

# NORTH AMERICAN PARASITIC COPEPODS BELONGING TO THE FAMILY DICHELESTHIIDAE.

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## INTRODUCTION.

This is the sixteenth<sup>1</sup> paper in the series dealing with the parasitic copepods in the collection of the United States National Museum, and comprises the family Dichelesthidae.

The genera belonging to this family are closely related to the Caligidae and Lernaecidae and are included with them in the group known as the Caligoida. They are gill parasites and when fully developed the females probably remain attached to the same spot on the gills of their host. In this sense they may be properly called fixed parasites, but they never burrow into the tissues of the host after the manner of the Lernaecidae, and yet one of the genera, *Caetrodes*, furnishes a very respectable compromise in this direction. While it does not itself burrow into the gill filament of its host, it does in some way so irritate the gill epithelium that the latter grows up into a flap or fold, entirely surrounding the body of the copepod and holding it securely in place.

Also other genera, such as *Anthosoma*, *Eudactylina*, *Nemesis*, and *Dichelesthium*, produce enough irritation with their prehensile claws in the gill epithelium to cause it to grow up around the claws themselves, but so far as known it never surrounds any portion of the copepod's body, not even the anterior margin of the head. In consequence of thus remaining at least partially free there is no instance of any material change in the parasite's bodily form or structure sub-

<sup>1</sup>The fifteen preceding papers, all of which were published in the Proceedings of the United States National Museum, are: 1. The Argulidae, vol. 25, pp. 635-742, pls. 8-27. 2. Descriptions of Argulidae, vol. 27, pp. 627-655, 38 text figures. 3. The Caliginae, vol. 28, pp. 479-672, pls. 5-29. 4. The Trebinae and Euryphorinae, vol. 31, pp. 669-720, pls. 15-20. 5. Additional Notes on the Argulidae, vol. 32, pp. 411-424, pls. 29-32. 6. The Pandarinae and Cecropinae, vol. 33, pp. 323-490, pls. 17-43. 7. New Species of Caliginae, vol. 33, pp. 593-627, pls. 49-56. 8. Parasitic Copepods from Pacific Coast, vol. 35, pp. 431-481, pls. 66-83. 9. Development of *Achtheres ambloplitis* Kellicott, vol. 39, pp. 189-226, pls. 29-36. 10. The Ergasilidae, vol. 39, pp. 263-400, pls. 41-60. 11. Descriptions of New Genera and Species, vol. 39, pp. 625-634, pls. 65-68. 12. Descriptions of New Species, vol. 42, pp. 233-243, pls. 30-34. 13. The Lernaecopodidae, vol. 47, pp. 565-729, pls. 25-56. 14. The Lernaecidae, vol. 53, pp. 1-150, pls. 1-21. 15. The Sphyriidae, vol. 55, pp. 549-604, pls. 50-59.

sequent to attachment. The grotesque transformations so common in the Lernaeidae and Sphyrriidae are entirely unknown here, and there are not the complicated differences in size and morphology between the two sexes. The males are smaller than the females but they never become pygmies, and the structure of the two sexes is so similar that it betrays specific as well as generic identity.

The material for the present paper has been derived chiefly from the collection of the United States National Museum, which included most of the genera. This material has been supplemented with specimens collected by the present author at Beaufort, North Carolina, in 1905, while working for the United States Bureau of Fisheries, which include six new species.

There are also three more of the drawings by J. H. Blake, placed at the author's disposal by the late Dr. Richard Rathbun. Specimens, descriptive notes, and pencil sketches of a new species of *Lernanthropus* from the Pacific coast came to the author many years ago from Dr. M. T. Thompson.

The same methods of dehydration and clearing have been used as in the Lernaeidae and Sphyrriidae, and with excellent results. Much of the internal morphology has been determined from these cleared specimens, and they have been supplemented by serial sections of *Nemesis*, *Eudactylina*, *Dichelesthium*, and *Lernanthropus*.

As here constituted the family is made up of 20 genera, of which one, *Bassettithia*, is a new genus name to take the place of one already occupied, and 107 species, of which 9 are new to science.

The present author has been unable to examine any specimens belonging to the genera *Norion*, *Krøyeria*, *Congericola*, *Lamproglena*, *Donusa*, *Bassettithia*, *Pseudoclavella*, *Cybicola*, and *Ventriculina*. But it has seemed wise to include keys to the species of these genera, based necessarily upon their published descriptions.

#### HISTORICAL.

Abildgaard was the first to notice any of the species belonging to this family. In 1794 he described and figured<sup>2</sup> two new species, which he referred to the genus *Caligus* and named, respectively, *crassus* and *oblongus*. In 1816 Leach, probably without knowing of Abildgaard's description and figures, established a new genus and species upon some specimens from the gill cover of a shark captured on the coast of England, which he named *Anthosoma smithii*.<sup>3</sup> About the same time or a little later Risso published his "Histoire Naturelle des Crustacés des environs de Nice," in which he described (p. 162) a new species of the genus *Caligus*, which he called *Caligus imbricatus*. Leach afterwards had an opportunity of examining

<sup>2</sup> Skrivter af naturhistorie Selskabet, Kjøbenhavn, vol. 3, pp. 46-54, pl. 5, figs. 1-11.

<sup>3</sup> Suppl. Encyc. Brit., vol. 1, p. 406.

Risso's type specimens and found them the same as his own, yet Risso described them again in 1826 under the name *Otrophesia imbricata*,<sup>4</sup> and even quoted Leach as the authority for his new generic name. A careful examination of the three descriptions and their accompanying figures makes it evident that they were all dealing with the same species. But it is not a species of *Caligus*, and hence Leach's generic name is valid with the specific name given by Abildgaard, and the species becomes *Anthosoma crassum*. It was retained, however, in the genus *Caligus* by Lamarck, who even made separate species of *imbricatus* and *smithii*. All other authors since Leach have adopted his genus, although there has been considerable division of opinion over the three specific names.

Similarly Abildgaard's second species, *oblongus*, was made the type of a new genus by Hermann in his "Memoire Apterologique" in 1804. Like Leach, he seems not to have known of Abildgaard's description and figures, for he named his new genus type *Dichelesthium sturionis*. This genus name was adopted by Oken, 1816, Desmarest, 1825, and Nordmann, 1832, but was changed to *Dichelestium* by Latreille, 1817, and all other subsequent authors except M. J. Rathbun, 1905, and Norman and T. Scott, 1906, who retained Hermann's original spelling. To none of them, however, except White, 1850, and the last two just mentioned, not even to those who claimed that Abildgaard's species and Hermann's were identical, did it occur that the species name given by the former must take precedence over that of the latter (see p. 86).

To these two original genera others have been added from time to time, as indicated in the key upon page 20. Of these Blainville added *Lernanthropus* in 1822, Nordmann contributed *Lamproglena* in 1832 and *Donusa* and *Norion* in 1864, P. J. van Beneden contributed *Ergasilina* in 1851, *Eudactylina* and *Krøyeria* in 1853, and *Congericola* in 1854. He was apparently unaware that this last genus was identical with Milne Edwards's *Cycnus*, since he makes no mention of the latter. But since the name *Cycnus* had been pre-occupied (see p. 57) Beneden's name becomes valid.

The remaining genera have come at scattered intervals, most of them within the present century. The descriptions and figures have been uniformly good, so that now we have reliable data upon their general form and habits. But there has been much less information with reference to their internal morphology and their life history.

Heider in 1879 published a monograph entitled "Die Gattung *Lernanthropus*," in which he gave an excellent account of the internal anatomy, and included also the minute histology of the various tissues, but this is the only genus to be so treated, and in reference to

<sup>4</sup> Hist. Nat., Paris, vol. 5, p. 136.

the life history Heider gave merely the oögenesis, with nothing on the larval development. Heider's remarkable description has served as a basis for the present paper, and with it have been compared the morphology of *Dichelesthium*, *Nemesis*, and *Eudactylina*.

#### ECOLOGY.

While the component genera and species of the present family are fixed parasites in the sense that they do not move about freely over their hosts like the Caligidae and Argulidae, they are not absolutely incapable of motion like the Lernaeidae. Consequently while there is a greater or less loss of the powers of locomotion there is no marked sexual dimorphism, the body frequently retains its segmentation and flexibility, and none of the appendages are lost or abnormally transformed.

*Sexual dimorphism.*—There is more or less disparity in size between the two sexes, but the general body structure remains the same, so that the male of any genus can be easily located through its resemblance to the female, and while the males are always smaller than the females they are never reduced so much as to become pygmies.

In the subfamily Anthosominae the genus *Lernanthropus* is the one in which the male is best known. Here the male is not only smaller than the female, but it lacks the dorsal plates which cover the body of the latter, so that the laminate legs project for their entire length in dorsal as well as in ventral view. The segments of the thorax are more completely fused than in the female and are seldom indicated by anything except the modified legs.

In the subfamily Eudactylinae the males of *Congericola*, *Nemesis*, and *Eudactylina* are known. They differ from the females in having a relatively shorter and narrower genital segment, and the segmentation in the *Nemesis* male is almost wholly obscured.

In the subfamily Pseudocycninae the males of *Pseudocycnus*, the only ones known, differ from the females in the fact that the long genital segment of the latter is replaced by a very short, almost spherical segment, in front of which the fourth legs stand out rigidly on either side. The cephalothorax is relatively the largest region in the body, while the abdomen terminates in two large flaring anal laminae.

In the subfamily Dichelesthinae the males of *Hatschekia* and *Dichelesthium* are almost perfect counterparts of the females, half a size smaller. None of the males in any of these subfamilies is found attached to the female after the manner of the pygmy males of the Lernaeopodidae and Sphyriidae. But they are all attached independently to the host in the same manner as the females.

*Locomotion.*—Both sexes are free swimmers during development, but after attachment to their host it is probable that they do not move about. The swollen and lacerated condition of the host's skin at the spot where the female parasite's claws penetrate it indicates that the attachment is a permanent one and not temporary. The structure of the second antennae, which serve as attachment organs in most of the genera, also indicates that they are intended for permanent attachment. And at least in *Anthosoma* and *Dichelesthium*, and in both sexes of the latter, the skin of the host grows up around the buried claws and completely envelops them. Neither sex of *Hatschekia*, *Nemesis*, or *Eudactylina* is fastened as securely as this, and they could easily loosen their hold upon the gill filament and move about from one place to another after the manner of *Ergasilus*, and it is possible that the males may go farther than this, for when removed from the gills and placed in water the male of *Nemesis* is able to move itself about vigorously by means of its swimming legs, and can even swim in a bungling fashion, but the body of the female is apparently too heavy and she quickly sinks to the bottom.

*Prehension.*—The chief organs of prehension are the second antennae and maxillipeds. The former are large and powerful in all the genera and are armed sometimes with stout claws, as in *Lernanthropus*, *Norion*, and *Hatschekia*, and sometimes with strong chelae, as in *Krøyeria*, *Dichelesthium*, and *Pseudoclavella*. In *Anthosoma* the second antennae are also elongated and form a pair of arms something like the maxillae of the Lernaeopods. In *Nemesis* and *Eudactylina* the second antennae are weaker, while the maxillipeds are greatly enlarged and become chelate, so that they usurp most of the functions of prehension.

When the second antennae terminate in claws the two appendages are opposed to each other like the arms of a pair of pincers, and the tips of the claws are usually thrust past each other so that they overlap for quite a distance, and in this way a very firm hold is obtained. In fact, the skin and flesh of the host have to be cut away before the parasite can be removed. On the other hand, if each antenna terminates in a chela, they are attached separately and usually some distance apart. The chela is supposed to give a somewhat stronger and more permanent form of attachment, but the interlocking of the claws just mentioned makes them fully as powerful as the chelae.

*Hosts.*—This family of parasites is confined exclusively to salt-water fish, and practically all of them to the fish's gills. The genera *Eudactylina*, *Krøyeria*, *Nemesis*, and *Ergasilina* infest sharks and rays of various species; *Anthosoma* is found on sharks and the sunfish; *Dichelesthium* has thus far been found only upon the sturgeon;

*Lernanthropus* and *Hatschekia* are cosmopolitan, using a great variety of fish from every ocean and nearly every latitude; *Congericola* is found on the Labridae, or wrasse fishes, chiefly in the Mediterranean; most of the other genera are made up of single species widely scattered.

Being found chiefly upon nonedible fishes, the species of this family have but little economic importance, and in addition they are of such small size and occur in such limited numbers that their importance is still further restricted. In most families of parasitic copepods the number of specimens upon a single host may be increased under favorable conditions until it becomes a menace to the life of the fish. Nothing of the sort has ever been reported in connection with the present family.

*Food.*—The presence of the great majority of the species upon the gills of their hosts and the color of the contents of the digestive tube when freshly examined leave no doubt that these parasites eat the blood of their host. The walls of the stomach also have the same structure as those of other blood eaters. That the amount consumed by a single parasite is small may be inferred from the fact that it is content to remain upon the gills, in company with other kinds of parasites, instead of boring into the flesh to get at some large blood vessel.

#### MORPHOLOGY.

*General body form.*—In general the body of a dichelesthiid is elongate and tapers gradually from the head to the abdomen. The thorax is usually distinctly segmented and the genital segment is but little wider and longer than the preceding segment, but in the genera *Pseudocycnus*, *Congericola* and *Krøyeria* the genital segment is greatly elongated and is considerably wider than the free segments. In the genus *Lernanthropus* there is considerable fusion of the thoracic segments, and the body is greatly modified by the transformation of the posterior swimming legs into soft laminae, nearly as long as the body itself. In *Pseudocycnus* and *Hatschekia* only two of the anterior thoracic segments are free, the posterior segments being fused with the genital segment to form a body region much longer than the cephalothorax. Another factor which profoundly modifies the general body form is the presence of dorsal plates, or wings, or both. In *Lernanthropus* the dorsal plate which covers the posterior thorax and abdomen is sometimes elongated and widened so much, and is wrapped around the body in such a way, as to give the body the appearance of being clothed in a skirt.

In *Sagum* the dorsal plate is prolonged at the posterior corners into large lobes, which have the appearance of a military cloak draped around the body. In *Norion* the dorsal plate is prolonged

forward at the anterior corners as if to form a pair of large flowing sleeves.

In *Anthosoma*, beside the large dorsal carapace over the cephalothorax, each thorax segment carries a pair of lateral plates or wings, which overlap like tiles on a roof, and give the parasite a peculiarly bizarre appearance.

We may say, then, that the body of a dichelesthid is made up of four parts or regions, a cephalothorax composed of the head and first thoracic segment fused, a free thorax of from two to four segments, a genital segment either alone or fused with the preceding thorax segments, and an abdomen of one or more segments. For appendages there are two pairs of antennae, a pair of mandibles, two pairs of maxillae, a pair of maxillipeds, and from two to five pairs of swimming legs.

*Antennae.*—The first antennae are attached to the anterior margin of the cephalothorax, are cylindrical in form, and are composed of a number of short joints placed end to end and plentifully supplied with setae. The number of joints varies considerably, not merely in different genera but also among the species of the same genus; but since the muscles of these first antennae are poorly developed it is difficult, as Heider has said, to determine just how many segments there are. In his figures of the species of *Lernanthropus* he represented the antennae as varying from three to nine segments, and a similar variation has been found in the species described by the present author. Furthermore, the basal joint in some species is enlarged much more than in others. In the different genera the number of joints varies from three in *Pseudocycnus* and *Pseudoclavella* up to nine in *Bassettithia* and fifteen in *Nemesis*, the basal ones being indistinctly separated (fig. 72).

The second antennae are fastened to the ventral surface of the head close to the anterior margin. Being the chief organs of prehension they are large and stout in most of the genera. They are made up of two or three joints, the terminal one in the form of a strong claw which is usually curved, sometimes barbed (*Cybicola*) and sometimes strongly chelate (*Pseudoclavella*, *Dichelesthium*, *Krøyeria*). Rarely these appendages are armed with setae only (*Lamproglena*, *Donusa*, *Ventriculina*). The basal joints are swollen and armed with powerful muscles by means of which the terminal claws can be driven into the flesh of the host (figs. 4, 24, 32, 78, 98).

*Mouth parts.*—The proboscis is formed of an upper and an under lip, which project from the ventral surface of the head. Near the base the margins of the two lips are tolerably parallel and separated by only a slight distance, but each lip soon begins to taper and in consequence the margins diverge. On either side at the point where

the divergence begins the under lip sends out a lobe, which curves forward and upward around the upper lip and fastens the two securely together in the form of a tube (figs. 75 and 80).

The mandibles originate on the ventral surface of the head outside of the proboscis. Each is somewhat swollen at the base, then tapers into a long and narrow shaft, which passes into the proboscis tube through the opening between the upper and under lips. Inside the proboscis each mandible is widened a little toward the tip and flattened dorso-ventrally and the edges which face each other are finely toothed. In *Lamproglena* and *Lernanthropus* the mandibles are curved like a saber or sickle, with the convex side inward; in *Hatschekia*, *Dichelesthium*, and *Caetrodes* they are straight and have more the shape of a stylet.

The first maxillae vary greatly in different genera; when fully developed, as in *Lernanthropus*, they are biramose, the endopod or palp arising nearer the proboscis and consisting of a tiny process armed with a single seta. The exopod is farther away from the proboscis and is made up of two more or less elongated joints, tipped with two or three setae (fig. 75), but in many of the genera the endopod is entirely lacking and the exopod is destitute of setae. In *Hatschekia* these maxillae consist of small papillae, each armed with three setae, similar to those of the Ergasilidae. In *Anthosoma* both rami are straight spines, the endopod several times the length of the exopod (fig. 5).

The second maxillae are usually smaller and weaker than the maxillipeds. They are normally composed of a swollen basal joint, an elongated and slender second joint, and a small terminal claw, and are prehensile in function. In *Lernanthropus* the concave margin of the claw is armed with two rows of small teeth, and there is a small accessory claw at its base on the inner side (figs. 22 and 25). In *Lamproglena* these maxillae are the chief organs of prehension and each is armed with a very stout curved claw, while the maxillipeds are much smaller and each is tipped with three tiny claws.

The maxillipeds in most of the genera are important organs of prehension and are much stronger and more powerfully developed than the maxillae. They usually consist of a swollen basal joint furnished with strong muscles and a curved terminal claw. In some genera these claws are simple and shut down against the side of the basal joint, as in *Donusa*, *Pseudoclavella*, and *Lernanthropus*. In other genera the terminal claw is barbed or furnished with one or more teeth on the concave margin, as in *Cybicola*, *Pseudocycnus*, and *Congericola*, and in *Nemesis*, *Eudactylina*, *Dichelesthium*, and *Anthosoma* there are outgrowths upon the basal joint into which the tip of the claw fits, making it virtually a chela (fig. 82). *Dichelesthium* is the only genus in which both the second antennae and the



Table showing relative structure of antennae and mouth parts.

Genus.	First antenna.	Second antenna.	First maxilla.	Second maxilla.	Maxilliped.
<i>Anthosoma</i> .....	6 joints.....	3 joints; uncinat.	Spines biramose.....	3 joints; uncinat.	2 joints; chelate.
<i>Bassettia</i> .....	9 joints.....	2 joints; uncinat.	Spines biramose.....	Unknown.....	Unknown.
<i>Caetodes</i> .....	5 joints.....	2 joints; uncinat.	2 joints; uniramos.	2 joints; uncinat.	2 joints; uncinat.
<i>Congericola</i> .....	6 joints.....	2 joints; uncinat.	1 joint; uniramos.	1 joint; setose.....	3 joints; uncinat.
<i>Cybicola</i> .....	7 joints.....	Barbed claw.....	2 joints; uniramos.	2 joints; uncinat.	Barbed claw.
<i>Dichelesthium</i> .....	8 joints.....	3 joints; chelate.	Biramose.....	2 joints; uncinat.	2 joints; chelate.
<i>Donusa</i> .....	6 joints.....	2 joints; setose.....	1 joint; uniramos.	2 joints; uncinat.	2 joints; uncinat.
<i>Ergasilina</i> .....	5 joints.....	2 joints; uncinat.	Unknown.....	2 joints; uncinat.	2 joints; uncinat.
<i>Eudactylina</i> .....	4-8 joints.....	3 joints; uncinat.	Spines biramose.....	3 joints; uncinat.	2 joints; uncinat.
<i>Hatschekia</i> .....	3-5 joints.....	2 joints; uncinat.	1 joint; uniramos.	Lacking.....	2 joints; chelate.
<i>Krøyeria</i> .....	7-8 joints.....	3 joints; chelate.	2 joints; uniramos.	3 joints; setose.....	2 joints; uncinat.
<i>Lamproglana</i> .....	Fused joints.....	4 joints; setose.....	Unknown.....	2 joints; setose.....	2 joints; uncinat.
<i>Lernanthropus</i> .....	6-7 joints.....	2 joints; uncinat.	2 joints; uniramos.	2 joints; uncinat.	2 joints; uncinat.
<i>Nemesis</i> .....	11-15 joints.....	2 joints; uncinat.	Spines biramose.....	3 joints; setose.....	2 joints; uncinat.
<i>Norion</i> .....	6 joints.....	2 joints; uncinat.	2 joints; uniramos.	2 joints; uncinat.	1 Uncinate; 2 chelate.
<i>Peniculisa</i> .....	Fused joints.....	2 joints; uncinat.	Lacking.....	Lacking.....	2 joints; uncinat.
<i>Pseudoclavella</i> .....	3 joints.....	2 joints; chelate.....	2 joints; uniramos.	3 joints; uncinat.	2 joints; uncinat.
<i>Pseudocycnus</i> .....	3 joints.....	2 joints; uncinat.	3 joints; uniramos.	3 joints; setose.....	3 joints; uncinat.
<i>Sagum</i> .....	6 joints.....	2 joints; uncinat.	2 joints; uniramos.	2 joints; uncinat.	Barbed claw.
<i>Ventriculina</i> .....	4 joints.....	3 joints; setose.....	Unknown.....	2 joints; uncinat.	2 joints; uncinat.

1 Female.

2 Male.

maxillipeds are chelate. In the other genera, when one of these appendages is chelate, the other will be found to be armed with simple claws or often only with setae. *Lamproglena*, as noted above, is the chief exception, and here the second maxillae and maxillipeds have apparently changed places. The preceding table has been compiled for the purpose of contrasting the structure of the antennae and the mouth parts, with the exception of the mandibles, in the various genera. The available data on the structure of the mandibles at the present time is too meager to warrant their inclusion in the table.

*Swimming legs.*—The swimming legs vary greatly in number and structure. Most of the genera have four pairs, but in *Eudactylina*, *Nemesis*, *Lamproglena*, and *Donusa* there is a fifth pair. In the first three the fifth leg consists of a single laminate process, but in *Donusa* each fifth leg is biramose and the rami are three jointed, like the other four pairs. In addition to the genera just named the first four pairs of legs are also biramose in *Congericola*, *Pagodina*, *Krøyeria*, *Peniculisa*, and *Sagum*, nine genera in all out of the twenty in the family. In *Donusa* and *Krøyeria* each ramus is three jointed, but in the other genera the number of joints varies, no two genera being alike. In *Bassettithia* the first three pairs of legs consist of basal joints only, while the fourth pair are biramose, with one-jointed rami. In *Cybicola* and *Ventriculina* there are only three pairs of legs, the first pair biramose, with one-jointed rami, the second and third pairs uniramous. In *Pseudoclavella* the first two pairs are biramose, the third and fourth pairs uniramous. In *Pseudocycnus* the first and fourth pairs are uniramous and are made up of the basipod only, the second pair is biramose, the rami one jointed, and the third pair is uniramous and two jointed. In *Hatschekia* and *Caetrodes* only the first two pairs of legs are present, each biramose and the rami two jointed. In *Dichelesthium* the first two pairs are biramose and the third pair uniramous, while the fourth pair is entirely lacking. In *Lernanthropus* the first two pairs are biramose with one-jointed rami, while the third and fourth pairs are modified into long cylindrical processes, apparently concerned in respiration. In *Anthosoma* the first three pairs are replaced by foliaceous plates and the fourth pair is lacking, while in *Norion* apparently only the first pair is present, and these are uniramous and one jointed. In the following table these differences are brought out clearly. The most noticeable feature is the prevailing lack of uniformity. The absence of fifth legs is the only character that approaches regularity and even there twenty percent of the genera show exceptions. It almost seems as if the various characters must have been shuffled for each genus separately in order to produce such prevalent and radical discrepancies.

Genus.	First leg.	Second leg.	Third leg.	Fourth leg.	Fifth leg.
<i>Anthosoma</i> .....	Single foliaceous plate. Uniramose; basipod only.	Single foliaceous plate. Uniramose; basipod only.	Single foliaceous plate. Uniramose; basipod only.	Wanting.....	Wanting.
<i>Bassettithia</i> .....	Biramose; rami two-jointed.	Biramose; rami two-jointed.	Wanting.....	Biramose; rami one-jointed.	Wanting.
<i>Caetodes</i> .....	Biramose; rami two-jointed.	Biramose; rami two-jointed.	Biramose; rami one-jointed.	Biramose; rami one-jointed.	Wanting.
<i>Congericola</i> .....	Biramose; rami one-jointed.	Uniramose; two-jointed.	Uniramose; one-jointed.	Wanting.....	Wanting.
<i>Cybicola</i> .....	Biramose; rami two-jointed.	Biramose; rami two-jointed.	Biramose; rami one-jointed.	Uniramose; rami one-jointed.	Wanting.
<i>Dichelesthium</i> .....	Biramose; rami three-jointed.	Biramose; rami three-jointed.	Biramose; rami three-jointed.	Biramose; rami three-jointed.	Biramose; rami three-jointed.
<i>Donusa</i> .....	Biramose; rami three-jointed.	Biramose; rami three-jointed.	Biramose; rami three-jointed.	Biramose; rami three-jointed.	Uniramose; one-jointed.
<i>Eudactylina</i> .....	Biramose; rami one-jointed.	Biramose; rami one-jointed.	Biramose; rami one-jointed.	Biramose; rami one-jointed.	Wanting.
<i>Hatschekia</i> .....	Biramose; rami three-jointed.	Biramose; rami three-jointed.	Wanting.....	Wanting.....	Wanting.
<i>Kroyeria</i> .....	Biramose; rami two-jointed.	Biramose; rami two-jointed.	Biramose; rami three-jointed.	Biramose; rami three-jointed.	Wanting.
<i>Lamproglena</i> .....	Biramose; rami two-jointed.	Biramose; rami two-jointed.	Biramose; rami two-jointed.	Biramose; rami two-jointed.	Uniramose; one-jointed.
<i>Lernanthropus</i> .....	Biramose; rami one-jointed.	Biramose; rami one-jointed.	1 Uniramose; 2 biramose; one-jointed.	Biramose; rami one-jointed.	Wanting.
<i>Nemesis</i> .....	Biramose; rami one-jointed.	Biramose; rami one-jointed.	Biramose; rami one-jointed.	Biramose; rami one-jointed.	Uniramose; one-jointed.
<i>Norion</i> .....	Uniramose; one-jointed.	Wanting.....	Wanting.....	Wanting.....	Wanting.
<i>Erqasilina</i> .....	Biramose; rami one-jointed.	Biramose; rami one-jointed.	Biramose; rami one-jointed.	Biramose; rami one-jointed.	Wanting.
<i>Peniculusa</i> .....	Biramose; rami one-jointed.	Biramose; rami one-jointed.	Biramose; rami one-jointed.	Biramose; rami one-jointed.	Wanting.
<i>Pseudoclavella</i> .....	Biramose; rami one-jointed.	Biramose; rami one-jointed.	Uniramose; one-jointed.	Uniramose; one-jointed.	Wanting.
<i>Pseudocycnus</i> .....	Uniramose; one-jointed.	Biramose; rami one-jointed.	Uniramose; two-jointed.	Uniramose; one-jointed.	Wanting.
<i>Sagun</i> .....	Biramose; rami one-jointed.	Biramose; rami one-jointed.	Biramose; rami laminate.	Biramose; rami spatulate.	Wanting.
<i>Ventriculina</i> .....	Biramose; rami two-jointed.	Uniramose; two-jointed.	Uniramose; two-jointed.	Wanting.....	Wanting.

1 Female.

2 Male.

*Integument.*—In none of the genera is the skin hardened into inflexible chitin, as occurs in so many of the Lernaeidae. The modifications of the skin, called variously carapace, dorsal, or lateral plates, wings, lobes, etc., are often hardened into chitin, as in *Anthosoma*, *Nemesis*, and *Dichelesthium*, but there are also some genera in which they remain soft, as in *Lernanthropus* and *Bassettithia*; but in sections that are double-stained the skin always takes the red eosin, but refuses the second color, showing that it has been modified even though it remains soft. Such a section demonstrates that the skin is made up of very thin layers packed closely together. Moreover, it is not uniform in thickness, but varies greatly in different parts of the body. It is nearly always thicker upon the appendages than upon the body itself, and the framework which supports the various appendages, together with the rods and bands which connect the bases of each pair of appendages across the median line, and the framework around the sex openings appear to be formed by a thickening of the skin. A comparison of the different layers of the skin shows that the outer layers are denser and more homogeneous in structure, darker in color, and more strongly refractive than the inner layers. Consequently Heider was led to the conclusion that the increase in thickness takes place by the addition of layers from the inside, which seems probable. Another notable difference in thickened portions of the skin is that the inner layers often show a distinct granulation and sometimes an irregular striping, perpendicular to the surface. Through this skin open excretory ducts leading from the inner chitinogen layer. So far as observed these appear to be usually cylindrical and uniform in diameter, rather than funnel shaped as in the Lernaeidae. They are scattered everywhere over the skin in great numbers, but are especially numerous upon the head and the free edges of the carapace and dorsal plates. But beside these slender ducts there are a few along the edge of the dorsal carapace, which are funnel shaped and whose diameter is much larger. And the inner or larger end of the funnel is oval rather than circular in outline. A pair of large ducts open between the bases of the maxillipeds and a similar pair on either side near the bases of the first and second antennae.

The outgrowths of the skin are of three kinds. First, there are processes of the skin itself, soft in texture, hollow, and filled with the chitinogen layer from the inside of the body. These are found in considerable numbers on the antennae, especially on the terminal joints, and may be designated as tactile processes. Here also belong the large setae on the anal laminae, which are hollow and whose lumen is filled with tissue from the inside of the body. A second group comprises the tactile setae which arise from small warts placed

in an invagination of the skin. These setae are solid, but the warts are partially hollow, and to them slender cords of granular protoplasm lead through the skin. The third group includes the hairs which appear in various places on the skin and the setae that are found on the appendages. These are solid, they arise directly from the surface of the skin and not from a wart or process, and they are not connected in any way with the interior of the body through the skin.

Under the skin is found a layer of tissue which has been called by Hartmann the chitinogen layer and by Heider the matrix, and which varies considerably in the different genera. In *Lernanthropus* Heider has described this as not a continuous cellular layer, but instead a protoplasmic ground substance without any distinction of cells, but with small nuclei and granules scattered through it, giving it a granular appearance. In *Dichelesthium* the chitinogen layer varies greatly in thickness, being reduced to a membrane at and near the joints between the body segments, but increased many times in the center of the segments. Here also the cells are not separated by walls or membranes, but the nuclei are scattered through a common ground substance. There is, however, on the side next to the skin a row of nuclei, slightly larger than the others and placed very close together, which stand out with especial distinctness and have every appearance of a pavement epithelium whose tiny component cells have been completely fused. At the joints the chitinogen layer is made up of this pavement epithelium alone, but elsewhere the ground substance is greatly thickened and gathered into rounded masses of varying size, through which nuclei are scattered indiscriminately (fig. 105). In *Nemesis* the skin itself is very distinctly striated transversely and the matrix beneath it is so thin that in many places it can only be distinguished with difficulty. It is thicker on the ventral than on the dorsal surface and enters the large basal joints of the swimming legs, but even here no nuclei or cell walls can be seen.

Inside the matrix is the connective tissue which surrounds all the organs and holds them in place like a mesentery. It is made up of a delicate network of fibers, which are usually branched where they are attached to the inner surface of the matrix. In among the fibers may be seen here and there small connective tissue cells with a distinct nucleus. This tissue enters the large basal joints of the swimming legs in *Nemesis*, and the modified laminae of the third and fourth legs in *Lernanthropus*, filling the entire cavity, except for the meshes between the fibers of the tissue itself and the portion already filled by the matrix. In the laminate legs of *Lernanthropus* the matrix is so thin that the connective tissue fibers penetrate through

it and are attached to the inside of the skin itself. They thus serve as stays or supports of these legs, rendering them less liable to collapse.

#### INTERNAL MORPHOLOGY.

*General statement.*—Inside the skin are found the muscles for moving the body and its various appendages. The digestive system consists of a mouth, an esophagus, usually inclined forward, a straight intestine, and a short rectum. The nervous system consists of two ganglia, one above and one below the esophagus, a ventral nerve trunk, divided posteriorly, and nerves extending to various parts of the body. The reproductive system is made up of paired ovaries or testes, oviducts, or sperm ducts leading back along the lateral margins, cement glands between the oviducts and the body wall, sperm receptacles in the female and spermatophore receptacles in the male. The excretory system consists of a number of small glands distributed in various parts of the body, the ducts leading from them opening to the surface through the skin.

*Musculature.*—The most important muscle groups are those including the longitudinal muscles of the dorsal and ventral surfaces, the muscles which move the various appendages, and the dorso-ventral muscles. The largest and longest muscles in the body are two connected with the second antennae. Each is attached to the distal end of the basal joint of the antenna and has its origin near the posterior margin of the cephalothorax. At its origin and for a third of its length it is bifid, then the two branches unite into a single large band. Inside of these muscles in the anterior part of the cephalothorax are two much smaller ones curved like parenthesis marks, which are connected with the first antennae. Behind the origin of these curved muscles on either side are small bundles of fibers which have their origin on the dorsal surface and run downward and forward to the base of the mouth tube. Behind these in the posterior center of the cephalothorax are two pairs of narrow longitudinal muscles which run back through the second segment and are attached to its posterior margin. Outside of these in the second segment are two other longitudinal muscles on either side, which run from the first segment through the second into the anterior part of the third segment. From this last point to the middle of the fifth segment there are two pairs of muscles on either side. From the middle of the fifth to the genital segments there are three muscles on either side, and in the posterior part of the genital segment and the abdomen there is only one.

On the ventral surface there is but a single muscle on either side of the midline, which is broken at places corresponding to the breaks in the dorsal muscles.

In connection with the various appendages it may be noted that their musculature varies according to their importance and function. For the first antennae there are only a few weak muscles, except in *Eudactylina*, where the basal joints are prehensile and need strong muscles. The second antennae are supplied with powerful muscles; in addition to the long dorsal ones already mentioned there are smaller ones on the ventral surface of the head and others within the joints; those which flex the claw of the chela are especially well developed. In *Ergasilina*, *Krøyeria*, and *Congericola* the musculature of the second antennae is even better developed than in *Dichelesthium*.

For the mouth tube there is a pair of flexors and a pair of extensors, both originating on the ventral surface of the head. The muscles connected with the mandibles are weak; in *Lernanthropus* Heider considered it more or less doubtful if there was any muscle running to the mandibles. There are none connected with the first maxillae in any of the species examined by the present author and none have been mentioned by any investigator. In connection with the second maxillae in *Dichelesthium* there are three pairs of muscle bands, originating on the dorsal surface and running to the basal joint of the appendages. One of each pair originates outside and the other inside of the long muscle going to the second antennae. In *Krøyeria*, *Nemesis*, and *Donusa* the second maxillae are well developed and demand a good muscle supply.

The maxillipeds in all the genera are powerful prehensile organs but they are exceptionally developed in *Eudactylina*, *Nemesis*, *Lernanthropus*, and *Cybicola*. In the two former they are true chelae and in the two latter the terminal claw is toothed. The basal joint of these appendages in each of these genera is filled with strong flexors and extensors, which control the movements of the terminal claw or chela.

The usual muscles are found in connection with the swimming legs in all the genera, but when the legs are reduced to a single ramus, as in *Dichelesthium*, *Pseudoclavella*, and *Ergasilina*, or to mere papillae bearing setae, as in *Pseudocycnus* and *Cybicola*, or wholly disappear, as in *Hatschekia*, *Caetrodes*, and *Norion*, we find a corresponding reduction or disappearance in the musculature. Those genera like *Lernanthropus*, *Anthosoma*, and *Sagum*, in which the swimming legs have been transformed into laminae, show considerable musculature. In *Lernanthropus gisleri*, for example, the first pair of laminae (third legs) show finely branched muscles whose fibers form a definite network over the entire lamina. In other species also the muscles often run to the very end of the lamina.

In connection with the rectum most genera show the dilator muscles which serve in rectal respiration.

The dorsoventral muscles are chiefly isolated bundles along the sides of the thorax and genital segment, which assist in the passage of the eggs along the oviducts.

*Digestive canal.*—The general form and position of the digestive canal have already been stated. In *Lernanthropus* the esophagus passes inward and backward straight to the ventral surface of the stomach, which it enters close to the anterior end. In *Nemesis* and *Dichelesthium* there is a sharp bend or flexure in the esophagus, the outer three-fifths pointing forward and the inner two-fifths backward, but it enters the ventral surface of the stomach at the same place, close to the anterior end (fig. 71). The digestive tube is widened considerably in the head, then is narrowed through the thorax and is abruptly contracted in the abdomen. The length of the widened or stomach portion varies greatly in different genera. In *Lernanthropus* and *Dichelesthium* the enlarged portion runs through the entire body, remaining about the same diameter, and is abruptly narrowed to the rectum on entering the abdomen. In *Hatschekia*, *Eudactylina*, and *Lamproglena* the widened portion begins to narrow somewhere in the thorax, and from there tapers gradually to the anus. There is no definite place where it can be said that one part ends and another begins. In *Nemesis* the intestine retains its wide diameter through the fourth thorax segment and is then rather abruptly narrowed in the fifth segment, after which it tapers gradually to the anus without any definite rectum. In *Congericola*, *Krøyeria*, and *Cybicola* the stomach narrows into the intestine at the posterior margin of the head, remains narrow through the free thorax segments, and then widens again in the fused posterior body. The walls of the digestive tube contain both longitudinal and transverse muscles, and by their rhythmic contraction and relaxation peristaltic movements run backwards and forwards over the entire canal. By this means the canal contents are pushed back and forth, a portion being thoroughly digested while the rest is excreted.

The epithelium in the esophagus and rectum is thin, and is made up of smaller cells nearly uniform in size. In the enlarged portions the epithelium is considerably thicker, and, especially in the anterior stomach, contains many digestive cells, which are much larger than the rest of the epithelial cells (fig. 68).

*Female reproductive system.*—In the females of some genera like *Hatschekia*, *Lernanthropus*, *Peniculisa*, *Eudactylina*, *Pseudocycnus*, etc., the ovaries are situated in the anterior thorax or the anterior part of the fused posterior body. In other genera like *Nemesis*, *Dichelesthium*, etc., the ovaries are in the posterior part of the head, directly above the stomach. The oviducts lead from the anterior ends of the ovaries outward, downward, and backward, and are convoluted to



the right and left in the space between the digestive tube and the lateral walls of the body.

The ovaries are covered with a thick connective tissue coat, inside of which are the egg glands twisted into many folds and windings. The eggs pass forward in the ovary and gradually increase in size; on entering the oviduct they increase more rapidly and attain their maximum within the first convolution. They are then scattered throughout the rest of the oviduct without any order and are not flattened at all. In this they present a strong contrast to the *Lernaeidae*, whose eggs are arranged in a single row like flattened coins and in a straight oviduct without convolutions.

The cement glands are elongated and cylindrical or club-shaped. In *Lernanthropus* the cement glands are club-shaped and lie above the oviducts on either side of the intestine and close to its dorsal wall. They reach forward to the first convolution of the oviduct in the third thoracic segment. The glandular portion includes practically the whole of the organ but is unsegmented, while the ducts are very short and open into the oviduct close to the vulvae. In *Eudactylina* the glands are similarly situated but extend forward only to the fifth thoracic segment and the club-shaped glandular portion is distinctly segmented (fig. 76). In *Hatschekia*, *Dichelesthium*, and *Pseudocycnus* the cement glands are slender cylinders, ventral to the oviducts and unsegmented (fig. 89).

The semen receptacles vary in size and shape, as well as position. In *Lernanthropus* they are ventral to the intestine, elongate, and club-shaped, and they reach forward nearly as far as the cement glands. In *Dichelesthium* and *Pseudocycnus* they are short and triangular, on the ventral surface of the body cavity, the pointed end anterior, the posterior margin three-lobed. The receptacle opens into the oviduct on either side close to the vulva (fig. 89).

*Male reproductive system.*—The situation of the testes corresponds to that of the ovaries; in some genera they are in the anterior portion of the thorax or of the fused posterior body, and in other genera in the posterior portion of the cephalothorax. Similarly also the sperm ducts are given off from the anterior ends of the testes and pass downward, outward, and backward in more or less intricate convolutions along the sides of the thorax. In *Lernanthropus* they first turn inward and backward along the dorsal surface of the intestine as far as the genital segment, where they almost come together on the midline. They then make a complete turn and run forward again alongside of and close to the first fold to a point opposite the anterior end of the testes. They now turn outward, downward, and backward along the sides of thorax, sending convolutions into the bases of the modified third and fourth legs, and then turn forward to the anterior ends of the spermatophore receptacles (fig. 37).

Posteriorly the walls of the ducts are thickened and serve as glands for the secretion of the cement substance which forms the walls of the spermatophores. In *Dichelesthium*, *Nemesis*, and *Eudactylina* the general course of the ducts is the same, but the first long fold is omitted and there are not as many convolutions.

Inside the spermatophore receptacles the sperms are gathered into the spermatophores, which are afterward attached to the females. These spermatophores are ellipsoidal and in *Lernanthropus* the ends of the discharging tubes, where they are applied to the vulvae of the female, are swollen into large brown spherical receptacles, which remain in place on the vulvae long after the spermatophore itself has disappeared (fig. 104). In *Dichelesthium* the spermatophores are narrower ellipsoids and are attached side by side on the midline of the abdomen close to the genital segment. Their discharge tubes then cross each other and enter the vulva on the opposite side.

*Nervous system.*—The nervous system includes first a supra- and an infra-esophageal ganglion. The former takes more or less the shape of a flattened cone, and from the anterior end nerves are sent to the first and second antennæ and the anterior part of the head. The pair running to the first antennæ originate close together at the center of the anterior end of the ganglion in *Lernanthropus*; they are apparently fused into a single strand for some distance, then separate and enter the base of each antenna. In *Dichelesthium* they originate at the corners of the anterior end and are divergent. Outside of this first pair arises another nerve on either side which goes to the second antenna. The infraesophageal ganglion is considerably elongated and tapers gradually backward into the ventral nerve trunk. From it branches extend to the mouth parts, the swimming legs, and the reproductive organs.

The ventral nerve trunk runs back to the fifth thoracic segment and there divides, the two branches separating a little and continuing through the fifth and genital segments. From the ventral trunk branches are given off to the various muscles of the thorax, and from the two posterior branches of the trunk itself are supplied the nerves leading to the muscles controlling the vulvae and semen receptacle in the female, and the spermatophore receptacles and ejaculatory ducts in the male. They also control the dilator muscles of the rectum during respiration (see fig. 71).

*Vascular system.*—Since only a single genus, *Lernanthropus*, possesses anything in the way of a vascular system, the description of it is reserved for that genus alone. In other genera circulation is accomplished by means of the peristaltic movements of the digestive canal together with those concerned in rectal breathing. In most genera, however, there is very little movement of the fluid contents of the body cavity.

## ONTOGENY.

Nothing is known of the development of any genus beyond the nauplius stage. Such nauplii as have been obtained will be described under the various species to which they belong.

## SYSTEMATIC DESCRIPTIONS.

## Family DICHELESTHIIDAE.

*Anthosomadae* BAIRD, British Entomostraca, 1850, p. 296.

*Caligidae, Race I* LEACH, Dictionnaire des Sciences Naturelles, vol. 14, 1819, p. 524.

*Caligidae, Race I* DESMAREST, Des Crustacés, 1825, p. 334.

*Ergasilina, Division B* BURMEISTER, Acta Acad. Caes. Leop. Carol. Nat. Cur., vol. 17, 1833, p. 328.

*Ergasilina, Division B* KRØYER, Naturhistorisk Tidsskrift, vol. 1, 1837, p. 198.

*Dichelestidae* MILNE EDWARDS, Histoire Naturelle des Crustacés, 1840, p. 481.

*Lernaeiformidae* NORDMANN, Mikrographische Beiträge, pt. 2, 1832, p. 55.

*Dichelestini* NORDMANN, Bulletin Soc. Imp. des Nat., Moscou, vol. 37, 1864, p. 474.

*Dichelestina* HELLER, Reise der *Novara*, 1865, p. 212.

*Dichelesthiina* GERSTAECKER, Bronn's Klassen und Ordnungen, vol. 5, 1871, p. 724.

*Dichelesthiidae* M. J. RATHBUN, Fauna of New England, 1905, p. 97.

*Dichelesthiidae* BRIAN, Copepodi Parassiti dei Pesci d'Italia, 1906, p. 62.

*Dichelestiidae* CALMAN, Lankester's Zoology, pt. 7, fas. 3, 1909, p. 103.

*Dichelestiidae* T. and A. SCOTT, British Copepoda, 1912, p. 105.

*Family characters of female.*—General body form long and narrow; head fused with first thorax segment and the two covered with a carapace; free thorax segments usually simple, but sometimes furnished with wings or dorsal plates or both; abdomen small and unsegmented; egg strings long and filose; eggs uniseriate, sometimes strongly flattened, sometimes swollen into separate spheres.

Two pairs of antennae, first pair slender and setose, second pair stout and uncinatate; mouth parts similar to those of the *Caligidae*; one pair of mandibles, two pairs of maxillae, one pair of maxillipeds; usually four pairs of swimming legs, third and fourth pairs sometimes transformed into lamelliform plates, or rudimentary, or even lacking.

*Family characters of male.*—Smaller than the female, but not a pygmy; head and first thorax segment fused and covered with a carapace; remaining thorax segments fused and sometimes covered with a dorsal plate, but never furnished with wings; abdomen minute and unsegmented.

Antennae and mouth parts similar to those of the female; swimming legs also similar, with sometimes a fifth pair on the genital segment.

This family is chiefly parasitic upon salt-water fish, but a few species, like the one for which the family is named, are found upon fish that enter fresh water.

KEY TO SUBFAMILIES AND GENERA.

1. One or more body regions furnished with plates or wings, or both.
  1. No plates or wings on any body region..... 5
  2. All the swimming legs replaced by lamellar plates..... 3
  2. The two anterior pairs of legs of the usual biramose form, the posterior pairs sometimes modified..... 4
  3. Cephalothorax with a divided carapace; swimming legs represented by three pairs of large wings..... *Anthosoma* Leach, 1816, p. 23
  3. Free thorax and abdomen covered with separate dorsal plates; swimming legs fused into a single plate..... *Norion* Nordmann, 1864, p. 26
  4. Cephalothorax with large carapace extending over the free segments; only two pairs of legs, first and second, with filiform, two-jointed rami.
    - ..... *Caetrodes* Wilson, 1906, p. 27
  4. Carapace produced into lateral wings; posterior body covered with a single dorsal plate, with large lateral lobes; third and fourth legs transformed into laminae..... *Sagum* Wilson, 1913, p. 28
  4. Lateral margins of carapace curled over ventrally; dorsal plate of posterior body without lobes; third and fourth legs with elongate, fleshy rami.
    - ..... *Lernanthropus* Blainville, 1822, p. 30
5. All four pairs of swimming legs present and equally developed.
  - ..... EUDACTYLINAE. 6
  5. All four pairs of swimming legs present, but one or more of them modified or rudimentary..... PSEUDOCYCNINAE. 12
  5. One or more pairs of swimming legs lacking; those present usually modified or rudimentary..... DICHELESTHIINAE. 13
  6. Second antennae armed with a stout chela, cheliform..... 7
  6. Second antennae armed with a simple claw, uncinata..... 8
  6. Second antennae armed with setae only, setiferous..... 11
  7. Genital segment produced into a wide and flattened posterior process on either side of the abdomen..... *Peniculisa* Wilson, 1917, p. 53
  7. No posterior processes, but the genital segment and abdomen much elongated and narrow..... *Krøyeria* Beneden, 1853, p. 54
  8. Legs all uniramous; claw on second antennae large but simple and not a chela.
    - ..... *Ergasilina* Beneden, 1851, p. 56
  8. Legs all biramous; claw on second antennae much smaller..... 9
  9. Two anterior free thorax segments short and narrow, posterior ones elongate and widened; exopods of swimming legs three-jointed, endopods one-jointed..... *Congericola* Beneden, 1854, p. 57
  9. Free thorax segments all the same length and width; exopods and endopods of swimming legs with the same number of joints..... 10
  10. Rami two-jointed in the female; maxilliped with simple claw.
    - ..... *Nemesis* Risso, 1826, p. 58
  10. Rami three-jointed in the female; maxilliped with a large and stout chela.
    - ..... *Eudactylina* Beneden, 1853, p. 65
  11. Abdomen as long as rest of body; rami of swimming legs one-jointed; anterior thorax segments shorter and narrower than posterior ones.
    - ..... *Lamproglena* Nordmann, 1832, p. 71

11. Abdomen very short; rami of swimming legs three-jointed; anterior thorax segments longer and wider than posterior ones.

*Donusa* Nordmann, 1864, p. 72

12. First three pairs of legs mere stumps; fourth pair with two short unsegmented rami.....*Bassettithia*, new genus name, p. 72

12. First two pairs of legs biramose, rami two-jointed; last two pairs mere stumps without rami.....*Pseudoclavella* Basset-Smith, 1898, p. 73

12. First and third pairs of legs uniramous, unsegmented; second pair biramose, rami unsegmented; fourth pair mere stumps without rami.

*Pseudocycnus* Heller, 1865, p. 74

13. First two pairs of legs biramose, rami two-jointed; third and fourth pairs wanting or reduced to setae; second antennae uncinatae.

*Hatschekia* Poche, 1902, p. 81

13. First two pairs of legs biramose, rami one-jointed; third pair lamellar; fourth pair lacking; second antennae chelate.

*Dichelesthium* Hermann, 1804, p. 85

13. First legs biramose, rami one-jointed; second pair uniramous; third pair mere stumps without rami; fourth pair lacking; second antennae large but not chelate.....*Cybicola* Basset-Smith, 1898, p. 88

13. First legs biramose, rami two-jointed; second and third pairs uniramous, rami one-jointed; fourth pair lacking; second antennae with setae only, no chela or claw.....*Ventriculina* Basset-Smith, 1903, p. 89

*Rejected genera.*—In 1837 Krøyer published<sup>5</sup> the description of a new species of parasitic copepod, which he named *Aethon quadratus*. It was founded on a single specimen taken from the gills of a West Indian *Serranus*. For discussion of this genus see p. 30.

In 1860<sup>6</sup> Lubbock described and figured a new species which he called *Baculus elongatus*. He said that it resembled the Caligidae more than the Dichelesthidae, to which its long antennae would ally it. It has since been proved to be a stage in the development of *Penella*, and hence becomes a Lernaean.

The genus *Clavella* is rightly a Lernaepod, as was explained<sup>7</sup> but it has been used by many authors to designate species belonging to the present family. To obviate the difficulty of having the same genus in two different families Poche suggested the name *Hatschekia* for such species as belong to the Dichelesthidae, and for these species the name *Clavella* becomes a synonym.

A genus called *Cycnus* was established by Milne Edwards<sup>8</sup> to include a single species, but the name had already been used by Hubner for a genus of Lepidoptera in 1816 and hence cannot be retained for the copepod genus. In 1854 P. J. van Beneden described a genus and species which he claimed as new and to which he gave the name *Congericola pallida*.<sup>9</sup> This has proved to be the same generically as Milne Edwards's specimens, but differs from them specifically. Ac-

<sup>5</sup> Naturhistorisk Tidsskrift, vol. 1, p. 257, pl. 2, fig. 9; pl. 3, fig. 1 a-c.

<sup>6</sup> Trans. Linnaean Soc., vol. 23, 1860, p. 190, pl. 29, figs. 40 and 42.

<sup>7</sup> Proc. U. S. Nat. Mus., vol. 47, 1915, p. 666.

<sup>8</sup> Histoire Naturelle des Crustacés, vol. 3, 1840, p. 495.

<sup>9</sup> Bulletin Acad. de Belgique, vol. 21, pt. 2, p. 583.

cordingly Beneden's genus name must be substituted for that of Milne Edwards, and the type of the genus becomes *Congericola pallida* Beneden.

Nordmann in 1832 described<sup>10</sup> a genus and species called *Epachthes paradoxus*. The next year Burmeister<sup>11</sup> showed that Normann's genus was a synonym of *Lernanthropus*.

In January, 1898, Bassett-Smith proposed a new genus to be known as *Helleria*, with the type species *armata*.<sup>12</sup> This name had already been used three times for crustacean genera which were not copepods. This fact being called to his attention, Bassett-Smith in November of the same year changed the name to *Cybicola*.<sup>13</sup>

Gerstaecker published<sup>14</sup> a new genus of Siphonostoma called *Lonchidium*, with the single type species *aculeatum*. This proved to be generically the same as Beneden's *Krøyeria*, which had appeared in the preceding year. This fact was recognized by Nordmann in 1864,<sup>15</sup> but it was misinterpreted by Bassett-Smith,<sup>16</sup> who reversed the precedence and made *Krøyeria* a synonym of *Lonchidium*.

Risso in 1816 published a *Histoire Naturelle des Crustacès des Environs de Nice*, in which he described (p. 162) a new species of the genus *Caligus*, *C. imbricatus*. Leach later in the same year established in the Supplement to the *Encyclopedia Britannica* (vol. 1, p. 406) a new genus of Entomostraca, which he called *Anthosoma smithii*. Both Risso's specimens, which were examined by Leach, and those of Leach himself were subsequently shown to be the same as had been described by Abildgaard in 1794 as "*Caligus crassus*."<sup>17</sup> Leach's generic distinction, however, was valid, and hence the species became *Anthosoma crassum* (Abildgaard); but in spite of this Risso again described his species as new in *Histoire Naturelle des principales de l'Europe meridionale* (vol. 5, 1826, p. 136), this time under the name *Otrophesia imbricata*, which, of course, becomes a synonym of *Anthosoma crassum*.

P. J. van Beneden established a new species and genus of parasitic copepod,<sup>18</sup> which he named *Pagodina robusta*. This is shown on page 60 to be identical with the genus *Nemesis* and becomes a synonym of the latter.

For Nordmann's proposed new genus, *Stalagmus*, see page 36.

<sup>10</sup> Mikrographische Beiträge, vol. 2, p. 45.

<sup>11</sup> Acta Acad. Caes. Leop. Carol. Nat. Cur., vol. 17, p. 307.

<sup>12</sup> Ann. Mag. Nat. Hist., ser. 7, vol. 1, p. 10.

<sup>13</sup> Idem, vol. 2, p. 371.

<sup>14</sup> Archiv für Naturgeschichte, vol. 20, 1854, p. 185.

<sup>15</sup> Bull. des Nat. Moscou, vol. 37, p. 468.

<sup>16</sup> Proc. Zool. Soc. London, 1899, p. 473.

<sup>17</sup> Skrivter af naturhistorie Selskabet, Kjøbenhavn, vol. 3, pt. 2, p. 46.

<sup>18</sup> Bull. Acad. Roy. Belgique, vol. 20, 1853, p. 482.

## Genus ANTHOSOMA Leach.

*Caligus* (part) ABILDGAARD, 1794. See under *Anthosoma crassum*.

*Generic characters of female*.—General body form short and rather stout. Cephalothorax covered with an ovid carapace more than half the entire length of the body. Genital segment and abdomen entirely covered dorsally by two large elytra, which overlap considerably along the midline; also, entirely concealed ventrally by three pairs of overlapping foliaceous swimming legs. Abdomen small and one-jointed. Egg strings narrow and three times the body length. First antennae slender, six-jointed; second antennae stout, jointed, terminating in a strong claw; maxillipeds short and very strong, with a powerful terminal claw.

*Generic characters of male*.—General body form and appendages very similar to those of the female, but the genital segment and abdomen have no dorsal elytra and so are visible in dorsal view. The first two pairs of foliaceous swimming legs have one-jointed rami in the notches on the inner margins.

*Type of the genus*.—*Anthosoma crassum* (Abildgaard), monotypic.

*Remarks*.—This genus has but the single species and it is easily recognized by the dorsal elytra and the foliaceous swimming legs, since they are quite different from anything found in other genera. In spite of the fact that the genus is so old and so well known there are still some details of structure which have never been presented.

## ANTHOSOMA CRASSUM (Abildgaard).

Plate 1, figs. 1-8.

*Caligus crassus* ABILDGAARD, Skriver af naturhistorie Selskabet, Kjøbenhavn, vol. 3, 1794, p. 46, pl. 5, figs. 1-3.

*Caligus imbricatus* RISSO, Histoire naturelle des Crustacés des environs de Nice, 1816, p. 162, pl. 3, fig. 13.

*Anthosoma smithii* LEACH, Supplement to 4th, 5th, and 6th ed. Encyclopedia Britannica, vol. 1, 1816, p. 406, pl. 20, figs. 1-6.

*Otrophesia imbricata* RISSO, Histoire naturelle des principales de l'Europe méridionale, vol. 5, 1826, p. 136.

*Anthosoma crassum* GOULD, A Report on the Invertebrata of Massachusetts, 1841, p. 340.

*Anthosoma crassum* STEENSTRUP and LÜTKEN, Kongel. Danske Vidensk. Selsk. Skrifter, ser. 5, vol. 5, 1861, p. 397, pl. 12, fig. 24.

*Anthosoma crassum* T. and A. SCOTT, British Parasitic Copepoda, 1913, p. 108, pl. 23, figs. 5-6.

*Host and record of specimens*.—A single female from the gills of the sand shark, *Carcharias littoralis*, at Woods Hole has received Cat. No. 6039, U.S.N.M. Another female from the gills of the porbeagle shark, *Lamna cornubica*, probably from Woods Hole, bears Cat. No. 8108 U.S.N.M. A finely preserved male from the mouth of

a sand shark, *Carcharias littoralis*, at Woods Hole was taken by Dr. Edwin Linton and has been given Cat. No. 53570, U.S.N.M. Two females and a male from the mouth of a mackerel shark, *Isurus oxyrinchus*, were taken June 17, 1888, by Vinal Edwards at Woods Hole and have been given Cat. No. 53571, U.S.N.M.

*Specific characters of female.*—In addition to what has just been given under the generic characters we may note the following: The carapace covering the cephalothorax is yellowish brown, deeper in color through the center and paling towards the margins. The antennal area is separated from the rest of the head by well-defined marginal invaginations and by a somewhat indistinct dorsal groove. In the larger and more mature females there is usually an invagination at the center of the posterior margin of the carapace, sometimes extending quite a distance as a triangular slit. In younger females and sometimes in older ones the margin is entire. The carapace projects backward over the free thorax and overlaps the genital segment. On the dorsal surface of the fourth segment is a pair of large elytra which entirely cover the posterior part of the body and overlap along the median line. These are white in color like the membraneous legs and are similarly covered with minute transparent dots or depressions.

The genital segment is oblong with nearly parallel margins, the proportion of the length to the width being as 4 to 3. The egg strings are attached to its posterior margin, considerably below the dorsal surface, side by side on the median line.

The abdomen is attached to the ventral surface of the genital segment below and in front of the bases of the egg strings. It is made up of a single small joint. The anal laminae are thick and fleshy, much longer than the abdomen itself, and they taper to a blunt point. They are entirely destitute of setae and spines.

The first antennae are rather long, seven-jointed, thickest through the tip of the third joint, and thence tapering gradually. Below and behind the basal joint of each antenna, and filling the marginal notch in the carapace, is a thick triangular process or palp. When the antenna is folded back against the carapace this process is nearly concealed, but it stands out prominently if the antenna be turned forward at right angles to the body axis. The joints of these antennae are only sparingly supplied with setae. The second antennae are transformed into strong attachment organs. They are three-jointed, the basal joint much swollen, the second joint narrowed distally and armed on the ventral surface with a stout peg so placed as to interlock with the tip of the terminal claw. The latter is short and is bent into a half circle.

The upper and under lips are fused and produced into a long, stout and bluntly rounded mouth tube. At its base on either side are



the first maxillae, which are slender, conical, about three-fourths as long as the mouth tube, each tipped with two long setae. The palp is short, conical, and tipped with two spines of unequal length.

The second maxillae are peculiar; the two basal joints are much swollen and rather short; the third joint is abruptly narrowed to half the width of the second, but is much longer. It is enlarged and almost squarely truncated at the distal end, produced into a conical process on the outer margin, and surrounded with a fringe of short spines. The fourth joint is hemispherical and is attached to the inner margin of the tip of the third joint. The flat side is turned outward and is surrounded with a fringe of short spines.

The maxillipeds are large, very stout, and furnished with a powerful terminal claw. There are three pairs of swimming legs, each transformed into a broad and thin lamella, covered with numerous minute transparent dots. Each leg of the two anterior pairs is notched on the inner margin, but does not show any rami; the margin of the third legs is entire.

*Color.*—Carapace dark brown at the center, paler and yellowish toward the edges; dorsal elytra and foliaceous legs gray-white, covered with minute transparent spots; free thorax, genital segment, and abdomen dark yellowish brown.

Total length, 10–15 mm.; carapace, 9.50 mm. long, 7 mm. wide; combined diameter of foliaceous legs, 10–11 mm.; egg strings, 40–50 mm. long.

*Specific characters of male.*—While the male resembles the female in size and general appearance, it also differs in several important particulars. The carapace is relatively longer and narrower and is similarly notched at the center of the posterior margin. The antennal area is only half as long as wide. There are no dorsal elytra on the fourth segment, so that the entire body behind the carapace is visible in dorsal view, but is covered ventrally as in the female by the foliaceous legs.

Each leg of the first two pairs is notched on the inner margin and carries in the notch a pair of distinct, though rudimentary, one-jointed rami. The appendages are practically the same as those of the female, the second antennae and maxillipeds being a little larger.

Color the same as that of the female, but appearing darker because of the absence of the dorsal elytra.

Total length, 8–10 mm. Carapace, 6 mm. long, 4.15 mm. wide. Combined diameter of foliaceous legs, 4 mm.

*Remarks.*—This shark parasite is very widely distributed and has been found upon several other kinds of sharks besides those here mentioned. It never occurs in any numbers on a host, but is more often solitary, although occasionally the two sexes are associated upon the same fish. Its favorite location is in the throat of the shark,

attached to one of the gill arches. In addition to the fact already noted that the imbricated foliaceous laminae enclosing the posterior body of the female and covering the sides and ventral surface of the male are found in no other copepod; the color of these laminae is also peculiar. The grayish-white background is thickly sprinkled with minute circular dots and irregular lines, which, being transparent, appear darker in color.

The species has been described and figured many times, but the female has thus far succeeded in absorbing all the attention and no figure of the male has appeared. The foliaceous legs of the male are of peculiar interest by reason of the presence of rudimentary rami upon the first two pairs, which do not appear in the female (figs. 7 and 8).

#### Genus NORION Nordmann.

*Norion* NORDMANN, Bull. Soc. Imp. des Nat. Moscou, vol. 37, 1864, p. 488.

*Norion* BASSETT-SMITH, Proc. Zool. Soc. London, 1899, p. 469.

*Generic characters of female.*—General body form an ellipsoid, flattened dorsoventrally, both surfaces covered with subconvex shields. Head fused with the first thorax segment and the two distinctly separated from the rest of the body by a short neck; the remaining thorax segments fused inter se; no abdomen. Dorsal carapace divided into anterior and posterior portions by deep lateral incisions, the anterior part projecting forward as a narrow, pointed wing on either side of the cephalothorax, the posterior part evenly rounded. Ventral carapace divided into right and left halves, anteriorly by the cephalothorax, posteriorly by a deep median incision, each half with a median longitudinal keel.

First antennae filiform, six-jointed; second antennae with a swollen basal joint and a powerful, curved terminal claw; first maxillae two-jointed, apparently setiferous; second maxillae and maxillipeds also two-jointed but uncinat. A pair of rudimentary first legs at the posterior margin of the cephalothorax, mere curved pads without rami.

*Type of the genus.*—*Norion expansus*, monotypic.

*Remarks.*—This genus was established by Nordmann upon a single female specimen taken from the inside of the gill cover of an unknown fish at Honolulu. He located the genus in the family Chondracanthidae near the genus *Tucca*. No investigator besides Nordmann has ever seen this genus, and none except Bassett-Smith has ever mentioned it. He recognized that it was not a Chondracanthid, and placed it in the present family, but he still retained Nordmann's idea that it was closely related to *Tucca*, and so he transferred that genus to the Dichelesthiidae along with *Norion*. The two genera, however, have nothing in common; in volume 39 of these proceedings

(p. 352) *Tucca* was shown to be an Ergasilid, and *Norion* is just as certainly a Dichelesthid.

Nordmann did not find any traces of the swimming legs, but the curved pads on the posterior margin of the cephalothorax are quite manifestly the rudiments of the first pair of legs, and it is also possible, as Basset-Smith has suggested, that the divided ventral plate may represent the remaining legs, but he was certainly wrong when he stated that the anterior wing-like expansions belonged to the ventral plate and that there were no dorsal plates.

A revised diagnosis is here presented in order to call attention again to this remarkable parasite and to offer certain corrections and suggestions in reference to its morphology.

The genus seems valid and corresponds well with *Anthosoma*, *Caetrodes*, and *Sagum*. Accordingly we may accept it as far as it has been described and await further information before finally deciding upon its validity.

#### Genus CAETRODES Wilson.

*Caetrodes* WILSON, Report on the Pearl Oyster Fisheries of the Gulf of Manaar, by W. A. Herdman, Supplementary Report No. 34, pt. 5, p. 203.

*Generic characters of female*.—Body regions distinct. Head covered with a dorsal carapace, which is obovate in shape, strongly arched and considerably widened anteriorly, narrowed and flattened posteriorly, where it projects back over the thorax segments but is not attached to them. Frontal margin turned under the carapace, carrying the base of the anterior antennae onto the ventral surface. Five free thorax segments, indistinctly separated and diminishing in width backwards, the fifth one sending back a wide lobe on either side of the genital segment. The latter small, transversely oblong and inclosed on three sides by the fifth segment. Abdomen small, hemispherical, one-jointed; anal laminae longer than the abdomen, narrow, and terminating in a spine and a claw.

First antennae five-jointed, slender, sparsely setose; second pair stout, ending in a prehensile claw. First and second maxillae rudimentary, uniramous, two-jointed, attached close beside the mouth tube and about the same size. Maxillipeds slender, two-jointed. Two pairs of biramous swimming legs close together at the anterior end of the thorax; rami linear, two-jointed. Egg tubes longer than the body, eggs large, not much flattened. Male unknown.

*Type of the genus*.—*Caetrodes pholas*, monotypic.

*Remarks*.—This genus is at once distinguished by the claws on the tips of the anal laminae, which assist the parasite in maintaining its peculiar hold upon its host. So far as known no other copepod is thus armed.

Genus *SAGUM* Wilson.

*Sagum* WILSON, Proc. U. S. Nat. Mus., vol. 44, 1913, p. 234.

*Lernanthropus* (part) KRØYER, Naturhistorisk Tidsskrift, ser. 3, vol. 2, 1863, p. 196.

*Generic characters of female.*—General body form similar to that of *Lernanthropus*, but somewhat shorter and stouter. Cephalothorax angular; antennal area separated from the rest of the head by deep marginal sinuses; lateral margins produced into an angular wing on either side; posterior body covered with a dorsal plate which is prolonged at the posterior corners of the third thorax segment into lobes, and which is more or less fused along the median line with the dorsal plate of the fourth segment. Antennae and mouth parts similar to those of *Lernanthropus*; first and second swimming legs much reduced, with one-jointed rami; third legs flattened into laminae which cover the ventral surface and reach back to the posterior margin of the body; fourth legs also flattened into laminae reaching the posterior margin, the tips of the rami ending in long flagella. Fifth and genital segments and abdomen reduced and concealed. Egg strings coiled into the space between the dorsal plate and the third and fourth legs and thus entirely concealed.

*Generic characters of male.*—Body divided into two sections, cephalothorax and posterior body, each covered with a dorsal plate, the two about the same size. Antennal area separated as in the female. First antennae seven-jointed and prominent; second antennae and mouth parts like those of the female. First and second swimming legs rudimentary; third pair with a single ramus in the form of a long cylindrical flagellum; fourth legs like those of the female, each ramus consisting of a basal lamina and a terminal flagellum, the exopod with an accessory flagellum. Genital segment and abdomen not covered, but visible in dorsal view.

*Type of the genus.*—*Sagum flagellatum* Wilson, monotypic.

## KEY TO THE SPECIES.

- Posterior processes at the corners of the third segment broad and extending diagonally outward away from the following segments, reaching the posterior margin of the dorsal plate..... *flagellatum* Wilson, 1913.  
 Posterior processes narrow and pointed, and closely appressed to the sides of the following segments, reaching only halfway to the posterior margin of the dorsal plate..... *angulatum* (Krøyer), 1863, p. 28.

*SAGUM ANGULATUM* (Krøyer).

*Lernanthropus angulatus* KRØYER, Naturhistorisk Tidsskrift, ser. 3, vol. 2, 1863, p. 196, pl. 9, fig. 1 a-q.

*Specific characters of female.*—General form short and stout; cephalothorax one-fourth of the entire length, its length and width in the proportion of 5 to 7, with an invagination on either side ante-

riorly, and a pointed angle at the center where the lateral margin is drawn backward. The anterior margin projects between the invaginations as a rounded rostrum, less than one-seventh of the length of the cephalothorax. Free thorax segments fused and covered with a single dorsal plate, which on the midline is the same length as the head. This plate does not project at the anterior corners, but is prolonged at the posterior corners into pointed processes, as long as the plate itself and closely appressed to the sides of the posterior body. This latter is covered with a dorsal plate as wide as long, which is somewhat invaginated at the center of the posterior margin. The fifth and genital segments and abdomen are entirely concealed between the third and fourth legs and this dorsal plate.

The egg strings are long and are coiled in this same space between the legs and the dorsal plate, and thus out of sight.

First antennae six-jointed, the first joint the largest, the last one the smallest, all well armed with setae. Second antennae with a stout and strongly curved basal joint and a short but strong terminal claw. First maxillae simple, three-jointed and tipped with a small seta; second maxillae and maxillipeds with stout basal joints and small terminal claws.

First swimming legs consisting of a short, rounded process tipped with three protuberances, the outer one lance-shaped, the middle one circular, the inner one ovate, tipped with a stout seta; second legs similar. Third legs biramose, the rami flattened into laminae, the outer ramus longer than the inner, the fold between the two projecting from ventral surface. Fourth legs each made up of two stout, broadly oval, slightly curved laminae, the outer one the larger, each ending in a flagellum. Abdomen smaller than the genital segment, much wider than long; anal laminae twice the length of the abdomen, regularly tapered, five-jointed, first joint much the largest.

*Specific characters of male.*—To the generic characters already noted we may add the following: General form an elongated oval, the cephalo-thorax a little wider than the posterior body. Antennal area projecting as in the female. First antennae twice the size of those in the female. Second antennae joined at the base across the midline by a chitin knob. Second maxillae and maxillipeds relatively larger than in the female, but otherwise the same. First and second swimming legs proportionally larger, but made up similarly of a basal process and three protuberances; third and fourth legs as already given.

Total length of female, 4.50 mm.; greatest width, 1.80 mm. Total length of male, 1.35 mm.; greatest width, 0.54 mm.

*Remarks.*—This species was originally described by Krøyer from several specimens, including both sexes, obtained from the gills of an undetermined species of West Indian *Serranus*. All other ac-

counts are copies of Krøyer's original and no one else has seen the species. The description given above is taken partly from Krøyer's text and partly from his figures, with such changes in his nomenclature as would make his statements intelligible. If this description be compared with that of *Sagum flagellatum*, given by the present author in volume 44 of these Proceedings (p. 235), it will be clearly seen that Krøyer's species belongs to the present genus and not to *Lernanthropus* where he placed it.

Heller, in his *Reise der Novara*, 1865, in a footnote on page 213 relative to the genus *Lernanthropus*, said:

Krøyer's genus *Aethon* is closely related to *Lernanthropus*, if not identical with it. Although Krøyer does not mention it in his latest work on the parasitic copepods, it is very evident to me that the new species, *Lernanthropus angulatus*, there described and figured by him, is identical with his *Aethon quadratus*, previously described. And this is the more likely because both were found upon a West Indian *Serranus* species.

A comparison of these two species described by Krøyer makes Heller's suggestion seem extremely improbable, and for the following reasons: In *Aethon* the cephalothorax is three-fourths as wide as the posterior body, from which it is separated by a distinct neck; the dorsal plate covering the posterior body is as wide as the free thorax; the first antennae are small and insignificant; the third swimming legs are close together on the median line, are only one-eighth the length of the posterior body, and are folded like those of *Lernanthropus*, projecting obliquely from the ventral surface.

In the present species, which is the second one described by Krøyer, the cephalothorax is as wide as the posterior body; there is no neck; the dorsal plate covering the posterior body is as wide as the free thorax; the first antennae are large and prominent; the third legs are flattened into laminae, which are as long as the posterior body, and cover its entire ventral surface. Krøyer said nothing about the fourth legs in *Aethon*, and presumably they did not possess the peculiar flagella which he noted in the present species. Such differences preclude Heller's suggestion of the identity of the two species. The genus *Aethon* probably becomes a synonym of *Lernanthropus*, but retains its own specific name, and hence becomes *Lernanthropus quadratus*.

#### Genus LERNANTHROPUS Blainville.

*Lernanthropus* BLAINVILLE, Journ. de Physique, de Chimie, d'Hist. Nat., vol. 95, 1822, p. 444.

*Epachthes* NORDMANN, Mikroskopische Beiträge, 1832, pt. 2, p. 45.

*Lernanthropus* BURMEISTER, Act. Acad. Caes. Leop. Carol. Nat. Cur., vol. 17, 1833, p. 303.

*Aethon* KRØYER, Naturhistorisk Tidsskrift, ser. 1, vol. 1, p. 257, pl. 2, fig. 9, 1837.

*Lernanthropus* STEENSTRUP and LÜTKEN, Kong. Danske Videns. Selsk. Skrifter, ser. 5, vol. 5, 1861, p. 395.

*Lernanthropus* KRØYER, Naturhistorisk Tidsskrift, ser. 3, vol. 2, 1863, p. 193.

*Lernanthropus* NORDMANN, Bull. Soc. Imp. des Nat. Moscou, vol. 37, 1864, p. 499.

*Stalagmus* NORDMANN, Bull. Soc. Imp. des Nat. Moscou, vol. 1864, p. 510.

*Lernanthropus* HELLER, Reise der *Novara*, 1865, p. 221.

*Lernanthropus* HEIDER, Arbeit. Zoolog. Inst. Wien, vol. 2, pt. 3, 1879, p. 269.

*Lernanthropus* GOGGIO, Atti Soc. Toscani Sci. Nat. Pisa, vol. 22, 1906, p. 134.

*Lernanthropus* BRIAN, Copepodi parassiti dei Pesci d'Italia, 1906, p. 63.

*Lernanthropus* T. and A. SCOTT, British Parasitic Copepoda, 1912, p. 110.

*External generic characters of female.*—Head fused with first thorax segment, the resulting cephalothorax oblong or pyriform, with a dorsal carapace whose lateral margins are curved over ventrally. Free thorax segments fused and covered with a dorsal plate, which is prolonged backwards over the genital segment and abdomen. The latter small and one-jointed. First antennae filiform, the joints more or less fused. Second antennae prehensile, unciniate. Mandibles stylet-shaped, toothed on the inner margin. First maxillae palp like; second maxillae and maxillipeds prehensile, unciniate. First two pairs of swimming legs rudimentary, biramose, the rami one-jointed; rami of third and fourth pairs transformed into broad lamellae. Each lamella of the third pair represents a fused exopod and endopod, projects at right angles or diagonally from the ventral surface and is folded along its midline, so that its cross-section is in the form of a half circle. There are usually four lamellae in the fourth legs, and they extend backward. Egg strings elongate, eggs uniseriate and strongly flattened.

*External generic characters of male.*—Cephalothorax separated from the free thorax and covered with a carapace whose lateral margins are flat. Free thorax fused with the genital segment and without a dorsal plate. Abdomen one-jointed and wholly visible in dorsal view. Second antennae prehensile and relatively larger than in the female. Third and fourth swimming legs, with the rami transformed into thread-like filaments.

*Internal generic characters.*—The usual digestive canal running straight through the entire body. Sex organs paired, the ovaries lying over the digestive canal in the second thorax segment, the testes similarly placed in the posterior part of the cephalothorax; sex ducts much convoluted. Cement glands club shaped, extending along the lateral margins of the dorsal surface and reaching forward to the posterior end of the ovaries. Semen receptacle also club shaped under the intestine at the posterior end of the genital seg-

ment. Spermatophore receptacle large and near the posterior end of the genital segment.

The distinguishing character of the genus is a closed vascular system made up of two ventral longitudinal trunks running under and close to the intestine, one on either side, and a single dorsal trunk over the intestine and between the paired sex organs. From these central trunks branches lead to the various appendages and there is also a network of capillaries over the dorsal surface and in the laminate swimming legs. No part of the system has any connection with the lumen of the body cavity. The trunks and capillaries are filled with a yellowish-red liquid, which streams back and forth under the influence of the peristaltic movements of the digestive canal, and aided by the contraction of the muscles of the various appendages and body regions. This liquid contains neither blood corpuscles nor any other definite constituents, and hence can not be called true blood, but it probably serves as an oxygen carrier between the body regions and into the appendages.

*Type of the genus.*—*Lernathropus musca* Blainville, 1822, monotypic.

KEY TO THE SPECIES.

(The number preceding the species name represents the total length of that sex and species.)

1. A dorsal plate covering the free thorax and genital segment, but leaving the abdomen visible in dorsal view-----12
1. A dorsal plate covering the entire body, leaving nothing visible except the rami of the third and fourth legs-----2
1. No dorsal plate, the free thorax, the genital segment and the abdomen entirely visible in dorsal view-----30
2. Third legs folded in the usual manner and projecting at right angles or obliquely to the ventral surface-----3
2. Third legs flattened into broad laminae parallel with the ventral surface and covering nearly the whole of it-----24
2. Third legs narrow laminae, uniramose or divided and lying flat on the ventral surface, but covering only a little of it-----27
3. Dorsal plate all one piece, with no transverse groove or marginal sinuses-----4
3. Dorsal plate divided into an anterior and posterior portion by a transverse groove or by marginal sinuses-----8
4. Males, dorsal plate no wider than the cephalothorax; third and fourth legs projecting well beyond its margin-----5
4. Females, dorsal plate but little wider than the cephalothorax, and about the same diameter throughout-----6
4. Females, dorsal plate widened posteriorly to twice the diameter of the cephalothorax-----7
5. Cephalothorax longer than dorsal plate; latter obovate, much narrowed posteriorly-----1 mm., male, *larvatus* Heller, 1865
5. Dorsal plate much longer than cephalothorax, not narrowed, but squarely truncated posteriorly-----1.50 mm., male, *lativentris* Heller, 1865
5. Cephalothorax and dorsal plate about the same length, the latter broadly rounded posteriorly-----1.50 mm., male, *holmbergii* Nordmann, 1864



6. Fourth legs projecting but little beyond the dorsal plate; rami slender and cylindrical.....3 mm., female, *vorax* Richiardi, 1880
6. Fourth legs projecting their entire length; rami flattened into lanceolate laminae.....4.50 mm., female, *mugilis* Brian, 1898
6. Fourth legs projecting their entire length; rami slender, cylindrical; dorsal plate divided by a deep longitudinal incision like the wings of a fly,  
8 mm., female, *musca* Blainville, 1822
7. Posterior margin of dorsal plate smoothly rounded; fourth legs not reaching this margin.....female, *polynemi* Richiardi, 1881
7. Posterior margin of dorsal plate smoothly rounded; fourth legs project well beyond this margin.....2.25 mm., female, *belones* Krøyer, 1863
7. Posterior margin of dorsal plate deeply bilobed, the sinus triangular and reaching center of plate.....3 mm., female, *trachuri* Brian, 1903
8. Posterior portion of dorsal plate the same width as the anterior portion or narrower.....9
8. Posterior portion of dorsal plate distinctly wider than the anterior portion.....19
9. Anterior portion of dorsal plate with large lateral wings; fourth legs projecting nearly their entire length,  
3.30 mm., female, *caudatus*, new species, p. 37
9. Anterior portion of dorsal plate with large lateral wings; fourth legs not projecting at all.....10
9. Anterior portion of dorsal plate without wings, but with processes at its posterior corners; fourth legs projecting more or less.....11
9. Anterior portion of dorsal plate without wings or processes; fourth legs projecting moderately.....12
10. Genital segment short and wide, without transverse folds; fourth legs cut to center, rami slender and acuminate,  
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37. Rami of fourth legs equal; third legs nearly as long as the fourth pair,  
5 mm., male, *nudus* Bassett-Smith, 1898
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38. Third legs only half the length of the fourth pair; anal laminae as wide as long-----male, *brevis* Richiardi, 1880

*Synonyms.*—Nordmann described a new genus and species under the name *Epachthes paradoxus* in his Mikrographische Beiträge, 1832, part 2 (p. 45). In the text on pages 46 and 47 he gave references to plate 12, figures 12, 13, and 14, but no such plate was published with his paper, and the only illustration that has ever appeared is a single figure published by Burmeister in 1833. He claimed that the species belonged in the genus *Lernanthropus* on account of its resemblance to *Lernanthropus pupa*, and this claim was afterwards acknowledged as correct by Nordmann himself. Accordingly the species *paradoxus* has been included in the key just given.

In the same paper in which Nordmann acknowledged Burmeister's claim<sup>19</sup> he endeavored to establish upon Beneden's *Lernanthropus petersi* a new genus, which he proposed to call *Stalagmus*. The validity of this genus has been denied by most authors, and apparently with good reason. Although it differs in many particulars from other species these differences do not seem to warrant generic distinction.

Again in this same paper Nordmann described (p. 508) and figured (pl. 7, figs. 5-8) some specimens which he referred to Beneden's species *krøyeri*, but which are certainly distinct, and hence they have been given the new name *nordmanni*.

In his discussion of this genus<sup>20</sup> Goggio established a new species which he named *lichiae*, but the following year he acknowledged it as a synonym of Brian's *trachuri*.

<sup>19</sup> Bull. Soc. Imp. Nat. Moscou, vol. 37, 1864, p. 510.

<sup>20</sup>Atti Soc. Tosana Sci. Nat., Pisa, vol. 22, 1906, p. 144.

Richiardi<sup>21</sup> gave a brief description, without figures, of a new species of *Lernanthropus*, which he named *micropterygis*. Goggio in the paper just referred to (1906) claimed to recognize Richiardi's species, and gave figures of male and female adults. He also claimed that Brian's species *thompsoni*<sup>22</sup> was a synonym of *micropterygis*.

Brian himself in his *Copepodi Parassiti dei Pesci d'Italia*, 1906 (p. 66), made *thompsoni* a synonym of *gisleri*, but later published an error slip stating that this was a mistake and that it should be a synonym of *micropterygis*. In this same paper (p. 65) Brian claimed that Heider's species "*krøyeri*, var." was a synonym of Richiardi's *brevis*, but Goggio, in the Pisa paper already referred to, identified *brevis* very differently and gave good figures of both sexes. If his interpretation is correct then Heider's name must be retained and does not become a synonym.

Heider, Valle, and Brian have each stated that probably the species described by Heller as *trigonocephalus* is identical with the one established by Krøyer as *scribae*. Heller frankly acknowledged that the two species had many similarities, but contended that they differed enough to warrant keeping them separate.

#### LERNANTHROPUS CAUDATUS, new species.

Plate 1, figs. 9-11; plate 2, figs. 12-15.

*Host and record of specimens.*—Three adult females were obtained from the gills of the sheepshead, *Archosargus probatocephalus*, at Beaufort, North Carolina, July 25, 1905. The best specimen was selected as the type of the species with Cat. No. 54061, U.S.N.M.; the other two become paratypes with Cat. No. 54062, U.S.N.M.

*Specific characters of female.*—General form short and thickset; cephalothorax narrowed anteriorly, swollen posteriorly, the lateral lobes produced considerably in front of the central margin. Anterior portion of dorsal plate produced into a large lateral lobe on either side, which curves over ventrally, leaving prominent rounded corners both anteriorly and posteriorly. Posterior portion of plate nearly a circle in outline, its margin evenly and smoothly rounded.

First antennae indistinctly six-jointed, not visible except in a ventral view. Second antennae of the usual pattern, the stout terminal claw strongly curved. Mouth tube rather small; maxillae also small and weak; second maxillae large and powerful; maxillipeds with a stout terminal claw nearly as long as the basal joint and jointed once near the center. First legs small and hidden beneath the maxillipeds, the endopod a conical knob tipped with a single long spine, the exopod flattened into a lamina, tipped with five short

<sup>21</sup> Processi verbali Soc. Toscana Sci. Nat., Pisa, vol. 4, 1885, p. 82.

<sup>22</sup> Atti. Soc. Ligustica Sci. Nat., vol. 9, 1898, p. 17, pl. 3, fig. 16.

and stout spines. Second legs with the basipod much swollen, almost spherical, but with the rami much smaller than those of the first pair. The exopod is flattened, circular in outline, and armed with several minute spines arranged irregularly. The endopod is boot shaped and apparently unarmed. The third legs are exceptionally long and narrow; the fourth pair are divided to their bases and project nearly their entire length behind the dorsal plate. Their rami are flattened into thin laminae, which are widest in the center and taper toward either end. The anal laminae are long and narrow-lanceolate, their tips reach a little beyond the posterior margin of the dorsal plate. None of the females carried egg strings.

Color a uniform yellowish gray.

Total length, not including fourth legs, 3.30 mm. Width of anterior portion of dorsal plate, 2 mm. Length of four legs, 2.85 mm.

(*caudatus*, long-tailed.)

*Remarks.*—The distinguishing characters of this species are the large lateral wings on the anterior portion of the dorsal plate and the broad rami of the fourth legs which project nearly their entire length. The females of *trigonocephalus*, *pagelli*, and *scribae* also have large lateral wings, but their fourth legs either do not reach the posterior margin of the dorsal plate, or barely pass it. The plate in *trigonocephalus* is so narrowed posteriorly that the fourth legs sometimes project beyond its lateral margins, but they hardly pass the posterior margin, and they are only cut to their center, while here the rami are separated to their very base. The boot shape of the endopod of the second legs is also peculiar and unlike that of any other species.

These parasites are not at all common, since many sheepheads were examined during the summer, but only these three specimens were obtained. The side view shown in figure 12 gives the best idea of the lateral lobes of the anterior thorax and also of the exceptional length of the third legs.

**LERNANTHROPUS TENUIS, new name.**

*Lernanthropus*, species BRIAN, Atti Soc. Ligustica Sci. Nat., vol. 9, 1898, p. 19, pl. 3, fig. 14.

*Remarks.*—In the reference above given Brian described a species of parasitic copepod which he referred to the present genus, but to which he gave no specific name. In going over the described species for the purpose of making the key which appears above it was found that this species did not belong with any hitherto described. Accordingly the above name is suggested for it.

(*tenuis*, slender, thin.)

**LERNANTHROPUS RATHBUNI, new species.**

Plate 2, figs. 16-19; plate 3, figs. 20-22.

*Host and record of specimens.*—Two females were obtained from the gills of a hogfish, *Orthopristis chrysopterus*, at Beaufort, North Carolina, July 24, 1905. They are made types of the new species with Cat. No. 54069, U.S.N.M.

*Specific characters of female.*—Cephalothorax subquadrangular, as wide as the body, with broad lateral flaps, each of which projects in a rounded lobe forwards and backwards. The sinus between the lobe and the antennal area anteriorly is narrow and deep; that between the lobe and the thorax posteriorly is broad and shallow. Anterior and posterior portions of the dorsal plate about the same length and width, with a broad sinus on either margin between them. The anterior portion is gradually narrowed anteriorly to meet the cephalothorax, without any lateral prominences or shoulders. The posterior portion is obovate, strongly narrowed posteriorly, with a broad sinus at the tip, through which can be seen the anal laminae and a portion of the abdomen. The genital segment is much wider than long and projects in a half circle on either side. The abdomen is only half as wide as the genital segment and is two-jointed, the joints of the same length and width.

The anal laminae are broad ovate, flattened dorsoventrally, and attenuate at their tips. The egg strings are attached to the sides of the genital segment; they are the same width as the rami of the fourth legs and a little longer than the entire body.

The first antennae are attached considerably behind the frontal margin; they are quite distinctly segmented, with seven joints. The second antennae are of the usual pattern, a swollen basal joint and a strong terminal claw. The second maxillae have a fairly stout basal joint and a long and slender claw, which is bent into a half circle near its tip, the basal portion being straight. Proximal to the curve on the inner margin is a small tooth, between which and the tip are two rows of minute teeth, one along each side of the inner margin.

The maxillipeds are large and strong, the base of the claw being considerably reinforced, but the claw itself is curved only a little.

The first legs have a broad flattened exopod tipped with four large spines and a fifth, much smaller one at the distal end of the outer margin.

The endopod is conical and ends in a single long slender spine; the inner margin bears distally a row of minute teeth. Inside the endopod is a single large spine. The second legs have oblong flattened rami, the exopod tipped with a long spine, the endopod with three spines of about the same size at the tip and two much smaller ones on the inner margin. Inside the endopod is a small rounded knob. The

third legs are of the usual pattern, well separated and standing out at right angles to the ventral surface. The fourth legs are divided nearly to their base; the rami are cylindrical, slender, and taper to a rather fine point; they are about two-thirds as long as the body. A pair of fifth legs is present in the form of short tapering rami, one on either side of the fifth segment, in front of the genital segment.

Color (preserved material) yellowish brown.

Total length, 3.15 mm. Cephalothorax, 1 mm. long, 1 mm. wide. Greatest width of body, 1.15 mm. Length of fourth legs, 2 mm.; of egg strings, 4 mm.

(*rathbuni*, to Richard Rathbun, who did much excellent work on the parasitic copepods.)

*Remarks.*—The distinguishing characters of this new species are the position of the first antennae, removed some distance from the frontal margin, the deep and narrow sinus on either side of the antennal area, the reentrant sinus at the tip of the dorsal plate, the presence of a fifth pair of legs, and the details of the various appendages.

The species can not be very common, for after these two specimens were obtained a large number of hogfish were examined without finding any more of the parasites.

LERNANTHROPUS LEIDYI, new species.

Plate 3, figs. 23-27; plate 4, figs. 28-30.

*Host and record of specimens.*—Forty females were obtained from the gills of the white perch, *Morone americana*, at Beaufort, North Carolina, July 12, 1905. One of these has been selected as the type of the species with Cat. No. 53572, U.S.N.M. The others become paratypes with Cat. No. 53573, U.S.N.M. A second lot of 50 females was obtained from the gills of the yellowtail, *Bairdiella chrysura*, July 20, 1905, also at Beaufort; these have been given Cat. No. 53574, U.S.N.M. A third lot was obtained from the same host at Beaufort by Dr. Edwin Linton September 19, 1902. This lot contained a single male and 30 females and has been given Cat. No. 53575, U.S.N.M., the male being isolated and placed in a separate vial.

*Specific characters of female.*—General body form oblong, about twice as long as wide, with the fourth legs projecting their entire length. Cephalothorax subquadrangular in dorsal view, slightly narrowed anteriorly, the lateral margins curled over ventrally a long distance. A narrow antennal area is separated at the anterior margin, to the sides of which are attached the first antennae. Anterior portion of dorsal plate much wider than posterior in young females and somewhat wider in mature adults, with a deep sinus on each lateral margin at the junction of the two portions. Posterior portion narrowed and shortened in young females, leaving both the



genital segment and the abdomen exposed in dorsal view. In mature adults it is lengthened and broadly rounded, leaving only the anal laminae visible dorsally.

Genital segment twice as wide as long, with protruding, convex lateral margins. Abdomen only half the width of the genital segment, narrowed anteriorly and with convex sides. Anal laminae cylindrical, filiform, five times as long as wide, with bluntly rounded tips, without setae.

First antennae small and indistinctly segmented, apparently about seven-jointed, somewhat flattened antero-posteriorly and regularly tapered, with two tiny setae at the tip. Second antennae on the ventral surface of the lateral flaps of the cephalothorax, consisting of a stout basal joint and a curved terminal claw. First maxillae at the sides of the mouth tube and very small; second pair long and slender, with a short terminal claw, having a row of saw teeth along each lateral margin. On the side of the terminal joint below the base of the claw is a small spine. The maxillipeds, like the second antennae, are made up of a stout basal joint and a curved terminal claw, apparently jointed near the center.

The exopod of the first legs is quadrangular, with five stout triangular spines along the terminal margin; the endopod is narrowed to a thin neck where it joins the basal joint, with a single long and slender spine at the inner distal corner. There is also a small spine on the ventral surface of the basal joint just above the endopod.

The third legs stand out at right angles to the ventral surface, with their tips considerably enlarged, as shown in figure 29.

Each fourth leg is divided to its base; the rami are slender, taper to a blunt point, and project practically their entire length behind the dorsal plate. The egg strings are considerably thicker than the rami of the fourth legs, and about as long as the body and legs together.

Color (preserved material), a uniform yellowish brown.

Total length of body, 2.50 mm.; of cephalothorax, 0.75 mm. Width of cephalothorax, 0.65 mm.; of anterior body, 1.15 mm.; of posterior body, 1 mm. Length of fourth legs, 1.85 mm.; of egg strings, 3.85 mm.

*Specific characters of male.*—Cephalothorax exceptionally large, wider than the body and about half the entire length, the posterior margin widened and bilobed, the anterior margin narrowed and squarely truncated. Body narrowed where it joins the cephalothorax, widened through the bases of the first and second legs and in the genital segment.

First antennae more distinctly seven-jointed than in the female; second antennae and maxillipeds relatively larger and stouter. First and second swimming legs like those of the female; third legs reduced to minute uniramous stumps, easily overlooked. Fourth legs unira-

mose, three-fourths as long as the whole body, rather stout and bluntly rounded at the tips. Anal laminae slender and filiform, four times as long as wide, each tipped with two tiny setae.

Color (preserved material), a uniform yellowish brown.

Total length, 1 mm. Cephalothorax 0.40 mm. long, 0.35 mm. wide. Fourth legs, 0.72 mm. long.

(*leidyi*, to Dr. Joseph Leidy, one of the early American pioneers in the study of the Crustacea.)

*Remarks.*—This new species is especially distinguished in the female by the long and slender fourth legs and by the shortness of the dorsal plate, which shows the anal laminae and sometimes a portion of the abdomen. In the male the best mark of recognition is the large squarely truncated cephalothorax and the greatly reduced third legs. The latter scarcely show in dorsal view and are so reduced as to be easily overlooked. The species is fairly common, and many specimens can often be obtained from a single fish.

#### LERNANTHROPUS POMATOMI Rathbun.

*Lernanthropus pomatomi* R. RATHBUN, Proc. U. S. Nat. Mus., vol. 10, 1887, p. 567, pls. 33–35.—M. J. RATHBUN, Occasional Papers, Boston Soc. Nat. Hist., vol. 7, 1905, p. 98.

Mr. Richard Rathbun established this species in 1887 for more than one hundred specimens taken from the gills of bluefish *Pomatomus saltatrix* Linnaeus, caught in Vineyard Sound in 1883 and 1885. He published a complete description of both sexes, accompanied by excellent figures, in the reference given above.

A few specimens were found at Beaufort, North Carolina, by the present author in 1905, and from one of the females, whose eggs were just ready to hatch, many nauplii were secured. These were examined at the time and differed considerably from the one in figure 57.

The following is a list of the specimens at present in the collection of the United States National Museum, including those obtained by Rathbun:

Cat. No.	Specimens.	Locality.
6026 . . . . .	30 females . . . . .	Vineyard Sound, Massachusetts.
6027 . . . . .	2 males . . . . .	Do.
6050 . . . . .	20 females . . . . .	Do.
6051 . . . . .	2 males . . . . .	Do.
6056 . . . . .	15 females . . . . .	Do.
6156 . . . . .	25 females . . . . .	Do.
12684 . . . . .	8 females, 1 male . . . . .	Do.
54065 . . . . .	20 females . . . . .	Woods Hole, Massachusetts.
54066 . . . . .	10 females, 1 male . . . . .	Beaufort, North Carolina.
54067 . . . . .	2 females, 5 males . . . . .	Woods Hole, Massachusetts.
54068 . . . . .	7 females . . . . .	Do.

*Specific characters of nauplius.*—General form ovate, nearly twice as long as wide, widest through the bases of the third appendages, narrowed posteriorly, with evenly curved lateral margins. Appendages long and slender. Eye double and situated so far forward as to touch the anterior margin. Balancers close to the posterior end of the body, long and slender, with a slight S curve, extending outward nearly at right angles to the body axis. On each lateral margin in front of the base of the balancer is a small but distinct notch.

General color brown, the food mass in the posterior portion of the body and the central digestive tract a very dark brown, the margins of the body and the muscles connected with the appendages much lighter in color, the appendages themselves and the balancers a light gray.

Total length, 0.35 mm. Greatest width, 0.19 mm.

*Remarks.*—This nauplius may be distinguished from that of *brevoortiae* by the length and narrowness of the body, by the greater relative length of the appendages, and by the presence of eyes, or rather of a compound eye, on the anterior margin. The color is also quite different in the two nauplii, especially by transmitted light.

#### LERNANTHROPUS BREVOORTIAE Rathbun.

Plate 7, figs. 51–55, 57; plate 8, figs. 58–60; plate 10, fig. 75.

*Lernanthropus brevoortiae* R. RATHBUN, Proc. U. S. Nat. Mus., vol 10, 1887, p. 563, pl. 30, figs. 7 and 8, pls. 31 and 32.—M. J. RATHBUN, Occasional Papers, Boston Soc. Nat. Hist., vol. 7, 1905, p. 97.

*Host and record of specimens.*—Mr. Richard Rathbun obtained about 50 specimens, all females, from the gills of menhaden, *Brevoortia tyrannus*, captured in Vineyard Sound in 1883 and 1885. The following specimens have been added to the Museum collection since his paper was published, all from the same host: Six females captured at Woods Hole, Massachusetts, September 3, 1904, with Cat. No. 54052, U.S.N.M.; 35 females, most of them very small, and a single male from the gills of several young fish only 4 inches long at Beaufort, North Carolina, August 10, 1905, with Cat. No. 54054, U.S.N.M.; 15 females, some of which are still fastened to the gill filaments, taken at Woods Hole, Massachusetts, August 6, 1901, with Cat. No. 54053, U.S.N.M.; 10 females taken July 20, 1905, at Woods Hole, Massachusetts, with Cat. No. 54056, U.S.N.M.; 2 females taken July 20, 1905, at Beaufort, North Carolina, with Cat. No. 54055, U.S.N.M. These records, with those of Rathbun, show that the species is quite common along our Atlantic coast, but thus far only a single male has been obtained, and yet diligent search for males was made at Woods Hole during the entire summer of 1903 and at Beaufort during 1905. Finally a school of very young menhaden

were captured in the pound net at Beaufort, and upon one of them, only 2 inches in length, were found two young female parasites of the present species and one male. This extreme inequality of the sexes is the more remarkable in view of the fact that other species of this same genus, obtained from fish caught at the same time, were about evenly divided. From these facts we may infer that the males of some species can be found only upon fish which are quite immature, and even the youngest fish are not to be overlooked as sources of desirable specimens.

*Specific characters of male.*—General body form short and stocky; cephalothorax as wide and almost as long as the body, with smoothly convex margins, the antennal area projecting anteriorly. Eye double and distinctly visible about one-third the distance from the anterior margin, just behind the antennal area. Body obovate, one-fifth longer than wide, bluntly pointed posteriorly. Genital segment considerably narrower than the free thorax, but long and containing large spermatophore receptacles. Abdomen much narrower than the genital segment; anal laminae short and very narrow.

First antennae like those of the female; second pair enlarged, with a very stout basal joint and a curved terminal claw. The bases of the basal joints are fused on the midline; on the inner margin above the fusion is a pointed process or peg against which the tip of the claw shuts when closed. Each mandible has a slender basal portion and an enlarged tip, which is toothed along its inner margin, the margins of the two mandibles being parallel. The first maxillae extend outward on either side from about the center of the base of the proboscis and at right angles to its long axis. Each consists of a small joint next to the proboscis, corresponding to the chewing blade and armed with a single stout spine, and a larger swollen joint, outside of the chewing blade, covered with hairs and tipped with two spines of unequal size.

The second maxillae are removed some distance behind the proboscis; their basal joint is moderately swollen, their terminal joint is long and slender, and is tipped with a short conical claw. The tip of the terminal joint and the outer margin of the claw are armed with minute spines.

The maxillipeds consist of a very stout basal joint furnished with powerful muscles, and a large terminal claw bent into a half circle.

The first swimming legs are seen in figure 55 and are almost exactly like those of the female, the only difference being that here the two rami are about the same size, while in the female the exopod is much larger than the endopod. The third and fourth legs are uniramous, thick cylinders bluntly rounded at their tips, the third pair about half the length of the fourth, and the latter one-fourth longer than the body behind the cephalothorax.

Color (preserved material) a uniform yellowish brown.

Total length, 1 mm. Width of cephalothorax, 0.45 mm.; of body, 0.40 mm.

*Specific characters of nauplius.*—Body of medium size and elliptical in outline, the posterior end somewhat pointed, the width about two-thirds of the length. Of the appendages the first antennae are the stoutest and are armed with the longest plumose setae. The second antennae and mandibles are rather slender, but carry the usual number of setae, four on the endopod and two on the exopod. The balancers are long and slender and are slightly enlarged at the base; the terminal portion is bent like the bowl of a spoon. They are carried well forward almost at right angles to the long axis of the body. In the egg strings these nauplii appear cinnamon brown by reflected light, but when examined by transmitted light the pigment changes to a dark olive green. This pigment occupies the whole center of the body and is arranged in the shape of a shield, the anterior end narrowed and convexly truncated, with small prominent corners, the posterior end bluntly pointed. Outside of this pigment mass is a strip of transparent mesenchyme, whitish or grayish in color, very narrow posteriorly, wider and denser anteriorly. Outside of the mesenchyme is a narrow clear margin, formed by the fusion of the dorsal and ventral portions of the cuticle.

The muscles which move the appendages are quite distinctly shown, especially through the mesenchyme.

Total length, 0.33 mm. Greatest width, 0.25 mm.

*Vascular system.*—Looked at from the dorsal surface we find a single central, longitudinal trunk, considerably enlarged in the cephalothorax and free thorax, and tapering gradually posteriorly. In the center of the cephalothorax is a pocket or receptacle, out of which leads posteriorly the enlarged longitudinal trunk, and anteriorly a short branch to each anterior corner of the head; there is also a short branch from the center of either side of the pocket. The longitudinal trunk gives off two branches near the posterior margin of the cephalothorax on either side, a single branch at the center of the free thorax, and a large branch in the genital segment leading to each fourth leg. In the carapace and the two portions of the dorsal plate, and in the laminae of the fourth legs these branches anastomose into a network of fine tubes which covers the entire surface. Within these tubes the vascular liquid is freely exposed to oxygenation. On the ventral surface we find two longitudinal trunks which give off branches to the various appendages.

At the anterior end are two branches which ramify towards the side lappets of the cephalothorax, in which there is often a profuse network of capillaries. Then follow branches to the second antennae, the second maxillae, the maxillipeds, and the swinging legs. The capil-

lary network in the third and fourth legs is especially profuse and fully equals that found on the dorsal surface.

The figures here given (figs. 59 and 60) of the vascular system were made in 1905 from living specimens. Heider called attention to the fact that this vascular system can not be recognized in specimens preserved in the ordinary way. And even in those which have been treated by the most approved methods it is usually unrecognizable, or at least it can not be traced in any detail.

**LERNANTHROPUS CARANGIS Hesse.**

*Lernanthropus caranxi* HESSE, Revue des Sciences Naturelles, vol. 7, 1878, p. 8 (reprint), pl. 1, figs. 1-7.

*Lernanthropus carangis* BASSETT-SMITH, Proceedings Zool. Soc. London, 1899, p. 470.

*Lernanthropus carangis* GOGGIO, Atti Soc. Toscana Sci. Nat. Pisa, vol. 22, 1906, p. 138.

*Remarks.*—This species was referred by its author to the present genus, and was so accepted by the two investigators named above. There are, however, several serious differences which must be adjusted before the species can be definitely located. The head is described and figured as distinctly separated from the thorax; the segments of the thorax are fused and carry at their anterior end three pairs of biramous legs, each consisting of a basal joint which covers half the width of the thorax, and two tiny one-jointed rami, armed with six or seven small spines. The posterior portion of the dorsal plate is split down the center for its entire length and the lateral margin of each half at its anterior end curves around the side of the body and is continuous with the lateral margin of a ventral plate which extends beyond the tips of the anal laminae. The fourth thorax segment is three times as thick dorsoventrally as the fifth, and is crescent-shaped in side view, with the points turned backward. Such a creature manifestly can not belong to the genus *Lernanthropus*, nor indeed to any of the other accepted genera, and yet its antennae and mouth parts, the first two and the fourth pair of legs, and the color are just like those of the present genus.

In view of these discrepancies and because no two of Hesse's figures agree in their details or correspond with his text, and further because only a single specimen has ever been found we are compelled to reject the species from the present genus, but are unable to locate it anywhere else.

**LERNANTHROPUS SCRIBAE Krøyer.**

*Lernanthropus scribae* KRØYER, Naturhistorisk Tidsskrift, ser. 3, vol. 2, 1863, p. 203, pl. 9, fig. 3 a-g.

*Lernanthropus scribae* HEIDER, Arbeiten Zool. Inst. Wien, vol. 2, 1879, p. 354.

*Remarks.*—It was suggested by Heider and has been repeated by other authors that this species described by Krøyer and the one des-

ignated as *trigonocephalus* by Heller in 1865 are identical. If this be true, then Krøyer's name takes precedence and must be retained, while Heller's becomes a synonym. But the identity of the two species does not seem possible, owing to the following differences:

1. The lateral margins of the head are smoothly convex in *trigonocephalus*, while they are sinuate with deep invaginations in *scribae*.

2. The wings on the free thorax project forward at the anterior corners and backward at the posterior corners in *scribae* and are simply rounded, without projecting, in *trigonocephalus*.

3. The posterior portion of the dorsal plate is strongly narrowed anteriorly and posteriorly in *trigonocephalus*, while it is nearly the same width throughout in *scribae*.

4. The genital segment, abdomen, and anal laminae are without transverse grooves in *trigonocephalus*; such grooves are present in *scribae* and give the genital segment the appearance of being made up of three joints, while each anal lamina appears also three-jointed.

5. The fourth legs in *trigonocephalus* are divided less than half their length, the rami are narrow, acuminate and equal, while they project laterally half their length beyond the dorsal plate. In *scribae* the legs are divided almost to their base, the endopod is considerably longer and wider than the exopod and both are bluntly rounded, while they do not reach the margin of the dorsal plate but are wholly covered in dorsal view.

Such marked differences seem to preclude the idea of the identity of the two species, and accordingly they have been kept separate.

#### LERNANTHROPUS NORDMANNI, new name.

*Lernanthropus krøyeri* NORDMANN, Bull. Soc. Imp. Moscou, vol. 37, 1864, p. 508; pl. 7, figs. 5-8.

*Remarks.*—P. J. van Beneden described and figured<sup>23</sup> a new species of *Lernanthropus*, to which he gave the name *krøyeri*. The species was afterward noted by Claus, who added a description and figures of the male. It has been subsequently mentioned by nearly every investigator who has worked in the Mediterranean, and finally both sexes were again described and figured by A. Scott,<sup>24</sup> this time from British seas. Meanwhile Nordmann, in the reference given above, described and figured three female specimens, which he identified as belonging to this species and which were taken from the gills of a large *Labrax lupus* on the coast of Normandy. A comparison of Nordmann's description and figures with those of Beneden and Scott shows that the species are not the same. The differences which separate them are the following:

<sup>23</sup> Ann. des Sci. Nat., ser. 3, vol. 16, 1851, p. 102, pl. 3, figs. 7-9.

<sup>24</sup> Trans. Biol. Soc. Liverpool, vol. 21, 1907, p. 95, pl. 3, figs. 1-13.

1. The length of the female figured by Scott was 21.70 mm., including the fourth legs, that by Claus was 12.50 mm. without the fourth legs, while Nordmann's species was only 7 mm. without the fourth legs.

2. The cephalothorax in *krøyeri* is trapezoidal in outline, the antennal area is separated from the rest of the head, with a large lobe on either side at its base. The two diameters of the head are in the proportion of 5 for length and 6 for breadth. In *nordmanni* the cephalothorax is triangular, pointed anteriorly, with sinuate sides, the antennal area is not separated, and the two diameters are equal.

3. The anterior portion of the dorsal plate in *krøyeri* is wider than long, the two diameters in the proportion of 4 to 3; in *nordmanni* it is longer than wide, in the proportion of 6 to 5.

4. In *krøyeri* the posterior margin of the dorsal plate is an evenly rounded half circle, in *nordmanni* it is squarely truncated, leaving sharp corners and a sinuate margin.

5. In *krøyeri* the dorsal plate entirely covers the genital segment, the abdomen, and the basal half of the fourth legs, its margin reaching well beyond the tips of the anal laminae. In *nordmanni* the abdomen is entirely, and the genital segment is partially, visible in dorsal view, and the fourth legs project nearly their whole length.

6. In *krøyeri* the fourth legs are widest at the center and taper toward both ends, the tips being acute. In *nordmanni* the fourth legs are of uniform width throughout with squarely truncated tips.

Such an accumulation of differences shows that Nordmann was dealing with a distinct species, and the name *nordmanni* is suggested for it.

(*nordmanni*, to Prof. Alexander V. Nordmann, who first described the species.)

**LERNANTHROPUS CHLAMYDOTUS, new species.**

Plate 4, figs. 31-35; plate 5, figs. 36-39; plate 6, fig. 40; plate 13, fig. 104.

*Host and record of specimens.*—Seven males and 16 females were taken by Dr. Edwin Linton from the gills of the silver gar, *Tylosurus marinus*, at Beaufort, North Carolina, September 1, 1902. A single female has been isolated and made the type of the new species, with Cat. No. 54063, U.S.N.M. The remaining specimens of both sexes become paratypes, with Cat. No. 54064, U.S.N.M.

*Specific characters of female.*—General shape short and thickset; cephalothorax half as long as the body, narrowed anteriorly, but widened across the posterior margin until it equals or slightly exceeds the anterior margin. The anterior end is inclined downwards and forwards and its lateral flaps are so long they protrude far in front of the ventral surface. This gives it an appearance very similar to the old-fashioned poke bonnet. Body with the shape of an hour-



glass, the dorsal plate all one piece, entirely covering the third and fourth legs and wrapped around ventrally like the skirts of a military cloak flaring outward.

Genital segment about as long as wide, its lateral margins not very convex; abdomen half the width of the genital segment, much narrowed anteriorly, widened through the posterior margin. Anal laminae flattened dorsoventrally, the basal half of uniform width, the terminal half tapered to a blunt point tipped with two small spines. Egg strings wide, but not very long, projecting half their length behind the dorsal plate.

First antennae entirely concealed in dorsal and lateral views, attached just above the bases of the second pair and apparently four-jointed, the jointing being indistinct. The last joint is heavily armed with setae. Second antennae composed of a stout basal joint and a curved terminal claw. They also are entirely covered by the sides of the cephalothorax, and can be seen only when the side flaps are pushed back. The mouth tube is short and conical. The first maxillae have an almost spherical inner portion, armed posteriorly with a single large spine. The outer portion is much longer, tapers to a blunt point, and is armed with two unequal spines, the largest one posterior. The second maxillae have a stout basal joint and a nearly straight terminal claw, which is bluntly rounded at the tip, where it is armed with a row of fine teeth along either margin for a short distance.

The maxillipeds are large and stout, the basal joint much swollen, and the terminal claw sharply curved near the tip.

First and second swimming legs similar to those of the male, third pair folded in the usual manner and extended in front of the body parallel with each other and at right angles to the body axis. Fourth legs biramose, divided not quite to the base, the rami flattened dorsoventrally into broad, bluntly pointed laminae, of which the exopod is a little the longer. In young females the tips of these fourth legs project beyond the posterior margins of the dorsal plate, but in the fully developed adult the legs are entirely concealed.

Color (preserved material) a uniform yellowish brown.

Total length, 3 mm. Cephalothorax 1 mm. long, 0.85 mm. wide. Anterior portion of dorsal plate 0.80 mm. wide, posterior portion 1.50 mm. wide.

*Specific characters of male.*—General form short and thick set like the female; cephalothorax almost circular in dorsal outline, a trifle wider than long, with both pairs of antennae projecting from its anterior margin. Body as wide as the cephalothorax and about twice as long, the anterior corners evenly rounded. Genital segment relatively much longer than in the female, its sides fused with the bases of the fourth legs. Abdomen narrow, trapezoidal and short, the

anal laminae attached to its posterior corners and some distance apart.

First antennae four-jointed, attached not to the frontal margin but to the ventral surface in front of the bases of the second pair, which are like those of the female. The mouth tube and mouth parts are also like those of the female, the maxillipeds a trifle larger, and the terminal claw not as strongly bent.

The exopod of the first swimming legs is a flattened lamina, squarely truncated at the tip, and the terminal margin armed with a row of five broad saw teeth. The endopod is cylindrical, enlarged through the center, and terminates in a stout, hairy spine, twice as long as the joint itself. It also carries a row of small sharp spines along its inner margin. Between the endopod and the midline is a tiny process, coming out of the basal joint and unarmed.

The exopod of the second legs is also laminate, but the lamina is rolled into a loose cylinder. The terminal margin is squarely truncated and armed with a row of 12 to 15 soft spinous processes. The endopod is cylindrical and squarely truncated, with a row of small spines along the inner and terminal margins, the two at the outer distal corner being larger and wider than the others. On the ventral surface close to the terminal margin is a large smooth spine about as long as the endopod itself, and farther back beside the inner margin is a secondary row of small sharp spines. Outside the exopod is a jointed spine nearly as long as the exopod itself.

The third legs extend diagonally backward from the posterior corners of the third thorax segment and are about the same length as the fourth pair. They are uniramous, flattened laminae and end in a single rounded knob armed with small spines.

The fourth legs extend nearly straight backwards from the posterior corners of the fourth segment. They also are flattened laminae, somewhat widened through the center, and they end in two knobs armed with small spines. These knobs with a fairly deep sinus between them, and the general makeup of the appendages, indicate that each is really made up of two rami fused together.

Color (preserved material) a clear yellow, faintly tinged with brown.

Total length, including fourth legs, 2 mm. Cephalothorax 1 mm. long, 1.15 mm. wide. Length of fourth legs, 1.60 mm.

(*chlamydotus*, *χλαμυδοτός*, clothed with a cloak.)

*Remarks.*—The distinguishing character of this tiny species is its general appearance. It looks in side view like a little old woman enveloped in a voluminous skirt and wearing a large poke bonnet. The armature of the swimming legs is also peculiar, especially that of the exopod of the second pair.

**LERNANTHROPUS PAENULATUS**, new species.

Plate 6, figs. 41-48; plate 7, figs. 49-50, and 56.

*Host and record of specimens.*—Two females with egg strings were taken from the gills of the amber jack, *Seriola lalandi*, at Woods Hole, by Vinal N. Edwards. These have been given Cat. No. 54057, U.S.N.M., and become paratypes of the new species. A female with egg strings and a male were obtained from the same host September 11, 1901, by Dr. M. T. Thompson at Woods Hole. The female is made the type of the species with Cat. No. 54058, U.S.N.M. The male becomes an arsenotype with Cat. No. 54059, U.S.N.M. Another male was taken from the gills of the same host by Dr. Edwin Linton at Beaufort, North Carolina, September 23, 1902, and has been given Cat. No. 54060, U.S.N.M.

*Specific characters of female.*—General form elongate and narrow; cephalothorax a little longer than wide, with large lateral flaps which entirely cover and conceal the second antennae and mouth tube except in a ventral view. Anterior portion of dorsal plate twice as long as wide, with nearly straight lateral margins, the distance between the second and third swimming legs being exceptionally large. Posterior portion much widened, especially at the posterior margin, and wrapped around the fourth legs and egg strings, leaving only the tips of the fourth legs visible. Genital segment small, with strongly convex sides; abdomen minute, one-jointed; anal laminae narrow lanceolate, as long as the abdomen and genital segment together, but entirely concealed by the dorsal plate.

First antennae six-jointed, tapering, the setae scattered except on the terminal joint; second antennae with the usual swollen basal joint and stout terminal claw, attached close to the anterior margin of the head and covered by the side lappets of the cephalothorax.

Mouth tube conical, rather long and narrow; first maxillae triangular, the tip armed with two spines, the outer one much longer than the inner; there is also a short but stout spine on the inner margin one-third of the length from the base. Second maxillae with a long and rather slender terminal claw; maxillipeds stout, the claw strongly curved.

Exopod of first swimming legs flattened, squarely truncated and tipped with five short and blunt teeth; endopod of the usual form, conical and tipped with a large spine. Exopod of second legs somewhat boot-shaped, the "heel" on the outer margin at the base, the "toe" armed with four small spines. Endopod like that of the first legs. No secondary spine inside of the endopod.

Third legs opposite the center of the dorsal plate, turned ventrally at right angles to the body axis, not very long and not wide enough to meet on the midline, even at the base, but leaving a con-

siderable interval. A small accessory lobe on the outside of each leg at the base of the outer fold. Fourth legs divided to their base, the rami flattened and widest at the center; a pair of short fifth leg rudiments just in front of the genital segment. Egg strings longer than the whole body; eggs small and numerous.

Color (preserved material) a uniform brownish gray.

Total length, 9.50 mm. Width of anterior portion of dorsal plate, 1.75 mm.; of posterior portion, 3.50 mm. Length of egg strings, 16.75 mm.

*Specific characters of male.*—Cephalothorax subpyriform or elliptical, the anterior end somewhat narrowed, the proportion of the length to the width as 5 to 4. Second (first free) segment about the same width as the head; third segment widened through the bases of the third legs, which stand out almost at right angles to the body. Fourth, fifth, and genital segments fused, with the fourth legs extending backward and outward at an angle of about  $45^\circ$ . The spermatophore receptacles are large and reach forward nearly to the center of the bases of the fourth legs.

First antennae six jointed; second pair relatively larger than in the female and appearing even larger still because they are not concealed at all. Mandibles slender, cylindrical, jointed once near the base, the tip flattened dorsoventrally and armed along the inner margin with a row of saw teeth. Maxillipeds a little larger than those of the female. First and second swimming legs as described for the female. Third legs biramose, the endopod much shorter than the exopod; fourth legs also biramose, the exopods flattened and much widened through the center, the endopods only half as long as the exopods and cylindrical.

Color (preserved material) a uniform yellowish gray.

Total length, 2.50 mm. Cephalothorax 1.25 mm. long, 1 mm. wide. Length of fourth legs, 1.50 mm.

(*paenulatus*, wearing the paenula or cloak.)

*Remarks.*—This species was determined to be new by the late Dr. M. T. Thompson, who had compiled a rough description of both sexes, accompanied by numerous pencil sketches, and had suggested the name which is given above. Two of his sketches are here published and the present author has borrowed freely from his notes.

The distinguishing characters of the species are the narrow body wrapped in its long cloak, the small and widely separated third legs, the visible tips of the fourth legs in the female, and the very short endopods of the third and fourth legs in the male. The female is long and narrow and thus the very opposite of *chlamydotus*, which is the only other species with the posterior portion of the dorsal plate enlarged and wrapped around the fourth legs and the egg strings.

**Genus PENICULISA Wilson.**

*Peniculisa* WILSON, Proc. U. S. Nat. Mus., vol. 53, 1917, p. 45.

*Peniculus* (part) KRØYER, Naturhistorisk Tidsskrift, ser. 3, vol. 2, 1863, p. 268.

*External generic characters of female.*—First thorax segment more or less distinctly separated from the head and with the second and third segments forming a sort of neck which is narrowed but not chitinized. Head elliptical, flattened, and covered with a dorsal carapace. Fourth, fifth, and genital segments fused, flattened, and covered with a dorsal plate. Posteriorly this fused trunk is prolonged into a wide flattened process on either side of the abdomen. The latter is small, one-jointed, and also prolonged into a flattened process at each posterior corner. Egg strings short and stout; eggs uniseriate and well flattened.

First antennae reduced to mere knobs; second pair much enlarged, uncinata, and prehensile; no maxillae; maxillipeds large, with strong claws.

Three pairs of rudimentary uniramous legs on the first three thorax segments; a fourth pair on the fused trunk some distance behind the anterior end.

*Internal generic characters of female.*—Esophagus inclined forward and entering the ventral surface of the stomach near the anterior end. Stomach narrowed into an intestine in the free thorax segments; intestine widened in the fused trunk and contracted into a short rectum in the abdomen. Ovaries dorsal to the intestine in the extreme anterior part of the fused trunk, oviducts much convoluted and occupying all the space dorsal and lateral to the intestine. Cement glands close together in the posterior portion of the fused trunk and ventral to the oviducts, the glandular portion an elongated ellipse, only reaching forward to the center of the trunk, the ducts very short. Semen receptacle on the floor of the trunk at the posterior end.

*External generic characters of male.*—General form similar to that of the female, but with differences in the body proportions. Posterior processes on the genital segment only a third as long as in the female, spatulate, strongly flattened at the tips. Abdomen without posterior processes, almost hemispherical in shape; anal laminae relatively larger and their setae longer. Antennae, mouth parts, and appendages similar to those of the female, except that the maxillipeds are larger and much stouter.

*Type of the genus.*—*Peniculisa furcata* (Krøyer), monotypic.

*Remarks.*—In these Proceedings (vol. 53, 1917, p. 45) certain reasons were presented for excluding the species *furcatus* from the genus *Peniculus*, where Krøyer had placed it, and establishing it as the

type of a new genus, which should belong to the family Dichelesathiidae rather than to the Lernaeidae. These reasons were based upon the external morphology, and it is gratifying to find that the internal structure gives added and convincing argument to the same end.

In the genus *Peniculus*, as in all the Lernaeidae, the ovaries are dorsal to the intestine at the anterior end of the second fourth of the fused trunk. The oviducts pass around the outside of the intestine to the ventral surface and thence straight back to the vulvae. There is not a convolution or the suggestion of one, and the eggs are pressed together so tightly that they are flattened into thin disks like a row of coins. In sharp contrast with this the oviducts in *furcatus* are convoluted back and forth until they fill the entire space, lateral and dorsal, between the intestine and the body wall. And the eggs inside of them remain spherical and are scattered about loosely without any definite arrangement. Accordingly we are justified in placing the new genus in the present family, to which it corresponds in all particulars, with the single exception of the posterior processes.

#### Genus KRØYERIA P. J. van Beneden.

*Krøyeria* BENEDEN, Bull. Acad. Roy. Belgique, vol. 20, 1853, p. 24.

*Lonchidium* GERSTAECKER, Archiv für Naturg., vol. 20, 1854, pt. 2, p. 185; 1858, p. 24.

*Krøyeria* CLAUS, Ueber den Bau und die Entwicklung parasitischer Crustaceen. Cassel, 1858, p. 24.

*Krøyeria* NORDMANN, Bull. Soc. Imp. des Nat. Moscou, vol. 37, 1864, p. 468.

*Krøyeria* HESSE, Ann. des Sci. Nat., ser. 6, Zool., vol. 8, 1879, p. 15, art. 29.

*Lonchidium* BASSETT-SMITH, Proc. Zool. Soc. London, 1899, p. 473.

*Krøyeria* BRIAN, Copepodi parassiti dei Pesci d'Italia, 1906, p. 67.

*Krøyeria* T. and A. SCOTT, British Parasitic Copepoda, 1912, p. 120.

*Generic characters of female.*—Cephalothorax broad, covered with a carapace having rounded lobes at its posterior corners. Inside each lobe on the posterior margin is a movable styliiform process, projecting backward. Second, third, and fourth thorax segments free, each with a pair of swimming legs, but without lobes or dorsal plates. Fifth and genital segments completely fused, elongate, narrow cylindrical, with nearly straight lateral margins. Abdomen short; anal laminae long, narrow, and setose.

First antennae filiform, seven-jointed; second pair stout and chelate; mandibles and first maxillae small and rudimentary; second maxillae and maxillipeds large and armed with powerful claws. Four pairs of biramose swimming legs, each ramus three-jointed, setose. Egg strings linear, as long as the whole body; eggs thick and not strongly flattened.

*Generic characters of male.*—Cephalothorax relatively larger than in the female, but having similar posterior lobes and styliform processes. Second and third thorax segments sometimes enlarged, fifth and genital segments much shorter and narrower. Abdomen longer and distinctly three-jointed, anal laminae long and armed with plumose setae.

Antennae, mouth parts, and swimming legs like those of the female, the second antennae and maxillipeds being larger and stronger.

*Type of the genus.*—*Krøyeria lineata* P. J. van Beneden.

KEY TO THE SPECIES.

1. Abdomen of female containing but a single joint----- 2
1. Abdomen of female two- or three-jointed----- 3
2. Free thorax segments as wide as the genital segment; the latter four times as long as wide----- *aculeata* (Gerstaecker), 1854
2. Free thorax segments much narrower than genital segment; the latter ten times as long as wide----- *lineata* P. J. van Beneden, 1853
3. Genital segment the same width throughout its entire length; abdomen with but two joints----- 4
3. Genital segment considerably widened posteriorly; abdomen three-jointed... 5
4. Cephalothorax nearly as wide as long; styliform appendages reaching center of fourth segment; anal laminae one-third the length of the abdomen, *scylli-caniculi* Hesse, 1878
4. Cephalothorax only half as wide as long; styloform appendages overlapping the genital segment; anal laminae two-thirds as long as the abdomen----- *carchariae-glauci* Hesse, 1878
5. Styliform appendages reaching posterior margin of third thorax segment; abdomen longer than genital segment----- *galei-vulgaris* Hesse, 1883
5. Styliform appendages only reaching posterior margin of second segment; genital segment four times as long as the abdomen. *acanthias-vulgaris* Hesse, 1878

*Remarks.*—This genus was established by Beneden in the reference given above and was placed in the family Caligidae, close to the genera *Trebius* and *Nogagus*. In the following year Gerstaecker described a closely allied parasite as a new genus and species, which he named *Lonchidium aculeatum*. In discussing its systematic affinities, although the structure of the swimming legs showed affinity with the Caligidae, Gerstaecker decided to place it with the Dichelesthiidae.

In 1899 Bassett-Smith made the two genera described by Beneden and Gerstaecker identical, but for some unknown reason adopted Gerstaecker's genus name and made Beneden's name a synonym. Brian in 1906 restored the name *Krøyeria* and was followed in this by T. and A. Scott in 1913. There is no doubt that their action is correct and that the name given by Beneden should be retained.

In the key given above the four species described by Hesse have been retained, and are separated according to the distinctive char-

acters stated in his text and portrayed in his drawings. By so doing, however, it must not be inferred that the present author is convinced of the validity of Hesse's species. As in all his work there are so many flat contradictions in both text and figures that his species can neither be accepted nor rejected with any certainty. Some future investigator must finally decide as to their truth or falsity. Meanwhile they seem to valid; and if so, may be distinguished as indicated.

**Genus ERGASILINA P. J. van Beneden.**

*Ergasilina* BENEDEN, Ann. Sci. Nat., ser. 3, vol. 16, p. 97, 1851.

*Ergasilina* VALLE, Boll. Soc. Adriatica Sci. Nat. Trieste, vol. 6, p. 67, 1880.

*Ergasilina* STOSSICH, Boll. Soc. Adriatica Sci. Nat. Trieste, vol. 5, p. 263, 1880.

*Generic characters of female.*—General body form long and slender; head small and covered with a carapace; first and second thorax segments fused and separated from the head, bearing two pairs of legs; third and fourth segments free, each with a pair of legs; genital segment no larger than the fourth segment; abdomen one-jointed, strongly tapered; anal laminae lanceolate, without setae.

First antennae five-jointed, destitute of setae; second pair with two basal joints and a long and stout terminal claw. Maxillae three-jointed, the terminal joint a small claw or spine, the penultimate joint armed with minute teeth. Four pairs of swimming legs, uniramous, two-jointed, without setae, the terminal joint tipped with spines. Egg strings unknown.

*Type of the genus.*—*Ergasilina robusta* P. J. van Beneden, monotypic.

*Remarks.*—This genus was founded upon a single female obtained by Beneden from the gills of the common European ray, *Trigon pastinaca* Linnaeus. Ten years later, in his monogram, *Recherches sur la Faune littorale de Belgique, Crustacés* (p. 149), he reported that the genus was found regularly upon the gills of this fish. In another monograph published in 1870 on *Les Poissons des Cotes de Belgique* (p. 15) he recorded finding three specimens upon the same host, and a fourth much smaller one, which was possibly the male.

Beneden's original description and figures are the only ones ever published, and unfortunately they were quite imperfect. If, however, the statements and figures which he did give were correct, there can be no doubt of the validity of the genus. The fusion of the first and second thorax segments, the exceptional size of the second antennae, and the fact that all the swimming legs are uniramous and without setae fully establish the genus, but such peculiar characters make it all the more desirable that they should



be confirmed by subsequent examination. If the species is as common as its founder claimed, there is no reason why some one should not give a new and detailed description that would satisfy all queries.

It is worthy of note that Valle in his list of parasitic copepods found upon fish in the Adriatic Sea<sup>25</sup> mentioned this species of Beneden and enumerated five other fish hosts upon which it is common. One of these was another species of *Trygon*, two were skates belonging to Bonaparte's genus *Laeviraja*, and two were sharks of the genus *Mustelus*. Specimens from these hosts were deposited in the Civic Museum of Natural History at Trieste.

Bassett-Smith<sup>26</sup> made Beneden's *Ergasilina* a doubtful synonym of *Nemesis*, and Brian in 1906, *Copepodi parassiti dei Pesci d'Italia* (p. 72), followed his example. They also made another of Beneden's "new genera," *Pagodina*, a synonym of *Nemesis*. This last synonymy is undoubtedly correct (see p. 60), but if Beneden's figures and text are at all reliable *Ergasilina* can not possibly be identical with *Pagodina* and *Nemesis* and must constitute a new genus.

Unfortunately the same name, *Ergasilina*, was given by Burmeister in 1833 to the family of parasitic copepods which includes the genera *Ergasilus*, *Bomolochus*, and their relatives, and the name has been used in that sense by many subsequent writers. Valle in the paper above quoted even went so far as to call the first family of parasites *Ergasilina*, including *Bomolochus* and *Ergasilus*, and then placed Beneden's genus *Ergasilina* in an entirely different family, the *Dichelestina*. Such a confusion of family and generic names is greatly to be regretted, but according to the rules recently adopted in scientific naming both the family and the genus must be allowed to stand.

#### Genus CONGERICOLA P. J. van Beneden.

Not *Cygnus* HUBENER for a genus of Lepidoptera, 1816.

*Cygnus* MILNE EDWARDS, *Histoire Naturelle de Crustacés*, 1840, p. 495.

Not *Cygnus* HESSE, *Ann. Sci. Nat.*, ser. 6, vol. 8, 1878, art. 11, p. 2.

*Congericola* BENEDEN, *Bull. Acad. de Belgique*, vol. 21, 1854, p. 583.

*Congericola* NORMAN, *Ann. Mag. Nat. Hist.*, ser. 7, vol. 11, 1903, p. 369.

*Congericola* T. and A. SCOTT, *British Parasitic Copepoda*, 1912, p. 124.

*Generic characters of female*.—Head fused with first thorax segment to form a small, rounded cephalothorax, separated from the body by a neck composed of two narrow free thorax segments, without lobes or plates. Fourth segment wider than the second and third and more or less free. Fifth segment fused with the genital segment to form an elongate, subcylindrical body wider than the head and neck. Abdomen short, one-jointed; anal laminae cylindrical, setose.

<sup>25</sup> *Boll. Soc. Adriatica Sci. Nat. Trieste*, vol. 6, 1880, p. 67.

<sup>26</sup> *Proc. Zool. Soc. London*, 1899, p. 476.

First antennae six-jointed; second pair two-jointed, short, uncinatc. Maxillae minute, setose; maxillipeds elongate, slender, with small terminal claws. Egg tubes long, eggs flattened but little. Four pairs of biramose swimming legs; no fifth legs.

*Generic characters of male.*—Cephalothorax elliptical, wider than the rest of the body; second, third, and fourth thorax segments free; fifth segment fused with the genital segment, narrower than the free segments and short. Abdomen one-jointed; anal laminae much longer than the abdomen, narrow-cylindrical.

First antennae six-jointed; second pair very long, stout, and tipped with strong curved claws. Mouth parts and swimming legs like those of the female.

*Type of the genus.*—*Congericola pallida* P. J. van Beneden.

KEY TO THE SPECIES.

- Two free segments the same width as the head; fourth legs much larger than the others, without setae.....*pallida* Beneden, 1854  
 Two free segments wider than the head; fourth legs smaller than the others, with setae.....*gracilis* (Milne Edwards), 1840

*Remarks.*—The name *Cygnus* was preoccupied by Hubener for a genus of Lepidoptera in 1816, and hence can not stand for a parasitic copepod genus, as was stated by Norman.<sup>27</sup> Hence Beneden's name must be adopted, and the type of the genus will be the species described by him.

**Genus NEMESIS** Risso.

*Nemesis* RISSO, Hist. Nat. des principales de l'Europe Meridionale, vol. 5, p. 135, 1826.

*Nemesis* ROUX, Crustacés de la Méditerranée, 1828, pl. 20, figs. 1-9.

*Nemesis* MILNE EDWARDS, Histoire Naturelle des Crustacés, 1840, vol. 3, p. 486.

*Pagodina* BENEDEN, Bull. Acad. Roy. Belgique, vol. 20, 1853, p. 482.

*Nemesis* HELLER, Reise der *Novara*, Crustacea, 1865, p. 220.

*Nemesis* VALLE, Boll. Soc. Adriatica Sci. Nat. Trieste, vol. 6, 1880, p. 66.

*Nemesis* BRIAN, Copepodi parassiti dei Pesci d'Italia, 1906, p. 71.

*Generic characters of female.*—Head fused with the first thorax segment, oval; four free quadrilateral thorax segments, each carrying a pair of biramose swimming legs, the first three as large as the cephalothorax or larger. Genital segment much smaller; abdomen narrower than the genital segment, two- or three-jointed; anal laminae minute and tipped with short spines.

First antennae ten- to fifteen-jointed, filiform, setose; second pair large, jointed, and ending in an exceptionally powerful claw. First maxillae minute, rudimentary; second pair two-jointed, terminating in a fleshy process. Maxillipeds very large, projecting their entire

<sup>27</sup> Ann. Mag. Nat. Hist., ser. 7, vol. 11, 1903, p. 369.

length beyond the carapace, and ending in a powerful sickle-shaped claw. First four pairs of legs biramous, rami two-jointed; fifth legs rudimentary, uniramous, two-jointed. Egg strings as long as the body, eggs thick and but little flattened.

*Generic characters of male.*—Body narrow and elongate. First thorax segment partially separated from the head; second, third, and fourth segments increasing in size; fifth segment smaller; genital segment smaller than the fifth segment; abdomen two-jointed; anal laminae narrow, elongate.

Basal joints of first antennae enlarged; second antennae small and weak. Maxillipeds modified into huge chelae, the dorsal jaw stout and bluntly rounded at the tip, the ventral jaw a long pointed claw. Fifth legs relatively much larger than in the female.

*Type of the genus.*—*Nemesis lamna* Risso, monotypic.

#### KEY TO THE SPECIES.

1. Cephalothorax triangular, widest at posterior margin, pointed anteriorly; first antennae six-jointed.....*carchariae-glauci* (Hesse), 1883, p. 60
1. Cephalothorax ovate, widest at anterior margin; fifth thorax segment as wide as the three preceding it.....*lamna* Risso, 1826
1. Cephalothorax ovate or elliptical, widest through the center; fifth segment half the width of the fourth or less; first antennae twelve- to fourteen-jointed.....2
2. Cephalothorax nearly as wide as the second segment and smoothly rounded; posterior margin of fifth segment three-lobed; fifth legs one-jointed, without setae.....*atlantica*, new species, p. 60
2. Cephalothorax two-thirds as wide as the second segment, with a knob on each lateral margin in front of the center; posterior margin of fifth segment evenly rounded; fifth legs two-jointed.....*versicolor* Wilson, 1913
2. Cephalothorax less than half the width of the second segment, smoothly rounded; fifth segment also smoothly rounded; fifth legs one-jointed, with setae.....*robusta* (P. J. van Beneden), 1853

*Remarks.*—This genus was established in 1826 by Risso with the species *N. lamna*. Two years later Roux accepted Risso's name for some specimens which he had obtained from *Lamna cornubica* Linnaeus. But he tried to establish a new species, to which he gave the name *carchariarium*, upon other specimens taken from the gills of *Carcharias vulpes* Cuvier. In 1865 Heller, after examining Roux's type specimens in the Vienna Museum, concluded that the two species *lamna* and *carchariarum* were simply different development stages of the same copepod, but instead of giving Risso's name priority and making Roux's name a synonym he discarded both names and called the species *N. mediterranea*. This name accordingly becomes a second synonym of *lamna*, as indicated by Brian in 1906, although it had previously been adopted by Richiardi, Valle, Bassett-Smith, and even by Brian himself in 1898.<sup>28</sup>

<sup>28</sup> Atti. Soc. Ligustica Sci. Nat. e Georg., vol. 9, p. 15.

In 1853 Beneden<sup>29</sup> published a description of a parasitic copepod which he claimed as a new genus and named *Pagodina*. It is the same as Risso's genus and hence becomes a synonym of *Nemesis*.

**NEMESIS CARCHARIAE-GLAUCI (Hesse).**

*Pagodina carchariae-glauci* HESSE, Ann. Sci. Nat., Zool., vol. 16, 1883, p. 13, pl. 12, figs. 12-19.

*Remarks.*—The female of this species was described and figured by Hesse, and recorded as having been found on the gills of *Carcharias glaucus*. This is one of the hosts of *Nemesis robusta*, and that circumstance would suggest a careful comparison of the two species to make sure that Hesse was justified in separating them. Although such a comparison is difficult owing to the meagerness of the descriptions, at the same time it reveals so many radical differences that it does not seem possible for the two species to be identical.

The distinguishing characters of the present species appear to be the pointed anterior end of the cephalothorax and its squarely truncated and scalloped posterior margin; the slenderness of the second antennae and the weakness of their terminal claws; the fact that the abdomen is fully as wide as the genital segment and only two-jointed; the three-jointed exopods and two-jointed endopods of the swimming legs, according to Hesse's text. In figure 19, however, he portrays the first two pairs of legs; the first pair have three-jointed exopods and two-jointed endopods, as the text calls for, but in the second pair both rami are one-jointed. It would seem as if some of these differences must be real, and if so they would establish the validity of the species.

**NEMESIS ATLANTICA, new species.**

Plate 9, figs. 61-69; plate 10, figs. 70-74.

*Host and record of specimens.*—Thirty specimens, including both sexes, were taken from the gills of the sharp-nosed shark, *Scoliodon terraenovae*, at Beaufort, North Carolina, July 26, 1905. A female with an attached male has been selected to serve as the type of the species, with Cat. No. 54051, U.S.N.M. The remaining specimens become paratypes with Cat. No. 32814, U.S.N.M.

Sixty specimens, including both sexes and development stages, were obtained by Dr. M. T. Thompson from the gills of the thresher shark, *Alopias vulpes*, at Woods Hole, July 20, 1902. The adult females, 30 in number, have been given Cat. No. 39564, U.S.N.M.; the males and young have been separated, with Cat. No. 39565, U.S.N.M. These specimens were especially numerous on the first pair of gills, the larger females with egg strings near the tips of the gill filaments, the males and undeveloped females nearer the bases.

<sup>29</sup> Bull. Acad. Roy. Belgique, vol. 20, p. 482.

*External specific characters of female.*—Body elongate and quite thick-set, made up of a distinct cephalothorax, four free thorax segments, a genital segment, and three abdomen segments. Carapace elliptical, a little longer than wide, about one-fourth of the entire length, with an evenly curved outline. Its width in proportion to that of the second segment is as 6 to 7. Both pairs of antennae usually project from the anterior margin, while from the sides a pair of huge maxillipeds stretch back to the center of the second segment.

First three free segments about the same size, their length less than half their width. Each is entirely covered dorsally with a plate whose ends curve around the sides of the segment and reach a short distance onto the ventral surface. Each plate overlaps the one behind it like shingles on a roof, while the ends of all of them are free and stand out a little from the ventral surface. There is space enough between these ends for the thoracic legs to work freely. The posterior corners of the fourth segment are prolonged into short semicircular lobes, which project from beneath the posterior edge of the dorsal plate. The fifth segment is much narrower than the other three, obovate in shape, and considerably narrowed where it joins the fourth segment. The dorsal plate is the same shape as the segment, with a three-lobed posterior margin, the middle lobe being much wider than the lateral ones and overlapping the genital segment. This plate does not curve around the sides of the segment and hence is invisible from the ventral surface.

The genital segment is transversely elliptical, narrower than the fifth segment, with strongly convex sides. Posteriorly it is slightly emarginate, and this, with the overlapping median lobe of the fifth segment, gives it something of a dumb-bell shape in dorsal view.

The abdomen is about half the width of the genital segment and three-jointed, the first two joints very short, the terminal one much longer and hemispherical. The anal laminae are narrow, spindle-shaped, and longer than the last abdomen segment, with three short terminal setae, and a fourth still shorter one on the outer margin. Egg strings a little wider than the abdomen and not quite as long as the entire body, with 25 or 30 eggs in each string.

The first antennae have 10 or more joints, the divisions at the base being very indistinct. The second, the fourth, and the two terminal joints are longer than the others, which are all about equal. Every joint bears at least one seta on its anterior margin, the second joint has two with four others on its ventral surface, and the fourth joint also has two, with another one on its ventral surface. The last two joints are ellipsoidal, the terminal one tipped with five or six long setae.

The second antennae are four-jointed, the first and third joints about equal and considerably longer than the other two. The

terminal joint is shortest and consists of a short curved claw with a bifid tip, carrying on its inner margin a long accessory spine.

The mouth tube is in the shape of a truncated cone, a half longer than wide, and is too opaque to reveal the structure of its bony framework. The first maxillae lie so close to the base of the mouth tube that they are partially overlapped by its sides. Each consists of a conical base surmounted by two long spines, which reach to the tip of the mouth tube.

The second maxillae are two-jointed, the terminal joint the longer, club-shaped, and terminated with a wicked-looking array of spines. There is first at the inner distal corner a large claw curved outward and armed with five rows of stout and acuminate spines. A semi-circular row of long stiff hairs starts from the inner corner of the base of this claw and curves around backward onto the ventral surface. At the outer distal corner is a semicircular row of large, stout, and acuminate spines, which runs around the corner and then sweeps down onto the ventral surface at either end. This combination of stiff hairs and sharp spines must make a very effective arrangement for keeping the mouth parts clean.

The maxillipeds are the grasping organs and are very large and powerful; they are two-jointed, the joints about the same length and both strongly curved, the terminal one a simple claw.

All four pairs of legs are biramose, the rami of the first pair one-jointed, of the other three pairs two-jointed. The first legs are peculiar, the exopod being a broad, falcate, strongly flattened lamina curving around beneath the endopod. This is armed on its outer margin with short and sharp teeth and is tipped with a curved, blunt spine. The endopod is made up of three parts, all attached at the same level; the outer one is a broad but simple plumose seta, the other two are flattened laminae, covered with short hairs, the inner one elliptical in outline, its terminal margin armed with spines, the middle one triangular and tipped with a large curved spine. The exopod is capable of independent motion and the living copepod keeps shutting it past (underneath) the endopod like the blade of a pair of shears. The other three pairs of legs are alike, each consisting of a wide basal joint, with an oblique outer margin, to which is attached the exopod, while the larger endopod is jointed to the terminal margin. In both rami the joints diminish in size from the base outwards, and all are heavily armed with spines. On either side of the fifth joint in ventral view may be seen a small rudimentary leg, pointed backwards.

Color a bright clear yellow, nearly opaque; the digestive tract and egg strings a dark brown or even black, the legs almost white, the bases of the second antennae, the maxillae, and the maxillipeds

washed with a dull rust color. The entire maxillipeds are sometimes crimson, in which case they are not easy to distinguish against the background of the gill filament.

Total length, 5mm. Cephalothorax 1.40 mm. long, 1.35 mm. wide. Free thorax and genital segment 3.30 mm. long, the first three segments 1.90 mm. wide. Abdomen 0.70 mm. long. Egg strings 4.50 mm. long.

*External specific characters of male.*—General make-up as in the female, but with the body narrower and more elongate. Carapace one-fifth longer than wide and one-third of the length of the entire body, with a very regular elliptical outline. First free segment the same width as the carapace, the third and fourth segments diminishing slightly in size, the fifth segment nearly suppressed, appearing only as a short and narrow neck between the fourth and genital segments. But small as it is it has a pair of uniramous legs, which can be plainly seen in dorsal view. Genital segment relatively much larger than in the female; it is fully as wide as the free segments and two-thirds as long as the carapace, with strongly convex sides. It is covered dorsally and ventrally with two plates which fit closely to the skin. The dorsal plate is slightly emarginate at the center posteriorly, and only extends to the posterior margin of the spermatophore receptacles. The ventral plate is deeply emarginate beyond the center of the spermatophore receptacles, leaving the posterior portion of the latter uncovered. The posterior ventral portion of the segment itself is divided into two broad lobes slightly overlapping the abdomen and tipped with two spines. The sinus between these lobes is narrow and slitlike and extends forward nearly as far as the emargination of the ventral plate.

The spermatophore receptacles are simple, very large, almost perfectly elliptical in outline, and together fill nearly the entire segment.

The spermatophores are correspondingly large, spherical, and dark purple in color, and are often found attached to the genital segment of the female, as in figure 70. It will be seen that they are more than half the size of the genital segment of the female and that but a single spermatophore at a time could be contained in one of the male's receptacles. They swell somewhat also on contact with the sea water and are immediately surrounded with a layer of slime which makes them appear still larger. Their size and their deep purple color makes them conspicuous on the genital segment of the female.

The abdomen has four joints instead of three, diminishing regularly in width from in front backward. The two basal ones are longer than the two terminal ones and have convex sides; the penul-

imate joint is the shortest. The anal laminae are broad, longer than the last two abdomen segments together, and each tipped with three long plumose setae.

The appendages are like those of the female except that the mouth parts are more heavily armed with spines and setae, and in the swimming legs the short spines of the female are replaced by long plumose setae.

Color similar in all respects to that of the female.

Total length, 2.15 mm. Cephalothorax 0.86 mm. long, 0.65 mm. wide.

*Internal specific characters of female.*—Esophagus with a sharp bend near its center, opening into the ventral surface of the stomach a short distance back of its anterior end. Stomach considerably enlarged, but abruptly narrowed at the posterior margin of the cephalothorax. Intestine somewhat convoluted, extending through the center of the body, narrowed in the genital segment and then widened into a fairly long rectum.

Supraesophageal ganglion large and well defined; infraganglion a long spindle reaching back to the posterior margin of the cephalothorax. Ventral nerve running back to the fifth segment.

Ovaries above the stomach at the posterior end of the cephalothorax, each ovate and filled with genital protoplasm and egg filaments. The latter are divided transversely into separate cells, the eggs each with its own nucleus and nucleolus. These cells are separated as they pass into the oviduct and each develops into an egg. The oviduct opens out of the posterior end of the ovary and runs through the thorax dorsal to the intestine and outside of the cement glands. It is convoluted in each of the free segments, and when the eggs are mature it fills practically all the space between the intestine and cement glands and the dorsal and lateral walls of the body. The oviducts open out of the dorsal surface of the genital segment, and just before reaching the external openings, the vulvae, each receives the duct of the cement gland on its side of the body.

The cement glands are situated on either side of the midline in the third, fourth, and fifth segments, dorsal to the intestine; they are cylindrical in the fifth segment with a wide diameter, are narrowed rapidly in the fourth segment, and just reach across the posterior margin of the third segment; they are not segmented.

The sperm receptacle is a large sack lying ventral to the intestine in the posterior end of the fifth and the anterior portion of the genital segments. It has already been noted that the spermatophores are exceptionally large, and this sack is correspondingly large, since it must hold the contents of two spermatophores.

The excretory glands are not readily located, but apparently they are situated at the posterior margins of the thoracic segments, espe-



cially in the lobes of the dorsal plates and inside the bases of the swimming legs.

*Internal specific characters of male.*—Digestive canal and nervous system similar to those of the female. Testes situated at the posterior end of the cephalothorax near the dorsal surface, with the sperm ducts leading back to the spermatophore receptacles in the genital segment. These receptacles occupy practically the whole of the genital segment, and each opens on the ventral surface near the center of its half of the posterior margin. Just in front of the receptacle the walls of the sperm duct are thickened and become glandular for the secretion of the cement substance which forms the outside wall or case of the spermatophore.

The excretory glands are more difficult to locate than in the female, and it is impossible to recognize them with certainty in any sections thus far examined.

(*atlantica*, of or belonging to the Atlantic Ocean.)

*Remarks.*—This species was found clinging to the very tips of the gill filaments, and while the total number of specimens is large, the yield from each fish was small. Four of the largest sharks examined contributed only three specimens, two males and a female.

When removed and placed in water both sexes are very restless and keep up a constant motion of all their appendages. The male by reason of the plumose setae on his swimming legs is able to kick himself about, and even to swim in a bungling fashion, but the female simply rolls around, and is practically helpless.

This species has already been contrasted with the one obtained from the hammer-head shark in the West Indies on page 239 of volume 44 of these Proceedings. The simplest way to tell these two species is by the presence or absence of a knob on either margin of the cephalothorax and by the visibility or invisibility of the fifth legs in dorsal view.

#### Genus EUDACTYLINA P. J. van Beneden.

*Eudactylina* BENEDEN, Bull. Acad. Roy. de Belgique, vol. 20, 1853, p. 235.

*Eudactylina* OLSSON, Lunds Univ. Arsskrift, vol. 5, 1868-9, No. 8, p. 24.

*Eudactylina* VALLE, Boll. Soc. Adriatica Sci. Nat. Trieste, vol. 6, 1880, p. 67.

*Eudactylina* T. and A. SCOTT, British Parasitic Copepoda, 1913, p. 125.

*Generic characters of female.*—Head fused with first thorax segment and covered more or less completely with a carapace, the latter usually emarginate posteriorly. Four free thorax segments, without dorsal plates or lateral processes, the first three with biramose swimming legs, the last one (fifth segment) with uniramose legs. Genital segment considerably smaller than the fifth segment; abdomen still smaller and from one- to three-jointed.

First antennae short and stout, five- to seven-jointed, the basal or subbasal joint usually armed with curved claws. Second antennae three-jointed, the terminal joint a stout curved claw. Mouth tube small, conical, and bluntly rounded; mandibles slender, stylet-shaped; first maxillae biramose, rami slender and fringed with hairs; second maxillae three-jointed, the last joint a small claw; maxillipeds large, with strong terminal chelae. First four pairs of legs short, biramose; rami of first pair two-jointed, of second, third, and fourth pairs three-jointed; exopod of second pair often modified; fifth pair uniramose, one-jointed. Anal laminae short but well armed with setae; egg strings as long as the body; eggs large, not much flattened.

*Generic characters of male.*—General body form and segmentation as in the female, but smaller, longer, and more slender. Genital segment and abdomen together forming half the entire length, the former considerably larger than the fifth segment. Abdomen three- or four-jointed.

First antennae stout, with a strong curved claw at the tip; second pair also stout, with two large terminal claws and spines on the first two joints. Maxillipeds with a normal basal joint and a long terminal claw not chelate. Swimming legs like those of the female, except that the second exopod is not modified. Anal laminae long and narrow, tipped with hooked claws.

*Type of the genus.*—*Eudactylina acuta* P. J. van Beneden, monotypic.

#### KEY TO THE SPECIES.

1. Entire body rough and covered with short, coarse hairs; second thorax segment not sensibly smaller than the others.....2
1. Entire body smooth, without hairs or spines except on the appendages; second thorax segment distinctly smaller than the others.....4
1. Frontal end of carapace and two abdomen segments covered with spinules; fourth and fifth segments fused.....*insolens* T. and A. Scott, 1912
2. Free thorax segments considerably wider than long; egg strings elongate and filiform; eggs minute and strongly flattened.....3
2. Free thorax segments as long as wide or longer; egg strings wide and short; eggs large, not much flattened.....*minuta* T. Scott, 1904
3. Head triangular, narrowed to a rounded point anteriorly; second, third, and fourth segments wider than the head, obcordate; abdomen four-jointed; anal laminae wide, flattened.....*squatinae-angeli* Hesse, 1883
3. Head tetragonal, narrowed but little anteriorly; second, third, and fourth segments transversely elliptical; abdomen two-jointed; anal laminae slender and cylindrical.....*aspera* Heller, 1865
4. Head oblong, narrowed anteriorly; maxillipeds strongly chelate, jaws about equal, their ends shutting together.....5
4. Head quadrate, as wide anteriorly as posteriorly; maxillipeds not chelate, claw longer than basal joint and shutting against a knob.....6
5. Second segment considerably smaller than the others; anal laminae broad and flattened, each with three rudimentary spines and a fringe of hairs on the inner margin.....*acuta* P. J. van Beneden, 1853

5. Second segment larger than the others; anal laminae narrow and cylindrical, each with two rudimentary spines and without the fringe of hairs.....*similis*, T. Scott, 1902
5. Second segment the same size as the third and fourth; anal laminae flattened, each with five stout spines and without the fringe of hairs; exopod of first legs one-jointed.....*acanthii* A. Scott, 1901
6. A large spine at each posterior corner of the carapace; no claws on first antenna; abdomen two-jointed.....*nigra* Wilson, 1905, p. 67
6. No spines at posterior corners of carapace; two huge curved claws on the first antennae; abdomen one-jointed.....*uncinata* Wilson, 1908

*Remarks.*—Hesse<sup>30</sup> described and figured two new species, both of which he referred to the present genus, and to which he gave the specific names *musteli-laevis* and *charchariae-glauci*. While it is fairly probable that these species do belong here, we cannot accept them as he has presented them on account of serious discrepancies in his text and figures. In his dorsal view of *musteli-laevis* (fig. 1) there are five free segments in front of the genital segment and the fifth legs are on the latter. In lateral view (fig. 2) the fifth legs are on the fourth free segment. In figure 1 the abdomen is one-jointed, in figures 2 and 11 it is two-jointed, and in figure 10 it is three-jointed. In figure 2 the first thorax segment is fused with the head, while in figure 14, which is a lateral view of *charcharias-glauci*, the first segment is distinctly separated from the head. The dorsal view of this latter species (fig. 13) shows the egg tubes coming out from under the fifth legs. The lateral view (fig. 14) shows that these legs are on the fifth free segment and distinctly separated from the genital segment. Furthermore figure 13 shows a pair of stalked eyes, of which Hesse stated in his text: "Les yeux sont petits et placés près du bord frontal à l'extrémité de deux petits appendices tubuliformes" (p. 11). Due allowance can be made for poor figures and faulty descriptions, but when both unite in ascribing a pair of stalked eyes to a parasitic copepod, prudence demands that the species be ignored until future investigation determines what it is and where it belongs.

EUDACTYLINA NIGRA Wilson.

Plate 11, figs. 76-85; plate 12, fig. 86.

*Eudactylina nigra* WILSON, Proc. Biol. Soc. Washington, vol. 18, 1905, p. 131.

*Host and record of specimens.*—Twenty specimens, all females, were obtained from the gills of the sand shark, *Eugomphodus littoralis*, at Woods Hole in July, 1902, by the author. One has been selected to serve as a type of the species with Cat. No. 54070, U.S.N.M. The others become paratypes with Cat. No. 54071, U.S.N.M. Another lot of 60 specimens, also all females, was ob-

<sup>30</sup> Ann. Sci. Nat. Zool., vol. 16, 1883, pp. 8-13, pl. 14, figs. 1-23.

tained from the same locality and host July 9, 1904, and have been given Cat. No. 54072, U.S.N.M.

*External specific characters of female.*—Body elongate, largest at the anterior end and regularly tapered to a blunt point at the posterior end. There are four free thorax segments, diminishing regularly in width but of very different lengths, the fifth segment being much the longest and the second (first free) segment the shortest. The first segment, being fused with the head, is always partially and sometimes completely hidden beneath the posterior margin of the carapace. Occasionally it is quite distinctly separated from the head, but this is due to lack of maturity, the tendency being for it to appear plainly in undeveloped females, and then gradually disappear as development progresses.

Carapace nearly as long as the second and third segments together, subquadrilateral in outline with rounded corners and a deeply emarginate posterior border. The lateral margins are also often more or less emarginate. The first antennae are prominent on the anterior margin, and their basal joints have an appearance similar to the frontal plates in the Caligidae. The dorsal surface of the carapace is grooved similarly to the cephalic area in the Caligidae, but no eyes can be detected. Both the second maxillae and the maxillipeds project beyond the margins of the carapace and stand out prominently in dorsal view.

There are four pairs of biramose swimming legs, together with a fifth and sixth pair, which are rudimentary and consist merely of a lamellar joint without rami. The sixth pair can be seen only on immature females and apparently disappear in the mature adult.

The egg sacks are attached to the sides of the genital segment near its posterior end. Each is fully as wide as the genital segment itself, considerably more than half as long as the entire body, and contains from 8 to 12 large eggs.

The abdomen is small, no longer and much narrower than the genital segment, and two-jointed. The basal joint is a little the wider while the terminal joint is much the longer, and is tipped with two tiny anal laminae, whose setae are hardly visible.

The first antennae are long and slender, and are made up of two large and stout basal joints and six short terminal ones.

The basal joints are fully half the entire length of the antenna, and on the dorsal surface the second of these joints ends in two stout claws which curve over ventrally on the posterior side of the third joint. On the ventral surface both basal joints are armed with a row of stout spines along their anterior border, while near the distal end of the second joint is a circular disk carrying two strong spines. From beneath this disk a large spine extends laterally, parallel with

the axis of the antenna. There are no other spines except a terminal tuft of 8 or 10 at the tip of the terminal joints, of which one is much longer than the others and curves around backward toward the body; the rest are straight.

The second antennae are stout and three-jointed; the basal joint is considerably swollen and carries a small spine on its outer margin.

The second joint is inserted in such a manner as to stand out diagonally from the ventral surface of the head. It bears on its anterior surface at the center a large elliptical plate of corrugated chitin, which is raised considerably above the surrounding surface. The terminal joint is in the form of a strong claw, which is strengthened at its base by two short and stout spines.

The mouth tube is an elongated oval in outline, the tip rather bluntly rounded. The opening is terminal or subterminal, and through it can be seen the tips of the stylet-shaped mandibles.

The first maxillae lie on either side of the mouth tube; each consists of a slender basal joint and two filiform rami, the endopod longer than the exopod and reaching beyond the tip of the mouth tube. Both rami are armed with short hairs arranged like those of plumose setae. The second maxillae are inserted far forward, close to the edge of the carapace; in fact they stand opposite the base of the mouth tube and are separated as far as possible from each other. Each is three-jointed, the two basal joints being considerably swollen and of about the same size, while the terminal joint is in the form of a short, straight claw. This claw is dentate along its posterior margin and also flanged with a circular flap near its tip. At the base of the claw and extending back some little distance on the outer surface of the second joint is a row of long stiff hairs.

The maxillipeds are large, even for this genus, and their pattern gives a ready means of identification of the species. They also are set close to the edge of the carapace and as far apart as possible, but are united across the midline by a broad band of chitin, which lies just behind the mouth tube. The basal joint is stout and tapers toward the distal end; it extends diagonally outward and backward beyond the margin of the carapace. At the base on the outer surface there is a medium-sized knoblike protuberance, which is corrugated and armed with short spines. The second joint is slightly narrower, but still stout and considerably longer than the basal joint. It is, however, strongly curved, so that the terminal joint is brought directly over the knob just mentioned. This terminal joint is in the form of a large chela, composed of a stout proximal and two distal portions. Of the latter the inner one is the inarticulate branch of the chela, and is a large knob with a corrugated inner surface. The outer portion, the articulate branch, consists of three parts, two

stout claws of about the same size standing side by side and slightly curved, and a large spatulate lamina, dorsal to them and standing on its edge with its flat side next to the claws.

The first four pairs of legs are biramose; in the first three pairs the endopods are distinctly three-jointed, while the exopods are indistinctly jointed, but the arrangement of the spines and notches on the lateral margins show that they are also three-jointed. Both rami of the fourth legs are indistinctly jointed, but again the spines and notches indicate that the exopods are three-jointed, while the endopods are only two-jointed. The basal portion of each foot consists of two joints imperfectly separated. The fifth legs consist of a semicircular flap on either side of the fifth segment, tipped with three small spines. Just in front of each fifth leg is a single spine standing out at right angles to the surface. In most females the rudiments of a sixth pair of legs may be seen on the genital segment behind the bases of the egg tubes. These are much more in evidence in young females, where they are fully as large as the fifth pair.

Color a dark brown or black, the brown due to the long and irregular ovaries, the black to the contents of the intestine. The eggs are also dark brown, so that the copepod shows plainly against the red background of the gills.

Total length, 2.40 mm. Carapace 0.50 mm. long, 0.40 mm. wide. Length of thorax, 1.70 mm.; of abdomen, 0.33 mm.; of egg strings, 1.30 mm.

*Internal specific characters of female.*—The esophagus enters the stomach near its anterior end and on the ventral surface. The stomach is not much enlarged and passes insensibly into the intestine posteriorly. The ovaries are situated in the posterior part of the cephalothorax near the dorsal surface. The oviducts are more or less convoluted, and when mature fill nearly all the space between the digestive canal and the body wall. The cement glands are in the dorsal portion of the genital segment and extend forward into the fifth segment. Each is slender, club-shaped with the swollen end anterior, and distinctly segmented. The semen receptacle is in the posterior portion of the genital segment, ventral to the oviducts and cement glands. The large maxillipeds have a correspondingly large set of powerful muscles, which are attached to the dorsal surface and sides of the cephalothorax.

*Nauplius.*—The nauplius is ovate in outline, slightly wider anteriorly, the length about twice the width, the margins very evenly curved. The plumose setae on the first antennae are longer than the appendages themselves, on the other two pairs they are about the same length as the appendages. The endopods of the second antennae and mandibles have five setae, the exopods two. The balancers are close to the posterior end of the body, are very narrow,

of the same diameter throughout, and are bluntly pointed. The color of the appendages and body margins is that of transparent cartilage; the center of the body is opaque and dark gray. The nauplius eye is not visible in any of the specimens examined.

*Remarks.*—This species is very abundant on the gills of the sand shark, where they appear as minute dark brown or black lines against the red filaments. They are firmly fastened by their maxillipeds, which are clasped around the filaments, with the terminal chelae buried in the tissue of the filament. When removed they always retain some of the tissue still clasped in the chelae, together with an abundance of slime, and must be thoroughly cleaned before they can be properly preserved. When placed in water they wriggle about like a worm, but can not move definitely in any direction. They get hold of any fragments of tissue or waste material that may be within reach and cling to them as tenaciously as to the gill filaments, but if they are well cleaned when removed and are kept free from such waste material they will live three or four days. No males could be found, although the gills of many fish were searched diligently for them.

#### Genus LAMPROGLENA Nordmann.

*Lamproglena* NORDMANN, Mikrographische Beiträge, 1832, pt. 2, p. 1.

*Lamproglena* MILNE EDWARDS, Histoire Naturelle des Crustacés, 1840, vol. 3, p. 487.

*Lamproglena* CLAUS, Zeit. für wiss. Zool., vol. 25, 1875, p. 352.

*Lamproglena* BRIAN, Copepodi parassiti dei Pesci d'Italia, 1906, p. 78.

*Generic characters of female.*—Head partially separated from the first thorax segment and divided by deep lateral sinuses into an anterior and posterior portion. First segment only half the width of the head and very short, forming a neck; second, third, and fourth segments increasing in size, the latter as large as the head; fifth segment smaller than the first; genital segment nearly spherical and much wider than the fifth segment. Abdomen made up of three segments, diminishing considerably in length and slightly in width from in front backwards, the three together nearly as long as the rest of the body.

First antennae indistinctly jointed, heavily armed with setae; second pair slender, four-jointed, strongly curved, setose and not uncinat. Mandibles awl-shaped, with a double curve. Second maxillae powerful prehensile organs, armed with stout claws. Maxillipeds also prehensile but weaker, with multiple terminal claws. First four pairs of legs biramose, the rami indistinctly two-jointed; fifth legs uniramous, one-jointed, and very small. Male unknown.

*Type of the genus.*—*Lamproglena pulchella* Nordmann, first species.

*Remarks.*—Nordmann described and figured the type species in considerable detail and then added on page 134 of the same paper two other species, but gave no figures for these and briefly described one of them only. These two species were found upon different hosts in the Red Sea, *L. lichiae* upon *Lichia aculeata* and *L. hemiprichii* upon *Hydrocycnus dentex*. Neither of them have been seen by any investigator except Nordmann, and it is impossible on the basis of the data he gives to distinguish them from the type species or from each other.

#### Genus DONUSA Nordmann.

*Donusa* NORDMANN, Bull. Soc. Imp. Nat. Moscou, vol. 37, 1864, p. 494.

*Generic characters of female.*—Head fused with first thorax segment to form a triangular cephalothorax, pointed anteriorly; second, third, fourth, and fifth segments free, each with a pair of biramose swimming legs. Genital segment very small, enlarged posteriorly. Abdomen three-jointed, tapered posteriorly; anal laminae slender, elongate, jointed near their tips, armed with nonplumose setae.

First antennae filiform with enlarged basal joints; second pair also filiform and setose, not uncinata. Second maxillae and maxillipeds large, strong, and tipped with stout claws. Five pairs of biramose legs, rami three-jointed. Male unknown.

*Type of the genus.*—*Donusa clymenicola* Nordmann, monotypic.

*Remarks.*—This genus was founded upon two female specimens taken on the west coast of Sweden from the Annelid, *Clymene lumbricalis* Fabricus. No one except Normann has ever seen specimens of the genus and no other investigator has even mentioned them except Levinsen, who published a list of parasitic copepods found upon Annelids and merely mentioned *Donusa* in the list. The genus seems to be well established, however, and both Nordmann's description and figures are clear-cut and decisive.

The fact that the fifth legs are biramose, with three-jointed rami, like the four preceding pairs, is the most distinctive character of the genus.

#### BASSETTITHIA, new genus name.

*Bassettia* STEBBING, Willey's Zoological Results, pt. 5, 1900, p. 672.

*External generic characters of female.*—Head fused with first thorax segment, the resulting cephalothorax globose, with strongly convex margins. Second, third, and fourth segments indistinctly separated; fifth and genital segments fused, oblong oval in outline, longer and wider than the rest of the body, with projecting posterior corners. Abdomen one-jointed; anal laminae narrow and tipped with minute setae.

First antennae nine-jointed; second pair prehensile with a stout terminal claw. First three pairs of swimming legs reduced to mere



tubercles without rami; fourth pair with minute, one-pointed rami. Male unknown.

*Type of the genus.*—*Bassettithia congri* (Stebbing), monotypic.

*Remarks.*—This genus was established in the year 1900 by Rev. T. R. R. Stebbing and was named in honor of Dr. P. W. Bassett-Smith, R. N. The name given by Stebbing, however, had been pre-occupied by Ashmead in 1887 for a genus of insects, and in its place is suggested the altered form given above, which includes a portion of the Smith as well as all of the Bassett.

#### Genus PSEUDOCLAVELLA Bassett-Smith.

*Pseudoclavella* BASSETT-SMITH, Ann. Mag. Nat. Hist., ser. 7, vol. 2, 1898, p. 92.

*External generic characters of female.*—Head fused with first thorax segment, the two globose and covered with a dorsal carapace, which is cleft at the center of the posterior margin. Second thorax segment free, narrower than the head; the remaining thorax segments fused with the genital segment into an elongated, spindle-shaped body, considerably narrowed posteriorly, and four times as long as the cephalothorax. Abdomen minute and one-jointed; anal laminae lamellar.

First antennae indistinctly three-jointed, setose; second pair two-jointed, the terminal joint a stout, strongly curved claw. First maxilliae minute, slender, and straight; second pair three-jointed, the terminal joint a curved claw. Maxilliped long and slender, the basal joint projecting beyond the margin of the head, the second joint long and filiform, the terminal claw short and curved. First two pairs of legs biramose, rami two-jointed except the endopod of the first pair, which has but a single joint. Third and fourth legs uniramous, one-jointed, tipped with setæ. Egg tubes as long as the entire body, eggs large and well flattened.

*Type of the genus.*—*Pseudoclavella ovalis* Bassett-Smith, monotypic.

*Remarks.*—The name chosen for this genus is unfortunate for the following reasons: Oken<sup>31</sup> first proposed the genus *Clavella*, with the type species *uncinata*, and both stand to-day as he established them, but they are Lernaeopods and not Dichelesthids. Krøyer<sup>32</sup> made Oken's *Clavella* a synonym of Cuvier's *Anchorella*, and then on page 195 he restored the genus *Clavella*, but took as its type the species *hippoglos* which is a Dichelesthid. Milne Edwards and subsequent writers followed Krøyer's mix-up and *Clavella* was regarded as a Dichelesthid genus until Poche in 1902 showed that if *Clavella* is to be retained at all it must be as a Lernaeopod genus,

<sup>31</sup> Lehrbuch der Naturgeschichte, 1815, p. 357.

<sup>32</sup> Naturhistorisk Tidsskrift, vol. 1, 1837, p. 193.

and he proposed the name *Hatschekia* for the Dichelesthiid genus. This has been universally adopted, but it leaves us with *Clavella*, a recognized Lernaeopod and *Pseudoclavella*, just as evidently a Dichelesthiid and not in the slightest degree a "pseudo" of the Lernaeopod.

**Genus PSEUDOCYCNUS Heller.**

*Pseudocycnus* HELLER, *Reise der Novara*, 1865, p. 218.

*Pseudocycnus* BASSETT-SMITH, *Proc. Zool. Soc. London*, 1899, p. 475.

*Pseudocycnus* BRIAN, *Copepodi parassiti dei Pesci d'Italia*, 1906, p. 76.

*External generic characters of female.*—Head fused with first thorax segment, second and third segments free; fourth and fifth segments fused with the genital segment into a cylindrical body several times longer than wide, and of about uniform diameter throughout its length. Abdomen one-jointed; anal laminae elongate-lanceolate, one-third as long as the entire body, very narrow. Egg strings filiform, longer than the body, eggs minute, numerous, and strongly flattened.

First antennae short and tapering, with a tuft of setae at the tip; second antennae prehensile, armed with a stout claw. Mouth tube short and conical.

First maxillae filiform and setaceous; second maxillae stout and uncinata; maxillipeds large, with a toothed terminal claw. First legs single laminae without rami or setae; second legs biramose, rami one-jointed, setiferous; third and fourth legs uniramous, one-jointed, with terminal setae.

*Internal generic characters of female.*—Esophagus entering the stomach on the ventral surface near the anterior end; intestine narrowed through the second and third thorax segments, then widened in the fused posterior body. Ovaries in the posterior portion of the cephalothorax near the dorsal surface; oviduct first narrow, then widened in the genital segment and convoluted along the lateral margins. The convolutions are small but quite regular, especially toward the posterior end. The external opening of the oviduct and hence the egg strings are dorsal to the abdomen. The cement glands lie side by side on the median line beneath the intestine. Each is filiform, very narrow, and about the same diameter for its entire length, without segmentation. The semen receptacle lies on the ventral surface of the genital segment beneath the intestine; it is pointed anteriorly and three-lobed posteriorly.

*External generic characters of male.*—Head fused with the first thorax segment, the two joined to the second segment by a short neck. Subsequent thorax and genital segments increasing regularly in width; abdomen abruptly reduced to less than half the width of the genital segment, one-jointed. Anal laminae flattened, much longer than wide, bluntly rounded, and armed with minute spines.

First antennae indistinctly jointed; second pair prehensile; second maxillae and maxillipeds similar to those of the female but relatively stronger. First swimming legs single laminae, unarmed; second pair biramose, rami one-jointed; third pair uniramose, one-jointed; fourth pair uniramose cylinders, one-jointed and half as long as the body.

*Type of the genus.*—*Pseudocycnus appendiculatus* Heller, monotypic.

*Remarks.*—The name of this genus is even more unfortunate than that of the preceding one. In his *Histoire Naturelle des Crustacés* (1840) Milne Edwards described and figured a new genus of parasitic copepods, to which he gave the name *Cycnus*. But Hubener had used this name 24 years before for a genus of Lepidoptera, and hence it can not stand for the parasitic copepods.

P. J. van Beneden<sup>33</sup> described and figured a copepod parasite which he claimed as a new genus and called *Congericola*. This has since been proved to be generically identical with Milne Edwards specimens, but specifically distinct. Accordingly the name *Cycnus* must be dropped and the name *Congericola* retained. But this leaves us the embarrassing necessity of retaining *Cycnus* as a valid genus among the moths and *Pseudocycnus* among the parasitic copepods, the two, of course, not being in the remotest degree related to each other.

PSEUDOCYCNUM APPENDICULATUS Heller.

Plate 12, figs. 87-96.

*Pseudocycnus appendiculatus* HELLER, *Reise der Novara*, 1865, p. 218, pl. 22, fig. 7.

*Pseudocycnus appendiculatus* BRIAN, *Copepodi parassiti dei Pesci d'Italia*, 1906, p. 76.

*Pseudocycnus appendiculatus* BRIAN, *Resultats des Campagnes scientifiques du Prince de Monaco*, 1912, fasc. 38, p. 15, pl. 5, fig. 3; pl. 6, fig. 11.

*Host and record of specimens.*—Sixteen females and a male were taken August 18, 1886, 100 miles south of Marthas Vineyard from the gills of the albacore, *Orcynus alalonga*, by the schooner *Grampus*. The females have received Cat. No. 12663, U.S.N.M., while the male has been separated and given Cat. No. 54073, U.S.N.M.

*External specific characters of female.*—Cephalothorax ovate, narrowed anteriorly, with somewhat concave anterior and lateral margins, and covered with a dorsal carapace. The posterior corners of this carapace are prolonged into wide well-rounded lobes above the basal joints of the maxillipeds. Anteriorly the dorsal and ventral surfaces are fused into a thickened margin which projects a little on either side external to the base of the antenna. The first thorax segment

<sup>33</sup> Bull. Acad. Belgique, vol. 21, 1854, p. 583.

appears in dorsal view only as a narrow neck between the posterior lobes of the carapace and is less than one-fourth the width of the head. The second, third, and fourth segments are abruptly widened to equal the carapace, with sharply convex lateral margins. Along the anterior border of these segments on either side is the rudiment of a dorsal plate appearing in the form of a thickened margin, which projects slightly. The fused posterior body is a little narrower than the fourth segment, about six times as long as wide, with nearly straight sides. It shows no traces of segmentation, but is divided quite regularly by the attachment of transverse rows of dorsoventral muscles. The egg strings are attached to its posterior margin close to the midline and over the base of the abdomen, and are longer than the entire body. The abdomen is about half as wide as the genital segment, one-jointed, and obliquely truncated at its posterior corners, to which are attached the anal laminae. These latter are lanceolate, somewhat flattened dorsoventrally, and taper to an acute point. Each is about one-third as long as the entire body, is eight times as long as wide, and is destitute of spines or setae.

The first antennae are indistinctly three-jointed and tapered, with a tuft of short spines at their tip. The second antennae are evidently the chief organs of prehension, and project nearly their whole length in front of the anterior margin. Each one is made up of a stout basal joint and a strongly curved terminal claw, which is usually carried at right angles to the basal joint, thereby increasing its holding power.

The mouth tube is short and rather wide and tapers to a blunt point. On either side of its base are the first maxillae, which are filiform, three-jointed, and destitute of setae or claws. The second maxillae are attached just outside of the first pair and are also three-jointed. The basal joint is swollen and filled with powerful muscles; the second joint is rather slender, its outer margin is crenate and is armed with a row of short spines; the third joint is in the form of a small curved claw.

The maxillipeds are powerful prehensile organs; the terminal claw has a sharp spine or tooth on its inner margin near the center.

The first swimming legs project from the sides of the first segment just inside the basal joints of the maxillipeds and so close to them as to be partially concealed. Each is made up of a single flattened lamina without setae or spines. The second and third swimming legs are on the ventral surface of their respective segments; the second pair is biramose, the rami one-jointed, the exopod armed with four spines, and the endopod with three. At the outer corner of the basal joint, outside the exopod, is a large curved spine, longer than

the rami plus their spines. The third legs are uniramous, one-jointed, and armed near their tip with three minute spines. The fourth legs project from the lateral margins of the fused posterior body, just behind the rudimentary plates of the fourth segment. Each is a minute, uniramous, fingerlike process, with two tiny spines at its tip.

*Color.*—Fresh living specimens are bright red, owing to the blood they contain. The elongate convoluted oviducts are brownish black, deepening into jet black in the deeper portions of the convolutions, especially toward the posterior end of the body. The egg cases are dark brown. Preserved material is light brownish yellow, the dorsoventral muscles slightly darker.

Total length, including the posterior processes, 16 mm. Width of carapace, 1.50 mm. Width of posterior body, 1.90 mm. Length of egg strings, 21 mm.

*Specific characters of male.*—General form that of a Greek cross, due to the elongate, rigid fourth legs, which project from the lateral margins near the center of the body. Cephalothorax, the largest division of the body, subovate, nearly as wide as long, with a slight rostrum projecting from the center of the anterior margin, and a chitinous framework visible through the dorsal surface. Both pairs of antennae show in front of the carapace in dorsal view, while the second maxillae project considerably on either side, and the maxillipeds stand behind the posterior corners like a pair of large lobes. Behind the head and more or less fused with it the first thorax segment appears as a short neck, reduced to less than half the width of the head. The second segment is considerably wider and at least four times as long as the first, with the swimming legs projecting from the lateral margins. The third segment is a little wider, but shorter, than the second, and in the living male the third legs project from its sides, but in preserved material they shrink back so as to be invisible in dorsal view. The fourth segment is still wider than the third and longer than the second, and from its lateral margins extend the fourth legs, which are long, cylindrical, and rigid, and which extend outward and backward at an angle of about  $60^\circ$  with the body axis. The fifth and genital segments are the same width as the fourth and are suboval in outline, with a single long and jointed seta on each lateral margin near the center. The abdomen is reduced to less than half the width of the genital segment, with concave lateral margins and a sinus at the center of the posterior margin. The anal laminae are longer than the abdomen and widely divergent; each is flattened dorsoventrally and emarginate at the tip, which is bluntly rounded and armed with a row of minute spines, one of which, at the tip of the lamina, is larger than the others.

The first antennae are apparently three-jointed and taper from the base to the tip. The setae at the tip are not symmetrically arranged,

but one or two are terminal and all the rest are on the posterior margin, next to the carapace. The second antennae are developed into powerful prehensile organs; their basal joints are long, much swollen, and filled with strong muscles, which are supported by several chitin bands and processes.

The terminal claw is strongly curved and sharply pointed, with a small and sharp spine near the base.

The rostrum is short and stout, with the upper lip obtusely rounded and the lower one more acute. The first maxillae are relatively large and three-jointed, the joints subequal in length. The two basal joints are moderately stout, the terminal one is slender and bifid at the tip, with the inner ramus longer than the outer. The second maxillae are made up of a rather stout basal joint, a narrower second joint of about the same length, and a spine-like terminal claw. The distal end of the second joint is armed with closely placed, acute, and more or less curved spines arranged in several rows, mostly along the outer margin.

The maxillipeds are composed of a very large and stout basal joint and a strongly curved terminal claw. The tip of this claw, and also the one on the second antenna, is of a dark red amber color. On the inner margin of the claw near the center is a smaller secondary claw or tooth, and proximal to this the claw is at least partly divided by a joint.

The first swimming legs consist of a single flattened lamina, with a tiny spine at its tip. They are so close to the maxillipeds that they are largely concealed beneath the basal joints of the latter, with only their tips visible. The second legs are biramose, the basal joint broad and stout, the rami short, stout, and one-jointed. The outer margin of the basal joint carries a long jointed seta; the exopod is larger than the endopod and is terminated by four stout spines, the outer of which is the largest. The endopod has three similar spines at the outer end and a fringe of fine hairs along the inner margin. The third legs consist of a single lamina, like the first legs but smaller, which is armed with three spines near its tip.

*Color.*—The living male is bright red from the presence of blood like the female; preserved material is light cartilage yellow, the tips of the claws of the second antennae and maxillipeds and the chitin framework of the appendages a dark amber red.

Total length, 4 mm. Cephalothorax 1.20 mm. long, 1.10 mm. wide. Body 0.80 mm. wide. Fourth legs 1.50 mm. long.

*Remarks.*—The fish were brought in alive by the *Grampus* and the parasites were taken from them by Mr. Richard Rathbun and studied while still living. He made detailed notes on their appearance and structure, and Mr. J. H. Blake made drawings of both a male and a

female. These notes and drawings are here for the first time made public.

Heller first established this genus with the present species as its type. His two figures, one of the dorsal and the other of the ventral surface, differ in minor details from those here given. The chief difference is in the number of the transverse divisions of the fused posterior body. He represented only 19 of these and left the posterior third of the body entirely free as though no divisions existed there. Blake has represented 25 divisions and they extend to the very posterior end of the body. His drawing was made from a living specimen, while Heller had only alcoholic material in which the posterior divisions were no longer visible.

In two preserved specimens of the present lot, which were cleared in cedar oil after having remained in alcohol for more than 30 years, the divisions are exactly as Blake represented them.

**PSEUBOCYCYNUS BUCCATUS, new species.**

Plate 12, figs. 97-100; plate 13, figs. 101-103.

*Host and record of specimens.*—Eight females were taken by the author from the gills of a Spanish mackerel, *Scomberomorus maculatus*, August 13, 1900, at Woods Hole, Massachusetts. One of these has been selected for the species type and has received Cat. No. 54077, U.S.N.M., while the others become paratypes with Cat. No. 54078, U.S.N.M. Another lot of five females was obtained from the gills of the cero, *Scomberomorus cavalla*, at Woods Hole July 29, 1887, by Vinal N. Edwards. These have been given Cat. No. 54079, U.S.N.M.

*External specific characters of female.*—General body form a narrow, elongated cylinder. Cephalothorax obovate, considerably widened anteriorly and narrowed posteriorly. Second and third thorax segments free, the same width as the head, the second segment twice as long as the third, both segments with convex lateral margins. Fourth, fifth, and genital segments fused into a cylindrical body five times as long as wide with a uniform diameter. Egg strings about as long as the body and one-third its diameter. Abdomen abruptly reduced to half the diameter of the genital segment, one-jointed; anal laminae short and conical, each tipped with a single seta.

First antennae minute, cylindrical, indistinctly six-jointed, with a few minute setae on the terminal joint and short bristles scattered over the surface of all the joints. Second antennae three-jointed, the two basal joints moderately swollen, the terminal joint a long curved claw, with an accessory spine or tooth on its concave margin near the center and another much smaller one on the inner margin near the base. Mouth tube conical and close behind the second antennae;

first maxillae filiform; second pair with a swollen basal joint, a slender second joint, and a short spine-like terminal joint or claw. The outer margin of the second joint and the terminal claw are armed with minute teeth.

The maxillipeds are the characteristic appendages of this species. The basal joints are enlarged so as to occupy the entire sides of the cephalothorax, reaching forward to the bases of the second antennae and projecting backward outside of the narrowed cephalothorax beyond the anterior margin of the second segment. Each basal joint is apparently made up of two parts, posterior and anterior, separated by a well-defined groove. The posterior part carries the long, slender, and strongly curved terminal claw, while the anterior part is like a large pad with a rounded tip. Both parts carry a heavy fringe of hair, that on the anterior part being twice the length of that on the posterior. The swimming legs are reduced to mere vestiges; the first pair are represented by tiny knobs on the ventral surface of the cephalothorax inside the bases of the maxillipeds. The second pair appear as a bilobed lamina on either side of the second segment. The third pair are short, flattened laminae on the third segment, while the fourth pair are entirely lacking. None of the legs have either spines or setae.

Color a light flesh red, the convolutions of the oviducts along the sides of the posterior body a dark brown, separated into stripes by transverse bands or dorsoventral muscles. Prehensile claws yellow, tipped with dark red.

Total length, 5 mm. Greatest diameter, 0.75 mm. Egg strings 4.50 mm. long, 0.25 mm. wide.

*Specific characters of nauplius.*—General shape an elongated cone, the bluntly pointed end posterior. The first antennae carry the usual pair of plumose setae and also a pair of stout spines at the base of the setae, on the posterior distal corner of the terminal joint. The exopods of the second antennae and mandibles carry four plumose setae, the endopods two. The endopods of the second antennae are longer than the exopods and are armed at their tip with a stout claw, between the bases of the setae. The endopods of the mandibles are much shorter than the exopods and unarmed.

The balancers are long needle-like spines, extending laterally at right angles to the body axis, so that the two fall in the same straight line.

At the posterior end of the body can be seen, inside of the skin, the tips of the appendages of the future metanauplis.

*Color.*—The dark mass of pigment in the center of the body is brown, the surrounding tissues are grayish white.

Total length, 0.25 mm. Width through the bases of the mandibles, 0.10 mm.



(*buccatus*, large-jawed, alluding to the maxillipeds.)

*Remarks.*—When removed from their host these parasites float in water, and even in alcohol, and it is very difficult to wet the outside of their bodies. So long as they remain alive they snap their maxillipeds viciously together in an endeavor to fasten to something. If a gill filament or similar fragment be left in the watch glass with them, they will all find it and fasten to it. They can not swim, but by wriggling their bodies in a manner similar to that of the mosquito larva they can propel themselves slowly, but such motion is entirely aimless, since they can not control its direction at all.

This species differs in many particulars from *appendiculatus* and when the male is discovered it is possible that it will demand a new genus for its reception. Its general make-up, however, is very much like that of the present genus, and it may be left here until the male is discovered.

The swimming legs are even more degenerate than those of *appendiculatus*; the fourth pair have entirely disappeared, and the first pair can be located only with the help of structures beneath the skin. The maxillipeds are different from anything heretofore found in that the basal joint is partly divided lengthwise.

#### Genus HATSCHEKIA Poche.

*Clavella* KRØYER, Naturhistorisk Tidsskrift, vol. 1, 1838, p. 196.

*Clavella* MILNE EDWARDS, Histoire Naturelle des Crustacés, 1840, vol. 3, p. 494.

*Clavella* P. J. VAN BENEDEN, Ann. des Sci. Nat., ser. 3, vol. 16, 1851, p. 99.

*Cygnus* HESSE, Ann. des Sci. Nat., ser. 6, vol. 8, 1878, art. 11, pp. 1-34, pls. 19-21.

*Clavella* T. SCOTT, 18th Ann. Report Fishery Board, Scotland, 1900, p. 159.

*Clavella* BRIAN, Atti Soc. Ligustica Sci. nat. e geog., vol. 13, 1902, p. 37.

*Hatschekia* POCHE, Zool. Anz., vol. 26, 1902, p. 16.

*Hatschekia* T. and A. SCOTT, British Parasitic Copepoda, 1912, p. 112.

*Generic characters of female.*—Head and thorax separated, the former small and usually rounded. First two thorax segments more or less free, but often fused with each other, each with a pair of biramous swimming legs. The remainder of the thorax, including the genital segment, fused into a subcylindrical trunk, elongate and narrow. Abdomen short and one-jointed or lacking; anal laminae minute with tiny setae.

First antennae small, filiform, three to six jointed, the joints often indistinct. Second antennae short and stout, with strong terminal claws, and often with an accessory spine at the base of each antenna. Mandibles and first maxillae small, the latter as tiny knobs at the sides of the mouth, armed with spines. Second maxillae apparently lacking, maxillipeds slender and uncinat.

Two pairs of biramose swimming legs and occasionally the rudiments of a third and fourth pair. Egg strings short, eggs large and not much flattened.

*Generic characters of male.*—Head separated from the thorax and well rounded; entire thorax fused into a spindle-shaped or elongate body, whose segmentation is often very obscure. Abdomen more or less distinct, one-jointed; anal laminae much larger than in the female and armed with spines.

First antennae relatively longer and stouter than in the female; second pair projecting in front of the cephalon, and tipped with strong claws.

Maxillipeds very long and slender, projecting far beyond the margin of the head. Two pairs of swimming legs, uniramous and one-jointed.

*Type of the genus.*—*Hatschekia hippoglossi* (Krøyer), first species.

KEY TO THE SPECIES.

1. Head more or less spherical, the first and second thorax segments forming a distinct neck; trunk four to ten times the length of the head..... 2
1. Head angular or widened transversely, no neck; trunk short and thick, from two to four times the length of the head..... 6
2. First and second thorax segments completely fused, the two longer than the head; trunk cylindrical, lobed posteriorly..... 3
2. First and second thorax segments completely fused, but less than one-third the length of the head; trunk flattened, no lobes..... 4
2. First and second thorax segments only partially fused, much shorter than the head; trunk cylindrical, no lobes..... 5
3. Second thorax segment wider than the head; second legs visible in dorsal view; first antennae three-jointed..... 2.33 mm., *linearis* Wilson, 1913
3. Second thorax segment narrower than the head; second legs not visible in dorsal view; first antennae five-jointed... 9.50 mm., *hippoglossi* (Krøyer) 1837
3. Head, first two segments and trunk the same width; second legs visible in dorsal view; first antennae not distinctly segmented.  
1.50 mm., *sargi* (Valle), 1882
3. Second thorax segment wider than the head; no legs visible dorsally; first antennae two-jointed..... 1.70 mm., *budegassae* (Krøyer), 1863
4. Trunk as wide as the head, first and second segments narrower; sides of trunk smooth; first antennae three-jointed... 1.70 mm., *oblonga* Wilson, 1913
4. First and second segments as wide as the head, trunk much wider, its sides undulate..... 1.75 mm., *albirubra* Wilson, 1913
4. Trunk wider than the head, widest posteriorly, with three rows of knobs on the dorsal surface..... 1.90 mm., *scari* (Krøyer), 1838
4. Trunk as wide as head, first and second segments narrower; one sinus on either side; first antennae five-jointed..... 1 mm., *pygmaea* T. Scott, 1913
5. Head with a short and blunt posterior process; trunk six times as long as wide; first and second segments not distinct.  
2.40 mm., *cornigera* T. Scott, 1919
5. Head smooth, trunk ten times as long as wide; first and second segments distinct and wider than the trunk..... 4 mm., *tenuis* (Heller), 1865

5. Head smooth; trunk three times as long as wide, with rudiments of third and fourth legs on its margins.....1.60 mm., *subpinguis* Brian, 1913
5. Head smooth; trunk five times as long as wide; first antennae two-jointed; no legs visible dorsally.....1.75 mm., *mulli* (Beneden), 1851
6. Trunk as wide as or wider than the head and only twice as long or less, short and stout species.....7
6. Trunk three or four times the length of the head and the same width or less, longer and narrower species.....8
7. Head a quarter wider than long; trunk one-half wider than the head, with two lateral sinuses on each side; egg strings at right angles to body axis; first antennae five-jointed.....1 mm., *uncata* Wilson, 1913
7. Head a third wider than long; trunk not as wide as head, with a single sinus on either side; egg strings nearly parallel with body axis; first antennae four-jointed.....2.75 mm., *iridescens* Wilson, 1913
7. Head the same width and length; trunk a fifth wider than the head, with three sinuses on either side, containing rudiments of a third and fourth pair of legs; antennae five-jointed.....0.85 mm., *insolita* Wilson, 1913
7. Head wider than long, trunk a half wider than the head, without sinuses; egg strings twice the entire length.....1.80 mm., *pinguis* Wilson, 1908
8. Head winged on either side, so as to be wider than long; first antennae twelve to twenty jointed.....9
8. Head winged but fully as long as wide; first antennae short, only five to eight jointed.....10
9. Head large, triangular, widest at anterior margin; two free segments only a fifth the length of the head; genital segment pointed posteriorly; first antennae twelve-jointed.....2-3 mm., *crenilabri* (Hesse), 1878
9. Head widest at the center, transversely spindle-shaped; two free segments half the length of the head; genital segment rounded posteriorly; first antenna fourteen-jointed.....2 mm., *labri-mixti* (Hesse), 1878
9. Head widest at the center; two free segments nearly as long as the head; genital segment uniform in width, rounded posteriorly; first antennae twelve-jointed.....1.50 mm., *labri-donovaini* (Hesse), 1878
10. Trunk spindle or club shaped; first and second segments not separated from the trunk.....11
10. Trunk club-shaped or with parallel sides; first and second segments distinctly separated; both pairs of legs visible dorsally.....12
11. Trunk spindle-shaped, with lateral sinuses and rudiments of the third and fourth legs; head diamond-shaped.  
1 mm., *labracis* (P. J. van Beneden), 1870
11. Trunk club shaped, larger posteriorly, without lateral sinuses; head nearly spherical; no legs visible dorsally.....1.50 mm., *cluthae* T. Scott, 1902
12. Two free segments half the length of the head; genital segment squarely truncated posteriorly, with a distinct abdomen and with its sides concave.....1.50 mm., *acantholabri-exoleti* (Hesse), 1878
12. Two free segments less than a third the length of the head; genital segment indistinguishably fused with the abdomen and pointed posteriorly, its sides convex.....2.30 mm., *labri-trimaculati* (Hesse), 1878
12. Head almost as long as the rest of the body; genital segment the same width throughout and squarely truncated posteriorly,  
2 mm., *canthari-grisei* (Hesse), 1878
12. Head without lateral expansions; two free segments as long as the head; sides of genital segment straight.....3 mm., *pagelli-bogneravei* (Hesse), 1878

*Remarks.*—From the above key it will be seen that Hesse is responsible for seven of the species in this genus. But the same is true here, as in all the work done by Hesse, the discrepancies and contradictions in his text and drawings are so numerous and so vital that his species can not be accepted until they have been described and figured anew. Take, for instance, his species *crenelabri*. Figure 10, plate 19, shows a dorsal view of an adult female, in which the first antennae have 14 joints, all the same length, and the second swimming legs are biramose, the exopod two-jointed, the endopod one-jointed, both well supplied with setae. Figure 11 is a dorsal view of the head and first two thorax segments, enlarged, in which the first antennae have 14 joints, but the first or basal joint is as long as all the others taken together; the second swimming legs are uniramous, one-jointed, and destitute of setae. Figure 12 is a ventral view of the head and first two thorax segments, in which the first antennae have 24 joints, all the same size, and the second swimming legs are uniramous, two-jointed, and well armed with setae. The creature presented as a male of this species in figure 1 of the same plate certainly does not belong to the genus *Hatschekia*, nor indeed to any other known copepod genus.

*Clavella bramae*.—P. J. van Beneden in his *Les Poissons des Cotes de Belgique, leurs Parasites et leurs Commensaux* (Bruxelles, 1870) mentioned on page 43 *Clavella bramae*, new species, as a parasite on the gills of *Cantharus brama*. He did not give a description or figure of the species, and no other investigator has either seen or mentioned it, so that it becomes a *nomen nudum*.

*Clavella clavata*.—Müller in his *Zoologiae Danicae Prodrömus*, published in 1776, gave on page 227 a three-line description of a parasite which he called *Lernaea clavata*. Krøyer in *Naturhistorisk Tidsskrift* (vol. 1, 1837, p. 195) said in a footnote that he was unable to decide whether Müller's species belonged in the genus *Clavella*, because he had never seen it and Müller's description was unsatisfactory. On the next page, however, he placed it under *Clavella*, but with a question mark. These are all the data at present available and they are not sufficient to locate the species definitely.

*Clavella obesa*.—Richiardi published in 1880 what he termed a systematic catalogue of the crustacea living upon aquatic animals, which was included in the Report of the International Fisheries Exposition held in Berlin during that year. In this catalogue he gave the names of many parasitic copepods, which he claimed as new species, but which have never been described or figured. Among them was *Clavella obesa*, which thus becomes a *nomen nudum*.

*Cygnus? budegasse*.—Krøyer in his *Bidrag til Kundskab om Snyltekrebsene*, 1863, page 65, described and figured (pl. 12, fig. 3) a cope-

pod which he doubtfully referred to the genus *Cyenus*. He had but a single specimen, which had been in alcohol for 40 years, and he was hence unable to give many of the structural details. As we have already seen, the name *Cyenus* was preoccupied (see p. 58), and so this species can not retain that name, but it certainly does not belong to the genus *Congericola*, to which the true *Cyenus* species have been transferred. In size and general structure it corresponds well with the present genus, but it can not be definitely located until further details can be secured.

#### Genus DICHELESTHIUM Hermann.

*Caligus*, part ABILDGAARD, Skrivter af Naturhistorie Selskabet, vol. 3, 1794, p. 52.

*Dichelesthium* HERMANN, Memoire Apterologique, 1804, p. 125.

*Dichelesthium* LATREILLE, Regne Animal de Cuvier, 1829, vol. 4, p. 200.

*Dichelesthium* MILNE EDWARDS, Histoire Naturelle des Crustacés, 1840, vol. 3, p. 485.

*Dichelesthium* M. J. RATHBUN, Fauna of New England, No. 5, Crustacea, 1905, p. 97.

*Dichelesthium* BRIAN, Copepodi Parassiti dei Pesci d'Italia, 1906, p. 67.

*External generic characters of female.*—Head fused with the first segment to form an angular cephalothorax; four free thorax segments without dorsal plates or processes, but the second and third segments are produced into lateral lobes. Genital segment oblong, narrower than the free segments and tapered posteriorly; abdomen small and one-jointed, attached to the ventral surface of the genital segment. First antennae eight-jointed, with scattered setae; second antennae large, cheliform, projecting in front of the head.

Mandibles stylet-shaped, toothed at the tip; first maxillae biramose, the exopod much larger than the endopod; second maxillae two-jointed and tipped with a small claw, sharp spines, and tufts of hair; maxillipeds stout, uncinat.

First two pairs of swimming legs biramose, the rami one-jointed; third legs flattened uniramous laminae, one-jointed; fourth and fifth legs wanting.

Egg strings slender, much longer than the body and straight, eggs strongly flattened.

*External generic characters of male.*—General body form the same as that of the female; head relatively larger, its lateral margins more angular. Only three free thorax segments, diminishing regularly in size; fifth and genital segments completely fused, narrow, and short; abdomen one-jointed.

Antennae, mouth parts, and swimming legs like those of the female, except that in the second legs the endopod is short and wide and bears two spines and a wide flattened plate, and the third legs are relatively shorter and broader.

*Internal generic characters.*—The esophagus is inclined forward at an angle of  $45^\circ$  and enters the extreme anterior end of the stomach. The latter is enlarged only a little, and passes into a wide intestine which runs the entire length of the body and is contracted into a short rectum.

The ovaries are situated on either side of the intestine near the dorsal surface of the first thorax segment. The oviducts, starting from the anterior ends of the ovaries, curve downward, outward, and backward along the sides of the thorax to the vulvae. When fully developed they fill nearly the entire space between the intestine and the body wall. The eggs are scattered loosely through the oviducts, are not arranged in any definite order, and are not flattened. The sperm receptacle is just inside the ventral body wall and is oblong, with rounded ends.

In the male the testes and sperm ducts are arranged similarly with the spermatophore receptacle near the posterior end of the genital segment.

In the female the cement glands lie on either side of the intestine, ventral to the oviducts, and are confined to the genital segment. They are about the same diameter throughout their anterior half, which is glandular and not segmented, while the posterior half is much narrowed.

From the supraesophageal ganglion branches go to the two pairs of antennae and the front of the head; from the infraesophageal ganglion similar branches go to the various mouth parts and the first swimming legs. A ventral trunk runs back through the thorax to the anterior end of the fifth segment, where it divides into two branches, which separate a little and reach the posterior end of the genital segment. On either side of the intestine in each segment posterior to the first is a band of dorsoventral muscles which aid in the extrusion of the eggs.

*Type of the genus.*—*Dichelesthium oblongum* (Abildgaard), monotypic.

**DICHELESTHIUM OBLONGUM (Abildgaard).**

Plate 13, fig. 105.

*Caligus oblongus* ABILDGAARD, Skrivter af Naturhistorie Selskabet, vol. 3, 1794, p. 52, pl. 5, figs. 4–11.

*Dichelesthium sturionis* HERMANN, Mémoire Apterologique, 1804, p. 125, pl. 5, figs. 7–8.

*Dichelesthium sturionis* DESMAREST, Considerations generales sur la Classe des Crustacés, 1825, p. 337, pl. 50, fig. 6.

*Dichelesthium sturionis* LATREILLE, Règne Animal de Cuvier, 1817, vol. 3, p. 66; Familles naturelles du Règne Animal, 1825, p. 306; Cours d'Entomologie, 1831, p. 455.

*Dichelesthium sturionis* BOSCH, Histoire Naturelle des Crustacés, 1830, vol. 2, p. 223, pl. 18, b, fig. 2.

*Dichelesthium sturionis* NORDMANN, Mikrographische Beiträge, 1832, p. 41.

*Dichelestium sturionis* BURMEISTER, Beschreibung einiger neuen oder weniger bekannten Schmarotzerkrebse, 1832, p. 328.

*Dichelestium sturionis* RATHKE, Nova Acta Academiae Leopoldinae Carolinensis, 1836, vol. 19, p. 127, pl. 17, figs. 1-17.

*Dichelestium sturionis* KRØYER, Naturhistorisk Tidsskrift, vol. 1, 1837, p. 299, pl. 2, figs. 5 and 5a; Isis, 1840, p. 764, pl. 2, fig. 5; Kongeligt Danske Videnskabernes Selskab, vol. 9, 1842, p. 344, pl. 3, fig. 8.

*Dichelestium sturionis* GUERIN, Iconographie du Regne Animal, 1840, p. 43, pl. 35, fig. 10a-c.

*Dichelestium sturionis* MILNE EDWARDS, Histoire Naturelle des Crustacés, 1840, vol. 3, p. 485, pl. 39, fig. 4; Atlas du Regne Animal de Cuvier, 1849, pl. 79, fig. 2.

*Dichelestium sturionis* BASSETT-SMITH, Proc. Zool. Soc. London, 1899, p. 473.

*Dichelestium sturionis* HOFER, Handbuch der Fishkrankheiten, 1904, p. 182.

*Dichelestium sturionis* M. J. RATHBUN, Fauna of New England, No. 5, Crustacea, 1905, p. 97.

*Dichelestium sturionis* BRIAN, Copepodi Parassiti del Pesci d'Italia, 1906, p. 67.

*Dichelestium oblongum* NORMAN and T. SCOTT, Crustacea of Devon and Cornwall, 1906, p. 215.

*Dichelestium oblongum* T. and A. SCOTT, British Parasitic Copepoda, 1913, p. 106, pl. 31, figs. 7-18; pl. 45, figs. 4-5.

*Host and record of specimens.*—So far as known this parasite, which is very common in Europe as well as America, has never been found upon any host except the common sturgeon, *Acipenser sturio*. This fish is found along our Atlantic coast from Canada to the Carolinas and from it have been obtained the following specimens in the collection of the National Museum:

Catalogue number.	Specimens.	Locality.	Collector.
6173.....	25 females.....	Noank, Long Island Sound.	Bureau Fisheries.
6174.....	8 females.....	do.....	Do.
6175.....	1 female, 1 male.....	do.....	Do.
6189.....	1 male.....	Woods Hole.....	V. N. Edwards.
8184.....	do.....	do.....	Do.
8186.....	3 females.....	England.....	.....
11615.....	6 females.....	Vineyard Sound....	V. N. Edwards.
11616.....	1 female.....	do.....	Do.
12681.....	6 females, 2 males.....	Woods Hole.....	Do.
12682.....	2 females.....	do.....	Do.
12683.....	1 female, 2 males.....	do.....	Do.
34536.....	2 females.....	Long Island Sound.	A. E. Verrill.
54074.....	8 females.....	Woods Hole.....	V. N. Edwards.
54075.....	10 females.....	do.....	Do.
54076.....	5 females.....	do.....	Do.

*Remarks.*—This genus is monotypic and the single species has been described and figured so many times that the genus diagnosis is sufficient for the present paper. It is unfortunate that the wrong specific

name has become so widely known that it will be difficult to make the requisite change. It is evidently cosmopolitan in distribution, being found everywhere that the host occurs. The common sturgeon is not only found in salt water, but it also runs up our rivers. Whether these parasites remain upon the gills after their host enters fresh water has not been determined, but they probably do. Strangely enough out of the long list of investigators who have recorded this parasite not a single one has mentioned that it was to be found in fresh water.

**Genus CYBICOLA Bassett-Smith.**

*Helleria* BASSETT-SMITH, Ann. Mag. Nat. Hist., ser. 7, vol. 1, 1898, p. 10.

*Cybicola* BASSETT-SMITH, Ann. Mag. Nat. Hist., ser. 7, vol. 2, 1898, p. 371.

*Generic characters of female.*—Body elongate, without dorsal plates. Head rounded, not fused with the first thorax segment, as wide as the genital segment. First three thorax segments free, each with a pair of soft lateral processes, the remainder of the body fused into an elongate genital segment, which carries the long and narrow anal laminae on its posterior margin. Egg strings longer than the body, straight.

First antennae seven-jointed, setaceous; second pair in the form of strong claws with a single tooth on their inner margin. First maxillae three-jointed, uncinata; second pair also three-jointed, tipped with a short, curved claw dentate on its inner margin. Maxillipeds two-jointed, the basal joint very large and powerful, its outer margin undulate and fringed with bunches of fine hairs, the terminal claw stout, strongly curved, with a single tooth on its inner margin. Three pairs of rudimentary swimming legs, the first pair biramose, the other two uniramous, all the rami minute, one-jointed, tipped with a seta.

*Generic characters of male.*—Body shorter than in the female, head more oval. No free thorax segments, but the entire thorax fused with the genital segment; abdomen distinct with foliate anal laminae whose tips are fringed with fine hairs. Antennae and mouth parts like those of the female except that the maxillipeds are longer and less stout. Only two pairs of swimming legs, the first pair biramose, the rami broad, one-jointed and tipped with claws, the second pair uniramous, the rami two-jointed and also tipped with claws.

*Type of the genus.*—*Cybicola armata*, monotypic.

*Remarks.*—This genus was first named *Helleria*, but as that name was already in use for a genus of crustaceans Bassett-Smith himself changed it later in the same year. It has never been seen or mentioned by any other scientist. Its principal characteristics are the absence of the third and fourth swimming legs in the male and of the



fourth legs in the female, the fusion of the entire thorax with the genital segment in the male and the soft lateral processes on the sides of the free thorax segments in the female.

### Genus VENTRICULINA Bassett-Smith.

*Ventriculina* BASSETT-SMITH, Proc. Zool. Soc. London, vol. 1, 1903, p. 106, text fig. 12.

*Generic characters of female.*—Head fused with the first thorax segment; second, third, and fourth segments free, fifth and genital segments fused, but the fusion indicated by marginal incisions. Abdomen two-jointed with filiform anal laminae. Egg cases long and coiled, eggs uniseriate and well flattened. First antennae four-jointed, nonsetose; second pair three-jointed, setose but not uncinata; maxillipeds armed with stout prehensile claws. First legs biramose, rami two-jointed; second and third legs uniramose, rami one-jointed; fourth and fifth legs lacking. Male unknown.

*Type of the genus.*—*Ventriculina crosslandi*, monotypic.

*Remarks.*—Like the preceding genus this one has never been seen or mentioned by any investigator except Bassett-Smith. Its chief characteristics are the lack of the posterior swimming legs, the uniform diameter of the thorax, and the fact that the second antennae are nonprehensile. Bassett-Smith's statement given above, that the abdomen is two-jointed is open to doubt, and the coiling of the egg tubes might well have been the result of placing the specimens in alcohol.

It is worthy of note that the host is not a fish but a sipunculid from the coast of Zanzibar.



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## EXPLANATION OF THE PLATES.

### PLATE 1.

Fig. 1, dorsal view of the male of *Anthosoma crassum*; fig. 2, dorsal view of the female, after T. and A. Scott, showing how the entire body is concealed by the dorsal plates of the head and thorax; fig. 3, first antenna of male; fig. 4, second antenna of male, side view; fig. 5, first maxilla, with palp; fig. 6, second maxilla; fig. 7, first swimming leg; fig. 8, second swimming leg; fig. 9, dorsal view of the female of *Lernanthropus caudatus*; fig. 10, first swimming leg of same; fig. 11, second swimming leg.

### PLATE 2.

Fig. 12, side view of the female of *Lernanthropus caudatus*; fig. 13, ventral view of same; fig. 14, second maxilla; fig. 15, maxilliped; fig. 16, ventral view of female of *Lernanthropus rathbuni*, showing rudiments of fifth legs on the sides of the fifth segment; fig. 17, maxilliped of same; fig. 18, first swimming leg endopod on the left; fig. 19, second swimming leg, endopod on the right.

### PLATE 3.

Fig. 20, dorsal view of the female of *Lernanthropus rathbuni*; fig. 21, side view of same; fig. 22, second maxilla; fig. 23, first antenna of *Lernanthropus leidy*; fig. 24, second antenna of same; fig. 25, second maxilla; fig. 26, maxilliped; fig. 27, first swimming leg.

### PLATE 4.

Fig. 28, dorsal view of the female of *Lernanthropus leidy*; fig. 29, side view of same; fig. 30, dorsal view of male of same; fig. 31, first antenna of female of *Lernanthropus chlamydotus*; fig. 32, second antenna of same; fig. 33, mouth tube and first maxillae; fig. 34, second maxilla; fig. 35, maxilliped.

### PLATE 5.

Fig. 36, dorsal view of female of *Lernanthropus chlamydotus*; fig. 37, dorsal view of male of same, cleared in oil of wintergreen, showing the reproductive system; *sp*, sperm ducts; *sr*, spermatophore receptacle; *t*, testes; fig. 38, first swimming leg of male, endopod on the left; fig. 39, second leg, endopod also on the left.

### PLATE 6.

Fig. 40, side view of female *Lernanthropus chlamydotus*, showing position of oviducts; fig. 41, dorsal view of female of *Lernanthropus paenulatus*; fig. 42, side view of same; fig. 43, dorsal view of male of same; fig. 44, first antenna of female; fig. 45, mandible of male; fig. 46, first maxilla of female; fig. 47, maxilliped of female; fig. 48, first legs of male.

### PLATE 7.

Fig. 49, first legs of female of *Lernanthropus paenulatus*; fig. 50, second leg of same; fig. 51, dorsal view of male of *Lernanthropus brevoortiae*; fig. 52 second

antenna of same; fig. 53, maxilliped; fig. 54, second maxilla; fig. 55, first leg; fig. 56, second leg of male of *L. paenulatus*; fig. 57, nauplius of *Lernanthropus brevoortiae*.

PLATE 8.

Fig. 58, side view of female of *Lernanthropus brevoortiae*; fig. 59, dorsal view of vascular system of same; fig. 60, ventral view of vascular system.

PLATE 9.

Fig. 61, ventral view of female of *Nemesis atlantica*; fig. 62, dorsal view of male of same; fig. 63, second antenna of female; fig. 64, mouth tube and first maxillae; fig. 65, first swimming leg of female; fig. 66, second leg; fig. 67, fourth leg; fig. 68, cross section through head at the base of the maxillipeds; *ds*, dorsoventral muscle; *lm*, longitudinal muscle; *m<sub>ax</sub>p*, maxilliped; *n*, ventral nerve cord; *ov*, ovary; *st*, stomach; fig. 69, cross section through fifth thorax segment; *cg*, cement glands; *in*, intestine; *lm*, longitudinal muscle; *sr*, semen receptacle.

PLATE 10.

Fig. 70, dorsal view of female of *Nemesis atlantica*; fig. 71, longitudinal section on the midline; *cg*, cement gland; *oe*, esophagus; *ov*, ovary; *sr*, semen receptacle; *vd*, ventral nerve cord; fig. 72, first antenna; fig. 73, second maxilla; fig. 74, genital segment of male, ventral view; fig. 75, mouth tube and first maxillae of *Lernanthropus brevoortiae*, male.

PLATE 11.

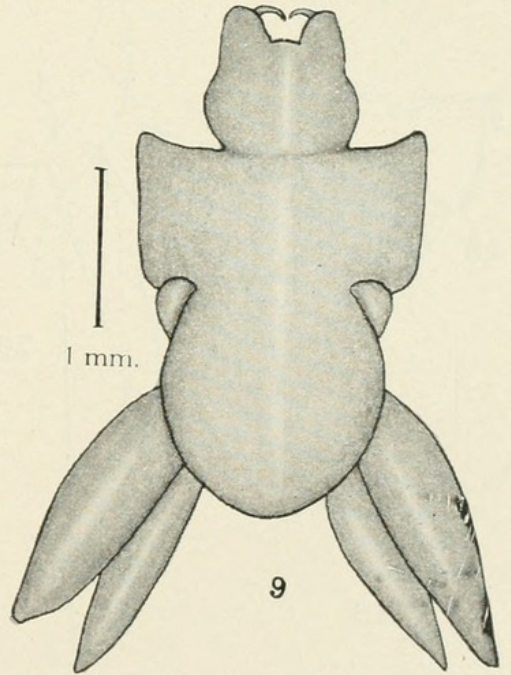
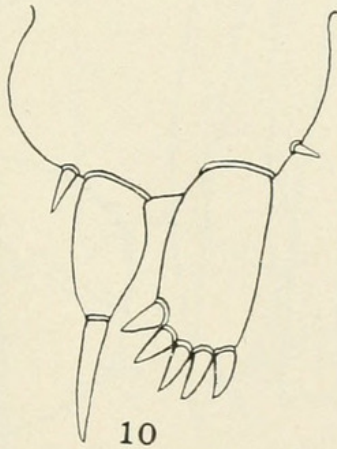
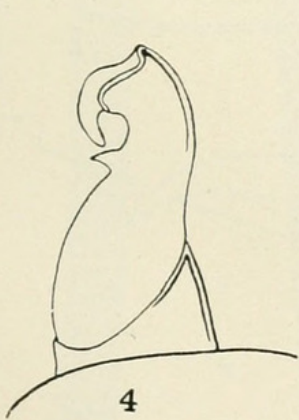
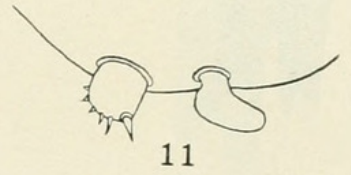
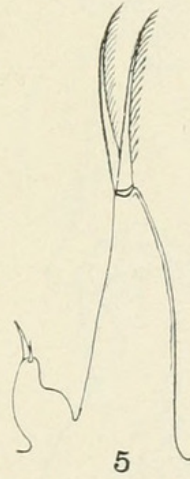
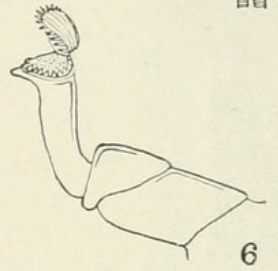
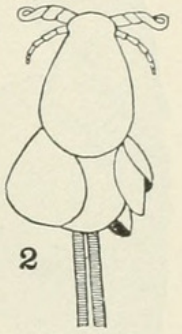
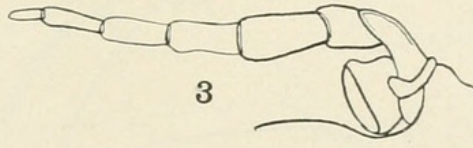
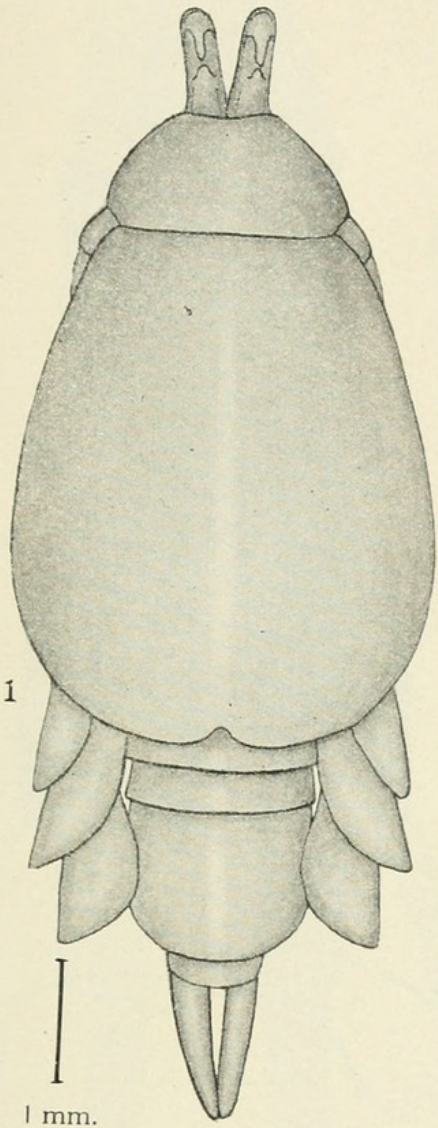
Fig. 76, dorsal view of female of *Eudactylina nigra*; fig. 77, first antenna; fig. 78, dorsal view of second antenna; fig. 79, ventral view of second antenna of another specimen; fig. 80, mouth tube and first maxillae; fig. 81, second maxilla; fig. 82, maxilliped; figs. 83 to 85, first, second, and third swimming legs.

PLATE 12.

Fig. 86, nauplius of *Eudactylina nigra*; fig. 87, dorsal view of female of *Pseudocycnus appendiculatus*, drawn by J. H. Blake; fig. 88, dorsal view of male, drawn by J. H. Blake; fig. 89, body of female cleared in oil of wintergreen, showing cement glands (*cg*), oviducts (*o*), and semen receptacle (*sr*); fig. 90, first antenna, female; fig. 91, second antenna; fig. 92, maxilliped; figs. 93 to 95, first, second, and third swimming legs; fig. 96, second maxilla; fig. 97, first antenna of *Pseudocycnus buccatus*; fig. 98, second antenna; fig. 99, second maxilla; fig. 100, maxilliped.

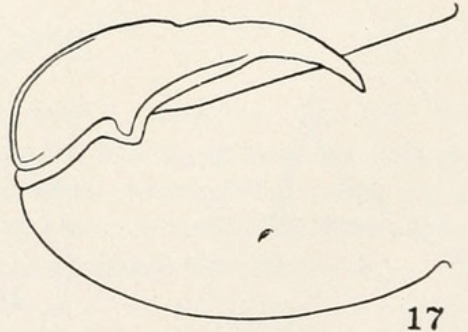
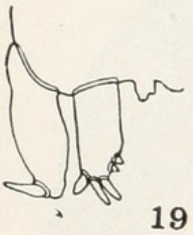
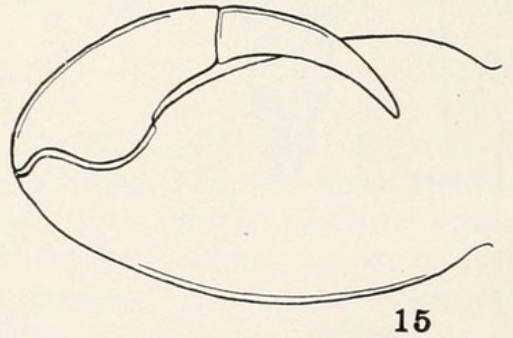
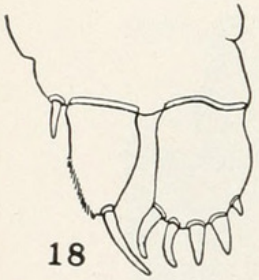
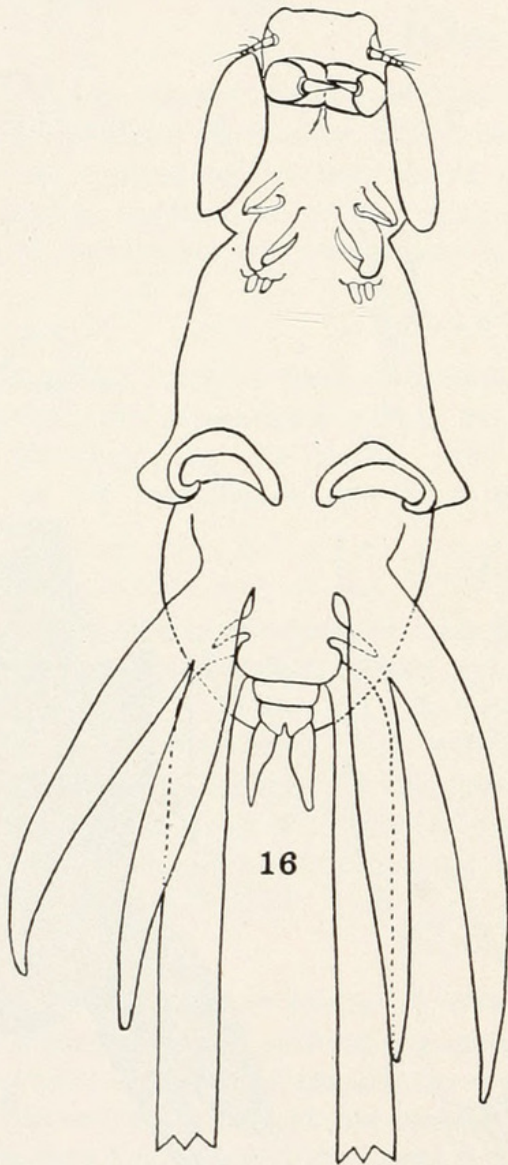
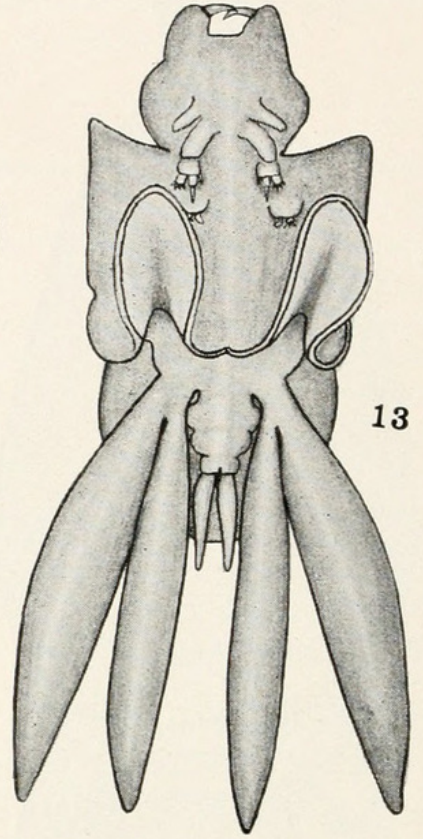
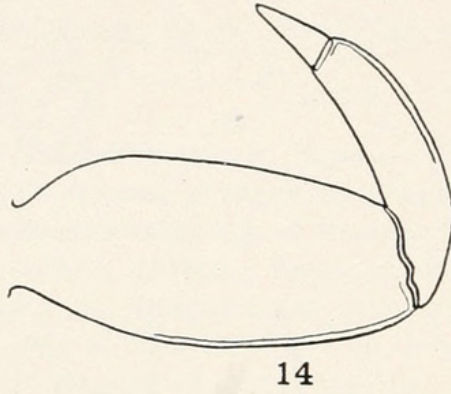
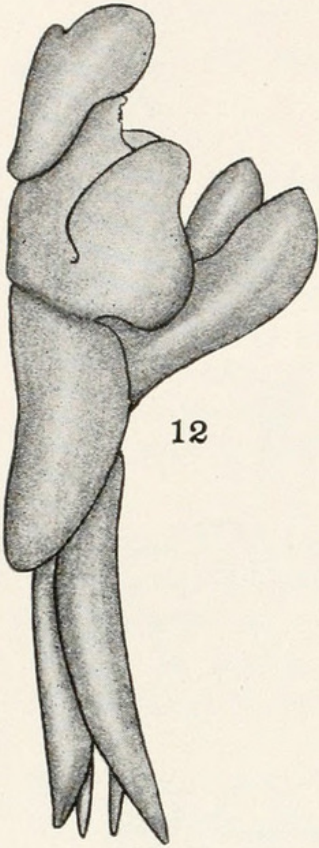
PLATE 13.

Fig. 101, dorsal view of female of *Pseudocycnus buccatus*; fig. 102, ventral view of another specimen without egg strings; fig. 103, nauplius; fig. 104, dorsal view of genital segment of female *Lernanthropus chlamydotus*, showing large spermatophores in position at the openings of the oviducts; fig. 105, cross section of the skin and underlying tissues in *Dichelesthium oblongum*.



ANTHOSOMA CRASSUM AND LERNANTHROPUS CAUDATUS.

FOR EXPLANATION OF PLATE SEE PAGE 97.



FEMALES OF LERNANTHROPUS CAUDATUS AND L. RATHBUNI.

FOR EXPLANATION OF PLATE SEE PAGE 97.



Wilson, Charles Branch. 1922. "North American parasitic copepods belonging to the family Dichelesthidae." *Proceedings of the United States National Museum* 60(2400), 1–100. <https://doi.org/10.5479/si.00963801.60-2400.1>.

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