III.—NOTES ON SOME CRUSTACEAN PARASITES OF FISHES.

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Plates V.–VIII.

Contents.

INTRODUCTORY NOTE.

Parasitic habits are not restricted or peculiar to any particular class of organisms, but may be found more or less in evidence in all departments both of the animal and vegetable kingdoms. There are, however, certain groups of plants and animals whose surroundings and conditions of life seem to be specially favourable to the adoption of parasitic habits, and amongst the Crustacea such habits seem to prevail to a considerable extent, especially amongst the so-called "lower forms" belonging to that class.

Different kinds of animals have to act the part of *hosts* to these parasitic crustaceans, and the animals which are called upon to willingly, or unwillingly, act this part belong chiefly to the same class to which the parasites themselves belong and to the fishes. Fishes appear to be special favourites in this respect. Scarcely any part of a fish's body is free from the intrusion of these unwelcome or (in some cases, perhaps) welcome visitors; they are found running over the skin of the fish, they adhere to the fins, the gills and gill covers, they are found on the lips, the tongue, and the roof and sides of the throat, in the nasal fossæ, and in other and even more strange and out-of-the-way places on or about the body of the fish.

The degree of parasitism varies greatly even amongst closely-allied species; in some cases the relationship of the crustacean to the fish is decidedly that of a parasite, but in other cases it would be inaccurate to describe the association of the one with the other as truly parasitic. Sometimes, however, it is more convenient to use the terms *parasitic*, *parasite*, etc., in this broad sense, even though it may not in some cases be strictly correct, in order to avoid the complications that would arise by any attempt to describe, in a strictly accurate manner, the various degrees of relationships that exist between crustaceans and the fishes which have become their hosts; it is in this wider sense that such terms are used in the present paper.

The study of the parasitic crustacea is in some respects more difficult, if also more interesting, than that of the species which live under normal

conditions. Their structure has, because of their parasitic habits, become more or less altered, and, in consequence of this, the forms which not a few of them have assumed are greatly at variance with those which usually characterise free-living species. Some of these parasitic crustaceans have assumed forms so strangely abnormal and grotesque that even the most experienced naturalists have failed to recognise their relationship to the crustacea, and only by the study of their development and life-history have their true affinities been determined.

Amongst crustacean parasites of fishes, the Copepoda is the group that is probably the most largely represented, and I therefore propose to devote the chief portion of this paper to the consideration of this group; a few of the Isopoda and Amphipoda that have been observed are also referred to.

A small list of Copepod-parasites of fishes was published in Part III. of the *Twelfth Annual Report of the Fishery Board for Scotland* (1894). Since that time other species, besides those enumerated in that list, have been obtained, and during the past summer special attention has been devoted to the study of these organisms, with the result that several interesting forms have now to be added to the copepod fauna of Scotland.

The crustacean parasites mentioned in the sequel have for the most part been obtained on fishes captured in the Firth of Forth, in the Firth of Clyde, or in some other part of the sea around the Scottish coasts; a few interesting species have been obtained on fishes brought to the Fish Market at Aberdeen, and with regard to these I am unable to state the place where the fishes were captured, though I believe that those on which the parasites were found were in most instances taken somewhere off the coast of Scotland.

In the preparation of these notes various works on parasitic Copepoda have been consulted, and in this respect the late Dr Baird's *History of the British Entomostraca* is still indispensable. Several valuable papers on the copepod parasites of fishes have in recent years been published by Dr. Basset-Smith, R.N, one of the latest being *A Systematic Description of Parasitic Copepoda found on Fishes, with an enumeration of the known species.* *

The classification of Gerstäcker† is that which Dr. Basset-Smith has chiefly followed in his *Systematic Description*, and as it appears to be the one which is now generally adopted, the species mentioned in the present paper are arranged as far as possible in conformity with it.

Mr. Andrew Scott, assisted by Mrs. Scott, has prepared the drawings necessary for the elucidation of the species recorded here.

I have also to acknowledge my indebtedness to Mr. Peter Jamieson, the Laboratory Assistant, for help in the collection of specimens for this paper.

The COPEPOD Parasites of Fishes.

According to recent classification the Copepod parasites of fishes have been arranged under seven families, the names and arrangement of which are as follows :—Ergasilidæ, Caligidæ, Dichelestidæ, Philichthyidæ, Lernæidae, Chondracanthidæ, and Lernæopodidæ. The Philichthyidæ is the only one of the seven families which does not seem to be represented in the British fauna; but even this family may also yet be found to have representatives amongst the Copepod fauna of our seas.

* *Proc. Zool. Soc. London*, April 1899.

† *Vide* Copepoda in Bronn's "Klassen und Ordnungen des Thierreichs," v. i. (1866–74).

Fam. ERGASILIDÆ.

This family has apparently only two, or at most three, genera belonging to it, but the number of species is about twenty-two. All the species are small and easily overlooked. I have notes of two species each of which represents a separate genus.

Genus *Bomolochus*, Nordmann (1832).

Bomolochus soleæ, Claus.

1864. *Bomolochus soleæ*, Claus, Zeitschrift für Wissenschaft. Zool., vol. xiv., p. 374, Pl. XXXV.
1893. *Bomolochus soleæ*, T. Scott, *Eleventh Ann. Rep. Fish. Board for Scot.* (III.), p. 212, Pl. V.

This copepod is found occasionally on the back of the common sole, *Solea vulgaris*. Those I have observed were on the coloured side, and were not easily noticed. It is a species that may readily escape detection, and may therefore be more frequent than it at present appears to be. I have found *Bomolochus soleæ* on *Solea vulgaris* captured near Grimsby, and also on the same species of fish captured in the Firth of Forth and in the Firth of Clyde. The specimen described and figured in the *Fishery Board Report*, referred to above, is from the Firth of Forth.

Genus *Thersites*, Pagenstecher (1861).

Thersites gasterostei, Pagenstecher. (Pl. V., figs. 1–7.)

1861. *Thersites gasterostei*, Pagenstecher, Arch. f. Naturg. vol. xvii., p. 118, Pl. VI., figs. 1–9.
1863. *Ergasilus gasterostei*, Kröyer, Naturh., Tidsskr., R. 3, vol. ii., p. 223, Pl. XII., fig. 2.
1892. *Thersites gasterostei*, Canu, Copep. du Boulonnais, p. 245, Pl. XXIII., figs. 13–18.
1899. *Ergasilus gasterostei*, Basset-Smith, Proc. Zool. Soc. London (April 1899), p. 444.

Description of the Female.—The cephalothorax is considerably dilated on the dorsal aspect, so that when viewed from the side or from above it appears to be almost spherical; abdomen short (fig. 1). The specimen represented by the figure carried two ovisacs, which were large in proportion to the animal.

The antennules (fig. 2) are very short, moderately stout, and five-jointed; the two end joints are each rather shorter than any of the other three, and they are all sparingly setiferous; the formula shows approximately the proportional lengths of all the joints—

Proportional lengths of the joints,	16 · 10 · 11 · 7 · 8
Numbers of the joints,	1 · 2 · 3 · 4 · 5

The antennæ are short and stout, and are each provided with a strong terminal claw (fig. 3).

The mandibles appeared to have a bilobed-pectinated biting part, but owing to the structure of the Copepod these organs were somewhat difficult to dissect out; the maxillæ were also somewhat obscure.

The anterior foot-jaws (1st maxillipedes) are simple, and provided with one or two small setæ. The posterior foot-jaws (2nd maxillipedes) have an enlarged basal part to which is articulated a more slender curved arm bearing a few strong apical spines (fig. 4).

The first three pairs of thoracic feet have both branches apparently three-jointed, but the outer branches are rather shorter than the inner ones (fig. 5 represents the first pair). In the fourth pair, the first two joints of the outer branches appear to be coalescent, so that they seem to be only two-jointed, but the inner branches, as in the preceding three pairs, are three-jointed (fig. 6). The abdomen is short but moderately stout; in the adult female it seems to be shorter than it really is, from being partly hidden by the enlarged cephalothorax; the first abdominal segment is rather broader than the next and is longer than the entire length of all the others; the caudal segments are short and the principal furcal setæ are stouter and much more elongated than those adjacent.

Length about ·8mm. ($\frac{1}{30}$ of an inch).

Habitat.—Found adhering to the inner surface of the gill-covers of a three-spined stickleback (*Gasterosteus aculeatus*), captured in Sinclair Loch, Barra, Outer Hebrides, in May 1894; and on another taken in the River Forth, near Alloa, February 1896. The same species of Copepod was also found on the inside of the gill-covers of a fifteen-spined stickleback (*Gasterosteus spinachia*), captured in Loch Etive in May 1896.

Remarks.—This Copepod has by some writers been ascribed to the genus *Ergasilus*, but it does not fit in very readily with the characters of that genus. The typical *Ergasilus* has the body moderately elongated, whereas in the present form the body is, except for the short abdomen, not only short but almost spherical in general appearance. I therefore agree with Dr. Canu's restoration of Pagenstecher's generic name, *Thersites*, for this species.

Fam. Caligidæ.

The Caligidæ contain a much larger number of genera and species than any other of the seven families amongst which the Copepod parasites of fishes have been arranged. According to Dr. Basset-Smith, the number of genera belonging to the Caligidæ is (exclusive of *Nogagus*) 25, while the number of species is 124. Two of the genera—*Caligus* and *Lepeophtheirus*—contain 49 and 26 species respectively, or 75 in all, which is fully three-fifths of the total number belonging to the whole family. As for *Nogagus*, no female Copepod which could satisfactorily be ascribed to this genus has ever been observed, and students of the Copepoda are now of opinion that the various "species" of *Nogagus* are really the males of species belonging to other genera, *i.e.*: *Pandarus*, *Dinematura*, etc.

Steenstrup and Lütken, in their valuable memoir on Copepod parasites of fishes,* include under *Caligus* the species belonging to that genus and also those belonging to *Lepeophtheirus*. The various forms belonging to these two groups have a close resemblance to each other, not only in their general appearance, but also in their structure; but there are two characters by which the species belonging to the one group are easily separated from those belonging to the other; these characters are the presence or absence of *sucking disks* or *lunulæ* on the frontal plates, and the unifid, or bifid form of the appendages described by Steenstrup and Lütken as *palpi*. In *Caligus*, *lunulæ* are always present and the *palpi* are unifid, in *Lepeophtheirus*, on the other hand, *lunulæ* are always absent and the *palpi* are bifid. The importance to be attached to these differences is, of course, very much a matter of opinion, and *Lepeophtheirus* will by authors take its place as a "genus" or be reduced to a synonym of *Caligus*, according to the value they place on these differences. In the present paper I follow Dr. Baird and Dr. Basset-Smith in regarding the two as distinct genera.

* Særskilt aftrykt Kongl. Danske Vidensk-Selsk. Skrifter, 5te Række Naturh. o. Mathemat. Afdel. 5te Bind.

Genus *Caligus*, O. F. Müller (1785).

(1) Abdomen in the female composed of one segment.

The general outline of the body is more or less oval and greatly depressed. *Lunulæ*, or "sucking disks," are present on the frontal plates; the *palpi* are thorn-like, and end in a single point. Fourth pair of thoracic feet one-branched.

Caligus curtus, Müller. (Pl. V., figs. 8–12.)

1785. *Caligus curtus*, Müller, Entomostraca, p. 130, Pl. XXI., fig. 1.

1850. *Caligus mülleri* (?) and *diaphanus*, Baird, Brit. Entom., pp. 271 and 269.*

The *Caligus mülleri* and probably also *Caligus diaphanus* of Dr. Baird's "Entomostraca" are, according to Steenstrup and Lütken, synonymous with *Caligus curtus* (Müller), and this seems to be also the opinion of recent writers on this group of Copepods. In view of this, however, it may be noted that in most, if not in all, the other species of *Caligus* and *Lepeophtheirus* the male is usually, and sometimes considerably, smaller than the female; but the *Caligus diaphanus* of Baird, which is considered to be the male of *Caligus curtus* (Müller), is frequently very much larger than the ovigerous females of that species. Some species are, however, subject to more variation than others, and this may account, partly at least, for the difference in size.

Caligus curtus is not only a common species, but may be found on various kinds of fishes, including several species of *Gadus*, ling, hake, torsk, plaice, and other flat-fishes; the grey and the long-nosed skate, etc. A certain amount of variableness in size and general appearance is observable amongst the different specimens that have been examined; but the difference was not greatly in excess of that which has been noticed in specimens belonging to some of the other species.

Caligus rapax, M.-Edw. (Pl. V., figs. 13–19.)

1840. *Caligus rapax*, M.-Edw., Hist. Nat. Crust., vol. iii., p. 453, Pl. XXXVIII., fig. 9.

1850. *Caligus rapax*, Baird, op. cit., p. 270, Pl. XXXII., figs. 2 and 3.

This, like *Caligus curtus*, is one of the more common species, but it differs from most other *Caligi*, at least to some extent, in being much more commonly obtained as a *free-swimmer* in the open sea. We frequently find *Caligus rapax* in tow-net gatherings, collected both at the surface and at the bottom. Ovigerous females are, however, not so commonly met with as males and young females. But though it is apparently more of a free-swimmer in its habits than others, and also perhaps because of this, *Caligus rapax* is found on even a larger variety of fishes than *Caligus curtus*. There is scarcely a fish in our seas on which this *Caligus* may not at one time or another be found.

Like *Caligus curtus*, this species also exhibits a certain amount of variation in the forms and sizes of males and ovigerous females, but it is, if anything, more marked in the latter. Some females with ova from a large grey skate varied from 5·1mm. to 6·1mm. in total length; while the length of the abdomen in the same specimens varied from 0·7mm. to 1·1mm. Some difference was also observed in these specimens in the breadth of the last segment of the thorax. Two apparently adult males obtained on

*For other synonyms, see Basset-Smith's "Systematic Description" already referred to.

the same fish with the females show a difference of at least 0·7mm. in total length. These differences are more clearly exhibited in tabular form as follows :—

VARIATION IN SIZE OF *Caligus rapax* FROM *Raia batis.*

	Female Specimens.				Male Specimens.	
	No. 1.	No. 2.	No. 3.	No. 4.	No. 1.	No. 2.
Total length from forehead to the end of the caudal furca, .	5·2mm.	5·1mm.	5·2mm.	6·1mm.	3·8mm.	4·5mm.
Length of abdomen, .	·7mm.	·8mm.	·8mm.	1·1mm.	...	...
Breadth of last thoracic segment, . . .	·8mm.	·8mm.	1·0mm.	1·1mm.	...	...

Though the length of these female specimens varied to the extent of a full millimetre, there appeared to be no structural difference of any importance. Perhaps it may be noted in passing that fig. 2, Pl. XXXII., in Dr. Baird's work represents a young female and not a male—an error due no doubt to an oversight on the part of the artist.

(2) Abdomen composed of two segments.

Caligus diaphanus, Nordmann. (Pl. V., figs. 20–25.)

1832. *Caligus diaphanus*, Nord., Mikrog. Beiträge, ii., p. 26 (*non C. diaphanus*, Baird).
1894. *Caligus isonyx*, T. Scott, *Twelfth Ann. Rept. Fish. Board for Scot.* (III.), p. 310.
1896. *Caligus diaphanus*, Basset-Smith, Journ. M. B. Assoc., Plymouth, p. 156.

Both male and female of this species have the abdomen two-jointed. The species is a small one ; the female specimen represented by the drawing (fig. 20) is only about 4·4mm. in length ; the abdomen is moderately elongate, being about one-fourth of the entire length of the animal ; the last abdominal segment is small but quite distinct. The lateral margins of the last thoracic segment are convexly and evenly rounded, but posteriorly this segment is abruptly truncate, and is also not much longer than the abdomen.

The antennæ (posterior antennæ) are moderately short and armed each with a strongly but evenly hooked claw. The mandibles are slender and elongated, and the last joint is distinctly serrated on the inner edge (fig. 22). The posterior foot-jaws are robust, and furnished with strong terminal claws ; the penultimate joint is also produced near the base of the inner margin into a stout triangular tooth (fig. 24). The sternal fork has moderately long and slightly divergent branches (fig. 23). The apices of the *palpi* are single and spine-like.

The fourth pair of thoracic feet are moderately stout ; the branches are distinctly three-jointed, and carry five moderately long setæ (fig. 25). There is also on the last thoracic segment what appears to be a fifth pair of feet, each of which consists of a minute sub-triangular one-jointed appendage bearing a few small setæ. The caudal segments are very short.

In the male the abdomen consists of two sub-equal segments ; the last thoracic segment is narrow and not much wider than the abdomen. The antennæ appear to differ slightly from those of the female, especially in possessing a supplementary tooth near the base of the terminal claw.

Habitat.—Our specimens of this species were obtained in the gill-cavity of *Trigla gurnardus* from the Firth of Forth, the Firth of Clyde, and at Aberdeen Fish Market; also on *Trigla lineata* from the Clyde, and on a specimen of *Trigla hirundo* in the collection of fishes in the Laboratory at Bay of Nigg.

Genus *Lepeophtheirus*, Nordmann (1832).

The species belonging to this genus are, in their general form, very similar to *Caligus*, but, as already said, there are no *lunulæ* on the frontal plates, and the *palpi* are furcate instead of being simple and spine-like. Six or seven species belonging to this group have been obtained on fishes examined by me.

(1) Abdomen composed of one segment.

Lepeophtheirus pectoralis (Müller). (Pl. V., figs. 26–31.)

1776. *Lernea pectoralis*, Müller, Zool. Dan., p. 41, Pl. XXXIII., fig. 7.
1850. *Lepeophtheirus pectoralis*, Baird., Brit. Entom., p. 275, Pl. XXXII., fig. 10.

The specimen of *Lepeophtheirus pectoralis* represented by the figure on Plate V. (fig. 26) measures about five millimetres (one-fifth of an inch) in length; the cephalic shield is nearly circular; the last segment of the thorax is large and sub-quadrate, but its lateral margins are very slightly curved; the abdomen is short, and somewhat constricted near the middle, so that in certain positions it appears as if it were composed of two segments; the caudal segments are very short.

The antennæ (posterior antennæ) are provided with strong terminal hooked claws. The mandibles, which are small and slender, have the inner edge of the distal joint distinctly toothed (fig. 28). The posterior foot-jaws are strong, and they are armed with stout, curved terminal claws. In the sternal fork the branches become dilated in the middle then taper to a point at the end (fig. 29). The *palpi* are furcate.

The fourth pair of thoracic feet have the branches two-jointed, and are provided with three terminal setæ, and there is also a small seta or spine on the outer distal angle of the first joint. The fifth pair, which consist of small but comparatively broad lamelliform plates, provided with two or three minute terminal hairs, are situated behind the bases of the ovisacs, and are therefore easily missed.

The male (fig. 27) is little more than half the size of the female, but the cephalic shield is proportionally larger; the last segment of the thorax is small. In the male antennæ the basal joint is rather more dilated than in that of the female, while the terminal claw is smaller and more strongly hooked.

This is one of the more common and easily identified species of *Lepeophtheirus*. The peculiar form of the sternal fork, the small fourth pair of thoracic feet, and the short abdomen seem to be fairly good specific characters. Slight differences in the general form of the animal and in some of its structural details are occasionally observed, especially in specimens from different fishes, such as the plaice and the flounder.

Habitat.—Found for the most part adhering to the underside of the pectoral fins of plaice, *Pleuronectes platessa*, from the Firths of Forth and Clyde, and at the Fish Market at Aberdeen; on flounders, *Pleuronectes flesus*, from the Firth of Forth and the Moray Firth; and on common dabs, *Pleuronectes limanda*, from the Firth of Forth.

Lepeophtheirus nordmanni (M.-Edwards). (Pl. V., figs. 32–37.)

1840. *Caligus nordmannii*, M. Edw., Hist. Nat. Crust., vol. iii., p. 455, No. 10.
1850. *Lepeophtheirus nordmannii*, Baird, Brit. Entom., p. 275, Pl. XXXII., fig. 10.

This is a moderately large species; the specimen represented by the figure measures about half-an-inch in length (12 mm.). The cephalic shield is of an oval form and is distinctly larger than the last segment of the thorax. The abdomen is short (fig. 32).

The mandibles in this species are long and slender, but the last joint is comparatively short, and has a short serrated margin (fig. 34). The branches of the sternal fork are long and somewhat slender; they are also to some extent divergent (fig. 35). The posterior foot-jaws are large and armed with long terminal claws.

The branches of the fourth pair of the thoracic feet are three-jointed, and are provided with five setæ, three of which spring from the apex of the last joint, and one from the outer distal angle of the first and second joints (fig. 37). The fifth pair, which have a sub-triangular outline, are broadly foliaceous.

Habitat.—On a short sun-fish, *Orthagoriscus mola*, landed at Aberdeen Fish Market on 1st September 1899. One specimen only was obtained.

Remarks.—The abdomen of this specimen of *Lepeophtheirus nordmanni* obtained by me appeared to be rather more elongated than that which is represented in Dr. Baird's figure. He also describes the branches of the sternal fork as "sharp-pointed," but in our specimen the branches, though slender, are somewhat blunt at the ends.

Lepeophtheirus hippoglossi (Kröyer). (Pl. V., figs. 38–42; Pl. VI., figs. 1–2.)

1838. *Caligus hippoglossi*, Kröyer, Naturh. Tidsskrift, R. i., vol i., p. 625, Pl. VI., fig. 3.
1850. *Lepeophtheirus hippoglossi*, Baird, Brit. Entom., p. 276, Pl. XXXII., figs. 1–2.

The ovigerous female represented by the drawing (Pl. V., fig. 38) was rather more than half-an-inch in length (about 13·5 mm.). The cepalic shield was large and of an oval outline, but the last segment of the thorax was comparatively small and narrow, and rather longer than broad. The abdomen was small, and slightly constricted near the posterior end. The caudal segments were very short.

In this species the mandibles are long and slender, though scarcely so much so as those of *Lepeophtheirus nordmanni*. The sternal fork differs from that of any of the other *Lepeophtheirus* recorded here in having each of the two branches distinctly biped (fig. 2, Pl. VI.). The fourth pair of thoracic feet have the branches three-jointed and furnished with four setæ, three at the apex and one on the outer distal angle of the second joint (fig. 41, Pl. V.). The fifth pair consists of small triangular plates situated behind the bases of the ovisacs.

In the adult male (fig. 39, Pl. V.) the last thoracic segment is very small, and the fifth pair of feet are more or less exposed. The male is also much smaller than the female, being scarcely half as long. In the male the antennæ appear to be also somewhat different from those of the female, the basal joint is more dilated and the terminal claw is more strongly hooked.

Habitat.—Taken on the backs of large halibut, *Hippoglossus vulgaris*, landed at Aberdeen Fish Market during the summer and autumn of 1899.

This, like other species of *Lepeophtheirus*, exhibits a certain amount of variation, but full-grown specimens may usually be distinguished by the form of the ventral fork. *L. hippoglossi* appears to be found principally on the halibut, and is not uncommon. I have found a slightly immature specimen on a torsk, *Brosmius brosme*, in Aberdeen Fish Market, but probably it had been accidentally transferred to the torsk by contact of that fish with a halibut.

Lepeophtheirus thompsoni, Baird. (Pl. V., figs. 43–45.)

1850. *Lepeophtheirus thompsoni*, Baird, op. cit., p. 278, Pl. XXXIII., fig. 2.

1899. *Lepeophtheirus thompsoni*, Basset-Smith, Proc. Zool. Soc. Lond. (April 1899), p. 455.

This is a smaller species than the last; the female represented by the drawing (fig. 43) is about one-third of an inch (8·5 mm.) in length. In this species the last segment of the thorax is sub-quadrate in outline, rather longer than broad, and increases slightly in width posteriorly. The abdomen is elongated, and its thickness increases to a slight extent for a short distance beyond the middle, when a slight decrease begins and where also a small constriction is sometimes visible. The caudal segments are very short.

The antennæ of *Lepeophtheirus thompsoni* are armed with stout and strongly-hooked claws (fig. 45). The mandibles are somewhat similar to those of *Lepeophtheirus pectoralis*. The sternal fork is also somewhat like that of the same species, but the branches of the fork are scarcely so much dilated (fig. 44). The fourth pair of thoracic feet are distinctly three-jointed, and moderately stout; they each bear three terminal setæ, and a seta or spine at the outer distal angle of the first and second joints, but that on the first joint is very minute. The fifth pair, which are oval in outline, are very small and situated below and slightly anterior to the bases of the ovisacs.

Habitat.—On the gills of turbot, *Bothus maximus*, captured in the Firth of Forth, the Firth of Clyde, and on the gills of turbot examined in the Fish Market at Aberdeen.

Lepeophtheirus stromi, Baird. (Pl. VI., figs. 3–8.)

1847. *Caligus stromii*, Baird, Trans. Berw. Nat. Club (1847).

1850. *Lepeophtheirus stromii*, Baird, Brit. Entom., p. 274, Pl. XXXII., figs. 8 and 9.

We have obtained this copepod on salmon, *Salmo salar*, captured in Montrose Bay and Bay of Nigg (Aberdeen). I have seen no specimens from the Firth of Forth or the Firth of Clyde, but they will doubtless be found on salmon captured within these estuaries as well as elsewhere.

Lepeophtheirus stromi has the abdomen proportionally rather more elongated than that of *L. thompsoni*, and the ovisacs are usually very long and slender. The dorsal surface in this species has a curious metallic lustre, different from most of the others of the same genus. Males appear to be comparatively scarce.

The branches of the sternal fork are moderately short and stout, and are broadly rounded at the ends (fig. 5). The fourth pair of thoracic feet have the branches three-jointed and provided with four short setæ; the outer distal angle of the first joint is apparently not provided with a seta in this species, but is simply rounded. The fifth pair of feet are broadly

sub-triangular, and have three small terminal hairs arranged as shown on the figure.

Figure 8 represents a young specimen newly hatched.

Lepeophtheirus pollachii, Basset-Smith. (Pl. VI., figs. 9–15.)

1896. *Lepeophtheirus pollachius*, Basset-Smith, Ann. and Mag. Nat. Hist. (6), vol. xviii., p. 12, Pl. IV., fig. 1.

1899. *Lepeophtheirus pollachii*, Basset-Smith, Proc. Zool. Soc., Lond. (April 1899.)

The length of the specimen represented by the drawing (fig. 9) is about three-tenths of an inch (7·5mm.). The cephalic shield is sub-orbicular, but the last segment of the thorax is sub-quadrate, and is nearly as large as the cephalic shield; this segment also slightly increases in width towards the posterior end. The abdomen is about as long as the last thoracic segment, and tapers somewhat towards the extremity. The caudal segments are of moderate size.

The antennæ are armed with moderately large terminal claws strongly hooked at the end. The mandibles are elongate and slender; the last joint, which is short and about as broad as the preceding one, is serrated on the inner edge. The sternal fork has moderately short and simple divergent branches, and resembles the letter V inverted (fig. 13). The posterior foot-jaws are stout, and provided with strong terminal claws. The branches of the fourth pair of thoracic feet, which are three-jointed, are moderately elongated and slender; three spiniform setæ spring from the end of the third joint, while the first and second joints are each provided with a seta or spine on the outer distal angle (fig. 15). The fifth feet are small, sub-quadrate, and bear each three small apical setæ.

The male is about as long as the female, but the last segment of the thorax is very small; the abdomen is composed of two sub-equal segments (fig. 10). The antennæ and the posterior foot-jaws of the male also differ to some extent from those of the female.

Habitat.—Our specimens were obtained adhering to the inside of the mouth of a lythe, *Gadus pollachius*, caught in the salmon-nets in Bay of Nigg, Aberdeen, June 22nd, 1899.

This species appears to develop moderately long ovisacs.

(2) Abdomen composed of two segments.

Lepeophtheirus (?) *obscurus* Baird. (Pl. VI., figs. 16–19.)

1850. *Lepeophtheirus obscurus*, Baird, Brit. Entom., p. 277, Pl. XXXII., fig. 11.

1896. *Caligus obscurus*, Basset-Smith, Ann. and Mag. Nat. Hist. (6), vol. xviii., Pl. IV., fig. 2; Journ. M. B. Assoc. Plymouth (1896), p. 157.

1899. *Lepeophtheirus obscurus*, Basset-Smith, Proc. Zool. Soc. Lond. (April 1899), p. 456.

The length of the female specimen represented by the drawing (fig. 16) is about one-fourth of an inch (8·2mm.). The cephalic shield is sub-orbicular, but rather longer than broad. The last segment of the thorax is about two-thirds of the length of the cephalic shield, and of a sub-cylindrical form, and its posterio-lateral angles are produced into boldly-rounded lobes. The abdomen is in length equal to about three-fourths of the length of the last segment of the thorax, and is distinctly jointed near the posterior end. The caudal segments are very small.

The antennæ are armed with large and strongly-hooked terminal claws

(fig. 17). The mandibles somewhat resemble those of *Lepeophtheirus pectoralis*. The sternal fork, which appears to vary to some extent, has moderately stout branches; these branches are somewhat dilated in the middle and slightly divergent (fig. 18). The branches of the fourth pair of thoracic feet appear to be only two-jointed, like those of *L. pectoralis* ; each branch is, for the most part, provided with five setæ arranged as shown in the drawing (fig. 19), but some specimens want the marginal seta on the end joint; the seta at the outer distal angle of the first joint is a very small one. The fifth pair are broadly foliaceous, and situated beneath and slightly anterior to the basal part of the ovisacs.

No males have been observed.

Habitat.—On the gills, inside gill-covers, and under the pectoral fins of brill, *Bothus rhombus*, captured in the Firth of Forth and the Firth of Clyde.

It is very doubtful if the copepod described here, or the one described under the same name by Dr. Basset-Smith, be the *Lepeophtheirus obscurus* of Dr. Baird's monograph. The copepod described by Dr. Baird as *Lepeophtheirus obscurus* was a male, and was probably, as he himself suggests,* a male of *Lepeophtheirus hippoglossi*. Figure 39, Plate V., of the present paper represents an adult male of *Lepeophtheirus hippoglossi*, and if Dr. Baird's figure of *L. obscurus* be compared with it the resemblance between them will be seen to be very close. Moreover, Dr. Baird, in describing *Lepeophtheirus obscurus*, says :—"Abdomen small; not more than one-third the size of last ring of thorax. . . . Sternal fork well developed, each branch being bifurcated, the inner branch being much smaller than the other." All this, as well as the remaining parts of the description, agrees exactly with what we see in the male of *Lepeophtheirus hippoglossi*.

The *Lepeophtheirus* from the brill, described in the preceding notes, resembles *L. thompsoni* to some extent, and may probably be only a form of that species. It seems to differ, however, in having a somewhat longer abdomen; in having the abdomen more distinctly segmented; in the sternal fork being rather different in form; and in the form of the fifth thoracic feet being slightly different.

Dr. Basset-Smith describes the sternal fork of his *Lepeophtheirus obscurus* as having bifurcating branches,† but in some other respects as closely resembling *L. thompsoni*. If the bifurcate form of the sternal fork be a character more or less constant in Dr. Basset-Smith's specimens, they are likely to be different from that which I have recorded, and that notwithstanding their otherwise close similarity to *Lepeophtheirus thompsoni*, for, as already pointed out, though the form of the sternal fork in my specimen varies to some extent, in none of those examined has it been observed to have bifurcated branches.

The male specimen described by Dr. Baird as *Lepeophtheirus obscurus* may, in view of what has been stated by Dr. Basset-Smith, be after all a distinct species, the female of which is the form recorded by that author, and, if that be so, we have here another example of the want of uniformity between the sexes of the same species, which is sometimes observed amongst the parasitic Copepoda. This disparity between the sexes, however, is, I think, of less frequent occurrence amongst *Caligus* or *Lepeophtheirus* than it is amongst some of the other groups. If, for example, the female *Caligus* or *Lepeophtheirus* be distinguished by a short or a long abdomen, the male of the same species to which the female belongs has usually, though perhaps not in every case, the abdomen

* Brit. Entom., p. 363.

† *Journ. M. B. Assoc., Plymouth* (April 1899), p. 158.

correspondingly short or long. Now, in regard to the forms under consideration, it will be observed that the females of Dr. Basset-Smith's *Lepeophtheirus obscurus* have the abdomen moderately long and two-jointed, whereas Dr. Baird's male has a "small abdomen" consisting of one segment. It may be that, notwithstanding this discrepancy, the two forms belong to the one species; but I am inclined to think that Dr. Baird's own suggestion—that his *Lepeophtheirus obscurus* is the male of *Lepeophtheirus hippoglossi*—is after all the correct explanation of the difficulty.

Genus *Trebius*, Kröyer (1838).

This genus resembles *Lepeophtheirus* in its general configuration, in the absence of *lunulæ* on the frontal plates and in the possession of bifurcated *palpi*. On the other hand, the most distinctive and obvious difference between *Trebius* and *Lepeophtheirus* is that in the former the fourth pair of thoracic feet are furnished with two branches instead of only one branch, as in the case of the latter.

The only species belonging to this genus is the one described below.

Trebius caudatus, Kröyer. (Pl. VI., figs. 20–26.)

1838. *Trebius caudatus*, Kr. Naturh. Tidsskrift (1838), R. i., vol. ii., p. 30, Pl. I., fig. 4.
1850. *Trebius caudatus*, Baird, op. cit., p. 280, Pl. XXXIII., figs. 3, 4.

In the female of this species the cephalic shield, which is about as long as the entire remaining portion of the thorax, is nearly oval, and rather longer than broad. The last segment of the thorax is sub-cylindrical, its breadth being equal to about four-fifths of the length; the posterio-lateral angles are rounded and fringed on the posterior aspect with three small but stout spines. The abdomen is long and slender, and composed of two segments; a slight constriction is also observable towards the distal end of the second segment, which has in some specimens the appearance of an additional joint. The caudal segments are small.

The antennæ (posterior antennæ) are armed with strongly-hooked terminal claws (fig. 22). The mandibles are somewhat similar to those of *Lepeophtheirus*, but the end-joint appears to be rather stouter than the preceding one, and is distinctly serrated on the inner margin (fig. 24). The *palpi* are bifurcated, but the inner branch of each *palpus* is rather shorter than the other. The sternal fork is small, and the branches are simple and comparatively short (fig. 23). In the fourth pair of thoracic feet the basal joints are stout and comparatively short; both of the three-jointed branches are also short, but the outer ones are armed exteriorly with five moderately stout marginal spines, and interiorly with plumose marginal setæ. The inner branches are also setiferous, but they want the exterior marginal spines.

The male (fig. 21), which is scarcely half the length of the female, has the fourth thoracic segment very small. The abdomen consists of two segments, and is of moderate length; the two segments are somewhat unequal, the first being rather shorter than the other. The caudal segments are slightly longer than those of the female.

The length of the female specimen figured is about four-tenths of an inch (10mm.). In another specimen of about the same length the abdomen measured 3mm.; while in a somewhat larger one, the entire length of which was 11mm., the abdomen measured 4mm. in length, or fully two-thirds the entire length of the animal.

Habitat.—On the grey skate, *Raia batis*, from the Firth of Forth, the Firth of Clyde, and the Moray Firth, and on specimens of the same fish brought to the Fish Market at Aberdeen. I found *Trebius* also on a specimen of thornback, *Raia clavata*, captured in the Firth of Clyde on April 22nd, 1897.

Genus *Dinematura*, Latreille, 1829 (modified by Burmeister, 1831).

Burmeister objected to the form of the word "*Dinemoura*" used by Latreille, and changed it to *Dinematura*. This change in the form of Latreille's name appears now to be generally accepted and used.

Dinematura producta (Müller). (Pl. VI., figs. 27–31.)

1785. *Caligus productus*, Müller, Entom., p. 132, Pl. XXI., fig. 3.
1850. *Dinemoura lamnæ*, Baird, op. cit., p. 286, Pl. XXXV., fig. 7.

The *Dinemoura* (*Dinematura*) *lamnæ* of Baird's monograph, now identified as the *Caligus productus* of Müller, has been obtained by me on one or two occasions during the past autumn on young porbeagle sharks, *Lamna cornubica*, caught in the North Sea, and landed at the Fish Market at Aberdeen. The larger specimens of *Dinematura* measured fully four-fifths of an inch (20mm.) in length, exclusive of the ovisacs, which were long and slender (fig. 27). One of the porbeagle sharks, on which we obtained several specimens, was about three feet three inches in length.

The antennæ of *Dinematura producta* (fig. 28) are armed with powerful hooked terminal claws. The mandibles are elongated and very slender (fig. 29). The anterior foot-jaws (fig. 30) are moderately stout, and each terminates in a hook-like apex; a short but stout and slightly curved appendage also springs from the inner aspect, and near the distal end of the penultimate joint. The posterior foot-jaws are short and stout, and somewhat rudimentary in structure.

The first three pairs of thoracic feet are two-branched and somewhat similar to those usually observed in the Caligidæ, but the fourth pair are large and foliaceous. The caudal segments are composed of broad quadrangular plates, the width of which is equal to about two-thirds of the length; their outer margin is nearly straight, but the inner is gently and evenly convex; the apex is subtruncate, and bears three small setæ, while a fourth seta springs from a notch near the distal end of the outer margin (fig. 31). No males have been observed.

The characters by which this species may be distinguished include, amongst others, the form of the dorsal plates, the abruptly-hooked antennæ, the structure of the *palpi* and of the anterior foot-jaws, the form of the fourth pair of thoracic feet, and of the caudal furca.

One of the specimens obtained at the Fish Market at Aberdeen measured three inches (75mm.) from the forehead to the ends of the long ovigerous tubes.

Genus *Echthrogaleus*, Steenstrup and Lütken (1861).

Echthrogaleus coleoptratus (Guérin). (Pl. VI., fig. 32.)

1817. *Dinematura coleoptrata*, Guérin, Icon. d. reg. Animal, vol. iii., Pl. XXXV., fig. 6.
1850. *Dinemoura alata*, Baird, op. cit., p. 285, Pl. XXXIII., fig. 8.

One or two specimens of this curious little species were found adhering

to the fins of a porbeagle shark brought to the Fish Market at Aberdeen.* The specimen figured (fig. 32) measured from the front of the head to the end of the caudal furca about seven-sixteenths of an inch (11mm.), and the ovisacs, which were slender, were fully four times the length of the body—about two and one-quarter inches altogether.

The dorsal plates are adorned with small impressed circular marks, forming a more or less regular pattern, and this, together with the form of the plates, gives to them a fairly close resemblance to the elytra of certain coleopterous insects. This species appeared to be less frequent than the *Dinematura producta* already recorded.

Genus *Cecrops*, Leach (1816).

Cecrops latreillii, Leach.

1816. *Cecrops latreillii*, Leach, Ency. Brit. Suppl., vol. i., p. 20, figs. 1–5.
1850. *Cecrops latreillii*, Baird, op. cit., p. 293, Pl. XXXIV., fig. 1.
1892. *Cecrops latreillii*, A. Scott, Trans. Nat. Hist. Soc. Glasgow, vol. iii., Part III., p. 266.

Several specimens of *Cecrops* were obtained on a short sun-fish, *Orthagoriscus mola*, captured in the Firth of Forth in October 1890. They were found adhering to the gills of the fish, and do not appear to be very uncommon on this species of *Orthagoriscus*. One or two specimens were taken from the gills of a sun-fish captured 14 miles east from Lerwick, Shetland, on 17th August 1893. The specimens recorded by Dr. Baird, which were obtained on sun-fishes captured at different parts of the coasts of England and Ireland, were also taken from the gills.

Genus *Pandarus*, Leach (1816).

The principal generic characters of *Pandarus* are, according to Dr. Baird, as follows:—(1) Several pairs of lamellar, elytraform appendages. (2) All the thoracic feet fitted to a certain extent for walking and armed near their extremities with short and thick hooks. There appears to be but one British species of *Pandarus*, viz., *P. bicolor*. The *Pandarus boscii*, described by Dr. Leach and Dr. Baird, is now considered to be a form of *P. bicolor*; indeed, Dr. Baird himself suggests that *P. boscii* is "only a variety" of the more common species.

Pandarus bicolor, Leach. (Pl. VI., figs. 33–38.)

1816. *Pandarus bicolor*, Leach, Ency. Brit. Suppl., vol. i., p. 405, Pl. XX., figs. 1–2.
1850. *Pandarus bicolor*, Baird, op. cit., p. 288, Pl. XXX, fig. 10.

Several specimens of *Pandarus bicolor* have been obtained during the past autumn on sharks which have been brought to Aberdeen Fish Market, and known by the name of tope or topers, *Galeus canis*. The parasites were found for the most part adhering to the fins of the topers, and less frequently on other parts of the fish.

The specimen figured measured about two-fifths of an inch in length, exclusive of the ovisacs, which were long and slender (fig. 33). The dorsal surface was adorned with dark chocolate-coloured blotches arranged somewhat as shown in the drawing.

The female antennæ are small and somewhat rudimentary; they are

* The specimens of *Echthrogaleus coleoptratus* recorded by Dr. Baird were obtained by Dr. Johnston also from a porbeagle shark captured in Berwick Bay.

each provided with a large gibbous, cushion-like appendage which seems to arise from the base of the antenna, and to project considerably forward on the under side (fig. 35). These appendages may probably be used as "sucking discs," seeing that the other means of attachment possessed by this copepod do not appear to be very greatly developed. The *palpi* are small but moderately stout and somewhat cone-shaped. The appendages, which appear to be the posterior foot-jaws, are greatly dilated, clumsy, and unshapely, with a broad cushion-like extremity.

The four pairs of thoracic feet are all two-branched; the first pair has the outer branches two-, and the inner apparently only one-jointed; the inner branches are also somewhat abnormal in shape. The second and third pairs have both branches moderately short and stout and composed of two joints, while in the fourth pair both branches appear to be only one-jointed.

On one of the topers examined at the Aberdeen Fish Market in October last I obtained a specimen—a male—of a *Nogagus*-like copepod, which I am inclined to consider as being the male of our *Pandarus*. (Figure 34 represents the specimen referred to). In some of its structural details this *Nogagus* closely resembles *Pandarus bicolor*. The antennæ are provided with dilated cushion-like appendages somewhat like those of the *Pandarus*, but they differ in being armed with terminal claws (fig. 36). The *palpi* are somewhat similar, and so also are the exterior foot-jaws. The posterior foot-jaws differ in possessing a distinct though small terminal claw. All the four pairs of thoracic feet are each two-branched, each branch is two-jointed, and the branches are provided with densely plumose hairs.

Nogagus, as a genus of copepods, is now to a large extent, if not altogether, obsolete. All the species of which it is composed are represented only by males. Several of these males have already been identified as the males of species belonging to other genera, and those which have not yet been satisfactorily disposed of will, it is believed, be also found to be the males of other species. The *Nogagus*-like form referred to as found on the toper in the Aberdeen Fish Market, though differing considerably in general appearance from *Pandarus bicolor*, coincides so closely with it in several of its structural details, that there seems to be little doubt of its being really the male of the *Pandarus*.

Habitat.—From what is stated both by Dr. Baird and Dr. Basset-Smith, it would appear that *Pandarus bicolor* is not confined to *Galeus canis** though it seems to be more frequent on that fish. The parasite has been recorded by these authors as occuring also on *Carcharius glaucus*, and *Scyllium catulus* (the Greater Spotted Dog-fish).

Genus *Lemargus*, Kröyer (1838).

The thoracic feet in *Lemargus* differ from those of *Cecrops* in being for the most part broadly foliaceous, and forming at the same time branchial appendages. The intermediate body-segments are smaller than either the anterior cephalic shield, or the posterior lamelliform dorsal plates. There appears to be but one British species of *Lemargus*.

Lemargus mu icatus, Kröyer. (Pl. VI., figs. 39–42.)

1838. *Lemargus muricatus*, Kr. Naturh. Tidsskrift, R. i., vol. i, p. 488, Pl. V., fig.
1850. *Lemargus muricatus*, Baird, op. cit., p. 294, Pl. XXXIV., figs. 3–4.
1892. *Lemargus muricatus*, A. Scott, Trans. Nat. Hist. Soc. Glasgow, vol. iii., Pl. III., p. 266.

* This is the same as *Squalus galeus*, Linn., mentioned by Dr. Baird, and *Galeus vulgaris* of Day.

A few specimens of *Lemargus muricatus* were obtained on a large sun-fish, *Orthagoriscus mola*, captured in the Firth of Forth in October 1890. My son (Mr. A. Scott) describes the copepods as burrowing in hollows formed in the flesh of the fish behind the anal fin; they were not, as in the case of *Cecrops*, found on the gills. T. Edward has recorded this parasite from the Moray Firth, but it does not appear to have been very frequently observed.

Lemargus has three-jointed, moderately long and well developed antennules. The antennæ are short, but they are armed with stout and strongly-hooked terminal claws. The mandibles are long and stylet-shaped, and minutely serrated at the distal end (fig. 40). The anterior foot-jaws are very small and armed with short but broad and sharp-pointed terminal claws, finely serrated on the inner edges (fig. 41). The posterior foot-jaws form strong and powerful grasping appendages, as shown in the figure (fig. 42).

The thoracic feet are all two-branched, but the first and second pairs are not so broadly foliaceous as the others, and approach more to the normal type of feet observed in this group of parasites. In the first pair the outer branches are considerably longer than the inner ones; but the branches of the second pair, which are short and two-jointed, are sub-equal in length. In the third and fourth pairs both branches consist of broad, one-jointed plates, almost devoid of spines or setæ of any kind. In the fifth pair one of the branches forms a large lamelliform plate, but the other branch is very small and bears at the apex a few minute spines.

Fam. Dichelestidæ.

This family includes, according to Dr. Basset-Smith, about 15 genera, but only three or four of them are represented in the British seas, and two are noticed in the present paper.

Genus *Clavella*, Oken (1815)

Clavella hippoglossi, Kröyer. (Pl. VII., figs. 1–6.)

1838. *Clavella hippoglossi*, Kr., Naturh. Tidsskrift, R. i., vol. i., p. 196, Pl. II., fig. 3.

This, which is so far the only species of *Clavella* I have observed, has the body very slender and of a reddish colour, the ovisacs are very elongated and of a colour similar to that of the body. We have found a number of these on the gills of large halibut, *Hippogossus vulgaris*, brought to the Fish Market at Aberdeen; they resemble the gill filaments of the fish so closely, both in form and colour, that they are easily missed. It was chiefly by accident they were first observed by us, from noticing a portion of their reddish thread-like ovisacs projecting beyond the ends of the gill filaments.

The head in *Clavella hippoglossi* is small and rounded; the neck is comparatively narrow and indistinctly segmented; the genital segment is elongated, narrow, and cylindrical, and the abdomen is extremely short. The posterio-lateral angles of the genital segment are produced into small rounded processes, about equal to the length of the abdomen, so that the posterior end has a trilobed appearance.

The entire length of the specimen figured (fig. 1), exclusive of the ovisacs, is about the seven-twentieths of an inch (9mm). The following are the measurements of another and rather larger specimen:—Entire length of the body, 9·5mm.; length of head and neck combined, 1·5mm.;

length of genital segment, 8mm.; length from forehead to end of ovisacs, 23mm.

Clavella hippoglossi has well developed and moderately stout five-jointed antennules, which are sparingly setiferous (fig. 2). The antennæ are moderately large and provided with powerful terminal hooks suitable for grasping (fig. 3). The mandibles are small, elongated and tapering, and armed with a few small teeth at the distal end of the inner margin. The maxillæ, or *palpi*, are very small, but comparatively stout, and are provided with two or three special tooth-like processes. The foot-jaws are elongated and slender. Both pairs of the thoracic feet are two-branched and both branches appear to be two-jointed (fig. 6). No males have been observed.

Genus *Cycnus*, M.-Edwards (1840).
Syn. *Congericola*, Van Beneden (1854).

The species belonging to *Cycnus* are in general appearance somewhat similar to *Clavella*; they may be distinguished, however, by the possession of four pairs of two-branched thoracic feet, instead of only two pairs, but these thoracic feet are not so fully developed as in *Clavella*. I have only observed one species of *Cycnus*, viz.:—

Cycnus pallidus (Van Beneden).

1854. *Congericola pallidus*, Van Ben., Bull. Acad. Roy. Belg, vol. 21, pt. ii., p. 583.
1896. *Cycnus pallidus*, Basset-Smith, Journ. M. B. Assoc. (Feb. 1896), p. 159.

About 30 specimens, counting adult, immature and damaged, of this species were obtained on the gills of a large *Conger vulgaris* sent from the Clyde by Mr. F. G. Pearcey, naturalist on board the "Garland." The conger was captured at Station IX., near the mouth of the estuary, on December 13th, 1899. In form and colour these parasites closely resemble pieces of the gill-filaments, and may therefore be readily overlooked. The specimens I observed were found to adhere very firmly to the gill-filaments, so much so that several specimens were damaged in the course of removing them.

None of the specimens measured reached to quite four millimetres; one specimen was about 3·7mm. in length, exclusive of ovisacs, and from the forehead to the end of the ovisacs the length was 8·2mm.; another specimen, measured in the same way, reached to 3·8mm. and 9·3mm. respectively; the same specimens measured about ·7mm. in width.

Fam. Lernæidæ.

This family appears to contain a strangely mixed lot of parasitic copepods. The adult females belonging to some of the genera in this group have a somewhat abnormal appearance; development in their case is retrogressive, and to such an extent that in some instances nearly all traces of the characters which distinguish these copepods from the other orders of crustacea are obliterated. *Lernæa branchialis* may be cited as an example of extreme degradation. On the other hand, there are some species which have rather an elegant shape and possess copepod characters of a more distinctive form.

Three genera of the *Lernæidæ* are represented in the present paper.

Genus *Lernæenicus*, Lesueur. (1824).
Syn. *Lerneonema*, M.-Edw. (1840).

Lernæenicus sprattæ (Sowerby). (Pl. VII., figs. 7–10.)

1806. *Lernæa spratta*, Sowerby, Brit. Miscell., vol. ii., p. 17, Pl. LXVIII.
1850. *Lerneonema spratta*, Baird, op. cit., p. 341, Pl. XXXV., fig. 10.
1876. *Lernæenicus sprattæ*, Richiardi, Atti. della Soc. Tosc., vol. iii.
1891. *Lerneonema spratta*, T. Scott, *Ninth Ann. Rep. Fish. Board Scot.*, Pt. III., p. 306.

In August 1890 my son, Mr. John Scott, observed a sprat, or a small herring, he was not sure which, swimming about in one of the Leith Docks with a *Lernæenicus* attached to one of its eyes, but he failed to capture it. My son, Mr. Andrew Scott, has obtained the species in the Morecambe Bay district of Lancashire and has sent me one or two sprats for examination, having the parasite *in situ*, and the drawing on Plate VII. represents one of these sprats with the parasite attached to its eye (fig. 7). One of the sprats sent me for examination has no fewer than three specimens of *Lernæenicus* attached to one of its eyes. Figure 8 represents a *Lernæenicus*, which my son dissected, from the eye of a sprat. This specimen exhibits the thorax as having a moniliform structure a short distance posterior to the head. The head is provided with the barbed processes peculiar to these organisms. The head is also furnished with distinct though small antennules, but it is doubtful if these can be of any use to the animal; the antennules are represented by figure 7. The antennæ, though small, have the end-joints chelæform and well adapted for grasping (fig. 10). The length of the specimen figured is about seven-tenths of an inch (18mm.), exclusive of the ovisacs, and if the length of the ovisacs be added the total length reaches to about 43mm., or one inch and three-fourths.

Genus *Lernæa*, Linn. (1767).

This genus contains what appear to be the most degraded of the copepod parasites of fishes. It requires some stretch of the imagination to associate the large, mature, and bizarre-looking female *Lernæa* with the elegant and agile *Cyclops*, yet in their early stages of growth the two are not very dissimilar. *Lernæa* was placed by Linnæus amongst the Mollusca in the Class Vermes.

Lernæa branchialis, Linn. (Pl. VII., figs. 11 and 12.)

1767. *Lernæa branchialis*, Linn., Syst. Nat., 12th ed., p. 1092.

This well-known fish parasite is moderately common. We have records of it from various places around the Scottish coasts, as the Firths of Forth and Clyde, and the Moray Firth. Also on haddocks landed at the Fish Market at Aberdeen.

The species appears to vary to some extent. The specimen represented by figure 11 is probably the more common form; it is distinguished by having a moderately long neck, similar to that shown by Dr. Baird.* Another form with a much shorter neck is represented by figure 12.

Lernæa minuta, n. sp. (Pl. VII., fig. 13.)

Description of the Female.—Length of the specimen figured, about three-tenths of an inch (8mm.). Cephalic lobe somewhat dilated, horns

* Brit. Entom., Pl. XXXV., fig. 12.

not greatly developed. Thoracic feet, four pairs, small but distinct, and situated immediately behind the cephalic lobe. Neck short and moderately slender. Genital segment, moderately large and slightly sigmoid. Ovisacs elongated, slender, and twisted, as in *Lernæa branchialis*.

Habitat.—On the gills of the speckled goby (*Gobius minutus*).

Remarks.—Our superintendent, Dr. T. Wemyss Fulton, while examining some small fishes sent to the Laboratory from the Solway during November 1899, observed a small *Lernæa* on the gills of a specimen of *Gobius minutus*. This he kindly handed over to me along with a considerable number of specimens of the same species of goby. On making a careful examination of all these specimens—about 134 in number—three more specimens of the *Lernæa* were obtained; making in all four specimens of this parasite from 135 fishes, or about 3 per cent.

The average length of the specimen figured, exclusive of ovisacs, is a little over 7mm.

I have not been able to find any previous record of this small *Lernæa*, and have therefore described it as a new species under the name of *Lernæa minuta*.

Genus *Hæmobaphes*, Steenstrup and Lütken.

Hæmobaphes cyclopterinus (Fabr.). (Pl. VII., fig. 14.)

1780. *Lernæa cyclopterina*, Fabr., Fauna Grœnl., p. 337.
1861. *Hæmobaphes cyclopterina*, Stp. and Lütk., Bidrag til Kundskab, p. 405, Pl. XIII., fig. 30.
1891. *Hæmobaphes cyclopterina*, T. Scott, *Ninth Ann. Rept. Fish. Board Scot.*, Pt. III., p. 310.

I have only seen two specimens of this curious Lernæan, and both were found on the gills of the pogge, *Agonus cataphractus*. One was obtained at Dunbar by Mr. Jamieson, Laboratory Assistant, in April 1891, on the gills of a pogge taken from the stomach of a cod; the other was taken also from the gills of a pogge captured by the "Garland" in the Firth of Forth in February 1892. This specimen was recorded in the Annals of Scottish Natural History for April of the same year. It is represented in the present paper by figure 14 on Plate VII.; the neck and upper part of the thorax of this specimen was accidentally damaged.

I have recently examined a large number of pogges without finding a single example of this *Hæmobaphes*; probably the species is a rare one.

Hæmobaphes ambiguus, sp. n. (Pl. VII., fig. 15.)

A *Hæmobaphes*-like parasite was found on the gills of a specimen of the spotted dragonet, *Callionymus maculatus*, captured in the Solway in October 1899.

This parasite differs from *Hæmobaphes cyclopterinus* in having a very short neck, and in the abdominal portion of the genital segment being more produced; moreover, this produced part is compressed and somewhat dilated at the end, the margins are somewhat irregular in outline, and the lateral lobes are moderately prominent (fig. 15). Only one ovisac is shown in the figure; the other was accidentally destroyed.

The entire length of the specimen figured is about the seven-twentieths of an inch (11·5mm.).

I have been unable to find any published description of this form; and as it agrees with *Hæmobaphes* in some of its more prominent characters, I have decided to regard it for the present as "new."

Fam. CHONDRACANTHIDÆ.

Genus *Oralien*, Basset-Smith (Proc. Zool. Soc. Lond., April 1899, p. 489).
Syn. *Lernentoma* (pars.), Baird, Brit. Entom., p. 329.

This genus has been established by Dr. Basset-Smith for *Lernæa asellina*, Linn. (*Lernentoma asellina*, Baird), because of the marked difference in the arrangement of the cephalic appendages. In the typical *Chondracanthus* these appendages are arranged in more or less proximity, but in *Lernæa asellina* the head, which is rounded anteriorly and provided with antennules and antennæ as well as lateral lobe-like projections, is produced behind into a cylindrical and moderately elongated neck, at the base of which, where the neck joins the thorax, is situated the mouth and the several mouth organs. By this arrangement a considerable distance intervenes between the antennal appendages and the mouth parts. But besides this departure from the arrangement of the parts usually observed in the genus *Chondracanthus*, the general appearance of the animal also exhibits a marked difference from that of the other species belonging to that genus.

Oralien asellinus (Linn.). (Pl. VII., figs. 16–18.)

1761. *Lernæa asellina*, Linn., Fauna Suec., 2101.
1838. *Chondracanthus triglæ*, Kr. Naturh. Tidsskrift, R. i., vol. ii., p. 135, Pl. III., fig. 3.
1850. *Lernentoma asellina*, Baird, op. cit., p. 329, Pl. XXXV., fig. 4.

In this species the front part of the head is enlarged by the development of a lobe-like projection on each side; this part is usually buried deeply in the tissues of the fish. The antennules are short, moderately stout, simple appendages. The mandibles, which are somewhat similar to those of *Chondracanthus*, are stout and falcate, and their convex margins are fringed with short but moderately stout spines (fig. 18). The maxillæ, maxillipedes, and other appendages are somewhat similar to those of *Chondracanthus cornutus*.

The size of specimens varies to some extent; the more usual dimensions, however, seem to be as follows:—Length, exclusive of ovisacs, about 8 mm.; length from front of head to end of ovisacs, about 12 mm. A specimen from a common gurnard, *Trigla gurnardus*, measured only 5·5mm. in length of body and 8·5mm. to the extremity of the ovisacs.

I have obtained the species on the gills of gurnards, plaice, halibut, and other fishes captured on all parts of the Scottish coasts examined by us.

It is of interest to note that in the various works on the copepod parasites of fishes which I have consulted no two authors agree in their figures of this species. It may be that there is more than one species included in *Chrondracanthus asellinus*, or the differences referred to may be due to the variableness of the species.

Genus *Chondracanthus*, De la Roche (1811).
Syn. *Lernentoma* and *Chondracanthus*, Baird.

In this genus the head, though distinct, is not separated to any great extent from the thorax. The antennules are usually more or less conspicuous in front of the head, and these and the antennæ are in close proximity to the mouth organs. The genital segment is more or less cylindrical, as in *Chondracanthus cornutus*, or constricted, as in

Chondracanthus soleæ. Ten species are recorded in the sequel, but one of them is somewhat doubtful and apparently undescribed.

Chondracanthus cornutus (Müller). (Pl. VII., figs. 19–31.)

1776. *Lernæa cornuta*, Müller, Zool. Dan., vol. i., pl. 33, fig. 6.
1850. *Lernentoma cornuta*, Baird, op. cit., p. 328, Pl. XXXV., fig. 2.

This species, as represented by the figure in Dr. Baird's "British Entomostraca," has the genital segment of a cylindrical form and without any marked constriction in the middle; and in his description of the species Dr. Baird makes no allusion to any constriction of the posterior "two-thirds" of the thorax; had any constriction been observed, as conspicuous as it is, for example, in *Chondracanthus soleæ* or *Chondracanthus fluræ*, he would very likely have referred to it. Moreover, the figures of the same species by Nordmann* and Kröyer,† though showing a slight constriction of the thorax, agree fairly well with that of Dr. Baird.

Specimens agreeing in their general appearance with Dr. Baird's figure of *Chondracanthus cornutus*, except that they exhibit a slight constriction, as shown in the figure by Nordmann, have been found on the plaice, *Pleuronectes platessa*, and the common flounder, *Pleuronectes flesus*. I find on the plaice two forms of the *Chondracanthus*; the more common one (represented by figure 19) is the smaller of the two, and is also proportionally broader. The specimen of this form represented by the figure referred to measured 5·8mm., exclusive of ovisacs. The antennules of this specimen were considerably dilated, and showed little structure. The antennæ were furnished with strongly-hooked terminal claws, while the mandibles were moderately stout and tapered towards the end, where they became somewhat attenuated. The anterior foot-jaws had a moderately stout basal part, but the end-joint was more slender and was serrated on the inner edge (fig. 23).

The male of this form, which is very small, is represented by figure 24; it measured scarcely the half of a millimetre in length; the abdomen, which appeared to be distinct from the thorax, was more or less segmented.

A specimen of the less common and more elongated form is represented by figure 27; it measured nearly 7 millimetres in length. The posterior portion of the thorax in this form is long and narrow, and slightly constricted in the middle; the antennules (fig. 28) appear to be scarcely so robust as in the smaller form, but the mandibles and other appendages do not seem to differ much.

Habitat.—The smaller form has been obtained on plaice from the Firth of Forth, Firth of Clyde, Moray Firth, and at Aberdeen Fish Market. The larger form was found on the gills of a plaice in the collection of fishes in the Laboratory at Bay of Nigg, but the locality where this plaice came from is not stated on the label.

Chondracanthus annulatus, Olsson. (Pl. VII., figs. 46–51.)

1867. *Chondracanthus annulatus*, Olsson, Prodr. Faunæ Copep. Parasit. Scand., vol. v., p. 30, Pl. II., figs. 13–15.

A number of specimens of this *Chondracanthus* were obtained from the gills of a large grey skate, *Raia batis*, caught in the North Sea and landed at the Fish Market at Aberdeen, June 30th, 1899.

In this species the body is elongate, moderately narrow, and cylindrical in form; it is about four times longer than broad, and not much

*Mikrogr. Beitr., vol. ii., Pl. 9, fig. 5.
†Naturh. Tidsskr., R. iii., vol. 2, Pl. 13, fig. 7 (1864).

compressed. The head is well defined, the neck is short, and the posterior part of the thorax is slightly constricted in the middle. The abdomen is very short, and so are the posterio-lateral processes of the thorax. As the abdomen and lateral processes are about the same length, they give to the posterior end of the thorax a more or less trilobed appearance (fig. 46). The specimen represented by the figure is about 14mm. ($\frac{11}{20}$ of an inch) in length, exclusive of ovisacs, and from the front part of the head to the extremity of the ovisacs the length is about 2 inches.

The antennules in the female are very short and considerably dilated; the mandibles differ very little from those of *Chondracanthus cornutus*. The two pairs of thoracic limbs are both very short.

A male specimen, which is represented by figure 47, measured about 3 millimetres in length; its antennules were smaller than those of the female, and were rather more setiferous. The antennæ were short, but they were armed with strong, though somewhat short, terminal claws.

Chondracanthus clavatus, Basset-Smith. (Pl. VII., fig. 35–37.)

1896. *Chondracanthus clavatus*, Basset-Smith, Ann. and Mag. Nat. Hist. (6). vol. 18, p. 13, Pl. V., fig. 6.

In this species the thorax increases in width towards the posterior end; the posterio-lateral appendages are of moderate length, as shown by the figure (fig. 35). The antennules are considerably dilated and somewhat like those of *Chondracanthus cornutus* in their general appearance. The mandibles and the other appendages are also nearly the same as in that species, but the posterio-lateral thoracic processes are considerably longer, being equal to about one-sixth of the entire length of the animal.

The average length of the specimens I have measured is 6·5mm., but some are found a little smaller and some larger. The ovisacs are also not very elongate; the largest specimens I have observed scarcely reached a total length (including ovisacs) of 10mm.

Habitat.—On the gills of lemon soles, *Pleuronectes microcephalus*, caught in the Firth of Forth, in the Firth of Clyde, and on other parts of the Scottish coast. The male of this species is very like that of *Chondracanthus cornutus*.

Chondracanthus soleæ, Kröyer. (Pl. VII., figs. 41–45.)

1838. *Chondracanthus soleæ*, Kr., Naturh. Tidsskr., R. i., vol. i., p. 139, Pl. III.
1864. *Chondracanthus soleæ*, Kr., op. cit., R. iii., Pl. II., p. 330.

The specimens of *Chondracanthus* which I record under this name of Kröyer's were found on black soles, *Solea vulgaris*, captured in the Firth of Clyde in October and December 1899, and on turbot, *Bothus maximus*, captured in the Firth of Forth in July 18?2. Kröyer obtained his specimens also from black soles. The species is distinguished by its comparatively small and robust form, by the comparatively elongated posterior thoracic appendages, and by the elongated posterio-lateral processes of the thorax. Moreover, the posterior portion of the thorax is distinctly constricted in the middle, as shown by the drawing (fig. 41). In comparing the antennules and antennæ, the mouth organs, and other appendages of this form with those of *Chondracanthus cornutus*, it is found that, though there is a certain amount of resemblance between them, differences are observable, which, taken in combination with the marked difference in the general appearance of the animals, present as good grounds for separating *Chondracanthus soleæ* from *Chondracanthus*

cornutus as there are for separating *Chondracanthus clavatus* from the same species.

The male of *Chondracanthus solea* resembles also in some respects the male of *Chondracanthus cornutus*, but appears to differ in the form of the antennules and of the second pair of thoracic feet (figs. 44, 45); the antennules are considerably dilated and of a somewhat triangular form; and the second pair of feet have a sub-quadrate outline.

A moderately large female, obtained on a specimen of *Solea vulgaris* captured in the Clyde, measured about 8·5mm., exclusive of the ovisacs, which were as long as the specimen itself. In this specimen the lateral processes at the posterior end of the thorax were a millimetre in length, which was somewhat less than in some of the other specimens examined.

Chondracanthus fluræ, Kröyer. (Pl. VII., figs. 32–34.)

1864. *Chondracanthus fluræ*, Kr., op. cit., R. iii., vol. ii., pp. 323 and 330, Pl. XIII., fig. 6.

Kröyer obtained this species from the long rough dab, *Platessa limandoides* (Bl.), or *Drepanopsetta platessoides*, Fabr., as this fish is now called. Specimens of *Chondracanthus fluræ* have been obtained on long rough dabs captured in the Firth of Clyde; some of them were taken on specimens captured at Station III. (Kilbrennan Sound) in December last. This parasite has not been observed by us on any other kind of fish. *Chondracanthus fluræ*, like the one last described, has the posterior portion of the thoracic segment in the female distinctly constricted in the middle, but it is more robust, and the thoracic limbs, as well as the posterio-lateral processes, are short. Kröyer's description of the species, which accords very well with the Clyde specimens, is as follows:—"Forma crassa robustaque, latitudine fere dimidiam longitudinis partem obtinente, capite mediocri, latiore quam longiore, subsemilunato; annulis thoracicis omnibus perbene distinctis, latioribus quam longioribus, primo secundoque insequentibus multo angustioribus. Antennæ anterioris paris latitudine capitis paulo breviores, basi sejunctæ, articulo terminali conico, seta apicis instructo. Membra annuli thoracici primi et secundi minuta, eadem ferme longitudine ac latitudine, vix vel parvum furcata. Processus annuli thoracici quarti posteriores ipso annulo breviores (tertia quartave parte), crassi subconici. Abdomen dimidiam processuum longitudinem superius conicum, biarticulatum. Ovaria externa gracilia, elongata?"*

This species is smaller, but comparatively more robust, than the one last recorded. The specimen represented by the drawing measures about 4·7mm. in length; while the length of a somewhat larger specimen is 5·5mm., exclusive of ovisacs, and from the forehead to the end of the ovisacs the length is fully 10·5mm.

Chondracanthus merluccii, Holten.

Chondracanthus merluccii, Holten, Mem. Soc. Hist. Nat. Copenhag., vol. v., Pl. III., fig. 2.
1892. *Chondracanthus merluccii*, T. Scott, *Tenth Ann. Rept. Fish. Board for Scot.*, Pt. III., p. 262.
1896. *Chondracanthus merluccii*, Basset-Smith, Journ. M. B. Assoc. Plymouth, p. 161.

This is a moderately common parasite on the hake, *Merluccius vulgaris*. I find it most frequently clinging to the roof and sides of the mouth, and

* Naturh. Tidsskr., R. III., Bd. 2, p. 330 (1864).

sometimes on the under side of the tongue and the inside of the gill-covers. *Chondracanthus merluccii* differs from the other species in having, besides its usual thoracic limbs, a pair of moderately long appendages near the middle of the posterior portion of the thorax, and also in the posterio-lateral processes being considerably elongated. The mandibles, which are distinctly toothed on the upper margin, and the other cephalic appendages are all more or less similar to the same appendages in other species of *Chondracanthi*.

A female specimen of average size measured about half an inch in length, exclusive of ovisacs. The males are very small, and sometimes more than one of them may be observed sticking on a female. The species varies to some extent both in its general outline and in the proportional lengths of the various appendages.

Chondracanthus lophii, Johnston.

1836. *Chondracanthus lophii*, Johnston, Loud. Mag. Nat. Hist., p. 81, fig. 16.
1850. *Lernentoma lophii*, Baird, op. cit., p. 330, Pl. XXXV., fig. 3.

This is one of the more common of the copepod parasites of fishes; it seems to be to a large extent peculiar to the angler, *Lophius piscatorius*, and is usually found adhering to the inside surface of the gill-pouches. A considerable percentage of the anglers captured by the "Garland" are more or less infested with this copepod. I have records of it from the Firth of Forth, the Firth of Clyde, and other parts of the Scottish coasts. The oviferous tubes are slender, usually elongated, and more or less twisted.

Chondracanthus zeus, De la Roche. (Pl. VIII., fig. 1.)

1811. *Chondracanthus zei*, De la Roche, Nouv. Bull. des Sc. de la Soc. Philom., vol. ii., p. 270, Pl. II., fig. 2.
1850. *Chondracanthus zei*, Baird, op. cit., p. 327, Pl. XXXV., fig. 1.

In this species the dorsum is ornamented with a number of processes, which gives the specimens a bizarre appearance not usually observed amongst the *Chondracanthi*.

I obtained a specimen of *Chondracanthus zeus* on the gills of a John Dory, *Zeus faber*, caught in the Firth of Forth in 1891; this specimen is recorded in Part III. of the *Tenth Annual Report of the Fishery Board for Scotland* (1892). A second specimen was obtained in the Firth of Forth in 1896, also on the gills of a John Dory. *Chondracanthus zeus* has also been obtained in the Firth of Clyde, on a John Dory, captured there by the "Garland."

The length of the specimen represented by the figure was about half an inch, but the species varies to some extent both in size and ornamentation.

Chondracanthus limandæ, Kröyer. (Pl. VII., figs. 38–40.)

1864. *Chondracanthus limandæ*, Kr., op. cit., R. iii., vol. ii., pp. 322 and 330, Pl. XIV., fig. 2.

Kröyer obtained this species on *Platessa limanda* (*Pleuronectes limanda*, Linn), the common dab. I have obtained on two different specimens of the common dab what appears to be the same species of copepod. The common dab from which the specimen represented by the

drawing (fig. 38) was obtained was captured in the Firth of Clyde in 25-30 fathoms, November 1899. A second specimen, exhibiting even a closer resemblance to the figure, was obtained on a common dab taken by the "Garland" at Station VII. in the Moray Firth on January 24th of the present year (1900).

This species is moderately robust; the first thoracic segment is very short; the second is of moderate size, and has on each side a slightly elevated and broadly rounded knob—"annulo secundo duobus tuberculis humeralibus praèdito magnis."* The posterior portion of the thorax is more or less distinctly constricted, so that this portion of the thorax appears as if it were divided into two slightly unequal parts. The thoracic limbs are more rudimentary than those of *Chondracanthus cornutus*; in that species the second pair are distinctly bifid, but in the present form they are not so, or they show at most the merest trace of bifurcation, agreeing in this respect also very closely with Kröyer's description—"Membra annuli thoracici primi et secundi latiora quam longiora semilunaria, haud furcata, posterius par priori multo majus." The posterio-lateral projections of the thorax are comparatively short and stout; the abdomen is very short and composed of two segments.

The specimen represented by the drawing is about 5mm., exclusive of the ovisacs, which are about the same length, giving a total length of about 10mm.

The male is very small; one which I measured was only 0·65mm. (scarcely one-thirty-eighth of an inch) in length.

Chondracanthus ornatus, sp. n.

I have recently obtained on the gills of specimens of the spotted dragonet, *Callionymus maculatus*, a *Chondracanthus*-like copepod, which appears so far to be undescribed. The female of this copepod viewed from above has a general outline closely similar to that of an equilateral triangle, the bluntly-rounded head forming the apex and the truncate posterior end the base; the front of the head is indistinctly tri-lobed, one bluntly-rounded lobe being in the centre, and projecting slightly in front of the two lateral lobes, which are also bluntly rounded; the neck connecting the head with the thorax is very short; along each side of the thorax (forming the sides of the triangle) there are three or four more or less distinct tubercles†, and a series of three similar tubercles extends along the middle of the dorsum; the posterior tubercle of the middle series stands well up, but each of the other two stands at a slightly lower elevation than the one immediately behind; the abdomen is exceedingly small and inconspicuous. The ovisacs are of moderate length and stoutness, like those of *Chondracanthus limandæ*.

The length of the more typical of my female specimens is as follows: From forehead to the posterior end of body, 5mm. (one-fifth of an inch); from forehead to the end of the longest of the two ovisacs, 11·5mm. (nearly half an inch); the width of the thorax at the posterior end is just a little over 5mm., so that the body of the animal, as I have already said, has a general outline closely similar to that of an equilateral triangle.

The male is very small; it scarcely reaches to 0·6mm. ($\frac{1}{40}$ of an inch) in length. I have not had time to get drawings of this interesting species prepared, but it has such a characteristic form that the description of the female I have given, together with the *habitat* of the species, should facilitate its identification. I have obtained the species on the

* Kroyer, Naturh. Tidsskr., R. III., Bd. 2, p. 230 (1864).

† The arrangement and position of these lateral tubercles seems to vary slightly in different specimens; the description refers to the *general appearance* as seen from above.

gills of *Callionymus maculatus* from the Firth of Clyde, collected in 1899, and from the Moray Firth, collected at Station VII. on January 24th, 1900. From the ornate character of the species I have called it *Chondracanthus ornatus.*

Fam. Lernæopodidæ.

This, the last of the series of seven families into which the parasitic copepods of fishes have been divided, contains ten genera, and five of these are represented in the present paper, viz.:—*Thysanote*, *Charopinus*, *Lernæopoda*, *Brachiella*, and *Anchorella.*

Genus *Thysanote*, Kröyer (1863).

Thysanote impudica (Nordmann). (Pl. VIII., figs. 2–5.)

1832. *Brachiella impudica*, Nord., Mikrog. Beitr., vol. ii., p. 92, Pl. VIII., fig. 3.
1899. *Thysanote impudica*, Basset-Smith, Proc. Zool. Soc. Lond. (April 1899), p. 497.

I ascribe to this species a small *Brachiella*-like parasite found on the gills of a specimen of *Trigla hirundo* (the red gurnard) in the collections of fishes in the Laboratory of the Fishery Board for Scotland at Bay of Nigg, Aberdeen. I have not been able to ascertain definitely where the fish was captured, but it was probably taken either at the mouth of the Forth estuary or in the Firth of Clyde.

Genus *Charopinus*, Kröyer (1863).

Charopinus dalmanni (Retzius). (Pl. VIII., figs. 6–10.)

1831. *Lernæa dalmannii*, Retz., Froriep's Notizen, vol. xxix., p. 617, Pl. VI., fig. 5.
1863. *Charopinus dalmannii*, Kr., Naturh. Tidsskr., R. iii., p. 280, Pl. XIV., fig. 6.
1878. *Stylophorus hypocephalus*, Hesse, Ann. Sci. Nat. (6), vol. viii., art. 15, p. 1.
1891. *Charopinus dalmannii*, T. Scott, Ninth Ann. Rept. Fish. Board for Scot., Pt. III., p. 310.

In this species the head, or anterior portion, of the thorax is ventrally and abruptly deflexed, and at the angle of the thorax thus formed there springs from each side a long, moderately slender and indistinctly annulated appendage, which becomes dilated and lunuleform at the apex. These two lunuleform apices, which, though not actually joined, fit very closely together, are buried in the tissues of the fish infested by this parasite. These appendages, by which the parasite anchors itself to the fish, are usually described as the second maxillipedes. The posterior portion of the thorax becomes gradually enlarged towards the distal end, and assumes a more or less clavate form; two moderately long and slender processes spring from the ventral aspect and just in front of the ovisacs; the two sides of the posterior portion of the thorax curve slightly inwards near the base, and each terminates in a small lobe. The abdomen, which is situated between and slightly in front of these lobes, is almost obsolete. The ovisacs are of moderate length, and saccate, and the ova are small and arranged in multiserial order. The following measurements are taken from a specimen of average size:—Length of second

maxillipedes, 22mm.; length of head and thorax (anterior to the angle from whence the second maxillipedes spring), 9mm.; length of posterior portion of thorax, 15mm.; length of ovisacs, 20mm.; length of the ventral thoracic appendages, 10mm.; total length from the apices of second maxillipedes to the end of ovisacs, 55mm. (nearly $2\frac{1}{4}$ inches).

The male of this large copepod scarcely reaches beyond two millimetres in length.

The antennules in the female are apparently three-jointed, and are moderately stout. The antennæ are short, stout, and feebly clawed (fig. 8). The mandibles, which are of moderate length and somewhat slender, are serrated at the distal end of the inner margin (fig. 9). The anterior foot-jaws (maxillipedes) are stout and feebly clawed.

In the male the thorax and abdomen (fig. 7) are more or less segmented); and the maxillipedes are short and stout, and, being armed with strong terminal claws, form powerful grasping organs.

Habitat.—In the nasal fossæ (or spiracles) of the grey skate, *Raia batis*. All the specimens we have obtained have been found in the nasal fossæ of the grey skate. *Charopinus dalmanni* appears to be moderately common on the large skate brought to the Fish Market at Aberdeen; sometimes two and three specimens have been found in the same spiracle of the skate examined in the market. I have also taken this species from a grey skate captured at the mouth of the Forth estuary.

Charopinus dubius, sp. n.

I record provisionally under this name a *Charopinus* which has been obtained adhering to the gills and gill-arches of the cuckoo ray, *Raia circularis*, Couch. The fishes from which these copepods were obtained were captured in the Firth of Clyde during December 1899. No specimens of this copepod have so far been observed in the spiracles of the cuckoo ray.

This *Charopinus* resembles more or less closely the *Charopinus* of the grey skate, and may only be a form of that species. The following points, however, deserve notice :—

Charopinus dubius is distinctly smaller than *Charopinus dalmanni*. The second maxillipedes are more slender in proportion to their length, and they are joined to each other at the apex by small horn-coloured plugs, which unite to form a thin circular horny disk, hollow in the middle and with the margins slightly reflexed. This disk is usually buried in the hard substance of the gill-arches, and is difficult to dissect out while retaining its union with the maxillipedes. The ovisacs are also rather more elongate and slender.

The most obvious difference between *Charopinus dalmanni* and the present form, other than that of size, is the character of the apices of the second maxillipedes; the difference here is very distinct and must of itself be held as alone of specific value if the differences recognised by Kröyer are to be considered valid. According to that distinguished observer, the more important specific characters by which *Charopinus dalmanni* (Retz.) and *Charopinus ramosus*, Kr., are distinguished, are taken chiefly from the form assumed by the apices of the second maxillipedes. Kröyer's definitions of these species are as follow :—

" *Charopinus dalmannii.*

*Laminæ cartilagineæ, quibus affigitur femina, semilunares."

*Naturh. Tidsskr., R. 3, Bd. 2 (1863–64), p. 362.

"*Charopinus ramosus.*

Laminæ, quibus affigitur femina, exterius in ramos binos elongatos graciles, crucem fere, efficientes productæ."

My specimens differ from both of these species in the important characters specially referred to; they also differ in their habitat. *Ch. dalmanni* has been found only in the spiracles of the grey skate; *Ch. ramosus* was found by Kröyer on the gills of the Thornback skate, *Raia clavata*, Linn.,* whereas the form I am now recording was found attached to the gill-arches (chiefly) and on the gills of *Raia circularis*.

Different specimens of *Ch. dubius* differ somewhat in the proportional lengths of the parts. The following tabular statement shows the lengths of two fairly typical specimens, to which the sizes of *Ch. dalmanni* are added for comparison :—

Length of	*Charopinus dubius.*		*Charopinus dalmanni.*
	No. 1.	No. 2.	
Second maxillipedes,	11 mm.	11·5 mm.	22 mm.
Anterior portion of thorax and head,	6 ,,	5 ,,	9 ,,
Posterior portion of thorax,	8·5 ,,	6 ,,	15 ,,
Posterior appendages,	4 ,,	4 ,,	10 ,,
Ovisacs,	18 ,,	damaged	20 ,,
Apex of second maxillipedes to end of ovisacs,	37 ,,	...	55 ,,
Apex of second maxillipedes to posterior end of thorax,	19 ,,	18 mm.	...

Genus *Lernæopoda*, Kröyer (1837).

Specimens of *Lernæopoda* have been obtained on a number of different kinds of fishes, and several species appear to be represented among them, but some of the so-called species approximate so closely as to render their identification somewhat difficult. Five species are recorded here.

Lernæopoda (?) *elongata* (Grant). (Pl. VIII., figs. 11–15.)

1827. *Lernæa elongata*, Grant, Brewster's Edin. Journ. Sci., vol. VII,, p. 147, Pl. II., fig. 5.

1850. *Lernæopoda elongata*, Baird, Brit. Entom., p. 333, Pl. XXXV., fig. 5.

The specimen I record under this name is rather smaller than those occasionally described, but it apparently agrees with the species named in some at least of its more important characters, *i.e.*, the form of the cephalic shield, the large and well-developed anterior pair of maxillipedes, and the very long and slender posterior maxillipedes. The abdomen is very short, and the posterior processes of the genital segment are almost obsolete.

The entire length of the specimen represented by the figure was at least three-quarters of an inch, and it was obtained on a porbeagle shark, *Lamna cornubica*. Where the fish was captured I cannot exactly say, though probably it was in the North Sea, somewhere off the Scottish coasts.

*Op. cit., p. 358.

One or two of the cephalo thoracic appendages are represented by figures 4–8.

Lernæopoda galei, Kröyer. (l. VIII., figs. 16–25.)

1837. *Lernæopoda galei*, Kr., Naturh. Tidsskr., R. i., vol. i., p. 272, Pl. III., fig. 5.

1850. *Lernæopoda galei*, Baird, op. cit., p. 334, Pl. XXXV., fig. 7.

A number of specimens of *Lernæopoda galei* have been obtained on tope (or topers, as the fish is sometimes called), *Galeus canis*, Rondel. (*Galeus vulgaris*, Flem.), occasionally brought to the Fish Market at Aberdeen. Specimens have also been sent to me by Mr. Duthie, the fishery officer at Girvan, which he had obtained on topers captured in Clyde waters and landed there. The parasites were most frequently found adhering to the skin beneath and between the ventral fins of male fishes; it appeared to be less frequent on females. *Lernæopoda galei* has also been obtained on a male specimen of the lesser spotted dog-fish, *Scyllium canicula*, caught in the Firth of Clyde, and on a specimen of the same kind of dog-fish sent from the Moray Firth. This Moray Firth specimen was also a male.

In this species of *Lernæopoda* the arms are only moderately elongated; the body becomes gradually dilated posteriorly, and is truncate at the end. The abdomen is almost obsolete, and is situated between two distinct though short and slender processes which spring from the end of the genital segment.

The antennules, antennæ, and mouth-organs are somewhat similar to those of *Lernæopoda elongata*. The specimen represented by the drawing is about 13mm. in length from the forehead to the end of the posterior appendages, and exclusive of the ovisacs and the second maxillipedes. In another specimen, which measured about 14mm., the ovisacs measured fully 9mm., and the posterior appendages about 3mm.

Lernæopoda bidiscalis, W. F. de Vismes Kane.

1892. *Lernæopoda bidiscalis*, W. F. de V. Kane, Proc. Roy. Irish Acad. (3), vol. ii., p. 203, Pls. IX. and X.

The species described under this name has hitherto been observed only on the male of the tope, *Galeus canis*. It is found adhering to the ends of the claspers, and the place where the parasites are attached is almost invariably found to be torn and bleeding. The describer of the species draws attention to this circumstance. I have found it to be almost invariably the case with topers landed at the Fish Market at Aberdeen, and Mr. Duthie, fishery officer at Girvan, finds that male topers caught in the Clyde and landed at that place have also the ends of the claspers torn and bleeding where these parasites were adhering. Whether these wounds are caused directly by the parasites or are produced by the efforts made by the sharks to shake off their tormentors is a question that does not yet appear to have received a satisfactory answer. Usually one, but sometimes two, parasites are found adhering to the same clasper, and on a few occasions we have found two parasites on each of the two claspers of the same fish. The fishes from which the parasites were obtained were chiefly adult males with well-developed claspers; we have rarely observed this *Lernæopod* adhering to the claspers of young males.

The specimens of *Lernæopoda bidiscalis* observed by us had for the

most part the anterior portion of the head of a bright red or orange colour, and frequently the male was found adhering to the female.

Tope (or topers) are occasionally brought to the Aberdeen Fish Market by the steam trawlers, and it is from the fishes landed there that I have obtained most of my specimens of this parasite. Mr. Duthie has recently, however, sent me specimens of the parasite obtained on male topers captured in the seaward portion of the Clyde and landed at that port. The discovery of this species by Mr. Duthie makes an interesting addition to the Clyde Copepod-fauna.

One of the more obvious characters by which the species may be distinguished is that of the comparatively large roundish disks which terminate the short second pair of maxillipedes. The whole animal is short and robust—very different in appearance from the more elegant *Lernæopoda galei.*

One of the most typical female specimens obtained by us gave the following measurements:—From forehead to end of thorax, 5·5mm.; from forehead to end of posterior thoracic appendages, 7mm.; from forehead to end of ovisacs, 13mm.; greatest width of thorax, almost 4mm.

The male of *Lernæopoda bidiscalis* has a general resemblance to that of *Lernæopoda galei*, but the maxillipedes and other mouth-organs, and the antennal appendages, differ somewhat in structure from those of that species.

Lernæopoda salmonea (Gisler), (Pl. VIII., fig. 26.)

1751. *Pediculus salmonis*, Gisler, K. S. Vet. Ak. Handl., vol. xii., p. 171, Pl. VIII., figs. 1–5.
1761. *Lernæopoda salmonea*, Linn., Faun. Suec. (2nd edition), p. 509, No. 2102.
1850. *Lernæopoda salmonea*, Baird, op. cit., p. 335, Pl. XXXV., fig. 6.

This species was obtained on the gills of a diseased salmon, *Salmo salar*, caught in the Firth of Tay in January 1891, and also on the gills of a trout sent to the Fishery Board's laboratory from a loch in Sutherlandshire. *Lernæopoda salmonea* is a smaller species than any of the others already mentioned; the specimen represented by the figure measured only about 6mm.

In this species the arms are short and moderately stout. The cephalothorax seen from above is sub-triangular, while the posterior portion of the thorax assumes a sub-clavate form by gradually increasing in width towards the distal extremity. The posterior thoracic processes and the abdomen are very minute (fig. 26).

Lernæopoda cluthæ, sp. n. (Pl. VIII., figs. 27–37.)

The cephalothorax in this species is small and sub-triangular. A distinct and comparatively narrow neck connects the cephalothorax with the posterior portion of the body; this posterior portion is somewhat dilated and sub-cylindrical, and, in spirit specimens, shows a few pseudo-constrictions. Two short processes spring from the posterior end of the genital segment, and the abdomen, which is situated between these processes, is very small. The thoracic arms (second maxillipedes) are slender and of moderate length.

The antennules and antennæ are somewhat similar to those of species already recorded (figs. 30, 31). The mandibles are small, and their biting margins are finely and somewhat irregularly serrated, and in this respect they differ very markedly from the same appendages in *Lernæo-*

poda galei. The maxillæ (fig. 32) are small, and have the end-joint armed with two moderately elongate and stout terminal spines. The anterior foot-jaws (first maxillipedes, fig. 33) are more slender and rather more elongate than those of *Lernæopoda galei* (fig. 34).

The male of *Lernæopoda cluthæ* differs considerably from that of *Lernæopoda galei*, or *Lernæopoda bidiscalis*, and especially so in the structure of the abdomen and caudal appendages. In the male of *Lernæopoda cluthæ* the abdomen is distinctly segmented, and the caudal furca consists of two slender processes, while in the two other species named the furca assumes the form of broadly oval, or club-shaped, appendages, divergent and reflexed upon the abdomen (fig. 37).

The female specimen represented by fig. 28 measures, from the front of the head to the end of the posterior thoracic appendages, 5mm., and from the termination of the same thoracic appendages to the extremity of the elongated second maxillipedes about 8mm. The posterior thoracic appendages are scarcely 1mm. long, and the length of the ovisacs, which varies considerably in different specimens, is scarcely 4mm., in the one represented by the figure.

Habitat.—Attached to the gill-filaments of the Fuller's Ray, *Raia fullonica*, captured in the Firth of Clyde in April 1897.

This *Lernæopod* is quite distinct from any of the other species recorded here. The form of the female; the form and armature of its mandibles, maxillæ, and first maxillipedes, and the general structure of the male, all differ from any other species of *Lernæopod* known to me.

Besides the species of *Lernæopoda* recorded in the preceding notes, there are other two forms which for the present will have to stand over, as there has not been time to study their characters sufficiently to allow of their being included in the present paper. One of these forms was obtained on the gill-filaments of the grey slate, *Raia batis*; the other was obtained on the gill-filaments of the cuckoo ray, *Raia circularis*, both from the Firth of Clyde.

Genus *Brachiella*, Cuvier.

This genus differs from *Lernæopoda* in having the cephalo-thorax more or less elongated and moderately slender. The arms (second maxillipedes), are, as in *Lernæopoda*, usually separate except at the ends where they are united to a hard horny button, which serves to anchor the parasite to its host. In some of the species at least there are two pairs of caudal appendages.

The following are the species of *Brachiella* that have come under my observation :—

Brachiella rostrata, Kröyer. (Pl. VIII., figs. 38–39.)

1837. *Brachiella rostrata*, Kr., Naturh. Tidsskr., R. i., vol. i., p. 207, Pl. II., fig. 1.
1864. *Brachiella rostrata*, Kr., op. cit., R. iii., vol. 2, p. 364, Pl. XVII., fig. 8.

A number of specimens of this fine species have been obtained on the gills of large halibut, *Hippoglossus vulgaris*, brought to the Fish Market at Aberdeen. In the female of *Brachiella rostrata*, the mouth-organs have a close resemblance to those of *Lernæopoda*. The mandibles and maxillæ of this species are somewhat similar to those of *Brachiella insidiosa*. The antennæ, which are moderately stout, do not show much structural development, and the anterior maxillipedes though short have moderately strong terminal claws.

The female specimen represented by the drawing (fig. 38) is fully 17mm. in length from the head to the end of the posterior thoracic appendages. The male of this species, one of which is represented by fig. 39, measures about 2mm. in length.

Brachiella insidiosa, Heller. (Pl. VIII., figs. 40 and 41.)

1865. *Brachiella insidiosa*, Heller, Reise der Novara, p. 239, Pl. XXIV., fig. 1.
1896. *Brachiella insidiosa*, Basset-Smith, Ann. and Mag. Nat. Hist. (6), vol. xviii., p. 14, Pl. VI., fig. 2.

This is a moderately robust species, the cephalothorax is short, and so are the second maxillipedes. There are two pairs of posterior appendages to the thorax in this species; those at the posterior angles are elongated and slender, and the intermediate ones are short (fig. 40). The female specimen represented by fig. 40 measured about 12·5mm.; the male (fig. 41) is somewhat like the male of *Brachiella rostrata*.

The mandibles in the female of *Brachiella insidiosa* are more powerfully armed than those of *B. rostrata*; but the maxillæ are rather smaller.

Habitat.—On the gills of hake, *Merluccius vulgaris*, captured in the Firths of Forth and Clyde, and on hake brought to the Fish Market at Aberdeen.

Brachiella merluccii, Basset-Smith. (Pl. VIII., fig. 42.)

1896. *Brachiella merluccii*, Basset-Smith, op. cit. (6), vol. xviii., p. 14, Pl. VI., fig. 1.

From Dr. Basset-Smith's description of this species, which contains all that is of special note concerning it, I extract the following reference to the general appearance of the female:—"Cephalothorax of moderate length, about equal to that of the genital segment, tapering towards the head and bent forward in an obtuse angle. Head slightly widest in front, the arms (second maxillipedes) not quite so long as the cephalothorax, being united in the whole length by a thin membrane. Organ of attachment, a chitinous cup with a short pedicle."

"Genital segment fiddle-shaped, very thick, carrying posteriorly two pairs of elongated processes; a dorsal pair directed backwards and outwards and a vertical pair rising on either side of a filiform abdomen (post-abdomen, Gerst.), these being directed backwards, outwards, and upwards, encircling the ovisacs."

In a concluding note Dr. Basset-Smith directs attention to the peculiar position which this species occupies in the genus *Brachiella*. According to the present classification this species, he says, should be placed with *Anchorella*, for in the female the second maxillipedes are short and are also united in their whole length, but the peculiar *Brachiella*-form of the male causes it to be placed in this genus.

From the peculiar habit of the animal it is somewhat difficult to get a specimen into a good position for drawing. Figure 42 gives a side view of a specimen measuring about 8·5mm. in length. The antennal appendages and mouth-organs agree in general structure with other species of *Brachiella*.

A certain amount of variation is observable between different specimens, but the general configuration of the animal, its short arms, and the number and position of the posterior appendages, are all so characteristic of the species that there need be little difficulty in identifying it.

I have obtained specimens of this *Brachiella* on hake captured in the

Firth of Clyde by the "Garland," and also on large hake brought to the Fish Market at Aberdeen. *Brachiella merluccii* is usually found attached to the gill-rakers of the hake, and chiefly on the larger specimens of the fish.

Genus *Anchorella*, Cuvier (1817).

In this genus the arm-shaped appendages are very short, and they are united to each other from the base so as to resemble a single organ (Baird).

Anchorella emarginata, Kröyer. (Pl. VIII., figs. 49–51.)

1837. *Anchorella emarginata*, Kr., Naturh. Tidsskr., R. i., vol. i., p. 287, Pl. III., fig. 7.

A specimen of *Anchorella* which appears to belong to *Anchorella emarginata*, Kr., was obtained on the gills of a twaite shad (*Clupea finta*) captured near Dunbar, at the mouth of the Firth of Forth, in February 1897. This form, though small, readily attracted one's attention because of its extremely long and slender cephalothorax when compared with the robust form of the body and ovisacs (fig. 49).

The antennules in this species are of moderate length and apparently three-jointed. The mandibles are very small and armed with a few teeth (fig. 51). The maxillæ are rather larger than the mandibles, and are provided with three apical spines; the secondary branches of the maxillæ are very small (fig. 50). The first maxillipedes are small and moderately strong; the terminal claws are small. Dr. Basset-Smith states that in this species the second maxillipedes are not completely united at their bases; this is shown to be the case in our specimen also. In this particular, *Anchorella emarginata* does not altogether agree with the characters of the genus, and seems to form a connecting link between that genus and *Brachiella*. On the other hand, *Brachiella merluccii*, as has been shown, partakes also of the characters of the same two genera, though apparently more closely allied to the genus to which it has been ascribed. It will be observed, further, that in this specimen now under consideration the cephalothorax springs apparently from near the middle of the genital segment and becomes somewhat attenuated towards the end; also that the abdomen is so minute that it is not shown in my drawing (fig. 49). This drawing represents a side view of the specimen, and the projection of the posterio-lateral lobe on the side next the observer prevents the abdomen from being seen.

The specimen, of which the figure is a representation, measures, exclusive of the elongated cephalothorax and of the ovisacs, scarcely two and a half millimeters in length.

Anchorella (?) *rugosa*, Kröyer. (Pl. VIII., figs. 45–48.)

1837. *Anchorella rugosa*, Kr., Naturh. Tidsskr., R. i., vol. i., p. 294, Pl. III., fig. 6.

1850. *Anchorella rugosa*, Baird, op. cit., p. 338, Pl. XXXV., fig. 8.

The *Anchorella* which I ascribe to Kröyer's *A. rugosa* was obtained on the gills and gill-covers of the cat-fish, *Anarrhichas lupus*, Linn., where it is sometimes not very rare. I find also on the cod-fish what appears to be the same species of *Anchorella*. It is evident, however, that these organisms, so far as the British species are concerned, require a more careful study than they have yet received.

Anchorella rugosa differs very distinctly from the last, especially by the structure of the second maxillipedes. In this species these appendages are much more atrophied, being reduced to little more than a small button-like projection at the anterior end of the robust genital segment. The cephalothorax is not so elongated as in the form just described; it is also proportionally stouter and more rugose. The genital segment is considerably dilated, and, when looked at from above, or below, has a nearly square outline, the two sides being slightly emarginate or constricted. The ovisacs are stout and of moderate length.

The antennules and mandibles (fig. 47) are somewhat similar to those of *Anchorella emarginata* but larger. The maxillæ are distinctly larger, besides being somewhat different in structure; moreover, the anterior maxillipedes are considerably stouter than the same organs of that species.

The male is greatly dilated on the dorsal aspect (fig. 46), and measures only about a millimetre in length. The anterior and posterior foot-jaws are stout, and armed with short but strong terminal claws.

I have obtained *Anchorella rugosa* on *Anarrchichas lupus* in the Firth of Forth and the Firth of Clyde, and also on the same species of fish brought to the Aberdeen Fish Market.

It seems to me that *Anchorella rugosa*, Kr., is quite distinct from *Anchorella emarginata*, Kr., as shown by that author's descriptions of the two forms. As these descriptions are short, it may be of interest to give them in the author's own words, which are as follow :—

Abdomine nullo vel indistincto.

Anchorella emarginata, Kr.

"Caput mediocre vel parvum, a collo bene distinctum; collum gracile, longissimum; brachia gracilia, brevissima, bulla simplice; annulus genitalis dilatatus (latior fere quam longior), obcordatus, postice medio sinum præbens rotundatum."

Anchorella rugosa, Kr.

"Caput latum complanatum, a collo bene distinctum; collum elongatum sed crassus, valde rugosum; brachia fere rudimentaria, quasi in discum dilatata, bulla minuta, simplice; annulus genitalis latior quam longior, sub-quadratus, postice late truncatus, supra infraque rugis sulcisque insignitus."

Dr. Baird's description of *Anchorella rugosa*, Kr., agrees with that of Kröyer, but the figure of the species seems to represent some other form. Kröyer in his remarks on the genus also refers to this difference in Dr. Baird's figure.* This want of agreement is probably due to some misunderstanding on the part of the artist.

Anchorella rugosa, var. (Pl. VIII., fig. 52.)

The specimen represented by figure 52, though it agrees very closely with that from the *Anarrchichas*, differs somewhat in the structure and armature of the mandibles and maxillæ; the antennules also are slightly different, and will require further study. This form has been obtained on the haddock (*Gadus æglefinus*).

Anchorella uncinata, Müller. (Pl. VIII., figs. 43 and 44.)

1776. *Lernæa uncinata*, Muller, Zool. Dan., vol. i., Pl. XXXIII., fig. 2.

1850. *Anchorella uncinata*, Baird, op. cit., p. 337, Pl. XXXV., fig. 9.

Specimens of what I take to be this species are not uncommon on

* Naturh. Tidsskr., R. III., B. ii., p. 366 (1864).

species of *Gadus*, such, for example, as *Gadus merlangus*, captured in the Clyde and other parts of the Scottish coasts.

In this species (which belongs to Kröyer's division B) the abdomen is quite distinct, and is in the form of a prominent roundish knob. The cephalothorax, though nearly of the same length, is scarcely so stout as in *Anchorella rugosa*, but the second maxillipedes are more produced (fig. 43). The genital segment is moderately elongate and ovate. The female represented by the drawing measures about seven millimetres in length, exclusive of the cephalothorax and ovisacs.

The male, which is very small, has a general resemblance to the male of *Anchorella rugosa* (fig. 44).

The female antennules are moderately stout, and apparently three-jointed. The maxillæ are small, somewhat dilated towards the distal end, and provided with two terminal spines. The first maxillipedes are also small, they are each armed with a short terminal claw.

Anchorella stellata, Kröyer.

1838–39. *Anchorella stellata*, Kr., Naturh. Tidsskrift, R. i., vol. ii., p. 142, Pl. III., fig. 5.

1864. *Anchorella stellata*, Kr., op. cit., R. iii., vol. ii., p. 383.

This species of *Anchorella* was obtained on some specimens of hake, *Merluccius vulgaris*, forwarded from the Clyde to the Laboratory at Bay of Nigg. The fishes were captured by the "Garland" in Kilbrennan Sound on December 18th, 1899.

In *Anchorella stellata* the cephalothorax is moderately long and slender, and has the appearance of being continuous with, and but a prolongation of, the united second maxillipedes—the head being at one end of the prolongation and the chitinous plug, which terminates the maxillipedes, at the other; the length of this portion of the animal measures on an average about 6mm. The genital segment is ovoid in shape and measures about 4mm. in length by fully 2mm. in thickness. When the animal is alive or only recently dead this segment has the appearance of a pellucid and almost transparent bag, so that the creature is liable to be passed over under the belief that it is only a small roundish mass of mucus; in spirit the genital segment assumes a whitish appearance.

The membranous tissue surrounding the second pair of maxillipedes, and binding them together, is nearly transparent, and the maxillipedes could be easily seen side by side within their investment; it could also be observed that each maxilliped terminated in two or three minute roundish lobes, which together were arranged in a semi-circular manner round the inferior aspect of the apices of the maxillipedes, while from between the apices on the upper side proceeded the small chitinous process by which the creature attached itself to the fish. Moreover, in each of the specimens of this *Anchorella* that was examined, the chitinous process was observed to be adherent to the basal part of a scale, but the process did not penetrate through the scale, but spread out into a sucker-like disk between its outer and inner surfaces; and this sucker-like disk when closely examined exhibited a series of clear oval markings, which were arranged at regular intervals, and in a stellate manner, just within the circumference of the disk. The markings, which could be easily seen with a hand-lens, did not extend to the margin as shown in Kröyer's figure, but a small portion of the margin formed a continuous rim round the periphery of the disk; it is from this stellar arrangement of the pellucid markings that the specific name is derived.

The abdomen is scarcely developed in this species; it appears as a very

slightly produced middle portion of the posterior end of the genital segment, while on each side of it is a minute tubercle representing the posterio-lateral processes so characteristic of species of *Chondracanthus* and *Brachiella*.

The specimens of *Anchorella stellata* which I have observed were found adhering to the scales near the bases of the pectoral and ventral fins, especially those of the pectorals, of the hake. It is interesting to note that Kröyer found his specimens of this *Anchorella* also on the same species of fish.

In concluding for the present these notes on the copepod parasites of fishes, I may mention one point which has been of some interest to me in the course of my study of the structural details of the various species I have had the privilege to examine. A cursory glance over the plates of figures which accompany these notes shows that almost all the species that have been recorded arrange themselves naturally into three distinct groups by the structure of their mandibles. In the group to which *Caligus* and *Lepeophtheirus* belong the mandibles are for the most part long and slender; their apex has usually a slight inward curve, and the inner edge of this curved portion is minutely serrated; the mandibles in this group are also usually composed of several more or less distinct joints.

In the second group represented by *Chondracanthus* the mandibles are large and falciform—somewhat like a broad-bladed scimitar—with one edge, and sometimes with both edges, fringed with setæ or teeth.

In the third group represented by *Brachiella* and *Lernæpoda* the mandibles assume a cleaver-like form, and the anterior third part, more or less, of the inner margin is nearly straight and armed with teeth usually coarse, and sometimes irregular in shape. Other peculiarities of structure —as for example, that of the antennules, characteristic of certain groups— may also be observed by anyone who cares to devote a little time to the study of these interesting organisms.

I will now proceed to notice briefly a few crustacean parasites of fishes belonging to some of the groups that have come under my observation, and my notes will, as in the preceding part of this paper, refer principally to Scottish species.

(1) Branchiura.

Argulus foliaceus, Linn.

A few years ago this curious little entomostracan was found to be very common on the greyling, *Thymallus vulgaris*, in the upper waters of the Clyde. So much were these fishes infested by the little parasites that they were blamed for being the cause of the unhealthy appearance which these fishes at this time had assumed. A friend secured a number of the parasites and sent them to me, and promised to try and obtain some more. It happened, however, that within the next few days a heavy rain set in and flooded the river, and he was thus prevented from securing other specimens; and when the weather moderated he found that the *Argulus* had all disappeared, and that the fish had assumed a more healthy appearance.

Argulus foliaceus has also been taken on the three-spined stickleback, *Gasterosteus aculeatus*, in the Union Canal near Edinburgh, by Miss Janet Carphin, who kindly presented me with a few specimens.

Several species of *Argulus* have been described by Continental writers on parasitic crustacea, but *A. foliaceus* is the only one I know of as occurring in Scottish waters.

(2) Isopoda Parasita.

Several species of the parasitic Isopods of fishes have been observed, of which the following may be referred to :—

Gnathia maxillaris (Mont.).

Specimens of *Gnathia*, which I consider to belong to this species, have been found adhering to the gills of the common gurnard, *Trigla gurnardus*, and of the lemon sole, *Pleuronectes microcephalus*, sent by the "Garland" from the Clyde to the Laboratory at Bay of Nigg. Females only of the *Gnathia* were observed, and in each case the Isopod was attached to the gills, under the gill-covers.

Ægа strömii, Lütken.

A specimen of this Isopod was presented to me by one of the men on board a beam-trawl fishing boat belonging to Granton. The crustacean was found adhering to a large cod captured in the North Sea a considerable distance south-eastward of May Island.

Ægа tridens, Leach.

A specimen of this species was brought to me by a Rothesay fisherman, who obtained it on a cod he had captured on his fishing lines in Rothesay Bay. One was obtained on a torsk in Aberdeen Fish Market on 15th September 1899.

Ægа monophthalma (Johnston).

A fine specimen from a large cod captured by one of the Shetland fishing boats was handed to me for examination; it undoubtedly belonged to the species named, as described and figured in Prof. G. O. Sars' Crustacea of Norway, vol. ii.

I have had an opportunity of examining another fine species of *Ægа*, viz., *Ægа psora*. The species is included in the British fauna, but the specimens I saw were obtained on cod captured in Icelandic waters.

Cirolana borealis, Lilljeborg.

This Isopod is not very rare in the deeper parts of the Clyde, as, for example, to the east of Arran, in Kilbrennan Sound, and Loch Fyne, but I have never happened to find it there as a parasite. It has, however, been found adhering to several of the fishes brought to the Fish Market at Aberdeen, and on one or two occasions it was observed to be moderately frequent. I have notes of its occurrence on the following fishes:—The grey skate, *Raia batis*; the saithe, *Gadus virens*; the torsk, *Brosmius brosme*; and the conger, *Conger vulgaris*. The *Cirolana* were observed on the saithe in June, and on the conger in October, and on the other two species of fishes during the intervening months.

(3) Amphipoda Parasita.

There are only two Amphipods to which I wish to refer, viz. :—

Callisoma crenata, Spence Bate.

So far as I have been able to study the habits of this Amphipod, it seems to be a species whose energies are devoted for the most part to the removal of dead and decaying animal matter, rather than the destruction of living tissue. It would seem, however, that it does not confine its

operations to decaying animal matter, but is ready to attack living organisms should there be a favourable opportunity for doing so. In October last, when examining some specimens of *Galeus canis* in the Fish Market at Aberdeen, which had just been landed from one of the trawlers, a large male was observed to be infested with small amphipods. These amphipods belonged to the species named above—*Callisoma crenata*. It was found, on the closer examination of the fish, that the amphipods had penetrated the skin at the base of and immediately behind the claspers, and were burrowing in crowds in the hole they had formed. The skin and flesh of the fish appeared to be much injured by the parasites. Specimens of the same kind of fish were on one or two subsequent occasions observed to be similarly infested with the *Callisoma*.

Laphistius sturionis, Kröyer.

This Amphipod has been observed adhering to the cod, and also to the back of the angler, *Lophius piscatorius*, but only on the surface of the skin, and not, like *Callisoma*, burrowing in the flesh of the fish. *Laphistius* has been obtained as a parasite in the Firth of Forth and in the Firth of Clyde.

The following list contains the names of fishes on which the crustaceans, recorded in the preceding notes, were found :—

List of Fishes on which Copepod-Parasites have been Found.

Scientific names.	Common names.
Trigla lineata, Gmelin.	The Streaked Gurnard.
Trigla cuculus, Linn.	The Red Gurnard.
Trigla lucerna, Linn.	The Sapphirine Gurnard.
Trigla gurnardus, Linn.	The Grey Gurnard.
Agonns cataphractus, Linn.	The Pogge.
Zeus faber, Linn.	The John Dory.
Lophius piscatorius, Linn.	The Angler.
Gobius minutus, Gmelin.	The Spotted Goby.
Callionymus maculatus (Bonap.).	The Spotted Dragonet.
Cyclopterus lumpus, Linn.	The Lump-Sucker or Cockpaidle.
Anarrhichas lupus, Linn.	The Cat, or Wolf-fish.
Gasterosteus aculeatus, Linn.	The Three-spined Stickleback.
Gasterosteus spinachia, Linn.	The Fifteen-spined Stickleback.
Gadus callarius, Linn.	The Cod.
Gadus æglefinus, Linn.	The Haddock.
Gadus minutus, Linn.	The Poor or Power-cod.
Gadus merlangus, Linn.	The Whiting.
Gadus virens, Linn.	The Cod-fish or Saithe.
Gadus pollachius, Linn.	The Pollack or Lythe.
Merluccius vulgaris, Cuv.	The Hake.
Molua molva, Linn.	The Ling.
Onos (*Motella*) *cimbrius*, Linn.	The Four-bearded Rockling.
Brosmius brosme, Cuv.	The Torsk or Tusk.
Hippoglossus vulgaris (Flem.).	The Halibut.
Drepanopsetta platessoides.	The Long-Rough Dab.
Bothus (*Rhombus*) *maximus*, Linn.	The Turbot.
Bothus rhombus, Linn.	The Brill.
Pleuronectes platessa, Linn.	The Plaice.
Pleuronectes microcephalus, Don.	The Lemon Dab. Lemon Sole.
Pleuronectes cynoglossus, Linn.	The Pole Dab. Witch Sole.
Pleuronectes limanda, Linn.	The Common Dab.

LIST OF FISHES ON WHICH PARASITES HAVE BEEN FOUND—*continued.*

Scientific names.	Common names.
Pleuronectes flesus, Linn.	The Flounder.
Solea vulgaris, Quen.	The Sole. Black Sole.
Salmo salar, Linn.	The Salmon.
Salmo trutta (Flem.).	The Sea-trout.
Clupea sprattus, Linn.	The Sprat.
Clupea finta, Linn.	The Twaite Shad.
Conger vulgaris, Cuv.	The Conger.
Orthagoriscus mola, Linn.	The Short Sun-fish.
Galeus canis, Linn.	The Tope, or Toper.
Lamna cornubica, Cuv.	The Porbeagle Shark.
Scyllium canicula, Linn.	The Lesser-spotted Dog-fish.
Raia batis, Linn.	The Skate. Grey or Blue Skate.
Raia clavata, Linn.	The Thorny. Thornback Skate.
Raia oxyrhynchus, Linn.	The Long-nosed Skate.
Raia fullonica, Linn.	The Shagreen Ray, Fuller's Ray.
Raia circularis, Couch.	The Cuckoo Ray, Sandy Ray.

The number of fishes in this list is forty-seven. The majority of them have yielded one or two kinds of parasites only, while on a few as many as four and five different species have been obtained. The grey skate has yielded the largest number of parasites of any of the fishes examined, six different kinds having been found on specimens of this species. They comprise *Caligus curtus*, *Trebius caudatus*, *Chondracanthus annulatus*, *Charopinus dalmannii*, *Lernæopoda* sp, and *Cirolana borealis*. The saithe and the torsk come next with five species each. The hake and the toper have yielded four, while three each have been obtained on the common gurnard, the halibut, the turbot, the plaice, the conger, and the sun-fish. Eleven fishes have yielded two, and twenty-six only one species of parasite each.

CONCLUDING REMARKS.

The study of the distribution of these organisms is still being continued, and their habits and development will also form subjects of research as opportunities occur. It is probable that there is scarcely a fish within the Scottish seas, as there doubtless is in other seas, which does not at one time or other during its life harbour one or more crustacean parasites, and this itself furnishes a sufficient reason for the study of these creatures, and in this study more than one interesting problem is still awaiting solution. For example, we find, on the one hand, a species such as *Caligus curtus*, which seems to have no limit to the number of fishes from which to choose an associate for itself; on the other hand, we see a crustacean, such as *Lernæopoda bidiscalis*, which appears to be limited not only to a particular kind of fish, but also to a particular part of that fish. The interest in the difference between these two forms is increased when it is remembered that both in their early stages of life are free-swimming, and that they live in a medium which is favourable to their dispersal over a wide area; moreover, there are fishes of various kinds passing from time to time within easy reach of both during their free-swimming stages. How comes it, then, that in the one case the limit of existence in the adult is so greatly circumscribed, whilst there is almost unlimited scope in the other?

There is, of course, a possible explanation which might to a certain extent account for the difference I have alluded to, and that is that the difference is the product of the *habitat*; in other words, that the animals

were practically the same species, and that the differences observed in their form and structure were simply the result of the difference in the mode of life they had happened to adopt. One might, in support of such an explanation, point to the close resemblance to each other of the young of the so-called different species—a resemblance so close that at this early stage it is difficult even for an expert to decide in some cases which belongs to one species and which to the other.

It must also be admitted that in the adult forms of certain species modifications are observed which have a provoking tendency to bridge over the space that intervenes between one species and another, and which are exceedingly troublesome to the systematist.

Notwithstanding all this, however, the explanation I have referred to can scarcely be considered tenable, except to a very small extent. There are too many difficulties in the way of accepting such an explanation; but it shows that even in a limited subject like that of the parasites of fishes there is still work for the theorist as well as for the student who simply deals with the practical aspect of the study.

DESCRIPTION OF THE PLATES.

PLATE V.

Thersites gasterostei, Pagen.

Fig. 1. Female, dorsal view . . . . . × 40.
Fig. 2. Antennule . . . . . × 380.
Fig. 3. Antenna . . . . . × 253.
Fig. 4. Posterior foot-jaw . . . . . × 833.
Fig. 5. Foot of first pair . . . . . × 253.
Fig. 6. ,, fourth ,, ... × 253.
Fig. 7. Abdomen, dorsal view . . . . . × 127.

Caligus curtus, Müll.

Fig. 8. Female, dorsal view . . . . . × 48.
Fig. 9. Antenna . . . . . × 53.
Fig. 10. Sternal fork . . . . . × 53.
Fig. 11. Second foot-jaw . . . . . × 40.
Fig. 12. Foot of fourth pair . . . . . × 18.

Caligus rapax, M.-Edw.

Fig. 13. Female, dorsal view. . . . . × 7.
Fig. 14. Male ,, ... × 7.
Fig. 15. Mandible . . . . . × 166.
Fig. 16. One of the *palpi*—male . . . . . × 96.
Fig. 17. Sternal fork . . . . . × 80.
Fig. 18. Posterior foot-jaw . . . . . × 40.
Fig. 19. Foot of fourth pair . . . . . × 40.

Caligus diaphanus, Nordm.

Fig. 20. Female, dorsal view . . . . . × 11·4.
Fig. 21. Male ,, ... × 19.
Fig. 22. Mandible . . . . . × 253.
Fig. 23. Sternal fork . . . . . × 160.
Fig. 24. Posterior foot-jaw . . . . . × 80.
Fig. 25. Foot of fourth pair . . . . . × 80.

Lepeophtheirus pectoralis, Müll.

Fig. 26. Female, dorsal view, ... × 7·5.
Fig. 27. Male ,, ... × 16.
Fig. 28. Mandible . . . . . × 253.
Fig. 29. Sternal fork . . . . . × 80.
Fig. 30. Posterior foot-jaw . . . . . × 53.
Fig. 31. Foot of fourth pair . . . . . × 80.

Lepeophtheirus nordmanni (M.-Edw).

Fig. 32. Female, dorsal view . . . . . × 33.
Fig. 33. Antenna . . . . . × 20.
Fig. 34. Mandible . . . . . × 20.
Fig. 35. Sternal fork . . . . . × 20.
Fig. 36. Posterior foot-jaw . . . . . × 20.
Fig. 37. Foot of fourth pair . . . . . × 20.

Lepeophtheirus hippoglossi (Kr.).

Fig. 38. Female, dorsal view . . . . . × 3·7.
Fig. 39. Male ,, ... × 5.
Fig. 40. Mandible . . . . . × 88.
Fig. 41. Foot of fourth pair . . . . . × 9.
Fig. 42. Foot of fifth pair . . . . . × 190.

Lepeophtheirus thompsoni, Baird.

Fig. 43. Female, dorsal view . . . . . × 6·5.
Fig. 44. Sternal fork . . . . . × 80.
Fig. 45. Antenna . . . . . × 53.

PLATE VI.

Lepeophtheirus hippoglossi (Kr.).

Fig. 1. Posterior foot-jaw . . . . . × 26.
Fig. 2. Sternal fork . . . . . × 40.

Lepeophtheirus stromi, Baird.

Fig. 3. Female, dorsal view . . . . . × 4.
Fig. 4. One of the *palpi* . . . . . × 80.
Fig. 5. Sternal fork . . . . . × 53.
Fig. 6. Foot of fourth pair . . . . . × 26.
Fig. 7. Foot of fifth pair . . . . . × 190.
Fig. 8. Newly-hatched specimen . . . . . × 53.

Lepeophtheirus pollachii, Basset-Smith.

Fig. 9. Female, dorsal view . . . . . × 10.
Fig. 10. Male, dorsal view . . . . . × 13.
Fig. 11. Antenna . . . . . × 80.
Fig. 12. Mandible . . . . . × 165.
Fig. 13. Sternal fork . . . . . × 53.
Fig. 14. Second foot-jaw, female . . . . . × 26.
Fig. 15. Foot of fourth pair . . . . . × 26.

Lepeophtheirus (?) *obscurus*, Baird.

Fig. 16. Female, dorsal view . . . . . × 10.
Fig. 17. Antenna . . . . . × 80.
Fig. 18. Sternal fork . . . . . Enlarged.
Fig. 19. Foot of fourth pair . . . . . × 53.

Trebius caudatus, Kr.

Fig. 20. Female, dorsal view . . . . . × 6·6.
Fig. 21. Male ,, ... × 11.
Fig. 22. Antenna . . . . . × 40.
Fig. 23. Sternal fork . . . . . × 80.
Fig. 24. Mandible . . . . . × 103.
Fig. 25. Posterior foot-jaw . . . . . × 40.
Fig. 26. Foot of fourth pair . . . . . × 26.

Dinematura producta (Müll.).

Fig. 27. Female, dorsal view . . . . . × 3·3.
Fig. 28. Antenna . . . . . × 13.
Fig. 29. Mandible . . . . . × 53.
Fig. 30. Anterior foot-jaw . . . . . × 13.
Fig. 31. Caudal furca . . . . . × 5.

Echthrogaleus coleoptratus, Guérin.

Fig. 32. Female, dorsal view . . . . . × 6.

Pandarus bicolor, Leach.

Fig. 33. Female, dorsal view . . . . . × 8.
Fig. 34. Male (?) ,, ... × 7·5.
Fig. 35. Antenna, female . . . . . × 35.
Fig. 36. ,, male . . . . . × 35.
Fig. 37. Foot of second pair, female . . . . . × 18.
Fig. 38. ,, ,, male . . . . . × 26.

Lemargus muricatus, Kr.

Fig. 39. Female, dorsal view . . . . . × 3·3.
Fig. 40. Mandible . . . . . × 53.
Fig. 41. Anterior foot-jaw . . . . . × 13.
Fig. 42. Posterior foot-jaw . . . . . × 12.

PLATE VII.

Clavella hippoglossi, Kr.

Fig. 1. Female, dorsal view . . . . . × 10.
Fig. 2. Antennule . . . . . × 95.
Fig. 3. Antenna . . . . . × 40.
Fig. 4. Mandible . . . . . × 500.
Fig. 5. Posterior foot-jaw . . . . . × 84.
Fig. 6. Foot of first pair . . . . . × 126.

Lernæenicus sprattæ (Sow.).

Fig. 7. Parasite *in situ* on eye of sprat . . . . Natural size.
Fig. 8. Female, dorsal view . . . . . × $7\frac{1}{5}$.
Fig. 9. Antennule . . . . . × 126.
Fig. 10. Antenna . . . . . × 80.

Lernæa branchialis, Lin.

Fig. 11. Female, dorsal view . . . . . × $1\frac{2}{3}$.
Fig. 12. ,, var. . . . . × $1\frac{2}{3}$.

Lernæa minuta, n. sp.

Fig. 13. Female, dorsal view . . . . . × 7.

Hæmobaphes cyclopterina (Fabr.)

Fig. 14. Female, dorsal view . . . . . × 6.

Hæmobaphes ambiguus, n. sp.

Fig. 15. Female, dorsal view . . . . . × 7.

Oralien asellinus (Linn.)

Fig. 16. Female, dorsal view . . . . . × 4·8.
Fig. 17. Antennule . . . . . × 152.
Fig. 18. Mandible . . . . . × 152.

Chondracanthus cornutus (Müll.).

Fig. 19. Female, dorsal view . . . . . × 4·8.
Fig. 20. Antennule . . . . . × 27.
Fig. 21. Antenna . . . . . × 40.
Fig. 22. Mandible . . . . . × 84.
Fig. 23. Anterior foot-jaw . . . . . × 126.
Fig. 24. Male, dorsal view . . . . . × 53.
Fig. 25. Foot of first pair . . . . . × 250.
Fig. 26. Foot of second pair . . . . . × 250.
Fig. 27. Female, dorsal view, var. . . . . × 4·8.
Fig. 28. Antennule . . . . . × 35.
Fig. 29. Mandible . . . . . × 123.
Fig. 30. Foot of second pair . . . . . × 760.
Fig. 31. Foot of first pair . . . . . × 760.

Chondracanthus fluræ, Kr.

Fig. 32. Female, dorsal view . . . . . × 6.
Fig. 33. Antennule . . . . . × 35.
Fig. 34. Mandible . . . . . × 84.

Chondracanthus clavatus, Basset-Smith.

Fig. 35. Female, dorsal view . . . . . × 6·4.
Fig. 36. Antennule . . . . . × 35.
Fig. 37 Mandible . . . . . × 84.

Chondracanthus limandæ, Kr.

Fig. 38. Female, dorsal view . . . . . × 12.
Fig. 39. Antennule . . . . . × 80.
Fig. 40. Mandible . . . . . × 250.

Chondracanthus soleæ, Kr.

Fig. 41. Female, dorsal view . . . . . × 6·4.
Fig. 42. Antennule . . . . . × 40.
Fig. 43. Mandible . . . . . × 126.
Fig. 44. Antennule, male . . . . . × 380.
Fig. 45. Foot of second pair . . . . . × 380.

Chondracanthus annulatus, Olsson.

Fig. 46. Female, dorsal view . . . . . × 4.
Fig. 47. Male ,, ... × 40.
Fig. 48. Antennule, female . . . . . × 84.
Fig. 49. Mandible ,, ... × 126.
Fig. 50. Antennule, male . . . . . × 380.
Fig. 51. Antenna ,, ... × 190.

PLATE VIII.

Chondracanthus zeus, De la Roche.

Fig. 1. Female, dorsal view . . . . . × 3·7.

Thysanote impudica (Nordm.).

Fig. 2. Female, dorsal view . . . . . × 9·6.
Fig. 3. Mandible . . . . . × 250.
Fig. 4. Maxilla . . . . . × 250.
Fig. 5. Anterior foot-jaw . . . . . × 80.

Charopinus dalmanni (Retz.).

Fig. 6. Female, dorsal view . . . . . × 1·3.
Fig. 7. Male, side view . . . . . × 14.
Fig. 8. Antenna . . . . . × 168.
Fig. 9. Mandible . . . . . × 127.
Fig. 10. Maxilla . . . . . × 127.

Lernæopoda elongata (Grant).

Fig. 11. Female, dorsal view . . . . . × 4·7.
Fig. 12. Antenna . . . . . × 53.
Fig. 13. Mandible . . . . . × 80.
Fig. 14. Maxilla . . . . . × 80.
Fig. 15. Anterior foot-jaw . . . . . × 40.

Lernæopoda galei, Kr.

Fig. 16. Female, side view . . . . . × 4.
Fig. 17. Male, side view . . . . . × 16.
Fig. 18. Antennule, female . . . . . × 126.
Fig. 19. Antenna, ,, ... × 20.
Fig. 20. Mandible . . . . . × 126.
Fig. 21. Maxilla . . . . . × 126.
Fig. 22. Anterior foot-jaw, female . . . . . × 53.
Fig. 23. Anterior foot-jaw, male . . . . . × 64.
Fig. 24. Posterior foot-jaw, ,, ... × 64.
Fig. 25. Abdomen, ,, ... × 26.

Lernæopoda salmonea (Gisler.).

Fig. 26. Female, dorsal view . . . . . × 6.

Lernæopoda cluthæ, n. sp.

Fig. 27. Female, side view . . . . . × 10.
Fig. 28. ,, dorsal view . . . . . × 7·5.
Fig. 29. Male, side view . . . . . × 42.
Fig. 30. Antennule, female . . . . . × 195.
Fig. 31. Antenna . . . . . × 195.
Fig. 32. Mandible . . . . . × 380.
Fig. 33. Maxilla . . . . . × 380.
Fig. 34. Anterior foot-jaw . . . . . × 80.
Fig. 35. Anterior foot-jaw, male . . . . . × 95.
Fig. 36. Posterior foot-jaw ,, ... × 95.
Fig. 37. Abdomen ,, ... × 53.

Brachiella rostrata, Kr.

Fig. 38. Female, dorsal view . . . . . × 4·7.
Fig. 39. Male, side view . . . . . × 18.

Brachiella insidiosa, Heller.

Fig. 40. Female, dorsal view . . . . . × 3·5.
Fig. 41. Male, side view . . . . . × 9·6.

Brachiella merluccii, Bassett-Smith.

Fig. 42. Female, side view . . . . . × 5·3.

Anchorella uncinata (Müll.).

Fig. 43. Female, side view . . . . . × 3·8.
Fig. 44. Male, side view . . . . . × 64.

Anchorella rugosa, Kr.

Fig. 45. Female, side view . . . . . × 3·8.
Fig. 46. Male, side view. . . . . × 32.
Fig. 47. Mandible . . . . . × 380.
Fig. 48. Maxilla . . . . . × 190.

Anchorella emarginata, Kr.

Fig. 49. Female, side view . . . . . × 11·4.
Fig. 50. Maxilla . . . . . × 380.
Fig. 51. Mandible . . . . . × 380.

Anchorella (?) rugosa, var.

Fig. 52. Female, side view . . . . . × 3·8.