Fleas." They are abundant everywhere in ponds and ditches, and a few species are found in the sea.

One of the commonest species in fresh water is *Daphnia pulex*, of which specimens are exhibited together with an enlarged drawing of the animal as seen under a low power of the microscope

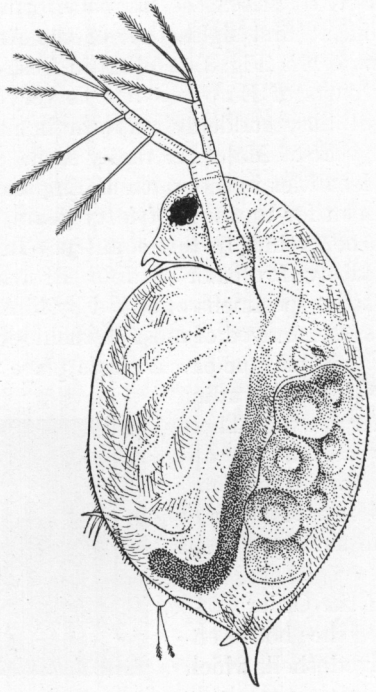

FIG. 10.

Daphnia pulex. Female carrying eggs in the brood-chamber. Enlarged. [Table-case No. 1.]

(Fig. 10). *Leptodora kindtii* is the largest species of the Order. It is found chiefly in lakes, and its glassy transparency makes it a very beautiful object when alive. It is exceptional in the small size of the carapace, which does not enclose the body and serves only as a brood-pouch.

Sub-class II.—OSTRACODA.

(Table-case No. 1.)

The number of somites, as indicated by the appendages, is smaller than in any other Crustacea, there being, at most, only two pairs of trunk-limbs behind those belonging to the head-region. The carapace forms a bivalved shell completely enclosing the body and limbs. There is a large, and often leg-like, palp on the mandible. The antennules and antennae are used for creeping or swimming.

The Ostracoda (Fig. 10) are for the most part extremely minute animals, and only one or two of the larger species can be exhibited. They occur abundantly in fresh water and in

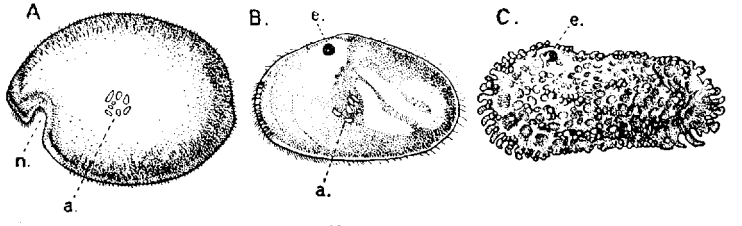

FIG. 11.

Shells of Ostracoda, seen from the side. A. *Philomedes brenda* (Myodocopa); B. *Cypris fuscata* (Podocopa); C. *Cythereis ornata* (Podocopa): all much enlarged. *n.*, Notch characteristic of the Myodocopa; *e.*, the median eye; *a.*, mark of attachment of the muscle connecting the two valves of the shell. A. and C. are marine species, B. is from fresh water. (From Lankester's "Treatise on Zoology," after Brady and Norman, and Müller.)

the sea, and their fossil remains are found in all geological formations from the oldest to the most recent. The giant of the group is the deep-sea *Gigantocypris* which may measure nearly an inch in length. Nearly all the Ostracoda belong to two Orders, the *Myodocopa* and the *Podocopa*, of which the former may generally be distinguished by a notch (Fig. 11, *n.*) in the front of the shell.

A series of enlarged drawings gives some idea of the diversity of form and ornamentation in the shells of these minute Crustacea.

Sub-class III.—COPEPODA.

(Table-case No. 2.)

There are, at most, ten free somites behind the head. The carapace is reduced or absent. The first thoracic limbs form maxillipeds, and are followed by four or five pairs of two-branched swimming feet. The posterior region of the body (the so-called "abdomen") is generally narrowed and is without limbs, but the terminal segment carried a pair of appendages, forming the "caudal fork."

Many Copepoda are found in fresh water, but the majority inhabit the sea, where they are often extremely abundant.

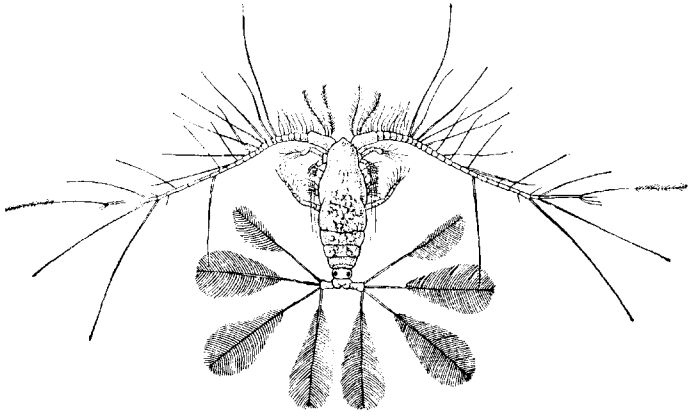

FIG. 12.

Calocalanus pavo, one of the free-swimming Copepoda of the "plankton." Enlarged. (From Lankester's "Treatise on Zoology," after Giesbrecht.)

They form one of the most important constituents of the "plankton," the assemblage of floating organisms in the waters of the open ocean. Since it is chiefly on the plankton that the other inhabitants of the sea ultimately depend for food, it may be said that the Copepoda, notwithstanding their small size, play a more important part in the economy of nature than any other Crustacea.

Many Copepoda live as parasites on fishes and other aquatic animals, and as a result of this parasitic life their structure becomes greatly modified and degenerate.

The Order EUCOPEPODA (Fig. 12) includes the great majority

of the Copepoda, both free-living and parasitic. True paired compound eyes are never present, but the median unpaired eye is often well developed. Most of the free-swimming species are extremely minute, few attaining the size of *Euchaeta norvegica*, of which specimens are exhibited. The enlarged drawings show the brilliant colours of some pelagic species.

The parasitic species are usually much larger than those which live a free life, and a number of species taken from common fishes are exhibited. *Pennella*, which is found on whales and fishes, is the giant of the sub-class, some specimens being even larger than that exhibited here.

The order BRANCHIURA includes a small number of fish-parasites whose exact relations to the other Copepods are obscure. They possess a pair of compound eyes, and a piercing stylet, connected with a poison-gland, in front of the mouth. *Argulus foliaceus* is common on fresh-water fishes in this country. The large *Argulus scutiformis* is taken from marine fishes in Japan.

Sub-class IV.—CIRRIPEDIA.

(Table-cases Nos. 3 and 4.)

The members of this group are sedentary animals, attached by the anterior part of the head-region, and having the body generally enclosed by a fleshy mantle, representing the carapace, strengthened externally by shelly plates. There are typically six pairs of trunk-limbs, each two-branched and many-jointed.

On account of their shelly covering the Cirripedia were classed by the older naturalists with the Mollusca, and it was only when their larval stages were discovered in 1829 by J. Vaughan Thompson that their affinities with other Crustacea were recognised. Nearly all the Cirripedia are hermaphrodite, having both sexes combined in each individual, a condition very rare among the Arthropoda. In some cases, however, there are dwarf male individuals which pair either with females or with hermaphrodites of normal structure.

The Sub-class may be divided into five Orders, but three of these comprise only a few imperfectly-known forms which cannot be exhibited here.

The Order THORACICA includes the typical Cirripedes, in which the six pairs of feathery trunk-limbs are well developed. Two sub-orders are recognised.

In the sub-order *Pedunculata* (the Stalked Barnacles) there is a fleshy peduncle, or stalk of attachment, at the free end of which is the " capitulum " formed by the mantle enclosing the body and limbs.

Specimens of the common Goose-Barnacle, *Lepas anatifera* (Fig. 13), are exhibited showing the external appearance with the feathery " cirri " extended from the opening of the shell; in another specimen half of the shell is removed to show the form

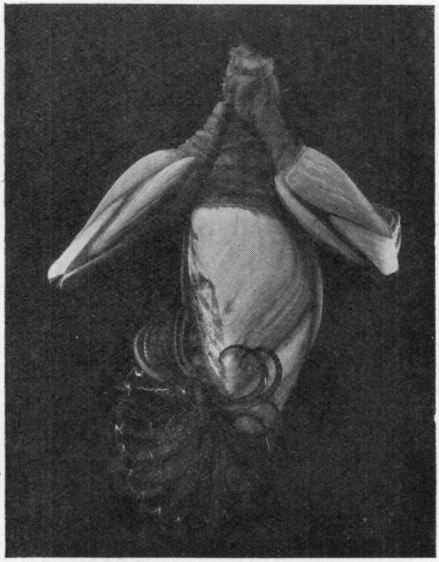

FIG. 13.

Group of specimens of a stalked Barnacle (*Lepas anatifera*). One showing the cirri extended as in life. [Table-case No. 3.]

of the body and limbs within it; and a third preparation shows the five valves of the shell (Fig. 14A) separated from each other. Like many other barnacles, the species of *Lepas* are commonly attached to floating objects, drift-wood, ships' bottoms, and the like; most of the species have an extremely wide distribution in all the oceans. The great length sometimes reached by the peduncle of the common goose-barnacle is shown by a fine group of specimens mounted in a jar by the doorway at the south end of the gallery.

Among the other genera of stalked barnacles exhibited, *Polli-*

cipes may be noted as having rows of valves on the capitulum which pass gradually into the small scales covering the peduncle. This shelly armour of the peduncle was more fully developed in certain extinct genera, as is shown in the cast of the fossil *Loricula* exhibited in this case. A species of *Pollicipes* is used for food on the coasts of Brittany and Spain. The genus *Scalpellum* is of interest not only on account of the deep-sea habitat of many species and the great size of some (*Scalpellum giganteum*), but also and more especially because of the dwarf male individuals already alluded to, which are found in this genus and in the

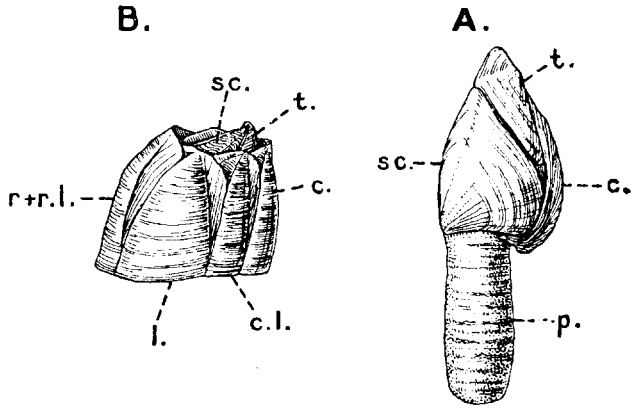

FIG. 14.

A. A stalked Barnacle (*Lepas anatifera*). B. A sessile Barnacle (*Balanus hameri*). *p.*, The peduncle. The other letters relate to the "valves" or parts of the shell; *c.*, carina; *c.l.*, carino-lateral; *l.*, lateral; *r.* + *r.l.*, rostrum and rostro-lateral fused together; *sc.*, scutum; *t.*, tergum. (From Lankester's "Treatise on Zoology," after Darwin.)

related *Ibla*. In the different species of *Scalpellum* three conditions are represented. In some, all the individuals of a species are similar and hermaphrodite as in ordinary barnacles; in others, as in *Scalpellum peronii*, of which a specimen is shown, the large hermaphrodite individuals have small males attached to them like parasites; in others, again, the separation of the sexes is complete and the larger individuals are purely female.

Most barnacles are hatched from the egg as actively swimming larvae of a type which is found in many other Crustacea, and is known as the *Nauplius*. They have three pairs of appendages, an unsegmented body, and a conspicuous median eye. Like many other "pelagic" animals, the Nauplii of barnacles living

at the surface of the ocean often have long spines and outgrowths from the surface of the body, which are probably of service in keeping the animals afloat. A coloured drawing of one of these spiny larvae is exhibited. In its later development the young barnacle passes into a stage in which the body and limbs are enclosed in a bivalved shell like an Ostracod. On account of this resemblance the stage is known as the "*Cypris*" stage, after one of the genera of Ostracoda. After swimming about for some time longer it attaches itself by means of its antennules, casts off its bivalved shell, and gradually assumes the structure of the adult.

The Sessile Barnacles or Acorn-shells, forming the sub-order *Operculata* (Fig. 14B), agree in most points of structure and development with the stalked barnacles, but they have no peduncle. The shelly plates of the mantle are, for the most part, soldered together to form a cylindrical or conical case, the opening of which is protected by four movable "opercular" plates. In a preparation of *Catophragmus polymerus* here exhibited, names are attached to those parts of the shell which are found (though often reduced in number by coalescence) in all the typical Operculata, the "scutum" and "tergum" forming the movable lid or "operculum," while the others form the outer "wall." In the genus *Catophragmus*, however, there are numerous additional plates outside those which usually form the wall. These outer plates correspond to the additional capitular plates found, among the Pedunculata, in *Pollicipes*, of which a specimen is placed alongside for comparison.

One of the commonest British Barnacles is the little *Balanus balanoides* which is familiar at the seaside, coating rocks and stones as if with "rough cast." At the other extreme of size is another species of the same genus, *Balanus psittacus*, the largest member of the sub-class, of which some fine specimens are exhibited in Wall-case No. 4. It is found on the coasts of Chile, where it is "universally esteemed as a delicious article of food."

Several species of sessile Barnacles are commonly found attached to large marine animals such as whales and turtles. The curious *Tubicinella* which burrows into the skin of whales is exhibited here, and a large cluster of *Coronula diadema*, growing on the skin of a whale, is mounted at the side of the doorway at the south end of the gallery.

Darwin's Monograph of the Cirripedia, published 1851–1854, is still the chief work of reference on this group of animals; it is

of special interest to the historian of biological theory, because, in the course of its preparation, Darwin had to deal with the problems of specific and individual variation as they present themselves to the systematic zoologist. Like other groups of sedentary organisms, plants and corals for example, the Cirripedia are particularly subject to great variation dependent on differences of environment, and Darwin often found considerable difficulty in deciding as to the limits of species. In Table-case No. 4 is exhibited a small series of specimens selected by Darwin himself to illustrate the variations of *Balanus amphitrite*, and accom-

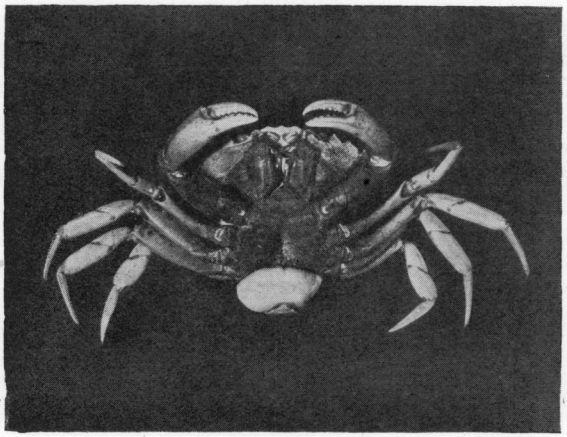

FIG. 15.

Sacculina carcini attached under the abdomen of a common Shore-crab. [Table-case No. 4.]

panied by a list in his handwriting. Of this species Darwin wrote in his Monograph :—

" In order to show that it has not been from indolence that I have put so many forms together, I may state that I had already named and fully described in detail eight of the following forms as species, when I became finally convinced that they were only varieties. . . . After studying such varying forms as *B. tintinnabulum* and *amphitrite*, it is difficult to avoid, in utter despair, doubting whether there be such a thing as a distinct species, or at least more than half a dozen distinct species in the whole genus *Balanus*."

The members of the Order RHIZOCEPHALA are parasites living on other Crustacea, and they offer one of the most striking

examples of the degradation in structure associated with the parasitic habit of life. In the adult they lose every trace, not only of Crustaccan, but even of Arthropodous structure, although the very close resemblance of their larval stages to those of the normal Cirripedes shows that they have been derived from forms similar to the latter. The body is enclosed in a fleshy mantle, which has a small opening to the exterior. From the short stalk by which the animal is attached, fine root-like filaments branch in all directions throughout the body of the host (generally a Crab), and serve for the absorption of nourishment. The parasite has no mouth or food-canal, no limbs, and only a feebly developed nervous system.

Sacculina carcini, of which a specimen is exhibited (Fig. 15), is found on the common shore-crab (*Carcinus maenas*) and other Crabs.

The remarkable changes which the presence of *Sacculina* induces in its hosts are illustrated by a series of specimens in Wall-case No 2 already referred to.

In their larval development the Rhizocephala pass through Nauplius and Cypris stages closely similar to those of ordinary barnacles. Drawings of the larval stages of Sacculina are exhibited.

Sub-class V.—MALACOSTRACA.

The body consists of nineteen limb-bearing somites (or twenty, if the eye-stalks be reckoned as appendages). A *thorax* of eight and an *abdomen* usually of six somites are sharply distinguished by the character of the appendages.

This sub-class is much larger and more varied than any of the others. It may be divided into five divisions as follows :—

Division 1. *Phyllocarida.*
,, 2. *Syncarida.*
,, 3. *Peracarida.*
,, 4. *Hoplocarida.*
,, 5. *Eucarida.*

Division 1.—PHYLLOCARIDA.

(Table-case No. 5.)

The carapace is bivalved, enveloping but not coalescing with the thoracic somites, and bearing in front a movably articulated rostral plate. The eyes are stalked. The last somite of the

abdomen has no limbs, but the telson carries a pair of appendages forming the "caudal fork." The thoracic limbs are flattened and leaf-like.

The existing species belonging to this division are few in number but are very widely distributed in all seas. *Nebalia bipes* (Fig. 16), of which a specimen is exhibited, occurs on the British coasts and ranges from Greenland to Chile and Japan. A coloured drawing of a living *Nebalia* is hung in Wall-case No. 4.

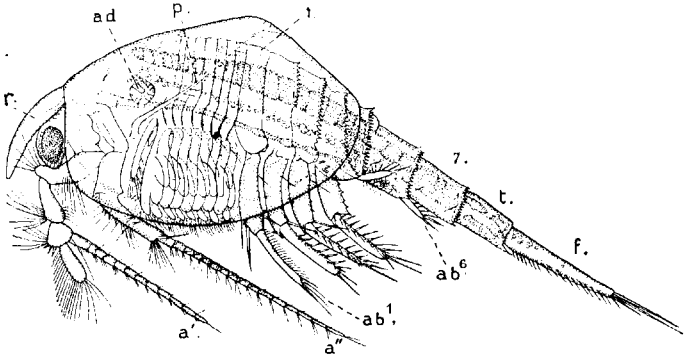

FIG. 16.

Nebalia bipes, female, from the side (enlarged). *a.'*, Antennule; *a.''*, antenna; *ab.*^{1}–*ab.*^{6}, the abdominal limbs; *ad.*, the adductor muscle joining the two valves of the shell; *f.*, the caudal fork; *p.*, palp of maxillula; *r.*, rostral plate; *t.*, telson; 1–7, the seven somites of the abdomen. (From Lankester's "Treatise on Zoology," after Claus.)

It is probable that the fossil forms known as the *Ceratiocaridae*, which are abundant in many rocks of Palaeozoic age, should be referred to this division.

Division 2.—SYNCARIDA.

(Table-case No. 5.)

There is no carapace, and all the thoracic somites, or all except the first, are distinct. The eyes may be stalked or sessile. The thoracic limbs carry exopodites and a double series of plate-like gills.

This division includes, among living Crustacea, a small number of very peculiar forms nearly all found in the fresh waters of Tasmania and Victoria (Fig. 17). They are of special interest on account of the fact that they appear to be survivors of an

ancient group of Crustacea of which the remains are found fossil in Carboniferous and Permian rocks. The drawing of the fossil *Palaeocaris praecursor* (Fig. 18), exhibited in the case, shows the

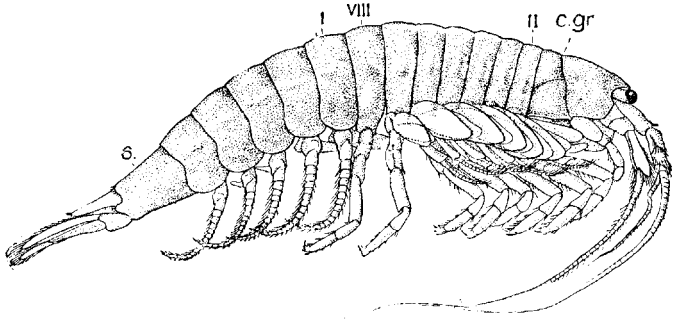

FIG. 17.

Anapides tasmaniae, male, from the side (slightly enlarged). *c.gr.*, "Mandibular groove"; II–VIII, the thoracic somites; 1–6, the abdominal somites. [Table-case No. 5.]

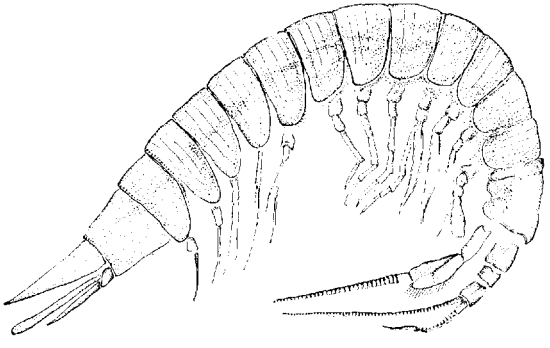

FIG. 18.

Palaeocaris praecursor, from the Coal Measures of Derbyshire.

great resemblance in general form between that species and the recent *Anaspides* (Fig. 17).

Division 3.—PERACARIDA.

(Table-case Nos. 5–7.)

The carapace, when present, does not coalesce dorsally with more than four of the thoracic somites. The eggs and young are

carried in a brood-pouch formed by overlapping plates attached to the bases of the thoracic limbs.

The following Orders are included in this division :—

Order 1. *Mysidacea.*
,, 2. *Cumacea.*
,, 3. *Tanaidacea.*
,, 4. *Isopoda.*
,, 5. *Amphipoda.*

Order 1.—Mysidacea.

(Table-case No. 5.)

The general form is shrimp-like (Fig. 19). A carapace is present, but it leaves free at least five of the thoracic somites. The eyes, when present, are stalked and movable. There are swimming branches (exopodites) on the thoracic legs.

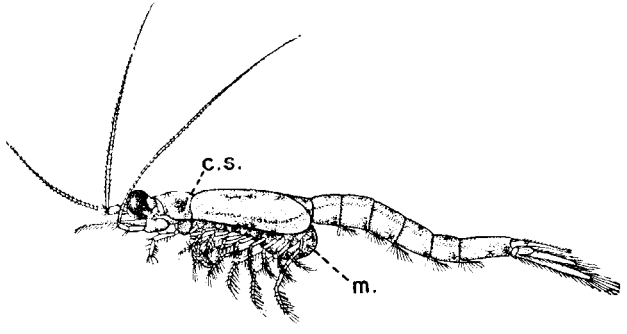

Fig. 19.

Mysis relicta, female, from the side. *c.s.*, "Mandibular groove"; *m.*, Brood-pouch. (From Lankester's "Treatise on Zoology," after Sars.)

Most of the Mysidacea live in the sea and many species are found on the British coasts. *Macromysis flexuosus* is one of the commonest species. A coloured drawing of the closely allied *Leptomysis* is hung in Wall-case No. 5. A drawing of *Arachnomysis leuckartii* in the Table-case gives an example of the remarkable forms assumed by some deep-sea members of the Orde . The family *Lophogastridae*, all of which are inhabitants of the deep sea, reach a much greater size than do the members of the other families. A specimen of *Gnathophausia ingens* from the *Challenger* Expedition is exhibited, and alongside of it is placed a copy of a coloured drawing from a living specimen of *G. zoëa*

(Fig. 20), showing the vivid red coloration characteristic of many deep-sea Crustacea.

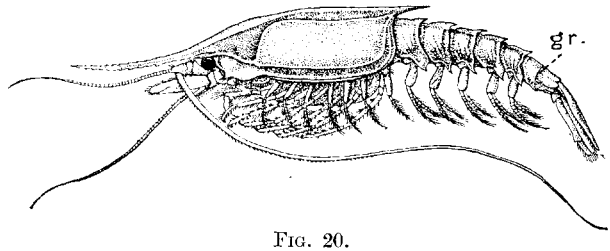

FIG. 20.

Gnathophausia zoëa, female, from the side, one-half natural size. *gr.*, a groove dividing the last abdominal somite. (From Lankester's "Treatise on Zoology," after Sars.)

Order 2.—Cumacea.

(Table-case No. 5.)

A carapace is present, but it leaves four or five of the posterior thoracic somites free. The eyes are not stalked, and are usually coalesced into one. Swimming branches (exopodites) are usually present on some of the thoracic limbs. The abdomen is generally very slender, and the last pair of appendages (uropods) are

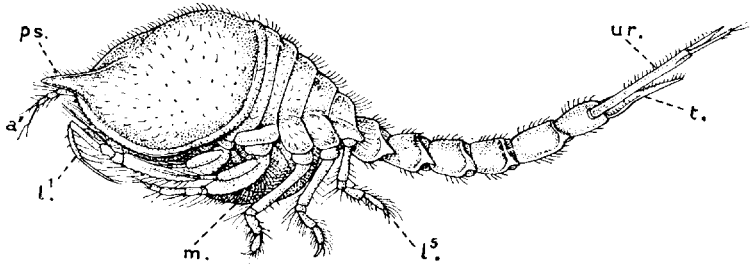

FIG. 21.

Diastylis goodsiri, female, from the side, enlarged. *a.'*, antennule; *l.*^{1}–*l.*^{5}, the five pairs of walking-legs; *m.*, brood-pouch; *ps.*, "pseudo-rostrum," formed by lateral plates of the carapace; *t.*, telson; *ur.*, uropods. (From Lankester's "Treatise on Zoology," after Sars.)

elongated. The other abdominal appendages are absent, at least in the female.

The Cumacea are all marine, burrowing in sand and mud, and being occasionally taken in great numbers swimming at the surface of inshore waters. As a rule, they are very small, the specimens of the common British species *Iphinoë trispinosa* here

shown being perhaps larger than the average, but in Arctic seas, where they are especially abundant, they often attain a much greater size, as is shown by the specimen of *Diastylis goodsiri* (Fig. 21) from the Kara Sea.

Order 3.—Tanaidacea.

(Table-case No. 6.)

Six of the thoracic somites are always distinct, the reduced carapace involving only the first and second (Fig. 22). On each side the overhanging carapace encloses a cavity within which lies (as in the Cumacea) a branchial appendage attached to the first thoracic limb. The second thoracic limb is chelate or pincer-like, and the second and third may carry minute vestiges of swimming-

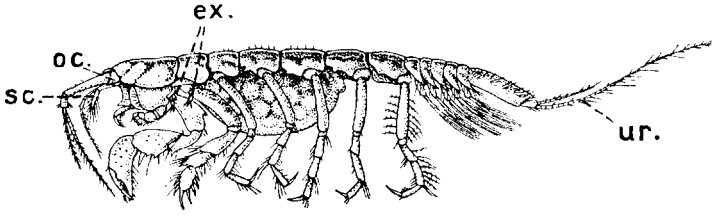

Fig. 22.

Apseudes spinosus, female, from the side, enlarged. *ex.*, vestiges of exopodites on second and third thoracic limbs; *oc.*, the small and immovable eye-stalks; *sc.*, scale or exopodite of antenna; *ur.*, uropod. (From Lankester's "Treatise on Zoology," after Sars.)

branches (exopodites) (Fig. 22, *ex.*). The eyes, when present, are set on small and immovable stalks (Fig. 22, *oc.*).

The Tanaidacea, which are all marine, and generally of very small size, are of great interest as preserving, along with the Cumacea, links of connection between the stalk-eyed or "podophthalmate" type of the Mysidacea and the sessile-eyed or "edriophthalmate" Isopoda and Amphipoda.

Order 4.—Isopoda.

(Table-case No. 6.)

There is no distinct carapace. As a rule, only the first thoracic somite is fused with the head, and the other seven are free. There are no exopodites on the thoracic limbs. The eyes, when present, are sessile. The body is usually flattened from above downwards. The abdominal appendages are lamellar and respiratory.