upward slope of the forehead is further indicated by the upward bevel along the edge of the marl matrix filling the brain-cavity, close to the broken edge of the frontoparietal region. The brain-case itself, though relatively narrow as compared with that of modern dolphins, is nevertheless nearly one and a half times as wide as long.

The zygomatic process of the squamosal is relatively weak and ends in a blunt conical point 30 mm. behind the supraorbital process, which slightly exceeds it in size. This is in strong contrast to Agorophius, Prosqualodon, and modern toothed cetaceans, in which it is large and thickened, and produced forward so as to be nearly in contact with the supraorbital process (in the figure of Agorophius, it is seen to be broken near the tip in the only known specimen). Correlated with this difference, is the form of the glenoid cavity for the articulation of the jaw. In Archaeodelphis the cavity is nearly flat, and faces almost ventrally, though the posterior border, evidently forming a distinct postglenoid process, appears to be slightly broken away. Medially the articulating surface extends for a distance nearly equal to its length. In Agorophius, Prosqualodon, and Patriocetus, as in the modern dolphins, the articulating surface is relatively larger and includes the concave ventral (or anterior) face of the zygomatic process. This difference evidently implies in Archaeodelphis a more precise limitation of the movements of the jaw, to insure a certain amount of shearing action between the opposing sets of teeth, in addition to their seizing function (the main use of teeth in modern cetaceans). Possibly such a cutting action enabled Archaeodelphis to feed upon small armored fishes, such as the young of ganoids. It may be regarded as a primitive feature, inherited from the supposed creodont or carnivorous ancestors.

Most remarkable is the development of the exoccipitals and their extension backward, outward, and downward, thereby greatly increasing the massive aspect of the mastoid region. A somewhat similar appearance is shown by Agorophius and Prosqualodon but in these genera the exoccipitals do not extend so far backward, hardly surpassing the base of the condyles, whereas in Archaeodelphis they equal or exceed the protuberant condyles and are produced strongly downward below them.

The occipital condyles are very different from those of modern cetaceans. In the Delphinidae their articulating surface is relatively large and almost continuous with the surrounding bones of the occiput so that the head rests firmly upon the atlas with its correspondingly enlarged and flattened anterior facets. In Archaeodelphis on the contrary, as well as in Agorophius and Prosqualodon, they are relatively smaller but very much more protuberant and are set off by a distinct neck or constriction. Their greatest axis is not quite vertical though much more nearly so than in most modern cetaceans, as for example, Delphinus. An approach to this condition, however, is found in Platanista among the more primitive living forms. This much more primitive condition was doubtless correlated with free instead of fused cervical vertebrae, a fact which, taken in connection with the enlarged mastoid region for muscle attachments, indicates a very much greater mobility of the head both up and down, and sidewise, than in modern cetaceans. Probably with the more forward-opening nostrils, the rostrum rather than the vertex of the head was first thrust above water in breathing, or the front of the head merely elevated from the horizontal position when near the surface, as a seal might do.

Very fortunately the base of the rostrum and most of the lower portion of the cranium were embedded in the matrix, so that it has been possible by clearing this carefully away, to disclose the structure of these important parts. Contrary to the condition shown by the type-specimen of Agorophius in which the nasals, intermaxillaries, and vomer seem to have been loosely attached, and have become lost, these bones in Archaeodelphis are strongly soldered together. A very remarkable and interesting development of the vomer and adjacent bones is seen in a front view of the rostrum (Fig. 2) which in the specimen is broken short off so as to give nearly a vertical section. The dorsal three fourths of the premaxillaries are considerably thickened with outward-flaring inner faces bounding the sides of the nasal opening. Their ventral fourth encloses the vomer whose lateral wings are here expanded to form a cylindrical tube, containing the mesethmoid cartilage. This tube was obviously continued forward with its supporting rod of cartilage to give strength to the rostrum, as in the Denticeti. At its base, the tube separates the two intermaxillaries medially for a space of 9 to 14 mm. and is continued dorsally as a thin knife-like partition quite to the under side of the nasals, so as to divide the nasal chamber longitudinally. There appears to be also a vertical wing on each side lining a portion of the outer wall of the nasal opening. Ventrally, the vomer is continued as a median keel from the rostral cylinder and appears on the palatal aspect as a narrow line separating the maxillaries. Viewed from the posterior narial opening,

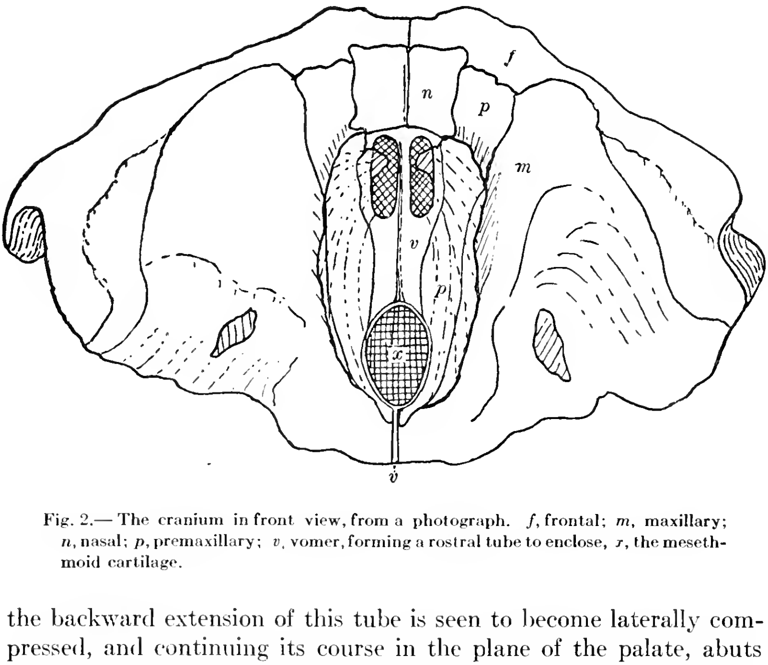


Fig. 2.— The cranium in front view, from a photograph. *f*, frontal; *m*, maxillary; *n*, nasal; *p*, premaxillary; *v*, vomer, forming a rostral tube to enclose, *x*, the mesethmoid cartilage.

the backward extension of this tube is seen to become laterally compressed, and continuing its course in the plane of the palate, abuts against the wall of the nasal cavity some 30 mm. from the opening of the posterior nares. With the apparent exception of Ceterhinops, no similar rostral tube is known in other cetaceans, for, as in Prosqualodon (Abel, 1912) it is usually open dorsally at the base and the mesethmoid cartilage, more or less ossified, appears at the base of the rostrum between the intermaxillaries.

The posterior part of the narial passage is flattened dorsoventrally, with divergent sides, and is largely enclosed by the arching palatals and the incurved pterygoids, except medially where these bones are separate below. Behind the pterygoids the narial passage viewed from below, is continued as a broad shallow trough with raised and slightly divergent sides, nearly to the foramen magnum, much as in modern dolphins, except that this portion of the narial passage lies nearly in the plane of the palate instead of being bent at an angle with it. This angle is obvious in Agorophius (True, 1907, plate) as well.

The palatal region, so important for its diagnostic characters in the Cetacea, is beautifully preserved except for the tooth-bearing parts of the maxillaries. In most extinct cetaceans, however, this aspect of the skull is seldom preserved or figured so that full comparisons are not as yet possible. In the specimen, only the basal portions of the maxillaries between the tooth-rows remain. Here a slight longitudinal groove-like depression is indicated on each side of the median line, corresponding perhaps, with the shallow palatal grooves seen in Delphinapterus. The palatal bones are perfect and lie in a plane very slightly depressed from that of the maxillaries. As usual in Cetacea, as well as in seals, the tooth-rows lie anterior to the front margin of the palatals. Each palatal is expanded at its forward end, where its outline is strongly convex, so that there is a distinct emargination at the median portion of their combined front edges. Together they nearly fill the space between tooth-rows, and are in contact medially for a trifle less than one third their length before diverging evenly at their posterior ends. At the ventral edge of the orbit each sends up a dorsal branch at right angles to the palatal portion. Just above this edge and close to the anterior margin of the ascending wing is a small but distinct sphenopalatine foramen (Fig. 1, **1**).

The pterygoids are relatively small, their ventral portion incurved so as partly to embrace the opening of the posterior nares. They are widely separate and their posterior margins divergent.

Laterally, on either side of the trough that continues the narial passage, is a deep groove with sharply defined boundaries, extending forward as far as the pterygoid bone. About half way on the length of this groove opens the large foramen ovale, (Fig. 1, **5**) its course continued laterally as a shallow furrow. The orbit shows three large foramina for nerves. Slightly above and in advance of its center is the optic foramen of relatively small size (Fig. 1, **2**). Below and behind this is the very large orbital fissure (foramen lacerum anterius) deeply excavated in the wall of the orbit, while close against it postero-externally, and separated only by a thin bony partition is the foramen rotundum (for the second division of the fifth nerve) lying in the same deep groove with the orbital fissure (Fig. 1, **3** and **4**).

What appears to be the opening of the lachrymal canal lies just below and ahead of the optic foramen, where the outline of a small lachrymal bone can be faintly traced, wedged in between the ascending process of the palatine and the base of the orbital portions of frontal and maxillary. The antorbital foramen perforates the latter just exterior to the lachrymal, and appears in the section of the broken rostrum as a large triangular orifice with its point directed downward.

The tympanic bullae are lost, and were evidently but loosely attached as is usual in Cetacea. The petrous and mastoid portions of the ear-bones, however, are still present, and as in some of the more primitive existing cetaceans, (Balaena, Platanista) are firmly wedged between exoccipital and squamosal. The petrosum is small (17 × 11.5 mm.), roughly egg-shaped, with its long axis directed anteroposteriorly, and lies close against a bony eminence bounding the inner side of the glenoid fossa. The mastoid portion (28 mm. long) extends obliquely outward and backward to the periphery, expanding to a width of 20 mm. where it reaches the outer surface of the cranium. A notch separates it from the postglenoid process.

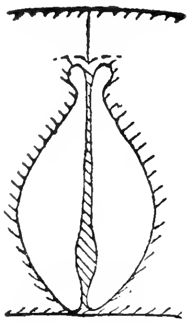


Fig. 3. — Diagrammatic cross-section of nasal passage at base of rostrum, to show the vestigial dorsal nasal chambers.

The nasal cavities are fortunately preserved intact and were, with some difficulty, quite cleared of matrix on one side of the median septum formed by the vomer. The greater part of their vertical diameter is taken by the narial passage itself which extends from the laterally compressed anterior opening, obliquely backward and downward, expanding laterally as it approaches the posterior nares. Directly back of the anterior narial opening and wholly above the air-passage itself, is a pocket extending backward and nearly cut off below by a blunt projection of the outer wall of the cavity, so that a distinct dorsal division of the nasal chamber (Fig. 3) is formed, a primitive feature of which no vestige remains in modern cetaceans. Stromer (1903, pl. 11, fig. 1–3) has shown sections of the nasal cavity of *Zeuglodon* (*Basilosaurus*) *zitteli* in which there is a much better developed olfactory chamber, similarly situated, and wholly cut off ventrally from the main air-passage by a *lamina terminalis* extending inward from the outer wall of the cavity. He found also indications of naso- and maxillo-turbinals. It is therefore probable that the blunt projection from the outer wall of the nasal cavity, above referred to, is the remnant of a *lamina terminalis*, but there is no indication of turbinal bones, which probably had atrophied.

Measurements.— The following dimensions indicate the size of the cranium:

	mm.
Tip of nasals to end of occipital condyles	180
Front edge of palatal bone to same point	158
Anteroposterior length of temporal fossa	92
Length of right orbit	54
Length of nasals	41
Combined width of nasals	38
Width across front of orbits	145
Mastoid width	180
Least width between temporal fossae	64
Combined width of palatal bones	69
Width across occipital condyles	57
Approximate width across supraorbital processes (twice one half)	190
Height of muzzle at tip of nasals	70

Summary of Relationships.

Of primitive cetaceans whose skull characters are sufficiently known to admit of comparison with Archaeodelphis, three genera stand out as bearing a considerable degree of similarity to it, namely, Agorophius, Prosqualodon, and Patriocetus. The first of these, with the single species *A. pygmaeus*, is still known from the type-specimen only — now lost — the history and peculiarities of which have been fully set forth by True (1907). Although the intermaxillaries and nasals as well as most of the inferior side of the cranium of this specimen were not preserved, still it bears obviously a general superficial resemblance to Archaeodelphis in the somewhat flattened profile, the great anteroposterior extent and the breadth of the temporal fossae, and the resulting narrowness of the region separating the two fossae anteriorly. This narrow isthmus in both genera, is formed dorsally by the parietals which instead of being excluded from the peak of the cranium as in modern cetaceans, meet behind the frontals at the dorsal line. Further points of resemblance are found in the shape of the brain-case and in the great lateral extent of the orbital portion of the frontal with its well-developed and tapering postorbital process.

Both species, further, have small and prominent occipital condyles, indicating a considerable mobility of the head. On the other hand, Archaeodelphis differs from Agorophius in many important characters, both primitive and progressive. Thus its basicranial axis is not bent at an angle with the plane of the palate, whereas in Agorophius the fragments of basioccipital and basisphenoid remaining, clearly form a distinct angle with the palate, foreshadowing the considerable angle seen in many modern dolphins; again, the zygomatic process of the squamosal is but weakly developed in Archaeodelphis whereas in Agorophius it is large and well arched for the extensive jaw-articulation, in addition to being much more produced forward. On the other hand, Archaeodelphis is the more progressive in its higher vertex and shows a special development of the mastoid region downward and backward. A comparison of nasals, intermaxillaries, and vomer is not possible, but since these parts are lost in the type-specimen of Agorophius, it may be that they were less solidly fused than in Archaeodelphis. In the latter, the extraordinary formation of the vomer, completely enclosing the mesethmoid cartilage in a tube and dividing the nasal cavity by a thin bony septum is possibly a specialization; while the retention of elongate, narrow nasals well solidified with the surrounding bones and a distinct olfactory chamber dorsal to the main air-passage are primitive characters.

From his study of the three known specimens of Prosqualodon, from the Miocene of Patagonia, Abel (1912) has shown, that although possessing many primitive characters, such as the low vertex, narrow brain-case, broad zygomatic processes, parietals meeting at the vertex behind the frontals, and large temporal fossae, it shows nevertheless a great advance over Agorophius in many respects, and though hardly ancestral to Squalodon, yet foreshadows many of its delphinoid characters, such as the reduction of the nasals, the greater anteroposterior compression of the cranium, more nearly vertical nasal passages, and relatively smaller temporal fossae. Its teeth Abel interprets as being more specialized than in the squalodonts, and as a further progressive character, the intermaxillaries are toothless. It has a well-marked maxillary notch as in squalodonts and modern dolphins.

In comparison with Patriocetus, a new generic term proposed by Abel (1912, p. 69) for *Squalodon ehrlichii*, Archaeodelphis is at once distinguished by the absence of the pronounced overhanging ledge that partly roofs over the front end of the temporal fossa, somewhat as in the zeuglodonts (Basilosaurus). The zygomatic process of the squamosal is large as in Agorophius and Prosqualodon, and as in the former the dorsal profile of the brain-case is nearly flat. The basicranial axis seems to be bent slightly to form an angle with the plane of the palate. As True (1907) had previously indicated, this cetacean seems very different from typical Squalodon, though its characters are still imperfectly known. The recent discovery of a well-preserved example in the upper Oligocene at Linz (König, 1911) should help to elucidate its relationships when the promised studies of Dr. Abel on this important specimen are published.

There seems to be no close relationship between Archaeodelphis and the zeuglodonts, which, as lately shown by the studies of Dames (1894), Stromer (1903), Fraas (1904), and Andrews (1906), appear to be only remotely connected with the more typical cetaceans (Mesoceti and Denticeti) if not a wholly independent offshoot from a primitive creodont stock. They reached their maximum development in both size and skeletal modification during Eocene times, and then became extinct. Their ancestry, however, seems to be clearly indicated through the discovery by Fraas (1904) of the skull of a small species (*Protocetus atavus*) from the lower Middle Eocene of Mokattam, near Cairo, Egypt. This was a primitive surviving type, contemporaneous with more evolved types that inhabited the same Eocene seas. Its dentition, however, instead of exhibiting the usual compressed premolars and molars with serrate edges, is like that of a typical creodont.

So far as can be judged from the specimen here described, Archaeodelphis stands as a very primitive cetacean, probably nearest related to Agorophius of known forms, and to be associated tentatively with it in a separate family, Agorophiidae. It represents a dolphin-like animal belonging in a general way to a type ancestral to the Squalodontidae and through them to the more modern delphinoids.

A word may be added as to Leidy's genus Ceterhinops. This was founded on a fragment of a cranium which included portions of maxillae, premaxillae, vomer, and frontal. The vomer formed at its base, a cylindrical tube, much as in Archaeodelphis, and this was continued dorsally as a thick bony septum quite separating the nasal passages. The figure given by Leidy (1877, pl. 34, fig. 7) indicates, however, a skull of different configuration, perhaps lacking such nasal bones as Archaeodelphis possessed, and having the basal ends of the premaxillae tapering to a point between the frontal and the maxillae. Its fragmentary nature renders a further comparison difficult, but indicates a possible relationship. Leidy's specimen came from the Ashley River phosphate beds of South Carolina.

REFERENCES.

Abel, Othenio.

1912. Cetaceenstudien. III. Mitteilung: Rekonstruktion des schädels von *Prosqualodon australe* Lyd. aus dem Miozän Patagoniens. Sitzb. K. akad. wiss. Wien, math.-nat. cl., **121**, pt. 1, p. 57–75, pl. 1–3.

Andrews, C. W.

1906. A deseriptive catalogue of the Tertiary Vertebrata of the Fayûm, Egypt. London, 4to, 38, 324 pp., illustr.

Dames, W. B.

1894. Ueber zeuglodonten aus Aegypten und die beziehungen der Archaeoceten zu den übrigen cetaceen. Palaeont. abhandl., **5**, no. 5, 36 pp., 7 pls.

Fraas, Eberhard.

1904. Neue zeuglodonten aus dem unteren Mitteleocän vom Mokattam bei Cairo. Geol. palaeont. abhandl., **10**, 24 pp., 3 pls.

König, Anton.

1911. Ein neuer fund von *Squalodon ehrlichii* in den Linzer sanden. Jahresb. Mus. Franc.-Carol. Linz, **69**, p. 109–121, pl. 1.

Leidy, Joseph.

1877. Description of vertebrate remains, chiefly from the phosphate beds of South Carolina. Journ. Acad. nat. sci., Phila., ser. 2, **8**, p. 209–261, pl. 30–34.

Stromer, Ernst von.

1903. Zeuglodon-reste aus dem oberen Mitteleocän des Fajûm. Beitr. palaeont. u. geol. Oesterreich-Ungarns, **15**, pt. 2–3, p. 65–101, pl. 8–11.

True, F. W.

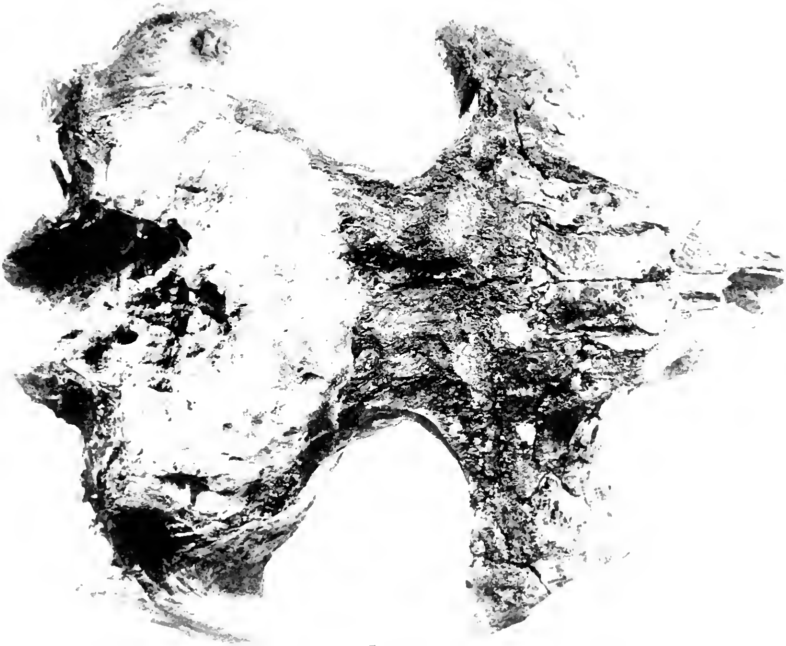
1907. Remarks on the type of the fossil cetacean *Agorophius pygmaeus* (Müller). Smithson. contr. knowl., 8 pp., 1 pl.

EXPLANATION OF THE PLATE.

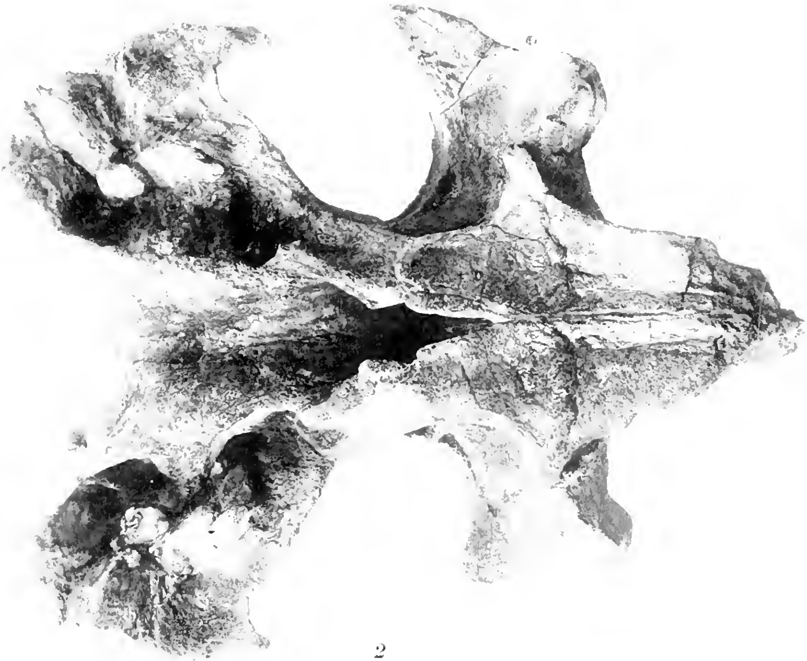
EXPLANATION OF THE PLATE.

Archaeodelphis patrius Allen.

Fig. 1. The type-cranium from above.
Fig. 2. The same from below.



1



2

Bulletin of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE.
Vol. LXV. No. 2.

NEW GENERA AND SPECIES OF ALEOCHARINAE WITH A POLYTOMIC SYNOPSIS OF THE TRIBES.

By Adalbert Fenyes.

CAMBRIDGE, MASS., U. S. A.:
PRINTED FOR THE MUSEUM.
October, 1921.

No. 2.— *New Genera and Species of Aleocharinae with a Polytomic Synopsis of the Tribes.*

By Adalbert Fenyes.

Diglotta pacifica, sp. nov.

Apterous, subopaque, with sparse and pale pubescence.

Dark brown, the elytra scarcely paler; antennae yellowish brown, scarcely paler at base; legs dirty yellow.

Antennae rather short, slightly incrassate towards the apex; joints 1 and 2 about equal in length; 3 elongate, but much shorter than 2; 4–10 from about as long as wide to moderately transverse; 11 but little longer than 10, conical.

Head large, fully as broad as the prothorax, subglobose, mouth-parts produced in front; moderately, sparsely, and somewhat coarsely punctate; eyes small; genae not margined.

Prothorax cordiform, about as long as broad, base almost only one half as broad as apex, sides very strongly narrowed to the base; broadly and vaguely impressed in its entire length; more finely and more densely punctate than the head.

Elytra rudimentary, extremely short, about one half as long as, and almost narrower than, the prothorax, strongly dilated towards the apex, with truncate hind margin; punctate as the prothorax.

Abdomen elongate oviform, at base about as broad as the elytra; punctate as the head.

Length 1.5 mm.

Type.— Coll. A. Fenyes 25,028. S. Cala.: beach between Coronado and South San Diego, April, 1912, under seaweed. Paratype.— M. C. Z. 9,981. S. Cala.: La Jolla, June, 1913.

There is one example in the Blaisdell collection, taken also in the vicinity of San Diego, and probably belonging to the same species. This species is the first of the genus recorded from the Pacific Coast of North America.

Thaxteria, gen. nov.

Apterous; front-body rather parallel, the abdomen elongate oviform, dilated; the insect bears a strong resemblance to a Termite. This new genus does not seem to be related, even remotely, to either Abroteles Casey, Corotoca Schioedte, Perinthus Casey, Spirachtha

Schioedte or Termitothymus Silvestri — these five genera being apparently the only known holotetramerous, termitophilous Aleocharinae genera of the Neotropical region. I am not able to give a complete description of the genus, as I cannot dissect the type-species.

Labrum subtruncate. Maxillary palpi 4-jointed, with joints 2 and 3 incrassate.

Antennae 11-jointed, somewhat longer than head and prothorax together, slender, scarcely incrassate towards the apex; joint 1 very long, almost as long as the head, somewhat curvate; joints 2–10 gradually and slightly decreasing in length and slightly increasing in width, 2 longer than broad, 10 about quadrate; 11 about as long as 9 and 10 together, oviform.

Head together with the eyes as broad as the prothorax, subpentagonal, basal angles prominent but rounded, base somewhat narrowed but apparently not constricted to a neck; genae not margined; eyes apparently longer than the tempora.

Prothorax broader than the elytra, moderately transverse, almost tetragonal, though a little narrower in front than behind, the sides subparallel and scarcely sinuate, all the angles rounded; strongly convex, in the middle at base with a small hemielliptical, abrupt impression; hypomera not visible from a lateral point of view.

Scutellum small.

Elytra perhaps a trifle shorter than the prothorax, perceptibly narrower than the latter; the sides subparallel and slightly sinuate anterior to the outer hind angles, their basal margins conjointly emarginate in the middle; the entire sutural region of each elytron longitudinally, abruptly, and deeply depressed under the level of the elytral disc, these depressions conjointly presenting an elongate, trough-like cavity.

Abdomen a good deal broader than the elytra, much longer than the frontbody; the segments of equal length, none of them depressed at base and each of them with a fringe of moderately long, sparse hairs on the apical margin; lateral border rather broad.

Legs moderately long; femora and tibiae almost straight, the front tibiae with a fringe of long, dense, silky hairs on the inner margin; tarsi 4–4–4-jointed the first and last joints of all the tarsi elongate. All the coxae contiguous.

Type and only species: — *T. insularis*, sp. nov.

Thaxteria insularis, sp. nov.

Strongly shining, without distinct sculpture or punctuation.

Head, prothorax, and elytra light brown, the elytral cavity paler, yellowish; abdomen, antennae, and legs yellow.

Length about 4 mm.

TYPE.— M. C. Z. 9,982. Grenada: Grand Etang, near the boat-landing in nest of *Eutermes morio santa luciae*, December, 1912. Roland Thaxter.

CYPHEA WALLISI, sp. nov.

Rather short, robust, somewhat depressed moderately shining; with moderately dense, rather coarse sculpture and with inconspicuous pubescence. Similar in habitus to *Cyphea curtula* Erichson from Europe (the type-species of the genus), with similar male characters, but smaller in size and darker in color.

Black, the abdomen brownish black at base; antennae and legs almost black.

Right mandible with a strong tooth; maxillary palpi 4-jointed; ligula entire; labial palpi 2-jointed.

Antennae 11-jointed, rather short, incrassate towards the apex, ciliate; joint 2 longer than 3; 10 strongly transverse; 11 about as long as 9 and 10 together.

Head narrower than the prothorax; genae entirely margined; eyes longer than the tempora.

Prothorax almost broader than the elytra, strongly transverse, about twice as broad as long; apex emarginate, narrower than the base; sides strongly rounded; base rounded, feebly bisinuate; hind angles obtuse, but distinct; with a broad transverse impression at the base.

Mesosternal process long, obtusely pointed. Metasternal projection short in contact with the mesosternal process.

Elytra considerably longer than the prothorax, emarginate at the outer hind angles.

Abdomen broad, feebly narrowed towards the apex; tergites 3 and 4 impressed at base; tergite 6 shorter than 5.

Tarsi 4–4–5-jointed; hind tarsi with joint 1 much longer than 2.

In the male each elytron has a small tubercle near the suture at about the anterior third; tergite 7 has a small tubercle near the apex in the middle; tergite 7 and sternite 6 are concealed in the type.

Length 1.5 mm.

TYPE.— Coll. A. Fenyes 28,827. PARATYPE.— M. C. Z. 9,983. Manitoba: Winnipeg. J. B. Wallis. Several specimens, one of which was found under a poplar log.

Strophogastra, gen. nov.

The 4–5–5-jointed tarsi, 11-jointed antennae, 4-jointed maxillary palpi and 2-jointed labial palpi refer the minute representative of this genus to the Thamiaraeini; it is isolated by its entire ligula, non-dentate mandibles and short first joint of the hind tarsi. The peculiar form of the abdomen and the remarkable male characters of the only species render this genus recognizable, even without microscopic study of the mouth and tarsi.

Labrum transverse, subsinuose on the anterior margin. Mandibles not dentate, though both with a rounded projection on the inner margin. Maxillae with inner lobe shorter than the outer lobe, a few spines on the apical portion of the inner margin and with hairs on the basal portion; the outer lobe with long pubescence at apex. Maxillary palpi 4-jointed; joint 2 rather short; 3 incrassate; 4 long, subulate. Mentum not clearly visible. Ligula apparently entire, rather long, narrowed towards the apex. Labial palpi apparently 2-jointed, both joints elongate; joint 2 subtruncate at apex.

Mesosternal process subacute, moderately long, not carinate, slightly raised above the level of the metasternal projection. Metasternal projection rather long, its apex concealed by the mesosternal process.

Abdomen with the ventral surface strongly convex, with the extremity turned upwards.

Middle coxae approximated; middle acetabula entirely closed. Tarsi 4–5–5-jointed; none of the basal joints elongate; the last joint of each tarsus long.

Type and only species: — *S. penicillata*, sp. nov.

Strophogastra penicillata, sp. nov.

Rather short and broad, subfusiform, not very depressed, dull; throughout very finely and very densely, the elytra scarcely more strongly, punctate; without conspicuous pubescence. Not unlike a Datomicra or a very small Acrotona, but distinct at first sight by the structure of the abdomen and by the remarkable male sexual characters.

Pitchy black, the elytra and the abdominal apex somewhat paler; antennae pitchy black, the legs paler.

Antennae about as long as head and prothorax together, not stout, moderately incrassate towards the apex; joint 2 longer than 3; the penultimate joints moderately transverse.

Head narrower than the prothorax.

Prothorax slightly narrower than the elytra, transverse, about one half broader than long, narrowed in front, rounded at the sides and angles, without impressions or lateral bristles.

Elytra considerably longer than the prothorax, slightly dilated from base to apex, scarcely sinuate in the outer hind angles.

Abdomen narrower than the elytra, with rounded sides, strongly narrowed towards the apex; tergites 3–6 gradually and rapidly decreasing in width; 7 almost three times as long as 6.

Legs moderately long; the tibiae without bristles.

In the male the abdominal apex with long straight hairs, and with 2 or 3 longer hairs which are curved inwards; the eighth tergite lightly notched in the middle of the hind margin; the ninth and the anal styles visible; the sixth sternite with a rather long spike in each outer angle, the spikes provided with 3–5 spinules which are directed obliquely upwards and outwards.

In the female the hairs at the abdominal apex are short and rather inconspicuous; the eighth tergite and the sixth sternite apparently simple.

Length 1.1 mm.

TYPE.— Coll. A. Fenyes 28,848 ♂. PARATYPE.— M. C. Z. 9,984. Manitoba: Stonewall, in rotten fungus, 18 August, 1918. J. B. Wallis. Eight males and four females have been examined.

MESARAEUS, gen. nov.

Elongate, narrowest in the middle, with dilated abdomen, apparently apterous; not unlike in shape to certain species of Leptusa of the subgenus Oreusa, but larger in size, with longer antennae and entirely different anatomical characters. Belongs in the Athetini (tarsi 4–5–5-jointed, antennae 11-jointed, maxillary palpi 4-jointed, labial palpi 3-jointed), where it is rather isolated, though perhaps nearest to Falagriota Casey, and Myrmecopora Sauley.

Labrum transverse, emarginate in the middle. Mandibles of the rather usual form; the right mandible with a feeble tooth below the apex. Maxillary lobes of the usual form; the inner lobe hooked at apex, but without spinules on the inner margin, where it is moderately densely pubescent with rather long hairs; the outer lobe corneous outwardly, pubescent at apex. Maxillary palpi 4-jointed, rather short and stout; joints 2 and 3 stout; 4 elongate. Mentum apparently truncate at apex. Ligula cleft, but not absolutely clear in my dissection. Labial palpi 3-jointed, the joints decreasing in thickness; 2 short; 3 elongate.

Antennae 11-jointed, long, somewhat incrassate towards the apex; joints 1–3 subequal; the penultimate joints about square; joint 11 almost longer than 9 and 10 together, rather broad, rounded at apex.

Head fully as broad as the prothorax, subtruncate at base, with a narrow neck; genae not margined; eyes moderate, rather prominent.

Prothorax about as long as broad, subhexagonal, convex, not impressed.

Prosternum membranaceous behind the front coxae, without additional corneous plates.

Mesosternum short, entering but little between the middle coxae, broadly rounded at apex, not raised above the level of the metasternum.

Metasternum long, produced between the middle coxae, with a large intercoxal piece.

Elytra shorter and not broader than the prothorax, (connate?); slightly sinuate at the outer hind angles.

Abdomen large, elongate, oviform, in its broadest portion broader than the elytra; the first three free tergites impressed at base.

Legs rather long, thin; tarsi 4–5–5-jointed; hind tarsi shorter than the tibiae, with elongate first joint. Middle coxae rather separated; middle coxal cavities entirely open behind.

The genus is erected for *M. laevigatus*, a new species from Argentine. The species is probably myrmecophilous, and is very likely apterous, for I could find no wings in the example dissected. The absence of wings explains the form of the body; because in apterous species the median parts of the body are usually the narrowest ones, and the mesosternal and metasternal parts are contracted.

Mesaraeus laevigatus, sp. nov.

Strongly shining, almost impunctate; with very scarce inconspicuous yellowish pubescence, and with longer black bristles on the sides, these bristles being rather dense around the abdominal apex.

Reddish brown, the abdomen vaguely infuscate towards the apex and on the lateral margins; antennae and legs slightly paler than the body.

Antennae longer than head and prothorax, rather thin.

Head unimpressed.

Prothorax broadest at the basal third, the front margin deeply emarginate for the reception of the narrow neck.

Sexual characters not distinct in the five examples before me.

Length 3 mm.

TYPE.— Coll. A. Fenyes 28,905. PARATYPE.— M. C. Z. 9,985. Argentina: Buenos Aires (province), 2 September, 1917. C. Bruch.

HYDROSMECTINA MACRA, sp. nov.

Elongate, parallel, rather depressed, feebly shining; very finely and very densely, the abdomen towards the apex less densely, punctate; pubescence almost inconspicuous. Dissection shows 4–5–5-jointed tarsi, 11-jointed antennae, 4-jointed maxillary, and 3-jointed labial palpi, bilobed ligula and both mandibles modified on the inner margin, the left mandible with an acute process, the right one with an obtuse dentiform projection which is larger than that of the left mandible, also a very short mesosternum with pointed apex, and posteriorly broadly open middle coxal cavities. These characters refer the species to Hydrosmectina; I am not aware of it having been described previously, for *Atheta* (*Hydrosmectina*) *subtilior* Bernh., appears to be a Thecturota, with 4–4–5-jointed tarsi.

Pitchy brown, the head darker, the abdomen scarcely darker; antennae a little paler than the body; legs testaceous.

Antennae longer than head and prothorax together, slender, but little incrassate towards the apex; joints 1–3 decreasing in length, 4–10 gradually slightly broader, 10 scarcely transverse; 11 about as long as 9 and 10 together.

Head almost as broad as the prothorax, large, quadrate, with rounded basal angles, the vertex with a rounded foveola; genae not margined; eyes rather large, though a little shorter than the tempora, slightly prominent.

Prothorax narrower than the elytra, about as long as broad, scarcely narrowed towards the base, the sides parallel; with an entire longitudinal linear impression in the middle.

Mesosternum short, pointed at apex; the middle coxae contiguous, their cavities broadly open behind.

Elytra much longer than the prothorax, with parallel sides, scarcely sinuate in the outer hind angles.

Abdomen elongate, parallel; tergite 7 a little longer than 6; tergites 3–5 transversely impressed at base.

Legs rather short, with short tarsi.

Sexual characters not observed.

Length — with extended abdomen — 1.8 mm.

TYPE.— Coll. A. Fenyes 28,656. PARATYPE.— M. C. Z. 9,986. S. Cala.: Pasadena, April, 1918 in storm-debris. Several specimens.

Lipodonta, gen. nov.

Near relative of Atheta Thomson, differing in the non-dentate right mandible and in the very large eyes. Lypoglossa Fenyes, and Tomoglossa Kraatz are closely related to Lipodonta, but Lypoglossa differs at once in its large size, while in Tomoglossa both mandibles are bisinuate, though not dentate.

Labrum transverse, emarginate in front, with rounded angles. Mandibles both mutic. Maxillae: inner lobe dentate at apex, ciliate towards the base; outer lobe ciliate at apex. Maxillary palpi 4-jointed; joint 3 the longest of all; 4 moderately long. Mentum transverse, emarginate. Ligula cleft beyond the middle. Labial palpi 3-jointed; joints 2 and 3 rather elongate.

Antennae 11-jointed, rather long, but little incrassate towards the apex.

Head rather large; genae entirely margined; the eyes very large.

Prothorax transverse.

Mesosternal process pointed.

Elytra wider and longer than the prothorax.

Abdomen slightly narrowed towards the apex; tergites 3–5 transversely impressed at base.

Legs moderately long; tarsi 4–5–5-jointed; hind tarsi with joint 1 scarcely longer than 2. Middle coxae very approximated; middle acetabula entirely closed.

Type and only species: — *L. veris*, sp. nov.

Lipodonta veris, sp. nov.

Elongate, rather narrow, subparallel, somewhat depressed; dull, the abdomen rather shining; scarcely pubescent. Reminds somewhat of Homalota and its allies, but with 5-jointed middle tarsi.

Brownish black, the head almost black, the abdomen scarcely paler than the elytra; antennae dark brown, scarcely paler at base; legs testaceous.

Antennae longer than head and prothorax, rather thin, scarcely incrassate towards the apex; joints 2 and 3 almost equal; 4–10 from longer than wide to about as long as wide; 11 about as long as 9 and 10 together.

Head rather large, subtransverse, rounded, with a rather large central fovea; dull, coarsely and sparsely punctate; genae entirely margined; the eyes very large, prominent.

Prothorax scarcely broader than the head with the eyes, feebly transverse, distinctly narrowed-sinuate towards the base, widest in the anterior third where it is subangulate, with a transverse basal foveola and a shallow longitudinal impression; rather dull, more finely and more densely punctate than the head.

Elytra wider and rather longer than the prothorax, slightly emarginate in the outer hind angles; feebly shining, still more finely punctate than the prothorax and about as densely so.

Abdomen subparallel, slightly narrowed towards the base and towards the apex, the sides slightly rounded; segment 7 a little longer than 6; segments 3–5 transversely impressed at base; shining, rather densely and not too finely punctate, more sparsely so towards the apex.

Sexual characters not distinct.

Length — somewhat extended — 2.5 mm.

Type.— Coll. A. Fenyes 28,605. Paratype.— M. C. Z. 9,987. S. Cala.: Pasadena, Arroyo Seco, March, 1918 in flood-debris. A good series.

Periergopus, gen. nov.

Tarsi 4–5–5-jointed; antennae 11-jointed; maxillary palpi 4-jointed; labial palpi, ligula, and mandibles not distinctly visible in the unique type-species; genae not margined; mesosternum not pointed, broadly truncate-emarginate; middle coxae separated; hind tarsi with the first joint longer than the second; mesosternum not carinate; middle acetabula closed; prothoracic hypomera visible from a lateral point of view; head constricted at base; prosternum not corneous behind the anterior coxae; tibiae not spinose; eyes longer than the longitudinal diameter of the tempora; seventh tergite not longer than the sixth; tergites 3–5 impressed at base; meso- and meta-sternal processes approximated, in close contact; mesosternum and metasternum long; embolic piece between mesosternal and metasternal processes absent.

The above diagnosis will suffice to characterize this genus and will distinguish it from its nearest relatives, Zyras and Astilbus. It differs from Zyras principally in the non-margined tempora; from Astilbus in the approximated meso- and metasternal processes; while the male sexual characters of the only species are unique.

Type and only species: — *P. sculptus*, sp. nov.

Periergopus sculptus, sp. nov.

Narrow and parallel in front, with much broader, but parallel, elytra and abdomen; moderately shining, the abdomen more strongly so; head, prothorax, and elytra coarsely granulose, the abdomen very sparsely, finely punctate.

Lead-black, with feeble metallic lustre; antennae lighter at base; legs somewhat lighter in color, the femora abruptly yellowish in basal half.

Antennae not longer than head and prothorax together, rather slender, somewhat incrassate distally; joint 2 shorter than 1 or 3, the penultimate joints moderately transverse, 11 about as long as 9 and 10 together, round pointed at apex.

Head as broad as the prothorax, quadrate, base subtruncate, basal angles prominent though rounded, front longitudinally carinate; neck broad, but abrupt; genae not margined; eyes longer than the longitudinal diameter of the tempora.

Prothorax about as long as broad, almost quadrate, widest behind the acute front angles, thence almost straight to the obtuse but distinct hind angles, slightly sinuate before the latter, the lateral margins distinctly beaded.

Scutellum large.

Elytra more than one half broader than the prothorax, but almost shorter than the latter, with prominent shoulders and slightly dilated sides; scarcely sinuate in the outer hind angles.

Abdomen as broad as the elytra, broad, subparallel, the tergites of equal length, tergites 3–5 transversely impressed at base; margins well developed.

Legs rather long and slender; hind tibiae distinctly curvate.

In the unique male the intermediate antennal joints are distinctly dilated unilaterally towards the inner margin; the eighth tergite elliptically emarginate at apex, with the angles of the emargination rounded but distinct, the surface of the tergite with six obliquely placed granules, three on each side; the sixth sternite scarcely produced; the tarsi of the hind legs greatly dilated, the first joint being broader than the tibia.

Length 5 mm.; elytra 1.8 mm. wide.

Type.— M. C. Z. 9,988♂. Cameroun. George Schwab. Received from Roland Thaxter.

Gnathusa tenuicornis, sp. nov.

Rather broad, subparallel; moderately shining, somewhat less so on the elytra; the pubescence inconspicuous. Almost indistinguishable from the type-species of the genus (*G. eva* Fenyes), but with entirely different antennae. That the difference in the antennal structure is not a sexual character, is proven by the fact that *G. eva*, with strongly incrassate antennae has been found only at Tahoe City, Cal., whereas *G. tenuicornis* has been taken only above Tahoe City, in the high mountains, and also further north at Glacier in British Columbia.

Black, antennae pitchy, legs brown.

Antennae almost shorter than head and prothorax, very little incrassate towards the tip; joint 3 almost one half shorter than 2; 4–10 transverse; 11 a little longer than 10.

Head large, transverse, finely and sparsely punctate; genae entirely margined; eyes slightly shorter than the tempora.

Prothorax slightly wider than the head, very strongly transverse, the sides subparallel and feebly rounded; with a feeble, rounded basal impression and with a feeble longitudinal furrow; finely and rather sparsely punctate.

Elytra slightly broader and about a fourth longer than the prothorax, alutaceous; finely and not densely, roughly punctate.

Abdomen parallel. tergites 3–5 impressed at base; finely and very sparsely punctate, almost smooth behind.

Length 2.6 mm.

TYPE.—Coll. A. Fenyes 18,369. PARATYPE.—M. C. Z. 9,989 B. Col.: Glacier. Four specimens. Found also in California, in the mountains near Deer Park Springs.

The genus Gnathusa may prove to be synonymous with Mniusa Mulsant and Rey (Eurylophus J. Sahlberg), but is probably a valid genus, because of the structure of the mandibles, and not a subgenus of Ocyusa Kraatz where it has been placed previously.

ANOCALEA, gen. nov.

The non-margined genae and short metasternum distinguish Anocalea from Ocalea Erichson with which it agrees in all important characters.

Type and only species: — *A. thaxteri*, sp. nov.

ANOCALEA THAXTERI, sp. nov.

Elongate, moderately narrowed towards the head and the abdominal apex, neither depressed nor convex; strongly, the elytra more feebly, shining; head not finely, sparsely, prothorax a little more finely, sparsely, elytra rather strongly, moderately densely, abdomen from base to apex gradually more finely, sparsely, punctate; pubescence yellowish, rather conspicuous; prothorax, elytra and abdomen with a few coarser black hairs on the margins.

Black, with slight aeneous lustre; elytra brownish yellow, triangularly and vaguely infuscate around the scutellum, scarcely infuscate along the lateral margins; antennae black, joint 1 pitchy; legs brownish yellow.

Antennae scarcely longer than head and prothorax together, moderately incrassate towards the apex; joints 1–3 decreasing in length; 4 longer than broad, 10 scarcely transverse; 11 about as long as 9 and 10 together, acuminate.

Head a little narrower than the prothorax, subquadrate, not foveolate; neck broad; genae not margined; eyes apparently shorter than the tempora.

Prothorax considerably narrower than the elytra, transverse, about a third broader than long; sides narrowed in the anterior third, thence almost parallel to the base, the base and all the angles rounded; with a round foveola at base.

Mesosternum with a rudimentary carina.

Elytra about a third longer than the prothorax, the sides parallel, the shoulders prominent but rounded, the outer hind angles distinctly emarginate.

Abdomen subparallel, tergites 3–5 transversely impressed at base, tergite 7 not longer than 6.

Legs moderate, middle tibiae spinose and with two lateral bristles; all the tarsi 5-jointed, hind tarsi with joint 1 a little longer than 2.

Sexual characters not conspicuous.

Length 2.8 mm.

Type. — M. C. Z. 9,990. Paratype — Coll. A. Fenyes 29,241. S. Chile: Punta Arenas. Roland Thaxter. Several hundred examples were taken in the Antarctic forest in herbage traps.

Hygropora americana, sp. nov.

Moderately elongate, rather robust, almost parallel, rather feebly shining, scarcely pubescent.

Pitchy brown, the antennae and legs somewhat paler.

Ligula bilobed, each lobe with a narrow, acute, small appendage.

Antennae slightly longer than head and prothorax, rather robust, very slightly incrassate towards the apex; joint 3 considerably shorter than 2; 4–10 transverse, gradually broader; 11 not quite so long as 9 and 10 together, distinctly constricted in the middle.

Head subtriangular, very finely and rather densely punctate; genae entirely margined; the eyes about as long as the tempora.

Prothorax much wider than the head, fully a third wider than long, scarcely narrower in front than behind, strongly rounded at the sides, with a very obsolete transverse impression at the base; very finely and rather densely punctate.

Elytra slightly longer and not wider than the prothorax, parallel, with deeply emarginate outer hind angles; densely and a little more coarsely than the prothorax, punctate.

Abdomen almost parallel, the seventh tergite not longer than the sixth;

extremely finely and densely, evenly punctate; the sixth sternite moderately produced and rounded.

Tarsi 5–5–5-jointed.

Length 2 mm.

Type.— Coll. A. Fenyes 17,800 ♂? Paratype.— M. C. Z. 9,991. B. Col.: Vancouver, Shawnigan Lake, shores of a stagnant pool near Koenig's Hotel. Sixteen specimens.

Polylobus thaxteri, sp. nov.

Attenuated in front and still more so behind; shining, the elytra somewhat dull; head and prothorax finely, sparsely, elytra a little more strongly and more closely, the abdomen moderately sparsely, behind more scatteredly, punctate; pubescence sparse but conspicuous, yellowish, the abdominal apex with rather coarse, long, black bristles. The generic position of this species is somewhat doubtful, for the outer lobe of the maxillae lacks the small lobules said to be characteristic of Polylobus.

Head light brownish; prothorax light brownish yellow, vaguely infuscate on the disc; elytra light brownish yellow; abdomen dark brown, lighter at base and apex; antennae and legs light brownish yellow.

Antennae slightly longer than head and prothorax together, rather slender incrassate towards the apex; joint 1 slightly longer than 2; 4 longer than broad, 10 slightly transverse; 11 about as long as 9 and 10 taken together.

Head much narrower than the prothorax, transversely quadrate, the sides parallel with prominent tempora; genae entirely margined; eyes about as long as the tempora, rather prominent.

Prothorax at base about as broad as the elytra, strongly transverse, fully one half broader than long, narrower in front than behind, the sides rounded; not impressed; hypomera not visible from a lateral point of view.

Mesosternal process long, pointed, its apex from a lateral point of view free, curvate and situated above the level of the short metasternal projection.

Elytra much longer and, at apex, broader than the prothorax, the outer hind angles strongly emarginate.

Abdomen pointed, tergite 7 longer than 6, tergites 3–6 transversely impressed at base.

Legs moderate; tarsi 5–5–5-jointed, hind tarsi with joint 1 longer than 2. Middle coxae approximated but not contiguous; middle acetabula closed.

In the male tergite 8 subangularly emarginate at apex, with about 6 acute, dentiform prominences.

Length 2.8 mm.

TYPE.— M. C. Z. 9,972 ♂. PARATYPE.— Coll. A. Fenyes 29,277. S. Chile; Punta Arenas 1906. Roland Thaxter. Several specimens.

MICROGLOTTA BARBERI, sp. nov.

Moderately elongate, subparallel, somewhat robust and broad, feebly shining; with sparse, rather inconspicuous, yellow pubescence.

Head black, prothorax bright yellow-red; elytra reddish brown, vaguely infuscate around the scutellum and in the outer hind angles; abdomen reddish, with tergites 3–5 basally, 6 entirely and 7 almost entirely, blackish; antennae and legs light reddish.

Antennae almost as long as head and prothorax together, rather short, incrassate towards the apex; joints 2 and 3 subequal; 4–10 transverse, 10 about one half broader than long; 11 slightly shorter than 9 and 10 together, oval, distinctly constricted in the middle.

Head narrower than the prothorax, transverse, rather coarsely and sparsely punctate; genae entirely margined; eyes large, much longer than the tempora, slightly prominent.

Prothorax narrower than the elytra, transverse, about one half broader than long, narrower at apex than at base, the sides rather evenly rounded, the base rounded; convex; moderately sparsely and a little more finely than the head, punctate.

Elytra a little broader and a little longer than the prothorax, parallel, emarginate in the outer hind angles; more densely than the prothorax, and somewhat roughly, punctate.

Abdomen subparallel; tergite 3–5 distinctly impressed at base, tergite 7 scarcely longer than 6.

External sexual characters not perceptible.

Length 3 mm.

TYPE.— Coll. A. Fenyes 28,455. PARATYPE.— M. C. Z. 9,993. Va.: Chain Bridge in nests of *Riparia riparia* (Linné), 28 June, 1916. T. E. Snyder and H. G. Barber. Numerous examples together with the larvae.

PSEUDOPLANDRIA, gen. nov.

Body subfusiform, rather broad, moderately depressed; very similar to a Hoplandria Kraatz but with 5–5–5-jointed tarsi.

Labrum transverse, slightly emarginate, with rounded angles. Mandibles rather long, acute at apex, the right mandible with an acute tooth in the middle of the inner margin. Maxillae: inner lobe with 4–5 acute spines near the apex on the inner margin, below these spines, and at some distance, with another, longer, isolated spine, below the latter with finer spines and hairs; outer lobe hairy at apex. Maxillary palpi 5-jointed. Ligula long, bifid. Labial palpi 4-jointed.

Antennae 11-jointed, longer than head and prothorax, incrassate towards the apex; joint 3 scarcely shorter than 2; 4 longer than wide, 10 transverse; 11 longer than 9 and 10 together, acutely pointed.

Head narrower than the prothorax, transversely rounded, not constricted at base; genae entirely margined; eyes large, longer than the tempora, prominent.

Prothorax a little narrower than the elytra, very strongly transverse, the apex narrower than the base, the sides strongly rounded; hypomera not visible from a lateral point of view.

Prosternum not corneous behind the front coxae.

Mesosternal process rather broad, rounded at apex, long, carinate in its entire length.

Metasternal projection short, approximated to the mesosternal process.

Elytra a little longer than the prothorax, emarginate in the outer hind angles.

Abdomen narrowed from base to apex, tergite 7 longer than 6, tergites 3–5 transversely impressed at base.

Legs moderate; tibiae finely spinose; tarsi 5–5–5-jointed, the hind tarsi with joint 1 not longer than 2. Middle coxae separated, middle acetabula closed.

Type and only species: — *P. laeta*, sp. nov.

Pseudoplandria laeta, sp. nov.

Strongly shining; head and prothorax almost without sculpture, the latter with 4 fine, quadrangularly placed punctures in the middle of the disc, the elytra coarsely densely granulate; abdomen irregularly punctate, more densely so towards the sides of the individual segments which are almost smooth in the middle; pubescence rather coarse and rather conspicuous, more so on the margins of the body.

Color reddish, the head a little darker, the elytra infuscate with vaguely paler shoulders; antennae infuscate, reddish at base and apex; legs reddish.

In the male tergite 7 with a long, robust keel along the middle, the lateral margins of the tergite produced backwards so as to form an acute spine which does not attain the apical margin of the segment; tergite 8 with a hemielliptical smooth raised area in the middle, the tergite semicircularly emarginate at apex, the emargination apparently crenulate.

Length 3 mm.

TYPE.— M. C. Z. 9,994 ♂. PARATYPE.— Coll. A. Fenyes 28,968. Luzon: Los Banos. Several examples taken in refuse received from Roland Thaxter.

ALEOCHARA (ISOCHARA?) PERTURBANS, sp. nov.

The subgeneric position of this species is doubtful, it having characters attributed to Isochara, Rheochara, and Coprochara; it is placed temporarily in Isochara, because of the carinate mesosternum, but isolated in this subgenus by the Coprochara-like, though feeble, punctuation of the prothorax.

Moderately elongate, subparallel, somewhat depressed, shining, head and prothorax with mirror-like lustre; pubescence inconspicuous.

Black, head and prothorax with a faint metallic lustre; elytra blood-red, vaguely infuscate around the scutellum, the abdomen somewhat paler at apex; antennae nearly black, dark brown at base; legs brownish red.

Antennae rather long, almost surpassing the base of the prothorax, moderately slender, incrassate towards the apex; joints 2 and 3 of about equal length, the penultimate joints very moderately transverse; joint 11 longer than 9 and 10 taken together.

Head much narrower than the prothorax, about quadrate, scarcely visibly punctate.

Prothorax fully as broad as the elytra, rather strongly transverse, rounded at all the angles; evenly convex, with two series of sparse and very fine punctures along the smooth median line, also with similar additional punctures laterally and basally.

Mesosternum rather narrow, narrowed to the rounded apex where it is not modified, carinate in its entire length.

Elytra, at the sides, about as long as the prothorax, not sinuate at the outer hind angles; shining, rather sparsely and roughly, aciculately punctate.

Abdomen almost parallel; moderately shining; somewhat densely, roughly, aciculately punctate, the punctures becoming sparser on the last two segments.

Legs rather slender, anterior and intermediate tibiae finely spinulose on the outer margins, the hind tarsi shorter than the tibiae.

Length 3.8 mm.

TYPE.— Coll. A. Fenyes 28,843. Manitoba: Treesbank, 18 July, 1918. J. B. Wallis.

Polytomic synopsis of the tribes of Aleocharinae.

I. Tarsi 1–1–1-jointed.
(Antennae 11-jointed).
Tribal group: Holomonomera.
1a. Maxillary palpi 4-jointed.
(Labial palpi 3-jointed).
1. Tribe: Sympolemonini. (Sympolemon Wasmann).
1b. Maxillary palpi 5-jointed.
(Labial palpi 4-jointed).
2. Tribe: Dorylogastrini. (Dorylogaster Wasmann).

II. Tarsi 2–2–2-jointed.
(Antennae 12-jointed).
Tribal group: Holodimera.
3. Tribe: Adinopsini. (Adinopsis Cameron).

III. Tarsi 3–3–3-jointed.
(Antennae 11-jointed).
Tribal group: Holotrimera.
4. Tribe: Deinopsini. (Deinopsis Matthews).

IV. Tarsi 4–4–4-jointed.
Tribal group: Holotetramera.
1a. Antennae 10-jointed.
(Maxillary palpi 4-jointed).
2a. Labial palpi 2-jointed.
5. Tribe: Oligotini.
2b. Labial palpi 3-jointed.
6. Tribe: Nematoscelini. (Nematoscelis Wollaston).
2c. Labial palpi 4-jointed.
7. Tribe: Leptanillophilini. (Leptanillophilus Holmgren).
1b. Antennae 11-jointed.
3a. Maxillary palpi 2-jointed.
(Labial palpi 2-jointed).
8. Tribe: Termitoptochini. (Termitoptochus Silvestri).
3b. Maxillary palpi 4-jointed.
4a. Labial palpi 1 jointed.
9. Tribe: Termitomimini. (Termitomimus Trägårdh).
4b. Labial palpi 2-jointed.
10. Tribe: Pachyglossini.
4c. Labial palpi 3-jointed.
11. Tribe: Hygronomini.
3c. Maxillary palpi 5-jointed.
5a. Labial palpi 1-jointed.
12. Tribe: Heterotaxini. (Heterotaxus Bernhauer).
5b. Labial palpi 4-jointed.
13. Tribe: Ecitogastrini. (Ecitogaster Wasmann).

V. Tarsi 4–4–5-jointed.
Tribal group: Ditetramera.
1a. Antennae 10-jointed.
(Maxillary palpi 4-jointed).
(Labial palpi 3-jointed).
14. Tribe: Timeparthenini.
1b. Antennae 11-jointed.
2a. Maxillary palpi 4-jointed.
3a. Labial palpi 2-jointed.
15. Tribe: Gyrophaenini.
3b. Labial palpi 3-jointed.
16. Tribe: Bolitocharini.
2b. Maxillary palpi 5-jointed.
(Labial palpi 1-jointed).
17. Tribe: Oxypodinini. (Oxypodinus Bernhauer).
VI. Tarsi 4–5–5-jointed.
(Antennae 11-jointed).
Tribal group: Monotetramera.
1a. Maxillary palpi 4-jointed.
2a. Labial palpi 1-jointed.
18. Tribe: Pronomaeini. (Pronomaea Erichson).
2b. Labial palpi 2-jointed.
19. Tribe: Thamiaraeini.
2c. Labial palpi 3-jointed.
20. Tribe: Athetini.
1b. Maxillary palpi 5-jointed.
(Labial palpi 4-jointed).
21. Tribe: Hoplandriini.
VII. Tarsi 5–5–5-jointed.
Tribal group: Holopentamera.
1a. Antennae 10-jointed.
22. Tribe: Decusini. (Decusa Casey).
1b. Antennae 11-jointed.
2a. Maxillary palpi 4-jointed.
3a. Labial palpi 2-jointed.
23. Tribe: Leucocraspedini. (Leucocraspedum Kraatz).
3b. Labial palpi 3-jointed.
24. Tribe: Oxypodini.
2b. Maxillary palpi 5-jointed.
4a. Labial palpi 2-jointed.
25. Tribe: Nanoglossini. (Nanoglossa Fauvel).
4b. Labial palpi 3-jointed.
26. Tribe: Dorylophilini. (Dorylophilus Wasmann).
4c. Labial palpi 4-jointed.
27. Tribe: Aleocharini.

This synopsis, necessarily artificial, appears to offer several advantages over former systems, *viz.*, ORDER (the tribal characters being arranged in mathematical progression), SIMPLICITY (not more than four characters being used for the definition of the tribes), UNIFORMITY (the same four characters being employed through the key) and RELIABILITY (the four characters utilized being absolute, *i. e.* expressed in numbers, and not being relative or comparative.

The generic types of the monotypic tribes are noted in the foregoing synopsis. A few short notes on the others will be of interest.

Oligotini (type Oligota Mannerheim) has Liophaena Sharp and Oligusa Wasmann as additional genera. Pachyglossini (type Pachyglossa Fauvel) and Hygronomini (type Hygronoma Erichson) each contain several genera.

Timeparthenini (type Timeparthenus Silvestri) seems to embrace Termitonannus Wasmann also. Gyrophaenini (type Gyrophaena Mannerheim) is a new tribe, erected for the rather numerous genera which are relatives of Gyrophaena and which formerly have been constituents of the next tribe: Bolitocharini (type Bolitochara Mannerheim). In the last two tribes the number of the labial palpal joints is not always easily ascertainable, and it would be perhaps a matter of expediency to erect a new tribe, intermediate between the Gyrophaenini and the Bolitocharini, for the genera which, while exhibiting a constriction which indicates an imperfect separation of the first two labial palpal joints, cannot be properly described as having three joints to the labial palpi; the designation:—"labial palpi $\frac{2}{3}$ jointed" would separate this future tribe from both Gyrophaenini and Bolitocharini.

Mataris Fauvel, placed formerly in the Pronomaeini, is said to have two-jointed labial palpi, and therefore must be transferred to the Thamiaraeini (type Thamiaraea Thomson). In this tribe (Thamiaraeini) the counting of the labial palpal joints offers some difficulties, which could be overcome by the above suggested formula (labial palpi $\frac{2}{3}$ jointed) and the erection of an intercalated tribe.

The largest tribe the Athetini (type Atheta Thomson) contains to a certain extent the elements of the time-honored tribe Myrmedoniini, but as Myrmedonia Erichson, is neither the largest, nor the most representative, genus of the tribe, it seems proper to substitute for it Athetini, this latter name suggesting the scope of the tribe more appropriately. The Hoplandriini (type Hoplandria Kraatz) contains a moderate number of genera which appear to be more closely related to the tribe Aleocharini than to the Athetini, thus again illustrating the weak points of a linear arrangement.

The Oxypodini (type Oxypoda Mannerheim) have to be separated from the Aleocharini because of the four-jointed maxillary and three-jointed labial palpi. Oxypodini is a large tribe, containing the bulk of the Aleocharini *olim*.

The last tribe Aleocharini (type Aleochara Gravenhorst) contains a moderate number of genera, sharply separated from the Oxypodini by the five-jointed maxillary and four-jointed labial palpi, and should contain Pyroglossa Bernhauer also, the palpi of the latter genus having apparently a supernumerary joint at apex.

Bulletin of the Museum of Comparative Zoölogy

AT HARVARD COLLEGE.

Vol. LXV. No. 3.

THE HOLOTHURIANS OF THE GENUS STICHOPUS.

By Hubert Lyman Clark.

With Two Plates.

CAMBRIDGE, MASS., U. S. A.:

PRINTED FOR THE MUSEUM.

February, 1922.

No. 3.— *The Holothurians of the genus Stichopus.*

By Hubert Lyman Clark.

The holothurians of the genus Stichopus are among the most conspicuous of the animals inhabiting weedy and sandy bottoms in shallow water throughout the tropics. Under normal conditions, their form and color are not unattractive and are occasionally handsome, but removal from the water, or confinement in a vessel with but little sea-water, results very soon in an extraordinary disintegration of the body-wall which soon reduces the creature to a most repulsive mass of slime. The body-wall contains so large a percentage of water that specimens even when most carefully killed undergo a very great shrinkage, often amounting to 50% or even more. If care is not taken in killing, the animal not only shrinks but becomes more or less badly distorted, and consequently most museum material gives little indication of either form or size in life. Naturally therefore the identification of specimens is not a simple task and it is not strange that with the passage of time a large number of specific names has been used in connection with Stichopus.

The difficulty of identifying species has been much increased by the attempt to use such characters as the number of tentacles, the number and distribution of pedicels, the size and arrangement of tubercles, and even the color as diagnostic factors. In life, each is of great importance and even in preserved material each may be of value but unfortunately the exceptional shrinkage and distortion to which preserved material is liable, and the alterations of color caused by alcohol, make such characters dangerous guides. Furthermore growth-changes are now known to produce some striking differences and it is necessary therefore to assign different degrees of value to the various characters in different species. The following evaluation will be of service.

Size.— All the known species reach a considerable size when adult. The two new species are unquestionably based on young specimens, and hence their size when adult remains to be determined. All of the well-known species reach a length of 200–300 mm. in life with a width of 50–100 mm. But many individuals exceed these dimensions and *variegatus* is often much bigger. Semper records specimens of that species from the Philippines 900 mm. long and 200 mm. wide. The largest Stichopus I have measured was one at Mer, Murray

Islands, which was about 725 mm. long by 125 mm. wide. In its preserved condition this specimen is now much flattened, 350 mm. long and 110 mm. wide. It is a safe assumption that any Stichopus under 100 mm. long in life is still immature; hence preserved material under 50 mm. and most of that under 70 mm. is unquestionably young.

Color.— While none of the species are brilliantly colored, pigmentation of the skin is usually very extensive. The pigment is commonly dark brown, approaching black, dark purple, dark green, and rusty-red or light reddish brown. Possibly black pigment occurs but usually the dark colors when carefully examined are seen to indicate brown, purple, or green. Unicolored individuals are common in many species but as a rule most of the species are speckled, spotted or mottled and variegated individuals with surprising combination of shades are often seen. In few species is the coloration sufficiently uniform and constant to be of value as a specific character, but in the type-species (*chloronotus*) it is very distinctive. On the other hand, in *badionotus* it seems to be of no value whatever, some individuals being uniformly light-colored, others uniformly dark and a large majority showing some combination of light and dark shades. As yet we are quite ignorant of the causes or significance of this diversity. Apparently individuals when very young, just after metamorphosis, have no pigment but this soon begins to develop, at first of light color and in more or less scattered patches. Subsequently the dark pigment develops, at first in specks or spots; it increases in most cases to form blotches and ultimately, very often completely fills the skin, giving rise to uniformly dark coloration. Light colored individuals would thus be the young, spotted and blotched the adults, and uniformly dark, the senescent. But unfortunately the problem is complicated by the entire lack of dark pigment in many cases, or by its very erratic development, and by the important fact that there is no close correlation between size and age in echinoderms. Until the life-history of some species has been completely worked out from the metamorphosis to the attainment of maximum size, we cannot interpret with confidence the diversity of color shown by certain species. But it is certain that little reliance can be placed on color or color-pattern as a specific character unless a large number of individuals of very diverse sizes have been examined in life. It is almost hopeless to draw any conclusions from the color of preserved specimens for neither alcohol nor formalin hold the natural colors satisfactorily. The distinctive colors such as red, green, blue, and yellow are particularly fugacious.

Body-form.— The body-form is quite characteristic. The ventral surface is flat, with a broad median ambulacrum and on each side an ambulacrum half as wide. The dorsal surface is elevated but only slightly arched, the sides of the body being nearly vertical. The vertical diameter of the animal is usually about four fifths of the horizontally transverse. As a rule, the margin between the side-wall and the ventral surface is much thickened and is provided with conspicuous papillae. This marked differentiation of the upper and lower surfaces is evident even in very small individuals and is a convenient recognition-mark for the genus.

Ambulacral Appendages.— There are typically twenty equal tentacles surrounding the mouth and there is no adequate ground for thinking that the normal adult of any species has more or fewer. But specimens with only eighteen or nineteen tentacles are frequent and those with 15, 16, 17, 21, or 22 are not unknown. It seems probable that most specimens with fewer than twenty tentacles are not fully mature, but they may be, like those with more than twenty, simply individual variants. At any rate, the number of tentacles is typically the same in all the valid species, and is of no value for distinguishing species.

The papillae occur primarily along the dorsal ambulacra and especially along the lateroventral margin of the body. The latter appear first and may be the only conspicuous papillae present. In many cases, the ambulacral papillae are all well marked but the interambulacra are free from them, while in other cases, there are numerous papillae on the interambulacral regions. Papillae are particularly liable to shrinkage, contraction, and even disappearance in alcohol and hence it is often very difficult to decide what the normal condition was. There is little doubt moreover that both the number and the prominence of papillae varies with age, increasing to maturity and perhaps decreasing again in senescence. At any rate, it seems clear that as a rule the papillae can not be relied on for specific characters.

The pedicels increase in number with age and are of little taxonomic importance. In very young individuals, there is a double row of pedicels along the midventral line and a single row down each side. Later these series widen, become more densely crowded, and may even merge, so that the whole ventral surface is closely covered with pedicels. Meanwhile scattered pedicels occur on the dorsal surface and these increase in number with age, but never form definite series. Specific differences do not seem to be associated with the pedicels.

Calcareous Particles.— The body-wall is always abundantly supplied with calcareous particles and these furnish the most reliable characters by which the species may be distinguished. The presence of *tables* is characteristic of all the species *sensu strictu* but these tables undergo notable changes with the growth of the individual. We do not yet know whether each table undergoes growth-changes or whether tables of very young individuals are resorbed and replaced by others. There is even a possibility that the tables of youth are lost by the sloughing off of bits of epidermis. In senescence, the tables undergo changes which seem to be unquestionably the results of resorption. The growth-changes are not yet well worked out, but those which are revealed by the tables have been well studied and set forth by Mitsukuri (1897, Ann. zool. Japon, **1**, pt. 1, 2) as they occur in *S. japonicus*. In most species, the tables are symmetrical, with a moderate, squarish truncate spire and a circular, smooth disk, but high spires, irregular disks, and even much distorted tables characterize certain species. The size of the tables is of importance, furnishing a reliable specific character in many cases.

In senescent individuals of *japonicus*, the tables are replaced by small, irregular, perforated plates. In no other species have such plates been found and there is no doubt that they represent, in *japonicus*, the disks of the resorbed tables.

In four species, true *buttons*, so characteristic of many species of Holothuria, occur. These buttons show great diversity in size and number of perforations and furnish a good specific character.

In half a dozen species, *rosettes*, or small rods several times dichotomously branched but with short, thick, curved branches, are more or less abundant. Their presence or absence may not be a good specific character, for there is some ground for belief that *simulans* which has rosettes is identical with *mollis*, which lacks them. But as yet we need evidence on the matter.

In all species of Stichopus *s. s.*, supporting *rods* occur in pedicels, papillae, and tentacles but there is little that is distinctive about them. On the other hand their absence in Thelenota and Astichopus is very characteristic. In Thelenota, minute, slender dichotomously branched *rods*, not at all like rosettes, occur in the body-wall, and their form and proportions afford a good specific character.

In many species, characteristic C-shaped bodies occur in the body-wall below the epidermis or at least beneath the layer of tables. The size of these Cs may furnish a good specific character for while there is some diversity even in one individual, it is not very great. In Astichopus, the C-shaped bodies are much stouter than in any species of Stichopus and are very commonly transformed into Os or Ss or even into irregular rods. There seems to be more or less individual diversity in the number of C-shaped bodies. Often they are absent from one preparation of the body-wall, and present in another. Their entire absence therefore can only be determined with great care. If present at all, they will usually be found near the bases of pedicels and papillae.

In Thelenota and Astichopus, the epidermis is full of very minute spherical or biscuit-shaped granules which may be grouped, or form a uniform layer.

Terminal plates are present in the pedicels and in many of the papillae. Anal teeth are quite lacking, nor is there any indication of calcified papillae around the anus.

Calcareous Ring.—Although stress has been laid by some writers on the form of the calcareous ring as a distinctive character, I am unable to make any satisfactory use of it. It undergoes considerable increase in bulk and no little change in form in the assumption of full maturity and apparently these changes continue during senescence. In young individuals there is little difference between the dorsal and ventral-sides of the ring, but a marked difference occurs in most large specimens owing to the much greater development of the dorsal side.

Polian Vesicles.— The number of Polian vesicles is not a safe guide to specific differences, for while the number is commonly 1–3, there may be as many as six. In Thelenota and Astichopus, the Polian vesicles are very long and are branched, a most unusual condition among holothurians. In the holotype of *Stichopus paradoxus*, two of the vesicles had short lateral branches near the base.

Madreporic Canal.— Apparently the madreporic canal is always single, embedded in the dorsal mesentery, but with the madreporite itself more or less free.

Gonads.— The presence of a tuft of gonads on each side of the dorsal mesentery has long been regarded as the chief distinguishing feature. But there is need of further study on living (or fresh) material, to ascertain what the age or seasonal differences may be. Examination of all the specimens of Thelenota available lead me to think that the gonads are unequally developed in that genus and that those of one side may, at least sometimes, be wanting.

Cuvier's Organs.— Cuvier's organs are wanting in all species of Stichopus, Thelenota, and Astichopus, with the possible exception of *S. paradoxus.* In Lampert's description of this species, he says that Cuvier's organs, brown in color and 7 cm. and more in length are present. Both the color and size given suggest that some other organs are here confused with Cuvier's organs, which in all authenticated cases are white or whitish and in preserved material are rarely more than 3 cm. long.

It is evident then that the calcareous particles are the only structures upon which much reliance can be placed in differentiating the species although the body-form and the gonads afford characters of real value in distinguishing the genus, and the Polian vesicles may also furnish a generic character.

Stichopus was established by Brandt in 1835, with three species. Of these *chloronotus* was the only member of a subgenus Perideris, while *cinerascens* and *leucospilota* were put in a subgenus Gymnochirota. Subsequent writers have agreed that the two Gymnochirotas are members of Holothuria in a broad sense, so that *chloronotus* is universally accepted as the type of Stichopus. This is most fortunate for *chloronotus* is a very well-known species with very definite characters including a fairly constant coloration (in life) and hence it is possible to define the genus in a satisfactory way.

Stichopus.

Brandt, 1835. Prod. Anim., p. 250.

Genotype:— *Stichopus* (*Perideris*) *chloronotos* Brandt, *Loc. cit.*

Aspidochirote holothurians with flattened ventral surface, markedly distinct from dorsal; pedicels more or less fully covering ventral side; dorsal surface with tubercles or papillae, at least along lateral margins; tentacles typically twenty; gonads in a tuft on each side of dorsal mesentery; no Cuvier's organs; no anal teeth or noticeable papillae around cloacal opening; numerous calcareous tables in epidermis; Polian vesicles few, unbranched; madreporic canal single.

Defined in this way the genus is easily recognized and it becomes possible to determine what its component species are. Examination of the literature shows that no fewer than eighty-one specific or varietal names have been used in connection with Stichopus, but these fall readily into four classes:— unidentifiable forms, holothurians not belonging in the genus as defined above, synonyms, and valid species. Each of these groups may be considered by itself.

Unidentifiable Forms.

Most of the names in the following list date back more than eighty years and have never been adequately diagnosed or associated with any well-known holothurians. There is therefore little to be said about them.

albifasciatus Selenka, 1867, p. 320 = *Holothuria albifasciata* Quoy and Gaimard, 1834, p. 132. Tonga. Not identifiable from available data but collecting at Tonga might reveal the holothurian described by Quoy and Gaimard.

cinerascens Grube, 1840, p. 36. Mediterranean Sea. Obviously not *cinerascens* Brandt but absolutely unidentifiable.

fuscus Ludwig, 1875, p. 97. Patagonia. Although Ludwig gives a good description the absence of any indication of the size of the calcareous tables makes it impossible to identify the species or determine its relation to *mollis, simulans, et al.* The locality "Patagonia" seems highly improbable for a true Stichopus.

lucifugus Brandt, 1835, p. 273 = *Holothuria lucifuga* Quoy and Gaimard, 1834, p. 134. Carteret, Solomon Islands. It is possible that this is *Holothuria pulchella* Selenka but satisfactory determination of the point is out of the question.

lutea Saville Kent, 1893, p. 235. Great Barrier Reef, Australia. While the name may refer to specimens of *horrens*, it is more likely to be synonymous with *variegatus*.

luteus Brandt, 1835, p. 273 = *Holothuria lutea* Quoy and Gaimard, 1834, p. 130. Tonga. Quite unrecognizable. Selenka's comments (1868, p. 117) on *lucifugus* have been applied by Lampert (1885, p. 109) to *luteus*, by some mistake.

maculatus Lampert, 1885, p. 109 = *Sporadipus maculatus* Grube, 1840, p. 37. Mediterranean Sea. Quite unrecognizable.

monotuberculatus Selenka, 1867, p. 320 = *Holothuria monotuberculata* Quoy and Gaimard, 1834, p. 131. Mauritius. Said by Selenka (1868, p. 117) to be identical with *H. lutea* Quoy and Gaimard but that throws no light on the matter.

sitchaensis Ludwig, 1881, p. 590 = *Diploperideris sitchaensis* Brandt, 1835, p. 252. Sitka, Alaska. In spite of Ludwig's description, the lack of measurements of the calcareous particles prevents the identification of the species. Collecting at Sitka may solve the problem.

unituberculatus Brandt, 1835, p. 273 = *Holothuria monotuberculata* Quoy and Gaimard, 1834, p. 131. Mauritius. Quite unidentifiable.

Species erroneously included in S*TICHOPUS*.

In listing here the holothurians which have been referred to Stichopus but which in my judgment are not properly members of that genus, I shall not attempt to state to what genus they should be referred unless such reference has been made by some earlier writer. Nor shall I ordinarily give the reasons which have led to the removal from Stichopus, but occasionally the decision is sufficiently novel to warrant a few words of explanation.

ananas Semper, 1868, p. 75 = *Trepang ananas* Jäger, 1833, p. 24. Celebes. Brandt (1835, p. 253) put this species in a subgenus, Thelenota, of Holothuria. This subgenus has never been recognized nor has any type been designated for it. In view of its well-marked peculiarities (see p. 48), *ananas* had best be removed from Stichopus. The name Thelenota is thus available for it and I designate it as the type of that genus. The appropriateness of the name is obvious.

challengeri Théel, 1886, p. 163. Between Marion Island and Kerguelen, 550 fms. A synallactine.

cinerascens Brandt, 1835, p. 251. Bonin Islands. Ludwig (1881, p. 597) says this is the species of Holothuria named *pulchella* by Selenka, 1867. Brandt's name must therefore replace the more familiar but later one.

flammeus Brandt, 1835, p. 273 = *Holothuria flammea* Quoy and Gaimard, 1834, p. 117. Yanikoro, St. Cruz Islands. Selenka (1868, p. 117) has shown that this name is a synonym of *Holothuria monocaria* (Lesson).

gyrifer Selenka, 1867, p. 319. Australia. Hawaiian Islands. Zanzibar. Selenka subsequently (1868, p. 117) placed this name as a synonym of *H. monocaria* Lesson.

kefersteinii Selenka, 1867, p. 318. Acapulco. Examination of type-material shows this is a Holothuria.

leucospilota Brandt, 1835, p. 251. Lagoon at Ualau, Kusaie, Caroline Islands. Ludwig (1881, p. 595) says this is the species of Holothuria named *vagabunda* by Selenka, 1867. Brandt's name must therefore replace the better known but much later one.

moseleyi Théel, 1886, p. 165. Off southern Chile, 175–345 fms. A synallactine.

multifidus Sluiter, 1910, p. 334. Tortugas, Florida. This remarkable species is best treated as type of a new genus, Astichopus (see p. 48).

natans M. Sars, 1867, p. 58. Norway: Lofoten, Bergen, Hardanger. A synallactine.

nigripunctatus Augustin, 1908, p. 7. Sagami Bay, Japan, 100 fms. Closely allied to *tremulus*, *q. v.* (p. 47).

pallens Koehler, 1895, p. 486. Bay of Biscay, 723 fms. A synallactine.

patagonicus Perrier, 1905, p. 11 = *Holothuria* (?) *patagonica* Perrier, 1904, p. 13. Santa Cruz, Patagonia. A Holothuria.

pentagonus Brandt, 1835, p. 273 = *Holothuria pentagona* Quoy and Gaimard, 1834, p. 135. Sydney, N. S. W. A Pentacta.

pourtalesii Théel, 1886a, p. 4. St. Kitts to Barbados, 208–734 fms. A synallactine.

richardi Herouard, 1896, p. 165. Gulf of Gascogne, 195 fms. A synallactine, probably.

rigidus Selenka, 1867, p. 317. Zanzibar, Society Islands, Florida. Examination of Selenka's types in the M. C. Z. collection brings out the interesting fact that while both belong in Holothuria (*sensu latu*), the one from Florida is quite distinct from that from the Society Islands. There is no specimen from Zanzibar in the M. C. Z. I restrict the name *rigidus* to the form from the Society Islands, which is easily recognized by the small rather delicate tables; these have eight vertical rods in the spire as Selenka says and there is a single peripheral circle of small holes in the smooth disk. The buttons have 5–8 pairs of holes and relatively small knobs. Selenka figures a button but it is evidently from the Florida specimen, (*Holothuria hypamma*), also found in the tropical Pacific and which I have described (Carnegie inst. Publ., 214, 1921, p. 177). Neither of the specimens at hand has the "large, roundish ellipsoids" described by Selenka. These probably were from the Zanzibar specimen, which would thus seem to represent a third species. Under the circumstances it is hard to see how Selenka could have written: "Die exemplare von so verschiedenen Fundplätzen waren bei der genauesten Vergleichung specifisch nicht auseinander zu halten." And none of the specimens are the least like Stichopus!

sagamiensis Augustin, 1908, p. 8. Sagami Bay, Japan, 100 fms. A synallactine.

sagamiensis var. *alba* Augustin, 1908, p. 10. Sagami Bay, Japan, 100 fms. A synallactine.

selenkae Barrois, 1882, p. 47. Concarneau, France. A Holothuria, probably *forskahli* Delle Chiaje.

tizardi Théel, 1882, p. 696, 59 of reprint. Faeroe Channel, 530–555 fms. A synallactine.

torvus Théel, 1886, p. 164. Off Chile, 1375 fms. A synallactine.

tremulus Gunnerus, 1767, p. 119. West coast of Scandinavia. Both the locality and the depth indicate this holothurian is not a true Stichopus, and its apparent resemblance to species of that group is a very interesting illustration of parallelism. With *nigripunctatus* of Japanese waters it may form a distinct genus, but the material at my disposal is not sufficient to warrant diagnosis. In any case however it may be called PARASTICHOPUS, and *tremulus* may be designated the genotype.

troschelii J. Müller, 1854, p. 87 (of reprint). Celebes. When published, this was only a *nomen nudum* but Lampert (1885, p. 89) examined the specimen in Berlin labeled "Holothuria. Holoth. sp. Troschelii Müller. Celebes, Schönlein. 1182. anat. Mus.," apparently the holotype, and finds it is identical with *Holothuria gräffei* Semper.

tuberculosus Brandt, 1835, p. 273 = *Holothuria tuberculosa* Quoy and Gaimard, 1834, p. 131. Tonga. A Pentacta.

Inspection of the above list shows that the synallactine holothurians have been the most frequently referred in error to Stichopus; of the twenty-five names given, ten undoubtedly refer to synallactines. Of the remaining fifteen, nine refer to species of Holothuria, *sens. lat.*, and two to species of Pentacta. The other four seem to need new genera for which Thelenota, Astichopus, and Parastichopus are suggested.

The last, containing the species *tremulus* and *nigripunctatus*, is probably nearer to Synallactes than to Stichopus, but the other two are closely related to this last-mentioned genus. The three genera may be distinguished as follows:

Tables, or at least perforated plates representing the disks of partly resorbed tables, abundant; minute granules wanting or very rare; pedicels with supporting rods; polian vessels simple or in one case with few short branches . . . . *Stichopus*

No tables or perforated plates but innumerable minute granules; no supporting rods in pedicels; polian vessels long and branched.

Granules not in groups, accompanied by dichotomously branched, slender rods . . . . *Thelenota*

Granules in groups, accompanied by small C, S or O shaped, or irregularly curved rods. . . . . *Astichopus*

Thelenota.

Brandt, 1835. Prod. Anim., p. 253.

Genotype:— *Trepang ananas* Jäger, 1833. De Hol., p. 24; pl. 3, fig. 1.

The holothurian for which this genus is recognized is one of the most conspicuous and best known species of the East Indian region, and is one of the most important of the commercial forms known as *bêche-de-mer*. It is of interest to report a second, and very distinct species from the Murray Islands, Torres Strait.

Astichopus, gen. nov.

Genotype:— *Stichopus multifidus* Sluiter, 1910. Zool. jahrb. Suppl., **11**, heft 2, p. 334, fig. A, a, b.

This interesting holothurian was hitherto known only from the holotype, taken in the southwest channel at the Tortugas, by Hartmeyer in 1907. But there is material in the M. C. Z. collection from Port Antonio, Jamaica, collected by myself in 1897 and 1909, which adds considerably to our knowledge. The individuals seen in 1897 were noted particularly because of their large size and relatively rapid movements. Of course, their actual movement was very slow but it was perceptible which cannot be said of other large holothurians occurring at Port Antonio. Unfortunately no measurements were made in life and the only one preserved was too large for any available container and consequently was cut into pieces, only five of which were preserved. One of these is the anterior end, including the calcareous ring and the extraordinary Polian vesicles, and another is the posterior end. These fragments indicate that this specimen was at least 450 mm. long in life and my recollection of the individuals seen confirms that estimate. In life, the most notable feature of the coloration was the white lower surface; in particular the pedicels, conspicuous for size and great number, were very white. The upper surface was dark, more or less mottled with blackish and shades of brown. In alcohol, the fragments are all light gray without markings. These big holothurians were conspicuous in about six feet of water on sandy bottom south of Navy Island, at Port Antonio.

In 1909, on eel-grass bottom, in water 2–3 ft. deep, south of Navy Island, I found a much smaller specimen which was narcotized and preserved whole and is in fine condition. It measures now about 220 mm. in length and 40–50 mm. in width; it is thus about the same size as Sluiter's holotype. In color, the lower surface is sharply set off from the upper, as it is yellowish white, while the back and sides are dark brown with numerous small blotches and spots of fawn-color. This is as different from the uniform light gray of the older material as it is from the spotted "clear yellowish-rose" of the holotype. But this color-difference in preserved material is of little importance, since my field label shows that the present specimen, in life, was "black and white." Moreover the label adds: "Same species as big ones noted in '97 at same place." Examination of the calcareous particles shows that this opinion was correct and the identity with Sluiter's specimen from the Tortugas seems to admit of no doubt, although I did not find a specimen at the Tortugas in 1917.

In its external appearance, Astichopus is intermediate between Stichopus and Holothuria, for while it has the flat ventral surface of the former, thickly covered with pedicels, and sharply distinct from the dorsal side, the entire absence of papillae and tubercles gives the specimens, especially after preservation in alcohol, a very Holothuria-like appearance. The genus is obviously the representative in the West Indies of Thelenota, but is not at all like *T. ananas* in its general appe‹rance. On the other hand, it is superficially very much like the new species of Thelenota from the Murray Islands, but is easily distinguished by the characteristic differences in the calcareous particles.

Synonyms.

Owing to the absence of any critical work on the species which have been added to Stichopus since 1867, the same form, owing to the great diversities of color and of development of papillae, has again and again had a new name bestowed upon it. The following list presents all of these names which I have been able to find. It is by no means impossible that I have been too drastic in assigning specific names to this list, but it seems very important that we should make a new start by recognizing only the unquestionably valid forms.

acanthomela, Zoological record, 1900, Echin., p. 78 = *xanthomela* Heilprin, 1888. Typographical error.

albofasciatus Brandt, 1835, p. 273 = *albifasciatus* Quoy and Gaimard, 1834. Either a slip of the pen, an emendation, or a typographical error.

armatus Semper, 1868, p. 75, Japan = *Holothuria armata* Selenka, 1867, p. 330 ≠ *japonicus* Selenka, 1867.

assimilis Bell, 1883, p. 62, Angola = *badionotus* Selenka.?

cylindricus Haacke, 1880, p. 47, Mauritius = *chloronotus* Brandt, according to Ludwig, 1883.

depressus Augustin, 1908, p. 11, Sagami Bay, Japan = *Parastichopus nigripunctatus* (Augustin), according to Oshima, 1915.

diaboli Heilprin, 1888, p. 312, Bermuda = *badionotus* Selenka.

ecalcarea Östergren, 1897, p. 9, Finmark = *Holothuria ecalcarea* M. Sars, 1858, p. 170 = *Parastichopus tremulus* (Gunnerus).

errans Ludwig, 1875, p. 97, Barbados = *badionotus* Selenka.

fuscus Pearson, 1903, p. 204, Ceylon = *chloronotus* Brandt. This name was suggested only for a variety of *chloronotus* but as the characters of that variety are the color and tuberculation of two alcoholic specimens, they do not seem adequate.

godeffroyi Semper, 1868, p. 75, Samoa = *horrens* Selenka.

godeffroyi var. *b* Semper, 1868, p. 247, Samoa = *horrens* Selenka.

griegi Östergren, 1897, p. 4, Norway = *Parastichopus tremulus* (Gunnerus).

hayticnsis Semper, 1868, p. 75, Hayti = *badionotus* Selenka.

hirotai Mitsukuri, 1912, p. 161, Ogasawara Islands = *variegatus* Semper.

laevis, Zoological Record, 1888, Echino., p. 12 = *levis* Sluiter. Apparently an emendation.

levis Sluiter, 1887, p. 198, Western end of Java Sea = *variegatus* Semper.

maculatus Greef, 1882, p. 158 (13 of reprint) Rolas Island, Saõ Thomé = *badionotus* Selenka.?

moebii Semper, 1868, p. 246, West Indies = *badionotus* Selenka.

naso Haacke, 1880, p. 46, Mauritius = *variegatus* Semper, and not *naso* Semper, according to Ludwig, 1883.

oshimae Mitsukuri, 1912, p. 171, Oshima Islands, Japan = *variegatus* Semper.

owstoni Mitsukuri, 1912, p. 175, Sagami Bay, Japan = *Parastichopus nigripunctatus* (Augustin), according to Ohshima, 1915.

panimensis Parker, 1921, p. 205, La Jolla, Cal. = *parvimensis* H. L. Clark. A slip of the pen.

pygmaeus Semper 1868, p. 75, Fiji, Samoa = *horrens* Selenka, juv.

roseus Augustin, 1908, p. 13, Sagami Bay, Japan = *japonicus* Selenka, according to Ohshima, 1915.
simultans Erwe, 1913, p. 388 = *simulans* Dendy and Hindle. A slip of the pen.
sordidus Théel, 1886, p. 167, New Zealand = *mollis* (Hutton).
tropicalis Fisher, 1907, p. 676, Hawaiian Islands = *horrens* Selenka.
typicus Théel, 1886, p. 161, Japan = *japonicus* Selenka, as a variety of which it was proposed.
vastus Sluiter, 1887, p. 198, Batavia Bay, Java = *variegatus* Semper.
xanthomela Heilprin, 1888, p. 313, Bermuda = *badionotus* Selenka.

The valid Species.

Having disposed of a large proportion of the names hitherto associated with Stichopus, we come to the still considerable group representing valid forms. In order that the characters which distinguish these species from each other may be set forth clearly, the following key is offered.

Key.

No buttons among the calcareous deposits.
- No rosettes among the calcareous deposits.
  - Tables present.
    - Tables more or less symmetrical, usually with regular spires; disk margins smooth.
      - Spire of tables more or less expanded and open at top, with one or two cross-bars.
        - C-shaped bodies moderate or small usually less than 75 μ in length, or even wanting altogether.
          - Tables and C-shaped bodies, or tables alone, present.
            - C-shaped bodies usually plentiful but sometimes scarce.
              - Disks of tables, with four to eight holes, about 30 μ in diameter; C-shaped bodies about 40 μ long...... *chloronotus*
              - Disks of tables, with a circle of peripheral holes, about 60μ in diameter; C-shaped bodies about 60 μ long....... *badionotus*
            - C-shaped bodies wanting.
              - Disks of tables square or squarish, 55–60 μ in diameter, with four large holes and 4 somewhat smaller ones at corners .... *mollis*
              - Disks more rounded, a little smaller, with the four corner holes much smaller than the others........ *anapinusus*
          - Tables and irregular perforated plates; no C-shaped bodies... *japonicus*
        - C-shaped bodies very large, 100–150 μ in length.............. *macroparentheses*

- Spires slightly tapered to the more or less solid top, with three or four cross-bars; C-shaped bodies wanting.
  - Spires rather solid with numerous teeth all over distal half. . . *regalis*
  - Spires less solid with few teeth. . . . . *japonicus* juv.
- Tables asymmetrical with more or less irregular or deformed spires, and often spiny margins. . . . . *ludwigi*
- Tables wanting, replaced by numerous small irregular perforated plates, apparently remains of table-disks. . . . . *japonicus*, senescent

Rosettes present.

- Large tables with heavy, smooth, conical spires, present in dorsal papillae. . . . . *horrens*
- No big tables with smooth, conical spires.
  - Large, irregular, asymmetrical tables present at least near bases of dorsal papillae. . . . . *ccnomius*
  - No such big, irregular tables.
    - Tables 20–45 μ in disk-diameter; disks nearly circular or a little irregular, with a circle of small peripheral holes, often incomplete; rosettes with branches somewhat cylindrical not expanded at tip.
      - Body as wide anteriorly as posteriorly, covered with numerous small tubercles and papillae, none of which are $\frac{1}{6}$ as high as width of body; C-shaped bodies three to five times diameter of table-disks.
        - Middle of back with scattered tubercles as large as those on sides; coloration in various shades of brown, unicolor, or mottled. . . . . *variegatus*
        - Middle of back with no large tubercles; coloration gray. . . . . *varicgatus* var. *herrmanni*
      - Body much narrower anteriorly than posteriorly, with large tuberculous papillae, $\frac{1}{3}$ as high as width of body; C-shaped bodies seven times diameter of table-disks. . . . . *naso*
    - Tables over 50 μ in disk-diameter; disks squarish with eight holes; rosettes with ends of branches expanded. . . . . *simulans*

Buttons present, with tables.

- C-shaped deposits wanting; diameter of top of spire much less than disk; buttons over 75 μ in length.
  - Calcareous particles large, tables with disks 120–170 μ across, and buttons 165–190 μ long. . . . . *johnsoni*
  - Calcareous particles much smaller.
    - Tables with disks 50–100 μ across; buttons large up to 165 μ in length *californicus*
    - Tables with disks about 45 μ across; buttons about 90 μ long. . . . . . *parvimensis*
- C-shaped deposits present; top of spire equal to or exceeding disk-diameter; buttons small, only 45–50 μ in length. . . . . *paradoxus*

Stichopus chloronotus.

Plate **2**, fig. 1–10.

Stichopus (*Perideris*) *chloronotos* Brandt, 1835, p. 250. Lugunor and Guam.
Stichopus chloronotus Selenka, 1867, p. 315, pl. 17, fig. 20–24; 18, fig. 25.
Stichopus cylindricus Haacke, 1880, p. 47. Mauritius.
Stichopus chloronotus var. *fuscus* Pearson, 1903, p. 204. Ceylon.

It is a pity that the very characteristic color of this species is so difficult to preserve, for in life, *chloronotus* is one of the most easily recognized of holothurians. But alcoholic material quickly assumes that unattractive yellow-brown tint which has been appropriately called "museum-color." Different specimens show different shades of this color, it is true, some being light and some dark, some mottled or clouded, some unicolor, but there is rarely any indication of the original shade left.[1] It therefore seems futile to attempt to recognize the variety which Pearson (*loc. cit.*) called *fuscus*, unless study of living *chloronotus* around Ceylon shows that such a form is recognizable in life. Even then the name *fuscus* cannot be used, since there is already a *Stichopus fuscus* Ludwig. Besides color, Pearson bases his proposed variety on the laterodorsal series of tubercles being single instead of double and the C-shaped deposits being very rare indeed. Since these are both characters subject to great individual diversity, I do not think they warrant recognition of a variety.

Ludwig has examined the type of Haacke's *Stichopus cylindricus* and reports (1883) that it is simply *chloronotus*. This would indicate that Haacke was misled by a distortion of the body-form, probably due to poor preservation, and it emphasizes the point that species, in this genus certainly, cannot be characterized by features so easily affected by methods and conditions of preservation.

In life *chloronotus* reaches a length of over 300 mm., but preserved specimens do not often exceed 200. A living specimen 250 mm. long is usually about 65 mm. wide and 40 mm. high, though of course, as in all holothurians, these dimensions depend greatly on the activity or quiescence of the animal. The color is deep green; in sunshine the green is obvious but in poor light many large specimens look black. The distal portion of the big dorsal papillae, which may be 10 mm. or

[1] Selenka (1867) says the color is "olivengrun bis olivenbraun," and his observations were made only on preserved material, but he may have simply inferred the green color from the name.

more high and 4 or 5 mm. in diameter, is blackish, with the extreme tip brown-orange. The pedicels are dark gray, while the tentacles are whitish with dark gray tips. Mitsukuri (1912) speaks of a *bluish* tinge in the specimens at the Riu Kiu Islands which he describes as "deep black." While it is not impossible that the northern specimens lack the green color of those in Torres Strait, the matter needs confirmation. The figure given by Saville Kent (1893) shows the color of Australian specimens very well.

The calcareous spicules of *chloronotus* were correctly described and figured by Selenka (*loc. cit.*) but it seems desirable to refigure them magnified to the same scale as those of the other species figured in this report. The tables (Plate **2**, fig. 1–3) are very small only 30–40 μ across the disks and with about eight teeth at the top of the spire. There are typically four large holes in the disk, each one beneath a side of the spire, and very commonly there is a much smaller hole opposite each corner of the spire, but one, two or three of these small holes are commonly wanting. The number of teeth at the top of the spire is often 10–12 and may be as many as 16. The C-shaped bodies are small, only 30–40 μ long. They show much diversity in shape (fig. 4–9), not infrequently being malformed, with an extra branch or with one end reversed, thus becoming S-shaped (fig. 10). They also show much diversity in abundance; usually they are very abundant, but they may be very few and scattered and hence hard to find. The supporting rods of the pedicels are well figured by Selenka.

Although the specimens at hand show considerable diversity of size, I fail to find any growth-changes. In the smallest the calcareous particles are essentially the same as in the largest, but there are no available specimens of either very large or very small size.

In Torres Strait, *chloronotus* is one of the characteristic animals of the reef-flats, where these are well covered by eel-grass (Posidonia). It does not occur under rock-fragments or among corals. It is extremely sluggish in its movements and seems to fear no enemies. Commensal annelids (Gastrolepidia) of the same green color as their host live on the back among the tubercles and are not easily dislodged therefrom.

The geographical range of *chloronotus* is extensive, from Mauritius to Hawaii, from Amami-Oshima, in the Riu Kius, on the north to the central Barrier Reef region of Australia on the south. It is not known from the Society or Hervey Islands. There are fifteen specimens in the M. C. Z., from the Hawaiian, Caroline, Fiji, and Samoan Islands, Torres Strait, Mauritius, and Mozambique. Neither Fisher nor I, in our collecting at the Hawaiian Islands, saw *chloronotus* and there may be an error in the label of the single specimen in the M. C. Z., which is said to have been taken at Honolulu in 1874 by W. H. Jones.

Stichopus badionotus.

Plate **2**, fig. 11–18.

Stichopus badionotus Selenka, 1867, p. 316. Florida. (Acapulco?).
Stichopus haytiensis Semper, 1868, p. 75, pl. 30, fig. 5. Hayti.
Stichopus moebii Semper, 1868, p. 246, pl. 40, fig. 11. West Indies.
Stichopus errans Ludwig, 1875, p. 97. Barbados.
?Stichopus maculatus Greef, 1882, p. 158 (13 of reprint). Rolas Island, Saõ Thomé.
?Stichopus assimilis Bell, 1883, p. 62. Angola.
Stichopus diaboli Heilprin, 1888, p. 312. Bermuda.
Stichopus xanthomela Heilprin, 1888, p. 313. Bermuda.
Stichopus acanthomela Zool. Rec., 1900, Echin. p. 78. *Err. typ.*

It is with no little hesitation that I unite under a single name all the species of Stichopus that have been described from the Panamic, West Indian, and West African regions, but I am quite unable after prolonged study to find any tangible characters by which they may be distinguished. This study has been based not only on the scores of specimens in the M. C. Z. collection but upon hundreds of living specimens examined at Bermuda, the Tortugas, Montego Bay, Port Antonio, and Port Royal, Jamaica. Experience has convinced me that color is absolutely unreliable as a distinguishing character and body-texture, form, and tuberculation seem to be equally hopeless. The calcareous particles too undergo growth-changes which lead into difficulties.

It may be frankly admitted that there is still much to be learned about the common West Indian Stichopus and it is by no means impossible that further knowledge will make the recognition of more than one species necessary. My only contention is that at present it is impossible to do this in any satisfactory way. I have seen no specimens from the African coast or its neighboring islands, but there is nothing in the descriptions of either Greef or Bell that would not apply to some specimens of the common species of Jamaica. To be sure Bell mentions and figures "flattened, reticulated bars" but as Théel (1886) has pointed out these seem to be the usual supporting rods of papillae or pedicels. If such bars actually occur in the body-wall proper, that would furnish a perfectly distinctive character for *assimilis*.

It is quite unusual for echinoderms on the west coast of Central America and Mexico to be identical with those of the West Indies, but I have examined with great care twelve specimens of Stichopus from Acapulco and the west coast of Central or South America (exact locality ?) labeled *badionotus,* including Selenka's cotypes, and cannot find any character or combination of characters which will separate them from the West Indian specimens. To be sure, Selenka says the C-shaped particles are entirely lacking in *badionotus,* but in this he was mistaken. They occur in all of our specimens, including his cotypes.

There are fifty-five specimens in the M. C. Z. which seem to be *badionotus.* They come from Acapulco, west coast of South America, Jamaica, Yucatan Bank, Florida, the Tortugas, Bermuda, and Tobago. They range in length from 20 to about 220 mm. and the diversity of color even in their dingy, alcoholic condition is equally great. In life, individuals over 300 mm. long are common, and such specimens are 60–75 mm. wide and 50–60 mm. high.

In 1902, while at Port Henderson, Jamaica, I examined 141 specimens of Stichopus, tabulating the color and color-patterns to see if I could find any correlation between color and size or habitat. No correlation was detected but there was some light thrown on the development of the diversity of coloration. The matter may be stated tentatively like this:— The typical and apparently the original coloration is buff with blackish or dark brown spots or blotches; this coloration is often persistent and characterizes the form which Heilprin (1888), finding at Bermuda, called *xanthomela.* From the blotched form, there are three lines of development; one in the direction of uniform blackness (*diaboli* Heilprin) through increased pigmentation; a second in the direction of brown, olive, or purple, with few blotches or markings of buff, yellowish or white, through increased pigmentation accompanied by alteration in the density or even in the color of the pigment; and third, in the direction of uniformly brownish yellow individuals through decreased pigmentation, at least so far as the dark pigment is concerned. The individuals studied were grouped in sixteen categories but even then there were many doubtful cases. The color of the tentacles ranges from almost white to almost black but is commonly yellowish. At Port Royal, Jamaica, where Stichopus is very common, uniformly dark yellowish brown individuals, and those that are buff with large dark brown blotches are about equal in number and together comprise about half the total. Another quarter is made up of those which are dark brown with yellowish spots and those which are buff spotted with brown. Unicolored individuals of a dark shade are rare. At Bermuda, however, conditions are conspicuously reversed and the uniformly blackish individuals are very much more common than the mottled forms.

In regard to the number of tentacles my observations in Jamaica yielded some interesting results. Of eighty-two individuals, whose tentacles were accurately counted, thirty-five had twenty, fifteen had nineteen and eighteen had eighteen; thus more than 83% had 18–20 tentacles. Of the others one had but twelve, six had sixteen, five had seventeen, while only two had twenty-one. That the typical number of tentacles for the adult is twenty is indicated by the fact that of sixty individuals which from size and condition of gonads were considered adult, 50% had that number and 90% had 18–21, while of twenty-two obviously immature specimens, only 23% had twenty and only 72% had 18–20, none having twenty-one.

In regard to the tuberculation of the body, large warts or tubercles along the sides, at the boundary of the ventral surface, are generally present but in 141 specimens these warts were wanting in more than 25%. Small warts or papillae are almost always present in life usually in some numbers but these may be quite lost in alcoholic material. There is so much diversity even in life that no stress whatever can be placed on this feature as a specific character. The same is true of the pedicels, for while there is no doubt a steady increase in the number of pedicels, at least up to maturity, the rate of increase is undoubtedly a matter of individual diversity and hence in some specimens the original serial arrangement may still be evident at maturity while in others it is totally obliterated.

The calcareous particles in *badionotus* comprise tables and C-shaped bodies. The tables (Plate **2**, fig. 11–13) resemble those of *chloronotus* but are larger and more fully developed. Typically, the disk is nearly circular, about 40–50 μ across and has a peripheral circle of holes. The top of the spire usually carries 12–16 teeth. The C-shaped bodies are much larger than in *chloronotus* but vary a good deal in size, a typical one (Plate **2**, fig. 16) is about 60 μ long.

Examination of the material in the M. C. Z. has brought out some points in the matter of growth-changes which are most interesting and suggest the importance of a much more thorough study of the matter. In one of Selenka's types of *badionotus*, from Acapulco, I found the tables like those figured as typical for the species (Plate **2**, fig. 11–13) but in a second specimen of about the same size, the disks of the tables had virtually disappeared (Plate **2**, fig. 14), although in no other respects were the specimen or the deposits peculiar. In the specimen from Florida which Selenka made a cotype of *badionotus*, the tables show still further absorption (Plate **2**, fig. 15) so that the rods of what was the spire are not connected at either top or bottom. As Selenka makes no reference to these peculiarities of the tables, my first impression was that in the fifty years which have elapsed since he examined the material, the tables had been partly dissolved, but a careful study fails to show any evidence of corrosion and I believe we have here a remarkable case of senescence similar to what Mitsukuri has shown (1897) occurs in *S. japonicus*. But it must be of rare occurrence in *badionotus* for I have found no other cases. It will also be noted that resorption in *japonicus* causes the spire to disappear leaving only the disk, while in *badionotus* the disk disappears leaving only the spire.

The youngest, or at least the smallest Stichopus I have seen from the West Indian region (except the type of *S. ecnomius*, *q. v.*) is a specimen, now about 20 mm. long taken at the Tortugas in 1917. My field-label reads: "Dredged in 4–5 fms. In cranny of sponge-covered rock fragment. Almost transparent holothurian (probably young Stichopus) 60–70 mm. long by 12–15 mm. wide. Gradually contracted with accompanying concentration of color and opacity in $MgSO_4$ but shrunk still more in alcohol. June 14, 1917." In this specimen the tables of the body-wall are very different from those seen in any other Stichopus but it seems probable that it shows the first step in the calcareous particles of *badionotus*. This idea would not have occurred to me, had I not already discovered a similar stage in *horrens*, confirming Mitsukuri's observations on *japonicus*. The tables in this little specimen from the Tortugas have the disk (Plate **2**, fig. 18) about 75 μ across and perforated with about fifteen holes. The spire (Plate **2**, fig. 17) is about 50 μ high, conical and toothed at the top. No C-shaped bodies were found with these tables.

It is evident that resorption might alter the spire of these juvenile tables into those of the adult tables but it is incredible that the disk could by resorption alone become the disk of an adult table. Of course, resorption associated with replacement of the lime could accomplish all the changes necessary, and this may be the actual process, but if such were the case why are not more of the intermediate conditions found? It seems more likely that the youthful tables disappear by being thrown off like wandering cells and particles of excreta and that their places are taken by newly formed tables of the adult type. This is, however, little more than speculation and only emphasizes how much investigation is needed into the problem of growth-changes.

Granting that all the Stichopus occurring in the West Indian region (excepting *ecnomius*) represent one species, the habits of *badionotus*, and its younger stages are as follows:— After metamorphosis, it settles down into some rock-cranny and there among sponges, worm-tubes, and ascidians, it leads a well-sheltered life. Up to the time it is 80–100 mm. long, it continues to live among rocks, but after that it lives more in the open and after it is 125–150 mm. long, it seldom if ever seeks the shelter of rocks. When it first settles down it is a colorless, transparent, somewhat gelatinous creature and the development of pigment takes place slowly. By the time it is 75–100 mm. long, the pigment in the body-wall has developed sufficiently to give the animal a very distinct coloration but it is still translucent and gelatinous. At this stage, young individuals are not rare on the under side of rock-fragments, or in their larger crannies. Their bright colors are noticeable; chestnut-brown ground color, with black circles around the papillae and yellow tips to papillae and pedicels. The translucent appearance and this characteristic coloration are misleading and it is difficult to believe that the individuals possessing them are only the young of *badionotus*. At a somewhat older stage, but while still dwelling among rocks and coral-fragments, the translucent appearance disappears, and buff and brown or blackish become the dominant colors. The dorsal and especially the lateral papillae are very well developed at this stage and are often prettily marked with a dark spiral line which runs from base to tip. This coloration is quite distinctive but the calcareous particles agree so completely with those of the larger individuals of the open, weedy flats that I am forced to believe these handsome individuals are only subadults of *badionotus*. After a length of 150–200 mm. is attained, *badionotus* lives altogether on the open sandy or weedy flats near shore, or at least where the water is less than three fathoms deep. Its occurrence at depths as great as ten fathoms is not, however, extraordinary. It is exceedingly sluggish in its movements and apparently is quite free from the attacks of enemies.

It is a curious fact that whereas five individuals were found at Tobago by our party in 1916, no large ones living out in the open were seen. All were in the semitranslucent, subadult stage, living under or among rocks. One specimen collected by Mr. John W. Mills, on Buccoo Reef, April 5, was so strikingly different from any other I have seen, it seems justifiable to give it a special name, although the calcareous deposits do not warrant considering it specifically different from the others. In life the tentacles, pedicels, and median ventral surface were gray, but the entire back and sides were bright carmine-red, a most unusual shade in a shallow-water holothurian. I name this striking form *Stichopus badionotus* var. *phoenius* (Greek, φοίνιος = blood-red). In its present condition in alcohol (M. C. Z. 1,182) it is easily distinguished from the other specimens from Tobago, by the uniformly reddish brown color.

Stichopus mollis.

Holothuria mollis Hutton, 1872, p. 15. New Zealand.
Holothuria (?*Stichopus*) *mollis* Hutton, 1879, p. 308.
Holothuria robsoni Hutton, 1879, p. 308. New Zealand.
Stichopus sordidus Théel, 1886, p. 167, pl. 8, fig. 3. Queen Charlotte Sound, New Zealand.
Stichopus mollis Dendy, 1897, p. 46, pl. 7, fig. 73–82.
Stichopus mollis Dendy and Hindle, 1907, p. 96, pl. 12, fig. 12.

This is the characteristic species of central and southern New Zealand; it occurs also on the southern coast of New South Wales (Eden) and is common on the shores of Victoria (Westernport, Geelong, Altona Bay); Albany Bay, southern West Australia is the westernmost locality from which it is recorded. It is a small species; alcoholic material runs from 70 to 140 mm. in length. Hutton says it is "about 6 inches in length and 1½ in breadth," and he adds that the color" is yellowish, largely mottled with brown above and in a lesser degree, below." Dendy says the color is brown, or brown and white, or white alone, but preserved specimens are often very dark brown, almost black, and they may have a purple or violet tinge. Nothing is recorded of its habits save that it lives in rock-pools and that the young occur near low water mark while the adults prefer deeper water. Joshua (1914) gives some notes on the occurrence of this species at Port Phillip Bay, Victoria, where it is common.

Stichopus anapinusus.

Holothuria anapinusa Lampert, 1885, p. 241, fig. 7. Sörres Island.
Stichopus anapinusus Sluiter, 1901, p. 30.

The type-locality for this East Indian species, given by Lampert as "Sörres Island," I have failed to locate on any available map, but Sluiter gives two definite East Indian localities where the Siboga took specimens. Nothing is recorded of habits, size, or color in life. Preserved specimens are small, 100–135 mm. long, and uniformly brown.

The resemblance of *anapinusus* to *mollis* is so very close that the published descriptions give no warrant for considering them distinct. But without material for comparison and as neither Lampert or Sluiter considered *mollis* at all, it seems best to keep them apart on geographical grounds (three thousand miles separates their known habitats) until actual comparison of specimens can be made. I do not expect that the distinction made in the key (p. 51) will prove to be the real difference between the species, if different they are.

Stichopus japonicus.

Stichopus japonicus Selenka, 1867, p. 318, pl. 18, fig. 33–36. Japan.
Holothuria armata Selenka, 1867, p. 330, pl.18, fig. 66. Hakodadi, Japan.
Stichopus japonicus var. *typicus* Théel, 1886, p. 161, pl. 7, fig. 2.
Stichopus roseus Augustin, 1908, p. 13. Sagami Bay, Japan.

So fully has this species been treated by Mitsukuri (1897, 1912) that there is no occasion for discussing it in detail. The growth-changes as revealed by the spicules, and the diversity shown in tuberculation is very remarkable and demand further investigation on living material. Further studies on the correlation between color and habitat are also desirable. The species is a large one, reaching a length of 430 mm. in life, and a breadth of 70–95 mm. The known geographical range is from Kagoshima, northward throughout Japanese waters, and along the eastern coast of Korea. Théel (1886) records two specimens from Hong Kong but Mitsukuri doubts the reliability of the record. Mitsukuri lists specimens from Vladivostock and even from Saghalien. The record of *japonicus* from Sitka, Alaska, (H. L. Clark, 1902) is based on a very young specimen, and is not to be relied on as evidence of the occurrence of the Japanese species on the American coast. As nothing is yet known of the growth-changes in *californicus*, which occurs at Sitka, it is not at all improbable that this small individual was the young of that form.

Stichopus macroparentheses,[1] sp. nov.

Plate 1, fig. 1–7.

Length about 50 mm.; diameter about 13 mm. Body moderately arched above (in life), flat ventrally. Tentacles nineteen. Papillae few, small, irregularly arranged along dorsolateral ambulacra. Ven-

[1] μακρος = long + παρένθεσις = parenthesis, in reference to the remarkably long C-shaped or parenthesis-shaped bodies.

tral margin fairly distinct but not marked by large papillae. Pedicels fairly numerous, in a conspicuous median series (8–10 pedicels wide) and in a somewhat less marked lateral series (4 or 5 pedicels wide) on each side of ventral surface; scattered pedicels also occur on the interambulacral areas. Mouth and anus both ventral in position. Calcareous ring well developed but not heavy; radial pieces with a conspicuous, rounded posterior notch; interradial pieces with posterior margin scarcely concave. Polian vesicle single. Madreporic canal single. Gonads in a very well-developed tuft, of more or less branched tubules, on each side of dorsal mesentery.

Calcareous particles present in several forms. Pedicels and papillae with well-developed terminal plates and numerous supporting rods of relatively large size. Epidermis full of closely crowded tables of moderate or small size; disk of the smaller ones with four symmetrical holes (Plate **1**, fig. 1); in larger ones, there are four smaller holes distal to and alternating with these, and often additional holes are present, their number ranging from one (Plate **1**, fig. 2) to twelve, very rarely more; disks range from 30 to 60 μ but the great majority are less than 50 μ. Spires of tables with one cross-bar, rather low down (Plate **1**, fig. 3); height of spire about four fifths diameter of disk; crown of spire with few, low, often minute teeth (Plate **1**, fig. 5) on the smaller tables, but on larger ones, the teeth are 12–20 in number and conspicuously long (Plate **1**, fig. 4). Beneath the layer of tables occur C-shaped bodies of relatively large size; these are widely scattered except around the bases of papillae and pedicels where they are commonly rather abundant; those of the dorsal surface (Plate **1**, fig. 6) are wide in proportion to the length, which may be over 100 μ, while those of the ventral surface are much narrower, as a rule, and reach a length of 165 μ; there is some diversity of size and not many of the "parentheses" reach these extreme measurements, but on the other hand there are few if any conspicuously smaller.

Color, in life, brown, with blackish markings dorsally; tips of papillae and pedicels, yellow. Body-wall more or less translucent. In alcohol, the translucence has disappeared and the color has become light brown indistinctly mottled with darker. Tentacle-stalks nearly white with tops yellowish.

HOLOTYPE, M. C. Z. 921. Jamaica: Montego Bay. March, 1912. H. L. Clark coll.

A paratype (M. C. Z. 1,214) was taken at Bird Key, Tortugas, in June, 1917. It is more slender than the holotype and somewhat longer, has nineteen tentacles, and there is much less brown in the coloration, which is somewhat gray.

Both specimens were found under rocks in very shallow water and were supposed to be identical with other small individuals found in similar situations which have proved to be the young of *badionotus*. While the external resemblance was so close that there was no suspicion of their difference aroused, the examination of the calcareous deposits showed that they were distinct. Further collecting and examination in life will probably reveal points by which *megaparentheses* can be readily distinguished from *badionotus* of any age.

Stichopus regalis.

Plate **1**, fig. 17, 18.

Holothuria regalis Cuvier, 1817, **4**, p. 22. Mediterranean Sea.
Stichopus regalis Selenka, 1867, p. 317, pl. 18, fig. 32.

This is a well-marked species confined to the western Mediterranean and eastern Atlantic coasts. It is common in the Adriatic Sea as well as on the southern and western shores of Italy. It is not yet recorded from the eastern Mediterranean although it will probably be found there. It has been reported from the Bay of Biscay and from the Canary Islands but little is as yet known of its occurrence in the Atlantic. It is said to extend down to a depth of 100 fms., but this is not based on reliable evidence and is highly improbable. The color in life is brownish or ochre-yellow, with numerous white spots; the middle of the ventral side may be reddish; the tentacles are whitish. It is a moderately large species reaching a length of 300 mm. and a width of perhaps 75 mm. The calcareous particles, tables alone, save for supporting rods and terminal plates in papillae and pedicels, were long ago well figured by Sars (1858) but I have repeated those of the tables (Plate **1**, fig. 17, 18) that they might be seen drawn to the same scale as in other members of the genus.

Stichopus ludwigi.

Erwe, 1913, p. 388, 389, fig. 1, pl. 8, fig. 24*a–f*. Southwestern Australia.

This is a well-characterized form, known only from the southwestern and southern coasts of Australia. The calcareous deposits are quite distinctive, particularly the tables. The preserved material was only 100–110 mm. long and was reddish gray in color, more or less spotted, blotched and marked with brown or blackish.

Stichopus horrens.

Plate **2**, fig. 19–23.

Stichopus horrens Selenka, 1867, p. 316, pl. 18, fig. 27–29. Society Islands.
Stichopus godeffroyi Semper, 1868, p. 75, pl. 30, fig. 4. Samoa.
Stichopus godeffroyi var. *pygmaeus* Semper, 1868, p. 75. Samoa and Fiji.
Stichopus godeffroyi var. b Semper, 1868, p. 246. Samoa.
Stichopus tropicalis Fisher, 1907, p. 676; pl. 70, fig. 1–1*i*. Hawaii.

In reaching the conclusion that all the Pacific specimens, with big, smooth, single-pointed spires on the tables near the ambulacral appendages, belong to a single species, I have fortunately had the holotype of *horrens* and a cotype of *pygmaeus*, as well as a cotype of *godeffroyi*, available for study. There are also in the M. C. Z. collection, thirty additional specimens of the same form from Friday Island, Badu, and Mer in Torres Strait, from the Philippines, the Carolines, Fiji, Samoa, the Society Islands and from Hilo, Lahaina, and Honolulu in the Hawaiian Islands. This material ranges in size from very small to large and throws some light on the growth-changes which are interesting and important.

The smallest specimen is only 15 mm. long by 6 or 7 mm. in diameter in its preserved condition. It was collected by me at Papeete, Tahiti, under a coral fragment, 5 August, 1913. My field-notes say it was, in life, "$1\frac{1}{2}$ inches long. Pellucid, almost transparent." Its calcareous deposits consist of tables alone; they are closely crowded and of characteristic shape (Plate **2**, fig. 23); the disks are 90–100 μ across and the spires about four fifths as much in height. It has conspicuous dorsal and lateral papillae and rather crowded, large, ventral pedicels.

The next smallest specimen is about 40 mm. long and 12 mm. in diameter; it is the cotype of *pygmaeus* Semper. It has the tables characteristic of *horrens* (Plate **2**, fig. 19, 20) but lacks C-shaped bodies and the big simple-pointed tables. But among the usual tables, there are here and there, tables similar to those of the little specimen from Tahiti. And it was the discovery of these tables that led me to the present interpretation of the growth-changes in *horrens*.

The holotype of *horrens* is about 50 mm. long and 20 mm. in diameter. Selenka's description and figures call for little comment except in one particular. He fails to note the fact that the large tables (Plate **2**, fig. 19) occur in the vicinity of the pedicels and papillae, while the big single-pointed tables are found only about the dorsal and lateral papillae. The largest specimens of *horrens* I have seen are about 200 mm. long; in life these were nearly or quite 300 mm. long and 60 mm. or more in diameter. The deposits are not essentially different from those of the holotype of *horrens*.

Judging then from available material, we find that in its early stages, *horrens* like *badionotus* is translucent with pedicels on the flattened ventral surface and papillae dorsally, living sheltered in the crevices of coral-rock. Its calcareous deposits consist of tables only and these have large disks with a few big holes and slender spires (Plate **2**, fig. 23). At a later stage these tables are largely or wholly replaced by smaller tables, some with only eight holes in the disk (four larger and four smaller) (Plate **2**, fig. 20) while others, near the ambulacral appendages—have a peripheral circle of holes around the disk (Plate **2**, fig. 19). Accompanying these tables, in the dorsal perisome, are scattered dichotomously branched rods, the so-called "rosettes." At this stage it is 50–75 mm. long in life (25–40 mm. in its preserved condition) and represents the stage *pygmaeus* Semper. With further growth the original tables completely disappear, tables with big single-pointed spires, develop in the papillae, and ventral pedicels as well as dorsal papillae become much more numerous; this is the stage *godeffroyi* Semper. The next step is the development of C-shaped deposits (Plate **2**, fig. 21–22) the appearance of which marks the *horrens* stage, *sensu strictu;* and then a marked development of the papillae on the dorsal interambulacra ushers in the "*godeffroyi* var. *b*" stage, *tropicalis* Fisher (1907) whose description, figures and general account leave little to be desired. Of course it must not be assumed that there is any definite correlation between size and these different growth-stages. The holotype of *horrens* is hardly one third the size of the cotype of *godeffroyi*. The development of the C-shaped bodies seems to be particularly subject to individual diversity and it is not impossible that in some individuals they never become common even in adult life. The development of the dorsal papillae is also subject to great individual diversity and so far as I can see no weight can be attached to the degree of their development.

The coloration of *horrens* is varied though not to the same degree as in *badionotus*. Fisher says that in the Hawaiian Islands the body is dark olive-green, mottled with deep brownish green, but in alcohol the color becomes yellow-ochre; the tentacles are greenish gray to whitish. None of the specimens that I saw in Torres Strait were like this but one was "olive-green of 2 or 3 shades, mottled; lower surface cream-color, as are lateral tubercles; pedicels dark." As a rule the coloration was a bewildering medley of brown of at least four shades, blackish, gray, bluish, and white; pedicels white with yellow tip. (See Carnegie inst. Publ. 214, pl. 18, fig. 4). A specimen found at Badu was more uniformly dark.

The distribution of *horrens* seems to be distinctly in the Pacific. The westernmost record I have found is that of the single specimen taken by the SIBOGA at the north end of Tiur Island, which is just west of lat. 132° E. In Torres Strait, at least at the Murray Islands, at Fiji, at Samoa, and at Hawaii, *horrens* seems to be common. Unlike *chloronotus* and *variegatus*, it does not occur exposed on the reef-flats but is always found among rocks and dead coral. It is very inert, quite slimy, and altogether one of the most repulsive animals on the reef.

STICHOPUS ECNOMIUS,[1] sp. nov.

Plate **2**, fig. 24–29.

Length 9 mm.; diameter about 3 mm. Body-wall arched; ventral surface flat. Papillae very conspicuous in two dorsal series and a lateral one on each side, at the margin of the ventral surface; there are 7–10 papillae in each series. Pedicels scattered on the ventral surface without definite arrangement in longitudinal series, of unequal size, more abundant posteriorly than anteriorly. Tentacles closely crowded about the mouth, apparently only twelve or thirteen in number.

Calcareous deposits, tables of two kinds and rosettes. Ordinary tables (Plate **2**, fig. 24) moderately large, with squarish disks and spires; disks about 60 μ across with four large and four smaller holes, and usually one or more peripheral holes in addition. Extraordinary tables (Plate **2**, fig. 27–29) occur in the pedicels but particularly in the papillae, in place of supporting rods, which seem to be quite absent. These tables have no definite shape and no two are exactly alike; they range in size from 50 to 200 μ across; sometimes several rods are more or less united by cross-bars somewhat like a spire, and in other cases anastomosing branches may cause an appearance like an irregular and incomplete disk, but as a rule there is no resemblance to a true table. In a few cases the rods, 4–6 in number, lie in the same plane and show some symmetry, and these form a connecting link with the rosettes, though they are much larger, fully 150 μ across. The rosettes are very remarkable for the number of the dichotomous divisions and

[1] ἐκνόμιος = unusual, strange, in reference to the remarkable deposits.

the shortness and curvature of the branches; the two figured (Plate **2**, fig. 25, 26) are the two simplest observed; as the divisions increase in number, they apparently cease to lie in one plane and the most complex rosettes are much flattened ellipses of a close and irregular network; the rosettes are usually about 60–70 μ long.

Color, in life, "yellow, with blue nodular spines"; the preserved specimen is uniformly dull yellow-brown.

HOLOTYPE M. C. Z. 890. Jamaica: Montego Bay, "on rocks in front of laboratory." 28 August, 1910. E. A. Andrews coll.

This remarkable little species is quite unlike anything I collected in Jamaica. It is obviously too young to fix its generic position, so that it is not impossible that it is not a Stichopus. The tables and rosettes, the form of the body and the arrangement of pedicels and papillae are quite Stichopus-like. The absence of C-shaped bodies is not significant in view of the youth of the specimen. On the whole, it seems more likely that it belongs to Stichopus than to any other known genus. But it is not impossible that it will prove to be a young Holothuria, and it is not inconceivable that it represents one of the earliest stages in the development of the common *H. floridana*.

STICHOPUS VARIEGATUS.

Stichopus variegatus Semper, 1868, p. 73, pl. 16, 30, fig. 1. Philippines, Samoa.
Stichopus naso Haacke, 1880, p. 46. Mauritius.
Stichopus levis Sluiter, 1887, p. 198, pl. 1, fig. 6. Mendano Strait and Bay of Batavia, D. E. I.
Stichopus vastus Sluiter, 1887, p. 198, pl. 2, fig. 46–48. Bay of Batavia.
Stichopus hirotai Mitsukuri, 1912, p. 161. Ogasawara Island, Japan.
Stichopus oshimae Mitsukuri, 1912, p. 171. Kageroma Island, Japan.

It may be hazardous to assert that such good observers and careful workers as Sluiter and Mitsukuri have added four synonyms to the well-known name given by Semper, when they supposed they were describing four new species, but after my observations at Mer and my examination of material in the M. C. Z., I am unable to reach any other conclusion. I grant at once that with no material from Japan and none from the Bay of Batavia, my conclusions cannot be considered final, and it is quite possible that *oshimae* will prove to be a distinct species, characterized by the very large C-shaped particles (up to 152 μ in length) and the very small tables, with disk only 20 μ in diameter.

But *variegatus* is unquestionably a very variable species and the eighteen specimens before me show great diversity in the development of the dorsal and lateral tubercles and in the relative abundance of the different sorts of calcareous particles, as well as in size and color. I am not able to throw any light on the growth-changes never having seen a very young specimen. Preserved specimens of *chloronotus*, *horrens*, and *variegatus*, when of the same size, often resemble each other so closely that only a careful study of the calcareous particles will reveal their identity. And yet in life the three species are quite unlike and are distinguishable from each other at a glance.

The color of a typical *variegatus* is fundamentally yellow-brown or brownish yellow. Semper's colored figure shows bright red tips to the papillae but I failed to detect any red on the individuals I saw in Torres Strait. In size, *variegatus* is the largest member of the genus; one brought up by a Japanese diver at Mer from a depth of 18 fms. measured 725 mm. in length by 125 mm. in width, and was thus very much larger than Sluiter's *vastus*. Average specimens are 300 to 400 mm. long in life but shrink to about half that in preservation.

The distribution of *variegatus* is from Zanzibar, Mauritius, and the Arabian Gulf to the Fiji, Samoan, and Caroline Islands; northward it reaches the southern islands of Japan and southward it reaches Port Molle on the Queensland coast. It is not known from Hawaii or the Society Islands.

Stichopus variegatus var. herrmanni.

Semper, 1868, p. 73, pl. 17, 30, fig. 2. Philippines: Bohol.

This is apparently a well-marked variety, of which Semper says he had specimens from Samoa as well as from Bohol. If the differences are constant, and so persistent that they are clear in preserved material, it would seem proper to consider *herrmanni* a distinct species. But it is notable that the form has not been recorded since 1868.

Stichopus naso.

Semper, 1868, p. 72, pl. 18, 30, fig. 3. Philippines: Bohol, near Talibon, 8–15 fms.

Comparison of Semper's plates 16 and 18 would seem to put beyond question the distinctness of this species from *S. variegatus*, but when one looks for characters which will serve for distinguishing alcoholic specimens, the difficulties are very great. The records of *naso* from other localities than the Philippines are not reliable for Ludwig (1883) has identified as *variegatus* the specimen from Mauritius which Haacks considered *naso*, and I have identified as *naso* specimens from Fiji and from Cebu, which reëxamination prove to be *variegatus*. Further investigations in the East Indian region may bring out more clearly what the essential characters of *naso* are, if it is really distinct from *variegatus*.

Stichopus simulans.

Stichopus mollis with "very peculiar type of spicule" Dendy, 1897, p. 48, pl. 7, fig. 83–87, Wellington, N. Z.

Stichopus simulans Dendy and Hindle, 1907, p. 97, pl. 11, fig. 5. Resolution Island.

Stichopus simultans Erwe, 1913, p. 388. East coast of Rottnest Island, West Australia.

The relationship of this species to *mollis* is indeed peculiar. Both Dendy (1897) and Joshua (1914) discovered their specimens by accident among specimens supposed to be *S. mollis*. On examining the specimens of *mollis* in the M. C. Z., I found among those from Westernport, Victoria, one that has the peculiar foliaceous rosettes of *simulans*. These rosettes are of course a very convenient recognition-mark but as the specimens that have them are otherwise indistinguishable from *mollis*, the rosettes may indicate an age or seasonal or sex condition rather than a specific difference. The matter deserves careful study by some Australasian zoölogist who can secure plenty of material at all seasons of the year. In size, color, habits, and distribution, *simulans* is remarkably like *mollis*.

Stichopus johnsoni.

Plate **1**, fig. 15, 16.

Théel, 1886a, p. 4. California: 5 miles south of Santa Barbara, 22 fms.

This well-marked species is no longer represented only by the unique holotype, for within the past few years two additional specimens have come into the M. C. Z. collection, one from Laguna Beach, California, and the other from a less definite locality — "Southern California." The calcareous particles (Plate **1**) not figured hitherto, are drawn to the same scale as in the case of other species. The buttons (Plate **1**, fig. 15) are not so very different from those of *californicus* but the tables (Plate **1**, fig. 16) are very distinctive. There is no information available as to color or size in life, nor is anything known of the habits and habitat. It is not impossible that *johnsoni* will prove to be a form of *californicus* characteristic of deeper water, or it may possibly prove to be a growth-stage. So far as present evidence goes however these are unwarrantable assumptions.

Stichopus californicus.

Plate **1**, fig. 8–12.

Holothuria californicus Stimpson, 1857, p. 524 (84 of reprint). Tomales Bay, California.
Stichopus californicus H. L. Clark, 1901, p. 164.

As the calcareous particles of this species have never been illustrated, they are figured herewith for easy comparison with the preceding and following species, to which *californicus* is very closely related. The buttons (Plate **1**, fig. 8) are relatively large and usually have 5–7 pairs of holes with no smaller ones around the margin, but some of the larger ones have small holes near the margin, alternating with the pairs of large holes (Plate **1**, fig. 9). The tables commonly have four large holes, with which four smaller and more distal holes alternate (Plate **1**, fig. 10), but often there are smaller holes on each side of the latter (Plate **1**, fig. 11). Rarely the tables are not tetramerously symmetrical, but have five or six central holes as indicated in figure 11. The spires of the tables are rather high (Plate **1**, fig. 12) with two cross-bars and 20–24 teeth at the top.

This is a large species, up to 500 mm. long in life, and 100–110 mm. in width. The color in life is reported as dark red, but alcoholic material is light brown. The geographical range is known to be from southern California to Puget Sound, and it probably extends considerably to the north of the latter region. At Friday Harbor, Washington, and at Monterey, California, *S. californicus* is one of the most common holothurians. A study of its growth-changes would be most interesting and important.

Stichopus parvimensis.

Plate **1**, fig. 13, 14.

H. L. Clark, 1913, p. 234. Lower California: Cedros Island.

The tables (Plate **1**, fig. 13) and buttons (Plate **1**, fig. 14) of this species are really diminutive when compared with those of *johnsoni*, its nearest relative geographically. It is certainly odd that *johnsoni*, the species with the largest tables, should be intermediate in its geographical position, between *californicus* with its tables of moderate size and *parvimensis* with its very small tables. It is not improbable that both *johnsoni* and *parvimensis* have arisen from *californicus* at the southern extremity of its range, the former with its large tables extending into and occupying the deeper, cooler water of a limited area off southern California, while the latter with its diminutive tables came to occupy the shallow, warmer water of Lower California.

The three original specimens of *parvimensis* were taken in 3½ ft. of water on a bottom covered with "sea-weed" (presumably "eel-grass"), near shore on the east side of Cedros Island, west coast of Lower California, March 12, 1911. This species is reported by Parker (1921, Journ. exper. zoöl., **33**, p. 205) under the name *panimensis* as "found in considerable numbers on the rocky shores" at La Jolla, California.

The length of the preserved specimens (about 200 mm.) indicates a species at least 350 mm. long in life. The color is now light chestnut-brown, paler below, with many of the pedicels very dark brown, and hence in their contracted condition appearing as minute black spots.

Stichopus paradoxus.

Lampert, 1885, p. 247, fig. 14, 17, 27. Australia.

This extraordinary and easily recognized species has not been met with since the original description of the unique holotype, a uniformly brown specimen, 140 mm. long.

LITERATURE.

Augustine, Ernst.

1908. Über japanische seewalzen. Abhl. K. Bayer. akad. wiss., math.-phys. klasse. Suppl., **2**, ab. 1, 44 pp., 2 pls.

Barrois, Théodore.

1882. Catalogue des . . . . échinodermes recueilles à Concarneau . . . . Lille, 68 pp., 4 pls.

Bell, F. J.

1883. Studies in the Holothuroidea. 2. Proc. Zool. soc. London, p. 58–62, pl. 15.

Brandt, J. F.

1835. Prodromus descriptionis animalium ab H. Mertensio. Fasc. 1. Petropoli, [78] pp.

Chiaje, Stephano Delle.

1823–1829. Memorie sulla storia e notomia degli animali senza vertebre del regno de Napoli. Naples, 4 vols.

Clark, H. L.

1901. The holothurians of the Pacific coast of North America. Zool. anz., **24**, p. 162–171, 14 text figs.

1902. Notes on some North Pacific holothurians. Zool. anz., **25**, p. 562–564.

1913. Echinoderms from Lower California with descriptions of new species. Bull. Amer. mus. nat. hist., **32**, p. 185–236, pl. 44–46.

Cuvier, G. L. C. F. D.

1817. Le regne animal. Paris, 4 vols.

Dendy, Arthur.

1897. Observations on the holothurians of New Zealand. Journ. Linn. soc. London. Zool., **26**, p. 22–52, pl. 3–7.

Dendy, Arthur, and Hindle, E.

1907. Some additions to our knowledge of the New Zealand holothurians. Journ. Linn. soc. London. Zool., **30**, p. 95–125, pl. 11–14.

Erwe, Willy.

1913. Holothurioidea. Michaelsen and Hartmeyer's Fauna Südwest Australiens, **4**, p. 349–402, pl. 5–8.

Fisher, W. K.

1907. The holothurians of the Hawaiian Islands. Proc. U. S. N. M., **32**, p. 637–744, pl. 66–82.

Greef, Richard.

1882. Echinodermen beobachtet auf einer reise nach der Guinea-insel São Thomé. Zool. anz., **5**, p. 114–120, 135–139, 156–159.

Grube, A. E.

1840. Aktinien, echinodermen und würmer des Adriatischen und Mittelmeers. Konigsberg. 92 pp., 1 pl.

Gunnerus, J. E.

1767. Beskrifning på trenne Norske Sjö-kräk, Sjöpungar kallade. Kongl. vet. akad. Handl., p. 114–124, pl. 4, fig. 1–3.

Haacke, W.

1880. Holothurien. Möbius's Beiträge zur meeresfauna der insel Mauritius, p. 46–48.

Heilprin, Angelo.

1888. Contributions to the natural history of the Bermuda Islands. Proc. Acad. nat. sci. Phil., **40**, p. 302–328.

Herouard, Edgard.

1896. Note préliminaire sur les holothuries provenant des dragages du yacht PRINCESSE-ALICE. Bull. Soc. zool. France, **21**, p. 163–168.

Hutton, F. W.

1872. Catalogue of the Echinodermata of New Zealand. Wellington.

1879. Notes on some New Zealand Echinodermata. Trans. and proc. N. Z. inst., **11**, p. 305–308.

Jaeger, G. F.

1833. De holothuriis. Turin, 42 pp., 3 pls.

Joshua, E. C.

1914. Victorian Holothuroidea with descriptions of new species. Proc. Roy. soc. Victoria, new ser., **27**, p. 1–11, pl. 1.

Kent, W. S.

1893. The great barrier reef of Australia. London, 17, 387 pp., 64 pls.

Koehler, Rene.

1895. Dragages profonds exécuté sa bord du CAUDAN. Rapport préliminaire sur les échinodermes. Rev. biol. Nord France, **7**, p. 439–496.

Lampert, Kurt.

1885. Die seewalzen. Wiesbaden, p. 1–312, pl. 1.

Lesson, R. P.

1830. Centurie zoologique. Paris, 228 pp., 80 pls.

Ludwig, H. F.

1875. Beiträge zur kenntniss der Holothurien. Arb. Zool.-zoot. inst. Wurzburg, **2**, p. 77–118, pl. 6, 7.

1881. Revision der Mertens-Brandtschen holothurien. Zeitschr. wiss. zool., **35**, p. 575–599.

1883. Verzeichniss der holothurien des Kieler museums. Bericht Oberhess. gesellsch. natur-und heilkunde, **22**, p. 155–176.

Mitsukuri, Kakichi.

1897. On changes which are found with advancing age in the calcareous deposits of *Stichopus japonicus* Selenka. Annot. zool. Jap., **1**, p. 31–42.

1912. Studies on actinopodous Holothurioidea. Journ. Coll. sci. Imp. univ., **29**, art. 2, p. 1–284, pl. 1–8.

Müller, Johannes.

1854. Über den bau der echinodermen. Abh. Berlin akad. wiss., 1853, (1854), p. 1–99, pl. 1–9.

Ohshima, Hiroshi.
1915. Report on the holothurians collected by the U. S. Fisheries Steamer Albatross in the northwestern Pacific during the summer of 1906. Proc. U. S. N. M., **48**, p. 213–291, pl. 8–11.

Östergren, Hjalmar.
1897. Über die holothuriiden Norwegens. Bergens mus. aarbog, no. 12, p. 1–9, 1 pl.

Pearson, Joseph.
1903. Report on the Holothurioidea. Ceylon pearl oyster fisheries. Suppl. rept. no. 5, 28 pp., 3 pls.

Perrier, J. O. E.
1904. Holothuries du Cap Horn. Bull. Mus. hist. nat. Paris, p. 13–17.
1905. Holothuries antarctiques du Museum d'histoire naturelle de Paris. Ann. sci. nat., ser. 9, **1**, p. 1–146, pl. 1–5.

Quoy, J. R. C. and Gaimard, J. P.
1834. Voyage de l'Astrolabe. Zoologie, **4**,

Sars, Michael.
1858. Bidrag til kundskaben om Middelhavets littoral-fauna. Nyt mag. naturv., 1857, **9**, p. 120–155, pl. 1, 2.
1867. Om nogle echinodermer og coelenterater fra Lofoten. Vid. selsk. Forhandl., 1867, p. 19–24.

Selenka, Emil.
1867. Beiträge zur anatomie und systematik der holothurien. Zeitschr. wiss. zool., **17**, p. 291–374, pl. 17–20.
1868. Nachtrag zur den beiträgen zur anatomie und systematik der holothurien. Zeitschr. wiss. zool., **18**, p. 109–119, pl. 8.

Semper, C. G.
1868. Reisen im archipel der Philippinen. Holothurien. 10, 288 pp., 40 pls.

Sluiter, C. P.
1887. Die evertebraten aus der sammlung des Kgl. naturwissensch. vereins in Niederlandisch-Indien in Batavia. Holothurioidea. Nat. tijdschr. Ned. Ind., **47**, p. 181–220, pl. 1, 2.
1910. Westindische holothurien. Zool. jahrb. Suppl., **11**, p. 331–342.

Stimpson, William.
1857. On the Crustacea and Echinodermata of the Pacific shores of North America. Boston journ. nat. hist., **6**, p. 444–532, pl. 18–23.

Thèel, Hjalmar.
1882. Report on the Holothurioidea, collected by the Knight Errant. Proc. Roy. soc. Edinburgh, **11**, p. 694–697.
1886. Report on the [Challenger] Holothurioidea. Part 2. **14**, p. 1–290, pl. 1–16.
1886*a*. Report on the [Blake] Holothurioidea. Bull. M. C. Z., **13**, p. 1–22, 1 pl.

EXPLANATION OF THE PLATES.

PLATE 1.

PLATE 1.

Figs. 1–7. *Stichopus macroparentheses* H. L. Clark.

1. Disk of typical table.
2. Disk of more developed table.
3. Spire of same, from side.
4. Spire of same, seen from above.
5. Spire of small table, seen from above.
6. C-shaped particle.
7. C-shaped particle.

Figs. 8–12. *Stichopus californicus* (Stimpson).

8. A typical button.
9. One end of a somewhat more developed button.
10. A typical table, seen from above.
11. Part of disk margin of more developed table.
12. A typical table, seen from side.

Figs. 13, 14. *Stichopus parrimensis* H. L. Clark.

13. A typical table, seen from above. (Spire with fewer terminal teeth than usual).
14. A typical button.

Figs. 15, 16. *Stichopus johnsoni* Théel.

15. A typical button.
16. A typical table, seen from above.

Figs. 17, 18. *Stichopus regalis* (Cuvier).

17. Spire of table, seen from side.
18. A typical table, seen from above.

All figures magnified 425 ×.

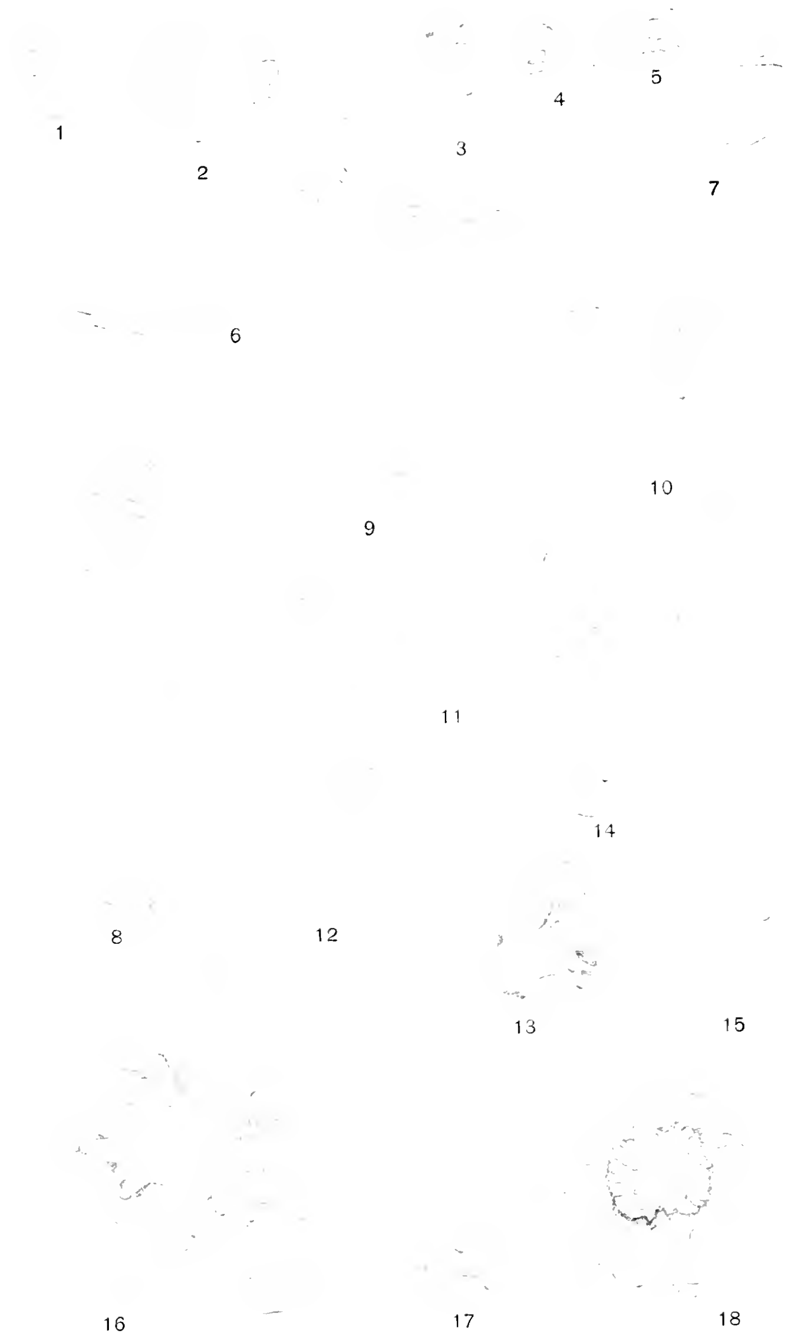

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18

PLATE 2.

PLATE 2.

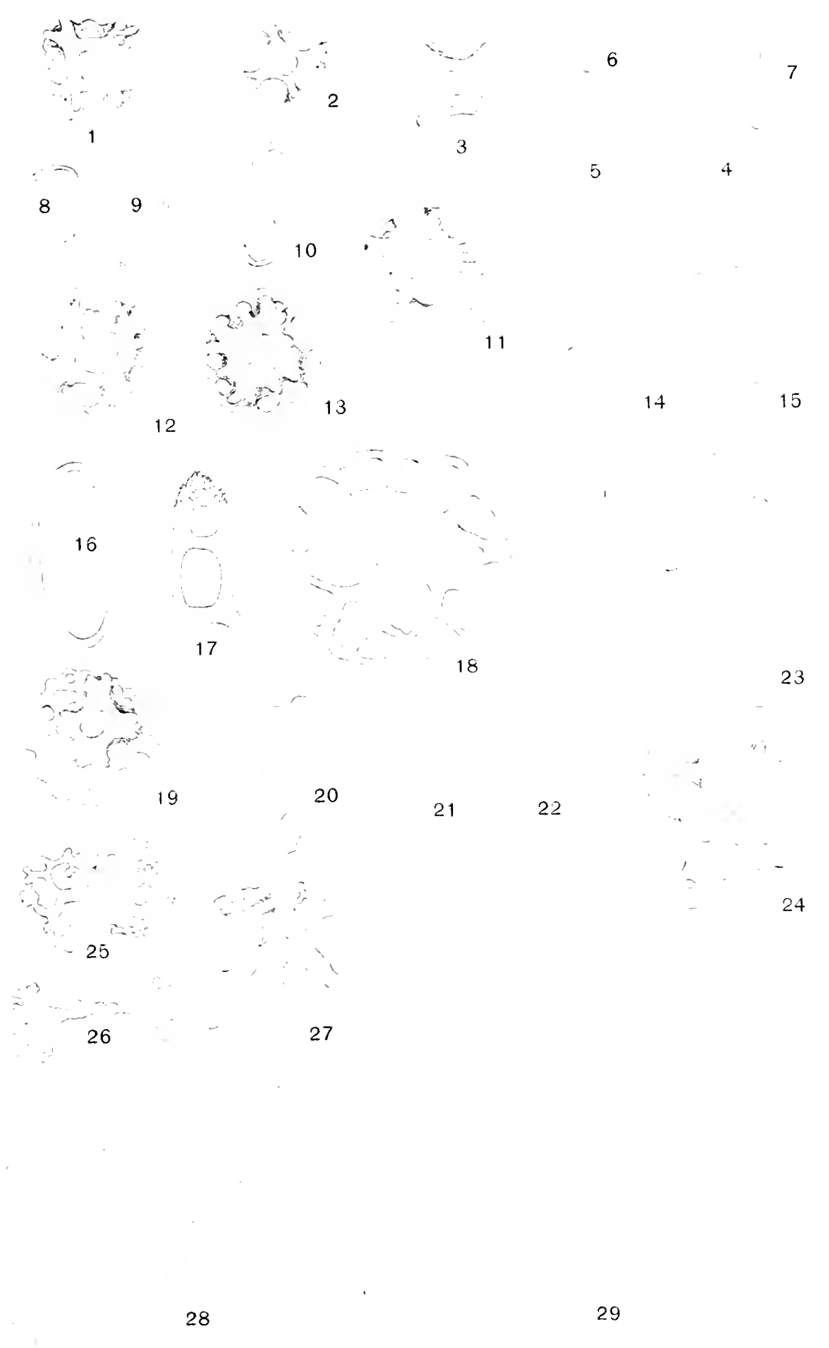
Fig. 1–10. *Stichopus chloronotus* Brandt.
- 1. A typical table, seen from above.
- 2. A simpler, common form of table, from above.
- 3. The same, seen from side.
- 4–6. C-shaped particles of a specimen from Torres Strait.
- 7. An abnormal C-shaped particle of same specimen.
- 8, 9. C-shaped particle of a specimen from the Caroline Islands.
- 10. S-shaped particle of same specimen.

Fig. 11–18. *Stichopus badionotus* Selenka.
- 11–13. Typical tables, seen from above.
- 14. Partially resorbed table, seen from side.
- 15. More fully resorbed table, seen from side.
- 16. C-shaped particle.
- 17. Spire of table of a very young specimen.
- 18. Disk of same.

Fig. 19–23. *Stichopus horrens* Selenka.
- 19. Typical table from near papillae, seen from above.
- 20. Typical table of body-wall; disk only.
- 21, 22. C-shaped particles.
- 23. Table of a very young specimen, seen from above.

Figs. 24–29. *Stichopus ecnomius* H. L. Clark.
- 24. A typical table.
- 25, 26. Rosettes.
- 27–29. Asymmetrical, irregular tables.

All figures magnified 425 ×.


1
2
3
6
7
5
4
8
9
10
11
12
13
14
15
16
17
18
23
19
20
21
22
24
25
26
27
28
29

Bulletin of the Museum of Comparative Zoölogy

AT HARVARD COLLEGE.

Vol. LXV. No. 4.

NOTES ON PHILIPPINE BIRDS COLLECTED BY GOVERNOR W. CAMERON FORBES.

By Outram Bangs.

CAMBRIDGE, MASS., U. S. A.:

PRINTED FOR THE MUSEUM.

April, 1922.

No. 4.— *Notes on Philippine Birds collected by Governor W. Cameron Forbes.*

By Outram Bangs.

In the last decade former Governor-General W. Cameron Forbes has presented to the Museum of Comparative Zoölogy three large collections of Philippine birds. One of these was made in 1911, another in 1913, and the third and finest collection in 1921 while, with General Leonard Wood and Colonel Gordon Johnston, Mr. Forbes was on an official tour of inspection of the islands.

On the excursions which resulted in the gathering together of these collections Mr. Forbes was sometimes accompanied by General Leonard Wood, the Honourable Dean C. Worcester, and Dr. Richard C. McGregor, and he had also the expert assistance of Mr. A. Celestino.

During the spring and summer of 1921 Governor Forbes and party visited most of the islands of the group. Bird collecting was carried on with enthusiasm by all the members of the party on every possible occasion, but stops at the different islands were at best limited to a few days and official business had, of course, precedence. The collections therefore while large, interesting, and fairly representative are by no means exhaustive.

The following notes, which include descriptions of five new forms, are based on the three collections.

I am under great obligations to Dr. Chas. W. Richmond and Mr. J. H. Riley of the United States National Museum for making some comparisons in Washington and for giving me data from other specimens in the collections under their care.

Irediparra gallinacea gallinacea (Temminck).

Twelve specimens, both sexes, mostly fully adult, Lake Liguasan, Mindanao, March and August.

The Comb-crested Jacana has been found in the Philippine Islands, apparently only in Mindanao. Specimens from that island I am unable in any way to distinguish from one skin in the M. C. Z. from Celebes, the type-locality of the species. Mr. J. H. Riley writes me that he has lately compared three specimens from Celebes with one from Mindanao with the result that he could find no differences. It is safe therefore to refer the Philippine bird to the typical form.

Plegadis falcinellus peregrinus Bonaparte.

Three specimens, two males and a female, from Mindanao, March and August.

These belong, as of course was to be expected, to the decidedly small form of Australia, Java, Celebes, etc., the range of which must be extended to include the Philippines as well.

Measurements.

No.	Sex	Wing	Tail	Tarsus	Culmen
57,552	♂	262	96	104	127
86,480	♂	258	98	100	131
86,481	♀	250	98	84	105

Sula dactylatra personata Gould.

Five adults, both sexes, Tubbataba Reef, Sulu Sea, August, 1913.

The Blue-faced Booby, which breeds in the Tubbataba Reef in the Sulu Sea is indistinguishable, so far as I can see, from the Australian form.

The color of the bill and feet was not noted on the labels of Gov. Forbes's birds; in the dry specimens the bill is pale yellow and the feet are dull greenish black.

Measurements.

No.	Sex	Wing	Tail	Tarsus	Culmen at Base	Width of Culmen
64,611	♂ ad.	418	190	59	101	30
64,614	♂ ad.	398	190	59	99	30
64,616	♂ ad.	405	184	57	100	28
64,612	♀ ad.	420	183	61	102	29
64,613	♀ ad.	424	185	59	103	28

Fregata minor minor (Gmelin).

Six specimens, two adult males in full breeding plumage, three adult females and one immature male, from Cavilli and Bancoran Islands, Sulu Sea, March and September.

I follow Rothschild in restricting Gmelin's name *minor* to the bird of the eastern Indian Ocean, north Australia etc. (= *F. minor listeri* Mathews), and with little doubt refer to this form the Philippine Frigate.

The color of the bill in the three females is *bright pink*, not far from between France-pink and geranium-pink of Ridgway. The soft parts were described by Governor Forbes on the labels as — "Eyelid bright red: bill light pink, nail white, tip black; feet pale pink." The males all have dark bills, their soft parts were noted on the labels as — "Bill blue-black; feet dull brownish, with a slight reddish tinge."

An adult female of *F. minor palmerstoni* (Gmelin), shot by Flood, 29 September, 1895 at Molokai, H. I. (115,028 M. C. Z.) has a decidedly pinkish bill, the color of which was noted on the label as "light purple."

Gmelin mentions the red bill in his short diagnosis of *minor* and Edwards's plate to which he refers shows a female Frigate with a red bill.

I have dwelt at the above length upon the red bill of the female of both *minor* and *palmerstoni* because it is a character that I have seen but little mentioned, and because I feel morally certain that the American bird — *Fregata magnificans* Mathews according to Rothschild, *F. minor rothschildi* Mathews according to Mathews — does not show it. We have a very large series of Frigate birds from America, and among the females none show any trace of reddish or pinkish on the bills, nor do I find the bill of the female described as pink on any label, or for that matter in any text-book.

This being the case, it is a matter of much interest to know what forms have a pink bill in the female, and what do not.

Fregata ariel ariel Gray.

Three specimens, from Tawi Tawi Island, two adult males and one adult female all taken 21 August, 1921.

Compared with *Fregata ariel iredalei* Mathews of the western Indian Ocean these are large birds with heavy bills, and appear wholly referable to true *ariel* of Australia etc.

Measurements.

No.	Sex	Wing	Culmen to Feathers
86,492	♂ ad.	501	87
86,493	♂ ad.	491	89
86,491	♀ ad.	552	92

BUTEO JAPONICUS (Temminck & Schlegel).

One immature example (sex not determined) was shot by Mrs. Robb White at Sagada, Bontoc, northern Luzon in July 1913 and given to Governor Forbes. This, I believe, is the first record for the species in the Philippines. The specimen, M. C. Z. 64,621, affords a wing length of 366 mm.

XANTHOLAEMA HAEMACEPHALA HAEMACEPHALA (Müller).

Two adult males, Mindoro, July. (Also two old skins in M. C. Z. labeled "Manilla").

Stuart Baker, (Ibis 1919, p. 219), has already pointed out the strong characters that distinguish the Philippine form of this little Barbet. I include it in these notes merely to emphasize the fact that it must be kept distinct from birds from India, the Malay Peninsula, Sumatra, etc. Its long bill, dark colors, and heavily striped under parts at once distinguish it.

XANTHOLAEMA ROSEA INTERMEDIA Shelly.

Four adults, both sexes, Negros, July.

This is another strongly marked representative form, peculiar to the Philippines. It differs from *X. rosea rosea* (Dumont) of Java etc. in its very much larger bill (averaging 22 mm. as against 16 mm. in true *rosea*), slightly larger size, darker colors, and much more heavily striped under parts.

LALAGE NIGER MITIFICA, subsp. nov.

Twelve specimens, both sexes, Lubang near Luzon, Mindanao, Palawan, Camiguin, Camotes, Basilan, Panay, Mindoro, and Cagayan de Sulu, June, July, and August.

TYPE.— M. C. Z. 64,329 adult ♂, Lubang, near Luzon, 6 July, 1913. W. Cameron Forbes.

CHARACTERS.— Similar to *L. niger niger* (Forster), (type-locality "in India Orientali" which I will farther restrict to Singapore, being as likely as anywhere else to have been whence the type actually came), but larger; in color the adult ♂ differing in the sheen of the head and back being darker and more purplish, less greenish; the rump slightly darker gray and the tibia grayer, less whitish. The adult ♀ decidedly grayer less brownish above — deep neutral gray (the upper parts in *L. nigra nigra* are hair-brown to Chaetura drab).

REMARKS.— Birds from Java are small and appear to be quite like those from Singapore and the southern Malay peninsula. The Borneo bird is a little larger and the one female before me is gray above as in the Philippine form.

MEASUREMENTS.

Lalage niger mitifica Bangs.

No.	Sex	Locality	Wing	Tail	Tarsus	Culmen from Base
86,669	♂	Panay	93	69	20	18
86,668	♂	Basilan	94	70	20.5	17.5
86,671	♂	Camotes	93	70	21	18
86,667	♂	Camiguin	95	73	20	19
57,520	♂	Cagayan de Sulu	92	69	20	19
64,329	♂	Lubang	92	71	20.5	19
64,330	♂	"	93	70	20	18.5
64,331	♂	Palawan	95	69	20	17.5
64,328	♀	Lubang	93	—	21	18.5
64,327	♀	Mindanao	92	72	21	19

Lalage niger niger (Forster).

No.	Sex	Locality	Wing	Tail	Tarsus	Culmen from Base
33,994	♂	Singapore	85	68	19	16
34,119	♀	Kelang	82	63	19	17
60,164	♂	Java	87.5	66	20	17
60,163	♂	"	88	70	20	16
60,166	♂	"	85	68	21	16
60,160	♀	"	87.5	67	19	18
60,159	♀	"	86	69	20	16
60,167	♀	"	83	64	20	17
12,182	♀	"	87	61	19	—

AEGITHINA TIPHIA AEQUANIMIS, subsp. nov.

Nine specimens, both sexes, from Palawan and Dumaran Islands, June, July, August, and September.

TYPE.— M. C. Z. 64,334 adult ♂, Puerto Princesa, Palawan Island, 4 August, 1913. W. Cameron Forbes.

CHARACTERS.— Similar to *A. tiphia tiphia* (Linné) and *A. t. viridis* (Bonaparte) of Borneo, but bill longer and heavier; the upper parts much more yellowish olive-green and the forehead, including the lores, broadly bright yellow.

MEASUREMENTS.

No.	Sex	Locality	Wing	Tail	Tarsus	Culmen to Base
64,332	♂ ad.	Palawan	64	49	20.5	19
64,333	♂ ad.	"	62	44	21	18.5
64,334	♂ ad.	"	62	44	20	18
86,684	♂ ad.	Dumaran	62	46	21	18
86,685	♂ ad.	"	61	50	19	18.5
41,304	♀ ad.	Palawan	61	47	20	18
86,683	♀ ad.	"	62	48	19	17

REMARKS.— The Palawan and Dumaran bird represents a very good form, easily separated from *A. tiphia tiphia* or *A. t. viridis* by its larger bill and much brighter upper parts. The series shows no individual variation, and no tendency to ever become dusky or black above.

ORTHOTOMUS RUFICEPS NUNTIUS, subsp. nov.

Three specimens from the Sulu Archipelago; an adult ♂ Sibutu, 23 August, an adult ♂ Cagayan de Sulu, 2 July, and an immature ♀ Jolo, 2 August.

TYPE.— M. C. Z. 57,529 adult ♂, Cagayan de Sulu, 2 July, 1911. W. Cameron Forbes.

CHARACTERS.— Similar to *O. ruficeps ruficeps* (Lesson), (specimens from Borneo), but slightly larger, with longer bill; upper parts clearer gray; crown slightly deeper brown.

MEASUREMENTS.

No.	Sex	Locality	Wing	Tail	Tarsus	Culmen from Base
57,529	♂ ad.	Cagayan de Sulu	56	47	24	20
86,601	♂ ad.	Sibutu	54	45	23	20.5

REMARKS.— There are, in the U. S. N. M., three skins from Sibutu similar in all respects to ours.

Birds from Palawan and Chulion Islands are somewhat smaller than those from Sulu, but agree in color more nearly with them, than they do with true *ruficeps* of Borneo.

ZOSTEROPS FORBESI, sp. nov.

Two adult males from Camiguin Island, 2 August, 1921.

TYPE.— M. C. Z. 86,369 adult ♂, Camiguin Island, 2 August, 1921. W. Cameron Forbes.

CHARACTERS.— Similar to *Z. basilanica* Steere, but larger; upper parts much brighter and yellower,— yellowish citrine rather more strongly yellowish on head and upper tail coverts; yellow of under parts brighter and clearer — bright yellow chrome.

MEASUREMENTS.

No.	Sex	Wing	Tail	Tarsus	Culmen from Base
86,369	♂ ad.	57	49	16	13
86,368	♂ ad.	56	47	15.5	13

REMARKS.— This new form which is well marked and quite distinct, belongs in the group characterized by possessing a wide stripe of yellow along the median under parts and gray sides and flanks. In the Philippines this group is represented by:

1. *Zosterops siquijorensis* Bourns & Worcester. Negros, Siquijor.
2. *Zosterops boholensis* McGregor. Bohol.
3. *Zosterops everettii* Tweeddale. Cebu.
4. *Zosterops forbesi* Bangs. Camiguin.
5. *Zosterops basilanica* Steere. Basilan, Bongao, Dinagat, Leyte, Mindanao, Papahag, Samar, Jolo, Tawi Tawi.

I have given the new form, which is named in honour of Governor W. Cameron Forbes, specific rank because in an enormous genus, largely composed of island forms, like Zosterops, I do not know where to draw the line between species and subspecies and much prefer leaving the question to be decided by some future reviewer of the genus.

Zosterops meyleri McGregor also of Camiguin Island, is a small species with *wholly* yellow under parts, belonging in a different group of the genus.

ORIOLUS XANTHONOTUS PERSUASUS, subsp. nov.

Four adults, both sexes, Palawan, August.

TYPE.— M. C. Z. 64,180 adult ♂, Puerto Princesa, Palawan Island, 14 August, 1913. W. Cameron Forbes.

CHARACTERS.— Similar to *O. xanthonotus xanthonotus* Horsfield of

Java, but larger with longer tail. Adult ♂ differing in color in much more heavily striped under parts and in the black of chest extending farther backward to include the upper breast; and much less sharply defined posteriorly against the white under parts; back more greenish yellow; yellow spot on outer tail feather large. The adult ♀ besides differing, as does the ♂, in heavier stripes below etc., has the whole pileum, occiput, upper neck, and sides of neck heavily streaked black and olive-green, and the throat and chest dull gray with whitish streaks. (A ♀ probably an older bird in the U. S. N. M. has the head neutral gray with an olive wash, very conspicuously streaked with black, the black streaks extending as in the others right to base of bill).

MEASUREMENTS.

No.	Sex	Locality	Wing	Tail	Tarsus	Exposed Culmen
64,180	♂ ad.	Palawan: Puerto Princesa	121	78	21	23
33,225	♂ ad.	" " "	118	74	20	22
64,181	♀ ad.	" " "	110	69	21	21
64,179	♀ ad.	" Iwahig Penal Colony	109	68	21	21

REMARKS.— The Black-headed Oriole has been recorded from Palawan and Calamianes Islands only in the Philippines. The Palawan representative form is strongly marked and easily to be distinguished from *O. x. xanthonotus* of Java.

The bird of Borneo may represent still another form, distinguished from true *xanthonotus* by slightly smaller size, the under parts less purely white, that is, much more suffused with yellowish or yellowish ochraceous, sometimes even with grayish and with the yellow tail-spots larger. This form probably should be known as *Oriolus xanthonotus consobrinus* Wardlaw-Ramsay (P. Z. S., 1879, p. 709, N. E. Borneo). Everett, however, (Birds of Borneo 1889, p. 119), in mentioning the type states that "It is dissimilar from all known immature individuals of *O. xanthonotus* and belongs rather to the *O. steerii* group." If this is true and there is in north Borneo a form of the Philippine group of Orioles, with the sexes alike in plumage and with the throat and chest plain gray, then the form of the Black-headed Oriole of Borneo, if recognized, should be named.

In old females from Java the pileum and cheeks are dark mouse-gray, blackish on the forehead, the black streaks narrow, almost obsolete and noticeable on the crown and occiput only. Females from the mainland and Borneo and Sumatra also, when adult, have faint blackish streaks on the crown. In immature plumage the head is wholly unstreaked, which I doubt to be the case in the Palawan form.

Bulletin of the Museum of Comparative Zoölogy

AT HARVARD COLLEGE.

VOL. LXV, No. 5.

EXPLORATION OF THE COASTAL WATER OFF THE NORTHEASTERN UNITED STATES IN 1916 BY THE U. S. FISHERIES SCHOONER *GRAMPUS*.

BY HENRY B. BIGELOW.

CAMBRIDGE, MASS., U. S. A.:

PRINTED FOR THE MUSEUM.

JULY, 1922.

No. 5.— *Exploration of the Coastal Water off the Northeastern United States in 1916 by the U. S. Fisheries Schooner* GRAMPUS.

By Henry B. Bigelow.

CONTENTS

INTRODUCTION.

DURING July–August, and again in October, November, 1916, the GRAMPUS cruised from Gloucester to Chesapeake Bay; both cruises being in the immediate charge of the late Mr. W. W. Welsh, of the

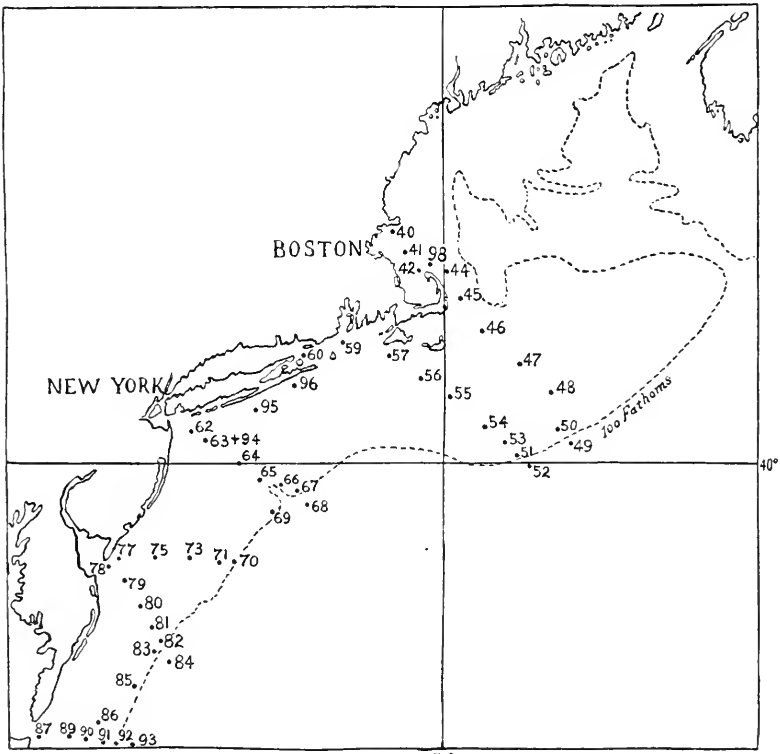


FIG. 1.— GRAMPUS Stations 10340–10398, July–August, 1916.

U. S. Bureau of Fisheries, to whose industry and skill the value of the results is due.

The main objective of the Cruise was the solution of certain fisheries problems. But it soon appeared that so far as temperatures were concerned 1916 was an aberrant season, hence full hydrographic data and plankton hauls were obtained at stations so located as to afford a section from Gloucester across the western side of the Gulf of Maine and Georges Bank, and a general survey of the coastal zone between New York and Chesapeake Bay.

The equipment of the GRAMPUS has been described (Bigelow, 1917a, p. 165).

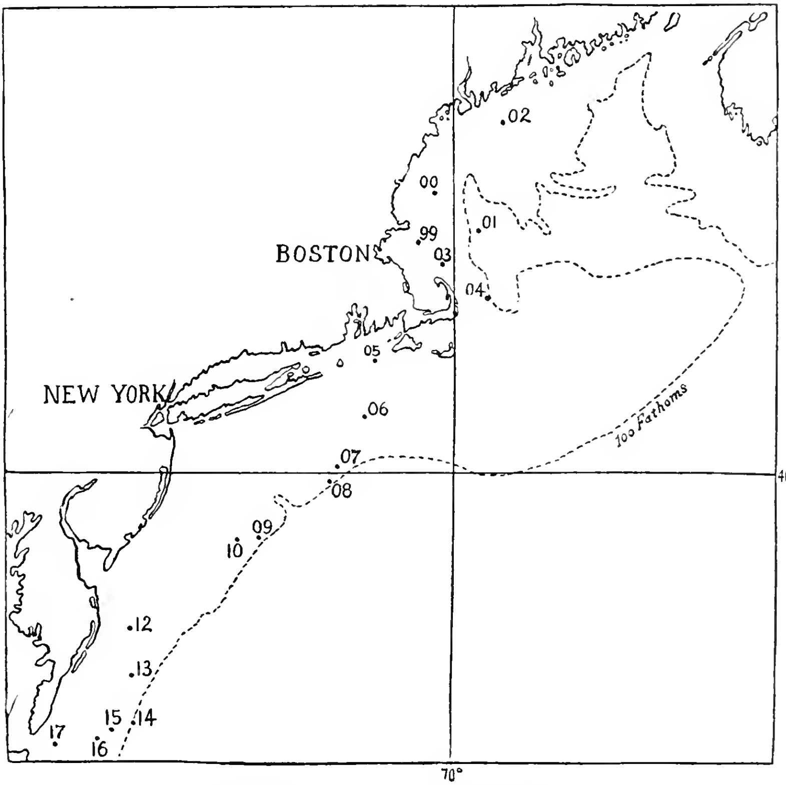


FIG. 2.— GRAMPUS Stations 10399–10417, October–November, 1916.

OCEANOGRAPHY.

THE GULF OF MAINE.

Temperature. Four years' work in the Gulf of Maine, together with earlier records (Bigelow, 1914a, 1917a), have shown that though the seasonal variation in its temperature, salinity, and plankton is extreme, annual fluctuations are usually slight. However, cold summers occur occasionally, for instance, 1882 and 1916. Thus the central part of Massachusetts Bay was 1°–4° colder at all depths on July 22 (Station 10341) and off Gloucester (Station 10340) than previously noted in summer in that general region (Fig. 3), though the localities of

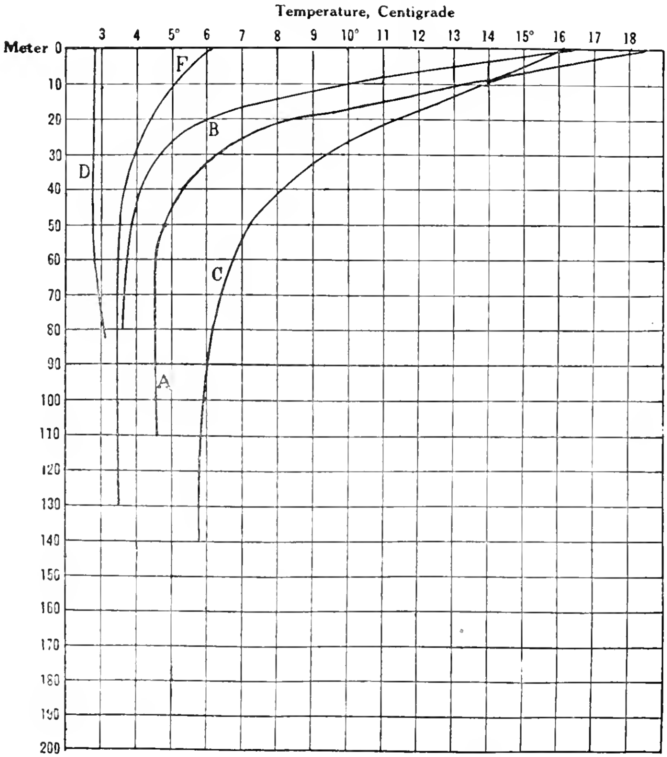


Fig. 3.— Temperatures off Gloucester at the mouth of Massachusetts Bay, various years and seasons.
A. July 10, 1912, Station 10002. B. July, 19, 1916, Station 10341. C. August 31, 1915, Station 10306. D. Feb. 13, 1913, Station 10053. F. May 4, 1915, Station 10266.

record for the several years are so close together that no regional temperature difference was to be expected on geographical grounds. In fact, below 50 meters, the July temperatures for 1916 are hardly higher than the May readings for the previous year; at 80 meters only about .5° higher than the winter minimum for 1913 (Bigelow, 1914b). The water off Cape Cod (Stations 10344, 10345, Fig. 5, 6) was likewise decidedly colder in 1916 than in the summers of 1913–1915, (the 20–40 meter temperature about 2°–3° lower than in 1913; 6°–9° lower than in 1914). And in the southwest corner of the Gulf (Station 10346) the surface was actually 10° colder on July 22, 1916 than on July 19, 1914, though that this very great discrepancy was chiefly due to active vertical circulation is clear, from the very small vertical range of temperature at the station in question. And the vertical warming below 100 meters so characteristic of this side of the Gulf in 1914 and

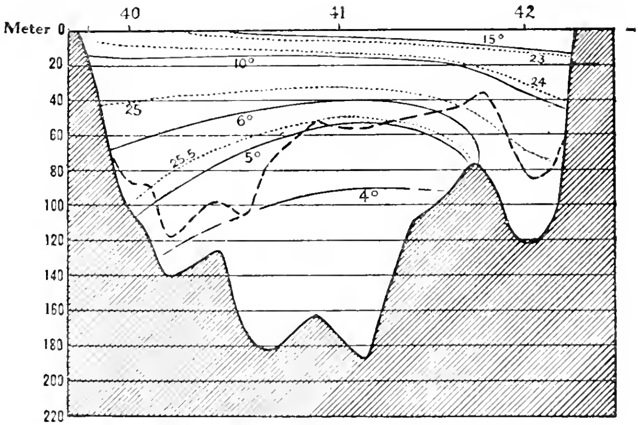


Fig. 4.— Profile of temperature and density crossing Massachusetts Bay just west of Stellwagen Ledge, July 19, 1916. Temperature curves solid. Density curves dotted. The contour of Stellwagen Ledge is shown by the heavy broken curve.

1915 (Bigelow, 1917a), was hardly appreciable in 1916. During the interval July 22–August 29, the mid-layers off northern Cape Cod warmed by about 1°–2° (Stations 10344, 10398, Fig. 5); even then, however, the temperature did not equal that of 1912 on the same date (Station 10043, August 29) or of 1913 three weeks earlier (Station 10086, August 5).

The Grampus did not visit the eastern side of the Gulf in July, 1916, but observations taken in the Bay of Fundy under the auspices of the Biological Board of Canada, summarized below in a letter from Dr. A. G. Huntsman, show that these waters were also unusually cold during that summer:

"The temperature of the water in the Fundy region" he writes, "was unusually low during the summer of 1916. The data given me by Craigie [(1916a, 1916b), Craigie & Chase (1918)], and by Vachon [(1918)] show that in the St. Croix river near St. Andrews and in Passamaquoddy Bay the temperature of the greater part of the water during the first half of August was approximately one degree (C.) lower in 1916 than in 1914. In the Bay of Fundy off Campobello Island, the water was slightly colder on July 25, 1916 than it had been on July 14, 1915, and nearly two degrees (C.) colder on August 16, 1916, than it had been on August 27, 1914. Also in the Bay of Fundy east of Grand Menan the temperature of the body of the water was nearly one degree (C.) lower on July 24, 1916, than on July 15, 1915, and more than two degrees (C.) lower on August 16, 1916, than on August 27, 1914. This shows that in the Bay of Fundy the water was colder in the summer of 1915 than in that of 1914, and still colder in that of 1916."

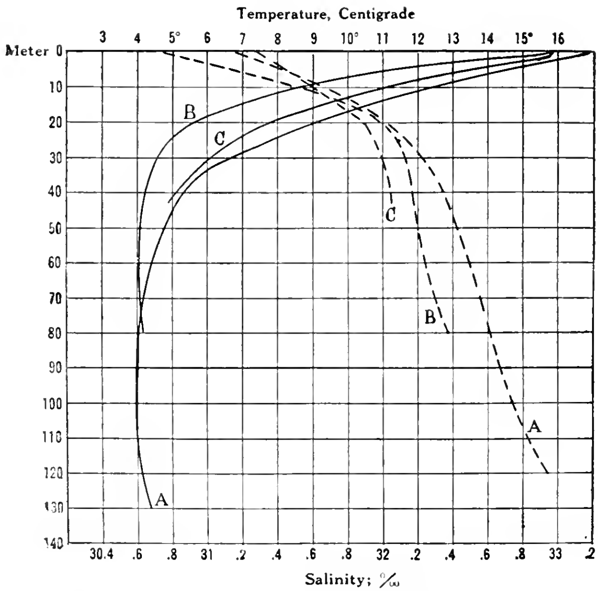


Fig. 5.— Temperatures (solid curves) and salinities (broken curves) off northern Cape Cod, July 19, 1914, Station 10213 (A). July 22, 1916, Station 10344 (B). August 29, 1916, Station 10398 (C).

Even at the end of October and the beginning of November both the sink off Cape Ann, and the deep trough north of it were appreciably cooler than earlier records (Bigelow, 1914b, 1917a) would have led us to expect (Fig. 9, 10). The general seasonal temperature cycle of 1916, however, was as previously observed. Thus, the surface cooled by about the same amount (6° ±) in 1916 as in 1912, and the deeper layers warmed (3° ± at 50 meters, 1.5° ± at 80–100 meters), between July and November at the mouth of Massachusetts Bay,

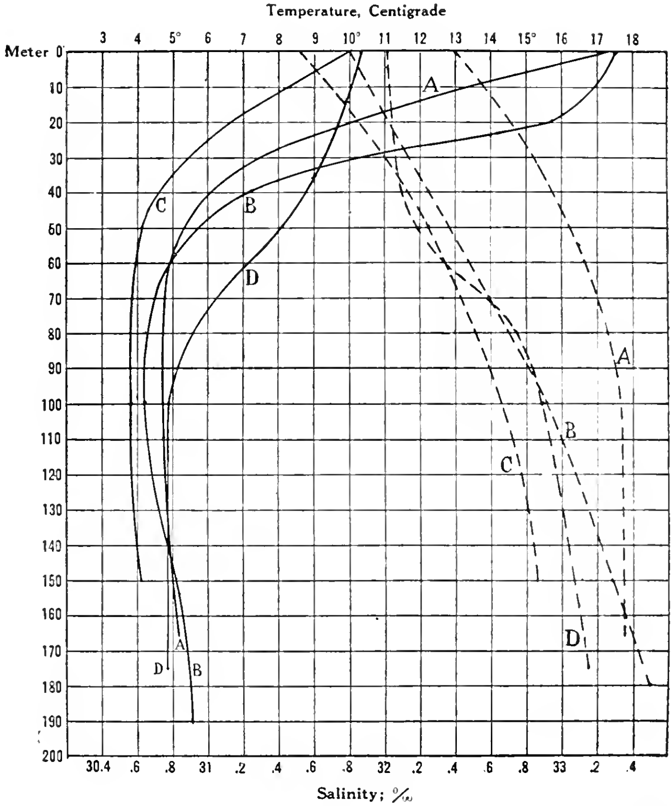


Fig. 6.— Temperatures (solid curves) and salinities (broken curves) off CapeCod, July 8, 1913, Station 10058 (A). July 19, 1914, Station 10214 (B). July 22, 1916, Station 10345 (C). November 8, 1916, Station 10404 (D).

with much the same relationship between the temperature curves for the two months off Cape Cod (Fig. 6) except on the surface.

The autumn stations illustrate especially, and this is their most interesting feature, the progress of autumnal cooling, and its local variations relative to distance from land. Off the mouth of Penobscot

Bay (Station 10402, Fig. 8) this had been so rapid that even as early as November 2 the temperature was practically uniform vertically down to 50 meters, indeed fractionally cooler at the surface than immediately below: near the Isle of Shoals and in the western basin however, (Stations 10400, 10401, Fig. 10) a temperature gradient of about 2° still persisted. The November records for the western basin are further valuable, there being no previous data for the off-shore parts of the Gulf between September 1 and May, as showing that the surface cooling which takes place during the autumn (Fig. 10), is accompanied there, just as near land, by a rise of temperature in the mid-depths consequent on the increasing freedom of vertical circula-

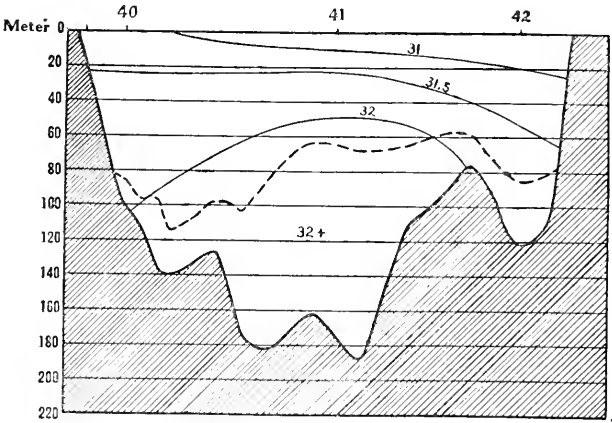


Fig. 7.— Salinity profile crossing Massachusetts Bay just west of Stellwagen Ledge, July 19, 1916. The contour of the Ledge is shown by the heavy broken curve.

tion allowed by decreasing vertical stability. Unfortunately none of the November stations went deep enough to reach the bottom layers of the Gulf, so important in their influence on its general hydrography.

Salinity. The general distribution of salinity in Massachusetts Bay, July, 1916, closely paralleled that of temperature (Fig. 4, 7), its water being freshest when warmest, saltest when coldest, with the curve for 32‰ agreeing almost exactly with 5°; 31.5‰ with 9°. And the salinity, like the temperature of the western side of the Gulf was then decidedly lower than in any recent summer of record; .5‰–1‰ lower for example at all depths off Gloucester than in July 1912, with even greater difference between 1916 and 1913, although

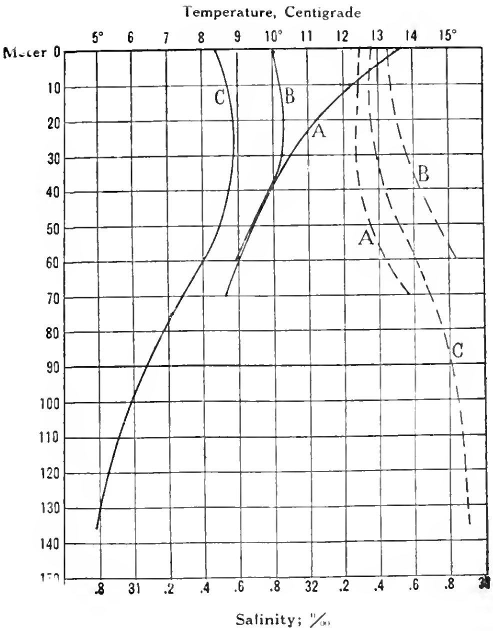


Fig. 8.— Temperatures (solid curves) and salinities (broken curves) off Penobscot Bay, September 16, 1915, Station 10318 (A). October 9, 1915, Station 10329 (B). November 2, 1916, Station 10402 (C).

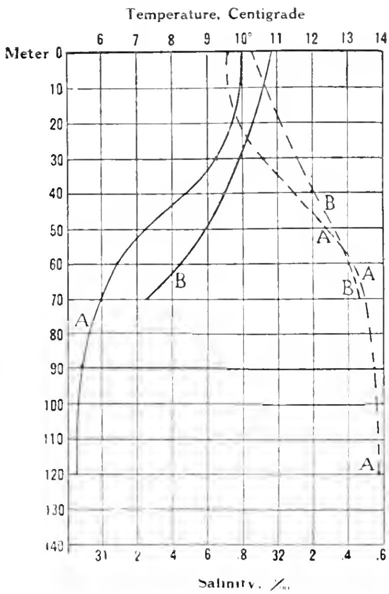


Fig. 9.— Temperatures (solid curves) and salinities (broken curves) at the mouth of Massachusetts Bay, Station 10399, October 31, 1916 (A). Mean of Stations 10338 and 10339, October 27, 1915 (B).

the station localities for these two years are so close together that none was to be expected on geographic grounds. The Stellwagen Sink (Fig. 7) also was fresher than we have ever found the similar sink off Cape Ann, even when the annual minimum of salinity is reached.

As a whole the salinity off northern Cape Cod was about the same

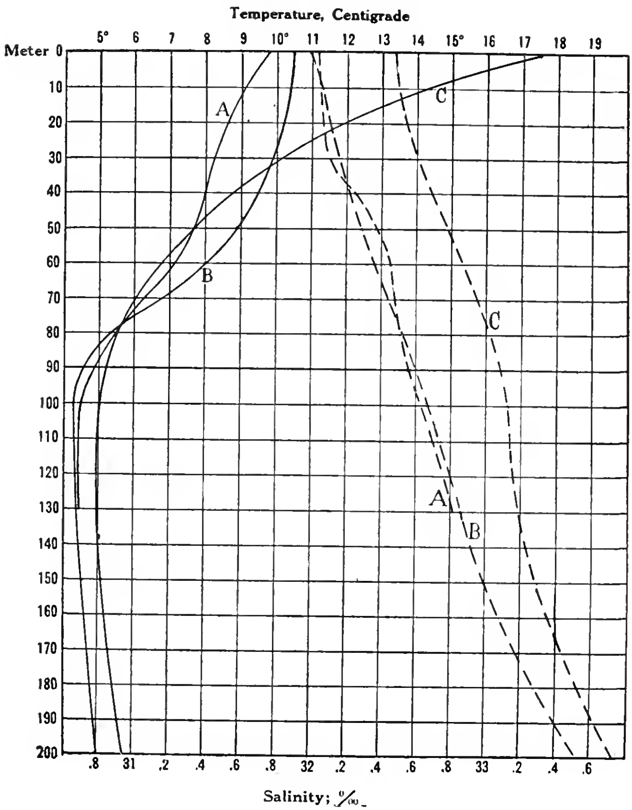


FIG. 10.— Temperatures (solid curves) and salinities (broken curves) in the Sink west of Jeffrey Ledge, Station 10400 (A), in the western Basin, Station 10401 (B), on November 1, 1916. In the western Basin, Station 10307, August 31, 1915 (C).

in the upper layers of water in July, 1916 as in that month of 1914 (Fig. 5). But from the 25 meter level down to 80 meters or so the water was decidedly fresher in the former summer than in any of previous record, nor did the salinity rise appreciably there between

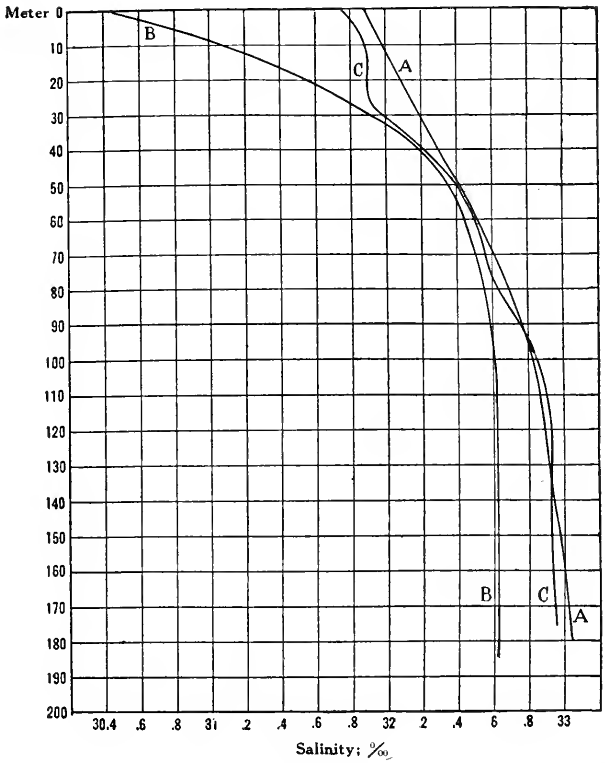


FIG 11.—Salinities in the deep basin of the Bay of Fundy, June 10, 1915, GRAMPUS Station 10282 (A). July 24, 1916, Vachon's Station 3 (B). August 25, 1916, Vachon's Station 3 (C).

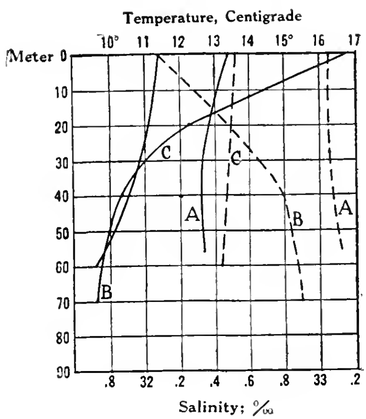


FIG. 12.—Temperatures (solid curves) and salinities (broken curves) on the northwestern part of Georges Bank, July 9, 1913, Station 10059 (A). July 20, 1914, Station 10215 (B). July 23, 1916, Station 10347 (C).

July 22 and August 29. A salinity comparison between the summers of 1913, 1914, and 1916 is less satisfactory for the deep southwestern basin of the Gulf, the stations for the several seasons not coinciding so closely in location. Nevertheless, that 1916 was the freshest summer of the three can hardly be disputed, the difference between the

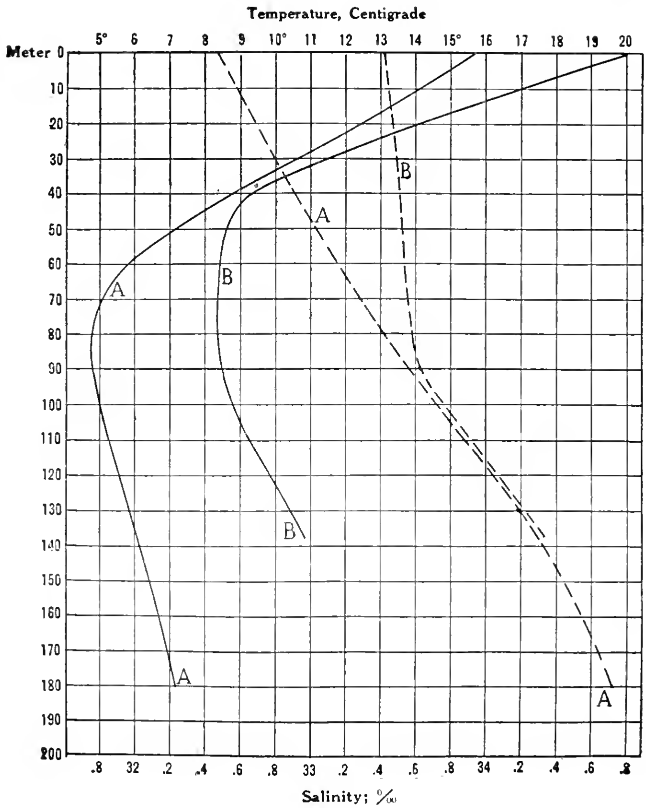


FIG. 13.— Temperatures (solid curves) and salinities (broken curves) at the outer edge of the Shelf south of Nantucket Shoals, July 24, 1916, Station 10351 (A). July 10, 1913, Station 10061 (B).

curves (Fig. 6) being too great to be accounted for by small differences in geographic location in the open sea. (Station 10314, in 1914 was situated 15 miles, Station 10058 in 1915, 25 miles east of the 1916 Station 10345).

The summer of 1916 was also fresh in the Bay of Fundy, to judge from Vachon's (1918) July records as compared with our Station in the deep water near its mouth in 1915 (Bigelow, Station 10282, June 10, 1915). True, there is a considerable seasonal interval between the latter and Vachon's earliest for (July 24, 1916), while differences in

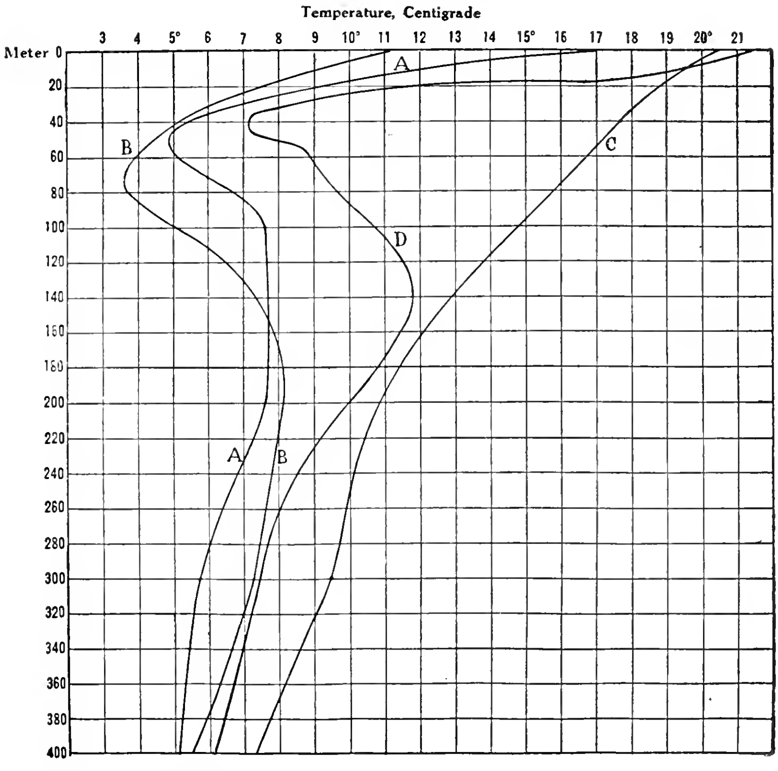


FIG. 14.— Temperatures over the Continental Slope south of Georges Bank, July 24, 1916, Station 10352 (A). South of Cape Sable, June 24, 1915, Station 10295 (B). South of Georges Bank, July 21, 1914, Station 10218 (C). South of Marthas Vineyard, August 17, 1889, Libbey's (1891) Station 9, Line G, (D).

geographic location may well be associated with varying salinities in a region of tidal currents as strong as those of the Bay of Fundy. But it is unlikely that the whole difference between the two sets of observations can be so accounted for, a conclusion consistent with the close agreement between the GRAMPUS salinities for June, 1915, and Vachon's for September 6, 1916 (Fig. 8).

It is not wise to lay much stress on our November salinities for 1916, not only for the reason given below (p. 178), but also because of differences in geographic location between them and the July stations. So far as they go, however, they suggest that the water was about as much salter than usual then than in July.

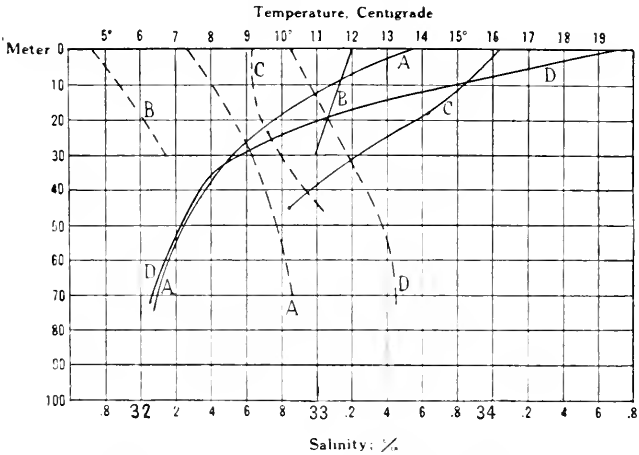


FIG. 15.— Temperatures (solid curves) and salinities (broken curves) on the Shelf off Nantucket Light Ship, July 25, 1916, Station 10354 (A). July 9, 1913, Station 10062 (D). Also on the Shoals, July 25, 1916, Station 10355 (B). July 9, 1913, Station 10060 (C).

GEORGES BANK, AND OFF MARTHAS VINEYARD.

Temperature and Salinity: — Annual comparisons are less satisfactory for Georges Bank with its violent tidal currents, and corresponding local differences in vertical circulation, than for the deeper and quieter waters to the north. But so far as the GRAMPUS records can be relied upon as typical of their respective years, the waters over its northwestern part were several degrees colder in July, 1916 than at the corresponding season in either 1913 or 1914 (Fig. 12). And this was equally true for the salinity of 1916 as compared with 1913, with a maximum difference between the two series of observations of about .6‰ (Fig. 12), though there was little discrepancy between 1916 and 1914 in this respect. But it was over the southern slope of the Bank that the hydrographic differences between July, 1916, and the summers of 1913 and 1914, were most striking, for while violent annual, even day to day, fluctuations are to be expected there because of the constant conflict between the warm Gulf Stream and the cool coastal and northern currents, nothing in our previous experience

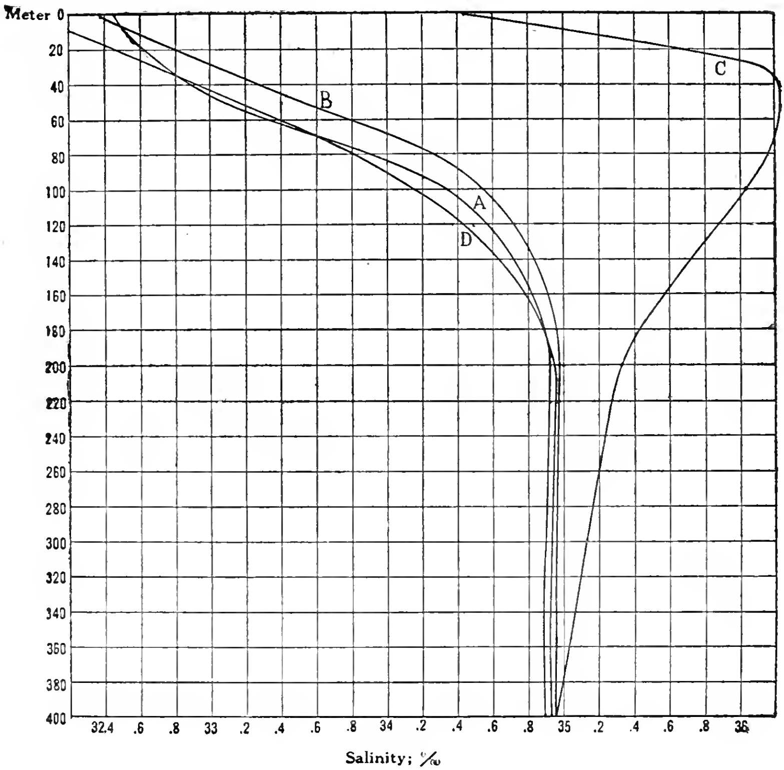


FIG. 16.— Salinities over the Continental Slope south of Georges Bank, July 24, 1916, Station 10352 (A). South of Cape Sable, June 24, 1915, Station 10295 (B). South of Georges Bank, July 21, 1914, Station 10218 (C). South of Cape Sable, July 28, 1914, Station 10233 (D).

foreshadowed summer temperatures so low as those of that year. Thus on the southern edge of the Bank, where our stations for 1916 (10349) and 1914 (Bigelow, 1917a, Station 10217) coincide closely in location, and where the surface temperatures were practically the same for the two years (17°–18°), the bottom water was 4° colder for

1916 (6.7°, as against 10.6°). Similarly, some forty miles further west (Station 10351, Fig. 13), both the immediate surface, and the depths below 50 meters, were 3°–4° colder than at the same relative location on the slope off Nantucket Light Ship in July, 1913 (Bigelow, 1915b, Station 10061), the minimum temperature (4.8°), being nearly as low as that of the Gulf of Maine at the same level (Fig. 10). And the less-depths were even colder over the outer part of the slope (Station 10352). This last Station is especially interesting, not only because the actual temperatures were much lower here in 1916 than in 1914 (Fig. 14), with vertical cooling much more rapid, but because the curve reveals a pronounced cold layer of 4°–5° at about 50 meters, with the

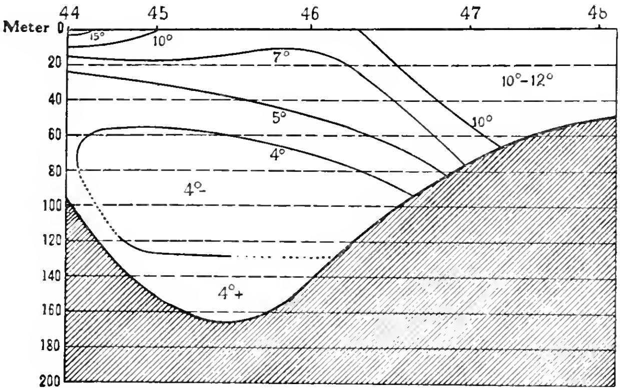


Fig. 17.— Temperature profile from the Basin of the Gulf of Maine to Georges Bank, July 22–23, 1916.

underlying stratum, 200 meters or so thick, about 3° warmer. In fact to again find water as cold as was the 40–60 meter level here it is necessary to descend into the abyss, below 500 meters. No such cold layer was encountered anywhere along the slope, from off Nantucket to the eastern channel in 1914 (Bigelow, 1917a, Stations 10218, 10220, 10261). But the distribution of temperature was of this type in 1913, judging from the one station in this region for that year (Bigelow, 1915, Station 10061), though the actual readings were higher (minimum at 75 meters about 10.8°). And temperature curves very similar to those of 1916, with the minimum layer at about the same level, though some 2°–5° warmer, result from Libbey's data for 1889 (Fig. 14. Libbey, 1891, p. 454).

There is, then, nothing unprecedented in a vertical distribution of temperature of this type, for this part of the slope: indeed its repeated occurrence suggests that something of the sort is to be expected except when obscured by encroachments of the warm water of the Gulf Stream. What was surprising for 1916 is that the temperature of this coldest layer was so very low: and that water so cold lay so close to the surface of the open sea at this latitude in midsummer. But to find these conditions reproduced it is only necessary to turn to the temperature curves in the mixture of Cabot Current and ocean water, at the same relative position on the slope off southern Nova Scotia, about 200 miles to the northeast.

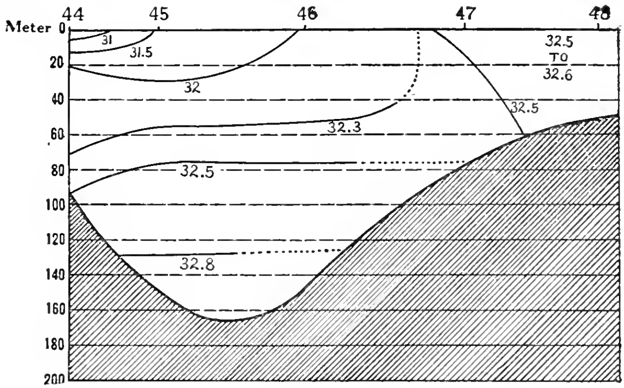


FIG. 18.— Salinity profile from the Basin of the Gulf of Maine to Georges Bank, July 22–23, 1916.

The temperatures over the shelf off Nantucket shoals were almost exactly the same for 1916 (Stations 10354, 10355) as for 1913, from about the 30 meter level down to the bottom in 70 meters, though 4°–5° lower on the surface (Fig. 15).

Generally speaking, salinity, like temperature, was decidedly lower in 1916 than in 1913 or 1914, both over Georges Bank (Fig. 12) and over the Shelf off Marthas Vineyard (Fig. 15), down to about 70 meters, with even wider divergence of the same sort between the stations for 1916 and 1914 on the Continental Slope (Fig. 16).[1] But the salinities of all our deep stations (Fig. 16), like their temperatures, are practically the same (34.8–35.2‰) below 250 meters. More

[1] The salinity curve for Station 10349 is probably much like that for Station 10352. But as there was some confusion of the water samples, it is omitted here.

instructive than the local differences, always to be expected along this zone of varying currents, is the fact that in its salinity (Station 10352), practically reproduces the mixed water as found off Nova Scotia in June of 1915 (Fig. 16), especially at the level of minimum temperature.

The general distribution of temperature and salinity is further illustrated here by the usual profiles normal to the coast. It is not

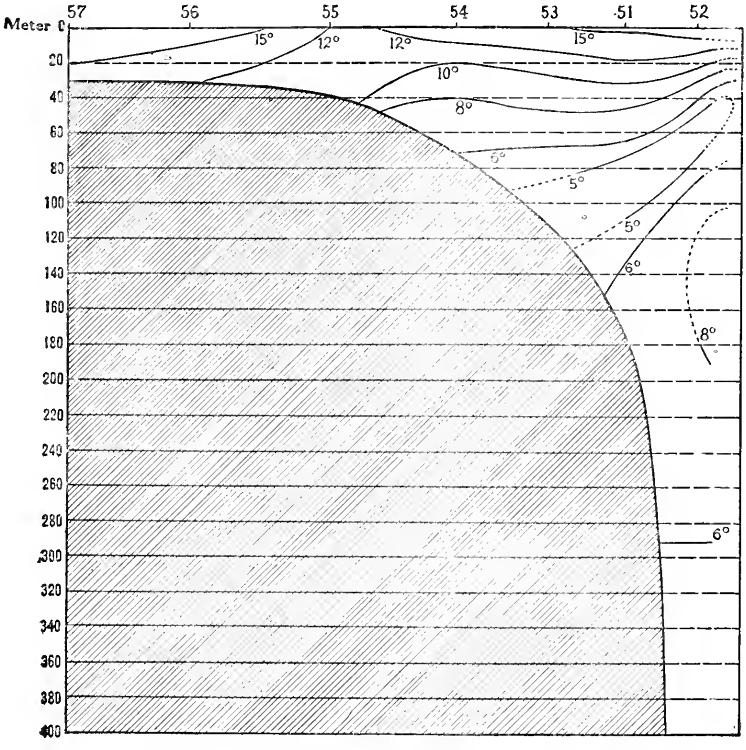


Fig. 19.— Temperature profile crossing the Continental Shelf off Marthas Vineyard, July 24–26, 1916.

possible to construct a complete profile across Georges Bank, data being lacking for the critical regions just inside, and just outside the 200 meter contour (no temperatures were taken at Station 10350, or beyond Station 10349). But partial ones for both salinity and temperature are given to show the relationship between the waters of the basin of the Gulf on the north, and those over its boundary rim on the south (Fig. 17, 18). The temperature profile shows that the water was slightly warmer over the Bank than in the Basin to the north, for while direct comparison between these two localities is obscured by the vertical uniformity of temperature on the Bank caused by active vertical circulation (p. 126), the mean temperature was higher there (about 10–11°) than for the same stratum of water

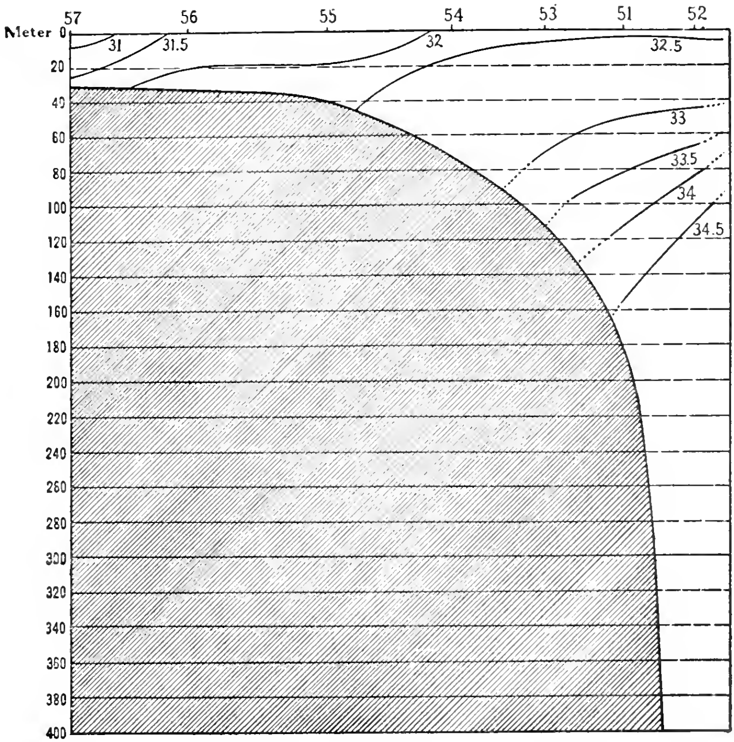


FIG. 20.—Salinity profile crossing the Continental Shelf off Marthas Vineyard, July 24–26, 1916.

in the Gulf (about 6°–7°). The water was likewise salter over the Bank than in the Gulf (p. 178) with the salinity of the whole column of water (0–50 meters) over the center of the former (Station 10348) about .3‰ higher (32.54–32.57‰) than the mean of the same stratum in the Basin (about 32.2‰).

The first complete profile afforded by the Cruise of 1916 is from the neighborhood of Marthas Vineyard out to the Continental Slope (Stations 10351–10357). Along this line (Fig. 19, 20), warmest and freshest at the shore end (Station 10357), as is usually the case in such shallow regions, the cold band (5°) touched the bottom only between the 90–130 meter contours if at all, with warmer bottom-

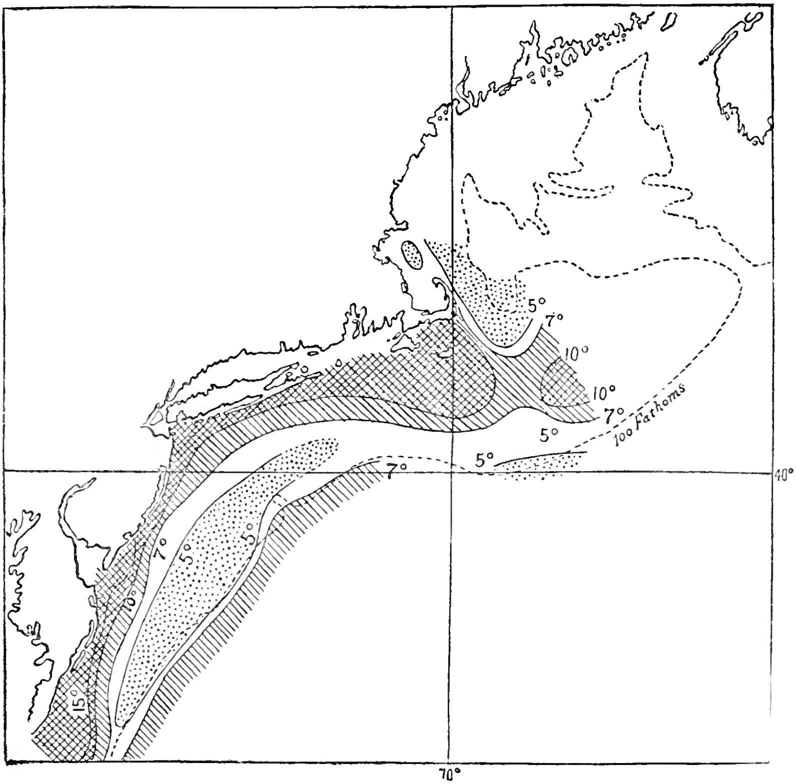


Fig. 21.—Chart of minimum temperature out to the 500 meter contour, July-August, 1916. Dotted, 5°—; unshaded, 5°–7°; single hatched, 7°–10°; cross hatched, 10°+.

water both on the shelf on the one hand, and deeper down the slope on the other. Passing thence off-shore the axis of the coldest layer rose to within 50 meters of the surface over the 1800 meter contour (Station 10352), which was near its seaward limit. Owing to the lack of hydrographic data for Stations 10350 and 10353 it is a question just what relationship the cold band bore to the slope of Georges Bank further east, *i.e.*, whether it passed north or south of the rather warmer water at Station 10349. Nor does the salinity help here, the records for the 30 and 80 meter levels at the latter Station being unreliable (p. 103).

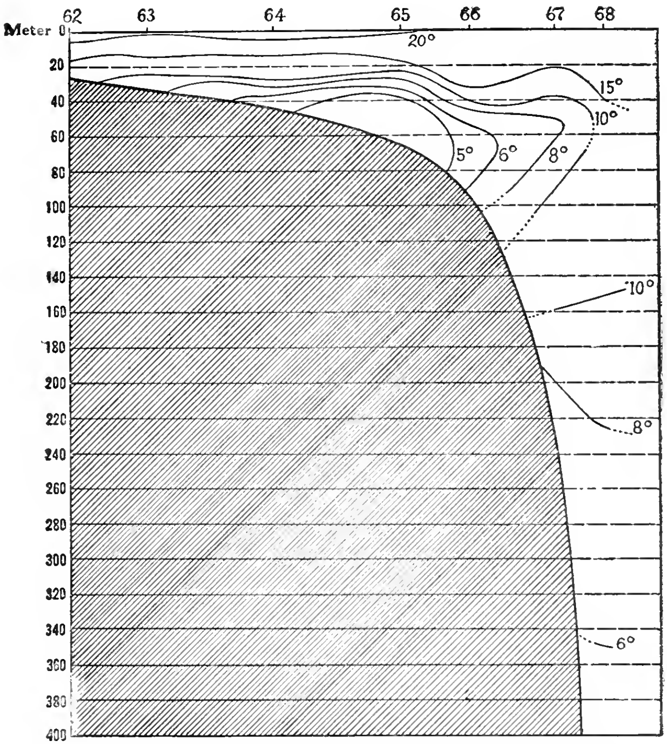


FIG. 22.— Temperature profile crossing the Continental Shelf off New York, August 1–2, 1916.

There is nothing novel in the discovery of such a shelf-like intrusion of cold coast into warmer off-shore water in this region, any more than in the existence of a cold band (p. 103). On the contrary, a phenomenon of this sort has long been recognized (Libbey, 1891, 1895; Bigelow, 1915), and was well exemplified in 1913 by the profile off Nantucket (Bigelow, 1915, p. 164, fig. 10); the only important difference between that year and 1916 being in its exact extent, and precise temperature.

The most important feature of the salinity profile off Marthas Vineyard (Fig. 20) is its failure to reach water as salt as 35‰, this demonstating that the inner edge of the Gulf Stream lay some distance outside of, instead of close to the Slope, as in July, 1914 (Bigelow, 1917a, p. 189, fig. 26).

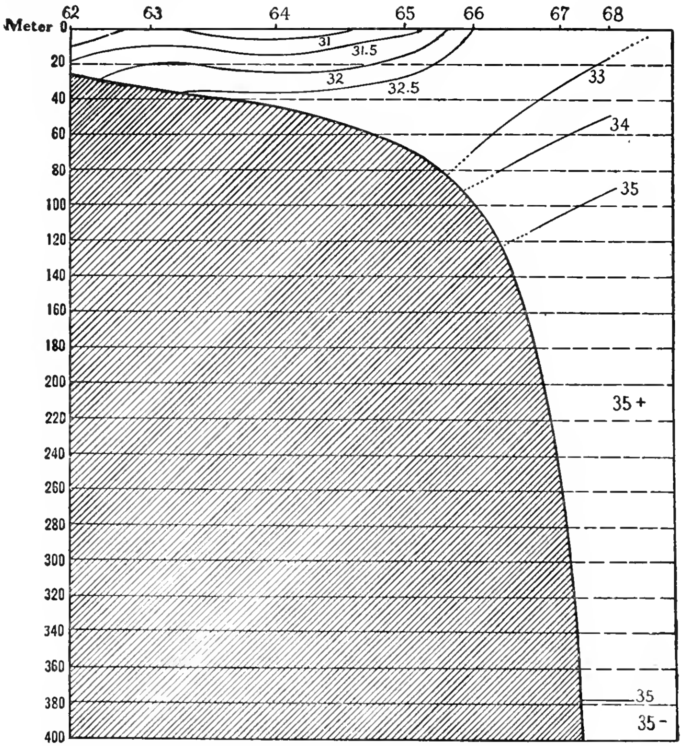


FIG. 23.— Salinity profile crossing the Continental Shelf off New York, August 1–2, 1916.

MARTHAS VINEYARD TO CHESAPEAKE BAY.

Temperature and Salinity.

Temperature and Salinity in August: — No observations were taken during the summer of 1916 over the outer part of the Shelf between Nantucket and New York; but an unbroken band of surprisingly cold (4°–5°) water with higher temperature (7°–9°) on the bottom deeper down the Slope, was again encountered at 50–100 meters depth all along the outer half of the Shelf from abreast of New York nearly to the latitude of Chesapeake Bay (Fig. 21), though whether or not continuous to the east with the equally cold water off Nantucket is uncertain.

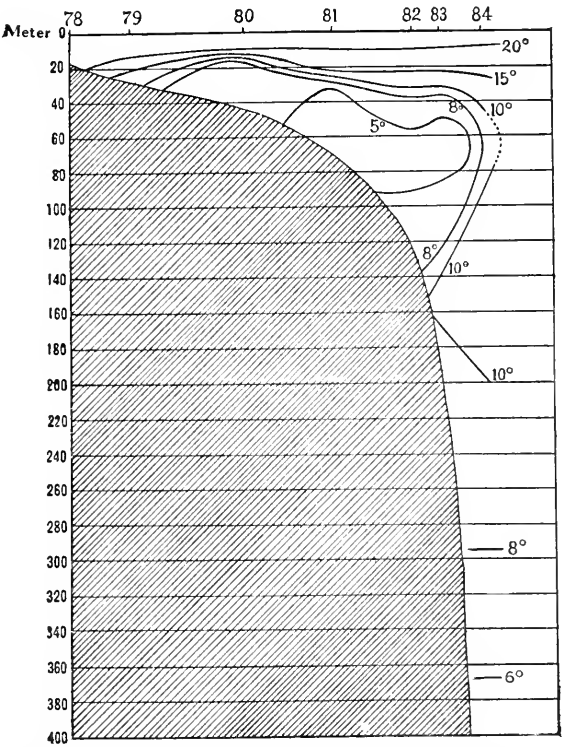


FIG. 24.— Temperature profile, crossing the Continental Shelf off Delaware Bay, August 11–12, 1916.

Three profiles across the Shelf, off New York, off Delaware Bay, and off Chesapeake Bay serve to show the distribution of temperature in some detail. On the first of these (Fig. 22) there was very little horizontal change in the upper 40 meters or so, out to the 100 meter contour, though the vertical temperature gradient was very steep; and the cold band (4°–5°), which lay here on the bottom, was only about 25 meters thick; but its influence was evident over the Slope as a shelf-like projection of water of 8°–10° into warmer water at Station 10368, where the comparatively high temperature of the upper 50 meters suggests the neighborhood of the inner edge of the Gulf Stream. Attention should also be called to the fact (p. 109) that the

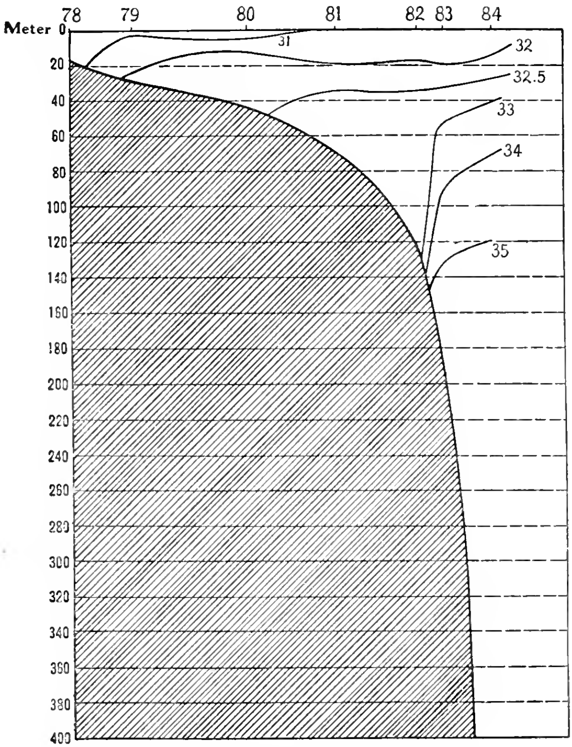


FIG. 25.— Salinity profile, crossing the Continental Shelf off Delaware Bay, August 11–12, 1916.

bottom water was about 3° warmer (8°+) between the 120 and 200 meter contours than higher up on the Shelf. The corresponding salinity profile (Fig. 23) illustrates the general land-sea increase in salinity, especially over the Continental Slope, with which we are familiar along our coast. And the steep gradient of the salinity curves over the Slope suggest that 35‰ water would have been found at the surface 20 or 30 miles further out at sea. The salinity of the cold band was about 32.8‰, that of the bottom water at 100–300 meters 35‰.

The temperature profile off Delaware Bay (Fig. 24) agrees in its general outlines with the foregoing; but here the cold band was not only much wider than off New York, but thicker as well (about 50 meters at its maximum), the 5° water indenting seaward as a very pronounced Shelf into the warmer water over the Slope, with the result that for a distance of about 20 miles it overlay bottom water some 2°–5° warmer. The two temperature profiles, taken together also suggest a minor warm band on the surface following the outer edge of the Shelf (Stations 10366, 10382), a phenomenon often encountered along this zone, where the interaction of warm and cool currents is so complex. The corresponding salinity profile (Fig. 25) shows the same general seaward rise in salinity over the Slope as observed off New York (Fig. 23). But the influence of the land water from Delaware Bay is evident across the whole breadth of the profile in the upper 30–40 meters, and especially at the off-shore end, where the surface layer is fresher than 32‰. On the bottom, at the outer edge of the Shelf the transition between the cold band (salinity 32.6‰–32.8‰) and the warmer salter water which bounds it offshore is as distinct in salinity as it is in temperature.

No water so cold as 5° was encountered on the profile off Chesapeake Bay (Fig. 26), though the lowest temperature there was only fractionally higher (5.08° at Station 10392), and water as cold as 6° was here limited to a very narrow zone at the outer edge of the Shelf. At the shore end, the profile reveals the influence of the Bay by high surface temperature, as does the salinity profile (Fig. 27) even more clearly. Its outer end, however, suggests that the Gulf Stream lay near by, and that 35‰ water washed the bottom between the 175 and 380 meter contours, though the data do not absolutely establish this. It is also worth noting that the salinity of the coldest water (about 32.8) is exactly the same here as off New York (p. 112, Fig. 23).

These profiles, together with the data for the individual stations (p. 178) show not only that the cold band, the most interesting discovery of the Cruise, was widest off Delaware Bay, but that it was there that water of 5° or cooler lay nearest the land, and nearest the surface (Station 10381, about 28 meters); there, too, the lowest temperature was recorded (4.02°). But its presence would not have been suspected from surface temperatures, which were upwards of 20° for this part of the Shelf as a whole (Fig. 28). Consequently the vertical temperature gradient, from the surface downward, was steeper than previously found in summer.

The salinity of the cold band was almost as uniform as its temperature, the extreme range, for the layer colder than 5°, being only about 32.4‰–33.2‰ (usually 32.6–32.8‰) as follows: —

Station	Range of salinity for 4°–5° water	Station	Range of salinity for 4°–5° water
10365	32.6–32.81	10382	32.6–32.7
10370	32.8–33.2	10383	32.6–33.
10373	32.5–32.6	10392	32.77
10381	32.4–32.61		

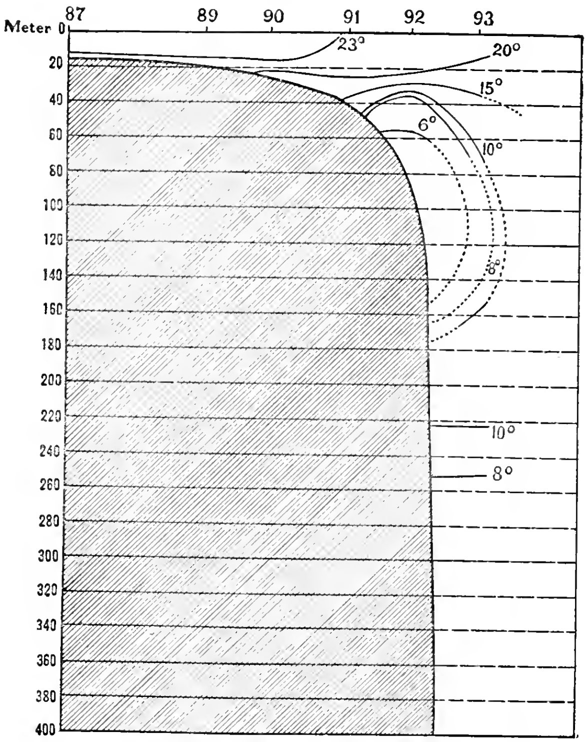


Fig. 26.— Temperature profile crossing the Continental Shelf off Chesapeake Bay, August 21–22, 1916.

In short this body of water was practically uniform in its physical characters, over a distance of 200 miles, irrespective of the depth at which it lay, or of its vertical thickness.

The hydrographic and biologic importance of a mass of water so cold, at such a trivial depth, so far south, must not obscure the fact that it did not extend out to the edge of the Shelf on the bottom,

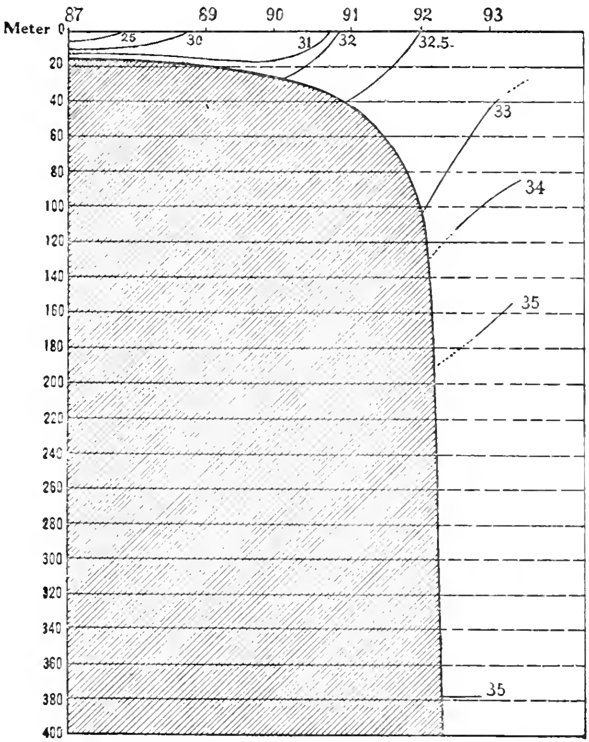


FIG. 27.— Salinity profile crossing the shelf off Chesapeake Bay, August 21–22, 1916.

though it did in the mid-depths. On the contrary, the bottom water (Fig. 29) all along the 150–200 meter zone was several degrees warmer, (8–9°) corresponding to the "warm band" long known off Marthas Vineyard and Nantucket, though it was slightly cooler than the GRAMPUS found it in 1913 (Bigelow, 1915, p. 164). This band was small in extent, it is true, in comparison with the cold zone, nevertheless it occupied an area of not less than 1200 square miles between the latitudes of New York and Chesapeake Bay. And if it extended without interruption (though with slowly decreasing temperature) as far east as the profile off Nantucket, which was probably the case in 1916, as in 1913 (Bigelow, 1915, p. 164, fig. 10), its total area can not

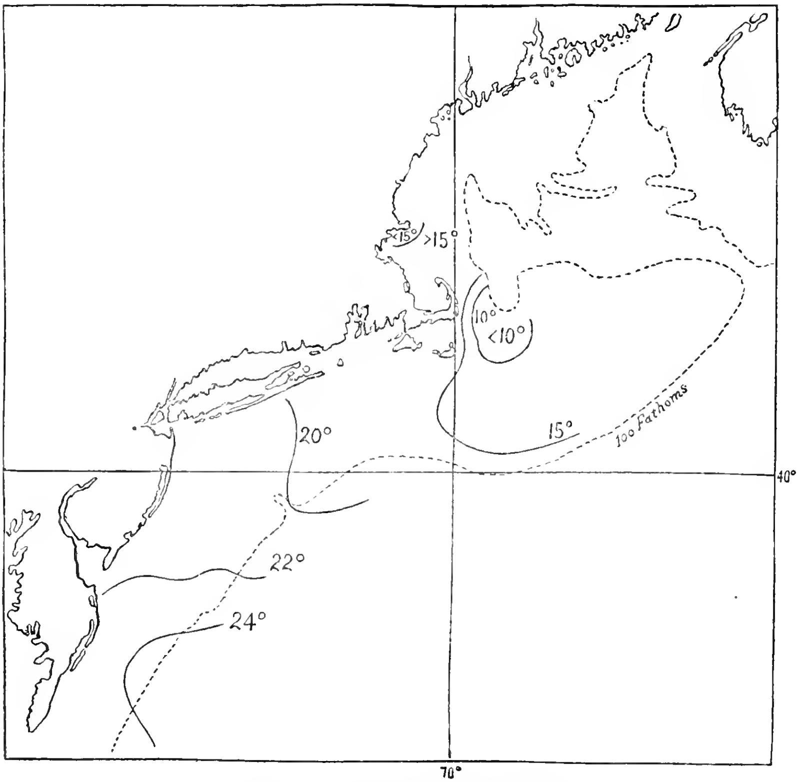


Fig. 28.— Surface temperature, August, 1916.

have been less than 2500 square miles. Its economic importance is as great as its biologic, for it is the chief, if not the exclusive, habitat of the Tilefish (*Lophalotilus chamaeleonticeps* Goode & Bean), a species the food value of which is now generally recognized, and which is the object of an important fishery, thanks to the efforts of the U. S. Bureau of Fisheries.

Direct station for station comparison between 1916 and 1913 is possible only in a few cases for this part of the coast water. But wherever it can be made, the contrast in temperature is considerable in the deeper layers, though there is but little difference on the

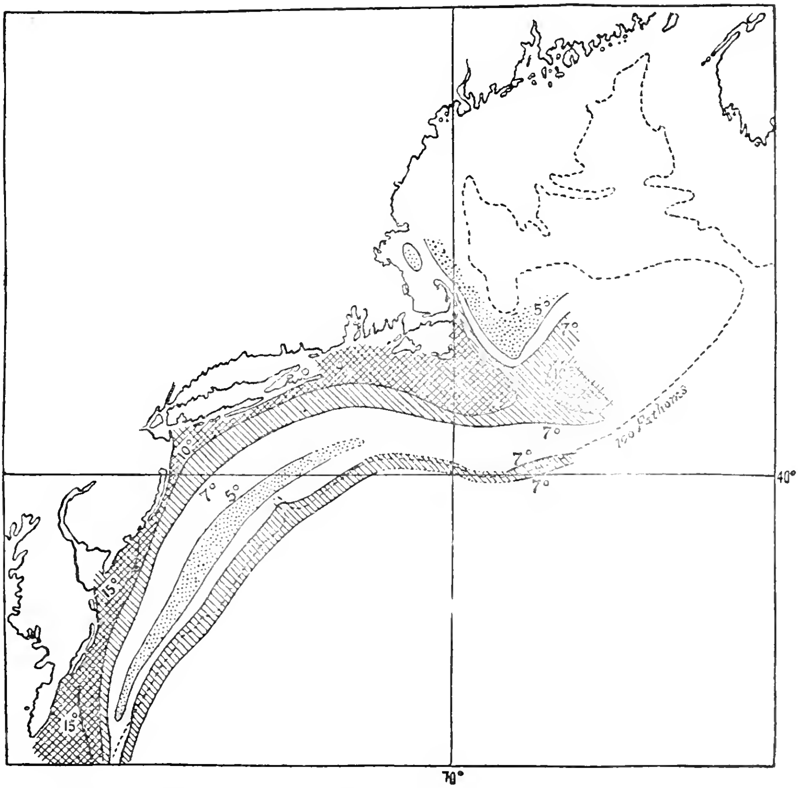


FIG. 29.—Bottom temperature, July–August, 1916. Dotted, 5°—; unshaded, 5°–7°; single hatched, 7°–10°; cross hatched 10°+.

surface. Thus a few miles off New York, the 40 meter temperature was 3° lower on August 1, 1916, than on July 12, 1913 (Fig. 30), though the difference in season would suggest just the reverse; not till the end of August did the temperatures for 1916 equal those taken a month earlier in 1913. Similarly, the minimum temperature, over the outer part of the Shelf on this line, was 2° lower in 1916 (Station

10365, 4.8°) than in 1913 (7°). And passing southward we find the temperature difference between the two years increasing, owing to the fact that while the temperature of the cold band was uniform throughout its length in 1916, in 1913 the coldest layer warmed gradually from north to south (Fig. 31, 33). The annual difference is further illustrated by the charts for bottom temperature (Fig. 29, Bigelow, 1915, fig. 8).

The salinity of the coastal water south of New York was likewise much lower as a whole in August, 1916 than in July–August, 1913. And not only was this true of the surface, which was fresher than 31‰ over the whole inner half of the Shelf in 1916, instead of only close to the mouth of Chesapeake Bay as in 1913, but of the whole

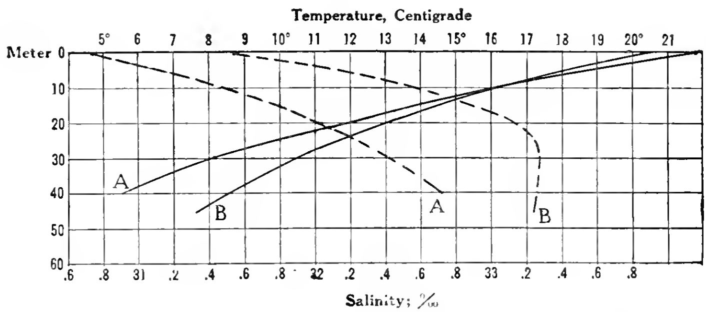


Fig. 30.— Temperatures (solid curves) and salinities (broken curves) off New York, August 1, 1916, Station 10364 (A). July 12, 1913, Station 10066 (B).

column, surface to bottom, as well. Thus the bottom water off New York was salter than 33‰ up to the 15 meter contour in 1913 (Bigelow, 1915, p. 195, fig. 39) whereas in 1916 salinities as high as 33‰ were confined to depths greater than 80 meters (Fig. 23). Off Delaware Bay (Fig. 25, 32) where the salinity on the bottom was 33–34‰ in 1913, it was only 32–32.8‰ in 1916, with a similar relationship in the upper layers. And off Chesapeake Bay the salinity contrast between the two years is even more striking, for the water over the whole Shelf above the 100 meter contour was fresher than 33‰ in 1916, whereas in 1913 its outer half was salter than 34‰, below the trivial depth of 10 meters or so.

The mixed water over the Continental Slope, like the coastal water proper, was much fresher above 200 meters in 1916 than in 1913, as illustrated by the pairs of stations at corresponding locations (Fig. 34),

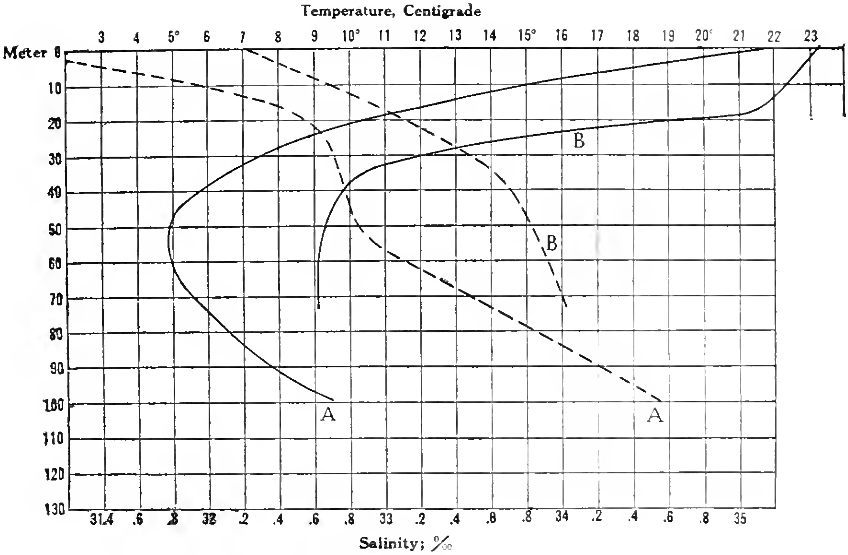


Fig. 31.— Temperatures (solid curves) and salinities (broken curves) on the outer part of the Shelf off Cape May, August 3, 1916, Station 10370 (A). July 19, 1913, Station 10070 (B).

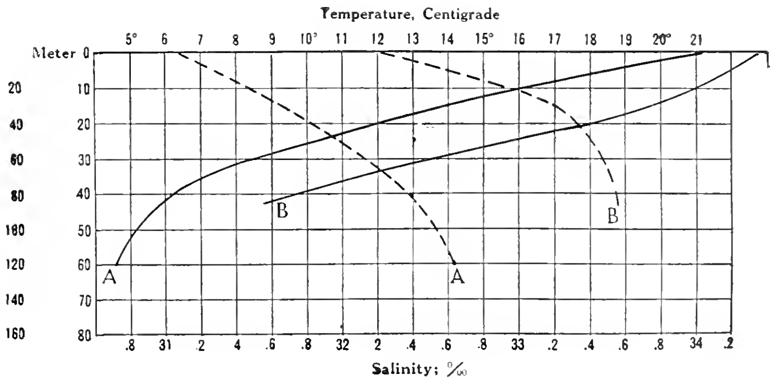


Fig. 32.— Temperatures (solid curves) and salinities (broken curves) off Delaware Bay, August 4, 1916, Stations 10373 and 10375 combined (A). July 21, 1913, Station 10072 (B).

with a maximum difference of no less than 38‰. And it was likewise cooler (Fig. 35), especially at 40–100 meters, *i.e.* at the level of the cold band, the effect of which is particularly evident off Delaware and Chesapeake Bays (Stations 10384, 10393), though with little annual difference on the surface. But all these off-shore stations approach each other closely both in salinity and in temperature at 400–500 meters. And the data for 1916 support our previous experience that abyssal temperatures (about 4°), and salinities (about 34.9‰) prevail at, and below 500 meters all along the slope from Chesapeake Bay to Nova Scotia.

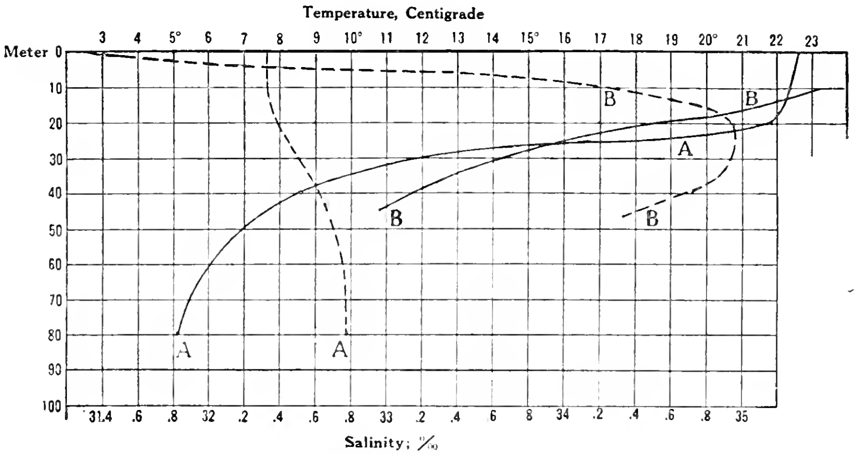


Fig. 33.— Temperatures (solid curves) and salinities (broken curves) off Chesapeake Bay, August 22, 1916, mean of Stations 10391 and 10392 (A). July 24, 1913, Station 10077 (B).

The combined evidence of temperature and salinity together with the plankton (p. 139) prove that in August the inner edge of the Gulf Stream lay further off-shore in 1916 than in 1913. Nor is there anything in the records for 1916 to suggest the salt tongues (35‰) encountered between Chesapeake and Delaware Bays in 1913.

The very considerable differences in absolute temperature and salinity between 1913 and 1916, just outlined, must not mask the fact that the same basic contrast between coast and off-shore water, *i.e.* the low temperature and salinity of the former, compared with saltness and warmth of the latter, obtained in the one year as well as the other. And while the transition from the one type of water to the other was not as sudden over the Slope in 1916 as in 1913, the seaward rise in temperature and in salinity revealed by the outermost stations on all the profiles south of New York for that year, together with the off-shore limitation of the cold band, and the presence of warmer water below it (p. 113) suggest that it would not have been necessary

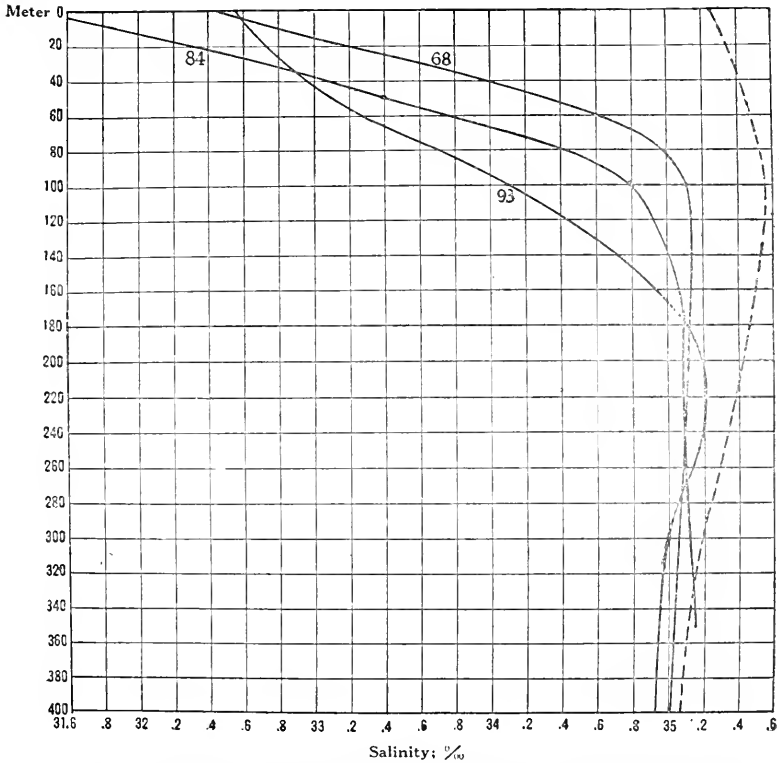


FIG. 34.—Salinity of the mixed water on the Continental Slope off New York, August 2, 1916, Station 10368 (68). Off Delaware Bay, August 12, 1916, Station 10384 (84). Off Chesapeake Bay, August 22, 1916, Station 10393 (93). Off Delaware Bay, July 20, 1913, Station 10071 (broken curve).

to run the profiles much further seaward to have reached the inner edge of the Gulf Stream.

Furthermore, though the actual values differ, the horizontal distribution of surface salinity over the Shelf was of essentially the same type in 1916 (Fig. 36) as in 1913, with the same general alternations of fresher and salter water. From northeast to southwest these are: *1*, an unmistakable outpouring of land water from the mouth of Long Island Sound, more evident and traceable further east, in 1916 (Fig. 36) than in 1913. *2*, An eddy off the mouth of the Hudson River, with fresher water on its inner, salter on its outer (northern) side, the

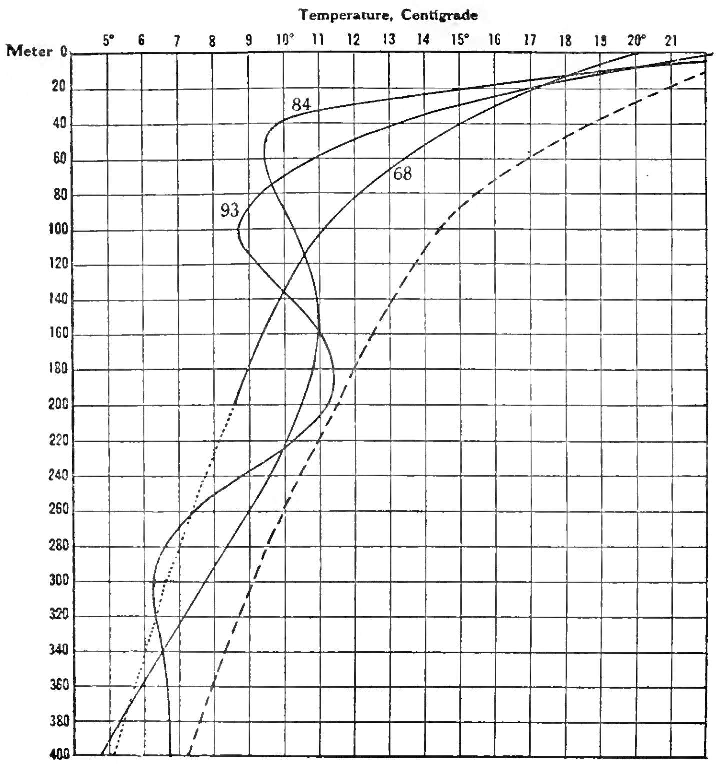


FIG. 35.— Temperature of the mixed water on the Continental Slope off New York, August 2, 1916; Station 10368 (68). Off Delaware Bay, August 12, 1916, Station 10384 (84). Off Chesapeake Bay, August 22, 1916, Station 10393 (93). Off Delaware Bay, July 20, 1913, Station 10071 (broken curve).

axis of the outflow, (or of the freshest water, which may be merely reminiscent of a pre-existing current), directed more to the south in 1913, more to the east in 1916. *3*, A similar phenomenon off Delaware Bay, much the same for the two years except that the actual salinities were lower in 1916 than in 1913. *4*, The outflow from

Chesapeake Bay, which was traceable further off-shore in 1913 than in 1916, though here the surface salinities for the two years differed but little. The Hudson, and the Delaware eddies, if they may be so christened, are similarly illustrated by salinities at 20 meters (Fig. 36), the curve for 32.5‰, at this level, roughly paralleling 32‰

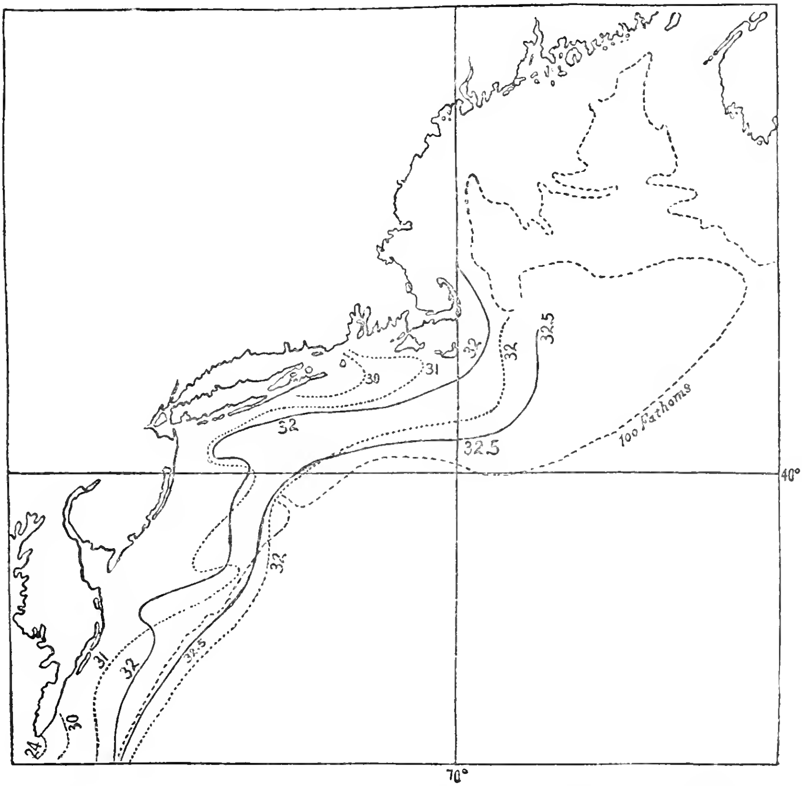


Fig. 36.— Salinity on the surface (broken curves) and at 20 meters (solid curves), July–August, 1916.

on the surface. But these evidences of land water were confined to this superficial stratum.

With a vertical range of temperature as great as obtained in 1916, the slightest vertical circulation by tides, currents or storms, or even by constant off-shore winds, may wholly mask the normal state of the surface by bringing up much colder water from a few fathoms deeper down. And conversely, the surface warms very rapidly along our coast in summer, under the sun's rays, if the weather be calm, and the wind on-shore. Allowing for such disturbing influences, the distribution of surface temperature was much the same, in its main outlines, in 1916 (Fig. 28) as at the same season in 1913 (Bigelow, 1915, p. 157, fig. 2) though the absolute values were slightly lower, the curves for 20° and 22° for 1916, closely paralleling 21° and 24° in 1913 (Bigelow, 1915, fig. 2), with the same north-south rise in temperature, and high surface readings off the mouth of Chesapeake Bay (Bigelow, 1915, p. 155, fig. 1, 2).

This was fundamentally true of the deeper water-layers as well, although the subsurface temperatures were much lower in 1916 than in 1913 (p. 115). That is to say, the coldest water occupied the same general position, relative to the warmer layers, in 1916 as in 1913, being localized along the outer part of the Shelf, with higher temperatures off-shore, as well as nearer land. But if corresponding profiles for the two years be compared, considerable differences appear in detail. Perhaps most important of these is that whereas in 1916 the greatest mass of cold bottom water, with the lowest actual temperature lay off Delaware Bay (p. 111, Fig. 29), in 1913 the cold band was, to all intents, obliterated a few miles south of the New York profile, its main body lying to the east of the latter (Bigelow, 1915, p. 162, fig. 8). And, correspondingly, the shelf-like indentation of cold water seaward into warm extended as far as Chesapeake Bay in 1916, whereas in 1913 it was limited to the edge of the Shelf from the Barnegat profile eastward (Bigelow, 1915, p. 166, fig. 11, 12). And no part of the coastal water (within the limits surveyed by the GRAMPUS) was as warm in 1916 as was the region between the Barnegat and Chesapeake profiles in 1913.

Temperature and Salinity in November: — No observations were taken on Georges Bank in November. But several stations were occupied during that month between Marthas Vineyard and Chesapeake Bay, especially welcome because they give us our first view of the subsurface temperature, salinity, and plankton of this section of the coast water, for the autumn. Unfortunately, however, these salinities must be regarded with suspicion (p. 178).

The most apparent change from August to November, one which might have been prophesied, was a decided cooling of the surface over the whole area, the actual readings now being from 11.3°–14.17° (the latter in the mouth of Chesapeake Bay) usually about 13°, as against 17°–24° in August (p. 111, fig. 28).

Below the surface an equally widespread change took place, for the November temperature curves for every station show either practical uniformity, vertically, or even a slight vertical warming, down to 30–60 meters, instead of the extreme vertical cooling which characterized the region as a whole in summer. Furthermore, although this layer of uniform temperature overlay a zone in which some vertical cooling obtained, the bottom water on the Shelf, at 30–80 meters, was as a whole considerably warmer in November than in August, the minimum temperature having risen from 4°–5° to about 8° off New York; from about 5° to about 9°–10° off Chesapeake Bay. A seasonal change of this sort was, of course, to be expected, in the absence of disturbances by extra limital currents, as the first step in the vertical equalization of temperature so characteristic of northern coastal waters in late autumn and winter.

The temperature of the warm zone deeper down the slope was likewise higher in November, when water as warm as 10° bathed the bottom below, say, 150 meters, as far north as the latitude of New York at least, than in August, a fact of biologic importance.

The seasonal change in temperature is further illustrated by comparing the profiles off New York for summer and for autumn. These, it is true, do not precisely coincide in location, except at their outer ends. But the geographic difference is not sufficient to presuppose any appreciable divergence in temperature, though it may for salinity (p. 120). Along this line, the layer of 10°–12° water was some 60 meters thick over the inner part of the Shelf in November (Fig. 37), instead of only about 10 meters thick, as in August, with the November curve for 10° closely paralleling the August curve for 7°. Perhaps the most interesting feature of this November profile is its demonstration of the fact, already recognized, that autumnal cooling in our coast waters proceeds from the land, seaward. As pointed out (p. 132) this process had progressed so far on the inner half of the Shelf as nearly to obliterate the pre-existing stability of the water. But further off-shore only the immediate surface had yet been chilled by the cool land winds, consequently the underlying water at 20–50 meters was 1°–2° warmer than the surface, so that the curves for 12° and 13° suggest a landward intrusion of off-shore water. This interpretation the salinities (if they are to be trusted) forbid; and in point of fact this apparent tongue is merely reminiscent of the maximum temperature reached at this level during late summer.

As pointed out (p. 178) it is a question how much dependence can be placed on the November salinities. However, they probably represent the actual conditions fairly well as a series, even though no one determination in particular is trustworthy. With this reservation, we find that the immediate effect of the outflows from the several large rivers and bays is no longer discernible at this season, which was to be expected, for the surface was then upwards of 32‰, even off Chesapeake Bay and off Long Island Sound, as against 30–31‰ in August (Fig. 36). And since no corresponding increase took place at 30–40 meter level, November salinity, like November temperature, was practically uniform vertically, down to this depth, at every station but one (10410).

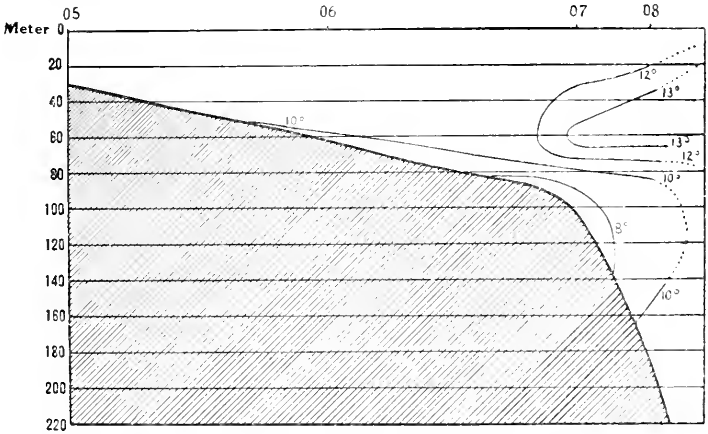


FIG. 37.— Temperature profile crossing the Continental Shelf off Marthas Vineyard, November 10–11, 1916.

These records afford no evidence that any Gulf Stream water had flooded the Shelf since August.

At the off-shore ends of the profile off Marthas Vineyard for November (Fig. 38) and off New York for August (Fig. 23), where the geographic locations coincide, the November salinities are slightly the lower, 34‰ water now being restricted to depths greater than 100 meters, only actually touching the bottom at and below 120 meters, instead of at about 9–100 meters as in summer; nor have the high temperatures at 40–70 meters of Stations 10407 and 10408 any counterpart in salinity (p. 123). The profile deserves a further word because of the low bottom salinity (32.8‰) at Station 10407, which coincides with the minimum temperature (about 8°); and is almost exactly the same as the salinity of the coldest water in July, though the latter lay some distance further up the Shelf (Fig. 22). This, of course, taken at face value, suggests that the very cold water moved down over the bottom during early autumn, with gradually rising temperature, which is not inconsistent with the August densities (p. 130). But it being possible that the 60 meter salinity at Station 10407 is too high, it is idle to discuss it further.

The partial profile off Chesapeake Bay is not figured here because the bottom salinity at Station 10415, if correct, would result in a very peculiar course for the curve for 33‰, whereas if it is too high, as is

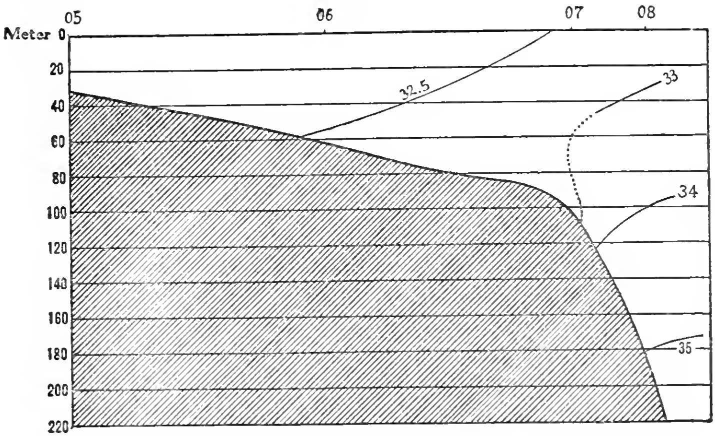


FIG. 38.— Salinity profile crossing the Continental Shelf off Marthas Vineyard, November 10–11, 1916.

very likely, this would not be the case. Suffice it to say that in November salinity was practically uniform vertically down at least to 50 meters out to the 200 meter contour along this line; and that the boundary between waters fresher than, and salter than 33‰ was practically vertical down to about 75 meters. Below that level there seems to have been a seaward projection of fresher, as there certainly was of slightly cooler water. Certainly neither this, nor the preceding profile reached the inner edge of the Gulf Stream.

DENSITY.

With the progress of modern oceanographic research it becomes increasingly clear that it is the juxtaposition of water masses of differing density which is primarily responsible for the most important ocean currents. And in coastal waters subject, as are ours, to violent fluctuations in temperature and salinity, the vertical distribution of density and its seasonal changes, largely determine the activity of vertical currents, with all that follows in their wake. The subject is extremely complex, and no attempt is made here to touch on more than its merest outlines. For a discussion of the principles involved, their calculation, and application to a definite area I refer to the results of the Canadian Fisheries Expedition (Sandström, 1919).

Our previous work has shown, as indeed was to be expected, that the waters of the western side of the Gulf of Maine are normally very stable, vertically, in summer. And 1916 was no exception to this rule. But the extreme steepness of the density gradient from the surface downward, and the fact that the rate of vertical increase (*i.e.*, vertical stability) was much less pronounced below 30–40 meters than above that level (Fig. 39) deserves emphasis, for its bearing on vertical circulation. The profile crossing Massachusetts Bay (Fig. 4) shows a close general correspondence between temperature and density, cold (5°) and heavy (25.5) water lying closer the surface in the center than near either the northern or southern shore; with the surface progressively lighter from north to south. For these horizontal inequalities the topography of the bottom is largely responsible, the central part of the Bay being partially enclosed below the 30 meter level by Stellwagen Bank, hence retaining the low temperature and high density of winter below that depth, whereas seasonal warming had penetrated in small measure even to the 100 meter level in the waters off the north shore with their strong tidal currents. Thus there was a dynamic tendency toward horizontal circulation even in the deepest layers of the Bay, as well as toward a movement of the surface water from south to north. But how far such currents are effective, as against the strong tides of this region, can only be settled by more intensive study.

Contrasted with the deeper parts of the Gulf (Stations 10344, 10345), the waters on Georges Bank show comparatively little vertical range of density (Fig. 39, 40); as they do of temperature (p. 105), and salinity (p. 105), a phenomenon resulting from active vertical circulation. And so far as the three GRAMPUS stations in that region go, they suggest that the upper layers were less dense over the southern than over the northern edge of the Bank. Density increases, in general, from the land seaward, over the inner half of the Shelf off Marthas Vineyard (Fig. 41); but is more uniform, horizontally, in the cold band (Stations 10351, 10352).

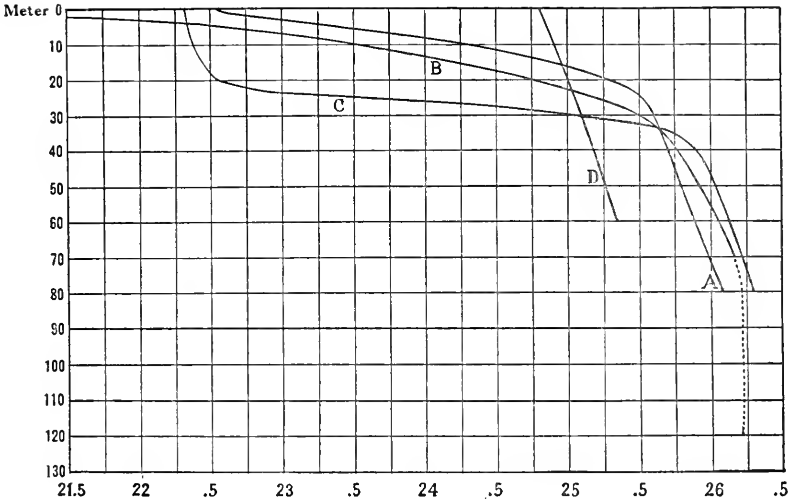


Fig. 39.— Density curves, for typical regions, July-August, 1916. A, Gulf of Maine, Station 10344. B, off Delaware Bay, Station 10382 (lower part, probable curve). C, off Chesapeake Bay, Station 10392. D, on Georges Bank, Station 10347.

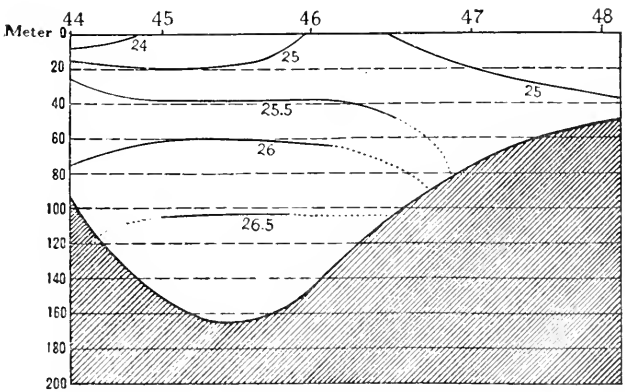


Fig. 40.— Density profile from the Basin of the Gulf of Maine to Georges Bank, July 22–23, 1916.

The vertical distribution of density was of essentially the same type in the coastal water off New York (Stations 10362–10365, Fig. 42), and off Delaware Bay (Stations 10379–10382, Fig. 39, 43) as in Massachusetts Bay; *i.e.*, the vertical stability of the upper layers pronounced, that of the bottom water slight, a phenomenon probably

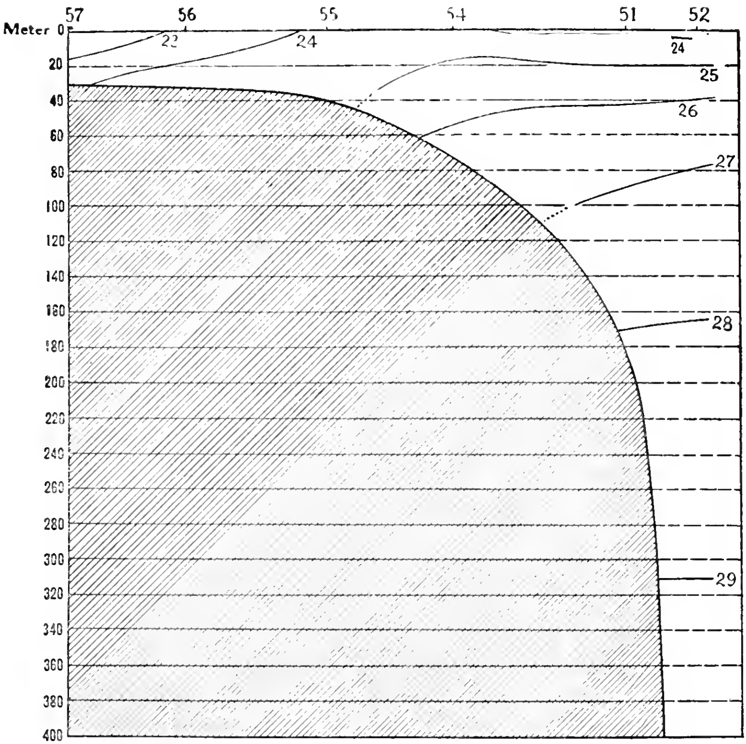


FIG. 41.— Density profile crossing the Continental Shelf off Marthas Vineyard, July 24–26, 1916.

chiefly responsible for the low bottom temperature here (p. 171). But within the influence of the outflow from Chesapeake Bay the intermediate water layer alone was notably stable, the density gradient being much less steep both from the surface down to 10–20 meters, and from, say, 40 meters down to the bottom than in the mid-layer. Consequently, while the upper and lower layers were insulated from each other, each was free to respond, with vertical currents, to any disturbing influence.

The subsurface densities at the outer ends of the profiles off New York (Fig. 42), off Delaware Bay (Fig. 43), and off Chesapeake Bay (Fig. 44) deserve discussion because of their bearing on the permanence

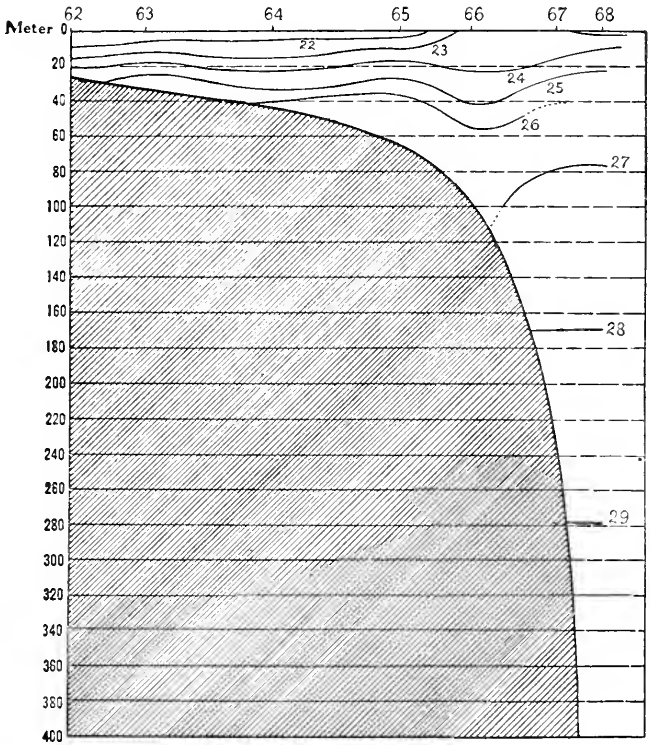


FIG. 42.— Density profile crossing the Continental Shelf off New York, August 1–2, 1916.

of the warm band which follows the slope at about the 200 meter level (p. 113). Any movement, down the slope, of the considerable mass of much colder water on the Shelf would obliterate this warm band, with far reaching biologic effect; indeed some such event was probably responsible for the destruction of Tilefish in 1884. But these profiles show that there was no dynamic tendency of this sort in August, 1916, but just the reverse, the coldest water being considerably lighter (about 26.2±) than the waters bounding it off-shore. The densities as indicated on the profile off New York (Fig. 42) would demand a movement of the cold bottom water down the Shelf to about the 60–70 meter contour (equal density lying about 10–20 meters deeper at Station

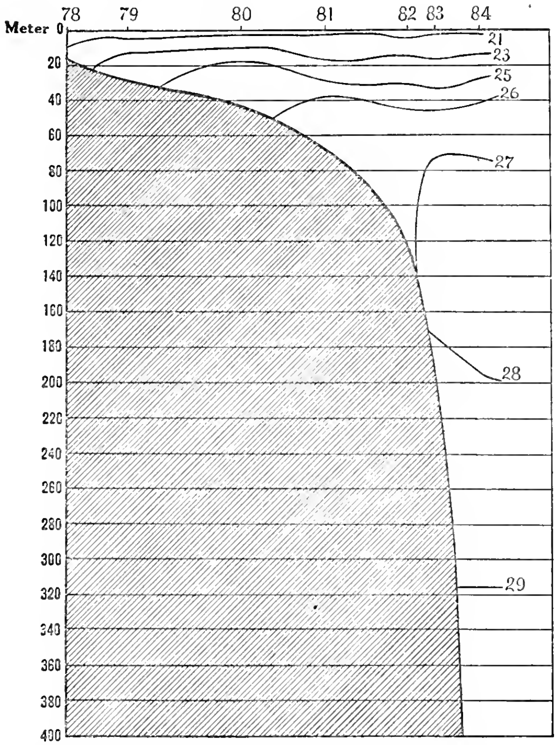


Fig. 43.— Density profile crossing the Continental Shelf off Delaware Bay, August 11–12, 1916.

10366 than at Station 10365). But from here seaward, there was some dynamic tendency for the cold water to rise from the bottom, with the warmer, but salter and hence denser off-shore water moving toward the slope below it, which is entirely consistent with the temperature profile (Fig. 22). Seldom, indeed, are the motions of water masses of different physical characters as precisely outlined by the temperature curves as in this case. All this points to a zone of active mixing over the slope; which all our data support. And the consequent dissipation of the cold zone at its outer edge, added to the gradual penetration of heat from above, amply explains the warming of the bottom water which took place by November.

Only once, and then as a surface stratum not over 150 meters or so

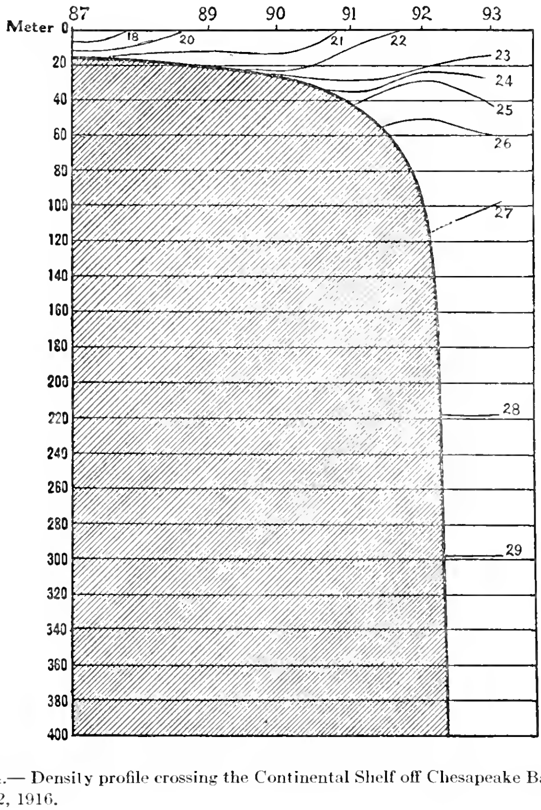


Fig. 44.— Density profile crossing the Continental Shelf off Chesapeake Bay, August 21–22, 1916.

thick, have we encountered undiluted Gulf Stream water on the Grampus cruises, even at the outermost end of our profiles (Bigelow, 1917a, p. 189); there is no actual evidence that such water even reaches the sea floor on the slope, and densities suggest that the heavier mixed water prevents this. But Gulf Stream water may approach close to land on the surface, before losing its distinctive characters, after prolonged on-shore winds; and thus exert an important, though sporadic influence on the coast water itself.

Unfortunately the unreliability of the November salinities (p. 178) precludes any discussion of the densities for that month further than to point out that thanks to vertical equalization of both salinity and temperature down to 30–50 meters, the upper layers of water then possessed little or no vertical stability.

PLANKTON.

Zoöplankton, Gulf of Maine.

In spite of the abnormally cool water, the animal plankton of the Gulf was essentially of the same type in July, 1916, as in previous summers, *i.e.*, consisted chiefly the copepod *Calanus finmarchicus;* with many Pseudocalanus and the other typically boreal organisms which are usually found there. And not only was the Arctic component, which reaches us in the spring, totally lacking in its western part in July and August, 1916, but forms which, while not purely Arctic, are primarily northern in origin were no more abundant there than we have usually found them in summer. Thus *Calanus hyperboreus* was detected at one station only (10345, 100–0 meters, 1 specimen); and only a single *Clione limacina* was taken in the Gulf (Station 10246, surface). On the other hand, none of the oceanic warm water forms, which occasionally appear there (Bigelow, 1917a, p. 246) were taken in July or August, 1916.

Among the typically boreal organisms, *Sagitta elegans* was notably abundant in July at 30 meters off Gloucester (Station 10340) where it formed an important element of the plankton. And in the center of Massachusetts Bay (Station 10341) where the upper layers (30–0 meters) were occupied by a swarm of Calanus, the catch at 80 meters consisted chiefly of *Sagitta elegans.* Large numbers were also taken in the channel between Stellwagen Bank and Cape Cod (Station 10342) though the Sagittae were overshadowed there in faunal importance by Calanus and Pseudocalanus. And *S. elegans* was likewise plentiful in the southwest corner of the Gulf (Stations 10344, 10346). As a whole Sagittae were most numerous relatively in the deepest hauls, as is illustrated by Station 10241, where none were taken on the surface, and relatively few in the swarms of Calanus at 40 meters, but where they constituted about half the catch at 80–0 meters.

Sagitta serratodentata did not appear at all in our hauls in the Gulf in 1916.

Large, noticeable forms, which usually give a distinctive character to the Gulf of Maine, were as a whole rare in the summer of 1916, apart from the Sagittae. For example, the amphipod *Euthemisto compressa* did not appear at all in the catches in Massachusetts Bay in July of that year (Stations 10340–10342), though then represented by an occasional specimen in the southwest part of the Gulf (Stations 10345, 10346), while its companion species, *E. bispinosa* was not taken there at all in the summer in question. A few *E. compressa* were, however, captured in the Bay in August, which reproduces our earlier experiences.

Adult copepods other than *Calanus finmarchicus* and Pseudocalanus were of so little faunistic importance in the Gulf, that the only species detected in the preliminary examination of the catches were one *Calanus hyperboreus* (p. 132), a few *Metridia lucens*, Anamalocera, and *Euchaeta norvegica* (Station 10341, 80–0 meters, occasional specimens). And the scarcity of the latter in the deeps of the open Gulf (Station 10345) is especially noteworthy, for it is usually one of the most striking members of the plankton of its deeper layers, occurring in practically every haul from 80 meters, or more (Bigelow, 1917a, p. 292, fig. 88).

Adult euphausiids were similarly rare in July, being represented by occasional specimens of *Thysanoessa raschii* (Station 10341), *T. inermis* (Stations 10341, 10342), and *Meganyctiphanes norvegica* (Station 10341) only. This was also true of the one pteropod, *Limacina balea* (Stations 10342, 10344), which is endemic in any numbers in our Gulf. But the presence of many euphausiid larvae off Cape Cod (Station 10344, 10345) suggests that this group may have been more important later in the season, as was certainly the case in 1915.[1] And the scarcity of *Limacina balea* is probably a seasonal phenomenon of the same sort, for we have never found it common off Massachusetts Bay or along Cape Cod so early in the season, though it approaches the western and northern coasts of the Gulf as the summer advances.

Tomopteris was not taken in any of the July hauls.

Considerable numbers of the neritic Hydromedusa *Mitrocoma cruciata* were present in Massachusetts Bay in July (Station 10340), though it has usually disappeared there by that season (Bigelow,

[1] In that year *Thysanoessa inernis* appeared in large numbers in August off Cape Ann, where it was rare earlier in the summer.

1917a, p. 305). And *Aglantha digitale* occurred in some numbers at all the July stations north of Georges Bank, notably in Massachusetts Bay (Stations 10340, 10341, 10343).

Melicertum campanula was encountered at one July Station (10340).

The total absence of *Staurophora mertensii* in the catches of 1916 deserves mention in view of the steady decrease which seems to have taken place in its numbers since 1912 (Bigelow, 1917a, p. 305). No explanation for this change is yet apparent.

The GRAMPUS did not visit the eastern or northern parts of the Gulf in 1916. But Dr. A. G. Huntsman, of the Biological Board of Canada, has very kindly supplied the following notes on the occurrence of certain plankton forms in the Bay of Fundy during that summer.

The relative numbers of distinctly northern forms present in this Bay during any given season are good evidence for, or against, an unusual influx of northern water, for only in small numbers are any of them (*e.g.*, *Parathemisto oblivia*) endemic there, it being, as he points out, entirely unsuitable for the development of most pelagic eggs and larvae. Such index animals are *Parathemisto oblivia; Tomopteris helgolandicai Mertensia ovum; Limacina helicina:* — perhaps *Clione limacina* (p. 174) and *Aglantha digitale*. Dr. Huntsman's notes regarding them are as follows: —

"*Parathemisto oblivia* was found very occasionally and only as isolated individuals, in 1916. It is an estuarial species occurring in large numbers in the Gulf of St. Lawrence, particularly in the estuaries of the northern part. It is virtually absent from the banks on the south coast of New Foundland, and is, therefore, an indicator of St. Lawrence water as opposed to that of the Labrador Current. But its presence in the Gulf of Maine and in the Bay of Fundy is not conclusive evidence of St. Lawrence water as it breeds successfully in the estuary of the Kennebecasis river near St. John, New Brunswick. *Tomopteris catharina* (= *helgolandica*) was not infrequent in May of 1916, but its numbers decreased during the summer. It was obtained however, in every month until October at least. This species appears never to be abundant south of the New Foundland banks, where it breeds. Wright (1907) however, reported the young from Canso (as "*T. mariana*"). It is rare in the Gulf of St. Lawrence and does not seem to breed there. As its range extends as far south as New York, the adults must survive for a long time in the south-flowing coastal water. *Mertensia ovum* was not found in 1916. *Limacina helicina* does not seem to occur in the Bay of Fundy, and was not found in 1916.[1] *Clione limacina* was not found in 1916, but has occurred in the Bay of Fundy in other years, sometimes in considerable quantities. It is abundant on the New Foundland banks and occurs regularly in the Gulf of St.

[1] For its occurrence in the Gulf of Maine see Bigelow, 1917a, p. 248.

Lawrence and off Nova Scotia. Larvae are found over this entire northern region, but not in the estuaries. *Aglantha digitale* is likewise very rare in the Bay of Fundy, and scarcely any specimens were taken in 1916. However, it resembles *Sagitta elegans* in breeding successfully in large numbers over an extensive area of coastal waters to the north and east."

These notes show that there was no unusual immigration of northern plankton animals into the Bay of Fundy in 1916, indeed, rather less than usual.

Our previous experience had been that the zoöplankton of our Gulf is much the same in November as in midsummer (Bigelow, 1914b, p. 403); and this was true in 1916. Thus the deeper November hauls caught chiefly large *Calanus finmarchicus* and Pseudocalanus, the only other copepods occurring in any numbers below 25 meters at these stations being *Metridia lucens*, *Euchaeta norvegica*, and an occasional *Calanus hyperboreus* (Station 10401). Further in regard to copepods I need only record a swarm of *Temora longicornis*, with occasional *Centropages hamatus* on the surface off Gloucester (Station 10399); of Pseudocalanus and young Calanus on the surface at Stations 10400, and 10401; of *Centropages hamatus* on the surface at Station 10404; many *Metridia lucens* on the surface off Penobscot Bay (Station 10402); and Anomalocera at Station 10400.

In November, just as in July, the only chaetognath detected in the Gulf was *Sagitta elegans*, large specimens of which occurred in greater or less numbers in all the deeper hauls, particularly at Stations 10399 and 10400, where they were in great abundance at 60–0, and 90–0 meters. And the fact that small specimens (10–12 mm. long) were taken on the surface at all the November stations, abundantly off Cape Ann (Station 10399), is worth noting. The general thesis that the number of Euthemisto present in the Gulf increases during summer and autumn is borne out by the fact that this hyperiid occurred at all the November stations. As a rule its few representatives were young, or at most medium sized; but at Station 10404 it was represented by large specimens of both species, *E. compressa* and *E. bispinosa*, such as often swarm along the Continental Slope. *Euthemisto compressa* was taken at Stations 10400–10404 in the Gulf; *E. bispinosa* at Stations 10399, 10401, and 10404. A similar increase evidently took place in the case of *Limacina balea* which was detected at Stations 10399, 60–0 meters; 10400, surface; 10402, surface; once, 10399, in considerable numbers. Whether the same change characterized the euphausiids is not clear, for while many large *Myganyctiphanes norvegica*, with a few *Thysanoessa raschii* were taken on the surface at Station 10402, a few Meganyctiphanes and *T. inermis* at 180–0 meters, Station 10401, and a few Meganyctiphanes at Station 10400, none were detected at Stations 10399, 10403, or 10404.

The occurrence of young *Aglantha digitale* in swarms off Cape Ann (Station 10399, surface, and 60–0 meters) and, in smaller numbers on Stellwagen Ledge (Station 10403), is worth a word, as is a swarm of Beroe (probably *B. cucumis*) further off shore (Station 10401, 80–0 meters). And, finally, I may add that Tomopteris was wholly lacking in November, just as it was in July (p. 133).

Discussion of the pelagic fish eggs, and young fishes taken in 1916 is reserved for a future communication.

The Quantitative Hauls. Thanks to abundant Calanus, the catches made in the Gulf in July with the quantitative nets[1] were very rich as illustrated by the following table:—

STATION	DEPTH METERS	VOL. PER SQ. METER C.C.	VOL. PER CUBIC M. C.C.	COPEPODS APPROX. PER SQ. METER	COPEPODS PER CUBIC METER	LARGE CALANUS PER SQ. METER	LARGE CALANUS PER CUBIC METER
10340	45	125	2.5	93000	2066	38000	844
10341	80	250	3.1	265000	3312	78700	983
10342	55	250	4.5	338000	6145	111000	2018
10344	80	225	2.5	179250	2240	74000	925
10345	150	200	1.3	139600	930	83600	557
10346	62	200	3.2	247200	3987	36800	1390
Average		208	2.8	210340	3113	78600	1119

And the Calanus population being largely confined to the deeper levels, as evidenced by the poverty of the surface catches, the plankton was evidently much denser, locally, than even the amounts per cubic meter would suggest. For example, the haul at 40 meters, at Station 10344, with the meter net, yielded about 6 liters in 15 minutes, upwards of two and one half million large Calanus.

These are considerably larger amounts of plankton, both per square, and per cubic meter, than were usually present in these waters in the summer or autumn of 1915, the only previous year when the same type

[1] Taken with the Michael Sars net, ½ meter in diameter, as in 1915 (Bigelow, 1917a, p. 307). The same method of counting was employed as previously (Bigelow, 1914a, p. 128).

of quantitative net was used; or, taking our records at their face value,[1] 1912, 1913, or 1914, as illustrated by the following table for the southwestern part of the Gulf:—

Year	Extreme vols. per sq. meter cc.	Extreme vols. per cubic m. cc.	Average vol. per sq. meter cc.	Average vol. per cubic m. cc.
1912	15–250		105	
1913 [1]	180	1.4	180	1.4
1914	60–210	.42–1.9	102	.94
1915	30–150	.7–1.	103	.74
Average for 4 years			122	1.03

Copepods were also more numerous, as follows:—

Year	Extreme nos. per square meter	Extreme nos. per cubic meter	Average no. per square meter	Average no. per cubic meter
1912	7,500–235,300	45–1012	103,575	723
1913 [2]	50,500	388	50,500	388
1914	53,500–189,500	306–1722	101,562	712
1915	42,500–112,500	368–1142	65,800	765
Total average =			80,359	647
1916	93,000–265,000	930–6145	210,340	3113

Zoöplankton on Georges Bank and off Marthas Vineyard.

Special interest attaches to the plankton along the outer (southern) edge of Georges Bank, because of the mixing of Cabot Current, Gulf Stream, and Bank water which takes place there (p. 165). Over the Bank itself (Stations 10347 and 10348) the July plankton, very scanty in amount (Station 10347, total bulk of vertical haul, 15, c.c.), was of the usual boreal type, without any distinct northern component, *i.e.*, chiefly *Calanus finmarchicus* and Pseudocalanus, *Sagitta elegans*, *Euthemisto compressa*, together with such neritic forms as Cyanea, the

[1] In 1912, 1913, and 1914 the Hensen, in 1915 the Michael Sars nets were used. In neither case has the coefficient of filtration been allowed for in calculating the results of the catches.

[2] One haul only.

free floating campanularian hydroids which apparently characterize the summer plankton of these shallow waters (Bigelow, 1914b, p. 414; 1915, p. 306); and many crab larvae. And the presence of these neritic organisms so far from land, illustrates how similar to an actual coast line in their effect on the plankton, are these shallow off-shore banks. It was along the outer edge of the Bank, and over the Continental Slope (Stations 10349–10352) where the temperature was very low (p. 101) that the plankton might have been expected to show an Arctic component, if anywhere. But nothing was taken which could be so described. However, tropical organisms, usually so common here at this season, were poorly represented in 1916, the nets yielding much the same assemblage as on the Bank, and in larger amount;[1] notably *Calanus finmarchicus*, and Pseudocalanus, with lesser amounts of *Metridia lucens;* occasional *Euchaeta norvegica* (Stations 10349, 10352) and *Eucheirilla rostrata* (p. 147) with large *Euthemisto*, both *E. compressa* and *E. bispinosa*, in considerable numbers, as is usually the case along the Slope. A few *Limacina balea* were likewise detected, as were *Thysanoessa inermis* and *T. raschii* (Station 10351), while *Nematoscelis megalops* was present in large numbers at the Station furthest off shore (10352). *Sagitta serratodentata*, not detected in the Gulf in the summer of 1916 (p. 133), was as numerous as *S. elegans* at Station 10349 and outnumbered it at Station 10351, while at Station 10352, neither of these chaetognaths was found, they being replaced there by occasional specimens of *Eukrohnia hamata* and *Sagitta maxima*[2] in the deep haul (500–0 meters), which also yielded a beautiful example of the mesoplanktonic medusa, *Periphylla hyacinthina* Steenstrup.

The only animals to which a Gulf Stream origin can safely be ascribed are a few *Salpa fusiformis* at Station 10349, many at Station 10352; a single *Physophora hydrostatica* (Station 10352), a large Pyrosoma (Station 10352), a few fragments of Gulf weed (Sargassum sp., Station 10353). This community contrasts, as strongly as did the salinities and temperatures of 1916, with the Gulf Stream plankton encountered at this general locality in 1914 (Bigelow, 1917a, p. 245), but almost exactly reproduces what we have previously found at this season at the same relative position on the slope off the northeast face of Georges Bank and off southern Nova Scotia (Bigelow, 1917a, p. 245), rather less tropical than the former, less northern than the latter.

[1] At Station 10349 the yield of the quantitative net was at the rate of about 175 c.c. per square meter of sea surface.

[2] I follow Huntsman (1919) in regarding the *S. maxima* of Conant (1895) Ritter-Zahony (1911) and Kramp (1918) as distinct from *S. lyra*, with which Michael (1911, 1919) has united it.

The shallow waters off Marthas Vineyard (Stations 10354–10356) were likewise occupied by a typically boreal plankton, as was the case in 1913 also, chiefly the copepods *Calanus finmarchicus* and Pseudocalanus, with *Sagitta elegans* taking the place of *S. serratodentata.* But large Calanus were less numerous close to land (Station 10357), where they were replaced by swarms of small copepods yet to be identified. And in general the various neritic animals played an increasingly important rôle as the GRAMPUS approached land. Of these I need mention only abundant decapod larvae in the 30–0 meter hauls at Stations 10355 and 10356; the Medusa Obelia at Station 10356, the copepod *Temora longicornis* (Stations 10356 and 10357), and Evadne (Station 10357).

ZOÖPLANKTON, MARTHAS VINEYARD TO CHESAPEAKE BAY.

The unusually low ocean temperatures which prevailed over the Shelf south of New York during the summer of 1916 add interest to the plankton of those waters. In July, 1913, the only previous summer for which plankton records are available for this region, copepods, which played the major rôle east of New York, were practically negligible further west and south, their place being taken by a combination of immigrants from the inner edge of the Gulf Stream, particularly Salpae, on the one hand, and neritic animals, *e.g.*, Mnemiopsis, on the other, together with swarms of Pleurobrachia whose exact faunal status is still doubtful. And the warmer and more saline waters over the Continental Slope carried with them a tropical plankton community. In 1916 the summer catches were of quite a different complexion, a rich copepod plankton occupying the whole breadth of the Shelf off New York, chiefly *Calanus finmarchicus*, associated with which were such other boreal forms as *Sagitta elegans*, and Euthemisto, *i.e.*, much the same as prevails in the Gulf of Maine.

The Calanus Community. This Calanus community, to give it the name of its most important member, reached as far south as Chesapeake Bay (Fig. 45). But south of New York it was lacking over a widening coastal zone (Stations 10377, 10378, 10379, 10387, 10390, 10391), where it gave place to neritic copepods (p. 146), ctenophores (p. 158), and other neritic forms, *e.g.*, crab (Callinectes) larvae. And on the line off Chesapeake Bay it was restricted to the extreme outer edge of the Shelf (Station 10392), a fact suggesting this as its extreme southern limit. The importance of *Calanus finmarchicus* in the natural economy of boreal seas being so great, and its presence in mass totally unexpected south of New York in July and August, the precise conditions under which it occurred there in the summer of 1916 require examination. To begin with, Calanus was by no means equally distributed throughout the area occupied by it (Fig. 45–47) or at all levels in the water, being most plentiful over the

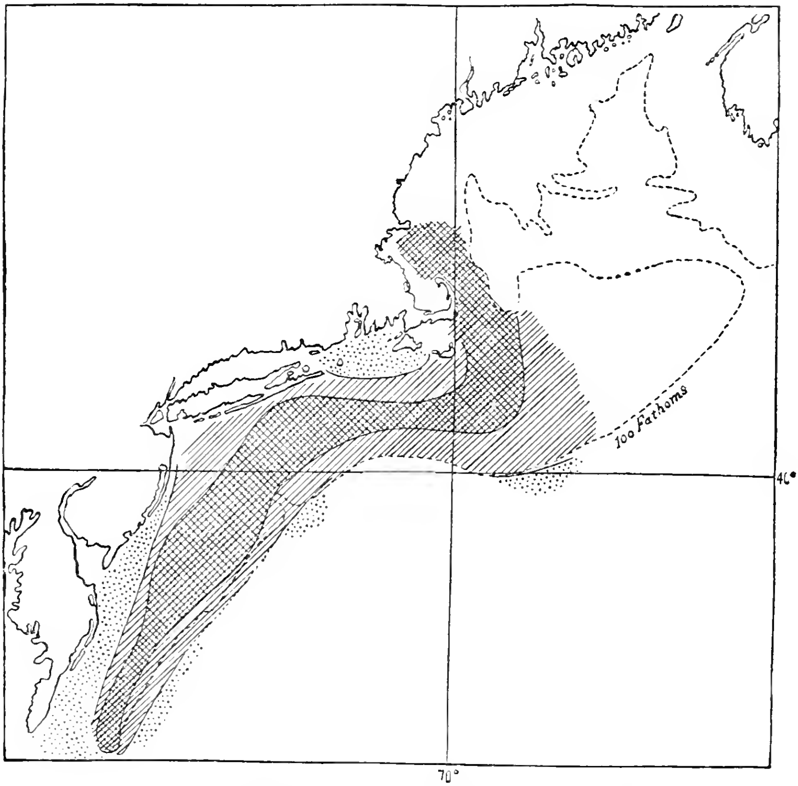


Fig. 45.— Chart showing the relative abundance of Calanus, horizontally, July–August, 1916. Cross hatched, Calanus swarms; single hatched Calanus moderately numerous; dotted, few or no Calanus.

outer part of the Shelf in the deep hauls (Station 10364, 40–0 meters, Station 10365, 50–0 meters, Station 10370, 50–0 meters, Station 10373, 60–0 meters, Station 10375, 40–0 meters, Station 10381, 69–0 meters, Station 10386, 45–0 meters, Station 10392, 75–0 meters), where the meter net yielded from 1–3 quarts, chiefly large Calanus. Nearer land fewer were taken (p. 139). And its numbers diminished similarly passing seaward from the 100 meter contour, there being very few at any level over the Slope (Station 10368, 500–0 meters, none, Station 10384, Station 500–0 meters, few, Station 10393, 250–0 meters and 500–0 meters none).

Our data on the absolute abundance of Calanus in these waters is confined to quantitative hauls at two stations off New York, at one of which (10363), the horizontal haul yielded few, at the other (10365) 2½ quarts at 50–0 meters. And the catches of the quantitative nets

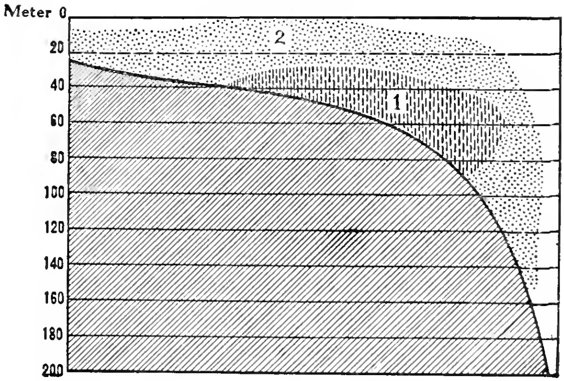


FIG. 46.— Profile off New York (Stations 10362–10370) showing the relative abundance of large Calanus, August, 1916. Hatched (1), rich, 1 liter or more taken; dotted (2), less than 1 liter; and blank, occasional or none.

differ correspondingly, the total volume of plankton being about 35 cc., of large Calanus 9,500 per square meter of sea surface at the former; 100 cc., with 27,000 large Calanus at the latter. Assuming that practically the whole catch of Calanus was made below 10 meters depth at these stations, an assumption justified by the fact that very few were taken on the surface, the number per cubic meter of water was at least 430 at Station 10363, 540 at Station 10365. And probably the actual density of the Calanus population at the latter was locally many times greater than this, the richness of the horizontal net catch at 50 meters, just noted, suggesting a localization at and near that level.

In estimating the abundance and bathymetric occurrence of *Calanus finmarchicus* over the rest of what I may call the Calanus zone, we must rely on the results of the quantitative hauls, which must be used with caution, first, because they fish both on the way down and on the way up, as well as at the level at which the major part of the haul is made; second, because the latter can not be known exactly, for even if a depth recorder be attached to the net it can only reveal the *greatest* depth reached; third, and most serious, because the amount of water filtered by the net varies, even when the hauls are of the same duration, owing to variations in the speed of the vessel. In hauls deeper than, say, 200 meters, so much time is occupied in lowering and hoisting the nets, and so uncertain is the level at which they work, that these objections become serious enough to vitiate all but the most general quantitative results. But this is not true of our shallow hauls on the Continental Shelf, where the few minutes spent in lowering and hoisting the net are only a trivial part of the total time it is at work. And inasmuch as the catches of vertical hauls in these shallow waters are very scanty, compared with the yields of the horizontal nets at the same stations, it is safe to assume that at least the major part of the latter can be credited to the approximate level at which the net is working during most of the haul. This can not be known absolutely. But when the extreme depth of the haul is only 40 or 50 meters, the total amount of wire outboard is so short that an error of more than 10 meters one way or the other is unlikely. The variations in the length of the column of water fished through prevent the results of such hauls from being strictly comparable one to another. But when all the hauls are of the same duration (30 minutes is the Grampus standard), the nets of the same diameter (or the catches reduced to one standard diameter), and when the speed of the vessel is so regulated as to keep the angle of the wire nearly constant (say 45°–50°) the results have considerable comparative value. At the worst, they tell us which regions or levels are well, which sparsely, populated; for example that the surface was uniformly barren of large Calanus south of New York, irrespective of the time of day, as illustrated by the following data for the surface catches at stations where this copepod was plentiful deeper down in the water: —

Station	Large Calanus	Time	Station	Large Calanus	Time
10362	none	9 A.M.	10380	occasional	2 A.M.
10363	"	3–4 P.M.	10381	few	8 A.M.
10364	few	7–8 P.M.	10382	"	noon
10365	none	7 A.M.	10384	none	9 P.M.
10369	"	5 A.M.	10386	occasional	5 P.M.
10370	occasional	4 P.M.	1[illegible]	"	3–6 A.M.
10372	few	2 A.M.	1[illegible]	none	9 A.M.
10375	occasional	8 A.M.	[illegible]	"	3 P.M.

Large amounts of Calanus were taken only from depths of 20 or more meters. For example, at Station 10362 very few were taken at 10 meters, many (1 pint) at 20 meters; Station 10363 many at 20 and at 30 meters; at Station 10381, only a few at 25 meters whereas a swarm (2 quarts) was encountered by the 70 meter net. On the other hand the deeper water (100–120 meters) at the outer edge of the Shelf was less productive in Calanus than the mid-depths, as illustrated by Station 10370, where the haul at 120 meters yielded only 1 pint, whereas there were swarms at 50 meters. At Station 10382 Calanus was apparently comparatively sparse at all levels down to 120 meters (bottom). The largest catches south of New York were made along the outer ⅓ of the shelf, at from 40–70 meters depth (Stations 10364, 10365, 10370, 10373, 10375, 10381, 10386, 10392). And though no study has yet been made of the proportion in which the different growth stages occur, it is worth noting that all these rich catches were composed in the main of very large individuals, giving the plankton the same monotonous aspect that so often characterizes it in the Gulf of Maine. Only at one Station (10362, 10–0 meters) along this part of the Shelf, and once near Long Island (Station 10396) were young Calanus numerous.

Never before in our Grampus cruises, has it been possible to correlate the occurrence of any of the more important plankton animals as closely with the physical state of its environment as can be done for the Calanus stock south of New York in the summer of 1916. The most cursory comparison of the temperature profiles (Fig. 22, 24, 26) with those for the relative abundance of large Calanus at different levels (Fig. 46, 47) shows a very close correspondence between catches of 1 quart or over and water of 4°–7°, the precise temperatures in which the richest hauls were made being as follows:—

Station	Approximate catch of Calanus	Depth of haul meters	Depth of minimum temperatures meters	Minimum temperatures
10364 [1]	swarm	40–0	40	5.5°
10365 [1]	swarm	50–0	40–60	.8°
10370	swarm	50–0	50	4.9°
10370	few	118–0	—	—
10373	3 quarts	60–0	60	4.5°
10375	1½ quarts	40–0	40	6°
10381	few	25–0	—	—
10381	2 quarts	70–0	30–65	4.5°
10395	3–4 quarts	38–0	38	9°

[1] Taken with net .63 meter in diameter.

This relationship between cold water and abundance of large Calanus is further illustrated by the close correspondence between the charts of minimum temperature on the Shelf (Fig. 21) and of the horizontal limits of the Calanus swarm (Fig. 45a). Station 10395, where the minimum temperature was about 9°, was the one exception to the rule that Calanus swarmed only in water of 6° or colder. But we have occasionally made large catches of Calanus in water warmer than 10° in the Gulf of Maine in August (for example, at Station 10027, 1914a, p. 103), though usually, it is true, where the underlying layers were colder.

As a whole the salinity of the waters most densely populated by

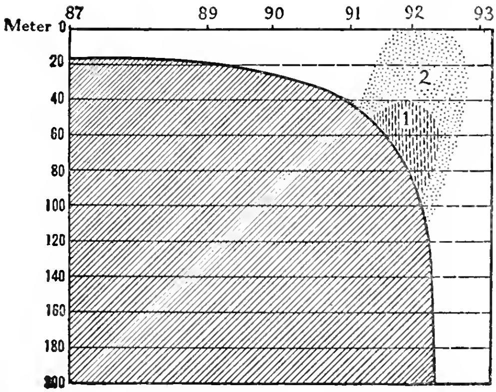


FIG. 47.— Profile off Chesapeake Bay, showing the relative abundance of large Calanus, August, 1916. Shading as in Fig. 4 and 6.

Calanus was likewise decidedly uniform, that of the coldest water on the Shelf south of New York being about 32.6‰ all along this zone from north to south (p. 112).

The presence of great numbers of Calanus (the largest catch of all) off Long Island (Station 10395) as late as August 26 shows that no diminution had taken place in its numbers there during the three weeks since the GRAMPUS sailed south from New York (Station 10362, August 1); a constancy recalling that temperature had risen only slightly, salinity not at all (p. 182) during the same period. And even as late in the season as this, large Calanus were taken in some numbers close in to the Long Island Beach (Station 10396). But by mid-November Calanus had decreased greatly in numbers over such parts of the Shelf as were visited by the GRAMPUS on her autumn run from Cape Cod to Chesapeake Bay (Stations 10405–10417), for nowhere at that season did the nets yield any such masses of this little crustacean as in midsummer. And the shrinkage was particularly evident on the outer part of the Shelf off Delaware Bay, where the Calanus swarm of August (Station 10370) had dwindled to only a fraction by November 12 (Stations 10409, 10410). *Calanus finmarchicus* was, however, taken in every November haul south of Cape Cod, except at the mouth of Delaware Bay (Station 10417), *i.e.*, it had colonized the coastal zone where it was wanting in August. Furthermore, the surface was by no means as barren of large Calanus in November as in August, most of the surface hauls then yielding a considerable number of medium sized individuals. This vertical equalization of Calanus corresponds to the vertical equalization of temperature and salinity which takes place in autumn (p. 123). And it suggests that the failure of the southern Calanus swarm to migrate to the surface during the midsummer nights, as it so often does in the Gulf of Maine and elsewhere (p. 143) was due either to the very high surface temperature, or possibly to the very low surface density. With the advance of autumn both these barriers are weakened by surface cooling, until in winter, thanks to the vertical uniformity of the water, the only physical barriers to vertical migration are sunlight and geotropism.

While (p. 143) no statistical study of the proportions of Calanus of different ages has yet been attempted, the fact that young stages were scarce, or absent, even on the surface, in November, is good evidence that no active multiplication of Calanus was taking place at that time, in contrast to the local swarms of juveniles encountered only shortly previous in the Gulf of Maine (p. 135).

No quantitative hauls were made during November; hence we have no data as to the actual numbers of Calanus present in the water at that time.

A notable difference between the Calanus community south of New York and the boreal plankton of the Gulf of Maine is the scarcity of the small copepod, Pseudocalanus among the former. In 1913 Pseudocalanus was not detected at all south of New York (1915, p. 292): in August 1916, apart from the Gulf of Maine, and Georges Bank, (Station 10347) it has been detected at two stations only, both on the line off New York (Stations 10363, 10365). Adults, at least, were equally lacking south of this in November, though it is possible that it may be represented among the young copepods taken at that season.[1]

Other Copepods. Where Calanus swarmed, few other large adult copepods occurred at the same level; (all the catches contain young

[1] November occurrences of Pseudocalanus are Stations 10399–10407.

and microcopepods, the identification of which must await the specialist), but over the coastal zone *Centopages typicus* was taken in numbers [1] (Fig. 48), particularly in the upper levels; and it was often plentiful on the surface where Calanus swarmed deeper down, for example, at Stations 10375, 10381. How closely this small copepod was confined to the immediate surface is illustrated by the fact that it abounded there at Stations 10375, 10380, 10381, 10383, 10386, though few or none were taken at the corresponding hauls from 40 or more meters; *C. typicus* was equally widespread in these waters in 1913 (Bigelow, 1915, p. 287). *Centropages hamatus* is more northern, occupying much the same zone in the Gulf of St. Lawrence as does *typicus* south of Cape Cod (Willey, 1919, p. 200). In 1916 *hamatus* was detected only twice, off New York (Station 10394) and in Vineyard Sound (Station 10396).

As is well known, many species of copepods are more neritic in habit than is Centropages. And such occur in greater or less numbers in most of our hauls near land south of New York. But until the examination of them is complete, only the more striking (on account of abundance, or ready identification) need be mentioned. Such is *Acartia tonsa*, which swarmed locally off Delaware Bay in August (Stations 10377, 10378, 10379), within the immediate influence of the outflow from the Bay. *Labidocera aestiva* was similarly limited to the region off the mouth of Chesapeake Bay (Stations 10387, 10389, 10390). But as this genus is abundant at Woods Hole during the summer (Wheeler, 1901), and is recorded by Willey (1919, p. 203) from the Gulf of St. Lawrence, it evidently covers a very wide range of latitude along the American coast. Its absence from most of our hauls is due to their location in the open sea, some distance from land. Neither Acartia nor Labidocera was taken in November.

Less distinctively neritic than the foregoing, though less oceanic than Calanus, is *Temora longicornis*. As noted, this species swarmed off Marthas Vineyard (Stations 10355, 10356, 10357); it also occurred off New York (Station 10362), but not further south, which reproduces our experience in 1913. But by November when the GRAMPUS again encountered it in numbers across the whole breadth of the Shelf off Marthas Vineyard (Stations 10405, 10406, 10408) it had extended its range far to the southward, being then taken both off Delaware Bay (Station 10411) and off Chesapeake Bay (Station 10417).

The large, easily recognized copepod *Metridia lucens* is rather more oceanic in our waters than *Calanus finmarchicus*, though often taken

[1] *Centopages typicus* has so far been detected at Stations 10362, 10375, 10379, 10380, 10381, 10386, 10387, 10388, 10391, 10394, 10395, 10396.

with it. In August, 1916, *M. lucens* was taken at the following stations south of Cape Cod; 10349, 10352, 10365, 10366, 10369, 10375, 10382, 10393. As the chart shows, these captures are localized along the outer part of the Shelf, and over the Slope, except for one locality off Delaware Bay (10375). In November *M. lucens* was not taken south of Cape Cod, though widely distributed then in the Gulf of Maine (Stations 10399–10403).

The Arctic *M. longa*, which occasionally appears in the Gulf of

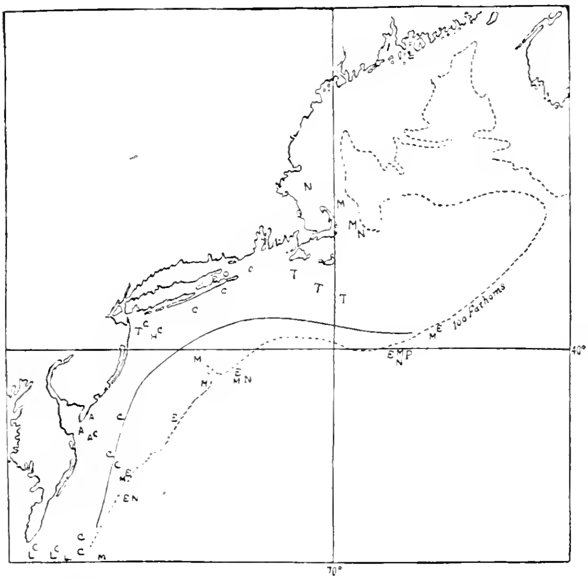


FIG. 48.— Occurrence of certain copepods, July–August, 1916. A, *Acartia tonsa*. C, *Centropages typicus*. E, *Eucheirella rostrata*. H, *Centropages hamatus*. L, *Labidocera*. M, *Metridia lucens*. N, *Euchaeta norvegica*. P, *Pleuromamma*. T, *Temora longicornis*. The solid curve marks the general line of demarkation between neritic and oceanic species west and south of Georges Bank.

Maine (Bigelow, 1917a), and is widespread in more northern waters on this side of the Atlantic (Willey, 1919), has not been detected in the GRAMPUS hauls of 1916.

No copepods to which a true tropical origin can be ascribed, were taken in 1916. But the list does include two large conspicuous forms which are typically oceanic in the North Atlantic, and which have usually been found, on our cruises, in the zone of mixed water along the Continental Slope, *i.e.*, Pleuromamma and *Eucheirella rostrata*. The former occurred off the Slope of Georges Bank only (Station

10352, 500–0 meters), the latter over the Slope and on the outer edge of the Shelf (Stations 10349, 10351, 10352, 10368, 10370, 10382, 10384). Eucheirella was limited to the deeper levels, as exemplified by Stations 10370 and 10382, where it occurred in the nets from 120 meters, but not in the 50 meter hauls.[1] Eucheirella is similarly distributed off Nova Scotia (Willey, 1919, p. 189, fig. 9). It occasionally penetrates within the Gulf of Maine (Bigelow, 1917a, p. 246).

South of the Gulf of Maine, *Euchaeta norvegica* is strictly limited to depths of 100 meters or more, outside the Continental Shelf. In 1916 it was taken at Stations 10352, 500–0 meters, 10368, 450–0 meters, 10384, 500–0 meters (Fig. 48).

A single large *Calanus hyperboreus* at Station 10381, 70–0 meters, deserves special mention, as being the most southerly known occurrence of this Arctic species, so common from Nova Scotia northward (Willey, 1919).

Other conspicuous copepods so far identified are Eucalanus (Station 10389), and the large blue *Anomalocera pattersoni* (Stations 10342, 10392, 10393, 10395, 10396, 10398). Neither of these were detected in the tows south of Cape Cod in November.

Euthemisto. The hyperiid amphipod Euthemisto occurred generally throughout the Calanus zone west of Cape Cod and south of New York in August, the relative abundance of the two species, *E. compressa* and *E. bispinosa*, at that time being as follows[2]: —

Station	Species present	Species predominant	Station	Species present	Species predominant
10362	C. B.		10380	C. B.	C. B.
10363	C. B.	B.	10381	C. B.	B.
10364	C. B.	B.	10382	C. B.	C. B.
10365	C. B.	C. B.	10384	O	
10368	C. B.	C.	10386	C. B.	C. B.
10369	C. B.	C. B.	10387		
10370	C. B.	B.	10389		
10373	C. B.	B.	10390		
10375	C. B.	C. B.	10392	C. B.	
10377			10393	C.	C.
10378			10394	C. B.	
10379			10395	C. B.	B.

[1] The depths of the other captures of Eucheirella are, Station 10349, 130–0 meters, Station 10351, 160–0 meters, Station 10352, 500–0 meters, Station 10368, 450–0 meters, and Station 10384, 500–0 meters.

[2] C. = *compressa*. B. = *bispinosa*. C.B. = about equal numbers of the two species. Predominant species named only for stations where one is several times as numerous as the other.

The limits of *E. compressa* and *E. bispinosa* correspond almost exactly with those of *Calanus finmarchicus*. The apparent absence of *E. bispinosa* over the Continental Slope off Chesapeake Bay (Station 10393), where *compressa* occurred in small numbers, is an exception to our previous experience that of the two species *bispinosa* is the more oceanic, as is the fact that it was along the middle of the Shelf that *bispinosa* predominated over *compressa*. But the relative abundance of these two species fluctuates much from haul to haul. Euthemisto, like large Calanus, only occasionally appeared in the surface hauls in mid-summer even where numerous deeper down, and then (as at Station 10395) usually as small specimens too young for specific identification. But on the outer edge of the Shelf off New York (Station 10369) young stages of both species formed the bulk of the rather scanty surface catch.[1] Although Euthemisto appeared so regularly in the deeper tows on the Shelf side by side with Calanus, it was, quantitatively, far less important than the latter, only once swarming in August (Station 10395). Other stations south of New York, where it formed a considerable part of the August plankton were 10362, 10363, 10370, 10375, 10380. At all these localities small, or medium sized specimens alone were taken, as has usually been our experience on the inner part of the Continental Shelf.

Both species occurred at practically all the November stations[2] south of Marthas Vineyard, except at the mouths of Delaware and Chesapeake Bays (Stations 10411, 10417), where none were detected, *bispinosa* being then the predominant member of the pair over the outer part of the Shelf south of Delaware Bay (Stations 10412–10416), and over the Slope off New York (Station 10408), while *compressa* was decidedly the more numerous of the two close to Marthas Vineyard (Station 10405). Elsewhere the two were roughly equal, or, as at Station 10407, *compressa* predominated at one level (in this case, surface) *bispinosa* at another (75–0 meters). Euthemisto was relatively a more important factor in the plankton of these waters in November than in summer, thanks to the diminution in the numbers of Calanus. Notably large amounts were taken at Stations 10415, 90–0 meters, and 10416, 40–0 meters (about $\frac{1}{2}$ liter in each case): juveniles swarmed on the surface at Station 10406 and 10412. But only occasionally (Station 10407, *compressa*) were any very large specimens noted at this season. Like Calanus, it was less strictly

[1] Euthemisto has been detected in the surface hauls at Stations 10364, 10368, 10369, 10373, 10392, 10396.

[2] *E. compressa*, detected at Stations 10405–10407, 10409, 10410, 10413–10416 as well as in the Gulf of Maine (p. 135); *E. bispinosa* at Stations 10406–10410, 10412–10416.

confined to the deeper water-layers in November than in August, occurring in the surface catches for Stations 10405–10410, 10412 and 10413, twice in large numbers (Stations 10406, 10412).

Euphausiids. Only a preliminary examination of the euphausiids has yet been made; hence some species may have been overlooked. But inasmuch as the group was practically non existent in the coastal water south of New York in the summer of 1913, its occurrence there in 1916 is worth discussion.

Thysanoessa inermis occurred among the Calanus, off Marthas

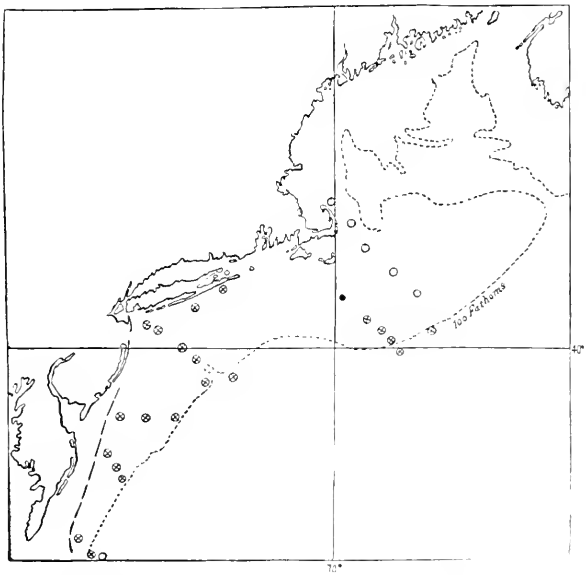


FIG. 49.— Occurrence of *Euthemisto compressa* (○), and *E. bispinosa* ×, or both species ⊗, July–August, 1916. ● = Larvae.

Vineyard in July, 1916 (Station 10354); likewise (usually in comparatively small numbers and represented by small individuals) at most of our stations in the Calanus zone south of New York in August. But its area of distribution was less extensive than that of Calanus, neither approaching as close to the land, on the one hand, or extending outside the Continental Shelf on the other, while Chesapeake Bay marked its extreme southern limit. *Thysanoessa longicaudata* was taken side by side with *T. inermis* off Delaware Bay at this time; displaced it over the outer edge of the Shelf off New York; and was the only

Thysanoessa detected in the hauls made in deep water over the Continental Slope. The occurrences of the two south of New York as so far established, are as follows: — *T. inermis*, Stations 10363, 10364, 10370, 10373, 10380, 10381, 10386, 10394, 10395; *T. longicaudata*, Stations 10365, 10369, 10370, 10373, 10380, 10384. The southern species, *T. gregaria*, has not been identified from any of the hauls in 1916; hence it was certainly less common, proportionately to the other species of the genus, than we have usually found it even in the Gulf of Maine in summer. Meganyctiphanes was not detected at all at the August stations south of New York, though it is possible that it may be represented among the very young euphausiids, nor was the boreal-arctic *T. raschii*.

Although Thysanoessa was so widespread in the Calanus zone at this time, it was not an important factor in the plankton, being entirely overshadowed by the swarm of Calanus with which it was associated.

Two oceanic euphausiids, *Euphausia krohnii* (Zimmer, 1909) and *Nematoscelis megalops*, which usually occur, sometimes in swarms, in the mixed water along the Slope east of Cape Cod, formed a considerable part of the catches made in August at this relative position off New York (Station 10368) and off Chesapeake Bay (Station 10393, 500–0 meters); with Nematoscelis (but not Euphausia) off Delaware Bay (Station 10384, 500–0 meters). In their bathymetric relationship to each other these catches reproduce our earlier experience, for at the only station where Euphausia was numerous (10368), it occurred in the surface haul, Nematoscelis in the haul from 450 meters just as was the case off Shelburne, Nova Scotia in 1914 (Bigelow, 1917a, p. 283). For the occurrence of Nematoscelis off Georges Bank, see page 138.

Except for Euphausia as noted above, no euphausiids were detected in the surface tows in these waters. And so far as the data go, they suggest the same limitation of Thysanoessa to the cold water layers as obtained for Calanus (p. 143).

In November Thysanoessa, if not wholly lacking south of Cape Cod, was at least so rare there that none have been detected in the preliminary examination of the plankton. Small numbers of Euphausia and Nematoscelis were, however, taken at the outer edge of the Shelf (Station 10408, 150–0 meters) and of Euphausia at Station 10409, 135–0 meters. I may also mention swarms of small mysids, not yet identified, off the mouths of Delaware and Chesapeake Bays (Stations 10411, 10412, 10417), November 16 and 17.

Sagittae. Sagittae, as pointed out (p. 139), occurred in greater or less numbers associated with *Calanus finmarchicus* throughout the Calanus zone; though only locally (Stations 10362, 10373, 10382, 10386) did they form any considerable part of the catch south of New York in summer. Their relative importance in the plankton was considerably greater in November, especially at the outer edge of the Shelf (Stations 10409, 10410, 10414); at the mouth of Delaware Bay (Station 10411) and at Station 10413. But at none of these localities did they swarm as sometimes in the Gulf of Maine; the largest catch of Sagittae, even with the 1 meter horizontal net, being only about ¼ liter.

During the summer of 1913 the prevalent chaetognath in this part of the coastal water was *S. serratodentata*, *S. elegans* being rare west of Nantucket, lacking south of Delaware Bay. In 1916, on the contrary, *S. elegans* was the predominant member of the pair throughout the Calanus zone, at that season, in fact the only Sagitta then taken over the inner half of the Shelf off New York and off Delaware Bay, except for an occasional *serratodentata* at Station 10363 (Fig. 50). But the latter was at least as numerous as *elegans* over the outer part of the Shelf, and no *elegans* were taken in any of the hauls on the slope (Stations 10368, 10384, 10393), as shown in the following table:—

Station	Species present	Species predominant[1]	Station	Species present	Species predominant
10362	E	E	10381	E S	E
10363	E S	E	10382	E S	S
10364	E	E	10384	S	S
10365	E	E	10386	E S	E S
10368	S	S	10387		
10369	E S	E S	10389		
10370	E S	S	10390		
10373	E S	E	10392	E S	S
10375	E	E	10393	S	S
10377			10394	E S	S
10378			10395	E	E
10379					
10380	E	E			

In limitation to the Shelf in midsummer, and in absence from the water next the land off Delaware Bay (Stations 10377, 10378, 10379),

[1] E = *elegans*. S = *serratodentata*. E S = about equal numbers of the two species.

and off Chesapeake Bay (Stations 10387, 10389, 10390), *Sagitta elegans* corresponds with *Calanus finmarchicus*.

With the advance of the season the relative importance of the two species of Sagitta was reversed, for in November *S. serratodentata* was the predominant member of the pair at all stations west and south of Cape Cod, except close to the land near Marthas Vineyard (Station 10405), at the mouth of Delaware Bay (Station 10411), and off Chesapeake Bay (Station 10413, 10414), where the two species oc-

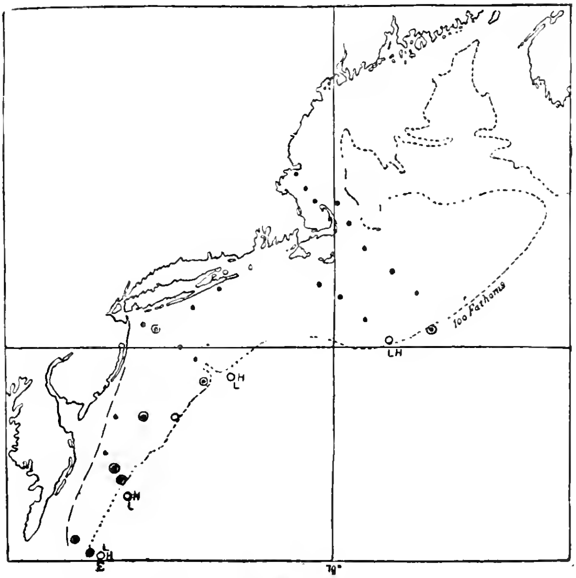


FIG. 50.—Occurrence of *Sagitta elegans* (●), *S. serratodentata* (○) or both, (⊙). Also *S. lyra* (L). *S. enflata* (E). *Eukrohnia hamata* (H), July–August, 1916.

curred in roughly equal numbers.[1] These records confirm our earlier experience that of these two Sagittae, which are so often companions in our waters, *elegans* is the more neritic, *serratodentata* the more oceanic.

In its bathymetric range, *Sagitta elegans* agreed with *Calanus finmarchicus*, in as far as it usually is lacking in the surface hauls in summer, even when plentiful in the deeper layers (so far detected on the

[1] S. elegans detected at Stations 10405–10407, and 10409–10416. *S. serratodentata* detected at Stations 10405–10410, and 10412–10416.

surface at Stations 10362, 10369, 10396 only). And it showed a similar tendency to congregate in the deeper layers in November: for example at Station 10406, where *serrodentata* predominated on the surface, *elegans* predominated at 50–0 meters; at Station 10409 there were more *elegans* at 135 than at 80 meters or on the surface: at Station 10410 *elegans* was taken only in the deep haul (95–0 meters): at Stations 10412 and 10415 it was (relative to *serratodentata*) more abundant in the deeper haul. On the contrary, there was no such apparent stratification at Stations 10414 or 10415.

But no such correlation obtains between its level of maximum abundance and the layer of minimum temperature as for Calanus (p. 143). On the contrary, it was far more abundant at 20 meters, Station 10362, temperature about 11° than at 40 meters, Station 10364, temperature 5°–6°. And in most of the hauls from the very coldest water, in which Calanus was so abundant (p. 143), *Sagitta elegans* was only a minor factor in the plankton (Stations 10364, 10365, 10370, 10373). But it does not follow that it was limited by low temperatures: on the contrary, it was numerous in the 40–0 meter haul at Station 10375 where the water was equally cold (4°–5°), as well as in the 70–0 meter haul at Station 10381 where it was hardly warmer (minimum about 6°). On the other hand a large catch of *Sagitta elegans* was made, late in August, at Station 10396, off Long Island, where the minimum temperature was about 12°. This discrepancy between its relative abundance and temperature confirms our earlier observations in the Gulf of Maine, where we have found it swarming in waters of very diverse temperatures and salinities, and at various seasons of the year.

The birthplace of the large *S. elegans* which often swarm in our waters is probably off the mouths of the bays near the land. But as the possibility has been suggested that some of them may come from the north (Huntsman 1919), small specimens are worth recording. Such (8–12 mm. long) were taken in some numbers in November, not only in the Gulf of Maine (p. 135), but near Marthas Vineyard (Stations 10405, 10406), and at the mouth of Delaware Bay (Station 10411).

Though the range of *Sagitta elegans* is practically coterminous with that of abundant *Calanus finmarchicus*, and the two are usually taken side by side in our hauls, they are, to a certain extent, mutually exclusive, for in all our experience we have seldom found Calanus and *S. elegans* abundant at the same place and level; when one swarms, the other usually does not. Probably this is due to the rapacious habits of Sagitta, which, in its centers of active propagation and growth, devours the Calanus and other copepods.

The following records of oceanic and tropical species completes the list of chaetognaths: — *Sagitta maxima* (p. 138), from Station 10352, 10368, hauls from 450 meters or deeper: *Sagitta enflata*, Station 10393, surface: *Eukrohnia hamata*, Stations 10352, 10368, 10384, 10393, 500–0, and 450–0 meters.

Pteropods.[1] The warm water pteropods and heteropods so num-

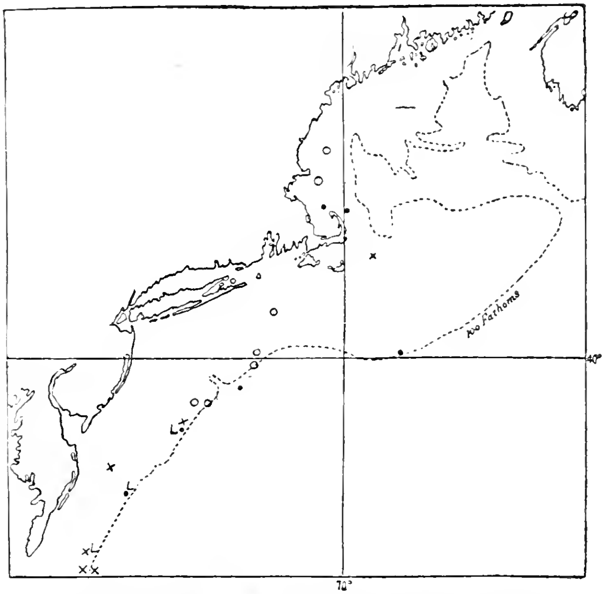


Fig. 51.— Occurrence of pteropods ● ● = *Limacina balea*, July-August. ○ = *Limacina balea*, October-November. ×, warm water species of Limacina. L, *Clione limacina*.

erous along the slope in 1913, were represented in 1916 only by one species of Limacina,[2] from Stations 10370, 10382, 50–0 meters, and 10386. The boreal *Limacina balea* (Fig. 51) occurred sparingly on the slope of Georges Bank (Station 10351) and in the Calanus zone on the Shelf south of New York (Stations 10370, 10382), as well as in the Gulf of Maine (p. 133, Stations 10342, 10344). And its presence

[1] Identified by Mr. W. F. Clapp.

[2] *L. rangii* or *L. Lesueurii*, but the condition of the specimens precludes positive identification.

in the bottom water (118–0 meters) at Station 10370 is especially interesting in view of the occurrence of the warm water Limacina in the haul from 50 meters there. In November *Limacina balea* was taken both in the Gulf of Maine (p. 135), and at practically every station from Marthas Vineyard to Delaware Bay (10406–10410), but not south of that point (10411–10417). As a whole the largest specimens were from the deepest hauls. It was taken on the surface at Stations 10406, 10408 and 10409.

Entirely unexpected, hence the more interesting, was the presence of very large specimens of the boreal-arctic pteropod, *Clione limacina* Phipps, among the Calanus off Chesapeake Bay in August (Fig. 52, Stations 10391, 10392): also off New-York (Station 10368); and off Delaware Bay (Stations 10370, 10380). The faunal significance of this occurrence is discussed elsewhere (p. 174). Clione was not taken in these waters in November, nor were any of the tropical pteropods.

Oceanic plankton. The fact, long recognized, that the 200 meter contour roughly marks the transition between coast and mixed water along our coast, and the varying proportions in which boreal and tropical-oceanic organisms mingle there, lends special interest to the plankton of this zone, tropical animals being more or less prominent in its plankton according as the inner edge of the Gulf Stream lies nearer to, or farther from the Continental Shelf. In 1913 the tropical element was well represented at our outer stations, in 1916 hardly at all, except by Salpae, apart from which the scanty catches closely reproduced the hauls off the southern Slope of Georges Bank. In fact the plankton was extremely uniform all along the Slope in 1916, except for local variations in the number of Salpae (Fig. 52). As noted (p. 138) these occurred in abundance off Marthas Vineyard; and a few *S. zonaria* and *S. fusiformis* were taken on the surface off New York (Station 10368). The former was likewise numerous both on the surface, and in the haul from 500 meters off Delaware Bay (Station 10384); while Salpae formed the bulk of the surface, 350 meter and 500 meter hauls off Chesapeake Bay (Station 10393). A large Pyrosoma, and a *Sagitta enflata* from that same Station also deserve mention, for their Gulf Stream origin.

The low temperature and salinity of the coast water, together with the scarcity of tropical fauna even over the Continental Slope points toward an even greater rarity of immigrants from the Gulf Stream into the waters over the Shelf. And in point of fact the only conspicuous plankton elements found there in August, 1916, to which this origin can be ascribed are Salpae, Physalia, and occasional fragments of Gulf weed. The former, in addition to the deep water stations just listed, were taken at Stations 10349, 10381, 10369, 10381, 10391, 10392 (Fig. 52); *i.e.*, only near its outer edge, until August 26, when they appeared near the coast off New York (Station 10394). Physalia was taken, or seen, at Stations 10369 and 10385; a single *Aglaura hemistoma* at Station 10393. Sargassum appeared twice in the tows (Stations 10353, 10393).

In November, as might be expected from the cool surface, tropical

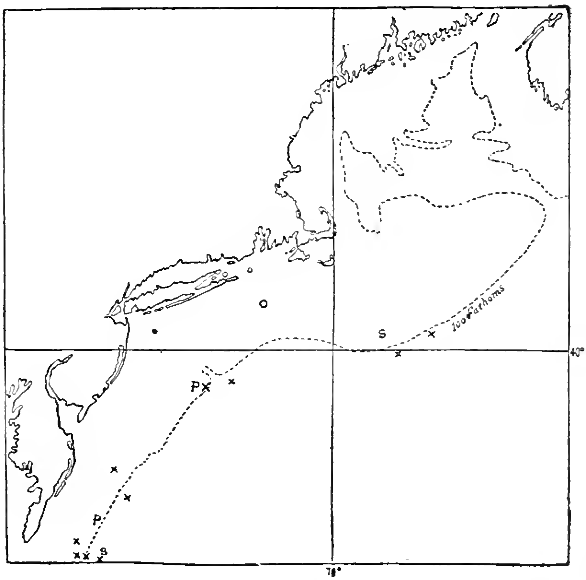


Fig. 52.— Occurrence of Salpae, July – early August (×). Late August (●). November (○). Physalia (P). Sargassum (S), July–August, 1916.

plankton elements were only occasional, the only records worth noting being the capture of many *Salpa zonaria*, near Marthas Vineyard (Station 10406, 50–0 meters, 10408 150–0 meters); a fragmentary *Rhopalonema velatum* (Station 10408, 150–0 meters), a *Physophora hydrostatica* (Station 10408, 75–0 meters), and a Phronima (Station 10408, 150–0 meters).

I may also mention the following captures of *Myctophum glaciale:* — 12 at Station 10352, 500–0 meters; 6 at Station 10368, 450–0 meters; 4 at Station 10393, 500–0 meters.

Neritic Coelenterates. Along any line normal to our northeastern coasts, four zones, characterized by rather different plankton communities, can be distinguished: *i. e.*, the neritic near the land; the true coastal water plankton occupying the greater breadth of the Shelf for at least part of the year; the plankton of the mixed water over the Slope, and the tropical oceanic plankton of the Gulf Stream still further off shore. True, these communities intergrade; but they are sufficiently distinct to afford a rough and ready working classification, and each has its important index species. In the Gulf of Maine, proper, the neritic plankton is almost negligible during most of the year, except for Pleurobrachia (if it belong in this category) and certain Medusae, the boreal coast water community occupying the water right up to the off lying islands and headlands. On the shallows of Georges Bank, however, there is a considerable neritic element (Bigelow, 1917a, p. 251). And passing south from New York we find this latter on the one hand, and tropical plankton on the other, assuming greater and greater importance in summer, while boreal plankton occupies an ever narrowing zone.

Among the neritic plankton, most conspicuous are certain coelenterates, especially the large Scyphomedusae, and ctenophores. Judging from our past experience (1915), we would expect to find the waters next the land, south of New York, supporting swarms of the latter in midsummer, particularly the genera Pleurobrachia and Mnemiopsis (Mayer, 1912). But the former was abundant at only one Station off Chesapeake Bay (10391, 40–0 meters) in 1916. Its only other records for this part of the coast for 1916 are Stations 10390, (26–0 meters), 10375 (surface) and 10394, one specimen on the surface. But it may have been more widespread, in small numbers, than these captures suggest, such a fragile organism being easily destroyed in the mass of unsorted plankton.

The chief center of abundance for *Mnemiopsis leidyi* was the same in 1916 as in 1913 (Bigelow, 1915, p. 323), *i.e.* the region off Delaware Bay. But its range (Stations 10377, 10378, 10379, 10380) was much less extensive. And only once, during the 1916 Cruise was it found in any abundance: then (Station 10379), however, it formed the bulk of the rather scanty catch on the surface, and is described in Mr. Welsh's field notes as swarming in the net from 27 meters.

A third ctenophore, *Beroe forskalii*[1] was sufficiently numerous off Chesapeake Bay to be an important factor in the plankton. It

[1] Most of the Beroes are now extremely fragmentary, but such as can be identified specifically belong to this species.

occurred at Stations 10386, 10387, 10389, 10390, 10391, both on the surface, and down to 40 meters; once (Station 10391, 40–0 meters) forming the bulk of the catch. This ctenophore was limited closely to waters within the immediate influence of the outflow from Chesapeake Bay. The fact that most of the specimens were young, whereas in July, 1913, many adults were taken off the Bay and in its mouth, is discussed elsewhere (p. 175).

Similarly associated with Chesapeake Bay water is the medusa *Liriope scutigera*, which, like *Beroe forskalii* was taken in large numbers (larval stages) off the Bay (Stations 10387, 10389, 10390, 10391), and nowhere else during the Cruise. And its dependence on land water, like that of Beroe, is interesting as well as unexpected, for not only is it independent of the bottom at all stages in development, but its relative *Liriope tetraphylla* is one of the most characteristically holoplanktonic animals (Bigelow, 1909). Neritic Medusae likewise occurred off Delaware and Chesapeake Bays in 1916 as they did in 1913; *e.g.*, *Laodicea cruciata* (Station 10390); *Aequorea aequorea* (Stations 10379, 10386, 10390); *Aequorea groenlandica* (Stations 10390, 10391); and Cyanea (Stations 10373, 10381, 10386, 10390, 10391, likewise on Georges Bank as noted, p. 137).

The occurrence of Aglantha, Mitrocoma, and Melicertum in the Gulf of Maine has already been mentioned (p. 134), as have the captures of *Periphylla hyacinthina* (p. 138, Station 10352, 500–0 meters), Aglaura (p. 157), Physophora (p. 138), and Physalia (p. 156). I need only mention, further, two specimens of *Calycopsis typa*, interesting in this connection because its range along our coast is apparently confined to the upper part of the Continental Slope (Station 10368, 450–0 meters; Station 10393, 500–0 meters).

Phytoplankton.

As yet only a hasty preliminary survey of the phytoplankton has been made: merely enough to reveal the main types and their general geographic distribution, and to identify certain of the more characteristic and faunistically important species[1] (Fig. 53).

Gulf of Maine. The phytoplankton of Massachusetts Bay and of the neighboring parts of the Gulf of Maine (Stations 10340–10346, 10398; 10400–10404) consisted almost wholly of Ceratium, not only in July but in August, and November as well.

[1] Identifications of peridinians follow Paulsen (1908); of diatoms, Gran (1908).

The mid-summer catches off Gloucester (Stations 10340 and 10341) were practically pure *Ceratium longipes* var *atlanticum;* other species of the genus being so rare, comparatively, that, if present, none were noted in the samples examined. A few *C. tripos* and *C. fusus* were however, detected in the Stellwagen Channel and off Cape Cod at this

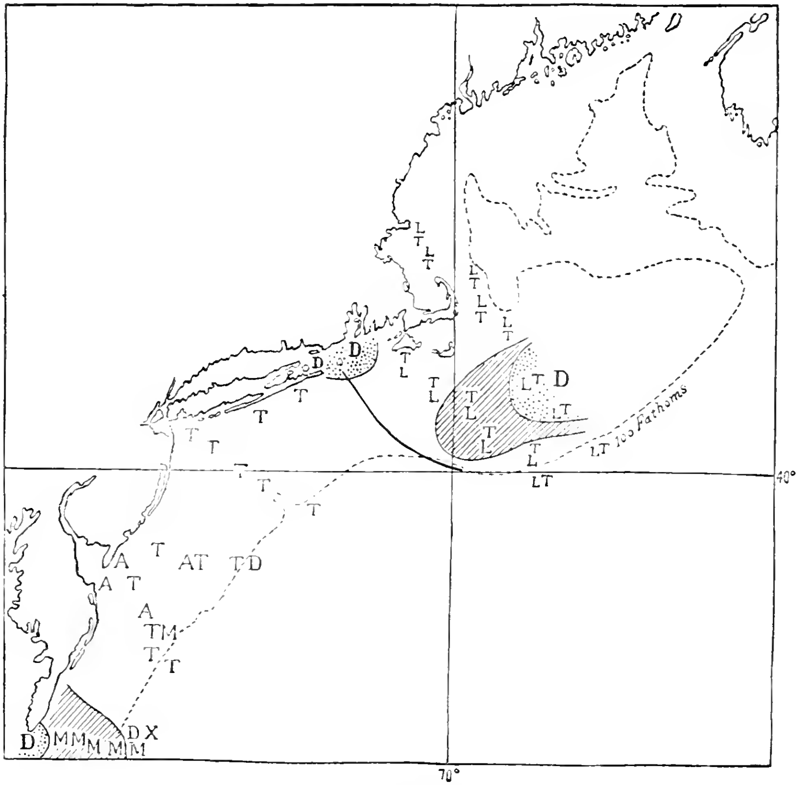


FIG. 53.— Phytoplankton communities. July–August. 1916. Dotted, diatom swarms. Single hatched, Ceratium and Diatom. Unshaded, Ceratium prevailed. $\frac{L}{T}$ *Ceratium longipes* predominates over *C. tripos.* $\frac{T}{L}$ *C. tripos* predominates over *C. longipes.* L.T., *C. longipes* and *C. tripos* in about equal numbers. T., *C. tripos*, but no *C. longipes.* M, occurrence of *C. macroceras.* D, Diatoms. A, Acanthometron. X, Trichodesmium. The curve is the western limit to *Ceratium longipes.*

season, the relative numbers in samples from these stations being two *tripos* and one *fusus* to 37 *longipes* at Station 10342: 4 *tripos* and 1 *fusus* to 40 *longipes* at Station 10344; 1 *tripos* to 40 *longipes* at Station

10345; 1 *tripos* to many *longipes* at Station 10346. At the last two Stations Peridinium occurred in small numbers; and at Station 10346 the tintinnid genus Cyttarocylis was more numerous than we have ever before found it on this side of the Gulf, a fact of some interest as this form has distinctly northern affinities. But not a single specimen of *Ceratium arcticum* was detected. The relative abundance of the two species of Ceratium, *longipes* and *tripos*, was reversed as the season advanced, the August catch yielding only about 5 of the former to 20 of the latter, with the following proportions in November samples: — Station 10400, *tripos* 12, *longipes* 6, *fusus* 1; Station 10401, *tripos* 17, *longipes* 7, *fusus* 1; Station 10403, *tripos* far outnumbers *longipes;* Station 10404, *tripos* 34, *longipes* 1, *fusus* 6. This seasonal increase in *C. tripos*, with corresponding decrease in *C. longipes*, reproduces our previous experience.

Diatoms were of no faunistic importance at any of the Gulf stations in July, August, or November (Stations 10400–10404, occasional *Rhizosolenia semispina*, *R. styliformis*, *Chaetoceras decipiens*).

Georges Bank to New York. The several Cruises of the Grampus show that the waters over Georges Bank are fertile in diatoms even in midsummer, though the precise locations where the diatom swarms have been encountered as well as their qualitative composition have differed from season to season. In 1913, diatoms swarmed on the western part of the Bank; in 1914, however, this region was occupied by a Ceratium plankton with but few diatoms, whereas the latter abounded on its northeast part. In both these years the bulk of the diatom catch in each case was Guinardia, with smaller numbers of *Rhizosolenia styliformis*, Chaetoceras, etc. But in July, 1916, when the Grampus encountered a diatom swarm at about the same location as that of 1913 (Stations 10347, 10348), Guinardia was not detected at all, the catch at the more northern of the two Stations (10347) consisting chiefly of the long, rod-like and easily recognizable *Thalassiothrix longissima* with *Rhizosolenia styliformis*, another unmistakable species, playing a minor rôle, while at Station 10348 the latter in connection with *R. shrubsolei* and an occasional *R. obtusa*, about equaled Thalassiothrix in abundance. But even here there were many Ceratium among the diatoms, (*C. longipes* and *C. tripos* in about equal numbers, with occasional *C. fusus*).

This seems to have been about the western limit of the diatom swarm at this time (no autumn records are available for Georges Bank) for at the outer stations ont he midsummer section next to the west (Stations 10352–10355) Ceratium (chiefly *C. tripos*, with occasional *C. longipes*, and only very few diatoms (the species just listed with *Chaetoceras decipiens* and others of that genus) played more nearly equal rôles. And as the GRAMPUS drew near land (Stations 10356, 10357) Ceratium predominated once more. At Station 10356 the relative abundance of *C. tripos* to *C. longipes* was about 15 to 1, with occasional *C. fusus*. And this type of plankton evidently persisted off Marthas Vineyard through early autumn, for the GRAMPUS again found *Ceratium tripos* dominant over the outer part of the Shelf in November (Stations 10406–10408), with an occasional *C. longipes* nearer land (Station 10406[1]). Diatoms, however, dominated the catches close in to the coast off Narragansett Bay both in July (Station 10359) and in November (Station 10405); on the former occasion chiefly several species of Chaetoceras with *Asterionella japonica;* on the latter chiefly Guinardia. And we then found diatoms (Guinardia, *Rhizosolenia alata*, *calcar-avis*, *styliformis*, and Coscinodiscus in small numbers out to the edge of the Shelf (Stations 10408, 10409).

New York to Chesapeake Bay. There is a hiatus in the summer stations between the lines off Marthas Vineyard and off New York. But probably this stretch of coastal water supported a Ceratium, not a diatom plankton, in July and August, as it did in November, for the very scanty summer catches off New York (Stations 10362, 10368) consisted chiefly of *C. tripos* (no *longipes* occurred as far west as this), together with a tintinnid, not yet identified, diatoms (Chaetoceras) being only occasional. A very scanty mixed phytoplankton of this same type occurred off Delaware Bay (Stations 10370, 10375, 10379, 10380–10384), mingled locally (Stations 10373, 10380) with the radiolarian Acanthometron, the latter, together with metazoan larvae and debris forming the bulk of the catches off its mouth. The off-shore hauls (Stations 10381–10384) off the Bay likewise yielded a few diatoms (chiefly species of Rhizosolenia).

It was on this line that the first examples of the warm water *Ceratium macroceras* were detected in August (Station 10381). And this species played the major rôle in the very scanty catches on most of the Shelf and over the slope off Chesapeake Bay (Stations 10389–10393), with a few diatoms, notably *Climacodium biconcavum*, at Station 10393. This locality was further interesting as yielding an occasional Trichodesmium, a tropical alga usually common in the surface waters of the inner edge of the Gulf Stream. And Acanthometron swarmed off the mouth of the Bay (Station 10389) among the megalops stages of the blue crab (Callinectes) so common there. At

[1] This is its most southerly record.

its entrance (Station 10387), however, the GRAMPUS made a rich haul of diatoms, chiefly *Rhizosolenia obtusa* with occasional Chaetoceras, *Thalassiothrix nitschioides*, Ditylium and others not as yet identified; with a few *Ceratium tripos* and *C. macroceras.*

Ceratium macroceras had spread northward over the Shelf as far as the latitude of Delaware Bay by November (Stations 10409, 10410, 10412, 10414–10416), where it then occurred side by side with *C. tripos*, occasional *C. bucephalum* (Station 10409), *C. heterocamptum* (Station 10410), and with Peridinium. But the most striking autumnal change which took place in the phytoplankton south of New York was a November flowering of diatoms, in which Bacteriastrum, a genus decidedly rare in summer, and *Rhizosolenia alata* predominated, with smaller amounts of such other forms as *R. styliformis*, *R. shrubsolei*, *Coscinodiscus subbulliens*, *Nitschia seriata*, Stephanopyxis, and Chaetoceras. Its center of abundance was over the middle of the Shelf (Stations 10412, 10413, 10416), where large catches were made; and these diatoms were the most important element of the plankton as far off-shore as Stations 10410 and 10415. But Bacteriastrum was not detected at the outermost Stations (10409, 10414), although *Rhizosolenia alata* occurred there in numbers.

Finally, I may mention the capture of swarms of the large and conspicuous cystoflagellate, *Noctiluca miliaris*, in November at the mouth of Chesapeake Bay (Station 10417), a record valuable because while this form is known from our coasts (Ostenfeld, 1913), it has not previously been encountered on the GRAMPUS cruises. This Station also yielded numbers of *Dinophysis homunculus*, Peridinium, *Ceratium macroceras*, *C. tripos*, and *Rhizosolenia alata*, among the metazoan larvae and debris to be expected there.

GENERAL CONSIDERATIONS.

From the oceanographic standpoint our coastal waters fall into three natural divisions, first the Gulf of Maine, second the outer edge of Georges Bank and off Nantucket, third the Shelf water south of New York, each being subject to its own peculiar set of hydrographic influences; through in 1916 all differed in the same way, *i.e.* in low temperature and salinity, from the summer state as we have previously found it.

In the Gulf of Maine the temperature of the upper 100 meters or so of water is governed chiefly by the chilling caused by rigorous winter climate and by the influx of cold water from the Cabot Current balanced against local solar heating in spring and summer and the warming influence of the influx of off-shore water into its eastern side. And since the Gulf lies to leeward of the continent it is its western part that is most responsive to climatic influences.

During the only year for which the early spring temperatures taken below the surface have been recorded (Bigelow, 1914b) for this region, the surface water commenced to warm early in March, under the influence of the sun, and by the end of that month the temperature of the upper 50 meters had risen from about 2.78° to about 4°. But in 1916, March [1] was so cold throughout New England, with snowfall so heavy, that it is doubtful whether even the immediate surface warmed appreciably until a month later. And undoubtedly solar warming of the sea proceeded more slowly than usual, for the weather continued abnormally cool and cloudy throughout May and June.

Climatic conditions thus indicate low sea temperatures in Massachusetts Bay for the summer of 1916, nor was the difference actually observed there between that and other years greater than can be explained so. And this probably applies equally to the upper 100 meters off Cape Cod (Stations 10344–10346), though there the precise annual relationship is masked by vertical circulation of varying activity at the several stations with resulting differences in the temperature gradients. Possibly some unusual westward flow of the Cabot Current also exerted a chilling effect on the surface waters of the Gulf in 1916. But with the few stations for that year all in the western side of the latter, evidence is lacking to either prove or disprove this suggestion.

The deeps of the Gulf are insulated from the direct influence of air-climate, being protected from the penetration of summer heat by the stable state of the water at that season (p. 126); from winter cold by depth (it is unlikely that the effect of a single winter's chilling reaches deeper than say 100–150 meters). And similarly such part of the cold Cabot Current as enters the Gulf floats on the heavier water it meets there. Hence it is not these factors directly, but variations in the amount and temperature of the indraught *via* the bottom of the eastern channel, which govern the temperature of the deeps within. In 1916 this indraught must either have lagged behind its normal schedule, or have been both cooler and fresher than usual, the very low temperatures prevailing along the Continental Slope of Georges Bank (p. 101), pointing to the latter.

[1] The mean temperature for March, 1916, at Boston was about 4.4° F., for April, 1° F., below normal; the March snowfall was 33 inches, according to the U. S. Weather Review.

More interesting than these slight annual fluctuations, and far more important in its bearing on oceanic circulation, is the apparent tendency of the bottom water of the Gulf to maintain one or other of the two alternate states, *i.e.*, to be either of about the same temperature as the cold mid-layer, or warmer and much salter, for a period of years, the prevalence of one or the other state probably depending upon the amount of water flowing in over the bottom. But until we have fuller data, I may simply call attention to this phenomenon, at the same time pointing out that a similar periodicity in the volume of the inflowing bottom current characterizes the Baltic (Knudsen, 1909, p. 48).

Georges Bank, from its geographic location, is less subject to the influence of land climate than is the western side of the Gulf, and obviously, land water can reach it only indirectly, *via* the general outflow from the western side of the latter. On the other hand, the warm salt waters of the Gulf Stream lie but a few miles south of the Bank, while the icy temperature and low salinity of the Cabot Current are close at hand, on the east. And so diametrically opposite are these currents in physical characters and origin that violent fluctuations in the salinity and temperature of the Bank water may be expected to follow any changes in their location.

Up to the present time, no detailed study of the seasonal, or annual hydrographic fluctuations has been attempted over a long period for any oceanic region on the western side of the Atlantic, such, for instance as Jee (1919) has made for the area centering at Latitude 50° N., Longitude 20° W. But it has long been known that the geographical location of the inner edge of the Gulf Stream does change from season to season, even from week to week (Libbey, 1891, 1895). Hence there is nothing surprising in the fact, demonstrated by salinity as well as by temperature, that the Stream, (*i.e.*, water salter than 35‰) did not touch the slope of Georges Bank at all in July, 1916, whereas two years earlier it then bathed the bottom along its whole length between the 100 and 200 meter contours (Bigelow, 1917a, fig. 37): nor does it involve any inherent improbability to turn to a current from the northeast for the original source of the very cold water encountered in its place (p. 103).

Winter cooling *in situ* being of slight effect here because of the distance from land, the only other possible origins for water so cold in this geographic location are upwelling from the Atlantic abyss, or outflow from the Gulf of Maine. And the first of these alternatives can be dismissed at once, both because the water in question was much too fresh to accord with abyssal origin, and because none of our profiles, either for 1913, 1914, or 1916, suggest that any updraught from the abyss ever reaches the upper layers along this zone, though it may be an important phenomenon in the deeps below 400 meters (Bigelow, 1915, p. 256; 1917a, p. 240, 1917b, p. 49); nor has the second possible explanation much to recommend it, for at the time of the Cruise the cold band on Georges Bank was entirely cut off from the equally cold bottom of the Gulf by an area of warmer but fresher water.

It agrees with the facts much better to credit a northern origin to the cold band. To begin with, the latter agreed both in temperature and in salinity with the mixture of Cabot Current and ocean water which is in constant process of manufacture off Cape Sable during late spring and summer; hence so far as its physical characters go, might well be a direct continuation of the latter. And this possibility is further supported by our observation that the salinity of the coldest water off Georges Bank, and off Nantucket, was almost exactly the same in 1916 as in 1913 and in 1914 (33.4‰–33.6‰), though its precise temperature varied from year to year (p. 102). Furthermore it is now established that one branch of the Cabot Current does flow past Cape Sable in May, when it has been detected as far west as longitude 67° W., another turning southward off the Cape, to cross the Shelf only eighty miles east of Georges Bank. Nor is there anything novel in the discovery of a cold band on the Bank itself, for not only have similar phenomena been known for many years south of Nantucket, but the GRAMPUS encountered a similar, though not so cold a band, extending its whole length from northeast to southwest in 1914.

The facts that the cold band of 1916 lay almost exactly in the prolongation of that of 1914; that a similar streak of comparatively low temperature (6.4°) was encountered at the same relative position on the Shelf some 60 miles further west in 1913 (Station 10062); and that the axis of the coldest water noted on the Shelf south of Nantucket in 1889 (Libbey, 1891), merely prolongs this general zone, practically amount to proof that a northeast to southwest flow of cold water takes place there annually, in late spring or summer, dovetailing in between the warmer, fresher Bank water on the north and the Gulf Stream on the south. But though this band is cold by comparison with the higher temperatures on either side, it is so much warmer than the Cabot Current abreast of Cape Sable that it can not be considered a direct off-shoot of the latter, but rather the result of its combination, *en route*, with warmer water, the mixture taking place over the Slope south of Cape Cable, to judge from the unity between the temperatures and salinities encountered there by the GRAMPUS in 1914 and 1915, and those of the cool band on Georges Bank.

There is of course, another conceivable source for cold northern water off our coast; one which has often been invoked, *i.e.*, the Labrador Current. But this may be dismissed in few words, there being no actual evidence, either in salinity, or temperature, that it ever makes itself felt so far south and west, except as a constituent, *via* the Gulf of St. Lawrence, of the Cabot Current. The possibility that temporary southwest off-shoots of the Labrador Current may occasionally reach our coast banks is always open. But until records of such are obtained, it is idle to discuss them; certainly needless to invoke them to explain temperature phenomena which would necessarily result from a very slight western extension of the Cabot Current.

Why Cabot Current water was so much more evident on Georges Bank in 1916 than in 1889, 1913, or 1914 is an open question. But I may point out that the observed phenomena would as well result from a failure of the Gulf Stream to approach the coast as closely as usual, or to a delay in this process until unusually late in the season, as from an unusually great flow from the northeast.

The only systematic survey of the coastal water south of New York previous to 1916 was made in 1913; a year which may have been as abnormal in one direction as 1916 was in the other. But limited though our work here has been, it is enough to show that subsurface temperatures and salinities along this part of the coast depend largely on the varying influence of the Gulf Stream; both, particularly the latter, being high where its inner edge encroaches on the Shelf, low elsewhere. The low salinities of 1916, along the Continental Slope, and over the outer part of the Shelf, can be so explained, for the warm salt current failed to approach the latter at all during the early summer of that year. And to the same cause can be credited the low temperature of the upper layers over the Slope as compared with 1913. But this explanation does not account for the hydrographic difference between the two years along shore, where Gulf Stream water was no more in evidence in 1913 than in 1916.

The three origins possible for cold coast water south of New York are upwelling; a cold northern current; or winter cooling due simply to low air temperatures with heavy snowfall during the preceding months. And widespread upwelling is as certainly ruled out from New York south as for Georges Bank (p. 165), both because the salinity of the cold water in question (32.6‰, p. 112) is far below that of the abyss (about 35‰), which is here the only possible source of such a submarine spring, and because none of our profiles off this part of the coast, winter or summer, suggest that abyssal water ever floods the Shelf, although it may flow up the Slope to within 400 meters or so of the surface.

If temperature by itself could be relied upon as an index to the origin of the cold band south of New York the latter might be explained off hand as the westward and southward continuation of the cold water off Georges Bank. Indeed it is likely that these two cold regions were actually continuous so far as their temperatures were concerned (there is a gap in the summer data from abreast of New York to Nantucket). But unity of temperature no more demands unity of origin in this case, than as between the western part of the Gulf of Maine and the cold water off Nantucket, because abnormal winter cooling would produce exactly the same result in this respect as an influx of cold northern water. In fact, the unity was not shared by salinity, the coldest water being about 1‰ fresher (32.6‰) south of New York than off Nantucket and Georges Bank (33.6‰). Such an east-west drop in the salinity of a northern current could of course result from its dilution by fresher coastal water encountered in its course. But in that case we would expect a progressive freshening from northeast to southwest, instead of the sudden dislocation, followed, by a zone of practically uniform salinity some 200 miles long, actually encountered. Furthermore, mixture of a cold northern current with coast water would necessarily raise its temperature while lowering its salinity, unless the latter were already as cold as the former.

Temperatures and salinities thus forbid the idea that the cold water south of New York was a simple continuation of the cold band further east, *i.e.*, the offspring of the Cabot Current, though the latter may have contributed in small measure to it. And to assume a possible extension of Labrador Current is even more far-fetched, there being no actual evidence in that direction.

A simpler explanation is that the low temperature south of New York, like the cold mid-layer in the Gulf of Maine, was merely reminiscent of the winter cooling which takes place every year in these latitudes on this side of the Atlantic. Unfortunately it is only for the surface that the winter temperature of the coastal waters south of New York has been systematically recorded. But the fact that the whole column of water off the mouth of Chesapeake Bay was chilled to 6°–7° as early as January, both in 1914 and in 1916, *i.e.*, at least a month before the winter minimum is to be expected, suggests that the water there was probably at least as cold as 4° in February. Similarly, the surface at various localities near land along this part of the coast, (Rathbun, 1887) was as cold as this or colder, both in December, and at the end of the winter, for the four years 1881–1884, with readings as low as 1.6°–6.5° at "Winter Quarter," and "Five Fathom Bank" lightships off Delaware Bay in March[1] which suggest a general winter minimum of say 2°–4°. And this probably applies equally to the whole column of water over the inner part of the Shelf from New York south to Chesapeake Bay, it being the general rule, on both sides of the Atlantic, that in the coldest months the temperature of the coastal water is practically uniform, vertically, from the surface down to 50 meters or so.

The data on variation of surface temperature recently collected by the International Committee for the Exploration of the Sea (Conseil, 1919) do not throw much light on this question, because given not for individual stations but for oceanic squares, that in question covering the whole area from Lat. 37° N. to Lat. 40° N., and from Long. 73° W. to Long. 77° W.; including, that is, not only the immediate coastal water, where winter chilling is extreme, but also the much warmer edge of the Gulf Stream. Even for this square, however, the average February temperature is given as 6.6°; that for February, 1910, as 3.4°.

Rathbun's (1887) records showed, and the more recent data by Dickson (1901), Matthews, (1907) and the International Committee, (1919), confirm, that winter temperature varies considerably from year to year, 1885 and 1910 being cold, 1881 and 1882 warm seasons. And in so far as the climate of the neighboring land mass is responsible for winter cooling, we might expect 1915–1916 to be another such cold winter in the coastal water south of New York as well as in the Gulf of Maine (p. 164), for not only was the mean air temperature lower than normal, but the snowfall was much greater, whereas the winter of 1912–1913 was warmer, and with less snow, than usual as illustrated by the following tables: —

	Temperature (Fahrenheit) departure from normal			Snowfall, inches		
1916[2]	Feb.	Mar.	Apr.	Feb.	Mar.	Apr.
New York	−3.°	−5.3°	− 1°	11.4	23.8	3.3
Cape May	−1.3°	−5.5°	+.4°	6.1	10.3	.01
Norfolk	− .7°	−3.6°	0	6.4	2.5	

[1] No temperatures were recorded for January or February of those years.

[2] Compiled from the U. S. Weather Review.

1913 [1]	Temperature (Fahrenheit) departure from normal				Snowfall, inches			
	Jan.	Feb.	Mar.	Apr.	Jan.	Feb.	Mar.	Apr.
New York	+ 9.8°	+ .2°	+6.5°	+2.9°	3	2.4	1	trace
Cape May	+ 9.1°	+1.5°	+4.2°	+ .5°	0	.8	0	0
Norfolk	+10.8°	+1.2°	+2.6°	+1.4°	0	1.2	0	0

The annual variation in snowfall deserves emphasis, for not only was there about six times as much snow at New York in 1916 as in 1913, but the heaviest fall took place at just the season (March) when spring warming ordinarily commences in the waters along shore.

It is during just such a spring as this, when the melting of the snow in the mountains back from the coast is not completed until late in the season, that the cold discharges from the Hudson and Connecticut Rivers, and from Delaware and Chesapeake Bays, may be expected to retard the normal spring warming of the waters off their mouths. And while they probably are not as important a factor in this respect as Tizzard (1907) supposed, temperatures taken by the U. S. Bureau of Fisheries in Chesapeake Bay during March, 1916, show that they do so function to some extent, for the whole column of water, in its deeper parts, was still only 3°–4° on the 6th and 7th of the month. Consequently, whether or not the minimum winter temperature of the coastal water was lower in 1916 than usual, we have good reason to assume that spring warming was abnormally delayed in the water next the land by climatic conditions during that spring, quite apart from any possible influence by northern currents.

Unfortunately we have no data on the rate with which spring warming, so rapid on the surface, normally penetrates downward into the deeper levels off this part of our coast with the advance of the season. This, since the downward propagation of solar heat by radiation is very slow (except in the uppermost layer) in sea water at rest (Krummel, 1907–1911; Murray & Hjort, 1912), by conduction negligible, depends chiefly on how actively the water is stirred by vertical currents, which in turn is governed by tides, currents, and the degree of stability of the water. And the weakness of the former (the rise and fall of the tide being only 3–4 feet), suggests that in the coastal waters south of New York it is principally the latter which governs,

[1] Compiled from the U. S. Weather Review.

and which therefore deserves chief consideration here. Now the stability of any column of sea water depends, of course, on the vertical distribution of density, and in winter, owing to uniformity of salinity and temperature, the density of our boreal coastal waters is practically uniform from the surface downward, *i.e.*, the water has no inherent stability, but is free to respond with vertical movements to any local disturbance. But as the surface warms, and is freshened by water from the rivers in spring, it becomes lighter than the underlying layers, a change continuing until summer, when the water is so stable that vertical currents are hindered, if not prevented, and the deeper layers insulated from temperature influences from above. The efficacy of this process depends on the precise interrelation between tidal and other currents on the one hand, and the vernal warming and freshening to which the surface is subject on the other. Wherever the former are weak, the latter rapid and considerable, surface density decreases so rapidly in spring that the column of water soon becomes extremely stable. And this is especially true if vernal warming be sudden, for if more gradual, stability may at no time be sufficient to hinder vertical mixing seriously, even though a greater amount of heat be absorbed by the water during the season. Hence, paradoxical though it appear, the more rapidly the surface is warmed by the sun with the advance of spring, the less can this solar warming penetrate downward.

This generalization is admirably illustrated in parts of the Gulf of Maine; even better in the southern part of the Gulf of St. Lawrence where though the surface warms to 18° by midsummer, the temperature only some 50 meters down hardly rises at all (Dawson, 1913, Krummel, 1907–1911, Bjerken, 1919).

The extreme vertical stability prevailing in summer in the coastal zone south of New York may similarly be expected to preserve the temperature of winter below 40–50 meters, until late in the season, unless warmed by an influx from the inner edge of the Gulf Stream, which never lies far outside the Continental Slope. And evidence that this insulation of the deeper layers is actually effective there is afforded by the fact that the temperature rises only very slowly at such a trivial depth as 30–40 meters, even as late as August, unless influenced by the Stream. For example there was no appreciable change in bottom temperature (8.3°–8.5° at 35–40 meters) from July 12 to August 1 in 1913, off New York (where the unchanged salinity showed that no important change had occurred in the composition of the water), though the surface was then very warm (19.4°–23.3°). And the 20–30 meter temperature was correspondingly constant at the same general locality, in 1916, warming only by about 1° from August 1 (Station 10363) to August 26 (Station 10394), though the surface temperature was then at about its annual maximum. And if the course of events be disturbed by the Gulf Stream, the event is at once betrayed by a rise in salinity, as well as in temperature. Consequently, in any year when the Stream does not encroach on the Continental Shelf until August or later, the vertical distribution of summer temperature in the coast water would naturally be of just the type which prevailed in July and August, 1916, *i.e.*, a very warm surface, sudden cooling down to 30–50 meters, with little if any further cooling from that level down to the bottom in 60–70 meters.

Inasmuch as the temperature of the cold water on the Shelf south of New York was not so low, in the summer of 1916, as the probable minimum of the preceding winter (p. 169), the difference between that summer and 1913 is not too great to be accounted for as simply the result of a cold winter, with heavy snowfall and tardy spring, coupled with a failure of the off-shore water to encroach on the Shelf as it did in 1913. Further support of this contention is afforded by the comparative narrowness of the cold band from New York southward, *i.e.*, its limitation to a strictly coastal zone, which did not even reach the outer edge of the Shelf on the bottom (p. 113). And while the possibility that northern water was partly responsible for its low temperature is open, the observed phenomena do not demand it.

It is clear that the precise salinity of this part of the coastal zone depends on the relative amounts of off-shore water on the one hand, and of river water on the other, which annually, or periodically mix there. But the low salinity of the water along shore south of New York for 1916, as contrasted with 1913, does not necessarily mean that the influx of land water was greater during the one spring than during the other, for it is not unlikely that the salinities at any particular time are the result of conditions prevailing during the preceding year, or even earlier. In waters subject to such diverse influences, fluctuations in salinity are to be expected. And until we have a more nearly continuous record of them it is idle to do more than record them, and to point out the major causes on which they depend.

We have yet to consider whether the plankton catches substantiate the general conclusion, reached above, that both in the Gulf of Maine, and in the coastal water south of New York, the low temperatures of 1916 were mainly due to local causes, whereas the cold band off Georges Bank was a product of the Cabot Current.

The total absence, in the Gulf, of the easily recognized Arctic faunal component which the Cabot Current carries with it, the presence or absence of which, in the eastern side of the Gulf and off Nova Scotia, coincides very closely with the expansion and contraction of the Current, does not suggest that there was more northern water in 1916 than usual. True, several of the more important Arctic "index" species, *e.g.*, Mertensia, *Limacina helicina*, and *Oikopleura vanhöffeni*, are so delicate that their absence at any particular time does not necessarily have any bearing on conditions some months earlier. But this objection does not apply to the copepods *Calanus hyperboreus*, and *Metridia longa*, so abundant further north (Willey, 1919). Nor were the microscopic members of the Gulf of Maine plankton any more Arctic in 1916 than usual.

Though our previous studies of the zoöplankton of the Gulf have not been sufficiently intensive to allow an exact seasonal comparison from year to year, they suggest that in 1916 the plankton retained up till midsummer features usually characteristic of May and June; just what might be expected if the low temperature of that year was simply due to the cold preceding winter and spring, the occurrence of the medusa *Mitrocoma cruciata* pointing, in particular, in this direction, for in 1915 it was comparatively abundant in May and June, disappearing in summer (Bigelow, 1917a, p. 305), whereas in 1916 it was taken in some numbers in July (Station 10340, p. 133). Furthermore, the microplankton of July, 1916 closely paralleled the June hauls of 1915 in the abundance of *Ceratium longipes*, scarcity of *C. tripos*, and total absence of *C. arctica*.

The plankton of the cold water off Georges Bank contained no Arctic indicators (p. 137). But apart from a few tropical forms, evidently stragglers from the Gulf Stream, it closely paralleled, as did its temperature and salinity (p. 103, 104) catches made in the mixed water off Cape Sable in July, 1914, the latter being no more Arctic than the former at that season, though several conspicuous Arctic forms have been found there in June (Bigelow, 1917a, fig. 81). And the facts that the microplankton of this cold band was not Arctic, as it was not tropical; and that while the diatoms on Georges Bank were more northern in their affinities in 1916 (*Thalassiothrix longissima*) than in 1914 (Guinardia) they were combined with characteristic temperate species (*Rhizosolenia styliformis*, *R. shrubesolei*), are equally strong evidence that the cold band was not a direct, but an indirect, expansion of the Cabot Current.

If my explanation of the low temperature south of New York as reminiscent of seasonal cooling during the preceding winter be correct, the plankton might also be expected to reproduce conditions prevailing some months earlier in warmer years. And that such was the case is indicated by the fact that Rathbun (1889) long ago recorded a typical boreal community, in fact much what we find in the Gulf of Maine, at many localities on the outer part of the Shelf between the latitudes of New York and of Chesapeake Bay, in April and May of 1887. For the details of the catches I refer to the original account, merely emphasizing here the abundance of Calanus, Centropages, Temora; the frequent captures of Euthemisto, euphausiids, Limacina, and *Clione limacina*. Similarly boreal in composition are two plankton samples collected by Capt. John McFarland of the fishing schooner VICTOR, May 3 and May 9, 1913, at 38° 45′ N. Lat.; 73° 52′ W. Long., and 38° 49′ N. Lat., 73° 38′ W. Long. respectively (*i.e.*, near the location of Station 10373). And Fowler's (1912) report of Calanus abounding along the New Jersey coast in June, 1911 and early July, 1912 shows that it is usually an important factor in the plankton community of this section of the coastal water until well into the summer. The fact that the Calanus swarm of 1916 was composed of large adults, hence was the result of a wave of reproduction which took place earlier in the season, likewise points to the conclusion that our August catches in 1916 were just what might be expected in a tardy season; they do not suggest that the pelagic community was immigrant from the colder seas to the north.

A possible exception to this generalization is the presence of *Clione limacina* off Chesapeake Bay, it being usually considered an Arctic form. But although Clione is widely distributed in New Foundland waters and in Arctic seas generally (Damas and Kofoid, 1907, Murray & Hjort, 1912), it is not a safe indicator of Arctic water, being at times abundant in Atlantic water, *e.g.*, south of Ireland (Massy, 1909, Murray and Hjort, 1912). While essentially it is a northern form on our Atlantic coast, usually occurring but sparsely even in the Gulf of Maine, seldom further south, it has occasionally been encountered there in swarms (Wood, 1869); and it has already been recorded as far south as the coast of Virginia (Rathbun, 1889, Dall, 1889). In all probability such local occurrences as that of 1916 are the result of temporary breeding activity, under rarely favorable conditions, of such few specimens as from time to time stray southward past Cape Cod, not of a direct immigration, *via* any Arctic Current. And support is lent to this conclusion by the fact that Clione larvae were taken at Station 10386, side by side with the adults.

The neritic plankton along the coast affords some further evidence of a tardy season, the limitation of the swarms of Pleurobrachia and Mnemiopsis (p. 158) to small areas, and the juvenile state of the Beroe off Chesapeake Bay, being most readily explained on this basis.

The scanty microplankton of the coastal water south of New York is easily reconciled with this, for it not only lacked Arctic indicators, but closely reproduced what we found here in 1913, if the tropical elements so conspicuous in that year be excluded.

The limits of Gulf Stream water off our coasts are usually as clearly outlined by its inhabitants as by its temperature and salinity; sometimes, indeed, more so, the former often surviving after its characteristic physical features have been obliterated by mixture with other waters. The scarcity of tropical plankton organisms in the summer of 1916 (p. 156), contrasted with their abundance in 1913, shows as clearly as do the low temperatures and salinities of that year, that the inner edge of the Stream lay some distance outside the Continental Slope.

TABLE OF STATIONS.

Station	Lat. N.	Long. W.	Date	Depth meters	Depth of plankton hauls, meters
10340	42° 32′	78° 38′	July 19	50	0, 30–0, 45–0.
10341	42° 18′	70° 27′	" 19	83	0, 30–0, 80–0, 83–0.
10342	42° 07′	70° 17′	" 19	60	0, 55–0, 60–0.
10343	Provincetown Harbor		" 20	30	0, 15–0, 30–0.
10344	42° 07′	69° 59′	" 22	88	0, 40–0, 80–0, 88–0.
10345	41° 52′	69° 40′	" 22	150	0, 100–0, 150–0.
10346	41° 27′	69° 22′	" 22	62	0, 30–0, 62–0
10347	41° 06′	68° 51′	" 23	78	0, 50–0, 60–0.
10348	40° 49′	68° 21′	" 23	51	0, 30–0, 45–0, 50–0.
10349	40° 15′	68° 05′	" 24	190	0, 130–0, 180–0.
10350	40° 23′	68° 15′	" 24	118+	None.
10351	40° 06′	68° 57′	" 24	182	0, 160–0.
10352	40° 00′	68° 44′	" 24	1000+	0, 500–0.
10353	40° 14′	69° 08′	" 25	110	0.
10354	40° 26′	69° 24′	" 25	76	0, 60–0, 70–0.
10355	40° 43′	69° 53′	" 25	36	0, 16–0.
10356	40° 57′	70° 18′	" 26	32	0, 10–0, 30–0.
10357	41° 11′	70° 44′	" 26	29	0, 20–0.
10359	41° 18′	71° 20′	" 28		0, 5–0.
10361	41° 04′	73° 02′	" 29	27	0, 20–0.
10362	40° 22′	73° 38′	Aug. 1	25	0, 10–0, 25–0.
10363	40° 13′	73° 21′	" 1	32	0, 20–0, 30–0, 32–0
10364	40° 01′	72° 56′	" 1	45	0, 40–0, 45–0.
10365	39° 41′	72° 39′	" 2	61	0, 50–0, 60–0.
10366	39° 40′	72° 23′	" 2	91	None.
10367	39° 34′	72° 01′	" 2	239	None.
10368	39° 33′	71° 53′	" 2	500+	0, 450–0.
10369	39° 21′	72° 29′	" 3	137	0, 137–0.
10370	38° 55′	72° 54′	" 3	118	0, 50–0, 118–0.
10371	38° 56′	73° 06′	" 3	84	0.
10372	38° 57′	73° 20′	" 3	75	None.
10373	38° 57′	73° 35′	" 4	62	0, 60–0.
10375	38° 59′	74° 08′	" 4	41	0, 40–0.
10376	Cape May Harbor		" 7	10	0, 5–0.
10377	38° 54′	74° 44′	" 10	16	0, 16–0.
10378	38° 48′	74° 53′	" 11	14	0, 14–0.
10379	38° 46′	74° 35′	" 11	27	0, 27–0.

Station	Lat. N.	Long. W.	Date	Depth meters	Depth of plankton hauls, meters
10380	38° 27′	74° 25′	Aug. 12	42	0, 35–0.
10381	38° 09′	74° 12′	" 12	69	0, 25–0, 69–0.
10382	37° 55′	74° 05′	" 12	120	0, 50–0, 120–0.
10383	37° 52′	74° 04′	" 12	175	None.
10384	37° 46′	74°	" 12	500+	0, 250–0, 500–0.
10385	37° 28′	74° 25′	" 13	140	None.
10386	37° 03′	74° 58′	" 13	62	0 45–0.
10387 [1]	36° 52′	75° 48′	" 21	13	0, 12–0.
10388	36° 51′	75° 38′	" 21		None.
10389	36° 50′	75° 27′	" 21	19	0, 18–0.
10390	36° 49′	75° 14′	" 21	26	0, 26–0.
10391	36° 48′	74° 55′	" 22	40	0, 40–0.
10392	36° 47′	74° 37′	" 22	82	0, 75–0.
10393	36° 46′	74° 29′	" 22	500+	0, 250–0, 500–0.
10394	40° 15′	73° 08′	" 26	42	0, 42–0.
10395	40° 32′	72° 44′	" 26	38	0, 38–0.
10396	40° 50′	72° 07′	" 26	29	0, 29–0.
10398	42° 10′	70° 09′	" 29	45	0, 35–0
10399	42° 30′	70° 21′	Oct. 31	137	0, 60–0.
10400	42° 58′	70° 14′	Nov. 1	142	0, 90–0.
10401	42° 37′	69° 46′	" 1	219	0, 90–0, 180–0.
10402	43° 37′	69° 15′	" 2	144	0, 50–0.
10403	42° 16′	70° 12′	" 8	32	0, 25–0.
10404	41° 53′	69° 37′	" 8	183	0, 150–0.
10405	41° 17′	71° 03′	" 10	36	0, 25–0.
10406	40° 37′	71° 19′	" 11	69	0, 50–0.
10407	40° 03′	71° 43′	" 11	93	0, 75–0.
10408	39° 52′	71° 47′	" 11	183	0, 75–0, 150–0.
10409	39° 10′	72° 41′	" 12	140	0, 80–0, 135–0.
10410	39° 10′	73° 01′	" 12	76	0, 76–0.
10411	Off Delaware Capes		" 16	16	0, 15–0.
10412	38° 14′	74° 39′	" 16	34	0, 34–0.
10413	37° 44′	74° 35′	" 17	56	0, 56–0.
10414	37° 15′	74° 30′	" 17	146	0, 140–0.
10415	37° 12′	74° 42′	" 17	91	0, 91–0.
10416	37° 06′	75°	" 17	41	0, 41–0.
10417	36° 59′	75° 41′	" 17		0.

[1] Approximate position.

TABLE OF TEMPERATURES, SALINITIES AND DENSITIES.

The salinities for the July–August Cruise were determined during the following autumn, and are, I believe, reliable within the usual limits of the titration process. But owing to the interruption of all oceanographic work by the war, the water samples from the November Cruise were not titrated until the summer of 1919. For this reason, and also because I believe, from experiment, that the standard water with which the titrations were performed had undergone some slight change due to erosion of the glass tubes in which it was contained, the salinities for that Cruise can not be depended upon except within wide limits. They, and the resulting densities are therefore useful only in a general, and comparative way.

Temperatures (centigrade); salinities (‰) and densities (at the temperature *in situ*). The densities are corrected for pressure, by Ekman's (1910) table 4 alone, this being sufficiently accurate for the small depths involved.

JULY–AUGUST CRUISE.

STATION	DEPTH METERS	TEMPERATURE CENTIGRADE	SALINITY	DENSITY *in situ*
10340	0	11.95°	31.18	23.66
	25	6.49°	31.87	25.17
	50	5.19°	32.00	25.54
10341	0	16.39°	30.48	22.22
	25	5.08°	32.03	25.46
	50	3.9°	32.2	25.83
	80	3.67°		
10342	0	17.22°	30.61	22.13
	30	7.73°	31.58	24.79
	60	6.14°	31.87	25.39
10344	0	15.83°	30.75	22.55
	25	4.91°	32.10	25.53
	50	4.07°	32.20	25.81
	80	4.19	32.38	26.08
10345	0	10. °	31.53	24.27
	50	4.17°	32.25	25.84
	100	3.85°	32.66	26.45
	150	4.06°	32.86	26.81
10346	0	7.22°	32.03	25.07
	30	6.41°	32.07	25.35
	60	4.47°	32.38	25.96

Station	Depth meters	Temperature centigrade	Salinity	Density *in situ*
10347	0	11.39°	32.54	24.81
	30	10.91°		
	60	9.61°	32.14	25.31
10348	0	11.67°	32.54	24.75
	25	11.34°		
	50	11.26°	32.57	25.10
10349	0	17.5°	32.47	23.49
	30	10.36	33.86 [1]	
	80	7.16°	32.47 [1]	
	130	6.75°	34.42	27.64
	180	6.72	34.83	28.23
10351	0	15.56°	32.47	23.93
	30	10.66°		
	80	4.82°	33.42	26.85
	130	5.88°	34.20	27.56
	180	7.13°	34.72	28.06
10352	0	16.95°	32.47	23.61
	50	4.85°	33.08	26.42
	100	7.65°	34.36	27.32
	200	7.65°	34.92	28.25
	300	5.75°	34.87	28.92
	400	5.15°	34.87	29.48
	500	4.1°	34.96	30.14
10353	0	15.°		
10354	0	13.61°	32.27	24.18
	30	8.71°	32.63	25.48
	70	6.07°	32.86	26.21
10355	0	11.95°	31.73	24.08
	30	10.97°	32.14	24.71
10356	0	16.11°	31.78	23.29
	30	12.14°	32.14	24.50
10357	0	17.78°	30.90	22.19
	25	14.28°	31.58	23.62
10359	0	16.67°	31.09	22.58
10361	0	20°	26.24	18.14
10362	0	21.1°	30.57	21.13
	22	11.9°	31.73	24.19
10363	0	20.5°	31.17	21.74
	30	8.15°	32.41	25.38

[1] These two water samples were probably transposed.

Station	Depth meters	Temperature centigrade	Salinity	Density *in situ*
10364	0	21.8°	30.73	21.06
	40	5.54°	32.72	26.02
10365	0	20.3°	31.26	21.86
	20	13.91°	32.23	24.18
	40	4.94°	32.72	26.09
	60	4.82	32.81	26.27
10366	0	19.4°	32.61	23.12
	30	15.58°	32.68	24.22
	60	5.89°	32.84	26.18
	90	5.8°	33.30	26.67
10367	0	19.72		
	50	8.08°	33.68	26.48
	100	10.92°	34.92	27.23
	150	10.65	35.25	27.77
	200	7.89°	35.07	28.32
10368	0	20°	32.48	22.87
	100	11.21°	35.10	27.32
	200	8.58°	35.07	28.21
	400	5.18°	34.99	29.58
	500	4.68°	34.92	20.04
10369	0	21.7°		
	90	7.99°		
10370	0	21.7°	30.99	21.27
	25	8.94°	32.66	25.42
	50	4.98°	32.86	26.24
	100	9.47°	34.54	27.18
10371	0	22.2°		
10373	0	21.1°	31.09	21.46
	60	4.52°	32.63	26.17
10375	0	21.9°	30.62	20.96
	40	6.18°	32.39	24.90
10376	0	24.4°	31.	20.52
10377	0	21.9°	30.86	21.13
	15	15.77°	31.29	23.03
10378	0	21.1°		
	14	21.04°	30.93	21.48
10379	0	23.6°	30.9	20.63
	25	10.88°	32.	24.59
10380	0	23.6°	30.57	20.44
	20	6.73°	32.38	25.51
	40	6.78°	32.41	25.64

Station	Depth meters	Temperature centigrade	Salinity	Density *in situ*
10381	0	23.6°	31.11	20.85
	20	17°	32.00	23.32
	30	4.12°		
	40	4.02°	32.61	26.10
	65	4.06°	32.61	26.21
10382	0	24.4°	31.11	20.62
	40	7.02°	32.61	25.75
	80	4.71°	32.72	26.31
	120	6 75°		
10383	0	24.7°	31.09	20.51
	25	13.45°	32.25	24.30
	50	4.88°		
	100	5.46°	34.20	27.48
	150	11.32°	35.23	27.63
	175	9.76	35.19	27.99
10384	0	24.7°	31.46	20 77
	50	9.52°	33.39	26.53
	100	10.29°	34.81	27.27
	150	11.01°	35.03	27.54
	250	9.29°	35.10	28.36
	350	6.22°	35.16	29.34
	500	4.73°	34.97	30.10
10385	0	23.4°		
10387	0	23.3°	23.73	15.38
	12	23.3°	31.08	20.95
10389	0	23.9°	30.75	20.49
	10	23.31°	30.79	20.72
	18	22.26°	31.02	21.23
10390	0	23.9°	30.75	20.49
	12	23.41°	30.75	20.67
	25	16.54°	31.92	23.40
10391	0	22.8°	32.18	21.88
	20	22.1°	32.14	22.12
	40	10.84°	32.50	25.08
10392	0	22.2°	32.50	22.29
	20	21.9°	32.59	22.54
	40	6.6°	32.72	25.89
	60	5.85°	32.77	26.12
	80	5.08°	32.77	26.30
10393	0	22.2°	32.56	22.33
	50	11.86°	33.10	25 39

Station	Depth meters	Temperature centigrade	Salinity	Density *in situ*
10393	100	8.73°	34.11	26.97
	200	11.23	35.21	27.88
	300	6.26°	35.03	28.99
	400	6.79°	34.92	29.32
	500	5.2°	34.97	30.03
10394	0	20.8°	31.15	21 64
	20	12.25°	32.25	24.53
	40	7.35°	32.41	25.54
10395	0	21.1°	31.11	21.54
	17	17.72°	31.29	22.62
	35	9.02°	32.21	25.13
10396	0	19.2°	29.65	
	28	12.13°	31 98	
10398	0	16.95°	31.27	22.70
	20	7.89°	31.89	24.97
	43	4.91°	32.05	25.57

October–November Cruise.

Station	Depth meters	Temperature centigrade	Salinity	Density *in situ*
10399	0	10°	31.71	24.41
	30	9.18°	31.91	24.86
	60	6.43°	32.41	25.76
	90	5.43°	32.56	26.14
	120	5.23°	32.59	26.33
10400	0	9.72°	32.03	24.71
	30	8.21°	32.09	25.12
	60	7.07°	32.45	25 61
	90	4.84°	32.57	26.23
	130	4.41°	32.81	26.65
10401	0	10.56°	31.98	24.54
	50	8.90°	32.30	25.28
	100	4.24°	32.65	26.40
	150	4.53°	32.99	26.89
	200	4.99°	33.53	27.53
10402	0	8.33°	32.36	25.18
	25	8.89°	32.34	25.18
	55	8.19°	32.56	25.62

Station	Depth meters	Temperature centigrade	Salinity	Density *in situ*
10402	85	6.59°	32.78	26.15
	135	4.97°	32.90	26.70
10403	0	9.17°	31.87	24.66
	30	8.39°	32.07	25.08
10404	0	10.28°	32.01	24.60
	50	8.04°	32.18	25.32
	100	4.85°	32.88	26.52
	175	4.78°	33.15	27.09
10405	0	11.95°	32.05	24.31
	30	12.52°	32.06	24.36
10406	0	11.67°	32.23	24.52
	30	11.85°	32.36	24.72
	60	9.98°	32.54	25.35
10407	0	11.28°	32.54	24.83
	30	11.85°	32.56	24.88
	60	13.08°	33.15	25.24
	90	7.72°	32.88	
10408	0	11.39°	32.59	24.86
	25	12.06°	32.63	24.83
	50	14.0°	33.71	25.46
	100	9.26°	34.01	26.80
	180	10.26°	35.00	27.79
10409	0	12.78		
	30	13.22	32.83	24.90
	60	13.34	33.62	25.58
	90	9.07	33.68	26.35
	135	10.28	34.78	27.39
10410	0	13.05	32.59	24.56
	25	13.62	32.83	24.74
	50	13.82	33.10	25.02
	75	11.18	33.12	25.65
10411	0	12.22	31.50	23.87
	15	12.49	31.51	23.89
10412	0	13.33	32.58	24.48
	30	13.66	32.58	24.58
10413	0	13.33	32.86	24.62
	25	13.55	32.90	24.74
	50	13.56	32.90	24.86
10414	0	13.05	33.12	24.96
	25	13.42	33.10	24.96
	55	13.11	33.17	25.24

Station	Depth meters	Temperature centigrade	Salinity	Density *in situ*
10414	85	9.34	32.86	25.80
	135	9.49	33.73	26.70
10415	0	12.78	32.85	24.80
	30	13.35	32.91	24.86
	60	13.36	32.99	25.08
	90	11.91	33.18	25.65
10416	0	13.78	32.92	24.64
	20	13.14	32.94	
	40	14.20		
10417	0	14.17	32.52	

TEMPERATURE AND SALINITY IN CHESAPEAKE BAY, MARCH, 1916.

Station	Date	Latitude	Longitude	Depth meters	Temperature	Salinity
8460	March 6	36° 57′ N	76° W	0	3.7°	28.15
				8	3.8°	29.72
				15	3.5°	30.53
				22	3.6°	30.55
8464	March 7	37° 15′ N	76° 5′ W	0	3.2°	
				4	3.3°	
				9	3.3°	
				18	3.2°	
				20	3.3°	
				27	3.3°	
				30	3.3°	
				40	3.4°	

BIBLIOGRAPHY.

Bigelow, H. B.

1909. Reports on the scientific results of the expedition to the Eastern Tropical Pacific, 1904–1905. XVI. The Medusae. Mem. M. C. Z., **37**, 243 pp., 48 pls.

1914a. Explorations in the Gulf of Maine, July and August, 1912, by the U. S. fisheries schooner Grampus. Oceanography and notes on the plankton. Bull. M. C. Z., **58**, p. 29–148, 9 pls.

1914b. Oceanography and plankton of Massachusetts Bay and adjacent waters, November, 1912–May, 1913. Bull. M. C. Z., **58**, p. 383–420, 1 pl.

1915. Exploration of the coast water between Nova Scotia and Chesapeake Bay, July and August, 1913, by the U. S. fisheries schooner Grampus. Oceanography and plankton. Bull. M. C. Z., **59**, p. 149–360, 2 pls.

1917a. Explorations of the coast water between Cape Cod and Halifax in 1914 and 1915, by the U. S. fisheries schooner Grampus. Oceanography and plankton. Bull. M. C. Z., **61**, p. 161–358, 2 pls.

1917b. Explorations of the United States coast and geodetic survey steamer Bache in the Western Atlantic, January–March, 1914. Oceanography. App. 5, Rept. U. S. comm. fisher. for 1915, 62 pp., 1 chart.

Bjerkan, Paul.

1919. Results of the hydrographical observations made by Dr. Johan Hjort in the Canadian Atlantic waters during the year 1915. Canad. fisher. exped., 1914–1915. Dept. naval service, p. 347–404, 3 pls.

Conant, F. S.

1895. Description of two new chaetognaths. Johns Hopkins univ. circ., **14**, p. 77–78, [pl. 1], fig. 6, 7.

Conseil permanent international pour l'exploration de la mer.

1919. Variations de la temperature de l'eau de surface dans certains carrés choisis de l'Atlantique pendant les années 1900–1913. Bull. hydrogr., 37 pp. 7 pls.

Craigie, E. H.

1916a. Hydrographic investigations in the St. Croix River and Passamaquoddy Bay in 1914. Suppl. 5th. Ann. rept. Dept. naval service [Canada], Fisher. branch, p. 151–161.

1916b. A hydrographic section of the Bay of Fundy in 1914. Suppl. 5th. Ann. rept. Dept. naval service [Canada], Fisher. branch, p. 163–167.

Craigie, E. H., and Chase, W. H.

1918. Further hydrographic investigations in the Bay of Fundy. Suppl. 7th. Ann. rept. Dept. naval service [Canada], Fisher. branch, p. 127–148.

DALL, W. H.
1889. A preliminary catalogue of the shell-bearing marine mollusks and brachiopods of the southeastern coast of the United States. Bull. 3 U. S. nat. mus., 221 pp., 74 pls.
DAMAS, D. ET KOEFOID, E.
1907. Le plankton de la mer du Grönland. Duc d'Orléans. Croisière océanog. mer Grönland, p. 345–454.
DAWSON, W. B.
1913. The currents in the Gulf of St. Lawrence. Dept. naval service [Canada], 461 pp., 1 chart.
DICKSON, H. N.
1901. The circulation of the surface waters of the North Atlantic Ocean. Philos. trans. Roy. soc., ser. A, **196**, p. 61–203, pl. 1–4.
EKMAN, V. W.
1910. Tables for sea-water under pressure. Publ. circ. 49, Cons. inter. expl. de la mer, no. 49, 48 pp.
FOWLER, H. W.
1912. The Crustacea of New Jersey. Ann. rept. New Jersey state mus. for 1911, p. 29–650, 150 pls.
GRAN, H. H.
1908. Diatomeen. Nordisches plankton. Botan. theil, 146 pp. Lief. 3, 19.
HUNTSMAN, A. G.
1919. Some quantitative and qualitative plankton studies of the eastern Canadian plankton. Canad. fisheries exped., 1914–1915, Dept. naval service, p. 405–486.
JEE, E. C.
1919. Review of the physical and chemical properties of the surface waters, and the variations of these properties during the period 1902–17, inclusive, in the area of the Atlantic Ocean centred on 50° N.: 20° W. Fisher. invest. Bd. agric. and fisher. Great Britain, ser. 3, Hydrogr. **3**, Atlantic Ocean, pt. 1, 23 pp.
KNUDSEN, MARTIN.
1901. Hydrographical tables. Copenhagen, 63 pp.
1909. Résumé de l'hydrographie des mers explorées par le conseil. Bull. trimestr. Cons. inter. expl. de la mer, 1906–1907. Suppl., 78 pp., 23 pls.
KRAMP, P. L.
1918. Chaetognatha collected by the TJALFE expedition to the west coast of Greenland in 1908 and 1909. Vid. medd. Dansk. naturh. foren. **69**, p. 17–55.
KRÜMMEL, OTTO.
1907–1911. Handbuch der ozeanographie. 2 vols. Leipzig and Stuttgart.
KUNTZ, ALBERT and RADCLIFFE, LEWIS.
1917. Notes on the embryology and larval development of twelve teleostean fishes. Bull. U. S. bur. fisher., **35**, p. 87–134.

Libbey, William and others.

1891. Report upon a physical investigation of the waters off the southern coast of New England, made during the summer of 1889 by the U. S. fish commission schooner Grampus. Bull. U.S. fish comm. for 1889, **9**, p. 391–459, pl. 124–158.

1895. The relations of the Gulf Stream and the Labrador Current. Rept. Sixth int. geogr. congress, p. 461–474, 1 chart.

Massy, A. L.

1909. The Pteropoda and Heteropoda of the coasts of Ireland. Fisheries. Ireland Sci. invest., 1907, no. 2, 52 pp., 1 pl.

Matthews, D. J.

1907. The surface waters of the North Atlantic Ocean south of 60° N. latitude, September, 1904–December, 1905. North Sea fisher. invest. comm., 2nd [British] rept. (southern area), 1904–1905, p. 269–348, 3 pls.

Mayer, A. G.

1912. Ctenophores of the Atlantic coast of North America. Carnegie inst., Publ. no. 162, 58 pp., 17 pls.

Michael, E. L.

1911. Classification and vertical distribution of the Chaetognatha of the San Diego region. Univ. Cal. publ. Zool., **8**, p. 21–186, pl. 1–8.

1919. Report on the Chaetognatha collected by the United States fisheries steamer Albatross during the Philippine expedition, 1907–1910. Bull. 100 U. S. nat. mus., **1**, pt. 4, p. 235–278, pl. 34–38.

Murray, John and Hjort, Johan.

1912. The depths of the ocean. London, 20, 821 pp., ills.

Ostenfeld, C. H.

1913. Noctiluca and Globigerina. Bull. trimestr. Cons. inter. expl. de la mer. Résumé observ. plankton, **3**, p. 291–297.

Paulsen, Ove.

1908. Peridiniales. Nordisches plankton. Botan. theil, 124 pp. Lief. 8, 18.

Rathbun, Richard.

1887. Ocean temperatures of the eastern coast of the United States, from observations made at light-houses and twenty-four light-ships. The fisheries and fishery industries of the U.S., sect. 3, p. 157–177, 32 charts.

1889. Notice of the small surface organisms taken in the tow-nets, and of the contents of Mackerel stomachs. Bull. U. S. Fish comm. for 1887, **7**, p. 259–267.

Ritter-Záhony, Rudolf von.

1911. Revision der chaetognathen. Deutsche Südpolar. exped., **13**, Zoöl., **5**, heft 1, p. 1–72.

Sandström, W. J.

1919. The hydrodynamics of Canadian Atlantic waters. Canad. fisher. exped. Dept. naval service, p. 4, 221–343, 15 pls.

TIZARD, T. H.

1907. Dr. Otto Pettersson on the influence of ice-melting on oceanic circulation. Geogr. journ., **30**, p. 339–344.

VACHON, ALEXANDER.

1918. Hydrography in Passamaquoddy Bay and vicinity. Suppl. 7th Ann. rept. Dept. naval service [Canada], New Brunswick. Fisher. branch, p. 295–328.

WHEELER, W. M.

1901. The free swimming copepods of the Woods Hole region. Bull. U. S. fish comm. for 1899, **19**, p. 157–192.

WILLEY, ARTHUR.

1919. Report on the Copepoda obtained in the Gulf of St. Lawrence and adjacent waters, 1915. Canad. fisheries exped., 1914–1915, Dept. naval service, p. 173–220.

WOOD, W.

1869. The Clio borealis on the coast of Maine. Proc. Portland soc. nat. hist., **1**, p. 185–188.

WRIGHT, R. Ramsay.

1907. The plankton of eastern Nova Scotia waters. [Suppl.] 39th ann. rept. marine and fisheries Canada, p. 1–19, 7 pls.

ZIMMER, CARL.

1909. Die nordischen schizopoden. Nordisches plankton, Lief. 12, 6, 178 pp.

Bulletin of the Museum of Comparative Zoölogy

AT HARVARD COLLEGE.

Vol. LXV. No. 6.

BIRDS FROM DARIEN.

By Outram Bangs and Thomas Barbour.

CAMBRIDGE, MASS., U. S. A.:

PRINTED FOR THE MUSEUM.

September, 1922.

No. 6.—*Birds from Darien.*

By Outram Bangs and Thomas Barbour.

The latter author, with Mr. W. S. Brooks, spent several months this spring (1922) in Panama. Part of the time was occupied in a journey to the Sapo Highlands and to the heavy forests of the Sambú Valley, previously unvisited by a zoölogist and one of the least known areas of all tropical America.

The original plan was to collect mammals and reptiles but having the opportunity to engage the services of Mr. C. F. Underwood while in Costa Rica, it was decided to attempt a collection of birds. Unfavorable weather conditions and the illness of Mr. Underwood made it undesirable to prolong this work. Nevertheless it is only proper to record that, working under conditions very different from the luxurious bird collecting of Costa Rica, with a veteran corps of trained assistants, and camping here, under the most difficult conditions, Mr. Underwood preserved every single bird worth saving. We worked under high pressure and had some good Chocoano Indian shooters, but the number of days devoted to ornithology was only about seventeen. Since nearly seven hundred birds were collected it will readily be understood that some of the days were long and well occupied. In one day eighty-seven birds were shot and skinned. One hundred and fifty-nine species are represented in the collection. It would have been easy to increase this list very considerably. The clearings about the village of Garachiné and about the Indian plantations on the Sambú swarmed with many species of birds characteristic of the open country. Many forms were so familiar to us all and so well represented in collections that our stays about the clearings were devoted to other activities. The collection really represents an attempt to obtain only those species unrepresented in the M. C. Z., so far as our knowledge went. Inevitably, however, many common species were preserved.

Field notes, in many cases of no great value, are appended. The only excuse for so doing is the paucity of data concerning the region and the fact that so many collections of birds are reported upon by persons who have not had the good fortune to share in securing the material.

Collections of mammals, reptiles, amphibians, and fishes were also obtained and reports upon these series, together with a general account of the country and its inhabitants, have been or will be published elsewhere.

Several occasions stand out as specially memorable. The chance to see two great flights of hawks (probably Swainson's) was very pleasing. One afternoon (16 April) coming down the Sambú in dugouts we noticed what we first believed to be an enormous gathering of turkey buzzards but in a short time the whirling or wheeling cloud passed westward near enough for us to see that what we had mistaken for buzzards was in reality an enormous crowd of hawks. They were very high, the day happened to be finely clear, and several thousand were visible. A few days later another migration was observed from a foothill of Mt. Sapo but the number of hawks was distinctly less.

On another afternoon, when resting after a steep climb, at the foot of a gigantic espavé tree, we heard a noise overhead and looking up were surprised to see the great crested head of a Harpy Eagle looking down at us. Hastily pushing in 2's I (Barbour) fired both barrels but the bird was very high and only a wing was broken. It had just sufficient power of flight to launch out from the tree top and in a second it was away, down the slope of an almost perpendicular valley which we searched for hours without avail. Although we had several fine views of flying Harpys we never got another shot, and losing this bird was a bitter disappointment.

In this paper we follow the order used by Ridgway in the Birds of North and Middle America (Bull. 50, U. S. N. M.).

It is also to be noted that whenever Chapman is referred to, with no specific reference, we allude to The Distribution of Bird-Life in Colombia (Bull. Amer. mus. nat. hist., 1917, **36**), and similarly with the use of Hellmayr's name, to A Contribution to the Ornithology of Western Colombia (P. Z. S. London, 1911).

In conclusion it gives us great pleasure to thank President Porras and the Señores Alfaro and Morales of his Cabinet in Panama; Dr. R. P. Strong and Major Bocock, Superintendent of the Hospital Santo Tomás and to many other officials and friends both here and in Central America who gave us help and advice.

Messrs. Nelson, Chapman, Todd, and Penard have also aided us by loaning specimens which have been invaluable, in connection with our material in Cambridge, in arriving at the taxonomic conclusions which we have reached.

Finally it may be well to add a word regarding the location of the collecting stations named. Esnápe was a camp on a stream of that name situated several hours march northeast of the junction of the

Sambú and Sabalo Rivers, Lat. 8° 02′ 13″ and Long. 78° 12′ 00″. The Quebrada Esnápe is said to be tributary to the Rio Taimití. Jesusito refers to camps at several points in the lowland forest on the Rio Jesusito which rises in the Sapo Mountains. It is one of a series of small streams which have their source in the highlands and flow toward the Sambú Valley, but which apparently, in this case, is not tributary to the Sambú but probably empties in a marsh drained by the Rio Celorio. Mt. Sapo refers to stations on the headwaters of the Rio San Antonio, a stream which enters the sea near the town of Garachiné. The river drains the western slopes of Mt. Sapo itself. The collections are all representative of the fauna of the lower Tropical Zone, the stations being all in the rain forest below 1500′.

ARDEIDAE.

1. Canchroma zeledoni Ridgway.

One skeleton, Jesusito.

Only a single Boat-billed Heron was seen during the entire trip and this was shot while night hunting with an acetylene lamp. It stared stupidly at the light and made no effort to escape.

2. Pilherodias pileatus (Boddaert).

One adult female, Jesusito, 6 April, 1922.

This appears to be the first record for Panama. It has already been recorded from western Colombia by Chapman.

A pair of these lovely night herons was observed several times near the lower camp on the Jesusito River. They were rather shy and appeared to be fairly active by day. Only one of the pair was killed.

CATHARTIDAE.

3. Sarcorhamphus papa (Linné).

One adult male, Pacora, April, 1922.

The chief of the Canal Zone Fire Department, Captain Brown, found this splendid vulture sitting on an open plain while hunting near Pacora. He approached the bird and found it to be perfectly blind, although its eyes gave no appearance of being abnormal. He kept it alive for some time and finally gave it to the Museum party.

King vultures were seen several times flying low over the tree tops in the Sambú Valley but none were shot.

AQUILIDAE.

4. Ibycter americanus americanus (Boddaert).

One adult female, Jesusito, 13 April, 1922.

This skin affords a wing-length of 355 mm., which places it as the small form representative of tropical South America, and which Swann has already recorded as being found northward to Panama.

This remarkable hawk was a constant source of surprise. Small parties of four or five were often encountered in the deep woods. They flapped sluggishly for short distances when disturbed uttering the most unearthly shrieks. They were feeding in the fruit trees and reminded one far more of macaws, in voice and actions, than of hawks. The Panamanians call them witches (brujos) and do not consider them at all as being in the catagory of eagles or other birds of prey.

About the Mt. Sapo camp small flocks of brujos appeared every morning and evening flying up and down the steep hillsides just above the forest, screaming like macaws all the while.

5. Rupornis magnirostris ruficauda (Sclater and Salvin).

One adult male, Jesusito, 7 April, 1922.

6. Falco albigularis Daudin.

Two adults, male and female, Jesusito, April, 1922.

Swann, reluctantly to be sure, recognizes three races of the White-throated Bat Falcon. We, however, detect no geographical variation in the species and cannot allow Chubb's two forms.

Occasionally, just at dusk, one of these hawks would dart past the lower Jesusito camp which was on a rough pebbly beach across the stream from an old abandoned Indian banana plantation. The pair secured were shot as they flashed by, to the intense excitement of our Chocoano companions.

TINAMIDAE.

7. Tinamus major castaneiceps Salvadori.

Two adult females, Jesusito, April, 1922.

Many of the large tinamous were killed for food and were delicious. The Indians had small difficulty in securing specimens but nevertheless they were very shy, having been persistently hunted. At dawn and eve their protracted and musical cry, oft repeated *in crescendo*, was one of the forest sounds which serve the Indians as most exact time-markers.

8. CRYPTURUS SOUI PANAMENSIS Carriker.

One adult female, Jesusito, 9 April, 1922.

The little tinamou was far rarer and far less shy than its larger ally. The Indians brought in a number, shot at such short range that they were impossible to preserve.

CRACIDAE.

9. CRAX GLOBICERA Linné.

One adult female, Jesusito, 13 April, 1922.

Miller and Griscom (American museum novitates), no. 25, p. 7, 1921, discredit *Crax panamensis* Ogilvie Grant, saying that in series all characters of that supposed species break down, and that it is not separable from *C. globicera* of Mexico to Honduras.

The pavones were rare, very rare, and it was only by making long excursions from the upper Jesusito camp far into the Sapo Hills that an occasional pavon could be secured for food.

10. PENELOPE CRISTATA (Linné).

One adult, male, Jesusito, 15 April, 1922.

The same remarks apply to this species. The Indians prefer the flesh of these birds to any other and have hunted them persistently for generations. In the region of the Rio Pavarondó near the Colombian frontier, where there are fewer Chocoanos, all game is said to be much more common.

ODONTOPHORIDAE.

11. ODONTOPHORUS GUIANENSIS PANAMENSIS Chapman.

Four specimens, adults both sexes, Mt. Sapo and Jesusito, April, 1922.

The Panamanians call this bird the "Mulatto Dog" (Perro Mulato), though the connection is not easy to see. About equally abundant with the following species, they were singularly tame and were often seen, in pairs, walking about camp in the most unconcerned fashion.

12. Rhynchortyx cinctus cinctus (Salvin).

Seven specimens, adults of both sexes, Mt. Sapo, April, 1922. Two downy young were also preserved.

When camp was quiet, as it sometimes was, these little quail often appeared, walking in pairs, and when disturbed ran away to some thicket. Neither this species, nor the preceding, were ever seen to take flight.

RALLIDAE.

13. Aramides cayanea cajanea (P. L. S. Müller).

One adult female, Jesusito, 12 April, 1922.

We are unable, with a very large series of specimens, to verify a single character of the so-called *Aramides cajanea salmoni* Chubb, of northern Colombia and Panama, and cannot satisfactorily separate birds from that general region from those from Guiana. A recognizable, insular form, however, *A. c. latens* Bangs and Penard, is found on Pearl Island, in the Bay of Panama.

Along the Sambú wood rails were often heard calling at dusk and during the early night. Away from the main stream of the river they were far more rare, indeed were but very seldom heard and the one female, killed by an Indian, was the only one which was brought to camp.

COLUMBIDAE.

14. Leptoptila cassini cassini Lawrence.

Six adults, both sexes, Mt. Sapo, Jesusito, and Rio Esnápe, April, 1922.

Pigeons of all sorts were scarce in the high forest although passing up and down the Sambú, especially through the mangroves, numbers of individuals of certainly three or more species were very conspicuous.

PSITTACIDAE.

15. Eucinetus haematotis coccineicollaris (Lawrence).

One adult, female, Jesusito, 9 April, 1922.

The little red collared parrots were not very abundant. However, in common with the other species, they fed in such gigantic trees that they were not easily observed and identified.

16. Pionus menstruus (Linné).

One adult (sex not determined), Jesusito, April, 1922.

Flocks of this species passed every day over the camp on the lower Jesusito at night-fall and about dawn. They whirred overhead, band after band, until the whole forest resounded with their screams and ordinary conversation was next to impossible. Whence they came or where they went we never knew, and these blue parrots seldom stopped to rest where we could observe them.

17. Amazona farinosa inornata (Salvadori).

One adult, female, Jesusito, 10 April, 1922.

In contrast to the preceding species this great plain looking green parrot roosted in myriads near the lower Jesusito camp. They stayed about for some time in the morning to feed, shrieking and chattering the while, but almost always far out of range of our twelve bore, so high were the high tree-tops. About eight every morning they flew toward the hills, returning late in the afternoon, occasionally accompanied by a few pairs of macaws none of which were ever shot.

CUCULIDAE.

18. Piaya cayana thermophila Sclater.

One adult female, Mt. Sapo, 24 April, 1922.

This specimen is not different from the average of skins from Costa Rica and the Canal Zone of Panama, and does not seem in any way to approach *P. c. nigricrissa* (Cabanis) of western Ecuador and West Colombia.

This cuccoo is rare in the deep forest. The only one shot chanced to light in some creepers at noon one day while watch was being kept under the "Cotinga Tree" to be mentioned later.

MOMOTIDAE.

19. Momotus subrufescens reconditus Nelson.

Three adult males, Rio Esnápe, April, 1922.

The first of these to be secured was caught in a steel trap set at the mouth of its enormous nesting burrow.

20. Urospatha martii semirufa (Sclater).

Three adults, male and two females, Mt. Sapo, April, 1922.

This and the preceding species of motmots were common and were heard daily calling during the hot still noon hours. Much larger series could easily have been secured.

21. Electron platyrhynchus minor (Hartert).

One adult, female, Jesusito, 9 April, 1922.

This specimen, with a culmen of 39 mm. differs in no way from (eight examples) birds from Costa Rica, and western Panama. Chapman has already pointed out that *E. p. suboles* Nelson, was either based on a slightly abnormal individual, or has a very restricted distribution which seems impossible as it is a species of the Tropical Zone.

This curious, broad-billed motmot was very rare and no other individual was secured or seen.

22. Hylomanes momotula obscurus Nelson.

One adult male, Mt. Sapo, 24 April, 1922.

An aged negro, armed with an ancient French muzzle loader, brought this motmot to camp one day. He said that he had killed it high on the slopes of the Cerro de Sapo itself.

ALCEDINIDAE.

23. Chloroceryle amazona (Latham).

One adult, female, Jesusito, 12 April, 1922.

This, and the two following species, were all abundant and many could have been secured. In general kingfishers were confined to the swift clear woodland torrents and were seldom seen about the sluggish Sambú or the lower Jesus, both streams having water the consistency and color of pea-soup.

24. Chlorocerle americana isthmica (Goldman).

Two adults, male and female, Mt. Sapo and Jesusito, April, 1922.

25. Chloroceryle inda (Linné).

Four adults, both sexes, Jesusito, April, 1922.

BUCCONIDAE.

26. Notharcus pectoralis (Gray).

One adult, female, Rio Esnápe, 3 April, 1922.

A single specimen brought to camp by an Indian hunter.

27. Malacoptila panamensis panamensis Lafresnaye.

Four adults, both sexes, Mt. Sapo, Rio Esnápe, and Jesusito, April, 1922.

This fine bucco was met with at most of the camps, but was rare and all of the individuals seen by the members of the party were secured.

28. Monasa pallescens pallescens Cassin.

Three adults, male and two females, Jesusito, April, 1922.

These vary among themselves as to the shade of gray on the wing-coverts and also as to the grayness or blackness of the throats and chests. We are unable to distinguish them, either by color or size, from skins from Antioquia, identified by Chapman as *pallescens*.

In the deep woods these beautiful birds were far from common but about the Indian habitations they were very abundant. At the house of Churima, where several nights were passed, they might be seen at any time dusting in the little pathway which led to the canoe landing or perched about the house almost as tame as the little paraquets which crawled about playing with the Indian children.

29. Nonnula frontalis pallescens Todd.

Eight adults, both sexes, Jesusito and Rio Esnápe, April, 1922.

This series agrees with skins already in M. C. Z. from the Canal Zone. The series presents some variation in color but on the whole is much paler than old "Bogota" skins. Some time ago Bangs and Penard compared Canal Zone skins with the specimens sent them by Todd, upon which *pallescens* (type-locality, Fundacion, Santa Marta, Colombia), was founded, and found them to agree essentially. There is a doubt in our minds as to Todd's having selected the right form for his new name; provided, however, there actually are two forms.

The little Nonnulas were never observed except in the darkest and dampest of lowland woods.

CALBULIDAE.

30. Jacamerops aurea penardi, subsp. nov.

One adult, male, Rio Esnápe, 3 April, 1922.

Type.— M. C. Z. 116,609 adult ♀, Costa Rica: Carrillo, 19 November, 1898. C. F. Underwood.

Characters.— Similar to *J. a. aurea* (P. L. S. Müller) of Surinam, but with a much more slender bill; colors about the same except that in the northern form the lower surface of the tail is perhaps rather more purplish, less greenish.

Measurements.

No.	Sex	Locality	Wing	Culmen to Base of Forehead	Width of bill at Nostril
		J. aurea aurea (P. L. S. Müller).			
47,855	♀	Brazil: "Amazons"	113	49	13
Penard Coll.	♀	Surinam: Paraku Saramacca	114	51	13
" "	♂	" " "	111	52	13
		J. aurea penardi Bangs and Barbour.			
116,608	♂	Costa Rica, Carrillo	111	51	12
116,609	♀	" " "	107	49	11
46,445	♀	Panama, Line of R.R.	108	47	11
87,472	♂	" Rio Esnápe	112	49	11.5

Remarks.— We have named this northern form of *J. aurea*, which ranges from the Caribbean slope of Costa Rica south at least to eastern Panama, in honor of our colleague Thomas E. Penard, who has lent us two fine topotypes of the typical form, and has kindly helped in the preparation of this paper with the loan of other specimens and with many suggestions on points of nomenclature, etc.

Having, by chance, previously concluded that this form should be separated, we turned to Ridgway's Birds of North and Middle America and found that, in reality, he had already called attention to the very slender bill of the northern form.

On comparison the bill in the two forms is seen at once to be so obviously broad in the southern and so slender in the northern that we consider that they must be separated on this character alone. Measurements, unfortunately, do not show these differences very well.

The splendid giant jacamá was killed among the very first birds taken and although afterward constantly sought, no other example was ever seen.

31. Brachygalba salmoni Sclater and Salvin.

One somewhat immature male, Jesusito, 7 April, 1922.

Directly across the stream and right opposite the lower Jesusito camp was a rather low dead tree and on this, every day, perched some small jacamás, all obviously immature. We shot them all, but in spite of many sharp Indian eyes only one was ever found, so thick were the nettles and thorny creepers into which they fell. The adults were never seen, although watched for daily.

RAMPHASTIDAE.

32. Pteroglossus torquatus torquatus (Gmelin).

Two adults, male and female, Jesusito, 9 April, 1922.

These gaudy little toucans were abundant and as they were stupid and fed in rather low trees many were killed to eat.

33. Selenidera spectabilis Cassin.

Four adults, both sexes, Mt. Sapo, April, 1922.

This toucan was much rarer than the preceding, but equally tame.

34. Ramphastos piscivorus brevicarinatus Gould.

One skeleton, Jesusito.

The big yellow-breasted toucans were common everywhere. They sounded like amphibians, not birds, and looked like tiny bow heavy airplanes as they flapped and then sailed, often for long distances, high over the forest. They were great favorites for food, and though in reality not very shy they flew so high they were by no means easy to secure.

CAPITONIDAE.

35. Capito maculicoronatus pirrensis Nelson.

Three adult males, Mt. Sapo, April, 1922.

Another beautiful species, never seen except when it visited the "Cotinga Tree." (*Cf. sub Cotinga naterreri*).

PICIDAE.

36. Melanerpes pucherani pucherani (Malherbe).

Two specimens, adult male and immature male, Mt. Sapo and Jesusito, April, 1922.

Small woodpeckers were often heard and seen but they were usually so high that it was quite impossible to kill them.

37. Celeus loricatus mentalis Cassin.

One adult female, Mt. Sapo, 21 April, 1922.

38. Ceophloeus lineatus mesorhynchus Cabanis and Heine.

One adult male, Rio Esnápe, 3 April, 1922.

This big woodpecker seems to have been rarer than the following species. They were not differentiated in the field, however, and large woodpeckers in general were much more abundant than the smaller species.

39. Campephilus malherbei Gray.

Five adults, both sexes, Rio Esnápe, and Jesusito, April, 1922.

TROGONIDAE.

40. Curucujus melanurus macrourus (Gould).

Four adults, two males, two females, Jesusito, April, 1922.

Four species of trogons were collected, they all seemed about equally abundant and the usual difficulty was encountered in getting decent specimens. The Curcujus and true Trogon were only found in the lowland forest. The Chrysotrogon only at some distance up in the Sapo Hills. The latter species sheds it plumes when shot, even more readily than the others.

41. TROGON STRIGILATUS CHIONURUS Sclater and Salvin.

One adult female, Jesusito, 12 April, 1922.

42. TROGONURUS CURCUCUI TENELLUS (Cabanis).

Three adults, male and two females, Mt. Sapo and Rio Esnápe, April, 1922.

These appear to be quite like birds from the Canal Zone and from Costa Rica and show no approach to *T. c. cupreicauda* Chapman, of western Colombia.

43. CHRYSOTROGON CALIGATUS CALIGATUS (Gould).

Two specimens, male and female, Mt. Sapo, April, 1922.

TROCHILIDAE.

44. EUTOXERES AQUILA SALVINI Gould.

One adult, female, Mt. Sapo, 20 April, 1922. W. S. Brooks.

The only specimen seen, and the same site was visited again and again, was taken while feeding on the red flowers of one of the small species of banana-like plants.

45. PHAETHORNIS GUYI CORUSCUS Bangs.

Three females, Mt. Sapo, April, 1922.

This was one of the solitary hermits of the dark damp groves of "tagua" or ivory nut-palms. The two following species were found in similar situations and while a good many were seen, they were so active and made such long erratic flights that they were by no means easy to collect. They visited none of the flowering trees and shrubs which were regularly watched for hummingbirds. The Threnetes was similar in habits.

46. PHAETHORNIS LONGIROSTRIS CASSINI Lawrence.

Three adults, both sexes, Rio Esnápe and Jesusito, April, 1922.

Simon, the latest authority on the Hummingbirds (Historie naturelle des Trochilidae, 1921), sinks *P. longirostris cephalus* (Bourcier and Mulsant) type-locality Rio San Juan, Nicaragua, into the synonymy of *P. longirostris longirostris* (Lesson and Delattre), type-locality Guatemala, and recognizes as a distinct species *P. cassini* Lawrence, type-locality Turbo, giving as its range northern Colombia to Veragua. It is, of course, true that specimens from extreme eastern Panama are much more different from true *P. longirostris* than are birds from Nicaragua and Costa Rica, in fact many specimens from the latter countries are barely distinguishable from *P. longirostris longirostris* of Guatemala.

We cannot accept *cassini* as a distinct species, though recognizing it as a subspecies and allowing *cephalus* to stand as a rather poorly characterized intermediate form.

47. Phaethornis adolphi nelsoni, nom. nov.

Phaethornis adolphi fraterculus Nelson, Smithsonian misc. coll., 27 September, 1912, **60**, no. 3, p. 9. Type-locality Cana, Panama. Not *Phaethornis fraterculus* Gould, Monogr. Troch., 1861, **1**, p. 18.

Two adults, female and sex not determined, Jesusito, April, 1922.

48. Threnetes ruckeri darienensis, subsp. nov.

Two adults, male, Mt. Sapo, 23 April, 1922.

Type.— M. C. Z. 87,511 adult ♂, E. Panama: Mt. Sapo, 23 April, 1922. Barbour, Brooks, and Underwood.

Characters.— Similar to *T. r. fraseri* (Gould) of Ecuador and western Colombia, and with similar dark green upper parts, but with the cinnamon throat-patch much larger and brighter and with the belly much paler and clearer gray. Similar also to *T. ruckeri ruckeri* (Bourcier), (Nicaragua to western Panama) but upper parts dark green instead of bronzy green; and belly gray, not buffy.

Chapman mentions the characters of this well-marked form and although he appears to have had plenty of material he did not name it.

49. Chalybura buffoni micans, subsp. nov.

Eighteen adults, both sexes, Mt. Sapo and Jesusito, April, 1922.

Type.— M. C. Z. 87,514 adult ♂, E. Panama: Mt. Sapo, 25 April, 1922. Barbour, Brooks, and Underwood.

Characters.— Similar to *C. b. buffonii* (Lesson) of the Magdalena Valley, (common in Bogota collections) but adult male with the tail, including middle rectrices, blue-black (a few skins only in the large series before us from eastern Panama and western Colombia have some slight greenish at base of middle rectrices and along the extreme outer edges of other rectrices, quite different from the dull, bronzy middle rectrices and the other extensively bronze rectrices, in *C. b. buffoni*) and underparts paler and much more bluish green. From *C. b. aeneicauda* Lawrence of Venezuela and the Santa Marta Region of Colombia the new form differs at once in its blue-black instead of green middle rectrices. Size similar to that in the other race.

This is another well-marked subspecies to the characters of which Chapman has already called attention but which he did not name. It seems to us too different from the other subspecies ever to be confused with any of them. Its range extends from the Canal Zone in Panama to western Colombia.

This big, mealy green hummer was a common visitor to low flowering shrubs near the two camps on the Jesusito and on Mt. Sapo. It was very abundant, though far more males were seen than females.

50. Klais guimeti (Bourcier and Mulsant).

One immature male, Mt. Sapo, 24 April, 1922.

51. Damophila panamensis Berlepsch.

Five adults, both sexes, Jesusito, April, 1922.

This species and the following were taken at flowering shrubs which they visited at all hours of the day in common with the Chalybura.

52. Polyerata amabilis (Gould).

Eighteen adults, both sexes, Jesusito, April, 1922.

53. Thalurania fannyi fannyi (Delattre and Bourcier).

Three adults, two males and a female, Mt. Sapo and Esnápe, April, 1922.

The two males are exceptionally fine ones, with very long tails, long bills and of very dark rich coloration. At first we thought they might represent a new form, but afterwards decided to consider them handsome old adults of true *fannyi*.

Measurements.

No.	Sex.	Locality	Wing	Tail	Culmen to base
87,556	♂ ad.	Mt. Sapo	53	45	25.
87,555	♂ ad.	Rio Esnápe	53	44	23.5

54. Heliothrix barroti (Bourcier and Mulsant).

Two adults, females, Mt. Sapo and Rio Esnápe, April, 1922.

These lovely hummers were seen very occasionally and then only when they came to bathe in the streams near camp. They hovered motionless over the brook for a few seconds and then dipped hurriedly up and down into the cool, clear water perhaps half a dozen times and then disappeared. By watching the pools during the late afternoon the two specimens, both females, were secured.

FORMICARIIDAE.

55. Cymbilanius lineatus fasciatus Ridgway.

One adult male, Jesusito, 9 April, 1922.

Nineteen species of ant-thrushes were taken. There is nothing special to remark as to their habits. All are found walking with characteristic tread on the floor of the deep, dark forest. Many were shot by the Indians who were especially useful in getting these birds as they made no noise while walking and one and all had keen eyesight. There was great rivalry to see who could secure the largest day's bag, tobacco being the reward.

56. Thamnistes anabatinus coronatus Nelson.

Two adults, male and female, Mt. Sapo, 20, 22 April, 1922.

57. Thamnophilus punctatus atrinucha Salvin and Godman.

Thirteen adults, both sexes, Mt. Sapo, Rio Esnápe, and Jesusito, April, 1922.

58. Dasyithamnus puncticeps puncticeps Salvin.

Four adults, one male, three females, Mt. Sapo, April, 1922.

59. Myrmotherula brachyura (Hermann).

One adult male, Jesusito, 7 April, 1922.

60. Myrmotherula surinamensis pacifica Hellmayr.

Three specimens, adult male and female and immature male, Mt. Sapo and Jesusito, April, 1922.

61. Myrmopagis axillaris albigula (Lawrence).

Twenty-eight specimens, adults of both sexes and immature males. Mt. Sapo, Rio Esnápe, and Jesusito, April, 1922.

This and the succeeding were two of the very commonest forest species. A very large series could easily have been collected.

62. Myrmopagis fulviventris (Lawrence).

Sixteen adults, both sexes, Mt. Sapo, Rio Esnápe, and Jesusito, April, 1922.

63. Microrhopias boucardi consobrina (Sclater).

Four adults, three males and a female, Mt. Sapo and Jesusito, April, 1922.

64. Cercomacra tyrannina tyrannina (Sclater).

Five adults, three males, two females, Rio Esnápe and Jesusito.

65. Myrmeciza laemosticta palliata Todd.

Twelve adults, both sexes, Mt. Sapo, April, 1922.

Making due allowance for the difference in season,— Todd's original series, from Santander, Colombia, was taken from August to December, ours in April — this series is scarcely separable from the well-marked Colombian form, *palliata*. The character, of our skins, on the whole, is very slightly intermediate, for instance, the flanks and sides in our males are slightly darker and more reddish brown than in Todd's. This, however, is not so in the female kindly lent us by Todd. In one of our males the black of the throat ends abruptly at the upper chest, in the others it is more or less extended irregularly over the chest and upper breast.

66. Myrmeciza maculifer cassini (Ridgway).

Thirteen adults, both sexes, Rio Esnápe and Jesusito, April, 1922.

67. Formicarius analis panamensis Ridgway.

Six adults, both sexes, Mt. Sapo, Rio Esnápe, and Jesusito, April, 1922.

One adult male gives a wing-length of 93 mm., the other three run from 85 to 88. In the two females it is 87 and 90 respectively.

This ant-bird called like a little tinamou. Its long clear whistle repeated *in crescendo* six or seven times was easily imitated and several times the bird was brought fairly near and a shot thus secured. In general, however, the species was much more shy than the others of the family.

68. Hylophylax naevioides naevioides (Lafresnaye).

Thirty-eight adults, both sexes, Mt. Sapo, Rio Esnápe, and Jesusito, April, 1922.

In the Birds of North and Middle America, Ridgway did not recognize the Costa Rican *Hylophylax naevioides capnitis* (Bangs). Now we have a very large series of each race and believe that the Costa Rican form can easily be distinguished from true *naevioides* of Panama. The characters originally claimed for the northern bird are slight, and perhaps only average characters, but besides these, the female of *capnitis* is much grayer, less buffy below and the spots on the chest much darker and more distinct, and in both sexes the subterminal dark band on the tail is narrower and the tip is darker more cinnamomeous, less buffy or whitish.

This was another of the excessively common woodland species of which an enormous series might easily have been secured.

69. Anoplops bicolor bicolor (Lawrence).

Five adults, both sexes, Mt. Sapo and Jesusito, April, 1922.

70. Phaenostictus macleannani chocoanus, subsp. nov.

Three adults, two males and a female, Mt. Sapo and Rio Esnápe. April, 1922.

Type.— M. C. Z. 87,352 adult ♂, E. Panama: Mt. Sapo, 20 April, 1922. Barbour, Brooks, and Underwood.

Characters.— Similar to *P. m. macleannani* (Lawrence) of the Canal Zone, but much paler throughout; pileum much grayer, less brownish; front paler still, whitish gray; chest-band pale cinnamon-rufous and margins to feathers of back and lower underparts very pale buff.

Measurements.

No.	Sex	Locality	Wing	Tail	Tarsus	Culmen to base
87,352	♂	Mt. Sapo	94	89	33	21
87,353	♀	" "	88	85	31	23
87,354	♂	Rio Esnápe	93	87	32	22

71. Rhopoterpe stictoptera Salvin.

Eight adults, both sexes, Mt. Sapo, Rio Esnápe, and Jesusito, April, 1922.

So far as we know this species has not been recorded from anywhere south of Nicaragua, yet we are unable to separate our eastern Panama skins from Nicaraguan specimens with which we have compared them.

72. Pittasoma michleri michleri Cassin.

One adult female, Mt. Sapo, 21 April, 1922.

Although special effort was made to secure the large Grallaria-like birds, this was the only individual secured.

73. Hylopezus perspicillata perspicillata (Lawrence).

Two adults, male and female, Rio Esnápe and Jesusito, April, 1922.

On geographical grounds these two skins must be referred to true *perspicillata*. Judged by characters alone one should be referred here and one to *H. perspicillata lizanoi* (Cherrie). In running through a large series of the latter we find all its characters to be very variable and the form seems hardly worthy of recognition.

FURNARIIDAE.

74. Sclerurus mexicanus anomalus, subsp. nov.

Two adults, male and female, Mt. Sapo, April, 1922.

Type.— M. C. Z. 87,367 adult ♀, E. Panama: Mt. Sapo, 25 April, 1922. Barbour, Brooks, and Underwood.

Characters.— Similar in size and proportions to *S. m. pullus* Bangs of Costa Rica and Chiriqui but coloration much paler; the upperparts and belly warm sepia or Vandyke-brown; rump and upper tail-coverts chestnut. Similar also to *S. m. mexicanus* Sclater but bill much shorter and stouter and throat and chest paler (not far from Sanford's-brown in the new form, and from chestnut or tawny chestnut in *mexicanus*) and more sharply defined against the color of the lower underparts.

Measurements.

No.	Sex	Locality	Wing	Tail	Tarsus	Culmen
87,367	♀	Panama, Mt. Sapo	78	48	22.	23.
87,366	♂	" " "	80	50	21.	—
107,336	♂	" Loma del Leon	79	52	22.	23.5
107,337	♂	" " " "	82	54	22.5	24.

REMARKS.— This form, which usually has been referred to *S. m. mexicanus* in spite of the fact that a much darker subspecies, *C. m. pullus* Bangs, occurred in Costa Rica and Chiriqui cutting the range in two, appears to be quite distinct. It differs from true *mexicanus* conspicuously, the latter form having a much longer and more slender bill (culmen to base, 26 to 27.5 mm.) and in the color of the throat and chest which are paler and brighter in the Panama bird. In western Colombia another dark form *C. m. obscurior* Hartert occurs, even darker than *pullus* and dusky rather than brownish on the lower underparts. With the few Guatemalan specimens seen by us, we are unable to separate *S. m. certus* Chubb of Guatemala from true *mexicanus*. We have not seen any skins from Amazonia. As we know the species the northern races stand thus: —

1. *Sclerurus mexicanus mexicanus* Sclater.
   Southeastern Mexico to Honduras.
2. *Sclerurus mexicanus pullus* Bangs.
   Costa Rica and Chiriqui.
3. *Sclerurus mexicanus anomalus* Bangs and Barbour.
   Panama, Canal Zone to extreme eastern Panama.
4. *Sclerurus mexicanus obscurior* Hartert.
   Northwestern Equador and western Colombia.

In the field we were not able to observe any great differences in habits of some of the furnariids from the dendrocolaptids.

75. SCLERURUS GUATEMALENSIS GUATEMALENSIS (Hartlaub).

Six adults, both sexes, Mt. Sapo, Rio Esnápe, and Jesusito, April, 1922.

These skins are somewhat darker, more olive-brown, less rufous brown than specimens from Guatemala and British Honduras; they can, however, be matched by certain examples from southwestern Costa Rica and western Panama. They are probably somewhat intermediate tending a little toward *S. g. salvini* Salvadori and Festa of western Ecuador, which, however, we have not seen.

76. XENOPS GENIBARBIS RIDGWAYI Hartert and Goodson.

Three specimens, two males and a female, Mt. Sapo and Jesusito, April, 1922.

77. Philydor fuscipennis Salvin.

One somewhat immature female of this very rare species was secured at Rio Esnápe, 3 April, 1922.

78. Automolus pallidigularis pallidigularis Lawrence.

Four adult males, Mt. Sapo and Rio Esnápe, April, 1922.

DENDROCOLAPTIDAE.

79. Dendrocolaptes sancti-thomae sancti-thomae (Lafresnaye).

Two adult females, Jesusito, April, 1922.

These specimens are wholly referable to true *sancti-thomae* from which they differ only in slightly darker chestnut tails, a difference perhaps due to being freshly made skins as compared with old material. The range of *sancti-thomae* therefore extends through eastern Panama to western Colombia (see Chapman, Bull. Amer. mus. nat. hist., 1917, **36**, p. 427) and north probably along the Caribbean slope of Panama and Costa Rica, just to southeastern Mexico. The well-defined *D. s. hesperius* Bangs, occupies a narrow belt in western Panama, western Costa Rica, and western Nicaragua.

The six forms of dendrocolaptids collected all had more or less similar habits. They have, as is well known, the habit of creepers but often drill vigorously with their bills, making quite as much noise as a small woodpecker. Although we saw several columns of army-ants we did not find these birds coming to the ground to feed upon them or the insects which they stir about as the formicariids naturally did.

80. Xiphorhynchus lachrymosus lachrymosus (Lawrence).

One adult female, Mt. Sapo, 24 April, 1922.

81. Xiphorhynchus nanus nanus (Lawrence).

Two adult males, Jesusito, April, 1922.

82. Glyphorhynchus cuneatus pectoralis Sclater and Salvin.

Eleven adults, both sexes, Mt. Sapo. Rio Esnápe, and Jesusito, April, 1922.

83. Dendrocincla lafresnayei ridgwayi Oberholser.

Six adults, both sexes, Mt. Sapo, and Jesusito, April, 1922.

84. Dendrocincla homochroa ruficeps Sclater and Salvin.

One adult female, Mt. Sapo, 21 April, 1922.

COTINGIDAE.

85. Cotinga natteri (Boissoneau).

Ten specimens, adults of both sexes and immature males, Mt. Sapo, April, 1922.

This splendid bird was only taken at the "Cotinga Tree" near the Mt. Sapo camp. Shortly after this camp was located two long trails were cut leading up two high hog-back spurs of the main range. One of these led to the ridge called La Jarcia where trees were cut down until a fine look-out was cleared. From this look-out a maze of steep crests and valleys was disclosed. We were always looking for white Cotingas and several were seen from our clearing evidently visiting a feeding tree but it stood in an absolutely inaccessible spot. After this, search for feeding trees was redoubled and before many days a tree with ripe fruit, a small fig evidently, was found on another ridge only a mile or so from the camp. After this tree was located some one or other of the party kept a constant watch there every day from dawn until dark. No white Cotingas came to the tree but ten blues were collected. The buccos and Cotingas at large visited the tree at three very definite times of day. A few in the early morning but most about 8.30 A.M., then there was a lull and the tree had only an occasional visitor, usually some migrant warbler, until noon when for about an hour there was abundant visitation, thereafter little appeared until about 4 P.M. This last feeding period was distinctly the least important of the three.

The birds came to the tree in perfect silence simply appearing from out of the vast immensity of the surrounding forest, remaining a few moments and then leaving as they came. Several other feeding trees were seen but they grew on such precipitous slopes that retrieving the fallen birds would have been impossible, had one been able to find a place to stand and shoot once the tree was reached. It is sometimes easy to locate a feeding tree from a distance but identifying the same tree when one is close to it in the forest is often next to impossible.

86. ATTILA CITREOPYGA CITREOPYGA (Bonaparte).

One adult male, Mt. Sapo, 20 April, 1922.

A single example of this species appeared one morning and no other was seen.

87. LIPAUGUS HOLERYTHRUS HOLERYTHRUS Sclater and Salvin.

One adult male, Mt. Sapo, 24 April, 1922.

This skin is slightly richer and more rusty in color than northern specimens (Guatemala to Costa Rica) and thus approaches *L. holerythrus rosenbergi* Hartert, type-locality Rio Dagua, western Colombia.

These reddish cotingas came to the tree quite often and frequently in company with other species, so they were not always collected.

This species and the following are beyond doubt really congeneric.

88. LATHRIA UNIRUFA CASTANEOTINCTA Hartert.

Six adults, both sexes, Mt. Sapo, April, 1922.

Chapman says he cannot distinguish *L. u. clara* of Panama from *L. u. castaneotincta* of western Colombia and northeast Ecuador. The present series bears out what he has said, though Panama birds are on the whole a trifle, either paler or duller than those from western Colombia.

The larger "red cotinga" was the one species of the family that was sometimes identified and shot in the forest away from a feeding tree.

89. PACHYRHAMPHUS CINNAMOMEUS Lawrence.

Three adults, two males and a female, Jesusito, April, 1922.

This species was only killed in a feeding tree on the summit of a steep hill near our upper Jesusito camp.

90. TITYRA SEMIFASCIATA COLUMBIANA Ridgway.

One adult male, Mt. Sapo, 24 April, 1922.

This specimen is rather small, the wing-length being only 116 mm. The tail-pattern is typically that of *columbiana*.

This bird appeared once, almost at dusk, and the flash of white made us think that at last the *pajaro del Espiritu Santo* had appeared.

PIPRIDAE.

91. Manacus vitellinus vitellinus (Gould).

Six adults, both sexes, Rio Esnápe and Jesusito, April, 1922.
A common species in thickets along the stream-courses.

92. Pipra erythrocephala actinosa, subsp. nov.

Thirty specimens, adults of both sexes, and young males, Mt. Sapo, Rio Esnápe, and Jesusito, April, 1922.

Type.— M. C. Z. 87,170 adult ♂, E. Panama, 21 April, 1922. Barbour, Brooks, and Underwood.

Characters.— Similar to *P. e. erythrocephala* (Linné) but larger. The adult male, similar in color; adult female slightly paler olive-green above and slightly paler and grayer, less yellowish olive below. Wing in adult male, 58.01 (57–59); fifteen specimens.

Remarks.— After recognizing the slightly different form we have just named, *Pipra erythrocephala* is made up of four geographic races, as follows:—

1. *Pipra erythrocephala erythrocephala* (Linné).
   Surinam, Cayenne, Venezuela, Trinidad, etc. Small wing in adult male, 54.55 (53–56); head intense orange-yellow.
2. *Pipra erythrocephala actinosa* Bangs and Barbour.
   Eastern Panama to the Santa Marta Region of Colombia. Larger wing in adult male, 58.01 (57–59), male similar in color, female slightly paler.
3. *Pipra erythrocephala flammiceps* Todd.
   Santander, Colombia. Small wing in adult male, 53–54; head darker, more reddish orange.
4. *Pipra erythrocephala berlepschi* Ridgway.
   Bogota Region of Colombia to Peru. Large wing in adult male 61., (60–62); head pale yellow.

In all the forms the adult female is a little larger than the male, about 2 mm. on the average, in the length of the wing.

These little manikins were most amusing birds to watch. While on a long tramp one experience with these lively little feathered imps was most pleasing. It was late afternoon when attracted by a most surprising whirring and snapping of wings; and searching about for a moment a low tree was found literally swarming with yellow-headed manikins. They had evidently met by design and were strutting, bowing, raising and lowering their wings and generally going through such antics as one only expects from Birds of Paradise. No females were anywhere about and the observation was never repeated though the tree was revisited on various occasions.

93. PIPRA VELUTINA MINUSCULA Todd.

Ten adults, both sexes, Mt. Sapo and Jesusito, April, 1922.

Our skins are wholly referable to this well-marked form, lately described by Todd; its characters were, however, long before dwelt on at length by Hellmayr, who refrained from giving it a name only because he had no skins from Veragua, the type-locality of *P. velutina velutina* Berlepsch.

The little Blue-headed Manikin frequently came to the "Cotinga tree" but many specimens were taken elsewhere as well.

94. CORAPIPO ALTERA ALTERA Hellmayr.

Four adult males, Mt. Sapo, April, 1922.

We agree with Carriker that the short first primary is a character that separates *C. altera altera* Hellmayr and *C. altera heteroleuca* Hellmayr specifically from *C. leucorrhoa* (Sclater).

For some reason only four specimens of this very conspicuous bird were found, all in a small low coppet near camp.

95. SCOTOTHORUS TURDINUS STENORHYNCHUS (Sclater and Salvin).

Five adults, both sexes, Mt. Sapo, Rio Esnápe, and Jesusito, April, 1922.

96. SAPAYOA AENIGMA Hartert.

Eight adults, both sexes, Mt. Sapo, April, 1922.

This series of full plumaged spring birds, shows that the male (besides having a semiconcealed yellow crest which the female does not possess) is paler and much more yellowish olive-green than the female, especially on the underparts, the throat and chest being often quite yellow.

This species was abundant and confined to the stream-bottoms.

97. LANIOCERA RUFESCENS (Sclater).

One adult female, Mt. Sapo, 22 April, 1922.

This bird was taken at the "Cotinga Tree" in company with the various species of what our outfit came to call "red cotingas." It is almost impossible to believe that the bird does not really belong in that family.

TYRANNIDAE.

98. Onychorhynchus mexicanus fraterculus Bangs.

Nine adults, both sexes, Mt. Sapo, Rio Esnápe, and Jesusito, April, 1922.

The Paradise flycatchers were abundant and widespread. One observation at the time seemed very striking. Two birds were captured only slightly wounded, each acted in exactly the same way. The mouth was opened wide, the great crest fully expanded and then the head was slowly waved from side to side. Exactly the same motion was often enacted by a large rose-crested cockatoo which was shot and wounded near Wahaai, Ceram. A captive cockatoo subsequently repeated the minatory gestures whenever it was shown a snake. It is curious that birds having wide transverse crests but so far separated in the system should use such a similar method of attempting to terrify an enemy.

99. Oncostoma olivaceum (Lawrence).

Two adults, male and sex undetermined, Rio Esnápe and Jesusito April, 1922.

It is surprising that this was found to be a rare bird in eastern Panama, it is so common throughout most of its range.

100. Placostomus coronatus superciliaris (Lawrence).

Eight adults, both sexes, Mt. Sapo and Rio Esnápe, April, 1922.

Nests made of a filamentous lichen, great pendulous purses quite without form, were observed hanging from limbs above all the streams. None were occupied but the Indians said that they were made by this boat-billed flycatcher, which was rather abundant.

101. Craspedoprion olivaceus bardus, subsp. nov.[1]

Eight adults, seven males and a female, Mt. Sapo, Rio Esnápe, and Jesusito, April, 1922.

Type.— M. C. Z. 87,029 adult ♂, E. Panama: Mt. Sapo, 20 April, 1922. Barbour, Brooks, and Underwood.

[1] Bardus, a um. Inactive, dull, sluggish, etc.

CHARACTERS.— Similar to *Craspedoprion olivaceus aequinoctialis* (Sclater) of eastern Ecuador and eastern Colombia, but larger; upperparts brighter, yellower, less dusky olive-green; chest and breast paler, yellower; lower underparts much brighter yellow. Similar also to *C. o. flavus* Chapman of the Santa Marta region of Colombia and of about the same size; the upperparts similar, but underparts very much deeper and richer yellow, (lemon-yellow), on the belly; the olivaceus flammulations of chest and breast darker, less grayish. Wing in seven males, 74–77; in one female 71.

REMARKS.— In 1914 when Chapman named his *C. o. flavus* from Santa Marta he gave its range as extending north to Panama, explaining that lack of proper material had caused the Panama bird to be called *C. aequinoctialis*. At that time Chapman had two Panama skins only. Since then the American Museum has received a series from eastern Panama collected by Richardson, these have kindly been lent to us and agree exactly with ours, and differ much from a good series from Santa Marta lent by the Carnegie Museum (W. E. C. Todd).

The color of the underparts in *flavus* of Santa Marta is much nearer to the color of the underparts in *C. olivaceus guianensis* McConnell of the Guianas and Venezuela (the forms of course differ in other respects) than it is to the rich, bright yellow of the lowerparts in the new bird from eastern Panama.

102. TYRANNISCUS VILISSIMUS PARVUS (Lawrence).

One adult male, Mt. Sapo, 23 April, 1922.

This species may well be more abundant than the appearance of only a single specimen in the collection would indicate. Such excessively small birds are really only found by chance.

103. MYIOZETETES CAYANENSIS HARTERTI Bangs and Penard.

Three adults, two males and a female, Jesusito, April, 1922.

Though somewhat intermediate, these skins are nearer to *harterti* than to *M. c. hellmayi*, Hartert and Goodson, of western Colombia and northwest Ecuador.

This is one of a number of species which were only found about the lower Jesusito camp where there was more or less of a clearing near by. It was not a bird of the forest at all.

104. Myiozetetes granadensis Lawrence.

Two adults, male and female, Jesusito, April, 1922.

These are slightly darker above and perhaps a little deeper yellow below than Canal Zone birds, in this respect being like skins from western Colombia. This difference having already been pointed out by Chapman. It seems to us, as it did to Chapman, that the form is not worthy of recognition.

This is another species, with king bird-like habits to which the same remarks apply as the preceding.

105. Pipromorpha oleaginea parca Bangs.

Five adults, both sexes, Mt. Sapo, April, 1922, Rio Esnápe, and Jesusito.

106. Mionectes olivaceus hederaceus Bangs.

Four adults, both sexes, Mt. Sapo, April, 1922.

These specimens are much nearer *hederaceus* of western Colombia than they are to *M. o. olivaceus* Lawrence of Costa Rica and western Panama.

107. Cnipodectes subbrunneus subbrunneus (Sclater).

Four males, Rio Esnápe, April, 1922.

All large birds, (wing, 94–97 mm.).

Ridgway recognized a large and small species occurring together. Hellmayr claims that the small examples are immature, but retains the name *C. s. minor* Sclater for the form ranging from eastern Peru to western Brazil, which he says differs slightly in color.

This was an inhabitant of the deepest woods, whereas very few other members of the family were found there.

108. Myiobius atricaudus atricaudus Lawrence.

Two adults, male and female, Jesusito, April, 1922.

A common bird of the open clearings, this and many other tyrant birds abound near the Indian's field, but as we confined nearly all of our work to the forest, few appear in the collection.

109. Myiodius sulphureipygius aureatus Bangs.

Thirteen adults, both sexes, Mt. Sapo, Rio Esnápe, and Jesusito, April, 1922.

This species occurred not only about the open clearings but where there were small sun-lit openings along the streams as well.

110. TERENOTRICCUS ERYTHRURUS FULVIGULARIS (Salvin and Godman).

Five adults, both sexes, Mt. Sapo, Rio Esnápe, and Jesusito, April, 1922.

111. NUTTALLORNIS BOREALIS MAJORINUS Bangs and Penard.

One adult female, Mt. Sapo, 24 April, 1922.

One afternoon a small, dull colored bird came to the "Cotinga Tree," fed upon the fruit and was promptly shot. When picked up it proved to be this familiar compatriot. The date seems rather late.

112. MYIOCHANES VIRENS (Linné).

Three adults, male and two females, Mt. Sapo and Jesusito, April, 1922.

113. MYIARCHUS CRINITUS CRINITUS (Linné).

One adult female, Jesusito, 9 April, 1922.

114. MYIARCHUS FEROX PANAMENSIS (Lawrence).

One adult male, Mt. Sapo, 26 April, 1922.

115. MYIARCHUS TUBERCULIFER NIGRICEPS Sclater.

Four adult females, Rio Esnápe and Jesusito, April, 1922.

Another of the species most characteristic of the clearings.

116. MYIODYNASTES LUTEIVENTRIS Sclater.

Three adults, male and two females, Mt. Sapo and Jesusito, April, 1922.

These birds were shot from a feeding tree which was often visited from the upper Jesusito camp. The tree was very high and many birds escaped. This species was a frequent visitor and fed greedily on the fruit. The specimens shot staining freely about the vent from the fruit-juices after the manner of some Cotingas. It is hard to believe that this species is not in very truth a Cotinga and not a tyrannid at all. This, indeed, seems about certain.

117. Myiodynastes maculatus nobilis (Sclater).

One adult female, Mt. Sapo, 24 April, 1922.

This example agrees in all of the distinguishing characters, longer wing (109 mm.); olive not cinnamomeus pileum; much paler and on primaries much narrower, wing-edgings, and much more narrowly streaked undertail coverts, with *M. m. insolens* Ridgway of southeast Mexico. If that form were migratory, which we believe it is not, this skin would of course be referred to it. Probably our bird is in reality an aberrant example of *nobilis* which approaches very close to *insolens* through individual variation. We have often seen such instances before, sometimes with island forms.

This is another species from the "Cotinga Tree" which may be misplaced in the system.

118. Tyrannus tyrannus (Linné).

Three adults, two males and a female, Jesusito, April, 1922.

This and the following were common yellow-billed king birds of the clearings.

119. Tyrannus melancholicus chloronotus Berlepsch.

Three adults, two males and a female, Jesusito, April, 1922.

OXYRUNCIDAE.

120. Oxyruncus brooksi, sp. nov.

Three adults, male and two females, Mt. Sapo, April, 1922.

Type.— M. C. Z. 87,199 adult ♂, E. Panama: Mt. Sapo, 25 April, 1922. Barbour, Brooks, and Underwood.

Characters.— Similar to *Oxyruncus frater* (Sclater and Salvin) of Costa Rica and western Panama, but at once distinguished by having white, not yellow, underparts; similar also to *O. hypoglaucus* (Salvin and Godman) of British Guiana and with white underparts as in that form, but with upperparts, paler and brighter, more yellowish, olive-green; larger wing-coverts broadly margined with light yellow; secondaries also widely margined terminally with light yellow; underparts with smaller and fewer blackish spots (than in any form), which became very sparse and indistinct on flanks and sides; flanks and sides washed with dull pale yellow; tail shorter.

MEASUREMENTS.

No.	Sex	Wing	Tail	Tarsus	Exposed Culmen
87,199	♂	90	52	19	15.5
87,198	♀	88	50	19	16.
87,200	♀	91	51	19	17.

REMARKS.— It gives us great pleasure to name this fine new form in honor of W. Sprague Brooks, who did so much to make the trip a success.

To find in eastern Panama a very distinct and white-bellied sharp-bill was indeed a surprise. We are, however, rather inclined to believe, that the new form, in spite of its white underparts is more nearly related to the yellow-bellied *frater* than it is to the only other white-bellied form, *hypoglaucus* of Mt. Roraima.

We have not followed the custom of modern ornithologists in allowing subspecific rank only, to the various forms of the sharp-bill. The discontinuous distribution of the species in tropical America, together with the excellent characters shown, may well, we think, be used as an argument for considering them all full species. The birds have the habits of Cotingas and these specimens came to the feeding tree in company with several species of Cotingidae. It is not improbable that the Oxyruncidae is scarcely separable from the Cotingidae.

TURDIDAE.

121. HYLOCICHLA USTULATA SWAINSONII (Cabanis).

Four adults, both sexes, Mt. Sapo, Rio Esnápe, and Jesusito, April, 1922.

122. TURDUS TRISTIS DAGUAE Berlepsch.

Five specimens, three adults, two males and a female and two spotted young, Mt. Sapo, April, 1922.

A deep wood thrush with the actions and appearance of our familiar robin but naturally in a very strange setting.

TROGLODYTIDAE.

123. PHEUGOPEDIUS FASCIATO-VENTRIS ALBIGULARIS (Sclater).

One adult, male, Jesusito, 8 April, 1922.

Most of the tropical wrens encountered were birds of the scattered patches of thick coppet and of the tangles of vines and creepers in the deep lowland forest. Some species, however, were decidedly terrestrial with the habits of ant-thrushes.

124. Henicorhina leucosticta darienensis Hellmayr.

Eight adults, both sexes, Rio Esnápe and Jesusito, April, 1922.

125. Thryophilus nigricapillus schottii (Baird).

Four adults, both sexes, Jesusito, April, 1922.

126. Thryophilus galbraithii galbraithii (Lawrence).

Two adults, male and female, Mt. Sapo, 25 April, 1922.

Though these skins just match some individuals from the Canal Zone, they are, however, as Chapman has already pointed out, slightly darker and less rufescent than the average from that region; wherefore we agree that the differentiation is too trifling to be considered of subspecific value.

127. Microcerculus philomela luscinia Salvin.

Two specimens, male and female, Mt. Sapo, April, 1922.

One of these, an adult female, 86,985, has the feathers of the chest and breast, gray with W-shaped markings of grayish white at their tips, below which is a dusky spot. It is somewhat closely similar to a specimen (121,307 M. C. Z.) from El General, Costa Rica. The other, a male, perhaps somewhat immature, though its back is plain Vandyke-brown, without dusky bars, has the chest and breast dark brownish gray, the whole underparts, crossed by fine, faint dusky bars. This skin also is very much like some birds from Costa Rica. We follow Carriker, (Birds of Costa Rica, p. 753) in allowing but one form to Costa Rica and Panama, which for the present we consider a subspecies of *philomela* of Guatemala. We have had for comparison one specimen only, an immature individual from Guatemala, which matches closely some of the Costa Rican immatures.

This curious little creature has the mouse-like habits of the tiny rails only it was a denison of the deepest, darkest, high and rather open woods. Elsewhere it would never have been seen in any case.

128. Leucolepis lawrencii assimilis Todd.

Twelve specimens, adults and immature, both sexes, Rio Esnápe April, 1922.

CORVIDAE.

129. Cyanocorax affinis zeledoni Ridgway.

Five adults, both sexes, Rio Esnápe and Jesusito, April, 1922.

Though really a bird of the banana patches and clearings, a few specimens were seen and shot in the forest. It is a favorite pet with the Indians and a good many find their way, alive, to the market in Panama, where they are promptly bought up.

VIREONIDAE.

130. Vireosylva flavoviridis flavoviridis Cassin.

One adult female, Mt. Sapo, 25 April, 1922.

131. Vireosylva olivacea (Linné).

Three adults, two males and a female, Mt. Sapo, April, 1922.

At times these vireos simply swarmed in the top of our "Cotinga Tree." We were often fooled into shooting one of them by mistake for some more desirable species which had suddenly entered their company.

132. Pachysylvia minor Berlepsch.

One adult male, Mt. Sapo, 21 April, 1922.

This is apparently a new record for Panama. Our skin has been carefully compared with two specimens from Ecuador, (one from Naranjo, Province of Guayas, the other from Santa Rosa, Province del Oro), kindly lent us by the American Museum of Natural History of New York; it wholly agrees with these.

133. Pachysylvia ochraceiceps butunensis (Hartert).

Three adults, male, female and sex undetermined, Mt. Sapo, April, 1922.

Measurements.

No.	Sex	Wing	Tail	Tarsus	Culmen
87,014	♂	59	37	16	14.
87,013	♀	61	40	16	14.5
87,015	—	60	30	15.5	14.5

Nelson in describing his *P. o. brevipennis* from the Canal Zone, Panama, named an intermediate form, almost exactly intermediate between *P. o. butunensis* and *P. o. ochraceiceps* (Sclater) (or *P. o. pallidipectus* Ridgway, if the slight and inconstant characters that distinguish the Costa Rican form be considered sufficient to hold that subspecies). Our skins differ from a topotype of *P. o. brevipennis,* by having the whole upperparts, posterior to the tawny crown, including the wing-coverts, olive-green with no brownish tinge, and the under wing-coverts and inner edges of the primaries much brighter yellow. A skin from Cana, extreme eastern Panama (Coll. U. S. Biol. Surv.) is quite like ours.

HIRUNDINIDAE.

134. Stelgidopteryx ruficollis uropygialis (Lawrence).

Two adult males, Jesusito, April, 1922.

Swifts and swallows were often seen high above the forest and some swallows flew about the Indian plantations. The only swallows seen in the forest were some which flew in and out of the dark woods near the lower Jesusito clearing. They always entered and emerged from the thick vegetation near the ground and at exactly the same spot, so we assumed they were nesting, but the nests were never located.

MNIOTILTIDAE.

135. Dendroica castanea (Wilson).

Seven specimens, both sexes, Mt. Sapo, Rio Esnápe, and Jesusito, April, 1922.

These are all in complete or nearly complete nuptual plumage.

The last date on which Bay-breasted warblers appeared in the "Cotinga Tree" was April 25th.

136. Wilsonia canadensis (Linné).

Five adults, both sexes, Mt. Sapo, April, 1922.

Every one of these birds was taken on April 22nd. None were seen before or after that date.

COEREBIDAE.

137. Chlorophanes spiza arguta, subsp. nov.

One adult female, Mt. Sapo, 20 April, 1922.

Type.— M. C. Z. 108,199 adult ♂, W. Panama: Divala, 29 October, 1900. W. W. Brown, Jr.

Characters.— Similar in size and proportions to *C. spiza exsul* Berlepsch of western Ecuador and western Colombia, but adult male, much darker green, in color as in *C. spiza guatemalensis* Sclater, Guatemala to Nicaragua, but at once distinguished from that form by smaller size and much shorter bill.

Remarks.— This new form ranges from Costa Rica (possibly from western Nicaragua) to eastern Panama. Its characters were long ago pointed out by Bangs, (Proc. Biol. soc. Washington, 29 June, 1906, **18**, p. 185) who, however, referred it to *exsul* having but one skin of that form for comparison. Additional material shows *exsul* to be decidedly paler green. This has also lately been pointed out by Lönnberg (Arkiv för zool., 1922, **14**, no. 25, p. 83).

C. s. spiza Linné can be distinguished without difficulty from either *exsul* or this new form. The decidedly bluish color of *spiza*, especially of the median lower underparts, always distinguishing it.

Another species taken in the "Cotinga Tree" and one which we probably should have collected more often, except that these small visitors were often mistaken, unless they got into the lower branches, for migrant vireos and warblers.

138. Dacnis cayana ultramarina (Lawrence).

Four specimens, three immature males and a female, Mt. Sapo, April, 1922.

These were occasionally killed by a chance shot taken at small birds seen flitting about the very high trees. We never got an adult male, much to our disappointment.

139. Coereba mexicana mexicana (Sclater).

One adult male, Mt. Sapo, 25 April, 1922.

This single skin is almost intermediate between *C. m. mexicana* and *C. m. columbiana* Cabanis but is perhaps somewhat nearer the former.

This was the only Coereba killed, as we did no collecting about the plantations, feeling that our best chance of getting rarities lay in concentrating every effort to get birds of the high forest.

ICTERIDAE.

140. Zarhynchus wagleri wagleri (Gray).

One adult male, Jesusito, 14 April, 1922.

We were constantly finding colonies of *oropendulas* but generally neglected to bring in specimens thinking that this could always be done with the result that it was usually left undone.

141. Cacicus cela vitellinus Lawrence.

Five adults, both sexes, Rio Esnápe and Jesusito, April, 1922.

142. Icterus galbula (Linné).

One adult male, Jesusito, 20 April, 1922.

A gorgeous bird came to one of the high feeding trees which we were watching and when shot proved to be this familiar species.

TANGARIDAE.

143. Tangara fulvicrissa fulvicrissa (Sclater).

One adult female, Mt. Sapo, 23 April, 1922.

We cannot, with a single female, be sure as to the subspecies, but think our bird is referable to true *fulvicrissa* rather than to *T. f. omissa* (Hartert) of Colombia.

144. Tangara palmeri Hellmayr.

Three males, two adult, one immature and one skeleton, Mt. Sapo, April, 1922.

It was a great pleasure to have four of these lovely tanagers visit the "Cotinga Tree." All were secured. We never saw one elsewhere and they were quite new to the natives.

145. Tangara gyroloides gyroloides (Lafresnaye).

One adult male, Mt. Sapo, 23 April, 1922.

This specimen belongs distinctly to this subspecies (according to

Hellmayr's ruling on the races of *gyroloides*) and not to *T. g. bangsi* of Costa Rica and western Panama.

To the favoring tree we also owe this, as well as the following, addition to the collection.

146. TANGARA INORNATA LANGUENS, subsp. nov.

One adult male, Mt. Sapo, 25 April, 1922.

TYPE.— M. C. Z. 107,508 adult ♂, Panama: Loma del Leon, 25 March, 1900. W. W. Brown, Jr.

CHARACTERS.— Similar to *T. i. inornata* (Gould) of Colombia and of about the same size, but paler and duller gray throughout; the crown, rump, and upper tail-coverts much less decidedly bluish; throat, sides of neck and sides much paler and duller, less bluish gray.

REMARKS.— Since we must now separate the Panama bird from the true *T. inornata* (Gould) of Colombia, it becomes necessary to examine carefully the status of the name "*C. ornata*," introduced by Lawrence in 1861.

The name "*ornata*" should not be used for the Panama form of *Tangara inornata* (Gould) because it was merely a *lapsus* for *inornata*. This is quite obvious from the circumstances surrounding its introduction. All forms, intended as new, were printed in heavy type and Lawrence would hardly have called one of the plainest of all the Callistes, *ornata*.

In an earlier paper (Ann. Lyc. nat. hist. N. Y., 1861, **7**, 298) Lawrence listed some Panama specimens of this species, under the name *Calliste inornata* Gould, expressing doubt as to whether they might not be the young of *C. franciscae* with which he was unacquainted. In the later paper (*Loc. cit.*, p. 332) in which he used *ornata* he simply mentions that the acquisition of young birds of *C. franciscae* established the *specific validity* of *ornata* (*i. e. inornata* the species). This was all he intended to do. He was not naming a new form. The characters he gave are purely those of the species and not of the Panama form. Indeed he does not in any manner refer to Panama specimens in this paper, unless by assuming a *lapsus* we revert to the specimens listed under *inornata* in his earlier paper.

This being the case, we are justified on purely nomenclatural grounds of designating the type-locality of *ornata* and rather than retain the name in its present doubtful state, we now designate the type-locality to be Bogotá, thus making *C. ornata* Lawrence a pure synonym of *C. inornata* Gould, regardless of whether the former be considered a *lapsus* or not.

We have selected a bird from the Canal Zone as the type of the new form so as to bring the type-locality as near to the northern and western end of the range of the subspecies as possible.

147. Thraupis cana cana (Swainson).

One young male from Mt. Sapo, 26 April, 1922.

We refer the bird to this form rather than to *T. c. diaconus* (Lesson), admitting, however, that with only one young bird in hand this allocation is little more than a guess.

Blue tanagers abound about the Canal Zone and all the clearings in Darien but are excessively rare in the woods. They are distinctly a bird of the savanna or drier districts.

148. Heterospingus xanthopygius (Sclater).

One young specimen (sex not determined) in nestling plumage, Mt. Sapo, 25 April, 1922.

This fine little bird was one of a party which came to the "Cotinga Tree" but once. Other specimens were seen about the flowers on another tree-top which could not be approached. They reminded one of the Cuban oriole in habits.

149. Ramphocelus dimidiatus dimidiatus Lafresnaye.

Two specimens, an immature male and adult female, Mt. Sapo, April, 1922.

A common species outside the forested area. *R. icterocephalus* was also constantly seen about the Darien "*platanales*" but none were killed.

150. Tachyphonus luctuosus panamensis Todd.

Two adult males, Rio Esnápe and Jesusito, April, 1922.

151. Eucometis cristata cristata (Du Bus).

Eight adults, both sexes, Mt. Sapo, Rio Esnápe, and Jesusito, April, 1922.

152. Chlorothraupis olivacea (Cassin).

Eleven adults, both sexes, Mt. Sapo, April, 1922.

153. MITROSPINGUS CASSINII CASSINII (Lawrence).

Three adults, two males and a female, Mt. Sapo, April, 1922.

Never seen except when a small band visited the Mt. Sapo "Cotinga Tree."

FRINGILLIDAE.

154. ARREMON AURANTIIROSTIS STRICTOCOLLARIS Todd.

Three adults, two males and a female, Rio Esnápe, April, 1922.

This fine finch was far more often seen about the edges of the clearings than in the heavy woods.

155. SPOROPHILA AURITA AURITA (Bonaparte).

One female, Mt. Sapo, 25 April, 1922.

156. CYANOCOMPSA CYANOIDES CYANOIDES (Lafresnaye).

One adult male, Rio Esnápe, 3 April, 1922.

157. PITYLUS GROSSUS SATURATUS Todd.

Three adults, two males and a female, Mt. Sapo and Rio Esnápe, April, 1922.

Bulletin of the Museum of Comparative Zoölogy

AT HARVARD COLLEGE.

Vol. LXV. No. 7.

THE BLACK FINLESS PORPOISE, MEOMERIS.

By Glover M. Allen.

With Three Plates.

CAMBRIDGE, MASS., U. S. A.:

PRINTED FOR THE MUSEUM.

January, 1923.

No. 7.— *The Black Finless Porpoise, Meomeris.*

By Glover M. Allen.

Among the collections brought back by Mr. F. R. Wulsin after a year's stay in China are three skeletons and an entire body of the small porpoise, *Meomeris phocaenoides*, a species of which very little is known and but few skulls or skeletons are preserved. Almost simultaneously (Ann. mag. nat. hist., August, 1922, ser. 9, **10**, p. 233) the announcement comes that another entire specimen has been received by the British Museum from Hankow, China, concerning which additional details are promised. In the meanwhile, since the opportunity has never before occurred to make direct comparison of a series of skeletons, the following notes are offered, together with such few observations on the gross anatomy as the condition of the entire specimen permitted. Thanks to the kindness of Mr. Gerrit S. Miller, Jr., I have also had for study the single skeleton of Meomeris in the U. S. National Museum (unfortunately without indication of locality) so that, in all, five skeletons are available.

History.

The history of the species is brief. It was first made known by Baron Georges Cuvier (1829) who, in the second edition of his Règne Animal, included it among "Les Delphinaptères" remarking: "M. Dussumier a découvert au Cap, une espèce de ce sous-genre, qui a la tête ronde, et les dents comprimées et obtuses du marsouin." He named it "*D[elphinus] phocaenoides*." In the English edition of the Règne Animal, by McMurtrie (1831, **1**, p. 209) it is included formally as *Delphinapterus phocaenoides*. The type is doubtless one of the two skulls in the Muséum d'Histoire Naturelle at Paris. According to True (1889) who examined them in 1883–84, these are:

> "No. A. 3087. Skull. Coast of Malabar. Dussumier. Type of *D. phocaenoides* Cuvier.
>
> "No. A. 3086. Skull. Cape of Good Hope."

That the Malabar specimen is considered the type in spite of Cuvier's statement that the original specimen was from the "Cap" (always the Cap de Bonne Espérance) is perhaps due to a later labeling. At all events, Van Beneden and Gervais (1868–80) in their Ostéographie, make no mention of Cuvier's locality, but credit the species to Dussumier with the statement that he procured it on the Malabar coast. A review of the evidence seems to indicate rather clearly that Cuvier was mistaken in assigning his specimen to the Cape. In a sketch of Dussumier's six voyages as a trader to India and the East Indies, Cuvier (1830) gives a most interesting account of the work of this versatile navigator. It was on his fifth voyage, concluded in 1827, that he undertook to gather information concerning the smaller cetaceans, and succeeded in bringing back "six espèces de Dauphins ou de Delphinaptères" in addition to large numbers of fishes and other animals. His chief collecting was done along the coasts of the Indian peninsula. Dussumier had evidently planned to publish his notes on the cetaceans but did not do so. Some of the species are named and figured, however, by E. Geoffroy St. Hilaire and F. Cuvier (1824–29) who credit Valenciennes with drawing up the actual descriptions. Among these, the only one from the Cape of Good Hope is "*Delphinus capensis,*" apparently a Phocaena, with prominent dorsal fin and $\frac{26\text{-}26}{23\text{-}23}$ teeth. Dussumier (1827), in a letter addressed to the Administration of the Paris Museum 14 October, 1827, himself reports briefly on the collections made during this notable voyage. Speaking of the cetaceans collected, he refers to the Finless Porpoise as "une espèce voisine des Delphinaptères, et manquant comme eux de nageoire dorsale." He considers it probably "un sous-genre nouveau par la différence de la tête qui, au lieu de resembler à celle des Marsouins, est tout-à-fait obtuse."

Pucheran (1856) in revising the cetaceans in the Paris Museum, seems to have been the first to suspect an error in ascribing the species to the Cape of Good Hope. He adduces some notes on Dussumier's *Delphinus capensis* (which he considers a Phocaena) and gives an account of a mounted skin, supposed to be from the Cape, with which apparently, Cuvier's type skull of "*D. phocaenoides*" had in some way become associated. Pucheran, commenting on this, feels certain that the two specimens cannot be from the same animal and suggests that the skin is probably "*Delphinus peronii*" (= *Lissodelphis peronii*), a species likewise without dorsal fin; while the skull, though certainly of Dussumier's collecting, is probably from some other locality; for after a careful examination of the latter's various manuscript catalogues of his collections, he finds no single mention of the Cape of Good Hope save in case of the *Delphinus capensis*, which is clearly stated to be from "la rade du Cap de Bonne-Espérance."

The evidence of Dussumier's catalogues seems fairly conclusive for he was a painstaking collector and made full notes on his specimens. Moreover, no subsequent examples have ever been taken on the South African coasts, which with their strong currents and lack of estuaries are perhaps unsuited to this species. Therefore, although included in Sclater's (1901) Mammals of South Africa and attributed to the Cape of Good Hope by many writers on the basis of Cuvier's statement, it should, nevertheless, be excluded from the known African fauna until its occurrence can be definitely established.

It is surprising that this should be the only one of the new species collected by Dussumier that was left unfigured; nor is it mentioned in F. Cuvier's volume on the Cetacea. J. E. Gray, however, appreciating the peculiarities of the skull, which he saw at Paris, in 1846 erected for the species the new genus Neomeris (preoccupied for a genus of polyps) under which it has generally been known.

The next specimen to reach Europe was one from Japan, described and figured in the Fauna Japonica by Temminck (1850) who states (p. 7) that he owes to "M. Burger le dessin et le squelette d'un petit Delphinaptère nouveau, très remarquable, qui sera décrit sous le nom de *Delphinapterus melas*." On a subsequent page (p. 14 of "Les mammifères marins") of this work the name *Delphinus melas* is used instead, with a footnote calling attention to the fact that the name has already been applied "pour désigner le *D. globiceps*," and stating at the same time that Cuvier's description of *D. phocaenoides* is too brief to make it certain that the Japanese animal is identical. This specimen was doubtless from the vicinity of Nagasaki, southern Japan, where for many years the Dutch had maintained a "factorerie." The figure of the exterior supplied by Burger was made under his supervision by a Japanese artist and represents a wholly black animal. Its proportions are much too slender while the depression shown at the back of the head gives an appearance of a distinct neck which is lacking in reality. No indication of the prominent dorsal ridge appears, though this may be due to faulty reproduction. The skeleton is briefly described and its important parts are figured. This account is the source of most subsequent mentions of the skeleton, which is still preserved in the museum at Leyden. It was examined by True (1889, p. 114) who misspells the collector's name as Brüger. According to the Japanese fishermen, these porpoises have the habit of making their way into the muddy waters of tidal marshes. The native name is given by Temminck as Namino-iwo (True spells it Nameno-juo) signifying "fish of the waves" from its rising frequently to the surface for air.

Aoki (1913) in his hand-list of Japanese and Formosan mammals, gives the Japanese name as Sunameri, but adds no further information.

Nearly twenty years later, Sir Richard Owen (1869) writing of the Indian Cetacea collected by Sir Walter Elliot, briefly mentions as "Sp. dub. *Delphinapterus molagan*, Owen," what was doubtless this same porpoise. His source of information was a drawing, subsequently lost, "copied from one made in the Chief Engineer's Office at Madras for Col. Monteith, which was taken from an individual, 32 inches long, of a uniform black colour, with a rounded obtuse head, small mouth, and *no dorsal*. The Tamil fishermen called it 'Molagan'," which suggested the specific designation. By a curious slip of the pen, True (1889, p. 116) in referring to this account, gives "the vicinity of the Cape of Good Hope" as the origin of the specimen on which Owen's name was based. It probably came in reality from the Indian coast near Madras.

There was at this time a skeleton of the species in the museum of the Asiatic Society of Bengal, at Calcutta, purchased at the Calcutta fish-bazaar 26 July, 1860 (Blyth, 1863); and Sclater (1891, p. 318) mentions a stuffed skin without locality in the same institution, perhaps from the same individual as the skeleton. Malm (1871) also included the species in his list of the cetaceans preserved in Swedish museums, 1869, on the basis of a skeleton in the Riks museum at Stockholm, but from his description it seems very probable that this represents some other species, probably a Phocaena.

In 1884, Murray obtained a specimen of this genus on the coast of Sind at Kurrachee, and believing that it represented a species distinct from the Japanese, he named it *Neomeris kurrachiensis*. The distinction was based on a supposed difference in the number of teeth, $\frac{21}{20}$ instead of $\frac{20}{19}$, and on the possession of a "purplish-red patch in front of the snout (on the upper lip) and on the throat." But the tooth formula given is within the range of individual variation while the purplish red instead of gray areas are probably to be explained by a discoloration due to the congestion of blood in the dead animal, for the colors of cetaceans are now known to change very quickly after death, especially if exposed to heat and sun.

A brief but valuable account of the habits of this porpoise is contributed to the Journal of the Bombay Natural History Society for 1886, by "A Member of the Society" who signs himself "Keswal." The article deals with western India, Konkan and coast, and is one of the sources of Blanford's (1888–91) account of the species. This writer (who was perhaps W. F. Sinclair of Bombay, a correspondent of Sir W. H. Flower) was well acquainted with the "Bhulga," as the Finless Porpoise is known to the native fishermen of that coast. He obtained three specimens, one of them a gravid female weighing sixty pounds, and having a total length between perpendiculars of 4 feet 2 inches. It is perhaps this specimen and foetus that later were sent to the British Museum, where Kükenthal studied the dermal denticles in the unborn young. A fairly good figure of the exterior, drawn by R. A. Sterndale, accompanies the account by "Keswal," and is reproduced by Blanford (1888–91).

Although J. E. Gray in his catalogue of the osteological specimens in the British Museum, published in 1847, includes a skull of this species received from the Paris Museum, it does not appear in the later catalogues of the cetaceans of that institution up to 1885. Possibly the specimen was merely on loan and was subsequently returned to the Muséum d'Histoire Naturelle after Gray had studied it in connection with his synopsis of the Cetacea, published in 1846 as part of the zoölogical reports of the voyage of the EREBUS and TERROR. Apparently the first specimen to be received at the British Museum, as well as the first to be discovered in fresh water, was one taken in 1888 off Ichang, in the "Yang-tse-kiang nearly a thousand miles from the sea." Flower and Lydekker (1891) refer to it briefly as differing from Indian examples only "in wanting a patch of small horny tubercles on the back." They add that "as such tubercles are present or absent in otherwise similar examples of *P[hocaena] communis,* it is doubtful whether they can be regarded as constituting a specific character"; a point well taken, since Wulsin's Chinese specimen from Kiang-su is normal in this respect.

More recently Lydekker (1909) has described and figured the exterior of one taken by fishermen of Travancore, India, and purchased by the local Trivandrum Museum. The figure appears to be from a rough sketch but indicates a considerable area of grayish white about the lips and on the fore part of the throat.

No additional examples seem to have been reported until the nearly simultaneous arrival of one from Hankow (Yangtse River) at the British Museum as mentioned by Hinton and Pycraft (1922) and the four received by the M. C. Z. as a result of Mr. Wulsin's collecting in China. Of these latter, one was obtained in a fresh-water stream flowing into Tung-Ting Lake, Province of Hunan, 120 miles south of Yo-chow, a record quite as remarkable as that from Ichang (Lydekker, 1909a). The lake is the type-locality of the lately discovered dolphin, Lipotes, and empties into the Yangtse. The great river and its larger affluents evidently form a common resort for the Finless Porpoise, for Mr. Wulsin's three other specimens were captured in a small tributary coming in near its mouth, at Kiang-yin, Province of Kiang-su, eighty miles northwest of Shanghai. Here the Chinese capture them by hanging a number of iron hooks from a stout cord, as a sort of barrage across part of the stream. If a porpoise strikes against a hook so that the point penetrates its skin, its subsequent struggles only serve to entangle it more firmly among the other hooks and cords, until it is drowned or captured.

Nomenclature.

First described by Cuvier in 1829 as a member of the genus Delphinus, in the broad sense as then used, it was shortly after transferred to Delphinapterus by McMurtrie, in 1831. Gray, in 1846, made it the type of a special genus, Neomeris, a name under which it has been subsequently known by most writers, although as pointed out by Flower (1883), the name is preoccupied for a genus of polyps. Nevertheless Neomeris is used by both Flower (1883) and True (1889) in their reviews of the Delphinidae, both however with the reservation that the genus might eventually be relegated to the synonymy of Phocaena, from which it chiefly differed in the absence of a distinct dorsal fin, a course which Blanford (1888–91) formally adopted. Nevertheless, Neomeris continued in use until Palmer (1899), again calling attention to its unavailability, proposed instead the new name Neophocaena. Very recently, however, Thomas (1922) has reviewed the whole matter and has reached a different conclusion. Referring to Gray's (1847) List of the osteological specimens in the collection of the British Museum, it appears that he includes under "Neomeris, Gray," "The Finless Porpesse. Meomeris phocaenoides." Whatever may have been Gray's intention, and although Meomeris seems to be an "obvious misprint," it nevertheless constitutes a new generic name with a designated type-species that is perfectly identifiable. By this ruling, already tacitly accepted in other cases, Meomeris becomes the proper generic name. Thomas further points out that the misprint Nomeris in an article by Coues, in the Century Dictionary, 1890, is in a similar case, and would have been available except for the earlier misprint of Gray!

Fortunately there are but few specific names applied to the species. These are, in addition to the original designation: *melas* of Temminck, *molagan* of Owen, and *kurrachiensis* of Murray. The detailed synonymy of the species follows.

Meomeris phocaenoides (G. Cuvier).

Delphinus phocaenoides G. Cuvier, Règne animal, 1829, ed. 2, **1**, p. 291. . . "Au Cap [de Bonne Espérance]."

Delphinapterus phocaenoides McMurtrie, Cuvier's Animal kingdom, 1831, **1**, p. 209.

Neomeris phocaenoides Gray, Zool. Voy. H. M. S. Erebus and Terror, 1846, **1**, Mamm., p. 30.

Meomeris phocaenoides Gray, List osteol. specimens British mus., p. 36. Thomas, Ann. mag. nat. hist., 1922, ser. 9, **9**, p. 676 (*genus validum*).

Delphinapterus melas Temminck, Siebold's Fauna Japonica. Mammifères, 1850, p. 7 (Aperçu général).

Delphinus melas Temminck, Siebold's Fauna Japonica. Mammifères, 1850, p. 14 (Mammifères marins), pl. 25–26 (not of Traill).

Neomeris melas Pucheran, Rev. et mag. zool., 1856, ser. 2, **8**, p. 551.

Delphinapterus molagan Owen, Trans. Zool. soc. London, 1869, **6**, p. 24.

Neomeris kurrachiensis Murray, Ann. mag. nat. hist., 1884, ser. 5, **13**, p. 351.

Phocaena phocaenoides Blanford, Fauna of British India. Mammalia, 1891, p. 574.

Nomeris melus Coues, Century Dict., 1890, **4**, p. 4449 (under Phocaena), misprint.

Neophocaena phocaenoides Palmer, Proc. Biol. soc. Washington, 1899, **13**, p. 23.

Neomeris sp., Lydekker, Proc. Zool. soc. London for 1908, 1909, **2**, p. 806.

Phaoecana phocaenoides Robinson and Kloss, Journ. Fed. Malay states mus., 1918, **8**, p. 79.

Illustrations.

Published figures illustrating the exterior or the anatomy of this porpoise are few and for the most part unsatisfactory. For convenience they are summarized as follows: —

Temminck, C. J., 1850, pl. 25–26; generalized profile view of exterior, outline figures of skull, teeth, cervicals, sternum, pectoral limb, dorsal vertebra.

Van Beneden, P. J., and Gervais, P., 1868–80, pl. 56, fig. 1–4; four views of cranium and jaw, probably of the type in the Paris Museum.

"Keswal," 1886, plate; profile sketch of exterior by R. A. Sterndale. The outline shows the rounded forehead and heavy front portion of body, and is a decided improvement over Temminck's figure.

Blanford, W. T., 1891, p. 575, fig. 187; a reduced copy of Sterndale's sketch (in "Keswal," 1886).

True, F. W., 1889, pl. 34; reproduces Temminck's figure of the exterior and Van Beneden and Gervais's dorsal view of the skull.

Kükenthal, Willy, 1889–93, pl. 16, fig. 24, 25; view of the embryo in British Museum, and a portion of integument showing horny papillae.

Lydekker, Richard, 1909, pl. 44, lower fig.; rough sketch in profile, showing the gray lips. The same figure is reproduced in Lydekker, 1909a, fig. 21 The head is misshapen, a distinct neck is shown, and the dorsal ridge begins and ends too far forward.

Specimens in Museums.

A list of the specimens recorded as preserved in the museums of the world includes some ten skulls or skeletons outside the four brought back by Mr. Wulsin. Of these, Cuvier's type skull is still in existence at Paris, and the skeleton on which Temminck based his *Delphinus melas* is at the Museum in Leyden. Although not specifically so stated, it is assumed that Murray's type of *Neomeris kurrachiensis,* or at least the skull, is preserved in the Kurrachee Museum. Doubtless there are others in some of the Indian museums of which no record is available, for "Keswal" (1886) had three specimens, one of which is perhaps that received from Bombay by the British Museum. The following include all that are known to me: —

Paris, Muséum d'Histoire Naturelle.
- skull, A. 3086, [Malabar], Cuvier's type.
- skull, A. 3087, Malabar coast.
- skins, mounted, ? two (*fide* Kükenthal, 1890).

Leyden, Musée des Pays-Bas.
- skeleton, type of Temminck's *Delphinus melas*, Japan.

London, British Museum (Natural History).
- skeleton, ♀, Gulf of Bombay.
- foetus from same specimen.
- mounted skin and skeleton, ♀, Ichang, China.
- cast of one taken off Travancore, India.
- entire specimen from Hankow, China.

Calcutta, Museum of the Royal Asiatic Society.
- mounted skin and skeleton, adult ♂, Calcutta.

Kurrachee, India, Kurrachee Museum.
- skull (? skeleton), Kurrachee, type of *Neomeris kurrachiensis* Murray.

Travancore, India, Trivandrum Museum.
- adult, Travancore (cast and ? bones).

Washington, D. C., United States National Museum.
- skeleton, 49,544, no history.

Cambridge, Mass., Museum of Comparative Zoölogy.
- four, including the skeletons, three skins and parts in alcohol.

Distribution.

It appears from the foregoing review that the eastward range of Meomeris, so far as certainly known, includes the coasts of southern Japan and the region about the mouth of the Yangtse River, as well as the river-system itself for a distance of nearly a thousand miles from the sea, to Ichang (where the gorges begin), and southward to Tung-Ting Lake and its larger affluents. It is at present unknown from all the area between the mouth of the Yangtse and the Ganges, but its occurrence in the coastal waters of the intermediate region can hardly be doubted, and future collecting must be relied upon to establish definite records. From Calcutta southward to Madras, and along the entire west coast of the Indian peninsula it is well known, though I have found no record of it for Ceylon. The Sind coast, whence Murray obtained the specimen he described as *Neomeris kurrachiensis,* is at present the most western locality known, though no doubt it will be found at least as far as the Persian Gulf. The supposed occurrence at the Cape of Good Hope is shown to be almost certainly erroneous, so that as yet there is no evidence of its presence in African waters.

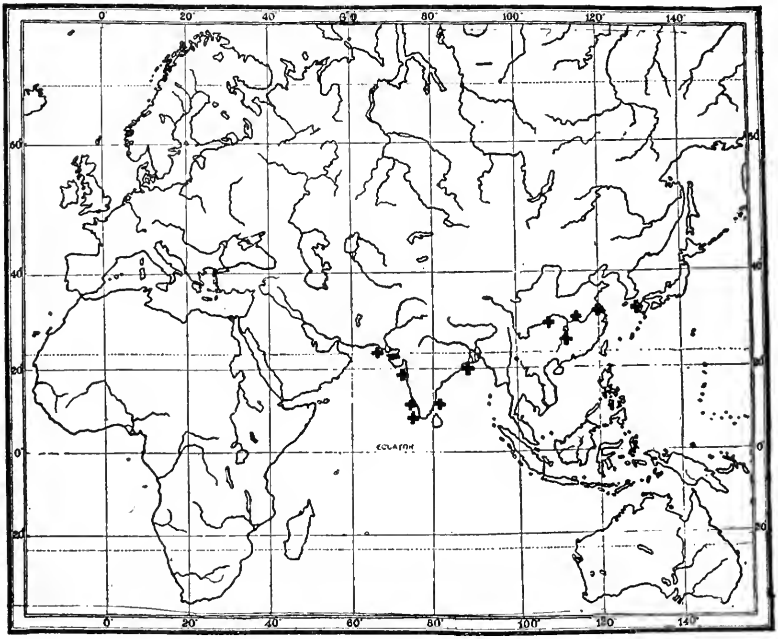
It is not to be overlooked that although its range is assumed to be continuous from the Japan Sea to the western Indian Ocean, future investigation may prove that the species is local in its distribution, restricted to certain favorable coasts and rivers. On the map (p. 242) the localities where individuals are known to have been captured are marked with a cross, +.

Habits.

The brief account given by "Keswal" (1886) contains nearly all the information that has been published as to the habits of this porpoise. Writing of the Bombay coast, he says that they live chiefly in the shallow salt-water tidal creeks and sounds among the reefs and islands. They are seldom seen in companies of more than four or five, and indeed are usually solitary. Like the Harbor Porpoise (Phocaena) they "roll" when rising for breath, and are rather sluggish in their movements, never jumping and frisking like the dolphins. This, it may be said, is true in general of all the smaller blunt-nosed cetaceans in contrast to the beaked forms which are as a rule more active and frequently leap out of water. Temminck's brief statement, that in the Japanese waters, this species "vit le long des côtes de cet empire, et qu'elle a l'habitude de s'enfoncer dans le limon des endroits marécageux" further testifies to its preference for shallow near-shore waters.

Nothing is known of the breeding habits. The foetus in the British Museum is said by Kükenthal (1890) to be 520 mm. long, or nearly half the length of the parent (1190 mm.).

Food.— The stomach of the individual obtained by Murray (1884)



Distribution of Meomeris.

contained "Crustacea (species of Penaeus)." The stomach examined by "Keswal" (? W. F. Sinclair) contained "many prawns (Palaemon), mostly of large size, 3 to 5 inches long; three very small 'bones' of sepias, the largest $2\frac{1}{2}$ inches, and one pen of a squid (Loligo)." That shrimp-like crustaceans form a large part of the diet is further indicated by the stomach-contents of one of Mr. Wulsin's specimens from Kiang-su Province, lower Yangtse, that consisted chiefly of shrimp remains of a species which Dr. Waldo S. Schmidt of the U. S. N. M. has kindly identified as *Palaemon japonicus* (Ortmann). Dr. Schmidt adds that this species has also been reported from Hankow, and he has it as well from Pe-chi-li Gulf, China. In addition to a mass of these shrimps, this stomach contained the spinal cords of two small fishes.

External Characters.

The external form (Plate **1**) is rounded and chunky, rather heavy forward, with tapering posterior end. In comparison with Phocaena, to which the genus obviously bears a close relation, the shape of the head is characteristic, being shorter and much more globose, recalling that of a Blackfish (Globicephala) with its full rounded front. This contour is continued evenly back from the forehead without any indication of a depression at the neck such as appears in Temminck's (1850) figure and Lydekker's (1909) sketch. "Keswal" (1886) gives the "live weight" of a gravid female, four feet two inches long, as sixty pounds avoirdupois.

Occupying about the third quarter of the distance between the snout and notch of flukes, is a prominent compressed dorsal ridge which reaches its highest point (about 25 mm.) about halfway of its length. In the specimen examined, this ridge bears three rows of small horny papillae which are faintly traceable on the midline for about 150 mm. anterior to the commencement of the ridge. Posteriorly they end abruptly at a point slightly behind its summit which corresponds therefore to the tip of the dorsal fin in Phocaena. The papillae of the two outer rows usually stand in the same transverse line while those of the middle row alternate with them except at the highest part of the ridge where all three are in line. No other indications of papillae were found, though Kükenthal (1890, 1889–93) reporting on the foetus in the British Museum, describes longitudinal rows of small papillae extending from the cheeks backward along the sides of the body and suggests that they are the vestiges of a dermal armor. The tail is practically like that of Phocaena in the shape of its flukes, except that the notch is possibly wider. The outline of the pectoral, however, differs greatly in being more nearly crescentic or scimitar-shaped, with the forward edge evenly recurved to the acuminate tip.

Size.— Except for the few external measurements given by Murray (1884) and Lydekker (1909), there are practically no series of dimensions published. "Keswal" (1886) gives 50 inches for the length, "between perpendiculars" of a gravid female he captured at Bombay. The individuals recorded by the two other authors were each 45 inches long, but the sex is not stated. Kükenthal (1890) gives 47 inches as the length of the female from which came the foetus in the British Museum, but this measurement was probably from the mounted skin, and possibly of the same individual that "Keswal" recorded. Of Mr. Wulsin's four examples, two were males and two females. The three largest of these he measured himself, and the smallest, which was brought back entire, I measured. The largest, a male, is the only one that seems fully adult, while the two next in size though apparently mature, still have many epiphyses distinct, and the smallest is probably a young adult.

TOTAL LENGTH OF MEOMERIS.

No.	*Sex*	*Inches*	*MM.*	*Authority*
19,996	♂	62.5	1,580	F. R. Wulsin
19,997	♂	57.75	1,460	"
19,998	♀	49.6	1,250	"
20,000	♀	49.2	1,245	G. M. Allen
—	♀ gravid	50.0	1,268	"Keswal," 1886
—	?	45	1,140	Murray, 1884
—	?	45	1,140	Lydekker, 1909
—	?	32	810	Owen, 1869

So far as these measurements go, they indicate a larger size for the males than for adult females, the largest male exceeding the largest female by a foot. The girth of Mr. Wulsin's larger male was 880 mm., that at the neck 72; length of pectoral 260.

The dimensions of his smallest specimen, between perpendiculars, follow.

MEASUREMENTS OF ♀, M. C. Z. 20,000.

	mm.
Snout to notch of flukes	1,245
" " commencement of dorsal ridge	585
" " highest point of same	735
" " posterior end of same	935
" " anus	850
" " anterior insertion of pectoral	230
" " posterior insertion	310
" " eye	80
" " angle of mouth	50
" " posterior edge of blow-hole	90
Eye to anterior insertion of pectoral	150
Width across both flukes	430

	mm.
Length of left fluke, notch to tip	210
Greatest breadth of fluke	110
Diameter of peduncle at commencement of flukes	30
Depth of notch between flukes (about)	20
Pectoral, greatest length	265
" greatest width	85
" length of the insertion	80
Length of genital groove (about)	100
Anus to urethral opening	45
Length of mammary slit	17
Chin to angle of mouth (on surface)	75
Angle of mouth to eye (" ")	45
Distance across corners of mouth	100

Color.— Observers of living or freshly killed specimens record the general color as "leaden black," or "plumbeous," lighter below, with pale gray areas on the throat and lips. Lydekker mentions also "numerous irregularly disposed, narrow lead-coloured streaks on the under surface of the lower jaw." In all Wulsin's specimens he noted that the lips were gray, the eyes pink. The one brought back in alcohol still showed indications of paler areas in these places. Its upper lip is narrowly edged with gray; but the lower lip is black from the angle of the mouth about halfway to the chin, then gray to the tip of the jaw, with a black submental spot. The rest of the throat, below a line running from the angle of the jaw to slightly above and including the insertion of the pectoral, is gray. The pale area is continued back slightly beyond the axilla ventrally on each side, but in the mid-ventral line the dark body-color extends forward in a V-shaped point to within about 135 mm. of the chin. The left pectoral is black except its anterior edge and distal half ventrally, which are gray. The right pectoral has only the basal half of the under surface gray.

Hairs.— Kükenthal (1890) describes four hairs on each side of the upper lip in a foetus 520 mm. long, preserved in the British Museum.

Anatomical Notes.

Blowhole.— This is of the usual shape among the Delphinidae: — a crescent with its concavity directed forward. Opening into the nasal passage just below it by a single elliptical orifice is a well-developed air-sac which extends forward above the intermaxillaries as a shallow pocket on each side for about 40 mm. Its greatest width is about 60 mm., and there is the usual pair of ridged cushions on each side that serve to close it. The stout epiglottis is median and projects about 30 mm. into the lower end of the nasal passage. Its upper end has the usual flexible lip or cover for closing the orifice.

GENITALIA.— The vaginal opening lies in the same groove with the anus and about 45 mm. anterior to it. There is a well-developed clitoris partly enfolded by two ridge-like lips, tapering anteriorly. The mammae are situated one on each side exactly opposite the vaginal opening.

KIDNEYS.— The kidneys are long-oval in shape, much flattened, about 145 by 45 mm., the adrenal bodies 25 by 13 mm. The kidneys show the composite or reticulate structure typical of cetaceans.

DIGESTIVE TRACT.— The tongue is short and wide with broadly rounded tip, free at the edge only. In the Common Porpoise (*Phocaena phocaena*) the edge of the tongue is thrown into narrow folds, but no such appearance could be made out in this specimen. The stomach is essentially as in Phocaena, with a large, somewhat heart-shaped anterior portion, thin-walled; then a thick-walled smaller chamber of oval form, corresponding to the true stomach; following this is a thin-walled tubular portion bent upon itself and slightly constricted at the turn, corresponding to the third and fourth divisions of the cetacean type of stomach. This portion communicates by a small opening with the fifth chamber which is merely a constricted portion of the same tube and merges with the small intestine. In the specimen examined it was the first compartment alone that contained food. Evidently considerable digestion takes place here, for of the shrimps it contained, only the more or less decalcified remains of the skeleton were left, and of the fishes, only two backbones, from which all the flesh had been digested away. Murray (1884) remarks that the intestines of his specimen were 31 feet long. No measurements of value could be taken from Mr. Wulsin's entire specimen; but the rectum was seen to be well-marked by a constriction where the small intestine ended. The length of the rectum was 130 mm.

SKELETON.

SKULL.— The skull (Plate 2) differs markedly from that of Phocaena by its shortened and broadly rounded instead of sharply tapering beak, and the flattened dorsal surface of the maxillaries and intermaxillaries. The pterygoids are more cut away at the sides, the condylar surface of the occiput is absolutely greater, and the basicranial axis is much more bent, forming with the plane of the palate an angle of about 45° instead of 35°. This last point comes out very clearly by producing backward the intermaxillary profile. In Meomeris this plane passes just below the vertex of the skull at about one third the height of the cranium above the temporal fossa, whereas in Phocaena it passes very much below the vertex and cuts the upper part of the temporal fossa. These important structural differences may be considered of generic value. Immature examples show conspicuous vacuities one at each side of the occiput above the condyles. The knob-like swellings at the proximal end of the intermaxillaries are essentially similar in both genera.

The teeth vary somewhat in form and number. One or two may be implanted in each intermaxillary, but in only one of the five skulls examined (U. S. N. M. 49,544) are there two in each of these bones. In the four others there are: one on each side (19,998); two in the right intermaxilla and one in the left (19,996); and one in the right and two in the left (19,997, 20,000). These intermaxillary teeth are short terete spicules, barely cutting the gum and are only about one half the height of the first maxillary teeth. These latter have their crowns undifferentiated in form from the cylindrical root, but the succeeding teeth are provided with laterally compressed spatulate crowns, the more posterior of which may show a faint median crease or nick, more apparent from the outer side in the upper teeth, and from the inner in the lower teeth. Of the lower teeth the anterior one or two on each side are similar to those corresponding in the upper jaw, minute spicules, less than one half the height of the succeeding teeth. Some specimens have the teeth more crowded than others so that there is an actual overlapping. In 19,998, the six posterior teeth of the upper jaw overlap so that their anterior edge is turned outward, while in the six teeth in front of these the overlap is in the opposite direction with the anterior edge of each tooth turned inward. The total number of teeth in the five skulls is as follows: —

No.	*Right upper*		*Left upper*		*Right lower*	*Left lower*	*Total*
	intermax.	*max.*	*intermax.*	*max.*			
U.S.N.M.							
49,544	2	18	2	17	16	16	$\frac{20-19}{16-16}$
19,996	2	15	1	15	16	15	$\frac{17-16}{16-15}$
19,997	1	16	2	17	17	18	$\frac{17-19}{17-18}$
19,998	1	18	1	18	18	17	$\frac{19-19}{18-17}$
20,000	1	19	2	17	19	18	$\frac{20-19}{19-18}$

Murray (1884) notes $\frac{21}{20}$ teeth in the Kurrachee specimen; Temminck (1850) gives $\frac{16}{16}$ as the number in his Japanese example, but this is probably a mistake for his figure clearly shows $\frac{18}{18}$ for the left side. Lydekker (1909) for the Travancore skull records $\frac{20\text{-}21}{19\text{-}20}$.

The five skulls measure as follows: —

	M.C.Z. 19,996	M.C.Z. 19,997	M.C.Z. 19,998	M.C.Z. 20,000	U.S.N.M. 49,544
Tip of rostrum to foramen magnum	215	205	204	204	220
" " " to maxillary notch	90	87	86	87	91
" " " to front edge of blow-hole	120	125	121	119	124
Tip of rostrum to vertex	170	173	170	169	180
" " " to median spine of palate	120	113	115	115	127
Greatest width	151	145	138	141	156
Width of rostrum at maxillary notches	71	70	67	68	79
" across occipital condyles	71	70	71	73	76
Length of upper tooth row	68	68	64	67	75
" " lower tooth row	64	68	64	65	71
" " mandible	165	159	157	153	170

At the vertex of the skull the frontals meet to form a thickened and slightly overhanging ridge which in the four Chinese skulls has a transverse width at the summit of about 30 mm. In the U. S. N. M. skull (locality unknown) there is a very low ridge which is not so markedly produced upward. In this specimen also the maxillary notches form a right-angled outline instead of a deep emargination.

The tympanic bulla closely resembles that of Phocaena but the periotic is very different, especially on the medial aspect. The posterior process of this bone tapers to a sharp instead of broadly rounded point, and the rounded anterior process is shorter and more bent down. In Phocaena the round pit leading in to the cochlea forms the ventral part of an oval depression (internal auditory meatus) of which the dorsal part is equally open and pit-like, whereas in Meomeris, this ventral portion is sharply separated by a bony ridge and the dorsal part is almost completely roofed over to form the beginning of the facial canal (*aqueductus Fallopii*) for the passage of the seventh nerve through the petrosum. In this respect Meomeris probably represents a much more primitive condition than Phocaena.

Vertebral Column.— Temminck was the first to describe the axial skeleton, and, omitting Malm's (1871) brief account of a skeleton at the Riks museum, Stockholm, as probably referring to some other species, Lydekker (1909) is apparently the only other writer to supply additional information. The number of vertebrae recorded by these authors and the counts in the five specimens I examined are as follows.

Vertebrae of Meomeris.

	Cervicals	*Dorsals*	*Lumbars*	*Caudals*	*Total*
Temminck, 1850	7	13	14	29	63
Lydekker, 1909	7	14	12	26	59
U. S. N. M. 49,544	7	13	13	26	59
M. C. Z. 19,996	7	13	13	29	62
M. C. Z. 19,997	7	13	13	28(+1)	62
M. C. Z. 19,998	7	13	12	28(+1)	61
M. C. Z. 20,000	7	13	12	31	63

Compared with *Phocaena phocaena* there are many and wide differences in the vertebral column. The atlas and axis are solidly fused, and even in the youngest of the five specimens examined, the third cervical is well anchylosed with the latter, though the sutural outlines in this specimen are still visible. The three anterior cervicals therefore are invariably fused together by their centra and dorsal portions while the neural spine of the atlas is broadened and produced backward so as completely to conceal the spines of the two other vertebrae fused with it. The four remaining cervicals are free and their centra increase progressively in length. In adult examples of *Phocaena phocaena* the *six* anterior cervicals are normally fused while their centra are much more reduced in length, a more progressive character. The lateral processes of the atlas are practically absent in Meomeris, but in Phocaena are prominently developed. A great difference also is seen in the dorsal spines of the thoracic and lumbar vertebrae, which in Phocaena are broad in profile, and high (nearly thrice the height of their centra) while in Meomeris they are narrow and relatively low (barely as high as their centra). In three of the five Meomeris, the tips of the neural spines on dorsals and lumbars are more or less bifid, some of the more anterior having a deep cleft at the summit, others having a posterior notch of varying depth. In most cases the division is asymmetrical with the right or the left portion more anterior indifferently. These notched spines occur in vertebrae 11 to 30, 13 to 28, and 12 to 23 in the three specimens respectively. The dorsal spine becomes obsolete on the 48th, 49th, 46th, 50th, and 51st vertebrae in the five skeletons.

The chevron bones, on account of their loose attachment and small size, are somewhat difficult to determine accurately, especially in immature specimens in which the terminal ones are not always completely ossified. In those that I was able to prepare carefully, there were twenty pairs (19,996, 20,000). The last one or two pairs are minute and consist of two separate flattened nodules that are too small to meet ventrally. In one specimen the halves of the first and second chevrons of the series are unfused in the median line but the two of the left-hand side have become fused forming a bridge across the intervening centrum. The few succeeding these first pairs have the longest keels.

Ribs.— Lydekker (1909) records fourteen pairs of thoracic ribs in the Travancore specimen. In the six other skeletons here noticed, there are thirteen pairs. Blanford's (1888–91) statement that there may be twelve pairs, is apparently based on Malm's (1871) record which obviously relates to some other species. Most interesting, however, is the fact that in all five skeletons I examined as well as in the Japanese skeleton reported on by Temminck (1850) there is in addition a pair of vestigial ribs in connection with the seventh cervical. This vertebrae has a long, round-pointed transverse apophysis along the lower side of which the vestigial rib lies in the same position as the portion with tubercular articulation in the ribs succeeding. The cervical rib itself varies greatly in size and shape in the different specimens and even on opposite sides of the same specimen (Plate **3**, fig. 6). It is best developed and most regularly shaped in 19,998, with a distinct tuberculum and a tapering capitular portion. The right cervical rib of this specimen is the larger and is solidly fused at its distal end, with the first thoracic rib, producing therefore a two-headed rib such as has been described for the Sulphur-bottom or Blue Whale (Turner, 1871). In no case was there any facet found for a capitular articulation of this cervical rib. The retention of this vestigial pair of ribs appears to be normal for Meomeris, and may be regarded as a character of generic value.

The first thoracic rib has a distinct capitular articulation with the seventh cervical. In one of the five skeletons, there were but six pairs of ribs having both capitular and tubercular attachments, but in all four of the others examined as well as in Lydekker's specimen, the number is seven, and the same is true of Temminck's Japanese skeleton (*fide* True, 1889). The *three* anterior pairs of thoracic ribs regularly articulate with the sternum by means of their sternal ribs. This is true in four of the five specimens examined and is shown also in Temminck's figure. In one case (U. S. N. M. 49,544), however, the fourth pair of sternal ribs articulates at the extreme posterior end of the sternum (Plate **3**, fig. 2); in the others the fourth pair joins the end of the sternum through the intervention of a cartilaginous bar, which in some cases may ossify with age. The fifth pair of sternal ribs has a strong cartilaginous attachment to that in front, while the sixth, seventh, and in one case an eighth very small pair, have similar but more slender attachments. The number of sternal ribs therefore corresponds usually with the number of thoracic ribs provided with two articular heads. The posteriormost pair of ribs is practically floating with the barest attachment to the elongated transverse apophyses of its vertebra, but those immediately in front articulate with the shorter and stouter transverse processes of their respective vertebrae by a well-defined flattened surface.

Sternum.— The form of the sternum in the five specimens is illustrated by the outlines, ventral aspect, of Plate **3**, fig. 1–5. As usual in Cetacea it shows great individual variation, partly correlated with age, with a tendency to break down into the original centers of ossification by the appearance of a median vacuity and lateral notches. Compared with that of Phocaena it is more reduced with at least one less rib articulation. The anterolateral corners are the thickest portions and have a slight emargination which is bridged by the distal end of the first sternal rib.

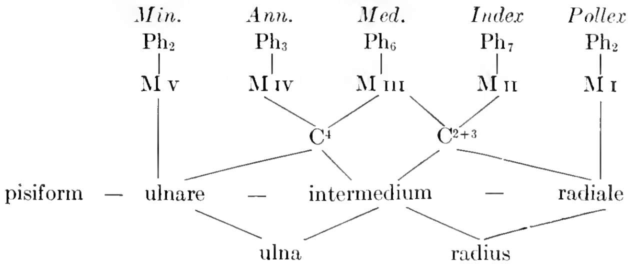
Fore Limb.— The scapula is not essentially different from that of Phocaena, and has strongly developed acromion and coracoid processes. The bones of the upper arm differ however, in that the humerus is much longer in proportion to the other bones. Compared with a large specimen of *Phocaena phocaena*, the humerus of an adult Meomeris is a full third longer although radius and ulna are of about the same length in both.

The number and relations of the bones of the wrist are not always easily determined for they do not become completely ossified until late in life and are therefore likely to be lost or isolated unless carefully prepared. Compared with *Phocaena phocaena* the structure of the carpus is practically identical. In only one of the five skeletons of Meomeris is the ossification of all the elements complete (Plate **3**, fig. 10). In all the others, even though the specimens are of nearly full size the carpal bones are separated from one another by the cartilage in which they are embedded. As described by Turner (1909) in Phocaena, there are in Meomeris the usual three proximal bones: radiale, intermedium, and ulnare. The radiale articulates proximally with radius and intermedium, distally with metacarpals I and II, and the more radial of the two carpalia. The intermedium touches radius and ulna, as well as radiale, both carpalia, and ulnare. The ulnare articulates with ulna, intermedium, the outer carpale, metacarpal V, and the pisiform. As in Phocaena, there are but two distocarpals, "the minimum number found in the Odontoceti" (Turner, 1909), of which the more radial is considered to represent a fusion of carpalia 2 and 3, while the more ulnar, supporting the fourth metacarpal, is taken to be carpale 4. The first and fifth carpalia are normally lacking. The fused carpal 2 and 3 articulates proximally with the intermedium, laterally with radiale and carpale 4, and distally with the inner borders of metacarpals II and III. Carpale 4 articulates proximally with intermedium and ulnare, laterally with the other carpale, and distally with the outer corner of metacarpal III, the entire base of metacarpal IV, and the inner corner of metacarpal V. The pisiform is at the extreme outer edge of the ulna. In the adult it articulates with the ulnare. It ossifies late in development and in animals not fully adult does not appear. It is not shown in Temminck's figure.

In the single old specimen (19,996, Plate **3**, fig. 10) the ulnare has a marked lateral prolongation continued out along the base of the broad fifth metacarpal to meet the small pisiform. This is in contrast to the condition in immature animals in which the ulnare is shorter than the base of metacarpal V. Possibly this prolongation of the ulnare in old animals originates from a second smaller center of ossification which would represent the fifth carpale. It is therefore most interesting to find that in the left carpus of 19,997, and the left only, there is a distinct minute fifth carpale imbedded in cartilage between the outer tips of ulnare and metacarpal V (Plate **3**, fig. 9, c^5). This is normally absent, but it may be that its center of ossification develops late and fuses with that of the ulnare to form the outer prolongation mentioned. The cause of its reduction or disappearance is doubtless to be found in the displacement of the fifth digit to a more posterior position so that the corresponding carpale is squeezed out, as it were, between metacarpal V and ulnare.

The full number of phalanges is somewhat difficult to ascertain because the ossification centers do not reach complete development until the animal is fully mature. In the oldest specimen, they are:

2, 7, 6, 3, 2 for the respective digits, which is one additional in all but the fourth finger, to the formula given by Turner for Phocaena. In the younger specimens not so many can be made out if ossification centers only are counted. The metacarpals and phalanges of digits II, III, and IV have distinct epiphyses ossifying from separate centers, but in digits I and V these seem to be suppressed. The normal hand formula according to the scheme given by Turner is



Pelvic bones.— These are small spindle-shaped bones in the usual position directly above the anus. They are thicker at one end, and in the largest example are 65 mm. long.

Summary.

Of this rare porpoise about a dozen specimens are preserved in the museums of the world. Its range comprises the shallow coastal waters from western India to southern Japan, and the Yangtse River system of China for nearly a thousand miles from the sea. Presumably it occurs on the coasts of the Malay peninsula and eastern India although no specimens are recorded from this intermediate region. Its supposed occurrence at the Cape of Good Hope is shown to be erroneous. Its chief food appears to be shrimps of the genera Penaeus and Palaemon, indicating perhaps that it feeds in large part near the bottom or in shallow depths. Externally it is dark slaty black with gray lips and throat. Although its relationship to Phocaena is undoubtedly close, there are excellent generic characters in the more rounded shape of the head, lack of dorsal fin, attenuate pectoral fin, the shortened and much more deflected rostrum (probably correlated with bottom feeding), the lesser degree of fusion and reduction of the cervical vertebrae, the normal possession of a pair of vestigial cervical ribs, lesser development of neural spines, reduction of the posterior part of the sternum, proportionately longer humerus, and (perhaps) increased number of phalanges.

LITERATURE.

Aoki, B.

1913. A hand-list of Japanese and Formosan mammals. Annot. zool. Japon., **8**, p. 261–353.

Beneden, P. J. van, and Gervais, Paul.

1868–80. Ostéographie des cétacés vivants et fossiles comprenant la déscription et l'iconographie du squelette et du système dentaire de ces animaux ainsi que des documents relatifs à leur histoire naturelle. Paris, 4to, viii, 634 pp.; atlas, folio.

Blanford, W. T.

1888–91. The fauna of British India including Ceylon and Burma. Mammalia. London, xx, 617 pp., 199 figs.

Blyth, Edward.

1863. Catalogue of the Mammalia in the Museum, Asiatic Society. Calcutta, [i], 187, [ii]–xiii pp.

Cuvier, Georges.

1829. Le règne animal distribué d'après son organisation, pour servir de base à l'histoire naturelle des animaux et d'introduction à l'anatomie comparée. Paris, ed. 2, 5 vols.

1830. Rapport fait à l'Académie royale des sciences, sur les collections rapportées récemment de la mer des Indes par M. Dussumier, de Bordeaux. Ann. sci. nat., ser. 1, **21**, p. 458–468.

Dussumier, J. J.

1827. [Letter to the Administration of the Muséum d'histoire naturelle at Paris regarding collections made on his fifth voyage to India,— dated 14 October, 1827.] Mém. Mus. d'hist. nat. Paris, **15**, p. 378–384.

Flower, W. H.

1883. On the characters and divisions of the family Delphinidae. Proc. Zool. soc. London, 1883, p. 466–513, fig. 1–9.

Flower, W. H., and Lydekker, Richard.

1891. An introduction to the study of mammals living and extinct. London, xvi, 763 pp., 357 figs.

Geoffroy-Saint Hilaire, Etienne, and Cuvier, Frédéric.

1824–29. Histoire naturelle des mammifères, avec des figures originales, coloriées, dessinées d'après des animaux vivans. Paris, folio, 3 vols., plates.

Gray, J. E.

1847. List of the osteological specimens in the collection of the British museum. London, xxv, 147 pp.

Hinton, M. A. C., and Pycraft, W. P.

1922. Preliminary note on the affinities of the genus *Lipotes*. Ann. mag. nat. hist., ser. 9, **10**, p. 232–234.

"Keswal" [? = W. F. Sinclair].
1886. Waters of western India. Part II.— Konkan and coast. Journ. Bombay nat. hist. soc., **1**, p. 153–175, plate.

Kükenthal, Willy.
1889–93. Vergleichend-anatomische und entwickelungsgeschichtliche untersuchungen an walthieren. Denkschr. Med.-nat. gesellsch. Jena, **3**, p. i–x, 1–448, pl. 1–25.
1890. Ueber reste eines hautpanzers bei zahnwalen. Anat. anz., **5**, p. 237–240.

Lydekker, Richard.
1909. On an Indian dolphin and porpoise. Proc. Zool. soc. London for 1908, **2**, p. 802–808, pl. 44–45.
1909a. Guide to the whales, porpoises, and dolphins (order Cetacea), exhibited in the department of zoology, British museum (Natural History). London, 46 pp., 33 figs.

Malm, A. W.
1871. Hvaldjur i Sveriges museer, år 1869. Kongl. Svenska vet.-akad. Handl., ser. 2, **9**, pt. 1, no. 2, 104 pp., 6 pls.

M'Murtrie, Henry.
1831. The animal kingdom arranged in conformity with its organization, by the Baron Cuvier . . . translated from the French, with notes and additions. New York, 4 vols., plates.

Murray, J. A.
1884. A contribution to the knowledge of the marine fauna of Kurrachee. Ann. mag. nat. hist., ser. 5, **13**, p. 348–352.

Owen, Richard.
1869. On some Indian Cetacea collected by Walter Elliot, Esq. Trans. Zool. soc. London, **6**, p. 17–47, pl. 3–14.

Palmer, T. S.
1899. Notes on three genera of dolphins. Proc. Biol. soc. Washington, **13**, p. 23–24.

Pucheran, Jacques.
1856. Notices mammalogiques. Rev. mag. zool., ser. 2, **8**, p. 545–552.

Sclater, W. L.
1891. Catalogue of Mammalia in the Indian museum, Calcutta. Part 2. Rodentia, Ungulata, Proboscidea, Hyracoidea, Carnivora, Cetacea, Sirenia, Marsupialia, Monotremata. Calcutta, xxix, 375 pp.
1901. The mammals of South Africa. **2.** Rodentia, Chiroptera, Insectivora, Cetacea, and Edentata. London, xii, 241 pp., illustr.

Temminck, C. J.
1850. Aperçu général et spécifique sur les mammifères qui habitent le Japon et les îles qui en dépendent. Les mammifères marins. Siebold's Fauna Japonica. Mammalia. Leyden, 4to, 59, 26 pp., 29 pls.

Thomas, Oldfield.
1922. The generic name of the Finless-backed porpoise, formerly known as *Neomeris phocaenoides*. Ann. mag. nat. hist., ser. 9, **9**, p. 676–677.

True, F. W.

1889. Contributions to the natural history of the cetaceans, a review of the family Delphinidae. Bull. 36, U. S. N. M., 191 pp., 47 pls.

Turner, William.

1871. On the so-called two-headed ribs in whales and in man. Journ. anat. phys., **5**, (ser. 2, **4**), p. 348–361.

1909. The skeleton of a Sowerby's whale (*Mesoplodon bidens*) stranded at St. Andrews, and the morphology of the manus in Mesoplodon, Hyperoodon and the Delphinidae. Proc. Roy. soc. Edinburgh, **29**, p. 687–720, fig. 1–11.

EXPLANATION OF PLATES.

PLATE 1.

PLATE 1.

Figs. 1, 2.— The smallest Finless Porpoise collected by Mr. F. R. Wulsin, side and front views respectively of the fresh specimen (M. C. Z. 20,000).

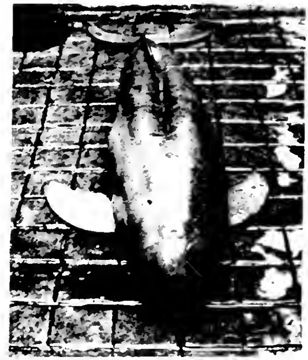
Fig. 3.— Dorsal view of flukes, same specimen.

Fig. 4.— Dorsal view of left pectoral fin, same specimen.

Fig. 5.— Head from above, same specimen.

Fig. 6.— Head in profile, same specimen. The four last views were taken from the preserved porpoise after reaching Cambridge; the deep creases at the sides of the neck are due to buckling of the skin in transit.

1



2

3

4

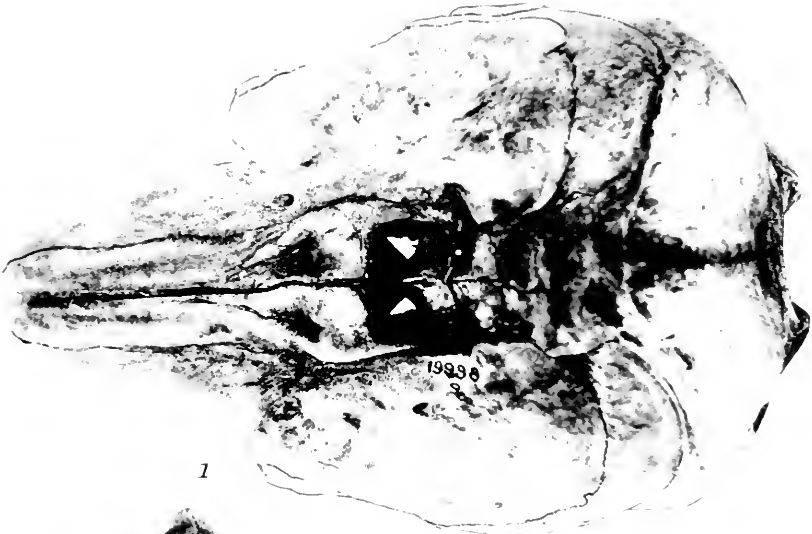
5

6

PLATE 2.

PLATE 2.

Fig. 1.— Cranium, dorsal view. M. C. Z. 19,998. × 0.5.
Fig. 2.— Same in profile. × 0.5.
Fig. 3.— Same, ventral view. × 0.5.



1

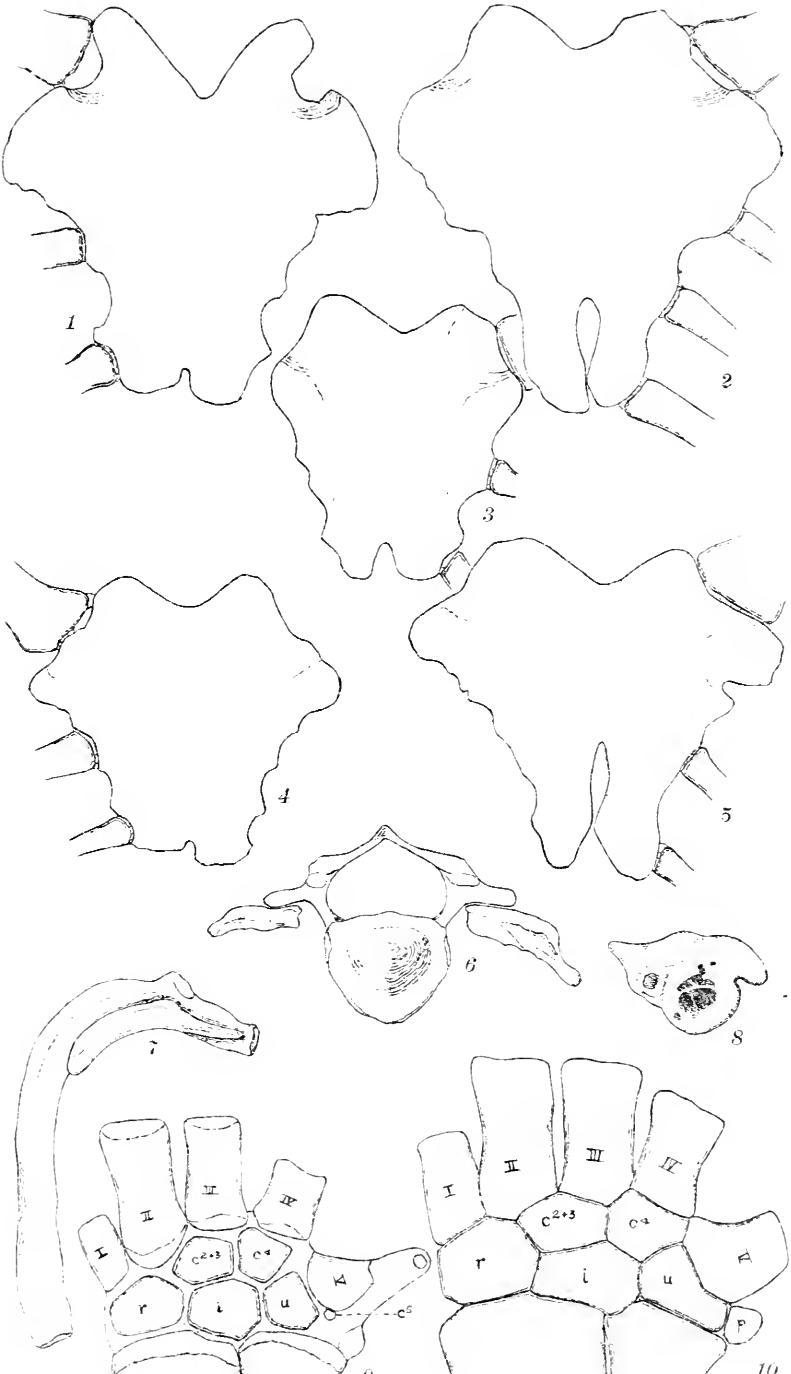
2

3

PLATE **3**.

PLATE 3.

Fig. 1.— Sternum, ventral view, M. C. Z. 19,996, adult male. × 0.6.
Fig. 2.— Same, U. S. N. M. 49,544, showing four sternal ribs. × 0.6.
Fig. 3.— Same, M. C. Z. 19,998, female. × 0.6.
Fig. 4.— Same, M. C. Z. 20,000, female. × 0.6.
Fig. 5.— Same, M. C. Z. 19,997, male. × 0.6.
Fig. 6.— Seventh cervical with two vestigial ribs in place, M. C. Z. 19,996. × 0.6.
Fig. 7.— Right cervical rib fused distally with first thoracic rib, M. C. Z. 19,998. × 0.6.
Fig. 8.— Petrous bone of the ear, medial aspect, M. C. Z. 19,997. × 0.8.
Fig. 9.— Dorsal view of right carpus, in which the elements are not yet completely ossified. A vestigial carpale 5 appears, exceptionally, M. C. Z. 19,997. × 0.6.
Fig. 10.— Right carpus completely ossified, M. C. Z. 19,996. × 0.6.


1
2
3
4
5
6
7
8
I
II
III
IV
V
c2+3
c4
r
i
u
c5
9
I
II
III
IV
V
c2+3
c4
r
i
u
p
10

Bulletin of the Museum of Comparative Zoölogy

AT HARVARD COLLEGE.

Vol. LXV. No. 8.

MAMMALS FROM DARIEN.

By Glover M. Allen and Thomas Barbour.

CAMBRIDGE, MASS., U. S. A.:

PRINTED FOR THE MUSEUM.

February, 1923.

No. 8.— *Mammals from Darien.*

By Glover M. Allen and Thomas Barbour.

In a previous paper (Bangs and Barbour, 1922) are listed the birds brought back from eastern Panama by the junior author and W. S. Brooks during a brief sojourn (March to May, 1922) in that country. This article gives an account of the expedition and a sketch of the conditions obtaining in the country traversed. In addition to other vertebrates (see Barbour, 1923), nearly one hundred mammals were collected, two of which represent hitherto undescribed forms. In as much as the publication of Major Goldman's (1920) excellent treatise on the mammals of Panama has laid such a satisfactory basis for further investigation, it seems worth while to publish a list of the species found by the expedition together with brief field notes. Of especial interest is the meeting of North American and South American types. Thus the discovery of a small Urocyon in the savannas of Panama adds a genus hitherto unreported from the isthmus south of Costa Rica, although its presence was to have been surmised from the fact of its recent and unexpected discovery in Venezuela. On the other hand the capture of a new species of Oecomys in the forest of eastern Panama, not only adds another genus to the known Panamanian fauna, but serves to link it with that of South America. Two genera of bats are also now definitely recorded for Panama, though both have previously been taken farther northward in Central America, namely, Noctilio and Thyroptera, the latter represented by a species very little known. Press of time prevented the preparation of large series of many species which would have been easily obtainable.

1. Chironectes panamensis Goldman. Panama Water Opossum.

The Zorro de Agua was very rare in the Sambú valley. It was met with but once, in the course of night hunting with a lamp. Unlike most Neotropical marsupials it was very active and although wounded, quickly made its escape among the great rock piles at the foot of a cliff beside the Rio Jesusito. All agreed that it was a rare species and but seldom killed by the Chocoano Indians.

2. Didelphis marsupialis etensis Allen. Eten Opossum.

A single specimen was taken at Ancon.

There were a few Zorros on Ancon Hill and this one was trapped by using ripe banana for bait. Another was trapped on the lower Rio Jesusito coming to feed on bananas that had ripened on a tree which leaned so as to be almost prone. There was so much in camp awaiting preparation that this animal, a female with nine young, was liberated.

3. Metachirus opossum fuscogriseus Allen.

One from Gatun, in the Canal Zone.

This female had three half-grown young clinging to her fur. She made no attempt to "play possum" but on the contrary was most snappish and aggressive, a trait noticed also by Goldman.

4. Philander laniger derbianus Waterhouse. Derby's Wooly Opossum.

A single male from Old Panama seems to be this, rather than the grayer race, *pallidus*, of western Panama. It is uniformly bright cinnamon above with an ill-defined gray shoulder-stripe.

A hunter who worked for us killed this Wooly Opossum one night in the scrubby woodland of the savanna near Old Panama. He declared that though he hunted regularly with a jack-light he but seldom killed this species.

5. Bradypus ignavus Goldman. Panama Three-toed Sloth.

An adult and a young one from Mt. Sapo.

In the high forest sloths were almost impossible to find. These two were found in a rather low palm growing in an open glade, hence they were easily caught by cutting down the tree. The camp followers declared the meat unfit for food but seeing it cooked and enjoyed, they, following the example, tried it and finally picked every bone clean.

An Indian child was seen using, as a toy, the crudely stuffed skin of a Cyclopes. It made a rude sort of doll.

6. Pecari angulatus bangsi Goldman. Bangs's Collared Peccary.

A skin and skull from Rio Jesusito, and a skull from Salamanca.

The Indians called the little peccary, "Bidóbe" and the white-lipped pig, "Bidó"; the Spanish names "Zajino" and "Puerco de Monte," respectively, are now widely used by foreigners as well as by natives. There are so many Indians hunting in the Sambú Valley that peccaries are far from common though we often heard them and saw their tracks. In regions where they are little disturbed they have their regular feeding stations, called comederos, under fruit trees but where they are much hunted they quickly abandon this habit.

7. Tayassu pecari spiradens Goldman.
Costa Rican White-lipped Peccary.

Goldman was doubtless correct in assuming that the eight skulls brought back by Dr. G. A. Maack, and now in the M. C. Z., labeled Isthmus of Panama, really came from Colombian territory. Except for a few specimens taken at Bas Obispo, it is probable that all his collections were from the vicinity of the town of Turbo, near the mouth of the Atrato River and on the Uraba Gulf.

8. Odocoileus chiriquensis Allen. Chiriqui White-tailed Deer.

Several skulls from the open country in and near the Canal Zone. The stunted heavy antlers are in strong contrast to those of more northern deer.

Thanks to Dr. Olson of the Ancon Dispensary and the members of the Tabernilla Hunting Club we have received and are still receiving, from time to time, skulls which will finely represent this beautiful form.

9. Mazama sartorii reperticia Goldman. Canal Zone Forest Deer.

A male and a female from the Jesusito.

Though both are adult, the skull of the female is larger than that of the male, which has a decidedly shorter rostrum. It would be interesting to know when the antlers are shed. The male of this pair, killed in April, has antlers about 85 mm. long, strong, and sharp-pointed; and one taken by W. W. Brown, Jr., at Divala on June 29, still retained the antlers. Indeed the Indians generally believe that they are not shed at all.

Living in the great forest they know of this species of deer only and call it "Begí." It is rather common.

10. Oecomys trabeatus, sp. nov.
Panama White-bellied Tree Mouse.

Type.— Skin and skull, M. C. Z. 19,837, male, from Rio Jesusito, eastern Panama, 10 April, 1922. Thomas Barbour and W. S. Brooks.

Description.— A small species related to *bicolor* of Ecuador but slightly larger and brighter, with longer pelage.

Middorsal area from crown to root of tail bright ochraceous rufous, finely lined with blackish hairs, brighter and clearer on the rump, paling to clear ochraceous at the sides of the body; ankles and base of tail dusky ochraceous all round. Bases of dorsal hairs everywhere plumbeous. Upper lips, and entire ventral surface of body, including inner sides of fore limbs to the wrists, and inner sides of hind legs almost to ankles, clear white, sharply defined at the sides, hairs everywhere white to their bases. Backs of hands and feet washed with pale ochraceous, the toes with minute whitish hairs. Ears dark brown, with minute scattered brown hairs on the exterior and ochraceous hairs on the inner surface. Tail dusky brown, monochrome, evenly covered with short appressed dark brown hairs, about the length of two caudal scales, but somewhat longer at the extreme tip. Vibrissae blackish, about 40 mm. long. Supraorbital vibrissa 27 mm.

Skull.— The skull is typical of the genus, with short rostrum, the brain-case with somewhat bulging outlines, antorbital plate not projecting forward, incisive foramina barely reaching the plane of the cheek-teeth, and the palate extending well behind the level of the molars. The premaxillaries distinctly exceed the nasals in backward extension, whereas in *O. bicolor* the opposite condition obtains. The supraorbital beading forms a slightly overhanging ledge and can be faintly traced as an indistinct ridge across the parietals to the outer corners of the interparietal.

Measurements. — The collector's measurements are: — total length 230 mm., tail 120, hind foot 22, ear 15. The skull measures: greatest (occipitonasal) length 26 mm., basal length 24, palatal length 13.5, diastema 7, upper cheek-teeth 4, zygomatic width 15, mastoid width 12, width outside last molars 5.

The discovery of this handsome little mouse is one of the important results of the expedition, and definitely extends the known range of this genus northward into Middle America. It was found in the forest in the course of hunting monkeys. It fell to the ground from a tangle of vines torn down when a small tree was felled to get a monkey which had lodged among the branches. Of the described species of this genus, it apparently comes closest to *O. bicolor* of Ecuador of which we have three specimens for comparison. It is, however, somewhat larger, longer-tailed, and has a much longer, fuller pelage, the hairs of the back measuring about 10 mm. against 5 or 6 in *O. bicolor*. The latter has, therefore, a much closer pelage and besides wholly lacks the bright rufous tone of *trabeatus*. The Latin name (signifying "of regal dress") is suggested by the coloring, pure white below like ermine, and of bright gold and rufous above. Its somewhat rounded braincase, shortened rostrum, broad hind feet and slightly tufted tail go with habits completely arboreal. The vibrissae are very long and more abundant than in *O. bicolor*. In their general outward appearance the mice of this genus and Rhipidomys parallel in an extraordinary way, the African bush mice (Thamnomys), to which of course they are in no way closely related.

11. Oryzomys talamancae Allen. Talamanca Rice Rat.

A single skin and skull from Rio Esnápe. This mouse was observed to run down a large tree and take refuge in a hole at the base of the trunk, whence it was finally, and with much difficulty, extracted. Goldman states that it ranges throughout Panama. Several specimens of this rat were trapped but, as with so many other trapped rodents, they were wholly destroyed by ants before they could be taken from the traps.

12. Melanomys caliginosus idoneus (Goldman). Panama Dusky Rice Rat.

Two specimens, Rio Jesús and Rio Jesusito.

This is apparently a common species at middle levels. To this species the same note applies as to losses by ants. It was abundant about an old clearing on the lower Rio Jesusito.

13. Sigmodon hispidus chiriquensis Allen. Boqueron Cotton Rat.

Two in alcohol from the Canal Zone.

These specimens were kindly given to the Museum by Dr. Clark and Mr. James Zetek of the Ancon Board of Health Laboratory to whom we are beholden for very many favours.

14. Heteromys australis conscius Goldman.
Cana Pocket Mouse.

A skin and skull from Rio Esnápe. The pelage is nearly uniform blackish above, very hispid, with but few finer hairs.

This mouse was found only once. Several lived in a series of holes in the stream bank near the Esnápe camp. The one preserved was shot at dusk at the stream shore but others occasionally got into the large steel traps at this camp, leaving only a foot behind. As these mice were several times seen in the daylight hours they are probably more or less diurnal.

15. Proechimys semispinosus panamensis Thomas.
Panama Spiny Rat.

Several were captured on the Rio Jesusito and Rio Esnápe. Goldman, after examining over 100 specimens, concludes that "in general characters *P. s. panamensis* is about midway between *P. s. centralis* and *P. s. semispinosus*" of Ecuador. To the former he refers the M. C. Z. series from western Panama, topotypes of Thomas's *chiriquinus*, considering them inseparable. From these latter, however, the five skins from Rio Jesusito and Rio Esnápe differ in being less richly colored, and especially in having the hind feet whitish with a dusky metatarsal area instead of uniformly dusky as in the Bogaba series. The tails too are somewhat shorter. No doubt the eastern Panama spiny rats approach typical *semispinosus*.

These "Macangueyes," as they are called by the Panamanians, were common in the lowland and foothill "taguales" or groves of ivory-nut palms. We tried them once when hard pressed for food and then ate them regularly. The flesh was excellent.

16. Dasyprocta punctata dariensis Goldman. Darien Agouti.

Four skins and skulls from Rio Jesusito and Rio Esnápe.

Called "Ñequi" by the Spanish speakers, and "Curiguá" by the Indians. We found the agoutis common throughout the forest. They were much hunted and very shy. They came sometimes to drink at the streams or sneaked out into the clearings about the camps, but generally were more often heard than seen. The skins shrink surprisingly and the old males, when fresh killed, are enormous, great paunchy creatures surprisingly heavy and excellent food.

17. Cuniculus paca virgatus (Bangs). Panama Paca.

The "Conejo Pintado" or "Benóăna" of the Chocoanos were rare where the expedition happened to be, though tracks were often seen and several of the animals were started in the course of night hunting. No special effort was made to secure specimens though it would have been possible to obtain a few. The Indians have hunted them so persistently that they are very shy.

18. Hydrochoerus isthmius Goldman. Isthmian Capybara.

It is interesting to establish the fact that, contrary to rumor, the "Poncho" does not occur in the Sambú drainage area, but is apparently confined entirely to the Tuyra Basin and even there has a rather limited range along the lower river.

19. Sciurus gerrardi choco Goldman. Darien Squirrel.

This was a common species in the forest. Several specimens from Rio Jesusito, Rio Esnápe, and Mt. Sapo are in the collection.

These squirrels were usually seen climbing about among the vines and creepers in very high forest trees. Once, while watching for Cotingas under a feeding tree, one was seen to come to the ground and explore about for some time. They were surprisingly noisy, until they were aware of the hunter's presence.

20. Microsciurus alfari venustulus Goldman.
Canal Zone Pygmy Squirrel.

Three skins and skulls from Mt. Sapo represent this form.

A rare little squirrel seen only high on the slopes of Mt. Sapo where there were groves of ivory-nut palms at about 3,000 feet elevation.

21. Sylvilagus gabbi consobrinus Anthony. Savanna Rabbit.

This pallid race is confined to the savanna region of southern Panama. Three were secured at the type-locality near the city of Old Panama.

Common and called "Mulita" by the hunters. With a little more time a large series could have been secured with a jack-light.

22. Urocyon cinereoargenteus furvus, subsp. nov. Panama Gray Fox.

Type.— Skin and skull, M. C. Z. 19,774, ? female, from the Panama Canal Zone, three miles west of Balboa.

Description.— Similar to *U. c. guatemalae* but paler and shorter-haired. Entire dorsal surface from between the eyes to the root of the tail, the flanks and thighs, a grizzled gray, very little darker on the nape and middorsal area. Superciliary spot whitish. Bases of the ears and sides of throat ochraceous; tips of ears, the fore arms and fore feet above, paler ochraceous slightly grizzled with grayish and dark-tipped hairs; hind feet grizzled grayish. Muzzle at base of vibrissae, lips at corner of mouth and an area between the rami of the jaws dusky brown. Under surface of fore and hind limbs and the sides of the belly between axilla and groin, pale buffy extending as a distinct narrow line along the outer edge of femur. Chin, upper lips, throat, a median line on lower side of neck, chest between fore limbs, and the inguinal region, whitish to the roots of the hairs. Tail brownish black dorsally, its sides grizzled white and dusky, and the ventral side pale buffy.

Through the kindness of Capt. H. E. Anthony, of the American Museum of Natural History, we have for comparison, in addition to Costa Rica specimens in the M. C. Z., a series of five gray foxes from Nicaragua considered to represent *U. c. guatemalae*. These, as might be expected, differ in their longer and darker-colored pelage, though captured at the same season. Dorsally, the hairs of the under fur are dusky at the base, tipped with dull buff, whereas in the Panama race, the under fur is clear pale buff to the roots. In *guatemalae* the over-hairs are nearly black with a subterminal white ring and a fine black tip but in the more southern race the black is replaced by a dusky brown, and is much more evenly distributed so that the mid-dorsal area is only slightly darkened. The length of the longest hairs on the shoulders is some 25 mm. instead of 33 mm. in a comparable pelage of *guatemalae*. The general effect is a much paler, more buffy and less black, mixture.

Skull.— The skull, though fully adult, is very much smaller than that of any available from Costa Rica or Nicaragua, with a shorter and narrower rostrum, but the size of the two upper molars in surface view equals, or exceeds, that of the more northern foxes, in which, among nearly all of the nine specimens available, the second upper molar is actually smaller. In *guatemalae* the audital bullae, though somewhat variable are in no case so inflated or so closely approximated as in the new race. The Panamanian fox has the bullae obviously more swollen on the median side, so that they overhang their bases, instead of sloping outward, as viewed from behind and are closely approximated. In this respect it resembles the Yucatan races, which, however, have smaller teeth.

Measurements.— The skull measures: greatest length 102 mm., basal length 99, palatal length 47, zygomatic breadth 54.5, least interorbital breadth 19, breadth across postorbital processes 31, greatest breadth of brain-case 40, mastoid breadth 39, length of audital bulla 19, distance between audital bullae 6, upper tooth-row (exclusive of incisors) 44.5, width across outer corners of m^1, 30, mandible 78, lower toothrow (exclusive of incisors) 50, alveolar length of upper carnassial 10, combined length of upper molars 14.

Remarks.— With the exception of a skin (without skull) from Tocuyo, Venezuela, described by J. A. Allen (1911) as *U. c. venezuelae*, this is the most southern record of Urocyon, the previous known limit of which was Pozo Azul, Costa Rica. The Venezuelan race is said to be even darker than *guatemalae*, with larger ears. The Panama Gray Fox seems to represent a pallid race probably confined to the semiarid savanna country. Its shorter pelage and less intense coloring are what would be expected in contrast to the longer-haired and darker-colored condition of the form inhabiting the more humid region to the north. Miller (1899) has already pointed out the similarity of the small Central American gray foxes to the Californian *Urocyon littoralis* to which they may eventually prove more closely related than to the larger *cinereoargenteus* of northern Mexico and the United States, of which they are at present regarded as subspecies.

This fox was kindly given us by Dr. Clark, Pathologist of the Board of Health Laboratory at Ancon to whom it was brought for autopsy after it was shot by an employee of the Canal Zone Sanitary Service. It had been preserved in formaldehyde a short while before coming into our possession.

23. Icticyon panamensis Goldman. Panama Bush Dog.

The Indians in the Sambú Valley knew of the Bush Dog but no one of the expedition had the good luck to secure one.

24. Procyon cancrivorus panamensis (Goldman). Panama Crab-eating Raccoon.

A specimen from Old Panama.

Both this Crab-eating Raccoon and the ordinary *P. lotor pumilus* Miller were common in the large mangrove swamps about Old Panama and a good many find their way alive into the Panama market. Both species without distinction are called "Mapachines," yet the hunters well know that two forms are confused. They are often hunted at night as they come out on the tidal flats to feed.

25. Potos flavus isthmicus Goldman. Isthmian Kinkajou.

One from the Rio Esnápe.

Goldman correctly gives "Cusimbí" as the native name for the Isthmian Kinkajou and then "Olingo" for the Chiriquian race, and for the races of Bassaricyon as well. It was, however, impossible to find anyone in Panama who had ever heard of the latter name. Quoting Anthony (1916) the names appear as "Cusumbi" and "Manteja." The second name, which should appear "Marteja" is really in use only for the night monkey (Aotus). It is derived from the Peninsular Spanish name of "Marta" for the marten or sable. The former name is also incorrectly rendered.

Kinkajous abounded in the high woods and were often heard at night. Their eyes were also frequently seen while night hunting. Once while camped for the night on the lower Sambú, a little band of them came climbing down some vines, which hung in the river, to drink and were clearly visible as they crossed the face of the moon.

26. Nasua narica panamensis Allen. Panama Coati.

Seen several times, usually single individuals and in the mangrove swamps along the lower Sambú. The name "Pisote" given by Goldman is a Costa Rican term and was probably supplied by Major Goldman's Costa Rican assistant, Señor Lizano. The Panamanian name is "Gato solo."

27. Grison canaster (Nelson).

A beautiful tame pet of this species which had been for some time in capitivity, was seen in Panama. It came from the upper Chagres Valley, where the species was said not to be uncommon.

28. Lutra repanda Goldman. Panama Otter.

A skull from Rio Chico, given by Dr. Clark of Ancon.

Otters were well known to the Indians who often promised specimens. Plenty of otter-sign was seen along the rapid highland streams but never a shot was offered. During absence in the interior two otters were brought to Garachiné for the expedition, by a negro hunter. The local Chinese storekeeper sent them to Panama for sale, not knowing that they were really wanted by naturalists enough to bring a price. Thus they were unfortunately lost.

29. Felis onca centralis Mearns. Central American Jaguar.

A skull of a female from the Rio Peluca was purchased in Panama.

Jaguars were abundant; their tracks were often seen and they were several times heard as well. Called "Tigre" in Spanish, the Indians call this beast "Ímama" and the somewhat less common Puma or "Leon," "Ímama-puru."

30. Felis pardalis mearnsi Allen. Mearns's Ocelot.

A skull from the Rio Gatuncito, purchased in Panama.

In Costa Rica the name "Tigrillo" applies to the Gray Fox, in Panama to the Ocelot, for which the Chocoano Indian name is the unwritable and almost unpronounceable "Ghlüghlü," very guttural and liquid.

Where the Rio Congo Timber Co. is clearing land on the west side of San Miguel Gulf, ocelots and other cats are said to be very numerous.

31. Rhynchiscus naso (Wied). Long-nosed Bat.

Several in alcohol from the upper Rio Jesusito. The adults seem referable to the typical form, with slender anterior premolar. With them are three young, the largest hardly bigger than a bumble-bee.

These were taken about April 20 which indicates therefore that the young are born rather early in the year. The stomachs of the adults were distended with a mass of insect remains, minutely cut up.

32. Saccopteryx bilineata (Temminck). Greater White-lined Bat.

Three from the ruins of Old Panama; four from Mt. Sapo.

The bats of this species from Old Panama were shot out of small and well-lighted recesses in the ruins of the Jesuit church. The four others came from an enormous tree, so hollow and so broken as to be quite light inside.

(Of *Centronycteris centralis* Thomas, hitherto known only from Bogaba, Chiriquí, the type-locality, the Museum possesses a skin and skull from Costa Rica, obtained by C. F. Underwood some years ago. The rarity of the species prompts its record here).

33. Noctilio leporinus (Linné). Bull-dog Bat.

This species has not hitherto been recorded from Panama. Two specimens in alcohol were presented by Dr. Clark of the Ancon Laboratory. They were taken in dwelling houses in Panama City into which they had chanced to fly; one in August 1913, the other at an unrecorded date but much more recently. The type-locality is Surinam. So far as can be determined by material at hand, they are typical. The fore arms measure 84 and 86.5 mm. respectively. Both are males.

34. Micronycteris microtis Miller. Nicaraguan Small-eared Bat.

A single specimen from Rio Jesusito.

A large hollow tree not far from the upper Jesusito camp when smoked out, yielded several desirable bats, among them this rare form,

35. Tonatia amblyotis (Wagner). Round-eared Bat.

This South American species has been once recorded from Panama, namely at Bogaba, Chiriquí. A second record is therefore afforded by a specimen from the Rio Esnápe.

This bat was shot at dusk one evening as it flew over the stream in front of camp.

36. TRACHOPS CIRRHOSUS (Spix). Fringe-lipped Bat.

Three from the Rio Jesusito seem to make the second record of the species for Panama. Of these, one is a male, and the two others are adult females, each containing a large embryo.

These were got from the same large hollow tree which, when fired, yielded the Micronycteris.

37. GLOSSOPHAGA SORICINA LEACHII (Gray).
Leach's Long-tongued Bat.

This is a common species in Panama, whence a large series from Old Panama was obtained by the junior author in 1909. One also was captured near Panama City on this trip.

38. HEMIDERMA PERSPICILLATUM AZTECUM (Saussure).
Short-tailed Bat.

Two from Old Panama. An abundant species.

The ruined vault or cellar in which Goldman and Osgood had the good luck to find Macrophyllum in 1910, is now unsuited for a bat roost as the site has been cleared, the cellar opened, and the roof removed presumably by treasure seekers. A few Hemidermas and Glossophagas were all there were to be found in the open area in 1922.

39. ARTIBEUS JAMAICENSIS Leach. Jamaican Bat.

Two from Rio Jesusito; one from Panama City. Common both in the forest and in open country. This species retires in day time into ruins, crevices or rocky cliffs, hollow trees, and dense foliage. especially of nispera or sapote trees.

40. ARTIBEUS WATSONI Thomas.

One from Ancon, Canal Zone, Panama.

This rather uncommon bat flew into a house one evening and was captured.

41. THYROPTERA ALBIVENTER (Tomes). White-bellied Disk Bat.

A single specimen from Rio Jesusito, eastern Panama. Not only is this genus an addition to the known Panamanian fauna, but the species itself is one so rare that its status has not hitherto been settled beyond question. The only Thyroptera previously recorded from Central America is *T. discifera,* which is of a nearly uniform brown color and also differs structurally from *T. tricolor,* the only other species currently recognized. In 1856, however, Tomes described *Hyonycteris* (= *Thyroptera*) *albiventer* from the Rio Napo, Ecuador, distinguishing it from *tricolor* by reason of its coloring. In the latter, the throat, upper chest, and sides are reddish brown, leaving a central area of the under parts whitish. In *albiventer,* however, the white area is much more extensive, and includes nearly all the under surface of the body except a narrow strip at the sides and the space between the rami of the mandibles, which is reddish brown, passing into that of the sides of the head and back. The specimen from Rio Jesusito agrees perfectly with Tomes's description. There is also in the Museum a mounted specimen from "Ecuador" which was referred to this species some years ago (G. M. Allen, 1908, p. 42). A careful comparison of the Panamanian specimen with others from Trinidad taken to represent *tricolor,* shows that *albiventer* differs not only in color-pattern but in several structural characters. Thus, the fifth finger is decidedly longer, although the fore arm and third and fourth fingers are practically the same in both. The tail is absolutely longer, but less of its tip is free, so that when the interfemoral membrane is stretched laterally, its outline is nearly a rectangle in *tricolor;* whereas in *albiventer* it forms a square. In *tricolor,* the tail measures (from anus) 26 mm. of which the terminal 9 mm. (34%) are free; whereas in *albiventer* the tail is 30 mm. long of which only the terminal 4.5 mm. (15%) are free. Both upper incisors have a distinct secondary cusp, that of the inner, however, barely noticeable. The peculiar syndactylism of the third and fourth hind toes, noted by Miller (1896) for *T. discifera,* obtains also in *T. albiventer* and *T. tricolor* and is characteristic of the genus, as far as known. Leaving out of consideration *T. bicolor* Cantraine, described from Surinam in 1845, and probably a synonym of *tricolor,* the existence of three distinct species of Thyroptera may now be regarded as proved.

This little bat was caught with the specimens of Rhynchiscus in the great, dry, curled-up Heliconia leaves. Another was captured but escaped.

42. Aotus zonalis Goldman. Canal Zone Night Monkey.

Five from the upper Rio Jesusito.

The "Martejas" were common and excellent eating. They were quite abundant and were heard every night. Two lived in a hollow tree near camp and fled when the tree was hit with an axe. They were shot while springing away. At night their movements seem rather leisurely, and they were slow about trying to escape.

43. Leontocebus geoffroyi (Pucheran). Geoffroy's Squirrel Monkey.

In all, nine examples were obtained from the Rio Esnápe and Rio Jesusito.

Called "Tití" by Spanish speakers and "Bichichí" by the Indians. Bands of these fine little marmosets were often seen in the lowlands. We saw none and heard of none on Mt. Sapo. They were very common on the lower Sambú, coming into the low bushes and hopping up and down and scolding the party as it drifted downstream in dugouts, homeward bound. Their flesh is very delicate.

44. Alouatta palliata inconsonans Goldman. Panama Howling Monkey.

An embryo in alcohol from eastern Panama and a skull from the upper Chagres River.

A good many of these monkeys are killed by the Indians because they are dull and stupid though they are less good to eat than Ateles, the spider monkeys, or Cebus, the white-faced monkeys, both of which were much more rare than the howlers in the country traversed.

45. Ateles dariensis Goldman. Darien Black Spider Monkey.

A skull from the upper Rio Bayano.

LITERATURE.

Allen, G. M.

1908. Notes on Chiroptera. Bull. M. C. Z., **52**, p. 25–62, 1 pl.

Allen, J. A.

1911. Mammals from Venezuela collected by Mr. M. A. Carriker, Jr. Bull. Amer. mus. nat. hist., **30**, p. 239–273.

Anthony, H. E.

1916. Panama mammals collected in 1914–1915. Bull. Amer. mus. nat. hist., **25**, p. 357–375, map. 5 text-figs.

Bangs, Outram, and Barbour, Thomas.

1922. Birds from Darien. Bull. M. C. Z., **65**, p. 191–229.

Barbour, Thomas.

1923. Notes of reptiles and amphibians from Panama. Occ. papers, Mus. zool. Univ. Mich., no. 129, p. 1–16.

Goldman, E. A.

1920. Mammals of Panama. Smithsonian misc. coll., **69**, no. 5, 309 pp., 39 pls.

Miller, G. S., Jr.

1896. The Central American Thryoptera. Proc. Biol. soc. Wash., **10**, p. 109–112, pl. 7.

1899. Descriptions of two new gray foxes. Proc. Acad. nat. sci. Phila., 1899, p. 276–280.

Bulletin of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE.
Vol. LXV. No. 9.

NOTES ON SOME SUMMER BIRDS OF NORTHERN PATAGONIA.

By James L. Peters.

CAMBRIDGE, MASS., U. S. A.:
PRINTED FOR THE MUSEUM.
May, 1923.

No. 9.— *Notes on some summer birds of northern Patagonia.*

By James L. Peters.

INTRODUCTION.

During eight months, from early in August, 1920, until nearly the middle of March, 1921, I visited various parts of the Gobernacion de Rio Negro, Argentina, and over five months of that period were spent at Huanuluan, one of the sections owned and operated by the Rio Negro Land Company, an English sheep-raising corporation.

Several short side trips were made from Huanuluan and in addition several stops to collect specimens *en route* to and leaving the region. The localities are all in the Gobernacion de Rio Negro and are close enough to permit of the consideration in a single paper of all the birds found, without causing undue confusion.

While the chief object of my visit was to make studies of the life-histories of the Anatidae for Dr. J. C. Phillips, collections of other birds from various localities were made and about 750 skins form the basis of this paper.

The first stop, from August 8 to 10, was at Rio Colorado, a small town on the southern railroad where it crosses the Colorado River. On the left bank of the river a series of scalloped bluffs attain a height of from 100 to 200 feet above the level of the valley and stretch in either direction as far as the eye can reach. On the right bank the country to the south of the river is flat and sandy for a few kilometres; then breaks into a series of long, low, sandy, or gravelly ridges. Rainfall is scanty; the vegetation consists largely of a few cacti, several species of thorny shrubs, and at least one species of Grease Bush (Larrea sp.?) is abundant.

On August 11 I made a journey of 150 miles by auto-stage to Puerto San Antonio del Oeste, a small seaport at the head of the Gulf of San Matias. The route traversed an undulating plain, the character of whose vegetation did not differ appreciably from that about Rio Colorado. In the hollows between the low ridges, settlers have dug wells and put in windmills to supply water for their sheep, and at such places little clumps of stunted willows flourish. Crossing the Rio Negro near Conesa the valley-floor is covered with bunch-grass, and in the moist hollows or along the side channels and back waters there are willows of considerable size.

It had been my original plan to leave San Antonio by train the following morning, but as my outfit had not been received, it became necessary to lay over for a week until the next train. Looking back now I see that such a delay really proved fortunate, since several species of small birds occurred at San Antonio that I did not encounter elsewhere, and furthermore, it was my only opportunity to observe conditions along the Patagonian sea-coast.

On August 19 I left San Antonio for Maquinchao on the weekly train. A few miles back from the coast, the character of the country undergoes a marked change; the undulating plain gives way to table-lands, often of great extent, low rocky hills, and long stretches of rough stony plains. Former drainage systems are represented by wide sandy valleys supporting a sparse growth of wire-grass. As one goes westward, small streams are sometimes found occupying short stretches of these valleys, fed sometimes by springs, sometimes by melting snow. The Grease Bush, an abundant and characteristic shrub of the coastal district, gradually disappears, and at an elevation of approximately 1,800 feet it dies out altogether and is replaced by other species, chief among them being one known locally as *Palo negro*.

Maquinchao, 375 kilometres from San Antonio, is at an elevation of about 2,900 feet (889 metres B.M.). All around are hills except where wide valleys run through from the southward; some of the hills are round topped, others are table-lands of varying extent; the hills rise 500 feet or more above the base-level; the streams, fed partly by springs from a source twenty miles south, flow through the valleys and each spring the valleys are flooded as the flow is increased by melted snow brought by tributaries from the mountains still further to the south and west. Twenty miles south of Maquinchao there is a great reed-bed, (*juncal*), several hundred acres in extent, and a large pond, (*laguna*), formed by the overflow of this stream in the spring.

I remained at Maquinchao (the office of the Rio Negro Land Company) only four days, leaving by automobile on August 23 for Huanuluan, sixty miles further to the westward and at an elevation of 3,100 feet. Here the appearance of the surrounding country does not differ materially from that about Maquinchao, except that it is more rugged.

A small stream, (*arroyo*), fed by springs from the southern slope of El Escorial, an isolated mountain range 4,600 feet above sea-level, situated ten miles or so to the westward, flows through the sandy wire-grass covered plain, (*mallin*), upon which the *estancia* and buildings are situated. While the plain continues eastward, the *arroyo* runs dry fifteen miles from its source, except during unusual seasons; and for most of its course it flows between dry banks, but here and there it spreads out to form wet, soggy meadows with weedy channels, and pools, and occasional small stands of reeds. Some six miles west of the *estancia* there is a muddy lagoon, with a patch of reeds in its centre, which sends a branch to the main *arroyo*.

The rainfall in the Huanuluan-Maquinchao region, as in other parts of Patagonia, is under ten inches annually, being precipitated mostly during the autumn and winter months. There are no trees and the scanty shrubs are of the general type found in arid regions; except for a small spreading species known as *Chupa de Sangre*, there are no cacti. The bushes grow larger on the easterly slopes of the hills, which form a lee to the strong westerly winds so continuous in this part of the world.

Huanuluan was my headquarters for nearly six months, except during a short trip made December 5 to 7 with Sr. Andres Turconi, to Paso Flores, (1,800 feet), on the Limay River, and a visit to the region south of Maquinchao, December 14, 1920 to January 6, 1921. My final departure from Huanuluan was on the afternoon of January 28, by auto-stage, and on the afternoon of January 29 I reached Bariloche, on Lake Nahuel Huapi.

Travelling westward from Huanuluan, the base-level continues to rise slowly for about fifteen miles; followed by a gradual descent to the Rio Cumayo, then a climb to beyond Pilcaniyeu; a drop to the Rio Pichileufu, a slight further rise, and finally a descent to Lake Nahuel Huapi, 2,500 feet, (756 metres) above sea-level.

Down the valley of the Cumayo and up its tributary, the Arroyo Coquelen, there is a slight but noticeable change in the flora, for a plumed bunch-grass appears which attains a height of six feet in favorable locations.

Going westward toward Lake Nahuel Huapi, there are no marked changes until reaching the Rio Pichileufu; thence the country begins to take on a greener appearance, little brooks trickle from the hills and the vegetation along the streams becomes dense; indeed, each succeeding mile brings additional evidence of increasing precipitation. The streams are larger and run through a veritable tangle of shrubs and small twisted trees. Up among the rocky hills a cedar-like tree appears, (*Librocedrum chilensis*); at first, small and stunted, clinging precariously to the steep slopes, but gradually becoming more numerous and growing in profusion.

The Pichileufu also delimits the succession of table-lands for the area of the Patagonian Plateau. Instead of flowing through a valley marked on either side by flat-capped *planicies*, the river runs by the foot of cliffs, the tops of which are grotesquely carved into spires and minarets.

Nahuel Huapi is a magnificent lake nearly thirty miles long and about five wide, with many bays and arms. The eastern portion extends into the dry Patagonian Plain, but the western arms run back between precipitous mountain slopes of bare rock and steep forest-clad hillsides. The longest arm, extending directly west, terminates at Puerto Blest, a small landing at the extreme western extension of the lake, only three kilometres, as the condor flies, to the summit of the Continental Divide. A long, sheltered, longitudinal valley, with many small lakes, and with well-watered and forested slopes, extends southward from Nahuel Huapi well into the Gobernacion de Chubut, south of latitude 42° S.

About Bariloche the hills rise gradually a few hundred feet above the level of the lake, their southern and western slopes heavily forested, the northern and eastern less densely wooded, and with here and there pasture-like open spaces. A short distance to the west, the mountains rise to between 6,000 and 7,000 feet, their summits covered with snow at all seasons; well above all the neighboring peaks stands El Tronador, (11,400 feet).

I collected in the vicinity of Bariloche until February 21. On February 3 a trip was made to Puerto Blest and the Lago de los Cántaros, and from the 9th to the 12th I was at the Fish Hatchery, seven miles east of Bariloche, where Mr. James Brophy made me most comfortable.

On February 22 I started by the familiar auto-stage for the railroad at Neuquen, 320 miles to the northeast. The route passed eastward to Pilcaniyeu, then south to Colegio and northeast to Mencue, where the night of the 22nd was spent. The day following, an all day run past the Cerro de la Policia, through the sandy stretches south of the Limay, and crossing of the Limay at Senillosa by moonlight, brought me to Neuquen the night of the 23rd.

Thirty-five miles northeast of Mencue the vegetation changes from that characteristic of the Patagonian Plateau to the type found at the lower altitudes; the Grease Bush again becomes the dominant shrub, and the plumed bunch-grass grows on the sandy flats. The little Seed-Snipe, (*Thinocorus rumicivorus*), is seen no more, and the characteristic cry of the Gallito, (*Rhinocrypta lanceolata*), is heard in the *chaparral*.

There are few towns of any size in the Gobernacion de Rio Negro; Viedma, the capitol, near the mouth of the Rio Negro, Choele-Choel, and Roca, the centres of irrigated districts along the Rio Negro; San Antonio at the head of the Golfo de San Matias and the starting place of the Patagonian railroad; Valcheta, a town in a small irrigation project on the same railroad; whatever town happens at the moment to be its railhead, and Bariloche, the principal settlement of the region about Lake Nahuel Huapi, make up a list of the more important towns.

Except in the irrigated districts, the chief industry of the territory is sheep-raising. Two or three large companies have fenced ranges many hundreds of square miles in extent. The settlers and the descendants of the native Tehuelches tend their small flocks of sheep or goats on horseback, pasturing them on the vast unfenced public lands or *fiscal*.

There are no improved roads anywhere. The cart-paths follow the lines of least resistance along the principal routes. Goods from the outside are freighted by cart-troops, (drawn by horse, mule, or ox), from points on the railroads, to the small settlements or to the *Boliches,* sort of country stores, where anything from a night's lodging to a new pair of stirrups or a can of sardines may be obtained. The proprietors of these stores almost all come from Syria, but are universally called *Turcos*. They advance the settler credit on the basis of his wool crop and generally end by acquiring the sheep, as well as the wool, in settlement.

The law is represented by a *Commissario* and twenty or more *Vigilantes* in the larger towns, and by a *Subcommissario* and a handful of *Vigilantes* at a few of the smaller settlements. Their efforts are devoted largely towards checking the theft of horses and sheep.

There are a few lines over which auto-stages are operated on a weekly basis; the most important of these are: from Rio Colorado to San Antonia, via Conesa; Roca to Norquinco, via El Cuy and Maquinchao; Neuquen to Bariloche, via Mencue and Pilcaniyeu.

LIFE ZONES.

In traversing this portion of Argentina from east to west it becomes apparent that at least three life zones should be distinguished. Much additional field-work must be done before it will be possible to define their boundaries or to characterize them fully, and for that reason the accompanying short outline should not be considered as more than a starting point for future investigation.

ZONE 1.— In the Gobernacion de Rio Negro this occupies the valleys of the Rio Colorado and Rio Negro and probably the interlying region as well; it extends up the Rio Limay to some point between Paso Limay and Senillosa, and in the central and southern parts of the territory prevails below 1,000 to 1,500 feet, its boundary in general probably trending southeasterly. It is readily characterized by the presence of a Grease Bush.

The characteristic birds are: —

Rhinocrypta lanceolata (Geoffroy and d'Orbigny).
Teledromas fuscus (Sclater and Salvin).
Siptornis patagonica (d'Orbigny).
Spizitornis parulus patagonicus Hellmayr.
Spizitornis flavirostris (Sclater and Salvin).
Brachyspiza capensis choraules Wetmore and Peters.

Numerous species from the Pampas extend their range southwest into this zone but do not pass beyond it to the next higher, among these are: —

Colaptes campestroides (Malherbe).
Knipolegus hudsoni Sclater.
Mimus triurus (Vieillot).
Phytotoma rutila rutila Vieillot.
Poospiza nigrorufa (d'Orbigny and Lafresnaye).
Embernagra platensis platensis (Gmelin).
Diuca diuca minor Bonaparte.
Gubernatrix cristata (Vieillot).

ZONE 2.— This occupies the western portion of the territory except for a narrow strip at the extreme west. Its chief distinction from the foregoing is the complete absence of the Grease Bush and its associations.

The characteristic birds are: —

Tinamotis ingoufi Oustalet.
Thinocorus orbignyanus Geoffrey and Lesson.
Geositta rufipennis rufipennis (Burmeister).
Eremobius phoenicurus Gould.
Muscisaxicola maculirostris d'Orbigny and Lafresnaye.
Muscisaxicola capistrata (Burmeister).
Pseudosicalis lebruni (Oustalet).
Phrygilus aldunatei (Des Murs).

ZONE 3.— The third zone covers the east Andean Slopes in the extreme western portion of the territory. This is a well-defined area characterized by a temperate zone forest in a region of normal precipitation. The avifauna has a very strong admixture of Magellanic forms including the following: —

Columba araucana Lesson.
Anas specularis King.
Eustephanus galeritus (Molina).
Colaptes pitius cachinnans Wetmore and Peters.
Dyctiopicus lignarius (Molina).
Scytalopus magellanicus (Gmelin).
Scytalopus niger Swainson.
Hylactes tarnii tarnii King.
Pteroptochos rubecula hylonympha Peters.
Cinclodes patagonicus rupestris (Kittlitz).
Aphrastura spinicauda (Gmelin).
Siptornis sordida sordida (Lesson).
Pygarrhicus albogularis (King).
Agriornis livida fortis Berlepsch.
Pyrope pyrope (Kittlitz).
Phytotoma rara Molina.
Phrygilus gayi (Eydoux and Gervais).

A fourth, or Paramo Zone doubtless exists here at an altitude of above 3,500 feet.

HISTORICAL SKETCH.

The birds of Argentina treated in this paper appear to have been but little discussed in ornithological literature. Compared with the birds of Tierra del Fuego, or even southern Patagonia, very little seems to be known of the birds of northern Patagonia, except those of the littoral and the lower Rio Negro valley.

Many reports have been published on the birds of the Straits of Magellan. Santa Cruz is known through the Zoology of the Voyage of the Beagle; from the collections made by Le Brun early in 1884 and incorporated in the report of the Mission Scientifique du Cap Horn; from observations made by C. V. Burmeister in 1888 and 1889; and by the work of the Princeton Patagonian Expedition between 1896 and 1899. The Argentine Government has also contributed occasional reports, particularly of expeditions made along the coast.

Collections in Chubut were made by Henry Durnford in 1877 and again in 1878 and 1879; by C. V. Burmeister in 1886–1887 and also in 1888–1889; while Dr. Gerling visited the region about Lake General Paz, in extreme western Chubut, in 1902. Durnford's birds were reported upon in the Ibis, Burmeister's and Gerling's in the Anales del Museo Nacional de Buenos Aires.

The littoral of northern Patagonia is well known through the work of Alcide d'Orbigny in 1828–1829, Charles Darwin in 1833, and W. H. Hudson in 1870–1871, the latter penetrating about 100 miles up the valley of the Rio Negro. In 1879 Dr. Doering accompanied General Roca's expedition against the Tehuelches. His report covers the region from Azul, now in the western portion of Buenos Aires Province, to the Rio Colorado, and up the long tongue of land between the Rio Colorado and Rio Negro, to the confluence of the Limay and the Neuquen. Burmeister's route in 1886 traversed the southeastern portion of the Gobernacion de Rio Negro, paralleling the coast at a distance of about fifty miles. Ornithological collecting has of course been carried on in northern Patagonia since that time, but so far as I can ascertain nothing has been published in recent years with the exception of a few scattered notes, based chiefly on birds collected in the general vicinity of Neuquen.

The following collections have been made in northern and western Patagonia within the last few years, but the results have not been published:—Gordon Bowman, vicinity of Lake Nahuel Huapi, 1912–1913; J. R. Pemberton, a collection made in the course of a survey for the line of the Patagonian railroad 1911–1913, and Emilio Budin, from Lake Nahuel Huapi to Maiten, western Chubut, in 1918.

ACKNOWLEDGEMENTS.

I express my thanks to Mr. T. C. Norris, Manager, Mr. Charles McKinnon, Assistant Manager of the Rio Negro Land Company, and to their competent staff, for many favors and for hospitality during my long stay, and to Mr. J. H. Hobson, in charge at the Huanuluan section, whose knowledge of the country, and whole-hearted coöperation contributed in a large measure to whatever success I may have had.

I wish also to thank the authorities of the Museum of Comparative Zoölogy for many courtesies extended during the progress of my work; Mr. Outram Bangs for his advice, freely given whenever asked; Dr. Thomas Barbour for assistance in revising the manuscript, and Dr. J. C. Phillips whose generous interest made possible the trip, and who has kindly asked me to report upon the collection.

LIST OF SPECIES.

The following list comprises all the species collected between August 8, 1920 and February 20, 1921, at or between the localities described in the introduction. In addition, some six or seven species are included which were not taken, but which are all easily recognized and known to occur in northern Patagonia.

The classification followed is that of Sharpe's Hand-List. Nomenclature has been brought up to date and under each species the original description is cited and the type-locality given. With the exception of a few cases where the original texts were not available, all citations have been personally verified. I have endeavored to include a brief notice of the status of each bird, whether or not it is migratory, a short account of its habits, and such taxonomic discussion as seems relevant.

RHEIDAE.

1. Pterocnemia pennata (d'Orbigny).

Rhea pennata d'Orbigny, Voy. Amér. Mérid., 1835, **2**, Itin., p. 67, note. Patagonia.

Ostrich, Avestruz, Choique.

About Maquinchao and Huanuluan the Rhea is locally a common resident, numerous in some sections, almost absent in others. When not disturbed it wanders rather leisurely, the footprints being not over two feet apart. When alarmed the bird runs off with rather a swaying, awkward gait, but surprisingly fast, fully as swiftly as a horse and often over loose rocky ground.

Breeding is irregular; it may begin as early as June, and it extends until October. So much has been written of the breeding habits that it is unnecessary to go into much detail regarding them. Several females lay in a common nest, instances of a single nest containing sixty eggs are not uncommon, and I was told of an instance, apparently well authenticated, of one of seventy-four eggs.

Both the bird and its eggs are much esteemed by the Indians for food. They are hunted on horseback and caught by means of the *boleadores*. The pursuit is generally conducted by two mounted men who run the Rhea in a circle until it becomes dazed and confused.

At Huanuluan I found my first brood of young on December 1, six birds, accompanied by an adult, running rapidly across a stony plain. On December 14 between Huanuluan and Maquinchao, Rheas were very common, adults, fully grown young, and one brood of chicks were seen. South of Maquinchao on December 27 I saw a brood of eight young; the largest brood found comprised a dozen or fifteen. An adult male killed on December 14 had many newly grown fresh feathers. The stomach contained only a quantity of partly digested vegetable matter. The pads on the soles of the feet were full of thorns.

This species does not appear to be in any immediate danger of extermination. No doubt as more land is fenced, the numbers will decrease somewhat and there is always the danger that at some time they will be systematically hunted by the sheep-growers, who regard with a jealous eye any herbivorous wild animal.

TINAMIDAE.

2. Calopezus elegans elegans (d'Orbigny & Geoffroy).

Eudromia elegans d'Orbigny and Geoffroy, Mag. zool., 1832, cl. 1, pl. 1, and text. Arid regions from lat. 38° to 46° S. especially south of the Rio Negro, Patagonia.

Martinete.

A very common resident in the eastern part of the province, common about Maquinchao, but from there westward decreasing in number; about Huanuluan the Martinetes occurred sparingly in a few localities. They are strictly terrestrial, never resorting to flight unless forced to do so. Their mottled gray and white plumage is particularly adapted to concealment in the desert vegetation, and when squatting on the ground it is next to impossible to see them. Their note is a clear, sweet whistle, rather ventriloquial. Breeding probably commences late in October in the interior, doubtless somewhat earlier near the coast. About November 1 one of the peons at Huanuluan brought in three fresh eggs. January 14, 1921, I shot three birds about half grown. Near the coast where this Tinamu is common, it is much hunted. A favorite method is based on the bird's disinclination to fly. A low brush fence is built in the shape of a hopper with an opening at the small end and the birds are driven in,— a device used in nearly every country to "hunt" game of one sort or another.

The range given for this species when first described was "dans tous les terrains sablonneux et arides qui entourent le grand bassin des Pampas . . . On la rencontre depuis le 38^e^ degre de latitude jusqu'au 46^e^ . . . Elle ne commence a etre commune que dans les terrains deserts qui se trouve au sud du Rio-Negro, en Patagonie." So far as I am aware no definite type-locality has ever been assigned for this species. I therefore designate the mouth of the Rio Negro.

Chubb has described, (Bull. B. O. C., 1917, **38**, p. 31), *Calopezus elegans morenoi*, from Neuquen, Argentina. Birds taken at Maquinchao and Huanuluan do not differ from specimens taken at San Antonio, which may be considered virtual topotypes. Apparently *C. e. morenoi* is not the inland race of *Calopezus elegans*, but a form inhabiting the upper Rio Negro Valley and extending northward to Mendoza. An adult male from Tunuyan, Province of Mendoza, taken March 27, 1921 belongs to this form.

3. Tinamotis ingoufi Oustalet.

Tinamotis ingoufi Oustalet, Ann. sci. nat. Zool., 1890, **9**, p. 18. Vicinity of Santa Cruz.

While staying at Huanuluan I was told of a Red-winged Martinete which was found in a few favored localities in that section. During the summer of 1920, however, it appeared to be absent, visits to its reputed haunts proved fruitless, and the shepherds who always reported any unusual species confessed that they had not seen a single one that summer; even lamb-marking time, in late November, when every inch of the country was systematically examined, failed to bring a single report of its presence.

On January 20, 1921 the horse-boy brought in a juvenal female that he had just killed with a sling shot.

This skin has been carefully compared with the original description, and with a plate published in the report of the Mission scientifique au Cap Horn, and after making due allowance for immaturity, I have no hesitation in identifying it as *T. ingoufi*. While congeneric with *T. pentlandi*, with which it has been compared, it bears not the slightest resemblance to that bird. This instance of its occurrence in northwestern Patagonia extends its known range over six hundred miles.

COLUMBIDAE.

4. Columba araucana Lesson.

Columba araucana Lesson, Voy. Coq. Zool., 1827, livr. 4, pl. 40. Talcahuano, Province of Concepcion, Chile.

This large pigeon was not uncommon on the wooded hills about Bariloche. An adult male secured on February 16 is in fall plumage and lacks the white collar on the nape and the metallic feathers on the hind neck.

5. Zenaida auriculata auriculata (Des Murs).

Peristera auriculata Des Murs, Gay's Hist. Chile. Zool., 1847, **1**, p. 381. Central Chile.

In western Rio Negro a very common summer resident. At Maquinchao a few were present on August 21, but at Huanuluan it was not seen until September 11, and did not become really common until after the first of October. It was not uncommon at Bariloche. Their favorite haunts are the gullies and ravines where bushes are dense.

On November 14 I shot a female, with an egg in the cloaca, ready to lay, though the first nest was not found until December 1; this nest was a frail platform of twigs and contained two white eggs; other nests found between the 20th and 27th of December at Puesto Horno, thirty miles south of Maquinachao, contained only one egg each. The bird shot on September 11 was evidently completing a prenuptial moult, since it is in fresh plumage, and skinning it revealed several pin-feathers on the breast and flanks.

Although *Zenaida auriculata* is a wide-ranging species covering the greater part of South America, there appear to be no constant characters by which it can be subdivided, except that a local desert inhabiting race, *Z. a. pallens* Bangs and Noble, is found in northwestern Peru, (Auk, 1918, **35**, p. 446. Huancabamba, Peru).

6. Metriopelia melanoptera melanoptera (Molina).

Columba melanoptera Molina, Sag. stor. nat. Chili, 1782, p. 236. Chili.

A common summer resident in the arid western portion of Rio Negro. It was seen for the first time at Huanuluan on October 11, inhabiting much the same situations as the previous species, but the two forms are never seen in close association. A nest containing a single egg was found on November 14. This dove is easily identified in flight by the sharp contrast between the black wings and tail and the pale vinous color of the underparts. A patch of bare skin below and in front of the eye is orange in life and very conspicuous when the bird is seen at close or mid-range.

RALLIDAE.

7. Fulica armillata (Vieillot).

Fulica armillata Vieillot, Nouv. dict. hist. nat., 1817, **12**, p. 47. Paraguay.

Very common summer resident frequenting the *lagunas* and *juncales*. At Huanuluan a few individuals were seen among the reeds in the *laguna*, August 25. During September their numbers increased, and they then began to frequent the larger patches of reeds along the stream, where they could be heard *chuckling* or giving their diabolical laugh. On several occasions they were found along the *arroyo* in open running water; when flushed in such situations they pattered along, legs dangling, in a straight line endeavoring to get their momentum for flight.

On the large *laguna* at Neluan, twenty miles south of Maquinchao, they were very abundant during the last half of December. They gathered nightly in shallow water at the end of a little sand-spit, crowding up to one another until they formed a solid black mass which did not break up until the sun was high the next morning. If alarmed from their resting place early in the morning, the entire mass started for the middle of the pond with a great whir of wings, the dangling legs of each bird throwing up a cloud of spray like a miniature stern-wheel steamer.

This coot also occurred in some small ponds formed by old river meanders, now grown up with reeds and wooded to the water's edge, near the mouth of the Arroyo Niriguao, (a small river flowing into the eastern end of Lake Nahuel Huapi).

COLYMBIDAE.

8. Colymbus chilensis (Lesson).

Podiceps chilensis "Garnot" Lesson, Man. d'orn., 1828, **2**, p. 358. Baie de la Concepcion.

Locally common in certain districts.

At Huanuluan on October 9th while trying to *squeak* a *Phleocryptes melanops* out of a small clump of reeds, two of these little grebes appeared for a moment in a small opening at such close range that it was not possible to shoot them. Again on November 12 a single individual appeared from a clump of reeds in the centre of a *laguna*, about six miles west of the Estancia buildings. They were common on the big *laguna* at Neluan, twenty miles south of Maquinchao, between the 16th of December and the 1st of January. These birds probably gathered here from an extensive reed-bed a mile or so further east.

9. Colymbus calipareus calipareus (Lesson).

Podiceps calipareus Lesson, Voy. Coq. Zool., 1830, **1**, livr. 16, p. 727. Falkland Islands.

Locally common in certain sections.

Two were seen on the *laguna* at Huanuluan on November 12 and again on the 16th; they remained constantly together in open water away from the reeds, diving very little. On both occasions they kept out of gunshot.

On the *laguna* at Neluan they were very common, sometimes occurring singly, more often in loose companies of half a dozen, and on one occasion a compact body of twelve was found.

A few were seen along the southern shore of Lake Nahuel Huapi.

A small grebe, almost certainly *Podilymbus podiceps* (Linné), was seen momentarily at the edge of the reeds in the *laguna* at Huanuluan; unfortunately the bird was out of gunshot.

10. Aechmophorus major (Boddaert).

Colymbus major Boddaert, Tab. pl. enlum., 1783, p. 24. Cayenne.

Two of these large grebes were seen on a tidal creek at San Antonio in mid August.

LARIDAE.

11. Larus maculipennis Lichtenstein.

Larus maculipennis Lichtenstein, Verz. doubl., 1823, p. 83. Montevideo, Uruguay.

Gaviotina.

Two small gulls shot at San Antonio on August 14 and 17 belong to this species. One, an adult male, is assuming the breeding plumage; the underparts strongly suffused with pink, many dusky feathers in the head and the legs, feet, bill, and circumorbital ring deep carmine. The other, an immature female, has no trace of the pinkish suffusion, but had dusky feathers in the auriculars only, a wide, dusky, subterminal tail-band, and the feet, legs, and basal two thirds of the bill pale coral-red.

12. Larus glaucodes Meyen.

Larus glaucodes Meyen, Nov. act. Acad. Caes. Leop., 1832, **16**, p. 115, pl. **24**. Die Kuste von Chile.

Gaviotina.

This species is the one generally, if not exclusively, found along the wet meadows bordering the streams in the arid western portion of Rio Negro. From the time of my arrival Black-headed Gulls were very common in such situations, particularly near the *estancia* buildings at Maquinchao and Huanuluan, attracted no doubt by the remains of slaughtered sheep, but they also appeared promptly whenever kitchen scraps were thrown out, and came up to within a few feet of the door of the building where I was accustomed to do my skinning, to pick up bird bodies.

Full spring plumage was completely assumed by the tenth of September, but the pale rose color of the underparts began to fade early in October.

Towards the middle of November the gulls used to sit in a solid mass at the borders of pools in the meadow, instead of being scattered up and down the *arroyo*, as had been their custom during the early part of the spring, and when not engaged in scavenging about the buildings, they continued to rest thus in a body until about the first of the year when they vanished utterly. Apparently they do not breed in this region, but remain here until nearly the first of January before departing for their nesting grounds.

13. Larus dominicanus Lichtenstein.

Larus dominicanus Lichtenstein, Verz. doubl., 1823, p. 82. Habitat ad littora Braziliae.

Gaviota.

The South American Black-backed Gull was common at San Antonio, at the time of my stay there in August. They could be seen at any time flying over the town, even descending into the streets and yards to feed with the hens. On August 16 there was a flock of at least two hundred on the beach, all of them adults.

On Lake Nahuel Huapi this species is said to breed on La Isla de las Gaviotas, (Gull Island), a small rocky island near the southern shore of the lake, about five miles to the west of Bariloche. While passing the rock on February 4, 1921, about fifty birds were in sight, nearly all of them in adult plumage, a few gray ones among them.

THINOCORIDAE.

14. Thinocorus orbignyanus Geoffroy and Lesson.

Tinocorus orbignyanus Geoffroy and Lesson, Cent. zool., 1830, p. 137, pl. 48, male, pl. 49, female. San-Yago du Chile.

This seed-snipe is a characteristic resident of the western portion of the Plain of Patagonia; I found it only in the vicinity of Huanuluan, almost invariably up among the higher gullies and ravines which cut back into the table-lands or head far up on El Escorial.

All during the spring until as late as the first of December, its flight-song was a striking sound in these localities. Although given at intervals during the day, when a glimpse of the singer might be caught as he descended to earth, his performance was best heard at dawn. Late in November I was camped just below the rock rim of a *planicie,* and then with the first faint flush of dawn a bird near at hand began his melodious *co boss,* then the call was taken up by a bird in the distance and soon calls could be heard coming from all sides.

15. Thinocorus rumicivorus rumicivorus Eschscholtz.

Thinocorus rumicivorus Eschscholtz, Zool. atlas, 1829, p. 2, pl. 2. Concepcion Bay, Chile.

Coralero.

A common resident in the western parts of Rio Negro, migrating in winter as far as Buenos Aires. All of them, however, seemed to have returned before the middle of August. Unlike its larger relative, *T. orbignyanus*, it does not frequent the rocky gullies and ravines, but is found on the gravelly plains and sandy valleys. It is very tame and unsuspicious, never seeking to escape by flight, unless almost stepped on, and then flying only a short distance, when it resumes feeding. The food consists entirely of vegetable matter; nearly all the birds I killed had the bills covered with some sticky substance and the crop [1] frequently full of seeds.

The flight-song is a characteristic sound on the *mallines* from August until December; during that month and even into January it is occasionally given. The bird flies up gradually a short distance into the air and then descends slowly on set wings, uttering a few sweet bubbling notes in the early part of the descent. This performance is occasionally given on moonlight nights.

October 23 I shot a female with a fully formed egg (less the shell), in the oviduct, and on December 7 I saw young. A nest with four eggs found at Puesto Horno, thirty miles south of Maquinchao, on December 20, may have represented a second brood. The nest was merely a hollow scraped in the sand near a small herbaceous plant not over three inches high. The female spent considerable time off the nest, engaged not only in carefully covering the eggs with small twigs and pieces of dry grass, but actually filling the spaces between the eggs with similar material, so that even knowing the exact position of the nest, it was impossible to see anything unusual, since the top of this covering was exactly flush with the ground.

Our present knowledge of the geographic races of *Thinocorus rumicivorus* is very unsatisfactory.

An adult female taken seven miles east of Bariloche on February 13, 1921, is smaller, (wing 109, culmen 11, tarsus 16.75) than four females from the region of Maquinchao — Huanuluan, (average, wing 116.75, exp. culmen 10.94; tarsus 18.52), and in wing measurements comes

[1] The Thinocoridae are unique among Charadriformes in the possession of a crop.

close to *T. r. venturii* (Rothschild, Bull. B. O. C., 1921, **41**, Barracas al Sud., Buenos Aires). On the other hand, however, the Bariloche bird is darker above than the birds referred to, whereas *venturii* is described as being lighter. Unfortunately *venturii* was described from a migrant which complicates a situation already sufficiently involved.

HAEMATOPODIDAE.

16. Haematopus palliatus durnfordi Sharpe.

Haematopus durnfordi Sharpe, Cat. birds Brit. mus., 1896, **24**, p. 117 (p. 107 in key) pl. 6. Tombo Pt. Chubut.

Oyster-Catchers occurred on certain tidal gravel flats at San Antonio where two males were killed on August 17, 1920.

These two birds were examined by Dr. R. C. Murphy in connection with his study of the water-birds in the Brewster-Sanford collection and he refers them to *durnfordi*.

CHARADRIIDAE.

17. Oreopholus ruficollis ruficollis (Wagler).

Charadrius ruficollis Wagler, Isis, 1829, p. 653. Type-locality Patagonia suggested by Brabourne & Chubb 1912.

A fairly common resident, migratory in the western part of Rio Negro. A few were seen at Rio Colorado and at San Antonio; at Maquinchao I was told that they had arrived shortly before the 20th of August. Its usual haunts are the flat grassy plains and the gentle gravelly slopes up among the hills. The note is a sweet mournful whistle suggesting a bluebird, *Sialia sialis*. They breed late in October. On November 2 a female was found leading a brood of three young but a few hours old; on December 1 I shot a juvenal male fully grown and feathered

18. Belonopterus chilensis chilensis (Molina).

Parra chilensis Molina, Sag. stor. nat., Chili, 1782, p. 258. Chile.

Teru-Teru.

An abundant species of the grassy *mallines;* a few winter.

The Teru-Teru is by far the most conspicuous and striking bird of the region, not only by reason of his voice and color, but also by the fact that the bird continuously forces his presence upon every passer-by. A man or a dog within 200 yards of a lapwing cannot fail to attract notice and as soon as the alarm is sounded from two to a dozen birds will be flying about overhead emitting a deafening chorus of screeches; after making themselves as conspicuous as possible for a few minutes, they fly off quietly and light a short distance away, then crouching low they slink away through the grass. Just before joining in an attack, and at its termination they utter a somewhat different note, lacking the rasping ear-piercing qualities of their war cry. It was always difficult for me to find their nests for the reason that their attack on the intruder is not confined to the vicinity of the nest, but extends over a considerable area and is always reinforced by owners of nests in adjoining territory. Young birds escape notice by lying quietly stretched out in the grass and manage to escape detection unless almost stepped on.

During the spring the Teru-Teru, (doubtless the male), sometimes changes his manner of flight to a series of slow leisurely wing-beats, raising the wings almost vertically at each stroke; upon alighting the wings are extended for a moment, then partly folded, and while the shoulders are held forward the bird runs a few steps forward before folding the wings. They also have the habit of bobbing the head while standing still.

Iris deep red; tibiae pink; the young have a light hazel iris.

Molina's name *Parra chilensis* is believed by some ornithologists to be inapplicable to the present species by reason of a reference to a two-lobed frontal shield in the original description. As far back as 1874 Harting, (P. Z. S., 1874, p. 451), renamed this species *occidentalis*, believing that Molina's name referred to a Jacana, and Lowe, (Bull. B. O. C., 1921, **41**, p. 111), again renamed the same bird *molina*, also believing that a Jacana was intended. Molina's diagnosis of a "Parra with moderate toes, dusky feet and sub-crested occiput" should certainly fix the name to this species. Furthermore the long accurate account of its habits, which he gives, establishes without doubt his intention to describe the bird now under discussion.

The three South American races of *Belonopterus chilensis* may be characterized as follows: —

Belonopterus chilensis chilensis (Molina). Neck and sides of head gray; a wide black streak connecting the black of throat and breast; tarsus shorter. Chile, western Argentina, highlands of southern Peru.

Belonopterus chilensis lampronotus (Wagler).[1] Neck and sides of head brownish gray; black on underparts less extensive; black of throat and breast connected by a narrow black line; tarsus shorter, 67–77 mm. E. Argentina, Paraguay, Uruguay, southern Brazil.

Belonopterus chilensis cayennensis (Gmelin).[2] Neck and sides of head brownish; black of throat and breast not connected; tarsus longer, 77–82 mm. Colombia (Tropical zone), Venezuela, Guianas, Brazil (except southern).

19. Leucopolius falklandicus (Latham).

Charadrius falklandicus Latham, Index orn., 1790, **2**, p. 747. Falkland Ids.

Rather common on the mud- and sand-flats near San Antonio. The species was first met with at Huanuluan on September 12 and the two females shot showed a prenuptial moult, complete except for a few pin-feathers on the head and neck. No direct evidence of their breeding was secured although they were seen about the shores of the *laguna* at Neluan about the end of December and a few at Huanuluan on January 9.

Lowe, (Ibis, 1922, p. 475–495), has shown anatomical grounds for separating Leucopolius Bonaparte, (type *Charadrius leucopolius* Wagler), from Charadrius Linné, (type *Charadrius hiaticola* Linné).

SCOLOPACIDAE.

20. Neoglottis flavipes (Gmelin)

Scolopax flavipes Gmelin, Syst. nat., 1788, **1**, p. 659. New York.

The Yellow-legs arrived at Huanuluan on September 19, a solitary bird at the edge of the *arroyo*, the following day four more appeared,

[1] *Charadrius lampronotus* Wagler, Syst. Av., 1827, sp. 48. Habitat in Paraguayae, Braziliae, Cajennae. I restrict the type-locality to Southern Brazil.

[2] *Parra cayennensis* Gmelin, Syst. nat. 1788, **1**, p. 706. Cayenne.

and on the 27th a flock of thirty or forty; they were generally common from that time on.

Two adult females shot on September 30 were both quite fat, each had numerous pin-feathers, particularly on the neck.

21. Neoglottis melanoleuca (Gmelin).

Scolopax melanoleuca Gmelin, Syst. nat., 1788, **1**, p. 659. Chateau Bay, Labrador.

The Greater Yellow-legs arrived at Huanuluan on October 6; on that day several were seen with a small flock of the Lesser Yellow-legs; they never became common, though a few were seen daily thereafter in company with the smaller species.

22. Pisobia maculata (Vieillot).

Tringa maculata Vieillot, Nouv. dict. hist. nat., 1819, **34**, p. 465. Iles Antilles et dans les parties méridionales des Etats-Unis.

The Pectoral Sandpiper came to my notice but twice; October 6 when one was seen with a small mixed flock of Yellow-legs, and again on October 23 when I killed an adult male. This specimen was just growing two new innei primaries, the rest of the remiges and rectrices were as yet unmoulted.

23. Pisobia bairdii (Coues).

Actodromus bairdii Coues, Proc. Acad. nat. sci. Phila., 1861, p. 194. Fort Resolution, Great Slave Lake.

A few Baird's Sandpipers appeared at Huanuluan on September 12. An adult female taken at that time was in good condition and with a sprinkling of pin-feathers. By October 21 the species was fairly common in flocks of from three or four to twenty-five or more individuals, numbers which were maintained until well into January.

None of the four species of North American sandpipers just enumerated were found in the region about Lake Nahuel Huapi.

24. Capella paraguaiae (Vieillot).

Scolopax paraguaiae Vieillot, Nouv. dict. hist. nat., 1816, **3**, p. 356. Paraguay ex Azara.

A fairly common summer resident, occurring at Huanuluan in the wet meadow bordering the stream. It was present abundantly at the time of my arrival. August 23, and also at the time of my departure at the end of January.

From the first the males were *winnowing,* usually at dusk, on cloudy days and on moonlight nights, but often on bright days as well. When thus engaged they fly in a wide circle or ellipse, at intervals expanding the tail until the outer feathers are at right angles with the main longitudinal axis, at the same time swooping down suddenly, recovering as quickly and resuming normal flight. The characteristic *winnow* is of course given on the downward swoop with the tail expanded. As spring progressed this aerial performance decreased in frequency and after November 25 ceased entirely except on moonlight nights.

Hudson gives the number of eggs for this species as four; but of the three nests found on the meadow at Huanuluan all contained two. Two nests were found on October 7 by flushing the bird off the nest; a simple grass-lined affair in a slight depression screened from observation from above by a few blades of grass. The following day another nest was found also containing two eggs from which large embryos were removed.

25. Nycticryphes semicollaris (Vieillot).

Totanus semi-collaris Vieillot, Nouv. dict. hist. nat., 1816, **6**, p. 402. Paraguay ex Azara.

I met this bird only at Huanuluan where it was uncommon. On November 3 one was jumped from the wetter portion of the meadow and ten days later I flushed one while traversing the same spot. January 12, 1921, two were put up within a stone's throw of the *estancia* buildings, and one of them was secured.

THRESKIORNITHIDAE.

26. Theristicus melanopis (Gmelin).

Tantalus melanopis Gmelin, Syst. nat., 1788, **1**, p. 653. In insula novi anni.

Bandurria.

Not uncommon summer resident, frequenting the vicinity of the swampy meadows and sandy wire-grass flats. It arrived September 29, 1920, at Huanuluan.

The Bandurria, as it is universally called is one of the most characteristic and conspicuous birds of the summer landscape in western Patagonia; it is a bird that cannot be likened to any other species; its appearance, attitude, flight, and above all, its note, are not characteristic of any other bird. On the ground it is hard to see, the buff head and neck and silvery back blending with the grass. When it rises, however, a slow stately flight, the black and white underwing lining and buff head and neck immediately make it conspicuous. If alarmed while feeding, it flies off slowly, not rising far above the earth, and usually goes off 300 to 400 yards before alighting again. At other times it appears to fly for the sheer love of flying, rising into the air to become only a speck, then descending in wide sweeping spirals.

The note is a rich banjo-like *plank*, very carrying, and often heard before the distant flying bird is seen. Hudson describes it as sounding "like blows of a powerful hammer on a metal plate."

ARDEIDAE.

27. Nycticorax cyanocephalus cyanocephalus (Molina).

Ardea cyanocephala Molina, Sag. stor. nat. Chili, 1782, p. 235. Chili.

Dormilon.

Rather uncommon about Huanuluan and Maquinchao during the spring and early summer, but becoming more numerous during January. Its first appearance was on September 29, an adult female shot near the *estancia* buildings at Huanuluan; it was again met with on November 12 on a small lagoon some six miles west of Huanuluan, and on December 22 I shot a female at Puesto Horno, 30 miles south of Maquinchao. It was not uncommon in the large reed-bed at Neluan, twenty miles south of Maquinchao.

January 8 two appeared along the *arroyo* immediately in the rear of the buildings at Huanuluan, and the following day three more were seen at the *laguna*, six miles to the westward. Not one of these birds was in full adult plumage; the adult female taken September 29 had underparts as in the young; top of head deep blackish brown; back dark brown; a single occipital plume. The Puesto Horno bird is a female of the year before in worn plumage.

PHOENICOPTERIDAE.

28. Phoenicopterus chilensis Molina.

Phoenicopterus chilensis Molina, Sag. stor. nat. Chili, 1782, p. 242. Chili.

The Flamingo was met with only at the *laguna* at Neluan, twenty miles south of Maquinchao, between the 16th of December, 1920 and January 3, 1921. Here there were four birds. They were wild and easily alarmed, and one which I finally succeeded in shooting was obtained only by a very long shot after a tiresome stalk.

A few flamingos were also seen February 22 at Laguna Blanca, a small pond beside the Bariloche-Neuquen Road, about 200 kilometres northeasterly of the former place.

ANATIDAE.

29. Cygnus melancoryphus (Molina).

Anas melancoryphus Molina, Sag. stor. nat. Chili, 1782, p. 234. Chili.

Cisne.

I found Black-necked Swans locally common in western Rio Negro. At Huanuluan four of them appeared early in October and were seen repeatedly for several days, but finally disappeared. Four swans seen on a small *laguna*, six miles west of Huanuluan, November 12, may have been the same birds.

At Neluan, however, where a large reed-bed and lake were close together, they were very common, and bred in the deep secluded pools of the *juncal*, where, on December 28, I saw two pair each accompanied by two cygnets. A day or two later I found a pair with six young on the waters of the big *laguna*. Six is the greatest number of young for which I can find record; Gibson records two instances of nests with six eggs.

30. Chloëphaga leucoptera (Gmelin).

Anas leucoptera Gmelin, Syst. nat., 1788, **1**, p. 505. Falkland Islands.

Abutarda.

Common permanent resident in western Rio Negro, probably less numerous in the winter. Their usual haunts are along the stream courses.

Breeding birds are paired off early, but the first eggs were not found until September 30. The nests are placed on dry hummocks, not far from water, and contain from five to seven eggs. Incubation is performed by the female with the male standing sentinel close by. When leaving the nest to feed, the female covers the eggs with a coverlet of down, although when frightened off this protection is of course not spread.

Upon hatching, the young are led off under the protection of both parents, the female always keeping near the young, the male ever on the lookout. On one occasion I surprised a pair with six young some distance from the water; the female led off the goslings and the male feigning wing-droop endeavored to lead me away. I have occasionally surprised broods swimming in the deeper pools on the streams, and in such cases the young remain quietly on the water, making no effort to swim away or hide, and are quite incapable of diving. For a time I had two broods of five young each which I tried to rear. At first a swimming tank was provided for them, but as the goslings entered the water only when pushed in and immediately showed a strong desire to get out again as soon as possible, this was abandoned and water was then provided for drinking purposes only.

The sexes are totally dissimilar both as to voice and plumage and might easily be taken for different species; on the other hand the downy young do not differ at all.

Early in October a flock of upwards of forty of these Upland Geese made their appearance at Huanuluan and remained throughout the season, although their numbers had dwindled to less than twenty by the time of my departure, the end of January. Flocks of non-breeders were a characteristic feature of the summer life of nearly all of the species of Anatidae occurring in western Rio Negro.

31. Anas cristata cristata Gmelin.

Anas cristata Gmelin, Syst. nat., 1788, **1**, p. 540. Statenland.

The Crested Duck was not uncommon in western Rio Negro. Specimens were taken at Huanuluan and it was also seen at Neluan, twenty miles south of Maquinchao.

32. Anas specularis King.

Anas specularis King, Zool. journ., 1828, **4**, p. 98. Straits of Magellan.

This duck is found in Rio Negro along the streams running into the Andean Lakes. At Lake Nahuel Huapi it occurred at the mouth of the Arroyo Niriguao, near the eastern extremity of the lake. On October 20 I shot a pair at Huanuluan, but the species is probably accidental in the arid interior of Patagonia.

33. Mareca sibilatrix (Poeppig).

Anas sibilatrix Poeppig, Froriep's Notizen, 1829, **31**, p. 10. Chile.

The South American Widgeon was one of the common ducks occurring in western Rio Negro.

34. Nettion flavirostre (Vieillot).

Anas flavirostris Vieillot, Nouv. dict. hist. nat., 1816, **5**, p. 107. Buenos-Ayres.

A few seen at Huanuluan, Maquinchao, and Neluan; not a common duck in western Rio Negro.

35. Querquedula cyanoptera (Vieillot).

Anas cyanoptera Vieillot, Nouv. dict. hist. nat., 1816, **5**, p. 104. Amerique méridionale sur la Rivière de La Plata et à Buenos-Ayres.

The Cinnamon Teal is not a very common resident in western Rio Negro. At Huanuluan it was usually associated with *Q. versicolor* and *N. flavirostre* in shallow weed-grown pools.

36. Querquedula versicolor (Vieillot).

Anas versicolor Vieillot, Nouv. dict. hist. nat., 1816, **5**, p. 109. Paraguay.

A common resident in western Rio Negro occurring most frequently in small pools and the larger reed-clumps.

37. Dafila spinicauda (Vieillot).

Anas spinicauda Vieillot, Nouv. dict. hist. nat., 1816, **5**, p. 135. Buenos-Ayres.

The Brown Pintail is the abundant breeding duck, comprising from 80% to 85% of the total number of individuals in western Patagonia.

38. Spatula platalea (Vieillot).

Anas platalea Vieillot, Nouv. dict. hist. nat., 1816, **5**, p. 157. Amerique méridionale et particulièrement au Paraguay.

This shoveller is a migrant, locally common and possibly a local breeder in western Rio Negro.

39. Metopiana peposaca (Vieillot).

Anas peposaca Vieillot, Nouv. dict. hist. nat., 1816, **5**, p. 132. Paraguay and Buenos Aires.

Apparently a migrant, uncommon at Huanuluan where a few males only were seen. At Neluan, December 28, a flock of nearly fifty, males predominating, was found in a small lagoon at the edge of a large reed-bed.

40. Erismatura ferruginea Eyton.

Erismatura ferruginea Eyton, Monog. Anat., 1838, p. 170. Chile?

Rare in western Rio Negro; an adult female was killed at Neluan December 28.

41. Erismatura vittata Phillipi.

Erismatura vittata Phillipi, Archiv naturg., 1860, p. 26. Chile.

While this ruddy duck is far more common than the preceding, nevertheless it is not very numerous. It came to my notice only on the larger *lagunas*, particularly at Neluan where a small series was collected late in December and early in January. It also occurred on the lagoon six miles west of Huanuluan.

CATHARTIDAE.

42. Sarcorhamphus gryphus (Linné).

Vultur gryphus Linné, Syst. nat., 1758, **1**, p. 86.

Huitre.

A few Condors occur in western Rio Negro. On December 21 while exploring a cañon running southward from Puesto Horno I saw a Condor sailing high overhead; it was said to breed in that vicinity. They formerly bred on El Escorial, a low isolated range of hills west of Huanuluan, but have been driven from this locality. Mr. James Nairn of Maquinchao showed me photographs of a young bird that had been taken there.

As might be expected Condors are not infrequently seen sailing over the mountains which enclose Lake Nahuel Huapi.

FALCONIDAE.

43. Polyborus plancus (Miller).

Falco plancus Miller, Icon. anim., 1777, pl. 17. Tierra del Fuego.

Carancho.

A fairly common resident.

While the Carancho is primarily a carrion-hawk, its taste for young lambs is a not inconsiderable source of loss to the sheep-growers. In spite of a bounty of ten centavos a head their numbers vary but little.

Breeding commences late in September; two eggs are laid in a large bulky nest placed in some dense bush. On November 23 I found a nest containing three young almost ready to leave the nest.

At Bariloche Caranchos were found to be fairly common about the eastern end of Lake Nahuel Huapi, but were not seen in the wooded sections further west.

44. Ibycter albogularis (Gould).

Polyborus albogularis Gould, P. Z. S., 1837, p. 9. Santa Cruz, Patagonia.

Rare resident. On November 28 a black and white hawk lit on a post in the sheep-pens at Huanuluan; stalked from behind a brush-wind break, I found the bird without the right foot and half the tarsus, the stump completely healed. On January 29, while *en route* to Bariloche I saw another in flight a few miles west of Huanuluan.

45. Milvago chimango chimango (Vieillot).

Polyborus chimango Vieillot, Nouv. dict. hist. nat., 1816, **5**, p. 260. Rare au Paraguay — commun a la Rivière de la Plata.

Chimango.

Very common resident, especially about the settlements, but becoming rarer towards the mountains.

46. Circus cinereus Vieillot.

Circus cinereus Vieillot, Nouv. dict. hist. nat., 1816, **4**, p. 454. Paraguay — et près de la rivière de la Plata.

This marsh hawk is not uncommon along the *mallines* or in the vicinity of water. At the big reed-bed at Neluan they were abundant and aggressive, hovering close overhead and uttering a *käk käk käk* repeated many times. It is highly probable that this hawk is semi-colonial in its nesting. I feel certain that many pairs were breeding in the reed-bed just mentioned, and Durnford (Ibis, 1878, p. 397) records "On the 26th October [1877] we found many pairs nesting on some low swampy land amongst long grass."

On February 17 I saw a female hovering over a hen-yard on the outskirts of Bariloche.

47. Geranoaetus melanoleucus australis Swann.

Geranoaetus melanoleucus australis Swann, Syn. list Accip., ed. 2, 1922, p. 67. Valle del Lago Blanco, Chubut.

Not uncommon resident.

The Chilean Eagle is usually seen sailing high overhead where it is most easily recognized by its broad blunt wings and comparatively short tail. A female shot thirty miles south of Maquinchao on December 22 had a wing-spread of five feet eleven inches.

48. Buteo erythronotus erythronotus (King).

Haliäeetus erythronotus King, Zool. journ., 1827, **3**, p. 424. Port Famine, Tierra del Fuego.

Not uncommon along the line of the railroad or telegraph-lines, where the poles furnish convenient nesting sites; elsewhere less common. Hudson says that the stomachs of all these hawks that he examined contained the remains of cavies (*Caviella australis*). On October 25 I shot one at Huanuluan with a fresh-killed gopher, (*Ctenomys colburni*), lying beside him, while one killed four days later had the partly digested remains of a gopher in his crop and was in the act of swallowing a small lizard.

On a few occasions I have watched these hawks "hanging in the air" after the fashion of *Archibuteo lagopus, i.e.* sustaining themselves by slow wing-beats while facing a light breeze.

49. Cerchneis sparveria cinnamomina (Swainson).

Falco cinnamomina Swainson, Anim. in menag., 1837, p. 281. Chile.

Not met with in eastern Rio Negro; uncommon about Maquinchao, but becoming more numerous towards the Rio Limay. I saw a single bird near Huanuluan early in September, but did not meet with it again there until January 13 when I shot a female in much worn and faded plumage. On a short side trip to Paso Flores on the Limay between December 5 and 7 I saw five individuals at different points along the valley of the Cumayo. A few were also noted about the southeastern end of Lake Nahuel Huapi.

BUBONIDAE.

50. Asio flammeus breviauris (Schlegel).

Otus breviauris Schlegel, Mus. Pays Bas, 1863, **2**, p. 4. Brazil.

Not uncommon resident. At San Antonio several were started from among the sand dunes; in the regions about Maquinchao-Huanuluan, short-eared owls were frequently flushed from among the bushes on the stony plains or on the more gentle slopes and gullies, and on one occasion I shot one as it was coursing along at the base of the rim rock. I was told at Maquinchao that nests and young are often found during the cutting of the alfalfa fields in December.

This species was met with at Bariloche February 12.

51. Bubo virginianus magellanicus Daudin.

Bubo magellanicus Daudin, Traite d'orn., 1800, **2**, p. 210. Vicinity of the Straits of Magellan.

On the evening of February 9 I shot an adult male horned owl near the fish-hatchery, about seven miles east of Bariloche. This locality is on a small wooded stream, bordered on either side with the characteristic desert vegetation of arid western Patagonia.

This specimen conforms very closely to average measurements for *B. v. magellanicus*. I am not certain that this species occurs regularly in the arid portions of Patagonia. It is not uncommon on Tierra del Fuego and the Straits of Magellan.

Doering (Com. cient. exped. al Rio Negro. Entrega 1, Zoologia, 1881, p. 49) states that this owl is very abundant on the islands in the Rio Negro. Hudson (Idle days in Patagonia, 1893, p. 190) mentions killing one in the willows along the Rio Negro.

Specimens of horned owls from the Straits of Magellan north into Peru, Paraguay, and southern Brazil, are generally referred to this race.

52. Speotyto cunicularia cunicularia (Molina).

Strix cunicularia Molina, Sag. stor. nat. Chili, 1782, p. 263. Chili.

Not uncommon resident.

The presence of a pair of burrowing owls is never long in doubt, since at the approach of an intruder, one or both birds fly about in circles uttering an angry *pip pip pip pip churrr*.

The burrows are large with a strange collection of pebbles, horse-dung and skulls of gophers, together with fragments of bones of small rodents; a hole near Huanuluan had some tail feathers of *Eremobius phoenicurus* scattered about the opening. Fully grown young were seen at burrow-mouths for the first time on January 24.

A male taken at Huanuluan is typical *cunicularia*, while a female collected at San Antonio approaches *cunicularia* in size but tends towards *grallaria* in having slightly less feathering on the tarsus and darker brown markings.

53. Glaucidium nanum nanum (King).

Strix nana King, Zool. journ., 1827, **3**, p. 427. Port Famine, Tierra del Fuego.

Not uncommon near Lake Nahuel Huapi where three were taken. Two of these were found on branches overhanging a road running west from Bariloche along the southern shore of the lake, both in broad daylight though in heavily shaded situations; the third was perched on a dead branch in full glare of the noonday sun.

Hudson and Doering both mention this little owl as occurring along the Rio Negro Valley about Choele Choel.

I have been rather puzzled whether to refer my specimens to typical *nanum* or whether they should not be placed with *G. n. vafrum* Wetmore (Journ. Wash. acad. sci., 1922, **12**, p. 323. Concon, Intendencia of Valaparaiso, Chile).

This form is described as differing in that the dark bars on the tail are twice or more the width of the light bands, and in being slightly larger. One of the Bariloche birds agrees in the character of the tail-bands, but falls short of the measurements given for *vafrum*. The other two have the light and dark tail-bands nearly equal in width, or with the dark bars only slightly wider; their measurements also fall short of those given for *vafrum*.

Measurements of *G. n. vafrum* (from the original description): 2 males, wing 104.1–106; tail 70–76.2; culmen from cere (1 specimen) 12 mm. 2 females, wing 110–114; tail (1 specimen) 74.6; culmen (1 specimen) 12.5 mm.

Measurements of *G. n. nanum* from Lake Nahuel Huapi: 1 male, wing 97; tail 75; culmen from cere 11.5 mm. 2 females, wing 102.5–107; tail 76.1–79.2; culmen from cere 11.8–12 mm.

PSITTACIDAE.

54. Cyanoliseus patagonus (Vieillot).

Psittacus patagonus Vieillot, Nouv. dict. hist. nat., 1817, **25**, p. 367. 32 degrés de latitude australe jusqu'a la côte des Patagons.

A local resident, migratory in the western part of its range in Rio Negro.

The Baranquero Parrot was common about Rio Colorado in August; a flock of about twenty-five frequented the outskirts of the town. At San Antonio it was much less numerous, my only observation for the week spent there was four birds seen in flight on August 16.

A few were seen along the Cumayo and the Coquelen December 5–7. A few pair going into crevices among the rocky walls of the cañon at Puesto Horno thirty miles south of Maquinchao December 21 were doubtless breeding there, as were parrots seen in a similar location near Casa Aleman (35 miles N. W. of Huanuluan) on January 29.

CAPRIMULGIDAE.

55. Thermochalcis longirostris (Bonaparte).

Caprimulgus longirostris Bonaparte, Journ. Acad. nat. sci. Phila., 1825, **4**, p. 284. Brazil.

Rare summer resident.

On the evening of October 30, while setting mouse-traps along a brushy gully a short distance east of the Estancia Huanuluan, I flushed a whip-poor-will from among the rocks, and promptly shot it. The bird had four fully grown rectrices, the others were still in their sheathes, unerupted.

Efforts to secure additional specimens of this species proved fruitless. The natives are acquainted with a *pajaro de la noche* which they say sits in the road at night and cries, but judging from their accounts it is probably more numerous further to the east.

TROCHILIDAE.

56. Eustephanus galeritus (Molina).

Trochilus galeritus Molina, Sag. stor. nat. Chili, 1782, p. 247. Chili.

This hummer was not uncommon at Puerto Blest at the extreme western extremity of Lake Nahuel Huapi. Here on February 3 I found several about a large crimson bell-flower growing there in some profusion. They were very wild and restless and I was unable to collect any. On February 20 one was seen in flight at Playa Bonita, a beach on the southern shore of the lake, five miles west of Bariloche.

PICIDAE.

57. Colaptes pitius cachinnans Wetmore and Peters.

Colaptes pitius cachinnans Wetmore and Peters, Proc. Biol. soc. Wash., 1922, **35**, p. 43. Bariloche, Gobernación de Rio Negro, Argentina.

Four specimens of this flicker were taken in a small grove of trees on a springy hillside not far from Bariloche, on February 17.

In the field this species bears a strong resemblance to *Colaptes auratus*, particularly in its characteristic flight and display of the white rump.

The four birds referred to above were an adult male and female in somewhat worn plumage but with the postnuptial moult begun, and an immature male and female.

Dyctiopicus lignarius (Molina).

Picus lignarius Molina, Sag. stor. nat. Chili, 1782, p. 343. Chili.

Uncommon resident about Lake Nahuel Huapi. On February 20 I heard a woodpecker calling from beside the lake road running west from Bariloche, and a few moments later caught a glimpse of the bird disappearing over a ridge to the southward. Although I was unable to secure the bird, there can be little doubt that it belonged to this species.

PTEROPTOCHIDAE.

58. Scytalopus magellanicus (Gmelin).

Motacilla magellanica Gmelin, Syst. nat. 1788, **1**, p. 979. Tierra del Fuego.

According to Dr. Dabbene, (Hornero, 1919, **1**, p. 262) both this species and *S. niger* (Swainson) are found in the wooded region about Lake Nahuel Huapi. The two species, however, are practically indistinguishable in the field, and moreover are extremely difficult to secure, so that a very great percentage of individuals met with, escape unidentified. The only specimen that I succeeded in killing was an immature female. This bird was shot February 16, near Bariloche, in a swampy bit of woodland containing much half rotten fallen timber.

The following remarks may apply to either species of Scytalopus, which are not uncommon at the western extremity of Lake Nahuel Huapi, are less numerous further east and do not occur outside the Andean forest zone.

On February 3 several were heard in the cane thickets bordering the trail from Nahuel Huapi to the Lago de los Cántaros, and occasionally a small form appeared momentarily, either flitting across the trail or showing itself through an opening in the dense canes. Such glimpses were always at very close range and in most instances were followed by a shot at the place where the bird disappeared, with no success.

59. Rhinocrypta lanceolata (Geoffroy and d'Orbigny).

Rhinomya lanceolata Geoffroy and d'Orbigny, Mag. zool., 1832, cl. 2, pl. 3 and text. Sur les bords du Rio Negro.

Gallito.

This is a common and very characteristic resident of the zone of the Grease Bush in the valleys of the Rio Colorado and the Rio Negro. The appearance of a stranger is greeted by a series of characteristic notes, difficult to describe, but once heard rarely forgotten. It is strictly terrestrial, the wings being short, soft, and rounded, but the feet are large and well muscled. The Gallito presents a ridiculous appearance when seen dashing from cover to cover across a short open space, the tail is carried at an angle of from 70 to 80 degrees; the greater the speed the greater the angle.

60. Teledromas fuscus (Sclater and Salvin).

Rhinocrypta fusca Sclater and Salvin, Nom. Avium Neotr., 1873, p. 76, 161. Mendoza.

Uncommon. This species was met with only at San Antonio where a female was collected on August 18. Like the preceding form it is wholly terrestrial and similar also in its attitude and manner of carrying the tail when running. Where, however, the Gallito complains in a loud voice at the presence of a trespasser, this bird does not so advertise itself but remains silent.

61. Pteroptochos rubecula hylonympha Peters.

Pteroptochos rubecula hylonympha Peters, Proc. N. E. zoöl. club, 1923, **8**, p. 45. Bariloche, Argentina.

The babblers are characteristic birds of the forested slopes about Lake Nahuel Huapi. Their favorite haunts are small dense tangles or thickets which have grown up over rotten logs. Here they live in the half dark interior, emerging but seldom and quickly scurrying back at the approach of danger. Their note is a loud, chuckling laugh, given generally just as one is passing by a thicket, and is most startling.

62. Hylactes tarnii tarnii King.

Hylactes tarnii King, P. Z. S., 1831, pt. 1, p. 15. Insula Chiloe et Portu Otway.

This large Tapaculo is not uncommon on the forested slopes about Lake Nahuel Huapi. It is less retiring than the foregoing species, and does not frequent such dense thickets, but usually it is found in more extensive patches of heavy undergrowth, often in the vicinity of water. One's attention is generally attracted by the note, a loud, liquid chuckle, and the bird is soon discovered running along the top of a fallen log or hopping clumsily about the lower branches of the underbrush. They are inquisitive and *squeaking* will often bring them into view.

A series of five specimens taken in the vicinity of Bariloche between February 1 and 17 are all emerging from the postnuptial moult and are in a pin-feathery condition.

FURNARIIDAE.

63. Geositta cunicularia cunicularia (Vieillot).

Alauda cunicularia Vieillot, Nouv. dict. hist. nat., 1816, **1**, p. 369. Rivière de la Plata et Pampas de Buenos-Ayres.

A very common resident of the dry sandy plains. It is distinctly terrestrial, always being found on the ground; I do not recall ever having seen it perch. Like many of the Tracheophones, and particularly the Furnariidae, its note is rather loud and musical repeated in syllables. Easily recognized by its small size, pale coloration, and by the white V, formed when the tail is spread, this little bird is far from inconspicuous.

64. Geositta rufipennis rufipennis (Burmeister).

Geobamon rufipennis Burmeister, J. f. O., 1860, **8**, p. 249. Cordillera de Mendoza; type-locality subst. by Dabbene, An. Mus. nac. hist. nat. Buenos Aires, 1919, **30**, p. 133.

I first met with this species on November 27 on the southern slope of El Escorial, at an altitude of about 4,000 feet; at that time I shot an adult female; again on December 10 it was encountered on a rocky slope near Huanuluan where another female was killed. At Talagapa, forty miles south of Maquinchao, another bird with either food or nesting material, probably the former, in its bill, was seen to enter a cavity in the face of the cañon wall. Again at Huanuluan four or five were observed up among the rocks on January 27.

In actions it is precisely like the preceding species but is markedly larger; the V-shaped mark on the tail is chestnut and the underwing coverts a rich brown. Moreover, it is invariably found in rocky situations, whereas *G. c. cunicularia* frequents the dry, sandy plains.

65. Upucerthia dumetaria dumetaria Geoffroy.

Upucerthia dumetaria Geoffroy St. Hilaire, Nouv. ann. Mus. hist. nat., 1832, **1**, p. 394. Patagonie.

Not uncommon resident.

I first met with this species at San Antonio where it was fairly common in the bushes growing close to the edge of the salt-marsh. In western Rio Negro I found it on the plains, up the ravines and gullies, but always among the bushes. It feeds on the ground where its long curved bill is of great assistance in capturing the insects which seem to form a large part of its diet. It is not unusual to find a place in the lee of some bush where one of these birds has been feeding, scratching, and tearing up the surface over an area of several square feet. About Lake Nahuel Huapi it is less common; an immature female, shot just back of the beach on the southeast shore of the lake, on February 10, is my only record for that station.

Its usual note is a series of loud non-musical syllables given on a descending scale.

The types of *Upucerthia d. dumetaria*, two mounted adults collected by d'Orbigny in Patagonia, are still in existence in the Paris Museum.[1]

66. Cinclodes fuscus fuscus (Vieillot).

Anthus fuscus Vieillot, Nouv. dict. hist. nat., 1818, **26**, p. 490. Moins rare dans les compagnes de Montevideo et de Buenos-Ayres qu'au Paraguay.

I did not meet with this species either at Rio Colorado or San Antonio, possibly because most of the birds were still in winter haunts farther north, or perhaps because there were then no fresh, wet meadows or small brooks of which it is so fond.

At Huanuluan it appeared with the first wave of migrants on September 6; the first female was taken on September 13. For several days after their arrival they abounded along the *arroyo*, especially about cut-banks and under bridges. Soon after the first of October, however, their numbers began to diminish and by late October all had left, save for a straggler seen one morning early in November. This is an unusually silent species, an occasional faint *chip* being the only note that I can recall having heard.

67. Cinclodes patagonicus rupestris (Kittlitz).

Opetiorynchos rupestris Kittlitz, Mém. Acad. imp. sci. St. Peterb., 1831, **1**, p. 188. Valparaiso, Chile.

This appears to be the resident Cinclodes of western Rio Negro; no data regarding migration are available.

I did not find this species at Huanuluan until November 27; on

[1] Ménégaux and Hellmayr, Mem. Soc. hist. nat. Autun, 1906, **19**, p. 56.

that day I shot an immature male and another immature individual which I was unable to sex; these were beside a small *arroyo* flowing between rocky banks not far from the southern end of El Escorial. Beside these, two or three others were seen, too wild to secure. On December 2 an immature female appeared near the *estancia* house at Huanuluan. This bird was doubtless a straggler from some breeding station further west.

About Lake Nahuel Huapi they are common along the wooded shores of the lake and in the vicinity of running water. Both adults and immature were taken there.

To a North American ornithologist their actions, notes, appearance, and habitat are strongly suggestive of the water-thrushes (*Seiurus noveboracensis* and *S. motacilla*).

68. Eremobius phoenicurus wallisi (Scott).

Henicornis wallisi Scott, Bull. B. O. C., 1900, **10**, p. lxiii. Arroyo Eje, Patagonia.

A common resident in arid northwestern Patagonia.

This is another thoroughly terrestrial species seldom taking wing unless closely pressed; it runs rapidly over the brushy, stony plain, dodging behind rocks or doubling under cover of a bush, the tail carried at an angle.

On October 3 at Huanuluan one was flushed from a nest built on the ground in the middle of a *Chupa de Sangre* cactus; the nest was nicely made and arched over, preventing any view of its contents from above. On November 5 I shot an adult female with a fully formed egg in the oviduct, and with her a fully grown immature male, perhaps from an earlier brood.

According to Salvadori, (Ibis, 1908, p. 452), most of the characters noted by Scott for separating *Henicornis wallisi* fail to hold, and it differs from *phoenicurus* "only in having the middle rectrices wholly brown or with but a small ferruginous patch at the base of the inner web while in the types the whole basal portion of both webs is ferruginous."

Since all the birds in a series of fifteen from the vicinity Maquinchao-Huanuluan have the middle rectrices wholly brown, I have referred them to *E. p. wallisi*, but feel that at best it is a poorly marked race and that additional topotypical material of *E. p. phoenicurus* may show them to be indistinguishable.

69. Aphrastura spinicauda (Gmelin).

Motacilla spinicauda Gmelin, Syst. nat., 1788, **1**, p. 978. Terra del Fuego.

This species is another representative of the Magellanic fauna occurring in northwestern Patagonia only in the forests of the east Andean slopes.

About Lake Nahuel Huapi I found it not uncommonly during February, as far east as the Arroyo Nirico. Generally found in small companies of half a dozen or more individuals, both adults and immature were present together. It is a very active species, somewhat wren-like in actions, and with a considerable variety of notes, squeaks and scolds for the most part.

70. Phleocryptes melanops melanops (Vieillot).

Sylvia melanops Vieillot Nouv. dict. hist. nat., 1817, **11**, p. 232. Paraguay.

This wide-ranging species is a common summer resident, but is confined exclusively to the reed-beds. Every patch of reeds, no matter how small, always has its quota.

At Huanuluan it was first seen on September 10, being among the early migrants.

In common with many grass- or reed-inhabiting species it is inclined to be secretive, but also inquisitive and hence rather readily *squeaked*. The note most frequently given is a wren-like scold, but it also gives a call which sounds like the noise produced by striking two dead reeds together.

A juvenal shot at Huanuluan November 4 is well grown and feathered except that the rectrices are not fully grown out.

For such a wide-ranging bird *Phleocryptes melanops* is remarkably constant. I can detect no difference in specimens from eastern Argentina, western Argentina, western Rio Negro and Chile, nor are the birds of Paraguay and Uruguay said to differ. It is, however, represented in Bolivia by a local race *P. m. schoenobaenus* Cabanis and Heine.

71. Leptasthenura aegithaloides pallida Dabbene.

Leptasthenura aegithaloides pallida Dabbene, Hornero, 1920, **2**, p. 135. Puesto Burro (near Maitén) western Chubut.

Common resident. This spiney-tail was collected at San Antonio, Huanuluan, and Bariloche, and was observed in the region south of

Maquinchao. It is very tit-like in its actions, gleaning actively among the leaves and terminal twigs of the bushes, pausing a moment to give its little chattering, scolding note before flying off to the next bush.

72. Siptornis patagonica (d'Orbigny).

Synallaxis patagonica d'Orbigny, Voy. Amér. Mérid., 1839, **4**, Ois., p. 249. Coteaux des rives du Rio Negro en Patagonie.

This species was found only at San Antonio where a male and a female were taken on August 18. It is an active species, though rather secretive and quick to take alarm.

Skins of *Siptornis patagonica* are easily identified by the character of the throat-patch which is black, each feather with a large lanceolate white spot at the tip. Except for the outer web of the outermost rectrix there is no rufous in the tail, the feathers being nearly or quite black, edged with brownish.

Iris light gray-brown.

73. Siptornis baeri Berlepsch.

Siptornis baeri Berlepsch, Bull. B. O. C., 1906, **16**, p. 99. Cosquin, Province de Cordoba.

Three specimens, two males and a female, were taken at Rio Colorado August 8 to 10. It is with some hesitation that I refer these birds to *S. baeri*, the type-locality being in the Cordova Hills over 500 miles further north, nor can I find any published record for its occurrence at any intermediate station. However, the Rio Colorado specimens agree perfectly with Berlepsch's original diagnosis *supra* and with his supplementary remarks (Ornis, 1907, **14**, p. 363).

The species is best distinguished from *S. sordida flavogularis* by the much shorter tail, (64.5–72.5 mm.), shorter and heavier bill; gray superciliary and postauricular region (not brownish), and by having the lower edge of the throat-patch faintly blackish.

In this connection it is interesting to note that Dr. Doering (Com. cient. exped. al Rio Negro. Entreg. 1. Zoologia, 1881, p. 44, 46) mentioned this, then undescribed, species under the name of *Synallaxis sordida*. He makes direct comparison with *Synallaxis flavigularis* describing all the differences just pointed out. According to Doering he found this species in the region situated between the Rio Colorado, Rio Negro, and Rio Neuquen.

74. Siptornis sordida sordida (Lesson).

Synallaxis sordidus Lesson, Rev. zool., 1839, p. 105. Chile.

Four specimens, adults and immature, taken at Bariloche, belong to the typical form.

75. Siptornis sordida flavogularis (Gould).

Synallaxis flavogularis Gould, Zool. voy. Beagle, 1839, p. 78, pl. 24. Bahia Blanca and Santa Cruz, Patagonia.

This was the common spiney-tail of the Huanuluan-Maquinchao region, always found in the thicker and denser growths of bushes. The first specimen was not taken until October 21, which leads me to believe that these birds may be migratory to some extent. From late in August until October 21 only three spiney-tails had been collected, all of them belonging to the following species; from that time, however, until the end of December about twenty were shot at Huanuluan and the region twenty to thirty miles south of Maquinchao, and of these all but two belong to this species.

76. Siptornis modesta modesta (Eyton).

Synallaxis modestus Eyton, Jardine's Contr. ornith., 1851, p. 159. Bolivia? Berlepsch, J. f. O., 1901, **49**, p. 94, regards Chile as the type-locality.

Five specimens were collected at Huanuluan between August 29 and November 27. On the latter date a pair was taken on El Escorial at an elevation of about 4,000 feet.

S. modesta is readily distinguished from *S. sordida* by certain tail characters. In the former all the rectrices are more or less bicolored; in the latter the two outer pair, (sometimes the third), are uniform rufous, the fourth usually bicolored, the two central pair dark brown.

77. Siptornis anthoïdes (King).

Synallaxis anthoïdes King, P. Z. S., 1831, pt. 1, p. 30. Straits of Magellan.

This species was only encountered near Lake Nahuel Huapi. Here on February 11 and 12 an adult male and adult female were shot on a brushy, gravelly plain not differing greatly in character from the dry plains further east. Uncommon, wary, and with secretive habits I found *S. anthoides* hard to collect.

78. Siptornis hudsoni (Sclater).

Synallaxis hudsoni Sclater, P. Z. S., 1874, p. 25. Conchitas, Buenos Aires.

Hudson's Spiney-tail is rare through this region. On November 24 passing a sandy hummock sparsely grown with grass and low shrubs, I caught sight of a small bird running and dodging in and out ahead of me. Its actions and style of coloration suggested a pipit, but when flushed it showed a light chestnut patch on the wings.

This specimen was the only one taken during six months in Patagonia.

79. Pseudoseisura gutturalis (d'Orbigny and Lafresnaye).

Anabates gutturalis d'Orbigny and Lafresnaye, Mag. zool., 1838, cl. 2, p. 15. Patagonia.

Not uncommon in the region about Huanuluan and Maquinchao, frequenting the sheltered or moister areas where the bushes grow more luxuriantly.

In habits somewhat jay-like and unlike most Tracheophones, this one is rather inquisitive. Once while setting a line of mouse-traps, I was followed about for some time by a bird which first flew from side to side in the ravine, then perched for a few moments to utter a selection of harsh notes. The following morning a female was found in one of the traps, doubtless my former companion.

A female with an incubation-patch was shot on October 3. The nest is a large domed structure generally placed in a thorny bush, and with a tunnel-entrance; the nesting cavity is usually lined with wool. The nests are very strongly built and force is required to gain entrance.

80. Pygarrhicus albogularis (King).

Dendrocolaptes albogularis King, P. Z. S., 1831, p. 30. Straits of Magellan.

This strange little bird is not uncommon on the wooded slopes rising from the south shore of Lake Nahuel Huapi. It feeds on the trunks and larger branches, climbing in the manner of the Brown Creeper, (*Certhia familiaris*), but occasionally running out onto the twigs; its note is a faint *tick*. During the late summer or early autumn it occurs in small companies, apparently a pair accompanied by fully grown young.

Immature birds differ markedly from adults in having the feathers of the crown broadly tipped with rufous; and the feathers of the back with a broad, pale, mesial stripe; the flanks are blackish, the feathers with pale shaft-stripes of varying width.

TYRANNIDAE.

81. Agriornis livida fortis Berlepsch.

Agriornis livida fortis Berlepsch, Ornis, 1907, **14**, p. 352. Valle del Lago, Gobn. Chubut, Argentina.

This large flycatcher was not uncommon in the open clearings about Bariloche; near the fish-hatchery, seven miles east of Bariloche, it occurred rather numerously about the junction of the arid zone of western Patagonia and a tongue of transition which followed down a little stream.

Specimens from Lake Nahuel Huapi, while not quite typical of *A. l. fortis*, are, nevertheless, closer to that form than to *A. l. livida* (Kittlitz) of Chile.

82. Agriornis striata striata Gould.

Agriornis striatus Gould. Zool. voy. Beagle, 1839, p. 56. Santa Cruz.

Not uncommon in the vicinity of Huanuluan in the more brushy locations. It appears to be migratory. The first bird seen was on September 11, an adult male shot on one of the outbuildings at the *estancia*. On October 30 a female with an incubation-patch was killed; the condition of the ova and oviduct indicated that the bird had laid some time before; fledgelings were observed on several occasions during November and on December 3 a nest was found which probably represented a second brood. It was placed in a thick bush, two and one half or three feet from the ground, a very bulky structure lined with feathers of *Calopezus elegans* and containing three eggs, white with some rusty spots at the larger end.

Legs, feet, and upper mandible black; lower mandible pale flesh or pinkish horn color.

83. Agriornis montana leucura Gould.

Agriornis leucurus Gould, Zool. voy. Beagle, 1839, pl. 13. Patagonia.

Found sparingly at Huanuluan; one bird was seen about the *estancia* buildings late in August but was not secured, though a male with somewhat worn primaries and rectrices was killed near the same spot on September 24. Another was seen up a rocky gully at an elevation of about 4,000 feet on El Escorial November 27. An adult male taken at the *estancia* on January 17 doubtless represents a post-breeding straggler.

84. Myiotheretes rufiventris (Vieillot).

Tyrannus rufiventris Vieillot, Encyc. meth., 1823, p. 856. Montevideo.

Rare. On November 2 I shot two males about ten miles northwest of Huanuluan, the only ones seen during the entire stay in Rio Negro.

85. Pyrope pyrope (Kittlitz).

Muscicapa pyrope, Kittlitz, Mém. Acad. imp. sci. St. Peterb., 1831, **1**, p. 191, pl. 10. El Tomé, Chile.

This flycatcher was common in the clearings or semi-wooded pastures above Lake Nahuel Huapi, where dead trees or branches furnish suitable perches.

The iris of the adults is red; in the immature it is brown. The two outer primaries of the adult male are attenuated for about fifteen millimetres. I have seen no specimens of the adult female which showed this character, and likewise the two outer primaries of the immature are normal in every respect.

86. Taenioptera murina (d'Orbigny and Lafresnaye).

Pepoaza murina d'Orbigny and Lafresnaye, Mag. zool., 1837, cl. 2, p. 63. Patagonia.

A single specimen of this small tyrant-bird was taken at San Antonio on August 18. When first seen it was hopping about on the ground acting precisely like *Upucerthia dumetaria* which I took it to be until I shot it.

The species was not found elsewhere.

87. Taenioptera rubetra Burmeister.

Taenioptera rubetra Burmeister, J. f. O., 1860, **8**, p. 247. Sierra de Mendoza.

Locally common in western Rio Negro, two were shot near Huanuluan on October 18 and another on November 2. On December 9

I happened upon four adult males near the *estancia* buildings, a locality which had been thoroughly worked, and where their presence could not have been overlooked. They were probably postbreeding wanderers. A single specimen was taken at Maquinchao January 6, 1921.

It is rather doubtful whether the type-locality Sierra de Mendoza given by Burmeister is correct. Dabbene (An. Mus. nac. hist. nat. Buenos Aires 1910, **11**, p. 317) does not include it in the species of the "2nd zone" in which the Sierra de Mendoza lies, Reed (Las Aves de la Provincia de Mendoza, Mendoza, 1916) does not record it, neither was it found by the various collectors whose names appear in Harterts' Oiseaux de la Republique Argentine (Nov. zool., 1909, **16**, p. 159–267). Sanzin (Hornero, 1918, **1**, p. 150) records a specimen from La Paz, Province of Mendoza, a town on the plains of western Argentina near the border of the Province of San Luis.

88. Knipolegus anthracinus Heine.

Cnipolegus anthracinus Heine. J. f. O., 1859, p. 334. Bolivia.

A male was taken at Rio Colorado on August 7.

89. Lichenops perspicillata andina Ridgway.

Lichenops perspicillatus β. andinus Ridgway, Proc. U. S. N. M., 1879, **1**, p. 483. Western South America from Chili to New Granada.

La Viuda.

A common summer resident. Hudson says that without doubt the species is migratory, at least in the southern portion of its range. This statement is borne out by my experience. A single male appeared at Huanuluan with other early migrants on September 6; after the 20th it became more numerous both along the *arroyos* and in drier situations where there was a dense growth of *Moyi* bushes. The first female was not taken until October 21, though a bird in brown plumage was seen a few days before. However, the male too is frequently found in the brown plumage.

It was not uncommon near Bariloche up the eastern edge of the tree-zone. The Silver-bill is a very silent species, but occasionally it utters a feeble, high-pitched *quee*.

All males from northwestern Patagonia agree with Ridgway's description of *andina* in the restriction of the amount of white on the outer webs of the primaries; they also average larger.

4 males, Eastern Argentina. Wing 85.5 to 90.5 (Av. 88.25; tail 61.5 to 65 (63.5); culmen 16.7 to 17 (16.9) mm.

7 males, N. W. Patagonia. Wing 91.5 to 95.5 (Av. 94.1); tail 65.4 to 70.5 (68.6); culmen 16.8–17.6 (17.15) mm.

90. Muscisaxicola macloviana mentalis d'Orbigny and Lafresnaye.

Muscisaxicola mentalis d'Orbigny and Lafresnaye, Mag. zool., 1837, cl. 2, p. 66. Cobija in Bolivia, Arica atque Patagonia.

Little is known of the habits of this flycatcher; it winters in the eastern portion of Rio Negro where d'Orbigny found it in small bands of from three to fifteen individuals. Hudson met with them on the Rio Negro in June "in flocks of a dozen or twenty birds." Darwin found it from Bahia Blanca southward. Durnford does not record it from the Chubut Valley between October and April. Doering lists a "*Ptyonura capistrata* Burm" from Azul, Carhue, Rio Colorado and Rio Negro, which may or may not be the species in question.

On August 15 I shot a male at San Antonio, a single bird perched on a small bush in the midst of an otherwise open field, the only individual of this species noted there. On September 10 a female completing the prenuptial moult was taken at Huanuluan, but no more were found there. On February 3 I shot an adult pair at Puerto Blest at the extreme western extension of Lake Nahuel Huapi. Another summer record for western Patagonia is of a bird killed by Koslowsky at Valle del Lago Blanco, Chubut, Oct. 2, 1901 (Hartert, Nov. zool., 1909, **16**, p. 194). Apparently in Argentina this species breeds from the wooded Andean slopes from Lake Nahuel Huapi south to Tierra del Fuego and winters in eastern Patagonia.

Bangs and Penard (Bull. M. C. Z., 1919, **63**, p. 26) pointed out the existence of a cotype of *Muscisaxicola mentalis* d'Orb. and Lafr. and of the type of *Muscisaxicola albimentum* Lafresnaye (= *M. mentalis*) in the M. C. Z.; they also discussed the use of the name *mentalis* for the continental representative of *Sylvia macloviana* Garnot. They did not, however, fix a definite type-locality for this wide-ranging bird.

The two types are indistinguishable from specimens from Patagonia. Since d'Orbigny (Voy. Amér. mérid. 1844, **4**, Ois., p. 355) gives a rather comprehensive account of its habits and occurrence during the winter in eastern Patagonia where he doubtless took specimens, I designate Carmen de Patagones, Argentina, as the type-locality of *Muscisaxicola mentalis* d'Orbigny and Lafresnaye.

91. Muscisaxicola maculirostris d'Orbigny and Lafresnaye.

Muscisaxicola maculirostris d'Orbigny and Lafresnaye, Mag. zool., 1837, cl. 2, p. 66. La Paz, Bolivia.

A fairly common resident in western Rio Negro arriving at Huanuluan October 5.

Beginning October 12 this tyrant-bird began a most peculiar aerial performance which was continued until about the first of December. Rising either from the ground or from a perch, the male starts off on a short flight and at intervals raises the wings perpendicularly over the back, at the same time drops the tail and legs and utters a loud *pe, chēē*. On November 27 I shot a female at an elevation of about 4,000 feet on El Escorial; this bird showed an incubation-patch.

92. Muscisaxicola capistrata (Burmeister).

Ptyonura capistrata Burmeister, J. f. O., 1860, **8**, p. 248. Mendoza.

A rather uncommon summer resident in western Rio Negro arriving at Huanuluan on September 25. These first migrants, a flock of a dozen or more, were scattered about over a dry sandy flat covered with a sparse growth of wire-grass; two were killed before the flock took alarm and moved off. Just a month later I shot a mated pair in breeding condition, carrying nesting material; strangely enough neither bird had quite completed the prenuptial moult, and both had a few pin-feathers on the dorsal and lateral tracts. November 9 a female with an incubation-patch was killed in a rocky situation similar to that in which the pair of October 25 was killed. I have never heard this species utter a sound.

93. Lessonia rufa (Gmelin).

Alauda rufa Gmelin, Syst. nat., 1788, **1**, p. 792. Bonaria.

A very common summer resident in western Rio Negro. The first migrant at Huanuluan, a lone male, appeared on August 28; a few more arrived on September 6 and on the 10th a flock of about twenty-five males drifted slowly by the *estancia*, stopping to feed on their way. The females arrived September 24.

This species was confined to the sandy valleys, preferring the moister stretches along the *arroyos*. It was in such situations that females with nesting material were observed on October 22, and also on November 4 a nest with two eggs was found. Two other nests, one with three eggs on November 17, and one on January 10, with three dead young, were discovered. These nests were all placed on the ground, at the foot of tufts of grass, rather bulky affairs built of coarse grass and lined with duck feathers. The eggs are creamy white with rusty spots near the larger end.

The Chestnut-backed Tyrant-bird feeds on the ground, but short aerial sallies are occasionally made after insects; the flight is feeble, bat-like, low, and not long sustained. The only note is a weak swift-like twittering. Males are inclined to be pugnacious, both among themselves and with their neighbors, the pipits.

94. Stigmatura budytoides flavocinerea (Burmeister).

Phylloscartes flavocinerea Burmeister, La Plata reise, 1861, **2**, p. 455. Mendoza.

I met with this species only at Rio Colorado where a male was taken on August 8.

95. Spizitornis parulus patagonicus Hellmayr.

Spizitornis parulus patagonicus Hellmayr, Archiv naturg., 1920, **85**, p. 51. Neuquen, Argentina.

The identity of specimens of *Spizitornis parulus* from northern Patagonia is somewhat puzzling. *S. p. patagonicus* is described as differing from *S. p. parulus* in having a white belly and two wing-bars (instead of a yellow belly and a single wing-bar). Two birds from Rio Colorado agree in the double character of the wing-bar, but have a pale yellow abdomen. Judging from our present knowledge of the region about Lake Nahuel Huapi, it might be expected that true *S. p. parulus* of Chile would occur there; this, however, does not appear to be the case. A series of four adults from Bariloche, though in worn plumage, disclose upon close examination traces of the double wing-bar, while a fifth bird undergoing the postnuptial moult has just acquired new sets of wing-coverts showing this condition unmistakably. These skins also have pale yellow abdomens as do also three males in fresh autumn plumage taken at Potrerillos, Mendoza. For the present at least the range of *S. p. patagonicus* must be extended to include specimens of *S. parulus* from Argentina east of the Andes.

96. Spizitornis flavirostris (Sclater and Salvin).

Anaerctes flavirostris Sclater and Salvin, P. Z. S., 1876, p. 355. Tilo-tilo, Bolivia.

Six specimens of this little tyrant-bird were taken at San Antonio during the middle of August. This is the furthest south that this species has been recorded, and also the first record of its appearance on the coast, being known previously from only a few inland localities in central Argentina and southern Bolivia.

97. Tachuris rubrigastra rubrigastra (Vieillot).

Sylvia rubrigastra Vieillot, Nouv. dict. hist. nat., 1817, **11**, p. 277. Paraguay et à Buenos-Ayres.

Siete Colores.

This little gem, among the tyrant birds, is not an uncommon summer resident among the reed-beds of western Rio Negro, arriving at Huanuluan about September 10.

It is very elusive, showing itself only for a few seconds at a time and is not easily, if at all, *squeaked* from its favorite patch of reeds. The notes are a scold, and a short sweet two-syllabled piping.

A female with serum-filled incubation-patch was killed at Huanuluan on December 3.

98. Elaenia albiceps albiceps (d'Orbigny and Lafresnaye).

Muscipeta albiceps d'Orbigny and Lafresnaye, Mag. zool., 1837, cl. 2, p. 45. Yungas, Bolivia, *fide* Berlepsch, Ornis, 1907, **14**, p. 403.

An abundant resident in the vicinity of Lake Nahuel Huapi, occurring wherever there are woods or small groves of trees, and in such situations its characteristic note is heard on all sides. This note which is very similar to that of other members of the genus may be described as a mournful inspirated whistle and is best written *féo;* it is capable of several variations; in addition there is a chattering scold.

While I was at Bariloche a common, dark blue berry was ripe and comprised the chief food of the Elaenias, nearly all showing a deep purple stain on the oesophageal and abdominal walls from this cause.

Even as late as February 2 a female with a serum-filled incubation-patch was taken, but with this exception breeding seemed to be over.

On December 24 I shot an adult female at Puesto Horno, 30 miles south of Maquinchao; this bird was doubtless a straggler.

PHYTOTOMIDAE.

99. Phytotoma rara Molina.

Phytotoma rara Molina, Sag. stor. nat. Chili, 1782, p. 254. Chili.

The Chilean Plantain-cutter is common in the region about Bariloche, especially in the thickets of *Michai* when the fruit is ripe.

A series of seven adults and immature, both sexes, was collected there between January 30 and February 13. The iris in the adult is orange-red; in the immature dull brown.

100. Phytotoma rutila rutila Vieillot.

Phytotoma rutila Vieillot, Nouv. dict. hist. nat., 1818, **26**, p. 64. Paraguay ex Azara.

I did not observe this bird beyond Rio Colorado where two were taken in brushy land bordering the river. Hudson found it common in the lower Rio Negro Valley, but apparently its range does not extend much south of that river.

HIRUNDINIDAE.

101. Tachycineta meyeni (Cabanis).

Petrochelidon meyeni Cabanis, Mus. Hein., 1850, **1**, p. 48. Chile.

My field-notes on this swallow fail to show its status or distribution in northern Patagonia satisfactorily. According to Hudson it is strictly migratory in the lower Rio Negro Valley being absent from March to August, though a few winter in favored parts of Buenos Aires province.

It was fairly common at Rio Colorado at the time of my arrival, August 7, but was not found either at San Antonio or Maquinchao, and it did not arrive at Huanuluan until September 29. Neither did it breed there, disappearing before the middle of October, though stragglers appeared on November 12 and 13. It was present and apparently breeding at Paso Flores on the Rio Limay December 6. By the time of my arrival at Lake Nahuel Huapi, fall flocking had taken place and both this species and *Pygochelidon patagonica* were common about the southern shore of the lake. After February 5, there was a marked diminution in their numbers, a partial migration having doubtless taken place at this time.

102. Progne furcata Baird.

Progne furcata Baird, Rev. Amer. birds, 1865, pt. 1, p. 278, footnote. Chile.

The Patagonian Martin is rather locally distributed in western Rio Negro. On December 5 I found martins flying into the face of some cliffs bordering the upper Rio Cumayo and met with them sparingly in similar situations down to the Limay. Along the rocky walls bordering the long narrow valley running southward from Puesto Horno to Talagapa, they occurred rather numerously and they were apparently breeding in the crevices, December 21.

103. Pygochelidon patagonica patagonica (d'Orbigny and Lafresnaye).

Hirundo patagonica d'Orbigny and Lafresnaye, Mag. zool., 1837, cl. 2, p. 69. Patagonia.

Common summer resident; it did not arrive at Huanuluan until October 9. I found them along the sandy flats, particularly along the line of the cart-paths, where the old ruts and horse-tracks form miniature banks where they make their burrows, as also does *Geositta cunicularia.* The status of this species about Lake Nahuel Huapi has been discussed under *Tachycineta meyeni.*

TROGLODYTIDAE.

104. Cistothorus platensis hornensis (Lesson).

Troglodytes hornensis Lesson, L'inst., 1834, p. 316. En mer — 20 lieues dans le sud-est du Cap Horn.

I found short-billed marsh wrens only at a wet, sedgy meadow not over an acre in extent, about seven miles east of Bariloche. Here in one place, where in addition to the rank grass a few scattered tufts of a Juncus (?) grew and also some huge docks, seven wrens were killed in a few moments. Unfortunately not a single one of these proved to be adult, all are in fresh juvenal plumage. I have nevertheless referred these birds to the form inhabiting Chile and Patagonia from Chubut to the Straits of Magellan. This identification is based wholly on geographical grounds.

105. Troglodytes musculus magellanicus Gould.

Troglodytes magellanicus Gould, P. Z. S., 1836, p. 88. Fretu Magellanico.

Ratonera.

This is a very common migrant and local summer resident in northwestern Patagonia. Common at Huanuluan from September 17 to October 21, the height of abundance was reached on October 9 when these wrens were found in all kinds of places, such as reed-beds, cutbanks and brush-fences as well as in their favorite haunts, the brushy gullies. They did not remain to breed at Huanuluan. However, a male in full song was noted at Paso Flores on the Limay River December 6, and at Puesto Horno, thirty miles south of Maquinchao, males were in song at Christmas time, and a female shot there, showing traces of an incubation-patch, was carrying food. It was abundant at Bariloche.

I am indebted to Messrs. Chapman and Griscom for identifying this small series of house wrens.

MIMIDAE.

106. Mimus patagonicus patagonicus (d'Orbigny and Lafresnaye).

Orpheus patagonicus d'Orbigny and Lafresnaye, Mag. zool., 1837, cl. 2, p. 19. Patagonia.

The Patagonian mockingbirds were abundant at San Antonio in mid-August. At that time they were apparently paired, but singing only intermittently. About Huanuluan and Maquinchao I found them rather uncommon residents, confined to the sheltered, brushy gullies. A fully fledged bird was taken at Huanuluan, December 3.

TURDIDAE.

107. Turdus magellanicus King.

Turdus magellanicus King, P. Z. S., 1831, pt. 1, p. 14. In Fretu Magellanico.

This thrush occurs commonly as a resident in the region about Bariloche; further east it appears only as a migrant. A flock arrived at Huanuluan late in August and for a few days twenty or more frequented a certain brushy gully; they were very wild and could not be successfully approached. A lone male who had not migrated owing to the loss of his tail, was shot on September 23.

MOTACILLIDAE.

108. Anthus furcatus furcatus d'Orbigny and Lafresnaye.

Anthus furcatus d'Orbigny and Lafresnaye, Mag. zool., 1837, cl. 2, p. 27. Patagonia [= Carmen], *cf.* Hellmayr, Hornero, 1921, **2**, p. 181.

Two species of pipits very closely resembling each other in the field, occur in Argentina; nearly all field-observers confuse the two and I must plead guilty to the same error. Since but two specimens of this species were taken at Huanuluan, and over twenty of the following, I feel certain that the field-notes made there apply to *A. c. correndera* almost entirely.

The two specimens referred to are, a male shot September 24 in company with individuals of *correndera* beside the *arroyo* near the *estancia*, and a male shot October 24 on a small, wet meadow near the summit of El Escorial, at an altitude of about 4,100 feet.

109. Anthus correndera correndera Vieillot.

Anthus correndera, Vieillot, Nouv. dict. hist. nat., 1818, **26**, p. 491. Paraguay et jus'qu'a la rivière de la Plata.

A very common summer resident in western Rio Negro. At Huanuluan a few pipits arrived with the first rush of migrants on September 6, but did not become numerous until between the 15th and 20th; the first female was taken October 6.

They inhabited the sandy valleys, especially those watered by the *arroyos*. From the day of their arrival they were singing constantly; the song is simple but very characteristic, though subject to almost as many variations as there are singers; it may be written — *ten-cents apiéce chrrr, ten-cents apiéce chrrr*. It is always a flight-song, the bird ascending possibly fifty yards into the air the words being uttered while flying, and the *chrrr* while descending on set wings. Then there is a recovery and a repetition, the performance continuing for what seems an endless period. During early October the pipits produced a tremendous volume of sound on the meadows, but it began to wane after the middle of the month and continued to drop off gradually until by December 20 the song-period was definitely closed.

Breeding began shortly after November 1; on the 4th a nest was found containing three eggs; on the 13th I found four slightly incubated eggs and the male of the pair was taken; on the 14th a nest with three eggs was located and these hatched on November 24; a few other nests, generally with three eggs, were also found.

According to Hudson (who did not distinguish two species) these pipits are resident throughout the year in eastern Argentina and raise two broods, the first in August and the second in December, but in western Patagonia it is certainly migrant and probably only single-brooded.

Pipits were not uncommon in the vicinity of Bariloche, but unfortunately no specimens were taken there, so that I cannot determine their subspecific identity; birds from further east appear to belong to the typical form, not to *chilensis*. The possibility of the occurrence of *Anthus hellmayri dabbenei* Hellmayr (Hornero, 1921, **2**, p. 191. Rio Traful, Gobn. de Neuquen) in extreme western Rio Negro should also be considered.

Key to the Northern Patagonian Species of Anthus.

A. Two outer pairs of rectrices largely white.
  1. Hind claw long, almost straight; edgings of interscapulars forming two conspicuous pale dorsal stripes; bill longer and more slender.
     a. Less brightly colored . . . . *A. c. correndera.*
     b. More brightly colored . . . . *A. c. chilensis.*[1]
  2. Hind claw shorter, somewhat curved; no dorsal stripe; bill shorter *A. f. furcatus.*

B. Two outer pairs of rectrices smoky brown, or blackish tipped with pure white . . . . *A. h. dabbenei.*

FRINGILLIDAE.

110. Spinus barbatus (Molina).

Fringilla barbata Molina, Sag. stor. nat. Chili, 1782, p. 247. Chili.

This goldfinch is fairly common in the wooded hills rising about Bariloche. A series of eight adults, both sexes, was made up between January 31 and February 20; no immature birds were taken how-

[1] Unknown east of the Andes.

ever, neither were any of those killed in breeding condition. They were found for the most part in small restless bands numbering up to ten individuals.

111. Spinus ictericus ictericus (Lichtenstein).

Fringilla icterica Lichtenstein, Verz. doubl., 1823, p. 26. San Paulo, Brazil.

A few goldfinches were found in the brushy lands bordering the river at Rio Colorado where a female in winter plumage was shot on August 7.

112. Passer domesticus (Linné).

Fringilla domestica Linné, Syst. nat., 1758, **1**, p. 183. Europa [= Sweden] Fauna Suec., p. 212.

Common in the settlements, particularly along the line of the railroads. It occurred numerously at Puesto Horno, thirty miles south of the railroad at Maquinchao, and occasional arrivals were noted at Huanuluan, evidently coming from Nahuel Niyeu, the rail-head fifteen miles further east. It has adapted its time of breeding and assumption of breeding plumage to coincide with the reversed seasons of the south temperate zone.

113. Sicalis arvensis arvensis (Kittlitz).

Fringilla arvensis Kittlitz, Mém. Acad. imp. sci. St. Peterb., 1835, **3**, p. 470. Chile, Valaparaiso *fide* Chrotowski, Ann. Zool. mus. Polon. hist. nat., 1921, **1**, fasc. 1.

Uncommon. I did not find this species in eastern Patagonia though Durnford found it in the Chubut Valley. Two were seen at Huanuluan on October 29 and one of them was taken; it was also met with at Bariloche where two more were collected

114. Pseudosicalis aureiventris (Phillipi and Landbeck).

Sycalis aureiventris Phillipi and Landbeck, Archiv naturg., 1864, p. 49. Chile.

I am unable to add any facts of interest regarding this little known finch. It was found only in the general vicinity of Huanuluan where four males and a female were taken between October 6 and November 29.

115. Pseudosicalis lebruni (Oustalet).

Pseudochloris lebruni Oustalet, Miss. sci. Cap Horn, 1891, **4**, p. 98. Missioneros, Patagonia.

A fairly common resident in the Maquinchao-Huanuluan region, where it is pretty much confined to the rocky cliffs, though sometimes occurring in other situations. The call note is a characteristic *pink;* the song a succession of the same note, in quality mid-way between a chatter and a trill.

Apparently it is rather a late breeder, since a pair taken at Huanuluan on December 2 showed no signs of such activity. Late in December at Neluan, twenty miles south of Maquinchao, a pair appeared to be nesting in a crevice a short distance down a well. The entrance was hidden from above by a projecting corner of a sheet of corrugated iron, but a female flew up from under this each time that water was drawn.

Pseudosicalis lebruni appears to be a valid species, though seriously questioned by Dabbene (An. Mus. nac. hist. nat. Buenos Aires, 1910, **11**, p. 389, foot-note). The differences between it and other Argentine species of this genus are indicated in the subjoined key.

In common with other members of the genus the color-distinctions are variable, depending on season and the amount of wear. A male killed August 21 at Maquinchao in fresh plumage is largely gray above due to wide gray tips to the feathers, the feathers on the forepart of the crown are largely yellow, narrowly tipped with grayish. The birds collected from time to time until early January show the gradual change in the color of the back and rump due to the wearing of the feather-tips, so that birds in worn breeding plumage are grayish yellow on the back, clearer yellow on the head and rump. The yellow edging on the basal half of the outer web of the primaries is very apparent in fresh plumaged birds, but has practically disappeared by December 1.

The females are plain gray above in fresh plumage, paler on the rump where a few feathers are tinged with yellowish; a small amount of yellow is apparent on the forepart of the crown but this becomes practically worn off by mid-October.

Key to the Argentine Species of Pseudosicalis.[1]

A. Depth of bill equal (or nearly equal) to distance from anterior end of nostril to tip of maxilla.
   1. Longest primaries exceeding longest secondaries by less than tarsal length; under tail-coverts without white; flanks yellow.. .*P. lutea.*
   2. Longest primaries exceeding longest secondaries by length of tarsus; under tail-coverts tipped and edged with white; flanks grayish. *P. lebruni.*

B. Depth of bill less than distance from anterior end of nostril to tip of maxilla.
   1. Size large wing 90 to 95 mm.; culmen nearly straight. *P. aureiventris.*
   2. Size smaller wing 82 to 86 mm.; culmen arched. . . .*P. uropygialis.*

116. Brachyspiza capensis choraules Wetmore and Peters.

Brachyspiza capensis choraules Wetmore and Peters, Proc. Biol. soc. Wash., 1922, **35**, p. 44. General Roca, Gobn. de Rio Negro, Argentina.

This subspecies is the representative of the wide-ranging South American Song Sparrow along the valley of the Rio Negro and at the base of the Andes, at least from Lake Nahuel Huapi north to Mendoza.

Wintering specimens were taken at Rio Colorado in August where both this and the following species were present in some numbers. It was not met with at San Antonio, but since no series of Brachyspiza was collected there it could easily have been overlooked. Two adults, worn and moulting, and an immature male were taken at Bariloche between January 31 and February 10. These birds, while not quite typical, seem to belong to this race rather than to *B. c. chilensis.*

117. Brachyspiza capensis canicapilla (Gould).

Zonotrichia canicapilla Gould, Zool. Voy. Beagle, 1839, p. 91. Port Desire in Patagonia and Tierra del Fuego.

Chingolo.

An abundant resident. These sparrows are no doubt migratory to some extent and form winter flocks of considerable size. I found them at Rio Colorado and San Antonio in August; at Maquinchao

[1] *P. mendozae* (Sharpe) not seen by me; Dabbene (*loc. cit.*) questions its validity.

and Huanuluan they were present at the time of my arrival, though not in the numbers which arrived later in the season. For instance the resident birds at Huanuluan were reinforced by large numbers of migrants from the north (or east) on September 6, and these numbers were further augmented by fresh arrivals on September 10. By the first of October the resident birds were well differentiated from the migrants, though they were not yet ready to commence breeding. Flocks of migrants, however, were present as late as October 21, though their numbers were much reduced. Nesting began late in November. On the 20th a nest with one egg was found, on December 2 a recently completed nest without eggs. Young three or four days old were found at Puesto Horno about December 25 and fully fledged young were first seen at Maquinchao, January 6. On January 14 a nest containing two fresh eggs was taken at Huanuluan.

The normal complement of eggs seems to be two or three, laid in a bulky nest lined with feathers and placed a foot or two from the ground in a small bush.

118. Phrygilus gayi (Eydoux and Gervais).

Fringilla gayi Eydoux and Gervais, Mag. zool., 1834, cl. 2, pl. 23. Chile.

A fairy common denizen of the brushy pastures and open woods in the region about Lake Nahuel Huapi, but one which does not extend into the arid region to the eastward. Numbers of fully fledged young were in evidence during my stay at Bariloche.

The iris of the adult is a rich reddish brown; of the immature a dull brown.

119. Phrygilus aldunatei (Des Murs).

Chlorospiza aldunatei Des Murs, Gay's Hist. Chile. Zool., 1847, **1**, p. 356. Chile.

Not an uncommon migrant and probable summer resident in the arid western portion of the Rio Negro. A male was seen about the *estancia* buildings at Maquinchao on August 20. At Huanuluan a large brush-pile yielded specimens several times between September 1 and 17. After that date, however, I found them on the rocky hills. A female, one of a pair, shot on November 21, was not in breeding condition, though a male shot on December 1 was probably a breeding bird.

Two males in full song taken in a rocky location on December 26 near Puesto Horno, may have been breeding birds.

120. Rhopospina fruticeti (Kittlitz).

Fringilla fruticeti Kittlitz, Kupfertafeln naturg. Vögel, 1832, p. 18, pl. 23, f. 1. Valparaiso, Chile.

Nearly all writers on the birds of Patagonia generally pass by this species in a very few words, often quoting some previous writer. Hence knowledge of its habits does not increase very rapidly, and so far I have found the only mention of its nesting in Patagonia is by Durnford (Ibis, 1878, p. 393) who took a nest and two eggs on September 20, 1877, in the lower Chubut Valley.

I found it common at Rio Colorado early in August where it occurred in compact flocks of sixty to seventy individuals in the scrubby brush near the river; at San Antonio it was less common, a few solitary birds only were seen there.

At Huanuluan a male was shot on September 17, but the large flocks which later became so characteristic of the thick bushes did not appear until October 3. During October and November these flocks were rather numerous and as a rule contained up to fifty birds, the same flock usually frequenting the same locality. In contrast to their habits in the winter the summer bands were more scattered and when approached kept "ending over."

At Bariloche *Rhopospina fruticeti* was very common along the western boundary of the arid plains, always in flocks which at that time included fully grown young.

The call-note is a rather loud clear *chee;* the song a wheezy trill ending in one or two clear notes.

They appear to feed entirely on green food; the excrement is always loose and green, the belly-walls sometimes stained green, and the body-cavity when opened exhales that peculiar odor of fermented vegetation common to birds which live solely on such a diet. The bill is almost invariably soiled with some sticky green substance.

121. Diuca diuca diuca (Molina).

Fringilla diuca Molina, Sag. stor. nat. Chili, 1782, p. 249. Chili.

Diuca finches occurred abundantly about Lake Nahuel Huapi, particularly in semi-open situations or along roadsides. About the middle of February they began to gather in flocks of twenty-five or more individuals.

This race is found along the valley of the Rio Limay at least as far as Paso Flores, since four birds were seen there on December 6, and an adult male which was taken, agrees perfectly with specimens from Chile.

122. Diuca diuca minor Bonaparte.

Diuca minor Bonaparte, Consp. gen. Avium, 1850, **1**, p. 476. Patagonia.

This species apparently does not occur in western Patagonia; it was met with at Rio Colorado where it was fairly common in and about the edges of the town, generally in companies of five or six, often associated with House Sparrows; and at San Antonio where it was seen on the streets of the town. A male taken at Rio Colorado is in winter plumage, the back heavily washed with brown; in measurements it agrees with birds from Entre Rios.

ICTERIDAE.

123. Molothrus bonariensis bonariensis (Gmelin).

Tanagra bonariensis Gmelin, Syst. nat., 1788, **1**, p. 898. Bonaria.

This species appears to be migratory in western Rio Negro. It appeared at Huanuluan for the first time on September 28 when a lone male was shot; five more males appeared October 9 and two females October 22; no more cowbirds were seen at Huanuluan until January 8.

They were not uncommon at Maquinchao and at Puesto Horno. A young male, nearly fully grown, was shot at Bariloche on February 17; his foster-parent seemed to be a female of *Trupialis m. militaris.*

124. Agelaius thilius chrysopterus Vieillot.

Agelaius chrysopterus Vieillot, Nouv. dict. hist. nat., 1819, **34**, p. 539, female. Paraguay.

A common resident confined, however, to the reed-beds. In western Patagonia it appears to be migratory, since none were seen at Huanuluan prior to the general rush of migrants September 6. Late in December the blackbirds began to gather in flocks composed of both adults and young. At this time I was at Neluan, twenty miles south of Maquinchao where they swarmed about the edges of the great *juncal* there. My notes show that the flocking process was commencing at Huanuluan early in January, but that by the latter part of the month the species had apparently withdrawn from that section. It was not found at Bariloche.

Some authors have separated the form of *Agelaius thilius* from east of the Andes under the name of *A. t. chrysocarpus* (Vigors, P. Z. S., 1832, p. 3); this name, however, is a straight synonym for *Turdus thilius* (Molina, Sag. stor. nat. Chili, 1782, p. 250) and, moreover, is antedated by Vieillot's name as cited. The male of Vieillot's description is a composite bird, but his female is based on Azara's "Tordo Negro cobijas amarillas" which is certainly identifiable as the bird in question, and since birds from east of the Andes are separable from the typical form of Chile, the proper name of the Argentine Yellow-shouldered Blackbird should stand as *Agelaius thilius chrysopterus* Vieillot.

125. Trupialis militaris militaris (Linné).

Sturnus militaris Linné, Mantissa, 1771, p. 527. Straits of Magellan.

Pecho Colorado.

A common resident occurring usually in grassy situations.

A fully grown young bird was taken at Puesto Horno on December 26; in addition, specimens were taken at San Antonio, Maquinchao, and Huanuluan. It was very common at Bariloche but none were taken there.

The bright scarlet breast of the male is easily distinguished at two hundred yards.

Bulletin of the Museum of Comparative Zoölogy

AT HARVARD COLLEGE.

Vol. LXV. No. 10.

TWO NEW GENERA OF SEA-URCHINS.

By Hubert Lyman Clark.

CAMBRIDGE, MASS., U. S. A.:

PRINTED FOR THE MUSEUM.

July, 1923.

No. 10.— *Two new Genera of Sea-Urchins.*

By Hubert Lyman Clark.

There have recently come to the Museum, in one case as a donation and in the other on deposit, two remarkable Echini, each of which seems to represent an undescribed species, and in each case the combination of characters shown prevents its being assigned to any recognized genus. It is therefore necessary to erect new genera for their reception. One of the specimens is a bare test of a recent species from the China Sea, while the other is a well-preserved fossil from South Carolina.

The recent specimen was sent me some months ago by Monsieur P. Thiéry, of Pont-a-Mousson, France, who asked me to identify it. The specimen had been in his collection for several years and during the war was struck by a fragment of a German shell and its abactinal side seriously damaged. Examination of the specimen puzzled me and I returned it to M. Thiéry with the suggestion that it represented a new genus and advising him to publish a description of it. With characteristic but none the less extraordinary generosity he sent it back, presenting it to the Museum of Comparative Zoölogy, with the request that I describe it.

Before doing so I felt it was desirable to have my friend Dr. Mortensen of Copenhagen see it for there is no one now living whose judgment regarding Echini, I value as highly as that of my Danish colleague. Dr. Mortensen promptly returned the specimen with the assurance that it seemed to be a new genus (*vide infra*), and I therefore publish a full account of the specimen, making it the type of a new genus, Desmechinus[1] and designating it by the specific name, *anomalus* in reference to the unusual combination of characters which it shows. It may seem ungracious not to associate M. Thiéry's name in some way with this interesting echinoid, particularly in view of the admirable work he has done on the group, but I hope to be pardoned in my endeavour to make whatever names I coin significant, at least to some degree, of the animal with which they are to be associated.

[1] Gr. δεσμός, *a connecting link* + *echinus*, indicative of the apparently intermediate position it occupies between the Temnopleuridae and Echinidae.

Desmechinus, gen. nov.

Temnopleurids of the subfamily Trigonocidarinae, with a much flattened, sculptured test, the larger primary tubercles crenulate, and the periproct markedly eccentric, in contact with oculars I and II, and genital 1.

Genotype: The following unique species

Desmechinus anomalus, sp. nov.

Test flattened, with circular ambitus, 39 mm. in diameter and only 13 mm. high. There are 22 interambulacral plates in each column and 32 ambulacrals; the damaged condition of the abactinal system prevents certainty regarding these numbers. The abactinal system is about 10 mm. across, but only three oculars (II, III and IV) and two genitals (2 and 3) are present, the entire posterior part of the system with its adjoining coronal plates being broken away. There is a part of genital 1, with more than half the pore still adhering to the periproct, but genitals 4 and 5 are not to be found, while ocular V is entirely missing and of ocular I there is only a minute fragment. The anal plates are present and in position, and there is little reason to doubt that the undamaged abactinal system would have appeared exactly like that of Gymnechinus, oculars I and II and genital 1 being in broad contact with the periproct, while the other oculars were very markedly exsert. Genital 2, the madreporite, is conspicuous with its entire surface slightly swollen and very fully occupied by the numerous madreporic pores. Genital 3 carries 4 or 5 rather large, secondary tubercles.

Interambulacral areas about 14 mm. wide at the ambitus; each plate carries a primary tubercle and on either side of it (at the ambitus) are 2–4 secondary tubercles; a typical arrangement is for two secondary tubercles to stand on each side of the primary and in line with it, those on the inner side being almost or quite as large as the primary; there are also about 30 miliary tubercles of various sizes, so the plate-surface is very fully covered. Of course both above and below the ambitus, the number of tubercles decreases as the poles are approached. In addition to the tubercles, the surface of the interambulacral plates carries pits, grooves and lines of varying depth and irregular arrangement. The most conspicuous pits are 2 or 3, along the lower margin of the inner half of the plates, and 1 or 2 below the primary tubercle, especially on its inner side. The inner ends of the abactinal interambulacral plates are free from tubercles or markings but are very slightly bevelled so that there is a zigzag median line in the interradius; the inner ends of the upper and lower margins of the plates are also slightly bevelled. Many, but not all, of the larger tubercles, especially on the actinal surface, are crenulated, some of them very conspicuously so. The tubercles are, of course, imperforate.

Ambulacral areas about 10 mm. wide at ambitus; each plate carries, at or near its center, a conspicuous primary tubercle; each of these tubercles is connected with its fellows on the plates above and below by a narrow but conspicuous vertical ridge, on the inner side of which is a series of big pits; at the ambitus and above, one of these pits occu-

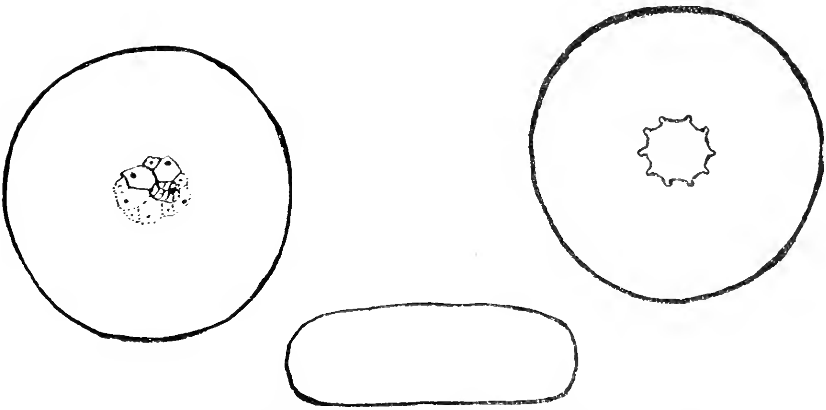


FIG. 1. Outlines of *Desmechinus anomalus*. Nat. size. From above, from the side, from below, to show proportions of height, periproct, and peristome, to diameter.

pies all the space between the tubercles of adjoining plates, but below the ambitus the pits soon disappear and the ridge itself does not extend half way to the peristome. Near the inner end of each plate is a tubercle which may perhaps best be regarded as a secondary but in the midzone it is nearly or quite as big as the primary. There are also 8–10 miliary tubercles scattered on the inner half of each plate and among these are a few small and more or less indefinite pits. Along the median radial line, the plates are a trifle bevelled with here and there a small pit; there are pits also, some of them rather conspicuous, along the horizontal sutures between the ambulacral plates. The primary tubercles, except abactinally, are generally crenulated. The outer half of each plate is occupied by the poriferous area, which is over 2 mm. wide at the ambitus. The arcs of 3 pore-pairs are very regular and in the midzone are so well spaced that the first pore-pair on each plate (the innermost) is directly above the first on the plate below, the second is above the second and the third is above the outer half of the second and most of the third. Immediately above each pore-pair is a tubercle; that above the first one is largest but least overhanging; the other two are nearly white, translucent (at least to some degree) and distinctly overhang the pores; the outermost pore-pair is often almost concealed by its tubercle; a miliary tubercle occupies the extreme upper, outer corner of the plate and a second one is on the lower margin between the first and third pore-pairs. Actinally the poriferous zones are narrower but the pore-pairs never form a single vertical series.

Peristome small and distinctly sunken, only 8.5 mm. across. Peristomal membrane missing. Gill-cuts deep and sharply defined with rather conspicuous flanges. Auricles rather conspicuous, but wide and low, not meeting across the ambulacra. Spines and pedicellariae wholly wanting. Color of bare test, above ambitus, dull purplish; somewhat yellowish on the poriferous areas, darkest on the median radial and interradial areas; lower surface of test cream-color. Holotype: M. C. Z. 4,635. China Sea.

This remarkable sea-urchin bears a striking resemblance to *Gymnechinus epistichus*, when seen from the upper surface. Actinally the resemblance is less striking because the peristome is so much smaller and more sunken. In *epistichus* the diameter of the peristome is more than a third of the horizontal diameter of the test, while in the present specimen it is less than one fourth. The test too is much flatter than in *epistichus*. Nevertheless, were it not for the sculpturing of the test, I should consider this Chinese sea-urchin, the adult of *epistichus*, for it is well known that the older and larger a regular sea-urchin becomes the smaller the peristome is proportionately, and, in species with low tests, the flatter they become. But to disregard the very evident sculpturing of the test involves confusion between two families (Echinidae and Temnopleuridae) which have hitherto been regarded by all students of Echini as perfectly distinct and natural groups. Except for the abactinal system, the new species is unquestionably a Temnopleurid. The abactinal system seems to be that of Gymnechinus, but the test of Gymnechinus shows no sculpturing. The holotype of *G. epistichus* (26 mm. h.d.) is one of the largest specimens of the genus on record and careful examination of its test with a lens reveals no sculpturing and no sign of crenulation on the tubercles.

Another sea-urchin which the new species suggests is *Opechinus spectabilis* Mortensen but the abactinal system and the poriferous areas are strikingly different. Dr. Mortensen, moreover writes: — "Regarding the Temnopleurid, I would say that I think it evidently a new genus. It seems related to Opechinus but the trigeminate pores, so distinctly developed, form so important a difference that I think they could hardly be congeneric."

We must choose then between the two horns of the dilemma. Either the present specimen represents the adult of *Gymnechinus epistichus*, the sculpturing of the test, supposed to be characteristic of the Temnopleuridae, being developed only after the urchin is two thirds grown, or we have the representative of a remarkable new Temnopleurid genus with an extraordinary resemblance to *Gymnechinus epistichus*. In view of the scanty material and its poor condition, it seems wiser to accept the latter alternative, as the acceptance of the former breaks down family lines and results in unfortunate confusion. It seems almost needless to add that if the first alternative is correct, as I think not at all unlikely, we shall have to make renewed efforts to delimit the Echinidae and the allied families.

The fossil echinoid from South Carolina belongs to Mr. William G. Mazÿck of Charleston, and he has kindly consented to my naming and describing it. Before doing so, I sent it to Dr. M. W. Twitchell, Assistant State Geologist of New Jersey, who has given special attention to the fossil Cassiduloids of North America. Dr. Twitchell kindly examined the specimen and wrote me: "I am quite confident you are correct in deciding that it is 'a new and well characterized Cassiduloid,' . . . I think it belongs to the family Cassidulidae but I am also quite positive that it should not be placed in the genus Cassidulus." After further discussion of its relation to other genera of the Cassidulidae, Dr. Twitchell expresses the belief "that you will have to establish and describe a new genus for your form — closely allied to Cassidulus on the one hand and to Echinolampas on the other." In view of this expert opinion I do not hesitate therefore to offer the following diagnosis of a new genus.

Pygidiolampas.[1]

Low, somewhat flattened Cassidulids with the abactinal ambulacra markedly petaloid, the petals nearly or quite closed; the peristome

[1] Πυγίδιον = "a thin, narrow rump" + *lampas*, the common termination of the names of several allied genera.

nearly central with a well-developed floscelle; the actinal surface flat with the ambulacra not at all depressed; and the periproct small, slightly longer than wide and completely on the actinal surface of a narrow posterior projection of the test.

Genotype: *Pygidiolampas eurynota*, sp. nov.

It may be that the posterior projection of the test is not a constant generic character, for the really essential features are the low test, the well-formed petals, the absence of any depressions for the ambulacra, the small elliptical periproct, wholly on the actinal surface without any trace of a depression or furrow about it. The position of the periproct is a sufficient difference between the new genus and Cassidulus, while the small size and the form of the periproct combine with the perfect petals and the flat actinal surface to distinguish Pygidiolampas from Echinolampas. The form and position of the periproct are strikingly suggestive of Pygurus but the form of the test and the character of the ambulacra are very different in the two genera. It is probable that the similar position of the periproct in Pygurus and Pygidiolampas is a case of parallelism rather than an indication of genetic affinity, for the characters of the ambulacra, which are certainly more fundamental than the position of the periproct indicate that Cassidulus is nearer the new genus than is Pygurus, and it is not unlikely that Echinolampas is even nearer. Very possibly some of the species now included in Echinolampas will be found to belong more naturally in Pygidiolampas.

As regards the geological age of the genus, we have no direct knowledge. Mr. Mazÿck writes: "I am sorry that I cannot give you any information regarding the geological horizon. The geographical location is Grove Plantation, Cooper River, about 14 miles from Charleston." Clark and Twitchell (1915, Mesozoic and Cenozoic Echinodermata of the United States) consider the echinoderms which they record from this famous plantation as Upper Miocene, so there is every reason to believe that Pygidiolampas is an Upper Miocene form, and thus somewhat later than most of the American species of Cassidulus, though that genus has a very great geologic range.

Pygidiolampas eurynota, sp. nov.

Length 46 mm.; breadth, across peristome, 40 mm.; height, 14 mm. Ambitus sharply defined, at the margin of the flat actinal surface; the anterior half of the ambitus is a semicircle but the posterior half is a very broad V-shape, the point of the V projecting somewhat from the general curve of the margin. Abactinal system at apex of the test, distinctly anterior, its center only about 19 mm. from the anterior margin. There is a large pore, almost a millimeter in diameter, at the apex of interambulacrum 4 and this may fairly be considered a genital pore. It is clear that no such pore exists or ever did exist in interambulacrum 5. As for other interambulacra, the condition of the specimen does not permit determination. An ocular pore, nearly half a millimeter across, is present at the apical end of petal V but none of the others can be detected with certainty.

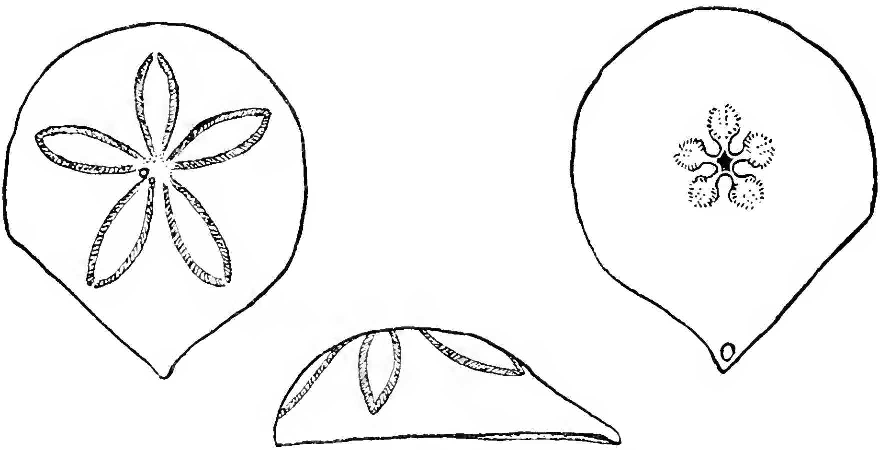


FIG. 2. *Pygidiolampas eurynota.* Nat. size. From above, from the side, from below.

The petaloid area occupies a large part of the abactinal surface; petals I and V are about 17 mm. long, 5.5–6 mm. wide at the middle with the interporiferous area, 3 mm. wide at that point; they taper almost equally towards each end and are nearly closed distally; the pores of each pair are apparently about equal in size and are connected by a deep groove; there are about 60 such grooves on each side of each petal. Petals II and IV are very similar but are shorter and wider, about 16 mm. long, 7 mm. wide, with interporiferous area about 4.5 mm. across. They have about 60 pore-pairs and are quite closed distally. Petal III is not essentially different, being 16 mm. long, 6 mm. wide, with interporiferous area about 3 mm. across; the distal end is damaged but it was undoubtedly nearly or quite closed. There is no tuberculation visible on the abactinal surface.

Actinal surface remarkably flat, with the bourrelets very conspicuously projecting around the mouth. Phyllodes short and wide, distal to the bourrelets and abruptly narrowed between them, not at all sunken below the actinal floor. Peristome small and nearly central. Ambulacra flush with the interambulacra, the boundaries between being almost indistinguishable. Interambulacrum 5 very slightly tumid, so that it is not so flat as the rest of the actinal surface. Periproct small, about 2.5 mm. long by a little more than 2 mm. wide, placed on the lower surface of the posterior projection of the test, close to the margin. Seen from the side, the projection seems to curve downward very slightly. No tuberculation is visible anywhere actinally.

The specimen is a dirty horn-color, more or less whitish on the upper surface, but the matrix in which it was imbedded was a dark gray in rather strong contrast.

Bulletin of the Museum of Comparative Zoölogy

AT HARVARD COLLEGE.

Vol. LXV. No. 11.

SOME MOLLUSCA FROM THE SOLOMON ISLANDS.

By William F. Clapp.

With Five Plates.

CAMBRIDGE, MASS., U. S. A.:

PRINTED FOR THE MUSEUM.

November, 1923.

No. 11.— *Some Mollusca from the Solomon Islands.*

By William F. Clapp.

The specimens upon which this paper is based, were gathered by Dr. W. M. Mann in 1916. The value of the collection has been greatly enhanced by the exact localities furnished by Dr. Mann, and also by the abundance of unusually well-preserved specimens of many of the species. This has made it possible to examine the animal and when of interest these observations have been included in this paper.

A careful census of the species previously recorded from the Solomon Islands, after eliminating records certainly erroneous, gives a total of one hundred and forty-six species and twenty-two varieties. Several of these are doubtful, such as *Simpulopsis salomonia* Pfeiffer, and will probably eventually have to be removed from the list when the true habitat is discovered. There are also one or more species which have been recorded from the Admiralty Islands or elsewhere, which may be found to inhabit the Solomons. Dr. Mann succeeded in finding forty-eight species and five varieties. Of these twenty-four species (with one new genus) and one variety, approximately 50%, were new, and twenty-four species and four varieties, had been previously recorded. It appears from these figures that the Solomon Islands offer a rich field for the shell collector.

STREPTAXIDAE.

1. Streptaxis costulosus (Pfeiffer).

Helix costulosus Pfeiffer, Proc. Zool. soc. London, 1852, p. 136. Insulis Salomonis.
Streptaxis costulosus Tryon, Man. conch., 1885, ser. 2, **1**, p. 63, pl. 12, fig. 30–32.

HELICARIONIDAE.

2. Helicarion aureus (Pfeiffer).

Vitrina aurea Pfeiffer, Proc. Zool. soc. London, 1854, p. 122. Salomon's Islands. Reeve, Conch. Icon., 1862, **13**, pl. 9, sp. 69. Tryon, Man. conch., 1885, ser. 2, **1**, p. 159.

It seems probable that the shell figured by Reeve is a Helicarion. Tryon lists *aurea* as unfigured overlooking Reeve's figure.

3. Helicarion planospirus (Pfeiffer).

Vitrina planospira Pfeiffer, Zeitschr. malak., 1853, p. 51. Insulis Salomonis. Reeve, Conch. Icon., 1862, **13**, pl. 9, sp. 65.

Helicarion planospirus Tryon, Man. conch., 1885, ser. 2, **1**, p. 171, pl. 38, fig. 64–66. Smith, Proc. Zool. soc. London, 1885, p. 588. Ugi, Santa Anna (Guppy), San Christoval. Guadalcanar (Macgillivray) Oberwimmer, Denks. K. akad. wiss., 1909, **84**, p. 515. Bougainville.

Pamua, Wainoni Bay, Wai-ai, San Christoval Id.; Three Sisters Id.; Paiua, Ugi Id.; Auki, Malaita Id.

The animal in alcohol is dark red and measures 22 mm. in total length. The right shell-lobe of the mantle is orbiculate, with a thickened ridge curving from the posterior to the anterior edge. The left shell-lobe is reflected over about one fourth of the shell with a sharp thickened ridge extending backward along the left side from the anterior edge to that portion of the posterior edge which is nearly opposite the apex of the shell. There is a deep depression in the posterior portion of the dorsal surface of the foot to contain the shell. The tail is sharp above with a large mucous pore and overhanging dorsal projection. The pedal line is very distinct and the sole of the foot shows clearly a well-defined central area.

The radula (Fig. 1, M. C. Z. 32,540, slide, 1,623) is about 3.1 mm.

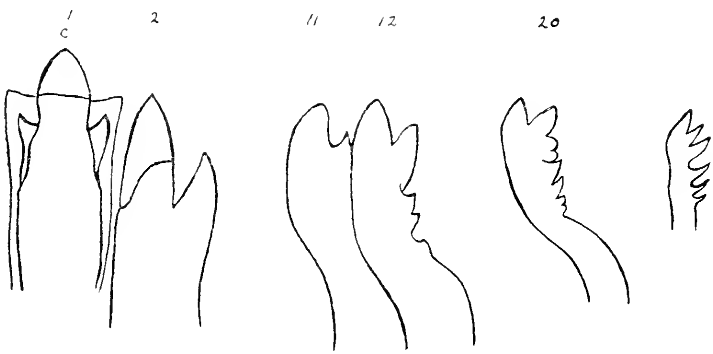


Fig. 1.— Helicarion planospirus (Pfeiffer) Radula.

long and 2 mm. wide consisting of 150 rows with a formula of approximately 250–(10?)–1–(10?)–250. The transition from the laterals to the uncini is gradual, the large cusp of the lateral decreasing in size, until it approaches in size and shape its denticle thus rendering those teeth from the twelfth on to appear bifid. At about the twelfth tooth small denticles appear on the outer edge. The outermost ten or twelve uncini are small and very spinous.

In size and shape the radula of *H. planospirus* is not very similar to the radulae of some other species of Helicarion which have been figured, (Tyron, Man. conch., 1885, ser. 2, **1**, p. 137, pl. 29, fig. 12. Hedley, Proc. Linn. soc. N. S. W., 1891, ser. 2, **6**, p. 24, pl. 2, fig. 11; p. 687, pl. 41, fig. 30), differing by being almost two thirds as broad as it is long and also in the large number of teeth in a row. The shape of the individual teeth are, however, typically Helicarion.

4. Helicarion malaitaensis, sp. nov.

Plate **1**, fig. 1–5.

Type. M. C. Z. 36,225. Auki, Malaita Id.

Shell depressed, thin, shining, with faint oblique arcuate growth-striae above, hardly discernible below, and very faint spiral impressed lines on the upper half of the body-whorl, corneous, lighter on base, whorls $2\frac{1}{2}$, spire nearly flat, suture impressed, columellar lip slightly membraneous, body-whorl flattened above, convex below.

G. d. 17 mm. l. d. 12 mm. alt. 8.5 mm.

Fig. 2.— Helicarion malaitaensis Clapp. Radula.

The shell differs from that of *H. planospirus* in being larger, more solid and much darker in color, and from *H. aurea* Pfeiffer (Reeve, Conch. Icon., 1862, **13**, pl. 9, sp. 69) in size and shape.

The animal in alcohol is gray, 32 mm. in length. The right shell-lobe extends completely over the apex of the shell, the left covering the anterior quarter of the body-whorl. The foot, divided longitudinally into three parts, is sharply carinated above, excepting for the broad depression in which the body-whorl of the shell rests. The tail, with a large dorsal projection and mucous pore. The pedal-line is very distinct.

Radula (Fig. 2, M. C. Z. 36,225, slide 1,629, 1,630) 3 mm. long, 2 mm. wide, consisting of 120 rows with about 350 teeth in each row. The formula being 165–8–1–8–165. The teeth differ from those of *H. planospirus* in having the large denticle of all but the innermost of the lateral teeth much broader, and with minute denticles on the cutting edge. The denticles on the outer edge of the uncini are much smaller and more numerous.

RHYTIDIDAE.

5. Delos rapida *var. B* major (Pfeiffer).

Helix rapida var. B *major* Pfeiffer, Zeitschr. malak., 1853, p. 54. Insulis Salomonis.

Elaea rapida var. B *major* Tryon, Man. conch., 1883, ser. 2, **1**, p. 129.

It seems probable that this variety should be removed from the Solomon Island species, the somewhat similar appearance of New Zealand Delos to the young of Rhytida, having originally caused the confusion.

6. Rhytida villandrei (Gassies).

Helix villandrei Gassies, Journ. conch., 1865, p. 210. New Caledonia.

Helix (*Rhytida*) *villandrei* Brazier, Proc. Zool. soc. London, 1872, p. 805. Recherche Bay, San Christoval, Solomon Group. Smith, Proc. Zool. soc. London, 1885, p. 594.

Rhytida villandrei Tryon, Man. conch., 1885, ser. 2, **1**, p. 119, pl. 23, fig. 45, 46. Gude, Proc. Mal. soc. London, 1907, **7**, p. 235.

Helix (*Rhytida*) *boydi* Angas, Proc. Zool. soc. London, 1869, p. 626, pl. 48, fig. 8. Recherche Id.

Wainoni Bay, San Christoval Id.

Brazier (1872) states that this species though described from New Caledonia was "taken there by missionaries."

7. Macrocycloides veronica (Pfeiffer).

Helix veronica Pfeiffer, Proc. Zool. soc. London, 1853, p. 58. Salomon's Islands. Reeve, Conch. Icon., 1853, fig. 1028.

Helix (*Macrocycloides*) *veronica* Tryon, Man. conch., 1887, ser. 2, **3**, p. 49, pl. 5, fig. 98.

8. Macrocycloides eustrophes (A. D. Brown).

Helix eustrophes A. D. Brown, Journ. conch., 1870, **18**, p. 391. Insulis Salomon dictis (Cox).
Helix (Macrocycloides) eustrophes Tyron, Man. conch., 1887, ser. 2, **3**, p. 49.

ZONITIDAE.

9. Nanina (Microcystis) nematophora (Pfeiffer).

Helix nematophora Pfeiffer, Proc. Zool. soc. London, 1854, p. 49. Salomon's Islands. Reeve, Conch. Icon., 1854, **7**, fig. 1333.
Nanina (Microcystis) nematophora Tryon, Man. conch., 1886, ser. 2, **2**, p. 114, pl. 38, fig. 46.

10. Nanina (Xesta) wanganensis (Cox).

Helix wanganensis Cox, Proc. Zool. soc. London, 1870, p. 82. Wanga, San Christoval, Solomon Islands.
Nanina (Microcystis) wanganensis Tryon, Man. conch., 1886, ser. 2, **2**, p. 124.
Xesta wanganensis Gude, Proc. Mal. soc. London, 1907, **7**, p. 235, pl. 21, fig. 15a–c.

The measurements "Diam. maj. 13, min. 12 mm.; alt. 8 mm.," given by Gude of a specimen contributed by Dr. Cox, are so very different proportionately, from those of the original description, "Diam., greatest 0.31, least 0.21, height 0.22 of an inch," that it is impossible that the two specimens measured belong to the same species.

11. Nanina (Xesta) compluviata (Cox).

Helix compluviatus Cox, Proc. Zool. soc. London, 1871, p. 646, pl. 52, fig. 10. Solomon Islands.
Nanina (Hemiplecta) compluviata Tryon, Man. conch., 1886, ser. 2, **2**, p. 44, pl. 14, fig. 100.

12. Nanina (Xesta) capitanea (Pfeiffer).

Helix capitanea Pfeiffer, Proc. Zool. soc. London, 1854, p. 49. San Christoval, Solomon Islands (Capt. Keppell). Reeve, Conch. Icon., 1854, **7**, fig. 1279.
Nanina (Xesta) capitanea Tryon, Man. conch., 1886, ser. 2, **2**, p. 72, pl. 19, fig. 83.

13. Nanina (Xesta) inornata (Hombron and Jacquimot).

Helix inornata Hombron and Jacquimot, Voy. Pole Sud, 1854, **5**, p. 7, pl. 4, fig. 11–14. Isles Salomon.

The placing of this species by the authors in the synonymy of *nouleti* Le Guillou, from Fiji, a course which has been followed by subsequent writers, is open to question. Since the land-shell fauna of the Fiji Islands is quite different from that of the Solomon Islands, it is not likely that any Nanina will be found to be identical in both groups.

14. Nanina (Xestina) salomonis (Le Guillou).

Helix salomonis Le Guillou, Revue Zool., 1842, p. 137. Isles Salomon.
Nanina (Xestina) salomonis Tryon, Man. conch., 1886, ser. 2, **2**, p. 87.

15. Nanina (Macrochlamys) keppelli (Pfeiffer).

Helix keppelli Pfeiffer, Proc. Zool. soc. London, 1854, p. 50. San Christoval, Salomons Islands (Capt. Keppell). Reeve, Conch. Icon., 1854, **7**, fig. 1305.
Nanina (Macrochlamys) keppelli Tryon, Man. conch., 1886, ser. 2, **2**, p. 130, pl. 43, fig. 35.

16. Nanina (Oxytes) subtecta (Pfeiffer).

Helix subtecta Pfeiffer, Proc. Zool. soc. London, 1855, p. 91. Salomons Islands.
Helix eucharis Reeve (*non* Deshayes), Conch. Icon., 1854, **7**, fig. 1298.
Nanina (Oxytes) subtecta Tryon, Man. conch., 1886, ser. 2, **2**, p. 130, pl. 43, fig. 35.

A specimen in the Pease collection, labeled *Helix subtecta* Pfeiffer, Solomon Islands, is a Dendrotrochus. The figure in Reeve also suggests a Dendrotrochus rather than a Nanina.

17. Nanina glaberrima (Pfeiffer).

Helix glaberrima Pfeiffer, Proc. Zool. soc. London, 1854, p. 52. Salomon's Islands. Reeve, Conch. Icon., 1854, **7**, fig. 1317.
Nanina (Thalassia) glaberrima Clessin, Pfeiffer, Nom. Helic. viv., 1881, p. 46.
Charopa glaberrima Tryon, Man. conch., 1886, ser. 2, **2**, p. 212, pl. 62, fig. 46.

18. Nanina radiaria (Pfeiffer).

Helix radiaria Pfeiffer, Proc. Zool. soc. London, 1854, p. 35. Salomon's Islands. Reeve, Conch. Icon., 1854, **7**, fig. 1322.
Charopa radiaria Tryon, Man. conch., 1886, ser. 2, **2**, p. 213, pl. 62, fig. 52.

Probably not a Nanina, certainly not a Charopa.

19. Fretum solidiuscula (Smith).

Helix (Nanina) solidiuscula Smith, Proc. Zool. soc. London, 1885, p. 589, pl. 36, fig. 2–2b. Santa Anna Islands.
Nanina (Eurypus) solidiuscula Tryon, Man. conch., 1886, ser. 2, **2**, p. 111, pl. 37, fig. 3–5.

20. Fretum treasuryensis (Tryon).

Helix (Nanina) nitidissima Smith (*non* M'll'd'f), Proc. Zool. soc. London, 1885, p. 589, pl. 36, fig. 1–1b. Treasury Id., Bougainville Straits.
Nanina (Eurypus) treasuryensis Tryon, Man. conch., 1886, ser. 2, **2**, p. 111, pl. 37, fig. 100–102.
Nanina nitidissima Dall, Field mus. nat. hist. Zool., 1910, **7**, p. 215.

21. Fretum malaitaensis, sp. nov.

Plate **1**, fig. 6–8.

Type. M. C. Z. 32,553. Auki, Malaita Id.

Shell minutely deeply perforate, thin, shining, early whorls smooth, very faint growth-striae on the upper half of the last whorl, corneous, whorls $5\frac{1}{2}$, convex, regularly increasing in size; last whorl not descending, periphery rounded. Aperture slightly oblique. Peristome simple. Columella obliquely descending, thickened above and reflexed, nearly covering the umbilicus, adnate.

G. d. 14.9 mm. l. d. 13.3 mm. alt. 9.5 mm.

This shell is very similar to *Nanina keppelli* Pfeiffer (Proc. Zool. soc. London, 1854, p. 50) from San Christoval, but differs, in being less depressed, and in the shape of the columella, which, in *keppelli* is described as, "*arcuatim descendente.*" Particular stress is placed on this character by Pfeiffer (Mon. Helic. Viv., 1859, **4**, p. 54) and the figure he refers to (Reeve, Conch Icon., **7**, t. 187, sp. 1305) shows clearly an arcuately descending columella which Pfeiffer (1859) contrasts with the very obliquely descending columella of *resplendens*

Philippi. The columella of *malaitaensis* is very similar to that of *resplendens* as figured by Reeve (Conch. Icon., **7**, t. 81, sp. 430).

The animal of *malaitaensis* possesses the caudal mucous pore,

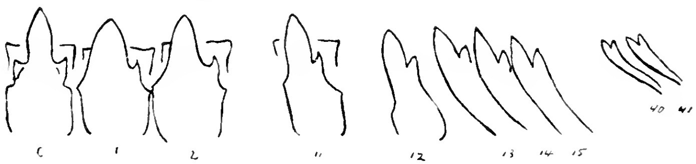


Fig. 3.— Fretum malaitaensis Clapp. Radula.

pedal-groove, and divided ventral surface of the foot, of the genus Eurypus Semper (= Fretum Sykes, Proc. Mal. soc. London, 1900, **4**, p. 140). Radula (Fig. 3, M. C. Z. 36,768, slide 1,631) containing about 100 rows of teeth with a formula of 35–12–1–12–35.

22. Fretum concavum, sp. nov.

Plate **1**, fig. 9–11.

Type. M. C. Z. 32,552. Auki, Malaita Id.

Shell perforate, thin, shining, early whorls smooth, later whorls with very strong numerous regularly spaced growth-wrinkles above, which end abruptly at the carina, very smooth below. Embryonic shell consisting of two whorls, darker in color than the later whorls. Shell chamois colored above, lighter below, fading to nearly white in the umbilical region. Whorls 5½, convex, regularly increasing in size, outline of spire, concave, last whorl not descending, strongly shouldered. Aperture nearly straight. Peristome simple. Columella obliquely descending, strongly thickened and reflexed in a narrow tongue-like process over a portion of the umbilical region.

G. d. 10 mm. l. d. 8.6 mm. alt. 5.9 mm.

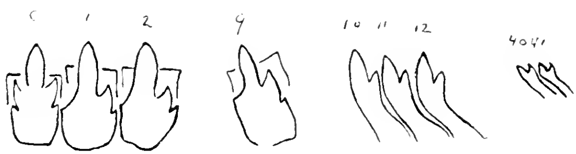


Fig. 4.— Fretum concavum Clapp. Radula.

The concave outline of the spire is the most striking character of the shell. The mantle of the animal is black with large irregular milk-white patches which show clearly through the semitransparent shell. The radula (Fig. 4, M. C. Z. 32,552, slide 1,633) consists of about 100 rows of teeth with a formula of 45–8–1–8–45. The teeth are not unlike those of *Fretum suteri* Sykes (Proc. Mal. soc. London, 1900, **4**, p. 140, pl. 13, f. 19).

23. Fretum manni, sp. nov.

Plate **1**, fig. 12–14.

Type. M. C. Z. 32,550. Auki, Malaita Id.

Shell perforate, thin, depressed, shining, smooth above and below, color yellow-ochre above and below, with what appears to be a narrow red band at the suture caused by the overlapping of the whorls; suture very slightly impressed, whorls 5½ regularly increasing in size, flat above, rounded below, slightly shouldered, outline of the spire nearly straight, last whorl not descending. Aperture oblique. Peristome simple. Columella obliquely descending, slightly thickened, very slightly flattened and reflexed only within the umbilical depression.

G. d. 7.3 mm. l. d. 6.4 mm. alt. 5.9 mm.

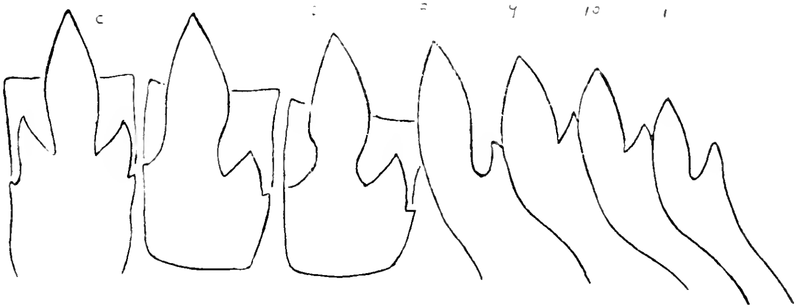


Fig. 5.— Fretum manni Clapp. Radula.

The reddish suture-line caused by the overlapping of the whorls while noticeable in many species of Fretum, is particularly well marked in this species. The radula (Fig. 5, M. C. Z. 32,550, slide 1,639) has a formula of 40–7–1–7–40.

24. Fretum pamuaensis, sp. nov.

Plate **2**, fig. 1–3.

Type. M. C. Z. 36,773. Pamua, San Christoval Id.

Shell perforate, thin, depressed, shining, with numerous fine growth-wrinkles above, smooth below, transparent pinkish buff above and below, suture slightly impressed; whorls $4\frac{1}{2}$ regularly increasing in size, somewhat flat above, rounded below, last whorl obsoletely angled, the growth-plicae extending from the suture and ending quite abruptly at the angle of the periphery, last whorl not descending. Aperture oblique. Peristome simple. Columella obliquely descending, thickened and slightly reflexed within the umbilical depression.

G. d. 7.1 mm. l. d. 6.4 mm. alt. 4. mm.

Similar in general appearance to *F. manni*, but differs in possessing one less whorl, the whorls therefore increasing in size more rapidly, in the suture being more strongly impressed, the whorls of the spire less flat, the upper surface strongly plicate in contrast to the smooth upper surface of *F. manni*. The color is very much lighter than in *F. manni*.

25. Fretum smithi, sp. nov.

Plate **2**, fig. 4–6.

Type. M. C. Z. 36,769. Ugi Id.

Shell perforate, very thin, finely plicate, with numerous growth-wrinkles above, smooth below, transparent honey-yellow above and below, suture strongly impressed. Whorls 5, convex above and below, last whorl rounded at the periphery, not descending. Aperture slightly oblique. Peristome simple. Columella arcuately descending, very slightly thickened and reflexed at the umbilicus.

G. d. 7 mm. l. d. 6.3 mm. alt. 4.3 mm.

Five specimens of this species were collected on Ugi by Dr. Mann, of which one bears the more exact locality of Paiua, Ugi. The shell is somewhat similar to *F. pamuaensis* but may be distinguished from that species by the less depressed spire, less oblique columella, and more deeply impressed sutures. The radula is typically Fretum in character, the formula being 45–8–1–8–45.

I have named this shell after Mr. E. A. Smith, who, in 1885 published an account of the land and fresh-water shells collected by Mr. H. B. Guppy in the Solomon Islands.

26. Fretum sororum, sp. nov.

Plate **2**, fig. 7–9.

Type. M. C. Z. 32,551. Three Sisters Id.

Shell perforate, thin, transparent, shining, depressed, with many faint microscopic growth-striae, strongest at the suture, nearly disappearing at the periphery and on the base; color antique-brown, fading to nearly white in the umbilical region, suture slightly impressed. Whorls $4\frac{1}{2}$, last whorl rounded at the periphery, not descending. Aperture slightly oblique. Peristome simple Columella arcuately descending, thickened.

G. d. 4.6 mm. l. d. 4.1 mm. alt. 2.3 mm.

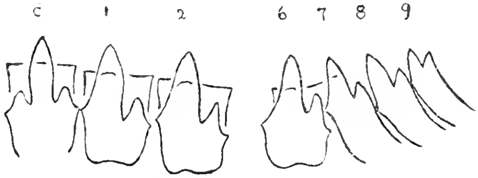


Fig. 6.— Fretum sororum Clapp. Radula.

From any of the preceding species of the genus, this shell is very easily distinguished by its small size. The animal has the posterior dorsal surface flattened, as in the other species of Fretum. The sole of the foot is tripartite, showing clearly a narrow central area. The radula (Fig. 6, M. C. Z. 32,551, slide 1,633, 1,644) is similar to those of the preceding species, having a formula of 40–6–1–6–40, and containing about 100 rows. The dividing line between the laterals and the marginals is more distinct than in any of the preceding species of Fretum, the change being unusually abrupt. The reproductive organs, heart, and kidney are shown in (Fig. 7, 8, M. C. Z. 32,551, slide 1642).

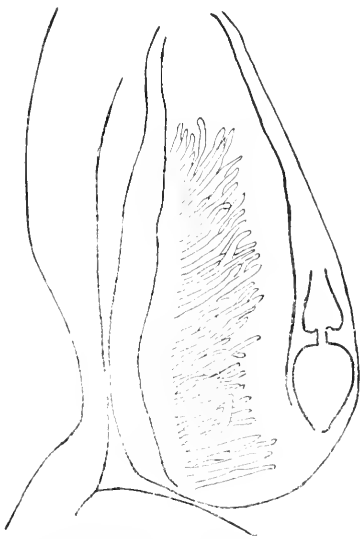


Fig. 7.— Fretum sororum Clapp. Heart and kidney.

27. Trochomorpha aukiensis, sp. nov.

Plate **2**, fig. 10–15.

Type. 32,535. Auki, Malaita Id.

Shell solid, depressed, broadly umbilicate, the umbilicus contained in the entire diameter of the shell four times. Color, light corneous, with four chestnut colored bands, the first, narrow, adjacent to the thread-like white line of the suture; the second very broad, covering most of the upper portion of the whorl; the third at the periphery, viewed exteriorly, apparently divided by the white sutural flange, particularly in young specimens, but seen through the aperture, appearing as one band; the fourth, a faint, ill-defined, lighter colored band, midway between the periphery and the umbilical region. Surface, above, with coarse, oblique nearly evenly spaced growth-lines, about six

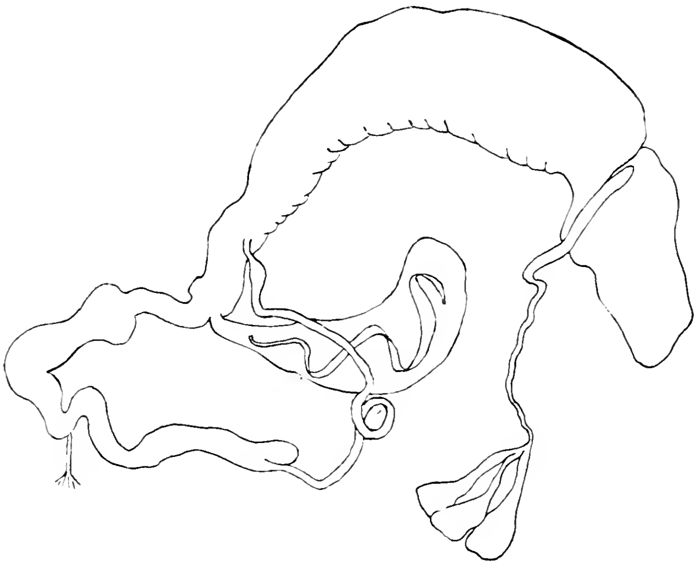


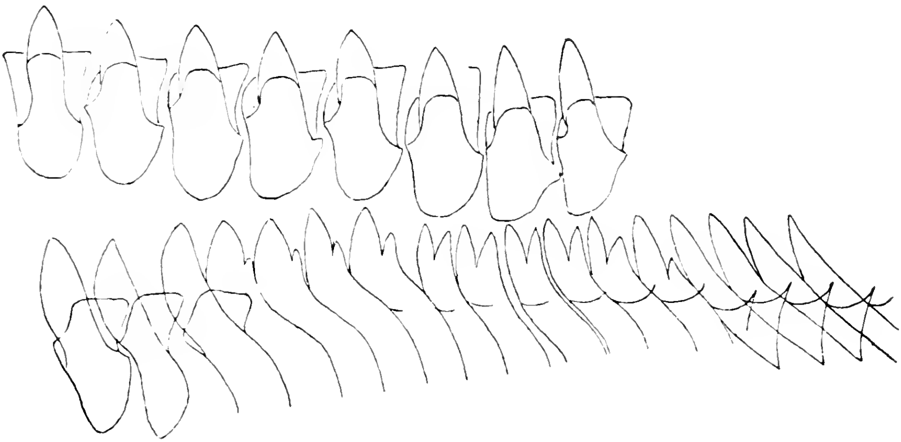
Fig. 8.— Fretum sororum Clapp. Reproductive organs.

per millimeter; below, with extremely fine growth-lines, about twenty per millimeter, accentuated, particularly in the region just below the periphery, by the periostracum. Whorls 5, convex above and below. Protoconch, consisting of $1\frac{1}{2}$ whorls. Suture impressed. Periphery, carinate, in young specimens acutely keeled and with a white flange. Aperture, very oblique.

G. d. 22 mm. l. d. 18 mm. alt. 7.4 mm.
Aperture g. d. 9 mm. l. d. 5.5 mm.
Umbilicus g. d. 5.5 mm.

There is no species from the Solomon Islands with which this could be confused.

The radula (Fig. 9, M. C. Z. 32,525, slide 1,845) exhibits some remarkable characters. The bifid marginals which are supposed to be characteristic of the Trochomorphidae, but which do not occur in *T. merziana*, appear in this species. In the specimen examined, at the 10th lateral, a small denticle appears, rapidly increasing in size, until at the 16th tooth it had attained equal size and the tooth is bicuspid. At the 20th and 21st teeth the cusp decreases in size rapidly and disappears entirely at the 22nd, which is a unicuspid lateral very similar to those of *T. merziana*, and the remainder of the teeth in the row are of this pattern. On the radula of this species there are then the follow-



9

FIG. 9.— Trochomorpha aukiensis Clapp. Radula.

ing teeth, one central, eleven unicuspid laterals, ten bicuspid marginals?, twenty-five unicuspid marginals. On the opposite side of the radula from that figured, the 19th and 21st teeth are bicuspid, while the 20th is unicuspid and similar in every way to those from the 22nd on.

28. TROCHOMORPHA BELMOREI (Cox).

Helix belmorei Cox, Proc. Zool. soc. London, 1871, p. 647, pl. 52, fig. 12. Solomon Islands.

Helix (Trochomorpha) belmorei Tryon, Man. conch., 1887, ser. 2, **3**, p. 76, pl. 14, fig. 16.

29. TROCHOMORPHA CONCAVA, sp. nov.

Plate **3**, fig. 1–3.

TYPE. M. C. Z. 32,523. Auki, Malaita Id.

Shell large, solid, depressed, widely umbilicate, spire subconcave. Color, above, cinnamon-brown, fading to light buff on the early whorls, below, with a broad chestnut-brown band, sharply defined at the upper edge by the narrow buff colored peripheral flange, the lower portion gradually fading into the light buff of the umbilical region. On approaching the aperture the band narrows rapidly, ending in a sharp point at the peripheral flange a short distance behind the aperture. Finely, irregularly wrinkled with oblique growth-lines, stronger above than below. Just above the peripheral flange are short, sharp, straight, incised lines, at irregular intervals, perpendicular to the growth-lines and therefore extending obliquely backward from the periphery. Just below the periphery similar lines occur, which, however, extend obliquely forward from the periphery. Whorls 6, last not descending in front. Protoconch smooth. Periphery sharply carinate, slightly flanged. Aperture oblique. Peristome but slightly thickened above, thickened but hardly reflexed below, columellar lip, thin, short, oblique. Parietal wall, calloused. Umbilicus contained in the diameter five times.

G. d. 35.3 mm. l. d. 30.6 mm. alt. 13.4 mm.
Aperture g. d. 14.5 mm. l. d. 8 mm.
Umbilicus g. d. 7 mm.

Specimens of this species occur in collections under the name of *T. belmorei* Cox (Proc. Zool. soc. London, 1871, p. 647, pl. 52, fig. 12). A comparison of the figures of the two species will show at once that there is little similarity between them. In *T. belmorei*, the color is darker, the suture less distinct, the base flat, and more coarsely striated than the spire, rather than less, as in *T. concava*. *Trochomorpha belmorei* lacks the dark band on the base, is much smaller, higher spired, and with the peristome sharply angled at the keel.

Trochomorpha concava is larger than any other species of the genus previously described from the Solomon Islands. There is a striking similarity in appearance between it and some specimens of Plectotropis from the Philippines.

30. Trochomorpha crouanii var. β (Le Guillou).

Helix crouanii Le Guillou, Revue zool., 1842, p. 138, var. *β*. Insulis Salomonis.
Helix (*Trochomorpha*) *crouanii* Tryon, Man. conch., 1887, ser. 2, **3**, p. 90.

31. Trochomorpha crustulum (Cox).

Helix crustulum Cox, Proc. Zool. soc. London, 1873, p. 150. Solomon Islands. Tryon, Man. conch., 1887, ser. 2, **3**, p. 90.
Trochomorpha crustulum Gude, Proc. Mal. soc. London, 1907, **7**, p. 235, pl. 31, fig. 14a–c.

Auki, Malaita.

The radula (Fig. 10, M. C. Z. 32,519, slide 1,856) is typically Trochomorphan. The first ten or eleven laterals are unicuspid, a denticle then appearing on the outer base of the cusp, increasing rapidly in size until the teeth are bicuspid. At about the 30th tooth the outer

FIG. 10. Trochomorpha crustulum (Cox). Radula.

cusp begins to decrease in size, the teeth from the 34th to the outer edge being unicuspid. The formula is 50–1–50.

The reproductive organs (M. C. Z. 32,519, slide 1,857) show little variation from the other species of Trochomorpha from the Solomon Islands.

32. TROCHOMORPHA DEIOPEIA (Angas).

Helix (*Trochomorpha*) *deiopeia* Angas, Proc. Zool. soc. London, 1869, p. 46, pl. 2, fig. 4. Marau Sound, Guadalcanar. Tryon, Man. conch., 1887, ser. 2, **3**, p. 89, pl. 17, fig. 53, 54.

33. TROCHOMORPHA EUDORA (Angas).

Helix (*Trochomorpha*) *eudora* Angas, Proc. Zool. soc. London, 1869, p. 47, pl. 2, fig. 8. New Georgia, Tryon, Man. conch., 1887, ser. 2, **3**, p. 88, pl. 17, fig. 47, 48.

34. TROCHOMORPHA EXALTATA (Pfeiffer).

Helix exaltata Pfeiffer, Proc. Zool. soc. London, 1885, p. 113. Salomon's Islands.

Helix cleryi Reeve (*non* Recluz), Conch. Icon., 1853, fig. 1026.

Helix (*Trochomorpha*) *exaltata* Tryon, Man. conch., 1887, ser. 2, **3**, p. 76, pl. 14, fig. 19.

From the above descriptions and figures it would appear that this species should be removed to the genus Dendrotrochus.

35. Trochomorpha fatigata (Cox).

Helix fatigata Cox, Proc. Zool. soc. London, 1873, p. 149, pl. 16, fig. 42-b. Solomon Islands.

Helix (Trochomorpha) fatigata Tryon, Man. conch., 1887, ser. 2, **3**, p. 76, pl. 14, fig. 17, 18.

36. Trochomorpha flava, sp. nov.

Plate **3**, fig. 4–6.

Type. 32,521. Auki, Malaita Id.

Shell, thin, trochiform, umbilicate. Spire, convex; base, flat, somewhat concave near the periphery. Color, cream-buff throughout, semitransparent, shining. Sculpture, consisting of coarse, somewhat regularly spaced, very

Fig. 11.— Trochomorpha flava Clapp. Reproductive organs.

oblique growth-lines, above and below. Whorls 6, slightly convex, the last flattened near the carina, not descending in front. Suture impressed, margined. Periphery acutely carinate. Aperture oblique. Peristome above, thin, sharp, acutely angled at the keel; below, white, slightly reflexed toward the columellar region. Parietal callous hardly visible. Umbilicus, narrow, deep, contained in the diameter of the shell nearly seven times.

G. d. 23.7 mm. l. d. 20.8 mm. alt. 12 mm.

Aperture g. d. 11 mm. l. d. 5.7 mm.

Umbilicus 3.5 mm.

This species does not appear to be closely related to any other from the Solomons. An examination of the animal shows that the reproductive organs (Fig. 11, M. C. Z. 32,522, slide 1,859) are typically Trochomorphan, the most noticeable difference being an excessively powerful retractor-muscle. The penis is somewhat longer and more twisted than in other species which have been examined. The radula (M. C. Z. 32,522, slide 1,862, 1,863) is similar to that of *T. zenobiella* (Fig. 17) in that minute denticles occur on either side of the central tooth. The inner laterals are also provided on the outer side with a minute denticle, and the laterals are all bifid. The two radulae differ in the number of teeth per row, the formula of *T. flava* being 45–1–45, that of *zenobiella* 34–1–34. These laterals which may be surely classed as bifid, do not appear in *T. flava* until the 13th or 14th tooth from the central, while in *T. zenobiella* they begin at the 9th or 10th tooth.

37. Trochomorpha floridensis, sp. nov.

Type. M. C. Z. 32,516. Florida Id.

Shell thin, semitransparent, shining, depressed, widely umbilicate, the umbilicus contained four times in the diameter. Color, light horn, with five reddish brown bands, the first, narrow, separated from the suture by the white thread-like carina of the previous whorl, the second broader, midway between the suture and periphery, the third, just above the acute, white, peripheral carina, the fourth, an equal distance below the carina, the fifth, but slightly below the fourth, leaving the major portion of the base including the entire umbilical region, light horn colored. Surface above and below with fine oblique growth-lines. Whorls 5, slightly convex, last whorl acutely keeled, the carina dividing the whorl into semiequal halves. Protoconch consisting of $1\frac{1}{2}$ whorls, pale horn color, with irregular, broken, undulating, transverse, microscopic, furrows and ridges, and numerous fine, microscopic, spiral striae, ending abruptly at the completion of the embryonic whorls. Suture, slightly impressed. Periphery, sharply carinate. Aperture, oblique. Peristome above, hardly thickened, somewhat produced forward midway between the suture and carina, below, thickened, slightly reflexed.

G. d. 17.5 mm. l. d. 15 mm. alt. 6.2 mm.
Aperture g. d. 7.3 mm. l. d. 3.7 mm.
Umbilicus g. d. 4.3 mm.

Florida Id.; Fulakora, Ysabel Id.

This species is similar to *T. xiphias* Pfeiffer, differing in having five, rather than four bands, and in the bands being consistently differently distributed, in the spire being higher, and the last whorl being less convex, above and below. From *T. henschei*, it differs in having a larger umbilicus, and having three bands above and two below the periphery, rather than the reverse, lacking entirely any umbilical band.

38. Trochomorpha godeti Sowerby.

Proc. Zool. soc. London, 1869, p. 578, pl. 56, fig. 10. Guadalcanar (Woodford). Pilsbry, Man. conch., 1893, ser. 2, **8**, p. 129, pl. 30, fig. 26–28.

39. Trochomorpha henschei (Pfeiffer).

Helix henschei Pfeiffer, Malak. blatt., 1867, **14**, p. 197. New Caledonia.
Trochomorpha henschei Pilsbry, Man. conch., 1893, ser. 2, **8**, p. 130, pl. 20, fig. 28–30. Solomon Islands.

40. Trochomorpha juanita (Angas).

Helix (*Trochomorpha*) *juanita* Angas, Proc. Zool. soc. London, 1873, p. 183, pl. 20, fig. 3. Solomon Isles.
Helix (*Trochomorpha*) *juanita* Tryon, Man. conch., 1887, ser. 2, **3**, p. 77, pl. 15, fig. 30.

41. Trochomorpha hidalgoiana (Crosse).

Helix hidalgoiana Crosse, Journ. conch., 1864, **12**, p. 283; 1866, **14**, p. 56, pl. 1, fig. 2.
Helix (*Videna*) *hidalgoiana* Tryon, Man. conch., 1887, ser. 2, **3**, p. 93, pl. 18, fig. 87, 88. Oceania.
Helix (*Trochomorpha*) *hidalgoiana* Pilsbry, Man. conch., 1894, ser. 2, **9**, p. 337. New Georgia.

42. Trochomorpha manni, sp. nov.

Plate **3**, fig. 7–9.

Type. M. C. Z. 32,528. Three Sisters Id.

Shell small, depressed, narrowly umbilicate. Color dark chestnut, fading to straw on the earlier whorls. Sculpture consisting of faint, irregular, microscopic growth-lines above and below. Whorls, 5, separated by a broad white sutural flange, the last, flattened above, convex below, not descending in front. Suture hardly impressed. Periphery, acutely carinate, sharply keeled. Aperture, oblique, not descending in front. Peristome above, flat, thin, sharp, not produced forward, white edged; below, thickened and slightly reflexed without, strongly thickened within; in the vicinity of the periphery, generally stained above and below with chestnut or purple. Parietal wall slightly callous. Umbilicus, deep narrow, contained nearly five times in the entire diameter of the shell.

G. d. 14.7 mm. l. d. 12.8 mm. alt. 5.4 mm.
Aperture g. d. 6 mm. l. d. 3 mm.
Umbilicus g. d. 3 mm.

This species shows some variation in color, there being a tendency in some specimens, for the typical chestnut coloring to fade until the shell is nearly straw colored. In these specimens, faint, ill-defined bands may be seen just above and below the periphery, and also a narrow chestnut colored area extending from the periphery to the suture, just behind the aperture. Evidence of the bands may be seen

FIG. 12.— Trochomorpha manni Clapp. Radula.

in the typically dark specimens, in the purple or chestnut tinted outer lip. The reproductive organs show no variation from the other species examined. The radula is unicuspid throughout (Fig. 12, M. C. Z. 32,529, slide 1,849), the formula being, 115, 45–1–45.

43. TROCHOMORPHA MATURA (Pfeiffer).

Helix matura Pfeiffer, Proc. Zool. soc. London, 1855, p. 92, pl. 31, fig. 10. Guadalcanar, Solomon's Islands.

Helix (Trochomorpha) matura Tryon, Man. conch., 1887, ser. 2, **3**, p. 88, pl. 17, fig. 50.

44. TROCHOMORPHA MELEAGRIS (Pfeiffer).

Helix meleagris Pfeiffer, Proc. Zool. soc. London, 1855, p. 107, pl. 32, fig. 8. Wanderer Bay, Guadalcanar, Salomon's Islands. Smith, Proc. Zool. soc. London, 1885, p. 593.

Helix (Trochomorpha) meleagris Tryon, Man. conch., 1887, ser. 2, **3**, p. 81, pl. 15, fig. 62.

45. TROCHOMORPHA MEMBRANICOSTA (Pfeiffer).

Helix membranicosta Pfeiffer, Proc. Zool. soc. London, 1854, p. 55. Salomon's Island. Reeve, Conch. Icon., 1854, fig. 1318.

Helix (Trochomorpha) membranicosta Tryon, Man. conch., 1887, ser. 2, **3**, p. 76, pl. 14, fig. 15.

46. Trochomorpha merziana (Pfeiffer).

Helix merziana Pfeiffer, Proc. Zool. soc. London, 1852, p. 135. Tryon, Man. conch., 1887, ser. 2, **3**, p. 89, pl. 18, fig. 55.

Helix (Videna) merziana Smith, Proc. Zool. soc. London, 1885, p. 593.

Wai-ai, San Christoval, Bio, Ugi Islands.

Specimens (M. C. Z. 32,510) from Wai-ai appear to be most nearly typical, but differ in having the yellow strigations more numerous. The average size of specimens in this lot is, g. d. 23.6 mm., l. d. 20. mm., alt. 10.6 mm. Specimens from Bio (M. C. Z. 32,512) differ from those from Wai-ai in being smaller, lacking nearly all of the yellow streaks on the upper surface, in being more depressed, with deeper sutures, and not having the thread-like yellow lines separating the whorls. The ultimate whorl is nearly as rounded below as above, the carina

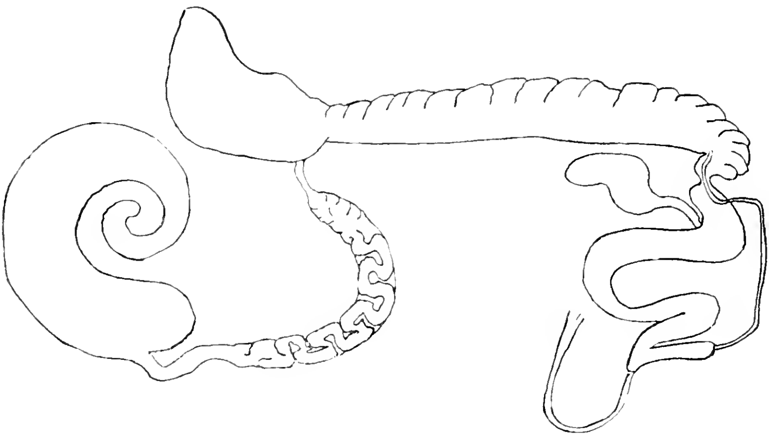


Fig. 13.— Trochomorpha merziana (Pfeiffer). Reproductive organs.

dividing it into equal halves. The average size of specimens from Bio Is., G. d. 20.7 mm., l. d. 17.9 mm., alt. 8.1 mm. Specimens from Ugi (M. C. Z. 32,514) differ from those from Wai-ai in much the same manner as do those from Bio. They are generally darker, with the base more rounded and the carina therefore dividing the ultimate whorl into two subequal halves. The base is frequently chestnut with no trace of banding. The width of the aperture from the columellar wall to the periphery is much less then in the specimens from Wai-ai. None of the differences are, however, constant, connecting links occurring in each lot. There is no reason from the material at hand, to believe that the differences show geographical races, rather than great variation of local colonies.

There is no noticeable difference in the anatomy of specimens from the above localities. The reproductive organs (Fig. 13) of a specimen from Wai-ai (M. C. Z. 32,510) are similar to those of other members of the genus which have been figured (Pilsbry, Man. conch. 1893, ser. 2, **9**, pl. 7, 8.) The radula (Fig. 14, M. C. Z. 32,510, slide 1,841), how-

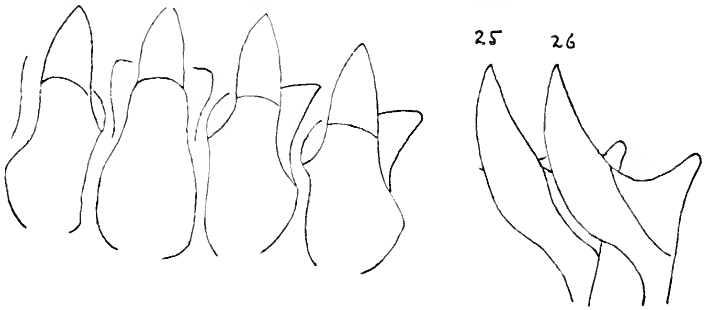


Fig. 14.— Trochomorpha merziana (Pfeiffer). Radula.

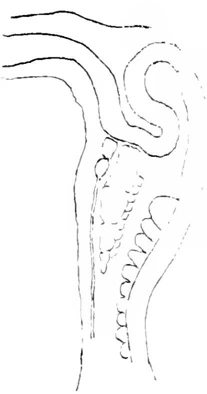


Fig. 15.—Trochomorpha merziana (Pfeiffer). Heart and kidney.

ever, while showing no variation in any of the specimens from Wai-ai, Bio, or Ugi, exhibits a very marked difference from that of any other species of Trochomorpha previously figured (Pilsbry, *Loc. cit.*, p. 2, pl. 8, fig. 11, 18), in that the marginals are not bifid. The transition from the laterals to the marginals is gradual, the formula being 120 ×50–1–50.

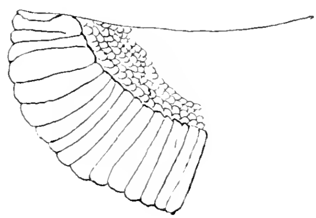


Fig. 16. — Trochomorpha merziana (Pfeiffer). Posterior portion of the foot.

47. Trochomorpha partunda Angas.

Proc. Zool. soc. London, 1867, p. 890, pl. 43, fig. 13–15. Galera or Russell Island.
Helix (*Trochomorpha*) *partunda* Tryon, Man. conch., 1887, ser. 2, **3**, p. 81, pl. 15, fig. 60, 61

48. Trochomorpha rendovaensis, sp. nov.

Plate **3**, fig. 10–12.

Type. M. C. Z. 36,777. Rendova Id., off New Georgia.

Shell small, solid, transluscent, hardly shining, umbilicate. Spire convex, base rounded. Color light buff, with five chestnut bands, the first, narrow, at the suture, the second, equally narrow, midway between the periphery and the suture, the third, very broad, extending above and below the periphery, the fourth, thread-like, hardly separated from the third, the fifth, broad, at the umbilicus. Sculpture consisting of oblique growth-lines above and below. Whorls 5, slightly convex, last not descending. Suture lightly impressed, margined. Periphery sharply carinate. Aperture very oblique. Peristome above, thin, sharp; below, slightly reflexed from the periphery to the umbilicus, the reflexed edge colored by the chestnut bands. Parietal callous very indistinct. Umbilicus contained in the diameter 4.3 times.

G. d. 11.2 mm. l. d. 10.5 mm. alt. 5.7 mm.
Aperture g. d. 4.7 mm. l. d. 3 mm.
Umbilicus 2.6 mm.

This shell is very similar to *T. henschei* as described and figured by Pilsbry (Man. conch., ser. 3, **8**, p. 130, pl. 20, fig. 28–30). It differs in being very much smaller and more closely coiled, by having a dark suture and dark, rather than white edged, peripheral keel.

51. Trochomorpha rhoda (Angas).

Helix rhoda Angas, Proc. Zool. soc. London, 1876, p. 267, pl. 20, fig. 10–12. San Christoval.

Helix (*Trochomorpha*) *rhoda* Tryon, Man. conch., 1887, ser. 2, **3**, p. 88, pl. **17**, fig. 51, 52.

49. Trochomorpha rubianaensis, sp. nov.

Type 32,532. Rubiana, New Georgia Id.

Shell solid, semitransparent, moderately umbilicate, the umbilicus contained in the diameter five times. Color, light corneous, with three reddish brown bands, the first, above, midway between the suture and periphery, the second just below the periphery, and the third, midway between the periphery and the umbilical region. Surface, above and below, with fine oblique growth-lines. Whorls, 5, convex above, flattened below, last whorl obtusely keeled. Protoconch, consisting of 1½ whorls, surface, granular, with no trace of transverse or spiral sculpture. Suture impressed. Periphery, obtusely keeled but not flanged. Aperture oblique. Peristome sinuous;

above, hardly thickened, subreflexed, somewhat produced forward; below, thickened, reflexed, basal lip straight, not oblique, nearly horizontal to the axis; columellar lip encroaching on the umbilical region, nearly parallel to the axis.

G. d. 14 mm. l. d. 12.3 mm. alt. 6.5 mm.
Aperture g. d. 6.3 mm. l. d. 4 mm.
Umbilicus, g. d. 2.8 mm.

This species, belonging to the group to which *henschei*, *xiphias*, *godeti*, and *floridensis* belong, is possibly most nearly like *godeti*. It differs from that species in having three chestnut bands and in being much smaller.

50. Trochomorpha sanctaeannae (Smith).

Helix (*Videna*) *sanctaeannae* Smith, Proc. Zool. soc. London, 1885, p. 594, pl. 36, fig. 7. Santa Anna.

Helix (*Trochomorpha*) *sanctaeannae* Tryon, Man. conch., 1887, ser. 2, **89**, pl. 18, fig. 56–58.

51. Trochomorpha scytodes (Pfeiffer).

Helix scytodes Pfeiffer, Proc. Zool. soc. London, 1854, p. 56. Solomon's Islands. Reeve, Conch. Icon., 1854, fig. 1310.

Helix (*Trochomorpha*) *scytodes* Tryon, Man. conch., 1887, ser. 2, **3**, p. 77, pl. 14, fig. 20.

52. Trochomorpha sebacea (Pfeiffer).

Helix sebacea Pfeiffer, Proc. Zool. soc. London, 1856, p. 383. Admiralty Islands.

Helix (*Discus*) *cerealis* Cox, Proc. Zool. soc. London, 1873, p. 147, pl. 16, fig. 1. Solomon Islands.

Helix (*Discus*) *thorpeiana* Brazier, Proc. Linn. soc. N. S. W., 1883, **8**, p. 228. Solomon Islands.

Helix (*Videna*) *sebacea* Smith, Proc. Zool. soc. London, 1855, p. 593.

Helix (*Trochomorpha*) *sebacea* Tryon, Man. conch., 1887, ser. 2, **3**, p. 81.

53. Trochomorpha semiconvexa (Pfeiffer).

Helix semiconvexa Pfeiffer, Proc. Zool. soc. London, 1854, p. 55. Salomon's Islands. Reeve, Conch. Icon., 1854, fig. 1316.

Helix (*Trochomorpha*) *semiconvexa* Tryon, Man. conch., 1887, ser. 2, **3**, p. 88, pl. 17, fig. 49.

54. Trochomorpha serena (Cox).

Helix serena Cox, Proc. Zool. soc. London, 1873, p. 149. Solomon Islands.

Helix (*Trochomorpha*) *serena* Tryon, Man. conch., 1887, ser. 2, **3**, p. 77.

55. TROCHOMORPHA XIPHIAS (Pfeiffer).

Helix xiphias Pfeiffer, Proc. Zool. soc. London, 1856, p. 383. Admiralty Islands. Nov. Conch., 1860, **2**, p. 149, sp. 242, tab. 38, fig. 6–9. Tryon, Man. conch., 1887, ser. 2, **3**, p. 89, pl. 18, fig. 59–61.

Rubiana, New Georgia Id.

The locality given by Pfeiffer and by Tryon, the Admiralty Islands, is incorrect, as is the case with several other species in the Cuming collection labeled from the Admiralty Islands but actually found only in the Solomons.

56. TROCHOMORPHA ZENOBIA (Pfeiffer).

Helix zenobia Pfeiffer, Proc. Zool. soc. London, 1863, p. 527. New Georgia. *Trochomorpha zenobia* Pilsbry, Man. conch., 1893, ser. 2, **8**, p. 131, pl. 42, fig. 14–16.

Wainoni Bay, San Christoval Id.

57. TROCHOMORPHA ZENOBIELLA, sp. nov.

Plate **3**, fig. 13–15.

TYPE. M. C. Z. 32,531. Rendova, New Georgia.

Shell rather solid, narrowly umbilicate. Color uniformly corneous throughout, with no trace of bands or other markings, translucent, dull. Sculpture consisting of oblique growth-lines of comparatively moderate size, above and below. Whorls $5\frac{1}{2}$, not descending in front. Protoconch of $1\frac{1}{2}$ whorls, smooth, with no trace of microscopic spiral striae. Suture slightly impressed. Periphery sharply carinate, provided with a narrow flange of the same color as the shell. Aperture oblique. Peristome above, hardly produced forward, flat and but slightly thickened; below, sinuous, thickened, and reflexed posteriorly. Parietal wall, callous. Umbilicus contained in the greatest diameter of the shell $5\frac{1}{2}$ times.

G. d. 15.8 mm. l. d. 14.6 mm. alt. 7 mm.
Aperture g. d. 6.8 mm. l. d. 4. mm.
Umbilicus 2.8 mm.

Moravo Lagoon, New Georgia; Rendova Id. off New Georgia; Kepi, Rubiana Lagoon.

This species, in color, shape, and general appearance, resembles the much larger and heavier *T. zenobia* Pfeiffer. The similarity is superficial, however, but there is no other Trochomorpha from the Solomon Islands with which this species can be easily compared.

The radula (Fig. 17, M. C. Z. 32,530, slide 1,852) consists of 100 rows of teeth with a formula of 34–1–34. The central teeth are provided with a minute denticle on each side of the mesocone. The

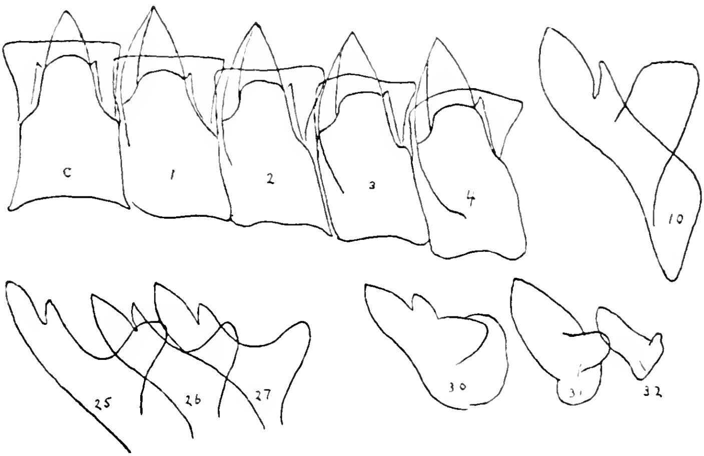


Fig. 17.— Trochomorpha zenobiella Clapp. Radula.

laterals are also provided with a similar denticle on the outer side, which, increasing in size, forms the bifid cusp of the transition teeth and of all of the marginals.

58. Dendrotrochus helicinoides (Hombron and Jacquinot).

Helix helicinoides Hombron and Jacquinot, Voy. Pol. Sud. Atlas, t. 7, fig. 34–37. Solomon Id. Pfeiffer, Zeitschr. mal., 1849, p. 77. Pilsbry, Man. conch., 1891, ser. 2, **7**, p. 76, pl. 15, fig. 72–74.

Helix cineracea Hombron and Jacquinot, Loc. cit., Atlas, t. 7, fig. 30–33. Nouv., Guinée. Pfeiffer, Mon. Helic. viv., 1859, **4**, p. 203. Haman Id. Pilsbry, Man. conch., 1891, ser. 2, **7**, p. 77, pl. 15, fig. 88, 89, pl. 16, fig. 6, 7. San Christoval, Ysabel and Stephens Islands.

Helix eleryi Recluz, Journ. conch., 1851, p. 211, pl. 5, fig. 10. Pilsbry, Man. conch., 1891, ser. 2, **7**, p. 76, pl. 15, fig. 81–83, 86, 87. Choiseul Bay, San Christoval. Shortland and Treasury Islands.

Helix cyrene Crosse, Journ. conch., 1869, p. 183. Oceania. Journ. conch., 1870, p. 102, pl. 21, f. 2.

Helix quirosi Cox, Proc. Zool. soc. London, 1873, p. 147. Pfeiffer, Mon. Helic. viv., 1876, **7**, p. 316. Insulis Salomonis.

Helix zelina Cox, Proc. Zool. soc. London, 1873, p. 150, pl. 16, fig. 6.

Helix septentrionalis Smith, Proc. Zool. soc. London, 1885, p. 593. Choiseul Bay, Shortland Island, Treasury Island.
Helix meridionalis Smith, Proc. Zool. soc. London, 1885, p. 593. Santa Anna Island.
Helix simboana Smith, Proc. Zool. soc. London, 1885, p. 593. Simbo.
?*Helix subtecta* Pfeiffer.
?*Nanina* (*Oxytes*) *subtecta* Tryon, Man. conch., 1886, **2**, p. 130.

Smith, 1885, notes the "typical form" from San Christoval and Ugi, the "dwarfed" from Guadalcanar and New Georgia and from San Christoval Rua Suva "white forms with pellucid zone on upper surface."

Specimens from Labeti, Rubiana Lagoon (M. C. Z. 32,473) appear to be typical *D. helicinoides*, unbanded, pale horn color.

G. d. 15.8 mm. l. d. 13.4 mm. alt. 10.8 mm.

Dr. Mann's collection contains the following variations:—

1. Similar to the above but showing narrow faint ill-defined chestnut bands above and below the suture. Reflexed lip stained with chestnut and with a chestnut blotch behind.

G. d. 16 mm. l. d. 13.7 mm. alt. 10.6 mm.

Rubiana Id., New Georgia, (M. C. Z. 36,782).

2. Smaller, higher spired, and with less convex whorls, otherwise similar to 36,782.

G. d. 14 mm. l. d. 12 mm. alt. 10 mm.

Rendova, Rubiana Id. (M. C. Z. 32,467).

3. Whorls but slightly convex. Chestnut banding lacking or ill-defined, the chestnut blotch behind the slightly reflected lip, above and below, persisting.

G. d. 14 mm. l. d. 11.6 mm. alt. 9 mm.

Three Sisters Id. (M. C. Z. 32,468).

4. Similar to the specimens from Three Sisters Id., differing in being more solid, the lip more broadly expanded and thickened. Fewer specimens show traces of banding, those which do, having the bands narrower, leaving a wider horn colored area at the suture.

G. d. 14.6 mm. l. d. 12.6 mm. alt. 10.6 mm.

Yandina, Russell Id. (M. C. Z. 36,783, 36,784).

5. In a large series the characters are shown to be very uniform and are those of typical *eleryi* Recluz, with a broad chestnut band above and a narrower one below the periphery, the upper leaving a light colored area at the suture and at the peripheral keel, the lower, narrower, situated just below the periphery.

G. d. 16.6 mm. l. d. 14.5 mm. alt. 11.7 mm.

Wai-ai, San Christoval Id. (M. C. Z. 32,470).

6. Identical with specimens from Wai-ai, and likewise showing very little variation.

Wainoni Bay, San Christoval Id. (M. C. Z. 32,497).

7. In one lot from Ugi Id. (M. C. Z. 32,463), the specimens differ from those from San Christoval in being uniformly larger and less sharply carinate, the base being more convex and the basal lip thicker.

G. d. 19 mm. l. d. 15.4 mm. alt. 14 mm.

8. In another (M. C. Z. 32,474) all of the specimens are albinistic, the brown bands of typical *cleryi* being replaced by transparent white, the light sutural and peripheral bands by opaque white. *H. cyrene* Crosse appears to have been described from a similar shell. Excepting in color the two forms from Ugi are identical.

G. d. 18.9 mm. l. d. 15.5 mm. alt. 13.7 mm.

9. The specimens from Bio are somewhat similar to the banded

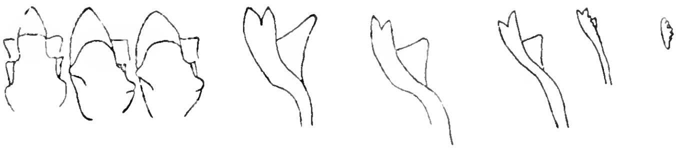


FIG. 18.— Dendrotrochus helicinoides (Hombron & Jacquinot). Radula.

form from Ugi, differing in being slightly less carinate, smaller, and with the white band at the suture narrower.

G. d. 16.3 mm. l. d. 13.6 mm. alt. 12.8 mm.

Bio Id. (M. C. Z. 32,472).

10. Similar to specimens from Wai-ai, but are smaller, more solid, and possess a more broadly flattened and thickened basal lip.

G. d. 15.4 mm. l. d. 13.5 mm. alt. 10.7 mm.

Fulakora, Isabel Id. (M. C. Z. 32,466).

It is impossible with the material at hand to consider the above as more than geographical races of the same species. Nevertheless the individuality of each colony is remarkable and leads to the suspicion that every island is developing or has developed one or more species of Dendrotrochus.

A careful examination of the anatomy of the animal from many of the above localities, fails to reveal any noticeable differences. The foot is as described by Hedley (Rec. Austr. mus., 1895, p. 91, pl. 25). The reproductive organs are also similar to those described by Hedley, several specimens containing one or more large spermatophores, the spermatheca being swollen almost to the bursting point.

The radula (Fig. 18, 19, M. C. Z. 32,473, slide 1,864) is similar to

FIG. 19. — Dendrotrochus helicinoides (Hombron & Jacquinot). Marginal tooth of radula.

Hedley's description having a formula of 160–1–160. The ectocone increases rapidly until equal in size to the mesocone, becoming at about the 15th tooth the outer cusp of a bifid marginal. This outer cusp continues to increase in size and is noticeably the larger in all but the outermost marginals. It is also interesting to note that beginning at about the 15th tooth, that portion of the outer edge of the tooth which is directly over the projection of the basal plate becomes minutely serrate. This serration becomes stronger toward the outer marginals, the outermost having even the outer cusp more or less denticulate.

ENDODONTIDAE.

59. Endodonta (Charopa) solomonensis, sp. nov.

Type. M. C. Z. 36,838. Ugi Id.

Shell, (Fig. 20–24) minute, subdiscoidal, umbilicate; postembryonic whorls closely radiately ribbed with about fourteen riblets per millimeter, interstices with a few microscopic growth-lines but no spiral striae. Color, uniformly reddish brown. Suture, deeply impressed. Spire, very slightly elevated. Whorls, $4\frac{1}{2}$. Protoconch, light yellow, smooth, shining, whorls $1\frac{1}{2}$. Periphery, rounded. Aperture, oblique, lunate, toothless. Peristome thin, sharp, margins converging. Columella lip, not reflexed, parietal wall having a thin transparent glaze, the riblets having been worn away. Umbilicus, deep, less than $\frac{1}{4}$ of the greater diameter.

G. d. 2.8 mm. l. d. 2.2 mm. alt. 1.3 mm.

No species of this genus have been previously recorded from the Solomon Islands. *E. solomonensis* is quite similar to *E. anguiculus* Reeve, Conch. Icon., **7**, fig. 802) from New Zealand, as described and figured by Suter (Manual of the New Zealand Mollusca, 1913, p. **701**, pl. 27, fig. 16, a, b).

HELICIDAE.

60. Camaena grossularia (Pfeiffer).

Helix grossularia Pfeiffer, Proc. Zool. soc. London, 1861, p. 192. New Georgia.
Helix (Camaena) grossularia Paetel, Cat. conchyl. sammlung, 1891, p. 137.

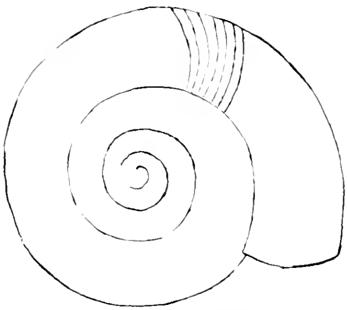


Fig. 20. — Endodonta (Charopa) solomonensis Clapp.

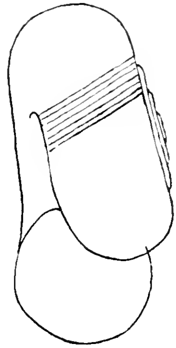


Fig. 21 .— Endodonta (Charopa) solomonensis Clapp.

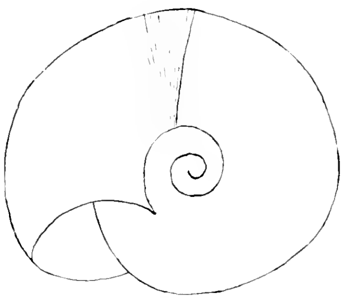


Fig. 22.— Endodonta (Charopa) solomonensis Clapp.

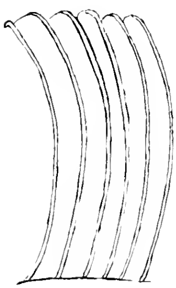


Fig. 23.—Endodonta (Charopa) solomonensis Clapp. Sculpture of shell.

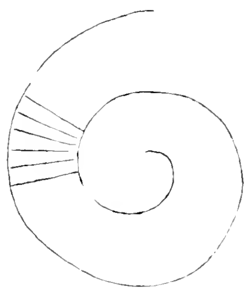


Fig. 24.—Endodonta (Charopa) solomonensis Clapp. Protoconch.

61. Chloritis (Eustomopsis) eustoma (Pfeiffer).

Helix eustoma Pfeiffer, Proc. Zool. soc. London, 1856, p. 383. Admiralty Islands. Pilsbry, Man. conch., 1890, ser. 2, **6**, p. 252, pl. 50, fig. 44–46, pl. 52, fig. 86, 87. Ugi, Faro, New Georgia, Ysabel.

Chloritis (Eustomopsis) eustoma Gude, Proc. Mal. soc. London, 1906, **7**, p. 43, 112. New Georgia.

Helix erinaceus Pfeiffer, Proc. Zool. soc. London, 1861, pl. 192. New Georgia.

Helix (Chloritis) erinaceus Pilsbry, Man. conch., 1890, ser. 2, **6**, p. 251, pl. 52, f. 88, 89. New Ireland, New Georgia.

Fulakora, Isabel Id. Rendova Id. Moravo Lagoon, New Georgia Id. Auki, Malaita Id. Paiua, Ugi Id. Wai-ai, San Christoval Id.

There is considerable variation in the specimens from the above

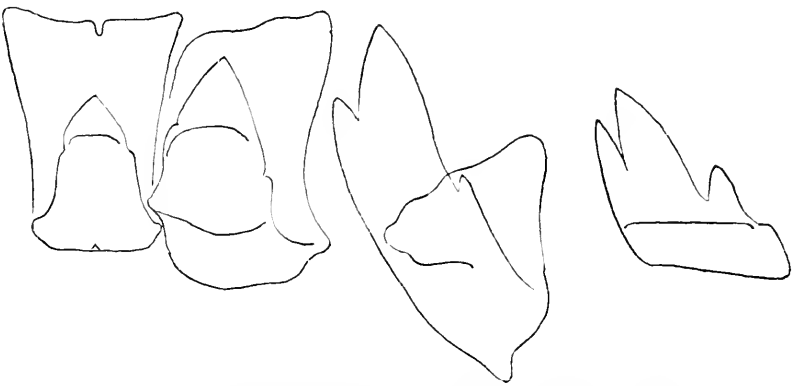


Fig. 25.— Chloritis (Eustomopsis) eustoma (Pfeiffer). Radula.

localities, but no constant differences can be seen. Specimens from Auki are generally larger than those from Ugi and Fulakora, with the right and left sides of the aperture more nearly parallel. The aperture is wider from the periphery to the parietal wall, and the last whorl much wider in proportion to the diameter of the shell. These characters, however, do not hold throughout the lot of 100 specimens from Auki.

The jaw is very similar to that of *C. leei* Cox, as figured by Pilsbry (Man. conch., 1894, ser. 2, **9**, p. 119, pl. 32, fig. 43).

The radula (Fig. 25, M. C. Z. 32,501 A, slide 1,897) has a formula of 50–1–50. Central tooth with a short mesocone extending over but little more than half of the base. Otherwise the teeth are quite similar to those of *C. argillacea* Fer. (Pilsbry, Man. conch., 1894, ser. 2, **9**, p. 121, pl. 20, fig. 6).

The reproductive organs (Fig. 26, M. C. Z. 32,501, slide 1,901; Fig. 27, M. C. Z. 32,501, slide 1,899 juv.) lack any accessory organs on the female side, and are remarkable for the comparatively short, stout spermatheca-duct, and the absence of a flagellum. The epiphallus is short, merging into the vas deferens without any constriction or dilation. The walls of the penis-cavity are strongly corrugated, but there is no well-defined papilla.

The sex organs of this species are so remarkably different from those of *leei* Cox, and *dinodeomorpha* Tapparone-Canefri that it seems improbable that those species should be grouped in the same section of Chloritis *ss.*

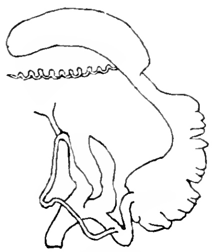


FIG. 26.— Chloritis (Eustomopsis) eustoma (Pfeiffer). Reproductive organs.

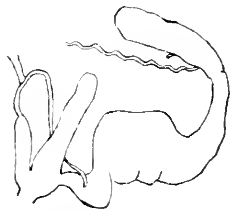


FIG. 27.— Chloritis (Eustomopsis) eustoma (Pfeiffer). Reproductive organs, juv.

62. CHLORITIS (EUSTOMOPSIS) MOELLENDORFFI (Ancey).

Chloritis moellendorffi Ancey, Proc. Linn. soc. N. S. W., 1897, p. 775, pl. 36, fig. 7. Tuom, German New Guinea.

Chloritis (Eustomopsis) moellendorffi Gude, Proc. Mal. soc. London, 1906, **7**, p. 44, pl. 4, fig. 4–4c. Rubiana, New Georgia.

63. CHLORITIS (EUSTOMOPSIS) CONOMPHALA (Gude).

Chloritis conomphala Gude, Proc. Mal. soc. London, 1906, p. 229, pl. 21, fig. 1a–d. Rubiana.

64. CHLORITIS (SULCOBASIS) BOUGAINVILLEI (Pfeiffer).

Helix bougainvillei Pfeiffer, Proc. Zool. soc. London, 1860, p. 133, pl. 50, fig. **7**. Bougainville Island.

Helix angasiana Newcomb, Ann. Lyc. nat. hist. N. Y., 1860, **7**, p. 283. Bougainville Island.

Helix (Chloritis) bougainvillei Pilsbry, Man. conch., 1890, ser. 2, **6**, p. 128, pl. 22, fig. 55, 56.

Chloritis (Sulcobasis) bougainvillei Gude, Proc. Mal. soc. London, 1906, **7**, p. 114. Dall, Field mus. nat. hist., 1910, **7**, p. 216. Solomon Islands.

65. Chloritis (Sulcobasis) cameratus Dall.

Field mus. nat. hist. Zool., 1910, **7**, p. 216, 220, pl. 4, fig. 2–4. Bougainville Island.

66. Chloritis (Sulcobasis) isis (Pfeiffer).

Helix isis Pfeiffer, Proc. Zool. soc. London, 1860, p. 133, pl. 50, fig. 8. Admiralty Islands.

Helix (Chloritis) isis Pilsbry, Man. conch., 1890, ser. 2, **6**, p. 256, pl. 32, fig. 46–48; pl. 49, fig. 16, 17.

Chloritis (Sulcobasis) isis Oberwimmer, Denks. K. acad. wiss., 1909, p. 516. pl. 1, fig. 2a–c. Bougainville.

67. Chloritis (?) mendanae (Cox).

Helix mendanae Cox, Proc. Zool. soc. London, 1873, p. 148. Solomon Islands.

Helix (Chloritis) mendanae Pilsbry, Man. conch., 1890, ser. 2, **6**, p. 225.

68. Chloritis (Sulcobasis) quercina (Pfeiffer).

Helix quercina Pfeiffer, Proc. Zool. soc. London, 1856, p. 382. Admiralty Islands.

Helix (Chloritis) quercina Pilsbry, Man. conch., 1890, ser. 2, **6**, p. 257, pl. 37, fig. 48, 49. Shortland, Faro, Isabel Islands (Admiralty Islands?).

Chloritis quercina Gude, Proc. Mal. soc. London, 1906, p. 228. Dall, Field mus. nat. hist. Zool., 1910, **7**, p. 216. Bougainville Island.

69. Chloritis quercina hombroni (Pfeiffer).

Helix hombroni Pfeiffer, Proc. Zool. soc. London, 1856, p. 382. Admiralty Islands.

Helix quercina hombroni Pilsbry, Man. conch., 1890, ser. 2, **6**, p. 258, pl. 37, fig. 45–47.

Helix janelli Hombron and Jacquinot (*non* Guillou), Voy. au Pol Sud, 1854, p. 8, pl. 14, fig. 15, 16.

Chloritis quercina hombroni Gude, Proc. Mal. soc. London, 1906, **7**, p. 114, 229. Solomon Islands. Florida Islands.

Fulakora, Isabel.

All of the twenty-six specimens received are of the depressed form known as *hombroni*. In spite of the fact that the specimens which were preserved in alcohol were all immature, an examination of the animal disclosed some interesting features. The jaw is similar to that of *Chloritis eustoma*. The radula (Fig. 28, M. C. Z. 32,505, slide 1,907) with a formula of 50–1–50, is also almost identical with that of *C.*

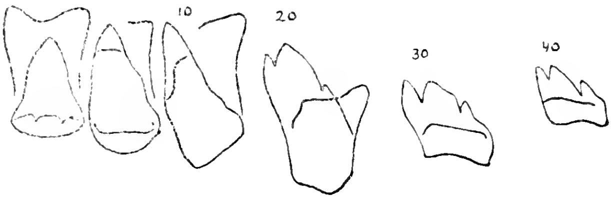


Fig. 28.— Chloritis quercina hombroni (Pfeiffer). Radula.

eustoma. The reproductive organs (Fig. 29, M. C. Z. 32,505, slide 1,912) are quite similar to those of *C. porteri* (Pilsbry, *Loc. cit.*, **9**, pl. 28, fig. 1.) The spermatheca-duct is very long. Penis-cavity containing a papilla. Epiphallus quite long, bearing the penis-retractor and ending in a flagellum. The flagellum is one of the last organs to appear on the male side and increases rapidly in length when the animal approaches sexual maturity. The specimen figured had not reached maturity and the flagellum will probably be found to be larger in mature specimens.

It is very remarkable that the reproductive organs of this species should prove to be so very different from those of *C. eustoma*, and altogether similar to those of other species of Chloritis with which *eustoma* is generally grouped. It is quite evident that in spite of the similarity of the jaw and teeth, *eustoma* does not belong to typical Chloritis.

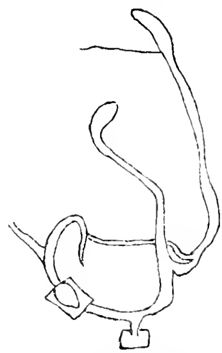


Fig. 29.— Chloritis quercina hombroni (Pfeiffer). Reproductive organs.

70. Papuina chancei (Cox).

Helix chancei Cox, Proc. Zool. soc. London, 1870, p. 171, pl. 16, fig. 5. Ysabel Island.

Helix (*Papuina*) *chancei* Pilsbry, Man. conch., 1891, ser. 2, **7**, p. 5, pl. 14, fig. 70.

Helix (*Papuina*) *amphizona* Pilsbry, Man. conch., 1891, ser. 2, **7**, p. **5**, pl. **8**, fig. 52–54. Solomon Islands.?

Dr. Pilsbry states (Man. conch., 1892, ser. 2, **8**, p. 288) that the locality Ysabel Island is incorrect and that the species should be recorded from New Ireland and New Britain.

71. Papuina chancei var. rechingeri Oberwimmer.

Densks. K. akad. wiss., 1909, p. 515, pl. 1, fig. 1a–c. Buin, Bougainville.

72. Papuina hargreavesi (Angas).

Helix (*Geotrochus*) *hargreavesi* Angas, Proc. Zool. soc. London, 1869, p. 625, pl. 48, fig. 2. Bougainville and Shortland's Islands. Smith, Proc. Zool. soc. London, 1885, p. 591. Faro Island, also between Bougainville and Choiseul Islands.

Helix (*Papuina*) *hargreavesi* Pilsbry, Man. conch., 1891, ser. 2, **7**, p. 9, pl. **4**, fig. 72–74.

73. Papuina gamelia (Angas).

Geotrochus gamelia Angas, Proc. Zool. soc. London, 1867, p. 888, pl. 42, fig. 1–3. St. Stephen Island and Ysabel Island.

Helix (*Papuina*) *gamelia* Pilsbry, Man conch., 1891, ser. 2, **7**, p. 10, pl. 3, fig. 44–47. Shortland, Treasury Islands.

74. Papuina boivini (Petit).

Helix boivini Petit, Rev. zool., 1841, p. 184. Isles Salomon.

Helix (*Papuina*) *boivini* v. Martens, Monatsb. K. Preuss. akad. wiss. Berlin, 1877, p. 276, pl. 2, fig. 11–13.

Helix boivini Pilsbry, Man. conch., 1891, ser. 2, **7**, p. 6, pl. 6, fig. 13–16, 19, 20. Bougainville.

Helix subrepta Hombron and Jacquinot, Voy. au Pol Sud, 1854, **5**, p. 5, pl. 4, f. 1–6. Isles Salomon.

Several hundred specimens from Fulakora, Isabel Id., M. C. Z. 32,483, show very slight variation, all having three dark chestnut bands; the first, narrow, just below the suture; the second, broader, above the periphery; the third, below the periphery, varying in width and frequently covering the entire base. Spire, two banded. The mantle-edge is stained with chestnut blotches directly beneath the chestnut bands.

The radula (Fig. 30, M. C. Z. 32,484, slide 1,887) is of the v-shaped type (Pilsbry, Man. conch., 1894, ser. 2, p. 137, pl. 37, fig. 9–10) differing from the figure of *P. vexillaris* in having the entocone larger, the ectocone appearing at the 5th or 6th lateral and rapidly increasing in size until nearly equal to the entocone. In the specimens examined,

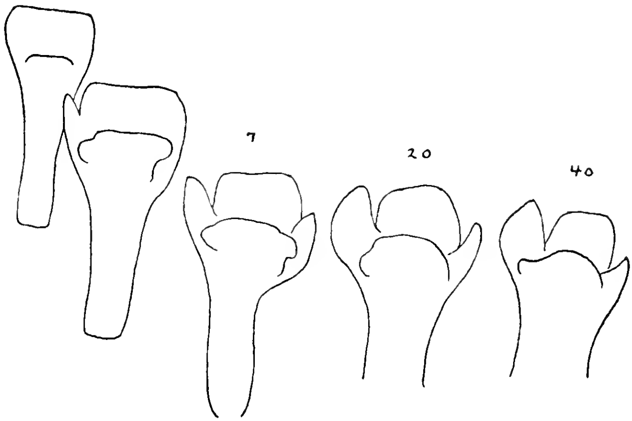


Fig. 30.— Papuina boivini (Petit). Radula.

no trace of a notch in the cutting edge of the central tooth, similar to that figured by Pfeiffer, (v. Martens, *Loc. cit.*) can be seen.

The reproductive organs (Fig. 31, M. C. Z. 32,484) differ from other species of Papuina which have been figured, in the exceedingly large and long spermatheca-duct; small, short, penis; slender epiphallus, with large retractor-muscle, and large vas deferens. There is no trace of a flagellum. *Helix colorata* Mousson (Land u. susswasser mollusken von Java, 1849) which has been considered a synonym of this species is not related to it.

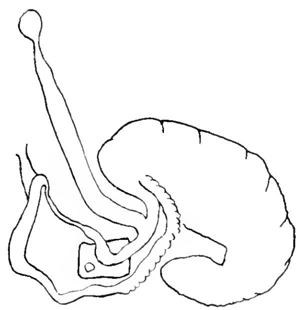


Fig. 31. — Papuina boivini (Petit). Reproductive organs.

75. Papuina ambrosia (Angas).

Geotrochus ambrosia Angas, Proc. Zool. soc. London, 1867, p. 889, pl. 43, fig. 9, 10. Galera or Russell Island.

Helix ambrosia Pilsbry, Man. conch., 1891, ser. 2, **7**, p. 7, pl. 4, fig. 75–77. Ysabel Island.

Florida Id. New Georgia.

76. Papuina malantensis (Angas).

Helix malantensis Angas, Proc. Zool. soc. London, 1876, p. 488, pl. 47, fig. 1–3. Malanta Islands.

Helix (Papuina) malantensis Pilsbry, Man. conch., 1891, ser. 2, **7**, pl. 16, fig. 17, 21, 22.

77. Papuina philomela (Angas).

Helix philomela Angas, Proc. Zool. soc. London, 1872, p. 610, pl. 42, fig. 2, 3. Ysabel Island. Cox, Proc. Zool. soc. London, 1873, p. 566. Louisiade and the Solomon Islands.

Helix (Papuina) philomela Pilsbry, Man. conch., 1891, ser. 2, **7**, p. 8, pl. 4, fig. 66, 67.

78. Papuina guadalcanarensis (Cox).

Helix guadalcanarensis Cox, Proc. Zool. soc. London, 1871, p. 645, pl. 52, fig. 8. Guadalcanar Island.

Helix (Papuina) guadalcanarensis Pilsbry, Man. conch., 1891, ser. 2, **7**, p. 9, pl. 4, fig. 80, 81, pl. 16, fig. 23, 24.

79. Papuina brodiei (Brazier).

Helix (Geotrochus) brodiei Brazier, Proc. Zool. soc. London, 1872, p. 20, pl. 4, fig. 6. Choiseul Island.

Helix (Papuina) brodiei Pilsbry, Man. conch., 1891, ser. 2, **7**, p. 10, pl. 16, fig. 9.

80. Papuina dampieri (Angas).

Helix (Geotrochus) dampieri Angas, Proc. Zool. soc. London, 1869, p. 47, pl. 2, fig. 6. Louisiade archipelago. Smith, Proc. Zool. soc. London, 1885, p. 592, pl. 16, fig. 5. Choiseul Bay, Bougainville Straits.

Helix (Papuina) dampieri Pilsbry, Man. conch., 1891, ser. 2, **7**, p. 11, pl. 5, fig. 88, pl. 16, fig. 18.

Papuina dampieri Smith, Ann. mag. nat. hist., 1905, ser. 7, **16**, p. 196.

81. Papuina walleri (Brazier).

Helix brenchleyi Angas (*non* Brazier), Proc. Zool. soc. London, 1878, p. 861, pl. 54, fig. 7.

Helix (Papuina) walleri Brazier, Proc. Linn. soc. N. S. W., 1883, **8**, p. 228. Ysabel Island. Pilsbry, Man. conch., 1891, ser. 2, **7**, p. 12, pl. 6, fig. 11, 12.

82. Papuina alfredi (Cox).

Helix alfredi Cox, Proc. Zool. soc. London, 1871, p. 323, pl. 34, fig. 1, 1a. Solomon Islands.

Helix (Papuina) alfredi Pilsbry, Man. conch., 1891, ser. 2, **7**, p. 12, pl. 6, fig. 7, 8.

83. Papuina macfarlanei (Cox).

Helix (Geotrochus) macfarlanei Cox, Proc. Zool. soc. London, 1873, p. 567. Solomon Islands.

Helix (Papuina) macfarlanei Pilsbry, Man. conch., 1891, ser. 2, **7**, p. 13.

84. Papuina coxiana (Angas).

Geotrochus coxianus Angas, Proc. Zool. soc. London, 1867, p. 889, pl. 43, fig. 7, 8. Ysabel Id.

Helix (Papuina) coxianus Pilsbry, Man. conch., 1891, ser. 2, **7**, p. 13, pl. 3, fig. 36, 37.

85. Papuina xanthochila (Pfeiffer).

Helix xanthochila Pfeiffer, Proc. Zool. soc. London, 1861, p. 192. Salomon Islands.

Helix (Papuina) xanthochila Pilsbry, Man. conch., 1891, ser. 2, **7**, p. 15, pl. 9, fig. 67, 68.

Papuina xanthochila Oberwimmer, Denks. K. akad. wissen., 1909, p. 515. Bougainville.

86. Papuina lilium Fulton.

Journ. mal., 1905, **12**, p. 22, pl. 6, fig. 4. Solomon Islands. Smith, Ann. mag. nat. hist., 1905, ser. 7, **16**, p. 196. Choiseul Island.

Helix (Geotrochus) xanthochila var. Cox, Proc. Zool. soc. London, 1873, p. 567, pl. 9, fig. 69.

Helix (Papuina) xanthochila var. Pilsbry, Man. conch., 1891, ser. 2, **7**, p. 15, pl. 9, fig. 69.

87. Papuina miser (Cox).

Helix (Geotrochus) miser Cox, Proc. Zool. soc. London, 1873, p. 146. Solomon Islands.

Helix miser Pilsbry, Man. conch., 1891, ser. 2, **7**, p. 20.

Helix beatrix Angas, Proc. Zool. soc. London, 1876, p. 265, pl. 20, fig. 1–5.

Helix (Papuina) beatrix Pilsbry, Man. conch., 1891, ser. 2, **7**, p. 15, pl. 14, f. 59–63.

Moravo Lagoon, New Georgia. Florida Id.

88. Papuina choiseulensis (Brazier).

Helix (*Geotrochus*) *choiseulensis* Brazier, Proc. Zool. soc. London, 1872, p. 21, pl. 4, fig. 7. Choiseul Island.
Helix (*Papuina*) *choiseulensis* Pilsbry, Man. conch., 1891, ser. 2, **7**, p. 16, pl. 10, fig. 90.

89. Papuina splendescens (Cox).

Helix splendescens Cox, Proc. Zool. soc. London, 1865, p. 696. Salomon Islands.
Helix (*Geotrochus*) *brenchleyi* Brazier, Proc. Linn. soc. N. S. W., 1875, **1**, p. 3. Maru Sound or Curacoa Harbour, Guadalcanar Island.

90. Papuina mendana (Angas).

Geotrochus mendana Angas, Proc. Zool. soc. London, 1867, p. 889, pl. 43, fig. 11, 12. Ysabel Island.
Helix (*Papuina*) *mendana* Pilsbry, Man. conch., 1891, ser. 2, **7**, p. 17, pl. 8, fig. 55, 56. Bougainville Id., Shortland Id., Stephen's Id., (and Ysabel Id.?).

91. Papuina weigmanni (Martens).

Helix (*Geotrochus*) *weigmanni* Martens, Conch. mitth., 1894, **3**, p. 10.

92. Papuina meta (Pfeiffer).

Helix meta Pfeiffer, Proc. Zool. soc. London, 1856, p. 381, pl. 26, fig. 5 (*non* fig. 4). Admiralty Islands.
Helix (*Papuina*) *meta* Pilsbry, Man. conch., 1891, ser. 2, **7**, p. 17, pl. 9, fig. 59–61, 63, 70. Ysabel and Bougainville.
Helix (*Geotrochus*) *deidamia* Angas, Proc. Zool. soc. London, 1869, p. 625, pl. 48, fig. 3. Ysabel Island.

93. Papuina meta var. acmella (Pfeiffer).

Helix acmella Pfeiffer, Proc. Zool. soc. London, 1860, p. 135, pl. 50, fig. 4. Admiralty Islands.
Helix (*Papuina*) *meta* var. *acmella* Pilsbry, Man. conch., 1891, ser. 2, **7**, p. 18, pl. 9, fig. 64–66, 62. Bougainville, Ysabel, Faro, and Florida Islands.

Dall (Field mus. nat. hist. Zool., 1910, **7**, p. 215) lists *Papuina meta* var. *bicolor* Pilsbry from Bougainville Island.

94. Papuina fulakorensis, sp. nov.

Type. M. C. Z. 32,490. Fulakora, Isabel Id.

Shell smooth, thin, semitransparent, dull above, slightly shining below, elevated trochiform, narrowly obliquely umbilicate. Spire conical. Color varying from buff to chocolate, unbanded, or with from one to three narrow, opaque, yellow bands, one slightly below the suture, one just above, another just below the peripheral carina. The bands when seen through the aperture are opaque white. Lip white, deep rose, or purple. Whorls 6, the last carinate, flattened below, descending in front but very slightly, if at all. Outline of the spire straight. Apex smooth, light buff or purple. Aperture oblique, lip strongly expanded, slightly reflexed. Columella broadly dilated, nearly perpendicular. Parietal callous very thin.

G. d. 22.5 mm. l. d. 20 mm. alt. 28.5 mm.

This species belongs to the group of *P. meta*, differing by being less solid, with the surface dull rather than shining, in having the last

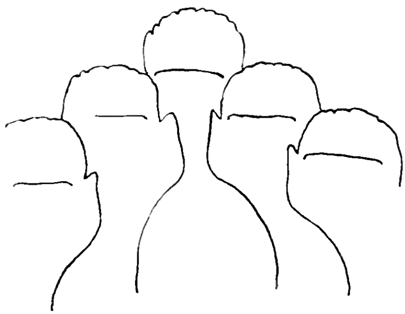


Fig. 32.— Papuina fulakorensis Clapp. Radula.

whorl more sharply carinated, and the base flat. The peristome is more broadly expanded and lacks the sinuous curve found in *P. meta*. The characteristic snow-white band of *P. meta* is adjacent to the suture while in *P. fulakorensis* there is a narrow space between the upper band and the suture. In *fulakorensis* the back of the lip is unstained. From *Papuina beatrix* it may be distinguished by its broad flat base and broadly expanded lip.

The radula (Fig. 32, M. C. Z. 32,491, slide 1,885) is of the v-shaped type, having about 100 rows of teeth with a formula of 110–1–110. There is no ectocone on the outer laterals as in *vexillaris* and *boivini*. The irregularly notched edge of the mesocone is present in those teeth not yet used for feeding.

95. Papuina plagiostoma (Pfeiffer).

Helix plagiostoma Pfeiffer, Proc. Zool. soc. London, 1856, p. 381. Admiralty Islands.

Helix (Papuina) plagiostoma Pilsbry, Man. conch., 1891, ser. 2, **7**, p. 19, pl. 10, fig. 88, 89. Solomon Islands.

96. Papuina guppyi (Smith).

Helix (Geotrochus) guppi Smith, Proc. Zool. soc. London, 1885, p. 591, pl. 36, fig. 4. Faro Island, Bougainville Straits.

Helix (Papuina) guppyi Pilsbry, Man. conch., 1891, ser. 2, **7**, p. 19, pl. **10**, fig. 95.

97. Papuina adonis (Angas).

Helix (Geotrochus) adonis Angas, Proc. Zool. soc. London, 1869, p. 624, pl. 48, fig. 4. Bougainville Island.

Helix metula Crosse, Journ. conch., 1870, p. 248.

Helix (Papuina) adonis Pilsbry, Man. conch., 1891, ser. 2, **7**, p. 20, pl. 10, fig. 86.

Papuina adonis Dall, Field. mus. nat. hist. Zool., 1910, **7**, p. 215.

98. Papuina mendoza (Brazier).

Helix (Geotrochus) mendoza Brazier, Proc. Zool. soc. London, 1872, p. 21, pl. 4, fig. 8. Choiseul Island.

Helix (Papuina) mendoza Pilsbry, Man. conch., 1891, ser. 2, **7**, p. 21, pl. **10**, fig. 8.

99. Papuina hermione (Angas).

Helix (Geotrochus) hermione Angas, Proc. Zool. soc. London, 1869, p. 625, pl. 48, fig. 5. Bougainville Island.

Helix biocheana Crosse, Journ. conch., 1870, p. 249.

Helix (Papuina) hermione Pilsbry, Man. conch., 1891, ser. 2, **7**, p. 21, pl. 9, fig. 73, 74.

100. Papuina blanda (Cox).

Helix blanda Cox, Proc. Zool. soc. London, 1873, p. 147. Solomon Islands.

Helix (Papuina) blanda Pilsbry, Man. conch., 1891, ser. 2, **7**, p. 21.

101. Papuina migratoria (Pfeiffer).

Helix migratoria Pfeiffer, Proc. Zool. soc. London, 1855, p. 108, pl. 32, fig. 3. Wanderer Bay, Guadalcanar.

Helix (Geotrochus) leucophaea Cox, Proc. Zool. soc. London, 1872, p. 20, pl. 4, fig. 5. Guadalcanar, San Christoval, and other islands of the Solomon Group.

Helix (Papuina) migratoria Pilsbry, Man. conch., 1891, ser. 2, **7**, p. 22, pl. 6, fig. 99, pl. 17, fig. 31, 32.

102. Papuina vexillaris (Pfeiffer).

Helix vexillaris Pfeiffer, Proc. Zool. soc. London, 1855, p. 113. Haman Island.

Helix phthisica Pfeiffer, Proc. Zool. soc. London, 1856, p. 383. Admiralty Islands.

Helix (Papuina) vexillaris Pilsbry, Man. conch., 1891, ser. 2, **7**, p. 46, pl. 14, fig. 4, 65–67, pl. 16, fig. 25, 26. New Georgia.

103. Papuina gaberti (Lesson).

Helix (Pileolus) gabertii Lesson, Voy. Coquille. Zool., 1830, **2**, p. 314. Nouvelle Guinee.

Helix trochus Quoy and Gaimard, Voy. Astrolabe, 1852, **2**, p. 100, pl. 8, fig. 5–7. New Ireland.

Helix trochoides Deshayes (*non* Poiret), Lamarck's Anim. sans vert., 1838, **8**, p. 122.

Helix (Papuina) gaberti Pilsbry, Man. conch., 1891, ser. 2, **7**, p. 48, pl. 7, fig. 35, 38, 39. New Ireland, New Guinea, Solomon Islands.

Dr. Pilsbry considers the Solomon Islands a doubtful locality for this species.

104. Papuina lombei (Pfeiffer).

Helix lombei Pfeiffer, Proc. Zool. soc. London, 1856, p. 382, pl. 36, fig. 6, 7. Admiralty Islands.

Helix lambei Pfeiffer, Malak blatt., 1857, p. 239.

Helix (Papuina) lambei Pilsbry, Man. conch., 1891, ser. 2, **7**, p. 48, pl. 7, fig. 21–26. New Georgia, Solomon Islands.

105. Papuina flexilabris (Pfeiffei).

Helix flexilabris Pfeiffer, Proc. Zool. soc. London, 1856, p. 382. Admiralty Islands.

Helix (Papuina) flexilabris Pilsbry, Man. conch., 1891, ser. 2, **7**, p. 49, pl. 4, fig. 68–71. Solomon Islands.

106. Papuina sellersi (Cox).

Helix sellersi Cox, Proc. Zool. soc. London, 1872, p. 646, pl. 52, fig. 9. Guadalcanar Island.

Helix (Papuina) sellersi Pilsbry, Man. conch., 1891, ser. 2, **7**, p. 51, pl. 15, fig. 75.

107. Papuina yulensis (Brazier).

Helix (*Geotrochus yulensis* Brazier, Proc. Linn. soc. N. S. W., 1876, **1**, p. 105. Yule Island, New Guinea.

Helix (*Papuina*) *yulensis* Pilsbry, Man. conch., 1891, ser. 2, **7**, p. 59, pl. 2, fig. 28–31.

Papuina yulensis var. Dall, Field mus. nat. hist. Zool., 1910, **7**, p. 216. Bougainville Island.

108. Papuina eddystonensis (Reeve).

Helix eddystonensis Reeve, Conch. Icon., 1854, fig. 1384. Eddystone Island, Australia.

Helix (*Papuina*) *eddystonensis* Pilsbry, Man. conch., 1891, ser. 2, **7**, p. 64, pl. 10, fig. 79, 80. Eddystone and Simbo Islands.

109. Papuina motacilla (Pfeiffer).

Helix motacilla Pfeiffer, Proc. Zool. soc. London, 1855, p. 113. Eddystone Island.

Helix (*Papuina*) *motacilla* Pilsbry, Man. conch., 1891, ser. 2, **7**, p. 66, pl. 11, f. 6, 7.

Helix (*Geotrochus*) *motacilla* Smith, Proc. Zool. soc. London, 1885, p. 591. Simbo Island.

110. Papuina gelata (Cox).

Helix (*Geotrochus*) *gelata* Cox, Proc. Zool. soc. London, 1873, p. 149, pl. 16, fig. 5a, 5b. Solomon Islands.

Helix (*Papuina*) *gelata* Pilsbry, Man. conch., 1891, ser. 2, **7**, p. 65, pl. 10, fig. 93, 94. Small island near Eddystone Island.

111. Papuina maddocksi (Brazier).

Helix gelata var *maddocksi* Brazier, Proc. Linn. soc. N. S. W., 1880, **5**, p. 446. Small island near Timbo or Eddystone Island. Pilsbry, Man. conch., 1891, ser. 2, **7**, p. 66, pl. 16, fig. 11–13.

G. d. 19. mm. l. d. 15.7 mm. alt. 14. mm.

M. C. Z. 32,480. Rendova Id.

The one specimen received is of the pattern called by Brazier variety "g." It appears to be much more closely related to *eddystonensis* than to *gelata*. Although mature, it is smaller than the dimensions given for *eddystonensis* or *gelata*, and much smaller than the dimensions of *maddocksi*, as given by Brazier, *l.c.*, g.d. 12., l.d. 9.5, alt. 7. lines.

The radula (Fig. 33, 34, M. C. Z. 32,480, slide 1,882) is similar to that of typical Papuina with the transverse rows straight.

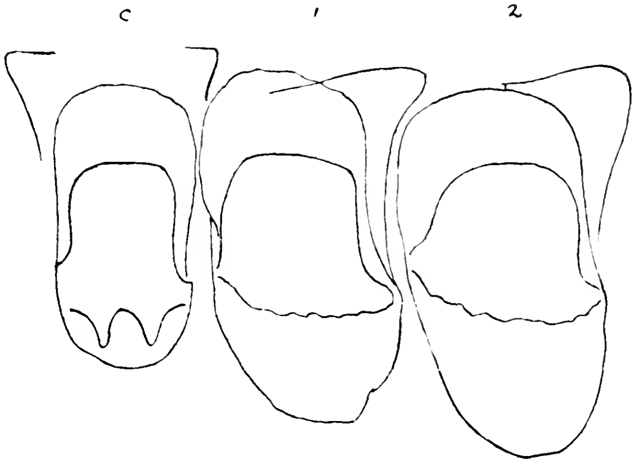


FIG. 33.— Papuina maddocksi (Brazier). Radula.

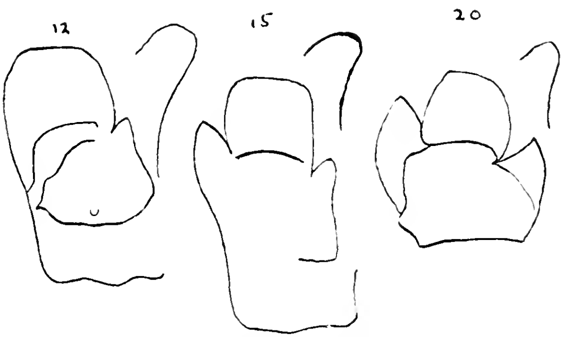


FIG. 34.— Papuina maddocksi (Brazier). Radula.

112. PAPUINA LEUCOTHOE (Pfeiffer).

Helix leucothoe Pfeiffer, Proc. Zool. soc. London, 1861, p. 192. New Georgia.
Helix (Papuina) leucothoe Pilsbry, Man. conch., 1891, ser. 2, **7**, p. 68, pl. 12, fig. 22–24.

113. Papuina caerulescens (Angas).

Helix (*Geotrochus*) *caerulescens* Angas, Proc. Zool. soc. London, 1869, p. 624, pl. 48, fig. 6. Guadalcanar Island.

Helix (*Papuina*) *caerulcscens* Pilsbry, Man. conch., 1891, ser. 2, **7**, p. 68, pl. 10, fig. 91, 92.

114. Papuina lienardiana (Crosse).

Helix lienardiana Crosse, Journ. conch., 1864, p. 282. Insulis Salomonis. 1866, p. 53, pl. 1, fig. 1. New Georgia. Tryon, Man. conch., 1891, ser. 2, **7**, p. 69, pl. 11, fig. 13–19.

Helix liernardiana var. *bifasciata* Crosse, Journ. conch., 1864, p. 283, 1866, p. 54, pl. 1, fig. 1a.

Helix liernardiana var. *pallidior* Crosse, Journ. conch., 1864, p. 283, 1866, p. 54.

Helix liernardiana var. *virido-flava* Crosse, Journ. conch., 1864, p. 283, 1866, p. 55.

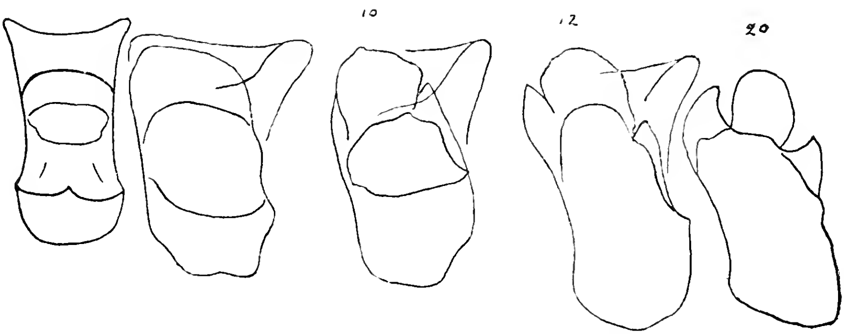


Fig. 35.— Papuina lienardiana (Crosse). Radula.

The one specimen from Auki, Malaita Id., is of the typical pattern, with two dark chestnut bands separated by a white peripheral zone. The bands are much broader, however, than those in the specimen figured by Crosse, being more similar in this respect to one of Pilsbry's figures (*Loc. cit.*, fig. 16).

The radula (Fig. 35, M. C. Z. 32,799, slide 1,890) is very similar to that of *P. maddocksi*, with the transverse rows straight.

115. Papuina eros (Angas).

Geotrochus eros Angas, Proc. Zool. soc. London, 1867, p. 888, pl. 43, fig. 4–6. St. Stephen Island and Ysabel Island.

Helix (Geotrochus) eros Smith, Proc. Zool. soc. London, 1885, p. 592. Shortland Islands.
Helix eros Pilsbry, Man. conch., 1891, ser. 2, **7**, p. 70, pl. 15, fig. 98–101.

Fulakora, Isabel Island.

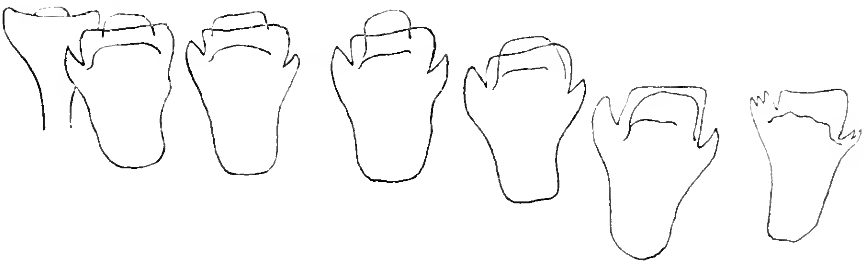


FIG. 36.— Papuina eros (Angas). Radula.

The specimens in this lot are somewhat different from those described by Angas, the light chestnut colored upper band containing dark chestnut blotches which descend obliquely forward and occasionally protrude above into the white sutural zone.

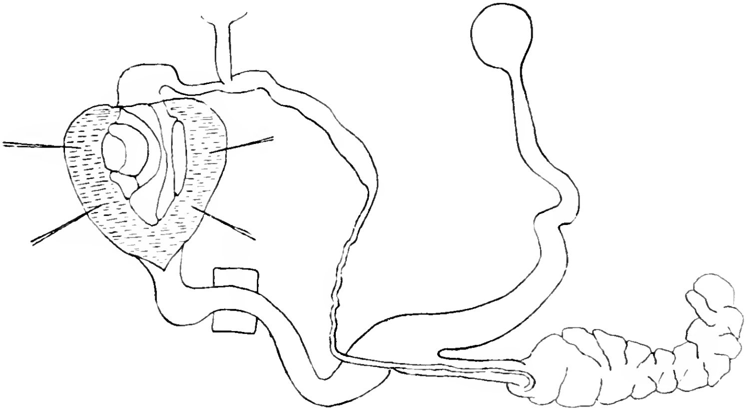


FIG. 37.— Papuina eros (Angas). Reproductive organs.

The radula (Fig. 36, M. C. Z. 32,488, slide 1,893) is very similar to that of *P. lienardiana*.

The reproductive organs (Fig. 37, M. C. Z. 32,488, slide 1,896) are of the *P. fringilla* type (Pilsbry, Man. conch., 1894, ser. 2, **9**, p. 138, pl. 37, fig. 7–8) with extremely long spermatheca duct, large penis and with the walls of the penis-cavity transversely corrugated. There is no papilla at the apex of the penis. The epiphallus is short and without a flagellum.

116. Papuina redempta (Cox).

Helix (Geotrochus) redempta Cox, Proc. Zool. soc. London, 1873, p. 566, pl. 48, fig. 6, 6a. Solomon Islands.
Helix (Papuina) redempta Pilsbry, Man. conch., 1891, ser. 2, **7**, p. 70, pl. 3, fig. 40, 41.

117. Papuina nigrofasciata (Pfeiffer).

Helix nigrofasciata Pfeiffer, Proc. Zool. soc. London, 1863, p. 524. Admiralty Islands.
Helix (Papuina) nigrofasciata Pilsbry, Man. conch. 1871, ser. 2, **7**, p. 71, pl. **11**, fig. 8, 9.

118. Papuina donnaisabellae (Angas).

Helix (Geotrochus) donna-isabellae Angas, Proc. Zool. soc. London, 1869, p. 471, pl. 2, fig. 7. Eddystone Island.
Helix (Papuina) donnaisabellae Pilsbry, Man. conch., 1891, ser. 2, **7**, p. 71, pl. 5, fig. 87.

119. Papuina novaegeorgiensis (Cox).

Helix novae-georgiensis Cox, Proc. Zool. soc. London, 1870, p. 170, pl. 16, fig. 3, 3a. New Georgia.
Helix (Planispira) novaegeorgiensis Pilsbry, Man. conch., 1890, ser. 2, **6**, p. 290, pl. 54, fig. 23, pl. 65, fig. 91.
Helix (Papuina) novaegeorgiensis Pilsbry, Man. conch., 1891, ser. 2, **7**, p. 72.

120. Papuina fringilla (Pfeiffer).

Helix fringilla Pfeiffer, Proc. Zool. soc. London, 1855, p. 113. Monda Island.
Helix (Papuina) fringilla Pilsbry, Man. conch., 1891, ser. 2, **7**, p. 73, pl. **16**, fig. 8. New Georgia, Solomon Group, Admiralty Islands.

121. Crystallopsis hunteri (Cox).

Helix hunteri Cox, Proc. Zool. soc. London, 1871, p. 646, pl. 52, fig. 11. Guadalcanar Island.
Crystallopsis hunteri Pilsbry, Man. conch., 1891, ser. 2, **7**, p. 105, pl. 13, fig. 41, 44, 45.

122. Crystallopsis aggiei (Heimburg).

Helix aggiei Heimburg, Nachr. Mal. gesselsch., 1890, p. 191. Insulis Salomonis.
Crystallopsis aggiei Pilsbry, Man. conch., 1893, ser. 2, **8**, p. 244, pl. 57, fig. 7–9.

123. Crystallopsis allasteri (Cox).

Helix allasteri Cox, Proc. Zool. soc. London, 1873, p. 564. Solomon Islands.
Crystallopsis allisteri Pilsbry, Man. conch., 1891, ser. 2, **7**, p. 106; **8**, p. 243.

124. Crystallopsis lactiflua (Pfeiffer).

Helix lactiflua Pfeiffer, Proc. Zool. soc. London, 1861, p. 190. New Georgia. Pilsbry, Man. conch., 1891, ser. 2, **7**, p. 188, pl. 13, fig. 36–38.
Helix isabellensis Souverbie, Journ. conch., 1863, p. 74, 173, pl. 5, fig. 1. Ins. Isabella.

125. Crystallopsis fictilia, sp. nov.

Plate **4**, fig. 1–3.

Type. M. C. Z. 32,455. Auki, Malaita Id.

Shell narrowly perforate, solid, globose, spire convex, base rounded. Surface with numerous microscopic spiral striae on the early whorls, the last smooth. Color porcelain-white throughout, semitransparent, shining, unbanded. Whorls 4, convex, the last descending in front, strongly contracted immediately behind the aperture. Suture impressed. Periphery rounded excepting that portion just above the aperture which is obtusely angled or carinate. Aperture large, oblique. Peristome hardly expanded above, produced forward in a broad curve, expanded and very slightly reflexed at the periphery and below. Columella descending in a straight oblique, broadly flattened plate leaving a minute perforation at its juncture with the lower lip.
G. d. 25.4 mm. l.d. 20.7 mm. alt. 20 mm.

This species appears to be most nearly related to *C. lactiflua* Pfeiffer (Proc. Zool. soc. London, 1861, p. 190) differing in being more globose and unbanded, in having the suture less deeply impressed, the last whorl not sharply carinate, the columella obliquely rather than vertically descending. The lip is less broadly expanded and the base more swollen.

126. Crystallopsis purchasi (Pfeiffer).

Helix purchasi Pfeiffer, Proc. Zool. soc. London, 1858, p. 21, pl. 40, fig. 4. Admiralty Islands. Pilsbry, Man. conch., 1891, ser. 2, **7**, p. 108, pl. 13, fig. 46, 47.

G.d. 26.3 mm. l.d. 20.6 mm. alt. 18. mm.
25. 18.7 17.4

M. C. Z. 32,460. Auki, Malaita Id.

These agree well with the description of *C. purchasi*, differing principally in being considerably larger than the dimensions given by Dohrn, viz., g.d. 22–23 mm., l.d. 17–17½mm., alt. 13–14 mm.

As with several other Solomon Island species, described by Pfeiffer, the locality Admiralty Islands is probably wrong.

127. Crystallopsis fulakorensis, sp. nov.

Plate 4, fig. 4–6.

Type. M. C. Z. 32,461. Fulakora, Isabel Id.

Shell thin, transparent, depressed, imperforate, white, with a narrow opaque white line at the periphery, surface regularly obliquely finely plicatulate, and microscopically striate. Whorls 3½, rapidly increasing in size, the last large, not descending in front, sharply carinate, but hardly flanged. Spire low. Aperture oblique. Peristome thin, expanded above and below, lip white. Columella straight, oblique. Base gibbous in the vicinity of the columella.

G.d. 26 mm. l.d. 19. mm. alt. 17. mm.
Aperture G.d. 14.5 mm. l.d. 13.5 mm.

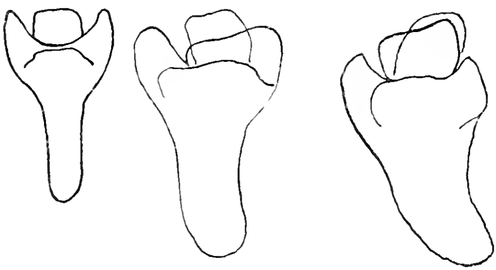


Fig. 38.— Crystallopsis fulakorensis Clapp. Radula.

The sharp, closely and regularly spaced, growth-striae, distinguish this species at once from any other Crystallopsis. In other characters, compared with *C. purchasi*, the spire is more depressed, the last whorl increases in size more rapidly, the carina is sharper, and the lip more broadly expanded. From the description of *C. rossiteri* Angas (Pilsbry, *Loc. cit.*, p. 109, pl. 21, fig. 26) it differs in color, and in lacking rose colored spots on the peristome and "numerous narrow white diaphanous bands." The figure of *C. rossiteri* (Proc. Zool. soc. London, 1869, p. 46, pl. 2, fig. 5.) does not appear to agree well with the description and dimensions given by Angas.

The jaw is delicate, similar in shape to that of *C. tricolor,* but nearly smooth, lacking the minute ribbing and the serrate cutting edge seen in the jaw of that species.

The radula (Fig. 38, M. C. Z. 32,462, slide 1,931) differs from that of *C. tricolor* principally in the crescent shaped cutting edge of the cusp of the central tooth, and in the basal plate projecting beyond the cusp. An ectocone appears on the fifth or sixth lateral. The formula is 80–1–80, the teeth being arranged in v-shaped rows.

The reproductive organs (Fig. 39, M. C. Z. 32,462, slide 1,934)

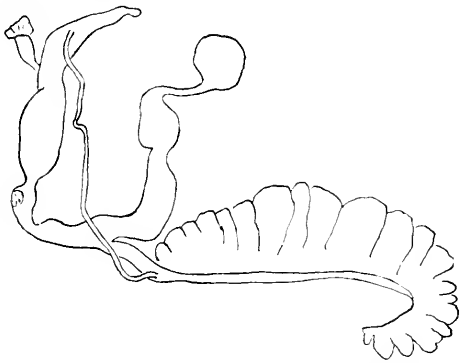


FIG. 39.— Crystallopsis fulakorensis Clapp. Reproductive organs.

differ from those of *C. tricolor* in having an epiphallus ending in a short flagellum. An enlargement of the spermatheca duct midway between the oviduct and the spermatheca is internally corrugated in a manner very similar to that of the internal structure of the penis.

128. CRYSTALLOPSIS ROSSITERI (Angas).

Helix (Corasia) rossiteri Angas, Proc. Zool. soc. London, 1869, p. 46, pl. 2, fig. 5. Ysabel Island.

Crystallopsis rossiteri Pilsbry, Man. conch., 1891, ser. 2, **7**, p. 109, pl. 21, fig. 26.

129. CRYSTALLOPSIS WISEMANNI (Brazier).

Helix (Corasia) wisemanni Brazier, Proc. Linn. soc. N. S. W., 1876, **1**, p. 3. Solomon Archipelago.

Crystallopsis wisemanni Pilsbry, Man. conch., 1891, ser. 2, **7**, p. 109.

130. Crystallopsis aphrodite (Pfeiffer).

Helix aphrodite Pfeiffer, Proc. Zool. soc. London, 1859, p. 26, pl. 44, fig. 2. New Caledonia.

Corasia aphrodite Pilsbry, Man. conch., 1891, ser. 2, **7**, p. 109, pl. 23, fig. 8–12. San Christoval.

Ugi Id.

131. Crystallopsis anadyomene (Adams and Angas).

Helix (*Corasia*) *anadyomene* Adams and Angas, Proc. Zool. soc. London, 1864, p. 38. Guadalcanar. Smith, Proc. Zool. soc. London, 1885, p. 590.

Corasia anadyomene Pilsbry, Man. conch., 1891, ser. 2, **7**, p. 110.

132. Crystallopsis psyche (Angas).

Helix (*Corasia*) *psyche* Angas, Proc. Zool. soc. London, 1869, p. 624, pl. 48, fig. 1. New Georgia.

Corasia psyche Pilsbry, Man. conch., 1891, ser. 2, **7**, p. 110, pl. 23, fig. 1.

133. Crystallopsis debilis, sp. nov.

Type. M. C. Z. 32,459. Waiae, San Christoval Id.

Shell imperforate, very thin, fragile, depressed above, spire scarcely elevated, ventricose below, with faint obliquely arcuate growth-wrinkles. Color, light straw-yellow, transparent, shining. Whorls 3, slightly convex above, the

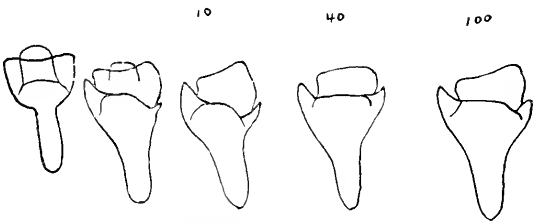


Fig. 40.— Crystallopsis debilis Clapp. Radula.

last concave above and below at the sharp peripheral carina, not descending in front, not constricted behind the aperture, not gibbous in the region of the columella. Aperture oblique. Peristome white, not thickened, slightly expanded, not reflexed. Columella arcuately descending, sharp, not thickened or reflexed.

G. d. 28. mm. l. d. 21.5 mm. alt. 17. mm.

The deep blue-green of the mantle shows clearly through the shell, which is so extremely delicate that it is very difficult to remove the animal without injury to the shell. The periostracum is somewhat caducous, exposing occasionally a white shell beneath.

The shell is very similar to the description of *H.* (*Corasia*) *psyche* Angas (Proc. Zool. soc. London, 1869, p. 624, pl. 48, fig. 1) from New Georgia, which I know only from the description. I do not consider it as belonging to that species because of its being apparently lighter colored, less solid, and with the base less ventricose. The dimensions are also quite different, although I am uncertain as to how Angas made his measurements. Its extremely fragile structure removes it at once from any previously described Crystallopsis.

The jaw is similar to that of *C. tricolor*, in having the central portion narrow and weak and the sides broad, but differs in having the ribs fewer and larger.

The radula (Fig. 40, M. C. Z. 32,459, slide 1,935–1,937) is very large, nearly as broad as long, with the teeth in v-shaped rows. There are approximately 200 rows, with a formula of 120–1–120. The teeth are similar in shape to those of *C. tricolor.*

The reproductive organs (Fig. 41, M. C. Z. 32,459, slide 1,939) of a specimen not fully mature are very similar to those of *C. fulakorensis.*

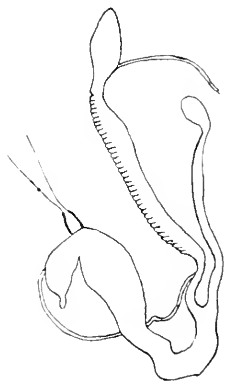


Fig. 41. — Crystallopsis debilis Clapp. Reproductive organs.

134. Crystallopsis tricolor (Pfeiffer).

Helix tricolor Pfeiffer, Proc. Zool. soc. London, 1849, p. 129. St. Christoval.
Corasia tricolor Pilsbry, Man. conch., 1891, ser. 2, **7**, p. 111, pl. 23, fig. 1–6. San Christoval, Ugi, Santa Anna.

Several lots from Ugi Id. although showing considerable variation, appear to be true *tricolor*, nearly all of the specimens having the white sutural line articulate with brown spots on the last whorl.

G. d. 26.7 mm. l. d. 22 mm. alt. 16.4 mm.

Specimens from Wainoni Bay (M. C. Z. 32,450) are quite different from typical *tricolor.* The shell is larger, more solid, and opaque. The brown markings at the suture are restricted to a narrow thread of interrupted spots or are entirely lacking. The contraction of the ultimate whorl just behind the aperture is very pronounced.

G. d. 31 mm. l. d. 25.5 mm. alt. 17.7 mm.

Specimens from Santa Anna (M. C. Z. 32,453) are small, fragile, transparent, high spired, and lack brown markings on the periphery or at the suture.

G. d. 24.3 mm. l. d. 21.4 mm. alt. 17.5 mm.

Immature specimens from Pamua (M. C. Z. 32,452) and Wai-ai, appear to belong to this species.

The radula (Fig. 42, M. C. Z. 32,704, slide 1,925, 1,926) is very

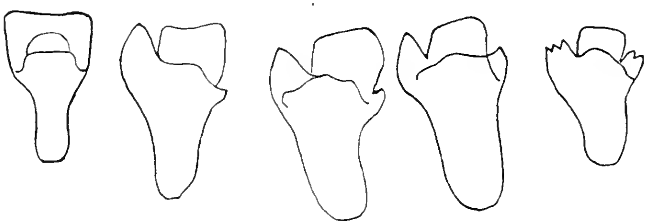


Fig. 42.— Crystallopsis tricolor (Pfeiffer). Radula.

similar to that of *Papuina boivini*, having v-shaped transverse rows and a formula of 80–1–80. The jaw (Fig. 43, M. C. Z. 32,704; slide 1,927, 1,928) is delicately ribbed and consequently with the cutting edge minutely serrate. The reproductive organs (Fig. 44, M. C. Z. 32,704) lack any accessory organs on the female side, there being no dart sac as in Helicostyla. There is practically no atrium or vestibule. The penis is large without epiphallus or flagellum. The spermatheca-duct is long and situated high on the oviduct.

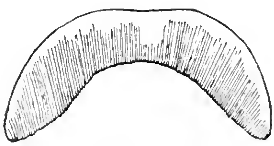


Fig. 43. — Crystallopsis tricolor (Pfeiffer). Jaw.

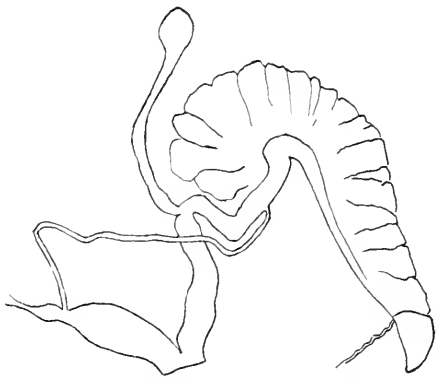


Fig. 44. — Crystallopsis tricolor (Pfeiffer). Reproductive organs.

135. Crystallopsis tricolor var. picta Smith.

Proc. Zool. soc. London, 1885, p. 589. North coast of San Christoval.

One specimen from Bio Id., with undulating brown stripes extending completely over the last whorl, above and below, belongs to this variety.

136. Crystallopsis tricolor var. transenna Pilsbry.

Crystallopsis tricolor var. *transenna* Pilsbry, Man. conch., 1891, ser. 2, **7**, p. 112, pl. 23, fig. 16–18, and fig. between 2 and 5. Solomon Islands.

137. Crystallopsis tricolor var. conica Gude.

Proc. Mal. soc. London, 1907, p. 235, pl. 21, fig. 13?.

138. Crystallopsis balcombei (Cox).

Helix (*Corasia*) *balcombei* Cox, Proc. Zool. soc. London, 1873, p. 565, pl. **48**, fig. 4. Solomon Islands.
Corasia balcombei Pilsbry, Man. conch., 1891, ser. 2, **7**, p. 111, pl. 23, fig. 15.

Seven specimens from Auki, Malaita Id., agree perfectly with the description and dimensions given by Cox, but are not at all similar to the figure in the Manual of conchology. The basal region in the vicinity of the columella is quite gibbous, more so than in *C. tricolor*.

139. Crystallopsis woodfordi (Sowerby).

Helix (*Corasia*) *woodfordi* Sowerby, Proc. Zool. soc. London, 1889, p. 578, pl. 56, fig. 6. Guadalcanar.
Corasia woodfordi Pilsbry, Man. conch., 1893, ser. 2, **8**, p. 243, pl. 57, fig. 4.

Cryptaegis, gen. nov.

Shell subglobose, imperforate, thin, corneous. Whorls few, the embryonic large. Aperture large, rounded. Lip not thickened or reflexed.

Animal with flat pointed tail, lacking dorsal carina, depression, or mucous pore. Foot not tripartite, lacking pedal groove. Mantle completely enveloping and concrescent over the shell. Jaw finely ribbed without median projection. Teeth of the radula with broad gouge-like mesocones, the central without side cusps, the laterals with ectocones, the marginals with ecto-and entocones. Reproductive organs of epiphallogonous type.

140. CRYPTAEGIS PILSBRYI, sp. nov.

TYPE. M. C. Z. 36,841. Wainoni, San Christoval Id.

Shell globose, entirely covered by the mantle, fragile, thin, shining, slightly transparent, deep colonial buff with indistinct olive-ochre streaks, with a narrow thread of chestnut at the suture and on the edge of the columella. Externally nearly smooth, but with many faint microscopic growth-ridges and traces of still fainter broken spiral lines on the upper portion of the last whorl. Internally, in some specimens, the external growth-lines are reproduced in numerous, regularly spaced, sharp ridges. Whorls 3. Protoconch large, consisting of $1\frac{1}{2}$ whorls, with the horn colored periostracum loosely attached, exposing more or less the milk-white calcareous embryonic shell. Suture lightly impressed. Periphery rounded. Aperture oblique, with the periostracum extending slightly beyond the peristome, which is neither thickened nor reflexed. Columella regularly curved.

G. d. 26. mm. l. d. 18.5 mm. alt. 22.5 mm.

Aperture: width, 17. mm. height, 19. mm.

Animal (in alcohol) cream-white, with the dorsal portion of the tail faint purple-brown and an irregular brown stain on the mantle just above the tail. Eye peduncles very long, the minute black eye showing midway between the base and the tip. Inferior tentacles short. Foot long. Tail flat, pointed, without dorsal carina or mucous pore. The sole of the foot simple, showing no trace of any division. Sides of the foot without pedal groove. Dorsal surface of the tail without depression for the shell, a strong thickened u-shaped ridge of the mantle forming a concavity into which the tail fits. Mantle, where stretched tightly over the shell, smooth, the remainder of the animal, irregularly, roughly, tuberculate above, the sole furrowed transversely. Respiratory orifice on the right side, slightly below the upper angle of the aperture of the shell.

Jaw (Fig. 45, M. C. Z. 36,841, slide 1,917, 1,921) very thin, in one piece, evenly and delicately ribbed, narrow and weak at the center, fastened insecurely to the upper half of the mouth.

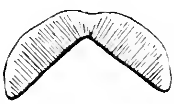


FIG. 45.— Cryptaegis pilsbryi Clapp. Jaw.

Radula (Fig. 46, M. C. Z. 36,841, slide 1919) shield shaped, nearly as broad as long, measuring about 8. × 10. mm., composed of 250 rows of teeth with a formula of 110–1–110. Transverse rows v-shaped, central teeth with broad gouge-like cusps, the innermost laterals provided with strong entocones, an ectocone appearing on the 8th to 11th lateral, the ecto- and entocones becoming denticulate only on the outermost marginals.

The reproductive organs (Fig. 48, M. C. Z. 36,841) with no accessory organs on the female side. Vagina very short. Penis containing a large, blunt papilla completely filling the upper half of the penis-

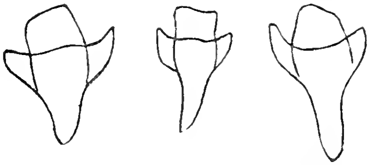


Fig. 46. — Cryptaegis pilsbryi Clapp. Radula.

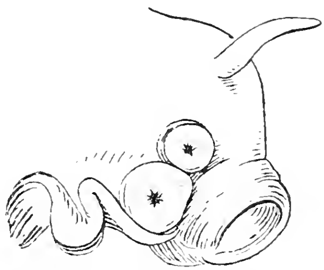


Fig. 47. — Cryptaegis pilsbryi Clapp Head.

cavity, the inner wall being coarsely papillose. Epiphallus with very thick walls. Retractor-muscle inserted on the epiphallus, imbedded in the uterus for a considerable portion of its length before becoming attached to the diaphragm. Epiphallus very short, ending in a strong, stout, blunt flagellum. Vas deferens short. Spermatheca-duct long, thick securely imbedded in the uterus.

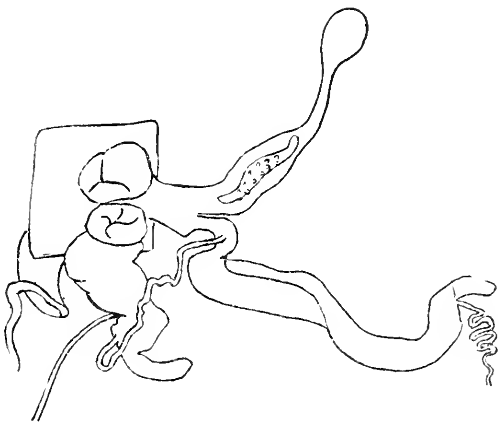


Fig. 48.— Cryptaegis pilsbryi Clapp. Reproductive organs.

Reproductive organs having externally large separate openings protruding in the form of low, blunt papillae from the right side, the short atrium evidently being thrust out, the male slightly behind and below the superior tentacles, the female larger and immediately below the male. In another specimen there is but one external orifice, but an atrium can scarcely be said to exist.

The lung is short with a rather even, coarse but thin walled reticulation. The kidney is more than twice as long as the pericardium, as in the epiphallagonous Helices. The secondary ureter is open. Length of lung 24 mm., of kidney 17 mm., of pericardium 7 mm.

Length of the animal (contracted in alcohol) 45. mm.

It seems probable that in life the superior tentacles are everted sufficiently far to bring the eye-spot to the tip. The protrusion of the reproductive organs externally may not be so great normally, immersion in alcohol causing many gasteropods to extend these organs. The jaw is very easily detached from the lip, which probably accounts for the fact that two of the specimens lack the jaw. The radula is almost identical with that of *Papuina vexillaris* as figured by Pilsbry (Man. conch., 1894, ser. 2, **9**, pl. 37, fig. 10). This type of radula is supposed to be confined to the arboreal snails. The stomach is very large and its contents show the animal to have been entirely herbivorous, as would be expected from the shape of the teeth, and confirms the conjecture regarding its environment. In one specimen examined the lower half of the spermatheca-duct was greatly swollen and contained one free gelatinous body, which from its position and appearance is probably a spermatophore introduced from another individual. This is very different from the smooth, slender spring-like, spermatophore of the zonitoids, in that it has two rows of tubercles on its inner face, recalling when magnified the arm of an octopod.

The systematic position of this species is very uncertain. The radula is similar to that of Papuina, and I am inclined to consider it as a very highly specialized and comparatively recent offshoot from Papuina of some closely related group.

Dr. Pilsbry very kindly allows me to make use of the following note concerning a specimen sent to him: —"The teeth agree wholly with those of your figure, but I find the formula to be 130–1–130. In radulae with so great a number of teeth, such variation is not unusual. The ectocone appears weakly on the 11th tooth. In the genitalia our figures agree excepting as to the orifice. It is not double in the specimen I examined. In your specimen it is simply more exerted, a not uncommon occurrence among the pulmonates."

BULIMULIDAE.

141. Placostylus (Placocharis) founaki (Hombron and Jacquinot).

Bulimus founaki Hombron and Jacquinot, Voy. Pol Sud. Zool. Moll., pl. 8, fig. 13–15. Isles Salomon.
Bulimus hombroni Crosse, Journ. conch., 1871, p. 178.
Placostylus (*Placocharis*) *founaki* Pilsbry, Man. conch., 1900, ser. 2, **13**, p. 79, pl. 34, fig. 10–14. Ysabel Island, Faro Island.

Fulakora, Ysabel Id.

142. Placostylus (Placocharis) founaki var. paletuvianus (Gassies).

Bulimus paletuvianus Gassies, Journ. conch., 1859, p. 370. Nou, New Caledonia.
Bulimus rhizophorarus Gassies, Faune Conch. Nouv. Caled., 1871, **2**, p. 91.
Placostylus (*Placocharis*) *founaki* var. *paletuvianus* Pilsbry, Man. conch., 1900, ser. 2, **13**, p. 80, pl. 34, fig. 18, 19. Solomons?.

143. Placostylus (Placocharis) kreftii (Cox).

Bulimus (*Charis*) *kreftii* Cox, Proc. Zool. soc. London, 1872, p. 19, pl. 4, fig. 4. Solomon Islands.
Placostylus (*Placocharis*) *kreftii* Pilsbry, Man. conch., 1900, ser. 2, **13**, p. 81, pl. 35, fig. 23–25.

144. Placostylus (Placocharis) guppyi (Smith).

Placostylus guppyi Smith, Proc. Zool. soc. London, 1891, p. 489, pl. 40, fig. 6. Solomon Islands.
Placostylus (*Placocharis*) *guppyi* Pilsbry, Man. conch., 1900, ser. 2, **13**, p. 82, pl. 35, fig. 26.

145. Placostylus (Placocharis) macfarlandi (Brazier).

Bulimus (*Eumecostylus*) *macfarlandi* Brazier, Proc. Linn. soc. N. S. W., 1875, **1**, p. 4. Solomon Archipelago.
Placostylus (*Placocharis*) *macfarlandi* Pilsbry, Man. conch., 1900, ser. 2, **13**, p. 83, pl. 35, fig. 21, 22.

146. Placostylus (Placocharis) calus (Smith).

Placostylus calus Smith, Proc. Zool. soc. London, 1891, p. 489, pl. 40, fig. 7. Solomon Islands.

Placostylus (*Placocharis*) *calus* Pilsbry, Man. conch., 1900, ser. 2, **13**, p. 83, pl. 35, fig. 20.

147. Placostylus (Placocharis) macgillivrayi (Pfeiffer).

Bulimus macgillivrayi Pfeiffer, Proc. Zool. soc. London, 1855, p. 108, pl. 32, fig. 2. Wanderer Bay, Guadalcanar.

Placostylus (*Placocharis*) *macgillivrayi* Pilsbry, Man. conch., 1900, ser. 2, **13,** p. 84, pl. 36, fig. 27–30.

148. Placostylus (Placocharis) palmarum (Mouson).

Bulimus palmarum Mousson, Conch., 1869, p. 62, pl. 4, fig. 5. Makite, ile de Saint-Christoval.

Placostylus (*Placocharis*) *palmarum* Pilsbry, Man. conch., 1900, ser. 2, **13,** p. 85, pl. 36, fig. 31, 32. Makito, San Christoval Id.

149. Placostylus (Placocharis) palmarum var. minor (Kobelt).

Placostylus palmarum var. *minor* Kobelt, Conch. cab., 1891, p. 42, pl. 9, fig. 6–9.

Placostylus (*Placocharis*) *palmarum* var. *minor* Pilsbry, Man. conch., 1900, ser. 2, **13**, p. 86, pl. 36, fig. 33, 34.

150. Placostylus (Placocharis) strangei (Pfeiffer).

Bulimus strangei Pfeiffer, Proc. Zool. soc. London, 1855, p. 8. Eddystone Island.

Placostylus (*Placocharis*) *strangei* Pilsbry, Man. conch., 1900, ser. 2, **13**, p. 87, pl. 34, fig. 15–17.

151. Placostylus (Placocharis) stutchburyi (Pfeiffer).

Bulimus stutchburyi Pfeiffer, Proc. Zool. soc. London, 1860, p. 137, pl. 51, fig. 8. Erumanga, New Hebrides.

Placostylus (*Placocharis*) *stutchburyi* Pilsbry, Man. conch., 1900, ser. 2, **13,** p. 88, pl. 36, fig. 35–37. New Georgia, (Brazier).

152. Placostylus (Placocharis) stutchburyi var. mendanae (Kobelt).

Placostylus (*scottii* Cox var.) *mendanae* Kobelt, Conch. cab., 1891, p. 133, pl. 32, fig. 6, 7.

Placostylus (*Placocharis*) *stutchburyi* var. *mendanae* Pilsbry, Man. conch., 1900, ser. 2, **13**, p. 89, pl. 37, fig. 40, 41. Solomon Islands.

153. Placostylus (Placocharis) scottii (Cox).

Bulimus (*Eumccostylus*) *scottii* Cox, Proc. Zool. soc. London, 1873, p. 152. Solomon Islands.

Placostylus (*Placocharis*) *scottii* Pilsbry, Man. conch., 1900, ser. 2, **13**, p. 90, pl. 37, fig. 38, 39.

154. Placostylus (Placocharis) uliginosus 'Heimburg' (Kobelt).

Placostylus uliginosus von Heimburg, Kobelt, Conch. cab., 1891, p. 73, pl. 17, fig. 6, 7.

Placostylus (*Placocharis*) *uliginosus* Pilsbry, Man. conch., 1900, ser. 2, **13**, p. 91, pl. 37, fig. 46, 47. Solomon Islands.

155. (Placostylus (Placocharis) hobsoni (Cox).

Bulimus (*Placostylus*) *hobsoni* Cox, Proc. Linn. soc. N. S. W., 1892, ser. 2, **6**, p. 567, pl. 20, fig. 2, 3. Malanta Island.

Placostylus (*Placocharis*) *hobsoni* Pilsbry, Man. conch., 1900, **13**, p. 91, pl. 37, fig. 44, 45. Maleita Island.

156. Placostylus (Placocharis) hargravesi (Cox).

Bulimus hargravesi Cox, Proc. Zool. soc. London, 1871, p. 323, pl. 34, f. 3. Treasury Island.

Placostylus (*Placocharis*) *hargravesi*, Pilsbry, Man. conch., 1900, ser. 2, **13**, p. 93, pl. 38, fig. 49–51.

157. Placostylus (Placocharis) hargravesi aukiensis, var. nov.

Type. M. C. Z. 32,442. Auki, Malaita Id.

G. d. 22. mm.	alt. 54.5. mm.	aper. 32. mm.	(Type).
22.	48.	29.	

Differs from typical *P. hargravesi* only in being much smaller and more fragile, in generally lacking the parietal tubercle and in having but 5 whorls. It appears to be a form which lives under conditions less favorable than those of the locality occupied by typical *hargravesi* from Treasury Island, and therefore shows characteristics one would expect in possessing a thinner, more delicate and smaller shell, and for the same reason lacking a parietal tooth in all but two specimens in one lot of forty-seven.

The comparatively large swollen nepionic whorls and the deeply impressed suture, render it impossible to connect this variety with *P. uliginosus* "Heimb." Kobelt (Pilsbry, *Loc. cit.*, p. 91, pl. 37, fig.

46, 47), or with *P. hobsoni* (Cox) (Pilsbry, *Loc. cit.*, fig. 44, 45), described from Malaita Id. The same differences separate this variety from *P. hargravesi* var. *heimburgi* Kobelt, (Pilsbry, *Loc. cit.* p. 93, 236, pl. frontisp., fig. 5) which appears from the description and figure to be much more closely related to *uliginosus* than to *hargravesi*.

The jaw of an immature specimen is similar to that of *P. miltocheilus*, but with fewer (approximately forty) and broader plates. The radula (Fig. 49, M. C. Z. 32,442, slide 1,950) of the same immature

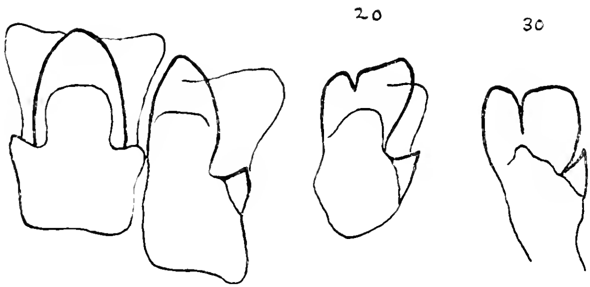


FIG. 49.— Placostylus (Placocharis) hargravesi aukiensis Clapp. Radula.

individual has the teeth arranged in slightly v-shaped rows. The formula is about 40–1–40. The ectocones of the central tooth are large, as are also those of the laterals and marginals. The division of the mesocone into two cusps does not begin until about the 15th lateral.

158. Placostylus (Placocharis) hargravesi var. heimburgi (Kobelt).

Placostylus hargravesi var. *heimburgi* Kobelt, Conchyl. cab., 1891, p. 38, pl. **8**, fig. 6, 7.

Placostylus (*Placocharis*) *hargravesi* var. *heimburgi* Pilsbry, Man. conch., 1900, ser. 2, **13**, p. 93, pl. frontisp., fig. 5.

159. Placostylus (Placocharis) artus, sp. nov.

Plate **4**, fig. 7, 8.

Type. M. C. Z. 32,448. Florida Id.

Shell compressed umbilicate, solid, slender, with numerous thread-like growth-striae, and a microscopic wavy spiral striation. Color, chalky white beneath a light olive-brown periostracum, with occasional narrow chestnut streaks in the more pronounced growth-wrinkles. Somewhat shining. Spire slightly convex. Whorls $5\frac{1}{2}$, slightly convex. Apex obtuse, light straw color, earlier $2\frac{1}{2}$ whorls punctate. Suture impressed, with a narrow spiral groove below, the intervening space white, lacking the periostracum. Aperture white within. Peristome thickened within. Outer lip not reflexed or expanded. Basal lip but slightly expanded. Columella broadly reflexed, nearly closing the umbilicus a strong fold entering the aperture. Parietal callus, thin, dark purple-brown in color, bearing a small white tubercle above the columellar fold.

G. d. 22.5 mm. alt. 64. mm. aper. 31. mm.

In the specimen which I have selected and figured as the type, considering it as probably most typical of the species, the parietal tooth is but slightly developed. In other characters, however, the specimen selected is most typical. Probably most closely related to *P. kreftii* (Cox), in its dimensions, being much more elongate and slender; in usually possessing a parietal tubercle, and in having the parietal callus purple-brown rather than white.

The parietal tubercle, being developed late in the life of the individual, it is to be expected that it should show considerable variability. In several species possessing a strong parietal tubercle, mature individuals are occasionally found with the tubercle hardly visible, or entirely lacking.

160. Placostylus (Placocharis) manni, sp. nov.

Plate 5, fig. 1, 2.

Type.— M. C. Z. 32,437. Auki, Malaita Id.

Shell minutely perforate, solid, large, long-ovate, acuminate above, swollen below. Penultimate whorl spirally striate. Last whorl with irregular heavy growth-wrinkles and coarsely malleated. Color dark reddish chestnut, in immature specimens the last whorl is overlaid with iridescent olive-green, exposing frequently the chestnut color beneath. Periostracum lost on early whorls leaving the spire light yellowish red. Surface somewhat shining. Whorls 6, convex, the last half of the last whorl descending rapidly in front and becoming considerably swollen. Protoconch consisting of $2\frac{1}{2}$ minutely punctate whorls, more or less worn smooth. Aperture bluish white within. Peristome white, outer lip sinuous, thickened within, not expanded or reflexed. Columella with a very strong white fold. Parietal callous white with a prominent white round tubercle just above the columellar fold.

G. d. 41. mm. alt. 85. mm. l. a. of aper. 43.5 mm.

This species is probably most nearly related to *P. macfarlandi* (Brazier), differing in being darker colored and in having the last whorl swollen almost to the point of distortion. The lip is much less thickened and expanded, the curve of the columella more pronounced.

161. Placostylus coxi (Pease).

Bulimus (?Borus) coxi Pease, Amer. journ. conch., 1871, **7**, p. 197. "Insl. Solomonis."
Placostylus (?) *coxi* Pilsbry, Man. conch., 1900, ser. 2, **13**, p. 90. Solomon Islands.

162. Placostylus (Euplacostylus) cylindricus Fulton.

Ann. mag. nat. hist., 1906, ser. 7, **19**, p. 154, pl. 10, fig. 3. Isabel Island.

163. Placostylus (Eumecostylus) cleryi (Petit).

Bulimus cleryi Petit, Journ. conch., 1850, p. 56, pl. 4, fig. 1.
Placostylus (Eumecostylus) cleryi Pilsbry, Man. conch., 1900, ser. 2, **13**, p. 96, 236, pl. 40, fig. 68–70; pl. frontis., fig. 7, 8.

Wai-ai and Wainoni, San Christoval Id.

164. Placostylus (Eumecostylus) phenax, sp. nov.

Plate **5**, fig. 3, 4.

Type. M. C. Z. 32,446. Wainoni, San Christoval Id.

Shell, rimate, oblong fusiform, thick, solid, outline of the spire nearly straight. Surface of the later whorls sculptured with coarse irregular growth-wrinkles, and finely, irregularly, spirally malleated. Color of the last two whorls, olive-brown more or less painted with narrow dark chestnut zigzag lines, particularly on the penultimate whorl. Whorls $6\frac{1}{2}$ (?), the earlier, lacking the periostracum, purplish red, the nepionic whorls worn nearly smooth, a portion amputated and plugged. The last whorl more rapidly descending, shouldered and constricted below the suture. Aperture narrow, auriform, retracted below, bluish white within, roughened internally by the external growth-wrinkles. Outer and basal lip expanded, thickened within cream-white or faintly edged with light brown. Columella broadly and abruptly expanded, entering the aperture in a thickened spiral fold. Parietal callus, thin, shining, white or tinged with light brown, with or without a strong elongate tubercle parallel to the entering fold of the columella.

G. d. 27 mm. alt. 82.5 mm. aper. 43. mm.

This species is apparently closely related to *P. cleryi* differing only in being smaller, with narrower aperture, and with the columellar fold more abruptly twisted. The nepionic whorls are so worn and broken in every specimen before me that it is difficult to ascertain the exact number of pitted whorls, but it is probable that there are not more than

$2\frac{1}{2}$. The species, however, is so clearly related to *cleryi*, that I have placed it in the same subgenus, Eumecostylus, in spite of its probable difference in the number of pitted nepionic whorls, believing that if the difference proves to be true that the definition of Eumecostylus should be modified. There is some resemblance between this species and the smaller *P.* (*Euplacostylus*) *koroensis* Garrett (Pilsbry, *Loc. cit.*, p. 101) particularly in the probable number of pitted whorls. One species of Placostylus from the Solomon Islands has been described as belonging to this subgenus, (*P.*(*Euplacostylus*) *cylindricus* Fulton, Ann. mag. nat. hist., 1907, ser. 7, **19**, p. 154, pl. 10, fig. 3). I am inclined to believe that this also should be removed to Eumecostylus, the restriction based on the number of pitted nepionic whorls having been removed. This would at present render Eumecostylus a Solomon Island group, Euplacostylus, Fijian.

165. Placostylus (Eumecostylus) sanchristovalensis (Cox).

Bulimus san-christovalensis Cox, Proc. Zool. soc. London, 1870, p. 172, pl. 16, fig. 7. "San Christoval."

Placostylus (*Eumecostylus*) *sanchristovalensis* Pilsbry, Man. conch., 1900, ser. 2, **13**, p. 97, pl. 37, fig. 48.

166. Placostylus (Aspastus) miltocheilus (Reeve).

Bulimus miltocheilus Reeve, Conch. Icon., 1848, pl. 49, fig. 322. San Christoval.

Placostylus (*Aspastus*) *miltocheilus* Pilsbry, Man. conch., 1900, ser. 2, **13**, p. 94, pl. 38, f. 53, 54. Port Makeva, Wanga Bay, Recherche Bay, and Port Achard.

G. d. 26 mm. alt. 62. mm. longest axis of aperture from outer edge of lip 36. mm.

M. C. Z. 32,429. Pamua, San Christoval Id.

Specimens from this locality appear to be typical *miltocherlus*.

G. d. 28. mm. alt. 67. mm. long. axis of aper 42. mm.

Similar to those from Pamua differing in being larger and with much stronger growth-wrinkles. The base generally less swollen or sac-like, columella more broadly expanded and flattened; the fold in the aperture, stronger, and white rather than vermilion as in typical *miltocheilus*.

Wainoni Bay, San Christoval.

167. Placostylus (Aspastus) miltocheilus var. stramineus Brazier.

Proc. Linn. soc. N. S. W., 1895, ser. 2, **9**, p. 569. Ugi. Pilsbry, Man. conch., 1900, ser. 2, **13**, p. 95, pl. 38, fig. 55.

Two immature specimens appear to belong to this variety.

M. C. Z. 32,436. Three Sisters Id.

G.d. 22. mm. alt. 56. mm. l.a. of aper. 31. mm.

M. C. Z. 32,433. Ugi Id.

Apparently the only form found on Ugi and very abundant.

G.d.	alt.	l.a. of aper.
19. mm.	44. mm.	26.5 mm.
18.5 mm.	40. mm.	25.5 mm.

M. C. Z. 32,434. Bio Id.

A form with the dark red peristome of *stramineus,* but much smaller than the specimens of that variety from Ugi. The shell is white, having lost the yellow cuticle.

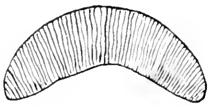


Fig. 50. — Placostylus (Aspastus) miltocheilus stramineus Brazier. Jaw.

The jaw (Fig. 50, M. C. Z. 32,434, slide 1,950) of this form is composed of approximately fifty narrow plates.

The radula (Fig. 51, M. C. Z. 32,434, slide 1,951) is broad with about 120 broadly v-shaped rows of teeth with a formula of 60–1–60. The central tooth is provided with a strong mesocone and also small ectocones. The laterals possess a large mesocone and

Fig. 51.— Placostylus (Aspastus) miltocheilus stramineus Brazier. Radula.

an ectocone but no entocone. At about the 10th lateral a notch appears in the mesocone, rapidly increasing in size until at the 13th tooth the mesocone has been divided into two nearly equal cusps.

The reproductive organs (Fig. 52, M. C. Z. 32,434, slide 1,952) are similar to those of other species of the genus which have been described.

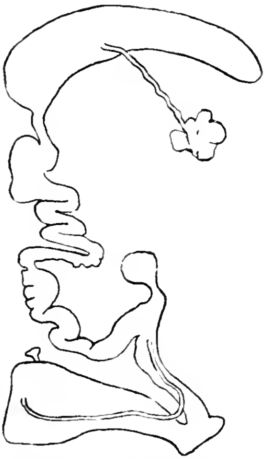


Fig. 52.— Placostylus (Aspastus) miltocheilus stramineus Brazier. Reproductive organs.

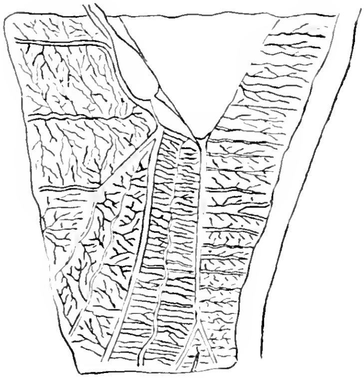


Fig. 53. — Placostylus (Aspastus) miltocheilus stramineus Brazier. Kidney.

The penis is very large, the retractor-muscle proportionately short and small. The vas deferens is firmly imbedded in the loose fitting external integument of the penis and is also closely bound to the oviduct. The spermatheca-duct is very short. The uterus is nearly black, very long, with many convolutions difficult to trace. Its color is similar to that of the intestine.

The kidney (Fig. 53, M. C. Z. 32,434, slide 1,953) is short and triangular typical of the genus.

Fig. 54.—Placostylus (Aspastus) miltocheilus stramineus Brazier. Sculpture of shell.

168. Placostylus (Aspastus) miltocheilus albolabris (Brazier).

Bulimus (Aspastus) miltocheilus var. *albolabris* Brazier, Proc. Linn. soc. N. S. W., 1895, ser. 2, **9**, p 569. San Christoval and Santa Anna.

Placostylus (Aspastus) miltocheilus var. *albolabris* Pilsbry, Man. conch., 1900, ser. 2, **13**, pl. 38, fig. 52.

Specimens of the variety *albolabris* were found at the localities noted; those from Santa Anna varying greatly in size.

The parietal callous is much thicker and more clearly defined in this variety than it is in any of the others.

G.d. 29. mm. alt. 57. mm. long axis of aper. 36. mm.

M. C. Z. 32,430. Bulimatarivo (or Star Harbor), San Christoval Id.

Large specimen,	G.d. 25. mm.	alt. 63. mm.	l. a. of aper. 37. mm.
Small specimen,	20.5 mm.	47.	29.5

M. C. Z. 32,431. Santa Anna Id.

169. Placostylus (Aspastus) miltocheilus minor Brazier.

Bulimus (*Aspastus*) *miltocheilus* var. *minor* Brazier, Proc. Linn. soc. N. S. W., 1895, ser. 2, **9**, p. 570. Ulana Id.

170. Placostylus (Aspastus) sellersi (Cox).

Bulimus sellersi Cox, Proc. Zool. soc. London, 1871, p. 644, pl. 52, fig. 3. Guadalcanar Id.

Placostylus (*Aspastus*) *sellersi* Pilsbry, Man. conch., 1900, ser. 2, **13**, p. 95, pl. 38, fig. 56, 57.

171. Simpulopsis salomonia (Pfeiffer).

Vitrina salomonia Pfeiffer, Zeitschr. malak., 1853, p. 51. Insulis Salomonis.

Simpulopsis salomonia Pilsbry, Man. conch., 1899, ser. 2, **12**, p. 226, pl. 63, fig. 76–78.

Pilsbry states that "possibly the locality is erroneous. If really from the Solomon Islands it will probably prove to belong to the Zonitidae."

STENOGYRIDAE.

172. Opeas gracile (Hutton)?

Bulimus grecilis Hutton, Journ. Asiat. soc. Bengal, 1834, **3**, p. 84, 93.

Opeas gracile Pilsbry, Man. conch., 1906, ser. 2, **18**, p. 125, pl. 18, fig. 3–6.

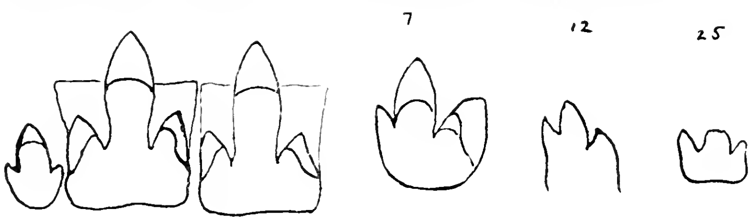


Fig. 55.— Opeas gracile (Hutton). Radula.

Labete, New Georgia Id. Makambo, Florida Id. Auki, Malaita Id. Three Sisters Id. Wainoni, San Christoval Id.

Less than twenty specimens in all, the majority immature, were obtained from the above localities. Some are undoubtedly *O. gracile.* Of the others it would be necessary to have a much larger series before attempting to decide to which of the Polynesian species they should be referred.

PARTULIDAE.

173. Partula flexuosa Hartman.

Proc. Acad. nat. sci. Phila., 1885, p. 204, fig. St. George's and Eddystone Islands. Pilsbry, Man. conch., 1909, ser. 2, **20**, p. 290, pl. 35, fig. 4, 5, 13.

174. Partula hastula Hartman.

Proc. Acad. nat. sci. Phila., 1886, p. 33, pl. 2, fig. 9. Erromango Island, Solomon Islands. Pilsbry, Man. conch., 1909, ser. 2, **20**, p. 291, pl. 35, fig. 6–8. Simbo or Eddystone Island (Brazier).

175. Partula incurva Hartman.

Proc. Acad. nat. sci. Phila., 1886, p. 31, pl. 2, f. 3. Rubiana (Brazier). Pilsbry, Man. conch., 1909, ser. 2, **20**, p. 291, pl. 35, fig. 9, 10.

176. Partula regularis Hartman.

Proc. Acad. nat. sci. Phila., 1886, p. 31, pl. 2, fig. 4. Savu, Galeria Id. (Brazier). Pilsbry, Man. conch., 1909, ser. 2, **20**, p. 292, pl. 33, fig. 11, 12.

177. Partula perlucens Hartman.

Proc. Acad. nat. sci. Phila., 1886, p. 31, pl. 2, fig. 2. Ugi or Golfe Island. Pilsbry, Man. conch., 1909, ser. 2, **20**, p. 293, pl. 35, fig. 12.

178. Partula hollandiana Pilsbry.

Man. conch., 1909, ser. 2, **20**, p. 293, pl. 37, fig. 8–10. Solomon Island.

179. Partula alabastrina Pfeiffer.

Proc. Zool. soc. London, 1856, p. 390. Salomon's Islands. Pilsbry, Man. conch., 1909, ser. 2, **20**, p. 294.

180. Partula micans Pfeiffer.

Proc. Zool. soc. London, 1852, p. 138. Insulis Salomonis. Pilsbry, Man. conch., 1909, ser. 2, **20**, p. 295, pl. 36, fig. 10, 11, 13, 14. Solomon Islands, Shortland Island.

Dr. Mann's collection contains the following forms of this species:—

1. Alt. 15 mm. g. d. 9 mm. l. d. 8 mm. aperture with peristome, length 9 mm., width 6.4 mm.

Apparently typical *micans*.

M. C. Z. 32,544. Bio Id.

One immature specimen (M. C. Z. 36,792) identical with specimens from Bio Id. was taken on Ugi Id.

2. Alt. 15.8 mm. g.d. 9 mm. l.d. 7.4 mm. aperture, length 9 mm., width, 6.2 mm.

M. C. Z. 32,545. Three Sisters Id.

Very similar to the specimens from Bio, but with slightly less convex whorls, the spire being more straight sided and the suture less deep.

3. Alt. 14 mm. g.d. 7.5 mm. l.d. 6.6 mm. aperture, length 7.7 mm., width 5 mm.

M. C. Z. 36,791. Rubiana, New Georgia.

The single specimen from this locality differs from the specimens from Bio in being smaller and more slender. *P. incurva* Hartman, described from Rubiana is a much larger species.

181. Partula cinerea Albers.

Malak. blatter, 1857, **4**, p. 98. Insulis Salomonis. Pilsbry, Man. conch., 1909, ser. 2, **20**, p. 296.

182. Partula coxi "Angas" Hartman.

Proc. Acad. nat. sci. Phila., 1885, p. 217. 1886, p. 32, pl. 2, fig. 7. Ysabel Island. Pilsbry, Man. conch., 1909, ser. 2, **20**, p. 296, pl. 36, fig. 1–4.

183. Partula pellucida Pease.

Proc. Zool. soc. London, 1871, p. 457. Guadalcanar. Pilsbry, Man. conch., 1909, ser. 2, **20**, p. 297, pl. 36, fig. 5, 6. Solomon Islands.

SUCCINEIDAE.

184. Succinea simplex Pfeiffer.

Proc. Zool. soc. London, 1854, p. 123. Smith, Proc. Zool. soc. London, 1885, p. 595.

Labeti, Rubiana Lagoon, New Georgia. Paiua, Ugi Id. Bio Id.

EXPLANATION OF THE PLATES.

All the figures are from photographs by George Nelson, and natural size except when otherwise noted.

PLATE 1.

PLATE 1.

Fig. 1–5. *Helicarion malaitaensis* Clapp.
Fig. 6–8. *Fretum malaitaensis* Clapp.
Fig. 9–11. *Fretum concavum* Clapp.
Fig. 12–14. *Fretum manni* Clapp. × 3

1 *2* *3* *4* *5* *6* *7* *8* *9* *10* *11* *12* *13* *14*

PLATE 2.

PLATE 2.

Fig. 1–3. *Fretum pamuaensis* Clapp. × 3.
Fig. 4–6. *Fretum smithi* Clapp. × 3.
Fig. 7–9. *Fretum sororum* Clapp. × 3.
Fig. 10–15. *Trochomorpha aukiensis* Clapp.

1

2

3

4

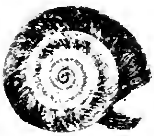
5

6

7

8

9



10

11

12

13

14

15

PLATE 3.

PLATE 3.

Fig. 1–3. *Trochomorpha concava* Clapp.
Fig. 4–6. *Trochomorpha flava* Clapp.
Fig. 7–9. *Trochomorpha manni* Clapp.
Fig. 10–12. *Trochomorpha rendovaensis* Clapp.
Fig. 13–15. *Trochomorpha zenobiella* Clapp.

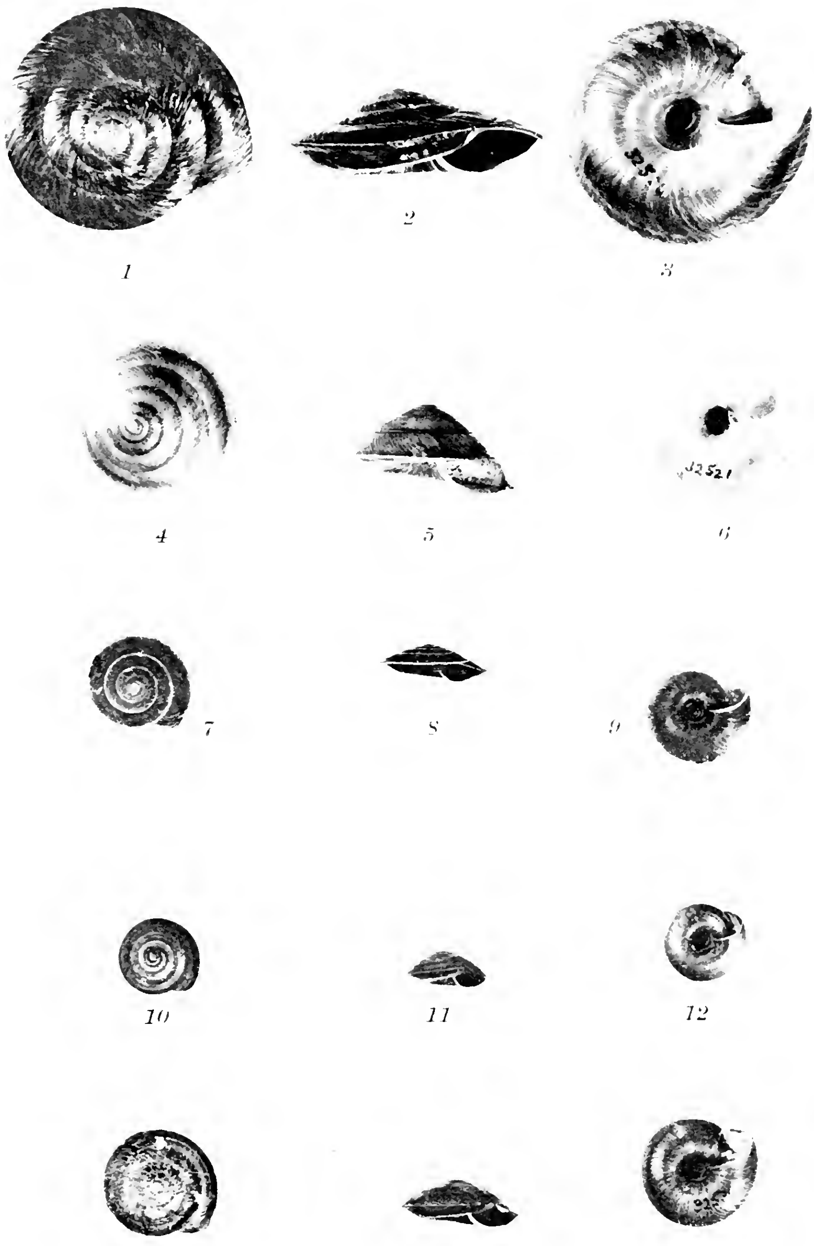
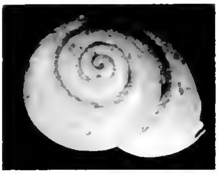

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15

PLATE 4.

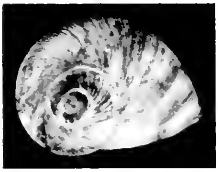
PLATE 4.

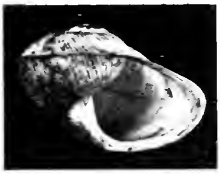
Fig. 1–3. *Crystallopsis fictilia* Clapp.
Fig. 4–6. *Crystallopsis fulakorensis* Clapp.
Fig. 7, 8. *Placostylus (Placocharis) artus* Clapp.


1


2

3


4


5


6


7


8

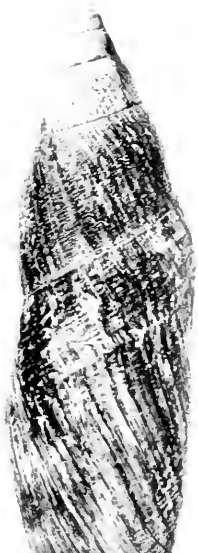
PLATE 5.

PLATE 5.

Fig. 1, 2. *Placostylus (Placocharis) manni* Clapp.
Fig. 3, 4. *Placostylus (Eumecostylus) phenax* Clapp

1

2



3

4

Bulletin of the Museum of Comparative Zoölogy

AT HARVARD COLLEGE.

Vol. LXV. No. 12.

DESCRIPTIONS OF NEW NEUROPTEROID INSECTS.

By Nathan Banks.

With Four Plates.

CAMBRIDGE, MASS., U. S. A.:

PRINTED FOR THE MUSEUM.

January, 1924.

No. 12.— *Descriptions of new Neuropteroid Insects.*

By Nathan Banks.

The continued study of the Hagen collection, together with recent accessions, particularly from Mr. C. F. Baker from the Philippines and from Mr. H. O. Parish from South America, has resulted in the recognition of various new species. This article contains the descriptions of many of these forms.

EMBIIDAE.

Oligotoma californica (Banks).

This was described from an immature male in the genus Embia, mature examples show it to belong to Oligotoma. Recently Mr. S. B. Freeborn and others have collected numerous specimens of female Embias from California; these are much spotted as is the case with females of certain old-world species. These forms (Plate 1, fig. 11) are doubtless the previously unknown females of *O. californica.*

Oligotoma inaequalis, sp. nov.

Type.— M. C. Z. 14,878. St. Croix. (C. E. Wilson).

Brown, head in front of eyes more yellowish, femora and tibiae, except at joints, nearly black. Head hardly narrowed behind, as long behind eyes as width of head at antennae; pronotum plainly longer than broad, barely wider behind. Wings grey-brown, with five pale lines, one, broken, between radius and radial sector, several cross-veins between radius and radial sector, the first at fork of radial sector, none behind. The genitalia are similar to *O. insularis,* but the second joint of the left cercus is much longer than this joint in the right cercus.

Length of body 7.5 mm.; fore wing 6 mm.

Larger and darker than *O. cubana,* and with an extra pale line in wing.

Oligotoma venosa, sp. nov.

Type.— M. C. Z. 14,879. Cuba: Santa Clara. (C. F. Baker).

Black, head back of eyes rather yellowish, wings brown, with four white lines. Head back of eyes about as long as width of head at antennae, but plainly narrowed behind; pronotum plainly broader behind; the appendages broken. The wings are peculiar in having more cross-veins than in other species, besides several in radial area, there are one or two connecting radial sector to its fork, and in the fore wing one from lower branch of radial sector back to the median vein.

Length of fore wing 4 mm.

Differs from others of the West Indies in much darker color, as well as in venation and small size.

PSOCIDAE.

Thrysopsocus stigmaticus, sp. nov.

Type.— M. C. Z. 14,877. Peru: Yurimaguas, April. (H. O. Parish).

Head reddish, antennae pale on base of first long joint, black beyond, first long joint distinctly densely black-haired, except toward base; prothorax and pleura reddish, anterior lobe of mesonotum black, rest pale; the abdomen brown; legs pale, femora more or less rufous. Wings hyaline, veins mostly black or dark, radius, lower side of cell and outer side of second cell and adjoining parts of veins pale; stigma brownish red, except a yellow spot at tip; three small black spots before the middle; one in base of first cell, one above it, and a curved one before cubitus; base of radial sector black, outer cell pale brown, which color extends outward in two parts, one obliquely below, and the other outward occupying two cells; hind wings hyaline, with dark veins. Wings with venation as in *T. bellus* but second cell is acute at base above and the stigma is very much produced behind, being nearly twice as wide (in proportion) as in that species.

Length of fore wing, 6.5 mm.

Epipsocus antillanus, sp. nov.

Type.— M. C. Z. 14,865. Jamaica.

Head red-brown; antennae and legs pale yellowish, hind tibia with dark band before tip; thorax yellowish above, more brown on sides; abdomen brown. Wings hyaline, with faint brown marks as follows: — an irregular band across wing from end of stigma, a narrow marginal band along outer edge, and a large spot just before fork of median and cubitus, ends of veins marked with small dark brown spots; venation largely pale. Stigma moderately deep, broadly rounded behind; radial sector forks just below end of stigma; median vein forks first near the same place, and each branch forks again half way to margin; areola postica about as long and as broad as the stigma. Hind wings with pale venation. Male with very large, prominent eyes, less than half their diameter apart in front.

Expanse 5.5 mm.

In Enderlein's table it would run out to Xenopsocus, on account of four branches to median, but these are differently arranged than in Kolbe's genus, which differs in various other venational points.

Pseudocaecilius wolcotti, sp. nov.

Type.— M. C. Z. 14,866. Porto Rico. (G. R. Wolcott).

Body and legs whitish; a brown mark in front of each eye reaching to base of antennae, a median dark spot behind mesoscutellum, a few faint marks on mesonotum. Head with short fine hair on face, but on vertex with scattered erect hairs. Wings hyaline, venation mostly pale; a black dot on base of stigma, a brown spot in apical part (but not reaching apex) of stigma, and another across the middle of areola postica, extending above to the cubitus. The radial sector and median vein before they touch are plainly brown, and the apical branches of these veins are also brown; there is a faint dark mark before end of anal. Stigma very long and slender, the areola postica more than twice as long as broad, but hardly one half as long as the stigma. Hind wings hyaline, venation pale.

Expanse 6.5 mm.

Peripsocus minutus, sp. nov.

Type.— M. C. Z. 14,912. Porto Rico, San German, 18 April, on *Acacia farnesiana*. (G. R. Wolcott).

Nasus brown, vertex pale, sometimes with dark median spot, antennae brown; thorax brown, traces of pale median line and pale over base of fore wings, scutellum with a median branched spot; abdomen pale brownish, darker in middle; legs pale. Wings faintly brownish, more distinct toward tip, with paler areas in some of the cells, mostly behind stigma, but not forming bands. Venation very similar to that of *P. madidus*, the last forking of median and of radial sector are opposite each other, the first branch of median is more at right angle than in *madidus*. The stigma is rather broader and more truncate at tip than in *madidus*. It is hardly more than one half the size of that species.

Expanse 3.3 mm.

EPHEMERIDAE.

Hagenulus eatoni, sp. nov.

Type.— M. C. Z. 14,867. Haiti, Diquini. (W. M. Mann).

In general the female is similar to *H. caligatus*, marked in the same general way, the legs and setae banded, the abdomen with black bands at ends of the segments, and many cross-veins in the wings are margined with brown. However, there are no margined cross-veins in the anal area of the wing, and those behind the radius are much larger, forming six or eight rounded or even elongate black spots. Besides the apical black band, each abdominal segment has an oblique mark on each side, and a trace of a median basal spot; a median and lateral black lines on the venter. The hind wings are almost equilaterally triangular, the costal edge being much longer than in *caligatus* and the lower lobe much shorter.

Expanse 18 mm.

The specimens that Eaton refers to at the end of his description of *caligatus* as four females with unmarked wings, are males, and probably the males of *caligatus*. All the specimens (mature) with spotted wings are females.

Rhithogena hespera, sp. nov.

Type.— M. C. Z. 14,917. Wash.: Pacoima. 31 March. (C. V. Piper).

♀ In the hind tarsi the first joint is a little longer than the second, and the second a little longer than the third; in the front tarsi the first joint is rather shorter than the second, which is barely longer than the third. Pale yellowish, scutelli rather darker; pleura unmarked except black spot in front of mid coxae, and mark at base of mid and hind coxae; legs pale yellow, each femur with black spot at middle and a dark tip; abdomen pale, an oblique dark mark on lateral posterior side of each segment (except the last two); venter unmarked, last two segments fumose; ventral plate with a median notch. Wings hyaline, venation yellowish, the cross-veins more brownish; in costal area near base is a prominent black comma-shaped mark.

Length, body 10 mm., fore wing 12 mm., femur I 2.5 mm.

Readily recognized by black mark near base of wings.

Epeorus morrisoni, sp. nov.

Type.— M. C. Z. 14,918. Nev.: Reno. (H. K. Morrison).

♂ Joints of hind tarsi short, but little longer than broad, first joint a little longer than the second, the second scarcely longer than the third. In front tarsi the first joint is equal to the second, and the second plainly longer than the third.

Dark brown; pleura mostly dark, with several yellow spots; abdomen dull brown above, darker near tip, most of segments with a dark brown apical margin, lateral margins pale yellowish; venter dull yellowish, unmarked; front legs brown, rather darker at tips of the tibia, hind legs paler, the femora streaked with brown above; setae dull yellowish or brownish, the joinings hardly darker. Wings hyaline, venation fine, brown, pterostigmatic region fumose, the veinlets there mostly forked or crossed. Forceps dark brown. Last ventral rather broadly emarginate in middle; the second joint of forceps is swollen on inner side.

Length, body 9 mm., wing 10.5 mm., femur I 2 mm.

EPEORUS UNDULATUS, sp. nov.

TYPE.— M. C. Z. 14,919. N. Mex.: Jemez Springs, 25 May. (John Woodgate).

♂ First joint of hind tarsi barely longer than the second, and second scarcely longer than the third; in front tarsi first joint as long as the second, and second plainly longer than the third.

Dark brown; pleura with some yellow spots, and dorsum of abdomen dark brown, venter very pale, the sides of dorsal segments very narrowly pale; forceps dark brown; setae paler brown; front legs brownish, darker at tips of tibia, hind legs pale, with dark streaks on femora. Wings hyaline, venation brown, pterostigmatic region rather fumose, veins here mostly simple. Last ventral segment shows an undulate margin.

Length, body 7.5 mm., wing 9 mm., femur I, 2 mm.

Similar to *E. morrisoni*, the tarsi being the same; the abdomen darker above, paler beneath, the last ventral segment shorter and the emargination more shallow and broader.

BAETIS LASALLEI, sp. nov.

TYPE.— M. C. Z. 14,914. Wisc: Milwaukee, 13 June.

Thorax brown, edge of mesonotum more yellow, abdomen pale whitish, with black dot on each side of each segment, last three segments above brown; setae pale, joinings not marked; legs pale. Wings hyaline, veins also, venation as usual, marginal intercalaries in pairs, and moderately long; hind wing rather large, reaching to middle of third abdominal segment, broad in the middle, narrowed toward each end, tip rounded, two longitudinal veins to tip, marginal vein behind, and two long intercalaries, the costal point strong and colored.

Fore wing 5 mm. long.

Distinct by broad hind wing; nearest to *B. phoebus* McDunnough, but broader hind wings, less pointed at tip.

BAETIS PARALLELA, sp. nov.

TYPE.— M. C. Z. 14,881. Nev.: Reno. (H. K. Morrison).

Pale brown, edge of mesonotum hardly more yellow, rest of mesonotum dark, shining brown, abdomen brownish, above darker brown on last three segments, pale beneath, sternum partly brown; front legs pale brownish, others pale; setae pale, joinings dark. Wings hyaline, venation pale, marginal intercalaries in pairs, moderately long, venation as usual. Hind wings reaching just beyond the second abdominal segment, elongate, sides nearly parallel, costal point sharp, no cross-veins noticeable.

In the female the body, including the abdomen, above and below, deep shining brown, the legs brownish, and the cross-veins plainly brown.

Fore wing 8 mm. long.

Cloeon carolina, sp. nov.

Type.— M. C. Z. 14,880. N. C.: Black Mts., May. (N. Banks).

Thorax, femora, and entire dorsum of the abdomen clear, polished, brown; venter of abdomen pale yellowish; setae pale whitish, joinings very slightly marked with brown. Wings hyaline, veins also hyaline, venation as usual, marginal intercalaries in pairs and moderately short.

Fore wing, 4 mm. long.

Related to *C. dubium* by the paired intercalaries, but separated by the entire dorsum of abdomen being brown.

PERLIDAE.

Peltoperla mindanensis, sp. nov.

Type.— M. C. Z. 14,806. Philippines: Mindanao, Surigao, and Kalambugan. (C. F. Baker).

Head and pronotum dark brown: thorax and abdomen yellowish, antennae, palpi, legs, and setae blackish, the bases of all pale. Wings blackish, venation black. Head short and broad; eyes of moderate size, finely hairy; ocelli small, remote, as near to eyes as to each other; lateral bosses small, situate near antennal carina, pronotum very much longer and broader than head, much broader than long, scarcely narrowed behind, straight across in front, sides rounded; setae no longer than width of abdomen; ventral plate very large and swollen, nearly reaching to tip of abdomen. Fore wings with four or five cross-veins beyond end of the subcosta; radial sector twice forked, seven to eight cross-veins in both median and cubital areas, no branches of cubitus to hind margin. In hind wing radial cell almost reaching base of wing; in fore wing discal long and slender.

Expanse 20 to 25 mm.

Neoperla bakeri, sp. nov.

Type.— M. C. Z. 14,811. Philippines: Mindanao, Surigao, Mt. Maquiling, Los Baños. (C. F. Baker).

Head and pronotum pale brownish yellow; thorax, abdomen, legs, and setae pale yellowish, tibia and apical part of setae darker; antennae and palpi pale brown. Wings hyaline, venation mostly yellowish, the costal veins paler yellow. Head fairly broad, eyes of moderate size, ocelli fairly large, nearly two diameters apart, in male not twice as far from the eyes, in female fully twice as far from eyes. Lateral bosses small, rounded, far in front of ocelli, as far from ocelli as ocelli from each other, but close to the eyes. Pronotum much broader than long, but little narrowed behind, front margin slightly convex. Ventral plate straight across at tip. Fore wings with discal cell long, ending a little before median bends to radius; radial sector with one branch; five to seven median, and four cubital cross-veins. In the hind wings the radial cell is much shorter than its pedicel, and the median vein is strongly bent upward.

Expanse 21 to 24 mm.

Differs from *N. clarissa* in more widely separated ocelli and darker head and pronotum, and in the male genitalia.

Neoperla consimilis, sp. nov.

Type.— M. C. Z. 14,809. Philippines: Mindanao, Iligan, Surigao, Kalambugan. (C. F. Baker).

Closely related to *N. bakeri*, in color of head, thorax, etc., except that the tibia is scarcely if any infuscate. On the head the ocelli are less than twice, hardly more than one diameter, apart, the lateral bosses are far forward as in *bakeri*, so that they are about three times as far from ocelli as ocelli from each other, the ocelli are about four times as far from eyes as from each other. Pronotum similar to that of *bakeri*, and the ventral plate straight across at tip. Venation much as in *bakeri*, yellowish, the costal veins paler, the radial sector with one branch.

Expanse 20 to 23 mm.

Neoperla hermosa, sp. nov.

Type.— M. C. Z. 14,810. Philippines: Mindanao, Surigao, Davao, Zamboanga. (C. F. Baker).

Pale yellowish; head and pronotum rather brownish, with indication of black spot in front of the ocelli; antennae brown, basal joints paler; palpi pale. Fore wings faintly infuscated, the veins slightly brown, but in the middle area beyond the anastomosis is a fairly large pale yellow spot, where the veins are also yellowish (resembling *N. fenestralis* of South America). Hind wings paler, with pale venation, setae pale yellow. Head fairly broad, the ocelli of moderate size, about two diameters apart, and plainly further from eyes; lateral bosses large, elongate, but little in front of ocelli, and plainly nearer to eyes than to ocelli. Pronotum plainly broader than long, front margin nearly straight across, sides broadly rounded. Ventral plate straight across. Discal cell with base much beyond bend of median to radius; radial sector with two branches, first at anastomosis; five to seven median cross-veins, three to six cubital ones. In the hind wing the radial cell about equal to its pedicel, the median vein not strongly bent.

Expanse 22 to 26 mm.

Neoperla oculata, sp. nov.

Type.— M. C. Z. 14,808. Philippines: Mindanao, Surigao. (C. F. Baker).

Head and pronotum brownish; thorax, abdomen, legs, and setae yellowish; antennae and palpi pale brownish; wings hyaline, costal veins yellowish, others brown; hind wing pale. Head much narrowed in front, eyes of male very large, ocelli large, but little more than diameter apart, hardly two diameters from the eye; lateral bosses large, transverse, not far in front of ocelli, closer to eyes than to ocelli; pronotum much broader than long, anterior margin convex, not much narrowed and broadly rounded behind. Discal cell of fore wings long and slender, it ends some distance in front of the bend of the median; cross-vein from radial sector to radius rather oblique; radial sector twice forked beyond anastomosis; five or six median cross-veins, four cubital cross-veins. In hind wings the radial cell is about as long as the pedicel, the median vein rather strongly curved.

Expanse 22 mm.

Neoperla (Javanita) atropennis, sp. nov.

Type.— M. C. Z. 14,807. Philippines: Mindanao, Surigao, Tangalan, Bukidnon. (C. F. Baker).

Head brown, more or less pale on sides, and on the bosses; antennae black; palpi brown; pronotum dark brown, thorax yellowish brown; abdomen yellowish; legs black, base of femora pale; setae dark brown. Wings black, faintly paler in the middle of cells. The head similar to *N. violacea,* but the lateral bosses are rather further forward, and as near to eyes as to ocelli; ocelli small, about two and a half diameters apart, about three times as far from the eyes. Pronotum plainly broader than long, much narrowed behind, front margin convex; eighth, ninth, and tenth ventral segments of female all straight across. Discal cell of fore wings long, its base almost back to where median bends to the radius; radial sector once or twice forked; seven to nine median cross-veins, six to eight cubital ones. In hind wing the radial cell is as long as its pedicel, and the median vein curves upward but little. In the male the last ventral segment is pointed in the middle.

Expanse 24 to 26 mm.

RAPHIDIDAE.

Raphidia crotchi, sp. nov.

Type.— M. C. Z. 14,861. California. (G. R. Crotch).

By the dark basal joint of antennae, shape of head, by genital plates, and the superior appendages it is related to *R. oblita;* it differs in that each genital plate has a large lobe on the upper outer edge, directed toward each other; the superior appendages are yellow on outer edges. In this specimen the stigma, which is yellowish, is long and begins close to the base of the first discoidal cell, a condition not found in other American species, but possibly this point is not constant. The head is rather suddenly constricted behind; pronotum not bicolored; the abdomen has the apical margins of the segments narrowly pale; the wings have four discoidal cells, the second in one wing crossed, the third apical vein in all wings is simple.

Expanse 18 mm.

HEMEROBIIDAE.

Hemerobius algonquinus, sp. nov.

Type.— M. C. Z. 14,862. N. Y.: Lake Placid, August. (E. P. Van Duzee). N. H.: Hampton, May. (L. A. Shaw).

Pale yellowish, cheeks dark, a dark stripe each side on pronotum. Wings pale, almost unmarked, a few scattered brown dots on the veins, and the gradates and some other cross-veins faintly brown. Three radial sectors, cross-vein from radius to median remote from radial sector, six inner, seven outer gradates, last of inner series a little before the next to last; wings moderately slender, costal area fairly broad at base. Male genitalia on the style of *H. castanae*, but the branches are less remote and less divaricate, and the upper not as long. Related by venation to *stigmaterus*, but the appearance is that of a small and pale *castanae.*

Length 7 mm.

Hemerobius hesperus, sp. nov.

Type.— M. C. Z. 14,863. Two ♀♀. Calif.: Tahoe, Angora Park, 10 July. (E. O. Essig, E. P. Van Duzee Coll.).

Face brown, with four indistinct pale spots in front, vertex brownish, pronotum with a broad dark stripe each side, leaving a pale median stripe and the lower lateral edges pale, rest of thorax pale, with lateral brown spots; abdomen dark, legs pale, unmarked. Wings with pale venation with brown interruptions, the brown extended on the membrane so as to form about ten more or less complete, narrow, transverse bands, those over the gradates scarcely more distinct than elsewhere, and sometimes beginnings of other bands, the gradates brown; six in inner series, seven in outer, last of inner series just before the next to last; three radial sectors at about equal distances apart; cross-vein between median and radius much more than its length before the radial sector; cross-vein from cubitus to anal about twice as long as that from cubitus to median; costal area not especially broad at base. In the hind wings the venation is pale, with cross-veins brown; both wings rather long and narrow.

Length 8 mm.

Lomamyia hubbardi, sp. nov.

Type.— M. C. Z. 14,864. Fla.: Cedar Keys; 4, 3; 75. (Hubbard and Schwarz).

Resembles *L. flavicornis;* the pronotum possibly a little longer and more narrowed in front. Wings strongly falcate, the outer point long and quite sharp, and the outer edge evenly concave (not irregularly as in *flavicornis*). The costal area at broadest part near the base is not twice as wide as before the stigma (in *flavicornis* about twice as wide). Head and antennae pale yellowish; thorax and legs less dotted than in *flavicornis*. Abdomen pale, with reddish brown marks on each segment, but the last dorsal segment is pale. Wings less marked than in *flavicornis*, the veins are faintly dotted with brown; no prominent dark marks in the costal area; the stigma is rufous and this color is continued to the tip and narrowly along the outer edge, no pale spot beyond the stigma.

Expanse 20 mm.

OSMYLIDAE.

Spilosmylus formosus, sp. nov.

Type.— M. C. Z. 14,818. Philippines: Mindanao, Surigao. (C. F. Baker).

Pale yellowish, thorax and base of abdomen rather darker. Wings marked with brownish; a faint yellow-brown incomplete transverse band above the bulla, beyond and behind the radial sector is a row of cells very clear, then a distinct yellow-brown stripe to apex, sharply marked above, behind fading off; the hind margin rather brownish; between radius and the subcosta yellowish, with two large dark spots, one above the bulla, the other before stigma, each marking the veins adjoining, therefore but two dark lines on each radius and subcosta. In the costal area beyond the stigma are three oblique brown streaks, the last connecting to apex. The bulla is large and contains curved brown veins as in the figure, very different from *S. modestus, inquinatus,* etc. Venation pale yellowish. In the hind wings two faint dark lines on subcosta and radius; venation pale. Pronotum slender, much longer than in *inquinatus*. Venation near base of radial sector as in *inquinatus* (section Ostreosmylus); other venation closely similar to *inquinatus*.

Expanse 36 mm.

In venation related to *S. inquinatus*, but the markings and bulla are very different.

CHRYSOPIDAE.

Nadiva, Goliva, and Rameta.

These three genera of Navas are based on closely related and probably identical species, agreeing with *Nothochrysa panchlora* Gerstaecker. Typically *panchlora* has wholly green venation, and a red margined pronotum, and in the fore wing the branches from cubitus to margin are mostly simple, but specimens occur in which about half are forked, and others with the gradates more or less darkened, and the red margin of pronotum faint or absent. In a specimen from Pernambuco the third cubital cell on one side is as in Chrysopa, and in one Bolivian specimen both wings are also as in Chrysopa. The Bolivian specimens have most of the branches of the cubitus to margin forked. I doubt, however, if there is more than one species. It is not a typical Nothochrysa, and Nadiva, as the oldest name, may be used for the genus. The oblique base of the third cubital cell, and the fact that in the hind wing the first cross-vein from first anal is beyond that connecting to cubitus distinguish the genus; it is more primitive than Nothochrysa.

Chrysopa sierra, sp. nov.

Type.— M. C. Z. 14,858. Calif.: San Gabriel Mts., Sister Elsie Peak. 10 June. (F. Grinnell).

Pale yellowish, cheeks with a shining black stripe; all joints of palpi marked with black; pronotum with a brown spot, outwardly margined with reddish on each side; two large brown spots on front of mesothorax; fore wings with two dark brown dots at extreme base in front, and one on tip of basal branch of anal behind; costals and gradates dark, other cross-veins dark at ends, in hind wings less marked; stigma long, obscure. Pronotum about as wide as long, narrowed in front; wings moderately slender, almost acute at tips, costal area at widest not equal to radial area, five to seven gradates, third cubital as long as the second, the divisory vein ends plainly beyond the cross-vein; inner gradates nearer to outer than to radial sector.

Expanse 30 mm.

Chrysopa seminole, sp. nov.

Type.— M. C. Z. 14,859. Fla.: Marco.

Green, head unmarked, last joint of palpi black, pronotum with a broad red stripe each side, not, however, reaching to the lateral margin. Venation green, gradates and cross-veins almost entirely black, branches of radial sector black at bases, and the marginal forks dark; in hind wings the costals, gradates and radial cross-veins dark at ends. Pronotum about as broad as long, rounded in front, sides nearly parallel; wings rather narrow, acute at tips, inner gradates of three or four veinlets, outer series of six or seven, the inner row much nearer to outer than to the radial sector.

Expanse 22 mm.

Chrysopa slossonae, sp. nov.

Type.— M. C. Z. 14,860. N. C.: Hendersonville. (F. Sherman). N. H.: Franconia (Mrs. A. T. Slosson). Va.: Great Falls.

Pale yellowish (greenish olive), a broad reddish or brownish stripe on each cheek reaching to the eye; last joint of palpi reddish; pronotum as broad as long, rounded in front, sides parallel. Wings broad, hind pair narrower, scarcely pointed at tip, costal area at widest is as wide as radial area; about ten gradates in each series, the outer row about as close to outer margin as to the inner row. Venation green, many cross-veins black at ends, the gradates and several basal cross-veins black.

Expanse 32 mm.

A rather large, broad-winged species near to the western *C. majuscula*, but lacks spots on clypeus. This is the species which in my Revision of the Chrysopidae I identified with *emuncta* Fitch, but an examination of the Fitch type shows that *emuncta* is a female of *Meleoma slossonae*.

Chrysopa peterseni, sp. nov.

Type.— M. C. Z. 14,812. Solomons: Florida: Tulagi. (W. M. Mann).

A large heavy species related to *C. ruficeps*. Antennae dark, except pale basal joint, no marks on head which is reddish; pronotum with fine dark marks on sides and behind; faint, large dark marks on meso- and metanotum near base of wings; legs unmarked. Wings hyaline, venation pale yellowish, but cross-veins and gradates largely brown; costals brown except near costal vein; radial cross-veins wholly, divisory, branches of anal, and some other cross-veins partly brown; marginal forkings brown. Wings large and broad; venation rather dense, radial sector with seventeen branches (some only cross-veins) eight inner, and eleven outer gradates, in subparallel series; the inner as near to radial sector as to outer row. Hind wings with gradates and some other veinlets dark. Divisory veinlet ends much beyond the cross-vein.

Expanse 32 mm.

Distinct from *C. ruficeps* and allies in more numerous gradates and darker venation.

Chrysopa bakeri, sp. nov.

Type.— M. C. Z. 14,814. Borneo: Sandakan. Basilan. (C. F. Baker).

Pale yellowish. Brown mark under each eye; two red spots on vertex; antennae pale, first joint with red stripe on outer side; side margins of pronotum reddish; brown spot above bases of wings; abdomen with broad reddish dorsal stripe; tibia with a median brown spot, less distinct on the hind pair. Wings much marked, the outer margin being almost wholly infuscated; venation pale; gradates, some cross-veins wholly, others at ends dark, and veinlets in the dark tip are dark; stigma yellowish, brown at each end, two prominent brown spots, one on origin of radial sector, other on radial sector behind the base of stigma; fainter marks at end of anal vein, and two or three along hind border; in hind wings the stigma also yellowish, and brown at each end, and faint brown spots in apex over the brown apical veinlets, otherwise venation pale. Basal joint of antennae rather long and not swollen; pronotum much broader than long. Wings rather slender, acute; costal area moderately broad near base; gradates 4–4; third cubital cell elongate, the divisory veinlet ending much beyond the cross-vein.

Expanse 22 mm.

In one specimen the basal joint of antenna is only weakly marked with red, and no spots on the vertex.

Chrysopa valdezi, sp. nov.

Type.— M. C. Z. 14,815. Borneo: Sandakan. (C. F. Baker).

Pale yellowish. Dark spot below each eye, and one between antennae, red spot above on basal antennal joint; two reddish spots on vertex; palpi mostly dark; pronotum with long dark spot each side; dark spots at base of each wing, and in front and below each fore wing, also two spots on front of mesonotum. Wings with pale venation, only partly marked with dark, the gradates and some marginal veins wholly dark; stigma yellowish, a brown spot at base. Venation of hind wings mostly pale, gradates dark. Wings rather narrow, acute at tips; divisory ends just beyond cross-vein; gradates 5–5, each well separated from next, but in subparallel series; hind wings with two inner and four outer gradates.

Expanse 26 mm.

Chrysopa rizali, sp. nov.

Type.— M. C. Z. 14,813. Philippines: Mindanao, Dapitan. (C. F. Baker).

Pale yellowish. Black spot under each eye, palpi largely black, black spot between bases of antennae, dark spot each side on pronotum, one over base of wing and one under and in front of fore wing. Venation pale; costals, gradates, and cubital cross-veins wholly dark; most of the radial cross-veins, the branches of radial sector, the divisory, many branches of cubitus and anal veins, and the marginal forkings more or less dark; the forkings in some cases bordered with faint brown clouds. Stigma yellow, a large dark spot at base, and one on radial sector behind stigma also dark, and a dark spot at end of anal vein. In hind wings the gradates, costals, marginal veinlets and a few others dark; a large dark spot at base of the yellowish stigma. Basal joint of antennae swollen; pronotum very broad; wings rather narrow, acute at tips; five and six gradates, widely separated from each other, so that in some cases one of inner row is nearer next of outer row than to next of inner row; the divisory ends slightly beyond end of the cross-vein. In the hind wing two inner gradates, and five outer ones.

Expanse 26 mm.

Ankylopteryx perpallida, sp. nov.

Type.— M. C. Z. 14,816. Philippines: Imugin, Nueva Vizcaya. (C. F. Baker).

Pale yellowish green throughout, no marks on body or wings. In fore wings the costal area is of moderate width, the radial sector strongly sinuate, eight inner and ten outer gradates in fairly even series, fore wings hardly acute at tips; hind wings plainly acute.

Expanse 26 mm.

Related to *A. polygramma*, but differs in the pale gradates, and in the more sinuate radial sector.

Ankylopteryx obliqua, sp. nov.

Type.— M. C. Z. 14,817. Philippines: Mindanao, Iligan. (C. F. Baker).

Pale yellowish or greenish, body without spots; basal joint of antennae with narrow dark line on outer side. Wings with yellowish veins, some costals at subcosta with dark dot; two radial cross-veins near middle of wing just as the radial sector bends upward are oblique and strongly marked with dark brown, and several veins behind them are marked with brown, and margined with yellowish brown; nearly all of the apical veins are faintly margined with yellowish brown, and there is a large yellow-brown spot on the costal area before middle, and behind it are various veins broadly margined with yellowish brown; some basal cross-veins near middle and in costal area also yellow margined. In hind wings several longitudinal veins are marked with brown. In fore wings the costal area is very broad, and the radial sector strongly curved, five outer gradates, inner very irregular.

Expanse 25 mm.

Differs from *A. nervosa* in pale basal costal vein, and in the yellow-brown spots and veins.

Loyola tripunctata, sp. nov.

Type.— M. C. Z. 14,829. Brazil: Teffe, 12 January. (H. O. Parish).

The entire insect is whitish, and finely white-haired. The head is with red in front of the antennae, and the pronotum is margined with red on the sides. There is an extremely small dark stigmal dot in each wing. The basal and discal bullae are in the same position as those of *L. beata*, and that of the hind wing is also as in *beata;* but in the fore wing beyond the discal bulla (about two cells length beyond) there is a smaller bulla, round in outline, and with four dark-tipped veins; the discal bulla has six dark-tipped veins, and the basal one nine, the latter is longer than in *beata* and curved. The costal area of the wing is broader than in *beata*, about as in *marionella;* the hind wing is also broader than in *L. beata*.

Expanse 48 mm.

MYRMELEONIDAE.

Weelius triseriatus, sp. nov.

Type.— M. C. Z. 14,840. Fijis: Wainganitu. (W. M. Mann).

Face pale, a large black interantennal mark; vertex yellowish, with ten elongate black spots, four in middle are longitudinal, others transverse, two in front and four behind. Thorax black, pronotum with a pale median line and two pale spots each side; rest of thorax with traces of median line, and lateral spots; beneath spotted with pale. Abdomen black, last few segments with pale spot at base. Legs pale, femora dark toward tip, front and mid tibiae dark outside, and with a subbasal cross-line pale, hind tibiae with a black line within, tarsi largely dark. Antennae moderately long, vertex as much elevated as in *W. acutus*, pronotum once and a half as broad as long, sides parallel, spurs hardly equal to basal joint on hind legs, on front and mid legs equal to basal joint, latter about one half of the fifth joint; legs have few stout spines and long hairs.

Wings hyaline, venation black and pale in streaks, stigma pale, a dark spot basally, no other marks. Wings are slender, broadest near tip, hind wings fully as long as fore wings, latter much more bluntly pointed than in *acutus*. The fore wings have about seven cross-veins before radial sector, several of them crossed, in hind wings five before the radial sector, about 12 or 13 branches to radial sector. In the fore wing the costal area is divided nearly its entire length from base to stigma into three series of cells; no banksian line.

Expanse 67 mm.

Differs from *W. acutus* in blunt-tipped wings, in the three series of costals, in absence of marks on wings, and in the longer hind wings.

Mystroleon, gen. nov.

Wings slender, acute, hind pair much shorter. In fore wings the second anal is connected to first by a cross-vein, then bends down and unites with the third for some distance. The radial sector in fore wing arises much beyond the cubital fork, in hind wing before. In the fore wings are seven cross-veins before radial sector, in hind wings but one. In fore wings the cubital fork diverges and runs to margin, and the radius and subcosta beyond stigma bends back in a long swing making a wide area near tip of wing. In the fore wing there are, as Walker states, apparently three radial sectors, the first and second branches of the radial sector being so connected to radius as to appear distinct; this is less apparent in the hind wing. The pronotum is broader than long, the front legs rather short and stout, hairy, hind legs very long and slender; no spurs, the basal tarsal joint of all tarsi is elongated and equals the fifth, the front and mid tarsi longer than the tibiae.

Type.— *Myrmeleon praedator* Walker.

A specimen from Obydos, Brazil (H. O. Parish). The vertex is much elevated; the hind legs are pale, the tips of femora broadly black, the mid legs much spotted, the front femora and tibiae mostly black, thickly black-haired.

Abatoleon, gen. nov.

Differs from Austroleon in the absence of tibial spurs; abdomen of female shorter than the hind wings.

Abatoleon deprivatum, sp. nov.

Type.— M. C. Z. 14,841. Argentina: Mendoza. (A. C. Jensen-Haarup).

Face pale, a large black interantennal mark, emarginate below, and containing a minute pale dot between antennae, vertex with a pale line across in front, above brownish, behind with a black mark each side; pronotum black, with a pale median line and a shorter one on each lower side behind the furrow, rest of thorax dark, with a few pale spots; abdomen dull blackish, unmarked, densely clothed with white and some shorter black hair; legs pale, spotted and dotted with dark, front femora largely dark on the outer side, all with long hairs and bristles, some white hairs of front femora are especially long; basal joint of tarsus about two thirds of the fifth joint, no spurs; wings moderately broad at stigma, venation black and white in streaks, a dark spot at stigma, one behind it, one at end of cubitus, and another at end of anal vein, and one above and just beyond the fork of cubitus, stigma whitish; hind wings much less marked. In fore wing three cross-veins before radial sector, two in the hind wing, six or seven branches to radial sector.

Expanse 28 mm.

In markings and even in venation this is practically a duplicate of *Austroleon frontalis;* it differs in the absence of spurs, in the rather shorter abdomen, and in the shorter and slightly stouter legs, especially in the shorter hind tibiae.

ASCALAPHIDAE.

Haploglenius extensus, sp. nov.

Type.— M. C. Z. 14,827 ♀. Bolivia: Sara. (J. Steinbach).

In the shape of the anal angle it agrees with *H. peruvianus* and *handlirschi.* It differs at once from them in having the wings, especially the hind wings more slender, and in that the dark of the costal area extends behind the radius to the width of a cell (or half a cell toward base). The hind wings are not so short in proportion to the front wings as in *peruvianus.* The thorax shows two pale stripes from pronotum back toward abdomen; the stigma is large and yellow, with a slight extension outward along radial side.

Fore wings 44 mm. long, 10 mm. wide.

Hind wings 41 mm. long, 8 mm. wide.

Haploglenius eurypterus Navas, according to description, does not differ from specimens of *luteus.*

Ululodes sinuatus, sp. nov.

Type.— M. C. Z. 14,828. Ecuador: Guayaquil, San Raphael. (Francisco Campos).

Belongs to the group of *U. quadrimaculatus* with broad wings, yellowish stigma, and the female with spotted wings. The species differs from all others of this section in that the outer margin of all wings just before tip is plainly sinuate and that the cross-veins before radial sector number five in fore wing and two in hind wing. Face densely clothed with black hair; thorax brown-haired, scutellum with large tuft of upright black hair; legs dark, tips of tibiae paler; abdomen dull blackish, each segment with a large triangular yellowish spot on posterior half. Wings hyaline or slightly smoky, venation dark, stigma pale, barely marked, only a couple of veinlets yellowish, apical area with three or four series of cells; five branches to radial sector in fore wings, six in hind wings; hind wings but little shorter, and nearly as broad as the fore wings.

Female similar to the male, but each hind wing has three large dark spots, one behind the stigma, one on hind margin just before this, and one behind the curve of anal vein.

Length of fore wing 29 mm., of hind wing 25 mm.

Eremophanes, gen. nov.

A schizophthalmous Ascalaphid of the tribe Suhpalascini; antennae bare, except on the basal joint, about two thirds the length of the fore wings; all tibiae with spurs equal to two tarsal joints; wings long and slender, their sides nearly parallel, the hind pair much shorter than the front pair; stigma short, two or three series of cells beyond the radius; abdomen of male not very elongate, with short appendages.

The male has a high ridge or lamella over the base of each fore wing, the female has each lateral corner of the anterior lobe of the mesothorax conically elevated.

Eremophanes bicristatus, sp. nov.

Type.— S. African Mus. Paratype.— M. C. Z. 14,920. Southern Rhodesia: Sawmills, 28 October.

Yellowish; face with yellowish hair, darker around the base of antennae and on vertex; prothorax with white hair; mesothorax with mostly black hair above, pale on sides, below, and on the metathorax; legs pale, with white hair and black bristles, tarsi darker near tip; antennae pale on base, brown beyond, knob large. Wings hyaline; subcosta and radius and the area between them plainly yellowish, the median and part of anal veins pale, rest of venation dark, stigma brownish yellow, seven or eight cross-veins before radial sector in the fore wing, four before the cubital fork, five branches to radial sector; at costal base are long, erect black spines.

Expanse ♀ 67 mm.; ♂ 64 mm.

LIMNEPHILIDAE.

Colpotaulius minusculus, sp. nov.

Type.— M. C. Z. 14,842. Colo.: Tolland. (Dodds).

Body brown, head and thorax with yellowish hair, antennae yellowish, basal joint black, legs yellowish, spines black, anterior femora and tibiae black on inner side, the tibia slightly curved, outside without spines, first tarsal joint very short, only one half as long as the second, which is scarcely longer than the third. Wings yellowish brown, scarcely mottled. Venation similar to other species, the discal cell no longer than its pedicel. The male genitalia seen from the side show very long and slightly curved superior appendages, within they are dentate near tip.

Expanse 14 mm.

Limnephilus toussianti, sp. nov.

Type.— M. C. Z. 14,868. Haiti: Port au Prince. (W. M. Mann).

In general similar to *L. submonilifer*. Yellowish with yellow hair and black bristles. Fore wings pale, venation interruptedly brown, membrane (except costal area) with faint brown irroration fairly distinct behind discal cell, more so in cubital area, and still darker in anal region; hyaline white mark on the thyridium. Front tibia faintly curved, a black line beneath and beneath femur, basal joint of tarsi equal to next, hind tibia rather strongly curved. In the fore wing the discal cell is very long, as long as its pedicel, its upper side straight; fork 1 scarcely reaches back on cell, forks 2 and 3 both equally sessile. In hind wing the discal cell is much shorter, forks 1 and 2 broad at base, fork 3 acute at base, but not pedicellate; no brand in wing.

Expanse 26 mm.

This is probably the form Walker recorded as *L. griseus*.

Limnephilus forcipatus, sp. nov.

Type.— U. S. Biol. Survey. Paratype.— M. C. Z. 14,843. Alberta: Lobstick Island, Ft. Chippewyan, 1 September. (F. Harper).

Black, with mostly yellow hair; palpi and legs pale, tibia with very few black spines, femora especially the hind pair more or less infuscated, in male the first joint of front tarsus is very much longer than the second; antennae brownish, basal joint black, tubercles of vertex and thorax yellowish, ocellar macrochaetae situated behind ocelli. Fore wings nearly hyaline, sparsely marked with brown in posterior half. The male genitalia appear as two pairs of claspers; the superior appendages with an inner apical tooth, the lower appendages with an upper apical tooth; the intermediate appendages small and scarcely visible.

Expanse 26 mm.

Limnephilus (Goniotaulius) clausa, sp. nov.

Type.— M. C. Z. 14,844. Colo.: Long Lake, August. (Cockerell). Colorado. (C. F. Baker).

Black, legs pale, femora black, and in the male the basal third of hind tibia black, tarsi partly black, head and thorax with much yellowish and some black hair; basal joint of antennae densely black-haired. Wings brownish yellow, apical part of stigma dark, apical parts of third and fourth apical and second and third subapical cells sometimes darker, few if any other dark marks, the oblong pale mark sometimes traceable. Venation similar to others of this section, but discal cell is as short as its pedicel; no brand in hind wings. The male genitalia are quite different from allied forms, the superior appendages are large triangular plates, within concave and enclose a pair of jet black processes.

Expanse 20 mm.

Ecclisomyia complicata, sp. nov.

Type.— M. C. Z. 14,845. Ontario: Go Home Bay, Inland Lake. 21 June. (E. M. Walker).

Body yellowish, vertex rather more brown, antennae narrowly annulate with brown, head and thorax with mostly grey hair, ocellar macrochaetae prominent, behind, but closer together than ocelli; abdomen dull brown above; legs with black spines, tibia of front legs spined to base and three on tip of femur, spurs 1, 3, 4. Wings a yellowish grey, with yellowish and grey hair, paler than in *E. conspersa*, the pale spots mostly not distinct, some more distinct near outer margin. Discal cell nearly one and a half times longer than its pedicel, the first fork reaches back before the middle of discal cell (proportionally farther than in other species). The male genitalia are very complicated; from the side are seen two long superior processes, the upper downcurved, the lower longer and incurved; a long median process enlarged and bristly toward tip, and a pair of much shorter lower appendages.

Expanse 24 mm.

Anisogamus atripennis, sp. nov.

Type.— M. C. Z. 14,846. California. (James Behrens).

Head and thorax black, with erect black and some pale bristles, antennae black, palpi paler, abdomen yellowish, legs blackish, tarsi rather paler, spurs

1, 3, 4. Wings black, with erect black, and appressed yellowish hair, pale mark on thyridium and at arculus. Wings more narrow and pointed than in most species, venation about as usual, discal cell rather more narrow, fully three times as long as its pedicel. Hind wings blackish, with black fringe and hair, the discal cell is more than twice as long as its pedicel, but the fork of median is as far back as base of discal cell, both apical and subapical cells being very long. The superior appendages of the female are pointed processes.

Expanse 40 mm.

Chilostigma subborealis, sp. nov.

Type.— M. C. Z. 14,847. Alaska. B. Col.: Wellington. Utah: Logan, near Alta. Alberta: Lake Minnewanka.

In markings close to *C. alascensis;* the wings are more strongly marked with dark, the anterior part of the fore-wing dark and the silvery white stripe more distinct, the silvery extension into the base of fifth apical cell is isolated, the stigma is reddish brown, and very strongly chitinized. The fore wings are more narrow than in *alascensis*, and the costal margin less strongly convex, in shape more like Hesperophylax. The male genitalia are on the plan of *alascensis;* in side view the upper outer corner of the lower appendages is not as extended as in *alascensis*, and above on the last segment are two black spots; the intermediate appendages are upcurved, but not nearly as stout, and approximated. From behind there is seen above the lower edge a median forked process, snow-white (in *alascensis* simply two lobes).

Expanse 26 to 34 mm.

Neophylax occidentis, sp. nov.

Type.— M. C. Z. 14,848. Nev.: Reno. (H. K. Morrison).

Body dark brown, basal joint of antennae dark brown, beyond yellowish, palpi and legs yellowish, a small wart between ocelli and posterior warts. Wings brown, more or less faintly mottled with pale, most noticeable in bases of apical cells and along outer margins and cubital and anal veins; fringe brown, interrupted with whitish, hind wings pale brown, fringe brown. In fore wings forks 1, 2, 3 all scarcely reach before anastomosis, discal cell extremely long as in other species, radius much bent at stigma; spines of legs black, spurs, 1, 3, 3. In hind wings (♂) are two forks distinct as usual, from base of second a cross-vein goes to what appears as fork 3, but in reality no more veins than in other species.

Expanse 21 mm.

In appearance it is a Neophylax, but on account of venation of hind wings and spur formula will doubtless form a new genus. It cannot be an Oligophlebodes on account of fork 2 in hind wing, wart behind ocelli, longer discal cell, etc.

Apolopsyche pallida, sp. nov.

Type.— M. C. Z. 14,849. Manitoba: Winnipeg Lake. (Robert Kennicott).

Body yellowish, vertex, palpi, and dorsum of abdomen more brown, legs pale yellowish, spines black, antennae yellowish. Wings whitish hyaline, clothed with fine white hair, wholly without marks. Fore wings moderately long and slender, discal cell rather longer than its pedicel, fork 1 hardly its width back on discal cell, fork 3 narrower at base than fork 2, fork of median vein with nearly acute base. In the hind wings the end of the discal cell is beyond the dot in the base of the second fork; maxillary palpi of male not especially long. Male genitalia not prominent, an oval piece each side above.

Expanse 17–19 mm.

Apatania canadensis, sp. nov.

Type.— M. C. Z. 14,851. Manitoba: Winnipeg. 1 October. (J. B. Wallis).

Body, legs, and antennae black, tibiae and tarsi paler. Wings pale grey, more hyaline in the middle, especially so in the fourth apical cell, venation dark, stigma fairly prominent. In both wings the fifth apical cell is long, petiolate, in hind wings the petiole much longer than the fork, in the fore wings about one half as long as fork, in some cases the fork is absent in hind wings; discal cell rather longer than its pedicel, fork 1 more than its width back on discal cell. Last joint of maxillary palpi slightly enlarged toward tip. Male genitalia show a pair of short upcurved superior appendages (much shorter than in *A. nigra*).

Expanse 19 mm.

I had formerly considered this the *A. pallida* Hagen, but the type of Hagen has male genitalia very similar to *stigmatella*.

Apatania shoshone, sp. nov.

Type.— M. C. Z. 14,850. Wy.: Yellowstone National Park. (H. M. Smith).

Body black, head and thorax with mostly grey hairs, palpi brown, antennae black, femora black, rest of legs pale. Wings pale brownish, uniform, a large dark spot over the stigmal area, venation dark brown. In color and venation very similar to *A. stigmatella* and the male genitalia are on the same plan, but the apical part of the lateral appendage is much larger, and with a much stouter point, the superior appendages have a longer free point than in *stigmatella*, these parts are pale yellow; in the female the last abdominal segment and its tubercles is wholly golden yellow.

Expanse 16 mm.

RHYACOPHILIDAE.

Atopsyche bolivari, sp. nov.

Type: M. C. Z. 14,839. Colombia: Tolima, Monte Socorro, Tochecito Quindini. (Eduard Fassl).

Similar in general to the other species; marked with brown, black, and yellowish hairs which form patches of erect hairs, but without definite pattern; anterior tibia dark, with pale spot in middle, tips of tarsal articles pale; antennae usually largely pale, but sometimes pale only on base. Wings slender, elongate, anterior wing with venation much as in *A. longipenne;* in the hind wings the first and second anal veins are united before the tip in the male, not in the female. In male the spines and genitalia are similar to *longipenne*, but the apical joint of the lower appendage is very much more slender.

Expanse ♀ 25 mm., ♂ 20 mm.

Rhyacophila rotunda, sp. nov.

Type.— M. C. Z. 14,856. Nev.: Reno. (H. K. Morrison).

Body black; head and thorax with some black but more yellow hair; middle of face below antennae with a silvery spot; palpi black; antennae brown; legs pale yellowish, anterior and mid femora mostly brown; genitalia mostly yellowish. Wings dark brown, with numerous small whitish or grey spots, a larger one from thyridium to end of anal vein, and several nearly confluent below stigma, the latter very dark brown. Hind wings brown. Fork 1 as far back as fork 2, the pedicel more than width of cell, fork 3 fully as long as fork 4, the latter shorter than its pedicel, first anal cell not twice as long as second. The male genital parts have the lower appendages heavy, with a short oblique second joint; the superior median plate is greatly enlarged and rounded.

Expanse 22 mm.

Rhyacophila nevadensis, sp. nov.

Type.— M. C. Z. 14,855. Nev.: Reno. (H. K. Morrison). Colo.: Tolland. (G. S. Dodds).

Generally pale, similar to *R. hyalinata*, but smaller. Palpi dark brown; antennae brown; head and thorax with yellow hair, legs very pale, unmarked, except the tarsi are darker. Wings yellowish hyaline, faint yellow spots along outer margin between the veins, clothed with fine short yellow hair, outer fringe brown, venation brown. Fork 1 reaches nearly as far back as fork 2, its pedicel twice the width of a cell, fork 4 a little longer than pedicel, fork 3 as long as fork 4, first anal cell twice the second. Lower male appendages long, similar to *acropedes*, but the second joint is not so foot-like, and the "sole" confined to the inner apical part.

Expanse 22 mm.

Rhyacophila anomala, sp. nov.

Type.— M. C. Z. 14,854. Colo.: Tolland. (G. S. Dodds).

Head and thorax black, with black and some pale yellowish hair; abdomen brown; palpi and antennae brown, latter faintly annulate and basal joints darker; legs yellowish, front femora blackish on the inner side toward base, tips of the tibia and tarsal joints dark, mid legs similar, hind legs with tips of tibia and the whole of tarsal joints (except the last) dark; wings dark, heavily maculate with pale, the stigma long and very dark, beyond middle of wing the pale spots tend to form cross-bands, in anal and cubital area the spots are more or less united into larger pale areas; hind wings dark, stigma long and very dark. Venation typical of genus, fork 1 as far back as fork 2, the pedicel longer than width of cell. Male genitalia are very different from usual Rhyacophila, but on the plan of those of *R. bifila*. There is a large ventral plate, emarginate at tip, and two large, elongate pieces above, the internal parts obscure.

Expanse 22 mm.

Rhyacophila minora, sp. nov.

Type.— M. C. Z. 14,857. N. H.: White Mts. (H. K. Morrison).

Head and thorax brown, with some yellowish hair; palpi and antennae brown; abdomen dark brown; appendages yellowish brown; legs yellowish. Wings brown, unmarked, except stigma very dark, and a pale spot at thyridium; fork 1 not quite as far back as fork 2, its pedicel twice the width of a cell, fork 3 nearly as long as fork 4, the latter about equal to its pedicel, first anal cell twice as long as the second. Male genitalia are very short; above are two approximate plates, hollowed and sculptured above, the lower appendages have the second joint narrowed from base to tip.

Expanse 15 mm.

SERICOSTOMATIDAE.

Goera fijiana, sp. nov.

Type.— M. C. Z. 14,819. Fijis: Viti Leon, Nadarivatu. (W. M. Mann).

Yellowish, clothed with yellowish grey hair, on face more brownish, antennae beyond base very pale. Wings infuscate, clothed with appressed golden hair, and some more erect brown hair, anal margin with a narrow strip of pale yellowish; fringe brown; hind wings uniform brownish, with brown fringe, and darker venation. Basal joint of antennae about as long as vertex, rest of antennae rather heavy, but little longer than the wings. Discal cell of fore wings moderately short, fork 1 one half way down on the discal cell, fork 2 sessile, fork 3 about as far back as 2, fork 5 narrowed at base by the swollen area behind. In the hind wings fork 1 is a trifle farther basad than fork 2; sixth ventral abdominal segment with a long curved, flattened, but not spatulate, median spine, seventh segment with a similar but shorter spine.

Expanse 15 mm.

Ganonema furcatum, sp. nov.

Type.— M. C. Z. 14,820. Philippines: Mindanao, Surigao. (C. F. Baker).

Pale yellowish, abdomen rather darker above. Head, thorax, and palpi with long yellow hair; tips of antennal joints dark; legs pale yellowish, hind tibia of male with a long fringe behind, the basal hairs nearly as long as the tibia itself. Fore wings yellowish on base, but brownish beyond; hind wings brown. Fore wings clothed with yellowish hair, on outer part the marginal fringe is brown. The fore wings are broad, even broader than *G. brevipenne;* the venation very similar to that species, but in the fore wing the radius near tip forks, the lower branch going to the radial sector (as normal in genus) but the upper branch continuing the vein out to margin (as in Ascalaphomerus), and fork 5 is almost as far back as fork 4. In hind wing fork 2 is rather shorter than in *brevipenne,* and the free space behind fork 5 is even broader than in that species.

Expanse 21 mm.

Phylloicus cubanus, sp. nov.

Type.— M. C. Z. 14,869. Cuba. (Johannes Gundlach).

Pale yellowish, with sparse yellow hair; abdomen more yellow-brown; antennae brown, except near base. Fore wings brown, with brown hair, and two broad pale bands with yellow hair. The first band obliquely across before origin of radial sector and base of fork 5, hardly distinct in the costal area; the second band is nearly as broad, covering the stigma, runs obliquely outward, then turns and runs toward anal angle of wing, each side of the stigma the brown is darker than elsewhere; fringe brown; hind wings faintly brownish, rather darker at tips, fringe brownish; hind tibiae and base of tarsus brownish. Basal joint of antennae has a rounded swelling above at tip, and the vertex is elevated medially. In fore wing the discal cell is much shorter than its pedicel, fork 1 extends but a short distance, the base of fork 5 is connected by cross-vein to median just before origin of fork 4, fork 3 does not extend back on median cell. In hind wing venation much like *P. assimilis.*

Expanse 19 mm.

Marilia scudderi, sp. nov.

Type.— M. C. Z. 14,872. Isle of Pines. (S. H. Scudder). Cuba. (Charles Wright).

Yellowish, with much white and grey hair. The apex of the fore wings of male are marked with black, especially behind; the stigma is dark, beyond it is a large white area, hyaline spot on the thyridium and base of fork 2. Hind wings with mostly brown or yellow-brown hair and fringes; tarsi marked with brown; antennae brown, white-ringed. Eyes of male touching; spurs 2–4–4. In fore wings the apical part is rather shortened; the discal cell hardly if any longer than its pedicel; fork 5 not as far back as fork 1. The male appendages have the second joint slender, and the clavate upper appendages are very long.
Expanse 13 mm.

Marilia wrighti, sp. nov.

Type.— M. C. Z. 14,873. Cuba. (Charles Wright).

Yellowish, clothed with white or greyish white hair. Black spot behind thyridium and with black hair nearly to the hind margin, some black hair on base of fork 2 and over the cross-vein behind. Eyes of male large, but still nearly diameter apart, further than in *M. major*. Venation much as usual; the discal cell extremely long and slender, much longer than pedicel, fork 2 very short pedicellate, fork 5 scarcely reaching before fork 1; in the hind wings the discal cell is fully twice as long as its pedicel; spurs 2–4–4. The male appendages are forcipate, the second joint swollen slightly beyond its base; the darker upper appendages are very short.
Expanse 24 mm.

Easily recognized by large size and the widely separated eyes.

LEPTOCERIDAE.

Oecetina peruviana, sp. nov.

Type.— M. C. Z. 14,831. Peru: Iquitos. (H. O. Parish).

Brown; palpi, head, and basal joint of antennae with dark grey hair, apical joints of antennae narrowly marked with black; legs yellowish grey to brownish, femur I of male with row of very long hairs above, especially near base (not in *O. excisa*). Wings infumate, darker than in *excisa*, the venation generally pale, the anastomosis very prominent, black, veins with brown or rufous hair, marginal fringe brown, at anal margin very long and dense and blackish; at end of each vein on the outer margin is a black spot, seven in all; hind wings brownish, with brown fringe. Discal cell of fore wing a little longer than pedicel, forks 1 and 3 acute at base, both just reaching to anastomosis, the three veins of latter nearly forming a straight line. Lower appendages of male genitalia heavier than in *excisa*, lateral appendages long, clavate at tip and with many long hairs.

Expanse 14 to 15 mm.

Oecetina amazonica, sp. nov.

Type.— M. C. Z. 14,830. Brazil: Manáos, June. (W. M. Mann). Argentina: Piedra Blanca, April. (H. H. Smith). Peru: Napo River. (H. O. Parish).

Yellowish brown, sparingly clothed with grey-brown hairs; legs paler; lower genital appendages nearly white, broad and parallel-sided for some distance, and with a short curved extension from lower corner. Wings very long and slender; anastomosis scarcely distinctly marked, hardly more than *O. excisa;* discal cell about equal to its pedicel; fork 1 with a short pedicel, hardly as long as width of cell; fork 3 acute at base, end of discal cell much beyond rest of the anastomosis; hind wings with the three forks similar to *excisa*.

Expanse 17 mm.

Setodes pretiosella, sp. nov.

Type.— M. C. Z. 14,832. Peru: Yurimaguas, March. (H. O. Parish).

Pale yellowish, with yellowish grey hair. Antennae brown above, each joint with a white ring; legs very pale yellowish. Wings subhyaline, with pale venation, with much pale yellowish hair and numerous (about a hundred or more) minute dots or tufts of black hair, situated on or between, or at the junction of veins, those in the apical half arranged more or less definitely into about six transverse rows; fringe rather bright yellowish, except at anal angle where it is longer and grey. Hind wings pale, with whitish hair and fringe; abdomen green (♀). Wings slender as usual, in fore wings the discal cell nearly as long as its pedicel, fork 1 with a pedicel nearly its length, fork 3 wider, and with a pedicel about one half its length; in hind wings fork 1 is very small, fork 5 more than twice as long as fork 2, and very wide.

Expanse 9 mm.

Setodes 12-punctatus occurs at Iquitos, Peru, and Para, Brazil.

Notanatolica grisea, sp. nov.

Type.—M. C. Z. 14,821. Philippines: Mt. Maquiling, Los Baños, Surigao, Mindanao. (C. F. Baker).

In color and markings very similar to the other species; the wings, however, darker than in *N. magna*. The palpi are not as densely haired as in other species, and the hairs are both black and white. The fore wings are very long and slender; the venation similar to *magna*, but fork 1 in both wings has a very short pedicel; the cross-vein from discal cell to radius is near end of discal cell.

Expanse 26 to 34 mm.

Mystacides canadensis, sp. nov.

Type.— M. C. Z. 14,832. Quebec: Lacolle, 22 July. Sherbrooke, July. (P. A. Begin).

Black; antennae pale, the basal joint and tips of others dark; legs pale; wings blackish, darker in stigmal and costal area, venation very similar to that of *M. sepulchralis*. The male differs strongly in genital parts; the inferior process is not furcate, but simply three very minute lobes at tip, the intermediate processes are very broad at base and taper outwardly to a sharp, hardly upcurved point; the lateral process has no lower tooth. Among European species it is nearest to *longicornis* but the tip of the intermediate appendages is not so slender as in that species.

Expanse 15 mm.

HYDROPSYCHIDAE.

Chimarrha manni, sp. nov.

Type.— M. C. Z. 14,825. Fijis: Somo-Somo, Taviuni. (W. M. Mann).

Black with black hair; vertex shining, legs and antennae dull black; abdomen tawny yellowish. Wings black, fore wings with several large bare areas in the basal part, which in certain lights are iridescent blue; a large spot over the discal cell, the area behind and part of the median cell, a rather smaller spot at origin of radial sector and fork of median, a small spot in costal area above the last, a long stripe behind base of median, and one behind apical half of cubitus. Two veins behind discal cell, fork at base of median and a longer line up from the arculus are white. The palpi are long, the second joint long and thick, the third rather longer and more slender, the fourth short, the fifth long and curved. Venation similar to *C. aterrima*, but the cross-vein from radius to radial sector is just beyond the end of discal cell in both wings; the radial sector at base of the discal cell is not curved, the upper anal cell extends nearly to tip of anal vein; in the hind wings fork 5 is back as far as fork of median and both are as far as base of the discal cell.

Expanse 14 mm.

Chimarrha obscurella, sp. nov.

Type.— M. C. Z. 14,824. Fijis: Somo-Somo, Taviuni. (W. M. Mann).

Brownish yellow, with mostly yellow hair; ocelli on black spot, wings dull pale brown, with blackish hair, arculus and end of median cell pale, a large bare spot behind base of discal cell; abdomen dull brown, legs pale. Palpi rather long and slender, second joint very long, with several golden bristles near inner tip, third hardly equal second, fourth about one half of third, fifth slender and curved. Venation much as in *C. aterrima*, discal cell blunt at base, the radial sector there curved upward; fork 5 back as far as base of the discal cell. In hind wings the discal cell is more slender, fork 5 not so far back as base of discal cell.

Expanse 10 mm.

Chimarrha (Curgia) fraterna, sp. nov.

Type.— M. C. Z. 14,876. Cuba. (Charles Wright).

Body yellow, with mostly golden hair; abdomen with segments margined with brown, antennae, tarsi, and palpi blackish. Wings brown, with black hair; fore wing with several large, golden yellow spots reaching from base through middle of wing; a basal streak reaching one third way out, with an upward extension at tip, beyond an elongate streak, much larger at base, pointed at tip, beyond this a transverse spot covering the bases of apical cells; these marks are practically the streak of *C. pulchra*, broken into three parts. The last joint of palpi is rather larger than the third joint; in the fore wing the radial sector is not curved at base of discal cell; forks 1 and 2 not extending back on discal cell, fork 3 very much longer than its pedicel; in hind wing this fork equals its pedicel.

Expanse 16–19 mm.

Chimarrha (Curgia) moesta, sp. nov.

Type.— M. C. Z. 14,871. Cuba. (Charles Wright).

Brownish to black; head with grey or yellowish hair; antennae yellowish brown, darker toward tip; palpi brown, second joint with cluster of bristles at tip; third joint but little shorter than second, fourth much shorter, fifth but little curved and about equal to the third; legs yellowish; thorax brown, with yellowish hair, and some black bristles. Wings brown, with darker veins, most of the hair brown or blackish, a patch of yellowish each end of the stigma in fore wing; anastomosis, thyridium, and arculus hyaline white; fringe blackish; hind wings colored as fore wings, but unmarked. In fore wings the radial sector is not curved at base of discal cell, forks 1 and 2 do not extend back on discal cell, fork 3 is full as long as its pedicel, fork 5, median and discal cells all equally far back.

Expanse 16 mm.

Philopotamus aequalis, sp. nov.

Type.— M. C. Z. 14,853. Colo.: Tolland. (G. S. Dodds).

Body black, antennae and palpi brown, front and mid legs dark brown, hind legs with femora dark brown and a pale band in the middle, tibia pale yellowish, tarsi brown. Wings brown, stigma darker, thyridium, arculus, cross-vein closing median cell, and the cross-vein above it are hyaline white. Venation similar to other species, fork 1 scarcely as long as discal cell, forks 3 and 4 subequal in length. The male appendages have a basal part fully twice as long as broad, and a broad apical part nearly as long as the basal.

Expanse 16 mm.

Agrees with *P. americanus* in the black femora and in size; it differs in having the second joint of the male appendages broad and of even width throughout (in *americanus* narrower and tapering toward the tip).

Dipseudopsis morosa, sp. nov.

Type.— M. C. Z. 14,826. Philippines: Mindanao, Dapitan. Basilan. (C. F. Baker). Borneo: Talang.

Blackish; antennae, palpi, wings brown; legs reddish yellow. Wings with brown venation, radius black, a pale spot over forking of median and cross-vein behind, and along hind margin at end of anal; membrane with minute golden hairs. Inner spur of hind tibia scarcely larger than the outer, rather thickened beyond middle, the two claws (seen from end) curving the same way, from side view crossed, brush of long hairs toward tip forming two narrow tufts. Cross-vein from discal to radius more than its length before end of discal cell; fork 1 with pedicel three times length of fork; fork 3 very short pedicellate.

Expanse 34 mm.

Hydromanicus trifasciatus, sp. nov.

Type.— M. C. Z. 14,823. Philippines: Mindanao, Surigao. (C. F. Baker).

Related to *H. albofasciatus*, but the three pale bands are of about equal width throughout, and are at about equal distances apart, thus the third band is situated more basally and the second more apically than in *albofasciatus*, and the first and second are not widened behind, and the third is not narrowed in the middle; in the hind wing a pale spot near costal tip. Body dark;

antennae and palpi dark, basal antennal joints paler; vertex shining, faintly greenish; legs yellow-brown; Wings uniform dark brown; fore wings with three narrow white bands, the third not reaching across, and in the fourth apical cell, half-way out is a faint white spot; hind wing dark, with pale costal mark near the tip. Venation much as in *albofasciatus*, but fork 1 has a longer pedicel, fork 2 is also pedicellate, fork 5 is not quite as far back as fork 4.

Expanse 17 mm.

Smicridea comma, sp. nov.

Type.— M. C. Z. 14,874. Cuba. (Felipe Poey).

Pale brown; face and legs yellowish, hind tibia dark brown, antennae annulate with white, head and thorax with mostly yellowish hair; wings with brown and yellow hair, of an even color throughout, except for a faint band before middle of whitish hair, and from the stigma a large comma-shaped white spot, the end of which reaches in a curve more than one half way across the wing, the costal part of this spot is rather elongate; apical fringe white; hind wings dark, with a brown fringe. Fork 1 about as long as pedicel; fork 2 very narrow at base, reaching a little before fork 3, both with pedicel nearly equal to the median cell, fork 4 very short pedicellate, fork 5 reaches hardly as far back as fork 4.

Expanse 13 mm.

Macronema tripunctatus, sp. nov.

Type.— M. C. Z. 14,822. Philippines: Mindanao, Surigao. (C. F. Baker).

Pale yellowish throughout. Extremely similar to *M. 5-punctatus* in general appearance and venation; it differs in having but three brown spots on each fore wing, those in front of the radial sector in *5-punctatus* being absent. The wing is much more densely clothed with short golden hair, the spots are located as follows:— one on cross-vein behind median cell, one in front of the anal vein, and one on the vein from median to cubitus near base.

Expanse ♂ 24, ♀ 20 mm.

Macronema pertyi, sp. nov.

Type.— M. C. Z. 14,833. Brazil: Tapajos. 30 June. (H. O. Parish).

Brown, with the usual white mark on vertex and basal joint of antennae, and fine green hair on vertex and metanotum, and green hairs on basal two thirds of wing, and silvery costal streak, as in *M. hageni* and allies. At two thirds way out on the fore wing is a broad yellowish white band, broadest behind, and on costal part with a silvery mark; toward tip is a narrower oblique band, and a row of connected spots along the margin, also yellowish; apical fringe pale yellowish. Hind wings dark, a pale spot on costa before the blackish tip.

Expanse 20 mm.

Macronema hageni, sp. nov.

Type.— M. C. Z. 14,834. Brazil: Tapajos, June. Obidos, August. Corry River, July. British Guiana: Mallali, March. (H. O. Parish).

Black; wings blackish, palpi and antennae brownish, latter dark at tips of the joints, basal joint with a silvery mark above; vertex with white line each side, and green scale-like hairs between, metathorax with similar green hairs in middle, and two thirds way out on the fore wings; costal area with a silvery streak, hardly reaching the silvery band at two thirds way out; an apical white lunule, and behind it a preapical row of white spots, between these and the silvery band is a large golden spot, more or less in five scarcely separated parts. Apical fringe white; hind wings dark, especially at tip, fringe dark; legs yellowish to brown, darkest on the posterior tibiae and tarsi above.

Expanse 20 mm.

This is doubtless what Ulmer has figured as *M. lineatum*, which from Pictet's figure and description must be very different.

Macronema lachlani, sp. nov.

Type.— M. C. Z. 14,835. Brazil: Teffe, 14 January. (H. O. Parish).

Brown; antennae and legs yellowish; vertex and metanotum with the white and green, and green scales on basal two thirds of fore wing as in *M. hageni*, etc. No silvery costal streak, faintly white at extreme base, and beyond rather yellowish; at two thirds way out is a broad band and another broad apical band, both yellowish, leaving the extreme apical margin dark; each band contains a narrow dark transverse streak, and the two bands are connected near middle by a longitudinal yellowish mark; all the yellowish parts have golden hair, and in the costal area between the two bands are two golden spots; the apical fringe, and the hind wing are blackish.

Expanse 20 mm.

Macronema burmeisteri, sp. nov.

Type.— M. C. Z. 14,836. Peru: Yurimaguas, April. Brazil: Santa Felipe, June. N. Pablo, February. (H. O. Parish).

Brown. Antennae with dark mark on each joint, basal joint silvery white above; vertex with white hair line each side, and the usual fine green hairs between, similar green hairs on metanotum and, on fore wings three fourths the way out, a long white streak in costal area to near middle, and beyond are two or three costal white spots; near tip is a broad band of yellowish or golden, and beyond are fine golden hairs in the black apical portion; fringe black, but yellowish at ends of the band; legs pale, darker on tibia and tarsi.

Expanse 20 mm.

Macronema mülleri, sp. nov.

Type.— M. C. Z. 14,837. Brazil: Flores, November. Teffe, December. (H. O. Parish).

Yellowish, also legs and antennae, basal joint of latter with silvery mark above; white line each side at eye, and between are faintly green hairs, and similar ones on the metanotum. Wings yellowish, with fine golden hair, the costal area with a silvery white streak to half way out, nearly two thirds way out is a silvery spot, and the costal margin beyond is blackish; near apical margin is a row of golden spots, and a little before, but much more than two thirds way out, is a narrow golden band; the apical fringe is pale yellowish. Hind wings hyaline, with yellowish fringe.

Expanse 20 mm.

Related to *M. lineatum* Pictet which is of the same yellow color, but with a silvery band at two thirds way out.

The South American Macronemas of the *lineatum* section can be separated as follows:—

1. Wings blackish, more or less evident green scales on basal part.........3
   Wings yellowish, no green scales.................................2
2. Silvery band at two thirds way out, and apical margin silvery..*lineatum*
   Golden band nearer tip, and apical margin golden..............*mülleri*
3. Two large yellow or golden bands connected in middle, each band with a central dark mark..................................*lachlani*
   Not as above..4
4. A yellow band before tip, much beyond two thirds way out..*burmeisteri*
   Two or more silvery bands..................................5
5. Two complete bands and apical margin silvery, a golden or silvery spot between the bands......................................6
   Without spot between bands...................................7
6. Spot silvery; apical band, extending around outer edge..*argentilineatum*
   Spot golden; apical band short, and before it a submarginal row of spots. *hageni*
7. Silvery band two thirds way out, hardly complete, and short apical lunule...*fraterna*
   Yellowish white complete band two thirds way out, a narrow preapical band, and apical margin pale.............................*pertyi*

Macronema braueri, sp. nov.

Type.— M. C. Z. 14,838. Brazil: Teffe, 30 June. (H. O. Parish).

Head, thorax, and legs yellowish, dark spot on face and one on clypeus, vertex with shining black band from eye to eye, middle of palpi black, ends pale; antennae black, except the yellow basal joint, abdomen yellow-brown. Wings yellowish, with fine yellow hair, more hyaline through the middle; with two cross-bands, near middle connected, and almost connected to a basal longitudinal stripe which ends in a subbasal half band; apical and outer margins narrowly black; fringe black. Hind wings blackish, the costal margin for three fourths the way out and some space behind it, yellowish; palpi short, third joint but little longer than the second, and scarcely longer than the fourth; vertex elevated in the middle; anterior tibia rather swollen and black, mid tarsi of female flattened, the last three joints dark. Discal cell much longer than broad, about as broad as median cell; fork 1 with a short pedicel; no costal cross-veins.

Expanse 20 mm.

In the apical mark of wing, structure of head, swollen metatarsi, color of front tibia, there is much resemblance to *Pseudamacronema arcuatum*, but fork 5 is present, and the discal cell closed.

Macronema gundlachi, sp. nov.

Type.— M. C. Z. 14,875. Cuba (Johannes Gundlach. Charles Wright).

Yellowish, clothed with very short grey and yellowish hairs; face grey-haired, a line of white hair each side on vertex by the eyes, rest of vertex, thorax, and wings with fine yellowish hair. Wings unmarked, venation fulvous, fringe brown; antennae pale, ends of joints narrowly dark; second joint of palpi two and a half times as long as third joint, last joint about equal to the others together. Vertex flat, with median suture, lateral warts reach about middle of eyes. Wings rather long; hind wings very broad. Discal cell about twice as long as wide at tip, fork 1 with a very short pedicel, fork 3 reaching one third back on median cell; cubital area before fork 5 is swollen above, the lower branch of the median being strongly upcurved toward the end; anal vein rather strongly sinuate, and uniting to second anal considerably before middle of wing; median cell three times as long as discal; in hind wings discal cell very minute.

Expanse 35 mm.

Leptonema insulanum, sp. nov.

Type.— M. C. Z. 14,870. Porto Rico: San Juan.

Pale yellowish, clothed with whitish or pale yellowish hair; antennae scarcely annulate at tips of joints; wings whitish, with pale greenish venation. Palpi slender, third joint slightly swollen, about three fourths length of the second, fourth about one half of the third. In general very similar to *L. albovirens* in appearance and in structure. In fore wing fork 1 has a shorter pedicel, hardly as long as discal cell, in hind wings fork 1 is scarcely as long as its pedicel. The appendages are similar to those of *albovirens;* the lower appendage, has the basal piece less swollen in the middle than in *albovirens*, the lateral superior appendages are deeply furcate at tip.

Expanse 32 mm.

EXPLANATION OF THE PLATES.

PLATE 1

PLATE 1.

Fig. 1. Macronema lachlani, tip of fore wing.
Fig. 2. Macronema burmeisteri, tip of fore wing.
Fig. 3. Macronema muelleri, tip of fore wing.
Fig. 4. Macronema pertyi, tip of fore wing.
Fig. 5. Macronema fraterna, tip of fore wing.
Fig. 6. Macronema hageni, tip of fore wing.
Fig. 7. Macronema braueri, fore wing.
Fig. 8. Thysopsocus stigmaticus, fore wing.
Fig. 9. Epipsocus antillanus, fore wing.
Fig. 10. Oligotoma venosa, fore wing.
Fig. 11. Oligotoma californica, head and thorax.
Fig. 12. Anisogamus atripennis, tip of abdomen.
Fig. 13. Oligotoma venosa, hind wing.

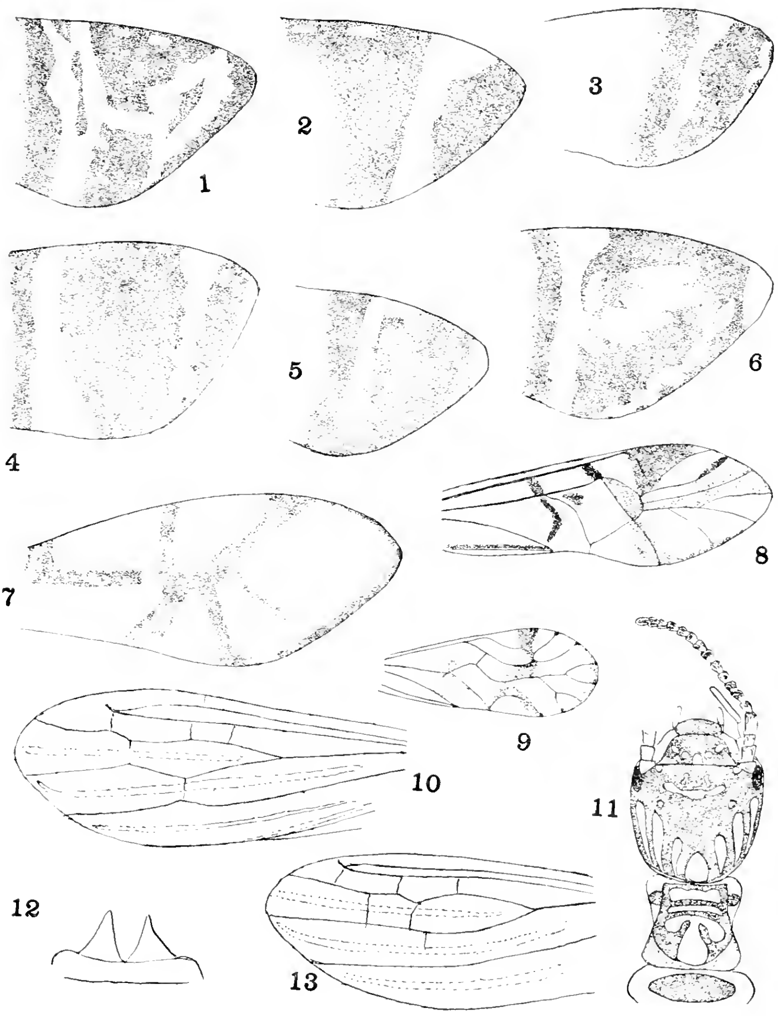

1
2
3
4
5
6
7
8
9
10
11
12
13

PLATE 2.

PLATE 2.

Fig. 14. Neoperla hermosa, male genitalia, above.
Fig. 15. Neoperla consimilis, male genitalia, above.
Fig. 16. Neoperla oculata, male genitalia, above.
Fig. 17. Hemerobius algonquinus male genitalia, side and tip.
Fig. 18. Baetis lasallei, hind wing, and male appendage.
Fig. 19. Neoperla bakeri, male genitalia, above.
Fig. 20. Peltoperla mindanensis, male, ventral segment.
Fig. 21. Neoperla atripennis, male genitalia, above.
Fig. 22. Oligotoma venosa, appendages.
Fig. 23. Hagenulus eatoni, hind wing.
Fig. 24. Raphidia crotchi, male genitalia, below.
Fig. 25. Baetis parallela, hind wing, and male appendage.
Fig. 26. Eremophanes bicristatus, side of thorax.
Fig. 27. Oligotoma inaequalis, appendages.

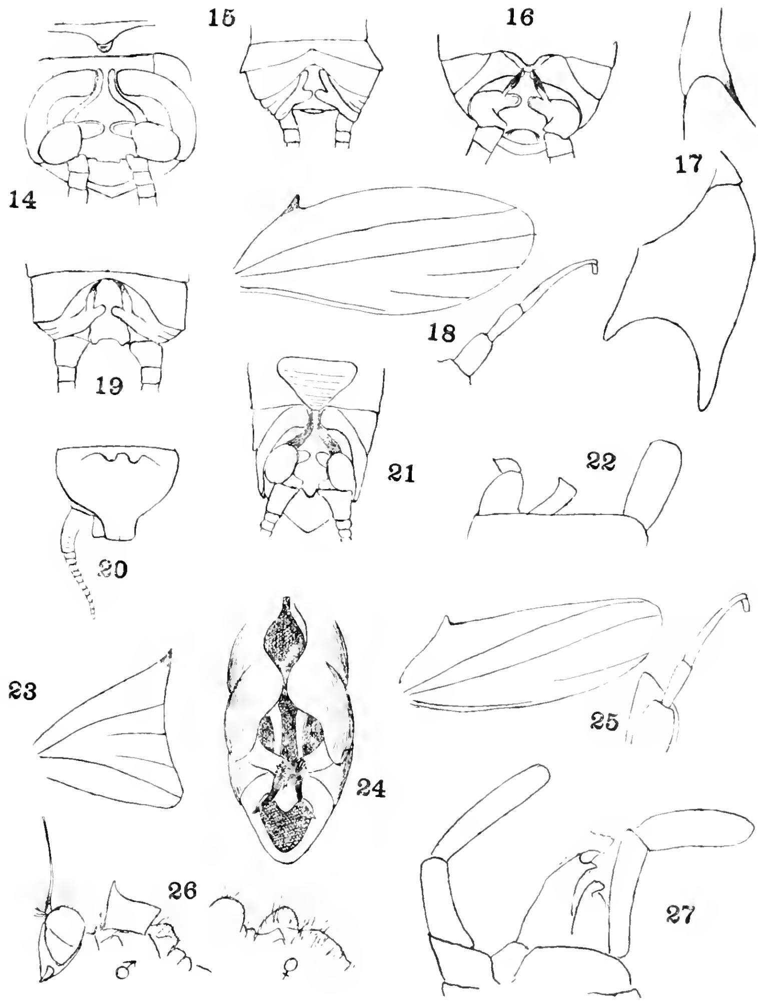

14
15
16
17
18
19
20
21
22
23
24
25
26
♂
♀
27

PLATE 3.

PLATE 3.

Fig. 28. Spilosmylus formosus, wing spots, right above; left, below.
Fig. 29. Ecclisomyia complicata, male genitalia, above.
Fig. 30. Ecclisomyia complicata, male genitalia, side.
Fig. 31. Dipseudopsis morosa, tibial spur.
Fig. 32. Chilostigma subborealis, male genitalia, side.
Fig. 33. Rhyacophila rotunda, male genitalia, side.
Fig. 34. Marilia scudderi, male genitalia, above.
Fig. 35. Apatania shoshone, male genitalia, side.
Fig. 36. Atopsyche bolivari, male genitalia, side.
Fig. 37. Rhyacophila minora, male genitalia, side.
Fig. 38. Notanatolica grisea, male genitalia, side.
Fig. 39. Hydromanicus trifasciatus, male genitalia, above.
Fig. 40. Oecetina peruviana, male genitalia, side.
Fig. 41. Ganonema furcatum, male genitalia, above.
Fig. 42. Marilia wrighti, male genitalia, above.
Fig. 43. Apatania shoshone, male genitalia, above.
Fig. 44. Raphidia crotchi, tip of abdomen, side.
Fig. 45. Limnephilus forcipatus, male genitalia, side and below.
Fig. 46. Oecetina amazonica, male genitalia, side.

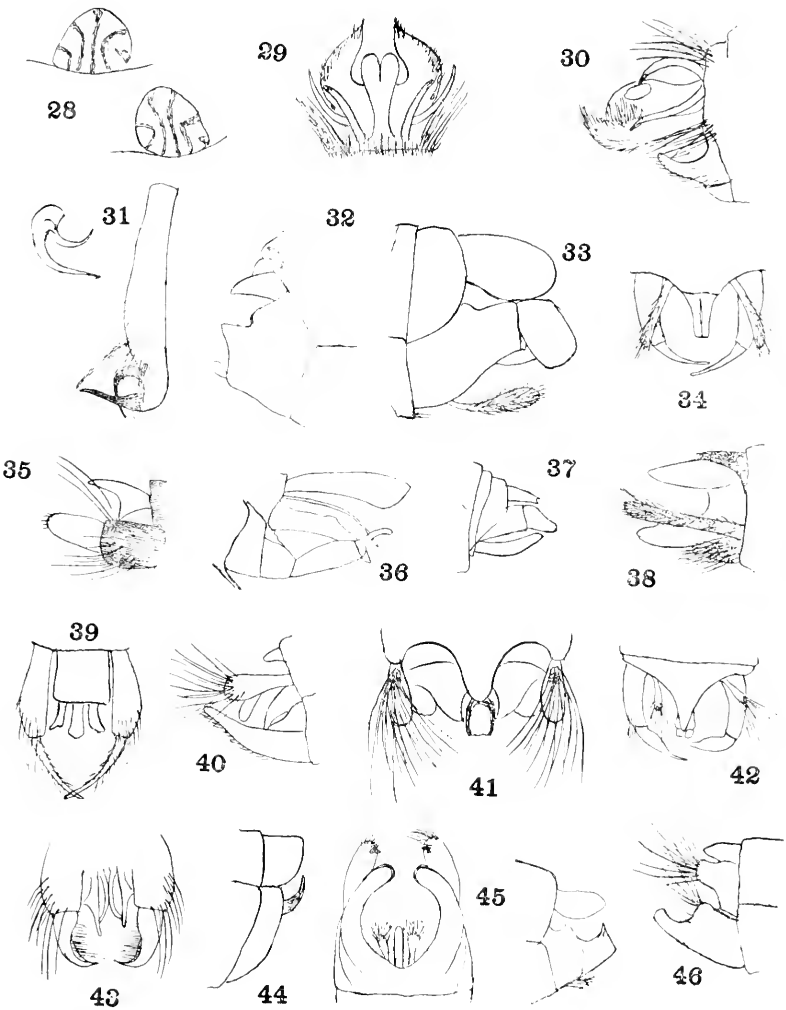
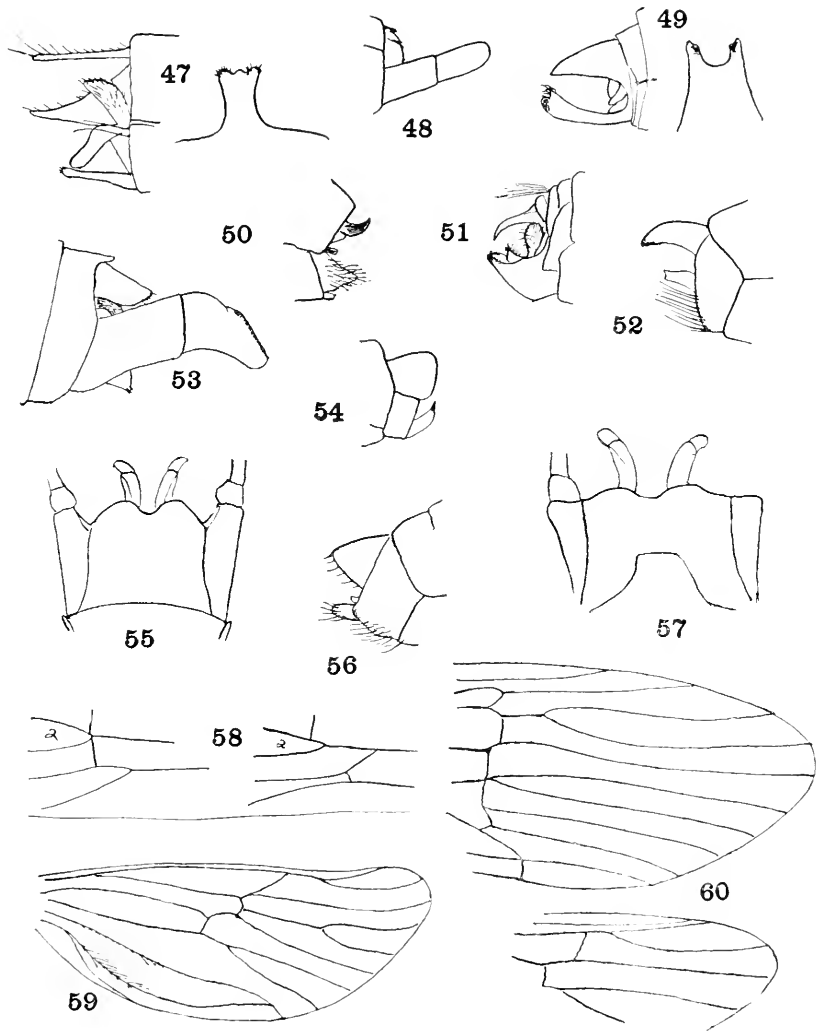

28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46

PLATE 4.

PLATE 4.

Fig. 47. Mystacides canadensis, genitalia, side, ventral piece.
Fig. 48. Philopotamus aequalis, genitalia, side.
Fig. 49. Rhyacophila anomala, genitalia, side, ventral piece.
Fig. 50. Apatania canadensis, genitalia.
Fig. 51. Neophylax occidentis, genitalia.
Fig. 52. Colpotaulius minusculus, genitalia.
Fig. 53. Rhyacophila nevadensis, genitalia.
Fig. 54. Apolopsyche pallida, genitalia.
Fig. 55. Epeorus morrisoni, male, ventral plate.
Fig. 56. Limnephilus clausa, male genitalia, side.
Fig. 57. Epeorus undulatus, male, ventral plate.
Fig. 58. Neophylax, venation, occidentis at left, concinnus at right.
Fig. 59. Atopsyche bolivari, hind wing.
Fig. 60. Notanatolica grisea, apex of wings.


47
48
49
50
51
52
53
54
55
56
57
58
2
2
59
60

Bulletin of the Museum of Comparative Zoölogy

AT HARVARD COLLEGE.

Vol. LXV. No. 13.

THE HOLOTHURIANS OF THE MUSEUM OF COMPARATIVE ZOÖLOGY. THE SYNAPTINAE.

By Hubert Lyman Clark.

With Twelve Plates.

CAMBRIDGE, MASS., U. S. A.:

PRINTED FOR THE MUSEUM.

June, 1924.

No. 13.— *The Holothurians of the Museum of Comparative Zoölogy. The Synaptinae.*

By Hubert Lyman Clark.

Although the collection of Synaptinae in the Museum of Comparative Zoölogy is not a large one, it is of much interest not merely because of the undescribed forms which it contains, but because of the light it throws on the range of diversity among specimens of long-known species. Moreover, special interest attaches to some of the material because it was collected and described by Semper, while other species were examined by Selenka and some of this material served as types for forms described in his important monograph on holothurians published in 1867. There are also cotypes of species described by others.

The classification is in fairly satisfactory condition and the study of the M. C. Z. collection does not suggest any changes. The recognized genera seem to be reasonably natural groups although much more material from the East Indian region is needed before the limits of some of them are determined. Specific limits too among the East Indian forms require much clearer indication than the present material permits. The nomenclature seems to have reached a state of considerable stability and questions concerned with it call for no discussion aside from the matter of the validity of certain forms.

The characters upon which the genera and species are based are both external and internal, macroscopic and microscopic, but the most important are the tentacles and the calcareous deposits in the body-wall and tentacles. Each of these demands a few words.

The Tentacles.

The number of tentacles is typically 12, but in one species it is constantly 11 and in at least one it is 10. Whether any species has normally and regularly 13 tentacles is still to be demonstrated, but in Synaptula the number ranges from 12 to 15 and in *S. recta*, it seems probable that 13 is the normal number. Euapta, Opheodesoma, and Synapta have typically 15 tentacles, while Polyplectana has 25 as the typical number, though many specimens, particularly small ones, have a much smaller number. As for the form of the tentacles they are usually considered as of two kinds, *pinnate* and *digitate*, the former having a slender terminal digit and the latter lacking it. It is interesting to find, however, that in the European species of Labidoplax there are connecting links between these two quite different sorts of tentacles. For in *L. buskii*, the tentacles have a distinct terminal digit and one digit on each side, while in *L. media*, (unfortunately not represented in the M. C. Z. collection), there are two lateral digits on each side, but no terminal digit.

The Calcareous Particles.

Calcareous particles of four kinds occur and as a rule each species has characteristic spicules of each kind, but in certain cases one or even two sorts may be absent.

1. *Anchors.* The anchors are the chief feature of the microscopic anatomy of synaptids and are wanting only in the little-known genus Anapta. The size and form of these particles show great diversity, but are remarkably constant within a species and hence furnish one of the best specific characters. In spite of their diversity they have certain features in common, which must be understood, if their value as a taxonomic character is to be appreciated. They lie in the epidermis of the body-wall, outside or over the anchor-plates. The shaft is not straight and the arms and the stock do not lie in the same plane with it. The arms are directed outwards and the stock is bent inwards and as a consequence it is very difficult to get an anchor to lie under the microscope in a perfectly horizontal plane. As a consequence, there is more or less asymmetry in most *camera lucida* drawings and in *microphotographs*, but usually, if the desired position is secured, the anchors are bilaterally symmetrical. Asymmetry, as shown in figures, is not therefore real. In nearly all fully-developed anchors, one of two conditions prevails; either the arms are smooth and there are minute knobs at the apex of the shaft or the apex is smooth and the arms are serrate on the outer side. In young or incompletely-developed anchors both apex and arms are smooth. Another important character is noted in the stock, which may be deeply divided, even somewhat branched, or on the other hand is not divided at all, but is covered along and near the margin by minute teeth or prickles. Good generic characters are given by the four possible combinations of these two features.

2. *Anchor-plates.* The anchor-plates lying below the anchors and serving as a support for them, to which are attached by the stock, are

very difficult objects to show in drawings. The outer surface is more or less concave, in most cases, and there is a fairly evident, but not clearly defined, thick rim around the plate except at the narrower end. In Euapta and Opheodesoma there is a well-marked arch across this narrow end, on the outer side, called the "bridge." This bridge is also evident in Synaptula, less so in Synapta, while in Leptosynapta it tends to become fused more or less fully with the plate. It is wanting in Labidoplax, but is represented in Protankyra by an irregular mass not at all like the slender bridge of Euapta. The perforations in the plate are rarely smooth and entire in adults, but always are so in the incompletely-developed plates. In the most specialized plates, such as those of Euapta, the serrations are on one surface of the plate on one side of the opening and on the other surface of the plate on the other side. In Opheodesoma, there is a tendency for the serrations on the outer side of the plate to completely surround at least some of the perforations. Excellent taxonomic characters are thus given by the condition of the bridge and the serrations, as well as by the form of the plate.

3. *Supporting rods.* In most synaptids, the walls of the digits or of the tentacles or of both, are supplied with calcareous rods, which furnish a fairly good taxonomic character. The absence of these rods is one of the distinguishing features of Opheodesoma, Polyplectana, Synapta, and Synaptula.

4. *Miliary particles or granules.* In most genera there are present very minute rods, grains, plates, or particles of lime which are conveniently termed miliary particles. When best developed they occur in patches in the epidermis, often around the anchors and plates, and are visible to the naked eye as white blotches on the skin. If less well developed they are scattered uniformly or more or less irregularly in the skin and are not visible except with considerable magnification. When least developed they are found only along the radii and sometimes only near the anterior end of the body. They may be wholly wanting. They are fairly characteristic in the different genera and in Leptosynapta and Protankyra, at least, they furnish excellent specific characters. When the form is distinctive, the miliary particles furnish one of the most reliable means of identifying species.

There are 710 specimens of 35 valid species in the M. C. Z. collection. Several invalid species, represented by type-material, naturally have also to be considered. The measurements given of the calcareous particles are calculated from sketches made with a *camera lucida*, after magnifications of 95 or 425 diameters. They are of course based on normal, fully-developed particles. The figures given are all drawn to the same scale, in order to facilitate comparison between allied species. Particular attention has been given to the anchor-plates in the effort to show the exact character of the serrations around the perforations and the nature of the so-called "bridge." Such detailed figures have not hitherto been published.

EUAPTA GODEFFROYI.

Plate 1, fig. 1–4.

Synapta godeffroyi Semper, 1868. Holothurien, p. 231.
Euapta godeffroyi Östergren, 1898. Öfv. K. vet.-akad. Forh., **55**, p. 113.

There are 12 specimens of this Indo-Pacific species from five localities. Four specimens were collected by Garrett at the Hawaiian Islands and were examined by Selenka. There are several labels with them; one reads "*Synapta serpentina*. Sandwich Islands. 1065," another "*Synapta serpentina* Mull. (as named by Selenka)." Selenka, however, records no *serpentina* from the "Sandwich Islands," but lists only a Zanzibar specimen as in the M. C. Z., so he may not be responsible for this misidentification. The specimens are unquestionably *godeffroyi*, but there are none in the M. C. Z. which can properly be called *serpentina* so I am unable to distinguish that species from *godeffroyi*. The four Hawaiian specimens of the latter range from 230 to 475 mm. in length; the largest is 20 mm., more or less, in diameter and in life was probably over a meter long. It has 16 tentacles with as many as 40 pairs of digits, about 30 polian vesicles and a single stone-canal. Color, pale brown, nearly white anteriorly, darkest posteriorly and dorsally; posteriorly, ventrally, dark, radial lines are well marked. Calcareous ring distinctly greenish in color. Cartilaginous ring wanting. The other three specimens have 15 tentacles each, with 20–30 pairs of digits. The coloration is similar, but in the two smallest specimens is much darker. In all the green color of the calcareous ring is notable.

A specimen from the Marshall Islands, 230 mm. long, has 15 tentacles, but they are very small, only 7–8 mm. long, or about one half the normal size. Its color is nearly white except for dark spots about 3 mm. in diameter, apparently in transverse series on the back, though the arrangement is obscure. There is no indication of "eye-spots" at the base of the tentacles on the disk. The calcareous ring is greenish. Cartilaginous ring wanting. One stone-canal, but very many polian vesicles. The miliary granules are excessively abundant in this specimen and its white color is, in part at least, due to them.

A specimen from Samoa is one of Semper's cotypes, and is apparently the specimen from which his figure of the calcareous ring was taken, as that much of the ring, which is conspicuously green, is carefully exposed. The specimen is 470 mm. long and has numerous polian vesicles, but only one stone-canal. The color is whitish, somewhat variegated dorsally with pale and darker brown.

A specimen taken by Garrett at the Society Islands is 190 mm. long and 9 mm. in diameter, and has 15 tentacles with 25–30 pairs of digits. It is variegated pale and dark brown and has the calcareous ring green. The miliary granules are very numerous, especially on the inner face of the tentacles, at the base of which are at least faint indications of eye-spots. The polian vesicles are numerous and the stone-canal single.

Other specimens are from Hawaii, Samoa, and the Murray Islands, northeastern Australia. They range from 120 to 290 mm. in length. All have 15 tentacles, but the number of digits ranges from 17 to 32 pairs. There are distinct eye-spots in the specimens from Samoa and the Murray Islands, but none in the Hawaiian specimens, which may be accounted for in part by the fact that the former have been in alcohol less than ten years while the former were taken in the "fifties" and have been in alcohol of more or less variable strength ever since. There are 15 or more polian vesicles and a single stone-canal in each of these specimens. In the smallest, the calcareous ring is not at all green, but in the others it ranges from greenish to apple-green, and in the Murray Island specimen even the madreporite is greenish.

The calcareous particles of *godeffroyi* are distinctive and quite constant in forms. The anchors and plates are typical of the genus. In the key to the species of Euapta in my Apodous holothurians (1908), *godeffroyi* is distinguished from the West Indian species, *lappa*, by the presence of misformed anchors, which I have never seen in the West Indian Euapta. But examination of the M. C. Z. material of *godeffroyi* shows that this is not distinctive as not a single malformation of an anchor has been detected in any specimen! The real difference between the East and West Indian species of Euapta is in the size of the anchors and plates. In *godeffroyi* the anchors range from 275 to 380 μ in length with an average size of about 325 μ. The anchors in the posterior part of the animal are a trifle larger than anteriorly, but the difference seems to be very insignificant. The arms of the anchor are about 22% as long as the whole anchor, while their width is about 50%. In *lappa*, on the other hand, the anchors range from 300 to 440 μ with the average at least 380 μ. The arms of the anchors, moreover, are over 30% of the length and their width 57%. The anchor-plates in each species are about two thirds as long as the anchors, but in *godeffroyi* the width of the plate is about 70% of its length while in *lappa* the plates are a trifle narrower, the breadth averaging only 64% of the length. The miliary granules of *godeffroyi* are nearly spherical or perhaps somewhat discoidal and only about 20 μ in diameter. No noteworthy differences in the calcareous deposits of specimens from different localities were seen in *godeffroyi*, but it does seem as though smaller anchors and plates occur in the smaller specimens and the largest deposits in the largest specimens. Thus a specimen from Hawaii, 120 mm. long, has anchors 280–310 μ long while another of the same lot, 420 mm. long, has the anchors 340–370 μ, and Semper's cotype from Samoa, which is 470 mm. long, has some anchors 380 μ.

The M. C. Z. material shows then that *godeffroyi* is to be distinguished from others which it superficially resembles, first, by its anchor-plates which are typical of Euapta, and secondly, by the anchors which are smaller than those of *lappa* and have shorter and slightly less extended arms. Another interesting and apparently useful character for distinguishing *godeffroyi* among its East Indian relatives is the more or less green calcareous ring. The presence or absence of eye-spots on the oral disk seems to be a very unreliable feature, though it is probable they are regularly present in normal living adults.

Euapta lappa.

Plate 1, fig. 5–7.

Synapta lappa J. Müller, 1850. Müller's arch., p. 134.
Euapta lappa Östergren, 1898. Öfv. K. vet. akad. Forh., **55**, p. 113.

There are 32 specimens in the M. C. Z. of this West Indian species. They come from Florida, Jamaica (Montego Bay, Port Antonio and the vicinity of Port Royal), and Tobago. They range from 100 to 480 mm. long in their preserved condition, but the largest could undoubtedly extend itself to a meter when alive, and that is probably the maximum for the species. Of the 29 specimens in which the tentacles are present and can be counted, 25 have 15 tentacles and 4 have 14. In a specimen from Montego Bay one tentacle is much smaller than the other 14; in another, two tentacles, (on opposite sides of the circle), are only 7 mm. long, while the other 13 are about 16 mm. long. The number of digits increases with age; in most of the Jamaica material there are 20–22 pairs, but in the largest specimen, which is from Tobago, there are 27–30 pairs. As in *godeffroyi* the calcareous ring is more or less green, there is a single stone-canal and the polian vesicles are very numerous. The cartilaginous ring is wanting, though there is considerable tough connective-tissue below the calcareous ring.

The calcareous particles are almost exactly like those of *godeffroyi*, but as explained under that species the anchors and plates are distinctly larger and their relative proportions are somewhat different. The figures (Pl. **1**, fig. 1, 2, 5, 6) show the degree of this difference. As in the East Indian species, so in *lappa*, the anterior anchors are not noticeably larger than the posterior anchors of the same specimen, but in the larger specimens, just as in *godeffroyi*, the anchors and plates are appreciably larger than in small specimens; thus in the largest specimen (480 mm. long) the anchors average 410 μ while in the other Tobagoan which is only three fourths as large the average is 360 μ and in still smaller specimens the average is only a little over 340 μ. Moreover there is a fairly striking difference between the specimens from Tobago averaged together and large specimens from Montego Bay, in that the anchors of the former seem to be distinctly larger.

Opheodesoma glabra.

Plate **2**, fig. 4–6.

Synapta glabra Semper, 1868. Holothurien, p. 12.
Opheodesoma glabra Fisher, 1907. Hawaiian hol., p. 723.

There are only two specimens of this species in the collection and each of these has features of special interest.

One is from Siboga St. 213, near Saleyer, D. E. I. and was identified by Sluiter. It is 215 mm. long and has 15 tentacles, each with about 22 pairs of digits. The calcareous ring is low, white, without a trace of green. Stone-canals and polian vesicles both numerous. The genital duct, in the mesentery, is notably long. On the oral disk are two minute eye-spots at the base of each tentacle. There is no cartilaginous ring and there are no supporting rods in the tentacles. The color is brown, darkest above, lightest below, not mottled. The body-wall is smooth to the touch.

The other specimen is from Luzon, Philippine Islands, but no more definite locality is given. It is 230 mm. long and apparently has 15 tentacles, but they are too much contracted to make an accurate count possible. The calcareous ring is tinged with green. Stone-canals and polian vesicles both numerous. The genital duct is not notably long. There are no eye-spots. The cartilaginous ring is well developed, opaque, white, with no openings in it below the calcareous ring. There are no supporting rods in the tentacles. The color is almost uniformly dark gray and the body-wall is slightly rough.

In view of the differences in color, body-wall texture, calcareous ring, eye-spots and cartilaginous ring, it might well be argued that these two specimens are not the same species, but the calcareous particles are identical and until more material is available, it is inadvisable to lay too much stress on differences in other characters.

The anchors in *glabra* show little difference in size according to the part of the body where they are examined; thus those from the dorsal side anteriorly, in the Saleyer specimen, measure about 263 μ, from the dorsal side posteriorly about 260 μ, ventral side anteriorly about 274 μ, and ventral side posteriorly about 260 μ; in all four regions they run from 260 to 275 μ. The anchor-arms are about 36% of the length of the anchor and their width is about 50% of it. The anchor-plates are about 213 μ long by 177 μ wide; that is they are about 80% of the anchor-length and their breadth is about 83% of their own length. Whether there are locality differences remains to be seen; there is no indication of it in these two specimens. Miliary granules in *glabra* are similar to those in Euapta, but are smaller as in the other species of Opheodesoma.

Opheodesoma grisea.

Plate **2**, fig. 1–3.

Synapta grisea Semper, 1868. Holothurien, p. 11.
Opheodesoma grisea Fisher, 1907. Hawaiian hol., p. 723.

There are six specimens of this species in the collection, all but one from Mer, Murray Islands, northeastern Australia. The largest of these is 650 mm. long, but the head-end is in poor condition and while 15 tentacles can be counted, the number of digits thereon is uncertain and the calcareous ring and its associated organs are wanting. A second specimen is 530 mm. long and has 15 tentacles of which those on the right dorsal side are 25 mm. long and those on the left ventral are 15 mm. There are about 32 pairs of digits in the longer ones. The calcareous ring, which is slightly tinged with green, is like that of *glabra*, as shown in Semper's figure (1868, Holothurien, Pl. **4**, fig. 8*a*).

The cartilaginous ring is very well developed, white, and opaque, with a circular foramen under each piece of the calcareous ring, both radial and interradial. Polian vesicles and stone-canals are both numerous. There are no eye-spots nor are there supporting rods in the tentacles. The color is variegated light and dark brown, the darker shade forming indistinct wide transverse bands.

The other specimens are 400–460 mm. long and are very similar to the larger one, having 15 tentacles, conspicuous cartilaginous ring, etc. In one specimen, one of the tentacles is rudimentary but does not seem to be regenerating. The color of these specimens is similar to the large ones, but the transverse dark bands are not equally distinct in all.

The anchors range from 275 μ to 357 μ and average about 315 μ; the arms are about 35% of the length but their width is 65–80 % of that length. They are thus actually larger and relatively much wider than in *glabra*. The anchor-plates are relatively smaller than those of *glabra* as they are about 73% of the anchor-length and their width is about 77% of their own length. Both anchors and plates show slight differences in details from those of *glabra* as will be seen in the figures given (Pl. **2**, fig. 6). The miliary granules of *grisea* (Pl. **2**, fig. 3) are similar to those of the other species of Opheodesoma.

The sixth specimen is from Zanzibar. It is 700 mm. long and lacks the head-end. The color is variegated with different shades of brown, but is more or less bleached by the long stay in alcohol. The anchors and plates are like those in the specimens from Mer, and hence, although it is labeled *serpentina*, it must, I think, be referred to *grisea*. The anchors are a little over 300 μ in length and their width is about 70% of that length; they are thus a trifle smaller than in the Murray Islands specimens.

Opheodesoma spectabilis.

Plate **2**, fig. 7–9.

Fisher, 1907. Hawaiian hol., p. 723.

There are 29 specimens of this species at hand, all from Pearl Harbor, Oahu, Hawaiian Islands. Of these, 3 are cotypes of Fisher's and 26 were collected by myself in December, 1913. There are two in which the number of tentacles cannot be determined satisfactorily, but the others each have 15. In general these specimens accord well with Fisher's description and figures. In two specimens, there are only 12 tentacles fully developed, the other three being more or less rudimentary. Many stone-canals and polian vesicles are present, save in one specimen where there are only a few polian vesicles. There is great diversity in the matter of the cartilaginous ring, but in general it may be said to be wanting in very small specimens and heavy in those that are full grown. There is an equally striking difference in the size of the calcareous particles between young and old. In a specimen 40 mm. long (probably 75–80 mm. long in life), the anchors average only about 232 μ in length, in one 100 mm. long, they run about 295 μ, and in specimens 160–200 mm., they average 326 μ. In full-grown adults, they often exceed 400 μ and average about 385 μ. The arms of the anchors are about one third as long as the anchor, but their breadth is two thirds of that length. It will be noted therefore that the calcareous particles afford very little assistance in distinguishing *spectabilis* from *grisea*. The most that can be said is that if specimens of the same size are compared, the Hawaiian species will be found to have anchors about 10% longer than the other and their arms will be relatively less broad.

Polyplectana kefersteinii.

Plate **1**, fig. 8–12.

Synapta kefersteinii Selenka, 1867. Zeitsch. f. wiss. zool., **17**, p. 360.
Polyplectana kefersteinii H. L. Clark, 1908. Apod. hol., p. 16, 77.

There are 23 specimens of this interesting species, including cotypes. They vary greatly in size and in number of tentacles, but they leave little room for doubt that the typical adult *kefersteinii* is 400–500 mm. long (in life) at least, and has 25 tentacles; specimens, however, undoubtedly grow to a greater size and may have 26 or 27 tentacles, possibly more.

The cotypes are 6 specimens from the Hawaiian Islands, several of which are more or less fragmentary. They are 95–150 mm. long, a typical one being 135 mm., and 9 mm. in diameter. In one case the tentacles are lacking and in another they can be counted only with difficulty, but there are apparently 25. Of the others, one has 22, one 23, one 25 and one, 140 mm. long, 26. These specimens are uniformly brown. The miliary granules are rods 17–35 μ long, usually expanded and notched or even branched at one or, generally, both ends. The anchors are appreciably larger in these cotypes than in any other specimens of *kefersteinii* I have examined. They are 310 μ long, with the arms only 22½% of the length; the breadth of the short, thick arms is fully 60% of the anchor-length. The plates are not so large as in some other cases, but are about 220 μ long and 160–175 μ wide. Miliary granules are fairly abundant, but there are none in the tentacles.

An anterior fragment of a specimen from Samoa, 33 mm. long and 7 mm. in diameter, received from Semper, has also been examined by Selenka, though it is apparently not a cotype. There are only 21 tentacles, which are rather long, but with 15–17 pairs of short digits. The calcareous ring is rather thin, with no trace of green, and the cartilaginous ring is also thin, but very wide. There is one stone-canal and many polian vesicles. The miliary granules while occasionally rod-like, as in the cotypes, are as a rule expanded into little imperfect rosettes or asymmetrical perforated plates. At the very tips of the tentacles, however, are numerous, minute, rod-shaped or oblong granules only 6–10 μ long. The anchors average about 260 μ long with arms only 68 μ long but 160 μ across. The plates are about 210 μ by 165 μ.

An old specimen, pale brown, but more or less bleached, about 140 mm. long, with 26 tentacles, is said to be from the "Isle of Pearls, Panama" but I do not credit the label. It is probable that the Hawaiian Islands is the correct locality. The anchors are about 280 μ long, with arms about 77 μ long and 170 μ across. The plates are about 210 μ by 165 μ.

There are 2 specimens about 110 mm. long from Lahaina, Maui, Hawaiian Islands, which I collected December 6, 1913. They are uniformly purple-brown in color and have 25 and 26 tentacles. The anchors in one specimen are 263–277 μ long, while in the other they are about 300 μ. The plates with the smaller anchors are only 190–200 μ long, while those of the other specimen are about 215 μ by 165.

There are 7 specimens, which I found at Hilo, Hawaii, December 8–10, 1913. They vary from 35 to over 200 mm. in length; the smallest is only 2.5 mm. in diameter while the largest is 17. The number of tentacles shows great diversity and is not closely correlated with size. A specimen 90 mm. long has only 16 subequal tentacles; one, 60 mm. long, has 20 tentacles; the little 35 mm. specimen has 22; one, 75 mm. long, has 23; the largest specimen and another, 160 mm. long, have 25 each; and a specimen 95 mm. long has 27 tentacles, but 3 are undigitated stumps and 3 others are noticeably smaller than the rest. In the specimen with 20 tentacles, 2, side by side, are undigitated; the specimen with 22 has one much smaller than the rest; and the one with 23 has one undigitated and 2 others much smaller than the others. The smallest specimen has very distinct "eye-spots" on the oral disk and the calcareous particles are very small; the anchors are

200–215 μ long and their arms are relatively long for the species, 26% of anchor-length, but the breadth of the arms is about as usual, 60% of anchor-length; the plates are mostly about 145 μ long by 130–140 μ wide, but some were found notably larger, 188 × 158 μ; many anchors and plates are in the well-known stages of development, beginning with simple rods and x-shaped bodies, an obvious indication of the youthfulness of the specimen; the miliary granules are very minute discoidal bodies often, but not always, with one or two handle-like projections and when two such projections occur, the granules might be described as rods with a disk-like enlargement at the middle. The specimen 90 mm. long has the miliary granules all rods, often enlarged at middle or near one end; the anchors are about 260 μ long with arms not quite one fourth as much, while the plates are about 200 × 158 μ. The largest specimen is over 200 mm. long, uniformly brown, lightest on the tentacles, the inner surface of which is sparsely speckled with dark brown. The tentacles are about 12 mm. long and have about 30 pairs of digits. The miliary granules are excessively abundant so that at middle of body the anchors and plates are actually imbedded in them. The anchors are about 290 μ long with the arms fully 26% of the length and the breadth well over the usual 60%; the plates are 220–235 μ by 167–180 μ.

A specimen which I collected on the reef at Papeete, Tahiti, August 5, 1913, is in fragments, but has a diameter of about 7 mm. It has only 18 tentacles and 3 of these are very small and 2 others smaller than the rest. The miliary granules are bent, branched and contorted rods, of rather unusual stoutness. The anchors are about 260 μ long, with long arms 26% of anchor and having a spread of 62% of anchor-length; the plates are 200 × 158 μ.

From Mer, Murray Islands, northeastern Australia, there are 4 specimens, 70 × 7 mm., 165 × 13 mm., 300 × 17 mm., and an anterior fragment, 8 mm. in diameter. These specimens were collected on the reef-flat at Mer in October, 1913. The smallest has 23 tentacles, with one smaller than the others; the two next larger have 24 tentacles, in each case with 2 small ones; the largest specimen has 25 equal tentacles. All these specimens are brown, in one case distinctly darker dorsally; the tentacles are more or less conspicuously speckled except in the largest specimen, where they are reticulated with brown. The miliary granules are very numerous and are nearly all more or less plate-like, much as in the specimen from Samoa. In the largest *kefersteinii* I have seen, the plates are very large, but the anchors are not so big as in the cotypes; they measure about 300 μ in length with the arms having the unusual length of $27\frac{1}{2}\%$ of the whole, but the usual breadth of about 62%; the plates measure up to $242 \times 190\ \mu$, very probably the maximum for the species.

There is an anterior end, 10 mm. in diameter, from Tutuila, Samoa, collected in 1917 by John W. Mills. It has 25 much-contracted tentacles and normal calcareous particles of the average size.

Synapta maculata.

Plate **3**, fig. 1, 2; Plate **4**, fig. 1; Plate **5**.

Holothuria maculata Chamisso and Eysenhardt, 1821. Nov. Act. Acad. Germ. **10**, p. 352.
Synapta maculata Jäger, 1833. De Holoth., p. 15.

There are 21 specimens of this very interesting holothurian from the following localities: Zanzibar; Port Galera, Philippine Islands; Hope Island, Great Barrier Reef, Australia; Mer, Murray Islands, northeastern Australia; Nukulau, Fiji; Moala, Fiji; Gilbert Islands; Tutuila, Samoa; Papeete, Tahiti.

The single specimen from Zanzibar is only an anterior fragment and shows no peculiarities worthy of note. It seems to be indistinguishable from Pacific specimens. The six specimens from Port Galera are typical though by no means full grown. They are 180–600 mm. long, indicating a length in life of about twice as much. All are dark colored, either dark reddish brown and blackish or dark grayish brown and blackish. Each has 15 tentacles and numerous polian vesicles and stone-canals, often on both sides of the mesentery, though more generally on the left. The cartilaginous ring is very markedly developed, so that the calcareous ring is more or less buried in it. It has circular foramina more or less developed near its posterior margin. The calcareous ring is white without any trace of green. It is one fourth to one third as high as the complete cartilaginous ring. There are no supporting rods in the tentacles, but very minute and irregular miliary granules are abundant there, usually in patches or in continuous lines along the sides of the digits near the tip. Similar granules are excessively abundant in the skin of the body. They are only about 10–15 μ in diameter.

The specimen from Hope Island is about 700 mm. long, and has 15 tentacles with 32–37 pairs of digits. The five Murray Islands specimens are relatively small, about 250 mm. and have 15 tentacles each with 24–39 pairs of digits. The two specimens from Nukulau are about the same length, but are much stouter and were no doubt much larger in life. The specimen from Moala is not noteworthy.

The Gilbert Island specimen is of considerable interest. It is only a little over 150 mm. long and although now bleached of all distinctive color, it is labeled *agassizii*. The anchors and plates are small and resemble those of the smallest one from Tahiti, described below. The specimen from Tutuila is typical, 15-tentacled, and of average size.

The three specimens from Papeete are also of much interest, and require special description. Two are the types of *Synapta agassizii* Selenka and show the coloration on which that supposed species was based. One of them is of average size and aside from the coloration is not unusual, but the other is the smallest specimen of *maculata* which I have seen, 150 mm. long, and shows growth-changes in the calcareous particles which are of great interest. Anteriorly the anchors and plates are typical though somewhat smaller than usual, the anchors measuring 680–740 μ, but posteriorly while a few of the deposits are as large as this, most are much smaller, the anchors being only 335–560 μ long, and the plates, although perfectly formed, are only 240–300 μ long by 175–190 μ wide and the margins of the holes are more or less dentate. The original deposits therefore are apparently much more like the familiar Leptosynapta type, than one would suppose from examination of an adult specimen. Even the anchors show to some degree an approximation to the Leptosynapta form, though the approach is not nearly so striking as with the plates.

The third specimen, from Papeete, Tahiti, is only a fragment of a very large specimen, well over a meter in length, which I collected August 5, 1913. As only a small amount of alcohol was available for its preservation, I made no attempt to keep the whole specimen, but merely kept the fragment, now before me, to provide a sample of the calcareous deposits that I might make sure the animal was undoubtedly *Synapta maculata*. Examination of these deposits shows them to be quite unusual and suggests the possibility of a second species of the genus existing at Tahiti. The anchors are not remarkable, but the plates (Pl. 5) are oval instead of oblong, about 735 μ long by 500 μ wide, the bridge is often incomplete and may be wanting, the large perforations are at the larger end and the margin of the plate is more or less irregular and incomplete. Since the specimen is so fragmentary, and it is not impossible that these plates are merely senescent, it would not be wise to regard them as indicative of a new species, but they are certainly very suggestive, as I have seen nothing approaching them in form in any Synapta examined.

The typical deposits in *maculata* are very characteristic. The anchors are 850–1160 μ in length and hence are easily visible to the naked eye. The arms are about 35–40% of the length while their breadth is about 65% of the anchor-length. The stock is not branched, but finely toothed along its margin, much as in Leptosynapta, and the arms are perfectly smooth. Usually there are some very minute spherical knobs at the apex, either in a single central series or in a short series on each side, but sometimes these are wanting even in anchors which seem otherwise to be fully developed. The anchor-plates are almost oblong, about 700 μ long by 350 μ, but the sides are not quite straight and parallel, the greatest width being evidently back of the middle, at the point where the 8 or 9 large holes occur in the plate. The number of small perforations may exceed 50. All holes, large and small, have smooth margins. The bridge across the lower end of the plate is not prominent or well developed but it is usually distinct.

SYNAPTULA HYDRIFORMIS.

Plate **3**, fig. 5, 6; Plate **4**, fig. 4.

Holothuria hydriformis Lesueur, 1824. Journ. Acad. nat. sci. Phil., **4**, p. 162.
Synaptula hydriformis H. L. Clark, 1908. Apod. hol., p. 23, 82.

There are 208 specimens of this species from the following localities — Bermuda: Hamilton Harbor, Fairyland Bay, and Hungry Bay; Florida: Woman Key, Loggerhead Key, and Key West; Jamaica: Port Royal "lakes," Umbrella Point (near Montego Bay), and Bognu Islands, Montego Bay; Tobago: Buccoo Bay. These specimens range in size from those just born, 2–3 mm. in length, up to full-grown adults, 75 mm. long in their preserved condition. The ordinary anatomical features of this species are so well known it is unnecessary to discuss them here, but some points in regard to the calcareous particles warrant a few words.

Comparison of specimens from the various localities revealed no differences of importance in the size of the anchors or plates, nor do there seem to be any differences associated with the part of the body-wall where the particles lie. But there are some notable growth-changes worthy of record. In a specimen 3 mm. long, the anchors are about 130 μ in length and the plates are 115 μ × 95 μ. In a specimen 5 mm. long the deposits are just a trifle larger, but in a fully-adult specimen, the anchors are 200–230 μ long and the plates are 165–185 μ long by 130–135 μ wide. The anchors thus just about double their size as the animal matures, but the plates do not increase quite so much. A peculiarity of the plates not hitherto recorded is that the bridge is raised only a little above the surface of the plate and is attached to it anteriorly as well as posteriorly. The condition is thus intermediate between that of *S. nigra* and that which occurs in Leptosynapta. The connection between the anterior part of the bridge and the plate is easily overlooked in young or incompletely-developed plates, but it becomes well-marked in those which are old and fully formed. The miliary granules of *hydriformis* are minute rosettes about 10 μ across, but they occur in enormous numbers, often forming white spots in the skin. Naturally, they are much more abundant in old than in young specimens. They are often disintegrated into the minute grains, of which they are formed, by long preservation in alcohol, probably due to very slight acidity.

Synaptula nigra.

Plate **3**, fig. 3, 4; Plate **4**, fig. 2.

Synapta nigra Semper, 1868. Holothurien, p. 12.
Synaptula nigra H. L. Clark, 1908. Apod. hol., p. 81.

There are 6 specimens from Mer, Murray Islands, northeastern Australia. They were 100–350 mm. long in life, but though carefully narcotized before killing are only 70–225 mm. in their preserved condition. They agree perfectly with Semper's description, except that the black stripe on the tentacles, which he considered characteristic, is wanting in 5 specimens and only faintly indicated in the sixth. There is only one stone-canal, but there are numerous polian vesicles. The cartilaginous ring is very well developed with foramina near the posterior margin as in Synapta. The calcareous ring is white with no tinge of green. There is no indication of eye-spots. There are no supporting rods or other calcareous particles in the tentacles.

The calcareous particles are quite characteristic for although the anchors are much as in *hydriformis*, they are larger, while the plates and miliary granules are noticeably different. The anchors and plates show a considerable increase in size with the growth of the animal; in the smallest specimen, the anchors are 225–240 μ long and the plates are about 175 × 155 μ, the width of plate being 88% of its length; in the next larger specimen, the anchors are 265 μ long and the plates are about 205 × 165 μ; in the largest specimen, the anchors run from 265 to 283 μ while the plates show even greater diversity, running from 185 to 228 μ in length while the width, usually less than 85% of the length, may run to as much as 92%. Of course there is much diversity of size in both anchors and plates, but these figures represent the usual typical size in each of the specimens. The arms of the anchors are about 30% of its length, while their breadth is about 65%. The miliary granules are about 15 μ across.

Synaptula psara.

Plate **3**, fig. 7, 8; Plate **4**, fig. 5.

Synapta psara Sluiter, 1888. Nat. tijds. Nederl. Ind., **47**, p. 219.
Synaptula psara H. L. Clark, 1908. Apod. hol., p. 84.

There is a single small specimen from Siboga station 273 at Pulu Jedau, Aru Islands. It was received labeled *lactea*, but it has all the characters of *psara* and must, I think, be referred to that species. It is only 37 mm. long and hence is obviously young. There are 13 unequal tentacles, ranging from 3 to 7 mm. in length. The calcareous ring shows no trace of green and the cartilaginous ring is well developed, much as in *nigra*. There is a single stone-canal and several, but not many, polian vesicles. The genital glands are fairly well developed for so small a specimen and are distinctly branched. There is a pair of small, but sharply-defined, eye-spots at the base of each tentacle, on the oral disk. There are no supporting rods in the tentacles, but miliary granules are more or less frequent there. The miliary granules in this species are peculiar, consisting of more or less complete circles of very minute spherical granules; with insufficient magnification each circle appears like a single piece. It is not impossible that in fresh material, the granules of a circle are united together, but that disintegration occurs easily in alcohol. This does not seem probable, however.

The anchors are 205–233 μ in length, with long, not widespread arms; their length is 38% of the anchor while their breadth is only 58%. The anchor-plates are 170–180 μ long by 120–140 μ in width. The teeth on the perforations are minutely rough at the tips, but whether this is natural or due to acid in the alcohol remains for further material to determine.

Synaptula recta.

Plate **1**, fig. 13; Plate **3**, fig. 9; Plate **4**, fig. 3.

Synapta recta Semper, 1868. Holothurien, p. 14.
Synaptula recta H. L. Clark, 1908. Apod. hol., p. 84.

There are 48 specimens from four widely-separated localities.

A very large specimen, 425 mm. long as preserved, is from Ponape, Caroline Islands, where it was collected in 1877 by Rev. A. A. Sturgis. It is light yellowish brown in color and is noteworthy for having 14 tentacles. The digits are short, though the tentacles are long and slender. The anchors are 280–300 μ long.

There are 9 specimens from Friday Island, Torres Strait, 225–275 mm. long. Each has 13 tentacles, one or two of which may be shorter than the others. There are about 25 pairs of digits. Eye-spots at base of tentacles, on oral disk, are conspicuous on those specimens which are light colored anteriorly, but are indistinct in the darker ones. The color is nearly uniform deep brownish purple, but some specimens are lighter anteriorly, and one has the miliary granules so excessively abundant it is much lighter than the others. There are no supporting rods in the tentacles, but there are numerous small dense patches of miliary granules which appear as white spots in water or air, but are less conspicuous in alcohol. The calcareous ring is pure white. The cartilaginous ring is present, but not heavy, about as wide as the calcareous one. There is one stone-canal, but numerous polian vesicles. The genital glands are branched and the intestine is slender and looped as usual. The anchors are 245–275 μ in length; their arms are less than 40% of the length while the breadth of the arms is about 60% of the anchor-length. Some curious malformations occur among them, the two arms being asymmetrical and of unequal size, and occasionally a third arm is more or less developed. The plates are 190–210 μ long while their breadth is from 150 to 170 μ or even more; occasionally the breadth is 95% of the length. Anchors and plates occur in the basal part of the tentacles, but they are no smaller there than elsewhere. Many of these plates in the tentacles have marginal holes in addition to the normal seven, though the additional openings are especially frequent near the small end of the plate. Development of these marginal holes is associated with increased width of the plate and it is such plates which have the width 90–95% of the length. The miliary granules, which may be excessively abundant, are typical little rosettes, about 10 μ in diameter.

A specimen only 75 mm. long from Bantayan Reef, Cebu, Philippine Islands, was collected May 2, 1909 by Dr. L. E. Griffin. It was found among the "roots" of a "red gorgonian," and was very light brown mottled with white. There are 13 rather long tentacles with very short digits. The internal anatomy reveals nothing noteworthy. The calcareous particles are rather small, the anchors being only 200–235 μ in length.

The remaining 37 specimens are all small, 20–75 mm. long, but the largest is an anterior fragment of a specimen which was probably considerably longer. The lot, taken from a cable near Catbalogan, Samar, Philippine Islands, in September, 1912, by A. L. Day, show some very interesting growth-changes. There are 3 which have only 9 tentacles, 19 have 10 tentacles, (in one case 2 are noticeably smaller), 2 have 11 tentacles, 3 have 12, (in one case they are noticeably unequal), and 10 have 13, though in one case, one is very small; in another, 2 are very small; and in a third, 3 are very small. The internal condition of the specimens is very poor; in one specimen, the intestine seemed to be straight, without a loop, but the condition is too poor to permit of positive decision. In the smallest specimens, the anchors are 160–175 μ and the plates 135–150 μ long by 117–129 μ wide; the width of the plates is thus about 82–86% of the length; in the larger specimens, the plates are narrower, the width 78–81% of length.

Synaptula reticulata.

Synapta reticulata Semper, 1868. Holothurien, p. 13.
Synaptula reticulata H. L. Clark, 1908. Apod. hol., p. 86.

A single specimen, supposed to be this species, is from Siboga St. 313, in Saleh Bay, Sumbawa, D.E.I. It is 22 mm. long with 10 tentacles, 2 mm. long. The calcareous particles are badly corroded, so that accurate identification of the specimen is not possible.

Leptosynapta acanthia.

Plate **6**, figs. 12–16.

Synapta acanthia H. L. Clark, 1899. Ann. N. Y. acad. sci., **12**, p. 126.
Leptosynapta acanthia H. L. Clark, 1908. Apod. hol., p. 92.

The 11 specimens are from Bermuda: 3 cotypes, dissected and more or less cut to pieces, were collected in 1898; 7 are specimens I collected at Coney Island cove, in April, 1899; and 1 received in 1918 from the Bermuda Biological Station is without exact locality given. The largest specimen was about 350 mm. long and 8–10 mm. in diameter in life, a somewhat translucent pinkish white in color. This material shows no growth-changes in the calcareous particles. The large anchors are 600–650 μ long, with the arms 37% of the whole length, their breadth 50% of the anchor-length; there are usually 6–12 conspicuous teeth on each arm. The small anchors range from

140 to 210 μ, and often, perhaps usually, have 1, 2, or even 3 teeth on each arm; the arms are 34% of the anchor and their breadth is about 70%. The plates are from 130 to 175 μ in length and the larger are 125–130 μ wide and have 6 or more toothed perforations besides the small smooth ones. No intermediate stages between the large and small anchors were found.

Leptosynapta circopatina,[1] sp. nov.

Plate **4**, fig. 6, 7; Plate **6**, fig. 9–11.

Length about 22 mm.; diameter about 2 mm. Tentacles much contracted, but apparently 12, each with 5 digits of which the unpaired terminal digit is distinctly the longest, while the lower pair are only a trifle smaller than upper; there are 3 or 4 relatively large sense-cups on the inner face of each tentacle. No stone-canal or polian vesicle was found, nor was there any indication of a calcareous ring, but it seems probable that better material will show all of these organs. The anterior anchors are easily distinguishable from those at the posterior end. They measure about 95 μ in length and seldom attain 100; the arms are only 26% of the length, but their breadth is 60%; there are 2 minute teeth on each arm. The posterior anchors are 110–127 μ long and the arms are 26% of the length, but their breadth is only 44% of the anchor-length; there are 3 or 4 teeth on each arm. The anchor-plates show a corresponding difference in size, but it is less marked. Those at the anterior end of the body are 82–94 μ long and 73–80 μ wide; the width is thus nearly 90% of the length; they carry practically no bridge and are perforated with the usual 7 large holes, 2 smaller ones at the side of the narrower end and 3 little ones posteriorly. All of the perforations are smooth and only rarely does a low tooth occur on the margin of one of the larger ones. Posteriorly, the plates are about 100 μ long and 87 μ wide, and often have several small smooth holes in the margin external to the 7 large perforations. No miliary granules were detected in either the body-wall or the longitudinal muscles, but relatively large tentacle-rods, over 50 μ long, more or less curved, expanded at each end, with a single perforation, and often a few short, rounded branches, there, are fairly numerous in the tentacles. Color (as preserved), yellowish brown.

Holotype.— M. C. Z. 38.

I collected a single specimen of this small species at Port Royal,

[1] *circus* = a circle + *patina* = a little plate, in reference to the form of the anchor-plates.

Jamaica, in December, 1902. It was found under a brick in the boat-canal which connects the "pond" back of Port Royal with Kingston Harbor. The color in life was pale, dull reddish. At the present time, there are very slight traces of decalcification, but as this has not affected the minute teeth on the anchor-arms, or the tentacle-rods, I do not think the absence of miliary granules and calcareous ring, or of teeth on the margins of the large perforations in the plates, can rightly be attributed to it. The size and form of the calcareous particles is very distinctive, but it is probable that this is a young specimen and when adults are procured, the anchors and plates will probably be larger and possibly show some modification of the form described and figured here.

Leptosynapta crassipatina,[1] sp. nov.

Plate 6, fig. 1–4.

Length about 40 mm. in life; 25 mm. by 3, as preserved. Tentacles 12, with 4 or 5 pairs of digits and 4–10 large sense-cups on the inner surface of each. There is one slender polian vesicle but no stone-canal was detected. The calcareous ring is well developed with the radial pieces about half a millimeter wide and a third of a millimeter high, and perforated just above the middle for the nerve; the interradial pieces are narrower, but about as high and are deeply notched on the posterior margin. The anterior anchors are not only smaller than the posterior, but are different in form. They are 117–130 μ long, the arms only one fourth as much, but their breadth is 65% of the anchor-length; the arms are smooth or with slight indications of a single tooth on each. The plates, accompanying these anchors, are 110–117 μ long and 80–92 μ broad, relatively thick and heavy, with the usual 7 toothed holes, 2 large smooth holes, one on each side at the base of the bridge, and 6–8 small smooth holes beyond. There are 2 or 3 small holes in the base of the bridge on each side, the bridge itself being well developed. The posterior anchors are 155–183 μ long, with the arms nearly one third as much and their width about 45% of anchor-length. The arms have each 3–7 conspicuous teeth on the outer margin. The accompanying plates are very similar to those in the anterior part of the body and not very much larger, their measurements being about 130 by 90 μ. The longest plate measured is scarcely 140 μ. Miliary granules very characteristic, but not very abundant, often in groups of

[1] *crassus* = heavy, coarse + *patina* = a little plate, in reference to the relatively heavy anchor-plates.

3–5; they are curved rods with expanded and notched or branched tips; occasionally there is a knob, or even two, near the middle of the rod on the convex, and rarely on the concave, side. There are no special tentacle-rods, but numerous miliary granules occur in the tentacles, especially near the base. Color, in life and also as preserved, nearly white.

HOLOTYPE.— M. C. Z. 1188.

Two specimens of this synaptid were dug in sandy mud by a mangrove key near Key West, Florida, June 17, 1917, while I was collecting Amphioplus. The general appearance was so much like *inhaerens* of the same size that it was not until the calcareous particles were examined that the novelty of the specimens was appreciated.

LEPTOSYNAPTA DOLABRIFERA.

Plate **7**, fig. 1–6.

Synapta dolabrifera Stimpson, 1856. Proc. Acad. nat. sci. Phil., **7**, p. 386.
Leptosynapta dolabrifera H. L. Clark, 1908. Apod. hol., p. 89.

The 19 specimens of this characteristic Australian species at hand, all but one from Port Jackson, and all adult or nearly so, throw very little light on variation due to locality or age.

The single specimen from Torquay, Victoria, is the anterior end of a rather large specimen, mounted in balsam, and presented by Mr. E. C. Joshua in 1915. Its anchors and plates are somewhat larger than those of the Port Jackson specimens, but none of the latter are quite so big as it, so the difference may be only one of age. The differences in the size of the calcareous particles between the larger and smaller Port Jackson specimens is very slight, but this is probably due to their being adult. The anchors at the anterior end of the body are 10–20% smaller than those posteriorly, but the plates show only an inconsiderable difference. The Port Jackson specimens are 35–65 mm. long. Eight of them I collected at Watson's Bay, August 26, 1913, under stones near low-water mark. They were more or less translucent and were 50–80 mm. long.

Anteriorly the anchors vary from about 160 to over 200 μ, posteriorly from 200 to 250 μ. The anterior anchors have shorter and more spreading arms than the posterior ones and the teeth thereon are fewer and less conspicuous. The anchor-plates are relatively long and narrow, measuring 140–190 μ in length by 100–130 μ in breadth. The miliary granules anteriorly are, like those of *roseola*, C- and O-shaped, but posteriorly are nearly straight rods. The tentacle-rods are only a little curved, 70–82 μ long, with expanded, perforated, notched, or slightly branched ends.

Leptosynapta galliennii.

Plate **11**, fig. 1–5.

Synapta galliennii Herapath, 1865. Quart. journ. mic. sci., n.s. **5**, p. 5.
Leptosynapta galliennii H. L. Clark, 1908. Apod. hol., p. 91.

The M. C. Z. has 4 beautifully-preserved specimens, presented by Dr. Östergren, labeled "*Synapta bergensis* Östergr. Norge, Bergen, Mathopen (60° 20′ N.), 5–15 m., mudder. 5/8, 1902. Hj. Östergren." Only one of the four is complete; it is 125 mm. long by 6 mm. in diameter and has 12 tentacles with 21 digits. One of the other specimens has 12 tentacles with 19 digits, but the other two are headless fragments. I am still of the opinion that *bergensis* is identical with *galliennii*.

The calcareous particles of the present specimens are typical. Anteriorly the anchors are about 675 μ long with their arms about 30% of that in length and 54% in width. The accompanying plates are about 500 μ long and 320 wide. But posteriorly the anchors are 800 μ–970 μ long with the arms one third that length, but less than half that in width. They have 7–9 prominent teeth on each arm whereas the anterior anchors have but 4 or 5. The posterior plates are 650–740 μ long by 420–475 μ wide and are notable for having several (typically 4) holes with dentate margins in the broad end beyond the usual 7. Near the narrow end the margin of the plate itself may be more or less dentate. The miliary granules in these Norwegian specimens seem to be confined to the anterior part of the radii, as I could find none elsewhere. They are relatively coarse, stout rods, usually C- or O-shaped, but often shaped like a club or a dumb-bell.

Leptosynapta ictinodes,[1] sp. nov.

Plate **7**, fig. 7–11.

Length of preserved specimen about 45 mm.; diameter 5–6 mm. Tentacles 12 with 13–15 digits (6 or 7 pairs), the terminal longest; sense-cups unusually numerous (20–30). Owing to the condition of

[1] ἰκτινώδης = kite-shaped, in reference to the form of the anchor-plates.

the specimen, it is not possible to determine the number of polian vesicles or of stone-canals. The calcareous ring is stout, about .70 mm. high, with the radial and interradial pieces similar and subequal, but the radial are perforated for the passage of the nerve and are a little more concave on the posterior margin than are the interradials. Anteriorly there is a well-marked peak on both radials and interradials.

Anterior anchors similar to those of the posterior end, but somewhat smaller, measuring 195–212 μ in length; the breadth across the arms is about 115 μ while the length of the arms is about 54 μ. Posteriorly the anchors are 235–247 μ with the width across arms about 130 μ and the arm-length about 70 μ. The anchor-arms are conspicuously dentate; on large anchors there may be as many as 9 teeth on each arm. The anchor-plates are about three fourths as long as the anchors and their width is about equal to three fourths of their length. They are remarkable for their lateral angles, which give them the form of a kite with the angles rounded. The larger the plate the more noticeable this kite-shape is, especially since the posterior end of the plate is more pointed in the larger examples. Another striking peculiarity of the plates is the abundant and large serrations of the margins of the large holes, the most anterior of which is conspicuously the largest. The narrow posterior end of the plate has about a dozen small, smooth perforations. The miliary granules are oval or elliptical in outline usually more or less constricted at the middle. They are very small, the largest only about 7 μ in length. The tentacle-rods are excessively numerous and occur even in the skin at the base of the tentacles. They are 42–80 μ in length and are more or less curved; at one extreme they are nearly straight save at the ends where the tips curve in abruptly; at the other extreme they are fully C-shaped. The tips are always more or less expanded and notched, and are often perforated. Color as preserved: very pale gray, but the body is covered with verrucae 150–200 μ in diameter and 180–225 μ high (more or less), which are full of lines and heaps of a dark, purplish brown, granular pigment. Posteriorly the verrucae are scattered and so widely separated they do not greatly affect the ground-color, but anteriorly they become more and more crowded until, just back of the tentacles the animal seems to be almost black. Of course, this crowding of the verrucae is partly, if not wholly, due to contraction of the body-wall. The pigment becomes bright rust-red in the presence of acid, but no visible effect is produced by an ordinary alkaline solution either before or after treatment with acid. The tentacles are cream-color in sharp contrast to the nearly black adjoining body-wall.

HOLOTYPE.— M. C. Z. 956.

Although this species is allied to *dolabrifera*, I think it must be quite distinct, for the color, the verrucae, the kite-shaped plates with their abundantly serrate holes, and the miliary granules are all very characteristic. A single specimen was collected at Westernport, Victoria, by Mr. J. Gabriel, who presented it to the M. C. Z. in November, 1913. It is probable that Mr. Joshua has met with this species, but did not distinguish it from *dolabrifera*, for in noting the color of that species (1914, Proc. Roy. soc. Victoria, n.s. **27**, p. 7) he says, "One specimen from Wilson's Promontory was a deep, purple-black."

LEPTOSYNAPTA INHAERENS.

Plate **7**, fig. 12–16.

Holothuria inhaerens O. F. Müller, 1776. Zool. Dan. Prod., p. 232.
Leptosynapta inhaerens Verrill, 1867. Trans. Conn. acad., **1**, p. 325.

There are 187 specimens in the M. C. Z. which I refer to this species. They come from at least eleven different localities and show considerable diversity in the size of anchors and plates, so that a somewhat detailed account of them is necessary.

Four particularly fine specimens from Norway, the gift of Dr. Östergren, are labeled "*Synapta inhaerens* (O. F. Müll.) Norge, Moldöen, Degnepollen (61° 57′ N.), 2–6 m., mudder. 8/14, 1902. Hj. Östergren." The largest is 125 mm. long and 7 mm. in diameter. In these specimens the anchors near the anterior end of the body are about 188 μ long and 110 μ across the arms which are about 75 μ long, while the accompanying plates are 155 μ long and 108 μ wide. Posteriorly, however, the anchors are 275–295 μ long, yet only 120 μ across the arms which are but 73 μ long.

Six specimens from Naples have been much cut to pieces, having served as material in several investigations. They are only of moderate size and one is very small, 20 mm. long by 1.75 mm. in diameter. The anterior anchors measure 172 μ in length, and 75 μ across the arms, which are about 40 μ long. The accompanying plates are 136 μ long by 103 μ wide. Posteriorly the anchors are 207 μ long, 82 μ across the arms, which are 52 μ long, and the plates are 148 $\mu \times$ 117 μ. In the little 20 mm. specimen the largest anchors and plates are just the size of the small ones in the large individuals.

Ten specimens from Massachusetts Bay are partially decalcified with curious results. These are cotypes of *Synapta gracilis* Selenka and are of about average size (75–100 mm.). In one of the least decalcified specimens, the anchors average about 210 μ long by 105 μ wide and the arms are 68 μ long. The plates are 150 μ × 105 μ.

From Provincetown, Mass., there are 64 specimens of average size, and condition, while from Nahant, Mass., there are 31 specimens of the same sort, but not so well preserved. These specimens call for no special comment as they are essentially like Woods Hole material. From that well-known biological Mecca, there are some 50 specimens in fairly good condition. The largest is nearly 150 mm. long and probably exceeded that measurement when alive. This is about the maximum size for American speciments of *inhaerens* though larger specimens may occur. In young specimens from Woods Hole the anterior anchors are only about 113 μ long, while the posterior are 153 μ long, and 70 μ across the arms, which are 40 μ long. In adult material from Woods Hole, however, the calcareous particles are 25% bigger; the anterior anchors are 140 μ, 85 μ across the arms which are 38 μ long; the accompanying plates are 125 μ × 87 μ. Posteriorly the corresponding measurements are 207 μ by 100 μ for the anchors and 150 μ by 97 μ for the plates.

There is a single specimen from Mendocino, California, above average size, but badly cut to pieces. It is the only cotype of Selenka's *Synapta albicans* in the M. C. Z. The largest anchor found was 200 μ long, most are about 190 μ; they are 82 μ wide across the arms which are about 45 μ long. The plates are 132 μ long by 94 μ wide.

Some 16 specimens from Pacific Grove, California, are of average size and in good condition. In these specimens the anterior anchors are about 150 μ long, while the accompanying plates are 118 μ long by 82 μ wide; the posterior anchors are 190–200 μ long and their plates 139 μ × 100 μ. One specimen is remarkable for the very wide anchor-plates which measure about 130 μ by 110 μ; some of these plates are widest back of the middle.

From an unknown locality, supposed to be on the Pacific coast of North America, south of San Diego, California, there is a bright brown leptosynaptid, which seems to be *inhaerens*. The posterior anchors vary from 143 to 170 μ in length and are noticeably narrow, only 63 μ across the arms which are 37 μ long. The anchor-plates are 100–115 μ long and about 84 μ wide. This specimen is supposed to have been taken by the ALBATROSS in 1911 and in 1913 it was "almost black," but has now become brown. It is only 35–40 mm. long by 4 mm. in diameter.

From Laguna Beach, California, a fragment of a leptosynaptid is

10 mm. long. It was "pink" in life, but shows no such color now. It was taken August 22, 1917. The anchors are 170–183 μ long, about 80 μ wide, across the 50 μ arms; the plates are about 130–135 μ by 90 μ.

Finally there are three fair adult specimens from Elly Bay, Belmullet, County Mayo, Ireland. These were sent to the M. C. Z. in July, 1920, by Miss Anne Massy, as part of the material upon which were based her remarks on *inhaerens* in her paper on Irish holothurians (1920, Sci. proc. Roy. Dublin soc., n.s. **16**, p. 57). In these specimens the anchors range from 155 μ to 230 μ and the plates from 130 μ to 160 μ. Miss Massy's measurements as published indicate much larger calcareous particles than these for she says the anchors range from 176 μ to 330 μ (though only 2 exceeded 297 μ), but about 70% are under 254 μ. She makes no distinctions of size or age nor of the anterior and posterior parts of the body. In a letter, however, she has kindly given measurements of 6 anchors from the anterior part of a 60 mm. specimen, and of 6 from near the posterior end; of the breadth across the flukes, as well as the length. According to these figures, the anterior anchors average 247 μ and the posterior 273 μ; in each case the breadth across the flukes averages only 42% of the length. In measurements I made on the Elly Bay specimens, the breadth is about 45% of the length in the long posterior anchors, but is 57% of the length in the small anterior ones. Miss Massy's figures show some astonishing extremes for she gives one anterior anchor as 209 μ long by 110 μ broad (52%) and another, also anterior, as 313 μ long by 110 μ broad (32%). I do not find such diversity in the Irish material before me. Miss Massy's measurements average about 30% larger than mine. I can only account for our differences on the assumption of a large "personal equation" in measuring such minute objects, unless it should develop that Miss Massy did not make sure that all of the anchors she measured were fully mature, uninjured, and lying perfectly flat. The age of the specimen, (not always correlative with its size), and the part of the animal examined are, as already said, factors of great importance to which she gave no attention. There are also evidently considerable differences in the size of the calcareous particles in *inhaerens* from different localities, and many of Miss Massy's measurements are based on specimens from Blacksod Bay, whence I have had no material.

Comparison of the observations made on the material from the different stations listed above shows that the anchors anteriorly are usually about 140–160 μ long, while posteriorly they range from 170 to 295 μ, the marked diversity being associated in large part with age and to some degree with locality. The plates show less diversity than the anchors and range from 115 to 160 μ; the width of the plates is .65–.75 of the length. Of the material at hand, the Norwegian specimens have the largest calcareous particles, while the specimens from Ireland come next. Evidently then the *inhaerens* of northern Europe has distinctly larger anchors and plates than are found in American specimens. Specimens from Massachusetts Bay, Naples, and Woods Hole rank third, fourth, and fifth respectively, but the differences between the specimens from these three localities are trivial and seem to have no significance. The specimens from the Pacific coast of America seem to have somewhat smaller calcareous particles than those from the Atlantic coast, and those from the southern part of the western coast than those from farther north. The largest anchors of specimens from Laguna Beach and further south are hardly equal to the smallest anchors of the Norwegian specimens, but the intergradations between these two extremes is so complete it does not seen possible to separate *inhaerens* into either varieties or subspecies. It must be granted, however, that our knowledge of the Pacific coast leptosynaptids is still very imperfect.

Leptosynapta latipatina.

Plate **7**, fig. 17–19.

H. L. Clark, 1921. Echin. Torres Strait, p. 161.

The only specimen of this species in the M. C. Z. is the holotype, the anterior end of which is lacking.

Leptosynapta multigranula,[1] sp. nov.

Plate **8**, fig. 3–7.

Length, 75 mm.; diameter, 5 mm. Tentacles 12 with 5 or 6 pairs of digits; there are 2–9 sense-cups on the inner face of each tentacle. Stone-canal single with a well-marked madreporite. Polian vesicles 2–5, unequal; the largest 5 mm. long. Calcareous ring well developed, the radial pieces perforated for the passage of the nerve; both radial and interradial pieces, but especially the latter, deeply concave on the posterior margin; the anterior margin is slightly peaked especially on the radial pieces.

The anchors of the anterior end are 190–280 μ long, 115–148 μ across

[1] *multus* = many + *granulum* = a little grain, in reference to the very numerous miliary granules.

the 60–82 μ arms. The arms are well curved, but are not, even at the tip, nearly parallel to shaft. They each carry half a dozen well-marked teeth. The anchor-plates are somewhat shorter than the anchors; they average nearly 200 μ long by 150 μ wide; they have the usual 7 large serrate holes and half a dozen small smooth holes in the posterior end. The anchors near the rear end are much larger than those anteriorly placed; they range from 343 μ to 445 μ, but average about 390 μ. The arms are long and slender and near the tips are almost parallel with the shaft; they bear 9 or 10 conspicuous teeth. The width from tip to tip of arms is about 45% of the anchor-length, but the length of an arm is not quite one third the anchor-length. The posterior anchor-plates differ little from those of the anterior end, but some are distinctly larger; the largest are 285 μ long by 220 μ wide.

Miliary granules abundant all over the body and even in the tentacles; they are particularly abundant along the radii. They are relatively large, more or less irregular C-shaped bodies; anteriorly the tips are often a little expanded and notched, and rarely the whole granule is merely a thickened curved rod, which in extreme cases is almost straight; posteriorly the tendency is towards a reverse extreme, the two tips of the granule approaching each other and in extreme cases fusing to form doughnut-shaped particles. Anteriorly the granules are 25–40 μ long; posteriorly they are 18–28 μ long and 11–15 μ across. In addition to the miliary granules in the tentacles, there are a few more elongated particles which may be designated as tentacle-rods; they are about 40 μ long, quite slender, more or less curved, and have the ends expanded and notched; occasionally there is a tooth or short branch on the inner (concave) side, near the middle. Color in life, "delicate flesh-pink." Preserved material has the ground-color yellowish, with the tentacles and longitudinal muscles pale lemon-yellow; entire body-surface and outer surface of base of tentacles covered with low, ill-defined, minute, dull red verrucae. Under high magnification, the pigment is a light brick-red, but it varies more or less in shade. Some specimens have the yellow ground-color very pale and the verrucae very numerous and thus appear to be pale red with nearly white tentacles..

Holotype.— M. C. Z. 1,269.

This species is common at the Tortugas, Florida, where I collected twenty specimens in sandy mud among the roots of eel-grass on the southwest side of Loggerhead Key, in June, 1917. Its superficial resemblance to *inhaerens* is sufficient to let it pass as that species, if no careful examination were made.

Leptosynapta multipora,[1] sp. nov.

Plate 9, fig. 1–5.

Length in life about 90 mm.; diameter about 4 mm. Tentacles 12, with 5 pairs of digits; terminal digit longest and basal pair shortest; there are about 20 sense-cups of moderate size on the inner surface of each tentacle. Owing to damaged condition of anterior end, no stone-canal or polian vesicle was found. Calcareous ring well developed, the radial pieces perforated for the passage of the nerve; both radial and interradial pieces are markedly concave on the posterior margin and slightly convex on the opposite side.

The anchors of the anterior end are very small, only 103–165 μ long, averaging about 140 μ; they are about 83 μ broad across the short, thick arms which are only about 35 μ long; there are only 2 minute teeth on each arm. The accompanying plates are nearly as long as the anchors, ranging from 113 to 148 μ and averaging 139 μ; the width is three fourths of the length, more or less. The plates have the usual 7-toothed holes, though the posterior one is small and the teeth are commonly wanting; the posterior end of the plate is exceptionally wide, but the number of perforations there is only about half a dozen as usual. The posterior anchors are very large and very different in form from those of the anterior end. They range from 280 to over 500 μ in length, but are for the most part over 400 μ. The arms are long, moderately slender and curved backward, but not nearly enough to become parallel with shaft; they are 150 μ long and 245 μ across from tip to tip in an anchor 450 μ long; each arm has 9 or 10 very conspicuous teeth. The plates accompanying these anchors are equally remarkable; they are 193–327 μ long and 136–200 μ wide. They have a dozen large, more or less dentate holes (the posterior, and even the most anterior may be smooth), the usual small smooth holes (a dozen or more) posteriorly, and several small dentate holes near the margin of the posterior end. When completely developed the large anchors and plates show little diversity in size or shape. These large anchors and plates are confined to the posterior part of the animal, but the small anchors and plates, abundant at, and characteristic of, the anterior end are to be found scattered sparsely among the big ones at the rear of the body. They are often very small there and in one case, the plate measured only 92 μ long by 70 μ wide. Miliary granules

[1] *multus* = many + *porus* = a passage or pore, in reference to the many perforations in the anchor-plates.

apparently wanting; none were detected anywhere. Tentacle-rods, few, slender and inconspicuous, forked or notched at each end. Color in life is recorded in my field-notes, as "a fine rose-colored Synapta"; the preserved specimen is a pale gray.

HOLOTYPE.— M. C. Z. 39.

This interesting leptosynaptid was dug in the sand at Drunkenman Cay, off Kingston Harbor, Jamaica, early on the morning of June 3, 1896. It was recognized at once as different from *inhaerens*, probably because of the color, but it was not critically examined for many years. No other specimens were taken that summer, nor have I met with it during my later visits to Jamaica, though I made a special trip to Drunkenman Cay in early December, 1902, for the purpose of getting more material. Although related to *acanthia*, it is quite distinct. The small anchors and plates are very similar to those of the Bermudan species, but are a little smaller, while the large anchors and plates are considerably smaller in *multipora*. The entire absence of miliary granules in the Jamaican form is an important difference between the two species and the small number of digits on the tentacles is noteworthy; this, however, may be associated with the much smaller size of the Jamaican specimen.

LEPTOSYNAPTA OOPLAX.

Plate **7**, fig. 20–24.

Synapta ooplax von Marenzeller, 1881. Verh. K. k. zool.-bot. Ges. Wien, **31**, p. 122.

Leptosynapta ooplax H. L. Clark, 1908. Apod. hol., p. 24.

The only specimens of this species which the M. C. Z. possesses are two which were taken by the ALBATROSS at Funafuti, December 24, 1899. Neither of these is a perfect specimen, but the larger is 235 mm. long and only 4.5 mm. in diameter. It is flesh-color, in alcohol. The anchors, both anteriorly and posteriorly are about 148 μ long, but the anterior anchors have arms about 30 μ long and 80 μ across, whereas the anchors at the rear end have the arms about 35 μ long and only about 50 μ across. There are usually one or two minute teeth on each arm of either type of anchor. The anterior plates are about 115 μ long by 66 μ broad; they are more or less asymmetrical and the large holes seldom appear to form a circle of six around a seventh as is usual in Leptosynapta. Moreover the large holes are of unequal size and some of them at least, and often all, have smooth margins. The plates accompanying the posterior anchors are more or less reduced in size; while usually about 70 μ long by 40 μ wide, they may be larger, but are often much smaller, plates less than 50 μ long and with only a few large smooth holes being met with occasionally. A curious optical delusion results from this very unusual reduction of the posterior plates; the posterior anchors with their narrower and more gracefully-curved arms *seem* much longer than those near the anterior end, although actual measurements show that this is not the case. It is possible that von Marenzeller's statement that the posterior anchors are the longer rests in part on this appearance, though he gives the measurement of a posterior anchor as 200 μ, a size not nearly approached by any of my material. Yet Ohshima (1914, p. 470) says the anchors in Japanese specimens range from 115 to 195 μ.

LEPTOSYNAPTA PARVIPATINA,[1] sp. nov.

Plate **4**, fig. 8, 9; Plate **6**, fig. 5–8.

Length, 47 mm.; diameter, 3 mm. Tentacles 12 (in one specimen there are 13), with 5 pairs of digits; the terminal digit is distinctly the longest, and the basal pair shortest; there are 8–10 sense-cups on the inner surface of each tentacle. No stone-canal was detected, but a single long polian vesicle was present. Calcareous ring well developed, the radial pieces larger than the interradial, only slightly concave behind, but with a well-marked anterior peak and perforated for the passage of the nerve; interradial pieces deeply concave behind and slightly convex anteriorly.

The calcareous particles are all notably small. The anchors at the anterior end are only 100–115 μ long; their arms are short and stout, about 27 μ long and 66 μ across from tip to tip; as a rule the arms are smooth, but occasionally a single minute tooth occurs on the outer margin near the tip. The plates accompanying these little anchors are 94 μ long or less, their width being three fourths of their length or a little more; in form, they are very typical leptosynaptid plates, but the anterior large hole is often replaced by two and frequently there are little perforations present along the sides of the plate; even asymmetry of a pronounced type due to the unequal development of the perforations, is not rare. Posteriorly the anchors are about half as long again, ranging from 136 to 165 μ; their arms are 42 μ long and 73 μ from tip to tip, and bear 4 or 5 small teeth on their outer margins.

[1] *Parvus* = little + *patina* = a small plate, in reference to the small size of the anchor-plates.

Their accompanying plates are quite different from the anterior ones, being more elongated and elliptical, but they are not much larger; they are 103–110 μ long and 70–80 μ wide; the posterior end is nearly as wide as the anterior; the most anterior perforation is often conspicuously the largest. Miliary granules abundant in the bases of the tentacles and along the middle of the longitudinal muscles. They show great diversity in shape, ranging from simple disks to curved rods, enlarged and notched at the tips; some of the disks are perforated at the center; the granules are from 14 to 33 μ, but for the most part are under 25 μ. Tentacle-rods scarcely distinguishable from the elongated miliary granules, but a few, about 30 μ long, are recognizable by their slenderness. Color in life "translucent pinkish white"; in alcohol pale brown, almost dirty white. Two of the specimens are yellow, as a result of a mishap during their preparation at the Tobago laboratory.

HOLOTYPE.— M. C. Z. 1,268.

This species was fairly common in the sandy mud of what we called Sandy Point, in Buccoo Bay, Tobago. We took 15 specimens there March 29 and 30, 1916, by sifting spadefuls of the muddy sand. The largest one seen was about 150 mm. long when fully extended, but was very slender and quickly broke in two. Most of the specimens were much smaller than this; one has 13 tentacles, but all of the others have 12. This 13-tentacled specimen is, in its preserved condition, about 40 mm. long and 2.5 mm. in diameter, which is apparently an indication that it is mature.

LEPTOSYNAPTA ROSEOLA.

Plate **7**, fig. 25–28.

Verrill, 1874. Invert. anim. Vineyard Sound, p. 362.

This species, originally described from the Woods Hole region, is poorly represented in the M. C. Z. There is a good lot of 28 specimens from Bermuda, collected in April, 1899, but there is only a single small specimen from Woods Hole. There are two very small synaptids from Port Antonio, Jamaica, one an anterior fragment, the other minus the head, which are best referred to *roseola*. Both are in poor condition, but they are not decalcified and the anchors are like those of *roseola* but are small, only 117–130 μ long. My Jamaica field-notes contain this entry concerning one of these specimens: "Under a rock on Titchfield Point reef, I found a small Synapta about half an inch long. It was a light flesh-color, thickly covered with dark reddish brown spots on tubercles."

Comparison of the Woods Hole and Bermuda specimens of *roseola* show a remarkable identity in the size of the anchors. Anteriorly they are about 140 μ in length, with arms 37 μ long and about 75 μ across. The posterior anchors are usually larger, ranging from 160 to 170 μ, with arms 42 μ long and only about 70 μ across. The plates are about the same size in all parts of the body, averaging about 118 μ by 82 μ, but larger plates do occur posteriorly. These figures indicate that these specimens are not so old as the ones I examined at Woods Hole in 1898, in which the contrast between the anterior and posterior calcareous particles was much more marked.

Labidoplax buskii.

Plate **4**, fig. 10; Plate **8**, fig. 8–10.

Synapta buskii McIntosh, 1866. Proc. Roy. soc. Edinburgh, **5**, p. 611.
Labidoplax buskii Östergren, 1903. Bergens mus. Aarb. 1902, no. 9, p. 12.

There are 6 specimens of this curious little synaptid in the M. C. Z., but half of them are completely decalcified; three are beautifully preserved, 18–24 mm. long, each with 11 well-expanded tentacles and no calcareous parts; the body-wall is translucent and the color is nearly white. They are from Kristineberg, Sweden, taken in July, 1905, and presented by Dr. Östergren. Of the other specimens, one is 8 mm. long and about a millimeter in diameter. It is light brown, has 11 tentacles and was dredged off Lofoten, Norway, in 200–300 fms. It is a donation from Professor Sars. The other two were taken in the Kattegat at 5 fms. and were received in exchange from the Copenhagen Museum in 1907. Each of these has 11 tentacles, in one case greatly contracted, but in the other fully expanded. There are no calcareous particles, decalcification having occurred.

The calcareous particles of the Norwegian specimen are thus the only ones I have examined. The anchors are 170 μ long, which is in accordance with Östergren's figures. They have arms nearly 50 μ long and nearly 80 μ across, which seem to be perfectly smooth, although Östergren says there are usually "3–5 small" teeth on each arm. The plates are about 140 μ long and 113 μ wide. They are quite symmetrical and show little diversity. The chief difference one sees among them is in the "handle" where the two perforations show considerable variety of size and form, and occasionally merge into one long slit.

In my diagnosis of Labidoplax (1908, Apod. hol., p. 94) I have called the tentacles "digitate," as they obviously are in the larger species, but in the finely-preserved specimens of *buskii* from Kristineberg it is clear that the tentacles are pinnate with a single pair of digits, much smaller than the terminal digit. This is an entirely different sort of tentacle from that of *digitata*, and would suggest that the two species are not congeneric. But the larger Norwegian species (*media*) has really digitate tentacles and yet is obviously too much like *buskii* to be placed in a different genus. If it should be ultimately shown that *media* is the adult of *buskii*, the tentacles of the latter would surely be a most interesting growth-stage, showing the transition from pinnate to digitate tentacles.

Labidoplax digitata.

Plate **10**, fig. 2–6.

Holothuria digitata Montague, 1815. Trans. Linn. soc. London, **11**, p. 22.
Labidoplax digitata Östergren, 1898. Öfv. K. vet.-akad. Förh., **55**, p. 116.

There is only a single specimen of Labidoplax in the M. C. Z. which can be referred to this species, if *thomsonii* is to be kept separate, and even in this there are no "giant" anchors. The specimen is supposedly from Naples as it was received from the Naples Zoölogical Station many years ago. It is 125 mm. long by 13 mm. in diameter and has 12 tentacles, each with two pairs of long digits. Some sense-cups are present on the tentacles, but they are not conspicuous. The anchors of the posterior end are 165–175 μ long and 135–150 μ across the arms from tip to tip. Thus the width of the anchor is only about 82–86% of their length. The arms seem to be smooth with no indication of marginal teeth. The anchor-plates are about 150 μ long and their width is 63–70% of the length. They have three large smooth holes across the anterior end, the middle one largest and back of it is a similar large hole; there are many other (18–20) small holes of diverse size and situation at the sides and posterior end of the plate; the surface of the plate is smooth, only rarely with a rough projection.

Labidoplax dubia.

Plate **8**, fig. 11–14; Plate **11**, fig. 8.

Synapta dubia Semper, 1868. Holothurien, p. 10.
Labidoplax dubia Östergren, 1898. Öfv. K. vet.-akad. Förh., **55**, p. 116.

The only indubitable specimen of this species in the M. C. Z. is one of those taken by the Albatross off eastern Japan (Station 3,723) in 13–16 fms. It is 65 mm. long by 4 mm. in diameter. The anchors (posteriorly) are 165–188 μ long with arms 48–57 μ long and 75–80 μ across, while the plates are 125–140 μ long with a width varying from 54 to 68 per cent of the length. Théel (1886, p. 14) gives the length of the anchors as 130–180 μ with the plates 100–112 μ, the width almost exactly half their breadth. Ohshima (1914, p. 471) says the anchors are 110–155 μ long and the plates 90–140 μ. It will be noticed that Ohshima's measurements of the plates show a range great enough to include both Théel's and mine, but his anchors are markedly smaller, his maximum not equalling my minimum. Théel's measurements, however, overlap both Ohshima's and mine very broadly and leave no doubt that the differences in our figures are due to the diversity shown by our specimens, a diversity by no means extraordinary. But the figures given in my Apodous holothurians (1908, p. 96) are about 30% greater for the anchors and 50% greater for the plates than the measurements here given, based on a specimen from the same lot. It is probable that some mistake was made in my earlier measurements, but it is possible that the specimen first examined was the oldest of the lot and really had exceptionally large anchors and plates. One point in favor of this latter explanation is that the measurements given fifteen years ago show that the plates were not only unusually long, but proportionately very narrow (only 41–44% of the length), as though they had continued their longitudinal growth beyond normal without increasing the normal width.

There is a headless fragment of a synaptid in the M. C. Z., taken in Tokyo Bay by E. S. Morse, many years ago, the calcareous particles of which show that it belongs in the genus Labidoplax. It is about 15 mm. long by 6 mm. in diameter, but it is difficult to decide what the normal size of the whole animal was. The color is brownish white. There are no miliary granules present. The anchors are about 118 μ long by 75 μ across the arms, which are usually smooth, but may have a tooth, or even two, on the outer margin. The plates (Pl. **11**, fig. 8) are remarkably short and wide, about 100 by 75 μ; there are three large perforations, two somewhat smaller and about eight little ones, besides the long slit in the "handle." While these anchors and plates are thus much shorter and wider than any I have seen in *dubia*, it seems that Ohshima has examined specimens of that species with calcareous particles as small as these, and I have therefore decided to regard this Tokyo specimen as a fragment of a young *dubia*.

Labidoplax thomsonii.

Plate **9**, fig. 6–10; Plate **10**, fig. 1.

Synapta thomsonii Herapath, 1865. Quart. journ. mic. sci., n.s. **5**, p. 6.
Labidoplax thomsonii Östergren, 1898. Öfv. K. vet.-akad. Förh., **55**, p. 116.

The five specimens, sent as *digitata* from the Naples Zoölogical Station and referred to this species, (Apodous holothurians, 1908, p. 97), are the only specimens of *thomsonii* in the M. C. Z. All are fully adult, the largest measuring 220 by 12 mm. They lack sensory-cups and "giant" anchors and the anchor-plates are similar to those which Ludwig describes as characteristic of *thomsonii*. The tentacles seem to be longer with relatively shorter digits than in *digitata* and the anchors show a very constant difference of form. The shaft of the anchor is relatively shorter and the stock heavier, so that the width across the arms from tip to tip equals (or nearly so) and often exceeds the length of the anchor. In the specimen, considered *digitata*, the stock in extreme width is less than one third the anchor-length, while in these *thomsonii* it is more than one third and may be one half. The anchor-arms are usually smooth, but occasionally have 1, 2, or 3 small teeth. The anchor-plates at the anterior end are essentially like those of *digitata*, but posteriorly they are obviously different; they are relatively wider, with a much more irregular margin, a rougher and more irregular surface, and fewer, (relatively), smaller perforations. The plates are about as long as the anchors and their width is about four fifths of their length. A typical anchor is 120 μ long, 136 μ across the arms, and 66 mm. across the stock. The plate is about 140 μ long, (including handle), and 116 μ wide, the handle being 42 μ long and 49 μ wide. It seems to me exceedingly doubtful whether *digitata* and *thomsonii* are really distinct, but just what the relation of the two forms is remains to be made clear. Comparative study of a large series of specimens of diverse sizes, from the vicinity of Naples, would probably solve the problem.

Protankyra abyssicola.

Plate **11**, fig. 6, 7; Plate **12**, fig. 1.

Synapta abyssicola Théel, 1886. Challenger hol., p. 14.
Protankyra abyssicola Östergren, 1898. Öfv. K. vet.-akad. Förh., **55**, p. 117.

As this deep-sea synaptid is always strongly contracted when it reaches the surface, and commonly more or less in fragments, it is not strange that such material as there is in the M. C. Z. is in very unsatisfactory condition. There are three lots of fragments, one from off the coast of Peru in 2,222 fms. (Albatross St. 4,651), one from off Point San Tomas, west coast of Lower California, in 1,090 fms. (Albatross St. 5,673), and one from off New Jersey, in 1,394 fms. (Blake St. 340).

The Peruvian material seems to be made up of parts of four specimens, about 150 mm. in length. They were discussed by me briefly (1920, Mem. M. C. Z., **39**, p. 124).

The specimens from off Lower California include two head-ends, so those fragments probably represent two specimens, briefly described in Bull. Amer. mus. nat. hist., 1913, **32**, p. 227. The two heads each show 12 tentacles, but the digits are so strongly contracted their form and even their number is uncertain, though there is no reason to doubt that the usual two pairs are present. The anchors are all more or less broken, but three that permitted measurement were 700–750 μ long with arms, 180 μ long and 325 μ across from tip to tip. The arms as a rule appear smooth, but careful examination with high power reveals 2 or 3 teeth on each arm, in several of the anchors. The plates are 575 μ long by 475 μ in width and have about 50 holes of which the larger ones have conspicuously dentate margins.

The New Jersey material consists of a headless fragment labeled "*brychia* Verrill." The anchors are nearly 770 μ long with arms about 300 μ long and only about 375 μ from tip to tip; there are 5 or 6 conspicuous teeth on each arm. The plates are about 735 μ long by 575 μ wide and are perforated by numerous small dentate holes. While these anchors and plates are exceptionally large for *abyssicola,* they are not nearly so large as in typical *brychia.* Moreover, the plates are shaped like those of *abyssicola* and do not resemble those of *brychia.* I think therefore this fragment from the western Atlantic must be considered an anomalous *abyssicola.*

In my Apodous holothurians (1908, p. 25, 99, and 103, and explanation of Plate **4**), seemingly contradictory statements occur in regard to miliary granules in *brychia*. Thus the statement is first made that "miliary granules" occur "along the radii," and again that "accessory calcareous bodies" are present, while on p. 103 there is the definite assertion that "there are no accessory calcareous bodies in the skin." In the explanation of Plate **4**, fig. 14 is said to represent the "miliary granules" of *brychia*. The truth is that the only accessory calcareous bodies in *brychia* are the elongated disks and oval rods which occur beneath the longitudinal muscles "along the radii." They do not occur elsewhere "in the skin" and are thus very different, in distribution at least, from the calcareous particles of Euapta and other genera, which are known as "miliary granules." But in Leptosynapta some species have miliary granules scattered abundantly in the skin, while in others they are confined to the radii, and in others they seem to be wanting. Hence it would seem to be necessary to call all the accessory calcareous particles of the body-wall, "miliary granules," regardless of their distribution. There is no essential difference between *abyssicola* and *brychia* in this particular so far as the material which I have seen shows.

PROTANKYRA BIPEDATA,[1] sp. nov.

Plate **8**, fig. 1, 2; Plate **10**, fig. 7.

Length of fragment, 35 mm.; diameter, 4–5 mm. Anterior end missing. Anchors symmetrical, about 550 μ long, with arms 150–160 μ long, and 425 μ across from tip to tip; each arm has half a dozen sharp conspicuous teeth on the outer margin near tip. The stock has each side constricted basally so that it is somewhat foot-like in appearance, and each of these "feet" is covered on the lower half and distal end with minute projections, making the surface rough. The anchor-plates are equal to or even exceed the plates, some of them measuring 590 by 500 μ; they are widest close to the distal (or anterior) end and are perforated with numerous serrated holes. Miliary granules are very abundant all through the skin; they are fundamentally C-shaped, but the degree of curvature shows some diversity and there is great difference in the relative width of the curved rod itself in different granules. They range in size, (length), from 20 to 50 μ.

HOLOTYPE.— M. C. Z. 47.

This fragment was received from the Amsterdam Museum in 1907 as having been collected at SIBOGA St. 306, which was off the east

[1] *bipedata* = having two feet, in reference to the form of the anchor-stock.

end of Flores in 137 fms. It is labeled *P. ludwigii* Sluiter, but it is hard to see how it can possibly be assigned to that species. For the anchors in *bipedata* are symmetrical and according to the original description and figures of *ludwigii*, "die Ankerarme sind unsymetrisch." In *bipedata* there are no accessory perforated plates in the body-wall whereas these are well developed and very characteristic in *ludwigii*. Finally the miliary granules are very different from those of *ludwigii* as figured by Sluiter (1890, Pl. **5**, fig. 7, 8).

In his account of the holothurians collected by the SIBOGA, Sluiter (1901, p. 130) says that the anchors and plates of the fragments from St. 306 agree "genau" with his earlier example of *ludwigii*, but the miliary granules are different. Strangely enough he makes no reference to the remarkable perforated plates of *ludwigii*, which are quite wanting in this fragment from St. 306. The SIBOGA took 4 synaptids at St. 294 which Sluiter asserts are "without doubt" *ludwigii*, but he does not mention the perforated plates or the amount of asymmetry in the anchors. Further information on these points is much to be desired.

Since this fragment from St. 306 is certainly not *ludwigii*, the question arises whether it might not be referred to some other known species. It is undoubtedly rather nearly related to *insolens* Théel, but the anchor-arms have not nearly so many teeth and the miliary granules are entirely different. Under the circumstances therefore I think this fragment from Flores must be made the type of a new species.

PROTANKYRA SIMILIS.

Plate **9**, fig. 11; Plate **12**, fig. 2–6.

Synapta similis Semper, 1868. Holothurien, p. 10.
Protankyra similis Östergren, 1898. Öfv. K. vet.-akad. Förh., **55**, p. 117.

The M. C. Z. is fortunate in having two specimens of this synaptid, one of which is certainly, and the other probably, one of Semper's types. The former is labeled Bohol, Philippine Islands, the latter simply Philippines. It is interesting to find that each has 12 tentacles and hence Semper's statement that there are only *ten* is probably a slip of the pen. The preserved specimens are about 70 mm. long by 8 mm. in diameter, and except for the number of tentacles conform well to Semper's description. The tentacles are remarkable from the fact that in addition to the two pairs of terminal digits, there is a distinct, but undeveloped digit present on each side. I have not noticed such digits in any other member of the genus. Semper gives the anchors as 357 μ long with arms about 115 μ long and 230 μ across from tip to tip. I find the anterior anchors distinctly smaller than this (277 μ), but posteriorly they may be considerably larger, the largest I have measured being 430 μ long; these large posterior anchors have 9 or 10 incurved teeth on each arm, and their stock is over 180 μ across. The anchor-plates, anteriorly 263 μ long by 230 μ wide, posteriorly 357 μ by 300 μ, are notable for their numerous, rather small perforations with entire, smooth margins. The miliary granules are abundant all over the body-surface; they are 42–70 μ long and are clearly forked at each end; they may be quite distinctly curved in the plane in which the fork lies; rarely each fork shows indications of having each of its branches forked. There are no real supporting rods in the tentacles, but in the wall of the tentacle itself there are very numerous elongated, oval bodies, more or less constricted at the middle, about 20–30 μ long and 7–8 μ wide. These are also present in the digits, but not at all commonly.

Anapta.

This genus was established in 1868 by Semper for a Philippine synaptid, which lacked anchors and plates, at that time the diagnostic character of Synapta, and also lacked the calcareous wheels characteristic of the only other genus in the family, Chiridota. Besides this negative character, Anapta is shown, by Semper's beautiful figures and careful description, to possess 12 pinnate tentacles as in Synapta, and other features which distinguish it as a well-marked genus. Additions to the genus were made by Sluiter in 1888 and Lampert in 1889 and their species are undoubtedly congeneric with and closely allied to Semper's genotype. But in 1892, Ludwig took the unfortunate step of making the absence of wheels and of anchors the one diagnostic feature of Anapta and included five synaptids in the genus, which agreed in this particular. It is true he gives "12 tentacles" as a feature of the genus, but he takes no account of the character of the tentacles, and in my judgement this is a very fundamental point in synaptid morphology. Naturally later writers followed Ludwig and species were added to the genus, which have little in common with Semper's Philippine species. In my Apodous holothurians (1908) I endeavored to give proper weight to the character of the tentacles, and suggested the genera Dactylapta, Scoliodota, and Achiridota for species which had been placed in Anapta, but which are really not closely allied to it. Before he had had an opportunity to know of my publication a young Russian, M. Britten, published (1908) a paper on holothurians from Japan and the Okotsch Sea, in which he described two additional species of Anapta, assigning them to that genus solely because of the absence of wheels and anchors. In 1912, the M. C. Z. fortunately secured cotypes of Britten's species from the St. Petersburg Museum, and I have thus been able to examine some of his material. Of his *Anapta amurensis,* one specimen is in fair condition, 23 mm. long and 6–7 mm. in diameter, taken on sandy mud in $2\frac{1}{2}$ fms. at the mouth of the Amur River. The color is nearly white. There are 12 *palmate* tentacles, each with 5 pairs of digits. The specimen is wholly decalcified and there is not even a calcareous ring. Britten notes the absence of a calcareous ring and it seems extraordinary that he apparently never suspected decalcification. He says that some of the specimens were a "fine rose-red." There is no doubt that these so-called Anaptas are Chiridotas and it seems highly probable that they are *C. laevis.* Of *Anapta ludwigi* Britten, the M. C. Z. has one specimen taken July 11, 1899, on a muddy bottom in 20–25 fms. off Poro Tomari, west coast, southern Sakhalin. Careful examination of this specimen has revealed two wheel-papillae from which the wheels had been completely dissolved out. The whole appearance of this specimen, but especially the tentacles shows that it is a Chiridota, and I have little doubt that it is *C. discolor.* Britten's specimens were more or less decalcified, but probably in most of them the wheel-papillae had simply been rubbed off during the rough treatment in the dredge, leaving no trace of the characteristic wheels.

Anapta thus contains only the three species described before 1890, and of them our knowledge is very imperfect. No further specimens of Sluiter's East Indian species, *subtilis,* have been reported since the holotype was described and it is quite possible that that was an aberrant synaptid of some other genus. The other two species are represented in the M. C. Z. collection.

ANAPTA FALLAX.

Lampert, 1889. Zool. jahrb. Syst., **4**, p. 848.

The only specimen that the M. C. Z. possesses of this South American species is a little fragment, 6–8 mm. long by a couple of millimeters thick, which has been considerably cut to pieces. It was taken by the ALBATROSS (Station 2,784) in 194 fms., (an excessive depth), off the southern end of South America, lat. 48° 41′ S., long. 74° 24′ W., and was discussed briefly in Apodous holothurians (1908, p. 26). It is unfortunate that Ludwig, who had some good material from a number of stations, never stated in just what way *fallax* is to be distinguished from *gracilis*. The difference is by no means clear and the material available does not permit my throwing any light on the matter. The present specimen seems to have no calcareous particles either in the tentacles or along the radii.

Anapta gracilis.

Plate 12, fig. 7, 8.

Semper, 1868. Holothurien, p. 17.

The M. C. Z. possesses one of Semper's cotypes taken near Manila. It is only an anterior fragment, 20 mm. long by 6 mm. in diameter, with 12 tentacles, mostly with 11 digits, but the number ranges from 9 to 13. The color is brown with the digits, oral disk, and very numerous verrucae nearly white. The sense-cups along the sides of the tentacles are very minute and would easily be overlooked with an ordinary lens. The calcareous particles in the verrucae are very small, 16–27 μ long and 5–10 μ thick. Their surface is not smooth, but very finely rough with minute points. This characteristic of the granules is not mentioned by Semper and he gives no figures. It is possible that it is due to the first indications of acid in the alcohol, which ceased with change of the preserving fluid, but it is so uniformly evident that it seems normal.

EXPLANATION OF PLATES.

All figures, except Plate **12**, fig. 6, are magnified 210 ×.

PLATE 1.

PLATE 1.

Fig. 1–4. *Euapta godeffroyi* (Semper). Hawaiian Islands.
- 1. Anchor-plate.
- 2. Anchor.
- 3. Miliary particles.
- 4. Supporting rods from tentacles.

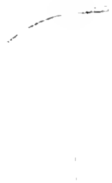
Fig. 5–7. *Euapta lappa* (J. Müller). Tobago.
- 5. Anchor-plate.
- 6. Anchor.
- 7. Miliary particles.

Fig. 8–12. *Polyplectana kefersteinii* (Selenka).
- 8. Anchor-plate. From cotype, from Hawaiian Islands.
- 9. Anchor. From cotype.
- 10. Miliary particles. From cotype.
- 11. Miliary particles. From specimen from Samoa.
- 12. Miliary particles. From specimen from Mer.

Fig. 13. *Synaptula recta* (Semper). Friday Island. Miliary particles.


1


11


12


5


13


10


6


9


8


2


3

4


7

PLATE 2.

PLATE 2.

Fig. 1–3. *Opheodesoma grisea* (Semper). Mer.
1. Anchor-plate.
2. Anchor.
3. Miliary particles.

Fig. 4–6. *Opheodesoma glabra* (Semper). Siboga St. 213.
4. Anchor-plate.
5. Anchor.
6. Miliary particles.

Fig. 7–9. *Opheodesoma spectabilis* Fisher. Pearl Harbor.
7. Anchor-plate.
8. Anchor.
9. Miliary particles.


9
1
7
6
3
2
5
8
4

PLATE 3.

PLATE 3.

Fig. 1, 2. *Synapta maculata* (Chamisso and Eysenhardt). Mer.
  1. Anchor, of less than average size.
  2. Miliary particles.

Fig. 3, 4. *Synaptula nigra* (Semper). Mer.
  3. Anchor.
  4. Miliary particles.

Fig. 5, 6. *Synaptula hydriformis* (Lesueur). Jamaica.
  5. Anchor.
  6. Miliary particles.

Fig. 7, 8. *Synaptula psara* (Sluiter). SIBOGA St. 273.
  7. Anchor.
  8. Miliary particles.

Fig. 9. *Synaptula recta* (Semper). Friday Island. Anchor.

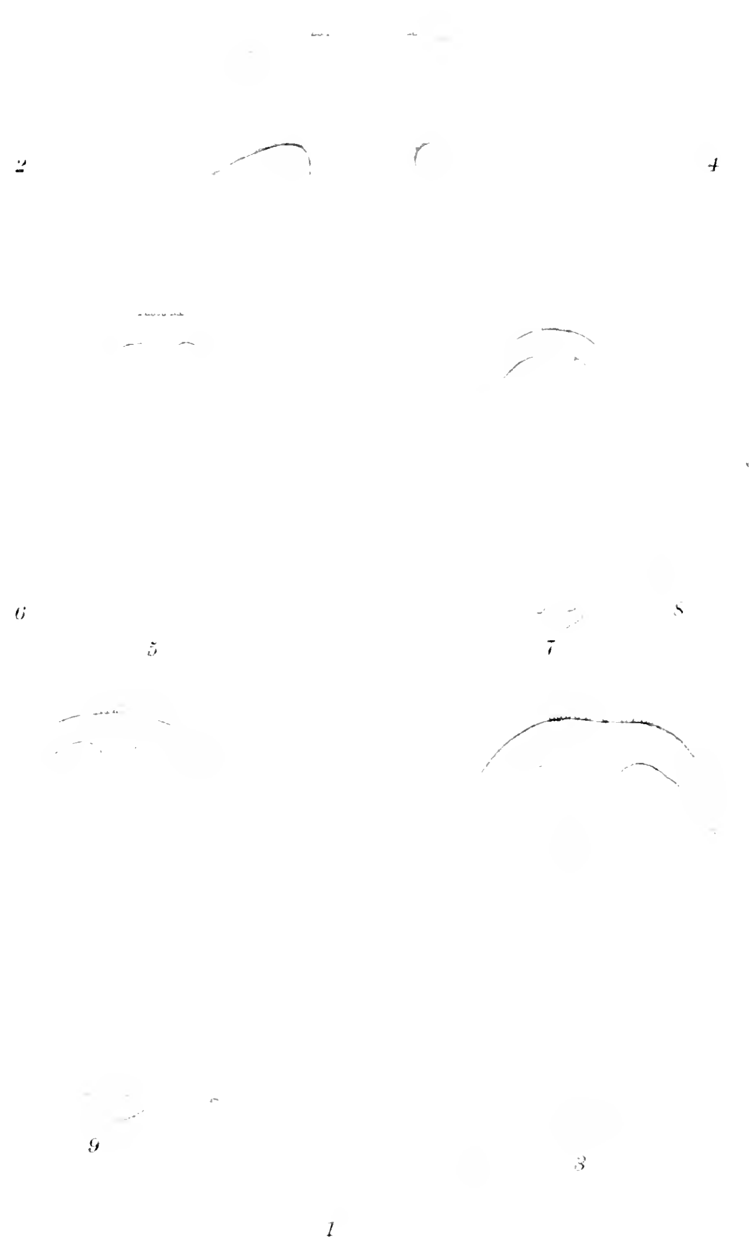

2
4
6
5
7
8
9
3
1

PLATE 4.

PLATE 4.

Fig. 1. *Synapta maculata* (Chamisso and Eysenhardt). Mer.
Anchor-plate of less than average size.

Fig. 2. *Synaptula nigra* (Semper). Mer.
Anchor-plate.

Fig. 3. *Synaptula recta* (Semper). Friday Island.
Anchor-plate.

Fig. 4. *Synaptula hydriformis* (Lesueur). Jamaica.
Anchor-plate.

Fig. 5. *Synaptula psara* (Sluiter). Siboga St. 273.
Anchor-plate.

Fig. 6, 7. *Leptosynapta circopatina* H. L. Clark. Holotype. Port Royal.
6. Anchor-plate from posterior part of body.
7. Anchor-plate from anterior part of body.

Fig. 8, 9. *Leptosynapta parvipatina* H. L. Clark. Holotype. Tobago.
8. Anchor-plate from posterior part of body.
9. Anchor-plate from anterior part of body.

Fig. 10. *Labidoplax buskii* (McIntosh). Lofoten.
Anchor-plate.

4

5

7

9

6

8

1

2

10

3

PLATE 5.

PLATE 5.

Synapta maculata (Chamisso and Eysenhardt)?

Anchor-plate, having no bridge, from the anomalous specimen taken at Papeete, Tahiti.

PLATE 6.

PLATE 6.

Fig. 1–4. *Leptosynapta crassipatina* H. L. Clark. Holotype. Key West.
1. Anchor-plate.
2. Anchor from posterior part of body.
3. Anchor from anterior part of body.
4. Miliary particles.

Fig. 5–8. *Leptosynapta parvipatina* H. L. Clark. Holotype. Tobago.
5. Anchor from posterior part of body.
6. Anchor from anterior part of body.
7. Supporting rods from tentacles.
8. Miliary particles.

Fig. 9–11. *Leptosynapta circopatina* H. L. Clark. Holotype. Port Royal.
9. Anchor from posterior part of body.
10. Anchor from anterior part of body.
11. Supporting rods from tentacles.

Fig. 12–16. *Leptosynapta acanthia* (H. L. Clark). Bermuda.
12. Anchor-plate from posterior part of body.
13. Anchor from posterior part of body.
14. Anchor-plate from anterior part of body.
15. Anchor from anterior part of body.
16. Miliary particles.

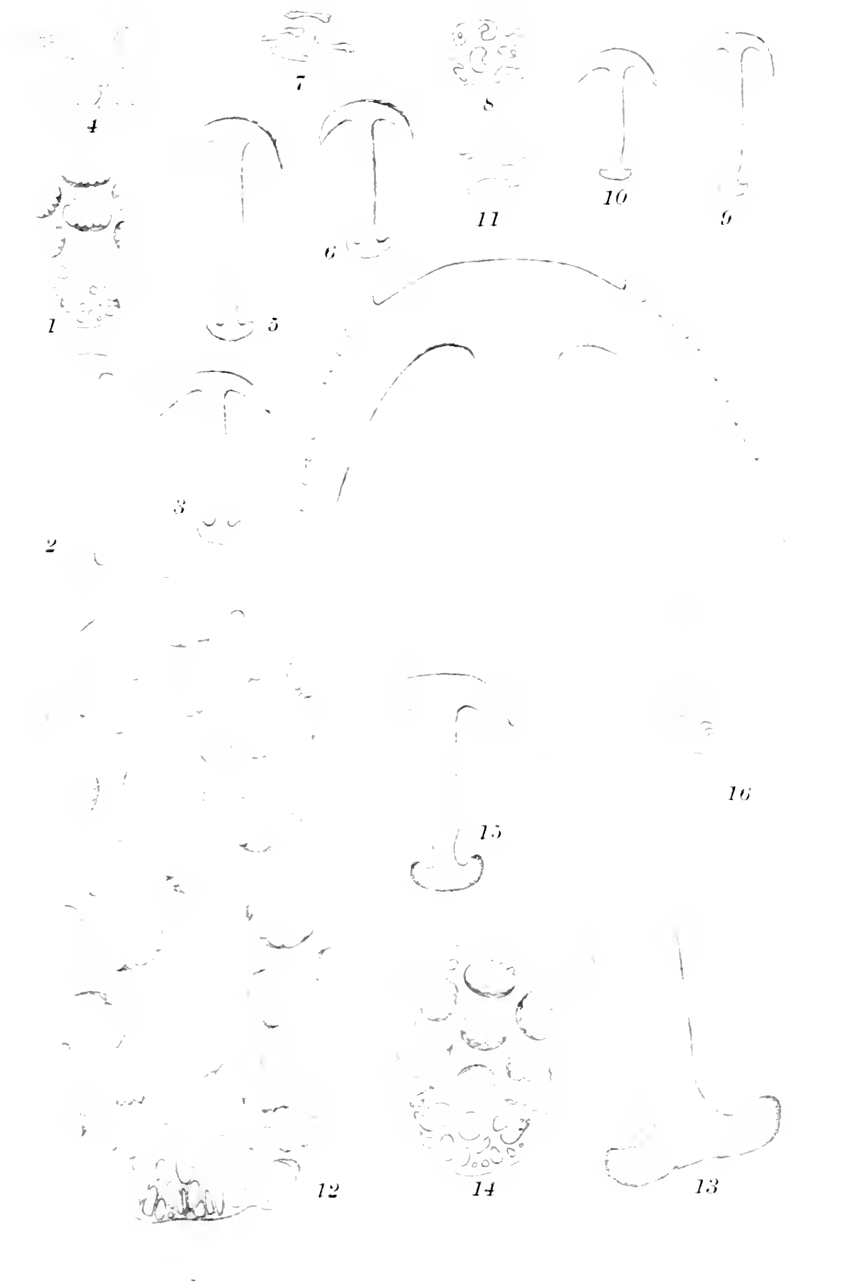

4
7
8
10
9
11
1
5
6
3
2
15
16
12
14
13

PLATE 7.

PLATE 7.

Fig. 1–6. *Leptosynapta dolabrifera* (Stimpson).
1. Anchor-plate. Specimen from Port Jackson.
2. Anchor from posterior part of body. Port Jackson.
3. Anchor from anterior part of body. Port Jackson.
4. Supporting rods from tentacles. Port Jackson.
5. Miliary granules from posterior part of body. Port Jackson.
6. Miliary granules from anterior part of body. Torquay.

Fig. 7–11. *Leptosynapta ictinodes* H. L. Clark. Holotype. Westernport.
7. Anchor-plate.
8. Anchor.
9. Supporting rods from tentacles.
10. Larger supporting rods from tentacles.
11. Miliary particles.

Fig. 12–16. *Leptosynapta inhaerens* (O. F. Müller).
12. Anchor-plate. Specimen from Woods Hole.
13. Anchor. Woods Hole.
14. Supporting rods of tentacles. Nahant.
15. Miliary particles from anterior part of body. Nahant.
16. Miliary particles from posterior part of body. Woods Hole.

Fig. 17–19. *Leptosynapta latipatina* H. L. Clark. Holotype. Friday Island.
17. Anchor-plate.
18. Anchor.
19. Miliary particles.

Fig. 20–24 *Leptosynapta ooplax* (von Marenzeller). Funafuti.
20. Anchor-plate from anterior part of body.
21. Anchor from anterior part of body.
22. Anchor-plate from posterior part of body.
23. Anchor from posterior part of body.
24. Miliary particles.

Fig. 25–28. *Leptosynapta roseola* Verrill. Bermuda.
25. Anchor-plate.
26. Anchor.
27. Supporting rods from tentacles.
28. Miliary particles.


6
5
4
3
2
1
11
10
12
8
9
7
14
13
15
16
19
24
17
18
21
23
28
22
20
26
25
27

PLATE 8.

PLATE 8.

Fig. 1, 2. *Protankyra bipedata* H. L. Clark. Holotype. Flores.
- 1. Anchor.
- 2. Miliary particles.

Fig. 3–7. *Leptosynapta multigranula* H. L. Clark. Holotype. Tortugas.
- 3. Anchor-plate.
- 4. Anchor.
- 5. One arm of anchor, showing ten teeth.
- 6. Supporting rods from tentacles.
- 7. Miliary particles.

Fig. 8–10. *Labidoplax buskii* (McIntosh). Lofoten.
- 8. Anchor.
- 9. Handle of anchor-plate, showing a single slit.
- 10. Supporting rods from tentacles.

Fig. 11–14. *Labidoplax dubia* (Semper). Eastern Japan.
- 11. Anchor-plate from posterior part of body.
- 12. Anchor from posterior part of body.
- 13. Supporting rods from tentacles.
- 14. Miliary particles from posterior radii.

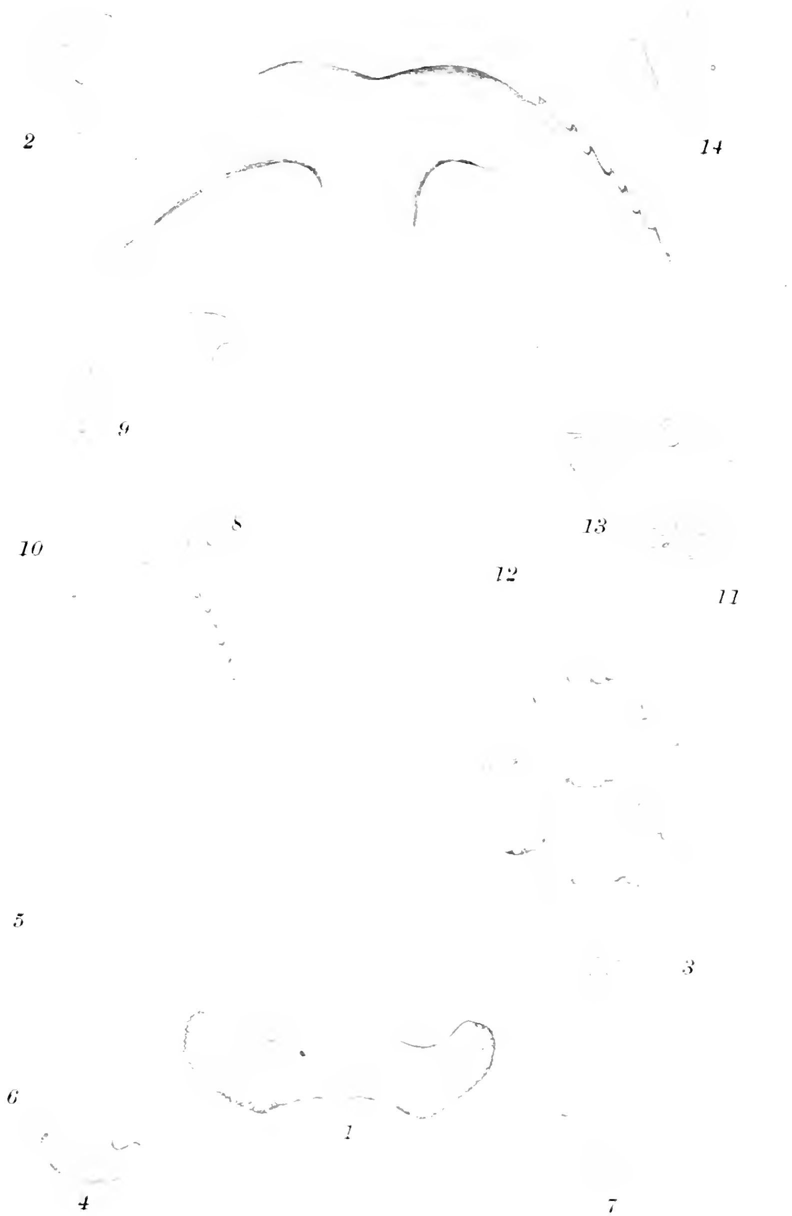

2
14
9
8
10
13
12
11
5
3
6
1
4
7

PLATE 9.

PLATE 9.

Fig. 1–5. *Leptosynapta multipora* H. L. Clark. Holotype. Jamaica.
- 1. Anchor-plate from posterior part of body.
- 2. Anchor from posterior part of body.
- 3. Anchor-plate from anterior part of body.
- 4. Anchor from anterior part of body.
- 5. Supporting rods from tentacles.

Fig. 6–10. *Labidoplax thomsonii* (Herapath). Naples.
- 6. Anchor-plate from posterior part of body.
- 7. Anchor-plate from anterior part of body.
- 8. Anchor from anterior part of body.
- 9. Miliary granules from anterior radii and bases of tentacles.
- 10. Supporting rods from digits of tentacles.

Fig. 11. *Protankyra similis* (Semper). Cotype. Bohol. Anchor.


1
2
3
4
5
6
7
8
9
10
11

PLATE 10.

PLATE 10.

Fig. 1. *Labidoplax thomsonii* (Herapath). Naples.
Anchor from posterior part of body.

Fig. 2–6. *Labidoplax digitata* (Montague). Naples.
2. Anchor-plate from posterior part of body.
3. Anchor from posterior part of body.
4. Anchor-plate from anterior part of body.
5. Anchor from anterior part of body.
6. Miliary particles from the tentacles.

Fig. 7. *Protankyra bipedata* H. L. Clark. Holotype. Flores.
Anchor-plate.


5
4
2
1
3
7
6

PLATE **11**.

PLATE 11.

Fig. 1–5. *Leptosynapta gallienii* (Herapath). Bergen.
  1. Anchor-plate from anterior part of body.
  2. Anchor from anterior part of body.
  3. Anchor-plate from posterior part of body.
  4. Anchor from posterior part of body.
  5. Miliary particles.

Fig. 6, 7. *Protankyra abyssicola* (Théel). Point San Tomas.
  6. Anchor.
  7. Miliary particles from radii.

Fig. 8. *Labidoplax dubia* (Semper) (?). Tokyo Bay. Anchor-plate.


1
8
2
5
7
3
6
4

PLATE **12**.

PLATE 12.

Fig. 1. *Protankyra abyssicola* (Théel). Point San Tomas.
Anchor-plate.

Fig. 2–6. *Protankyra similis* (Semper). Cotype. Bohol.
2. Anchor-plate.
3. Miliary particles.
4. A single miliary particle seen from the side.
5. Supporting rods from tentacles.
6. A tentacle, showing third pair of digits. × 15.

Fig. 7, 8. *Anapta gracilis* (Semper). Cotype. Manila.
7. Supporting rods from tentacles.
8. Miliary particles.


7
8
4
6
3
2
5
1

Bulletin of the Museum of Comparative Zoölogy

AT HARVARD COLLEGE.

Vol. LXV. No. 14.

EAST INDIAN COLLEMBOLA.

By Justus Watson Folsom.

With Five Plates.

CAMBRIDGE, MASS., U. S. A.:

PRINTED FOR THE MUSEUM.

June, 1924.

No. 14.— *East Indian Collembola.*

By Justus Watson Folsom.

The specimens forming the subject of this article were sent to the writer by Mr. Edward Jacobson, who collected them in Sumatra and Java. They consist of the following species:—

Achorutes armatus Nicolet. *Achorutes consanguineus,* sp. nov. *Entomobrya proxima,* sp. nov. *Lepidocyrtus parallelus,* sp. nov. *Lepidocyrtus setosus,* sp. nov. *Cremastocephalus celebensis* Schäffer. *Paronella segmentata,* sp. nov. *Cyphoderus orientalis,* sp. nov. *Papirioides jacobsoni,* gen. et sp. nov.

Of these species, the last is especially interesting, on account of its resemblance to the remarkable genus Corynephoria Absolon.

The collection has been given to the Museum of Comparative Zoölogy, Cambridge, Massachusetts.

I am indebted to Mr. A. N. Caudell, of the U. S. National Museum, for his opinion on a question of nomenclature.

PODURIDAE.

Achorutinae.

Achorutes Templeton.

Achorutes Templeton, 1835 (in part).
Hypogastrura Bourlet, 1842.— Börner, 1906.

The use of Hypogastrura in place of Achorutes should be abandoned.

Bourlet, 1839, proposed Hypogastrura, with *Podura aquatica* Linné as its type.

Bourlet, 1842, described *Hypogastrura murorum,* which belongs to Achorutes Templeton

Since Börner resurrected Hypogastrura in 1906, the name has, naturally, been adopted by many writers.

The reason for reviving Hypogastrura was that Bourlet made a misidentification; for in 1839 the species that he had in hand was not *Podura aquatica* L., but was probably the form that he described later as *Hypogastrura murorum.*

This case of a genus based upon erroneously described species has received long and careful consideration by the International Commission on Zoölogical Nomenclature, and is covered by Opinion 65 of the Commission.

Achorutes armatus Nicolet.

Plate **1**, fig. 1.

Podura armata Nicolet, 1841.
Achorutes armatus Gervais, 1844.— Nicolet, 1847.

This well-known species needs no description. It is highly variable in coloration. The specimens from Sumatra, which agree exactly with examples from Europe and North America, are the blackish blue variety. In moderately pigmented specimens the pigment is in the form of rounded spots due to granules of pigment surrounding hypodermal nuclei, and the pair of parallel dorsal stripes is present, as well as the median dorsal spot of the head. The type of dorsal clothing is shown in Figure 1. For detailed accounts of the species see Börner, '01, Linnaniemi, '12, and Folsom, '16.

This is a cosmopolitan species, which has already been recorded from Sumatra by Oudemans, '90.

Diëng Plateau, Java, 2000 M., December, 1914. Hundreds of specimens, on the surface of the water of pools.

Baso (west coast of Sumatra), October, 1913. Many specimens on fungi.

Fort de Kock, Sumatra, 920 M., November, 1920. Many examples on damp sand. January, 1921, seven specimens.

Achorutes consanguineus, sp. nov.

Plate **1**, fig. 2–11.

Blackish blue dorsally, pale ventrally; pigment in the form of rounded spots, in moderately pigmented specimens. Antennae dark blue. Legs pigmented basally, otherwise pale; or else mottled with pigment. Furcula unpigmented, or manubrium pigmented basally. Eyes 8 + 8, equal. Postantennal organs (Fig. 2, 3) with either four or five peripheral tubercles and an oval or roundish accessory body ("Nebenkörper"). Antennae shorter than the head (as 3 : 4). Sense-organ of third antennal segment (Fig. 4) with a pair of papillae subtended by a chitinous ridge, a stout spine-like seta, and a pair of long guard setae. Fourth antennal segment with about ten olfactory setae visible in dorsal aspect, as in Figure 5. Unguis (Fig. 6) with inner margin unidentate two fifths from the apex. Unguiculus extending one half as far as the unguis on hind feet, two fifths as far on fore feet, sublanceolate, acuminate. One knobbed tenent hair, as long as the unguis. Dentes (Fig. 7) not swollen apically, coarsely tuberculate dorsally, with seven dorsal setae. Mucrones almost half as long as dentes, with well-developed inner and outer lamellae, in form as in Figure 8 and 9. Rami of tenaculum quadridentate. Anal spines two (Fig. 10), minute, one fifth as long as hind unguis, on contiguous papillae shorter than the spines. Clothing dorsally of sparse short curving setae, of the type shown in Figure 11.

Length, 0.9 mm.

Diëng Plateau, Java, 2,000 M., December, 1914. Hundreds of specimens, mixed with *Achorutes armatus*.

ENTOMOBRYIDAE.

Entomobryinae.

Entomobrya proxima, sp. nov.

Plate **2**, fig. 12–15.

Ground color either pale yellow or white. Pigment blue, becoming blackish where dense. The type of coloration is shown in Figure 12. Head yellow dorsally, with an anterior black line connecting the eye-spots. Genae either pigmented or not. The thoracic segments and the first two abdominal segments are mostly yellow dorsally and pigmented laterally. Abd. 2 has a wide posterior band; abd. 3 is pigmented except along the anterior margin; abd. 4 is entirely pigmented except near the anterior margin, where the pigment forms longitudinal streaks; abd. 5 and 6 are pigmented except anteriorly. The body-segments are margined posteriorly with black. Antennae blue; first three segments dark blue apically. Legs white, with a little pigment on each segment. Furcula unpigmented. Eyes (Fig. 13) 8 + 8 on black patches; the two inner proximal eyes much smaller than the others. Antennae not quite twice as long as the head, with segments in relative lengths about as 12 : 25 : 26 : 38; first segment cylindrical; second and third subclavate; fourth narrowly elliptical. Pronotum exposed, not covered by the mesonotum. Body-segments in relative lengths about as 10 : 30 : 23 : 17 : 21 : 25 : 62 : 13 : 14. Unguis (Fig. 14) long, almost straight, with a pair of strong pseudonychia; inner margin with a tooth one fourth from the apex and a pair of teeth in the middle. Unguiculus extending two thirds as far as the unguis, almost parallel-sided, acute, obliquely truncate apically. Tenent hair long, with well-developed club. Furcula extending to the ventral tube.

Dentes slightly longer than manubrium; crenulate dorsally, the crenulations beginning two fifths from the base and ending before the apex at a distance twice the length of the mucro. Mucrones (Fig. 15) with two teeth and a long proximal spine; anteapical tooth somewhat stouter than the apical. Tenaculum quadridentate, with a long strong anterior seta. Dorsal clothing of short curving fringed setae, sparse on the thorax and the first two abdominal segments, but becoming abundant on the remaining segments. Antennae with stiff toothed setae of moderate length, numerous short curving toothed setae, and an occasional outstanding sensory seta. Legs with short fringed setae and a few outstanding sensory setae, minutely toothed. Furcula dorsally with curving fringed setae; ventrally with stiff fringed setae.

Length, 1.1 mm.

Two syntypes, Fort de Kock, Sumatra, 920 M., February, 1921, from the nest of one of the Sciuridae.

Lepidocyrtus parallelus, sp. nov.

Plate 2, fig. 16–21.

Elongate. Straw-yellow almost entirely, with a slight and variable amount of blue pigment, which increases with the size of the specimen. In the smaller specimens the head and body are yellow and without pigment (excepting the eye-spots). In larger specimens, the mesonotum is narrowly bordered anteriorly and laterally with blue. Next, the metanotum becomes edged with blue laterally (Fig. 16) and a spot of pigment occurs at the postero-ventro-lateral angle of the fourth urotergite. Finally, a little pigment appears on the bases of the legs, which are otherwise yellowish white; also dorsally and laterally on the sixth abdominal segment. First and second antennal segments yellow basally, blue apically and ventrally; third segment yellow basally, otherwise blue; fourth, blue throughout, or yellow basally. In some specimens the antennae and legs have white in place of yellow. Furcula yellowish white throughout. Eyes (Fig. 17) 8 + 8, the two inner proximal eyes smaller than the others. Eye-spots black, almost round, usually with an antero-ventral projection at the base of the antenna (Fig. 16). Antennae one and one half to one and four fifths times as long as the head; segments quite variable in relative lengths, but becoming successively longer; first three segments subcylindrical; fourth elliptico-cylindrical. Head hanging (Fig. 16) covered broadly by the mesonotum. Second and third abdominal segments subequal in length; fourth more than five times as long as the third. Unguis (Fig. 18) broad basally, with a pair of large pseudonychia; inner margin with a pair of teeth near the middle, and a single tooth one third from the apex. Hind unguis longer than the others. Unguiculus on first pair of feet extending two fifths as far as the unguis; on second pair, one half as far; third pair, two thirds. Hind unguiculi lanceolate, acute, obliquely truncate apically, un-toothed. Tenent hair broadly knobbed, as long as the concave margin of the unguis. Furcula extending to the ventral tube. Manubrium and dentes subequal in length, ventrally with scales, dorsally with curving fringed setae which are longer on the dentes than on the manubrium. Mucrones (Fig. 19) with the usual apical and anteapical teeth, and with a long proximal spine. Rami of tenaculum (Fig. 20) quadridentate; corpus elongate, with an unusually stout curving anterior seta. Most of the setae are fringed. Those of the head and body are short. Abd. 6 bears dorsal and lateral tufts of dense short clavate fringed setae. Abd. 4 and 5 have ventrally dense fringed pointed setae. On the dorsum of the abdomen are many long erect fringed sensory setae. Coxae with numerous long stiff setae, minutely fringed. The head and body are clothed dorsally with scales. The scales (Fig. 21) are mostly obovate or oblanceolate, though variable in form and size. They contain a brown pigment, but are violet by light reflected from the surface.

Length, 1.9 mm.

Nine syntypes. Fort de Kock, Sumatra, 920 M., November, 1920; January, 1921.

Lepidocyrtus setosus, sp. nov.

Plate 3, fig. 22–27.

Elongate (Fig. 22). General color pale yellow; body color yellowish white. Pigment blue, mostly in the form of irregular spots, but forming bands on the legs. Scales brownish. Head with a small median dorsal spot, an anterior transverse marking connecting the eye-spots, and a few spots on the cheeks. Mesonotum and metanotum bordered laterally with irregular spots (Fig. 22). Abdomen 1 and 2 with a few small irregular spots laterally; abd. 3 with large irregular lateral spots. Abd. 4 bears a large ventro-lateral spot and several lateral spots. Abd. 5 and 6 have a few small lateral spots. First three antennal segments each with a ventral stripe of pigment; first and third segments also pigmented apically; fourth with a proximal and a distal stripe. Coxae with a few irregular spots. Femora 1 and 2 with a spot on each side distally; femur 3 with a proximal spot and a distal blue band. Tibiotarsi with a proximal and a distal band. Furcula unpigmented excepting a dorso-basal spot on the manubrium. Head normally hanging under the mesonotum, as in Figure 23. Eyes 8 + 8 (Fig. 24), on black patches, the two inner proximal eyes slightly smaller than the others. Antennae four fifths as long as the body, with segments in relative lengths about as 11 : 13 : 12 : 19; first three segments subcylindrical; fourth narrowing distally. Fourth abdominal segment more than eight times as long as the third. Unguis (Fig. 25) almost straight, with a pair of lateral teeth; inner margin with a pair of teeth at the middle, and a tooth about one third from the apex. Unguiculus extending two thirds as far as the unguis on the hind feet, almost parallel-sided, acute, obliquely truncate apically. Tenent hair as long as the unguis, with a large knob. Opposite the tenent hair is a simple sensory hair about as long as the tenent hair. Furcula extending to the ventral tube. Manubrium two thirds as long as dentes. Dentes (Fig. 26) slender, tapering apically, crenulate dorsally, the crenulations beginning near the middle and extending almost to the mucro. Mucrones (Fig. 26) strongly rounded ventrally, tridentate; apical and anteapical teeth rather long; third tooth forming a stout oblique spine. Stout clavate setae occur densely on the dorsum of the head and the anterior region of the mesonotum (Fig. 22). Such clavate setae are present also on the dorsum of the remaining segments excepting abd. 5 and 6, and form a transverse row on the metanotum and the first three abdominal segments, respectively. A pair of very long minutely fringed bothriotricha occurs postero-dorsally on abd. 3 and on abd. 4 (Fig. 22). Long pointed fringed setae are present densely on abd. 5 and 6. Dense fringed setae occur on the legs and dorsally on the furcula. Occasional long outstanding sensory setae are present on antennae and legs. Scales mostly broadly lanceolate (Fig. 27) or subelliptical, with cuspidate apex.

Length, 1.8 mm.

Two syntypes, Fort de Kock, Sumatra, 920 M., February, 1921.

Cremastocephalus celebensis Schäffer.

Plate 3, Fig. 28, 29; Plate 4, Fig. 30, 31.

Cremastocephalus celebensis Schäffer, 1898.— Schött, 1901.— Börner, 1913.

Body-color probably white, but yellowish in the alcoholic specimen. Antennal segments (Fig. 28) blue apically, the pigment forming a band on each of the first three segments. A line connects the eyes anteriorly. Ill-defined spots of blue occur on the femur distally and the tibiotarsus proximally and distally. Orange pigment is present (Fig. 28) along the anterior and lateral borders of the mesonotum, the lateral borders of the metanotum, and in the form of diffuse spots elsewhere, particularly as paired dorsal spots on the metanotum, abd. 2, 3 and 4. The head hangs down normally. Eyes (Fig. 29) 8 + 8, pigmented separately, in two parallel rows on each side, the two inner proximal eyes smaller than the others. Postantennal organs absent. Antennae as long as the head and body, with cylindrical segments, in relative lengths about as 6 : 10 : 9 : 12. Thorax strongly arched. Mesonotum covering the prothorax, but not projecting over the head. Body-segments, excepting prothorax, in relative lengths about as 34 : 18 : 20 : 30 : 5 : 103 : 18 : 9. Abd. 4 thus twenty times as long as abd. 3. Unguis (Fig. 30) without lateral teeth; inner margin bidentate, with a proximal tooth one fifth from the base and a distal tooth two fifths from the apex. Unguiculus large, two thirds as long as the unguis on hind feet, shorter on the fore feet; inner margin forming an obtuse angle near the middle, with a prominent tooth. Tenent hair unusually large, much longer than the unguis, broadly expanded apically. Furcula attaining the ventral tube. Mucro tridentate, in form as in Figure 31. Near the apex of the dens is a dorsal broadly elliptical scale-like appendage. Head and body clothed densely with short setae (Fig. 28). Long clavate fringed setae are numerous on the dorsum of the body and abundant on the anterior region of the mesonotum. Long stout pointed fringed setae occur on abd. 5 and 6. Long straight simple outstanding sensory setae are present on the body, antennae and legs. Scales are absent.

Length, 1.4 mm.

My specimen agrees with Schäffer's description of *celebensis;* the teeth of the unguis being, however, more strongly developed than in his type.

Schött's figure shows no teeth on the unguis, and the antennae are represented as being twice as long as the body. I am not sure that Schött ('01, p. 322) is correct in his statement that the Japanese *C. affinis* Folsom is without doubt *celebensis* Schäffer; *affinis* has a different form of mucro, stouter distal setae on the tibiotarsi, and a long, gradually expanding club on the tenent hair. Börner ('13, p. 54) recognizes *affinis* as distinct from *celebensis,* and notes that these two species and *bicinctus* Börner are closely related morphologically.

C. indicus Imms ('12, p. 104) is evidently very closely related to *celebensis,* from which it differs chiefly in the relative lengths of the segments of the antennae and of the body. It might well be regarded as a variety of *celebensis.*

C. celebensis has already been recorded from Celebes, New Guinea, and Java.

One specimen, Fort de Kock, Sumatra, 920 M., November, 1920.

Paronella segmentata, sp. nov.

Plate **4**, fig. 32–37.

Ground-color pale yellow in alcoholic specimens; pigment dull purplish, blackish where dense (Fig. 32). Head yellow dorsally, pigmented ventro-laterally. Body yellow dorsally, clouded with faint spots of pigment laterally, with most of the segments blackish ventrally or ventro-laterally. Abd. 6 yellow. Antennae mostly yellow; first three segments each with an apical blackish band; second and third segments each with a diffuse purplish band near the middle; fourth segment pigmented apically. Legs mostly yellow; coxa and trochanter more or less dull purplish; femur purplish proximally;

tibiotarsus with two dark purple bands, one on each of the two subsegments. Furcula yellow, with manubrium faintly pigmented dorso-distally, and dentes feebly pigmented except proximally and distally. Eyes eight on each side. Antennae seven eighths as long as the head and body, with cylindrical segments, in relative lengths about as 19 : 17 : 12 : 18; last segment with about twenty-five annulations, obscure in places. Prothorax concealed by the mesonotum, which projects over the base of the head. Body-segments (excepting prothorax) in relative lengths as 45 : 15 : 10 : 16.5 : 8 : 112 : 18 : 8. Fourth abdominal segment thus fourteen times as long as the third. On the postero-ventro-lateral angle of the second abdominal segment is a peculiar organ in the shape of a large, heavily chitinized hook (Fig. 33). Tibiotarsus divided into two segments by a movable joint (Fig. 32). Unguis (Fig. 34) with a pair of strong lateral teeth one third from the base, a pair of inner teeth two fifths from the base, and another tooth three fifths from the base. Unguiculus extending slightly farther than the distal inner tooth of the unguis, lanceolate, with an angle tooth at the middle of the inner margin. Tenent hair strongly knobbed, as long as the unguis. Opposite the tenent hair is a long simple sensory seta which extends almost as far as the unguiculus. Near this seta is an elliptical or lanceolate striated scale. Furcula (Fig. 32) strong, extending to the head. Dentes one fifth longer than manubrium, narrowing but slightly from base to apex, with five subsegments. Mucrones six-toothed, in form as in Figure 35 and 36. Most of the setae are minutely toothed or fringed, and brownish. On the front and on the anterior border of the mesonotum, long stout pointed setae occur densely. On the posterior dorsum of the fourth abdominal segment are short curving minutely fringed setae; similar setae occur also on the fifth and sixth urotergites. The abdomen bears ventrally dense scales and setae. Antennae and legs with dense stiff or curving setae. Furcula with scales ventrally; dorsally with dense fringed setae of various lengths, long and stiff or short and curving. Occasional long slender simple outstanding sensory setae are present on antennae and legs. Short erect sensory setae occur sparsely on the dorsum of the body. The scales are variable in form and size, but are mostly narrowly to broadly lanceolate, or elliptical (Fig. 37). They are most abundant on the dorsum of the head and body, but are replaced by setae on the postero-dorsal region of abd. 4 and on abd. 5 and 6.

Length, 2.6 mm.

This species agrees closely with *tarsata* Börner ('06, p. 177) in the form of the mucrones. In *tarsata*, however, the proximal pair of teeth of the unguis is nearer the base of the claw than is the inner tooth of the unguiculus; the hind unguiculi are only a little shorter than the inner margin of the opposite unguis; the first antennal segment is about as long as the dentes; the tergites from the mesothorax to the furcal segment, inclusive, are related in length about as 50 : 22 : 9 : 25 : 13 : 122; and each dens bears apically a dorsal rounded protuberance. The description of *tarsata* includes no reference to the subsegmented dentes and the peculiar hook found on each side of the second abdominal segment in *segmentatus*. If these characters were present in *tarsata*, such a keen observer as Börner could scarcely have overlooked them.

Holotype, Fort de Kock, Sumatra, 920 M., January, 1922.

Cyphoderus orientalis, sp. nov.

Plate 5, fig. 38–41.

Elongate. White throughout. Eyes and postantennal organs absent. Antennae longer than the head (as 5 : 4), with segments in relative lengths as 3 : 5 : 3 : 8. First antennal segment clavate-cylindrical; second subclavate; third clavate; fourth elliptical. Last two antennal segments with abundant small curving setae, in addition to the straight minutely fringed setae. Prothorax reduced. Mesonotum covering the prothorax but not projecting over the head. Body-segments, omitting the prothorax, in relative lengths as 9 : 7 : 3 : 4 : 4 : 21 : 8 : 4. Fourth abdominal segment thus more than five times as long as the third. Femur with a transverse suture near the middle, forming two subsegments; tibiotarsus also with two subsegments, the suture being beyond the middle. Legs with dense stiff fringed setae and occasional long outstanding sensory setae. Unguis (Fig. 38) curving, rather slender distally, with a pair of inner basal lobes, which are long, slender and gradually tapering, and extend almost half as far as the unguis; a small tooth at the middle of the inner margin; and a pair of small basal lateral teeth. Unguiculus (Fig. 38) large, slender, tapering, extending three fourths as far as the unguis, on the hind feet, with a large basal acute outer lobe. Hind claws the largest. Ventral tube with a pair of eversible rounded papillae. Furcula attaining the ventral tube; the integument smooth. Manubrium longer than dens (as 10 : 7), relatively short and stout, scarcely narrowing posteriorly; dorsally with numerous straight or curving simple setae and several erect subclavate fringed distal setae; laterally with stiff simple setae; ventrally with scales. Dens (Fig. 39) with scales ventrally, but with no long distal scales projecting under the mucro. Dens laterally with a series of six stiff simple setae; dorsally, at the base, an erect clavate fringed seta; also dorsally, two longitudinal rows of setae, as follows: an outer series of eight, beginning proximally as fringed setae and gradually becoming pinnate, there being six pinnate setae; an inner series of seven setae, the last of which is pinnate and long, extending far over the mucro. The number of pinnate setae probably increases with the size of the specimen. Mucrones (Fig. 40) three fifths as long as dentes, slender, distally tridentate; apical tooth small, slightly hooked; second and third teeth subequal; a trace of a membrane extends anteriorly from the apices of the second and third teeth respectively. Rami of tenaculum quadridentate; corpus with a single strong anterior seta. The scales (Fig. 41) are mostly obovate, oblanceolate, or subelliptical, and colorless.

Length 1 mm.

Holotype, Sinabang (Simalur), Sumatra, February, 1913, from a termite nest.

SMINTHURIDAE.

DICYRTOMINAE.

Thorax strongly reduced dorsally. Abdominal segments consolidated; the segmentation obsolete, except in the case of the genital and anal segments. Furcal segment with a pair of dorsal papillae, each bearing a bothriotrichum. Eversible processes of the ventral tube longer than the tube itself, with tuberculate walls. Antennae elbowed between the second and third segments, both of which, or only the third, may be subsegmented; fourth segment shorter than the third, conical. Ventral margin of unguis with two teeth. Integument granulate. Tracheae absent.

PAPIRIOIDES, gen nov.

This genus agrees with Ptenothrix Börner in almost all respects (though the dorsal setae of the dentes are not serrate except obscurely near the base), but has as its distinctive character the large median dorsal club-like appendage of the fourth abdominal segment, shown in Figure 42. This curious structure is evidently homologous with the same organ in the remarkable species *Corynephoria jacobsoni* Absolon ('07). The two genera are in other respects, however, entirely different.

The histology and function of the "dorsal club" in Corynephoria have been studied carefully by Hoffman ('11), who infers that (1) during the act of leaping, the anal and genital segments are bent upward, and come into contact with the dorsal club, which acts as a mechanism for checking the violent movement of the abdomen; (2) the club acts as a repulsatory apparatus to hasten the movements of "recovery" of the furcula.

In Papirioides the dorsal club has doubtless the same function as in Corynephoria; though in the former genus the organ is cylindrical or subclavate with the spine-like setae distributed over the entire surface, while in the latter genus it is capitate, with the setae limited to the terminal region.

As the two genera are undoubtedly distinct, it is safe, as well a appropriate, to name this species also after the assiduous collector, E. Jacobson.

Papirioides jacobsoni, sp. nov.

Plate 5, fig. 42–46.

Body color pale yellow. Pigment violet, becoming blackish where dense (Fig. 42). Head dorsally yellow, or white; laterally pale violet; orally yellow, or white. Abdomen dorsally yellow; laterally with irregular spots of yellow or violet, with orange patches here and there. The coloration is erratic, but consists largely of irregular patches of various shades of violet, in which the walls and nuclei of hypodermis cells are visible where the pigment is not too dense. Isolated hypodermal nuclei appear as clear oval spots narrowly surrounded with pigment. The dorsal club of the furcal segment is yellow dorsally and violet ventrally, as are also abd. 5 and 6. Abd. 4 is violet at the base of the furcula. First antennal segment unpigmented; second with a broad band at the middle and one at the apex; third with a proximal and an apical band; fourth pigmented apically. Legs with the two precoxal segments, and the coxae and trochanters heavily pigmented. Femora pigmented more or less; tibiotarsi each with three bands of violet. Ventral tube pigmented. Manubrium and dentes pale violet, or manubrium white ventrally. Eyes (Fig. 43) 8 + 8, subequal, pigmented separately, for the most part. Antennae twice as long as the head, four-segmented, elbowed between the second and third segments; segments in relative lengths as 11 : 65 : 70 : 16. Third segment (Fig. 44) with distal half annulated, representing eight subsegments. Fourth segment elongate-conical, with nine or ten subsegments indicated. Unguis (Fig. 45) long and slender, almost straight; inner margin strongly bidentate, with a tooth at the middle and a tooth one fourth from the apex; lateral margin bidentate, with a tooth one third from the base and a tooth one third from the apex; outer surface with a minute tooth one fifth from the base. Unguiculus extending a little beyond the adjacent proximal tooth of the unguis; long, slender, gradually narrowing, acute, with a long inner basal spine and a subapical filament exceeding the unguis and unknobbed apically. Tenent hair absent, represented by a long stiff simple seta. Fourth abdominal segment with a large posterior median dorsal cylindrical or subclavate appendage; with also a dorsal pair of setigerous tubercles. Ventral tube emitting a pair of stout tubules, apically rounded, and tuberculate on distal half. Furcula extending to the mouth. Manubrium with a few dorsal setae; naked ventrally. Dentes longer than manubrium (as 8 : 5 ventrally); dorsally with simple curving setae, often obscurely serrate at the extreme base, and a few long outstanding sensory setae; ventrally with a few distal setae. Mucrones (Fig. 46) one third as long as dentes, with both dorsal margins finely serrate; median rib pale violet. Rami of tenaculum tridentate; corpus with a large anterior lobe bearing ventrally six curving setae. Short spine-like setae occur sparsely on the head and body dorsally, and numerously on the dorsal club of the furcal segment. Abd. 6 bears longer spine-like setae dorsally, and fringed setae posteriorly. Cuticula with a minute network.

Length, 2.5

Three syntypes. Fort de Kock, Sumatra, 920 M., November, 1920; January, 1921; February, 1921, on Fungi.

REFERENCES.

Absolon, K.

1907. Zwei neue Collembolen-gattungen. Wien. Ent. zeit., **26,** p. 335–343.

Börner, C.

1901. Zur kenntnis der Apterygoten-fauna von Bremen. Abh. Nat. ver. Bremen, **17,** p. 1–141.

1906. Das system der Collembolen. Mitth. Naturh. mus. Hamburg, **23**, p. 147–188.

1913. Zur Collembolenfauna Javas. Tijds. ent., **56**, p. 44–61.

Bourlet, Abbe.

1839. Mémoire sur les Podures. Mém. Soc. sci. agr. arts Lille, pt. 1, p. 377–417.

1841–1842. Mémoire sur les Podurelles. Mém. Soc. agr. etc. Nord. Sep., 1843. Douai. 78 pp.

Folsom, J. W.

1916. North American collembolous insects of the subfamilies Achorutinae, Neanurinae, and Podurinae. Proc. U. S. N. M., **50,** p. 477–525.

Gervais, P.

1844. In Walckenaer: Histoire naturelle des insectes. Aptères, **3,** p. 377–456.

Hoffman, R. W.

1911. Ueber bau und funktion der dorsalkeule von Corynephoria jacobsoni Absol. Zool. anz., **38,** p. 382–391.

Imms, A. D.

1912. On some Collembola from India, Burma, and Ceylon; with a catalogue of the Oriental species of the order. Proc. Zool. soc. London, p. 80–125.

Linnaniemi, W. M.

1912. Die Apterygotenfauna Finlands. II. Spezieller teil. Acta Soc. sci. Fennica, **40,** p. 1–361.

Nicolet, H.

1841. Recherches pour servir à l'histoire des Podurelles. Nouv. mém. Soc. Helv. sci. nat. Neuchâtel, **6,** p. 1–88.

1847. Essai sur une classification des insectes aptères de l'ordre des Thysanoures. Ann. Soc. ent. France, ser. 2. **5**, p. 335–395.

Oudemans, J. T.
1890. Apterygota des Indischen Archipels. Weber: Zool. ergeb., **1**, heft 1, p. 73–92. Leiden.
Schäffer, C.
1898. Die Collembola des Bismarck-Archipels. Arch. naturg., **64**, bd. 1, heft 3, p. 393–425.
Schott, H.
1901. Apterygota von Neu-Guinea und den Sunda-Inseln. Termesz. Fuzetek, **24**, p. 317–331.
Templeton, R.
1835. Thysanurae Hibernicae. Trans. Ent. soc. London, **1**, pt. 2, p. 89–98.

EXPLANATION OF PLATES.

PLATE 1.

PLATE 1.

ACHORUTES ARMATUS Nicolet.

Fig. 1. Dorsal setae of third abdominal segment, × 426.

ACHORUTES CONSANGUINEUS Folsom.

Fig. 2. Postantennal organ of left side, × 673.
Fig. 3. Postantennal organ of right side, × 673.
Fig. 4. Sense organ of third segment of left antenna, × 1080.
Fig. 5. Olfactory setae of fourth segment of left antenna, dorsal aspect, × 673.
Fig. 6. Left hind foot, × 673.
Fig. 7. Left dens and mucro, × 673.
Fig. 8. Left mucro, × 673.
Fig. 9. Dorsal aspect of right mucro, × 673.
Fig. 10. Left anal spine, × 673.
Fig. 11. Dorsal setae of first abdominal segment, × 673.

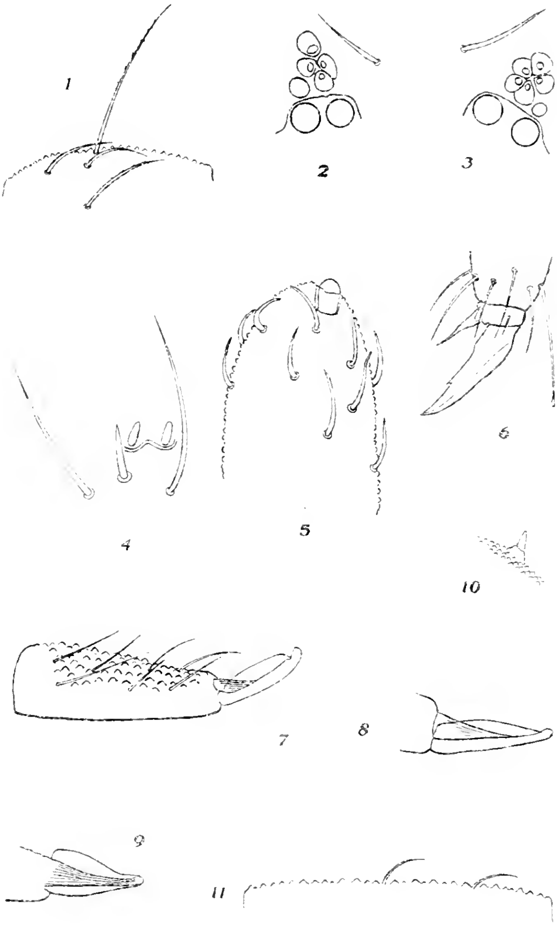

1
2
3
4
5
6
7
8
9
10
11

PLATE 2.

PLATE 2.

ENTOMOBRYA PROXIMA Folsom.

Fig. 12. Dorsal aspect, × 53.
Fig. 13. Eyes of left side, × 320.
Fig. 14. Right hind foot, × 790.
Fig. 15. Left aspect of right mucro and end of dens, × 790.

LEPIDOCYRTUS PARALLELUS Folsom.

Fig. 16. Head and thorax, × 41.
Fig. 17. Eyes of right side, × 262.
Fig. 18. Left hind foot, × 505.
Fig. 19. Left aspect of left mucro and end of dens, × 505.
Fig. 20. Left aspect of tenaculum, × 505.
Fig. 21. Scale from dorsum of body, × 505.

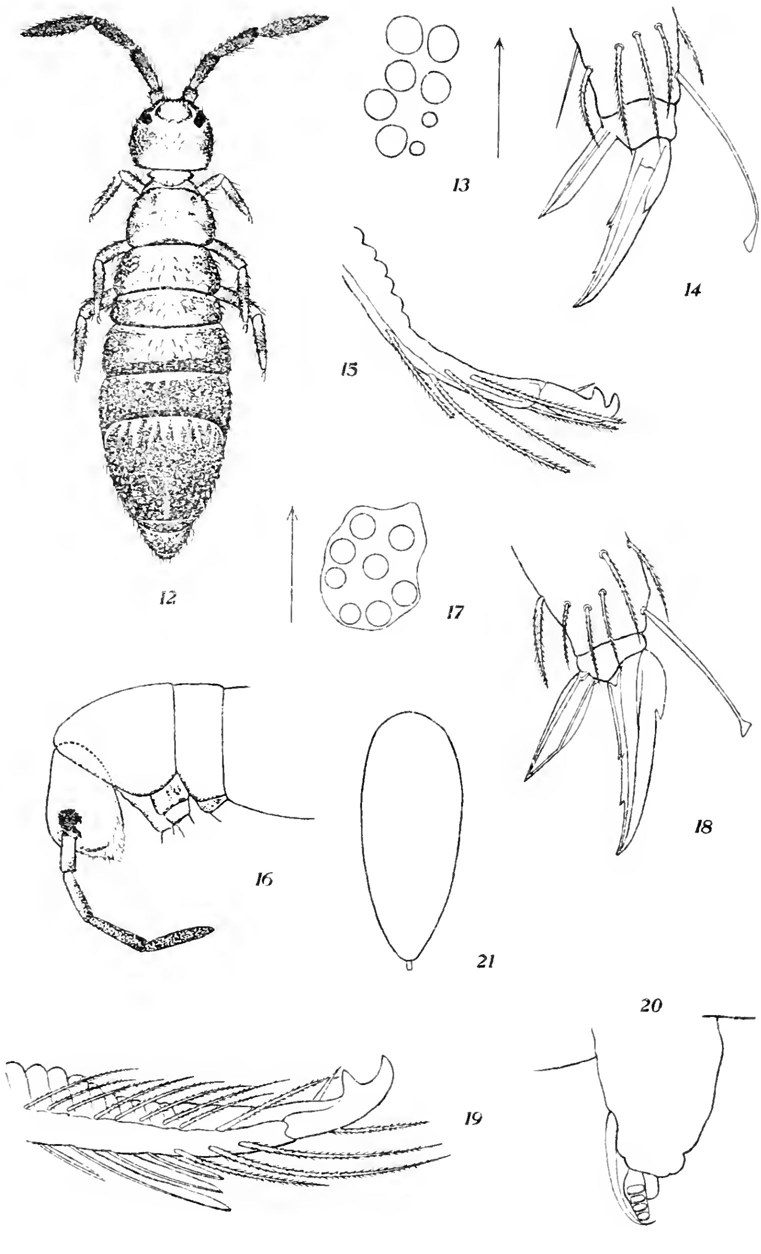

12
13
14
15
16
17
18
19
20
21

PLATE 3.

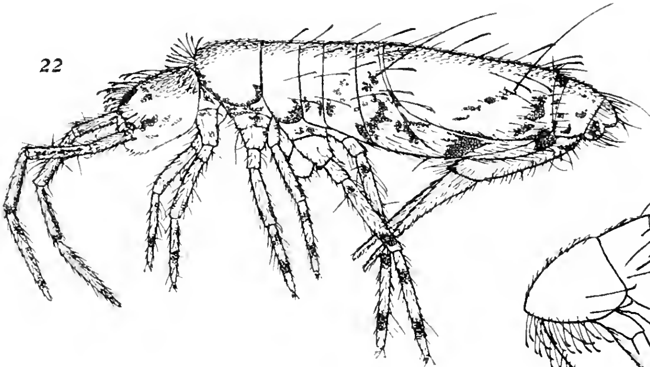
PLATE 3.

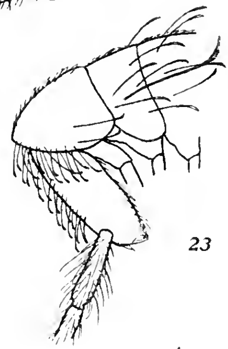
Lepidocyrtus setosus Folsom.

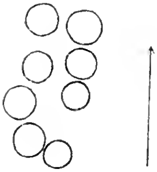
Fig. 22. Left aspect, × 25.
Fig. 23. Head and thorax, × 37.
Fig. 24. Eyes of left side, × 175.
Fig. 25. Right hind foot, × 370.
Fig. 26. Left aspect of right mucro and end of dens, × 505.
Fig. 27. Scale from dorsum of body, × 595.

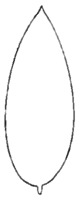
Cremastocephalus celebensis Schaffer.

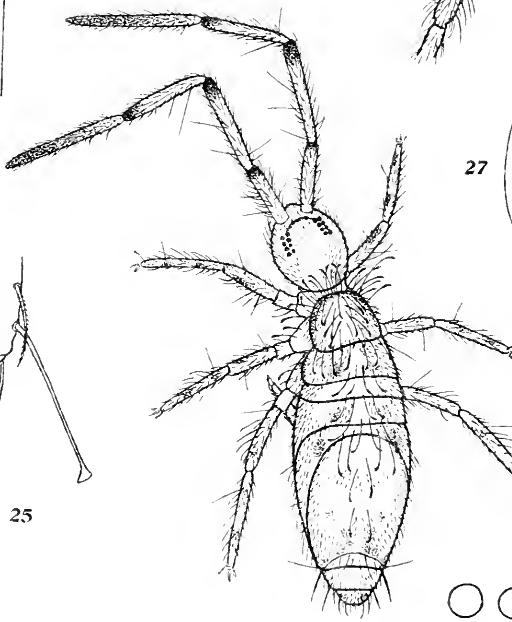
Fig. 28. Dorsal aspect, × 37.
Fig. 29. Eyes of left side, × 265.

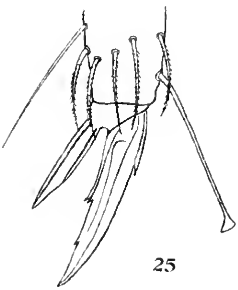

22


23


24


27


28


25


26

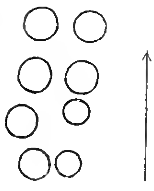

29

PLATE 4.

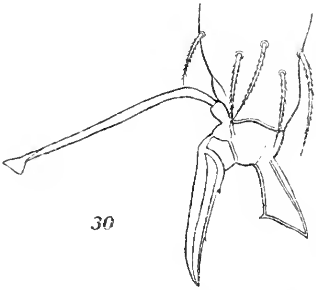
PLATE 4.

Cremastocephalus celebensis Schäffer.

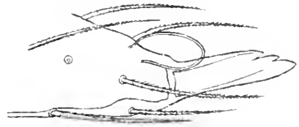
Fig. 30. Right fore foot, × 790.
Fig. 31. Left mucro, × 790.

Paronella segmentata Folsom.

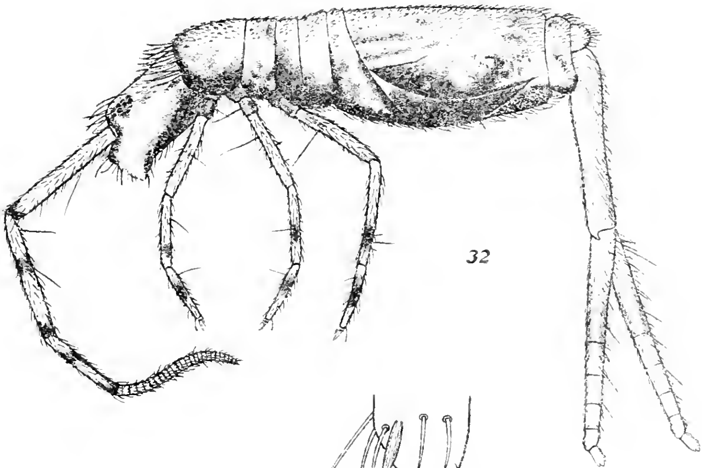
Fig. 32. Left aspect, × 25.
Fig. 33 Hook, arising from the left side of the second abdominal segment. × 88.
Fig. 34. Left hind foot, × 370.
Fig. 35. Left aspect of right mucro, × 370.
Fig. 36. Left aspect of left mucro, × 370.
Fig. 37. Scale from dorsum of thorax, × 510.



30

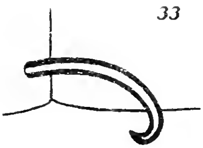


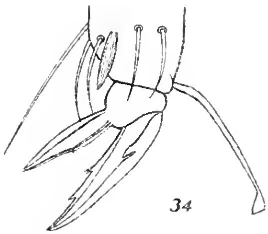
31



32

33

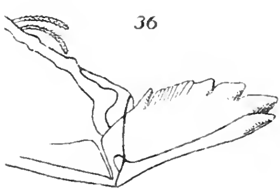




34

37

36



35

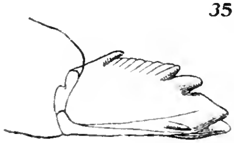


PLATE 5.

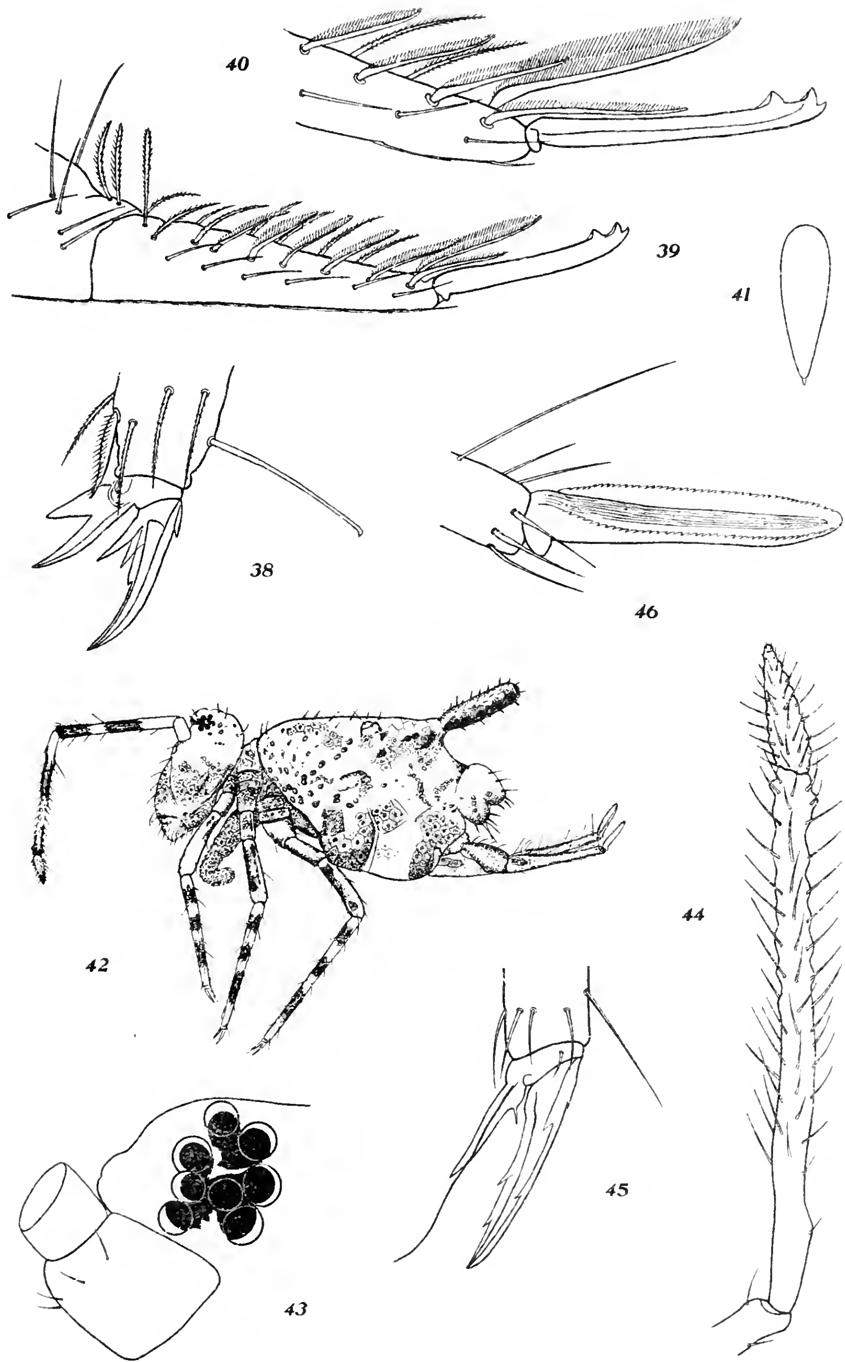
PLATE 5.

Cyphoderus orientalis Folsom.

Fig. 38. Right hind foot. × 702.
Fig. 39. Left dens and mucro. × 285.
Fig. 40. Left mucro and extremity of dens, × 450.
Fig. 41. Scale, × 330.

Pseudosinella (?) ... Paronellides jacobsoni Folsom.

Fig. 42. Left aspect, × 18.
Fig. 43. Eyes of left side and base of antenna, × 155.
Fig. 44. Right antenna, × 75.
Fig. 45. Left hind foot, × 285.
Fig. 46. Right mucro, × 170.


40
39
41
38
46
42
44
45
43