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Parasitic Copepods
from Fish in the
Indo-Tropical Region

by
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Some new or rare Parasitic Copepods found on Fish in the Indo-Tropic Region. By P. W. BASSETT-SMITH, Staff-Surgeon R.N., F.R.M.S., F.Z.S.

[Plates X.-XII.]

IN this paper, following two others published in the 'Annals,' I have adduced a few more interesting new forms of these parasitic animals, and also examples of some in which one sex alone has been described. With constant examination of the fresh fish at the markets and at the places where they were landed there was found no dearth of material to work upon; in fact, one is astonished at the great number and variety which are discovered, also how particularly prolific some fish are—the genus *Caranx* being the most noticeable; it was very rare not to find one or more species on a fish: from the inside of the operculum or attached to the head-kidney might be obtained *Caligus tenax*, Hell., *C. carangis*, Kr., *C. robustus*, sp. n.; and on *Caranx djedaba*, *Bomolochus megaceros*, Hell.; attached to the gills themselves *Lernanthropus giganteus*, Koll., or a second undescribed species found on *Caranx Rottleri*, the long dark-coloured egg-tubes making them very apparent; once on the surface-skin of a large *Caranx* I found specimens of a fourth species of *Caligus*

(*Caligus longipedis*, sp. n.) ; on the tongue of *Caranx djedaba* was frequently found an ulcerated patch of mucous membrane covered by a small variety ? of *C. tenax* ; on the roof of the mouth of another species (*Caranx ferdau*) were seen the tumours produced by *Caligodes carangis*, sp. n., and once I found the chitinous head and neck of a *Lernæa* deeply buried in the roof of the mouth, the body having rotted away.

In contradistinction to these stand out the fish of the family Sparidæ, which have strong crushing-teeth in the jaws ; I very rarely found any parasites in these fish, the different character of the food, perhaps, causing the peculiarity.

The sharks have many parasites, as described by Kröyer, Steenstrup and Lütken, M.-Edwards, Leach, Van Beneden, Heller, &c. ; but, though there are plenty of these fish in the waters round Aden, it was rarely one saw them before the surface had become too dry &c. A female specimen of *Alebion carchariæ*, however, was found.

The genus *Lernanthropus* appeared frequently, the regular flushing and pallor of the laminate processes representing the third and fourth thoracic feet at every vascular contraction make it evident that they act as branchiæ, as Hesse pointed out in his elaborately illustrated paper in 'Revue des Sciences Naturelles,' tome vii. (June 1878).

Ergasilidæ.

BOMOLOCHUS, Nordm.

Bomolochus megaceros, Hell. (Pl. X. fig. 1.)

As the male of this species has not been recorded, nor has one of any other species of this genus, so far as I have been able to find in published works, been obtained, it seems worthy of placing here on note, especially as though I have examined a large number of the female *Bomolochus*, both living and dead, yet only once was a male discovered. The minute size renders them undoubtedly very difficult to see, and it is only when attached to the female, as occurred in this case, that they are likely to be found. The peculiar elegance of the anterior antennæ, and the large hooked maxilliped with which it firmly attaches itself, were remarkable, being very unlike those of the female, of a much less degraded type. The drawing was made very quickly after capture, but in preparing the specimen for a permanent preparation it was unfortunately spoilt ; therefore there are many points which require further elucidation. The female *Bomolochus megaceros* I have taken from *Stromateus niger*, Bombay, Colombo, and

Beluchistan, and often on *Caranx djedaba*, Aden. The species is well defined and easily recognized.

Length 1 millim. Transparent.

Body distinctly segmented; the cephalothorax elongate, forming a solid carapace, followed by two free short thoracic segments and a large oval genital segment; the caudal portion is biarticulate, the first joint is almost square, the second elongated and tapering, carrying at its extremity two rather large caudal plates, each of these terminating in a very long strong simple bristle, having a minute hair at its base, and also a small one at the base of the caudal plate.

Anterior antennæ long, elegant, five-jointed, the first being short, carrying a long plumose hair on its under border; the second joint is very long, cylindrical, and tapering, bearing along its front border about twelve fine ciliated hairs and one long plumose hair near its termination; the third joint is about half the length of the last, with three plumose hairs near the end, one being extremely long; the fourth of much the same size, with two terminal plumose hairs; the last joint is half as long again as the fourth, terminating in six plumose hairs.

Posterior antennæ spring from close under the first; they are three-jointed, and resemble much the same organs in the female.

Second maxilliped is distinctly three-jointed, being very large and powerful; the basal joint is oval and muscular, the second broad and flattened, the surface being minutely granular, its front edge having a fine tooth about halfway down; the terminal joint is in the form of a long slender claw, with the concave edge minutely toothed; near the base of this and on the opposing joint one sees a fine bristle.

First, second, and third true limbs biramose, each branch three-jointed, the outer branch of the third bearing dentate spurs as in the female, all the others provided with ciliated hairs. Fifth pair uniramous, the terminal joint having its border fringed with fine hairs and terminating in three short thick ones.

Caligidæ.

CALIGUS, Müller.

Caligus longipedis, sp. n. (Pl. X. figs. 2, 3.)

This species was taken from the skin-surface of a *Caranx melamphigus* at Aden; both the male and the female were obtained. In the gills of the same fish were present, especially in the neighbourhood of the gland, numbers of *C. tenax*,

Hell., *C. carangis*, Kr., and attached to the gills themselves many specimens of *Lernanthropus giganteus*, Kr.

This *Caligus* appears at first sight to resemble *C. infestans* of Heller (which I have found also out here attached to the gills of "*Cybbium Commersonii*"), but is quite distinct, my species being chiefly distinguished by the structure of the first maxilliped, the narrow flat furcula, the presence of only three joints on the fourth peræopod, the large caudal plates, and the surface being spotted with blue instead of red.

Female.—*Carapace* slightly broader than long, with obtusely rounded posterior angles, narrowing considerably in front, where it unites with the anterior cephalic segment; this is the frontal plate, rather deeply emarginate in the centre, but thick antero-posteriorly, the lunulæ being on the outer third, large and very conspicuous, extending the whole width of the plate.

Anterior antenna: first joint equal in length to the width of the lunule, bearing about fourteen delicate plumose papillæ; second joint longer and slender, bearing at its end a number of fine hairs, with an isolated one on its posterior edge.

Second antennæ of moderate size, the terminal claw being rather slender, the spur from the basal joint being distinct.

Hamulus anterior long, narrow, and curved, springing from a globose base.

Palp large, sharp-pointed, rising from a bifid base and having a slight curve outwards.

First maxilliped has the basal joint of the usual shape, the second of a peculiar form, becoming broader at its termination, with the whole inferior border minutely crenate, almost dentate at the end; this joint terminates in two long curved processes, the outer being the longer and articulate.

Second maxilliped of comparatively very small size, the terminal claw being short and simple.

Furcula very distinct, though of only moderate size; from a dilated base with a narrow neck rise the two branches, which are nearly parallel to one another on the inner border, somewhat rounded on the outer, blunt-ended, and of an extremely flattened appearance, the width of the aperture being less than the length of the arms.

First peræopod of the usual form, the palmar joint carrying three short terminal claws, a slender bristle at the angle, and three moderately long plumose hairs from the under border.

Second peræopod of the usual form.

Third peræopod of very considerable size, the posterior

border of the apron extending over the upper part of the genital segment; the paddle-joints are placed some distance apart, the outer having four short plumose bristles on the inner border and three simple hairs on the outer, the penultimate joint having a long ciliated hair on the inner border and a short one on the outer side. Hamulus posterior rather long and slightly curved.

Posterior thoracic segment very large (about one third as long as broad), giving off the *fourth pereopods*, which are three-jointed and extremely long, extending as far as the caudal plates; the first joint is long and muscular, the second one third as long, giving off on its inner border a single slender curved claw nearly equal to the length of the terminal joint; this last ends in a pectiniform edge and three curved elongate claws placed close together near it, each of these having fine dentations at their bases.

Genital segment heart-shaped, about one third the length of the carapace and rather less broad.

Abdomen indistinctly two-jointed, equalling in length the last segment, the first joint being of a narrow oblong shape; the second is rather longer, broadening at its extremity, where it gives off the two caudal plates; these are very large, with narrow pedicles and square-cut extremities; the inner border runs nearly parallel to the outer and is covered with long cilia; these plates terminate in three long, straight, stout, plumose bristles and a shorter one on the outer border; the stout terminal bristles and caudal plates are pigmented blue; the egg-sacs are long and of a green colour in life.

Length 5 millim.

Male.—This differs from the female in being rather smaller, the carapace is narrower, the genital segment is oblong, the abdomen broader and more distinctly two-jointed, and the caudal plates are oval in shape: of the organs the *posterior antennæ* are smaller, terminating in a very short hook; the *hamulus anterior* is longer and more robust; the second maxillipeds have a thicker basal joint, with a double tooth on its inner border, and the terminal claw-joint also has a minute tooth near its extremity.

Length 4.5 millim.

Caligus robustus, sp. n. (Pl. XI. figs. 1, 2.)

A large number of specimens of both sexes were found of this species freely moving about, generally on the inner side of the operculum or on the bony gill-rays of various species of *Caranx* and *Thynnus*, viz. *T. macropterus*, *C. affinis*, and *C. djedaba* at Trincomalee, and *C. Rottleri* at Aden.

This species bears a resemblance to *Caligus irritans*, Hell.*, having the double long-shaped posterior thoracic segment and elongated biarticulate abdomen; it may readily be differentiated by its broader, more arched carapace and strong four-jointed fourth pair of legs, besides many structural details; the male too varies considerably.

Female.—Colour pure white; oculi pink.

Carapace strongly arched upwards, considerably broader than long, narrowing rapidly anteriorly, posterior angles rounded, posterior median lobe broad, sulcus on each side moderately deep. Frontal plate narrow, its anterior edge almost straight; lunulæ at the outer end shallow, small comparatively to those of *C. irritans*.

Anterior antennæ having the first joint about equal in length to width of the lunule; second joint longer and club-shaped.

Second antennæ of the usual form, but the terminal claw is more slender than in general.

Hamulus anterior very small, slightly curved; rostrum short.

Palp elongate, curved, with blunted end and an apparent constriction; but no bifurcation is seen near the extremity.

First maxillipeds of the usual form.

Second maxillipeds: these are very strong, the basal joint, both in young and old, having a very strong bifid tooth near the extremity of its inner border, to which the end of the strong terminal claw approximates; at the base of the latter is a fine hair on the concave border.

Furcula of moderate size; a long base with parallel sides and rounded extremity giving off direct two short, flattened, slightly divergent branches with blunted ends, the aperture between them being considerably more narrow than the length of the branch.

First peræopod has three short terminal claws, with three long plumose hairs on the under border of the last joint; but I have been unable to discover the usual simple bristle at the angle.

Second peræopod of the usual form, but the bent short claws on the upper border of the first and second joints of the outer branch are strong, and at the end of the last joint there is a very small spur, with a stronger one deeply fringed with fine hairs on the underside; plumose hairs from beneath as usual.

Third peræopod: paddle-joints rather widely separated, the

* 'Reise der Fregatte Novara,' pp. 177-179.

terminal joint of the outer with four ciliate hairs, increasing in length from without inwards; a longer one is seen from the inner side of the penultimate joint; the inner paddle has six plumose hairs on the last joint.

Hamulus with a dilated base and a short, thick, curved claw.

Fourth pereopods, rising from an elongated posterior thoracic segment, are robust in form, four-jointed, the basal joint being of a long oval shape, the three last of nearly equal size, the first two each giving off a strong claw; the last has three placed close together.

Genital segment heart-shaped, having a constriction above, giving the appearance of a double posterior thoracic segment; the whole length equals about two thirds that of the cephalothorax; the rudiments of the fifth pair of limbs are visible on the posterior rounded border.

Abdomen slightly longer than the last segment; it is very constricted at its origin, becoming rapidly broader to near the extremity, where there is another constriction, forming a joint as long as broad.

Caudal plates longer than broad, giving off three short terminal ciliate hairs and two smaller ones on the outer side.

Length 7-10 millim.

Male.—This is smaller, and has the cephalothorax more oval in shape; the genital segment is narrower, terminating posteriorly in two stout spines; two fine hairs are also seen on the outer border; the abdomen is made up of a short broad joint and a second oblong one; the caudal plates are rather large, with the inner borders finely fringed with hairs. The *second antennæ* have the last joint reduced to a short though rather powerful hook, and the hamulus anterior remains of the same size as in the female, which is unusual.

Length 5 millim.

Caligus tenax, Heller. (Pl. XI. fig. 3.)

As the male of this has not yet been described, I here take the opportunity of putting it on record. Heller found specimens of the species on *Caranx carangis*, Brazil; in these eastern seas I have taken very large numbers from the gill-chambers of various species of *Caranx* found at Trincomalee, Colombo, Muscat, and Aden, the males being fairly plentiful; these specimens were seen to have the abdominal segment generally shorter than those described by Heller*, but agree in detail of structure, except that on careful examination the

* 'Reise der Fregatte Novara,' pp. 172-173.

hamulus anterior will be seen to have a short basal spur, which he does not mention; they were generally taken with *C. carangis* of Kröyer*, which is easily distinguished from them by the absence of the small chitinous hooklets on the basal plate of the third peræopods, by the much smaller furcula, by the more rounded genital segment, and the greater size of the fourth pair of legs.

Male.—Taken from *Caranx melamphigus*.

Carapace much broader than long, narrowing quickly anteriorly and slightly at the posterior angles. Frontal plate very wide, deeply concave in front, the lunulæ, which are large, projecting considerably forward.

The *posterior antennæ* have a very short strongly curved terminal claw, which is very different from the long slender one of the female.

Hamulus anterior of moderate size; both basal and terminal spurs are much larger than in the other sex; the thoracic appendages are not altered.

Genital segment about one third as long as the cephalothorax, oblong in form, though narrowing anteriorly; about the juncture of the middle and the last third are three fine hairs placed close together and a single one at the posterior angle.

Abdomen nearly square, about one third the length of the genital segment, bearing the two short caudal plates.

Length 3-4 millim.

CALIGODES, Heller.

Caligodes carangis, sp. n. (Pl. XI. fig. 4.)

This genus was formed by Heller † to include an animal described by Kollar as *Chondrocanthus lafciniatus*, afterwards referred by Kröyer ‡ to Van Beneden's genus *Sciænocephalus* as *S. lafciniatus*.

The original specimens were taken from a species of *Belone* and are preserved in the Vienna Museum, being fully described by Kröyer.

On examining large numbers of the larger specimens of fish of the genus *Caranx* in the Aden market, I was struck by the frequency with which one saw on the palate of *C. ferdau* two small hæmorrhagic tumours, placed far forwards near the middle line; on closer inspection there were seen hanging

* 'Bidrag til Kundskab,' 1863, pp. 69-70.

† 'Reise der Fregatte Novara,' p. 180.

‡ 'Bidrag til Kundskab,' 1863, pp. 153-157.

from them slender opaque white bodies, often ten from a single tumour; on dissecting the tumours the head and neck of these peculiar parasites were seen to be deeply buried, the neck often being incased in a sort of red fibrinous tube; on first removing them I thought they were either Chondracanthi or one of the nearly allied genera. To the fish they must be a great inconvenience, situated as they invariably were. Only females were found.

The before-mentioned authors describe the elongated portion as a drawn-out posterior thoracic segment, but in these it appears to be a produced neck-like commencement of the true genital segment; my specimens, too, differ in having the fourth pair of thoracic legs well formed, as in *Synestius*, Steenstrup & Lütke*, instead of being rudimentary.

The four-jointed fourth pair of thoracic limbs, the large furcula, and the two laminate prolongations of the abdomen distinguish this species.

Female.—*Carapace* almost circular, very small, equal to about one seventh of the whole animal length. Frontal plate distinct, deeply excavated in the centre between the two lunulæ, which are of moderate size, projecting somewhat in front, but less in diameter than half the frontal plate.

Anterior antennæ have a short basal joint provided with the usual plumose hairs and a much longer second joint with simple hairs at the end.

Posterior antennæ placed well forward near the base of the rostrum; they are three-jointed, the last joint in the form of a moderately strong curved hook.

Hamulus anterior small; it has a broad base, and is in the shape of a simple short claw.

Palp short, simple, and blunt-ended; a second smaller one is seen in front a little to the outside.

Rostrum about twice as long as broad.

First maxilliped of the usual form of *Caligus*.

Second maxilliped powerful; basal joint long and thick, having on its inner surface a curious bifid tooth; the terminal claw is markedly curved.

Furcula very large and prominent; from a narrow neck spring the two branches, which diverge widely and are sharp-pointed, the width of the opening being greater than the length of the arms; seen from the side the furcula has the appearance of a grapple, being most admirably adapted for fixation of the animal. Oculi of a pink colour, placed over the centre of the rostrum.

* 'Bidrag til Kundskab,' 1861, p. 24.

First peræopod three-jointed; the first joint has a single hair from the upper border, the second is cylindrical, the third or palmar joint is provided with three short terminal claws, the outer being the longest, and a single bristle at the angle; I was unable to detect any trace of the usual plumose hairs from the under border.

Second peræopod has each branch provided with three joints; the upper border of each of the outer ones has a single claw; plumose hairs as in *Caligus*.

Third peræopod has the basal flap broad; on the inner surface near the centre on each side is a patch of small tooth-like processes about twelve in number, also a single row extending from the hamulus upwards; the hamulus is of moderate size and strongly curved; the paddles are small, placed near together, provided with feathered hairs as in *Caligus*, differing from that described by Kröyer. The last thoracic joint is ill-defined, but it appears of a square form, not projecting below the apron of the third pair of limbs.

Fourth peræopod well formed, four-jointed, the first joint being cylindrical and muscular, four times as long as broad; the other three joints are welded together as in *Caligus*, the terminal giving off three short curved claws placed close together, the outer one being the longest, each of the other joints has a claw of about the same length on its inner border.

Genital segment of a pyriform shape, with a long neck uniting it to the thorax, the whole being three and a half times the length of the cephalothorax, and three times as long as broad; the intestinal canal and ovaries are easily visible in the dilated portion, the ducts of the latter being placed near together; from the under posterior border outside these openings is given off on either side a long laminate process more than one third as long as the last segment, protecting the external ovarian tubes.

Abdomen broad and flat, terminating in two laminate appendages not quite so long as the ventral ones, differing thus markedly from the abdomen of *C. lanciniatus*.

The *caudal plates* are exceedingly small, wedged in between these two processes; they are slightly longer than broad, and give off three fine terminal plumose hairs, with a minute one on the outer border.

Egg-sacs very long, of a brown colour.

Length 11-12 millim.

ALEBION, Kröyer.

Alebion carchariæ, Kr. (Pl. XII. fig. 1.)

As only a single example of this animal is on record,

being described by Kröyer* from a male specimen obtained on a large shark in the Atlantic, I here give a short account of the female, which seems, without doubt, to be the same species, taken from a small shark at Aden, which I was fortunate enough to be able to examine immediately after its capture, before the parasites had been washed off, finding two mature females on the surface of the pectoral fin. The description of Kröyer is very full, so that it is unnecessary to enter into too great detail, only to point out the chief differences which appear.

In outward form the dorsal plate covering the last thoracic segment was much less apparent; the genital segment, though of almost equal proportional size to that of the male, had extending between the posterior processes a much shorter biarticulate abdomen, the first joint of which was rounded, slightly broader than long, the second being oval, more than twice as long as the first, giving off two caudal plates of an elongated oblong form, terminating in three large plumose bristles and a small outer one. On minute examination the posterior lobe of the carapace was seen to have on either side four small teeth, and laterally there are three others. The dentations at the posterior border of the genital segment are bicuspid, and those on the elongated portion are larger than the ones represented by Kröyer. The posterior antennæ are larger than in the male; the second maxilliped has a very short robust terminal claw, bearing a hair on the inner surface near the base. The first two peræopods do not vary, but in the third the detail seems to be somewhat different: the outer paddle is large and has three distinct joints, the first having on its inner border a long plumose hair, on the outer border, which is ciliated, there are two short thick bristles, the lower one being the longer; the second joint has a plumose hair on the inner border and one short bristle on the outer, on it is seen one reniform body; the third joint bears two reniform bodies and on the inner border are six plumose hairs: the inner paddle has an elongated stalk-like joint and the final one bears five distinct plumose hairs; the glandular(?) apparatus described by Kröyer is also seen. Fourth peræopods very rudimentary, the proportional size being given in the Plate. On the genital segment three bright red pigment-spots on either side are very apparent.

Length 7 millim.

* 'Bidrag til Kundskab,' 1863, pp. 165-168.

Dichelesthina.

PSEUDOCYCNUS, Heller.

Pseudocycnus appendiculatus, Hell.

Ten specimens of this rare animal were found attached to the gills of *Thynnus macropterus* at Aden; they were all mature females. These I kept alive for some time. The vascular system is very elaborate, and apparently these animals, like those of the genus *Lernanthropus*, are essentially "blood-suckers," being full of red blood. The specimens originally described by Heller* were taken in the Indian Ocean on a species of "*Coryphæna*," with which these agree in almost every detail, except that in my specimens stump-like rudiments of the fifth pair of limbs carrying a single small hair were present at the extreme end of the genital segment on either side just in front of the flap-like processes which protect the ovarian openings.

Length 10 millim.

LERNANTHROPUS, Nordm.

Lernanthropus nudus, sp. n. (Pl. XII. figs. 2, 3, 4.)

While at Aden I was astonished by the great number of specimens of an animal of this genus which were present attached to the gills of a large grey mullet (*Mugil*, sp.) very common in the market. Scarcely a fish would be examined without finding many specimens; as they attached themselves very firmly, they were not easily washed away. It seems to be a genus widely distributed, and I have taken out here a good many species. This one appears to be very remarkable. Obtaining them fresh and in large numbers, one was able to keep specimens alive for some time, when their brilliant red colouring and movements made them very interesting to watch, as described by Hesse. Both males and females were found separately, and also once "in copulâ," as shown in the figure; the males are much smaller than the females, but did not show the more brilliant colouring, as in Hesse's plates; the free-swimming embryos were taken from a watch-glass about twelve hours after the eggs were discharged. The chief characteristics of this species are the entirely exposed condition of the abdomen and the great length of the processes representing the fourth pair of limbs.

* 'Reise der Fregatte Novara,' pp. 218-219.

Female.—*Head* of large size, longer than broad, largest at the base, which is slightly rounded; it is strongly arched dorsally from side to side, the margin folding inwards on the under surface; in front the border is convex and prominent, showing no median notch, from the underside of which frontal border the six-jointed setiferous anterior antennæ are seen.

Thorax seen from the dorsal surface divided into three segments, each having a median indentation posteriorly; they are broader than the head and are together somewhat longer: the anterior segment is but indifferently marked off; this is the true second thoracic segment bearing the second pair of thoracic limbs, the first being united with the cephalic portion; it is less wide than the following segments and very short: the second free segment is much broader than long, with rounded sides, from under which can be seen projecting the third pair of limbs; the third free thoracic ring is slightly smaller than the last, but of similar shape, being not so long as broad and deeply cut away posteriorly; the sides of these segments are deeply pigmented, and the alimentary canal is easily visible down the centre; the usual posterior tunic or plate common to the whole genus appears to be, however, entirely absent, the abdomen being quite bare, projecting between the two greatly elongated processes representing the fourth pair of limbs; on either side of it from the posterior edge of the lobe of the last segment, is seen a small rounded flap or plate partially covering the base of the fourth pair of limbs; these may be the rudiments of the dorsal tunic.

The *abdomen* is rather longer than the last thoracic segment; it is composed of three distinct portions, the second partially overlapping the third: the first is of a rounded shape, but broader than long; the second is pointed at the extremity, it is constricted in the middle, dividing it into two parts; to the upper and wider are attached the ovarian tubes, to the narrower the two stalked dark spermatophores. The third abdominal joint is oblong in shape, traversed by the intestinal tube; the anal opening is seen at the end between the two caudal plates, which are oval in shape, somewhat divergent, and placed on the under border.

From the ventral side one sees the six-jointed setiferous *anterior antennæ*, and placed far forward the triarticulate *posterior antennæ*; the first two joints of the latter are very broad and muscular, the last in the form of a curved hook: beneath these on the median line is found the mouth, of a pointed conical shape; on each side of this near the base a slender triarticulate and a thicker biarticulate process can be

made out, probably the mandible and palp; on either side a little backwards are placed the two pair of maxillipeds, the first are much the most slender, the second joint having the point somewhat sickle-shaped.

The *second maxilliped* is very strong, the outer extremity of the large muscular joint extending a little beyond the margin of the cephalothorax; the terminal hook-like joint has a small tooth on the concave border about one third from the point. Under the lower margin of the cephalic border are seen the rudimentary first thoracic limbs; they are two-branched and single-jointed, the outer branch being of a square shape, having five short digitations with crenate edges on the border; the inner branch is very small, terminating in a single short bristle. The rudimentary second pair of limbs are placed a little further back and are much smaller than the first, the outer branch carrying four small digitations only; on the inner I could see no bristle. The third pair of limbs are converted into curved foliate processes as usual; they spring from the side and posterior border of the second free thoracic segment; these are very vascular and act as claspers for the animal. The fourth pair of limbs rise on the side of the abdomen from the last thoracic segment; they quickly become split into two processes, very long and narrow, their length being greater than that of the whole of the rest of the animal; they are pale red in colour, pulsatile, and no doubt act as branchiæ, as Hesse suggests; they are in constant motion, curling up and straightening out.

Length without processes 5 millim., with processes 11 millim.

Male.—Much smaller than the female, having the head proportionally larger and more oval in shape. The body is divided into two parts—the first is very short, carrying the second pair of rudimentary thoracic feet: the second portion, which is of a much more regular oval shape, carries on both sides two pair of appendages, the first pair being single-branched, springing from the anterior part, and equal in length to that of the body; the second pair are divaricate, proceeding from the posterior part of the body, and much longer than the anterior pair: between these is seen the genital segment, this tapers considerably to the abdomen, which is oblong in shape, terminating in two leaf-like caudal plates of almost equal length with the abdomen, but rather less than half as broad. The appendages are like those of the female, except that the structure of the terminal joint of the first maxilliped is quite peculiar, being dilated along its concave border and

thickened near the end, where the dentations are coarser; the point is more curved and minutely toothed.

Length without processes 5 millim., with processes 8 millim.

The embryos when first hatched are rounded, with an anterior projecting portion, and are sharp-pointed posteriorly, on each side of which is seen a long bristle; these bear on either side three pair of limbs, the first ending in a single hair, the second with three, the third pair with four. When a little older the body is more distinctly segmented, the second and third limbs become bipartite, each branch of the second has a single joint terminating in two fine hairs; each branch of the third consists of two joints, the end one giving off four long hairs.

The male is seen to attach itself firmly to the abdomen of the female by its powerful posterior antennæ, the body hanging freely between the long laminate processes.

NOTE.

The name "*Helleria*" being already appropriated for more than one genus of crustacean animals, I propose to alter the one so called by me (described in the *Ann. & Mag. Nat. Hist.* ser. 7, vol. i., January 1898, pp. 10-11, pl. v., and August 1898, vol. ii. pp. 93-94) to "*Cybicola*," to avoid any confusion.

EXPLANATION OF THE PLATES.

PLATE X.

Fig. 1. Bomolochus megaceros, ♂, Heller, highly magnified.

1 a. Anterior antenna. 1 b. Posterior antenna. 1 c. Second maxilliped. 1 d, e, f. First, second, and third pereopods. 1 g. Fifth pereopod. 1 h. Last abdominal joint and caudal plates.

Fig. 2. Caligus longipedis, ♀, sp. n., from the back, enlarged.

2 a. Cephalothorax from beneath, much magnified. 2 b. First maxilliped. 2 c. Third pereopod. 2 d. Fourth pereopod. 2 e. Caudal plates.

Fig. 3. Male of the same from the back, enlarged.

3 a. Posterior antenna. 3 b. Hamulus. 3 c. Second maxilliped.

PLATE XI.

Fig. 1. Caligus robustus, ♀, sp. n., from the back, enlarged.

1 a. Cephalothorax, much enlarged. 1 b. Outer branch of the second pereopod. 1 c, d. Third and fourth pereopods. 1 e. Caudal plate.

Fig. 2. Male of the same from the back, enlarged.

2 a. Posterior antenna. 2 b. Posterior extremity of genital segment.

Fig. 3. Caligus tenax, ♂, Heller, from beneath.

3 a. Hamulus anterior.

Fig. 4. Caligodes carangis, ♀, sp. n., from the back, enlarged.

4 b. The same in profile. 4 c. Genital segment and abdomen.
4 d. Cephalothorax from beneath, much enlarged. 4 e. Last joint of the first peræopod. 4 f. Third peræopod.
4 g. Caudal plates. 4 h. Last joint of the posterior antenna. 4 i. Second maxilliped. 4 j. Fourth peræopod.
4 k. Furcula from the side.

PLATE XII.

Fig. 1. Alebion carchariæ, ♀, Kr., from the back, enlarged.

1 a. Second maxilliped, much enlarged. 1 b. First and second peræopods. 1 c. Third and fourth peræopods. 1 d. Margin of the genital segment. 1 e. Extremity of posterior process of the genital segment.

Fig. 2. Lernanthropus nudus, ♀, sp. n., seen from the back, enlarged.

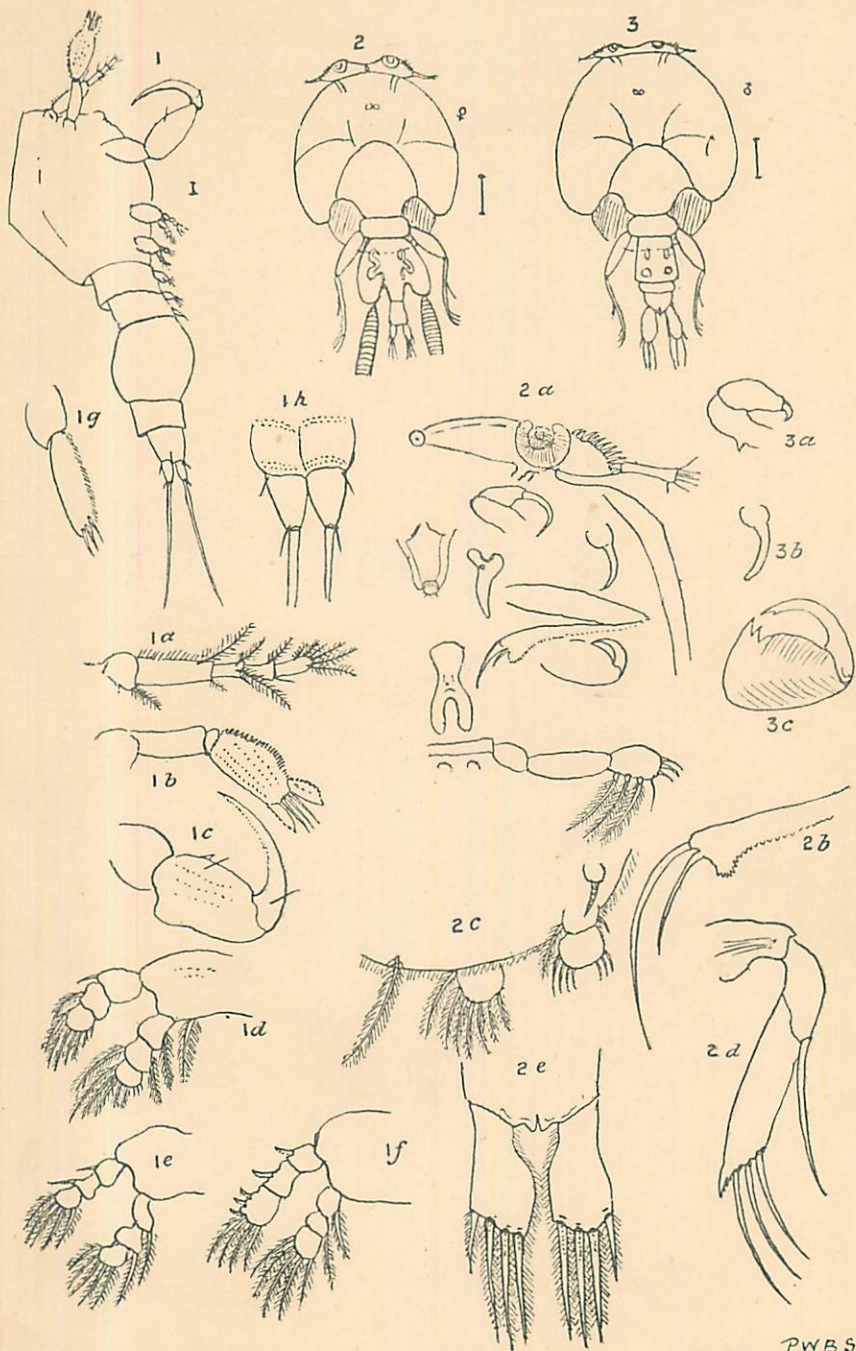
2 a. The same seen from the side. 2 b. Cephalothorax, much enlarged, from beneath. 2 c. Part of the margin of the first peræopod. 2 d. Abdomen and posterior processes, showing ovarian tubes and spermatophores attached.

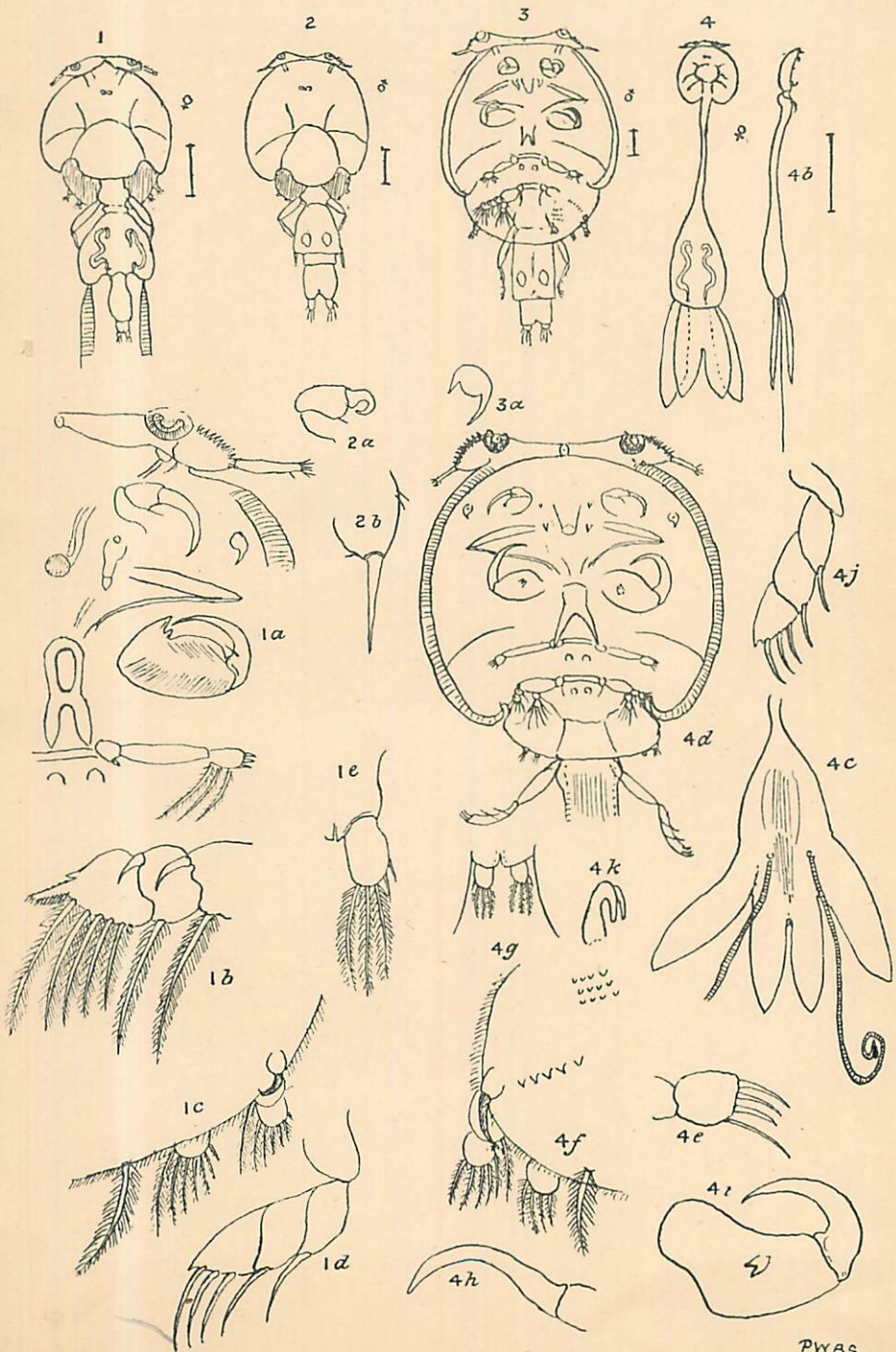
Fig. 3. Male of the same, enlarged.

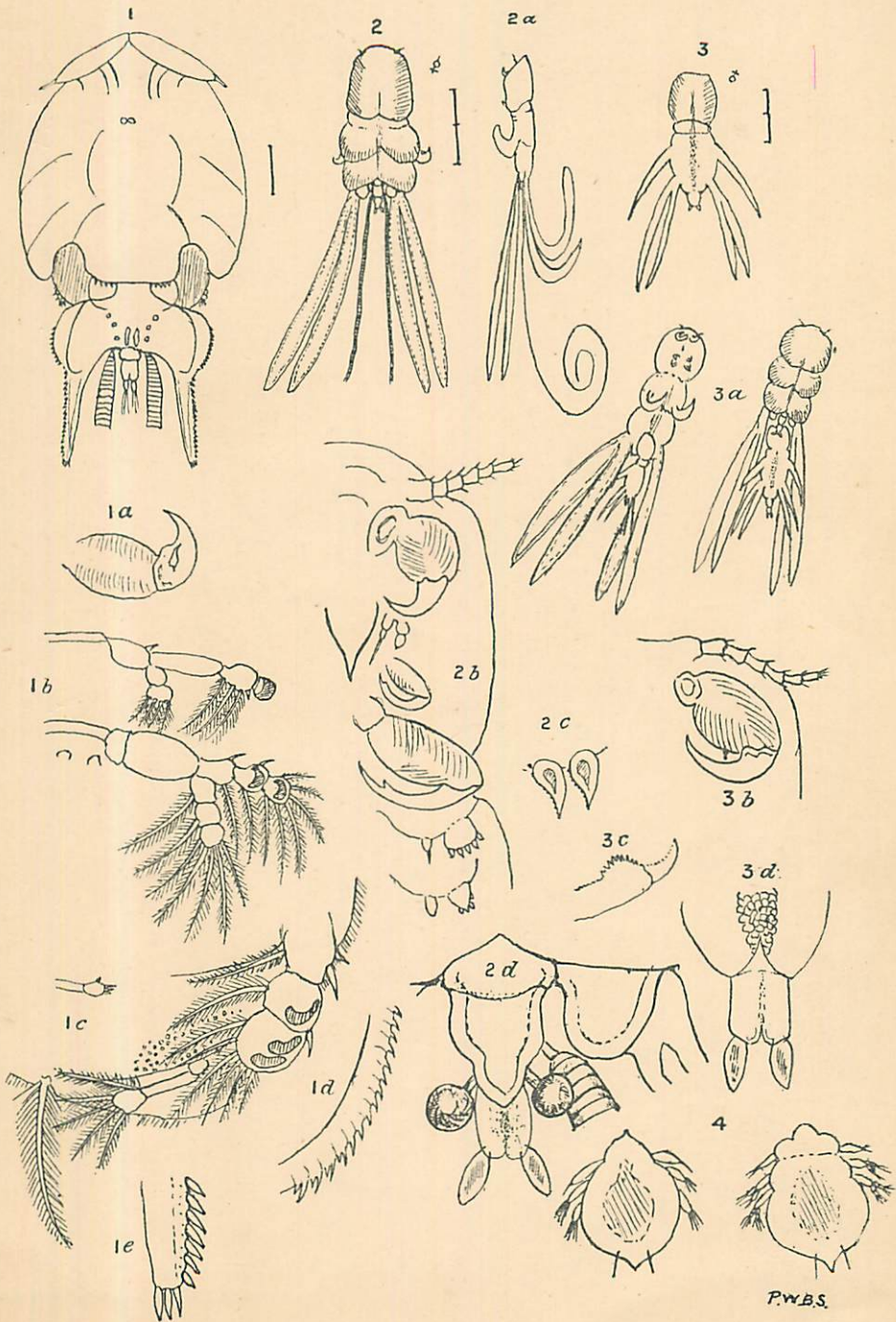
3 a. Male and female "in copulâ." 3 b. Anterior and posterior antennæ. 3 c. Extremity of first maxilliped. 3 d. Abdomen and caudal plates.

Fig. 4. Embryos in two stages of development.

N.B.—The line to the right of a figure shows the natural length of the animal.







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Further New
Parasitic Copepods

from Fish in the
Indo-tropical Region.

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by

P. W. Bassett-Smith

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Further new Parasitic Copepods found on Fish in the Indo-tropical Region. By P. W. BASSETT-SMITH, Staff-Surgeon R.N., F.Z.S., F.R.M.S.

[Plates III.-VI.]

DURING the past year, owing to H.M.S. 'Cossack' having visited a variety of harbours in the Indo-tropical region, the opportunity has been given me of adding considerably to what I had already seen at Bombay of these curious little parasites; continued research has shown very clearly that they are abundantly represented. In most cases, when inspecting any number of well-grown fish (for it is certainly more common to find the mature fish infested with one or more parasites than the younger ones), careful examination would bring to light some actively moving *Caligus* in the gill-cavity, or perhaps a more bizarre and anomalous form, attached to the lips, body, or elsewhere. One point has been very strongly impressed on my mind, namely the constancy with which most of them are found on any particular kind of fish; and one can predict with almost certainty the form that will be found, though at the same time it appears that one species may at times be taken on two or more distinct "hosts." As is only to be expected when the fish in this region are comparatively so little known, very few of these small parasites

have been described. I have therefore in this paper brought forward a few more of the best-marked forms, following "Gerstaecker's" classification, as before, having, however, to add to his genera a new one in the family Dichelesthiina.

It is very pleasing to be able to bring to light second species of two genera, both of which were created by Dr. Heller in 1865, my specimens having been obtained in localities considerably removed from that whence the original ones came; in the case of *Hermilius*, though the species differ, the genus of both host and parasite remains constant.

At present there are a large number of known species belonging to the genus *Caligus*, some of which have been described from single specimens, or even from the male alone; this should evidently be avoided as much as possible, for in different stages of growth they vary considerably in outward conformation, especially with regard to the shape of the genital segment; true differentiation can only be carried out by detailed examination of the articulate organs, maxillary and swimming-feet, &c. Since describing *C. hirsutus** many larger specimens of this species have been taken; in these the genital segment became broader and more winged, but the characteristic condition of the fourth peræopods is always present, as also the dilated appearance of the abdominal portion.

The work of collecting is difficult, for in a native market the crowds of moving, gesticulating, dirty, odoriferous men and women, though picturesque, render close inspection and examination of the fish almost impossible, besides the dislike the natives mostly have of a "saheb" touching anything they may want to eat; again, no doubt a large number of those parasites that live on the external surface get washed off before the fish are taken to the market.

Ergasilidæ.

BOMOLOCHUS, Nordm.

Bomolochus denticulatus, sp. n. (Pl. III. fig. 1.)

A series of specimens of this species were taken in small numbers at a time from the gill-cavities of a "Barracouda" (*Sphyræna jello*) from Trincomalee and Colombo, as well as from the gills of a "garfish" (*Hemirhamphus far*), also at Trincomalee, often together with a small *Caligus* not yet described.

* Ann. & Mag. Nat. Hist., Jan. 1898, p. 6.

This animal resembles very much *B. scomberesocis*, Kr., but after the examination of a number of specimens I believe it to be distinct, chiefly distinguished by the character of the "frontal processes" and the structure of the claws on the outside of the outer branches of the true legs, which here are strongly dentate, so markedly so that it appears impossible that "Kröyer" could have omitted to note the fact, especially as he makes such a point of the curious spur found at the end of each of these claws; the single specimen from which his description is taken was found in the tropical Atlantic, those of mine in the Indian Ocean and on different kinds of fish.

Female. — Body elongate. *Cephalothorax* five-partite; first segment much broader than long, convex above; third segment very globose in shape, projecting considerably dorsally as seen from the side (Pl. III. fig. 1 a). First segment rounded in front, giving off the frontal plates by narrow pedicles a short distance on each side of the middle line, where the frontal border is deeply cut out, presenting a fossa and a semilunar process as described by Kröyer*.

The *frontal plate* bears on each side on its anterior edge about fourteen delicately ciliated setæ; the inner two are large and curve over the central fossa, the outer three are longest and straight, directed outward; there are also from the upper surface three slender bristles, directed forward, placed nearly equidistant from one another, the outer being the shortest and most slender; on the dorsal surface on each side of the central fossa are two horny processes with strong muscular attachments, each bearing three very short obtuse-ended bristles of about equal length, pointing forward; these appear to be shorter and thicker than those of *B. scomberesocis*, Kr.

Anterior antennæ long, slender, three-jointed, minute hairs at the joints and a bunch at the end of the terminal joint.

Posterior antennæ biarticulate, each antenna folding on itself; the second joint is of peculiar structure, it terminates in two short crenate processes, between which are three small hairs; on the inner border is a tubercle with a strongly dentate surface, the whole inner face of the limb being covered with minute teeth. *Hamulus* placed laterally; it is two-jointed, the basal joint being broad and flattened, the second of equal length in the form of a strong claw, with a plumose appendage at its base.

* 'Bidrag til Kundskab,' 1863, pp. 217-219.

Mouth-organs are much the same as *B. megaceros*, *B. tricerus*, &c., but between the basal joints of the first peraeopods is seen an oval cavity with a ciliate margin.

First peraeopod with a strong basal joint bearing two branches, the outer two-jointed, the inner three-jointed, carrying plumose hairs.

Second, third, and fourth peraeopods two-branched, each with three joints, the outer of irregular shape, from the outer border of which spring short claws, on the upperside of these one sees five to seven very strong teeth, and at the end a short spur; the terminal joints and inner borders have plumose hairs as usual.

Fifth peraeopod single-branched, three-jointed, terminating in three simple hairs, the middle being the longest; there is also a fine hair placed halfway up this joint.

Genital segment and caudal joints one third the total length, slender and tapering, four in number, each joint wider than long; the terminal joint bears two elongated caudal plates, giving off from the end one very long and one short bristle; also a minute hair on the outer side.

Egg-sacs very large, as long as the whole animal; eggs round, three in the diameter of sac.

Length 3-4 millim.

Caligidæ.

HERMILIUS, Hell.

Hermilius longicornis, sp. n. (Pl. III. fig. 2.)

This is the second known species of this genus, which was formed by Dr. Heller in describing an animal with a peculiar bivalve-shaped cephalothorax*. His specimens were found on the gills of a "cat-fish" (*Arius acuta*), Java; mine were taken in quantity from the gills of another "cat-fish" (*Arius acutirostris*) at Trincomalee. From almost all the fish examined some specimens were obtained, the parasite being very abundant; it firmly clasps the gills with its folding-up cephalothorax, being anchored by the strong hooks of the second antennæ; on examining the fish only the egg-sacs are visible, their light colour causing them to be easily detected.

This species is readily separated from *H. pyriventris*, Hell., by the great size of the posterior antennæ and by the oblong form of the genital segment.

* 'Crustaceen: Reise der Fregatte Novara,' 1865.

Female.—The *cephalothorax* being folded up as a mussel is deeply notched in front and behind, the length of each valve is much greater than the breadth, and equals about two fifths of the total length; it has a rounded, somewhat lobed border, and fringing the margin is a wide band of lineate structure, which on higher magnification is seen to be due to minute parallel canals, and no doubt assists in the holding power of the valve; on the dorsal surface the chitinous ribs are seen as described by Heller.

Frontal plate narrow, with a straight border, from the outer and under side of which rises the *anterior antennæ*; these are small, two-jointed, the basal being longer than the second, having on its front border about ten ciliated setæ; the second joint is rod-shaped, terminating in a few fine bristles.

Posterior antennæ placed some distance back from the frontal border; they are very long and strong, the claw-like ends projecting well in front of the anterior border; each is composed of three joints—the basal is short, thick, and muscular, carrying a small sharp-pointed spur directed backwards, as in many of the "*Caligidæ*"; the second joint is short and thick, bearing the long terminal claw-joint on a firm articulation; it is widely curved, sharp-pointed, and has on its concave border one third from the point a secondary sharp hook, rather less long, but not articulate.

Rostrum of moderate size, three times as long as broad, tapering to the point.

First maxilliped very small, two-jointed, with a sharp-pointed palp near its base.

Second maxilliped very long, two jointed, the first being oval and muscular, the second slender, curved, chitinous, terminating in a short sickle-shaped point, with a minute tooth at its base.

Furcula very small, with a short dilated base, bearing straight, pointed, slightly divergent branches; the distance between the points equals the length of the branch.

First pereopod three-jointed, the basal short and thick, with a small lobe from the inferior border; the second joint is about twice as long, the third is short, bearing on the under border three long plumose hairs; at the extremity are seen three long straight bristles, the upper being the longest, equalling the whole length of the limb; at the angle is a very short bristle.

Second pereopod of the usual form; *third* as in "*Caligus*"; the two branches are here placed close together and are very

small; the *hamulus* is very small, slightly curved, and just overlaps the border.

Fourth peræopod very short, not reaching as far as the border of the genital segment; it terminates in three short simple hairs, with a fourth halfway down the lower border.

Genital segment large, oblong, lobed posteriorly, slightly narrower in front.

Abdomen small, as broad as long, about one sixth the length of the genital segment. Caudal plates longer than broad, bearing three short terminal *plumose* setæ and two short hairs on the outer border.

Egg-sacs long, as in *Caligus*.

Length 5 millim.

CALIGUS, Müll.

Caligus arii, sp. n. (Pl. IV. fig. 1.)

This species was found in greater or smaller numbers on every example of a "cat-fish" (*Arius acutirostris*) examined at Trincomalee, Ceylon. During the month of October 1897 both sexes were present in various stages of maturity, and appear never to attain any considerable size: during life they were very active; the "lunulæ" were very marked, projecting in front of the frontal border, the carapace markedly vaulted, and colour quite transparent, without spots; the posterior lobes of the genital segments in the immature females were strongly marked.

These animals were taken in company with *Hermilius longicornis* and *Lepeophtheirus longipalpus* on the inside of the operculum and on the roof of the mouth. This species seems to be nearest allied to *C. monacanthi*, Kr., taken in the West Indies, differing, however, entirely in the details of the swimming-feet, caudal plates, &c.

In the female the *cephalothorax* was almost circular in shape, slightly longer than broad, considerably shorter than the remaining portion of the animal, narrowing rapidly anteriorly; the posterior central lobe, which is broad, is separated from the posterior lateral angles by a deep cleft, the whole being strongly arched upwards and having the outer circular edge bordered with a strip of very fine short parallel tubes. Frontal plates of moderate size, somewhat indented in the centre. Lunulæ very large and prominent.

Anterior antennæ: first joint equal in length with breadth of lunule, bearing about twenty small plumose hairs; second joint club-shaped, with fine terminal hairs.

Posterior antennæ placed well to the outer side of the

rostrum, large, three-jointed, the terminal joint being unusually long, with oblique curved claw.

No *hamulus* detected.

First maxilliped of the usual form. *Mandible* slender, with the last third of the concave border strongly dentate. *Palp* short, sharp, slightly curved.

Second maxilliped: basal joint short and thick, the second a short curved simple claw, bearing a minute hair on the concave border one third from the point; this means of attachment is peculiarly small compared with that of the strong posterior antennæ. *Furcula* very prominent and strong; the base is broad, with straight sides, bearing large, divergent, simple branches with blunted ends, the width of the opening being equal to the length of the arms. The first of the swimming-feet (*peræopoda*) has from the short basal joint a long plumose hair equal in length to that of the second joint; the third joint or palm bears three short hooked claws on its outer end of about the same length, a fine slender hair at the angle, and three long plumose hairs from the under edge. *Second peræopod* of usual character, the third is peculiar; the *hamulus* is distinctly two-jointed, the spur being almost straight, not projecting beyond the border of the first joint of the outer branch; these two articulate branches are placed close together and are very large, the surface of the terminal joints being finely granular; the outer bears seven and the inner six plumose hairs. *Fourth peræopod* of moderate size, four-jointed, the three claws of the terminal joint and that of the penultimate being placed close together, of nearly equal length, a fifth being placed higher up; the last joint of the cephalothorax, from which these spring, is elongated and of a diamond shape.

Genital segment oblong, with a rounded anterior border and strongly lobed posterior angles, from between which rises the extremely elongated abdominal segment; this is biarticulate, the second joint being very short, its breadth equal to its length, its posterior border giving off two minute sessile caudal plates, which are broader than long; there are three terminal plumose setæ, two minute ones on the outer side, and a single one on the inner.

Length 5-6 millim.

Caligus platytarsis, sp. n. (Pl. IV. fig. 2.)

This animal was obtained in great numbers on a species of *Mugil* at Muscat, found in the gill-cavity; only females, more or less mature, were taken.

This species is remarkably characteristic in form by its rounded carapace, squarely cut genital segment, bearing at the angle the fifth peræopods, and elongated abdomen, the whole being spotted with pink; the form of the furcula and fourth peræopods are quite distinct, separating it from *C. isonyæ*, Steen. & Lützk.*, to which species it bears a resemblance; these authors lay great stress on the excavated condition of the front border of the frontal plate, and the secondary spur on the palp, which are not present in this species; their specimens were taken on a *Sphyræna* in the West Indies.

Female.—*Cephalothorax* rounded, as broad as long; frontal plates narrow. Lunulæ very shallow. *Anterior antennæ*: first joint twice as long as the breadth of the lunule, the front border provided with about fourteen fine plumose hairs, the second joint is rather short and slender, with fine hairs at the end. *First maxilliped* of the usual form, the second of moderate size, the terminal claw without hair on the concave border. *Hamulus anterior* not detected. *Furcula* quite peculiar, rising from a broad base; instead of ending in the usual elongated branches, there appear to be two thickened knob-like processes; this condition was found in all the specimens, and therefore was not due to fracture. I have not met with this condition in any other species. *First peræopod*: the basal joint bears a small lobe on the lower border, the second has a minute spur on the outer extremity, and the third carries three claws at the extremity of nearly equal length and three long plumose setæ from under border. *Second peræopod*: the first and second joints of the outer branch each carry a small spur-like claw on the upper border, the third or terminal has three of smaller size, with six long feathered hairs beneath; the inner branch is three-jointed as usual. *Third peræopod* has the paddle-branches placed some distance apart; the outer border of the second joint of the outer branch bearing three short simple hairs, the inner border four long plumose ones. *Hamulus* small and almost straight. *Fourth peræopod* of moderate length, four-jointed, the last three joints as usual welded together, terminating in a minute spur; the last joint carries on the outer side a moderately strong sharp simple claw, placed close to it equally distant from one another are four flattened "toes," covered with minute hairs like the tongue of a fly—two rising from the last joint, one from the third, and one from the second.

Genital segment flask-shaped, the posterior border cut off

* 'Bidrag til Kundskab,' 1861, pp. 18-19.

quite squarely with the abdomen; at the outer angle on either side one sees a small process carrying three fine hairs (rudimentary fifth peræopods), also a longer one placed just internal to it. *Abdomen* single-jointed, long, equal in length to that of the last segment of the cephalothorax and the genital one. *Caudal plates* much longer than broad, on a narrow base, carrying three long plumose hairs posteriorly—a shorter one on the inner border and two minute ones on the outer.

Length 6 millim.

Caligus Cossackii, sp. n. (Pl. IV. fig. 3.)

This species was taken from the gill-cavities of *Chryso-phorys sarba* at Bunder Abbas, in the Persian Gulf, in some quantity, both sexes; the male had also been taken before from the same fish at Colombo, together with a second undetermined species and *Lernanthropus atrox*.

These were very active, living for some time in a glass tube, showing great fondness for creeping up the glass out of the water, as Dana described, when they were with difficulty dislodged, at other times swimming briskly about; during life the genital segment showed a very corrugated edge and the intestine was clearly seen to pass down to the extremity of the abdomen between the caudal plates.

This species bears a considerable resemblance to *C. productus* of Steen. & Lütke., which varies considerably from the *C. productus* of Krøyer*, but is differentiated from them both by the character of the hamulus anterior, first peræopods, and by the caudal plates, &c.

Female.—*Cephalothorax* oval, much longer than broad, equal to one half the total length; frontal plate deeply excavated in the centre, having on the outer portion the very large and prominent lunulæ which extend to the back border of the plate. *Anterior antennæ*: first joint not quite so long as the breadth of the lunule; it is provided with about seventeen plumose hairs, these being longest at the outer end; second joint of moderate length. *Posterior antennæ* terminating in a very slender hook. *Hamulus anterior* very large, with a widely dilated base and a strongly recurved blunt hook. *First maxilliped* of usual form, the second having a short thick basal joint and a moderately large terminal claw with a minute hair on the concave border.

Furcula with a narrow base, giving off two pointed divergent branches, which again approach towards the extremity,

* 'Bidrag til Kundskab,' 1863, pp. 64-66.

the width of the opening being less than the length of the branch. *First peræopod*: the palm-joint is provided with three small simple claws of equal length; a fine hair at the angle and three long plumose setæ from the under border. *Third peræopod* carrying the two branches some distance apart, the first joint of the outer branch having on the outer side a single short spur, the second having three, with four plumose hairs on the inner border. *Hamulus* small, claw slightly bent. *Fourth peræopod* three-jointed, bearing at the extremity three curved simple claws, the outer being slightly the longest; on the centre of the inner border is a fourth, and from the end of the penultimate joint a fifth slightly shorter.

The *genital segment* is elongated, narrowing gradually anteriorly, broadest in the centre, slightly narrower and rounded posteriorly. *Abdomen* rather long, equal to the length of the last segment, divided into two parts, more or less well marked, of about equal lengths.

Caudal plates longer than broad, bearing three terminal plumose hairs and a smaller one on the outer border.

Length 5 millim.

Male.—Differs in its much more elongate form and oval genital segment; the terminal hook of the posterior antennæ is very small, but that of the hamulus anterior is very long and strong; the basal joint of the second maxilliped carries on the inner border a double-crowned tubercle, to which the point of the second joint approximates; the caudal plates are longer and profusely ciliated.

Length 3 millim.

The species described by Heller as *C. constrictus* is evidently a male, being very like this; but he states "the lunulæ are minute."

LEPEOPHTHEIRUS.

Lepeophtheirus rotundiventris, sp. n. (Pl. V. fig. 1.)

A single female specimen of this species was obtained from the gill-cavity of a species of *Lutjanus* at Colombo; a male was found on a *Serranus* at Muscat: though not taken at the same time, place, or on the same host, yet the occurrence of the distinctive characters in both of them, especially that of the fourth peræopod, justify me, I believe, in placing them in one and the same species. There is a resemblance of this animal to *C. brachyurus*, Hell., taken at Java, but they differ in important details; the peculiarly rounded genital segment and the very large last thoracic joint of this species at once draw the attention of the observer.

Female.—Carapace as broad as long, narrowing rapidly in front, where is seen the rather deep frontal plate, excavated considerably in the middle.

Anterior antennæ: first joint short and thick, with many plumose hairs on the anterior border; the second much longer, cylindrical, with a tuft of hairs at the end and one near the middle of the lower border. *Posterior antennæ* of moderate size. *Hamulus* has a rather dilated base, with short curved claw. *Palp* with two slightly divergent branches, both sharply pointed, the inner being the longer. *Maxillipeds* not remarkable. *Furcula* small, with very short, pointed, slightly divergent, simple branches, the base strong and broad, on either side having a double root.

First peræopod: the basal joint is short, the second cylindrical, and the palm bears three short end-claws, a long bristle at the angle, and three long plumose hairs from the lower border.

Second peræopod: the upper border of the first two joints of the outer branch bears each a single short spur, the third or last joint has two.

Third peræopod: the lamellar plate is large, the branches are placed close to one another, but not overlapping.

Hamulus posterior of moderate size, claw slightly bent. Last thoracic segment very large.

Fourth peræopods long and strong, distinctive of the species, consisting of four joints: the first long, cylindrical, and muscular; second to fourth fused, long, narrow, with parallel borders, the under being finely ciliated; from the last joint are three long curved hook-claws, the outer being much the longest, from the third joint a fourth, but less long, and from the second an extremely short one is visible.

Genital segment almost a perfect sphere; near the posterior edge are seen the rudiments of the fifth feet in the shape of a small tubercle with three hairs from it. Abdomen very short, one quarter the length of the genital segment, single-jointed, broadest near the centre, narrowing posteriorly. Caudal plates small, broader than long, with three terminal plumose hairs, and a shorter one on the outer border.

Length 4-5 millim.

Male.—*Cephalothorax* large, more than two thirds the length of the whole, oval, widest posteriorly, last thoracic joint not so large as in the female. *Genital segment* deeply excavated behind, causing the appearance of two lobe-like prolongations, each of these terminating in a long papilla, ending in a strong bristle, with two smaller ones on the inner border.

Abdomen near its termination broadens considerably, the caudal plates being widely separated. The *posterior antennæ* are of great size, the terminal hook extending nearly to the edge of the carapace; but the hamulus anterior is not proportionately increased. The other parts are as in the female.

Length 5-6 millim.

Lepeophtheirus longipalpus, sp. n. (Pl. V. fig. 2.)

A single well-grown female specimen of this species was obtained from the gills of *Arius acutirostris* at Trincomalee, with *Hermilius longicornis* and *Caligus arii*; the species is distinctly characterized by the peculiar structure of the maxillary palps and that of the fourth pair of legs.

Cephalothorax robust, a long oval; posterior lateral angles obtusely rounded; last thoracic segment well marked, diamond-shaped, with a secondary lobe at the juncture with the genital segment; the frontal plates are long, with a straight border, having a deep notch in the centre.

Anterior antennæ small, basal joint carrying about seventeen fine plumose hairs; second joint of equal length, with a terminal tuft.

Posterior antennæ: the first joint bears a strong spur directed backwards; the last joint long, forming a strongly bent claw.

Mandible of the usual form. *Palp* rising from below the base of the posterior antennæ, and inside the first foot-jaw is in the form of a long blunt curved horn directed inwards and backwards towards its fellow, and reaching almost as far as the furcula; this condition is quite peculiar, destroying a point which one had looked upon as almost of generic value, viz. the bifid palp.

Maxillipeds of the usual form. *Furcula* large, prominent, base broad, with slightly spreading roots; branches long, almost parallel to one another, blunted at the extremities, the width of the opening being about equal to two thirds the length of the branches.

First pereopod with a short basal joint, bearing a lobe on the under border; the palm with three minute terminal claws and three long plumose setæ from the under border.

Second pereopod of the usual form, but the upper border of each joint of the outer branch carries a single claw, the outer one being the longest.

Third pereopod: the two branches are placed close together, each distinctly two-jointed, the terminal joint of the outer carrying six hairs, short, but progressively increasing

in length from without inwards; the first joint of the inner branch has one, the second six short hairs. Hamulus very small.

Fourth peraeopod of considerable size and robust form, consisting of four joints, the last terminating in a minute spur, close to which are placed three end-claws, two others being placed at the inner end of the second and third joints; each of these five is seen to have a minutely crenate edge, which on higher magnification shows a beautifully serrated border, transversely striated; an abortive fifth limb is found at the angle of the genital segment in the form of a small tubercle, giving rise to three short plumose hairs.

Genital segment oval, with a truncated posterior border; equals half the length of the cephalothorax.

Abdomen elongated, as long as the last segment, consisting of a prolonged first joint and a second of a square form.

Caudal plates small, slightly longer than broad, with three long terminal plumose hairs and two minute ones on the outer border.

Length 6-7 millim.

ANURETES, Hell.

Anuretes perplexus, sp. n. (Pl. V. fig. 3.)

This genus was formed by Heller, and has been retained by Gerstaecker, the original specimen having been described by Kröyer as *Lepeophtheirus Heckelii*; it is distinguished by "the entire deficiency of separate tail-segments," all other parts agreeing with the genus *Lepeophtheirus*. The first specimen was obtained from *Ephippus gigas* in the Brazilian sea, described by "Koller" as *Caligus Heckelii*, being preserved in the Vienna Museum. A second specimen was taken from the same species of fish off New Orleans by Kröyer; he states that "this species has a moderately wide diffusion." I have been fortunate enough in a far removed locality—namely at Trincomalee, Ceylon—to find on a species of *Lutjanus* about a dozen specimens of a second form of this peculiar animal, though the necessity for making for it a distinct genus seems to me rather doubtful, for in some the position of the caudal plates is as Kröyer describes, but in a few these project a little beyond the posterior edge of the genital segment, though in none does "the abdomen appear drawn out."

Female.—*Cephalothorax* rather broader than long, narrowing in front; the posterior lateral angles obtuse, not

reaching so far backwards as the middle lobe; the frontal plate is narrow, convex forward, with a shallow median notch.

Anterior antennæ equal in length to half the frontal plate, of the usual form.

Posterior antennæ three-jointed, the basal with a well-marked sharp spur directed backwards, the end claw of moderate size. *Hamulus anterior* in the form of a very minute hook, with a dilated base, placed well towards the border near the extremity of the posterior antennæ. *Rostrum* not of unusual length (as in *A. Heckelii*), but less broad than long; the palp is simple, slender, sharp-pointed, and slightly curved, placed near the base of the first foot-jaw and the trunk, the point reaching a little in front of the latter.

First maxilliped of the usual form, but near the middle of the convex border of the second joint a minute hair is seen. *Second maxilliped* quite distinctive, forming a very powerful holding-organ, the basal joint being thick and muscular, having at the inner end of the concave border a strong triangular process, against which the large claw-like second joint is opposable; on the inner margin of the latter near the base is a strong bristle. *Furcula* very small, the branches being short, thick, and almost parallel; their length equals the breadth between the points.

First peræopod: first joint short, the second long, the lower border fringed with fine hairs, the palmar carrying at the end three hook-like hairs, the upper being the longest; at the angle there is a long fine bristle, on the inferior border three long plumose hairs of the usual form. Second of the usual form: the third has, on the large flap-like basal joint, the two small articulate branches placed close together at the edge, but not overlapping one another; they are of small size. The hamulus is small, but well-marked, the claw being almost straight. *Fourth peræopod* three-jointed, at the extremity of the last joint are three slightly curved claws, placed close together, of nearly equal length; at the juncture of the second and third joints is a fourth claw.

Genital segment about two thirds the length of the cephalothorax, almost round in outline, except for being cut away in the middle line posteriorly, forming there a shallow triangular depression; on the posterior border outside of this is seen a very prominent plate projecting beyond the genital segment, carrying three long plumose hairs terminally and one on the outer border—these are the fifth peræopods; there is also a strong bristle from the genital segment, external to these; rising from the under surface of the genital segment, in the middle line, are the true *caudal plates*, which are short,

giving off four plumose hairs, the second from the inside being very long, always projecting beyond the border. These caudal plates are sometimes quite hidden, at others they are just visible beyond the border; between them are two small bilobed tubercles, divided from one another by the extremity of the alimentary tube.

Egg-sacs as in *Caligus*, often long.

Length 3 millim.

Dichelesthiina.

LERNANTHROPUS, Nordm.

Lernanthropus atrox, Hell. (Pl. VI. fig. 3.)

At Bunder Abbas, in the Persian Gulf, attached to the gills of *Chrysophorys sarba*, a large number of specimens, both male and female, of a *Lernanthropus* were taken, the female so closely resembling *L. atrox* described by Heller, taken from a "*Pagrus*" in Australian waters, that I have felt justified in coming to the conclusion that they are the same, though in the one described by him the anterior antennæ are stated to be two-jointed only, which, though it may be presumptuous to say, as I have done in my last paper*, is probably due to an error of observation on his part, as invariably in my experience, and from descriptions and plates of Kröyer and Beneden, the anterior antennæ have at least six joints—a generic guide. As the unnecessary multiplication of species is to be deplored, I have referred my specimens to this species, giving here a representation of the animal as seen from the back and side, also a more enlarged drawing of the antennæ, as well as of the newly found male.

Female.—*Anterior antennæ* seven-jointed, the fourth joint being the longest, bearing a small lobe-like process from the lower border, the joints decreasing in size to the last, which carries a bundle of fine hairs.

Posterior antennæ with a long muscular basal joint and a strong terminal hook.

Length 4 millim.

Male.—Caput oblong in shape, cut off squarely in front; side margins infolding equally, about one third the length of the whole excluding the caudal processes.

Anterior antennæ seven-jointed, as in the female.

Posterior antennæ with very strong, curved, grasping-hooks, which project far beyond the cephalic border.

Rostrum pointed, but short; on either side are seen the

* Ann. & Mag. Nat. Hist., Jan. 1898, p. 2.

minute mouth-organs, a slender mandible, straight and sharp-pointed; outside this is the maxillary palp, with a thickened base, and a cylindrical second joint, ending in two short blunt hairs, the outer being much the shorter.

First maxilliped placed close behind the rostrum; it is two-jointed, the first extending to near the border of the head, muscular, the second a slender curved claw, having the concave border near the point markedly serrated.

Second maxilliped equal in size to that of the first, but having the terminal point simple.

First pair of thoracic feet minute, placed close under the cephalic border, two-branched, springing from a broad thickened basal plate, the outer branch bearing five short thick hairs, the inner branch more slender, terminating in a single long bristle. The second pair are placed a little posterior to the first and of like structure, the outer branch having, however, only three short hairs.

Genital segment an elongated oval shape, giving off on either side two pairs of lancinate foliaceous processes, equalling in length two thirds that of the whole animal.

Abdomen short, rounded, broader than long. Caudal plates simple, lancinate.

Length 3 millim., excluding processes.

PSEUDOCLAVELLA, gen. nov.

Body elongate, without dorsal plates or lateral processes; head obtusely rounded. Anterior antennæ setaceous, indistinctly three-jointed. Posterior antennæ two-jointed, terminating in a powerful simple hook. First maxilliped minute, three-jointed. Second maxilliped two-jointed, long, projecting beyond the cephalic margin. Thorax showing one distinct segment dorsally. Four pairs of limbs are present, the first and second biramose, the third and fourth from the genital segment minute, papilliform; genital segment four times as long as head and thorax. Abdomen short, caudal plates lamellar. Egg-tubes long, ovules flattened.

This genus may be known by its single free thoracic segment, by the absence of any lateral plates, by the presence of two pairs of well-formed thoracic limbs, by the oval genital segment, from the sides of which rise the third and fourth pair, stump like and rudimentary, by the setaceous indistinctly jointed anterior antennæ, and by the long slender second maxillipeds. It has a near relationship to *Clavella*, "Oken"; but in all cases the presence of four pairs of limbs was found (though easily shrivelled up and overlooked in

mounted specimens), the thorax only shows as one ring, the genital segment is proportionately much shorter, and the anterior antennæ, though setaceous, appear to be only tri-articulate.

Gerstaecker separates the *Dichelesthina* thus:—

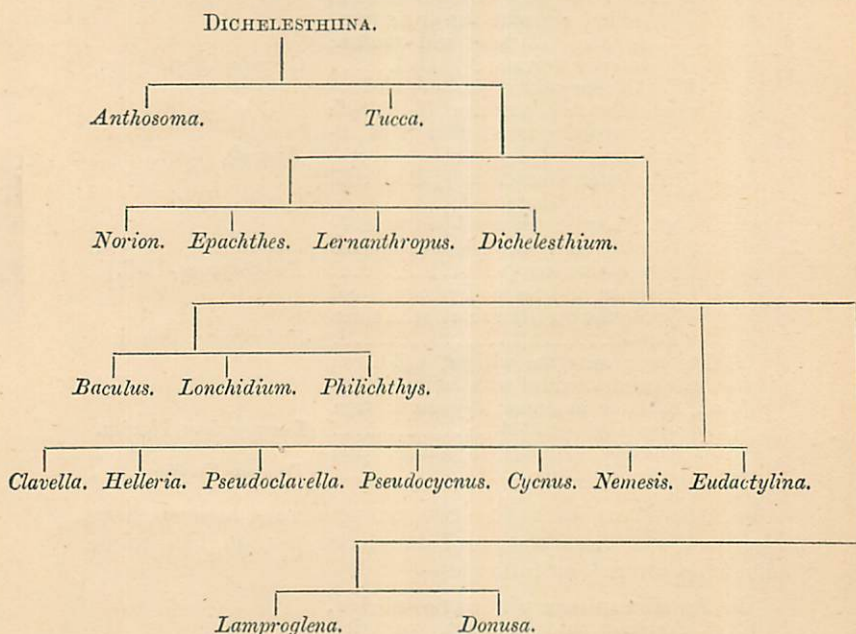
- A. Abdomen with two large dorsal plates *Anthosoma*, Leach.
- B. Abdomen without dorsal plates.
 - a. Ambulatory leg suppressed *Tucca*, Kr.
 - Norion*, Nordm.
 - Epachthes*, Nordm.
 - Lernanthropus*, Nordm.
 - Dichelesthium*, Herm.
 - b. Posterior legs or all changed into lamellar plates
 - c. Posterior legs neither bigger than front nor lamellar.
 - a'. Posterior antennæ with cheliform end-claw.
 - a''. All four pairs of limbs 2-branched.
 - a'''. Anterior antennæ 8-jointed *Lonchidium*, Gerst.
 - b'''. Anterior antennæ 4-jointed *Baculus*, Lubb.
 - b''. Only two first pairs 2-branched *Philichthys*, Stp.
 - b'. Posterior antennæ with single end-claw.
 - a''. Anterior antennæ single, posterior projecting.
 - a'''. Only two pairs of limbs formed; genital segment five or six times as long as head and thorax; anterior antennæ 6-jointed. *Clavella*, Oken.
 - b'''. All four pairs of limbs formed.
 - a⁴. Anterior antennæ 15-jointed; second to fourth legs 2-branched, 1-jointed *Nemesis*, Roux.
 - b⁴. Anterior antennæ 6-jointed; all limbs 2-branched. *Cycnus*, Edw.
 - c⁴. Anterior antennæ 3-jointed; only second pair 2-branched, the others stump-like. *Pseudocycnus*, Hell.
 - b''. Anterior antennæ with hooked basal joint; the posterior short, with three claws. *Eudactylina*, Bened.
 - c'. Posterior antennæ without end-claw; the point provided with hairs.
 - a''. Anterior antennæ 10-jointed; true legs single-jointed *Lamproglena*, Nordm.
 - b''. Anterior antennæ 5-jointed; true legs 3-jointed *Donusa*, Nordm.

In accordance with the two new genera which I have described, the classification of the latter portion has to be somewhat altered, as follows:—

- v'. Posterior antennæ with single end-claw.
 - a''. Anterior antennæ single, posterior projecting.
 - a'''. Only the two anterior pairs of limbs formed; genital segment

- five or six times as long as head and thorax; anterior antennæ 6-jointed *Clavella*, Oken.
- b'''*. Only three pairs of limbs formed, first biramose, second uniramous, third stump-like; anterior antennæ 6-jointed *Helleria*, B.-S.*
- c'''*. All four pairs of limbs formed.
- a⁴*. Anterior antennæ 3-jointed; first and second pairs of legs biramose, third and fourth stump-like; genital segment four times as long as head and thorax *Pseudoclavella*, g. n.
- b⁴*. Anterior antennæ 6-jointed; all four pairs of legs biramose *Cycnus*, Edw.
- c⁴*. Anterior antennæ 15-jointed; second, third, and fourth legs biramose, 1-jointed, first uniramous *Nemesis*, Roux.
- b''*. Anterior antennæ with hooked basal joint; posterior antennæ short, with three claws *Eudactylina*, Bened.

Expressed diagrammatically, thus:—



* Ann. & Mag. Nat. Hist., Jan. 1898, p. 10.

Pseudoclavella ovalis, sp. n. (Pl. VI. fig. 1.)

The gills of a *Serranus*, sp., captured at Muscat, were found to be crowded with these small parasites, which held very firmly on to the delicate margins of the gills by their strong posterior antennæ; the long dark-coloured ovarian tubes projecting considerably outwards made their detection easy; altogether there were hundreds of them in the one fish.

Female.—Caput of an oval shape, with a slight central lobe anteriorly, and somewhat broadened behind, where it unites with the single free thoracic segment, which is broader than long. The genital segment is of an elongated oval shape, robust in form, about four times as long as the cephalothorax. Abdominal segment small, broader than long, giving off two foliate caudal plates, each bearing three short, fine, terminal hairs and a fourth of smaller size on the outer border; on each side of the abdominal tubercle are seen the comparatively large egg-tubes filled with large flattened ovules in a single row.

Anterior antennæ rise from the head a little behind the anterior border; they appear to be three-jointed, but the divisions are very indistinct; from the basal joint, which is long and thickened, rise two pairs of short strong hairs on the front border; from the second, which is shorter, there are two short hairs above and one below; the last joint, which is longer, bears two short hairs near the base, one above and one below; a very long, strong, deeply rooted one on the upper border near the middle, with a tuft of smaller terminal bristles.

Posterior antennæ placed a little further back; it is two-jointed, the first being broad and stout, the second in the form of a strong, short, recurved, claw, with a thickened tuberculate base; this does not project beyond the cephalic border.

Rostrum short, blunt. *Palp* very minute, slender, straight. Outside this is seen a very small representative of the *first maxilliped*; it is three-jointed, the terminal joint in the form of a claw.

Second maxilliped large, the extremity of the basal joint projecting well beyond the border of the head; the second joint is very slender, longer than the basal, terminating in a curved sharp point.

Rising from the posterior border of the carapace on either side underneath are seen the first pair of thoracic limbs; there is a broad basal joint, giving off two small branches, the inner is single-jointed, terminating in two hairs, the outer

consists of two joints, the first having a minute hair on the outer side, the last with three small terminal ones. Placed a little more backward on the posterior outer angle of the thoracic segment are found the second pair of limbs, more distinctly visible than the first, being larger, the basal joint being strongly lobed, giving off two branches, each of two small joints, ending with a strong bristle. The next two limbs are rudimentary, the third being placed about one third down the side of the genital segment, in the form of an elongated tubercle terminating in three simple bristles. Two thirds down is seen the fourth pair of like character, but rather smaller.

Length 3 millim.

Lernæopodidæ.

BRACHIELLA, Cuv.

Brachiella multifimbriata, sp. n. (Pl. VI. fig. 2.)

This animal does not appear to correspond with any yet described; in outward form it is so characteristic, I venture here to describe it as a new species.

On a large *Serranus* at Muscat I found one of these attached to the inside of the operculum; but on opening the mouth the lips, tongue, palate, and cheeks were seen to be thickly studded with them, especially the inner fold of the lower lip; they were attached so firmly that the mucous membrane had to be cut away with them. Afterwards on careful examination of these I was disappointed to find only one pigmy male; this minute creature was hooked on to the cephalic portion of a female, as shown in Pl. VI. fig. 2*a*. I only succeeded in making a rough drawing of this, unfortunately losing the specimen while preparing it for mounting; it shows, however, distinctly the *Brachiella* form.

Female.—Colour pale, translucent, except for the ovaries and ovarian sacs, which are opaque white. Head and neck generally recurved forwards, equal very nearly in length to that of the genital segment. Arms of attachment (second maxillipeds) placed close to the latter, distinctly separated from one another in the middle portion, not quite equal in length to the neck; organ of adhesion a sucking-disk (as distinct from the drill usually found in *Anchorella*).

Genital segment: this from the back appears as an irregular elongated hexagon with concave sides, giving off from each of the two lateral points four filiform semitransparent processes; from the posterior angle on each side of a short

abdominal tubercle are two more processes, the dorsal being the longer.

Genital sac full of large round eggs.

Length about 7 millim. without processes.

Male minute, about 1 millim. long (Pl. VI. fig. 2 e).

Cephalothorax oval, distinctly divided off from the segmented caudal portion, which appears to consist of three joints, terminating in two lancinate plates.

Anterior antennæ placed close to the posterior, which spring from the upper and anterior border of the cephalothorax; the first is three-jointed, ending in three short hairs; the posterior has a thickened basal joint and a short square second, also terminating in three hairs.

First maxillipeds very large and strong, the root-joint very muscular, its upper border being much lobed; the claw is very strongly bent, thick at the base, and sharp at the point, with a short curved tooth about the centre of the concave border.

EXPLANATION OF THE PLATES.

PLATE III.

Fig. 1. Bomolochus denticulatus, ♀, sp. n., from the back, magnified.

1 a. Seen from the side. 1 b. Hamulus anterior. 1 c. Terminal joint of posterior antennæ. 1 d, e, f, g, h. First to fifth peræopods. 1 i. Last two joints of abdomen and caudal plates. 1 k. Spur on outer side of outer branch of peræopod, showing dentation, highly magnified.

Fig. 2. Hermilius longicornis, ♀, sp. n., from back, magnified.

2 a. Seen from the side, with valves closed. 2 b. Carapace seen from beneath. 2 c. Anterior antennæ. 2 d. Terminal joint of first maxilliped. 2 e. Third peræopod, much magnified. 2 f. Last joint of fourth peræopod. 2 g. Abdomen and caudal plates.

PLATE IV.

Fig. 1. Caligus arii, ♀, sp. n., enlarged, seen from the back.

1 a. Carapace from underside, much magnified. 1 b. Third peræopod. 1 c. Fourth peræopod. 1 d. Abdomen and caudal plates.

Fig. 2. Caligus platytarsis, ♀, sp. n., enlarged, seen from back.

2 a. Fourth peræopod, hairy toe of same highly magnified. 2 c. Fifth peræopod. 2 d. Furcula. 2 e. Caudal plate.

Fig. 3. Caligus cossackii, ♀, sp. n., seen from the back.

3 a. Carapace from below. 3 b. Third peræopod. 3 c. Fourth peræopod. 3 d. Caudal plate. 3 e. Male, much enlarged. 3 f. Second maxilliped of the same.

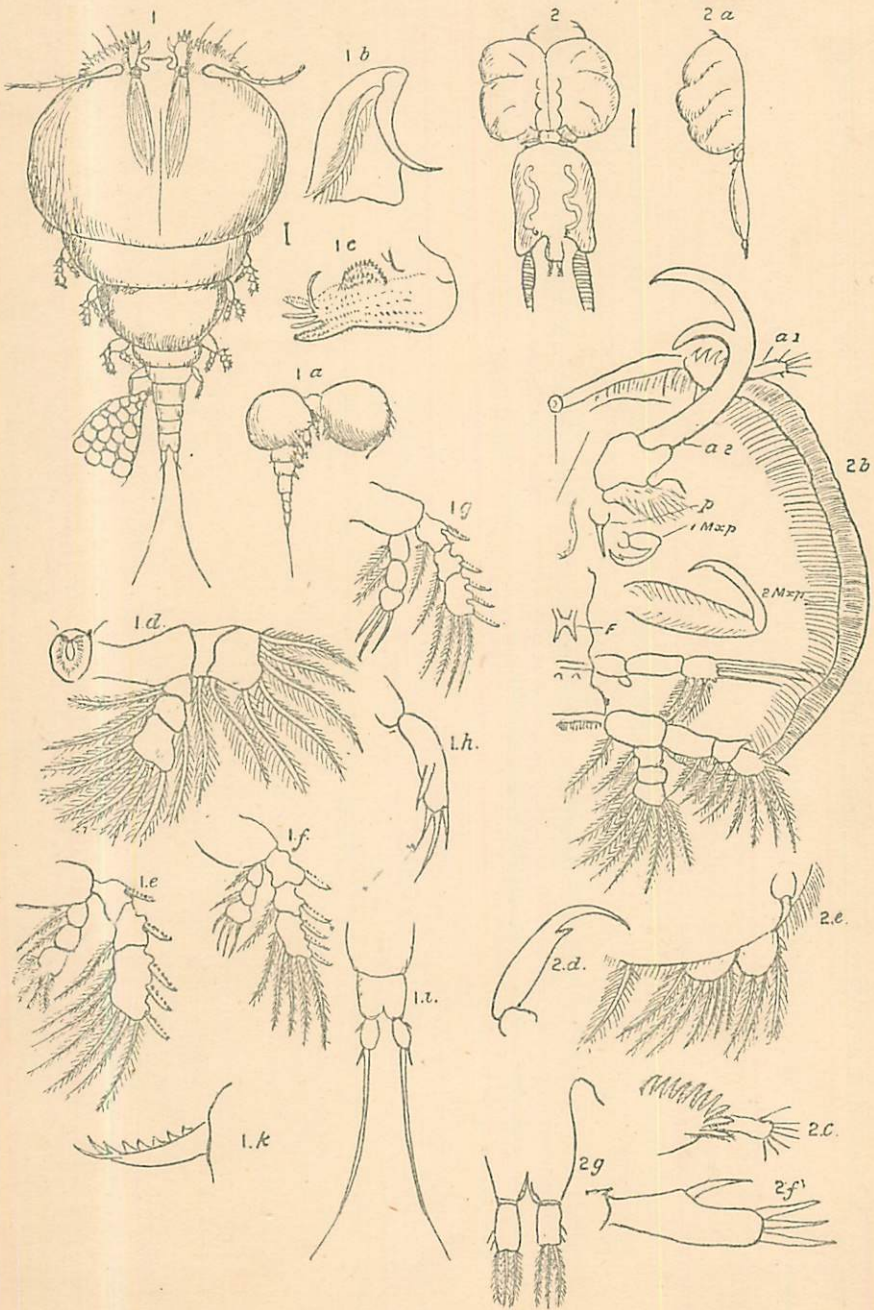
PLATE V.

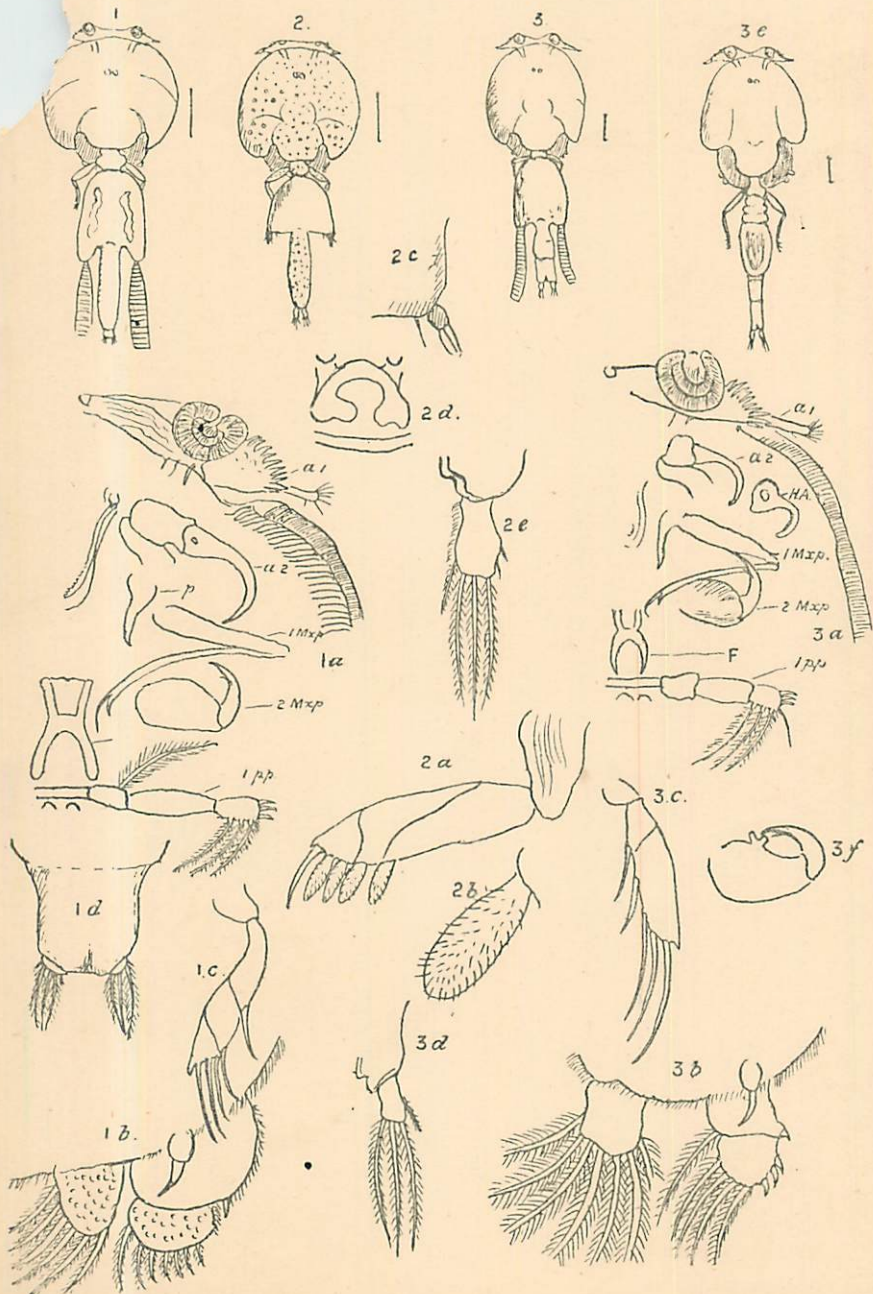
- Fig. 1. Lepeophtheirus rotundiventris*, ♀, sp. n., seen from the back.
 1 a. From beneath, much enlarged. 1 b. Terminal portion, with caudal plates. 1 c. Male.
- Fig. 2. Lepeophtheirus longipalpus*, ♀, sp. n., seen from back.
 2 a. Organs round the mouth. 2 b, c. Third and fourth peræopods. 2 d. Claw of fourth peræopod, much magnified. 2 e. Rudimentary fifth. 2 f. Caudal plate.
- Fig. 3. Anuretes perplexus*, ♀, sp. n., from the back.
 3 a. Cephalothorax from beneath. 3 b, c. Third and fourth peræopods, enlarged. 3 d. Terminal portion of genital segment, showing fifth peræopods and caudal plates. 3 e. The same in varied form.

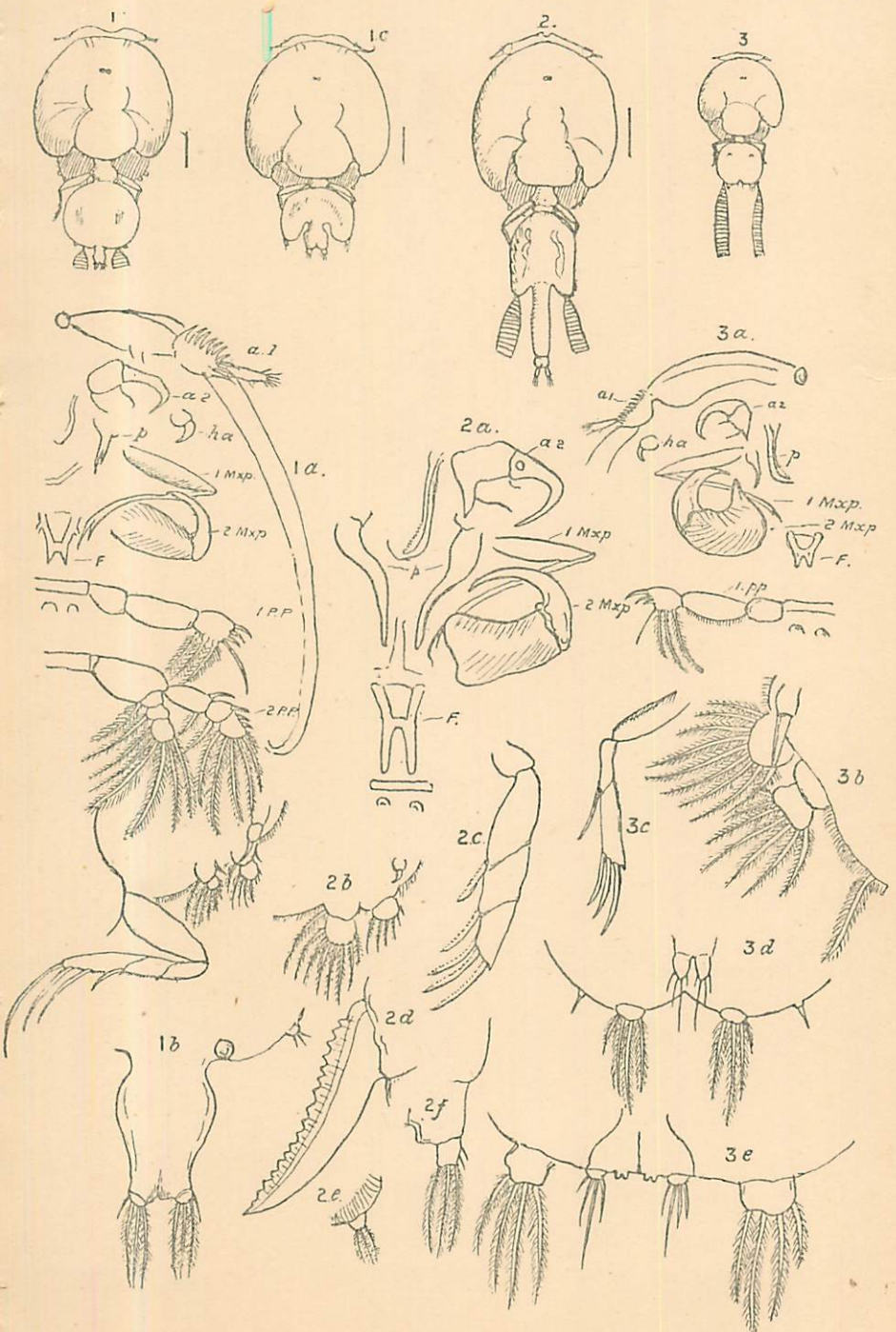
PLATE VI.

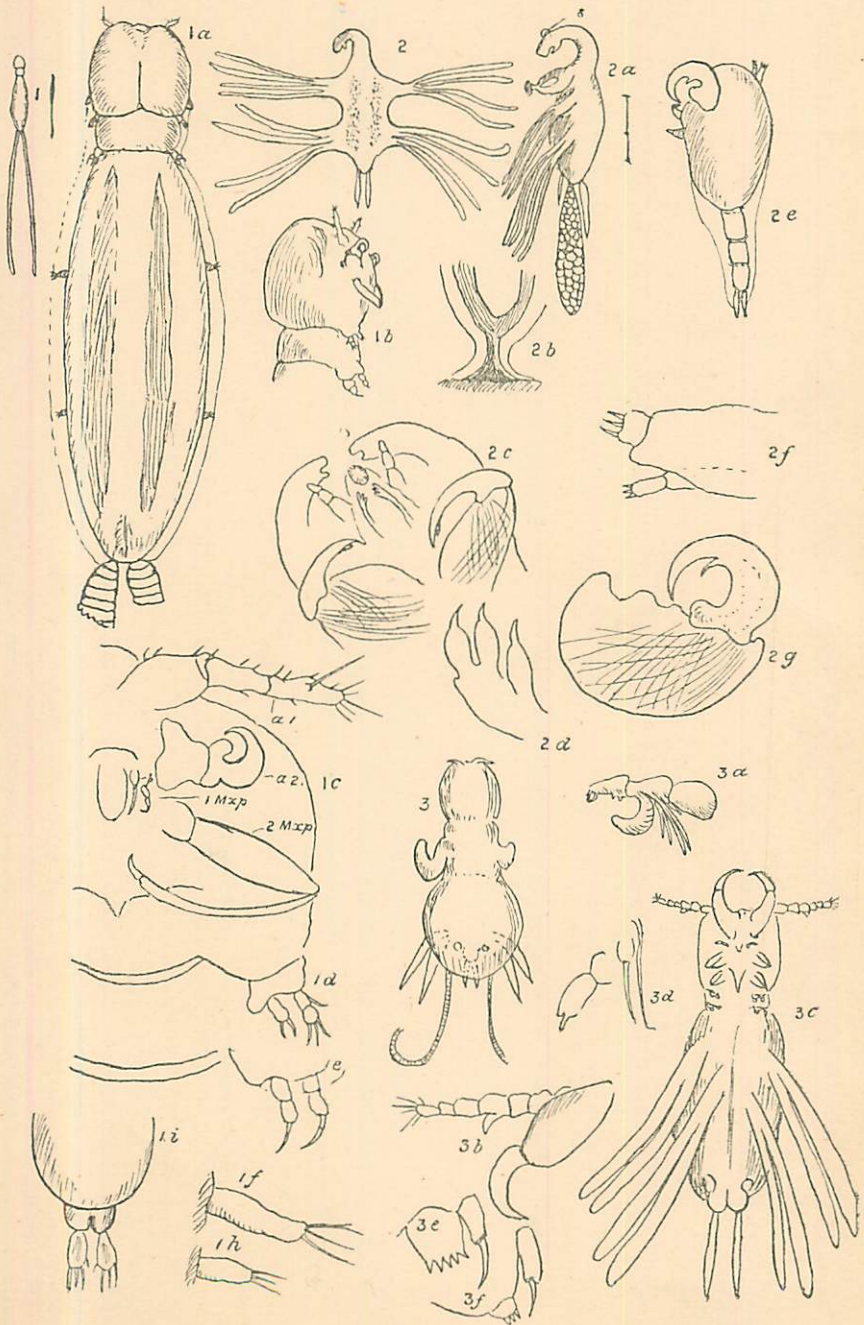
- Fig. 1. Pseudoclavella ovalis*, gen. et sp. n.
 1 a. Seen from the back, much enlarged. 1 b. Side view of head and thorax. 1 c. Underside of cephalothorax. 1 d, e, f, g. First to fourth limbs.
- Fig. 2. Brachiella multifimbriata*, ♀, sp. n., seen from the back, with processes spread out.
 2 a. Same, seen from the side. 2 b. Fixing-organ of second maxilliped. 2 c. Under surface of head, much enlarged, showing organs. 2 d. Palp, more highly magnified. 2 e. Male, highly magnified. 2 f. A. 1 and A. 2 of the same. 2 g. Strong first maxilliped of the same.
- Fig. 3. Lernanthropus atrox*, ♀, Heller, seen from the back.
 3 a. Seen from the side. 3 b. Anterior and posterior antennæ of the same, much enlarged. 3 c. Male, enlarged, seen from below. 3 d. Mandible and maxillary palp. 3 e, f. First and second thoracic limbs.

N.B.—The line to the right of the figure gives the natural length of the animal.









A
SYSTEMATIC DESCRIPTION
OF
PARASITIC COPEPODA
FOUND ON
FISHES,

WITH AN ENUMERATION OF THE KNOWN SPECIES.

BY

P. W. BASSETT-SMITH, STAFF-SURGEON R.N.
F.Z.S., F.R.M.S.



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WILSON
COLLECTION

A Systematic Description of Parasitic Copepoda found on
Fishes, with an Enumeration of the known Species.
By P. W. BASSETT-SMITH, Staff-Surgeon R.N., F.Z.S.,
F.R.M.S.

(Plate XXVI.)

The number of known Copepoda parasitic upon fishes has been gradually increasing of late years: and their peculiar modes of life, extraordinary forms, and the remarkable positions in which they are found have caused them to be an interesting study to those naturalists who are working in marine zoology, especially if they have been in the habit of handling fishes when recently caught.

From a morphological point of view the lower types are the more interesting, as exemplifying the effect of parasitism on the females, which lose more and more their ordinary appendages, becoming nothing better than fixed saccular animals, capable of imbibing nourishment and producing progeny; while the male, though often of very minute size, retains its general crustacean appearance. These points have repeatedly been investigated by Carl Vogt, Kurz, Claus, and others.

The literature on the subject is widely scattered, and many of the animals have exceedingly long lists of synonyms. It has been my object in this paper, which I trust will be of use to future workers, to gather together this material, and to put it into a workable form, as a basis for further investigation.

The latest attempt to systematize this group was made by A. Gerstäcker in Bronn's 'Class. und Ordn. des Thier-reichs,' 1866-1879, Crustacea, vol. v., Copepoda, which admirable work I have followed very closely, excepting in some groups which are mentioned later on. He has very largely based his classification on the structure of the articulate organs, which appears to be the most certain and scientific method. As the more lowly organized groups are reached, viz., those in which the female has lost almost all its articulate appendages, the characters and conformation of the males become most valuable guides: these being often very minute or pigmy-like. In many cases they are quite unknown, and are therefore a good field for further work, the discovery of new forms being very pleasing. There is no doubt that continued research, especially on the non-edible fish, in different parts of the world, would be rewarded by the discovery of a great number of new forms, and, what is badly wanted, further specimens to establish genera, many of which have been recorded by a single observer only, and not infrequently from one specimen only.

In a large number of cases the descriptions and plates found in the older works are most indefinite, making the diagnosis of the

species referred to at the time very doubtful. Those, however, of Nordmann, Steenstrup & Lütken, Krøyer, and Heller, besides those in many monographs which have appeared since, are beautiful records of patient investigation, the latest being by Thomson in 1889, from specimens taken in waters near New Zealand. Some of the errors that have been made are very remarkable. Gesner in his 'Historia Animalium, de aquatilibus,' 1658, states that a parasite, which he calls *Asilus marinus*, "is found on the Tunny and Swordfish, and is so small as to be easily overlooked, it being seldom to be seen except at the rising of the dog-star." He gives a figure: it is what is now known as *Brachiella thynni*, and was mentioned by Aristotle, Pliny, and Rondeletius. Strom, a long time ago, mistook the tail for the head of a *Caligus*, and the egg-tubes for antennæ. De Blainville thought the eye of a Sprat was the head of *Lernæenicus spratte*; and more recently M. P. Van Beneden (as Carl Vogt has pointed out) has described the *Leposiphile* of Hesse as an Isopod.

The frequency with which some of these parasites are protected from their enemies by being covered with adventitious growths, especially those which, from their degenerate form, have become most fixed, is noteworthy. The Lernæas often have the body (which is soft, and generally of a reddish colour, from the hæmic fluid* inside, and therefore not bad food for small fish) covered with a growth of algæ and sertularians, &c., quite masking their character; these, in one specimen in the British Museum, are so long as to resemble the real processes of *Lernæolophus*, and not until examined with a lens was their true nature detected. The body-portion of *Sphyrion* is often entirely hidden with this secondary parasitic growth, and as they themselves are furnished with hard processes, like bunches of calcareous algæ, they become very inconspicuous when in the water.

The bodies of *Lernæenicus* are pale yellow, with green external thread-like ovarian tubes. Most of the small scale-like *Caligidæ* found on the exterior of the fish are extremely difficult to detect, the larger members of this family being hidden under the fins or in the branchial cavities; but never have I seen so great a disproportion in the size of the parasite to the cavity as is sometimes the case with Isopods.

After a very considerable experience in examining fishes, several convictions are forced upon me: (1) that almost all fishes are infested with one or more species of parasite; (2) that as a rule these parasites are peculiar to them, though the difficulty of knowing when they are only varieties or distinct species always dogs one's steps in making a classification; (3) also that, as C. Vogt remarks, they may be divided into those which are blood-suckers and those which are mucus-eaters. A few specimens have been found free, taken in tow-nets when searching for Plankton; one species of *Caligus* has been taken on a Nautilus, but the genera commonly found in Tunicates and other invertebrates are not treated here.

The young attached condition of some of the *Caligidæ* has been

well demonstrated by Hesse; and the very interesting metamorphosis that the *Lernæa branchialis* goes through before becoming a fixed inert sac has been beautifully worked out by C. Claus, who has shown that copulation takes place when the animals are of very small size, the maturity of the ovules keeping pace with the increased growth of the female. The young unattached forms of this species have been taken in the tow-net by Mr. I. C. Thompson on more than one occasion; the juvenile conditions of other genera have been taken free, having been described as *Baculus* and *Hersellia*, which are probably the young of *Penella*.

In the family Ergasilidæ (p. 441), the genus *Thersites* Pagenst. does not appear to me to be distinct from *Ergasilus*, the only species of the former having been described from the gills of *Gasterosteus aculeatus*, from which, too, a species of the latter genus is taken; I have therefore united them together.

In the family Caligidæ (p. 444), the number of described species of *Caligus* is very large, and some of them have undoubtedly been known by many names; these I have endeavoured to place in their proper places. The genus *Papulina* of Van Beneden has been relegated to *Lepeophtheirus*, from which it has no marked differences; his genus *Calina* has been established, but the specimen described by him as *Caligeria* belongs to the old-formed genus *Alecion* of Kröyer. The *Lepeophtheirus huttoni* of Thomson, taken in New Zealand, a specimen of which he has been good enough to send me, should be placed with *Gloiopotes* Stp. & Lütke. Examples of the same species are present (unnamed) in the British Museum, taken at Madras. The genus *Noqaqus* has been entirely left out, as it contains only male forms of other genera. The name *Perissopus* has been retained for Dana's *Lepidopus*, which is already in use, and Van Beneden's *Chlamys* is of more recent origin.

In the family Dichelestiidæ (p. 468), the genus *Epachthes* has been kept for a single species described by Nordmann, though the generic differences of this from *Lernanthropus* are very doubtful. Two new genera described by me in 1898 (*Cybicola* and *Pseudo-clavella*) have been added.

The family Philichthyidæ (p. 477) has been formed to include all those parasites which are found only in the mucous canals and sinuses of various fish, and are so constructed as to be able to move freely in these spaces, the female having neither articulate limbs nor strong organs of attachment; the male is, however, of a distinct and rather high crustacean type. The first form found was the *Philichthys xiphæ*, Stp.; it was placed in the last-mentioned family, though the female resembled much a *Chondracanthus*. Hesse was the first to discover the minute forms, which he divided into two genera, *Leposphile* and *Colobomatus*. Since then Richiardi has described eight species of *Philichthys*, but they differ so much from the original that I have made for them a new genus, giving to it his name. Hesse, Richiardi, and Carl Vogt were strongly of opinion that these peculiar animals were worthy of being formed into a family of their own, especially as the known males are much alike and distinct.

In the family Lernæidæ, I have united the two genera *Lernæenicus* and *Lernæonema* under the older name, following the views set forth in the able paper by Richiardi in 1876. Five genera of this family are represented by single species.

In the family Chondracanthidæ (p. 488), the older name of *Sphyrion* has been retained for Krøyer's *Lesteira*. Two species are given, specimens of both being now in the British Museum—one, the larger (by far the largest of all these Copepod parasites), is from New Zealand, and is probably of the same species as that obtained by Guérin off the Cape of Good Hope, having few lobed processes on the float-like head. The second was taken off Dungeness; it is much smaller, with a greater number of lobe-like processes, and is described as *S. lumpi* Kr.

The position of the long known *Chondracanthus trigla* has been for many years a disputed point. Linnæus placed it with the Lernæas; Blainville described it as a *Lernentoma*, Milne-Edwards as a *Chondracanthus*, Heller thought it probably a species of *Medesicate*, and J. Steenstrup placed it between *Lesteira* and *Medesicate*. The animal differs from every other, except *Therodamus*, in having the anterior part of the head with the hook-like posterior antennæ separated by a long neck-like process from the mouth, which is placed at the juncture of this with the thoracic portion—a peculiarity pointed out by Milne-Edwards and others, differing thus from *Medesicate* and *Chondracanthus*; I have therefore placed it in a genus of its own—*Oralien*.

In the family Lernæopodidæ, as I have pointed out before, it is impossible to differentiate the genus *Brachiella* from *Anchorella* by the female alone, the union, complete or otherwise, of the second pair of maxillipeds not being characteristic, though the males are quite distinct, and should be always looked for and recorded. Many of the *Anchorella* are very superficially described, and are very indefinite. The genus *Thysanote* has been made to embrace a number of peculiar forms which have been placed with *Brachiella*.

The genus *Cestopoda* of Kurz has been added. While in India I obtained on two occasions specimens of this peculiar genus from different fishes; these have not yet been described. I have provisionally placed here the *Naobranchia cygniformis* of Hesse, but it is insufficiently described.

Family I. ERGASILIDÆ.

Cephalothorax pyriform or flattened, first segment the largest; nearly or wholly provided with limbs. Anterior antennæ of moderate length, 5- or 6-jointed, alike in both sexes. Posterior antennæ with 3 or 4 joints. Second maxillipeds in the form of hooks, generally 3-jointed. Fifth pair of thoracic limbs one-branched or sometimes rudimentary. Eye median, with two lenses. Sex-organs paired. Female with two egg-sacs. Young as a free-swimming larva. Male smaller than female and less freely locomotive.

G. 1. BOMOLOCHUS Nordm.

Cephalothorax rounded in front; segments rapidly decreasing in size. Anterior antennæ with enlarged and densely-bristled basal joints. Mouth-organs placed close behind the antennæ. Posterior antennæ 2- or 3-jointed, not unciform at the end. First four thoracic limbs biramose, triarticulate, setiferous; fifth pair uniramous, biarticulate. Abdomen 3- or 4-jointed, provided with two caudal plates. Male small, resembling the female, but with delicately plumose anterior antennæ.

(1) BOMOLOCHUS GRACILIS. ♀. <

➤ *Bomolochus gracilis* Heller, Reise d. Novara, 1865, p. 157, pl. xiii. fig. 3.

Host: gills of *Zyggæna malleus*, from Java.

(2) BOMOLOCHUS BELONES. ♀. <

Bomolochus belones Burmeister, Abhandl. Kais. Leopoldinischen Akademie, 1835, vol. xvii. p. 300.

➤ " " M.-E. Hist. Nat. Crust. vol. iii. 1840, p. 479.

Host: gills of *Esox belone* [*Belone vulgaris*]¹.

(3) BOMOLOCHUS ARDEOLÆ. ♀. <

➤ *Bomolochus ardeolæ* Kr. Bidrag til Kundskab, 1863, p. 220, pl. xi. fig. 3.

Host: gills of *Belone ardeola*. New Orleans.

(4) BOMOLOCHUS CHATOËSSI. ♀. <

➤ *Bomolochus chatoëssi* Kr. Bidrag til Kundskab, 1863, p. 214, pl. xi. fig. 5.

Host: gills of *Chatoëssus* sp. East Indies.

(5) BOMOLOCHUS TETRODONTIS. ♀. <

➤ *Bomolochus tetradonis* B.-S. Ann. & Mag. N. H. ser. 7, vol. 1. 1898, p. 4, pl. i. fig. 2.

Host: gills of *Tetrodon oblongus*. Bombay.

(6) BOMOLOCHUS SCOMBERESOCIS. ♀. <

➤ *Bomolochus scomberesocis* Kr. Bidrag til Kundskab, 1863, p. 217, pl. x. fig. 5.

Host: *Scomber esox*. Atlantic.

(7) BOMOLOCHUS MEGACEROS. ♀ ♂. ~

➤ *Bomolochus megaceros* Heller, Reise d. Novara, 1865, p. 153, pl. xiii. fig. 3.

➤ " " B.-S. Ann. & Mag. N. H. ser. 7, vol. ii. 1898, p. 51, pl. x. fig. 1.

In Coll. Brit. Mus.

Hosts: *Stromateus niger* and *Caranx djeddaba*. East Indies.

¹ The names of the fishes printed in italics are those used by the authors in the papers quoted. Synonyms added in square brackets are those adopted by Günther in the British Museum Catalogue of Fishes.