

# NORTH AMERICAN PARASITIC COPEPODS: NEW GENERA AND SPECIES OF CALIGINÆ.

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During the summer of 1905 it was the author's good fortune to enjoy two months' study of the parasites which infest our Southern fishes. The work was carried on during the months of July and August at the laboratory of the Bureau of Fisheries at Beaufort, North Carolina.

For this valuable opportunity the author is indebted to the courtesy of the Hon. George M. Bowers, U. S. Commissioner of Fish and Fisheries, to whom acknowledgment is gratefully made.

Thanks are also due to Dr. Caswell Grave, the director of the laboratory, for placing at easy disposal every facility which the laboratory afforded.

A good idea of the value and abundance of the material thus gathered may be obtained from the present paper, which includes only those forms belonging to the subfamily Caliginæ, the others being reserved for future publication. This paper may be considered as the supplement of the more extensive one already published upon the same subfamily.<sup>a</sup>

It also represents the first collected work upon the copepod parasites of our Southern fishes. Isolated forms have been reported from the middle Atlantic by Leidy in 1855; from the southern Atlantic by Say in 1818; by Dana in 1854, and by Rathbun in 1884, and from the Danish West Indies by Krøyer in 1863. But all of these accounts include scarcely a dozen species, fully two-thirds of which were described by Krøyer alone.

While his descriptions are nearly always accurate enough for purposes of classification, yet they were all made from preserved material, and therefore of necessity give us nothing in regard to the coloration or habits. And only one or two of the species have ever been seen since their original description.

<sup>a</sup>Proc. U. S. Nat. Mus., XXVIII. 1905, p. 479.

These are sufficient reasons to warrant a redescription of any of the species on obtaining fresh material. Two such redescriptions are here included, those of *Caligus haemulonis* and *Lepcophtheirus monacanthus*, and others will follow in future papers.

The other five species are new to science, and are particularly interesting because two of them are the types of new genera which stand as connecting links between some of the older forms and serve to emphasize their close relationship. A third species, *Parapetalus occidentalis*, is a new representative of a genus which previously had but a single species, and it changes the old generic diagnosis in many important particulars.

The drawings are all original and made from living material.

#### CALIGUS HÆMULONIS Krøyer.

Plate XLIX.

*Caligus haemulonis* KRØYER, 1863, p. 48, pl. IV, figs. 3a-d.—BASSETT-SMITH, 1899 p. 448.

*Female*.—Carapace orbicular, as wide as long, somewhat narrowed anteriorly, considerably less than half (0.4) the entire length. Frontal plates distinct, half as wide as long, with an emarginate frontal border and a deep incision at the center. Lunules orbicular and occupying the entire width of the plates, but not projecting anteriorly. Eyes large, with prominent lenses, and situated well forward. Posterior sinuses broadly U-shaped and comparatively deep. Median lobe three-sevenths as wide as the carapace, squarely truncated posteriorly and not projecting beyond the lateral lobes. Thoracic area large, its outline almost a perfect half circle; digestive glands large and horseshoe shaped, filling the entire width of the median lobe.

Free segment three-fifths as wide as the genital segment and comparatively long, showing a strong constriction anteriorly where it joins the carapace.

Genital segment oblong, half the width of the carapace, its width to its length as 5 to 7. Its posterior corners are evenly rounded and without lobes; its posterior margin is slightly concave.

Abdomen narrow and elongate, one-jointed, less than half the width of the genital segment, its length 2.4 times its width.

It is widest at the center and slightly narrowed toward each end; anal laminae small, each carrying three large terminal setae, and a short spine on the outer margin.

Egg strings as wide as the abdomen and reaching but little beyond the tips of the setae; eggs large and only 15 or 18 in each string.

Of the appendages the second antennae are small, with the terminal claw but slightly curved; the basal joint is armed posteriorly with a blunt spine half as long as the terminal claw.

First maxillae as long as the claw of the second antennae and bent sharply at a right angle near their center.

Mouth tube three-fifths as wide as long, with a bony framework considerably like that in *Caligus rapax*.

Second maxillæ only about half the length of the mouth tube, simple, slightly curved, and blunt; exopod papilla comparatively large, with a spine actually longer than the endopod.

Furca large; branches stout and a little curved like parentheses marks. Second maxillipeds with a weak terminal claw about half the length of the basal joint.

The first swimming legs carry a short, stout spine on the posterior border of their basal joint and a long, slender one at its anterior distal corner. Terminal joint with the usual three claws and a spine, but without any trace of the plumose setæ on the posterior border. Spines on the exopods of the second legs very long and slender, those at the tip of the terminal joint with a wide, membranous flange along both sides.

The seta next to these claws also has a narrow membranous flange along its outer side.

Rami of the third legs well separated; claw at the base of the exopod large, slightly curved, and blunt.

Fourth legs stout and three-jointed, with five claws, the terminal one at the inner corner about twice as long as the others. Fifth legs invisible dorsally and almost so ventrally, consisting of very small papillæ, each with a single seta and situated on the ventral surface at the posterior corners of the genital segment.

Oviducts not very densely coiled inside the genital segment; cement glands comparatively large and inclined somewhat away from the central axis, the cellular portion wide and club-shaped.

Total length, 3.75 mm.; carapace, 1.6 mm.; genital segment, 1 mm.; abdomen, 0.86 mm.; width of carapace, 1.6 mm.; egg strings, 1.2 mm.

*Male*.—Carapace more than half the entire length, but otherwise as in the female. Free segment very short and as wide as the genital segment; the latter oblong, one-half longer than wide, and only one-fourth the width of the carapace.

Abdomen four-fifths as long as the genital segment, two-jointed, the terminal joint twice the length of the basal.

Second antennæ small with a broad and spatulate terminal claw, which is bent in a half circle. These antennæ are not branched as in most *Caligus* males, but the base of the claw is armed with a knob of corrugated chitin on its inner surface.

First maxillæ actually longer than the second antennæ, slender and acuminate, and like the antennæ bent in a half circle.

Second maxillæ as long as the entire mouth tube, their base broadly triangular and carrying a large exopod papilla tipped with two short spines. Branches of the furca curved considerably more than in the female, leaving an elliptical sinus in the center. Base of the second

maxillipeds armed with a long and stout spine which overlaps the tip of the terminal claw. Body of the semen receptacles in the genital segment of medium size, situated close to the posterior margin of the segment, with a tube running the whole length of the segment and intricately convoluted. Fifth legs visible dorsally and appearing on the lateral margins of the genital segment about one-third the distance from its posterior end.

Total length, 2.2 mm.; carapace, 1.2 mm.; genital segment, 0.5 mm.; abdomen, 0.4 mm.; width of carapace, 1.1 mm.

Color of both sexes a uniform yellowish pink, thickly penciled on both the dorsal and ventral surfaces of the body and the two median pairs of swimming legs with spots and lines of a bright rust-colored pigment. The eyes are exceptionally clear, so clear in fact that they stand out plainly to the naked eye in spite of the minute size of the copepod. They are assisted in this by their deep reddish-brown color, which contrasts strongly with the pink of the body.

The species is readily distinguished by these large eyes and by the absence of any plumose setæ on the first swimming legs.

(*hæmulonis*, the generic name of their host.)

Several males and females of this species were obtained, some from the mouth of the blackfish, *Centropristes striatus*, others from the mouth of the catfish, *Hexanematichthys felis* and still others from the mouth of the seacat, *Felichthys marinus*. Those from the blackfish are Cat. No. 32816, U. S. N. M. collection, those from the catfish are Cat. No. 32815, U. S. N. M., and those from the seacat, Cat. No. 32813, U. S. N. M.

Krøyer obtained only three specimens, two females and a male, all from *Hæmulon elegans* Cuvier in the Danish West Indies.

The finding of the present specimens, therefore, adds three new hosts and extends the habitat of the species well up along the Atlantic coast. There can be no doubt that this is Krøyer's species, since it agrees in every essential particular with the description he has given except in the shape of the frontal plates and the genital segment. With reference to the latter it is enough to say that the females obtained by the present author were smaller (and younger?) than the one whose dimensions he has given. And the discrepancy is no greater than would ordinarily be expected between such different stages of maturity.

In regard to the projecting frontal plates the case is different. Krøyer had two females which presumably agreed in this particular, but they had both been preserved for some time while the present specimens were examined while alive.

We can only conclude that the absence of plumose setæ on the first legs is of more specific value than the shape of the frontal plates.

With reference to the habits of the species it may be said that their activity is in inverse ratio to their size. Both sexes, but particularly

the male, are very lively, moving about rapidly on the inside of the fish's mouth, so that they are difficult to catch uninjured. When transferred to an aquarium they swim about as constantly and as restlessly as *Caligus rapax*. But so far as observed neither sex manifested any desire to crawl up out of the water like so many other species.

CALIGUS RUFUS, new species.

Plate L.

*Types*.—Cat. No. 32812, U. S. National Museum.

*Female*.—Body elongate and narrow in all its parts; carapace elliptical, considerably narrowed anteriorly and posteriorly, six-elevenths of the entire length, and nearly one-half longer than wide; frontal plates exceptionally wide and prominent; lunules large, widely separated, and not projecting; frontal margin with a slight curve and a shallow incision at the center, in which can be seen the remains of the frontal filament.

Posterior sinuses narrow, triangular, and shallow; median lobe five-eighths the width of the carapace and projecting far behind the lateral lobes, its sides tapering rapidly, its posterior margin evenly rounded; thoracic area nearly half the entire length, with a wide and squarely truncate anterior margin; eyes comparatively large and situated far forward, close to the frontal plates.

Free segment short and only half the width of the genital segment; the latter oblong with straight sides and evenly rounded corners; fifth legs invisible dorsally.

Abdomen one-jointed, two-fifths as wide and two-thirds as long as the genital segment, tapering considerably; anal laminae long and narrow and inclined toward each other; terminal setae nearly as long as the whole abdomen; egg strings about three-fourths as wide as the abdomen and three-fifths of the entire body length; 30 to 40 eggs in each string.

Second antennae rather small, three-jointed, the basal joint carrying a large spine on its ventral surface, the terminal claw stout and strongly curved; first maxillae small and rudimentary, consisting principally of a swollen base on which are borne two papillae, each tipped with two setae, in addition to the short, slender, and nearly straight terminal portion.

Second maxillae slender and elongate, with a triangular base carrying on its anterior corner a large papilla armed with two setae. These maxillae curve outward slightly and reach nearly to the end of the mouth tube.

This latter, the mouth tube, is of an unusual pattern for the Caliginæ and resembles that found among the Pandarinæ more than in any species thus far described. It is narrow and fully four

times as long as wide, with a very simple bony framework indistinctly jointed near the center. The framework consists of four long bones, one on either margin of the upper and under lips. These bones are jointed to other short oblique ones, which are fastened to the ventral surface at the proximal end of the mouth tube. At the distal end they are connected by a series of transverse bones very similar to those found in *Caligus curtus*. The mouth opening is terminal and reaches nearly the whole diameter of the tube. It is surrounded with the usual fringe of long hairs.

The terminal claws of the first maxillipeds have a narrow membranous fringe along both margins. The second maxillipeds have a stout and swollen basal joint, while the terminal claw is much shorter, but strong and well curved. On the inner surface of the basal joint near its proximal end there is an elevation, at the top of which is a circular cup or pit, as though it were for the reception of the terminal claw, but the latter is not long enough to reach it. The furca is entirely lacking.

The first legs are small and weak, the basal joint with a small spine on its posterior border, the outer terminal claw twice as long as the other two. The second legs are large and stout with especially long and strong plumose setæ. The spine at the tip of the basal joint of the exopod is toothed along its inner margin, while the one on the second joint is toothed along both margins. The apron of the third legs is much longer than usual, making with the long setæ of the second legs powerful swimming organs. The rami of these third legs are very widely separated, the exopod three-jointed and approximated closely to the margin of the apron, but even then it does not cover half the distance to the two-jointed endopod.

The fourth legs are small and weak, three-jointed with five spines, the four outer ones about the same length, the one at the inner corner somewhat longer. The fifth legs are near the posterior margin of the genital segment on the ventral surface, and each shows two distinct papillæ standing side by side, the outer one carrying a single seta, the inner and larger one carrying two.

In fig. 24, showing the ventral surface of the genital segment, the oviducts are just beginning to coil, and their entire contents are granular. This specimen, therefore, is a young female which had never borne eggs. The cement glands are narrow, parallel to each other, and close to the mid line. The cellular part extends nearly to the base of the glands, leaving only a very short and inflated duct. The semen receptacles are of the usual spindle shape, comparatively small and slender.

On the external surface can be seen two spermatophores discharging their contents into the sperm receptacles through the sexual openings.

The ovaries and musculature of the carapace are peculiar, as is shown in fig. 25. The ovaries (*o*) are narrow and semilunar, the convex sides facing each other and almost touching at the mid line; they are somewhat narrower at the center and enlarged at either end, their posterior third lying within the thoracic area. The muscles of the carapace, instead of being narrow and separate, as in most species, are fused into broad sheets.

This fusion necessarily modifies the direction in some instances; for the fused sheet can extend in but a single direction, while the separate muscles nearly always diverge or may even be curved.

This is particularly true in the thoracic area. In the present species we find but four of these muscle sheets on either side, very simply arranged, in place of the complicated pattern assumed by the numerous (twelve or more) individual muscles in *Caligus curtus*<sup>a</sup> and allied species.

The muscles which run from the thoracic area back into the free and genital segments, as well as those in the two latter segments, are of the usual pattern.

Total length, 4.4 mm.; carapace, 2.35 mm.; genital segment, 1.1 mm.; width of carapace, 1.7 mm.; width of genital segment, 1 mm.

Color, a bright orange yellow, thickly penciled above and below with lines and spots of a brilliant reddish-brown or rust color.

In some specimens the color is confined to separate spots without any penciling. By transmitted light this is the most highly-colored *Caligus* thus far described, since a wash of the rust-colored pigment fills the tissues of the carapace in the immediate vicinity of the spots much as though the color had "run." This bright color, which appears upon the ventral surface and the appendages as well as upon the dorsal surface, is alone enough to differentiate the species.

(*rufus*, rust colored).

*Chalimus*.—Carapace elliptical, one-fifth longer than wide; second and third thorax segments not yet fused with the head, but free, and, with the fourth segment, diminishing regularly in size.

Eyes large and of a deep brown color with prominent reddish lenses; situated about in the center of the carapace.

Genital segment and abdomen still united and comparatively short; anal laminae large, and each of them armed with six setae. First antennae fully developed; second pair with a weak and nearly straight terminal claw. Mouth parts like those of the adult in miniature; mouth tube already very long and narrow.

Swimming legs rudimentary, the first and second pairs better developed than the third and fourth. First two pairs biramous, the rami simple and armed with nonplumose setae.

<sup>a</sup> See Proc. U. S. Nat. Mus., XXVIII, p. 518, fig. 24.

The endopod of the first pair is much shorter than the exopod and is without setae. The rami of the second pair are about equal in size. The third pair have no endopod but only a slight swelling where it will later appear. The fourth pair are simple and very short.

Total length, 1 mm.; length of carapace, 0.56 mm.; width of carapace, 0.47 mm.

Groundwork colorless but with the entire dorsal surface thickly sprinkled with rust-colored spots and lines. This fact, together with the shape of the mouth tube, is sufficient to identify the chalinus, since in other species this stage has a very limited amount of pigment.

This species was found upon the outer surface and in the gill cavity of the sea catfish, *Felichthys marinus*, the chalinus being found fastened to the pectoral fin. The female is lively, swims about actively, and lives a long time in captivity. It is singularly free, for a *Caligus*, from the pernicious habit of crawling up out of the water and remaining there till dried.

The distinguishing characters are the color, the long and narrow mouth tube, the weak first and fourth legs, and the wide separation of the rami of the third legs. The toothed spines on the exopods of the second legs are also peculiar.

#### LEPEOPHTHEIRUS MONACANTHUS Heller.

Plate LI.

*Lepeophtheirus monacanthus* HELLER, 1865, p. 183, pl. XVI, fig. 3—BASSETT-SMITH, 1896, p. 456.

*Female*.—Carapace ovate, considerably more than one-third the entire length and a trifle wider than long. Anterior margin of the frontal plates nearly straight and incised but little at the center. They are also not distinctly separated from the carapace but the two are fused more than in other species.

Posterior sinuses narrow, shallow, and inclined considerably toward the central axis. Median lobe about half the entire width, not projecting beyond the lateral lobes, and emarginate posteriorly. Thoracic area small, two-fifths of the length of the carapace, its outline the arc of an almost perfect circle.

Digestive glands small, shaped like a beehive, with the rounded ends inclined inward toward each other. Eyes small and placed far forward, with inconspicuous otocysts.

Free segment as long as wide, half the width of the genital segment with both ends convex and projecting into the carapace and genital segment, respectively.

Genital segment ovate, six-sevenths as long as the carapace, with evenly curved sides and short rounded lobes at the posterior corners. Fifth legs not visible in dorsal view. Abdomen conical, about the same width at its base as the free segment, but tapering rapidly



toward the tip. In preserved specimens there is a constriction on either side just back of the center, but living specimens show no joint here.

Anal laminae fairly large, inclined toward each other, each tipped with three short setae. Egg strings wide and considerably longer than the entire body, with 50 or 60 eggs in each string.

Of the appendages the second antennae are long and slender, with the terminal claw bent in a half circle near the tip. No first maxillae could be found but there is a small spine on either side in just about the position of these maxillae which may be their rudiment.

The second maxillae are close to the mouth tube, with a broad and swollen base and an abruptly narrowed, slender, and acuminate tip. Upon the base is borne a papilla armed with two setae, representing the rudimentary endopod.

The first maxillipeds are of the usual pattern; the second pair are long and slender, the two joints about the same length, the terminal claw bent in a half circle which embraces its entire length. The furca is long and narrow, the central sinus U-shaped, the branches slender and slightly enlarged at their tips.

The first swimming legs are peculiar in having only a single terminal claw, which, however, is longer than the entire terminal joint and two-thirds as wide, with a blunt tip.

The basal joint carries a spine on both the anterior and posterior margins at the distal end. The second joint has a single small spine at the distal end on the anterior margin.

The spines on the exopods of the second legs are unusually large. The rami of the third legs are close together and chiefly noticeable on account of a lack of plumose setae, each ramus having but three. In addition the endopod carries two spines while the exopod has five. The fourth legs are three-jointed with five spines, the four on the terminal joint being nearly in a row at the end and all about the same size.

Total length, 4 mm.; carapace, length, 1.55 mm.; free segment, 0.5 mm.; genital segment, 1.15 mm.; abdomen, 0.80 mm.; width of carapace, 1.66 mm.; width of genital segment, 1 mm.

Color, a transparent horn color, sometimes quite yellow, with small dark purple spots evenly distributed over the dorsal surface.

(*monacanthus*, *μόνος* one and *ἀκάνθη* a spine, in allusion to the single spine at the tip of the first legs.)

*Young female*.—Carapace nearly half the entire length, broadly ovate, wider than long, narrowed considerably anteriorly. Frontal plates wide, distinct, and very prominent; frontal margin with a slight incision at the center, its lateral ends showing a broad curve sweeping forward almost to the edge of the transparent border. The latter is corrugated in fine lines on either side of the curve and apparently acts

as a sort of sucker, like the lunules in *Caligus*. Nothing like this has ever been noticed in other species of *Lepeophtheirus*.

About half way between this lateral curve and the central incision is a single flagellum on either side, which reaches beyond the edge of the transparent border and is evidently sensory. The median sucker on the ventral surface at the base of the frontal filament seems especially well developed in this young form. The remainder of the carapace is similar to that of the adult. The free segment is relatively larger than in the adult, being three-quarters as long as the genital segment, and at the center, through the bases of the fourth legs, once and a half its width.

The genital segment is a narrow oblong, only one-fifth as wide as the carapace and two-fifths as long, with parallel sides. At the posterior corners where it joins the abdomen the beginnings of the sexual organs can be plainly seen. On the dorsal surface at either side is the *os uteri*, or opening of the oviduct to the exterior. This takes the form of a large, broad, and blunt papilla projecting from the angle of the genital segment, on a level with and alongside the dorsal surface of the abdomen.

Inside the genital segment can be seen the posterior end of the oviduct, coiled irregularly, enlarged somewhat, and easily mistaken for the semen receptacles of the male.

On the ventral surface can be seen the fifth legs as a pair of large and blunt papillæ, with tiny setæ at their tips. Just in front of these legs a joint can be plainly seen extending across the ventral surface of the genital segment, as though the fifth legs were to be separated from the rest of the segment. This joint also appears indistinctly upon the dorsal surface, but would never be noticed if it were not first discovered on the ventral surface. In front of the fifth legs on the ventral surface may be seen the cement glands, already well formed and with the division of the central lumen into cells plainly visible. In the posterior portion of the abdomen the respiratory muscles extending from the abdomen wall to the cloacal portion of the intestine show that this mode of respiration persists at least for a time after the molt from the chalimus into the adult form.

Several interesting facts may be learned from this study of the young female. Perhaps the most important one is the necessity for great care in distinguishing between young females and males. The specimens under consideration were judged at first to be males; they were of the right size; the proportions of the body regions were those of ordinary *Lepeophtheirus* males, and the coiling of the oviducts at the posterior end of the genital segment looked much like a pair of semen receptacles. But on examining them under high magnification, in order to explain the curious structures in the genital segment,

well-developed cement glands were found which proved the sex beyond a doubt. A second fact, therefore, would be that these glands develop first in the growth of the sexual organs and furnish a sure method of distinguishing the sexes.

A third inference is in regard to the so-called fifth legs; if there is a joint extending across the genital segment in front of them then they must be the rudiments of the sixth rather than the fifth pair of legs. When two pairs are visible upon the genital segment we call the posterior pair the sixth and the anterior pair the fifth. But this young female would seem to show that when only one pair are present they are as likely to be the sixth as the fifth pair. A genital segment which shows no signs of division in the adult may have been divided in the young with sufficient clearness to indicate beyond a doubt which pair of legs it is that are present.

Total length, 3.3 mm.; length of carapace, 1.7 mm.; length of free segment, 0.5 mm.; length of genital segment, 0.7 mm.; length of abdomen, 0.7 mm.; width of carapace, 1.7 mm.; width of genital segment, 0.4 mm.

*Nauplius*.—Body ovate, evenly rounded anteriorly but quite squarely truncated posteriorly between the balancers. Appendages proportionally longer than usual, but otherwise of the ordinary form. The entire center of the body filled with a mass of opaque yellowish yolk granules, which extend forward in three lobes the median of which is wider and blunter than the two lateral ones. The balancers are long, cylindrical, and quite strongly curved; they start out from the posterior corners at an angle of 45 degrees, but curve forward so much that their terminal halves are in the same straight line which is at right angles to the body axis. The pigment is of a peculiar deep Prussian blue and is distributed in the form of spots along either margin of the body outside the yolk. There is a large spot at the base of each balancer, and the two fuse across the mid line. The eye spot is also large and covers the entire space between the bases of the first antennæ.

Total length, 0.22 mm.; width of body, 0.12 mm.

This species was established by Heller in 1865 from specimens found on the gills of "*Pimelodus maculatus*," a catfish common in Brazil. The species has not been seen since, or at least has not appeared in any published writings. In the redescription as here given many interesting details have been added.

The present specimens were obtained from two species of the same family of catfish, namely *Hexanematichthys felis* Linnæus and *Felichthys marinus* Mitchill. The former lot of specimens is Cat. No. 32804, U. S. N. M., the latter Cat. No. 2800, U. S. N. M. On both fish the copepods were found in the gill cavity and on the inside of the operculum, rarely more than three or four on the same fish. But

they were fairly common and every haul of the fish yielded several specimens. Heller did not find any males and the most persistent search in the present instance throughout the entire summer also failed to yield any of that sex. There must be something peculiar in their habits or in the conditions by which they are surrounded to account for such a widespread disappearance of the males immediately after the breeding season.

The females, especially the young and such of the adults as are without their egg strings, are very lively when placed in an aquarium. They swim about rapidly and persistently, and rival the most pernicious of the *Caligus* species in crawling up above the surface of the water. They also move about over the skin of their host more rapidly than is usual in a *Lepeophtheirus*.

LEPEOPHTHEIRUS LONGISPINOSUS, new species.

Plate LII.

*Types*.—Cat. No. 32810, U. S. National Museum.

*Female*.—Carapace orbicular, about as wide as long and half the entire length. Frontal plates wide and distinct, their anterior margin nearly straight with a shallow incision at the center, in the bottom of which can be seen the remains of the frontal filament. Posterior sinuses wide and U-shaped, inclined somewhat toward each other. Median lobe half the entire width and projecting half its length behind the lateral lobes, with a slightly concave posterior margin. Thoracic area semicircular, but much less than half the entire length, owing chiefly to the shortness of the median lobe. Eyes large and situated far forward.

Free segment short and less than one-third the width of the genital segment, with concave sides and scarcely any thickening through the bases of the fourth legs.

Genital segment orbicular, with very evenly curved sides, the posterior lobes short, wide, and blunt, the posterior margin concave.

Abdomen the same width as the free segment, one-jointed, and about four-sevenths as long as the genital segment. Anal laminae large and oblong, tipped with three long plumose setae, with two shorter ones on the outer margin. Egg strings wider than the abdomen and three-quarters the entire length of the body, each with 25 or 30 eggs.

Second antennae with an unusually long and slender terminal claw, sharply bent near the tip; the basal joint is armed with a slender spine two-thirds as long as the terminal claw.

The first maxillae have a swollen circular base on which are two papillae armed with spines, the rudiments of the endopod. The tips of these maxillae are slender, slightly curved, and nearly as long as the terminal claw of the second antennae, which is exceptional even in a male of this genus.

The second maxillæ are elongate and triangular, the base but little enlarged, opposite the center of the mouth tube, and some little distance from it. Their tips are slender, straight, and simple, the entire appendage being somewhat longer than the mouth tube. The mandibles are slender with a curved terminal joint, armed with coarse rounded teeth on the concave margin and fine pointed teeth on the convex margin, another exceptional feature in this genus.

The mouth tube is short, two-thirds as wide as long, with a bony framework very similar to that in *Lepcophtheirus hippoglossi*, the soft flap at the tip of the upper lip being relatively wider, and the fringe of hairs around the mouth opening longer and denser.

The first maxillipeds are long and slender, and the basal joint is but little swollen; the terminal joint, including the claw, is twice the length of the basal and ends in a single claw which is strongly curved near its tip. At the base of this claw are two medium sized spines, one on the inner and the other on the ventral margin. The claw itself is branched, giving off two small accessory spines on its outer margin; so far as known this has never before been reported in this genus.

The second maxillipeds are large and stout and of peculiar structure; the basal joint is swollen and of normal form, the terminal claw is short and not much curved. From the base of this claw on the inner margin arises a stout conical spine, half the length of the claw and as wide at the base as it is long. The use of this spine is problematical, since from its size and position it must prevent the terminal claw from closing down on the basal joint in the usual manner.

The furca is large and relatively the longest of any yet described; its base is in the usual position, but when closed down against the ventral surface the tips of its branches reach beyond the posterior margin of the first legs.

These branches are wide and stout, with spatulate tips, and they diverge in the shape of a broad V. Each carries a slender, pointed secondary branch upon its inner margin near the base. These secondary branches are two-thirds as long as the primary ones, are parallel with each other, and leave the central sinus of a broad U-shape.

The basal joints of the first legs are each armed with two spines on the posterior margin, the outer one wider and longer than the inner. The second joint carries a short and blunt spine at its distal anterior corner. The terminal claws decrease regularly in size from in front backwards.

The second legs are of the ordinary pattern; the rami of the third legs are so close together as almost to touch on their adjacent margins. Each ramus is two-jointed; the basal spine on the exopod is large and nearly straight. The fourth legs are three-jointed with

four spines, the basal joint slender and one-third longer than the two terminal joints. The second and third joints are the same length; the inner terminal claw is slender and two and a half times as long as the others, equaling the combined length of the second and third joints. The fifth legs are entirely lacking.

The oviducts are rather loosely coiled in the genital segment, and very small compared with the size of the external egg cases. The cement glands are short and wide, somewhat club-shaped, and they reach scarcely beyond the center of the genital segment. Their constituent cells are thin, while the duct is enlarged and bent abruptly just as it leaves the cellular portion. The semen receptacle is narrow, about the same width throughout, and curved slightly forwards.

Total length, 3.2 mm.; length of carapace, 1.65 mm.; length of genital segment, 1 mm.; length of abdomen, 0.55 mm.; width of carapace, 1.6 mm.; length of egg strings, 2.15 mm.

Color a uniform light gray without pigment except in the eyes.

(*longispinosus*, *longus*, long and *spinosus*, armed with spines.)

This species was found on the gills of the Hammer-head shark, *Sphyrna zygaena*. It is chiefly remarkable for the length and slenderness of its spines and maxillæ, and also for the form and length of its furca. Specimens were secured from two sharks taken at different times and in different localities. These were all the sharks of this species that were obtained, and of course are not enough to decide whether the parasite is common or not.

#### Genus PARAPETALUS Steenstrup and Lütken.

*New diagnosis*.—First three thorax segments united with the head and covered by a rounded and shield-shaped carapace. Frontal plates with lunules as in *Caligus*. Fourth segment free, much narrower than the genital segment, and without dorsal plates or processes.

Genital segment enlarged nearly to the size of the carapace; its ventral surface produced on either side into a large membranous wing which reaches well beyond the lateral margin of the segment and curls up dorsally at the edge. Each wing is also produced posteriorly into a broad rounded lobe which reaches nearly to the tip of the abdomen. The genital segment is also produced on its ventral surface posteriorly into two short flattened lobes lying side by side at the median line between the bases of the wing lobes and under the origin of the egg tubes.

Abdomen narrow and elongate; its dorsal surface produced on either side into a wide membranous wing similar to those on the genital segment, but which curls downward at the edges around the egg strings. First and fourth swimming legs uniramous; second and third pairs biramous. Fused median eye and furca as in *Caligus*. Anal laminae medium size with short setæ.

## PARAPETALUS OCCIDENTALIS, new species.

Plate LIII.

*Types*.—Cat. No. 32808, U. S. National Museum.

*Female*.—Carapace one-third the entire length, ovate, considerably wider than long, and quite squarely truncated posteriorly. Frontal plates wide and prominent, with a slight incision at the center; lunules medium sized, widely separated, and projecting half their diameter. Posterior sinuses broad and shallow, the median lobe almost exactly one-third the entire width and not projecting behind the lateral lobes. The latter are squarely truncated posteriorly and slightly curved inward. Thoracic area less than one-fourth the entire length and semicircular in outline. Eyes small and fused on the mid line.

Fourth (free) segment two-fifths as wide as the carapace, and narrowed anteriorly where it joins the latter. It is entirely without dorsal plates, processes, or appendages except the fourth legs. Genital segment orbicular and only five-sixths as long as wide, while it is three-quarters the width of the carapace. It is produced on its ventral surface into two large membranous wings, which project well beyond the lateral margin on either side and curl up dorsally at the edges.

Each wing is considerably thickened at its base, where it also projects in front of the genital segment and comes up against the side of the fourth segment; but it thins rapidly and becomes very delicate and pliable toward the margins. Each wing, furthermore, is prolonged posteriorly into a well-rounded lobe, which reaches backward nearly to the posterior end of the abdomen. Between the bases of these large lobes the genital segment itself is prolonged backward into very much smaller, flattened lobes, which lie side by side at the median line under the bases of the egg strings. In young females the two are entirely separate, but later they often fuse into a single semicircular and laminate flap or lobe.

The abdomen is half as long again as the genital segment, and its dorsal surface for the entire length on either side is produced into a membraneous wing which extends out a little beyond the lateral margin of the genital segment and then curls over ventrally around the egg strings. These two wings also project posteriorly a little beyond the tips of the anal laminae.

On the posterior margin there is quite a deep incision at the middle for the anus. The anal laminae stand close to this incision, are of medium size, somewhat enlarged at the tip, and terminate in four short setae of about the same length.

The egg strings are wide, a little longer than the combined genital segment and abdomen, and each contains 60 or 70 eggs.

The second antennæ have a stout basal joint with a long and slender terminal hook. The mouth tube is about twice as long as wide, with the mouth opening circular, subterminal (a little more on the ventral side), and surrounded with a fringe of long hairs. The tube is constricted somewhat sharply on either side at about the center. The details of the bony framework supporting the lower lip are shown in Fig. 58, and of course differ from those shown in other genera of the Caliginæ.

There are first at the base a pair of long and wide bones (*a*) flattened dorso-ventrally, lying side by side along the mid line.

At their proximal ends these bones articulate with the ventral surface of the carapace, at their distal ends with two other pairs of bones (*b*) much smaller and cylindrical, also lying along the median line. The distal ends of this last pair articulate with the curved bones (*c*) surrounding the mouth. Outside the first pair are two irregular bones (*d*) on either side along the lateral margin; outside the second pair a single triangular bone (*e*) on either side, its broad base articulating with the distal ends of the first median pair and the marginal bones outside of them, its apex joining the bony framework around the mouth close to the distal ends of the second median pair.

Still outside of these triangular bones and along the lateral margin of the distal portion of the lip is a long bone curved outward quite strongly (*f*). The proximal end of this bone articulates with the outer proximal angle of the triangular bone just at the constriction in the lateral margin of the lip. Its distal end is bifid, the two branches joining the sides of the bony circle around the mouth.

The entire bony framework of the lip is thus definitely jointed along a line joining the constrictions in the lateral margins of the lip. This jointing constitutes the most essential difference between the structure of the tube in the present genus and that in *Caligus* and *Lepeophtheirus*.

The mandibles inclosed within the tube are similar to those in the two genera named. They are curved in toward each other at their tips, with coarse teeth along the inside of the curve and finer ones along the outside.

The first maxillæ are close to the tips of the second antennæ; they are rather small, with swollen bases and narrow, elongate, and blunt tips. The second maxillæ lie close to the mouth tube; they are simple and triangular, with broad bases and short, stout tips, slightly curved. From the ventral surface of the base arises a stout papilla, representing the endopod and tipped with two setæ. The outer of these is three times the length of the inner one and is jointed once near its base.

The first maxillipeds are like those usually found in the Caliginæ; the second pair have a large and stout basal joint furnished with powerful muscles and a long, slender, and strongly curved terminal claw. There are upon the inner surface of the basal joint a pair of stout



chitin knobs, one on either side of the mid line, and the tip of the terminal claw shuts in between these when it is closed. Between the bases of these second maxillipeds and the first pair of swimming legs is the furca. Its branches are broadly U-shaped, its base the shape of an ox yoke extending transversely across the median line.

The base of the U is connected with the center of the yoke by a narrow stem or petiole.

The first swimming legs are of the usual pattern with a stout blunt spine on the posterior margin of the basal joint; the plumose setæ on the terminal joint are short and weak.

In the second legs the basal joint of the endopod is very broad and overlaps the exopod considerably, while the spines on the exopod are also large and curved. The rami of the third legs are close together and stand out prominently; the claw at the base of the exopod is very large and stout and strongly curved.

The fourth legs are four-jointed with five spines; the basal joint is stout and as long as the other three; the spines are all of the same length, except the inner terminal one, which is half as long again as the others.

The digestive canal is similar to that in the other genera of this family, but the reproductive organs present marked differences.

The shell glands are comparatively large and of the usual club-shape, the distal three-fifths twice the diameter of the basal two-fifths; but the lumen of the glands shows no signs of a division into cells; on the contrary, it is milky white in color, rather opaque, and homogeneous throughout.

The semen receptacles and the arrangement for the reception of the spermatophores are also peculiar, as can be seen in fig. 67.

The semen receptacles are situated at the bases of the median lobes of the genital segment. Each is much enlarged into a flask shape at its inner end next to the median line, the posterior margins of the flasks being connected across the mid line by a narrow tube. Each flask also sends out posteriorly into the lobe of the genital segment a wide, nipple-shaped process.

From the tip of the nipple a slender, thread-like tube runs back to the posterior margin of the lobe. The spermatophores are fastened to the posterior ends of the lobes, and their contents are discharged through these tubes into the semen receptacles.

Total length, 6 mm.; length of carapace, 2 mm.; width of carapace, 2.3 mm.; length of genital segment, 1.5 mm.; length of abdomen, 2 mm.; width of ventral plates on genital segment, 3 mm.; length of egg strings, 5 mm.

Color a milky white, the plates on the genital segment and the lateral wings of the abdomen showing mottled by transmitted light, due to opaque spots in the inner tissues; egg strings showing spots of reddish purple when approaching maturity.

(*occidentalis*, belonging to the Occident or Western Hemisphere, the only other species being from the Indian Ocean and bearing the name *P. orientalis*.)

*Nauplius*.—Body an elongated ellipse, more than twice as long as wide, with evenly rounded ends. Pigment a beautiful reddish purple, distributed in a large irregular eye spot at the anterior end, a narrow line along either side halfway between the margin and the mid line, and a row of irregular spots across the posterior end. Balancers long and of the usual spathulate form, the cylindrical base being fully two-fifths of the entire length.

Total length, 0.4 mm.; width of body, 0.16 mm.

This new species was found upon the inside of the operculum of the coibia, *Rachycentron canadus* Linnæus. They seem to prefer the dorsal angle, four or five individuals being found there on either side, huddled close together. In addition to the types recorded above, a second lot, Cat. No. 32809, U. S. N. M., was obtained from the gill cavity of the same fish.

On being removed and placed in water they are found to be quite active, swimming about freely, though not with the rapidity of *Caligus* or *Lepcophtheirus*. They have a very marked propensity for coming to the surface of the water and lying there for hours at a time. They seem to hold themselves in position by getting a little air under the edges of the membranous wings and thus buoying themselves up. These wings are so thin and pliable, however, that they are constantly getting wrinkled and snarled up; and if left for any time in an aquarium the chances are that the wings will require considerable straightening before preservation.

This is the first species that has been obtained since Steenstrup and Lütken founded the genus in 1861. They did not succeed in finding any males, and a most careful search for them in the present instance was also without success.

There are now two clearly defined species of this genus, each of which is represented by females only.

Heller (1865) and Bassett-Smith (1899) noted the genus, but the account which each of them gives is evidently taken directly from the original description without the examination of any specimens.

The discovery of a second species would ordinarily modify the original genus diagnosis somewhat, but in the present instance it makes such radical changes that only a little of the original is left.

Steenstrup and Lütken evidently had a limited supply of specimens, all of which had been preserved in the East Indies and sent home.

They therefore content themselves with a genus diagnosis of two lines and a half, and a species description of only ten lines in length. Their diagnosis simply states that this genus differs from *Caligus*

and its near relatives in having the genital segment "girded with a membranous wing and the tail (really the abdomen) furnished with two elongate, retrovert wings which are in the form of a half moon."

Heller records the finding of the parasite on a new host in the Indian Ocean, but makes not attempt at a description.

Bassett-Smith, the most recent authority, gives the following genus diagnosis, presumably made up from Steenstrup and Lütken's text and figures:

Carapace rounded, scutiform. Frontal border with lunule. First and fourth pairs of thoracic limbs uniramous, second and third biramous. Genital segment of large size, covered over by two dorsal plates; also with two elongated flattened processes projecting backwards from the posterior border and origin of abdominal portion, which latter is biarticulate, terminating in two small caudal plates. (1899, p. 445.)

There are at least five serious errors in this diagnosis, brief as it is, besides some equally serious omissions.

The genital segment is not "covered over" by anything; its dorsal surface is uncovered except at the posterior end where the abdominal wings overlap it somewhat. Furthermore the covering of its ventral surface can not be called "plates;" they are rather membranous wings like those on the abdomen, as Steenstrup and Lütken call them. The most noticeable thing about them is that they are turned up dorsally at the edges in a perfect saucer shape, the genital segment lying in the bottom of the saucer. Nothing is said of this by any of the previous authors.

Again the "elongated flattened processes projecting backwards" are a part of the ventral wings and not a portion of the segment itself, as can be plainly seen in Steenstrup and Lütken's figure as well as in those here given. Their size, their shape, and above all their attachment prove this beyond a doubt.

The genital segment of the present species does have two flattened processes, but they are very short instead of elongate, ventral instead of dorsal, and they are not mentioned at all by Steenstrup and Lütken. In their preserved material, however, these tiny processes could have been easily overlooked.

Another error is in the statement that the abdomen is "biarticulate." Steenstrup and Lütken neither in their figures nor in their text give it as such; but they make no definite statement with reference to it. In their figure, however, as in the present species it is certainly one-jointed.

And, lastly, Bassett-Smith's diagnosis neglects to notice the large wings on either side of the abdomen, which are one of the chief characteristics of the genus.

Steenstrup and Lütken speak in their species description of the wings on the genital segment as "a thin marginal border, considerably widened posteriorly." This, taken in connection with the fact

that their figure is not shaded so as to show the relative positions of the two pairs of wings, and that they make no definite statement in this respect, leaves it not only possible but even probable that the arrangement in their species was just like that in the present one. Both species are transparent enough to show most of the details right through the wings.

And if their figure be compared with the one here presented it will be seen that a little shading would make the two identical as regards this wing arrangement. The absence of such shading made possible the errors in Bassett-Smith's diagnosis.

#### ABASIA, new genus.

*Genus diagnosis*.—Body elongate, with regions distinctly marked; first three thorax segments united with the head and covered by a rounded carapace. This latter is deeply notched on either side anteriorly, the portion between the notches being produced into a sort of broad rostrum one-third as long as the rest of the carapace. Frontal plates borne on the anterior end of this rostrum, distinct, and without lunules. Sides of the carapace folded over ventrally, as in *Lernanthropus*. Cephalic and thoracic portions more strongly arched and much thicker than the lateral areas. Fourth segment as in *Caligus*, small and without dorsal plates. Genital segment elongate acorn-shaped, nearly as large as the carapace, and without lobes or appendages. Abdomen two-jointed, the first joint many times larger than the second; anal laminae minute. Second antennae in the female and second maxillae in both sexes rudimentary; first maxillae and furca entirely wanting. Thoracic legs as in *Caligus*. Eggs comparatively large.

*Type of genus*.—*Abasia pseudorostris*.

(*Abasia*, from Abas, the son of Metanira, changed by Ceres into a lizard because he mocked the goddess.)

#### ABASIA PSEUDOROSTRIS, new species.

Plate LIV and Plate LVI, fig. 100.

*Type*.—Cat. No. 32811 U. S. National Museum.

*Female*.—Carapace orbicular, less than one-third the entire length as wide as long; deeply notched on either side close to the anterior margin. The portion on the mid line, included between these notches, forms a broad rostrum, one-third the entire width of the carapace, and projecting considerably in front of the latter. Frontal plates distinct, but short and narrow, the two together only as wide as the rostrum. Frontal margin deeply notched at the center and showing at the base of this notch the remains of a frontal filament; no lunules.

Central portion of the carapace, including the cephalic and thoracic areas, strongly arched and raised considerably above the lateral areas. To increase this difference the sides of the carapace are folded over ventrally around the appendages as in *Lernanthropus*. Posterior sinuses broadly triangular and shallow; median lobe only one-third the entire width and not projecting behind the lateral lobes. Thoracic area the smallest yet observed in any of the Caliginæ, only one-third the width and one-fourth the length of the carapace; cephalic area correspondingly large. Free segment short and less than one-third the width of the carapace, without plates or processes.

Genital segment the shape of an elongated acorn, not quite as wide as the carapace but longer, thus making its area about the same. Its sides are evenly curved and its posterior margin is squarely truncated without lobes or processes.

The abdomen is seven-eighths as long as the genital segment and two-jointed. The basal joint is elliptical, two-thirds as wide as the genital segment, and more than four times as long as the terminal joint, with evenly-curved sides. The terminal joint is less than half the width of the basal, and carries a pair of small and widely separated anal laminae, each tipped with four short setæ. The egg strings are the same width as the terminal abdomen joint and two-thirds as long as the entire body; eggs comparatively large, 40 to 50 in each string.

The first antennæ are two-jointed like those in *Caligus* and relatively as large, but the second pair are rudimentary. They are situated at the base of the rostrum, are three-jointed, the last joint terminated by a minute claw, and the whole appendage is only half the size of the terminal joint of the first antennæ.

The first maxillæ and furca are entirely lacking; the second maxillæ are reduced to mere points and are situated close to the sides of the mouth tube at its base. They are so small as to be easily overlooked.

The mouth tube is short and wide, with a framework similar to that in *Lepophtheirus hippoglossi*. The mouth opening is terminal and surrounded by a fringe of long hairs. The mandibles are inclosed in the mouth tube and are of the same general shape as in the other Caliginæ, with teeth along both margins.

The first maxillipeds are comparatively large and stout, and are situated far forward, their bases anterior to the center of the mouth tube and close to it. In fact, they occupy nearly the position usually taken by the second maxillæ. (See fig. 74.)

The two joints are about the same length, the terminal one ending in two claws, of which the inner is more than twice the length of the outer.

The second maxillipeds are much enlarged,<sup>a</sup> the terminal claw about the same length as the basal joint and strongly curved near the tip, with a minute accessory seta on the ventral surface near the base. Both joints are very strong and plentifully supplied with powerful muscles.

The swimming legs are similar to those in *Caligus*, but much reduced in size. The first pair have a comparatively small basal joint carrying one large spine on its posterior border; the middle joint is of the same size as the basal with a small spine at its anterior distal corner; the terminal joint is only two-thirds as large and tipped with the usual three claws and the long spine at the inner distal corner, but there are no plumose setae on the posterior margin of this joint.

The second legs are of the usual pattern, with large and prominent spines on the exopod. The apron of the third legs is so reduced as to be smaller than the second pair. Hence in a ventral view the third legs do not project behind the second but are covered by the latter. Their rami are so close together that they overlap; the exopod is three-jointed with a relatively large basal spine, but with very few plumose setae; the endopod is two-jointed, each joint with a single plumose seta.

The fourth legs are three-jointed, with four spines; the basal joint about as long as the other two; the inner terminal spine one-half longer than the other three, which are about equal. The fifth legs are entirely wanting in this species. The reproductive organs and musculature are similar to those in *Caligus*. The oviducts are coiled somewhat differently in the genital segment, as can be seen in fig. 80. The cement glands are rather large and extend well up toward the anterior margin of the segment. The cellular portion is somewhat club-shaped, with twelve to fifteen cells; the duct is enlarged into a sort of reservoir at its base where it leaves the cellular portion, and also bent outward, terminating very close to the base of the egg tubes. The semen receptacle is peculiar in that it is enlarged at either end instead of at the center.

There is also apparently a large accessory lobe connected with the enlargement at either end, a condition which has not been reported for any other genus.

Total length, 5.22 mm.; length of carapace, 1.67 mm.; length of genital segment, 1.8 mm.; length of abdomen, 1.6 mm.; width of carapace, 1.67 mm.; length of egg strings, 3.55 mm.

Color, a transparent cartilage groundwork beautifully penciled on the dorsal surface and the appendages with dichotomously-branched lines of wine-red. Pigment most conspicuous in the thoracic area, the genital segment, and at the posterior end of the abdomen.

<sup>a</sup> In Plate LIV these maxillipeds are magnified only half as much as the other appendages.

*Male*.—Carapace orbicular as in the female, but slightly longer than wide and fully three-fifths the entire length. Rostrum and carapace areas as in the female. Free segment short, five-ninths as wide as the genital segment; the latter elliptical, a little longer than wide, with evenly rounded sides; fifth legs not visible dorsally.

Abdomen only two-thirds the length of the genital segment, the same width as the free segment and two-jointed. But the joints are not as distinct as in the female and the basal one is only one-fourth as long as the terminal. The anal laminae are large, widely separated, and each is armed with two long plumose setae and three short spines.

Appendages as in the female, except that all, and particularly the swimming legs, are larger and better developed. But the chief difference lies in the second antennae; in the female these were degenerated to mere stumps, entirely useless. But in the male we find a pair of large and strong organs tipped with powerful pinchers, and evidently used for clasping organs. They are not only nondegenerate, but are actually better developed than in the males of other genera. They are three-jointed, the basal and second joints about the same size, the latter with a sharp projection on the inner margin at the distal end which forms a chela with the small and strongly curved end claw.

Reproductive organs as in *Caligus*, the testes rather small and situated far back, just in front of the groove separating the cephalic and thoracic areas. The *vas deferens* can be easily followed back to the semen receptacles which fill nearly the whole of the genital segment on either side of the intestine.

Inside the receptacles can be seen the large spermatophores, with their short coiled tubes through which the contents are emptied into the semen receptacles of the female after the spermatophores have been fastened to the outside of the female's genital segment during coition.

Total length, 2.34 mm.; length of carapace, 1.4 mm.; length of genital segment, 0.55 mm.; length of abdomen, 0.36 mm.; width of carapace, 1.3 mm.

Color as in the female, the reddish pigment rather more prominent.

*Nauplius*.—Body wide, spindle shaped, the frontal margin broad and but slightly curved with prominent lateral angles. Posterior end narrowed considerably more than the anterior, but with prominent angles at the bases of the balancers. Eye spot large and projecting from the anterior margin, deep wine-red in color. (Fig. 100.)

Pigment rust-colored with the red prominent, arranged in a narrow line parallel with either side of the body close to the margin, and extending from the balancers almost to the eye spot.

The outer margins of these lines are quite regular, but the inner margins are broken and ragged. Each line is enlarged at the anterior

end, while at the base of the balancers it forms a well-defined and quite regular ring just inside the margin.

The posterior half of the body inside of the pigment lines is filled with semiopaque yolk granules of a pale yellow color.

The balancers are one-fourth the length of the body, slightly curved outward, cylindrical at the base, with a flattened spatulate tip.

Total length, 0.4 mm.; width of body, 0.23 mm.

The colors of this nauplius blend finely and make it one of the most beautiful yet seen.

(*pscudorostris*, *pseudo*, false and rostrum.)

This new genus was obtained from the mouth of the lizard fish, *Synodus fatuus* Linnaeus. The frontal plate, rostrum, and anterior portion of the carapace were buried just beneath the skin of the roof of the mouth, while the large second maxillipeds were sunk through the skin and into the underlying tissue. This method of fastening is significant, taken in connection with the fact that the sides of the carapace are folded over ventrally as in *Lernanthropus*, and the apron of the third legs is so much reduced that it can not fill the gap at the posterior end of the carapace and thus function as a sucker.

It means that we have here a genus undoubtedly belonging to the Caliginæ, but one which has so far degenerated as to have given up those structures which in the other genera function as organs of adhesion. The lunules on the frontal plates, the thin pliable margin around the carapace, and the large apron of the third legs have all disappeared. And what is still more remarkable, in view of these facts, the second antennæ, which play such an important part in the other genera as grasping organs, have practically disappeared in the female. And the creature is thus thrown back upon the second maxillipeds alone for retaining its position upon its host. This is a condition obtaining only in the lower families of parasites, and furnishes an excellent example of a reversal of ordinary development. In many of the specific problems of development which have been so admirably worked out by various scientists, we find prophecies of future advancement. Old organs take new forms, new organs appear, or there is a different arrangement of the various parts of the body which amounts to very little in the creature under immediate consideration, but which in subsequent development, or in other and higher animals that appear later, becomes an important and essential character. Feathers did not mean very much to the flying lizards upon whose tails they first appeared, but they play an important part in the life of an ordinary bird. So here in degeneration or the reversal of development we find similar prophecies of future disappearance and loss.

The habits of the genus are very different from those of the rest of the Caliginæ, as would be expected from its structure.



The female can not swim, nor does she move about ordinarily on the body of the host, but remains fixed in one place.

The male, on the other hand, can swim a little and contrives to wriggle about over the fish's skin by a sort of jump-and-catch method, using the second maxillipeds and swimming legs.

Both sexes, when placed in an aquarium, lie most of the time upon their backs, with the swimming legs vibrating rapidly back and forth like the abdominal appendages of the Phyllopod. But in the present instance this is probably not a respiratory movement, for even the adults show distinctly the set of muscles used for cloacal respiration, as already described in other genera. The females have also the habit of raising the carapace or bending it to one side till it stands nearly at right angles to the rest of the body, the flexure taking place between the carapace and the genital segment. So constantly is this practiced that it is difficult to get one killed with the body straight. There is also more or less folding and unfolding of the sides of the carapace, very different from *Lernanthropus*, in which the carapace sides seem incapable of much voluntary motion.

#### TUXOPHORUS, new genus.

*Genus diagnosis*.—First three thorax segments united with the head and covered by a shield-shaped carapace. Frontal plates prominent and furnished with lunules as in *Caligus*. Eyes small with prominent lenses. Second antennæ small and weak. Second maxillæ articulate at the base, the rudimentary endopod borne on the basal joint. The other mouth parts and the mouth tube as in *Caligus*. Furca compound, its terminal branches bifid. Swimming legs as in *Caligus*.

Free segment short and wide, covered by two dorsal plates, which overlap the genital segment and project outward over the bases of the fourth legs. Genital segment enlarged, without plates or processes. Abdomen narrow, one-jointed; anal laminae large and well armed with setæ. Egg tubes wider than the abdomen and nearly as long as the entire body. Eggs and development as in *Caligus*.

*Type of genus*.—*Tuxophorus caligodes*.

(*tuxophorus*, ττυξ, a plate and φορέω to bear.)

#### TUXOPHORUS CALIGODES, new species.

Plate LV and Plate LVI, figs. 93-99.

*Types*.—Cat. No. 32805, U. S. National Museum.

*Female*.—Carapace ovate, narrowed but little anteriorly, as wide as long, and about half the entire length. Frontal plates prominent and furnished with large hemispherical lunules similar to those on *Caligus*. These lunules are widely separated and project hardly at all from the anterior margin. Posterior sinuses narrow and shallow; median lobe a little less than half the entire width, projecting only a trifle beyond the lateral lobes and quite squarely truncated posteriorly with promi-

ment corners. Lateral lobes broad and curved inward at the tips. Thoracic area in the shape of a spherical triangle about half the entire length of the carapace, with a blunt rounded point at the median line anteriorly. Eyes small with prominent lenses, situated about one-third the distance from the anterior margin.

Free segment short and relatively wide, covered by a pair of broad wings which extend outward to a level with the lateral margins of the genital segment and backward for some distance over the base of the latter. Their anterior margins are straight and inclined slightly backward, while the posterior margins are strongly curved and do not meet at the midline, leaving a space between them two-thirds of their own diameter. These wings are thus very similar to those on *Alebion* and *Gloiopotes*, except that in the latter the two are fused on the midline.

Genital segment acorn-shaped, considerably narrowed anteriorly where it joins the free segment, with short, wide, and well-rounded lobes at the posterior corners. On the ventral surface of these lobes are the rudimentary fifth legs, whose tips project a little beyond the posterior margins of the lobes, so as to be visible in dorsal view.

Abdomen at its base one-fourth the width of the genital segment; tapering toward the tip; one-jointed. Anal laminae long, narrow, and well-rounded at the ends, each carrying three long terminal setae and two small spines on the outer margin. Egg tubes wider than the base of the abdomen, three-fourths as long as the body, each containing about 50 eggs.

Of the appendages the first antennae are two-jointed, the basal joint longer than the terminal, and both joints heavily armed with setae and spines. The lunules are huge, semicircular, projecting well in front of the bases of the antennae, and reaching back nearly to the groove between the frontal plates and the carapace. The second antennae are rather small and weak, with a slender but strongly curved terminal claw. This claw carries on its inner margin near the base two accessory spines close together and borne on small basal papillae.

The basal joint carries a broad laminate spine on its posterior outer corner. The first maxillae are comparatively large and pushed forward until their base is actually in front of that of the second antennae. The whole maxilla is wide and stout and is curved strongly, especially near the tip. It is as large as the terminal claw of the second antennae and bears on its ventral surface near the center two small knobs or papillae, one on either side.

The second maxillae are also much larger than in *Caligus* and *Lepcophtheirus*. They are simple like those of the former, broad, stout, and curved away from each other, with blunt ends and a small flange on the convex margin. Each is jointed to the ventral surface

about opposite the tip of the mouth tube, so as to be freely movable, which is not the case in the genera just named. Moreover, the large papilla tipped with two spines and representing the rudimentary endopod, is in this case borne, not on the base of the exopod, but on the ventral surface of the carapace anterior to the joint. We have in these maxillæ, therefore, a basal joint fused to the surface of the carapace upon which is borne a freely movable exopod, the maxilla itself, and a rudimentary endopod much larger than usual.

The mouth tube is similar to that found in *Caligus*. As will be seen from fig. 83 the bony framework is more nearly like that of *Lepeophtheirus hippoglossi* than of any other species yet described, while the mouth opening itself is like that in *Caligus rapax*. There are rods running along either side of the mouth tube, with their proximal ends turned downward and outward toward the ventral surface just as in *L. hippoglossi*.<sup>a</sup> To these are attached near the base of the tube a pair of short rods arranged like the sides of the letter V, with the point turned toward the tip of the tube instead of toward the base as in *C. rapax*. Between the tips of these lateral rods in the lower lip is a series of small transverse rods similar to those in *C. curtus*. And the upper lip also ends in a soft flap like that in *C. curtus* and *L. edwardsi*, but not of the same shape.

Inside the mouth tube may be seen the mandibles, which are narrow, curved strongly at the tip, and toothed along the concave margin. The first maxillipeds are of the usual pattern, the two joints about the same length, the inner terminal claw twice the length of the outer, and both claws well curved. The second maxillipeds are comparatively weak, smaller, or at least no larger, than the second antennæ, with a terminal claw little more than half the length of the basal joint. This claw is not much curved and carries a slender accessory seta on the inside near its base.

The furca is peculiar in two respects; the furca itself is double and its branches are bifurcate. Kröyer reports a species of *Caligus* (*C. fallax*) in which the furca is double, while there are at least three species of *Lepeophtheirus* in which the branches are bifid (*L. hippoglossi*, *robustus*, and *bifurcatus*).

The present species, so far as known, is the first to show a combination of the two. But it does not show two complete furcæ, as Kröyer figures for *C. fallax*, neither is the division of the branches anything like that of the three *Lepeophtheirus* species named. The median sinus of this furca is broadly U-shaped; each branch is divided for about half its length, the inner branchlets parallel and forming the sides of the U, the outer one turned almost at a right angle. Both pairs of branchlets are broad, of the same diameter throughout, and with bluntly rounded ends. On either side of the base of the furca

<sup>a</sup> Proc. U. S. Nat. Mus., XXVIII, p. 500, fig. 6a.

another pair of branches are given off at right angles to the median axis. These are the same size and shape as the branchlets at the tip. The first legs are three-jointed, the basal joint carrying a small spine on its posterior border, a much larger one at the anterior distal corner, and a broad spathulate spine in the middle of the ventral surface at the distal end. The terminal joint has three short and stout terminal claws and the usual plumose setæ on its posterior border.

The second legs are like those of *Caligus*, the spines on the exopod being rather stout. The rami of the third legs are so close together that they almost touch, the exopod three-jointed, the endopod two-jointed. There is the usual large spine at the base of the exopod, a very small one at the outer distal corner of the second joint and three along the outer border of the terminal joint.

The fourth legs are four-jointed with five spines, the inner terminal one somewhat longer than the others, which are all about the same size. The basal joint is stout and longer than the other three, which are rather slender.

Both the fifth and sixth legs are visible at the posterior margin of the genital segment, the former on the ventral surface a little in front of the posterior end, the latter dorsal to them, but farther back at the extreme tips of the posterior lobes.

The reproductive organs and muscular system are similar to those in *Caligus*. The ovaries are paired and situated over the œsophageal portion of the digestive tract. The oviduct leads back to the genital segment, where it is coiled similarly to the condition in all the Caligidæ, but the coils are shorter than is usual in *Caligus* and *Lepeophtheirus*.

In the young females obtained from the pilot fish the condition and coiling of these oviducts is peculiar (see fig. 91).

In the posterior portion of the fourth or free segment the oviducts enlarge more abruptly and to a greater diameter than is usual in the Caligidæ. In fact, on entering the genital segment the two oviducts fill nearly its entire diameter for the anterior third of its length. They then narrow considerably, so that in the posterior half of the segment there is room for three coils on either side. These oviducts are filled for their entire length with a black granular and homogeneous mass which is wholly opaque. Anteriorly the mass is divided into short and wide segments, corresponding to the future eggs, while posteriorly, where the oviducts are much narrower, the segments at the same time increase in length. Their cubical contents are thus approximately the same throughout the entire oviducts. The cement glands are white in color, situated far forward in the genital segment, and quite strongly curved parallel with the margin of the segment, thus giving them the shape of ordinary parentheses marks. The glands themselves are wide, and the ducts leading from them are considerably

enlarged just before their entrance into the oviduct. Both glands and ducts are surrounded by a thick envelope which reaches forward nearly to the anterior margin of the genital segment and which covers a large portion of the oviduct coils.

The gland cells are wide and extend well back toward the posterior end, leaving a comparatively short and wide duct. In some of the young females the grooves separating the cells are invisible in the living animal, and the entire duct and gland have a uniform white color.

The semen receptacle is at the extreme posterior margin of the genital segment and of the usual spindle shape.

Total length, 5.67 mm.: length of carapace, 2.67 mm.; length of genital segment, 1.8 mm.: length of abdomen, 1 mm.: width of carapace, 2.65 mm.: length of egg strings, 4.33 mm.

Color a light gray, spotted on the dorsal surface along the ridges and grooves with a rich red-brown pigment. In young females the color is that of transparent cartilage, sprinkled over the entire dorsal surface, and on the ventral surface around the bases of the appendages with profusely branched blotches of a pale indigo blue. Sparsely scattered amongst these on both surfaces are smaller and less-branched spots of rose purple, the whole appearing, however, a uniform gray to the naked eye.

(*caligodes*, *caligus*, and the ending *εἶδος* denoting likeness or similarity.)

*Male*.—Carapace elliptical, slightly longer than wide, and not much narrowed anteriorly. Frontal plates prominent, but narrow; lunules as large as in the female and widely separated; front border emarginate. Posterior sinuses shallow, U-shaped, their sides parallel to the median axis; the median lobe not projecting and with sharp posterior corners.

Thoracic area relatively smaller than in the female and nearly semicircular.

Free segment short, but with rudimentary wings covering the bases of the fourth legs, which make it wider than the genital segment.

Genital segment ovate, with a concave posterior border and showing both the fifth and sixth legs plainly in dorsal view, the former on the lateral margins one-third the distance from the posterior end, the latter at the tips of the posterior lobes.

Abdomen less than half the width of the genital segment, but considerably longer; anal laminae large, almost as long as the abdomen proper and each tipped with three long plumose setae and carrying a smaller one on the outer margin.

Appendages as in the female, the only differences of note being the second antennae and second maxillipeds. The former are much enlarged with a swollen basal joint, a still larger second joint, and a

short but stout terminal claw bent into a half circle. The distal end of the basal joint and the whole ventral surface of the second joint are covered with a corrugated network of chitin ridges. At the distal end of the corrugation on the second joint a wide triangular spine extends downward on either side from the ventral surface and curves over toward its fellow on the opposite side until their tips almost meet. This is evidently the clasping organ used during the breeding season. The second maxillipeds are also somewhat larger and stouter than in the female.

The fifth and sixth legs are as plainly differentiated as in *Homoioetes palliata* (fig. 96). The former are large papillæ on the sides of the genital segment extending on the ventral surface well in toward the mid-line. The latter include the entire posterior lobes, and their inner margins extend forward nearly to the center of the genital segment.

The semen receptacles are of medium size and situated in the bases of the posterior lobes. The ducts leading to them are exceptionally large, in fact, nearly the diameter of the receptacles themselves, and much convoluted, and they fill the entire cavity of the genital segment outside the intestine.

Total length, 3.6 mm.; length of carapace, 2.16 mm.; length of genital segment, 0.75 mm.; length of abdomen, 0.74 mm.; width of carapace, 1.98 mm.

Color similar to the female, but paler, a light brownish gray to the naked eye, but showing under magnification the spots of blue and purple.

*Chalimus*.—Body elongate and spindle-shaped, the entire anterior margin of the carapace prolonged into a wide, triangular rostrum which projects in front of the first antennæ a distance equal to two-thirds of the length of the carapace behind the antennæ.

From the apex of this triangle extends the attachment filament, which is wider and stouter than in any chalimus yet examined, and its surface is wrinkled or corrugated transversely.

The sides of the triangular rostrum are slightly concave and at its base where it joins the carapace proper there is a deep reentrant angle on either side, out of which project the first antennæ. In consequence of the elongate rostrum the eyes appear back of the center, three-fifths of the length from the anterior end. But judged with reference to the first antennæ they are in about their usual position.

The posterior margin of the carapace is slightly concave.

The second and third thorax segments are fused together and considerably narrowed. The fourth segment is still narrower, and at its posterior corners may be seen the rudiments of the future dorsal lobes. With these lobes it is a little wider than the last segment, which is a fusion of the genital segment and abdomen. The future

separation of these two is indicated by a shallow constriction on either side. This fused segment tapers posteriorly and terminates in a pair of small anal laminae, nearly twice as wide as they are long. Each is armed with five setae, one of which, the second from the inner edge, is several times longer than the others. The first antennae are two-jointed, the joints of the same size, the terminal one only with setae. The second antennae are three-jointed, the terminal claw being slender and weak. The mouth parts are practically the same as in the adult; the terminal joint of the second maxillae is separated from the basal even thus early by a well defined groove, and the rudimentary endopod is carried on the basal joint.

There are only two pairs of legs present, both biramose, with the rami one-jointed. The endopod of the first pair is much smaller than the exopod and destitute of setae; the two rami of the second pair are the same size, but the endopod carries only a single seta. Rudiments of the third and fourth legs appear as slight projections on the ventral surface behind the first and second pairs.

Total length, 0.76 mm.; length of carapace, 0.5 mm.; greatest width, 0.3 mm.

Color a pale brownish gray, spotted over the entire dorsal surface with brownish or purple pigment. The spots along the sides of the digestive tube are fused into two prominent longitudinal lines, which extend from the eyes nearly to the anus.

This genus was obtained from the outside surface of the common cobia or crabeater, *Rachycentron canadus*, and the outside surface of the shark sucker *Echeneis naucrates*. The former specimens are taken as the types since they include both sexes. The latter specimens are Cat. No. 32806, U. S. N. M.

Eight specimens of the chalimus were obtained from the fins of a silver gar, *Tylosaurus marinus*, and are Cat. No. 32807, U. S. N. M. The majority of these latter were on the tail fin, but one was taken from the dorsal fin, another from the anal, and a third from one of the pectorals. In each of these specimens the dorsal plates on the fourth segment were formed and projected from its lateral margins.

The habits of the genus are quite similar to those of *Caligus*, with which the presence of lunules in the frontal plates still further allies it. But the females are not nearly as lively as those of *Caligus* and *Lepophtheirus*, and swim about very little, preferring to lie quietly at the surface or near the bottom. The males, however, are very active and move about restlessly all the time. Both sexes are hardy and live well in confinement.

The genus is of peculiar interest in that it forms another connecting link between the Caliginæ and the Euryphorinæ.

The presence of lunules and the simple form of the second maxillae are characters of the genus *Caligus*. The divided furca and the clear

differentiation of the fifth and sixth legs in both sexes are characters of the genus *Lepeophtheirus*. The presence of well developed plates on the dorsal surface of the fourth segment and their rudiments even in the male, the structure of the second antennæ, and the jointing of the second maxillæ with the rudimentary endopod on the basal joint are characters of the Euryphorinæ.

If we classify this genus with the Caliginæ it will be the only one possessing any of these characters belonging to the Euryphorinæ. On the other hand, if we classify it with the latter subfamily it will stand equally alone in the possession of lunules and in the structure of the mouth tube.

That it really belongs with the Caliginæ is clearly indicated when we come to consider its ontogeny. Both sexes show plainly, even in the adult, the glands and remains of the frontal filament by which the chalinus is fastened during its transition to the adult form.

With the other characters somewhat evenly divided this would turn the decision, even if it did not possess greater value than they. We have here, then, a genus undoubtedly belonging to the Caliginæ, as its development and general makeup clearly indicate, yet possessing several of the essential characters of the Euryphorinæ. While embraced within the first subfamily, therefore, it must be recognized as standing on the border line between the two. It is another of those instances which show that even the best efforts of the systematist can not hope to clearly differentiate all the forms that present themselves for consideration.

In addition to the foregoing new and rediscovered species belonging to the Caliginæ, many others were found.

The simplest method of recording these is to present an alphabetical list of the fish examined with the parasites found on each. They were all obtained in the immediate vicinity of Beaufort.

**Archosargus probatocephalus** WALBAUM. The Sheepshead.

An undescribed species of *Bomolochus* from the walls of the gill cavity, and an undescribed species of *Lernanthropus* from the gill filaments.

**Bairdiella chrysuræ** LACÉPÈDE. Mademoiselle: Yellow-tail.

An undescribed species of *Lernanthropus* from the gills.

**Brevoortia tyrannus** (LATROBE) GOODE. The Menhaden.

*Lernæenicus radiatus* Rathbun, imbedded in the flesh, mostly along the back. *Lernanthropus brevoortie* Rathbun, fastened to the gill filaments. *Anchorella scombræ* Krøyer, fastened to the gill arches.

**Carcharias obscurus** LE SEUR. Dusky Shark.

*Pandarus cranchii* Leach, on the outside skin near the lips.

**Centropristes striatus** LINNÆUS. The Blackfish.

*Caligus hæmulonis* Krøyer, on the walls of the mouth cavity.



- Chilomycterus schæpfi** WALBAUM. The Swell-toad.  
*Tucca impressa* Krøyer, fastened to the fins.
- Coryphæna equisetis** LINNÆUS. The Small Dolphin.  
*Caligus belones* Krøyer, on the outside surface, and an undescribed species of *Lernænicus* fastened to the fins.
- Echeneis naucrates** LINNÆUS. The Shark-sucker.  
*Turophorus caligodes* Wilson, on the outside surface.
- Epinephelus morio** CUVIER and VALENCIENNES. The Red Grouper.  
*Lepeophtheirus dissimulatus* Wilson, on the outside surface.
- Felichthys marinus** MITCHILL. The Sea-cat: Gaff Topsail.  
*Lepeophtheirus monacanthus* Heller, on the walls of the gill cavity and the mouth. *Caligus rufus* Wilson, on the outside skin.  
*Caligus hæmulonis* Krøyer, on the walls of the mouth cavity.
- Fundulus heteroclitus** LINNÆUS. The Common Killifish.  
*Argulus funduli* Krøyer, on the outside skin and the fins. *Caligus rufimaculatus* Wilson, on the outside skin.
- Gymnosarda pelamys** LINNÆUS. The Bonito.  
*Caligus bonito* Wilson, on the walls of the mouth and the gill cavity.
- Hexanematichthys felis** LINNÆUS. The Sea Cattfish.  
*Lepeophtheirus monacanthus* Heller, on the walls of the gill cavity.  
*Caligus hæmulonis* Krøyer, on the walls of the mouth.
- Leiostomus xanthurus** LACÉPÈDE. The Spot or Goody.  
*Lernænicus radiatus* Le Seur, imbedded in the muscles, usually in the vicinity of the fins.
- Menidia menidia** LINNÆUS. The Southern Silversides.  
An undescribed species of *Bomolochus* on the gill filaments.
- Merone americana** GMELIN. The White Perch.  
An undescribed species of *Lernanthropus* on the gill filaments:  
This is the same as that found on the Mademoiselle.
- Micropogon undulatus** LINNÆUS. The Croaker.  
An undescribed species of *Anchorella* on the gill arches.
- Mugil cephalus** LINNÆUS. The Common Mullet.  
*Anchorella lixæ* Krøyer, fastened to the gill arches. *Brachiella oblonga* Della Valle, fastened to the pectoral fins. *Caligus curtus* Müller, on the outside surface of the body. An undescribed species of *Bomolochus* on the gill filaments. An undescribed species of *Lernænicus* fastened to the outside of the operculum.
- Orthopristis chrysopterus** LINNÆUS. The Hogfish.  
An undescribed species of *Lernanthropus* on the gill filaments.
- Paralichthys lethostigmus** JORDAN and GILBERT. Southern Flounder.  
*Lepeophtheirus edwardsi* Wilson, on the outside surface.

**Prionotus tribulatus** CUVIER. The Big-headed Gurnard.

An undescribed species of *Lernanthropus* on the gill filaments.

**Pteroplatea maclura** LE SEUR. The Butterfly Ray.

*Argulus laticauda* Smith, on the outside surface.

**Rachycentron canadus** LINNÆUS. The Crab-eater or Cobia.

*Parapetulus occidentalis* Wilson, on the inside surface of the operculum. *Tuxophorus caligodes* Wilson, on the outside of the body.

**Scoliodon terræ novæ** Richardson. The Sharp-nosed Shark.

*Nesippus alatus* Wilson, fastened to the inside of the gill arches.

*Pandarus cranchii* Leach, on the outside skin and the fins.

*Perissopus communis* Rathbun, on the outside of the body, especially around the lips. An undescribed species of *Nemesis* on the gill filaments.

**Seriola lalandi** CUVIER and VALENCIENNES. The Amber Jack.

An undescribed species of *Lernanthropus* on the gill filaments.

**Sphyrna tiburo** LINNÆUS. The Shovel-head Shark.

*Nesippus alatus* Wilson, on the inside of the gill arches. *Eudactylina nigra* Wilson, on the gill filaments. An undescribed species of *Bomolochus* on the outside skin near the anus.

**Sphyrna zyggæna** LINNÆUS. The Hammer-head Shark.

*Nesippus alatus* Wilson, on the inside of the gill arches. *Lepeophtheirus longispinosus* Wilson, on the inside of the gill cavity. An undescribed species of *Nemesis* on the gill filaments.

**Synodus fœtans** LINNÆUS. The Lizard Fish.

*Abasia pseudorostris* Wilson, on the walls of the mouth cavity.

**Trichiurus lepturus** LINNÆUS. The Cutlass Fish.

*Caligus chelifer* Wilson, on the outside surface of the body. *Caligus rapax* Milne Edwards, also on the outside surface.

**Tylosurus acus** LACÉPÈDE. The Hound Fish.

*Tuxophorus caligodes* Wilson, a chalinus on one of the dorsal fins.

An undescribed species of *Lernanthropus* on the gill filaments: this is the same as that found on the Garfish. An undescribed species of *Bomolochus* from the gill filaments.

**Tylosurus marinus** WALBAUM. The Garfish or Billfish.

*Lepeophtheirus edwardsi* Wilson, on the outside surface. An undescribed species of *Lernanthropus* on the gill filaments. *Tuxophorus caligodes* Wilson, several chalimi on the fins.

**Upeneus maculatus** BLOCK. The Red Goatfish.

An undescribed species of *Lernænicus* fastened to the outside of the operculum and in the muscles along the back.

## EXPLANATION OF THE PLATES.

Plate XLIX. *Caligus hamulonis* Kröyer.

Fig. 1, dorsal view of female; fig. 2, dorsal view of male; fig. 3, second antenna and first maxilla of female; fig. 4, same of male; fig. 5, mouth and second maxilla; fig. 6, furca; fig. 7, second maxillipeds of female; fig. 8, same of male; figs. 9 to 12, first, second, third, and fourth swimming legs; fig. 13, genital segment of female, ventral view; fig. 14, genital segment of male, ventral view.

Plate L. *Caligus rufus*, new species.

Fig. 15, dorsal view of female; fig. 16, second antenna and first maxilla; above and to the left is an enlarged drawing of the maxilla; fig. 17, mouth and second maxillae; fig. 18, first maxilliped; fig. 19, second maxilla; figs. 20 to 23, first, second, third, and fourth swimming legs; fig. 24, genital segment of female, ventral view; fig. 25, carapace of female, enlarged, showing ovaries and musculature; fig. 26, dorsal view of chalimus; fig. 27, second antenna of same; fig. 28, second maxilliped; figs. 29 to 31, first, second, third, and fourth swimming legs.

Plate LI. *Lepcophtheirus monacanthus* Heller.

Fig. 32, dorsal view of female; fig. 33, dorsal view of very young female; fig. 34, second antenna; fig. 35, second maxilla; fig. 36, furca; fig. 37, second maxilliped; figs. 38 to 41, first, second, third, and fourth swimming legs; fig. 42, genital segment of female, ventral view; fig. 43, newly hatched nauplius.

Plate LII. *Lepcophtheirus longispinosus*, new species.

Fig. 44, dorsal view of female; fig. 45, second antenna and first maxilla; fig. 46, mouth tube; fig. 47, second maxilla; fig. 48, furca; fig. 49, first maxilliped; fig. 50, second maxilliped; figs. 51 to 54, first, second, third, and fourth swimming legs; fig. 55, genital segment of female, ventral view.

Plate LIII. *Parapctalus occidentalis*, new species.

Fig. 56, dorsal view of female; fig. 57, second antenna and first maxilla; fig. 58, mouth tube; fig. 59, second maxilla; fig. 60, furca; fig. 61, second maxilliped; figs. 62 to 65, first, second, third, and fourth swimming legs; fig. 66, genital segment of female, ventral view; fig. 67, posterior lobes of genital segment, enlarged, showing semen receptacle, ducts, and spermatophores; fig. 68, ventral view of genital segment and abdomen of very young female.

Plate LIV. *Abasia pseudorostris*, new genus and species.

Fig. 70, dorsal view of female; fig. 71, dorsal view of male; fig. 72, rostrum, first and second antennae of female; fig. 73, same of male; fig. 74, mouth tube, second maxillae, and first maxilliped, showing relative position of latter; fig. 75, second maxilliped; figs. 76 to 79, first, second, third, and fourth swimming legs; fig. 80, genital segment of female, ventral view.

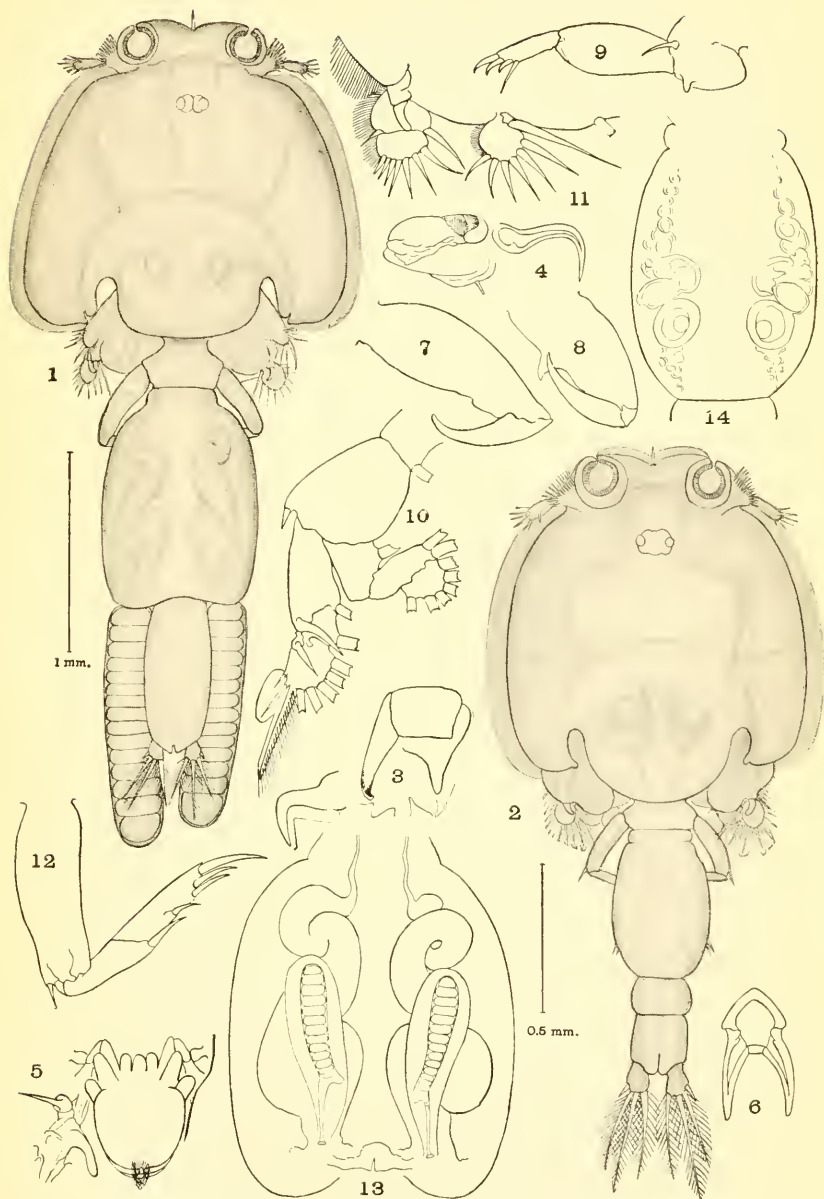
Plate LV. *Tuxophorus caligodes*, new genus and species.

Fig. 81, dorsal view of female; fig. 82, second antenna and first maxilla; fig. 83, mouth tube and second maxillae; fig. 84, mandible; fig. 85, first maxilliped; fig. 86, furca; figs. 87 to 90, first, second, third, and fourth swimming legs; fig. 91, dorsal view of genital segment and abdomen of very young female; fig. 92, ventral view of genital segment of adult female.

Plate LVI. *Tuxophorus caligodes*, continued.

Fig. 93, dorsal view of male; fig. 94, second antenna and first maxilla; fig. 95, second maxilliped; fig. 96, ventral view of genital segment, enlarged; fig. 97, dorsal view of chalimus; figs. 98 and 99, first and second swimming legs of same; fig. 100, newly hatched nauplius of *Abasia pseudorostris*.

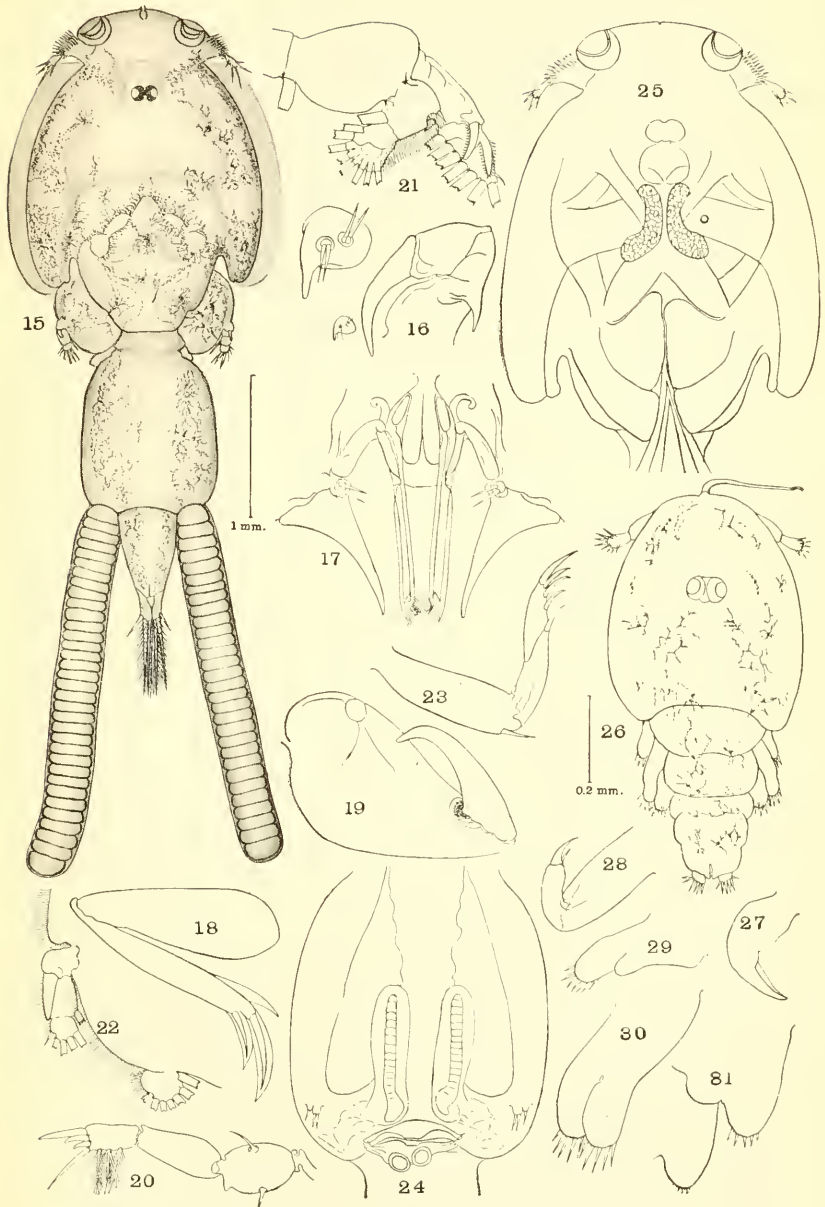




THE MALE AND FEMALE OF CALIGUS HAEMULONIS.

FOR EXPLANATION OF PLATE SEE PAGE 627.



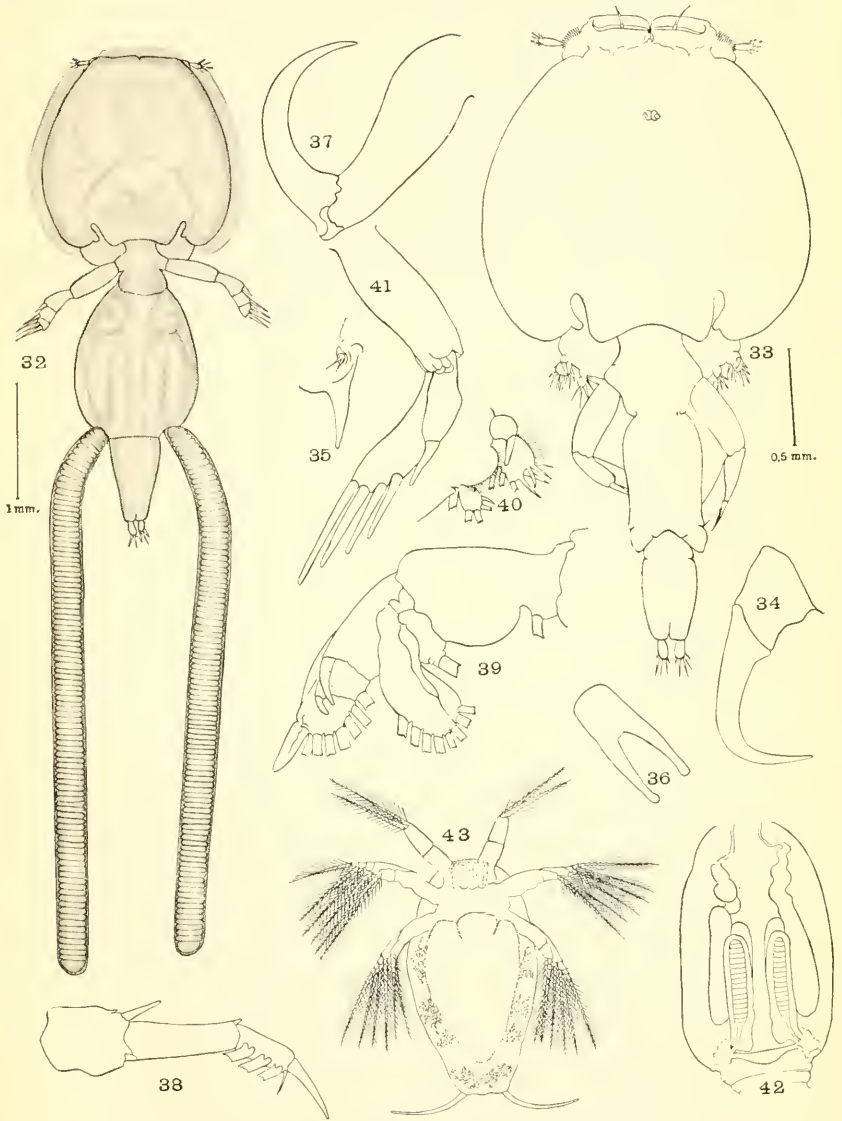


THE FEMALE OF CALIGUS RUFUS, NEW SPECIES.

FOR EXPLANATION OF PLATE SEE PAGE 627.



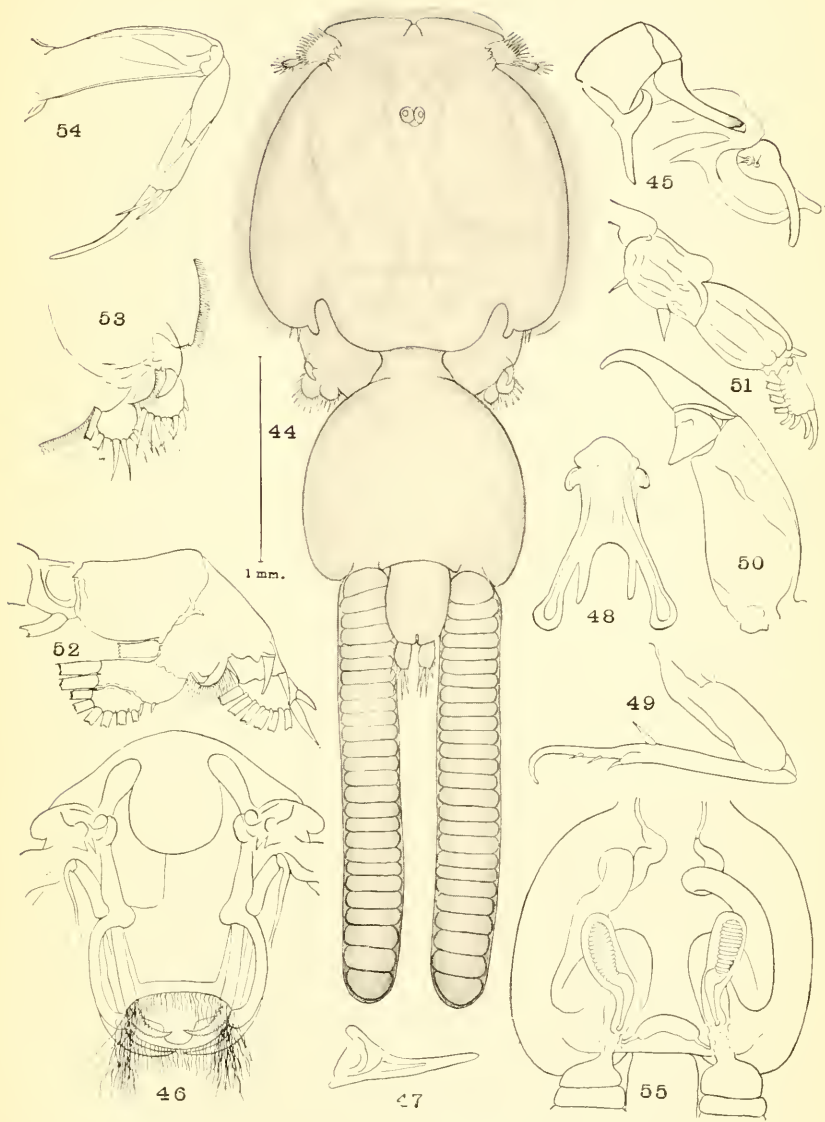




THE FEMALE OF LEPEOPHTHEIRUS MONACANTHUS.

FOR EXPLANATION OF PLATE SEE PAGE 627.

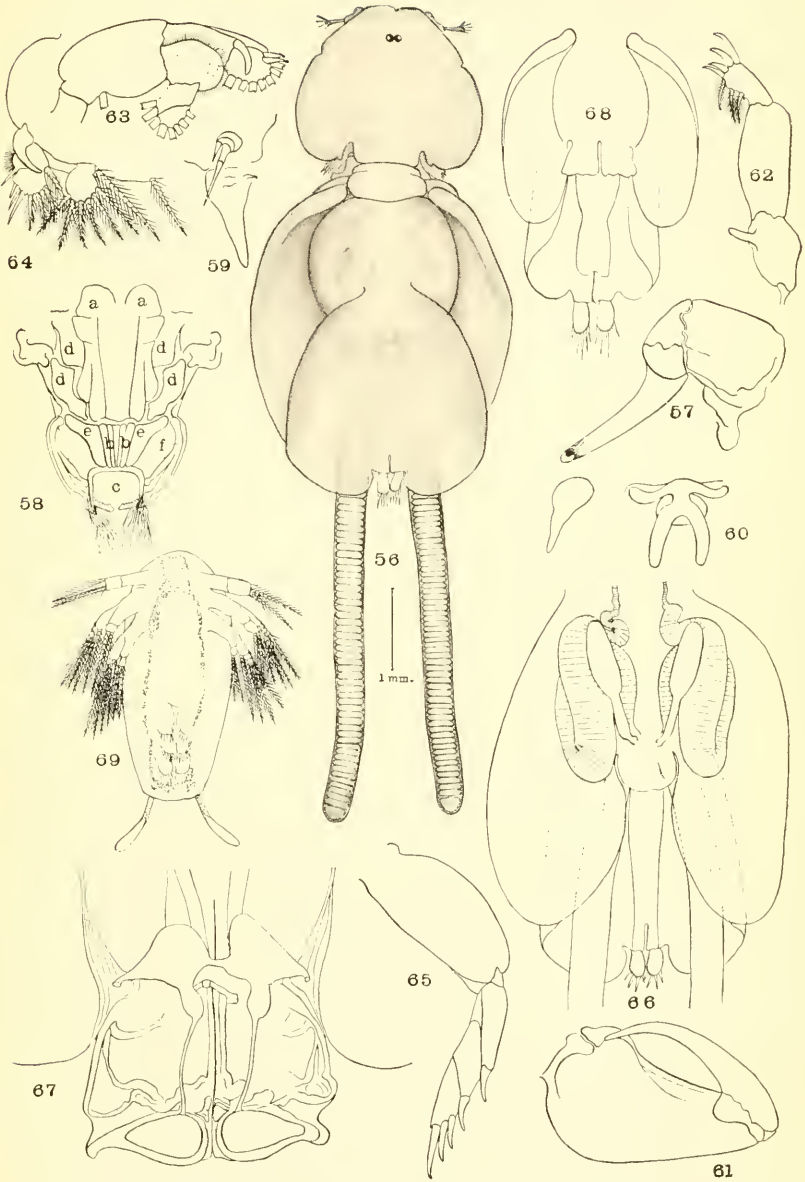




THE FEMALE OF *LEPEOPHTHEIRUS LONGISPINOSUS*, NEW SPECIES.

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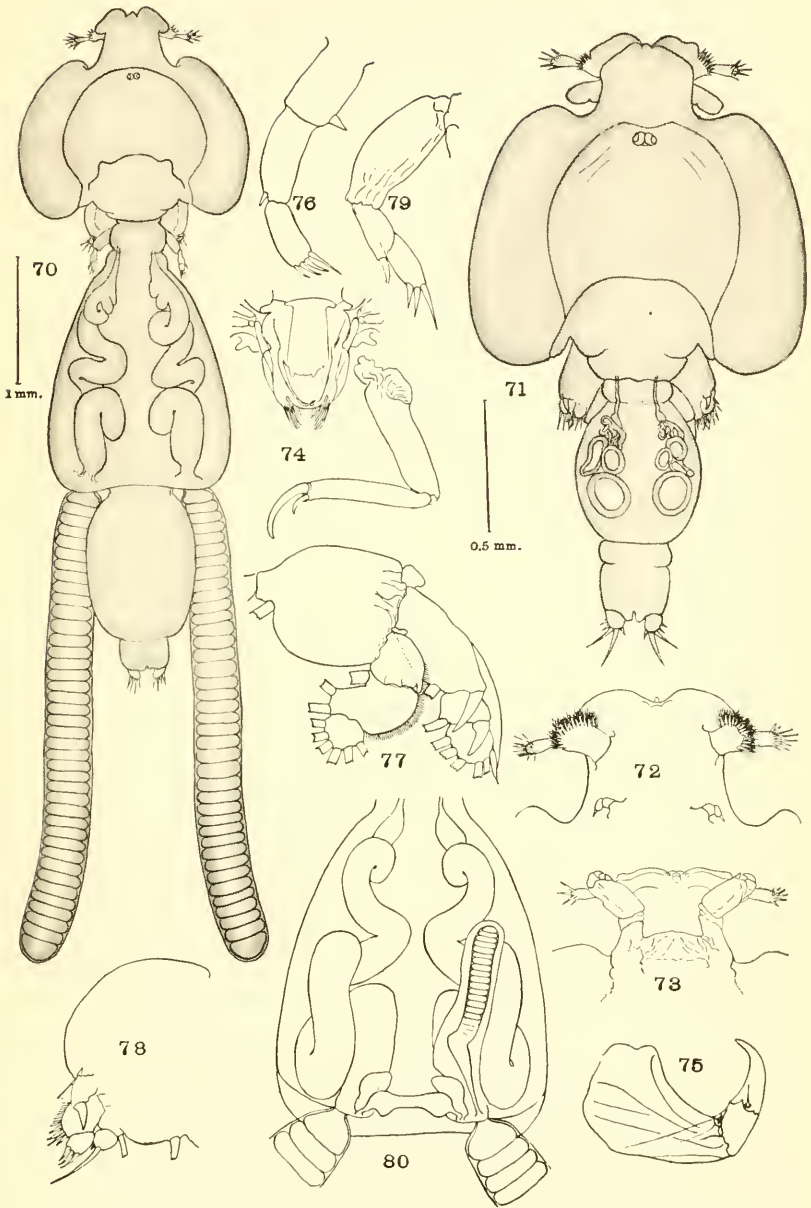




THE FEMALE OF *PARAPETALUS OCCIDENTALIS*, NEW SPECIES.

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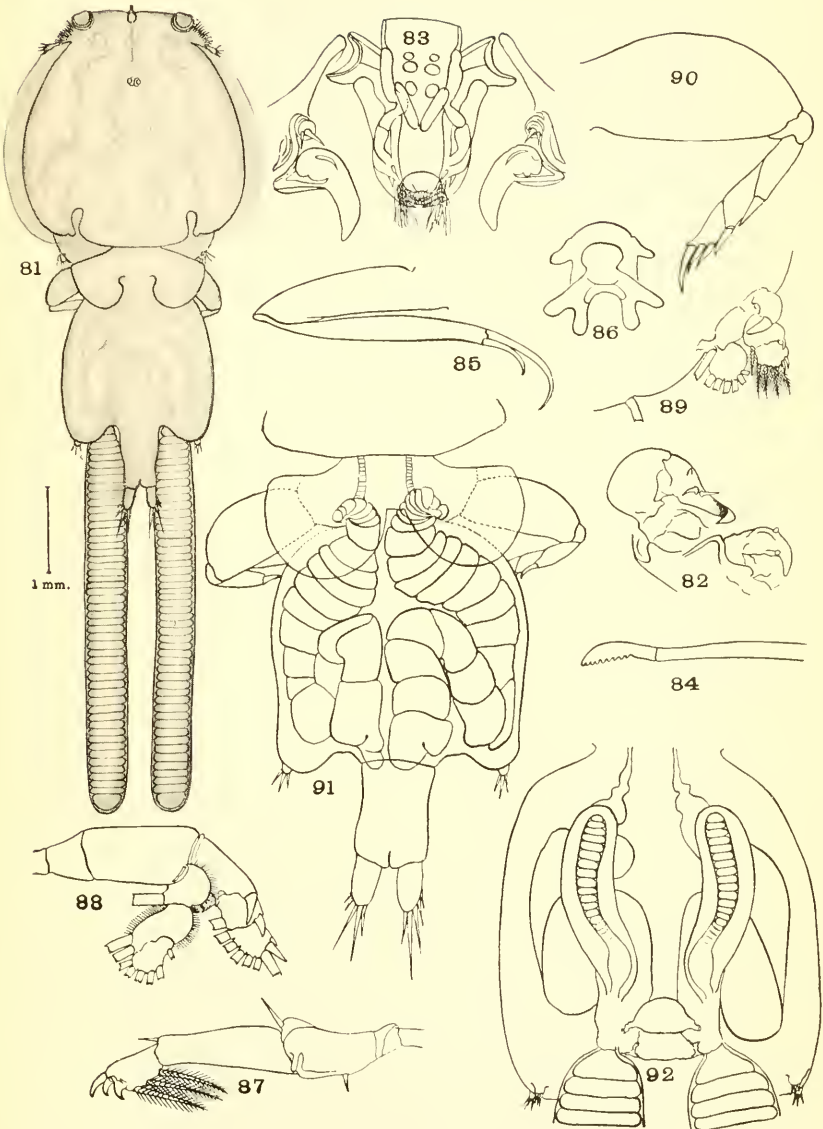


THE MALE AND FEMALE OF *ABASIA PSEUDOROSTRIS*, NEW GENUS AND SPECIES.

FOR EXPLANATION OF PLATE SEE PAGE 627.



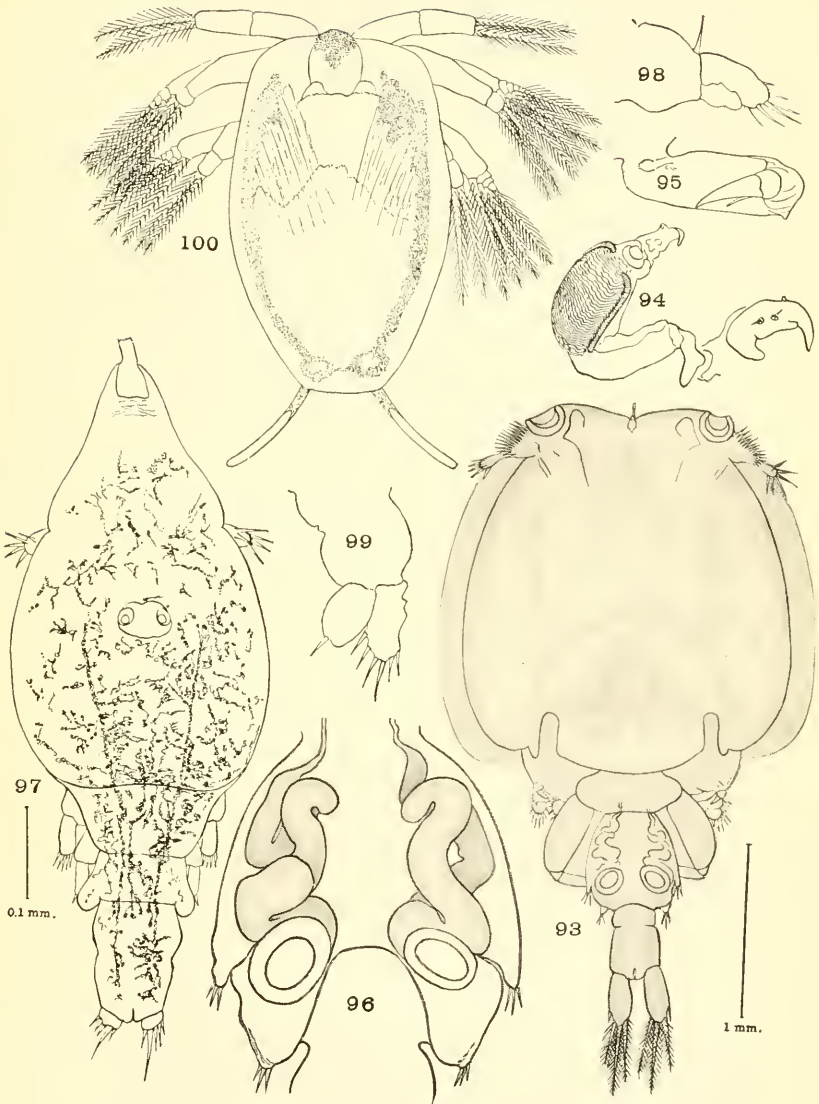




THE FEMALE OF *TUXOPHORUS CALIGODES*, NEW GENUS AND SPECIES.

FOR EXPLANATION OF PLATE SEE PAGE 627.





THE MALE OF *TUXOPHORUS CALIGODES*, NEW GENUS AND SPECIES.

FOR EXPLANATION OF PLATE SEE PAGE 627.

