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A MONOGRAPH

OF THE

FREE AND SEMI-PARASITIC

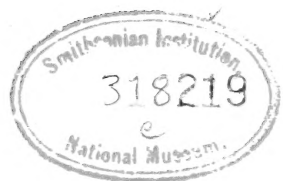
COPEPODA OF THE BRITISH ISLANDS.

BY

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A MONOGRAPH

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INTRODUCTION.

SINCE the publication, by the Ray Society in 1850, of Dr. Baird's work on the 'British Entomostraca,' much has been done by various authors in this country as well as on the Continent of Europe and in America, to extend our knowledge not only of the morphology and physiology of the group, but also of its distribution, both fossil and recent. Dr. Baird's work admirably fulfilled its purpose of gathering together what was at that time known of the British species, a very large amount of this knowledge being derived from the painstaking researches of the author himself. And though now of necessity somewhat obsolete owing to the continued labours of more recent collectors, no one who has studied the 'British Entomostraca' can fail to have been largely indebted to Dr.

Baird's work, which must always take rank among the classics of natural history.

The number of species of non-parasitic Copepoda noticed by Dr. Baird is thirteen, since which time several species, both fresh-water and marine, have been described by Sir John Lubbock, the Rev. Alfred Merle Norman, the late H. Goodsir, and by myself both singly and in conjunction with my friend, Mr. David Robertson, of Glasgow. The species comprised in this Monograph will number, so far as at present appears, one hundred and fifty-one.

The truly parasitic forms—fish-lice, &c., are excluded as not coming within the scope of my work. They are of themselves sufficient to occupy an independent volume, and to afford abundant work to any naturalist whose time and opportunities allow of his taking them in hand.

The researches of recent German writers—especially of Dr. Claus—on the physiology, minute anatomy, and embryology of the Entomostraca, are so full and exhaustive, that anything I could have said on those subjects would have been a mere epitome of what can be better studied in the works of those authors. I have, therefore, in the following pages, confined my descriptions to the external form, not travelling into details of physiological anatomy except so far as necessary for purposes of classification and specific description.*

I have not thought it needful to give exhaustive

* I hope, however, in an introduction to the second volume, to give a brief outline of the state of our knowledge on these subjects.

lists of specific synonyms, this, in the case of species known to the older authors having been excellently done by Dr. Baird. I have, however, given as fully as possible references to the descriptions of more recent observers, and when practically useful, also to those of older date, omitting such only as seemed to be of slight or merely literary interest. A list of the memoirs from which these details are taken is printed at p. 27.

The great majority of the Copepoda are free swimming species, a considerable number, however, being truly parasitic and living suctorially on the juices of Fishes, Annelids, Crustacea, and other aquatic animals. These do not enter into the scope of the present work. Another group, which may be called semi-parasitic, is found living (not suctorially nor attached in any way to the body of the host, but moving freely) in the cavities of various marine animals, notably in those of Ascidians, both simple and compound. The genera *Notodelphys*, *Botachus*, *Ascidicola*, *Doropygus*, *Lichomolgus*, and *Notopterophorus* are among the most important of this group. M. Hesse, of Brest, has closely studied these animals, and has described many species; as also have MM. Claparède, T. Thorell, Van Beneden, and others. Some species have also been found, perhaps living suctorially—though this is open to doubt—on the outer surfaces of sponges, sea-urchins, and star-fishes; to this list belong some members of the genus *Artotrogus*. These semi-parasitic Copepoda exhibit for the most part a transitional condition of the mouth organs, inter-

mediate between the true biting and chewing apparatus of the free swimming species, and the true suctorial mouth of the fish-lice and other thorough-going parasites. From a consideration of these peculiarities M. Thorell has proposed to arrange the Copepoda under three sections—*Gnathostoma*, *Pæcilostoma*, and *Siphonostoma*—which arrangement though adopted by Claparède and others is rejected by Claus chiefly, as it appears, owing to a difference of opinion as to the homologies of the various mouth organs. In this work I adopt the three divisions proposed by M. Thorell, because whatever opinion may be held as to the nature of the component parts of the mouth apparatus, each division seems to represent a well-marked natural group. Some remarks on this part of the subject will be found at greater length under the definition of the group *Pæcilostoma*.

Throughout the whole class Crustacea the mouth organs, and other cephalic appendages, are liable to the most profound modification according to the needs and circumstances of particular groups, and on this account the conformation of these parts offers a most natural and trustworthy guide to classification. In no order is this more conspicuously the case than in the Copepoda, which, from the lowest and absolutely inactive Epizoa,* to the most agile and highly organised of the free swimming Calanidæ, offer an endless variety of structure. So rudimentary, indeed, in development, are some of the lower Epizoa,

* These, however, are often separated from the Copepoda to form an independent order.

that without the evidence derived from the study of their embryology, and the successive phases of their life history, it would be impossible to assign them with any certainty to the place which they are now held rightly to occupy in the scheme of nature. And though none of the species which form the subject of the present Monograph, differ so widely as this, one from another, there yet exist variations of great interest pointing to very decided differences in mode of life. Next to the mouth organs, the anterior antennæ and the first and last pairs of swimming feet exhibit the most important variations of structure, the distinctive peculiarities of these parts being mostly connected with the sexual function, and therefore most fully developed in the male sex. The anterior antenna, which in the female is usually a simply-jointed, slender, tapering limb, in the male not unfrequently becomes partially swollen, nodose, hinged, or provided with serrated plates for the purpose of affording a more efficient grasp of the female, these modifications occurring sometimes in one antenna only, as in many Calanidæ, sometimes in both, as in Cyclopidæ. The modifications of the fifth pair of feet are very various; in some of the Calanidæ they become very powerful auxiliary clasping organs, but more generally they are quite rudimentary in both sexes (Cyclopidæ), while in most Harpacticidæ, though rudimentary in the male, they are usually somewhat more largely developed in the female, where they are foliaceous in character and appear to act as a support or protection to the external ovisac.

The colouring of the Copepoda varies very considerably, as does that of many larger Crustacea, with that of their food material and of the vegetation amongst which they live; a large number of the oceanic species are translucent and almost colourless, but one of these — *Anomalocera Patersonii* — often exhibits wonderfully brilliant tints of blue, red, and green; *Peltidium interruptum*, which is also chiefly an oceanic species, is constantly of a deep reddish-brown colour, and almost all the flat-bodied species (Peltidiidæ, Claus) are banded to some extent, sometimes very gorgeously, with shades of red or purple; the same may be said of some few species of Harpacticidæ, notably of *Thalestris rufocincta*, Norman, *T. longimana*, Claus, *T. rufoviolascens*, Claus, and *Westwoodia nobilis*, Baird. The colours of most of these are given as faithfully as possible in the plates illustrating the various species. The usual colour of the marine Copepoda, however, is a transparent yellowish brown or straw colour, against which the eye shows as a spot of brilliant ruby red, the internal digestive and glandular organs often being apparent as patches of a darker brown. The ovisacs, especially in some fresh water species, not unfrequently exhibit characteristic tints of blue, brown, or green; but the colouring of the inhabitants of fresh water seems to vary remarkably according to the locality and nature of food. Thus, *Diaptomus Castor*, Jurine, is usually of some shade of light brown, often with bluish ovisacs; but in an elevated Westmorland tarn I have found it of a brilliant vermilion red; and in peaty pools of no very

great elevation I have noticed *Cyclops serrulatus* to assume a deep brownish-red colour. Similar instances of variation might be noted in respect of many other species. It is, nevertheless, very remarkable that in many gatherings of Copepoda, the various species (or at least some of them) may be unerringly picked out by attending to the characters of colour only, and, indeed, this is practically often by far the readiest way of separating species under the low magnifying power of a hand-lens.

Amongst the non-parasitic Copepoda there is very great diversity of habit. Many of the marine species pass their life apparently near the surface of the open sea, and some of these—such as *Calanus finmarchicus*, Gunner, and *Anomalocera Patersonii*, Templeton, are frequently found in immense profusion, the first-named species having been said to form a very important part of the food of the Greenland whale, and it is remarkable that in the Arctic Seas not only do the Entomostraca attain an enormous development in point of members, but also in individual size; Arctic specimens, for example, of *Calanus finmarchicus* and *Metridia armata* being many times the bulk of those taken in our own latitude; the same observation is well known to hold good in respect of the higher Crustacea, Amphipods, &c., as has been pointed out to me by the Rev. A. M. Norman. A large number of species haunt almost exclusively the forests of Laminariæ which grow on rocky coasts, at and below low-water mark; the fronds of *Laminaria saccharina* in particular are the favourite abode of many species,

more especially of the flat-bodied *Porcellidiinæ* and their allies, which appear to find shelter in the numerous inequalities of its rugose fronds. Amongst the groves of smaller algæ with which tidal rock-pools are often so densely overgrown, Copepoda are always to be found in abundance, but though I have paid particular attention to the matter I have not found that the different species have any particular preferences as to the kinds of weeds which they haunt; it is probable that shelter rather than food is the reason of their liking for these marine forests. The brackish water of salt marshes and small estuaries sustains a peculiar Entomostracan fauna, the most characteristic members of which, amongst the Copepoda, are *Temora velox*, Lilljeborg, *Tachidius brevicornis*, Müller, and, less commonly, *Cyclops insignis*, Claus, *Nannopus palustris*, Brady, *Platychelipus littoralis*, Brady, *Mesochra Lilljeborgii*, Boeck, and *Delavalia palustris*, Brady; with these there is usually associated a peculiar group of Ostracoda, *Cythere castanea*, Sars, *Cytheridea torosa*, Jones, *Loxoconcha elliptica*, Brady. The Malacostraca, Foraminifera, and other branches of the fauna of such localities present likewise features of great interest, but it is impossible here to enter fully into the consideration of the subject; the reader who desires further information is referred to the papers mentioned below.* Pools of sea water above, or at

* "On the Crustacean Fauna of the Salt Marshes of Northumberland and Durham," by G. S. Brady, C.M.Z.S. ('Natural History Transactions of Northumberland and Durham,' vol. iii). "On the Ostracoda and Foraminifera of Tidal Rivers," by G. S. Brady, C.M.Z.S., David Robertson, F.G.S., and H. B. Brady, F.L.S. ('Annals and Magazine of Natural History,' ser. 4, vol vi, 1870). "On the Zoology of

the extreme limit of high water mark, are very frequently tenanted by a single species, *Harpacticus fulvus*, Fischer, which is very rarely to be met with in more purely marine situations. The bed of the sea, down to the extreme depths attainable round the British Islands, is inhabited by numerous Copepoda; on sandy bottoms the most abundant species are *Longipedia coronata*, Claus, and *Ectinosoma spinipes*, Brady, but Copepoda of some kind are found in greater or less abundance on all sorts of bottoms. One exception must be made to this statement; in various hauls from a bottom of slimy argillaceous mud, the product of the *débris* of disintegrating felspar rocks, taken from a depression of the depth of fifteen to twenty-five fathoms at the north end of Mulroy Lough, County Donegal, Mr. Robertson and myself could not detect one trace of life of any kind. The beds of fresh water lakes seem to be very sparsely populated with Copepoda, and as to swimming species it may, as a general rule be said that the weedier the pool and the smaller its extent, the more abundant in all probability, the Entomostraca.

A few words as to the best modes of collecting Copepoda will not be out of place here. In the case of tidal marine pools and small fresh water ponds, such as may easily be fished from the edge, a common ring net fitted with a muslin bag and attached to the end of a walking stick will answer every purpose. This may be worked to and fro amongst the weeds

Hylton Dene," by George S. Brady ('Transactions of the Tyneside Naturalists Field Club,' vol. vi).

or in the clear water, and the results, when cleared from coarse *débris* and extraneous materials, may either be put at once into spirit or, if it is wished to keep the Entomostraca alive, into water, fresh or salt as the case may be. Marine surface-swimmers may be taken in a similar way by working the net from the side of a boat, or a tow net may be thrown over and attached to the boat by a cord. A tow net put overboard from a vessel anchored for the night in a tide-way will often be found in the morning to have made good captures. And it may be noted that surface net gatherings made during the hours of dusk or darkness are commonly of much greater interest than those taken in daytime; it seems certain that many marine Crustacea which are found near the surface at night recede towards the bottom on the approach of daylight. Some of the pleasantest and most profitable hours which I have ever spent have been when, after a day's dredging, I have set out at sunset on a quiet boating excursion for the purpose of capturing such prey as could be got in the surface net. Many hours of this kind spent in the company of my old friend Mr. David Robertson, amongst the Scilly Islands, on the Firth of Clyde, on the sheltered bays of Roundstone and Westport, or on the stormier coasts of Northumbria will long live in my memory, not only by their results in the acquisition of valuable specimens, but as times of unalloyed delight in the contemplation of nature under a different guise from that in which we usually see her.

The washing of fronds and roots of *Laminariæ*,

which may be dragged up by means of the hooked grapnels used on many coasts by kelp burners, often affords multitudes of Copepoda. The weeds should be washed by agitation in a large tub of sea water, and when the operation is completed, the water, after being allowed sufficient time—a few seconds only—for the subsidence of coarse material, is to be poured off through a muslin net, on which the Copepoda, and probably numerous other swimming animalcula, will be intercepted. These may be cleaned while in the net by repeated douches of sea water. The products of the dredge, sand, mud, gravel, shells, &c., should be treated in a similar manner before being thrown overboard. I have no doubt that this method of procedure offers by far the best chance of extended acquaintance with the microscope life of the sea bed, and that numberless new species and interesting forms of life may be discovered by its means.

The preservation of specimens is probably best effected by alcohol in the form of rectified or methylated spirit, but this agent has the disadvantages of destroying many colours, and of rendering the animals opaque by coagulating their albuminous tissues. Still, among the numerous solutions which have from time to time been recommended none are on the whole so convenient or efficient. Perhaps the next best is a solution of chloral hydrate (twelve grains to a fluid ounce) in camphor water. As microscopic preparations, Copepoda are best mounted in some gelatinous medium containing a very small quantity of glycerine. Treated in this way mountings will keep in perfect

condition for many years—eternally for anything I know to the contrary—without the trouble of cementing round the edges of the glass cover. The formula which I habitually use is given below.* Before dissecting Copepoda for microscopic examination they should be macerated for a few hours in a solution of caustic potash; the fatty and granular tissues are by this means removed and the details of structure rendered clearly visible; the dissection is easily performed under the microscope with fine needles, either with or without the help of an erector.

The nomenclature of the body segments and appendages of the Copepoda, as of the Crustacea in general, has been somewhat confused by the variety of terms applied to the same part by different authors. It is, therefore, necessary to explain the application of the terms which I have here adopted. This will be understood by an examination of the table, at p. 14, which shows the names used by some recent writers on the Entomostraca for the appendages of the first

* Take any quantity of Nelson's gelatine, and let it soak for two or three hours in cold water which has previously been saturated with arsenious acid; pour off the superfluous water, and heat the soaked gelatine until melted. To each fluid ounce of the gelatine add one drachm of alcohol and mix well; then add a fluid-drachm of the white of an egg; mix well while the gelatine is fluid, but cool. Now boil until the albumen coagulates and the gelatine is quite clear. Filter through fine flannel, and to each fluid ounce of the clarified gelatine add six fluid drachms of Price's pure glycerine, and mix well. ('Carpenter's Microscope and its Revelations,' 3rd edition, p. 775.)

It is worth notice that this preparation is injurious to calcareous structures, such, for instance, as the spicules of Echinodermata, these being in a comparatively short time completely dissolved by the glycerine. If used for preparations of this kind the glycerine should be omitted.

twelve (cephalothoracic) somites. The abdominal segments in the Copepoda have no limb-like appendages.

The preparation of this Monograph has involved labour extending over several years, and in now bringing that labour to a close I must express my warmest thanks to all who have lent me their aid during the progress of my work. Especially are my acknowledgments due to Mr. David Robertson to whom for kind and ever active help during many pleasant excursions, as well as for gifts of numerous valuable gatherings of Copepoda, I am very largely indebted; to the Rev. Alfred Merle Norman who with unvarying kindness and liberality has placed his valuable collections at my disposal, to Mr. E. C. Davison, R.N., of Sunderland, for many very interesting collections made during the voyages of the "Porcupine" and at other times; to Sir John Lubbock, Dr. Claus, and M. T. Thorell for their liberal communication of information and specimens.

Nomenclature of Appendages of Cephalothoracic Somites.

Number of Body-segment.	Milne-Edwards, 1840.	Baird, 1849.	Baird, 1852.	Thorell, 1859. Sars, 1863. Lilljeborg, 1853.	Lubbock,* 1856.	Boeck, 1864.	Claus,* 1863. Brady, 1878.
† I	Ant. de la 1 ^{re} pr.	Superior tenna.	1 st pair an-tenna.	—	—	—	—
II	Ant. de la 2 ^{me} pr.	Antennule inférieure tenna.	2 nd pair an-tenna.	1 st or anterior antenna.	1 st antenna.	1 st antenna.	Anterior antenna.
III	Mandibules. Pâtes mâchoires de la 1 ^{re} pr.	Mandibles. Mandibles. 1 st foot-jaws.	Mandibles. Maxilla.	2 nd or posterior antenna.	2 nd or posterior antenna.	2 nd "	Posterior antenna.
IV	" 2 ^{me} pr.	2 nd "	2 nd "	2 nd "	Mandibles. 1 st maxilla.	Mandibles. Maxilla.	Mandibles. Maxilla.
V	" 3 ^{me} pr.	3 rd "	1 st pair of feet. 2 nd "	3 rd "	2 nd "	1 st foot-jaws.	Anterior foot-jaws.
VII	Pâtes de la 1 ^{re} pr.	1 st pair of feet. 2 nd "	1 st pair of feet. 2 nd "	1 st pair of feet. 3 rd "	Maxillipeds. 1 st pair of feet.	2 nd "	Posterior "
VIII	" 2 ^{me} pr.	2 nd "	2 nd "	2 nd "	2 nd "	1 st pair of feet.	1 st pair of feet.
IX	" 3 ^{me} pr.	3 rd "	3 rd "	3 rd "	2 nd "	2 nd "	2 nd "
X	" 4 ^{me} pr.	4 th "	4 th "	4 th "	3 rd "	3 rd "	3 rd "
XI	" 5 ^{me} pr.	5 th "	5 th "	5 th "	4 th "	4 th "	4 th "
XII	" 6 ^{me} pr.	6 th "	6 th "	6 th "	5 th "	5 th "	5 th "

* The terms used by Dr. Claus are not invariably as here stated; he uses interchangeably the words *first*, *superior*, *anterior*; and *second*, *inferior*, *posterior*. For myself, I think *anterior* and *posterior* the better terms where they apply to a series of two limbs only, as in the antenna and foot-jaws. Sir John Lubbock also sometimes uses the terms first, second, and third maxillipeds instead of first and second maxilla and maxillipeds as given in the foregoing table.

† Ophthalmic somite supporting eyes.

CLASSIFICATION.

THE sub-kingdom Annulosa, to which the Crustaceans belong, is, according to the commonly accepted arrangement, one of the primary divisions, and in the number of its members by far the largest division, of the animal kingdom. Its most conspicuous character is that which is expressed by the term *annulose*, its members being composed of a variable number of more or less distant rings or body-segments (technically termed *somites*), arranged in longitudinal series, one behind the other. Besides the CRUSTACEA, a group of which forms the subject of the present memoir, it contains several other important classes, the most familiar of which are the ANNELIDA (worms and leeches), ARACHNIDA (mites and spiders), and the INSECTA.

The CRUSTACEA, in their typical forms, are very distinctly segmented, the number of somites being variously reckoned at twenty or twenty-one; some of this number of segments are, however, in almost all cases suppressed, and not recognisable except theoretically. Some or other of the somites almost always carry appendages adopted for mastication, locomotion,

and other purposes; and respiration is usually carried on by means of branchiæ or gills. There is always an external skeleton or "crust" composed of a hard calcareous or a more flexible "chitinous" material, from which investment the class derives its name. All, or almost all, the Crustacea pass through a series of metamorphic changes before reaching maturity.

The Crustacea are divided into several sub-classes, the most important of which are the CIRRIPIEDIA or Barnacles; MALACOSTRACA, including such animals as crabs, lobsters, shrimps, sandhoppers, and woodlice; and the ENTOMOSTRACA, one order of which forms the subject of this monograph. The Entomostraca are mostly very minute animals, the vast majority of living species varying between one fifth and one fiftieth of an inch in length. Some, however, are much larger, reaching a length of an inch or an inch and a half. The Entomostraca are somewhat difficult to define in a way at once accurate and characteristic. The following is Professor Huxley's statement:—"In the Entomostraca, if the body possesses an abdomen (reckoning as such the somites which lie behind the genital aperture), its somites are devoid of appendages. Moreover, the somites, counting that which bears the eyes as the first, are more or fewer than twenty. There are never more than three pairs of gnathites. The embryo almost always leaves the egg in the condition of a *Nauplius*; that is, an oval body, provided with two or three pairs of appendages, which become converted into antennary organs and gnathites in the adult. This division of the Entomostraca comprises the

Copepoda, the *Epizoa*, the *Branchiopoda*, the *Ostracoda*, and the *Pectostraca*.

“The COPEPODA.—In these *Entomostraca*, which come nearest to the *Eurypteridæ*, the cephalic shield, which is discoidal and not folded longitudinally, is succeeded by a certain number of free thoracic and abdominal somites. The antennules and antennæ are large, and, as in the *Eurypteridæ*, are organs of locomotion and sometimes of prehension. The anterior thoracic members are converted into foot-jaws; the posterior serve as paddles, the limbs of each pair being often united together in the median line, as in *Limulus*. The embryo leaves the egg as a *Nauplius*.”

CHARACTERS OF FAMILIES.

1. **CALANIDÆ.**—Body elongated; abdomen distinct from thorax; anterior antennæ long, 24- or 25-jointed, that of the male, on the right side only, partially thickened and geniculated; posterior antennæ large, and usually 2-branched; mandible-palp usually 2-branched. Both pairs of foot-jaws large and well developed, many jointed, marginally setiferous. First four pairs of feet 2-branched, outer branches 3-jointed; fifth pair similar to the foregoing pairs, or much modified (especially in the male) and unlike on the two sides. Ovisac single.

2. **MISOPHRIIDÆ.**—Like *Calanidæ*, but that the anterior antennæ are composed only of 7—18 joints, and are much shorter than the cephalothorax; robust, and in general build decidedly cyclopoid.

3. **CYCLOPIDÆ.**—Cephalothorax ovate and usually much more robust than the abdomen; anterior antennæ seldom longer than the cephalothorax; those of the male alike on both sides and modified for the purpose of clasping; posterior antennæ unbranched. Palps of mandibles and maxillæ usually well-developed. Foot-jaws mostly less developed than in *Calanidæ*. First four pairs of feet as in *Calanidæ*; fifth pair rudimentary, alike in both sexes, and usually 1-jointed. Ovisacs two.

4. **NOTODELPHYIDÆ.**—Fourth and fifth body-segments of the female usually coalescent, swollen dorsally to form a matrix or covering for the ova after their passage from the ovarium. Anterior antennæ short, 5—15-jointed; posterior unbranched, 3-jointed. Mandible-palp 2-branched. Foot-jaws and swimming-feet like those of *Cyclopidæ*. Fifth pair of feet rudimentary or altogether absent. No external ovisac.

5. **BUPRORIDÆ.**—Body pouch-like, not distinctly segmented. Antennæ rudimentary, anterior 2- or 3-, posterior 1- or 2-jointed. No mandible-palp. Mouth-organs minute; maxillæ and foot-jaws short, broad, and adapted for chewing or grasping. Feet very small, papilliform, 2-branched; no external ovisac; abdomen very small, furcate. All the appendages of the body very small and imperfectly developed.

6. **HARPACTICIDÆ.**—Body sometimes complanate, but usually cylindrical; abdomen not sharply separated from the thorax. Anterior antennæ short, 4—10-jointed, length scarcely exceeding that of the first

somite; those of the male modified on both sides, so as to form clasping organs. Posterior antennæ 2—4-jointed, bearing a small secondary 1—4-jointed branch. Mandibles provided with a palp, which may be either simple and very minute or larger and 2-branched. Maxillæ composed of a setiferous grasping segment and a more or less complex laminar palp. First pair of foot-jaws jointed, with several marginal setiferous processes; second pair usually (not always) forming a strong prehensile hand. First four pairs of swimming-feet 2-branched, first pair usually unlike the rest, and converted into a prehensile apparatus; second, third, and fourth pairs alike or nearly so, and adapted for swimming; fifth pair foliaceous, larger in the female. Ovisac single, very rarely double.

7. *CORYCÆIDÆ*.—Body subpyriform; abdomen elongated, much narrower than the cephalothorax. Anterior antennæ 5—7-jointed, alike in both sexes, short; posterior simple, 3—4-jointed, forming a strongly clawed, prehensile hand. Mandibles, maxillæ, and first pair of foot-jaws minute, destitute (or nearly so) of palps. Posterior foot-jaws prehensile, and, in the male, powerfully clawed. First four pairs of feet adapted for swimming, 2-branched. Fifth pair rudimentary, alike in both sexes, rarely absent. One median eye, and usually two large simple lateral lenses. Ovisacs usually two.

8. *SAPPHIRINIDÆ*.—Body either elongated and subpyriform or broadly ovate and complanate; cephalothorax subovate and much broader than the abdomen, which may be either broad or elongated and subpyriform. Anterior antennæ 5—7-jointed, alike in the two sexes; posterior simple, clawed or setose at the apex; mandibles small, subulate, or very feebly dentate; maxillæ small, and attached to the base of, or near to, the mandible. First pair of foot-jaws setiferous at apex; second pair clawed in both sexes, but much more strongly in the male. First four pairs of feet 2-branched and adapted for swimming; fifth pair small, usually 1-jointed. Ovisacs two.

9. *ARTOTROGIDÆ*.—Body broad, complanate; abdomen short, but distinctly separated from the cephalothorax. Anterior antennæ short, 9—20-jointed, those of the male often modified to a small extent for clasping; posterior short, 3—4-jointed, secondary branch (when present) 1-jointed. Mouth produced into a short bell-shaped, or into a long, tubular siphon. Mandibles stilet-shaped, simple or provided with a slender, filiform palp; maxillæ composed usually of two setiferous digits; first and second pairs of foot-jaws simple, 2—4-jointed, strongly clawed at the apex. First four pairs of feet 2-branched (fourth pair rarely 1-branched); fifth pair rudimentary or wanting.

SYNOPSIS OF THE GENERA.

Fam. I.—CALANIDÆ.

alike or nearly alike in both sexes, inner branch of first pair of swimming feet	three-jointed; feet of fifth pair	{ like the preceding, two branched.....	.....	<i>Calanus.</i>
			{ unlike the rest; prehensile	<i>Metridia.</i>
one-jointed.....	three-jointed; of second, third, and fourth pairs	{ three-jointed, outer branch of fifth pair of feet in male	.....	<i>Pseudocalanus.</i>
			{ two-jointed; mandible palp	{ prehensile { non-prehensile { composed of two branches..... { composed of one branch.....	.....Centropages. .....Isias. .....Anomalocera. .....Parapontella.
dissimilar in the two sexes; that of the right side in the male more or less distinctly hinged, inner branch of first pair of swimming feet	two-jointed; of second pair	{ three-jointed.....	.....	<i>Diaptomus.</i>
			{ rudimentary	{ styliform, two-toothed { of normal size; mandibles { dilated, many-toothed; inner branch of posterior antenna .....	.....Dias. .....Candace. } many jointed } } one- or two-jointed } .....Temora. .....Pontella.

Anterior antennae 24—25-jointed,

Fam. 2.—MISOPHRIDÆ.

Anterior antennæ { sixteen—eighteen-jointed; secondary branch of posterior antenna } six-jointed *Misophris*.
 { seven-jointed; secondary branch of posterior antenna } two-jointed *Pseudocyclops*.
 { } four-jointed *Cervinia*.

Fam. 3.—CYCLOPIDÆ.

{ rudimentary, reduced to a tubercle { prehensile; with uncinat terminal claws..... *Thorellia*,
 bearing two branchial filaments. }
 Lower foot-jaw { not prehensile *Cyclops*.

Mandible-palp { many joints *Oithona*.
 { two-branched, secondary branch composed of { one joint, fifth pair { foliaceous *Lophophorus*.
 of feet } two- or three-jointed, cylindrical..... *Cyclopina*.

Fam. 4.—NOTODELPHYIDÆ.

External and internal branches of swimming feet composed of { one branch..... *Doropygus*.
 { two branches; posterior antennæ terminating in { several short setæ..... *Notodelphys*.
 of feet composed of { two stout claws; dorsal margin of cephalo-thoracic segments { simple *Botachus*.
 { } produced into wing-like expansions..... *Notopterophorus*.
 { two joints *Ascidicla*.

Fam. 5.—BUPRORIDÆ.

Contains only one British genus..... *Enterocola*.

Fam. 6.—HARPACTIDÆ.

Synopsis of Sub-families.

{ forming a prehensile clawed hand; anterior foot-jaws	{ bearing marginal setiferous processes, but not forming an uncinatè hand; inner branch of first foot	{ not elongated nor adapted for prehension	{ one-jointed two-jointed three-jointed	{ broad and lamelliform slender	..... <i>Longipediinae</i> (1).
					..... <i>Idyinae</i> (9).
} Posterior foot-jaws	} forming a powerful clawed hand	} and provided with strong, uncinatè apical claws	} one-jointed two-jointed three-jointed	} broad and lamelliform slender	..... <i>Porcellidinae</i> (8).
					..... <i>Amynoninae</i> (3).
					..... <i>Nannopinae</i> (6).
					..... <i>Tachidinae</i> (2).
					..... <i>Harpacticinae</i> (7).
					..... <i>Canthocamptinae</i> (5).
					..... <i>Stenheleinae</i> (4).

Synopsis of Genera.

Sub-fam. 1.—LONGIPEIDIINÆ.

{ three-jointed, inner branch of posterior antenna	{ five- or six-jointed two- or three-jointed; first pair of foot-jaws well developed	..... <i>Zostine</i> .
		..... <i>Longipedia</i> .
} Inner branch of first pair of feet	{ two-jointed five-jointed	..... <i>Ectinosoma</i> .
		..... <i>Bradya</i> .

	Sub-fam. 2.—TACHIDIINÆ.			
Both branches of first pair of feet	{ two-jointed { three-jointed; secondary branch of posterior antenna		.....	<i>Euterge</i> .
		{ one-jointed { two-jointed	.....	<i>Tachidus</i> . <i>Robertsonia</i> .
Contains only one genus	Sub-fam. 3.—AMYMONINÆ.		.....	<i>Amygone</i> .
	Sub-fam. 4.—STENHELIINÆ.			
Inner branch of first pair of swimming feet	{ two-jointed { three-jointed; secondary branch of posterior antenna	{ shorter than outer branch { longer than outer branch	.....	<i>Delavalia</i> . <i>Jonesiella</i> .
		{ small, one-jointed { three-jointed	.....	<i>Ameira</i> . <i>Stenelia</i> .
	Sub-fam. 5.—CANTHOCAMPTIINÆ.			
Mandible-palp	{ unbranched; inner branch of first pair of feet { branched; fifth pair of feet	{ usually elongated, three-jointed (rarely two-jointed); inner branch of fourth pair { elongated, two-jointed, bearing at the apex { shorter than the outer branch, two-jointed; mandible palp	{ two- or three-jointed; ovisacs { composed of one joint only { one strong uncinatè claw { two or more slender setæ { three-jointed { minute, or reduced to a few setæ	{ one <i>Canthocamptus</i> . { two <i>Diosaccus</i> <i>Attheyella</i> <i>Laophonte</i> <i>Mesochra</i> <i>Enhydrosoma</i> <i>Cletodes</i> <i>Tetragoniceps</i> <i>Normanella</i> .

Sub-fam. 6.—NANNOPINÆ.

Outer branch of first pair of feet { two-jointed *Platychelipus*.
 three-jointed *Nannopus*.

Sub-fam. 7.—HARPACTICINÆ.

First pair of swimming-feet having { two-jointed *Harpacticus*.
 both branches { three-jointed; middle joint of outer branch { greatly elongated *Thalestris*.
 outer branch composed of three, inner of { one joint; mandible palp { not much longer than { foliaceous *Dactylopus*.
 { two joints { simple, bisetose { elongated, sub-falciform, and strongly spined *Peltidium*.
 { two-jointed *Westwoodia*.
 { two joints *Ilyopsyllus*.
 { two joints *Zaus*.

Sub-fam. 8.—PORCELLIDIINÆ.

Contains only one genus *Porcellidium*.

Sub-fam. 9.—IDYINÆ.

Mandible-palp composed of { a basal joint, with two one-jointed branches *Idya*.
 { two irregularly shaped laminae, bearing branchial filaments *Scutellidium*.

Fam. 7.—CORYCÆIDÆ.

Posterior antennæ and all the mouth-organs { deficient *Monstrilla*.
 well-developed *Corycæus*.

Fam. 8.—SAPPHIRINIDÆ.

Contains only one British genus..... *Lichomolgus*.

Fam. 9.—AETOTROGIDÆ.

Fourth pair of feet composed of { one branch only *Dyspontius*.
 two branches; mouth produced into a suctorial tube, which is { longer than the cephalothorax *Solenostoma*.
 short and bell-shaped; posterior antennæ { three-jointed *Cycloplicera*.
 four-jointed *Artotrogus*.



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CLASSIFICATION OF THE BRITISH COPEPODA.

Sub-Kingdom.—ANNULOSA.

CLASS.—CRUSTACEA.

SUB-CLASS.—ENTOMOSTRACA.

Legion.—LOPHYROPODA.

Order.—COPEPODA.

Section 1.—*Gnathostoma.*

<i>Families.</i>	<i>Sub-families.</i>	<i>Genera.</i>
1. Calanidæ.....	1. Calaninæ	1. Calanus.
		2. Metridia.
2. Misophriidæ	2. Pontellinæ	3. Pseudocalanus.
		4. Candace.
		5. Dias.
		6. Temora.
		7. Diaptomus.
		8. Isias.
		9. Centropages.
		10. Parapontella.
		11. Pontella.
		12. Anomalocera.
		1. Misophria.
		2. Pseudocyclops.
3. Cervinia.		
3. Cyclopidaæ	1. Notodelphyinæ ...	1. Oithona.
		2. Cyclopina.
		3. Thorellia.
		4. Cyclops.
		5. Lophophorus.
4. Notodelphyidæ.	2. Doropyginæ.....	1. Notodelphys.
		2. Doropygus.
		3. Notopterophorus.
5. Buproridæ	3. Ascidicolinæ	4. Botachus.
		5. Ascidicola.
		1. Enterocola.

<i>Families.</i>	<i>Sub-families.</i>	<i>Genera.</i>
6. Harpacticidæ ...	1. Longipediinæ ...	1. Longipedia.
		2. Ectinosoma.
		3. Zosime.
	2. Tachidiinæ	4. Bradya.
		5. Tachidius.
		6. Euterpe.
	3. Amymoninæ.....	7. Robertsonia.
		8. Amymone.
	4. Stenheliinæ	9. Stenhelia.
		10. Ameira.
		11. Jonesiella.
		12. Delavalia.
	5. Canthocamptiinæ	13. Canthocamptus
		14. Attheyella.
		15. Mesochra.
		16. Tetragoniceps.
		17. Diosaccus.
		18. Laophonte.
		19. Normanella.
		20. Cletodes.
		21. Enhydrosoma.
		22. Nannopus.
	6. Nannopiinæ	23. Platychelipus.
		24. Dactylopus.
	7. Harpacticinæ ...	25. Thalestris.
		26. Westwoodia.
		27. Ilyopsyllus.
		28. Harpacticus.
		29. Zaus.
		30. Peltidium.
	8. Porcellidiinæ	31. Porcellidium.
		32. Idya.
	9. Idyinæ	33. Scutellidium.
		34. Cylindrosoma (incertæ sedis).

Section 2.—*Pæcilstoma.*

7. Corycæidæ	{ 1. Corycæus.
	2. Monstrilla.
8. Sapphirinidæ	1. Lichomolgus.

Section 3.—*Siphonostoma.*

9. Artotrogidæ	}	1. Cyclopicera.
		2. Artotrogus.
		3. Dyspontius.
		4. Solenostoma.



BRITISH COPEPODA.

Sub-Class—ENTOMOSTRACA, Müller.

(GNATHOPODA, *H. Woodward.*)

ORDER—COPEPODA.

Section I.—GNATHOSTOMA, Thorell.

Family 1. CALANIDÆ, Dana.

Body elongated; composed of from ten to twelve segments. Abdomen nearly cylindrical, much narrower than the cephalothorax and prolonged at the posterior extremity into two more or less cylindrical caudal branches. First segment of thorax often anchylosed with the head; fourth and fifth segments also often coalescent. Head only rarely divided into two segments. Anterior antennæ very long and composed of twenty-four or twenty-five joints; that of the right side in the male often modified for grasping. Posterior antennæ large, composed of a basal joint from which spring usually two branches, the primary branch consisting of two, the secondary

of several joints. Mandibles strongly toothed at the apex, palp (usually) two-branched. Maxillæ strong, and provided with a many-lobed palp. Foot-jaws strongly developed: first pair very broad; the basal joints having on the inner margin wartlike processes from which spring long ciliated bristles; the distal extremity divided into three short joints which are thickly beset with strong and long ciliated setæ: second pair longer and more slender, basal portion forming two long oval joints; apical portion usually 4—6-jointed. First four pairs of feet 2-branched, the outer branches always three-jointed. Fifth pair either like the foregoing, or much modified, unlike on the two sides, and in the male forming clasping organs; a heart is present. Eyes either median and stalked or paired (lateral) and sessile; in the latter case being often coalescent and composed of several lenses. Sexual organs in the female symmetrical, in the male asymmetrical. Ovisac single; borne in front of the abdomen.

This definition is framed so as to include the species belonging to the two families Calanidæ and Pontellidæ as described by Dr. Claus. There being, as I think, no sufficient ground for separating the latter as a distinct family, I here follow Dana and Boeck in considering the whole as one family, comprising two sub-families *Calaninae* and *Pontellinae*. The characters which chiefly distinguish the two groups are those of the eyes, footjaws, and anterior antennæ, but Claus has pointed out that the genus *Centropages* exhibits a transition as regards the eye, while *Centropages*,

Temora, and other genera have characters very similar to the *Pontellinæ* group in the antennæ and footjaws.

The chief points of generic distinction are to be found in the structure of the inner branches of the swimming feet—more especially in those of the first and second pairs,—in the characters of the fifth pair of feet and of the mandibles, maxillæ, and footjaws. As regards the mouth organs the most noteworthy modifications are those found in *Candace*, where the mandible is remarkably slender and its palp much dilated, the maxillæ being at the same time of quite abnormal structure; and in *Dias* and *Parapontella* where the apical portion of the lower footjaws is so much reduced in size as to be almost aborted.

Specific distinctions have sometimes been founded on the number of joints in the branches of the swimming feet, but it must be borne in mind that this character is liable to vary with the stage of development of the animal. A table of such variations is given amongst the remarks on the genus *Cyclops*, and I hope, in an appendix to the second volume, to illustrate from Arctic specimens in the possession of the Rev. A. M. Norman a somewhat similar process of development in *Calanus*.

DIAGNOSIS OF GENERA OF CALANIDÆ.

Alike or nearly alike in both sexes, inner branch of first pair of swimming feet	three-jointed; feet of fifth pair } unlike the rest; prehensile	} like the preceding, two-branched <i>Calanus</i> . } <i>Metridia</i> .	one-jointed <i>Pseudocalanus</i> .	} three-jointed, outer branch of fifth pair of feet in male } } two-jointed; mandible palp }	} prehensile <i>Centropages</i> . } non-prehensile <i>Isias</i> . } composed of two branches <i>Anomalocera</i> . } composed of one branch <i>Parapontella</i> .	} three-jointed <i>Diatomus</i> .	} rudimentary <i>Dias</i> . } styliform, two-toothed. } <i>Candace</i> .	} of normal size: mandibles } } dilated, many-toothed; inner branch of posterior antenna }	} many jointed } <i>Temora</i> . } one- or two-jointed } <i>Pontella</i> .
} dissimilar in the two sexes; that of the right side in the male more or less distinctly hinged, inner branch of first pair of swimming feet	} Anterior antennae 24-25-jointed								

Sub-family 1. CALANINÆ, Dana.

This sub-family is characterised by the presence of only one eye which is made up of several lenses; by the 24—25-jointed anterior antennæ and by the long and slender form of both thorax and abdomen: rostrum slender, and usually, if not always, furcate.

Genus 1. CALANUS, Leach (1819).

(LEACH, Dict. Sc. Nat., xiv, Art. Entomostraca.)

(*Cetochilus*, Roussel de Vauzème, Claus, Baird.)

Cephalothorax elongated, slender, consisting of five segments. Head produced into an attenuated, forked rostrum. Eyes small, situated at the back of the head, near the middle line, and composed each of two lenses. Anterior antennæ very long, composed of twenty-five joints; alike on the right and left sides in both sexes, and possessing no hinge-joint: those of the male are provided with thickened, club-shaped hairs. Posterior antennæ two-branched, the secondary branch having four small intercalated median joints. Maxilla forming a broad lacinated plate, armed with strong marginal setæ, some of which are plumose, and having attached to it two short and broad leaflike processes, which bear long branchial filaments. Mandibles large and strong, the cutting portion ending in a wide sharply-toothed mar-

gin; basal joint of the palp large and broad; branches densely setose, one 4-, the other 2-jointed. Anterior footjaws broad and strong; posterior elongated, the terminal portion being divided into five joints; both pairs armed with numerous strong and long setæ. Five pairs of feet adapted for swimming, two-branched, each branch being composed of three joints; in the male, however, the outer branches of the fifth pair are somewhat modified. Abdomen of the male 5-, of the female 4-jointed.

1. CALANUS FINMARCHICUS (*Gunner*). Pl. I, figs. 1—12.

- Monoculus finmarchicus*, Gunner. Act. Hafn., x, 175, figs. 20—23 (1765).
Cetochilus septentrionalis, Goodsir. Edin. New Phil. Journ., 35, p. 339, t. vi, figs. 1—11 (1843).
 — — Baird. Nat. Hist. Brit. Entom., p. 235, t. xxx, figs. 1 a—g (1850).
 — *helgolandicus*, Claus. Die frei lebenden Copepoden, p. 171, t. xxvi, figs. 2—9 (1863).
Calanus finmarchicus, Boeck. Oversigt over de ved Norges Kyster iagttagne Copepoder, p. 8 (1864).
 — — Brady. Nat. Hist. Trans. Northumberland and Durham, vol. iv, p. 424 (1872).
 — *magnus, borealis, and elegans*, Lubbock. Ann. and Mag. Nat. Hist., 2nd series, vol. xiv (Aug. 1854).

Anterior antennæ about as long as the body (figs. 2, 12), the twenty-third and twenty-fourth joints bearing, the one at the apex, the other near the middle, a long whip-like hair which is ringed and densely ciliated; in the male these hairs are more slender. Posterior antennæ two-branched (fig. 3), the outer

branch consisting of two joints, the inner of seven, four of which are very short; the inner branch bears long marginal hairs along almost its entire length. The basal joints of the fifth pair of feet in both sexes are minutely serrated on the inner margin (fig. 8). The fifth pair of feet in the female are like the preceding pairs, but in the male (fig. 11) have the first and second joints of the outer branch greatly elongated and are devoid of marginal hairs, the third joint being small, pear-shaped, and provided only with a couple of minute spines at the apex. The terminal spines of the swimming feet (fig. 10) are long, awl-shaped, and destitute of serratures or hairs. Tail setæ about as long as the abdomen. Length of the animal, including tail setæ, about one sixth of an inch (4 mm.). Colour variable, sometimes almost pellucid, at others yellowish or dark red; the body is often loaded with large highly refracting oil globules.

This species is found, often in immense numbers, all round our coasts both in the open sea and between tide marks, more especially in the early summer months. It is essentially a pelagic species, loving the clear ocean and not often to be met with in any great numbers amongst weeds. It appears to be generally distributed in the Arctic Ocean, the North Atlantic, and the European seas, and I have seen specimens collected by Mr. Eaton in the southern hemisphere, which are in no respect distinguishable from the northern species, though possibly identical with one considered specifically distinct by R. de Vauzème.* It has been said to

* 'Annales des Sciences Naturelles,' 1834.

constitute no inconsiderable part of the food of the whale.

The three species, *C. magnus*, *borealis*, and *elegans*, described by Sir John Lubbock (loc. cit.) from specimens taken in the Arctic Seas, seem to be founded, as pointed out to me by Mr. Norman, on different stages of development of the present species.

Having had no opportunity of seeing the old descriptions given by Gunner and Leach, I here follow M. Boeck who seems to have examined the literature of the subject with much care. The conclusion is that Gunner's description has been wholly misunderstood or overlooked by modern writers; his *Monoculus finmarchicus* (which has usually been identified with the *Temora longicornis* of the present monograph) being really the species now under consideration, *Calanus finmarchicus*. Leach's genus *Calanus* was established in order to receive Gunner's species, though the name has been used by recent authors (Dana, Lubbock, Claus) to include species wholly different. If this view be correct it is only right that the term *Calanus* should revert to the species for which it was first proposed; the genus *Cetochilus* being at the same time discarded.

Genus 2. METRIDIA, Boeck (1865).

(? *Pleuromma*, Claus.)

Head separate from the first ring of the thorax, and produced into a cloven rostrum: fourth and fifth

segments coalescent. Abdomen in the female consisting of three, in the male of five segments. Anterior antennæ as long as the cephalothorax, 25-jointed in the female, in the male 20-jointed and furnished with a hinge between the seventeenth and eighteenth joints. Second pair of antennæ as in *Calanus*; mouth organs as in *Calanus*. First pair of feet smaller than the rest: both branches of the first four pairs of feet three-jointed; fifth pair, unlike the others, composed of one branch only and dissimilar on the two sides; in the male formed for grasping.

The characters on which Boeck relies to separate this genus from *Pleuromma*, Claus, are the complete separation of the cephalic from the thoracic segments, the 3-jointed branches of the swimming feet, and the absence of lateral eye-spot. It is possible that further investigation may show these distinctions to be unfounded, but the male abdomen as figured by Claus in the case of *Pleuromma* is distinctly different from that of *Metridia* in being provided with lateral processes. M. Boeck, however, is wrong in stating the number of antennal joints in *Metridia* to be twenty-four. The real number is twenty-five, and in this respect it agrees with *Pleuromma*.

While this Monograph has been going through the press Mr. Norman has pointed out to me that the name *Metridia* (*Metridium* being already in use for a genus of Actinozoa) must be withdrawn, but as it seems doubtful whether *Pleuromma* ought or ought not to be adopted as the generic appellation, I prefer for the present to let *Metridia* stand.

1. METRIDIA ARMATA, *Boeck*. Pl. II, figs. 1—12; Pl. LVI, figs. 19, 20.

Metridia armata, *Boeck*. Oversigt over de ved Norges Kyster iagttagne Copepoder, p. 14 (1865).

Paracalanus hibernicus, *Brady and Robertson*. Annals and Magazine of Nat. Hist., ser. 4, vol. xii, p. 126, pl. viii, figs. 1—3 (1873).

Rostrum obtuse; anterior antennæ (fig. 2) nearly alike in both sexes, slender, a little longer than the cephalothorax, thick at the base and tapering gradually to the apex; the nine basal joints (except the first, which is very large) are broader than long, the rest being from twice to thrice as long as broad except the apical one, which is very short: each joint bears on its outer margin one or two short setæ (some of these being in the male developed into thickened rod-like appendages), and the seven or eight proximal joints are each produced on the outer margin into a short median spine or tooth; the last joint has one long and two small setæ, the penultimate one very long seta: in the male the antenna is twenty-jointed, hinged between the seventeenth and eighteenth joints (Pl. LVI, fig. 19). Both branches of the posterior antennæ are stout and nearly equal in size. Mandibles (fig. 3) strong, with a largely developed, biramous palp. Second pair of foot-jaws (fig. 6) very slender. The swimming feet (fig. 7) have the inner branch very short, only about half the length of the outer branch, the last joint of which is long and truncate at the apex; marginal and terminal spines very small, the latter (fig. 12) some-

what leaflike and minutely serrated on the outer edge. Fifth pair of feet cylindrical, unbranched, in the male four- and in the female three-jointed; those of the female, however, much shorter than of the male, and having joints of nearly equal length (fig. 10) terminated by two or three fine short setæ. In the male the first and fourth joints are much elongated (figs. 8 and 9), and the second joint bears a slender curved process; the foot of one side is also much more slender than that of the other. The inner branch of the second pair of feet in the male has the first joint very much excavated at the upper and inner margin, the lower margin of the excavation having a large and strong spine (Pl. LVI, fig. 20 *b*) at the angle, and two smaller ones internally. Abdomen of female 3-, of male 5-jointed. Caudal setæ short, scarcely half the length of the abdomen (fig. 11). Length, exclusive of the caudal setæ,* $\frac{1}{16}$ th of an inch (1.6 mm.). Arctic examples belonging apparently to this species, taken during the expedition of the "Alert" and "Discovery," and now in Mr. Norman's possession, are much larger, measuring at least twice as much ($\frac{1}{7}$ th of an inch).

I am indebted to my friend Mr. E. C. Davison, R.N., of Sunderland, for several collections of Entomostraca taken in the tow-net off Ireland and in other localities, and my knowledge of the present species is almost entirely derived from these gatherings, in several of which it occurred plentifully. The localities are as follows,—off the mouth of the Shannon; Galway Bay;

* Except where otherwise stated, the measurements of length are in all cases to be taken as exclusive of the tail setæ.

off Loup Head ; Dingle Bay ; near Valentia ; Rockall Bank ; in lat. $51^{\circ} 22'$ N., long. $12^{\circ} 25'$ W., and lat. $53^{\circ} 24'$ N., long. $15^{\circ} 24'$ W. I have myself taken it, though very sparingly, in the surface-net amongst the Scilly Islands.

It may be noted here that in most of the Calanidæ the apical spines of the outer branches of the swimming feet afford excellent distinctive characters, and, on this account, are carefully figured in the plates. The *first* swimming foot is, however, usually, if not always, destitute of a spine, its place being occupied by a stout hair or seta.

Genus 3. PSEUDOCALANUS, Boeck (1872).

(*Pseudocalanus*, Boeck, Nye Slægter og Arter af Saltvands-Copepoder, 1872. *Clausia*, Boeck, 1864. *Calanus*, Brady, 1865.)

Like the preceding except in the structure of the feet, which are composed as follows. The outer branch of the first four pairs is always 3-jointed ; in the first pair the inner branch consists of only one joint, in the second of two, in the third and fourth of three joints. The fifth pair of feet in the female are altogether absent ; in the male they form two very slender limbs, 5-jointed on the right, 3-jointed on the left side.

The term *Clausia*, at first proposed by M. Boeck for this genus, had been previously used by Claparède for a genus of parasitic Copepoda. It was, therefore, in a later publication, withdrawn by M. Boeck, the designation *Pseudocalanus* being substituted.

1. PSEUDOCALANUS ELONGATUS, *Boeck*, Pl. III, figs 1—9.

Clausia elongata, Boeck. Oversigt Norges Copep. p. 10 (1864).

Calanus Clausii, Brady. Nat. Hist. Trans. Northumberland and Durham, vol. i, p. 33, pl. i, figs. 1—11, 13 (1865).

Body elongated, ovate, anterior antennæ in the female (fig. 2) 25-jointed, the seventh and eighth (or eighth and ninth?) joints being coalescent, the rest gradually increasing in length and tenuity as they approach the distal extremity: in the male the number of joints is reduced to twenty by the coalescence of several, the seventh, eighth, and sixteenth joints (fig. 3) thus becoming much elongated; the two or three terminal joints are swollen at the distal extremity and contracted at the base, and in the male some of the other joints are also similarly enlarged; the outer margin of the antennæ is sparingly provided with short hairs. Fifth pair of feet wanting in the female; in the male (fig. 8) they are long and slender, the left consisting of three cylindrical tapering joints, of which the middle is the longest; the right of five joints, of which the first three are nearly equal in length, the fourth shorter and the fifth quite minute and claw-like. The first abdominal segment in the female is much the longest and is tumid in front; in the male it is very short: abdomen 4-jointed in the female, 5-jointed in the male; the caudal segments very short; tail setæ also short, scarcely equal to half the length of the

abdomen in the female, still less in the male (figs. 1, 9). Length about $\frac{1}{20}$ th of an inch (1·3 mm.). Colour yellowish or reddish yellow, quite transparent.

P. elongatus is a very common species, being distributed all round the British Islands between tide marks and in the open sea. It is often met with in considerable numbers. M. Boeck points out that in some specimens, which he supposes to be females, there are traces of a fifth foot in a rudimentary stage. I at one time also held this belief, but am indebted to Dr. Claus for suggesting to me that these specimens are in reality immature males, and that along with the imperfectly formed feet there are usually also other signs of immaturity in the animal. The female must, therefore, be considered to be constantly destitute of a fifth pair of feet.

2. PSEUDOCALANUS ARMATUS, *Boeck*, Pl. IV, figs. 1—11.

Pseudocalanus armatus, Boeck. Nye Slægter og Arter af Saltvands-Copepoder, p. 6 (1872).

Body elongated (fig. 1); head quite distinct from thorax; fourth and fifth thoracic segments coalescent, and produced at the dorsal angle into a strong backward-projecting spine; ventral angle rounded off. Anterior antennæ in the female stout (fig. 2), as long as the cephalothorax; 1st and 2nd joints large, and longer than the next following ten joints, which are short and broad; the 13th joint is about

twice as long as broad, and the remainder are mostly somewhat longer in proportion to their width, except the last, which is very short; the whole length of the antenna beset on its outer margin with long and stout hairs, those of the last five or six joints being especially strong and transversely ringed. The anterior antennæ of the male (fig. 3) are more slender, and the joints beyond the middle much longer, the 18th to the 24th being especially slender; the organ is not nearly so densely setose as in the female. The posterior antennæ and mouth organs do not differ materially from those of the genera already described; the posterior footjaw (fig. 7), however, has the first two joints with only three marginal setæ, near the middle of each joint. The swimming feet are much larger and stronger in build than in the preceding species, and have their terminal spines (fig. 9) beset on the inner margin with large and widely separated teeth. Fifth foot of the male (fig. 10) even more slender than in the preceding species, the last joint bearing at the apex two small terminal setæ, and on its inner margin a comb-like series of about nine or ten moderately long hairs. Caudal segments about as long as the last abdominal segment; setæ nearly as long as the abdomen. Colour very dark brown; so opaque, indeed, that scarcely any structure can be seen until cleared by solution of potash. Length $\frac{1}{10}$ th of an inch (2.55 mm.).

My only examples of this species were dredged in a depth of fifteen fathoms, off Portincross, Ayrshire, and off the south end of the Island of Bute.

M. Boeck states that the inner branch of the first pair of feet consists of two joints; but after careful examination I have not been able to see any separation into two segments. It is quite possible, however, that this character may vary somewhat in different individuals, as it certainly does in the case of *Temora longicornis*. It seems not unlikely that in very old specimens the separation of the segments may become more distinct, but in this case the individuals examined appeared to be fully grown and matured.

Genus 4. CANDACE, Dana (1846).

(DANA, American Journal of Science, ser. 2, 1846.)

(*Ifionyx*, Kroyer, 1849.)

Anterior antennæ 23- or 24-jointed, that of the male on the right side geniculated, and having the median joints only slightly swollen. Posterior antennæ stout; the secondary branch having no median joints. Rostrum rounded. Mandibles twisted, narrow, ending in two stout teeth, the palp very much expanded. Maxillæ bearing a long styliform process, masticatory portion subtriangular. First pair of footjaws very strong, bearing long uncinatæ setæ, second pair slender and small. Fifth foot in the female composed of one triarticulate branch on each side, those of the male dissimilar, the right prehensile. Abdomen composed in the female of three, in the male of five segments.

1. CANDACE PECTINATA, *nov. sp.*, Pl. X, figs. 1—12;
Pl. VIII, figs. 14—15.

Body elongated and slender; anterior antennæ (fig. 3) as long as the body, 24-jointed, the thickened basal portion 7-jointed, the remainder of about equal thickness throughout and extremely slender; third joint the largest, eighth to eleventh very short, seventeenth, eighteenth, and nineteenth the longest, the whole sparingly setiferous: right antenna of male (fig. 1) very slender beyond the hinge-joint and only slightly swollen in the middle; joint next above the hinge of a smoky brown colour, armed with a crest or comb of large and strong deeply coloured spines; the joint immediately above this principal armature and that below the hinge bear dentated plates of the usual character (fig. 2). The posterior antenna is large and stout, the main branch bearing two and the secondary branch one terminal brush of about six long setæ. Mandible-palp triangular, with two short setiferous branches (fig. 4) at the terminal angles. The basal portion of the maxilla (fig. 5) bears at its apex one very long and several shorter setæ; styliform process slender and carrying two apical setæ. First pair of footjaws long and strongly armed; second pair slender (fig. 6). Inner branches of the swimming feet two-jointed throughout (fig. 7); marginal spines of the outer branches very small; swimming setæ all densely plumose beyond the middle; terminal spine of outer

branch strongly pectinated on the outer and densely hairy on the inner margin (fig. 8); these spines and the plumes of the swimming setæ deeply coloured. Fifth pair of feet in the female simple, three-jointed; terminal joint long and curved, tapering to the extremity, which is sharp and twice dentated on the outer margin. Fifth pair in the male one-branched, that of the left side simple, four-jointed; the right having the last two joints modified into prehensile form (fig. 10). Last joint of the thorax in the male produced at one side into a long spine; first abdominal segment produced in a similar way, but on the opposite side (fig. 11). Caudal segments very short; setæ about as long as the abdomen. Length of the animal $\frac{1}{11}$ th of an inch (2·3 mm.).

A very few specimens of this interesting species were dredged by Mr. Robertson and myself in June, 1873, on very hard ground and in a depth of about forty fathoms, south-west of the island of St. Agnes, Scilly. It appears to be quite distinct from any species described by Dana, Kroyer, Claus, or Boeck, though the female antennæ very nearly agree with those of *C. longimana*, Claus.

Genus 5. DIAS, *Lilljeborg* (1853)

(*Acartia*, Dana, in part.)

Body long and slender, head narrowed above and produced into a slender rostrum. Abdomen consisting in the male of five, in the female of three segments.

udocalanus armatus n. 46

Anterior antennæ, in the female, 20-jointed, armed with long setæ, nodose, and (in the male on the right) geniculated. Primary branch of the posterior antenna much elongated, secondary branch short and 1-jointed. Labium very large, three-lobed, and setiferous, the middle lobe very broad. Mandibles as in *Calanus*. Branchial plates of the maxillæ small. Anterior foot-jaws largely developed and armed with many strong, uncinatæ setæ; posterior pair provided at the base with two large setiferous processes, the apical portion small. The swimming feet have the internal branch of two, the outer of three joints. The fifth pair of feet are one-branched, those of the male prehensile. Eye formed of several lenses.

The genus *Acartia* of Dana includes, no doubt, not only some species of *Dias*, but others which are properly referable to distinct genera. The term *Dias* has been generally adopted for the following species, and I have therefore retained it here.

1. DIAS LONGIREMIS, *Lilljeborg*, Pl. V, figs. 1- 14.

- Dias longiremis*, Lilljeborg. De Crustaceis ex ordinibus tribus, p. 181, tab. xxiv, figs. 1—13 (1853).
 — — Claus. Die frei-lebenden Copepoden, p. 193, taf. xxxiii, figs. 6—14, and taf. iii, figs. 1 and 2 (1863).
 — — Boeck. Oversigt over de ved Norges Copepoder, p. 12 (1864).
 — — Brady. Nat. Hist. Trans. Northumberland and Durham, vol. i, p. 35, pl. i, fig. 14, and pl. ii, figs. 11—18 (1865).
Calanus euchæta, Lubbock. Ann. and Mag. Nat. Hist., series 2, vol. xx p. 401, pl. x, figs. 1—6 (1857).

Head united with first ring of thorax, or only indistinctly separated. Anterior antennæ as long as the cephalothorax, the right of the male having nineteen, the left twenty-one joints; many of the antennal joints in both sexes much swollen at the apices, giving the organ a knotted appearance, the whole being beset with scattered hairs, some of which are excessively long: the ninth to the thirteenth joints of the male right antenna are much swollen to provide for the internal muscular apparatus, and the hinge is situated between the fourteenth and fifteenth joints (figs. 2, 3, 4). Anterior foot-jaw approaching in appearance that of *Pontella*, its numerous strong setæ being armed with short rigid divaricating hairs. Posterior foot-jaws bearing on the basal joint a papilliform process which supports a single very long seta and three smaller ones; the second joint has a single long seta which also springs from the summit of a papilla; the remaining joints are smaller and bear small marginal spines. Terminal spines of the swimming feet long, slender, sword-shaped, and finely serrated on the inner border. These spines are peculiar, for instead of having one or more small supplementary spines at their base, connected with the last segment of the foot by a movable joint, as is usually the case, the spine is, in this species, formed by a mere arched and pointed process of the outer edge of the foot (fig. 11). The fifth feet in the male consist each of a four-jointed branch, forming a pair of strong crooked and prehensile claws (fig. 13), the inner margins of which, especially on the right side, are produced into wart-like projections, and the terminal joints

are fringed with small spines or spine-like hairs. There is, however, considerable variety in the conformation of these organs. The fifth foot in the female (fig. 12) is small, three-jointed, the basal joint stout and bearing a single long seta, the next very small, and the terminal joint forming a long and slender curved claw. Abdomen very short, the first segment, in the female, being much the largest; caudal segments also short, about twice as long as broad: tail-setæ rather longer than the abdomen. Length $\frac{1}{20}$ th of an inch (1.3 mm.). Colour yellowish, whitish, or pellucid. *Dias longiremis* is found abundantly in the open sea and between tide marks all round the British islands; it occurs sometimes also in brackish water, but in that case is usually small and poorly developed.

Genus 6. TEMORA, Baird (1850).

(*Cyclops* (in part), Müller. *Calanus* (in part), Leach (*vide* Boeck), not *Monoculus*, Gunner.)

Body elongated; head distinct from the thoracic segments; rostrum bifurcate. Fourth and fifth thoracic segments either completely coalescent or their separation merely indicated by a furrow. Abdomen composed of four segments in the male, of three in the female. Anterior antennæ twenty-four- or twenty-five-jointed; that of the right side in the male having a hinge-joint and forming a prehensile organ. Mouth organs as in *Calanus*. Inner

branches of the first, second, third, and fourth pairs of feet two-jointed. The fifth pair are composed each of one branch, those of the male forming clasping organs. Abdomen of the female three-, of the male four-jointed.

1. TEMORA LONGICORNIS, Müller, Pl. III, figs. 10—19.

- Cyclops longicornis*, Müller. Entomostraca p. 115, t. xix, figs. 7—9 (1785).
- Temora finmarchica*, Baird. Brit. Entom. p. 228, t. xxviii, figs. 1 a—g (1850).
- — Claus. Die frei-leb. Copep., p. 195, t. xxxiv, figs. 1—11 (1863).
- — Brady. Nat. Hist. Trans. Northumberland and Durham, vol. i, p. 36, pl. i, fig. 15, and pl. ii, figs. 1—10 (1865).
- *longicornis*, Boeck. Loc. cit., p. 15 (1865).
- — Brady. Nat. Hist. Trans. Northumberland and Durham, vol. iv, p. 425 (1872).
- Diaptomus longicaudatus*, Lubbock. Ann. and Mag. Nat. Hist., ser. 2, vol. xx pl. x, figs. 11 and 12 and pl. xi, figs. 12 and 13 (not *Moniculus finmarchicus*, Gunner) (1857).

Body wide in proportion to its length, dorsal margin much arched, posterior dorsal angle rounded off, ventral produced and subangular. Anterior antennæ (fig. 12) rather longer than the cephalothorax, twenty-five-jointed, the segments more attenuated and increasing slightly in length towards the distal extremity, the basal joint, however, being the largest of all; each segment bears two short slender hairs at its apex. The right antenna of the male (fig. 11) has a

movable hinge between the eighteenth and nineteenth joints, the last four joints being very long and apparently representing a coalescence of eight joints; the inner margins of the joints immediately above and below the hinge are armed with finely denticulated plates; and the fourteenth to the eighteenth joints (both inclusive) are swollen, apparently to give more space for the powerful muscles by which the organ is moved. The posterior antennæ and the mouth-organs do not differ materially from those which have been already described. Inner branches of the first four pairs of swimming feet two-jointed; those of the first pair often apparently one-jointed owing to imperfect division. The fifth foot in the female (fig. 16) consists of a simple, cylindrical, and rather stout three-jointed branch, the last joint being the longest and having two small lateral, and two apical spines of about equal size. The right fifth foot in the male (fig. 17) consists of a large basal joint to which are articulated two opposable claws, one of these being long, simple and curved, the other composed of two broader joints, and bearing at the apex two tooth-like spines and two short hairs: the left foot is three-jointed, subchelate, but unbranched. The terminal spines of the swimming feet (fig. 19) are long and straight, with slightly curved apex and finely serrated inner border. The caudal segments (fig. 18) are extremely long and slender, quite equal in length to the whole of the abdomen, about eight or nine times as long as broad, and bearing a single short lateral spine on the external margin, about half way between the middle

and the distal extremity: terminal setæ plumose, not quite equal in length to the tail segments. Colour brown. Length $\frac{1}{20}$ th of an inch (1.3 mm.).

Temora longicornis is one of the most abundant of the marine Copepoda. It occurs often in great profusion in tidal pools amongst seaweeds, and is likewise taken abundantly in the towing net in the open sea. It seems, in fact, to be ubiquitous in the British seas.

2. TEMORA VELOX, *Lilljeborg*, Pl. VI, figs. 1—5.

Temora velox, Lilljeborg. De Crustaceis ex ordinibus tribus Cladoc. Ostrac. et Copep., p. 177, tab. xix, figs. 9 and 10, and tab. xx, figs. 1—9 (1853).

— — Brady. Nat. Hist. Trans. Northumberland and Durham, vol. i, p. 38, pl. i, fig. 16, and pl. iii, figs. 1—11 (1865).

Body robust, dorsum strongly arched, head distinct from the thorax, last thoracic segment in the female produced into two strong spines at the ventral angle. Anterior antennæ (figs. 1, 2) rather short and stout, not much longer than the cephalothorax, 24-jointed, moderately tapered to the apex, toward which the segments gradually increase in length, those near the base, up to the twelfth, being much broader than long, and those from the sixteenth onward about twice as long as broad; the middle portion of the antenna is densely setose on the outer margin, but the setæ are more scattered toward the apex; the right antenna of

the male has two long apical joints, at the base of which the hinge is placed, the two joints above and one below being armed with serrated plates; the 11th, 12th, 13th, and 14th joints have each usually a distinct but short spine, the 15th and 19th bear also similar but larger spines, and the number of joints is reduced to twenty-one owing to the coalescence of some of the number; the middle of the male antenna, as in the previous species, is much swollen. Fifth pair of feet in the female (fig. 3) 4-jointed, the terminal joint very small, rounded, and bearing two stout setæ, one large and one small, the other joints very much stouter, the penultimate produced below at the inner angle into a long serrated spine; the 2nd and 3rd joints bear each a single small seta. Fifth feet of the male very large and powerful, and provided on their opposing edges with several spines—mostly one in the middle of each joint; each branch is 3-jointed, the basal joints large and swollen, the terminal joint of one side ending in a blunt doubly toothed broad extremity, that of the other side forming a long slender claw. The middle segment of the abdomen in the female is much the shortest (fig. 5); the last abdominal and the caudal segments are beset with irregularly scattered short hairs or prickles. Caudal segments four times as long as broad; about equal in length to the terminal setæ, or to half the length of the abdomen. The ova are borne in a large undefined mass on the front of the female abdomen, and large oblong spermatic tubes are often found attached in the same situation in great numbers,

depending from the vulva like a bunch of candles. Length $\frac{1}{17}$ th of an inch (1.5 mm.). When alive the animal is of a pale brown colour, but on immersion in spirit assumes a peculiar vinous red or purple.

Temora velox is an inhabitant, almost exclusively, of the brackish water of estuaries and salt marshes, and in such localities I have taken it pretty extensively. I have only once met with it in the sea, amongst *Laminariæ* at Sunderland, and then only one or two specimens were taken. The other localities in which I have found it are, at Hylton on the Wear, Hartlepool, Alnmouth, Burgh Marsh near Carlisle, Cumbrae, Pensarn (Merionethshire), Oulton Broad and Lake Lothing (Suffolk), Whittlesea Dyke (Cambridgeshire), and in pools near the river Stour at Manningtree. In such situations it often occurs in immense profusion, especially in autumn, when the water has become heated by the direct rays of the sun.

Genus 7. DIAPTOMUS, *Westwood* (1836).

(*Cyclops* (in part), Müller. *Cyclopsina*, Milne Edwards, 1840.)

Body elongated, compressed; head distinct from the thorax, anterior antennæ 25-jointed, that of the male on the right side hinged. Posterior antennæ and organs of mastication as in *Calanus*. Inner branches of all the swimming feet three-jointed except the first, which has only two joints. Fifth foot consisting of two branches, prehensile in both sexes, the internal

branch much the smaller. Abdomen of the male 5-, of the female 3-jointed. Eye situated in the median line.

1. DIAPTOMUS CASTOR, *Jurine*. Pl. VI, figs. 6—13.

- Cyclops cœruleus*, O. F. Müller. Entomostraca, p. 102, t. xv, figs. 1—9 (1785).
 — *lacinulatus* (♀), Müller. Ibid., p. 105, t. xvi, figs. 4—6 (1785).
 — *rubens* (♂), Müller. Ibid., p. 104, t. xvi, figs. 1—3 (1785).
Monoculus Castor, *Jurine*. Histoire des Monocles que se trouvent aux Environs de Genève, p. 50, tabs. 4—6, (1820).
Cyclopsina — M. Edwards. Nat. Hist. Crust., vol. iii, 427 (1840).
Diaptomus Castor, *Westwood*. Partington's Cyclopædia, art. "Cyclops" (1836).
 — — *Baird*. Nat. Hist. Brit. Entom., p. 219, tab. xxvi, figs. 1, 2, 2 a—j (1850).
 — — *Claus*. Die freiliebenden Copep., p. 201, t. xxxv, figs. 15 and 16 (1863).
 — — *Lilljeborg*. De Crust. ex. ord. trib., t. xii, fig. 10, t. xiii, figs. 1—10, t. xiv, figs. 1—4 (1863).
 — — *Lubbock*. Trans. Linn. Soc. Lond., vol. xxiv, p. 197, pl. xxxi, figs. 7—11 (1863).
 — *Westwoodii*, *Lubbock*. Loc. cit., pl. xxxi, figs. 1—6.
 — *Castor*, *Fricè*. Die Krustenthierie Böhmens, p. 225, fig. 22 (1871).

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Anterior antenna (fig. 8) 25-jointed; gradually tapering from the base and beset with setæ of moderate length, one or two on each segment, except on the terminal one, which has five at its extremity; right antenna of male (fig. 7) provided with a hinge-joint, above which for the length of six segments it is much swollen; the 13th joint is armed with a strong marginal spine, and the 10th and 11th with spines of a similar kind though smaller; the hinge is situated

between the 18th and 19th joints. The posterior antennæ, the mouth-organs, and swimming feet present no marked characters. The fifth pair of feet in the female (figs. 10, 11) are alike on both sides, consisting of a rudimentary one- or two-jointed inner, and a much larger three-jointed outer branch. The inner branch bears three apical spines of variable size, but never very large; the outer branch has the basal joint very large, the second joint small, and the third in the form of a broad sword-like spine attached toward the inner side of the limb; the second joint bears in addition two small apical spines or setæ; both branches are nearly straight. In the male (fig. 9) the foot of the right side is much larger than that of the left, and terminates in a long, curved claw; the inner branch is in both feet quite rudimentary. The last thoracic segment in the female (fig. 12) is produced downwards at each side into a conspicuous sharply spined process; in the male (fig. 13) it is distinctly angulated, but has no conspicuous spine. The abdomen consists in the female of 3 and in the male of 5 segments; the caudal segments broad and short; terminal setæ strongly plumose, and about half the length of the abdomen. The eye is large and movable, and of a brilliant red. The colour of the animal itself is very variable; yellowish, red, bluish-green, or brown; once I have seen it so red as to look like scraps of animated sealing-wax when swimming in the water. In some cases the ovisac is of a different colour from the rest of the animal. Length $\frac{1}{20}$ to $\frac{1}{12}$ th of an inch (1.3 to 2.1 mm.).

Diaptomus Castor is of common occurrence in ponds, lakes, and ditches; its colour and perhaps its variations of structure probably depend much upon the character and quantity of its food as well as upon distinctions of race. The largest specimens are usually found in ditches and rather foul, weedy water; those of mountain tarns and lakes are, as a general rule, considerably smaller, not exceeding $\frac{1}{15}$ th or $\frac{1}{20}$ th of an inch in length. The most highly-coloured specimens that I have seen were taken in Grisedale Tarn, under Helvellyn, and are referred to above as being of a brilliant vermilion-red. The form described by Sir John Lubbock under the specific name *Westwoodii* does not appear to me sufficiently well defined or permanent in its characters to warrant its separation as a distinct species; it is indeed, so far as my observation goes, much commoner than the typical *D. Castor*. The characters upon which Sir J. Lubbock lays most stress are, 1st, those of the fifth pair of feet, which do not present any strongly-marked difference except as to the inner branch of that of the female (fig. 11), which is better developed than in the *Castor* form; 2ndly, in the angulation of the last thoracic segment, which after all appears to me to be nearly as marked in one form as in the other; 3rdly, in the length and spinous armature of the antennæ, both of which are liable to a good deal of variation; but the spine on the antepenultimate joint of the antenna of *D. Westwoodii* I have found in some cases to coexist with the other distinctive characters of *D. Castor*. For these reasons I think it best to unite both forms under the old

specific name. The observations made as to the ovisacs and spermatic tubes of *Temora velox* apply equally to the present species.

Genus 8. ISIAS, Boeck (1864).

Body moderately robust, with a well-rounded dorsum. Abdomen composed in the female of three, in the male of five segments. Anterior antennæ 24-jointed, that of the right side in the male forming a geniculated prehensile organ. Posterior antennæ as in *Calanus*. First four pairs of feet with both branches triarticulate. Fifth pair of feet in the female, having the outer branch 3-, the inner 1-jointed; in the male the outer branch consists of two, the inner of one or two joints.

1. *ISIAS CLAVIPES, Boeck, Pl. VII, figs. 3—13.*

Isias clavipes, Boeck. Oversigt Norges Copepoder, p. 18, (1864).

Anterior antennæ of the female (fig. 4) 25-jointed, about equal in length to the cephalothorax, joints short and broad at the base, and gradually increasing in length to the nineteenth, which is about four times as long as broad; first fifteen joints of the male antennæ each bearing a single club-shaped, ciliated, auditory seta: hinge-joint of the 21-jointed right male

antenna (fig. 5) situated between the eighteenth and nineteenth joints; eighteenth joint formed by the coalescence of the normal eighteenth and nineteenth, nineteenth by the twentieth and twenty-first, twentieth by the twenty-second, twenty-third, and twenty-fourth. Mouth organs and swimming feet as in *Centropages typicus*. Fifth pair of feet, in the female, two-branched (fig. 10), having the outer branch of three broad laminar joints, the second of which is produced at the inner margin into a strong ciliated spine; the third joint is as large as the other two together, is fringed internally with swimming setæ and bears at the apex one large and one small spine; inner branch 1-jointed, rudimentary, and bears two apical setæ. Fifth foot of the male (fig. 11) also two-branched, that of the right side being the larger; the outer branch in both cases 2-jointed, the second joint large and forming, especially in the right foot, a broadly expanded lamina, bearing three or four small marginal spines, and on the right side a large terminal ciliated spine; inner branch rudimentary; that of the right side provided with swimming setæ and 2-jointed. Terminal spines of the swimming feet (fig. 12) elongated, narrow, and bayonet-like, finely pectinated on the inner margin. Abdomen of the female divided into four, of the male into five segments, third segment in the male produced in front into a spiniform papilla. Caudal segments as long as the united length of the last two abdominal segments; setæ equal to half the length of the abdomen. Length $\frac{1}{17}$ th of an inch (1.5 mm.).

This fine and very distinct species appears to be

generally distributed in the British seas, but nowhere occurs in any great abundance. The localities from which I have specimens are as follows:—Off Robin Hood's Bay, Yorkshire, dredged in 35 fathoms; dredged off Portincross, Ayrshire (20 fathoms); off Cumbrae (15 fathoms), in Lough Swilly, Ireland, (3 fathoms); taken in the surface-net at Cumbrae, Bridlington Bay, and at Killybegs, Donegal (*Mr. E. C. Davison*); and amongst fuci in Clifden and Roundstone Bays, Ireland.

Genus 9. CENTROPAGES, *Kroyer* (1849).

(*Ichthyophorba*, Lilljeborg. *Calanopia*, Dana. ? *Catopia*, Dana.)

Body elongated. Head distinct from thorax, more or less distinctly divided by a groove into two segments, and produced into a cloven rostrum. Abdomen composed of five segments in the male, of three in the female. Anterior antennæ 24-jointed, that of the right side in the male geniculated and prehensile. Mouth organs as in *Calanus*, except that the anterior footjaws are armed with strong bristles as in *Pontella*. Both branches of the first four pairs of feet 3-jointed; outer branch of the right fifth pair in the male prehensile, internal branch adapted for swimming. Eye median and movable.

1. CENTROPAGES TYPICUS, *Kroyer*, Pl. VIII, figs. 1—10.

Centropages typicus, *Kroyer*. Nat. Tidskr. anden. Rækkes andet Bind, Side 588, (1849).

— — *Boeck*. Oversigt over de ved Norges Kyster iagttagne Copepoder, p. 19, (1864).

Ichthyophorba denticornis, *Claus*. Die frei-lebenden Copepoden, p. 199, pl. xxxv, figs. 1, 3—9 (1863).

— — *Brady*. Nat. Hist. Trans. N. & D., vol. i, p. 40, pl. iv, figs. 1—6, (1864).

Body elongated; last thoracic segment produced downwards at each side (but more strongly in the female than in the male), into a large and strong spine. Anterior antennæ as long as the body (fig. 1), bearing a strong pointed tooth on the outer margins of the first, second, and fifth joints; right antenna of the male (fig. 2) hinged between the eighteenth and nineteenth joints, and bearing denticulated plates above and below the hinge, much swollen in the middle, armed with a strong hook-like spine on the margin of the sixteenth joint. Fifth pair of feet in the female (fig. 9) much like the preceding pairs except that the outer branch has the middle joint produced internally into a very long and strong spine; in the male (fig. 10) the inner branch is on both sides adapted for swimming, but the outer branch of the right limb has the last two joints developed into a powerful grasping organ by the conversion of each joint into a curved claw, that of the middle joint being stout, crooked, and denticulated at the extremity; the outer branch of the left

foot has only two joints. The terminal spines of the swimming feet are sword-shaped, rather slender, and finely serrated (fig. 7). The first segment of the female abdomen bears three plumose spines, one of which is stronger than the other two, and the second segment is produced laterally into a papilla for the attachment of spermatophores. Caudal segments short, about as long as the last abdominal segment, setose on the internal margins and bearing five strongly plumose and rather rigid apical setæ which are considerably shorter than the abdomen. Length $\frac{1}{15}$ th of an inch (1.6 mm.). Colour brown.

Except in littoral situations this species seems to be at least as common in the British seas as the following (*C. hamatus*). It is taken frequently in the North Sea and in the Atlantic by the towing net; indeed few gatherings thus made, if at all good ones, are entirely without it. I have memoranda of its occurrence off the West Coasts of Scotland and Ireland, the East of England and Scotland, amongst the Channel Islands, between Cornwall and Cape Clear, &c. It occurs, too, amongst dredged material so frequently that it can scarcely in all cases have been captured by the dredge on its way up to the surface.

2. CENTROPAGES HAMATUS, *Lilljeborg*. Plate VIII, figs.
11—13.

Ichthyophorba hamata, Lilljeborg. De crustaceis, &c., p. 185,
t. xxi, figs. 1—5, 7—9, and t. xxii, figs.
9—12, (1853).

— — Brady. Nat. Hist. Trans. N. & D. vol. i,
p. 39, pl. iv, figs. 7—10 (1865).

— *angustata*, Claus. Die frei-lebenden Copepoden,
p. 199, t. xxxv, figs. 2, 10—12 (1863).

Diaptomus Bateanus, Lubbock. Ann. and Mag. Nat. Hist. (2nd
ser.), vol. xx, p. 404, pl. xi, figs. 1—3 (1857).

Centropages hamatus, Boeck. Oversigt Copepoder, p. 20 (1864).

Body slender, smaller than the foregoing species ;
spines of the last thoracic segment also smaller.
Anterior antennæ destitute of spines, of equal length,
but more slender than in *C. typicus* ; in other respects
the same. The fifth pair of feet in both sexes are also
similar to the same parts in *C. typicus*, but much more
slender, and the claw of the male right foot (fig. 13)
is not denticulated. The spines of the swimming feet
differ remarkably from those of *C. typicus* in having
their serrated armature much stronger and the teeth
separated one from another by a wide interval (fig. 12).
Length $\frac{1}{3}$ th of an inch (1.95 mm).

This species, like the preceding, occurs not uncom-
monly at the surface in the open sea and appears to
have much the same distribution. I have once taken
it between tide marks, amongst Algæ in rock-pools
near Ryhope (county Durham).

GENUS 10. PARAPONTELLA, *nov. gen.*

Head distinct from body. Fourth and fifth thoracic segments united. Abdomen of the male 5-, of the female, 3-jointed. Right anterior antenna of the male provided with a hinge-joint. Secondary branch of posterior antennæ large, 3-jointed. Maxilla minute, consisting of a large basal joint with an elongated terminal palp and two small branchial processes. Mandible slender and twisted, terminal teeth sharp and slender, two of them much longer than the rest (fig. 5); palp consisting of a single 3-jointed branch. Anterior foot-jaw bearing at the apex about six short and strong, curved, plumose spines. Posterior foot-jaw composed of a basal joint of moderate size, and a rudimentary 3-jointed apical portion, the basal joint bearing two large curved plumose setæ and two smaller ones. Inner branch of first pair of feet 3-jointed, of second, third and fourth pairs 2-jointed. Fifth pair of feet in the female simple, two-branched; each branch composed of a single joint; in the male, adapted for prehension, and composed of one branch on the left, of two on the right side.

The species described by Sir John Lubbock under the name of *Pontella brevicornis* appears to present some characters distinct enough to require its removal from the genus to which it has hitherto been assigned. The 3-jointed inner branch of the first swimming foot,

the rudimentary lower foot-jaw and the comparatively poor setose armature of the upper, the single-branched mandibular palp and the peculiar structure of the maxilla are points of difference which seem to me of generic importance. I have had no opportunity of examining living specimens, and cannot in my spirit-specimens make out eyes of any kind, but I am disposed to think that in this matter the species will be found to belong to the subfamily Calaninæ rather than to Pontellinæ.

1. PARAPONTELLA BREVICORNIS, *Lubbock*. Plate IX, figs. 1—16.

Pontella brevicornis, Lubbock. Ann. and Mag. Nat. Hist., 2nd ser., vol. xx, pl. xi, figs. 4—8 (1857).

Head separate from the thorax and ending in a short forked rostrum. Superior antennæ 18-jointed (fig. 3) about as long as the cephalothorax, moderately slender, and (except on the right side in the male) of nearly equal thickness throughout, the first joint large, the next six small, the rest from twice to thrice as long as broad, except the last which is about four times as long as broad and bears a finger-like apical process (longer in the male than in the female) and about seven long apical setæ; each joint bears a few short hairs, but the first, eleventh, thirteenth, and sixteenth have each one larger apical seta; the joints of the right male antennæ (fig. 2) are greatly reduced in number by coalescence, the last three being very long

and slender, the limb is much swollen at the hinge, and again a little above, and is provided with denticulated plates above and below the hinge joint; the setæ are but few except for a dense tuft at the extremity of the last joint. The rudimentary apical portion of the lower foot jaw (fig. 8) is obscurely (3?) jointed, and on its upper margin bears a corrugated segment sharply separated lengthwise from the lower portion of the limb. Terminal spines of the swimming feet, long, slender, and sword-shaped (fig. 13); the secondary spine is much larger than usual, and both are finely serrated on the inner edge. Fifth pair of feet in the female (fig. 12) two branched; branches nearly straight, cylindrical, and one-jointed; the inner one short and cloven at the apex, the outer twice as long, bearing one short spine at the middle of the outer margin, and one very long and two short at the distal extremity. Fifth pair in the male (fig. 11) composed of one branch on the left and two on the right side, three-jointed; those of the left foot broad and sub-quadrate, the last joint spinous at the angles; first joint of the right foot narrow, and having a short one-jointed branch which ends in a curved claw; second joint short and armed with a curved spine on the inner margin; third joint produced into a long slender claw. Abdomen of the female (figs. 15, 16) three-jointed; the first segment short and stout, the second smaller and produced downwards as far as the middle of the dorsal surface of the third segment; produced also into two small lateral spines. Caudal segments as long as the last abdominal segment in the female,

in the male as long as the last two. The third and fourth abdominal segments in the male each bear a sharp projecting spine on the right side, and the last thoracic segment is produced downwards into a hook-like spine. The caudal setæ are not as long as the abdomen. Length of the animal $\frac{1}{17}$ th of an inch (1.5 mm.). Colour dark brown.

This species is at times taken in great abundance by the surface net. I have a gathering taken in this way by Mr. E. C. Davison off the Yorkshire coast, which more than filled a four ounce bottle, and consisted of about equal quantities of *P. brevicornis*, *Anomalocera Patersonii*, and larval decapods. I have also notes of its occurrence in surface gatherings from Bridlington Bay, the Channel Islands, Westport Bay (Ireland), and Kinsale Harbour; in gatherings made amongst Algæ and *Zostera* at Clifden Bay and the Scilly Islands, as well as in tide pools on the Durham coast; also in dredged material from Cumbrae and Portincross, Firth of Clyde.

Sub-family 2.—PONTELLINÆ, *Dana*.

Having two or more paired lateral eyes, in addition to a large median eye which usually springs from behind the rostrum as a projecting globe; in other respects like *Calanina*.

*Genus 11. PONTELLA, Dana (1849).**(Pontia, Milne-Edwards.)*

Head distinct from thorax; fourth and fifth thoracic segments coalescent. Abdomen of the male 5-, of the female (2-?) or 3-jointed. Anterior antennæ 23- or 24-jointed; the sixth and seventh joints coalescent or distinct; the right antenna of the male greatly swollen in the middle from the thirteenth to the sixteenth, and hinged between the nineteenth and twentieth joints; the seventeenth, eighteenth, and nineteenth united into one long joint, which is toothed on the inner margin; the twentieth and twenty-first joints also coalescent and toothed. Posterior antenna having a well-developed secondary branch. Maxilla (Pl. 10A, fig. 6), well developed, composed of a broad prehensile portion, with a large 3- or 4-lobed branchial palp. Mandible-palp 2-branched, of moderate size. Basal portion of the posterior foot-jaw produced into three setiferous digits, apical portion 4-jointed, elongated. Inner branches of all the swimming feet 2-jointed. Fifth pair of feet on the right side only in the male, forming a powerful clasping organ, that of the left side much less strongly developed.

1. PONTELLA WOLLASTONI, *Lubbock*. Pl. X A, figs.
1—12.

Pontella Wollastoni, Lubbock. Ann. and Mag. Nat. Hist. series
2. vol. xx, p. 406, pl. xi, figs, 9—11, 18,
and pl. x, fig. 13, (1857).

— *helgolandica*, Claus. Die frei-lebenden Copepoden
p. 208, taf. iii, figs. 5—7; taf. xxxvi, figs.
1—10; taf. xxxvii, fig. 7, (1863).

Body elongated; anterior antennæ about as long as the cephalothorax, that of the male, on the right side, having two hook-like spines, one on the sixteenth and one on the seventeenth joint (fig. 2). The inner branch of the mandible palp is 4-, the outer 2-jointed. The right foot of the fifth pair in the male is 4-jointed (fig. 10); the second joint very broad, and produced at the inner margin into a long hook-like spine, the third joint slender, forming a movable prehensile hand, to which is attached the fourth joint in the shape of a strong claw; the foot of the left side (fig. 9) consists of a broad 2-jointed basal portion, to the extremity of which are attached two short branches, one subtriangular, which terminates in two small claw-like processes, the other broad, 2-jointed, the terminal joint bearing three marginal setæ, and a fringe of short fine hairs. The rostrum is broad and strong. Lateral angles of the last thoracic segment equal and armed with short hooks. Abdomen slender; the last two segments, in the male, short; caudal segments elongated, in the

male, as long as the last three segments. Abdomen of the female 3-jointed, both lenses of the paired eyes, and that of the median eye, smaller than in the male; the fifth foot (fig. 11) is composed of a 2-jointed basal portion, to which are attached two long subtriangular plates. Length $\frac{1}{8}$ th of an inch (3 mm.).

This species is known to me only from the type specimens which were taken by Sir John Lubbock at Weymouth, and which by his kindness I have had the opportunity of examining. They are not now in a condition to allow of accurate description, and I am, therefore, indebted chiefly to the excellent figures and descriptions of Dr. Claus and Sir John Lubbock, for the account of the species here given. That the *Pontella helgolandica* of Dr. Claus is identical with Sir John Lubbock's *P. Wollastoni*, there can be no doubt.

Genus 12. ANOMALOCERA, Templeton (1837).

(*Irenæus*, Goodsir.)

Body elongated. Head produced into a strong furcate rostrum, distinct from the thorax and incompletely divided by a transverse groove into two segments. The median eye is stalked. Lateral eyes sessile, each composed of two lenses (fig. 14). Anterior antennæ 24-jointed, that of the right side in the male forming a prehensile organ. Secondary branch of the posterior antennæ very small. Inner branch (fig. 2) of first pair of feet 3-jointed, those of the three

following pairs 2-jointed. Fifth pair of feet in the female having a rudimentary inner, and a long two-jointed outer branch; in the male, the inner branch is wanting, and the outer forms a prehensile organ.

1. ANOMALOCERA PATERSONII, *Templeton*. Plate XI, figs. 1—14, and Plate X, figs. 13, 14.

Anomalocera Patersonii, Templeton. Trans. Entom. Soc., vol. ii, p. 35. t. v, figs. 1—3 (1837).

— — Baird. Brit. Entom., p. 229, tab. xxvii, figs. 1 *a—i*, 2 *a—c*, (1850).

— — Boeck. Oversigt Norges Copepoder, p. 21, (1864).

Irenæus Patersonii, Goodsir. Edin. New Phil. Journ., xxxv, p. 339, t. vi, figs. 12—17; t. iv, figs. 1—9, 1843).

— — Claus, Die frei-lebenden Copopoden, p. 206, taf. ii, fig. 1; t. xxxvii, figs. 1—6, (1863).

Pontia Patersonii, Kroyer. Nat. Hist. Tidsskrift, anden Rækkes andet Bind, p. 561, t. vi, figs. 1—7 (1849).

Body elongated; inferior angles of last thoracic segment produced into large spine-like processes. Anterior antennæ half the length of the body, 24-jointed, those of the male (figs. 2, 3) provided with club-shaped (auditory?) appendages, in addition to numerous short hairs; that of the right side in the male excessively tumid in the middle from the thirteenth to the sixteenth joint, and hinged between the seventeenth and eighteenth joints. The fourteenth joint bears a long, straight, dagger-like spine, which is hooked at the apex and apparently jointed at the base, much like the sting of a nettle. The sixteenth, seventeenth, and eighteenth joints have

denticulated plates on their inner margins. The number of joints is reduced by coalescence to twenty-one. The main branch of the posterior antenna (fig. 5) is triarticulate; the secondary branch composed of five joints, of which all except the second are very small. The branchial appendages of the maxillæ (fig. 13, Plate X) are well developed, and the setæ of the prehensile lobes are strong and plumose. The anterior foot-jaws (fig. 14, Plate X) are large and armed with stout, curved, plumose setæ. Lower foot-jaws (fig. Pl. XI), 7-jointed, the basal joint very large, and bearing five long, curved, plumose setæ; the remaining joints slender. First pair of swimming feet small, both branches three-jointed. Second, third, and fourth pairs large, but having the inner branch two-jointed, and the terminal spines (fig. 7) long and slender, sword-shaped, finely serrated on the inner and setose on the outer margin. Fifth pair of feet in the female (figs 9, 10) two-branched; the inner branch rudimentary, consisting of one small joint with a cloven apex; outer branch long, two-jointed; the first joint long, bearing two small spines on the outer side, and one long one at the inner apical angle; second joint small, having three terminal spines, the innermost of which is longer than the other two, and is roughened with a series of wart-like prominences on the outer edge. Fifth foot of the male (fig. 8) composed of one branch, four-jointed, the last two joints forming a sort of grasping hand. The last thoracic segment of the male is produced only on the right side into a projecting spine. The inferior (ventral) angle

of the first abdominal segment of the female (fig. 11) is produced backwards forming a rather slender spine of about half the length of the second segment;* the third segment has a gibbous projection of the dorsal margin. Caudal segments in the female unequal in size, about once and a half as long as broad (fig. 12); in the male (fig. 13) slender and elongated, about four times as long as broad. Caudal setæ scarcely as long as the abdomen, stout and plumose. The rostrum is stout and furcate, the median eye stalked (fig. 2), and forming a conspicuous dark-coloured blue or brown globe; the lateral eyes (fig. 14) consist each of two comparatively small transparent circular lenses situated near the base of the rostrum. Length $\frac{1.2}{100}$ ths — $\frac{1.8}{100}$ ths of an inch (3—6 mm.). In colour *A. Patersonii* varies much; it is seldom without some trace of yellow and blue colouring, but not unfrequently the tints are so vivid and varied as to make the little animal quite a gorgeous object under the microscope. The representation of these varied hues given in fig. 1 is by no means exaggerated, and was drawn with as much accuracy as possible from one of many such specimens taken off Shetland by the Rev. A. M. Norman. It may be noted that in the antennæ and abdomen blue generally prevails, but over the body various shades of red, yellow, and green.

Anomalocera Patersonii is generally distributed over the Atlantic and the North Sea, as well as in the

* I have never been able to find the spine, which is said by Dr. Claus to exist on the first segment of the male abdomen.

Mediterranean; and often occurs in immense profusion.

Family 2. MISOPHRIIDÆ. Nov. fam.

Anterior antennæ 7- to 18-jointed, much shorter than the cephalothorax. No supplementary eyes, no furcate rostrum. Posterior antennæ provided with a large secondary branch; mandible-palp large and two-branched. Maxillæ and foot-jaws as in *Calanidæ*.

The characters here given are to a considerable extent intermediate between those of the *Cyclopidæ* and *Calanidæ*. The general habit of the three genera at present included in the family—*Misophria*, *Pseudocyclops*, and *Cervinia*—is decidedly akin to that of the *Cyclopidæ*; so also are the anterior antennæ and the swimming feet; the posterior antennæ and mouth-organs, on the other hand, more closely resemble the *Calanidæ*. Under these circumstances I propose to constitute a new family, *Misophriidæ*, for the reception of the three genera.

Diagnosis of Genera of Misophriidæ.

Anterior antennæ.	{	16—18-jointed; secondary branch of posterior antenna	{	six-jointed <i>Misophria</i> .
			{	two-jointed..... <i>Pseudocyclops</i> .
	{	7-jointed; secondary branch of posterior antenna—four-jointed		..... <i>Cervinia</i> .

Genus 1. MISOPHRIA, Boeck (1864).

Form of the animal closely resembling that of *Cyclops*. First pair of antennæ many-jointed: second pair large, two-branched, the primary branch composed of four large joints (Pl. XIII, fig. 12), the secondary branch of six small ones and attached to the basal joint of the larger branch. Mandibles (Pl. XVIII, fig. 12) large and strong, armed with several strong curved teeth, palp large, composed of a large basal joint and two one-jointed branchial branches. Maxillæ (Pl. XVIII, fig. 11) strong and provided with a largely developed palp which bears three appendages beset with branchial filaments. First pair of foot-jaws (Pl. XIII, fig. 13) short and broad and bearing four processes, each of which has several stout setæ at the apex. Second pair (Pl. XIII, fig. 14) more slender and like those of the *Calanidæ*. The swimming feet are like those of *Cyclops*: fifth pair small and consisting of only one branch.

1. MISOPHRIA PALLIDA, *Boeck*, Plate XIII, figs. 11—16,
and Plate XVIII, figs. 11, 12.

Misophria pallida, *Boeck*. Oversigt Norges Copepoder, p. 24 (1864).

First pair of antennæ 16-jointed, and about half the length of the first body segment (Pl. XIII, fig. 11 ;

the first three or four joints much thicker than the rest, fourteenth and fifteenth joints the smallest, and together about equal in length to the terminal joint. The secondary branch of the lower antenna (fig. 12) is much more slender than the primary, and is composed of six small joints of nearly equal length. The first pair of swimming feet are very small, and they, as well as the following three pairs, have both branches composed of three joints. The fifth pair of feet (fig. 15) are 1-branched, 3-jointed, the first joint broad and short, the second somewhat narrower, but of about the same length, the third longer and a little more slender; the first two joints each bear a stout apical seta, the third three more slender setæ. Last joints of the abdomen very short, tail segments (fig. 16), about as broad as long.

I had until lately seen but one example of this species, which was taken off Hawthorn (Durham Coast) on a sandy bottom in a depth of 27 fathoms, but while these sheets have been going through the press I have found other examples in a dredging from Portincross (Ayrshire), and in washings of *Laminaria* roots from Mulroy Lough (Donegal). It would appear to be of rare occurrence, as M. Boeck also had met with only one specimen. Though placed by that author amongst the Cyclopidae, I prefer to associate *Misophria* with *Pseudocyclops* and *Cervinia* as a distinct family. These genera must be looked upon as transitional forms occupying a position between the families *Calanidae* and *Cyclopidae*. There are some slight discrepancies between the description

here given and that of M. Boeck; these result probably from the observations in each case being confined to a single specimen, but judging from drawings kindly sent to me by that author, not long before his death, I have no doubt of the specific identity of the British and Norwegian specimens.

Genus 2. PSEUDOCYCLOPS, Brady (1872).

Body robust, head distinct from thorax; abdomen much more slender than the thorax, and composed of four segments in the male, of three in the female. Right anterior antenna of the male imperfectly hinged, swollen in the middle. Posterior antenna 2-branched, the secondary branch large, 2-jointed, first joint much expanded at the distal extremity, second joint small. Mandibles well developed, broad and strongly toothed at the extremity and having a large 2-branched palp. Maxillæ provided with a large, many-lobed palp. Upper foot-jaw robust, composed of three large basal, and three or four small apical joints; lower foot-jaw 4-jointed, bearing several long, setiferous marginal processes. First four pairs of feet 2-branched, each branch 3-jointed and adapted for swimming; fifth pair in the female composed of two 3-jointed branches, the inner branch much reduced in size; fifth pair in the male 2-branched, very complex in structure, adapted for clasping, and closely resembling the male copulative organs of some Ostracoda.

Though decidedly Cyclopoid in general form and appearance, this curious genus is perhaps more nearly allied to the *Calanidæ*, seeing that it agrees with the members of that family in possessing a biramose inferior antenna, and a large 2-branched mandible-palp; the maxillæ and foot-jaws also agree with those of the *Calanidæ*, though the feet, except in the fifth pair, resemble more closely those of the Cyclopidaë.

M. Boeck thought that this genus belonged to the male of his *Misophria*; but in this opinion I am unable to agree. Of the species first described (*Pseudocyclops crassiremis*) it is true that I found only the male; but of *P. obtusatus* I have taken many specimens, both male and female. From *Misophria* the genus is clearly distinguished by several characters, notably the following: the basal joint of the secondary branch of the posterior antenna is excessively broad and truncate, the succeeding joint or joints being very narrow, and the fifth foot in the female is distinctly 2-branched, each branch being triarticulate.

1. PSEUDOCYCLOPS CRASSIREMIS, *Brady*. Plate VII, figs. 1, 2, and Plate XII, fig. 14.

Pseudocyclops crassiremis, Brady. Nat. Hist. Trans. Northumberland and Durham, vol. iv p. 431, pl. xvii, figs. 1—8 (1872).

Left anterior antenna of male (Pl. VII, fig. 2) 17-jointed, basal joint large and stout, those next following

very short and broad, gradually decreasing in breadth to the fifteenth, which is about as long as broad ; last two joints more slender, about twice as long as broad, the whole limb densely beset on the outer margin, especially towards the base, with long setæ ; antenna of right side (fig. 1) 10-jointed, the central joints much enlarged, last two suddenly contracted and similar to those of the left side, antepenultimate joint armed with a strong lateral subfalciform process. Both branches of posterior antennæ bearing numerous long, curved terminal setæ, first joint of the lower branch enlarged and truncate at the distal end. Maxillæ composed of four digitate lobes, each bearing four long terminal setæ. Lower foot-jaw stout, with almost entire margins. Joints of swimming feet very broad, subtriangular, much produced at the external distal angle. Abdomen slender, 4-jointed, tail setæ slender, finely plumose, the longest equal to about twice the length of the abdomen. Length of animal $\frac{1}{38}$ th of an inch (.66 mm.).

Hab.—Off Seaham Harbour (Durham) dredged in a depth of twenty to thirty fathoms. One specimen only taken.

The type specimen of this species having been destroyed in dissection, I have now no opportunity of confirming the original description, and, though entertaining some doubt as to its distinctness, I retain it provisionally until its claim to specific rank can be further investigated.

2. PSEUDOCYCLOPS OBTUSATUS, *Brady and Robertson*. Pl.
XII, figs. 1—13.

Pseudocyclops obtusatus, B. & R. Ann. and Mag. Nat. Hist.,
ser. iv, vol. xii, p. 128, pl. viii, figs.
4—7 (1873).

Cephalothorax very tumid, obtusely rounded in front down to the rectangular and almost obsolete rostrum; dorsum strongly arched; first segment very large, nearly equal in length to half the cephalothorax; abdomen slender, in the male 5-, in the female 4-jointed. Anterior antennæ (figs. 2, 3) 18-jointed, stout, and about equal in length to the first cephalothoracic segment; basal joints (except the first) extremely short, gradually increasing in length to the terminal joint, which is twice as long as broad, closely beset on the anterior margin with hairs of moderate length; right antenna of the male swollen in the middle, but having no true hinge-joint: posterior antennæ 4-jointed (fig. 4), with a large biarticulate secondary branch springing from the basal joint. Mandible-palp (fig. 5) large, having a uniarticulate secondary branch. First four pairs of swimming feet (fig. 9) stoutly built, with short setæ and broad marginal lancet-shaped spines; branches subequal, triarticulate; the setæ of the inner margins (fig. 12) are peculiar, consisting of short, slender, abruptly truncated rods, from the extremities of which spring solitary short hairs: fifth pair (fig.

12) in the female having the inner branch very short, and beset with a few short transverse rows of minute setæ; those of the male (fig. 11) largely developed, each formed apparently of two modified 3-jointed branches, the outer branch on each side forming a strong terminal spine, and on the right having also a very large falciform claw; the remaining processes form a number of irregular lacinated plates. Abdominal segments short; caudal segments scarcely twice as long as broad; the longest tail-seta about equal in length to the abdomen. Length $\frac{1}{33}$ rd of an inch (.77 mm.).

P. obtusatus was taken, rather sparingly, by my friend Mr. David Robertson and myself in the surface-net during a moonlight cruise in Roundstone Bay, in July 1871. We have more recently found three or four specimens in a dredging made off the Island of Cumbrae in the Firth of Clyde, and others in washings of Laminaria from Mulroy Lough (Donegal).

Genus 3. CERVINIA, Norman, MS.

Body cylindrical, head small, united with first thoracic segment; abdomen 5-jointed, distinct from thorax; caudal segments elongated. Anterior antennæ short, 7-jointed; posterior larger, 3-jointed, the basal joint large and bearing a 4-jointed secondary branch. Mandible palp large, 2-branched; maxillar palp composed of two digitiform segments. Anterior

foot-jaw stout, 4-jointed, the three distal joints densely setiferous at the apex, the basal joint bearing three small marginal setiferous processes; posterior foot-jaw 5-jointed, with strong marginal spines and several apical setæ. All the swimming feet having both branches 3-jointed; fifth pair either absent or extremely small.

1. CERVINIA BRADYI, *Norman*, MS., Pl. XXIV A, figs. 3—13.

The anterior antennæ are not longer than the first body-segment, stout, and scarcely tapering towards the apex, first three joints broader and longer than the rest; distal half densely clothed with rather long setæ, most of which are strongly plumose (fig. 4). Posterior antennæ (fig. 5) very stout, 3-jointed, longer than the first pair; basal joint very large, about four times as long as the second, and twice as long as the third joint, bearing on its upper surface two hairs, and on the under a 4-jointed secondary branch; the second joint has 2 strong spine-like setæ at the apex, one of which is armed with three long lateral spines near its point, the other being densely clothed with short marginal setæ; the last joint bears four strong curved terminal spines, the two smaller of which are densely fringed with short cilia, the other two with strong divaricate spines;

the secondary branch has its two median joints very short, and bears three terminal setæ, each of the three preceding joints bearing a single long plumose seta. The biting extremity of the mandible (fig. 6) is broad and strongly toothed, palp composed of a large basal joint and two slender branches, one of which is indistinctly 3-jointed; all these bear numerous long plumose setæ. The first pair of swimming feet (fig. 10) is somewhat smaller than the following pairs, and has both branches of nearly equal length, the marginal spines are long and slender, the setæ short, and the first two joints narrowed at the bases. The second pair (fig. 11) has the peduncle forming a rounded process on the inner side (fig. 2*a*); branches subequal, with all the joints much narrowed at the bases; first joint of the inner branch (*b*) very large, distally dilated, outer angle acute and slightly produced, inner forming two very long curved spinous processes. Third pair (fig. 12) much like the second, except that the inner branch is shorter, the bases of the last two joints are not much narrowed, and the first joint has only one large curved spine (*c*); the fourth pair (fig. 13) has the inner branch very short, the marginal spine of the first joint being reduced to a curved bristle (*d*); the joints of the outer branch are elongated and basally constricted. The fifth pair were not observed, and are either entirely absent or very small. Caudal segments slender, about five times as long as broad, and equal in length to the last two abdominal rings; setæ strongly plumose, short, the longest about equal to the last four

abdominal segments. Length $\frac{1}{17}$ th of an inch (1.5 mm.).

A few (three) specimens only of this very remarkable copepod were taken by the Rev. Alfred Merle Norman in the dredge at Oban, in July, 1877. Its distinctive characters, especially as regards the antennæ and feet, will be recognised at a glance by reference to the Plate, and need not be further dwelt upon. The animal appears to be colourless or nearly so; all Mr. Norman's specimens are of the same sex, probably females, though none of them bear ova.

Fam. 3. CYCLOPIDÆ, *Baird* in part.

Body elongated; cephalothorax ovate and usually sharply separated from the abdomen, which is much more slender. Anterior antennæ of moderate length, scarcely ever longer than the cephalothorax; those of the male alike at both sides and adapted for clasping. Posterior antennæ 4-jointed and destitute of a secondary branch. Palps of mandibles and maxillæ well developed, or in some cases rudimentary. Foot-jaws nearly similar to those of the *Calanidæ*, but usually less strongly developed. First four pairs of feet alike or nearly so, 2-branched and adapted for swimming; never in any case for prehension. Fifth pair rudimentary, alike in both sexes. Heart wanting. Eye consisting of two coalescent lenses. Two ovisacs in the female.

The family *Cyclopidæ* differs from *Calanidæ* chiefly

in the absence of a secondary branch from the lower antennæ, and in the conformation of the fifth pair of feet, which are rudimentary, and alike in both sexes, those of the male not being used as clasping organs. The presence of two ovisacs in the female is another distinctive character. From *Harpactidæ* the family is distinguished mainly by the conformation of the foot-jaws and first pair of swimming feet, all of which in the latter family form powerful clawed prehensile organs; other less conspicuous differences, however, occur, as in the structure of the lower antennæ and the fifth pair of feet. The family at present includes only five British genera, one of which (*Cyclops*) is confined to fresh water; the rest are exclusively marine.

Diagnosis of Genera of Cyclopidæ.

Mandible-palp	{	rudimentary, reduced to a tubercle bearing two branchial filaments.	{	prehensile; with uncinatè terminal claws	<i>Thorellia.</i>
		Lower foot-jaw		not prehensile	<i>Cyclops.</i>
Mandible-palp	{	two-branched, secondary branch composed of	{	many joints	<i>Oithona.</i>
				one joint; fifth pair of feet	} foliaceous .....	Lophophorus.
				} 2- or 3-jointed, cylindrical ...	<i>Cyclopina.</i>

Genus 1. OITHONA, Baird (1843).

(Zoologist, 1843.)

Body much like that of *Cyclops*, but greatly attenuated. Head quite distinct from thorax. First pair of antennæ (Pl. XIV, fig. 2) much elongated, and, in the male, adapted on both sides for clasping: second pair (fig. 3) 4-jointed and destitute of any secondary branch. Mandible-palp (fig. 4) elongated, slender, bearing two stout dentated apical spines and a jointed secondary branch, together with a ciliated wart-like marginal process. Maxillæ stout, having a short 2-branched palp. First pair of foot-jaws (fig. 6) long and slender (somewhat like those of *Calanus*); second pair (fig. 7) also as in *Calanus*, but the terminal portion is indistinctly jointed. First four pairs of feet (fig. 8) 2-branched, all the branches 3-jointed. Last pair of feet rudimentary, bearing two small setiferous papillæ.

1. OITHONA SPINIFRONS, *Boeck*. Plate XIV, figs. 1—9; and Plate XXIV A, figs. 1, 2.

Oithona spinifrons, *Boeck*. Oversigt Norges Copepoder, p. 25 (1864).

? — *helgolandica*, *Claus*. Die frei-lebenden Copepoden, p. 105, t. xi, figs. 10—12 (1863).

First pair of antennæ about as long as the cephalothorax, 10- (11-?) jointed, beset, especially near base and

apex, with numerous very long setæ ; rostrum (Pl. XIV, fig. 1) small, pointed, and slender ; abdomen extremely long and slender ; second joint long, third and fifth of moderate length and about equal, fourth somewhat shorter ; tail segments shorter than any of the abdominal joints. Two median tail setæ of nearly equal length and about as long as the abdomen ; a small seta attached near the base of external margin of caudal segments. Length $\frac{1}{30}$ th of an inch (.85 mm.).

I have found this species in many gatherings from various parts of the British seas ; but, owing to the minuteness, together with the extreme delicacy and transparency, of the animal, have found it very difficult to dissect and examine satisfactorily. I think there can be little doubt of the identity of the species with Boeck's *O. spinifrons*, but I am not at all satisfied that this is not synonymous with *O. helgolandica*, Claus.

The following are some of the localities in which it has been observed : in the North Sea off Sunderland, Whitby and Bridlington, and in the Firth of Forth ; off Cumbrae in the Firth of Clyde ; off the Skelligs, and in Westport Bay, Kinsale and Valentia Harbours, Ireland. So far as I know it haunts exclusively the surface of the sea, being taken only in the towing-net.

Genus 2. CYCLOPINA, Claus (1863).

(Die frei-lebenden Copepoden p. 103, 1863.)

Body elongated and cyclopoid in form. First pair of

antennæ shorter than the cephalic segment, which is separated from the thorax. Second pair 4-jointed, the third joint very short; no secondary branch. Mouth-organs (figs. 4—7) as in the *Calanidæ*. First four pairs of feet 2-branched, both branches 3-jointed; fifth pair cylindrical, 2—3-jointed, composed each of one branch only, alike in both sexes.

This differs from the following genus *Thorellia* in the structure of the mouth-organs, especially in having a well-developed biramose mandibular palp, and in the non-prehensile character of the second foot-jaw.

1. *CYCLOPINA LITTORALIS*, *Brady*. Pl. XV, figs. 1—9.

Cyclops littoralis, Brady. Nat. Hist. Trans. Northumberland and Durham, vol. iv, p. 429, pl. xvii, figs. 9—14 (1872).

Anterior antennæ of the female short, 22- (23-?) jointed (fig. 2), joints from the third to the ninth very wide, being about three times as broad as long, the remainder subequal and about as broad as long; the seventh from the apex is produced considerably at its outer angle, and the whole limb is rather thickly set with long hairs. Mandible (fig. 4) provided with several strong, sharp teeth; palp 2-branched, the larger branch 3-jointed, the smaller composed of one joint. First and second joints of the fifth foot (fig. 8) short and broad, third much smaller and bearing four small terminal setæ, one of which is much longer and one much shorter than

the rest. Abdomen long and slender, the last two joints about as long as broad and shorter than either of the preceding two; caudal segments (fig. 9) slender, about four times as long as broad; the innermost of the two median tail setæ is nearly twice as long as the outer, the other two setæ very short; the caudal segments bear also a seta on the external margin not far from the base. Length $\frac{1}{35}$ th of an inch (.75 mm.).

C. littoralis, though distributed pretty generally round the coasts of Britain, has never been found in abundance, seldom more than one or two specimens in a gathering. It is, however, a very well-marked and distinct species and apparently quite different from those described by MM. Boeck and Claus. I have found it amongst weeds between tide-marks on the coasts of Northumberland and Durham (Whitley and Ryhope), and in the same district in depths of 4—45 fathoms; amongst the Scilly Islands in 14 fathoms; in Lough Swilly in 2 fathoms; and in Mulroy Lough (Donegal) in 16 fathoms.

2. CYCLOPINA GRACILIS, *Claus*. Pl. XXIV B, figs. 1—9,
and Pl. XCI, figs. 10, 11.

Cyclopina gracilis, Claus. Die frei-lebenden Copepoden, p. 104,
taf. x, figs. 9—15 (1863).

Body oblong-ovate, with a long and slender abdomen (fig. 9). First abdominal segment in the female nearly as long as the following three; last segment very short, about half as long as the furca, the

rami of which are three times as long as broad, and have a short seta on the external margin not far from the base; the terminal tail setæ are shortly plumose, the longest scarcely as long as the abdomen. Anterior antennæ (fig. 2) 11-jointed, the seventh joint much the longest and more slender than the six basal joints. The following formula represents the relative lengths of the joints :

1,	2,	3,	4,	5,	6,	7,	8,	9,	10,	11
7	8	4	6	2	5	14	6	4	4	5

The third joint of the posterior antenna (fig. 3) is very short, the terminal setæ sharply curved at their apices. Mandibles (fig. 4) divided at the apex into five sharp, slender teeth; basal portion of the palp elongated, bearing one terminal seta and two 1-jointed setiferous branches. Maxilla (fig. 5) having a large 3-lobed palp. Anterior foot-jaw (fig. 6) stout, 4-jointed, with several marginal setiferous processes; posterior slender, 5-jointed (fig. 7), the last three joints very short. Marginal setæ of the swimming-feet (fig. 8) short; spines of the outer branches sharp and slender; fifth pair of feet (fig. 9 *a, a*) 2-jointed, the terminal joint bearing four apical, subequal setæ. Length $\frac{1}{42}$ nd of an inch (.65 mm.).

Several specimens of *Cyclopina gracilis* were taken by the Rev. Alfred Merle Norman at Oban during the summer of this year (1877), and my own collection contains a few examples found amongst *Zostera* at Rathmullen (Lough Swilly).

3. CYCLOPINA (?) OVALIS, *Brady*, Sec Appendix, vol. 2.

Genus 3. THORELLIA, Boeck (1864).

(*Thorellia*, Boeck, *Oversigt*, &c., 1864. *Cyclops*, Norman, 1868. ? *Euryte* Philippi, Weigmann's *Archiv*, 1843.)

Body cyclopoid in shape. First pair of antennæ much shorter than the cephalothorax, many-jointed; second pair 4-jointed, unbranched. Mandibles, maxillæ, and first pair of foot-jaws as in *Cyclops*. Second pair of foot-jaws (Pl. XVI, fig. 8) 4-jointed, and forming a prehensile limb terminating in two uncinatè claws. First four pairs of feet 2-branched and adapted for swimming, each branch 3-jointed. Fifth pair of feet rudimentary, composed of a single branch.

1. *THORELLIA BRUNNEA, Boeck.* Pl. XVI, figs. 1—10.

Thorellia brunnea, Boeck. *Oversigt over de ved Norges Kyster iagt.* Copep., p. 26 (1864).

Cyclops nigricauda, Norman. *Last Shetland Dredging Report*, p. 295 (1868).

— *pallidus* (young). *Idem*, *ibidem*, p. 295.

First pair of antennæ in the female (fig. 2), 21-jointed, much shorter than the first cephalothoracic segment (which consists of the head fused with the first segment of the thorax); first joint much the largest, second equally wide but much shorter; following seven joints very short in proportion to width; next ten about as broad as long; last joint more than twice as long as broad; the whole limb beset on its upper margin with long setæ: in the male (fig. 3) the

antennæ are short, geniculated, and 14-jointed. Fifth pair of feet (fig. 10) 2-jointed, first joint very small; the terminal joint bears three lancet-shaped spines and one or two smaller setæ. Abdomen of the female 4-jointed, the first joint as long as the united lengths of the rest; caudal segments as long as the three preceding joints, very slender, about eight times as long as broad; in the male much stouter and only three or four times as long as broad; tail setæ finely plumose, the longest as long as the abdomen proper. Colour brown, variously marked according to habitat; antennæ or caudal segments or both sometimes darkly tinged with brown, and a similarly coloured band across the first segment of the body. Ovisacs large and divergent. Length $\frac{1}{18}$ th of an inch (1.4 mm.).

Thorellia brunnea occurs not very uncommonly on the fronds of *Laminaria saccharina* and other fuci in littoral situations and beyond low-water mark; in such a habitat Mr. Norman found it abundantly at Tobermory in the island of Mull, and I have myself noticed it in Westport, Clifden, and Mulroy Bays, Ireland, and on the Durham Coast. With Mr. Robertson I have also dredged it off the Island of Cumbrae, and off the Yorkshire Coast in a depth of 35 fathoms. Kinsale Harbour (*Mr. E. C. Davison*).

This genus would appear to be identical with *Euryte* (Philippi), but the description and figures given by that author (Weigmann's 'Archiv,' 1843) are not copious enough to warrant my adopting his generic name. M. Boeck notices that the eye is not placed in the

middle line, but rather to one side, and I have myself confirmed this observation. The point, however, which most clearly marks out the genus as distinct, is the peculiar structure of the lower foot-jaw, which is only 4-jointed, and terminates in two remarkable hooked claws.

Genus 4. CYCLOPS, Müller (1776).

Body expanded in front, attenuated behind, composed in the male of ten, in the female of nine segments. Head anchylosed with the first thoracic segment. Both anterior antennæ, in the male, forming powerful hinged clasping organs, shorter than the cephalothorax. Posterior antennæ unbranched, 4-jointed. Mandible dilated and toothed at the extremity; palp reduced to a small tubercle, which bears two branchial filaments. Maxillary palp obsolete; maxillæ themselves conical and bearing several strong, curved, apical teeth, and marginal setæ. First pair of foot-jaws slender, armed with several long marginal spines and setæ, 4-jointed. Second pair much more robust, somewhat like the first pair in the Calanidæ; third joint forming a broad laminar process, armed on the margin with powerful claws; the smaller apical joint bearing in like manner two slender claws and setæ. First four pairs of swimming feet 2-branched, both branches 3-jointed. Fifth pair rudimentary, composed of not more than three joints. One eye. Two ovisacs.

As regards discrimination of species the genus *Cyclops* is perhaps the most difficult and puzzling of all the Copepoda. The rough characters dependant on colouring and conspicuous structural peculiarities, such as are in many groups appreciable with the help of an ordinary pocket lens, are here either absent, or so subject to variation as to be of small use as critical marks, while the numerous examples in various stages of development which are always met with in a copious gathering of Cyclopidae constitute a source of constant confusion. The only safe rule in this state of things is to accept no specimens as types which do not show amongst them ova-bearing females. I do not at all believe that the fourteen species described in this book are all, or nearly all, of what will be ultimately recognised as British. It is impossible to think that this number can represent the complete Cyclopid Fauna of Britain, while G. O. Sars has described twenty-seven fresh-water species from Norway. Dr. Anton Friè has, however, described only ten species from Bohemia, Dr. Claus thirteen from Germany, and Uljanin fourteen from Turkestan. Heller also has noted ten species from Tyrol, some of which (*C. Clausii* and *C. Grelleri*) he considers to be new. The specific name *Clausii*, however, cannot stand, having been applied years ago by Sir John Lubbock to a British species.

The genus appears to be confined entirely to fresh or to fresh and brackish water, and it is probable that the few marine forms which have been described by various authors as species of *Cyclops* will, on

further examination, be found to belong to some of the allied genera. For example, *Cyclops nigricauda*, Norman = *Thorellia brunnea*, Boeck; and *C. littoralis*, Brady = *Cyclopina littoralis* of this monograph. Amongst species which must for the present remain doubtful are *C. ovalis*, Brady, *C. magniceps*, Lilljeborg, and *C. Clausii*, Lubbock, of which last-named I have seen no specimens, notwithstanding Sir John Lubbock's kind effort to supply me. Failing these, I am unable to find sufficient distinctive character in the published description of *C. Clausii* to warrant my retaining it here as a separate species.

The points on which specific diagnosis in this genus chiefly depends are the characters of the first antennæ and fifth pair of feet. As offering subsidiary characters the spinous armature of the swimming feet, together with the tail-segments and setæ, are also important. The mode of disposition of the ovisacs, and to a certain extent the colouring of these and other parts of the body, afford also useful helps to diagnosis.

The following table, exhibiting the changes of structure which take place during the development of Cyclops, is taken from Dr. Claus's work on the 'Free-living Copepoda of Germany and the Mediterranean,' p. 82.

	Number of body segments, exclusive of furca	Number of pairs of swimming-feet	Condition of branches of swimming-feet.	Superior antennæ.
First stage, of about 0.4 mm. in size	5	2	1-jointed	5-jointed.
	5	2	"	6 "
Second stage	6	3	First two pairs with 2-jointed, third pair with 1-jointed branches.	6 "
	6				7 "
Third stage	7	4	First three pairs with 2-jointed, fourth pair, with 1-jointed branches	6 "
	7				7 "
Fourth stage	8	4	As the preceding	8 "
	8			
	8	4	2-jointed	9 "
	8		"	10 "
Last stage	9	4	3-jointed	10 "
	9		"	11 "

(A. *Anterior antennæ* 17-jointed.)

1. CYCLOPS SIGNATUS, Koch. Pl. XVII, figs. 4—12.

Cyclops signatus, Koch. Deutschlands Crustaceen, &c., H. xxi, tab. viii (*vide* G. O. Sars) (1841).

— — G. O. Sars. Oversigt af de indenlandske Ferskvandscopepoder, p. 33 (1863).

— — Uljanin. Reise in Turkestan (Crustacea), p. 29, t. ix, figs. 6—11; and t. xi, fig. 8 (1875).

Monoculus quadricornis fuscus, Jurine. Histoire des Monocles, p. 47, pl. iii, fig. 2; and *prasinus*, p. 49, pl. iii, fig. 5 (1820).

Cyclops quadricornis var. *c.*, Baird. British Entomostraca, p. 203, t. xxiv, fig. 5 (1850).

- Cyclops coronatus*, Claus. Über das Genus Cyclops (Weigmann's Archiv, 1857), taf. ii, figs. 1—11; and Die frei-lebenden Copepoden, p. 97, taf. ii, fig. 16, and taf. x, fig. 1 (1863).
- — Friè. Die Krustenthiere Böhmens, p. 218, fig. 11 (1871).
- *obesicornis*, ♂ Templeton. Trans. Entom. Soc. London, vol. i, p. 196, fig. 12 (*vide* Claus) (1836).

Cephalothorax broadly ovate. Anterior antennæ (fig. 4) quite as long as the cephalothorax, attenuated towards the extremity, and bearing on the last joint a serrated ridge; the two preceding joints also bear longitudinal crests of a similar character, but not toothed; these are interruptedly continuous with a somewhat similar line, which courses down the limb across most of the joints to near its base; the eighth, ninth, tenth, twelfth, thirteenth, and fourteenth joints have the distal border edged with rows of fine teeth. Posterior antennæ (fig. 6) long and slender; second joint fringed on its lower margin with a comb-like series of short spine-like hairs; third and fourth joints much more slender. Fifth foot (fig. 11) 2-jointed; basal joint large and broad, finely ciliated on the inner margin, and bearing at the outer distal angle a long seta; second joint much smaller, produced at the apex into a small median process, which gives attachment to a long slender seta; two stouter and shorter setæ are attached to the lateral angles. The first segment of the abdomen is as long as the two following, the fifth is the shortest; caudal segments broad and short, not equal in length to the two preceding segments. Outer tail-seta very short; the next equal in length to the whole abdomen, including

the furca; third about half as long again as the second; innermost half as long as the third. Length of the female $\frac{1}{10}$ th of an inch (2·55 mm.), that of the male about one third less. Colour dusky brown or approaching black, or bluish; ovisacs dark.

This is one of the most widely distributed and commonest of the genus, occurring not unfrequently in ponds, lakes, and ditches. The characters of the first and second antennæ, together with those of the ovisacs, suffice to distinguish it almost at a glance.

I have had no opportunity of seeing Koch's figures of *C. signatus*, but Professor G. O. Sars states that they are quite characteristic and belong, undoubtedly, to the species now under consideration.

2. CYCLOPS TENUICORNIS, *Claus.* Pl. XVIII, figs. 1—10.

- Cyclops tenuicornis*, Claus. Das Genus Cyclops, t. iii, figs. 1—11; Die frei-lebenden Copepoden, p. 99, t. i, fig. 3; t. ii, fig. 17; t. iv, fig. 5 (1857).
- — Sars. Oversigt af de indenlandske Ferskvandscopepoder, p. 33 (1863).
- — Uljanin. Reise in Turkestan (Crustacea), p. 30, t. ix, fig. 12, 13 (1875).
- — Friè. Die Krustenthierè Böhmens, p. 219, fig. 12 (1871).
- *quadricornis albidus*, Jurine. Hist. des Monocles, p. 44, t. ii, figs. 10, 11 (1820).
- — var. *b*, Baird. Brit. Entom., p. 202, pl. xxiv, fig. 4 (1850).

Body somewhat narrower than in the preceding species. Anterior antennæ (fig. 2) nearly as long as

the cephalothorax, broad at the base, and tapering gradually to the extremity; last three joints long and slender and bearing a simple untoothed longitudinal ridge; first, fourth, and seventh joints larger than the rest, clothed on the outer margin, more especially near the base, with long hairs. Posterior antennæ very slender; the last two joints of about equal length, the second shorter and finely setose on the lower margin. Fifth foot (fig. 7) 2-jointed, first joint large and having one long apical seta, second smaller, with one very long and one small seta, and terminating in a small process, which is provided with one long slender seta. Caudal segments about twice as long as broad, somewhat longer than the preceding abdominal segment. Longest of the tail setæ (fig. 8) about equal in length to the abdomen, densely plumose, as also are the setæ of the swimming feet. Ovisacs irregularly shaped and adpressed. Length $\frac{1}{10}$ th of an inch (2.55 mm.).

C. tenuicornis is a very abundant species, occurring in lakes, ponds, and ditches, throughout England, Scotland, and Ireland; it appears to be of equally common occurrence on the Continent of Europe, and is very nearly allied to *C. signatus*, from which, however, it is distinguishable at once by the characters of the antennæ.

3. CYCLOPS STRENUUS, *Fischer*. Pl. XIX, figs. 1—7.

- Monoculus quadricornis rubens*, Jurine. Hist. des Monocles, p. 1, pl. i, and pl. ii, figs. 1—9 (1820).
- Cyclops pictus*, Koch. Deutschlands Crust., H. xxi, tab. i (*vide* Sars) (1841).
- *strenuus*, Fischer. Bulletin de la Soc. Imp. des Nat. de Moscow, tom. xxiv, p. 419, tab. ix, figs. 12—21 (1851).
- — Sars. Oversigt Ferskvandscopepoder, p. 27 (1863).
- *quadricornis*, Lilljeborg. De crust. ex. ord. trib., p. 150, t. xiv, figs. 5, 6; t. xv, figs. 1—11; and t. xxvi, fig. 19 (1853).
- *brevicaudatus*, Claus. Das Genus Cyclops, p. 34, t. ii, fig. 12; Die frei-lebenden Copepoden, p. 100 (1857).
- — Friè. Die Krustenthierè Böhmens, p. 221, fig. 15 (1871).

Anterior antennæ (fig. 1) reaching about to the fourth thoracic segment, only slightly tapering towards the apex; last three joints much less slender than in the foregoing species; joints of the posterior antennæ short and stout. Joints of the swimming feet destitute of cilia at the margins. Fifth foot (fig. 6) composed of two joints, the first having a moderately long apical seta, the second one very long seta at the extremity, and a spine-like seta on the inner margin. Caudal segments slender (fig. 7), about three times as long as the last abdominal segment. Of the four caudal setæ, the outer is the shortest and only about half as long as the caudal segments; all the setæ are finely plumose; the third seta is the longest, and about once and a half

the length of the furca. Length $\frac{1}{11}$ th of an inch (2·3 mm.).

This species does not appear to be so common as either of the foregoing. I have memoranda of its occurrence only in three places, Belsay and Plessy (Northumberland) and Seaton Marsh (Durham).

4. CYCLOPS GIGAS, *Claus.* Pl. XX, figs. 1—16.

Cyclops gigas, Claus. Das Genus Cyclops (Weigmann's Archiv, Band xxiii), p. 207, t. xi, figs. 1—5; Die freilebend. Copep., p. 100 (1863).

— — Sars. Oversigt Ferskvandscopepoder, p. 35 (1863).

— — Friè. Die Krustenthierc Böhmcns, p. 220, fig. 14 (1871).

Anterior antennæ (fig. 1) reaching to the third segment of the body, broadest at the base and moderately tapered towards the extremity. Mandibles strongly toothed (figs. 2, 3). Setæ of the swimming feet densely plumose beyond the middle (figs. 7, 8). Fifth foot (fig. 9) 2-jointed; the basal joint excessively broad and bearing a very long bristle at the outer angle; second joint much narrower and armed with a small spine and a long seta. The borders of the abdominal segments are beset with rows of small serratures or comb-like points; caudal segments moderately stout, equal to more than the length of the two preceding segments. Of the four strongly plumose tail setæ (fig. 10), the outer is much the shortest and distinctly shorter than the furca; the

innermost is about twice as long; the third is the largest, being longer than the whole abdomen. Colour brown. Length $\frac{1}{9}$ th of an inch (2·7 mm.).

The mature form of *C. gigas* I have taken in Lough Corrib (Ireland), and Lough Skene (Dumfries), and it occurs abundantly in a gathering sent to me by the Rev. H. A. Gatty from a pond at Donnington, near York, and in one from a pond in Lambton Park (Durham), for which I am indebted to the Rev. A. M. Norman. A form which, at one time, I believed to be specifically distinct, I have found abundantly in a great number of localities; it is characterised by having all the branches of the swimming-feet in the female 2-jointed, while in the male they are 3-jointed; but as I have never found any females bearing ovi-sacs, as the antennæ are only 11-jointed (this in itself being a character of the last stage of development before attaining maturity), and as the rudimentary (fifth) feet and other organs closely agree with those of *C. gigas*, I can scarcely doubt that it ought to be referred to that species. The immature form is figured in Pl. XX, figs. 11—16. I have found it plentifully in many of the lakes of Cumberland, Westmorland, and Northumberland, in the "Broads" of Norfolk and Suffolk, in Lough Skene (Dumfries), and in some ponds in the County of Durham.

5. CYCLOPS PULCHELLUS, *Koch.* Pl. XVII, figs. 1—3.

Cyclops pulchellus, Koch. Deutschlands Crust., H. xxi, t. ii (1841).
 — — Sars. Oversigt af de indenlandske Fersk-
 vandscopepoder, p. 37 (1863).

Body elongated, gradually tapered from above downwards; no marked separation between thorax and abdomen; the segments of the thorax, especially the penultimate one, are produced and acuminate at the posterior angles; the last thoracic segment, however, is not angulated, and is scarcely broader than the first abdominal ring. First pair of antennæ about as long as the first body segment. Abdomen slender and gradually tapering; caudal segments very slender, five or six times as long as broad, and more than equal in length to the last three abdominal segments. Outer and inner caudal setæ very short, the middle seta of moderate length, equal to that of the abdomen without the furca, finely plumose; a small seta on the external margin of the furca below the middle. Fifth foot 2-jointed (fig. 3); joints about equal in size; the first bearing one seta of moderate length; the second one long seta and a short spine. "Ovisacs elongate-ovate and widely divergent" (Sars). Length $\frac{1}{12}$ th of an inch (2.1 mm.).

This is one of the rarer British species. The following are the only localities in which I have known it to occur:—Bolam Lake and Paston Tarn (Northumberland), and a pond at Tresco (Scilly).

I have had no opportunity of comparing my specimens with Koch's figures; but they seem to agree in almost all points with Sars' description, the only important difference which I can discover referring to the fifth foot; Sars says, "articulus basalis minimus," whereas in my specimens the joints are about equal in size, and neither of them very small.

(B. *Anterior antennæ* 14-jointed.)

6. CYCLOPS INSIGNIS, *Claus.* Pl. XXI, figs. 1—9.

- Cyclops insignis*, Claus. Das Genus Cyclops (Weigmann's Archiv, Band xxiii), p. 209, t. xi, figs. 8—12; Die frei-lebenden Copepoden, p. 101 (1857).
 — — Sars. Oversigt Ferskvandscopepoder, p. 38 (1863).
 — — Friè. Die Krustenthierc Böhmcns, p. 222, fig. 17 (1871).
 — *Lubbockii*, Brady. Nat. Hist. Trans. Northumberland and Durham, vol. iii, p. 127, pl. iv, figs. 1—8 (1868).

Anterior antennæ (fig. 1) rather shorter than the first body-segment, 14-jointed, the eighth joint being incompletely divided; first and eighth joints larger than the rest; last two joints moderately long and slender. Posterior antennæ moderately robust. Mandibles (fig. 7) dilated at the apex; teeth broad and strong. Anterior foot-jaws moderately robust and bearing several plumose setæ; posterior foot-jaws strong, with a powerful terminal claw. Fifth foot (fig. 6) 2-jointed, first joint short and bearing a single seta;

second long, slender, and bisetose. The male has also a foliated club-shaped 4-setose appendage (fig. 8 *a*) on the first abdominal segment. Caudal segments (fig. 8) long and narrow, at least six times as long as broad; the two median tail setæ much longer than the rest, the innermost of the two being the longest and about twice the length of the furca; a short spine-like seta on the outer margin of the caudal segment below the middle. Length $\frac{1}{27}$ th of an inch (.9 mm.).

The only places in which I have found this species are at Hartlepool, where it occurred in brackish pools near the border of the slake, and at Pwllheli, in a bend of the river, not very far from the sea.

I at first thought it distinct from *C. insignis* or any other known species, and described it under the specific name *Lubbockii*, but I now believe my specimens to be identical with *C. insignis*, though differing slightly in some respects—especially as regards the setose furniture of the antennæ—from the typical form described by Claus.

(*C. Anterior antennæ 12-jointed.*)

7. CYCLOPS SERRULATUS, *Fischer*. Pl. XXII, figs. 1—14.

Cyclops serrulatus, Fischer. Bulletin de la Soc. Imp. des Nat. de Moscou, tom. xxiv, p. 423, tab. x, figs. 22, 23, 26—31 (1851).

— — Lilljeborg. De Crust. ex ord. trib., p. 158, t. xv, fig. 12 (1853).

- Cyclops serrulatus*, Claus. Das Genus Cyclops, p. 36, figs. 1—3 (1857).
 — — Sars. Oversigt Ferskvandcopepoder, p. 45 (1863).
 — — Claus. Die frei-lebenden Copepoden, p. 101, t. i, figs. 1, 2; t. iv, fig. 12; t. xi, fig. 3 (1863).
 — — Friè. Die Krustenthierè Böhmens, p. 222, fig. 18 (1871).
 — — Uljanin. Reise in Turkestan (Crustacea), p. 34, t. viii, figs. 1—8 (1875).

Body slender and elongated; anterior antennæ slender, 12-jointed, reaching to the middle of the third cephalothoracic segment, tapering gradually towards the apex, the last three joints being very long and slender. Fifth pair of feet 1-jointed, bearing two slender setæ and a ciliated lancet-shaped spine. Abdomen slender and elongated; caudal segments (fig. 6) slender, from four to six times as long as broad, and bordered externally with a comb-like row of minute spines. Tail setæ beset with five short cilia; outermost and innermost setæ short, the others of moderate length, the innermost and longest of the two being not very much longer than the abdomen. Length $\frac{1}{26}$ th of an inch (.98 mm.). The colour is very variable, apparently depending much upon the character of the food supply; it may be olive-green, dark brownish-red, or almost colourless.

C. serrulatus is an extremely common species, more abundant, indeed, than any other of the genus, occurring in all kinds of localities from the highest mountain tarns down to pools on the very verge of the sea, and seeming to delight as much in the muddy ditch as in the clear waters of the lake. A

mountain form, which I at one time thought distinct, and which differs from the typical *serrulatus* chiefly in its darker colour and in the less profuse ciliation of the various setæ, is figured in Pl. XXII, figs. 7—14.

8. CYCLOPS MACRURUS, Sars. Pl. XXIV, figs. 1—5.

Cyclops macrurus, Sars. Oversigt Ferskvandscopepoder, p. 45 (1863).

Cephalothorax elongato-ovate; last segment fringed at the angles with numerous fine hairs (fig. 3). Anterior antennæ (fig. 2) very short and slender, 12-jointed, about equal in length to the first segment of the cephalothorax, closely resembling those of *C. serrulatus* except in length. The five pairs of feet differ not at all from those of *C. serrulatus*. Abdomen much attenuated; penultimate segment bordered on the posterior margin (fig. 4) with a series of spine-like setæ; the other segments finely pectinated. Caudal rami exceedingly long and slender, equalling in length the three preceding segments; smooth for the greater part of their length, but towards the extremity of the external margin bearing a series of four or five small spines (fig. 5). The innermost of the two principal caudal setæ is about half as long again as the outer, and both are finely plumose. Ovisacs adpressed. Length nearly $\frac{1}{20}$ th of an inch (1.3 mm.).

This species is distinguished from the foregoing by the short antennæ, the very long and slender tail

segments, and the character of their spinous armature. I have not recognised it as British except in a gathering taken in Crag Lake, Northumberland, in September, 1876, but it is quite possible that it may have been overlooked in other cases. Professor Sars states that it occurs commonly in the larger sheets of water in Norway, but that he has not noticed it in small ponds.

(D. *Anterior antennæ* 11-jointed.)

9. CYCLOPS AFFINIS, Sars. Pl. XV, figs. 11—14; and Pl. XXIV B, figs. 10—15.

Cyclops affinis, Sars. Oversigt Ferskvandscopepoder, p. 47 (1863).

— — Uljanin. Reise in Turkestan (Crustacea), p. 36, t. xi, figs. 3—7 (1875).

In general appearance like *C. phaleratus*. Anterior antennæ much shorter than the first body-segment, moderately stout and composed of eleven segments, the last three of which are of nearly equal length. Fifth pair of feet 1-jointed, bearing three apical setæ, the innermost of which is ciliated and much larger than the other two. The caudal rami are only slightly longer (Pl. XV, fig. 13) than those of *C. phaleratus*; of the two principal setæ the inner is three times longer than the outer, exceeding the whole length of the abdomen, is finely aculeate, and at the same time imperfectly jointed (fig. 14) in the middle, the terminal portion being finely ciliated. The ovisacs are

small and closely adpressed to the abdomen. Length $\frac{1}{25}$ th of an inch (1 mm.)

The 11-jointed antennæ and the structure of the fifth foot, which consists of a distinct 1-jointed appendage, sufficiently separate this species from *C. phaleratus*. It seems, however, to be of rare occurrence, Professor Sars having noticed it but twice, in the neighbourhood of Christiania, while I have myself seen only a few specimens in a gathering taken by Mr. David Robertson in a canal at Peterhead, and one or two, which are doubtfully referable to *C. affinis*, and were taken in the river at Pwllheli, Carnarvonshire. A male of these Welsh specimens is figured in Plate XXIV B, figs. 10—15.

(E. *Anterior antennæ 10-jointed.*)

10. CYCLOPS KAUFMANNI, *Uljanin*. Pl. XXIV, figs. 6—12.

Cyclops Kaufmanni, Uljanin. Reise in Turkestan (Crustacea), p. 38, t. xii, figs. 2—4 (1875).

Abdomen not distinctly separated from the cephalothorax. Third, fourth, and fifth thoracic segments, and all the abdominal segments minutely dentated along their posterior margins. Anterior antennæ (fig. 7) 10-jointed; third, fourth, fifth, and eighth joints small; the rest of moderate length; those at the base considerably stouter; the whole antenna

scarcely as long as the first cephalothoracic segment. All the branches of the swimming feet 2-jointed (fig. 10). Fifth pair of feet (fig. 11) 2-jointed, first joint short and very broad, and armed on the external angle with a long spine, second much smaller, having one long spine at the apex and a minute tooth at the inner angle. Caudal rami short, finely and densely plumose, about equal in length to the preceding segment; of the setæ, the internal is nearly twice as long as the external; of the two intermediate setæ the internal is somewhat longer than the external, and about equal in length to the whole abdomen. Length $\frac{1}{18}$ th of an inch (1.4 mm.).

The only British locality in which this species has been noticed is a pond in Lambton Park (Durham), a gathering from which place, kindly sent to me by the Rev. A. M. Norman, contained many specimens. This is the more interesting, as from a pond in the same park Mr. Norman years ago obtained fragments (but no perfect specimens) of another Entomostracan—*Lynceus acanthocercoides*, Fischer—which has not been found elsewhere in Britain. *C. Kaufmanni* appears not to be known on the continent of Europe, the type specimens having been found in Turkestan. It is, however, very closely allied to an Austrian species—*C. Clausii*, Heller.

11. CYCLOPS HELLERI, *Brady*. Pl. XXII, figs. 15—18.

? *Cyclops Clausii*, Heller (1871). Untersuchungen über die Crustaceen Tirols, p. 7, taf. i, figs. 1, 2 (not *Cyclops Clausii*, Lubbock. Trans. Linn. Soc., vol. xxiv, part 2) (1863).

Anterior antennæ (fig. 15) 10- (?) jointed, reaching beyond the first cephalothoracic segment; the sixth and seventh joints larger than the rest. Both branches of the first four pairs of feet 3-jointed; last joint of outer branch in first and second pairs having three spines, those of the third and fourth pairs only two, on the outer margin; first and second joints in all cases having only one external spine. Fifth foot (fig. 17) 2-jointed; basal joint wide and bearing one long seta, apical joint smaller, bearing one long seta and one short spine. Lower abdominal segments pectinated with fine marginal serratures; caudal rami about equal in length to the last three abdominal segments; setæ about equal in length to the abdomen, and finely plumose.

I am not by any means sure that the species here described is identical with that of Heller, though if not so it is certainly closely allied to it, as well as to *C. Kaufmanni*, Uljanin; the anterior antennæ correspond, indeed, more exactly with those of the latter species (being apparently 10-jointed, while those of *C. Clausii*, according to Heller, have eleven joints); but on the other hand the fifth pair of feet agree more

closely with those of *C. Clausii*. I cannot help suspecting that after all both *C. Kaufmanni* and *C. Clausii* may be merely varieties of one and the same species. As regards nomenclature,—Heller's specific name, whether applicable to the present species or not, must be discarded, having been used by Sir John Lubbock to designate a far different form with 17-jointed antennæ. I therefore propose for this species the name *Helleri*.*

I have found *C. Helleri* at Tresco (Scilly), Fenham, near Newcastle, at Whitburn (County Durham), in Oulton Broad (Suffolk), and in Lough Cam (Conemara).

12. CYCLOPS PHALERATUS, Koch. Pl. XXIII, figs. 7—13.

- Cyclops phaleratus*, Koch. Deutschlands Crustaceen, &c., H. xxi, tab. ix (1841).
 — — Sars. Oversigt Ferskvandscopepoder, p. 46 (1863).
 — — Uljanin. Reise in Turkestan (Crustacea), p. 38, t. ix, figs. 1—5 (1875).
 — *canthocarpoides*, Fischer. Bulletin de la Soc. Imp. des Nat. de Moscou, tom. 24, p. 426, t. x, fig. 24, 25, 32—38 (1851).
 — — Lilljeborg. De Crust. ex ord. trib., p. 208 (1853).
 — — Claus. Das Genus Cyclops, p. 37, t. i, figs. 6—10 (1857); Die frei-lebenden Copepoden, p. 102, t. iv, figs. 1—4 (1863).
 — — Friè. Die Krustenthierè Böhmens, p. 223, fig. 19 (1871).

Anterior antennæ short and moderately stout, not

* The inscription on Plate XXII, "*Clausii*," should stand "*Helleri*."

much attenuated towards the apex; shorter than the first segment of the body, 10-jointed; the second, fourth, fifth, seventh, and eighth joints are very short; first, sixth, and tenth the longest (fig. 7). Posterior antennæ robust, with short joints. Fifth foot (fig. 12) reduced to a single wide and short process, which bears three subequal ciliated spines, the inner border of the thoracic segment to which it is attached bearing a row of about twelve small spines or serratures. Mouth organs small. Abdomen not distinctly narrower than the cephalothorax, tapering very gradually towards the extremity; last segment very short. Caudal rami subconical, about twice as long as broad (fig. 13), and beset with small spine-like hairs; tail setæ beset with very short marginal cilia; the innermost of the two principal setæ much the longest. Length $\frac{1}{25}$ th of an inch (1 mm.).

C. phaleratus is one of the less common British species, and likewise one of the most distinct and most easily recognised. The following are the localities in which I have found it:—Ormesby Broad (Norfolk), Bolam and Sweethope Lakes (Northumberland), ponds at Gibside (Durham), Kinny Lough (Co. Donegal), and near Westport (Mayo): canal at Peterhead (*Mr. D. Robertson*).

(F. *Anterior antennæ 8-jointed.*)

13. *CYCLOPS CRASSICORNIS*, Müller. Pl. XXIII, figs. 1—6.

- Cyclops crassicornis*, Müller. Entomostraca, p. 113, t. xviii, figs. 15—17 (1785).
 — — Sars. Oversigt Ferskvandscopepoder p. 47 (1863).
 — — Uljanin. Reise in Turkestan (Crustacea), p. 39, t. viii, figs. 9—16; t. xii, fig. 1 (1875).
 — *pauper*, Fric. Die Krustenthierc Böhmens, p. 223, fig. 20 (1871).

Body depressed (fig. 1), only slightly attenuated behind; no distinct separation between thorax and abdomen; abdomen almost of the same diameter throughout. Anterior antennæ (fig. 2) composed of eight short, stout joints; only about half the length of the first body-segment, densely beset with long hairs, some of which are plumose; first and fourth joints much the largest. Posterior antennæ stout, last joint very short. Mouth organs very small. Outer branches of the swimming feet (figs. 3, 4) strongly spined on the external margin, last joint bearing in the first three pairs three and in the fourth only two spines. Fifth foot (fig. 5) rudimentary, bearing three setæ, of which the outermost is long and slender. Margin of last abdominal segment serrated. Caudal rami (fig. 6) somewhat divergent and distant, about four times as long as broad, and nearly

equal in length to the preceding three abdominal segments, which are very short; external and internal tail setæ of about equal length, the innermost of the two principal setæ nearly twice as long as the outer, equal to the abdomen in length and minutely plumose. Length $\frac{1}{26}$ th of an inch (.98 mm.).

C. crassicornis seems to be of rare occurrence in Britain, and Sars makes the same remark as to its distribution in Norway, where he has found it only on muddy bottoms, at a depth of about a couple of fathoms, in large sheets of water. My examples, on the other hand, were taken by the hand-net near the edges of lakes of very moderate size, at Bolam (Northumberland), and Tresco (Scilly). I have not noticed the colour of the animal, but Professor Sars states it to be whitish or reddish, with dark blue ovisacs and red eyes.

(G. *Anterior antennæ 6-jointed.*)

14. CYCLOPS ÆQUOREUS, *Fischer*. Pl. XIX, figs. 8—10, and Pl. XXI, figs. 10—17.

Cyclops æquoreus, *Fischer*. Abhandl. der Akad. der Wissenschaft. München, Band viii, p. 654, t. xx, figs. 26—29 (1860).

— — *Brady*. Nat. Hist. Trans. Northumberland and Durham, vol. iii, p. 128, pl. iv, figs. 9—16 (1868.)

Body compressed, gradually attenuated from before

backwards. Anterior antennæ much shorter than first segment of cephalothorax, 6-jointed, stout at the base, and only slightly tapering towards the apex; fourth and sixth joints much the longest, third and fifth very short. Mandibles dilated at the apex and divided into several slender, sharp teeth. Upper foot-jaws very slender. Maxillæ (Pl. XIX, fig. 10) strongly toothed, divisions of the palp short but strongly setose. Fifth feet composed of a small basal joint and a triangular lamina, dilated towards the extremity, and bearing on the distal margin three spines and one seta of moderate length; outer and inner margins finely ciliated. Abdomen slender, the first joint about equal in length to the following two; last segment very short, and scarcely equal in length to the caudal segments, which are scarcely twice as long as broad. Outer and inner tail setæ very short; innermost of the two intermediate setæ the longest; about equal in length to the abdomen; both are fringed with fine short cilia. Ovisacs large and almost adpressed. Length $\frac{1}{30}$ th of an inch (.85 mm.).

Cyclops æquoreus is probably a pretty common inhabitant of the brackish pools of salt marshes. In such situations I have found it at Seaton Sluice (Northumberland), Manningtree (Suffolk), Pwllheli (North Wales), Clifden (Ireland), and at St. Mary's (Scilly). I have also specimens taken by Mr. Robertson near Belfast, and by the Rev. A. M. Norman in the West of Scotland. Fischer's specimens were taken in pools near the sea at Madeira, but the species does not

appear to have been observed by any other continental author. Its characters are, however, very distinct, especially as to the short 6-jointed antennæ and the laminated subtriangular fifth feet; and I do not doubt that when the proper localities are searched it will be found generally distributed round the European shores.

Genus 5. LOPHOPHORUS, nov. gen.*

Anterior antennæ (Pl. XIII, fig. 1) short and stout, 8- (?) jointed; posterior (fig. 2) simple, 3-jointed. Mandibles (fig. 3) dilated at the extremity, strongly toothed, and provided with a 2-branched palp (fig. 4), the primary branch of which is 3-jointed; secondary branch short, 1-jointed, and attached to the basal segment, which is much the longest of the three. Maxillæ (fig. 5) powerfully toothed and bearing three expanded branchial plates. First foot-jaw (fig. 6) stout, the last two or three joints armed with strong curved spines; second foot-jaw (fig. 7) very stout and robust, otherwise somewhat like that of *Cyclops*. First four pairs of swimming feet (fig. 8) 2-branched, the branches 3-jointed; fifth pair foliated (fig. 9), bearing a strong resemblance to those of many Harpactidæ.

* λόφος, a plume; φέρω, I carry.

1. LOPHOPHORUS INSIGNIS, *nov. sp.* Pl. XIII, figs. 1—10, and Pl. XV, fig. 10.

The anterior antennæ are half as long as the first segment of the body, and densely clothed with long, beautifully plumose setæ, as also are the feet and other limbs. The fifth foot (fig. 9) consists of two foliated processes (the lower of which is much the largest), and bears four large strongly pennate setæ and three simple setæ. The tail appendages are short (fig. 10), and have each two stout and beautifully plumose setæ, as well as two shorter simple hairs. Ovisacs two, broadly pear-shaped, each containing three or four very large ova. Length $\frac{1}{28}$ th of an inch (.9 mm.).

Three specimens only of this very distinct and beautiful Copepod occurred in a dredging made by Mr. Robertson and the Rev. A. M. Norman, six miles off the Durham coast, near Hawthorn, on a sandy bottom, and in a depth of twenty-seven fathoms.

Family 4. NOTODELPHYIDÆ, Thorell.

Body composed of eleven or twelve segments; abdomen subcylindrical, narrower than the cephalothorax, and divided at the extremity into two caudal segments. First thoracic segment usually united with

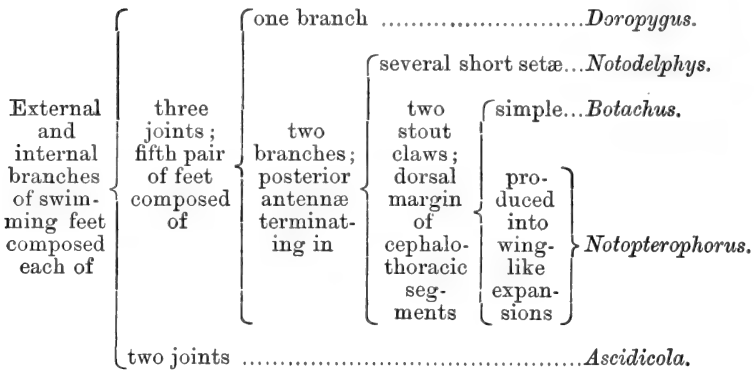
the head, fourth and fifth segments in the female mostly coalescent, and forming the envelope of the ovisac. Anterior antennæ composed of from five to fifteen segments; posterior 3-jointed, simple, and terminating in a strong claw or in several curved setæ. Mandibles strongly dentated and provided with a 2-branched palp. Maxillæ composed of a biting portion, from which spring several short laminae fringed with branchial filaments. Two pairs of foot-jaws somewhat similar to those of the Cyclopidæ. First four pairs of feet adapted for swimming and 2-branched; fifth pair small or altogether absent. No external ovisac, the ova being matured in a pouch formed by the integument of the enlarged fourth segment of the thorax.

The animals belonging to this family are found almost exclusively in the branchial sacs or body cavities of the simple (or rarely of the compound) Ascidians. They are not true parasites, not being provided with any suctorial apparatus, moving about quite freely within the body of the host, and not attaching themselves in any way to its tissues. They are, indeed, in all probability, Cyclopidæ, which have become modified in build by their inactive habits and the restricted boundaries of their dwellings. It is evident that under these conditions the long antennæ and limbs of the free-swimming species would be an encumbrance, or at any rate could be of very small service, and one would almost be inclined to believe that these appendages must still be in course of degradation owing to constant disuse. The clasping

antennæ of the male, too, are very much less specialised than in the true Cyclopidae, and one is tempted to query whether this may not be a slight degree of that retrograde development which is so conspicuously shown in the lower parasitic crustacea, where the males have become little more than mere sperm-sacs.

This family is here represented by the genera *Notodelphys*, *Doropygus*, *Botachus*, *Notopterophorus*, and *Ascidicola*.

Synopsis of Genera of Notodelphyidae.



Sub-family 1. NOTODELPHYINÆ.

Body flattened, head consolidated with the first thoracic segment; six abdominal segments in both sexes. Anterior antennæ 10—15-jointed, and in the male adapted for clasping, as in *Cyclops*. Caudal

segments bearing numerous long, finely plumose setæ.

This sub-family contains only one genus—*Notodelphys*.

Genus 1. NOTODELPHYS, Allman (1847).

Body elongated, cephalothorax somewhat depressed, abdomen much attenuated, cylindrical; caudal appendages consisting of four large plumose setæ attached to the apex of each segment, together with two or three small lateral setæ. Anterior antennæ composed in the male of 10 or 11, in the female of 15 joints; posterior unbranched, armed at the apex with a strong movable claw and several curved setæ. Mandible-palp 2-branched; basal portion very large and broad, internal branch composed of two, external of two or more joints. Maxillæ composed of a prehensile or biting segment, which is provided with strong curved setæ, and three or four broad laminæ fringed with plumose branchial filaments. Anterior foot-jaws stout, subtriangular, 5-jointed, the basal joint constituting the bulk of the limb; posterior slender, 3-jointed; both pairs armed with numerous strong curved setæ on the inner margin. Branches of the first four pairs of feet 3-jointed and beset with finely plumose setæ; fifth pair very small, 2-branched, branches composed of one joint only.

1. NOTODELPHYS ALLMANI, *Thorell*. Pl. XXV, figs.
1—10.

- ? *Notodelphys ascidicola*, Allman. Ann. and Mag. Nat. Hist.
vol. xx, pl. i, figs. 1—13 (1847).
— — Baird. Brit. Entom., p. 238, pl. xxx,
figs. 7, 8 (1850).
— *Allmani*, Thorell. Bidrag till Kannedomen om
Krustaceer som lefva i arter af
Släktet Ascidia, p. 31, tabs. i and
ii, fig. 1 (1859).
? — *elegans*, Thorell. Loc. cit., p. 39, tab. iv, fig. 5.
? — *rufescens*, Thorell. Ibid., p. 35, tab. ii, fig. 2.

Anterior antennæ (fig. 2) shorter than the first body-segment, stout at the base and gradually tapering to the apex, densely beset along its whole length with finely plumose hairs; the second joint is very short, the first, third, fourth, and fifth large, the fourth and fifth nearly equal, and twice as long as any of the remaining joints, which are short and of nearly equal length. Posterior antennæ (fig. 3) robust, the third and most slender joint being scarcely more than twice as long as broad. Mandible palp (fig. 4) stout, the outer branch 3-jointed.* The maxilla (fig. 5) consists of a strongly clawed or setose prehensile portion, with a branchial palp, which is composed of two large and two small laminæ, bearing marginal plumose filaments. The anterior foot-jaws (fig. 6) are very stout, bearing several short digitiform

* This is misrepresented in the plate, the portion shown as a long terminal joint being in reality the thickened base of the large apical seta.

marginal segments, all of which have stout apical setæ, the stronger ones being plumose or pectinated, last three joints very small; posterior foot-jaws (fig. 7) slender, 3-jointed, with several plumose marginal setæ, that arising from the second joint being much the strongest; the terminal joint is very small, the penultimate much larger, and the first three or four times as large as the second. The first pair of swimming feet (fig. 8) has the external margin of the first joint of the outer branch fringed with short strong hairs ("dentibus angustis, dense serratus," Thorell); the margins of the two following joints, as well as those of the inner branch, are perfectly smooth; in the following pairs of feet, however (fig. 9), all the joints of the inner, as well as the first of the outer branch, are finely fringed on their external borders; all the setæ are very finely plumose (much more finely than could be shown in the engraving). The fifth pair of feet (fig. 10) are composed each of two 1-jointed branches, the outermost of which is of oblong subquadrangular outline, and bears a long spine at the apex, and a short tooth-like process on the inner margin; the inner branch is broader and shorter, and has two apical setæ, the innermost of which is stout and spine-like; there are also four small teeth on the inner margin; the peduncle of the foot is armed at its inner angle with a row of about six small spines. Caudal segments about once and a half as long as the preceding abdominal ring; the small lateral setæ situated a little below the middle of the external margin; internal

margin of the segments finely ciliated. The ovarian sac forms a conspicuous prominence on the back of the animal, and has its angles well rounded. The ovaria, according to Thorell, are greenish yellow, the ova brown green. Length* of female $\frac{1}{8}$ th— $\frac{1}{5}$ th of an inch, of male $\frac{1}{17}$ th— $\frac{1}{12}$ th of an inch (3—5 and $1\frac{3}{4}$ —2 mm.).

Mr. Norman has recorded this species as occurring in the “branchial sac and water-passages of *Ascidia venosa*” from Shetland. I have not myself seen any British specimens, and my drawings have been made entirely from Swedish specimens, for which I am indebted to the kindness of M. Thorell. The following list of localities is given by Dr. Baird (*loc. cit.*), but it must be remembered that at the date of his work the Ascidian parasites were scarcely at all known, and it is extremely probable that many of the specimens then named *N. ascidicola* might now be referred to other species of the genus. “Belfast Bay; Strangford Lough, County Down; W. Thompson and G. C. Hyndman, Esqrs., Killery Bay, County Galway; R. Ball and W. Thompson, Esqrs., Bangor, County Down; R. Peterson, Esq., Glandore Harbour, County Cork, Dublin Bay, and Southampton Water; George J. Allman, Esq. In the branchial sac of the *Ascidia communis*.”

The characters upon which M. Thorell has founded the seven species of *Notodelphys* described in his work are mainly the length and proportions of the

* The lengths of the species of *Notodelphys*, except *N. prasina*, are those given by M. Thorell.

caudal segments and the position of the lateral setæ upon their external margins, together with the appearance of the external margin of the first joint of the outer branch of the first foot. The marginal spines of this branch, the setose armature of the second antennæ, and of the fifth pair of feet, &c., afford other means of specific diagnosis; but it seems to me that the distinctions are, in some cases, at any rate, much too trivial, and that in all probability a more extended investigation would lead to the conclusion that at best some of these forms deserve to be classed only as varieties. In the case of the present species the distinctions drawn between it, *N. rufescens*, and *N. elegans*, do not appear to be of specific importance.

As regards Mr. Allman's description and figures of *Notodelphys ascidicola*, it must, I fear, remain doubtful to which species of the genus they were meant to refer; it is, indeed, more than probable—from the number of localities given in Mr. Allman's paper that several species of *Notodelphys* were the subjects of description, while some of the figures (14, 15, and 21) undoubtedly refer to a quite distinct genus—*Ascidicola*, Thorell. It seems best, therefore, to follow M. Thorell, discarding altogether the specific name *Ascidicola*, which, however, will stand as the designation of a separate genus.

2. NOTODELPHYS CERULÆA, *Thorell*. Pl. XXVII, figs.
10—13.

Notodelphys cerulæa, Thorell. Loc. cit., p. 37, tabs. iii and iv,
fig. 4 (1859).

? *tenera*, Thorell. Ibid., p. 36, tab. iii, fig. 3.

This species differs scarcely at all from the preceding. The posterior antennæ (fig. 11) have near the margin of the apical joint two subcrescentiform rows of small cilia, the branches of the fifth pair of feet (fig. 13) are somewhat shorter and wider than in *N. ascidicola*, and the first foot has the outer margin of its first joint (fig. 12) either smooth or very finely denticulated. The ova and ovaria are said to be blue. Length of female $\frac{1}{8}$ th— $\frac{1}{6}$ th of an inch (3—4 $\frac{1}{2}$ mm.), of male $\frac{1}{7}$ th— $\frac{1}{4}$ th of an inch (1 $\frac{1}{2}$ —1 $\frac{3}{4}$ mm.).

I cannot find any good reason for separating this from the foregoing species, but for the present retain it, giving drawings of the more prominent distinctive characters.

I have notes of its occurrence in the following British localities:—In *Ascidia parallelogramma*, off Hawthorn (Durham Coast); in *Ascidia parallelogramma* and *A. venosa*, Shetland, and from between tide-marks, Roundstone (*Rev. A. M. Norman*).

3. NOTODELPHYS AGILIS, *Thorell*. Pl. XXVI, figs.
1—10.

Notodelphys agilis, Thorell. Loc. cit., p. 40, tabs. iv, v, fig. 6 (1859).

The caudal segments of the abdomen are here more

than twice as long as the preceding segment, and the lateral seta is placed on the middle of the external margin (fig. 9). Both branches of the fifth pair of feet (fig. 10) are very much smaller than in either of the foregoing species and much more slenderly spined. Length of female $\frac{1}{2}$ th— $\frac{1}{8}$ th of an inch (2—3 mm.), of male $\frac{1}{2}$ th of an inch (3 mm.).

N. agilis has occurred in Ascidians taken off the coasts of Durham and Yorkshire, in depths of from twenty to thirty fathoms, and among specimens from the branchial sac of *Ascidia sordida*, Shetland, sent to me by the Rev. A. M. Norman.

4. NOTODELPHYS PRASINA, *Thorell*. Pl. XXX, figs. 11—15.

Notodelphys prasnia, Thorell. Loc. cit., p. 41, tab. v, fig. 7 (1859).

The caudal segments (fig. 15) are in this species much shorter and stouter than in any other, their length being not more than equal to the breadth. The two principal tail setæ, more especially the inner one, are very broad. The branches of the fifth pair of feet (fig. 14) are very small, the outer about thrice as long as broad, the inner about as broad as long. Length of female $\frac{1}{11}$ th of an inch (2·3 mm.).

This species was more abundant than any other in a collection of Entomostraca taken from the branchial sacs of *Ascidia mentula* at Oban by the Rev. A. M. Norman, to whom I am much indebted for the

opportunity of examining his captures. Mr. Norman has also recorded *N. prasina* as occurring in the same Ascidian in Shetland.

Sub-family 2. DOROPYGINÆ, *nov. sub.-fam.*

Body more or less compressed; anterior antennæ short, 8—10-jointed; in the male not modified for clasping. Caudal segments curved and bearing very small apical spines.

Genus 2. DOROPYGUS, *Thorell* (1859).

Body dorsally elevated, somewhat compressed; caudal segments bearing at their apices curved spines or hairs. Anterior antennæ 8- to 10-jointed; very small, about one third the length of the first body segment, posterior 3-jointed, terminating in a curved claw. Basal joint of the mandible-palp large, 2-branched, the external branch composed of one, the internal of two joints. Maxillæ composed of a prehensile aculeated portion, and three or four more or less rounded segments, which are fringed with finely plumose branchial filaments. First pair of foot-jaws broad, subtriangular, 5-jointed, the last joint minute; second pair elongated, 3-jointed; both provided with numerous strong marginal setæ. Branches of the first four pairs of feet usually 3- (rarely 2-)

jointed, setæ naked or finely plumose; fifth pair small, 1-jointed. Inhabiting the branchial sac of various simple Ascidians.

1. DOROPYGUS PULEX, *Thorell*. Pl. XXVIII, figs.
1—12.

Doropygus pulex, Thorell. Loc. cit., p. 46, tab. vi, fig. 8 (1859.)

Adult female.—Cephalothorax produced into a short, blunt, triangular rostrum, third and fourth thoracic segments united to form the ovarian envelope. Abdomen much narrower than the cephalothorax (fig. 1), and bent upon it so as to form almost a right angle. Fifth abdominal segment longer than the fourth (figs. 11, 12), partially furcate, and divided into two subtriangular segments. Caudal segments very long and slender, transversely divided near the middle, curved and divergent, and bearing three or four minute apical setæ. Anterior antennæ 10-jointed, the two basal joints about once and a half the width of the third joint, the third, fourth, fifth, and sixth progressively decreasing in width, the last four subequal as to width, the sixth joint longer than any except the first. The whole limb is densely beset with long hairs on the external margin and apex, and the second joint has also two conspicuous tooth-like spines. The posterior antenna (in the adult) has the claw longer than the second joint (fig. 5, Pl. XXVIII, is taken from an immature specimen, and

does not show correctly the relative lengths of the joints in the adult). The first pair of feet (fig. 8) have both branches broad, 3-jointed, and of nearly equal length, all the joints short and broad, the terminal ones broadly rounded or subtruncate at the apex; marginal setæ long, stout, and densely plumose; spines of the external branch long and stout. The second, third, and fourth pairs (fig. 9) are longer than the first, the spines of the external branch are smaller, the setæ also much smaller and destitute of plumes. The fifth pair consist each of a single small bisetose lamina. The caudal segments are about as long as the preceding four abdominal rings, slender, curvate, and jointed near the middle, the apices bearing three minute hairs (figs. 11, 12).* Length $\frac{1}{12}$ th of an inch (2.1 mm.).

Many immature specimens of this species were found in Ascidians dredged by Mr. Robertson, the Rev. A. M. Norman, and myself, off the coasts of Durham and Yorkshire, and also by Mr. Norman at Oban and Shetland. Except a few kindly sent to me by M. Thorell, I have seen no adult of *D. pulex*. On this account, probably, my drawings do not in all respects agree with those of M. Thorell. The British species of the genus, and, indeed, all the Ascidian parasites of Britain require much closer and more

* The figures of anterior antennæ and caudal segments given in Pl. XXXI, figs. 1 and 2, represent either an unnamed species or a variety of *D. pulex*; at present I prefer to adopt the latter supposition, as the general characters of the specimens coincide with those of *D. pulex*. The specimens were found by Mr. Norman in *Ascidians* from Roundstone Bay, Ireland.

extended investigation than I have had the opportunity of bestowing upon them. I believe, however, that the representations given in these plates, though unavoidably incomplete, will be found to be correct as far as they go.

2. DOROPYGUS AURITUS, *Thorell*. Pl. XXIX, figs. 1—11;

Doropygus auritus, Thorell. Om Krustaceer i Ascidier, &c., p. 50, tabs. vii and viii, fig. 10 (1859).

Adult female.—Thoracic segments separated at their junctions by deep sulci, and produced into gibbous prominences; head as seen from the side subtriangular; caudal segments (fig. 11) stout and slightly curved, and armed at the apices with four or five curved hook-like spines. Anterior antennæ (Pl. XXIX, fig. 2) having the first two joints greatly dilated, and bearing several stout setæ, but no spines, 8-jointed. The swimming feet do not differ materially from those of *D. pulex*, except that the inner branch of the first pair (fig. 8) is only 2-jointed, and the setæ of all are distinctly plumose. The second joint of all—more especially of the outer—branches is much shorter than the first and third. Fifth pair of feet (fig. 10) small, oblong-ovate, bearing a few irregularly placed, minute, marginal cilia, the basal portion having also a small setiferous tubercle or rudimentary external branch.

Length of female $\frac{1}{8}$ th— $\frac{1}{5}$ th of an inch ($3\frac{1}{4}$ —5 mm.), of male $\frac{1}{2\frac{1}{5}}$ th of an inch (1 mm.).

Mr. Norman records this species as having been taken from “the branchial sac and water-passages of *Ascidia mentula*,” in Shetland. I have myself seen no specimens except Swedish ones sent by M. Thorell, from which my figures were drawn.

3. DOROPYGUS NORMANI, *nov. sp.* Pl. XXXII, figs. 1—14.

Adult female.—Cephalothorax subpyramidal, attenuated towards the front, ovarium broadly rounded behind. Anterior antennæ (fig. 2) 10-jointed, the two basal joints very broad, the second short and bearing two stout spines on the outer margin, the remaining eight joints successively narrower to the apex and subequal, the fourth and seventh, however, being longer than the rest; the whole limb dorsally beset on its outer margin with long setæ, which are either very indistinctly, or not at all, plumose. Apical claw of the posterior antenna (fig. 3) very much shorter than the second joint. The mandible-palp (fig. 4) has the outer branch (*a*) slender, indistinctly biarticulate, and provided with five setæ, the inner branch (*b*) 3-jointed, its last joint bearing a series of minute spine-like cilia on the outer margin. The “external lamina” of the maxilla (fig. 5, *l e*) bears four setæ, the “ultimate lamina” (*l u*) seven, and the “middle

lamina" (*l m*) four setæ, all of them being, as usual, finely and densely plumose, and doubtless branchial in function. The first foot-jaw (fig. 6) does not differ materially from that of *D. pulex*; the second (fig. 7) is small, subovate, and fringed with about ten plumose hairs. Branches of the first pair of feet (fig. 8) nearly equal; marginal spines of the external branch long and slender; branches of the second and third pairs (fig. 9) subequal, the external branch bearing setæ in place of spines, the internal branch 2-jointed; fourth pair (fig. 10) more slender and sparingly setiferous, the joints of the outer branch dilated and obliquely produced at the distal extremity, and narrowed at the base; fifth pair (fig. 11) three or four times notched towards the extremity of the inner edge, and bearing two short terminal setæ; penultimate abdominal somite rather shorter than the last, which is partially divided so as to form two subtriangular segments (fig. 13). Caudal rami (fig. 10) distant, nearly straight, about once and a half as long as the last abdominal segment, bearing two very minute apical hooks (fig. 14). Length nearly $\frac{1}{8}$ th of an inch (3.3 mm.).

This species is undoubtedly very nearly allied to, if not identical with *D. psyllus*, Thorell, but the maxillæ and foot-jaws differ decidedly from those of that species as described in M. Thorell's work. The replacing of the spines of the third and fourth feet by long setæ, and the dentated margin of the last joint of the inner branch of the mandible palp are distinctive characters, as also is the serrated outline of

the spines of the first feet* (fig. 12). Whether these distinctions will be found on further research to hold constantly good, one may perhaps doubt, but for the present there seems no sufficient reason for withholding from this form a specific name. But the inconstancy of characters amongst the Notodelphyidæ is extremely bewildering, and until much more attention has been paid to them it is impossible to define with accuracy the limits of species. In this particular instance the difficulty is the greater owing to M. Thorell's imperfect account of his *Doropygus psyllus*, of which he had found only two specimens, a number which is often insufficient for the purpose of complete description.

Doropygus Normani occurred in some abundance in a collection of parasites found in the cavities of Ascidians which were taken between tide-marks at Roundstone, Ireland, by the Rev. Alfred Merle Norman, whose name I am glad to have the opportunity of associating with the species.

4. DOROPYGUS PORCICAUDA, *nov. sp.* Pl. XXVII, figs. 1—9; and Pl. XXXIII, 14—16.

Adult female.—Basal joint of the anterior antenna

* The substitution of setæ for spines on the margins of the external branches of the swimming feet is an important feature, if constant, but in some examples one or more of the setæ were wanting, and there seemed to be small spines closely adpressed to the limb; I could not, however, satisfy myself whether or no these might be the scars or broken extremities of lost setæ.

very large, bearing several long, stout, and often densely plumose setæ (fig. 2), and two slightly curved spines; second, third, fourth, and fifth joints successive more slender, sixth and seventh of about equal width, last three much smaller; the whole limb is beset with stout setæ which, except on the basal joint, are only slightly or not at all plumose. Terminal claw of the posterior antenna (fig. 3) much shorter than the second joint. Both branches of the first pair of feet (fig. 5) 3-jointed, their setæ, like those of the other feet, finely plumose; marginal spines entire at the edges. The articulations of the outer branches of the second, third, and fourth pairs of feet (figs. 6, 7) are very oblique, each segment being contracted at base and dilated at apex, as in *D. Normani*; the maxillæ agree in every respect with *D. Normani*, but the second pair of foot-jaws (Pl. XXXIII, fig. 15) are like those of *D. pulex*, to which species also the caudal segments closely approximate in character. The species seems in fact to occupy an intermediate position between *D. pulex* and *D. Normani*. Fifth foot simple, bearing two short setæ at the apex, which is obliquely truncate (fig. 8), inner margin ciliated. Last abdominal segment (fig. 9) partially divided so as to form two subtriangular portions; caudal segments elongated, much longer than the united lengths of the two preceding, convoluted at the apex, and bearing three minute terminal hairs. Length $\frac{1}{7}$ th of an inch (4 mm.).

Doropygus porcicauda was found very commonly in Ascidiæ dredged by the Rev. A. M. Norman in Birtirbuy Bay, Ireland; also in specimens of *Ascidia parallelogramma* dredged in a depth of twenty-seven fathoms off Hawthorn on the Durham Coast.

Genus 3. BOTACHUS, *Thorell* (1859).

Body elongated, narrow, fusiform; caudal rami armed at the apex with curved spines. First pair of antennæ 8-jointed (9-jointed, *Thorell*); second pair 3-jointed, clawed at the apex. Mandible-palp 2-branched, the inner branch 2-, the outer 1-jointed. Maxillæ composed of a basal masticatory portion and a trilaminar setiferous palp; first pair of foot-jaws stout, subtriangular, 5-jointed; second pair slender, setiferous at the apex. First four pairs of feet with both branches 3-jointed, joints of the inner branch hispid at the margins; fifth pair rudimentary, 1-jointed.

1. BOTACHUS CYLINDRATUS, *Thorell*. Pl. XXXIII, figs. 1—13.

Botachus cylindratus, *Thorell*. Om Krustaceer i Ascidiæ, p. 55, tab. ix, fig. 12 (1859.)

Female.—Animal elongated, curvate (figs. 1, 2), abdomen slightly more slender than the thorax;

caudal rami abruptly flexed upon the abdomen, bearing two strong curved spines and a few setæ (fig. 13). Anterior antennæ short, bent at a right angle in the middle (fig. 3); distal half densely setiferous; posterior antennæ (fig. 4) stout. The inner branches of the swimming feet are short (figs. 10, 11) and destitute of marginal spines, but bear three or four slender terminal setæ; the marginal spines of the outer branches (fig. 11, *a*) are surrounded with a delicate ciliated lamina. Fifth pair (fig. 12) 1-jointed, with three apical cilia, two long and one short. Length $\frac{1}{8}$ th of an inch (1.4 mm.).

In the branchial sac and water-passages of *Ascidia mentula*, Shetland and Oban (*Rev. A. M. Norman*).

Genus 4. NOTOPTEROPHORUS, *Costa* (1852). 1829

Body composed of ten segments and provided with several dorsal wing-like expansions; anterior antennæ 10- (8-, Hesse) jointed; posterior 3-jointed, clawed at the apex. Mandibles, maxillæ, and foot-jaws, similar to those of *Doropygus*. Inner branch of first pair of feet 2-jointed; the rest have both branches 3-jointed.

Except for the peculiar wing-like dorsal appendages there seems to be little to separate this genus from *Doropygus*. Perhaps, indeed, we may look upon these expansions as only an extreme development, with modification, of the dorsal gibbosities of *D. auritus*.

1. NOTOPTEROPHORUS PAPILIO, *Hesse*. Pl. XXXI, figs.
3—12.

Notopterophorus papilio, *Hesse*. *Annales des Sciences Naturelles*
(1864), sér. 5, Zool., tome i, p. 338, pl. xi,
figs. 1—13; vol. iii, p. 221 (1865).

The animal is composed of a slender body, on the dorsal aspect of which the delicate membranous integument is produced into six (*Hesse*) large bifurcated wing-like expansions (figs. 3, 4). The antennæ are very like those of *Doropygus*; the anterior (fig. 5) are 10-jointed, the first two joints being very large, the rest very much narrower and shorter, and tapering gradually to the apex; the posterior are 3-jointed (fig. 6), the joints successively decreasing in size from the first; terminal claw small. Mandible well developed (fig. 7); basal joint of the palp large, secondary branch small, 1-jointed. Inner branch of the first pair of feet (fig. 11) 2-jointed, shorter than the outer branch; the first joint short; second joint of the outer branch very short. Fifth pair apparently absent. Caudal segments of moderate length, cylindrical, tapering, and armed at the apices with four small hook-like spines (fig. 12). "Colour of the head white, of the occiput, the first two abdominal segments, and the eye purplish-red; the rest of the abdomen yellow, and the intestinal tube black, thorax apple-green; feet and membranous expansions white." Length $\frac{1}{5}$ th of an inch (5 mm.).

Found by the late Mr. Albany Hancock in the branchial sac and water-passages of *Ascidia mentula* from Shetland, and more recently by the Rev. A. M. Norman in Ascidians from Oban, Loch Fyne, and Herm (Channel Islands).

My knowledge of this species is derived entirely from M. Hesse's memoir, and from specimens kindly given and lent to me by my friend the Rev. A. M. Norman; but owing to the long immersion of the animals in spirit I have not been able to observe satisfactorily many of their characters, especially those of the delicate membranous wing-like expansions, which, when exposed to the action of alcohol, become shrivelled, opaque, and shapeless. I therefore give a short abstract of M. Hesse's description:—These expansions, which are six in number, are membranous, flat, papillose, hyaline, contractile, and fixed by the base to different parts of the body. The first is triangular, divided at the extremity into long lashes, and fixed to the back of the neck, forming a sort of hood for the protection of the head; the other four expansions are lateral, placed two at the base of the neck, the other two at the middle of the second thoracic segment; they, especially the second pair, are much larger than the first, and are also divided into lash-like extremities. These appendages, closely resembling in general effect the wings of a butterfly, are, of course, not used in the same way, but are nevertheless moved with considerable energy by means of the powerful muscles to which they are attached, and they are endowed at all points with a

contractility which modifies their form according to the will of the animal. The use of these expansions is unknown, but may probably, M. Hesse thinks, be to act as *points d'appui* for the movements of the creature, or to aid in removing obstacles from its path. For my own part I find it difficult to believe that these excessively delicate organs can be of much use for such purposes, or to understand why, if they are so used, they should be entirely wanting in so many other species which live under the same conditions. We must, I think, admit that their use is at present quite unknown.

[NOTOPTEROPHORUS ELONGATUS, *Buchholz*. Beiträge zur Kenntniss der Innerhalb des Ascidiën lebenden parasitischen Crustaceen des Mittelmeeres, p. 127, taf. viii, fig. 6, and taf. ix, fig. 6.

One or two specimens, which, I have no doubt, were referable to this species, occurred amongst those sent to me by my friend the Rev. A. M. Norman, but they seem to have been lost during examination, and I am now, unfortunately, unable to figure or describe them.]

Sub-family 3. ASCIDICOLINÆ, *Nov. sub-fam.*

First and second thoracic segments coalescent; abdomen composed in the female of five, in the male of six segments. Matrical envelope formed by a

division of the covering of the fifth somite into two laminar folds.

Genus 5. ASCIDICOLA, Thorell (1859).

(*Coiliacā*, Hesse.)

Body elongated, narrow, subcylindrical; abdomen a little narrower than the cephalothorax; caudal rami short, armed with several setæ. Anterior antennæ 7-jointed (5- or 6-jointed, Thorell), short and stout; posterior 3-jointed, clawed. Extremity of the mandible divided into several sharp, slender teeth; palp simple, 2-jointed. Maxillæ composed of two setiferous laminæ. First pair of, foot-jaws short and broad, 2-jointed; second pair small 1-jointed, setiferous. Four pairs of very small feet, branches 2-jointed; fifth pair wanting. Two ovaries. Ovisacs composed of two delicate leaf-like laminæ.

1. *ASCIDICOLA ROSEA, Thorell.* Pl. XXX, figs. 1—10.

Ascidicola rosea, Thorell. Om Krustaceer i Ascidier, p. 59, tabs. ix and x, fig. 13 (1859).

Notodelphys ascidicola (*jun.*), Allman. Ann. and Mag. Nat. Hist., vol. xx, pl. i, fig. 14, and pl. ii, figs. 15 and 21 (1847).

Female.—Anterior antennæ (fig. 2) extremely short, stout, 7-jointed, beset with numerous short setæ; terminal joint of posterior antennæ long and narrow, bearing two apical claws (fig. 3). Mandible-palp

(fig. 4) armed with six stout spine-like setæ, two of which are much longer than the rest. Lobes of the maxillæ (fig. 6) broad, and armed at the apices with several stout setæ; first pair of foot-jaws (fig. 7) very broad, shortly aculeate at the apex; second pair (fig. 8) much smaller and more slender, 1-jointed, bearing four slender terminal setæ. Outer branches of the swimming feet bearing on the basal joint one short apical spine, and on the second joint four or five somewhat longer spine-like setæ. The basal joint of the inner branch in the first pair (fig. 9) is destitute of setæ, but the second joint bears four short spines, and one excessively long seta; the basal joint in the second, third, and fourth pairs has a single apical seta of moderate length, while the second joint bears three very long setæ. The penultimate segment of the abdomen bears at the posterior angles a brush of minute hairs. Length 1.5th of an inch (5 mm.).

This species occurred not uncommonly in specimens of *Ascidia mentula* dredged by the Rev. A. M. Norman at Oban and in Birtirbuy Bay, and in *Ascidia sordida* at Shetland; my own collection contains several specimens taken from Ascidiæ which were dredged off the Durham Coast.

Family 5. BUPRORIDÆ, Thorell.

Body not distinctly segmented, anterior antennæ small and rudimentary, two- or three-jointed, posterior one- or two-jointed. Mandibles destitute of palps.

Maxillæ and foot-jaws small, short and broad, adapted for grasping. Feet small, first four pairs two-branched. No external ovisac. Abdomen very small.

Genus 1. ENTEROCOLA, Van Beneden (1861).

Head distinct from thorax ; anterior antennæ simple, two-jointed, posterior one (?)-jointed. Mouth-organs minute, rudimentary. Posterior foot-jaws larger, 2-jointed and having a rudimentary palp. Four pairs of feet, short, two branched, much like the antennæ in general appearance ; abdomen rudimentary, bifid.

The mouth-organs, especially, of this genus seem to require more minute examination. The animal is of a sedentary and degraded type, very like in general appearance, as M. van Beneden remarks, to some of the *Tardigrada*. I have not myself seen any perfect specimens, and though, in deference to Dr. Claus' opinion, associating it with *Buprorus*, I must confess some doubt as to whether this may ultimately be found to be its proper position. M. van Beneden has not given any precise definition of the genus, but the foregoing is condensed so as to embody what appear to me the most important points of his description.

1. ENTEROCOLA ERUCA, *Norman*.

Enterocola eruca, Norman. Last Shetland Dredging Report, p. 300 (1868).

“ Allied to *Enterocola fulgens*, Van Beneden (‘ Re-

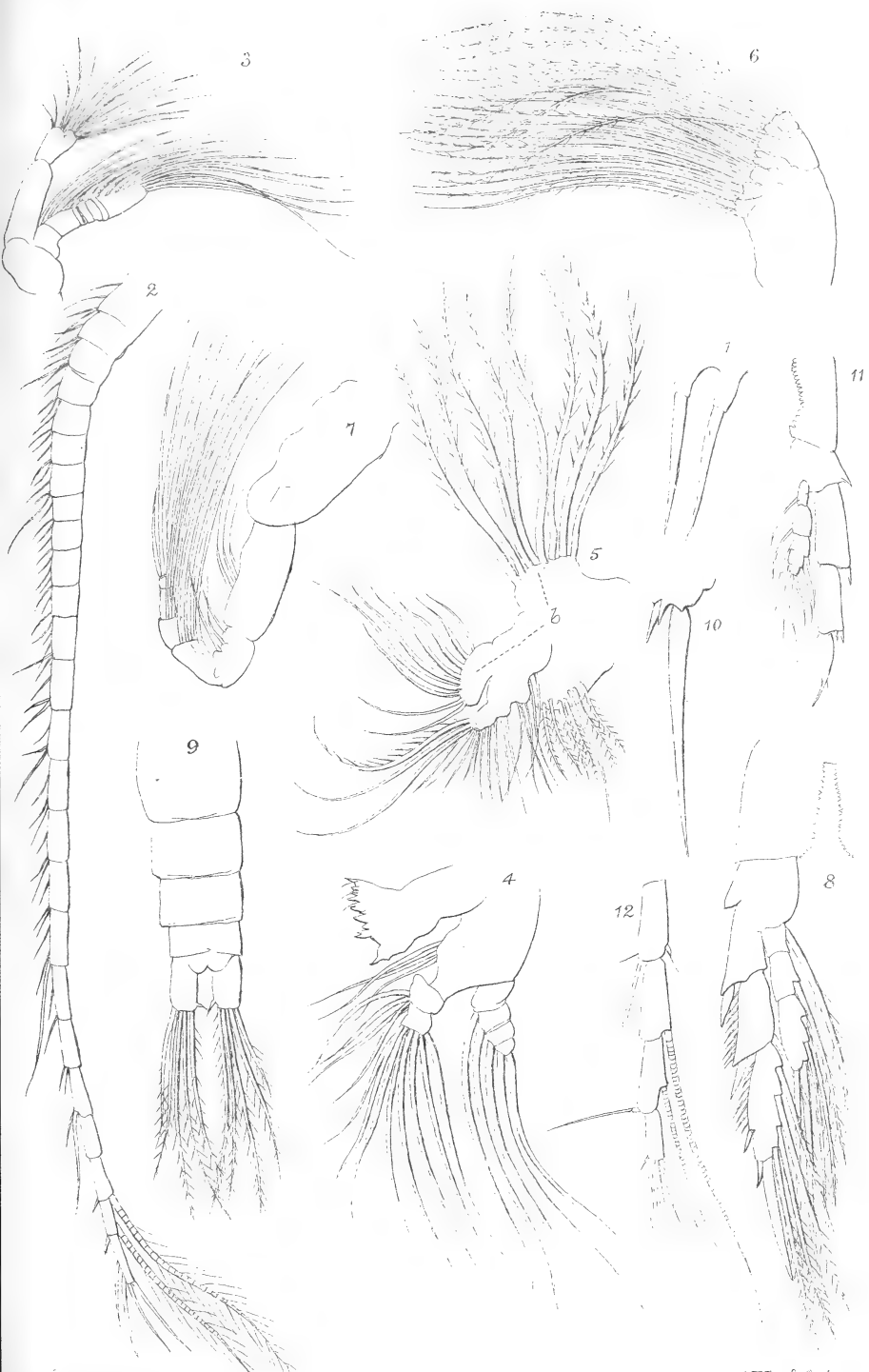
cherches sur la Faune littorale de Belgique, Crustacés' (1861), p. 149, pl. 26), but is apparently distinct. The feet have one branch, stout, papillary, not furnished with any claw, the other much more slender, terminating in three minute curved spines. The fifth segment of the body has a cylindrical tubercular process on each side of the back. The abdomen is composed of two (? three) articulations, and terminates in a furca, the branches of which are shorter than broad and are furnished with a spine at the tip. Adhering to the intestine of *Ascidia intestinalis*."

Mr. Norman's single specimen of this animal, though kindly placed at my disposal, is not in a condition to allow of any satisfactory dissection, owing to the unfortunate drying up of the preservative spirit. I am unable, therefore, to add anything to the description quoted above, which doubtless embodies all that could be made out by examination of the animal in its entire condition.

PLATE I.

Calanus finmarchicus.

- Fig. 1. Rostrum.
2. Anterior antenna of female.
 3. Posterior antenna.
 4. Mandible and palp.
 5. Maxilla, (*b*) branchial plates.
 6. Anterior foot-jaw.
 7. Posterior foot-jaw.
 8. Foot of fifth pair.
 9. Abdomen of female.
 10. Terminal spine of swimming foot.
 11. Right fifth foot of male.
 12. Terminal joints of anterior antenna of male.



G.S. Erady del.
A.H. Hollick sculp.

Calanus finmarchicus.

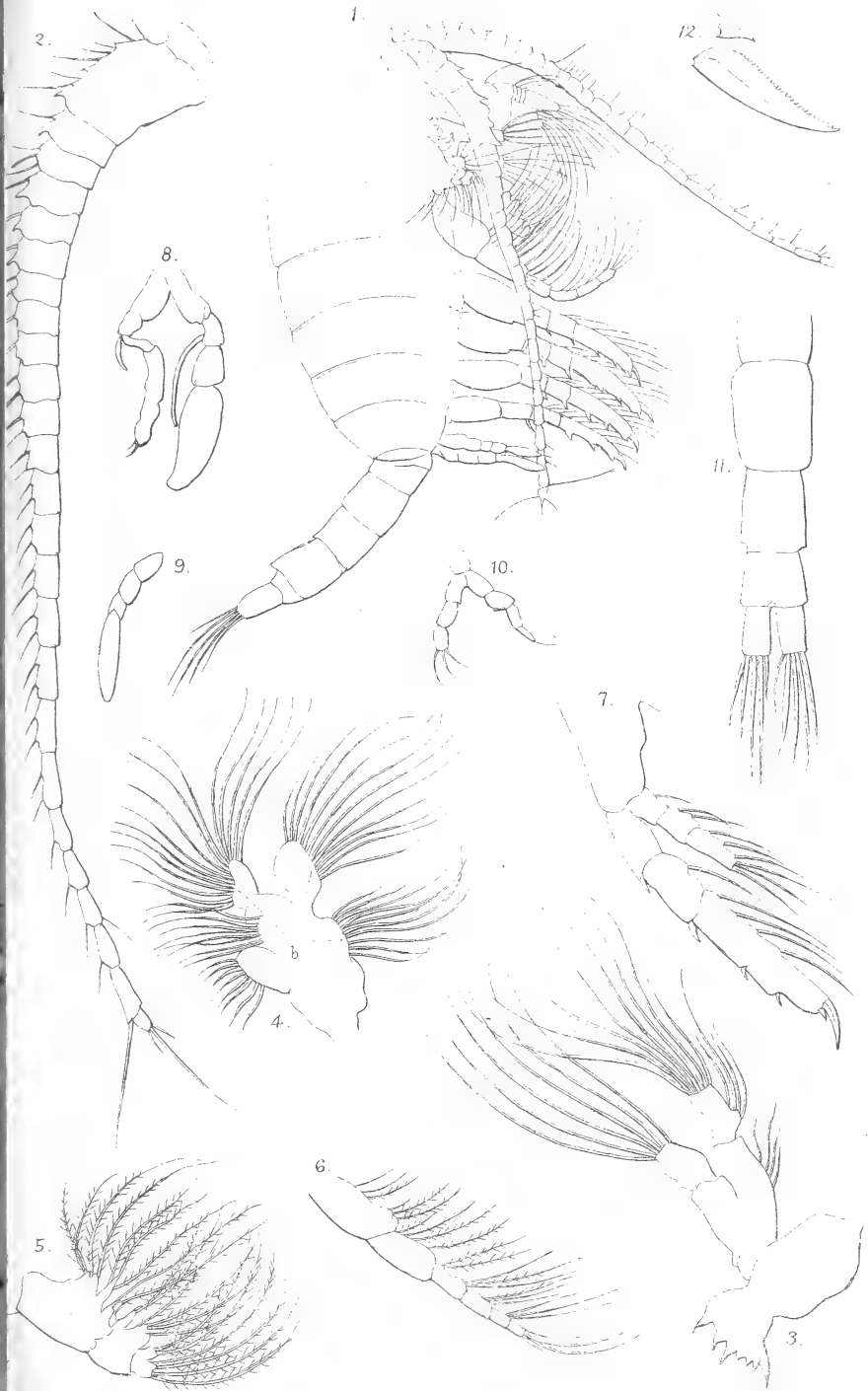
H. West & Co. imp.



PLATE II.

Metridia armata.

- Fig. 1. Male seen from right side.
2. Anterior antenna of male.
3. Mandible and palp.
4. Maxilla.
5. Anterior foot-jaw.
6. Posterior foot-jaw.
7. Foot of third pair.
8. Fifth pair of feet of male.
9. The same seen laterally.
10. Fifth pair of feet of female.
11. Abdomen of female.
12. Terminal spine of swimming foot.



G.S. Brady & A.T. Hollock

Metridia armata.

1882

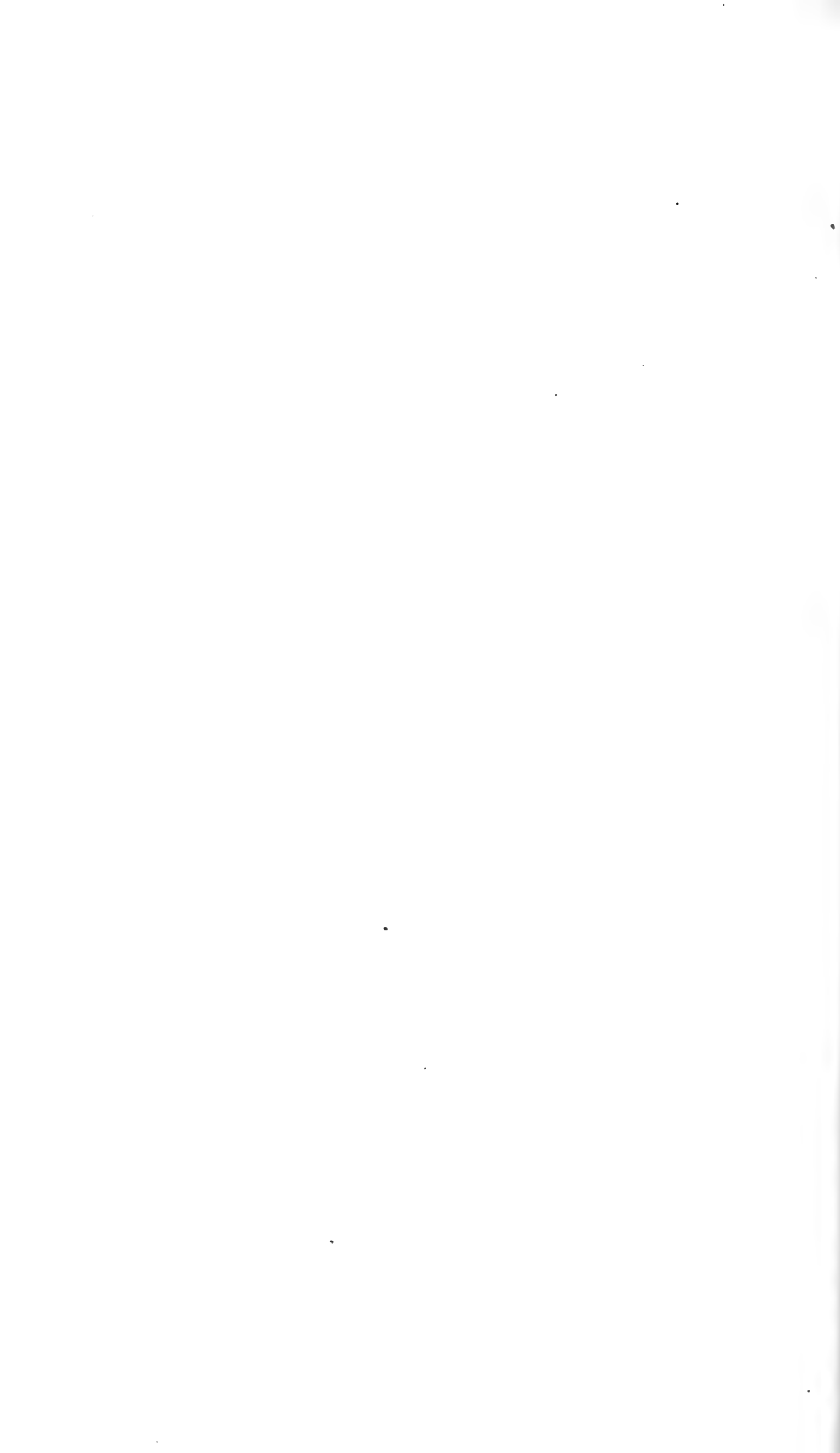




PLATE III.

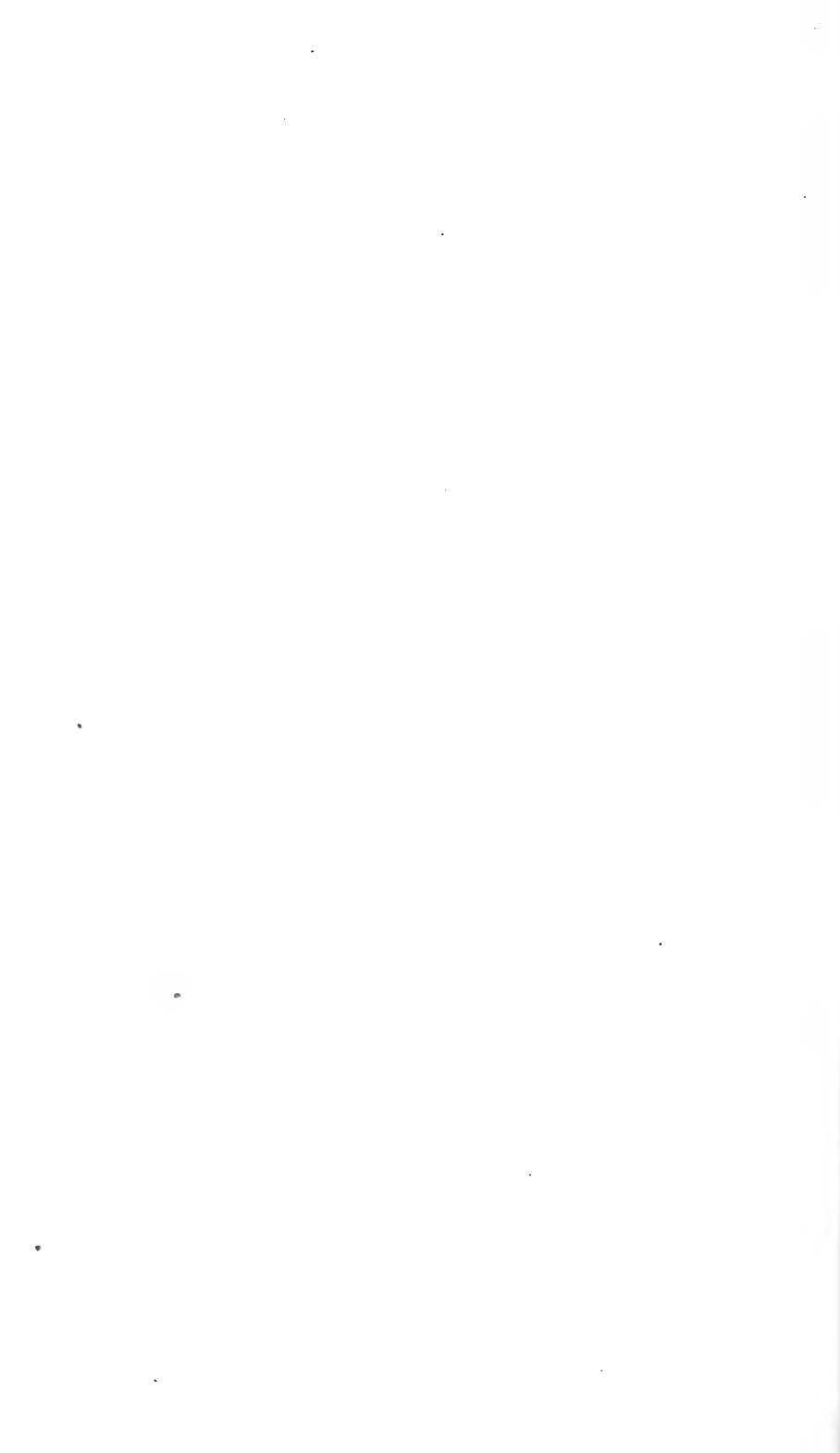
Pseudocalanus elongatus.

- Fig. 1. Female seen from above.
2. Anterior antenna of female.
3. Anterior antenna of male.
4. Posterior antenna.
5. Posterior foot-jaw.
6. Swimming foot of first pair.
7. Terminal spine of swimming foot.
8. Fifth pair of feet of male, *a* left, *b* right.
9. Abdomen of male.

Temora longicornis.

10. Male seen from side.
11. Right anterior antenna of male.
12. Anterior antenna of female.
13. Posterior antenna.
14. Posterior foot-jaw.
15. Foot of fourth pair.
16. Foot of fifth pair of female.
17. Fifth pair of feet of male, *a* right, *b* left.
18. Caudal segments.
19. Terminal spine of swimming foot.





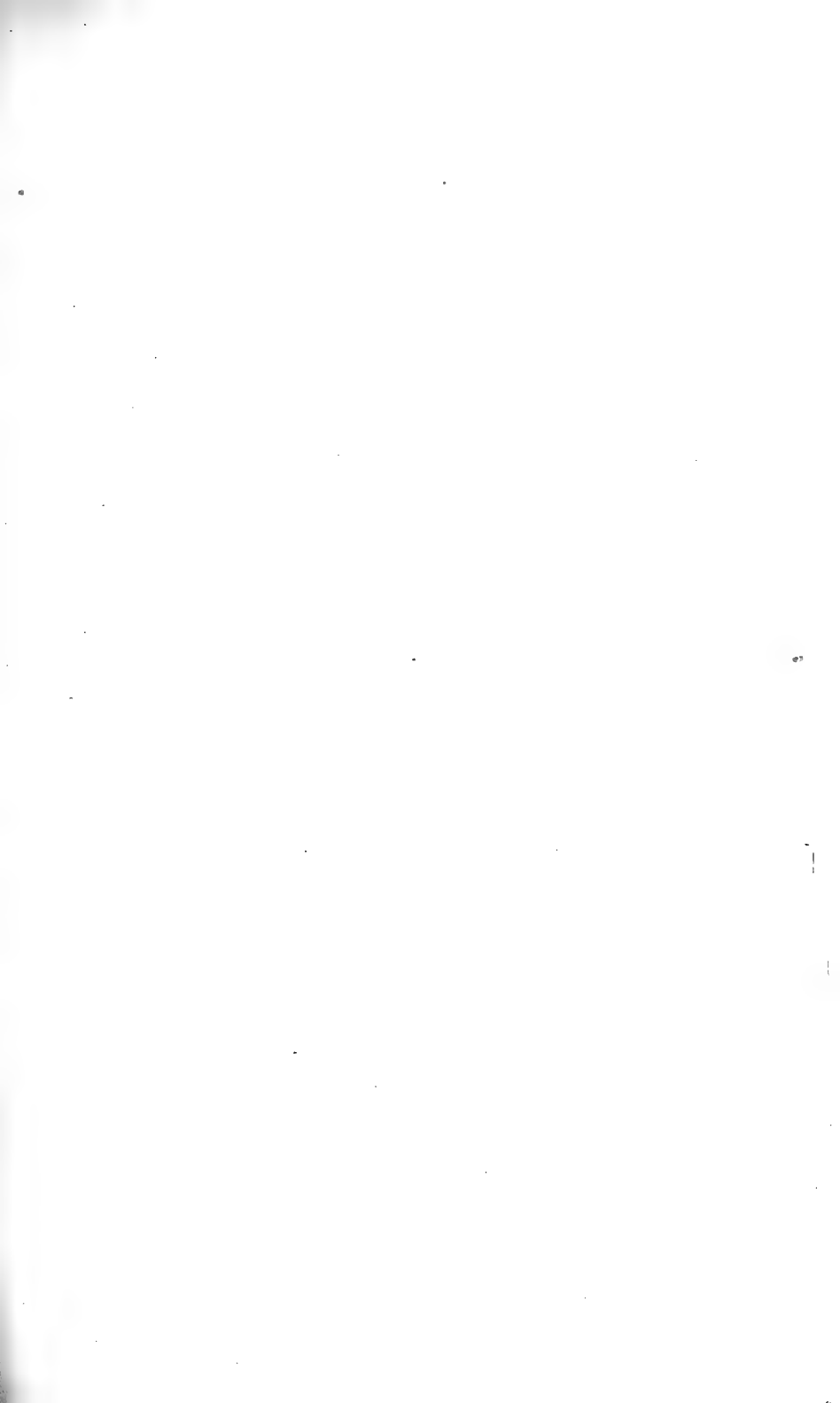


PLATE IV.

Pseudocalanus armatus.

- Fig. 1. Female seen from left side.
2. Anterior antenna of female.
3. Anterior antenna of male.
4. Mandible and palp.
5. Maxilla; *b* branchial plates.
6. Anterior foot-jaw.
7. Posterior foot-jaw.
8. Foot of second pair.
9. Terminal spine of swimming foot.
10. Foot of fifth pair of male.
11. Abdomen of female.



G. S. Brady del
A. T. Hollick lith

Pseudocalanus armatus.

W. West & Co. inc.



PLATE V.

Dias longiremis.

- Fig. 1. Female seen from right side.
2. Anterior antenna of female.
3. Right anterior antenna of male.
4. Left anterior antenna of male.
5. Posterior antenna.
6. Mandible and palp.
7. Maxilla.
8. Anterior foot-jaw.
9. Posterior foot-jaw.
10. Fourth swimming foot.
11. Terminal spine of the same.
12. Fifth foot of female.
13. Fifth pair of feet of male.
14. Abdomen of female.



G. S. Brady del.
A. T. Holmck lith.

Diastis longiremis.

W. W. C. 8. 29. 1881

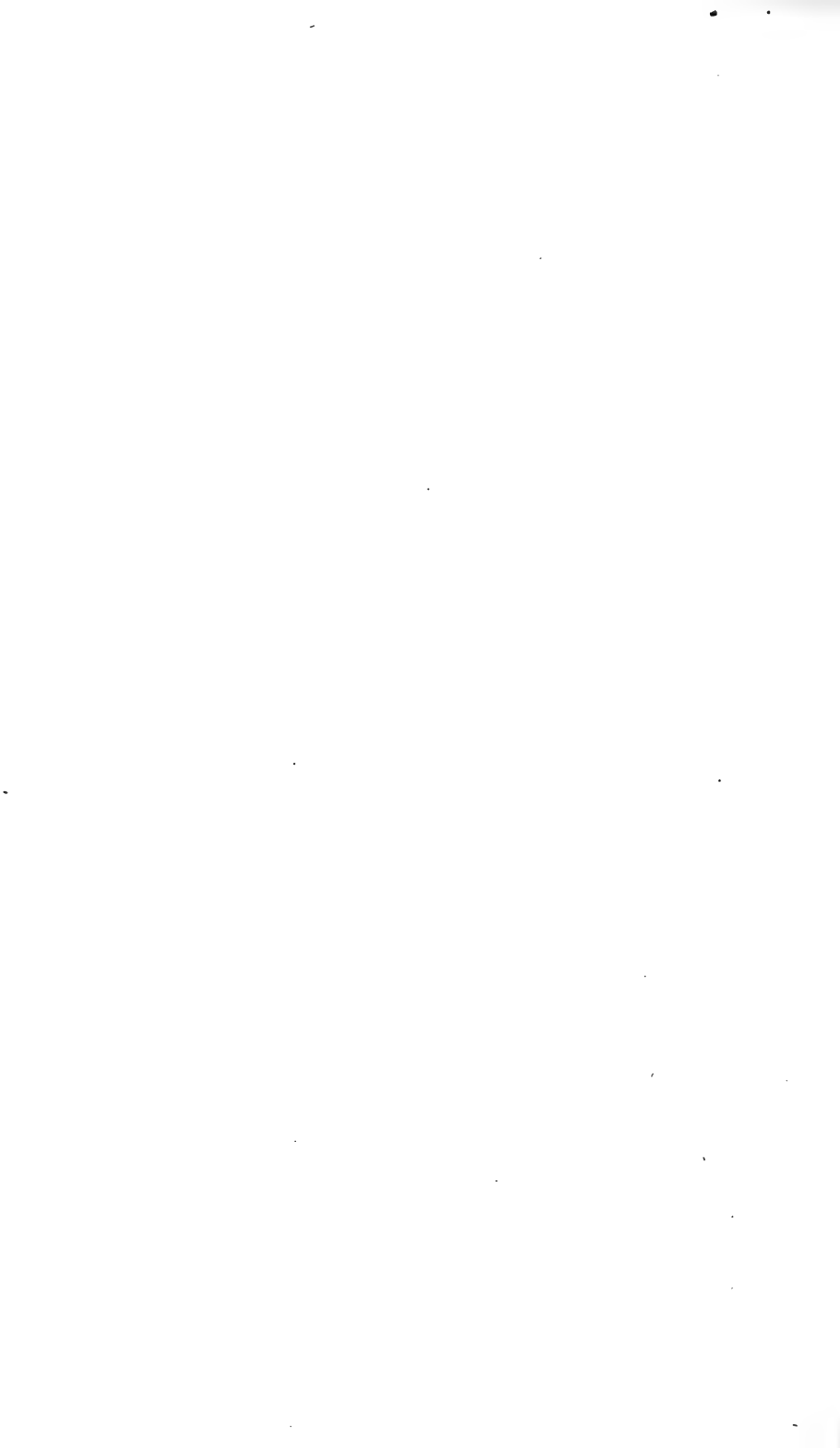




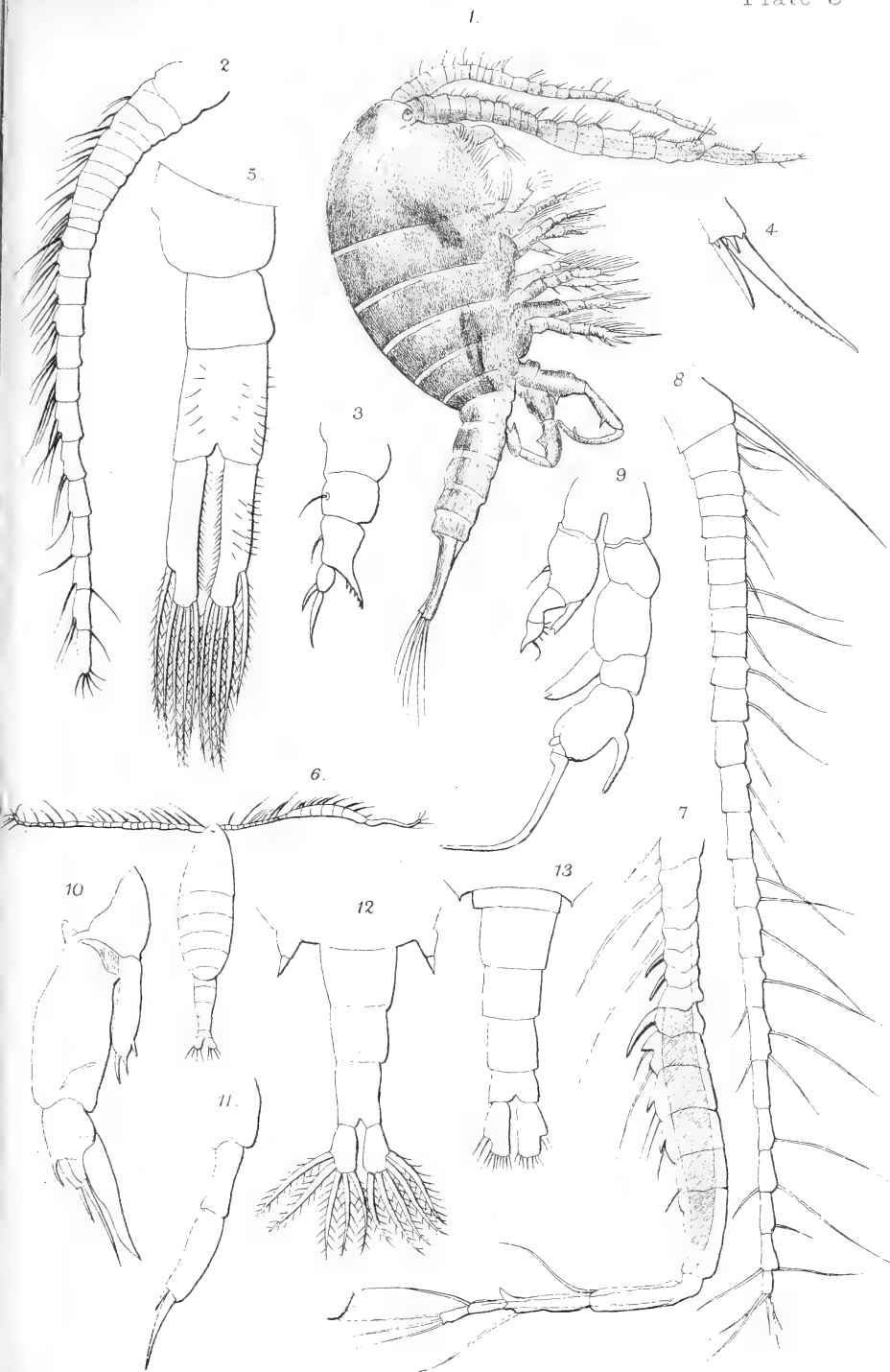
PLATE VI.

Temora velox.

- Fig. 1. Male seen from right side.
2. Anterior antenna of female.
3. Fifth foot of female.
4. Terminal spine of swimming foot.
5. Abdomen of female.

Diaptomus Castor.

6. Male seen from above.
7. Anterior portion of anterior antenna of male
(" *Westwoodii* ").
8. Anterior antenna of female (" *Castor* ").
9. Fifth pair of feet of male.
10. Fifth pair of feet of female (" *Westwoodii* ").
11. Inner branch of fifth pair (" *Castor* ").
12. Abdomen and extremity of thorax of female
(" *Westwoodii* ").
13. Abdomen and extremity of thorax of male
(" *Westwoodii* ").



1-5. *Temora velox*.
 6-13. *Diaptomus castor*.

G.S. Brady del.
 A.T. Höllick lith.

W. West & C^o Inc.



PLATE VII.

Pseudocyclops crassiremis.

- Fig. 1. Right anterior antenna of male.
2. Left anterior antenna of male.

Isias clavipes.

3. Male seen from right side.
4. Left anterior antenna of male.
5. Right anterior antenna of male.
6. Maxilla.
7. Anterior foot-jaw.
8. Posterior foot-jaw.
9. First foot.
10. Fifth foot of female.
11. Fifth foot of male.
12. Terminal spine of swimming foot.
13. Mandible and palp.



1-2. *Pseudocyclops crassinervis*.
 3-13. *Isias clavipes*.

G.S. Brady del.
 A.T. Hobbs sculp.

W. West & Co. engr.



PLATE VIII.

Centropages typicus.

- Fig. 1. Female seen from above.
2. Right anterior antenna of male.
3. Apical joints of left anterior antenna of male.
4. Posterior antenna.
5. Mandible and palp.
6. Posterior foot-jaw.
7. Terminal spines of swimming foot.
8. Third swimming foot.
9. Fifth foot of female.
10. Fifth pair of feet of male.

Centropages hamatus.

11. Right anterior antenna of male.
12. Terminal spines of swimming foot.
13. Right fifth foot of male.

Candace pectinata.

14. Posterior antenna.
15. Anterior foot-jaw.



PLATE IX.

Parapontella brevicornis.

- Fig. 1. Male seen from above.
2. Right anterior antenna of male.
 3. Left anterior antenna of male.
 4. Posterior antenna.
 5. Mandible and palp.
 6. Maxilla.
 7. Anterior foot-jaw.
 8. Posterior foot-jaw.
 9. First swimming foot.
 10. Third swimming foot.
 11. Fifth pair of feet of male.
 12. Fifth foot of female.
 13. Terminal spines of swimming foot.
 14. Abdomen of male.
 15. Second and third segments of female abdomen
seen from behind.
 16. Abdomen of female seen from side.



G.S. Brady del.
A.T.H. Thack. lith.

W. West & Co. imp.

Parapontella brevicornis.

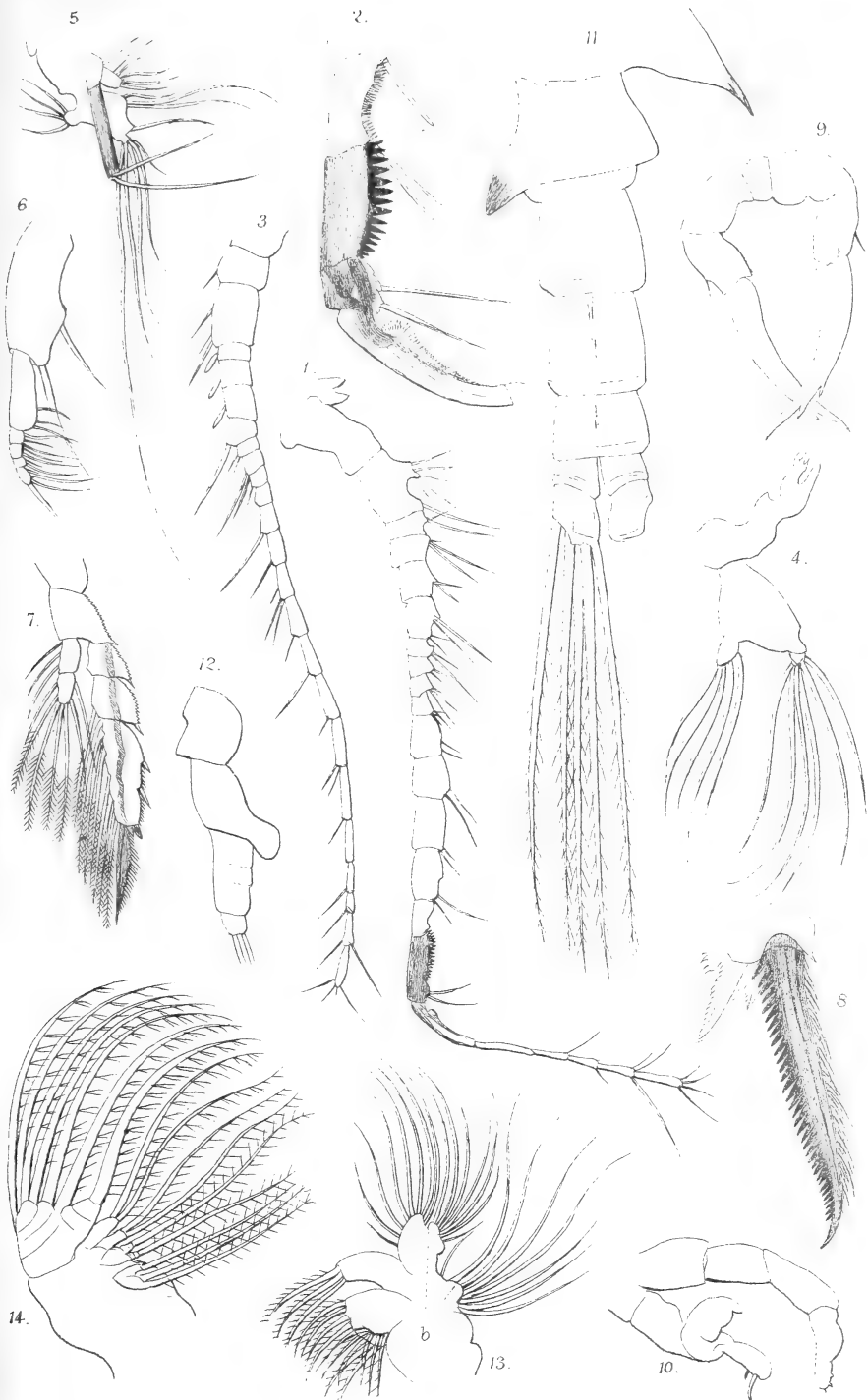
PLATE X.

Candace pectinata.

- Fig. 1. Right anterior antenna of male.
2. Hinge joints of the same.
3. Anterior antenna of female.
4. Mandible and palp.
5. Maxilla and palp.
6. Posterior foot-jaw.
7. Fourth foot.
8. Terminal spine of same.
9. Fifth pair of feet of female.
10. Fifth pair of feet of male.
11. Abdomen and last thoracic segment of male.
12. Abdomen of female seen laterally.

Anomalocera Patersonii.

13. Maxilla and palp.
14. Anterior foot-jaw.



G.S. Brady del.
A.T. Hollick sculp.

1-12. *Candace pectinata*
13, 14. *Anomalocera Patersoni*.

W. N. S. 2 29 imp.

PLATE X A.

Pontella Wollastoni.

- Fig. 1. Anterior antenna of female.
2. Anterior antenna (right) of male.
3. Posterior antenna.
4. Mandible.
5. Mandible-palp.
6. Maxilla.
7. Anterior foot-jaw.
8. Posterior foot-jaw.
9. Left foot of fifth pair, male.
10. Right foot of fifth pair, male.
11. Foot of fifth pair, female.
12. Abdomen of male.

(The figures in this plate are taken from the work of Dr. Claus, 'Die frei-lebenden Copepoden,' &c.)



G. S. Emery del.
A. T. Hollick lith.

W. West & Company.

Pontella Wollastoni.





PLATE XI.

Anomalocera Patersonii.

- Fig. 1. Male seen from right side.
2. Right anterior antenna of male, with eye.
3. Left anterior antenna of male.
4. Anterior antenna of female.
5. Posterior antenna.
6. Posterior foot-jaw.
7. Terminal spine of swimming foot.
8. Fifth pair of feet of male.
9. Fifth foot of female.
10. Spine of same more highly magnified.
11. Abdomen of female seen laterally.
12. Caudal segments of female.
13. Caudal segments of male.
14. Rostrum and lateral eyes.



G.S. Brady del.
A.T. Hollick lith.

Anomalocera Patersonii

W. H. McCombs





PLATE XII.

Pseudocyclops obtusatus.

- Fig. 1. Male seen from right side.
2. Right anterior antenna of male.
3. Left anterior antenna of male.
4. Posterior antenna.
5. Mandible and palp.
6. Maxilla.
7. Anterior foot-jaw.
8. Posterior foot-jaw.
9. Foot of first pair.
10. Terminal spine, &c., of swimming foot.
11. Fifth pair of feet of male.
12. Foot of fifth pair of female.
13. Abdomen of male.

Pseudocyclops crassiremis.

14. Fifth pair of feet of male.



G.S. Brady del.
A.T. Ho Wick lith.

1-13, *Pseudocyclops obtusatus*.
14, " *crassiremis*.

W. West & Co. imp.



PLATE XIII.

Lophophorus insignis.

- Fig. 1. Anterior antenna of female.
2. Posterior antenna.
3. Mandible.
4. Mandibular palp.
5. Maxilla.
6. Anterior foot-jaw.
7. Posterior foot-jaw.
8. Foot of fourth pair.
9. Foot of fifth pair.
10. Abdomen and tail.

Misophria pallida.

11. Anterior antenna of female.
12. Posterior antenna.
13. Anterior foot-jaw.
14. Posterior foot-jaw.
15. Foot of fifth pair.
16. Tail.



G.S. Brady del.
A.T. Holsinger lith.

1-10, *Lophophorus insignis*.
11-16, *Misophria pallida*.

T. West & Co. imp.

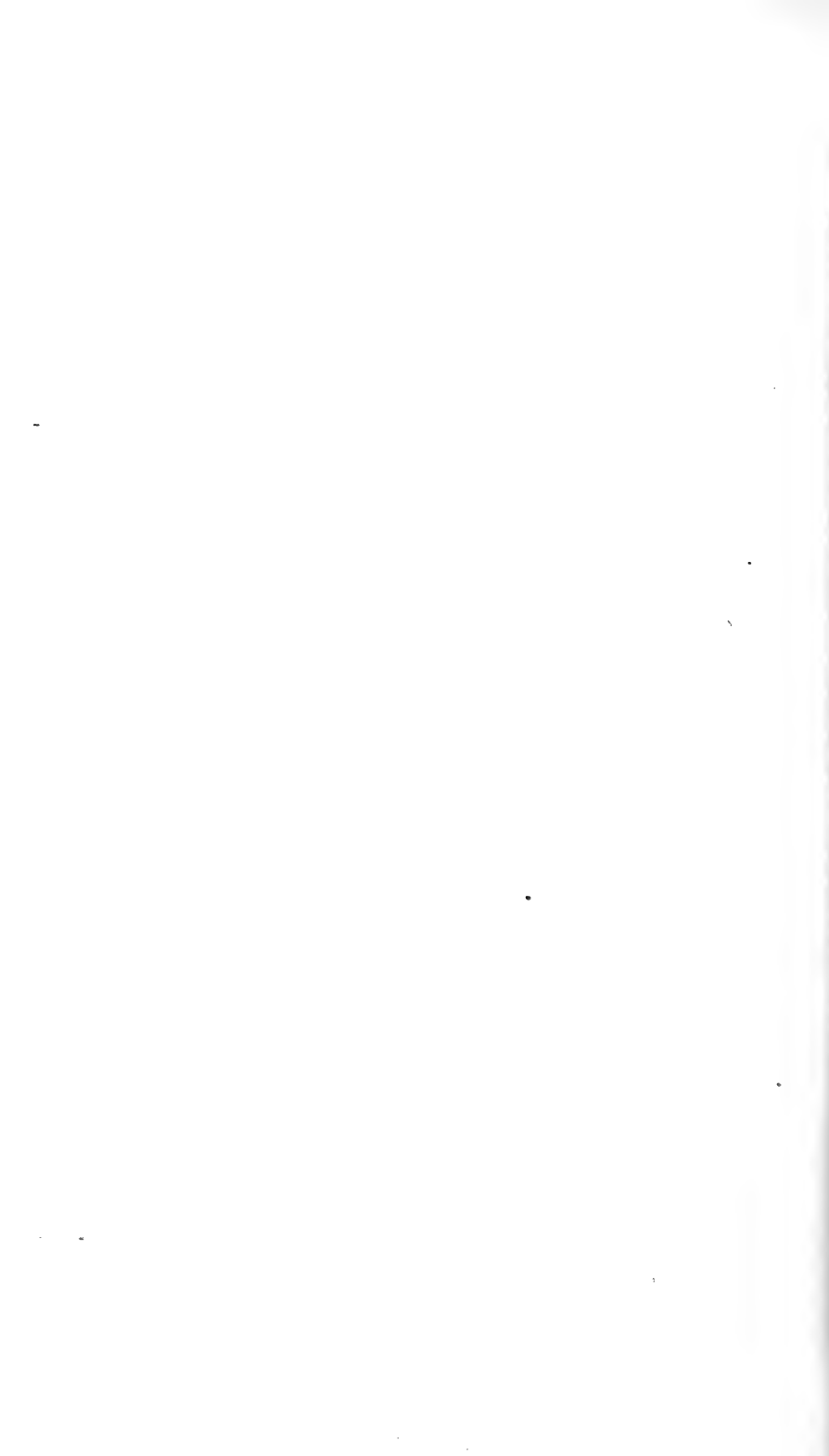
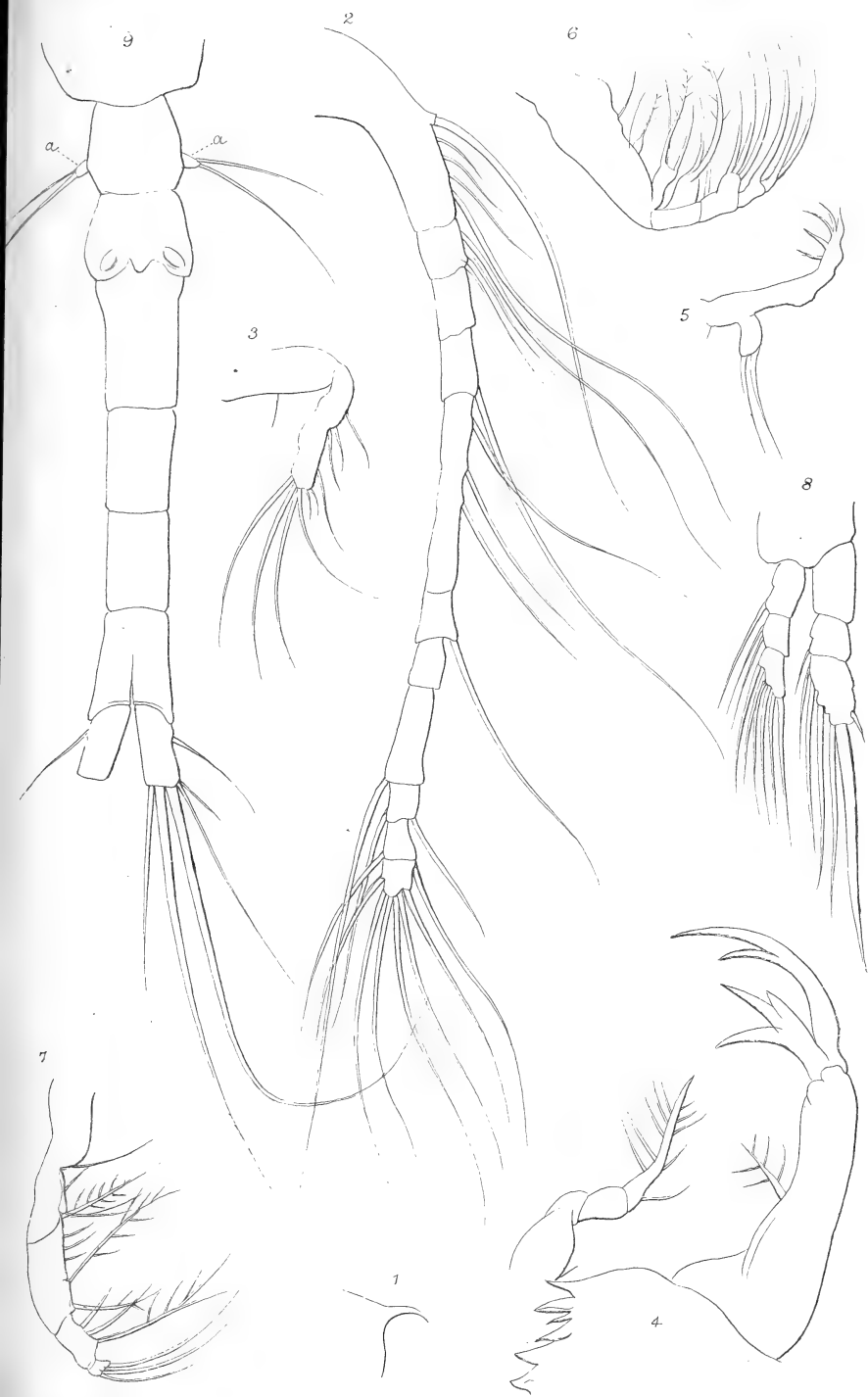




PLATE XIV.

Oithona spinifrons.

- Fig. 1. Rostrum.
2. Anterior antenna of female.
 3. Posterior antenna.
 4. Mandible and palp.
 5. Maxilla (?).
 6. Anterior foot-jaw.
 7. Posterior foot-jaw.
 8. One of swimming feet.
 9. Abdomen and last thoracic segments of female ;
(a) fifth foot.



S.S. Brady: del.
A.T. Hollister: lith.

Oithona spinifrons.

W. West & Co. imp.



PLATE XV.

Cyclopina littoralis.

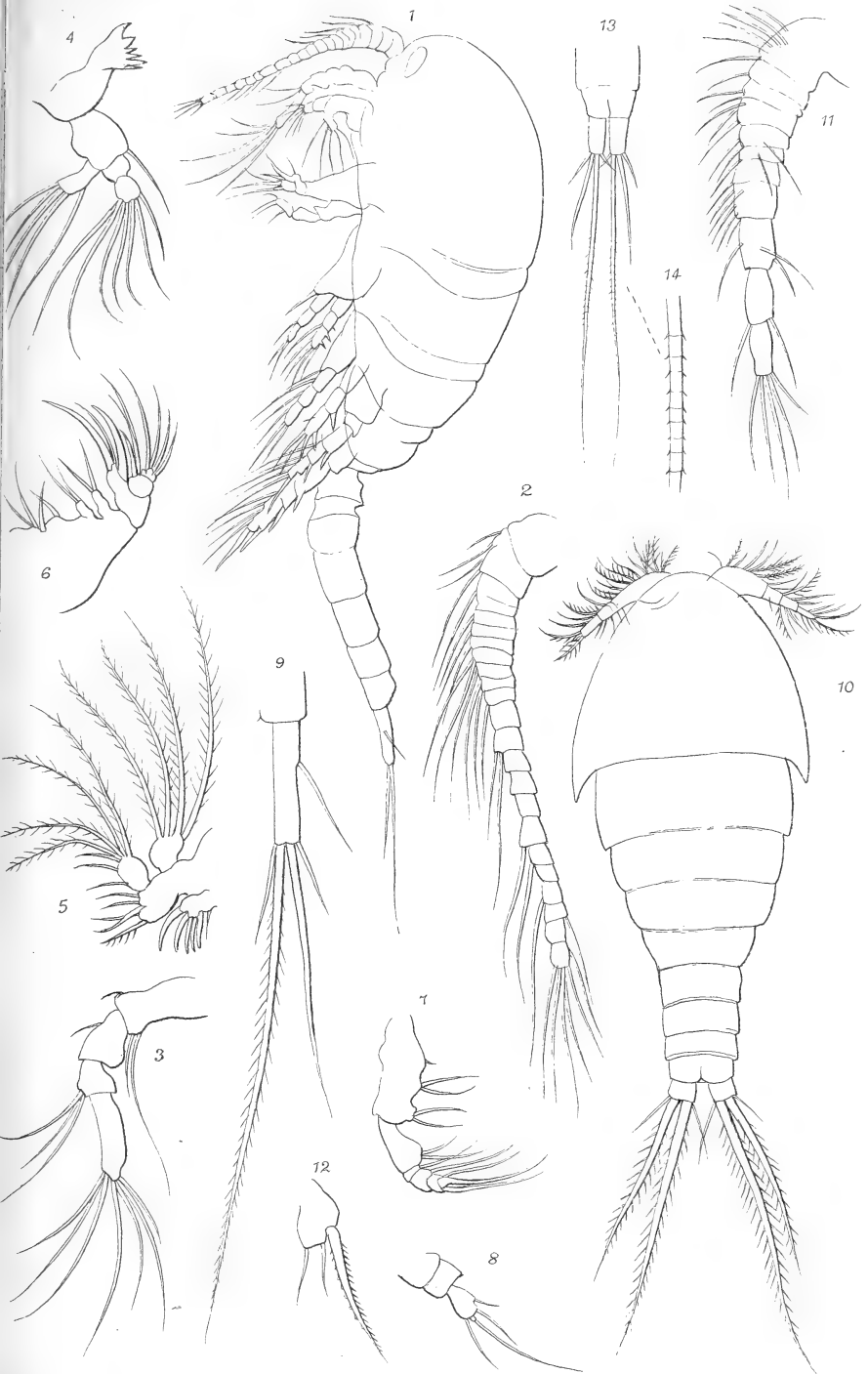
- Fig. 1. Female seen from left side.
2. Anterior antenna of same.
3. Posterior antenna of same.
4. Mandible and palp.
5. Maxilla.
6. Anterior foot-jaw.
7. Posterior foot-jaw.
8. Fifth foot.
9. Caudal segments.

Lophophorus insignis.

10. Female seen from above.

Cyclops affinis.

11. Anterior antenna of female.
12. Fifth foot.
13. Tail.
14. Part of one of tail setæ, more highly magnified.



G.S. Brady del.
 A.T. Huxford lith.

1.-9. *Cyclopina littoralis*.

W. West & Co. imp.

10. *Lophophorus insignis*. 11-14. *Cyclops affinis*.





PLATE XVI.

Thorellia brunnea.

- Fig. 1. Female seen from left side.
2. Anterior antenna of same.
3. Anterior antenna of male.
4. Posterior antenna.
5. Mandible and palp.
7. Anterior foot-jaw.
8. Posterior foot-jaw.
9. Swimming foot, one of third pair.
10. Last thoracic segment, with fifth pair of feet
and first two abdominal segments.



50 Brady det.
A.H. Moe illus.

4 W. 1913

Thorella bournsea.

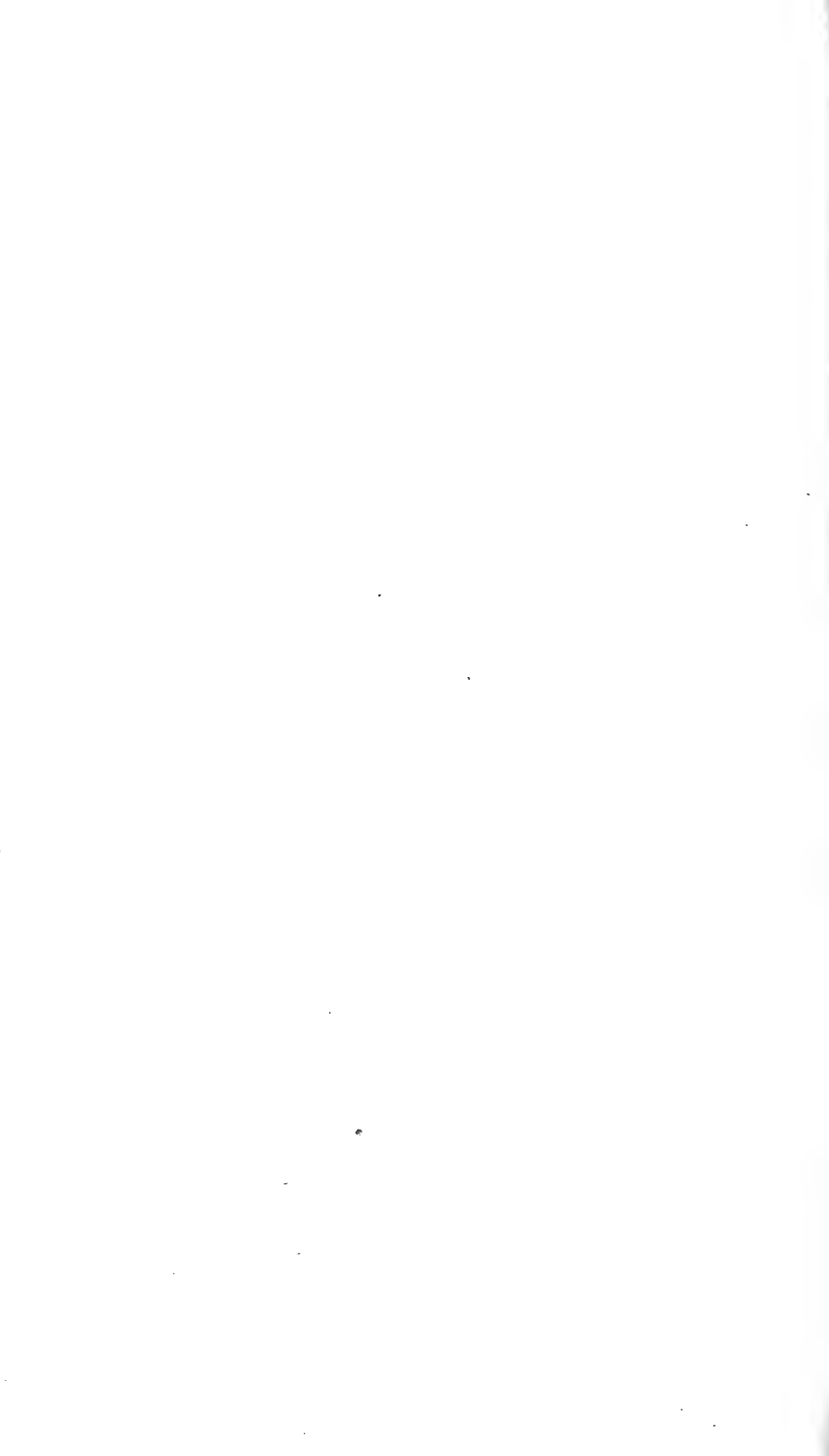


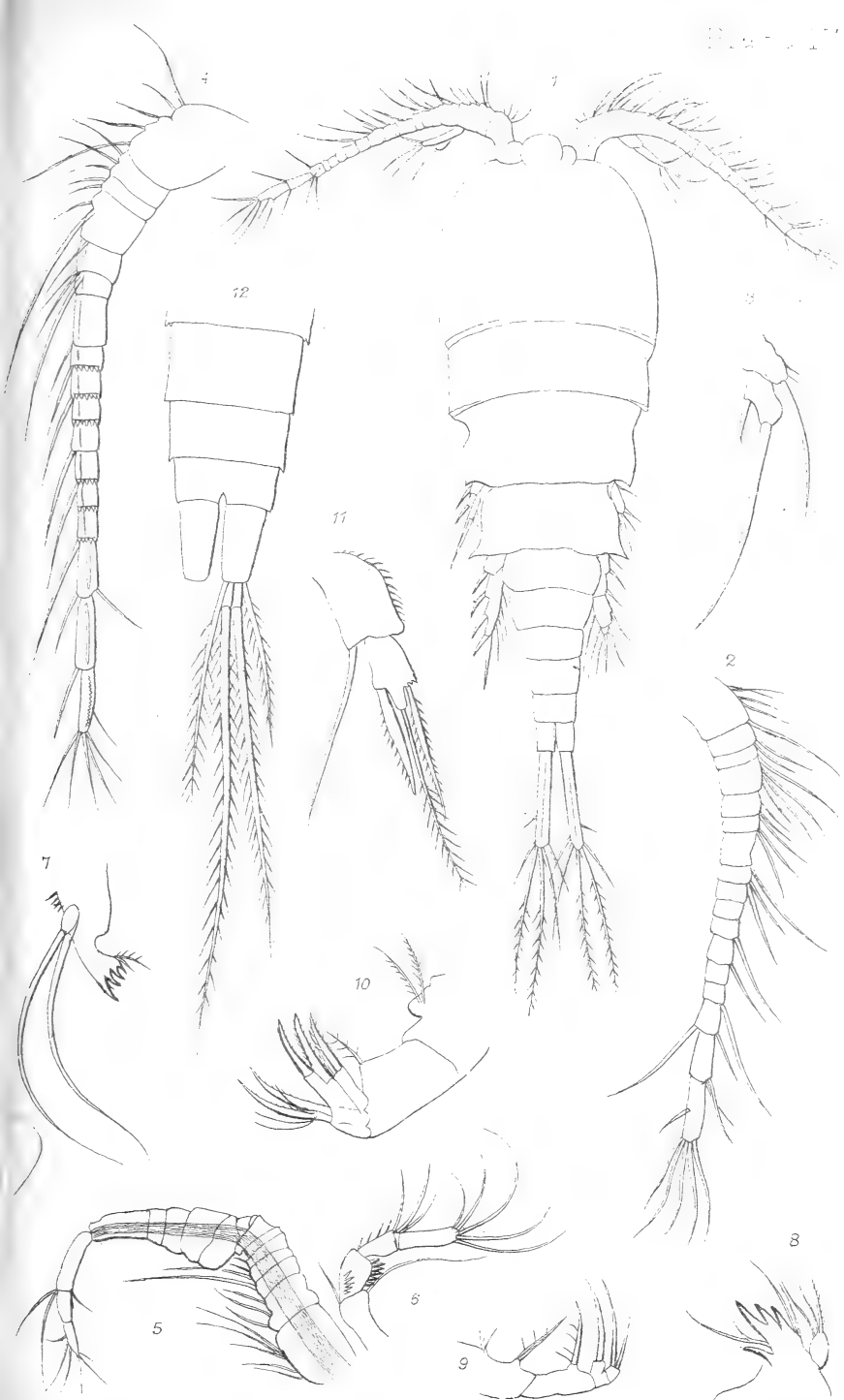
PLATE XVII.

Cyclops pulchellus.

- Fig. 1. Female seen from above.
2. Anterior antenna of same.
3. Foot of fifth pair.

Cyclops signatus.

4. Anterior antenna of female.
5. Anterior antenna of male.
6. Posterior antenna.
7. Mandible and palp.
8. Maxilla.
9. Anterior foot-jaw.
10. Posterior foot-jaw.
11. Foot of fifth pair.
12. Abdomen and tail.



G.S. Brady, det.
 A.T. Clark, 1911.

1-3, *Cyclops pulchellus*.
 4-12, ,, *signatus*.

H. W. Hensley, det.



PLATE XVIII.

Cyclops tenuicornis.

- Fig. 1. Female seen from above.
2. Anterior antenna of same.
3. Mandible and palp.
4. Maxilla.
5. Anterior foot-jaw.
6. Posterior foot-jaw.
7. Fifth foot.
8. Caudal segment and setæ.
9. Anterior antenna, penultimate stage of development.
10. Labrum.

Misophria pallida.

11. Maxilla.
12. Mandible and palp.



G.S. Brady del
A.T. Holsinger lith

1-10, *Cyclops tenicornis*.
11-12, *Misophria pallida*.

W. H. Cresson



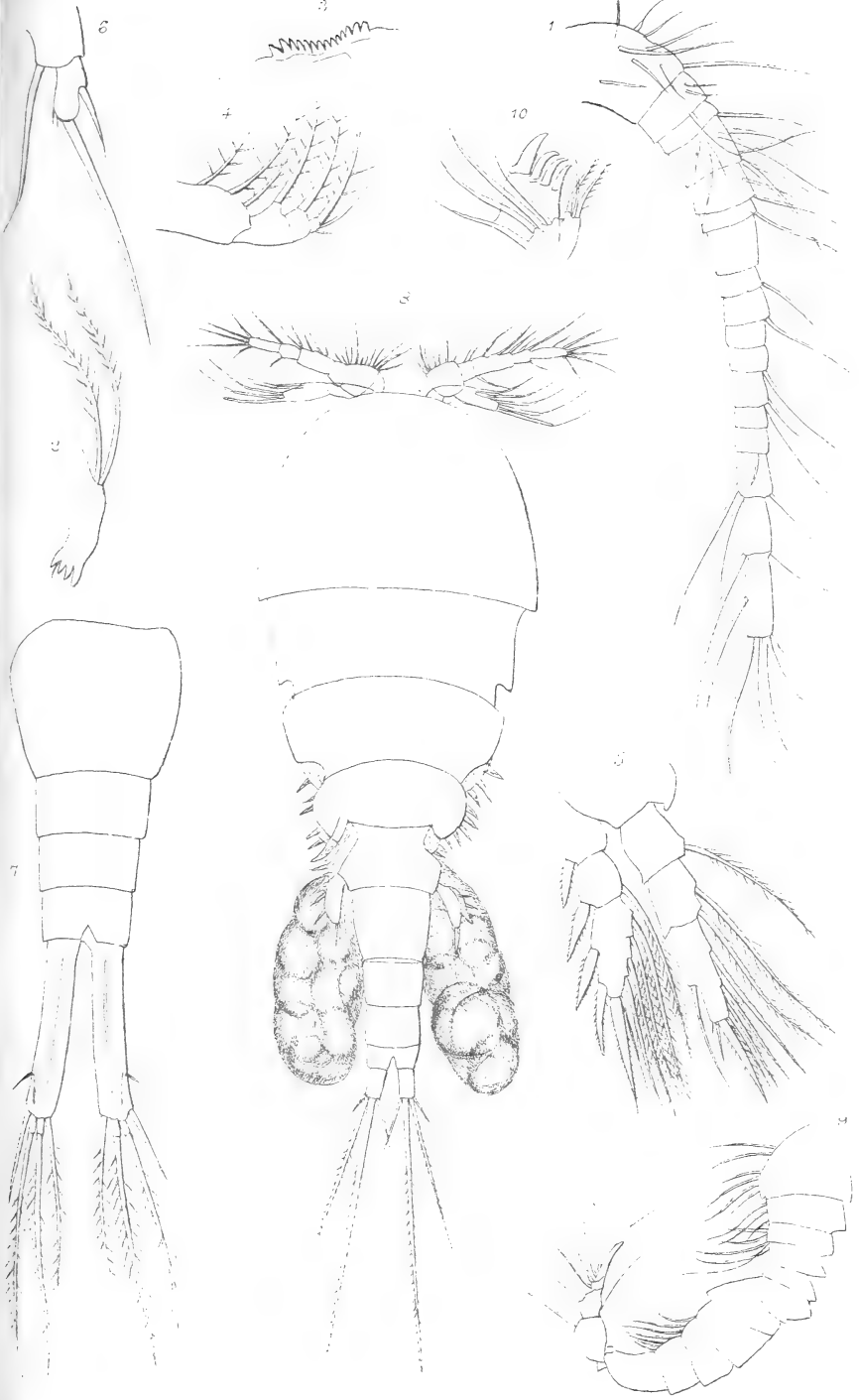
PLATE XIX.

Cyclops strenuus.

- Fig. 1. Anterior antenna of female.
2. Mandible and palp.
3. Labrum.
4. Anterior foot-jaw.
5. Foot of fourth pair.
6. Foot of fifth pair.
7. Abdomen and tail.

Cyclops æquoreus.

8. Female seen from above.
9. Anterior antenna of male.
10. Maxilla.



Sci. Ex. 100
A. H. C. G. 1874

1874
Sci. Ex. 100
A. H. C. G. 1874

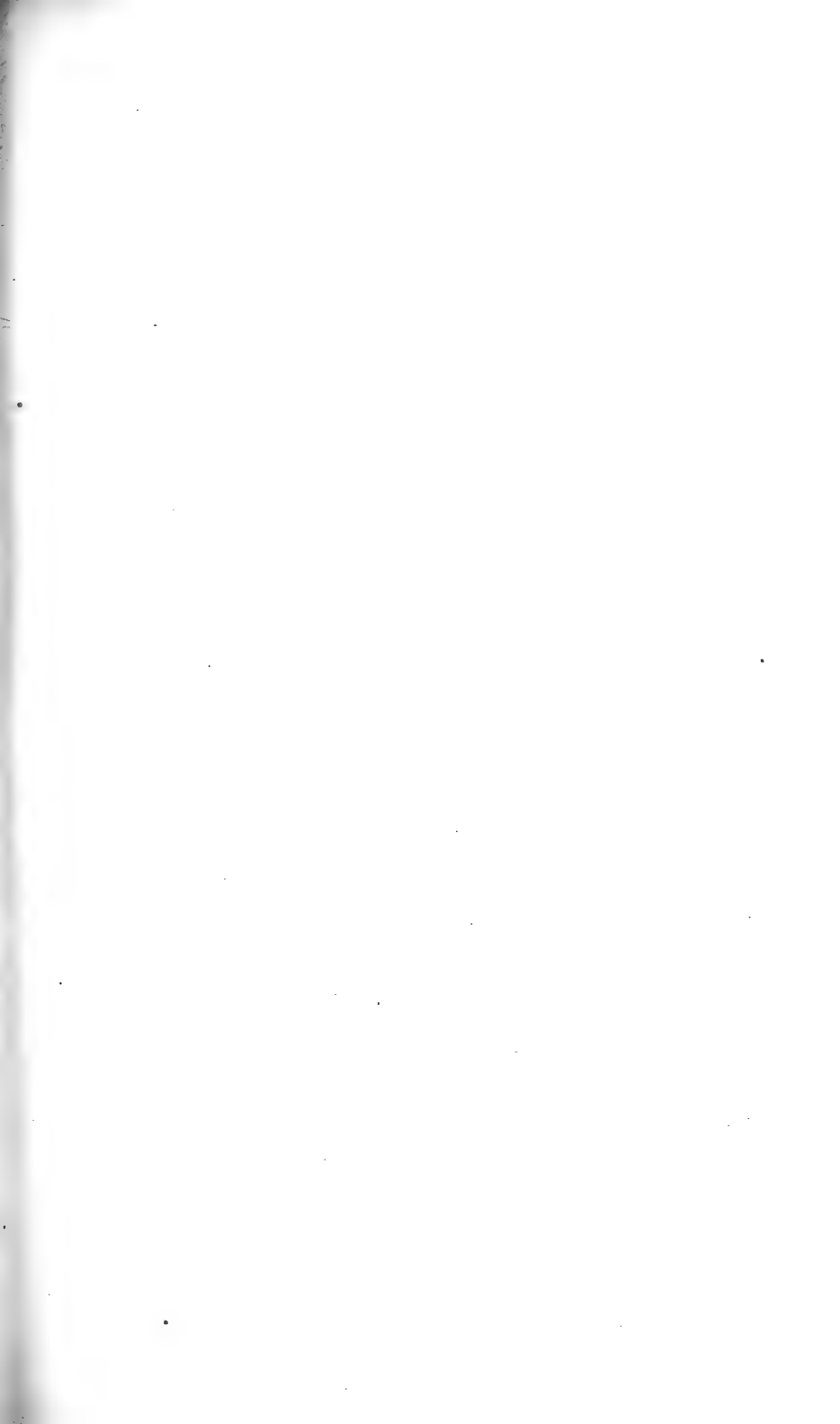


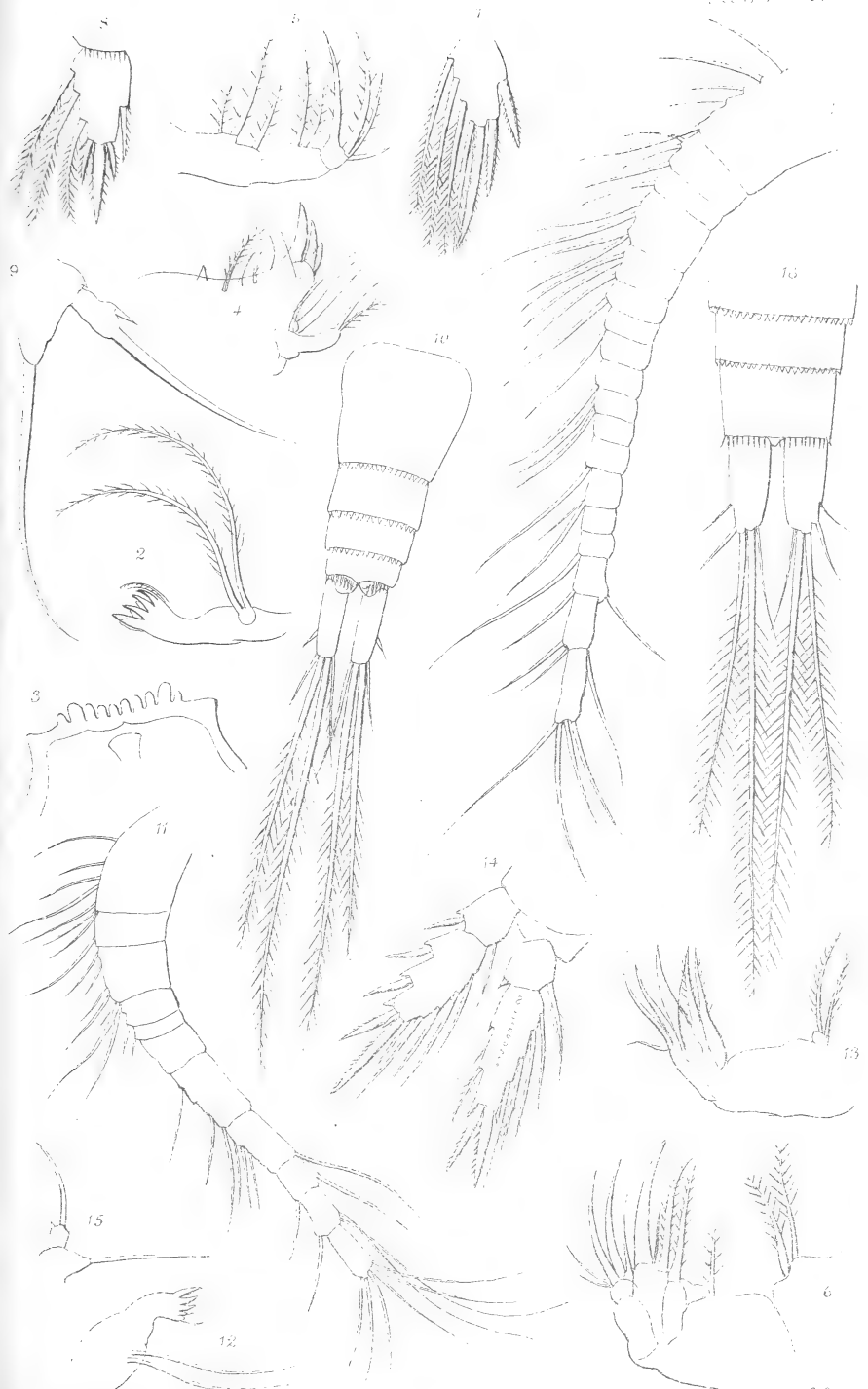
PLATE XX.

Cyclops gigas (adult female).

- Fig. 1. Anterior antenna.
2. Mandible and palp.
3. Labrum.
4. Maxilla and palp.
5. Anterior foot-jaw.
6. Posterior foot-jaw.
7. Fourth foot; apical joint of outer branch.
8. Fourth foot; apical joint of inner branch.
9. Fifth foot.
10. Abdomen and tail.

The same, penultimate stage of development.

11. Anterior antenna.
12. Mandible and palp
13. Posterior foot-jaw.
14. One of swimming feet.
15. Fifth foot.
16. Abdomen and tail.



G. E. M. and
A. T. M. del.

W. Wood & Co. engr.

Cyclops sigas.

PLATE XXI.

Cyclops insignis.

- Fig. 1. Anterior antenna of female.
2. Anterior antenna of male.
3. Posterior antenna.
4. Mandible.
5. Maxilla.
6. Anterior foot-jaw.
7. Posterior foot-jaw.
8. Fifth foot.
8 a. Appendage of first abdominal segment of male.
9. Caudal segment and setæ.

Cyclops æquoreus.

10. Anterior antenna of female.
11. Posterior antenna of female.
12. Mandible.
13. Anterior foot-jaw.
14. Posterior foot-jaw.
15. One of first pair of swimming feet.
16. Abdomen and lower segments of thorax.
17. Foot of fifth pair.



G.S. Brady del.
A.T. Hollick 1872

1872 Brady & Hollick

1--8, *Cyclops insignis*

9--17, " " " "



PLATE XXII.

Cyclops serrulatus.

- Fig. 1. Posterior antenna.
2. Mandible and palp.
3. Anterior foot-jaw.
4. Posterior foot-jaw.
5. Foot of fifth pair.
6. Caudal segments.

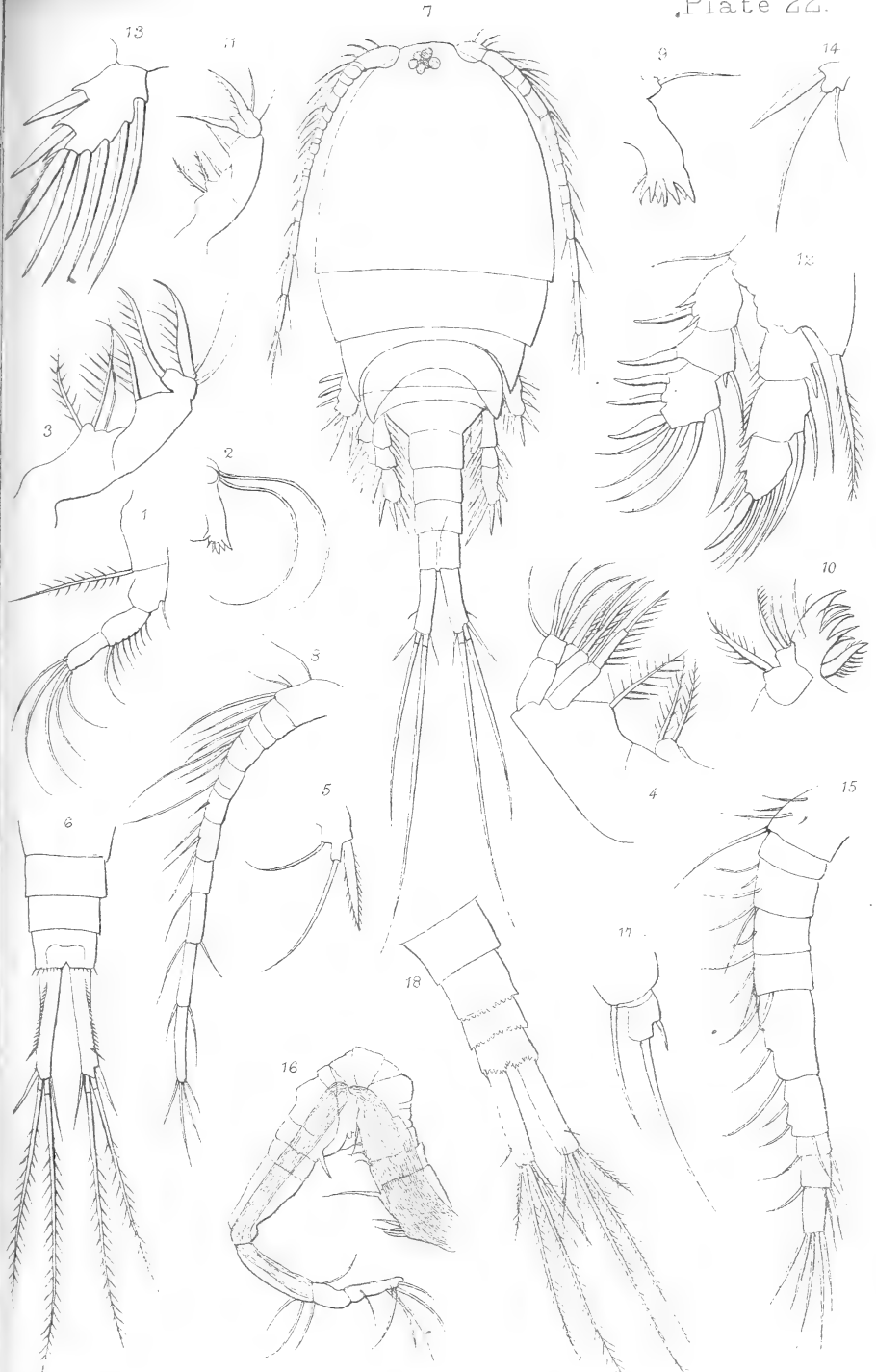
Variety of same.

7. Female seen from above.
8. Anterior antenna of same.
9. Mandible.
10. Maxilla.
11. Anterior foot-jaw.
12. Foot of first pair.
13. Fourth foot ; last joint of outer branch.
14. Foot of fifth pair.

*Cyclops Helleri.**

15. Anterior antenna of female.
16. Anterior antenna of male.
17. Foot of fifth pair.
18. Abdomen and caudal segments of male.

* In inscription of Plate XXII, for *Clausii*, read *Helleri*.



G.S. Brady, del.
A.T. Hollis, lith.

1-6, *Cyclops serrulatus*.
 7-14, " " *varmontanus*.
 15-18, " " *clausii*.

W. West & Co. imp.



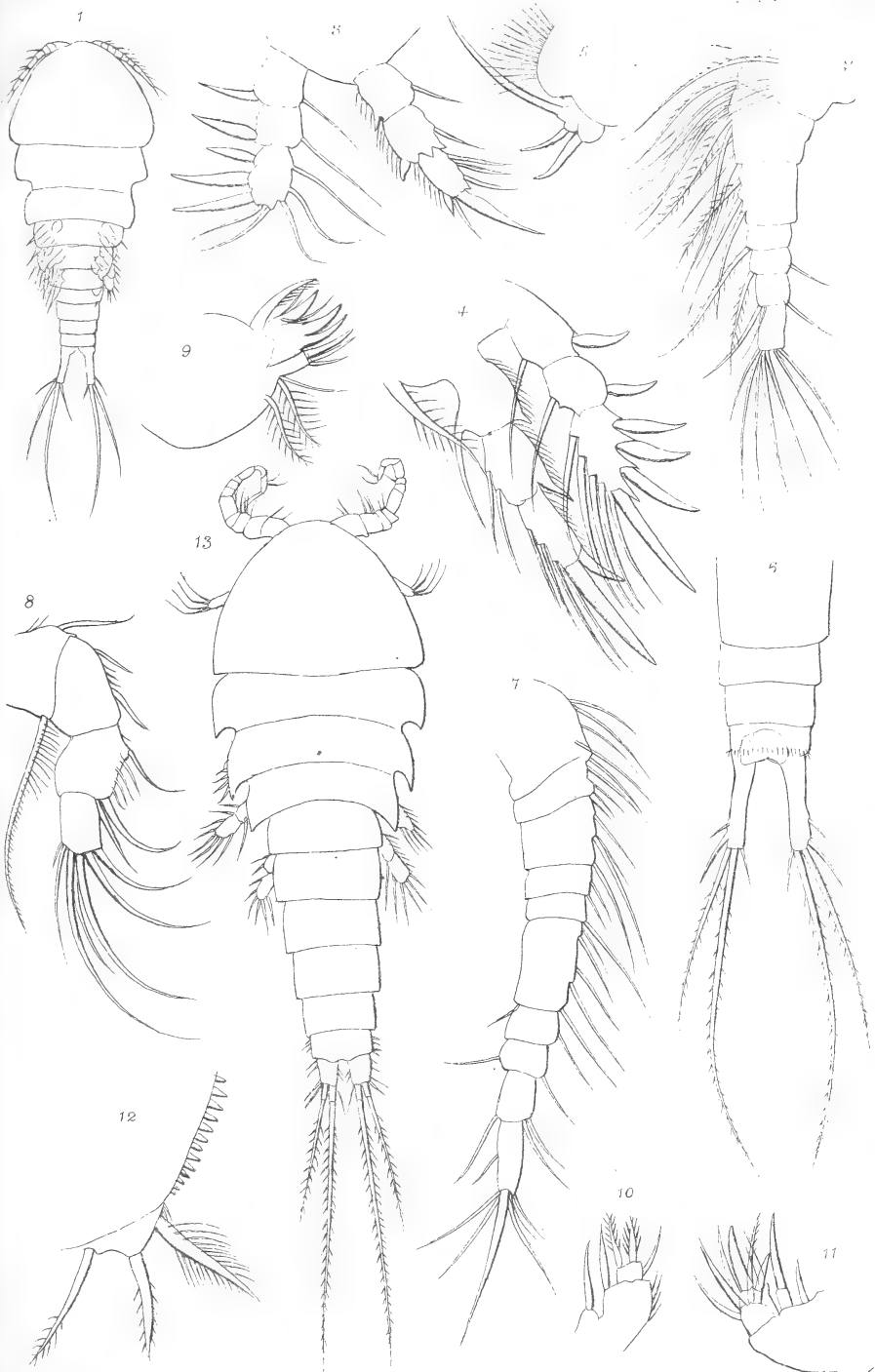
PLATE XXIII.

Cyclops crassicornis.

- Fig. 1. Female seen from below.
2. Anterior antenna of female.
3. Foot of first pair.
4. Foot of second pair.
5. Foot of fifth pair.
6. Abdomen and tail.

Cyclops phaleratus.

7. Anterior antenna of female.
8. Posterior antenna.
9. Maxilla.
10. Anterior foot-jaw.
11. Posterior foot-jaw.
12. Foot of fifth pair.
13. Male seen from above.



G.S. Brady det.
A.T. Hollick lth.

1-6. *Cyclops crassicornis*.
7-13. " *phaleratus*.

W. West & Co. impo

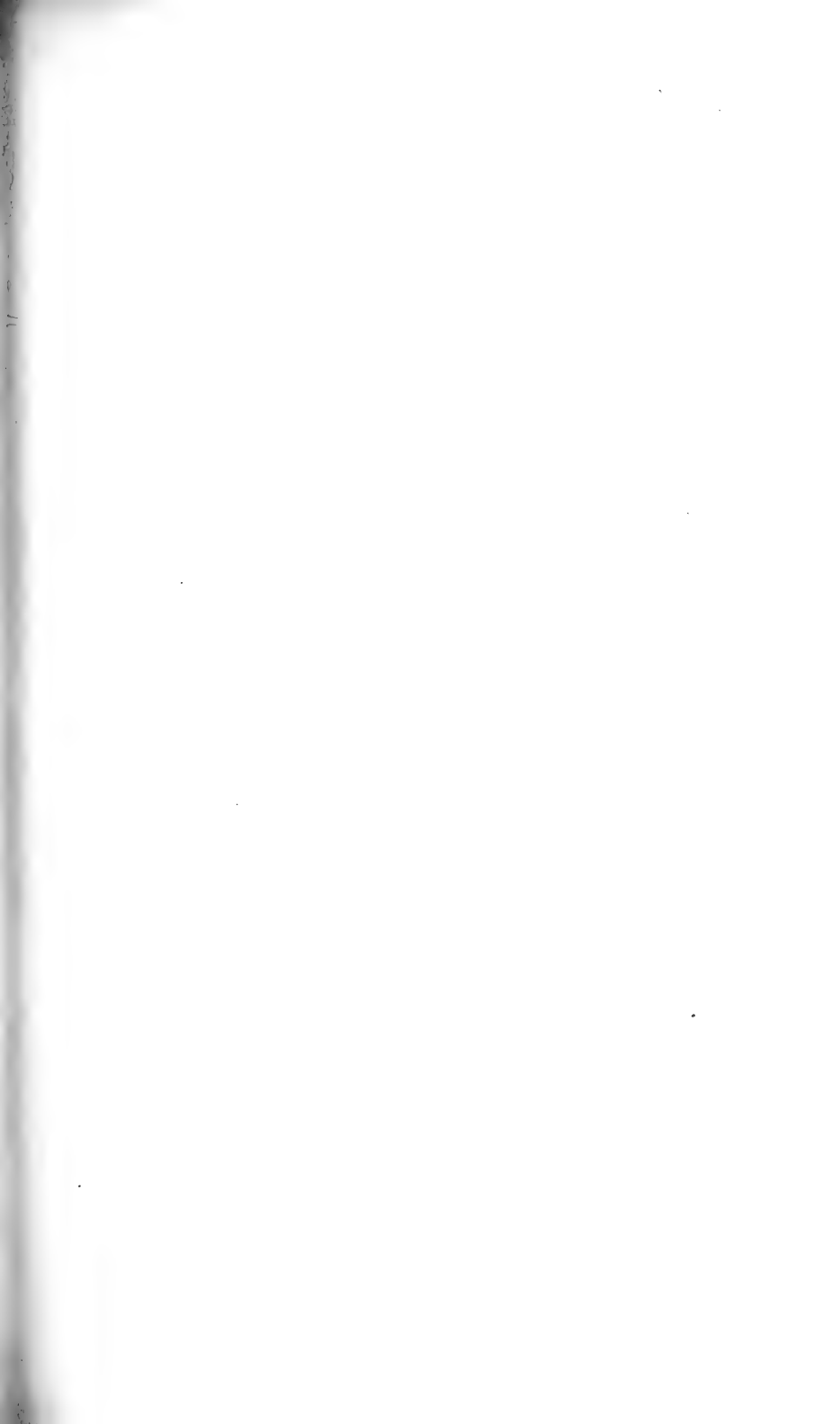


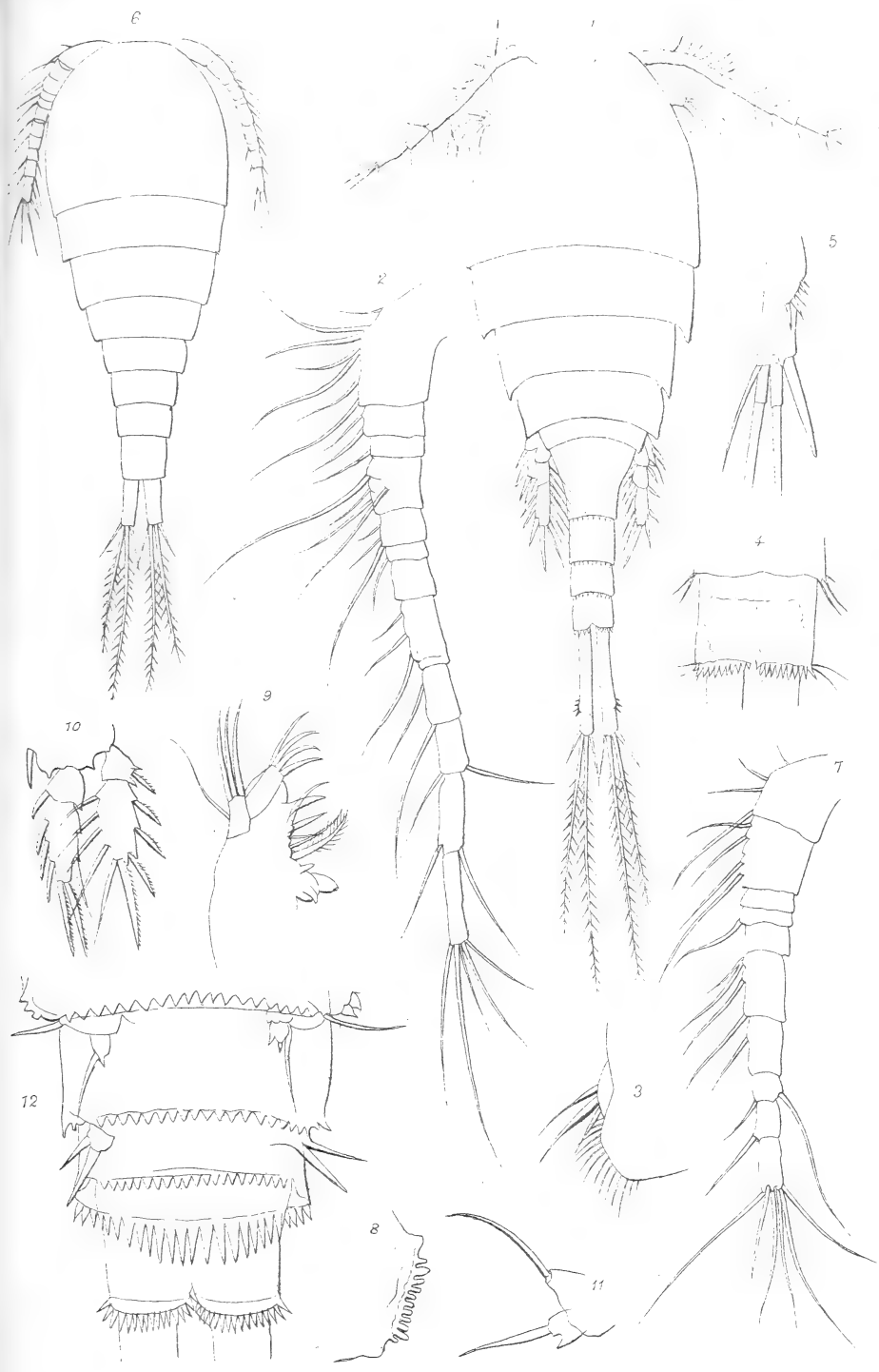
PLATE XXIV.

Cyclops macrurus.

- Fig. 1. Female seen from above.
2. Anterior antenna of same.
3. Fifth foot.
4. Penultimate abdominal segment.
5. Caudal segment.

Cyclops Kaufmanni.

6. Female seen from above.
7. Anterior antenna of same.
8. Labrum.
9. Maxilla.
10. One of swimming feet.
11. Fifth foot.
12. Portion of abdomen.



G. S. Brady ed.
 A. T. E. White del.

1-5. *Cyclops macrurus*.
 6-12. " *Cyclops Kaufmanni*.

W. H. C. & Co. engr.



PLATE XXIV A.

Oithona spinifrons.

- Fig. 1. Adult female.
2. Right anterior antenna of male.

Cervinia Bradyi.

3. Adult (female?).
4. Anterior antenna.
5. Posterior antenna.
6. Mandible and palp.
7. Maxilla.
8. First foot-jaw.
9. Second foot-jaw.
10. Foot of first pair.
11. Foot of second pair.
12. Foot of third pair.
13. Foot of fourth pair.

12

13

1

11

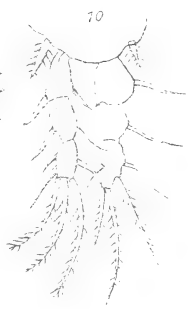
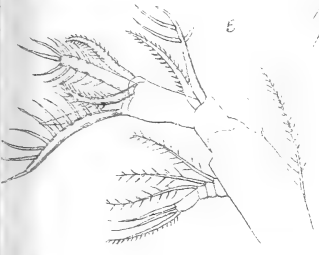




PLATE XXIV B.

Cyclopina gracilis ♀.

- Fig. 1. Adult female (after Claus).
2. Anterior antenna.
 3. Posterior antenna.
 4. Mandible and palp.
 5. Maxilla and palp.
 6. Anterior foot-jaw.
 7. Posterior foot-jaw.
 8. Foot of fourth pair.
 9. Abdomen and tail, with (*a, a*) fifth feet.

Cyclops affinis ♂?

10. Anterior antenna.
11. Labrum.
12. Anterior foot-jaw.
13. Foot of fifth pair.
14. Appendage of first abdominal segment.
15. One of caudal rami with setæ.



S.S. Brady det.
A.H. Hodge illus.

U.S. Geol. Surv.

1-9 Cyclops gracilis ♀
10-15 Cyclops affinis?



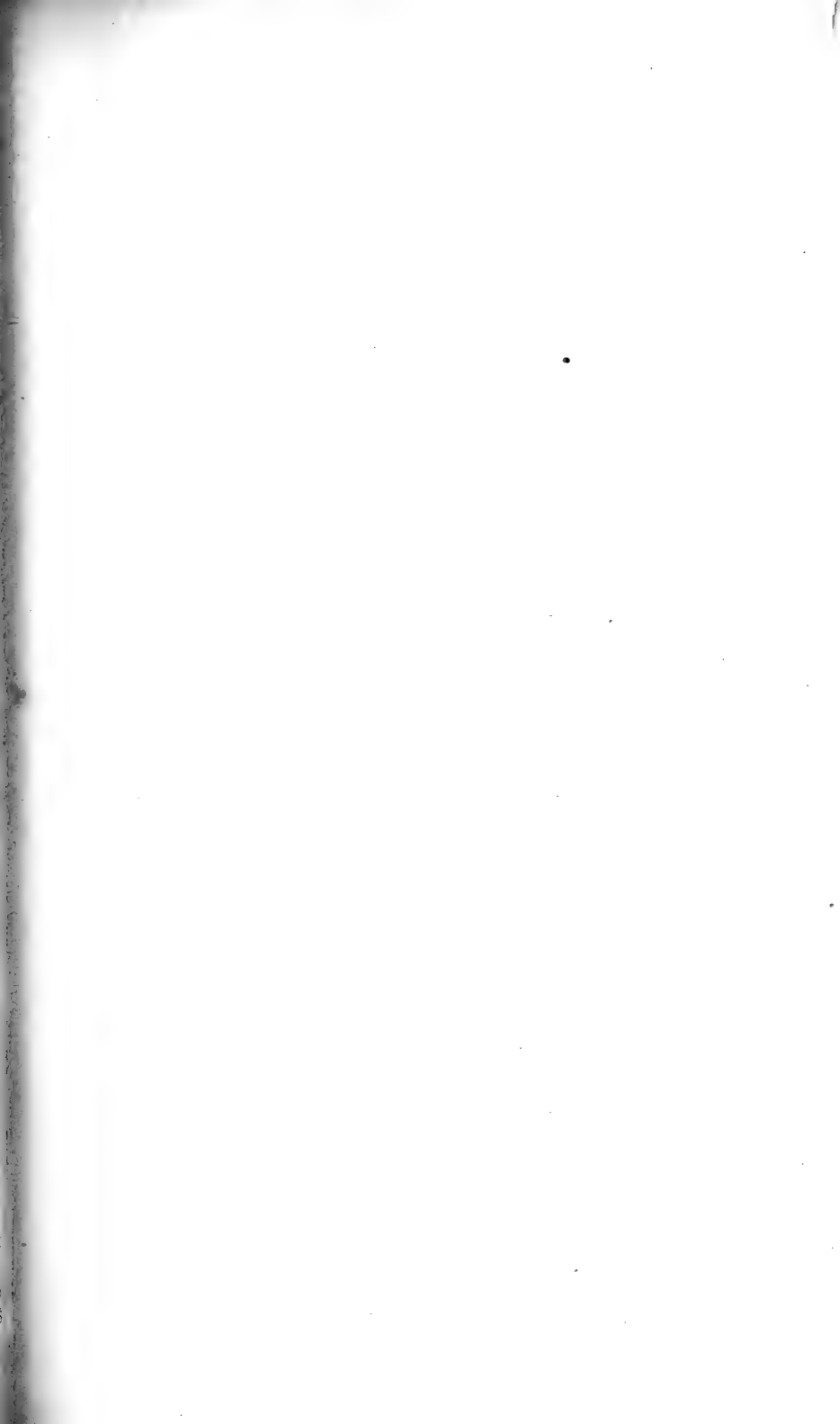


PLATE XXV.

Notodelphys Allmani.

- Fig. 1. Female from above.
2. Anterior antenna of same.
3. Posterior antenna of same.
4. Mandible.
5. Maxilla.
6. Anterior foot-jaw.
7. Posterior foot-jaw.
8. Foot of first pair.
9. Foot of third pair.
10. Foot of fifth pair.

(These figures are drawn from Scandinavian specimens sent by M. Thorell.)

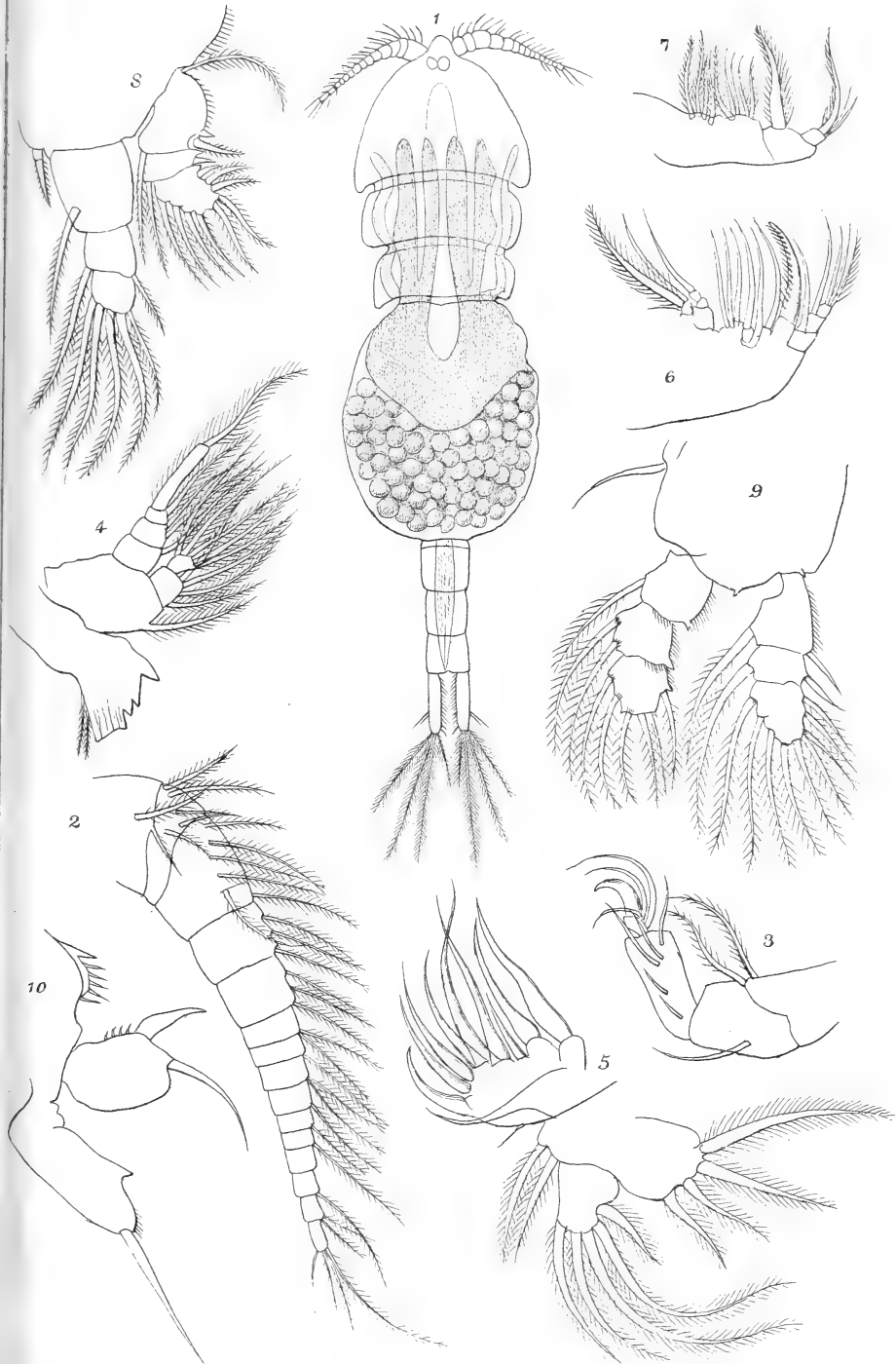
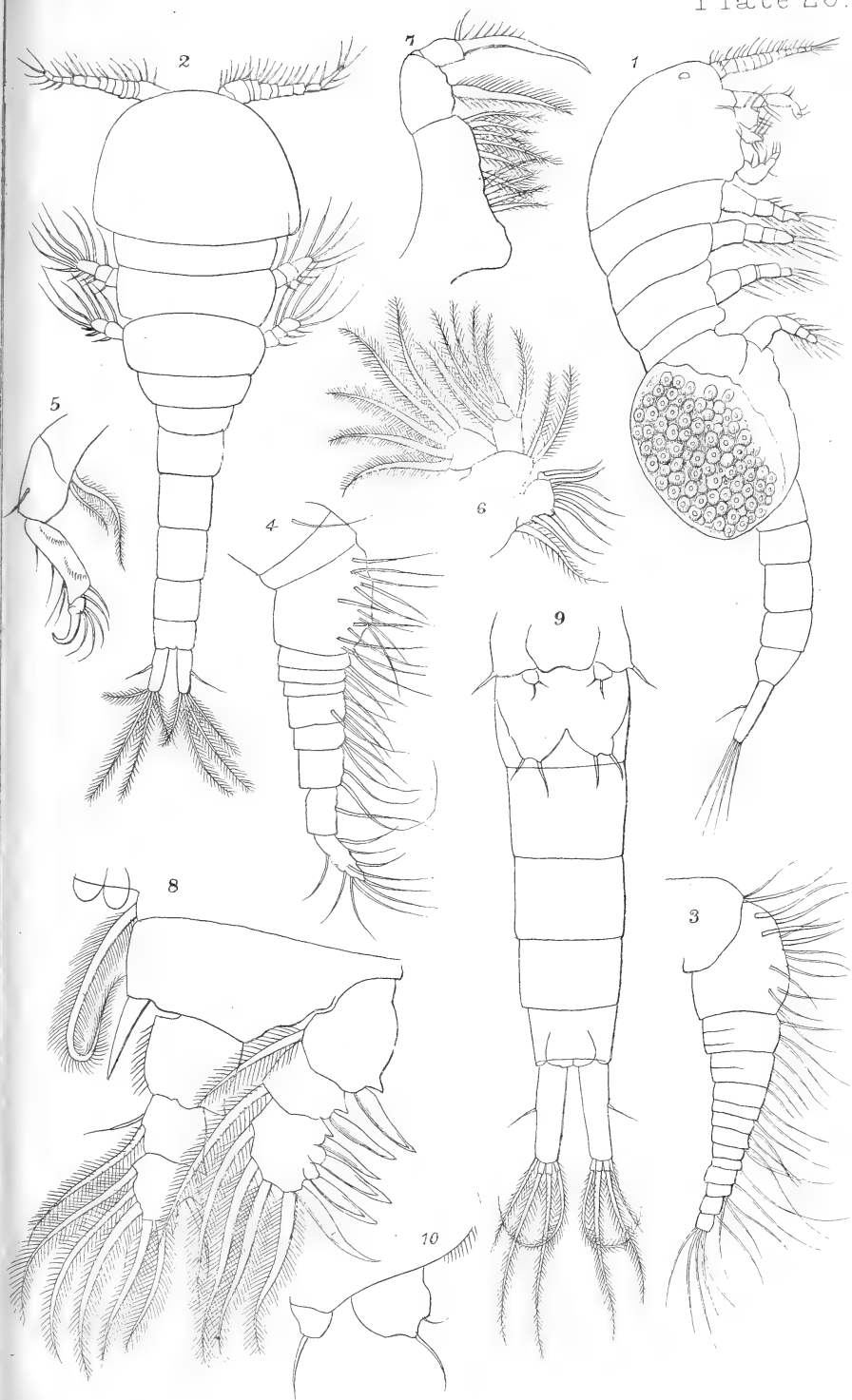


PLATE XXVI.

Notodelphys agilis.

- Fig. 1. Female, adult.
2. Male, adult.
3. Anterior antenna of female.
4. Anterior antenna of male.
5. Posterior antenna.
6. Maxilla.
7. Posterior foot-jaw.
8. Foot of first pair.
9. Abdomen and fifth pair of feet of male.
10. Foot of fifth pair, female.



G. S. Brady del.
A. T. H. Clifton lith.

Notodelphys agilis.

W. H. & Co. lith.



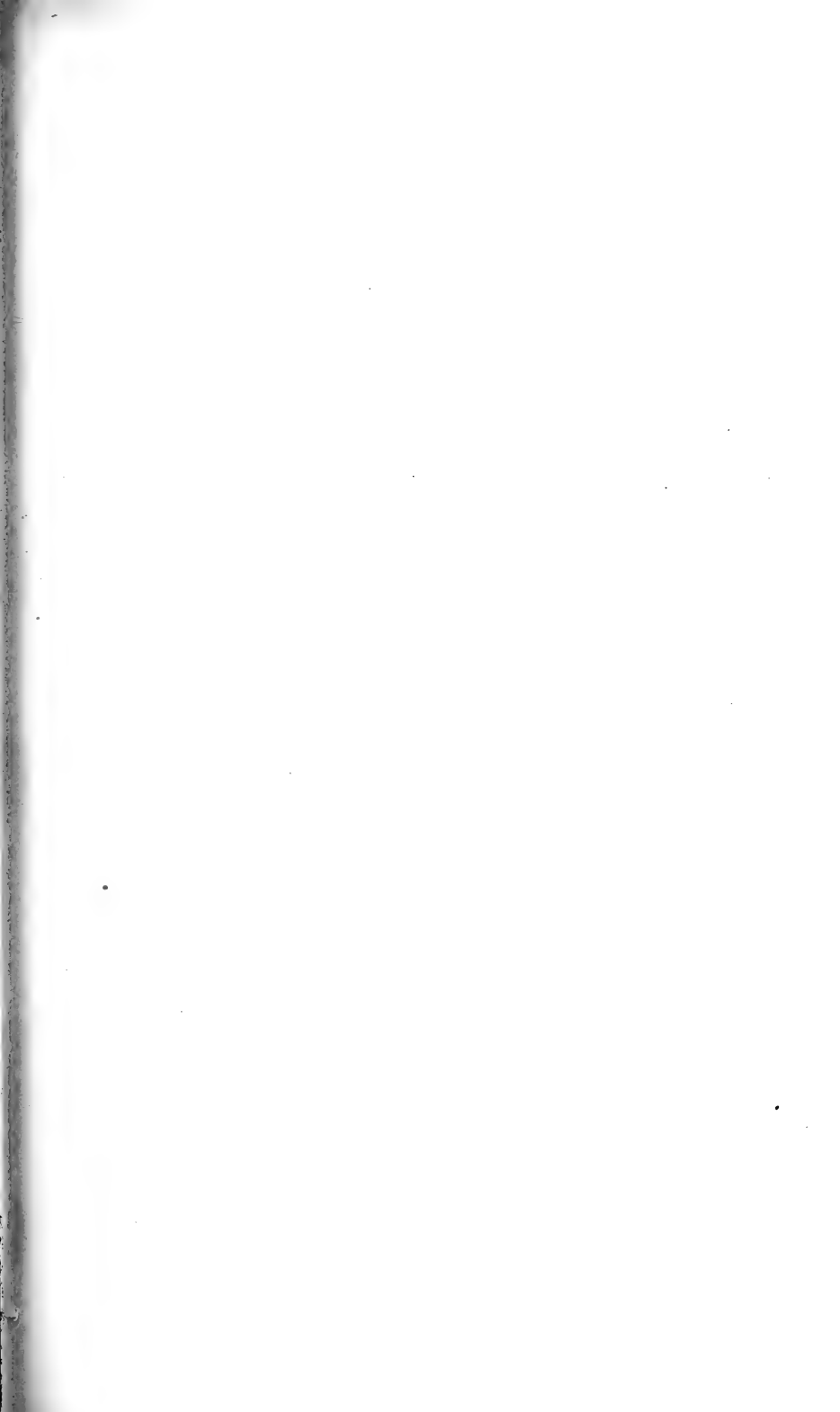


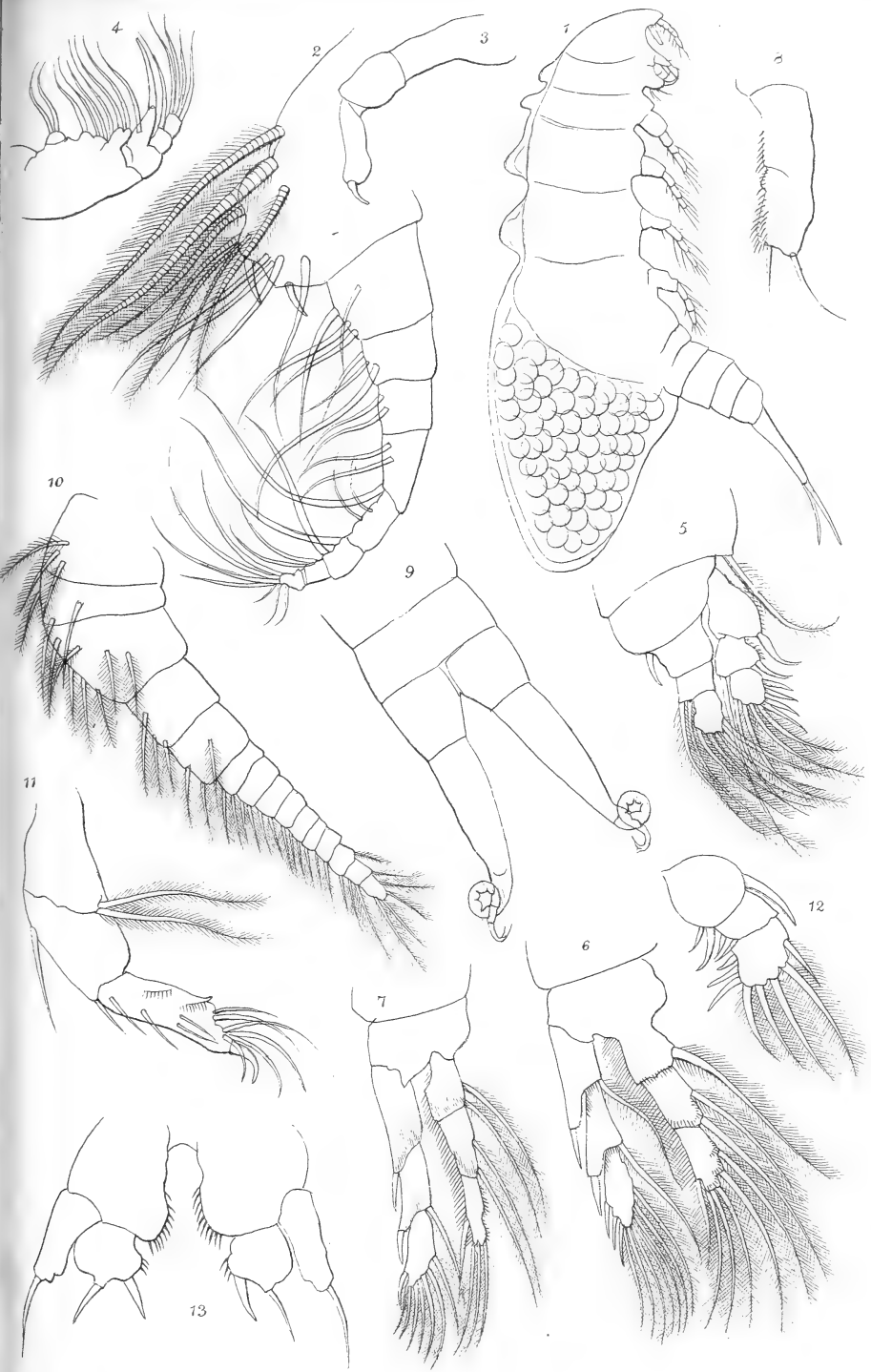
PLATE XXVII.

Doropygus porcicauda (female).

- Fig. 1. Adult female.
2. Anterior antenna of same.
3. Posterior antenna.
4. Anterior foot-jaw.
5. Foot of first pair.
6. Foot of second and third pairs.
7. Foot of fourth pair.
8. Foot of fifth pair.
9. Terminal segments of abdomen

Notodelphys cerulæa (female).

10. Anterior antenna.
11. Posterior antenna.
12. Outer branch of first foot.
13. Fifth pair of feet.



1-9, *Doreopygus porcicauda*.
 10-13, *Notodelphys oerulea*.

G. S. Brody del.
 A. T. Hoyle sculp.

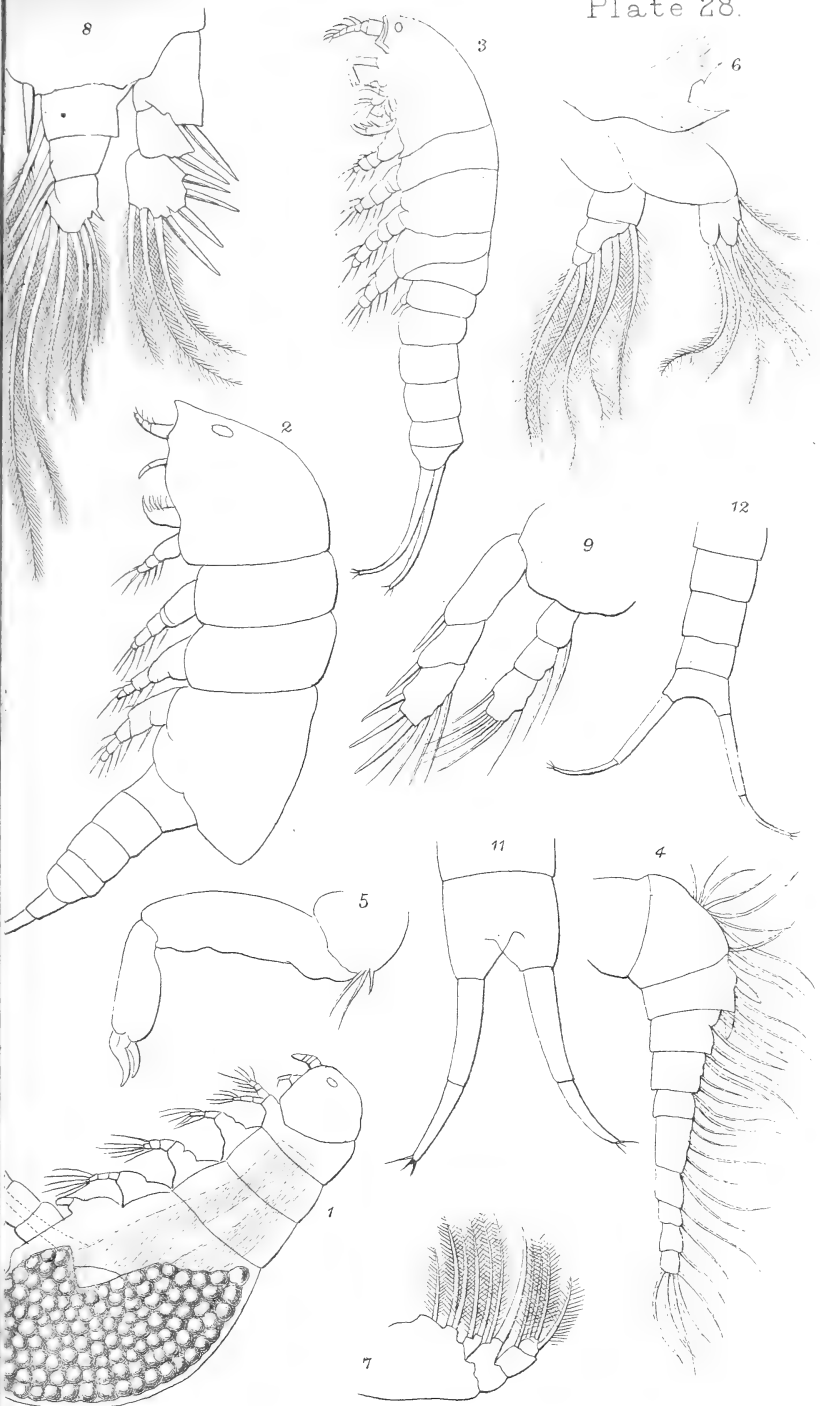
W. Hest & Co. Lith.



PLATE XXVIII.

Doropygus pulex.

- Fig. 1. Adult female, with ova (after Thorell).
2. Female, younger.
3. Adult male.
4. Anterior antenna of female.
5. Posterior antenna.
6. Mandible and palp.
7. Anterior foot-jaw.
8. Foot of first pair.
9. Foot of fourth pair.
10. Foot of fifth pair.
11. Caudal segments of female.
12. Caudal segments and abdomen of male.



del.
lith.

Doropygus pulex.

W. West & Co. imp.

PLATE XXIX.

Doropygus auritus (female).

- Fig. 1. Female with ova (after Thorell).
2. Anterior antenna of same.
3. Posterior antenna.
4. Mandible.
5. Maxilla.
6. Anterior foot-jaw.
7. Posterior foot-jaw.
8. Foot of first pair.
9. Foot of third pair.
10. Foot of fifth pair.
11. Caudal segment.



C. S. Brady del.
A. T. Follett sc.

W. H. Cresson

Doropygus auritus.



PLATE XXX.

Ascidicola rosea (female).

- Fig. 1. Adult female.
2. Anterior antenna of same.
 3. Posterior antenna.
 4. Mandible and palp.
 5. Anterior portion of body. *a*, anterior antenna ;
b, posterior antenna ; *c*, mandible ; *d*, maxilla ;
e, anterior foot-jaw ; *f*, posterior foot-jaw ;
g, first foot.
 6. Maxilla.
 7. Anterior foot-jaw.
 8. Posterior foot-jaw.
 9. Foot of first pair.
 10. Foot of third pair.

Notodelphys prasina (female).

(From Scandinavian specimens sent by M. Thorell.)

11. Anterior antenna.
12. Mandible.
13. Outer branch of first foot.
14. Foot of fifth pair.
15. Caudal and last abdominal segments.



G. S. Briggs, Jr.
 A. T. H. Cole, Jr.

1-10 *Ascidicola rosea*.
 11-15 *Notodelphys prasina*.





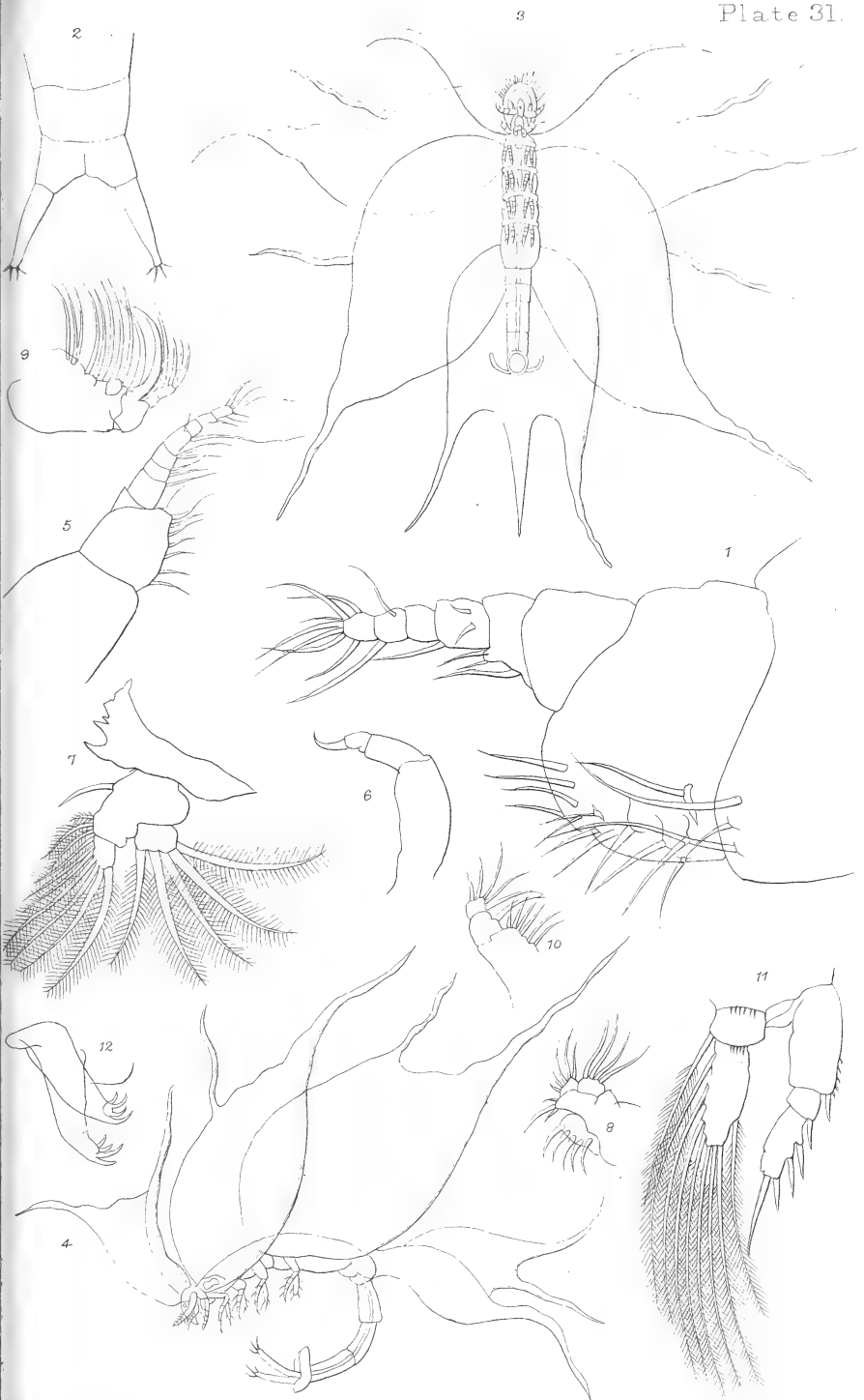
PLATE XXXI.

Doropygus pulex? var.

- Fig. 1. Anterior antenna of adult female.
2. Caudal segments.

Notopterophorus papilio.

3. Female from above.
4. Female from side (after Hesse).
5. Anterior antenna.
6. Posterior antenna.
7. Mandible.
8. Maxilla.
9. Anterior foot-jaw.
10. Posterior foot-jaw.
11. Foot of first pair.
12. Tail, seen laterally.



G.S. Enady del.
A.T.H. Vick lith.

1, 2 *Doropygus pulex* var.
3-12 *Notopterophorus papilio*.

W. West & Co. lith.



PLATE XXXII.

Doropygus Normani.

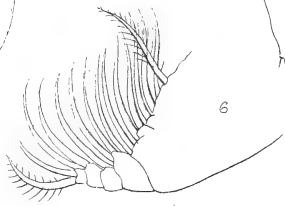
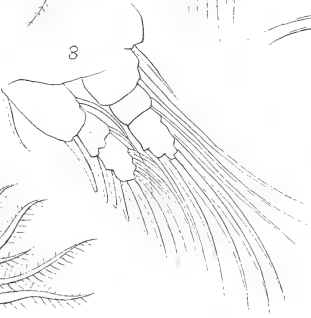
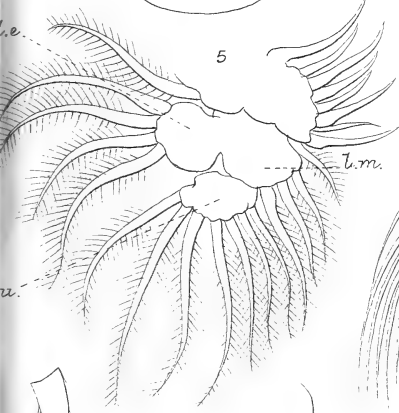
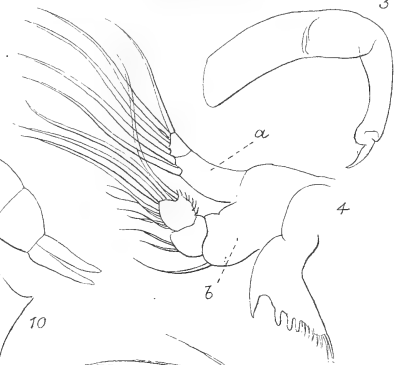
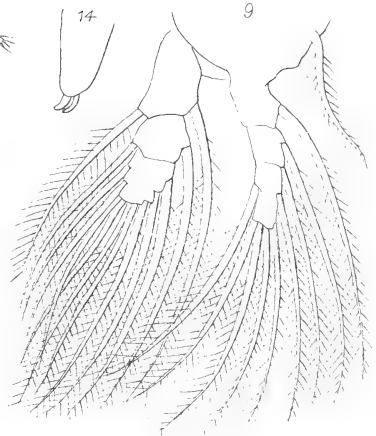
- Fig. 1. Adult female, seen from side.
2. Anterior antenna of same.
3. Posterior antenna.
4. Mandible.
5. Maxilla.
6. Anterior foot-jaw.
7. Posterior foot-jaw.
8. Foot of first pair.
9. Foot of second pair.
10. Outer branch of fourth foot.
11. Foot of fifth pair.
12. Marginal spine of fifth foot (highly magnified).
13. Caudal segments.
14. Extremity of same, more highly magnified.

13

7

14

9



G.S. Brady del.
A.T. Holtheke lith.

W. West & Co. imp.

Doropygus Normani.



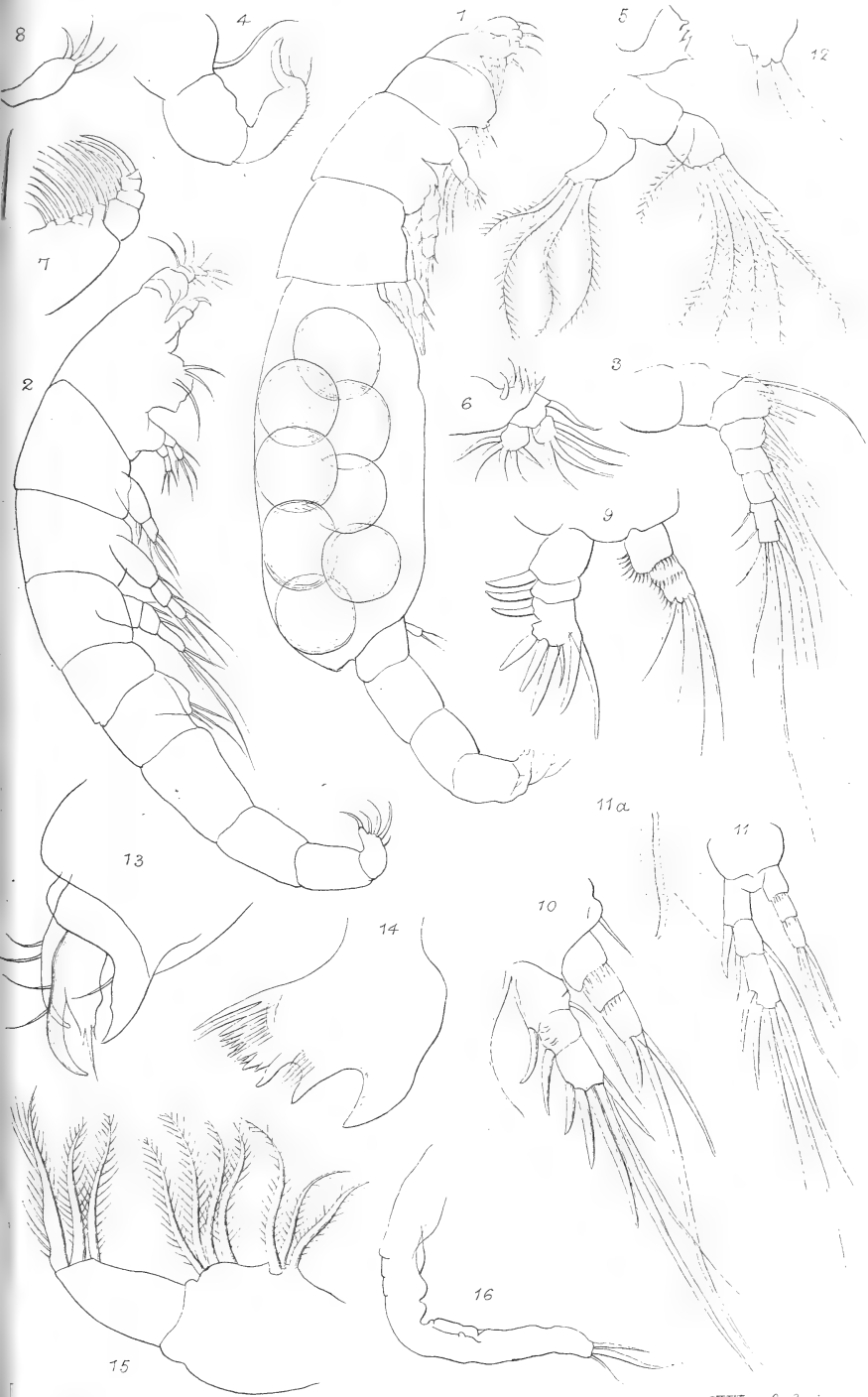
PLATE XXXIII.

Botachus cylindratus.

- Fig. 1. Adult female.
2. Young male ?
3. Anterior antenna of adult female.
4. Posterior antenna.
5. Mandible and palp.
6. Maxilla.
7. Anterior foot-jaw.
8. Posterior foot-jaw.
9. Foot of first pair.
10. Foot of second pair.
11. Foot of fourth pair. *a*, spine of outer branch,
more highly magnified.
12. Foot of fifth pair.
13. Tail.

Doropygus porcicauda.

14. Mandible, extremity.
15. Posterior foot-jaw.
16. Extremity of tail.



G.S.Brady del.
A.H.Hollick lith.

W.West & Co. imp.

1-13 *Botachus cylindratus*.
14-16 *Doropygus porcicauda*.

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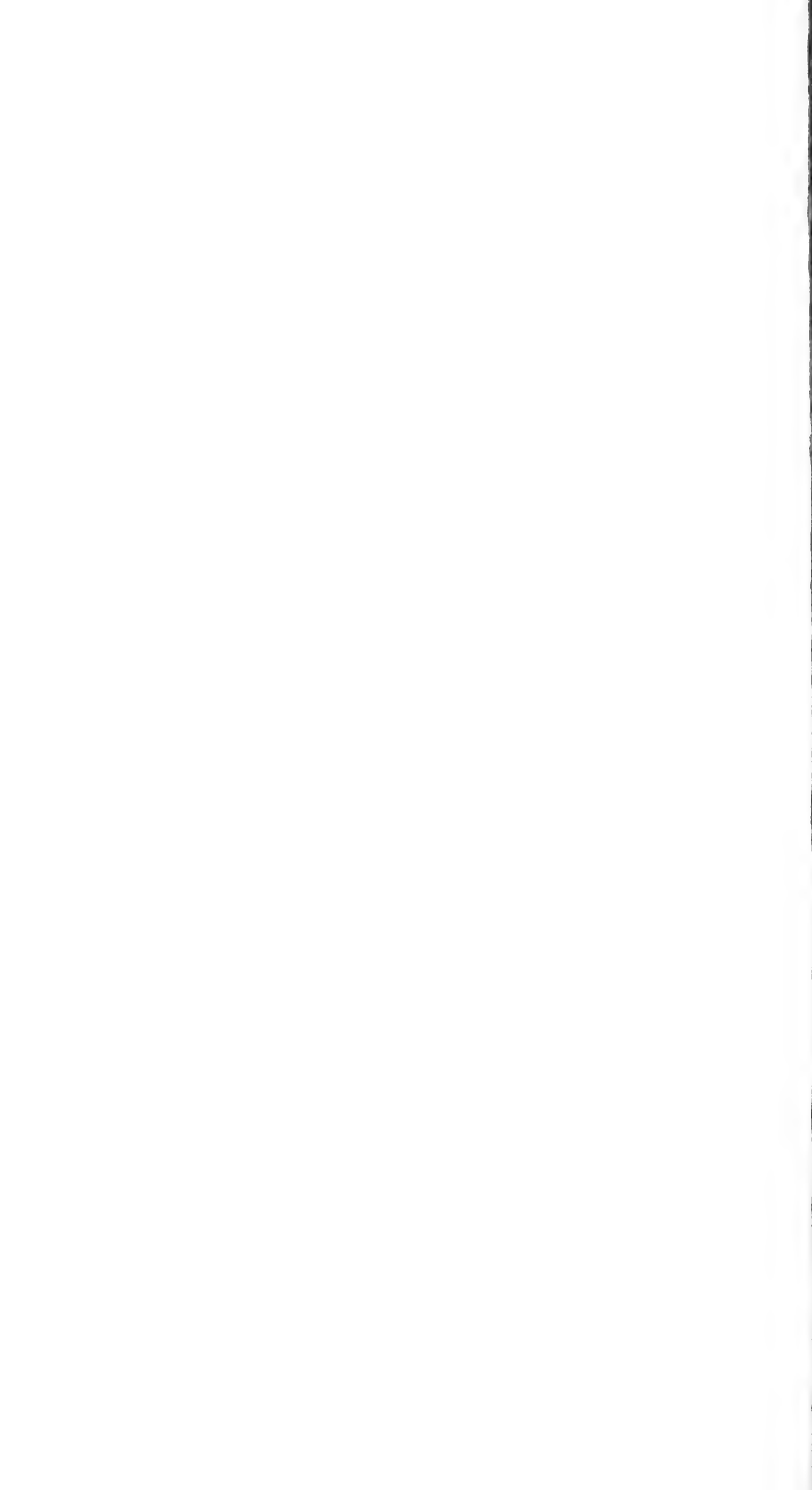
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