

On the Propagation, Structure, and Classification
of the Family Sphæromidæ.

By

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With Plate 7.

I. INTRODUCTORY REMARKS.

THREE years ago H. F. Moore ("Rep. Porto Rican Isopoda," in 'U. S. Fish Comm. Bull.' for 1900, vol. ii, p. 172, 1901) wrote on the Sphæromidæ: "No attempt is made to furnish a key to the genera, owing to the extreme confusion that exists in this family, and it is doubtful if the following two species are properly assigned generically. The dissimilarity of the sexes has frequently misled authors into placing them in widely separated genera, and, while this has not been done in the present case, the limitations of the genera are so indefinitely established that the author has not been able to satisfy himself of the generic affinities of the species described." It may be added that Moore, in reality, refers both his species to genera to which they do not belong. But his critical remarks quoted are correct, and convey an idea on the state of things; other authors have complained in a rather similar way, and the extreme difficulty in arriving at some clearness has probably been felt by every carcinologist who has attempted to name or describe a number of animals belonging to the family Sphæromidæ.

During a stay in Messina and Siracusa in 1893 I collected

especially marine animals of various orders and classes; of Sphæromidæ I gathered a large number of specimens, most of them belonging to the genera Sphæroma (Bosc) and Cymodoce (Leach). In attempting to name the material of Cymodoce, I soon felt that the first thing to be done was to separate the adult males, which proved to belong to three species, then to refer immature males and the females to their respective adult males. The literature could not help me, but, fortunately, the number of specimens of nearly all stages of all species was so rich that the task could be carried through. During this examination I observed that the adult females had neither eggs nor young in the marsupium, but that the brood could be discerned through the skin of the ventral surface of the thorax; the young occupied internal pouches, as had been shown by Leichmann to be the case in Sphæroma rugicauda (Leach). Furthermore, I observed that in the same adult females of Cymodoce the proximal half of the maxillipeds is strongly expanded, forming large ciliated plates not found in immature specimens or males, and that the end of the mandibles is light-coloured, while it is dark-brown or black in other specimens; a subsequent dissection showed that the three anterior pairs of mouth-limbs and the distal half of the maxillipeds in egg-bearing specimens of Cymodoce have been so strongly reduced that the animals cannot eat, while the proximal half of the maxillipeds has been exceedingly expanded; in Sphæroma the mouth-parts are similar in both sexes and in young animals.

These facts and other features were discovered ten years ago, but a publication was postponed. During a stay in London in 1902 I looked through the large collection of Sphæromidæ in the British Museum, wrote numerous notes, and figured some details; most of the specimens examined being types or co-types for species established by Leach, Say, White, Miers, and Haswell, this perusal has been of great importance for my study. The next year I began to work out a revision of the genera of Sphæromidæ. The U. S. National Museum, and especially Dr. Chas. Chilton in New Zealand, favoured

me—as loan or present—with a good number of forms, for which I am most grateful. I have drawn more than a hundred figures, but seeing that further material must be procured, and that for this reason and other obligations, years must pass away before I can finish a more detailed paper, I think a preliminary abstract of the main results, together with brief diagnoses of the genera, and notes on reference of species, may be useful to my fellow-students. Nearly every year new species are described and new genera established; the latter are, in most cases, imperfectly defined, and the species are frequently referred to genera to which they do not belong. Though most preliminary communications—to put it very mildly—contribute more to the swelling of the literature than to advancement of science, I hope yet that this paper may be considered by zoologists as an exception from the rule.

During the preparation of this paper I received further aid from other sides. From the authorities of the Zoological Museum in Berlin I obtained some forms of much interest; Professor E. L. Bouvier, Director of the Entomological Department of the Museum in Paris, lent me an important typical specimen; Mr. A. Viré, the ardent explorer of the cave-fauna in France, has presented me with two valuable forms; Dr. Joh. Thiele, at the Berlin Museum, and especially my friend Dr. W. T. Calman, at the British Museum, answered queries on certain structural features in various animals. I beg the authorities of the Zoological Museums in London, Washington, Berlin, and all the gentlemen named, to accept my sincere thanks for their aid.

The number of forms seen by me is very large. Twenty-eight genera (not counting mere synonyms) have been established by earlier authors; of these I have been able to examine material preserved in spirit of all but three; of one (*Ancinus*) of these three I saw an exsiccated specimen, and the two genera not seen by me seem to be of slight importance. That I have seen numerous new species is a matter of course; many of them have been inspected, but not being able to give illustrations here, I establish as few as possible,

describing in all only two new species as types for new interesting genera and adding some remarks on an old quite imperfectly known form. For various reasons I cancel two genera; some of those still maintained are of slight value, but I did not think it proper to withdraw more than absolutely necessary. I must establish seven new genera, six of which are types of importance. Most of the species hitherto established are enumerated, but I did not wish to mention every species of *Sphæroma* and *Cymodoce* scattered in the vast literature. The enumeration is undertaken in order to refer the species to the genera to which they really belong; a perusal of my notes on such genera as *Sphæroma*, *Cymodoce*, *Næsa*, *Cassidina* will convey an idea of the extreme confusion as to classification in nearly the whole literature. Rather frequently the descriptions—especially when accompanied with figures—of species unknown to me are sufficient for reference, but in several cases this must be doubtful; in too numerous cases—especially when the species in question differ as to shape of the proximal joints of the antennulæ or of the end of abdomen from the type of that genus to which they have been referred in the literature—is it unfortunately impossible to say anything on the real relationship, because figures and especially descriptions are too incomplete.

Only in very few cases titles of papers are given; if such references to literature had been inserted everywhere in the systematic "notes" the bulk of this paper would have been very much increased. The synonymy of several species of *Sphæroma* and *Cymodoce* is extremely intricate, and is omitted. It is scarcely necessary to say anything on my treatment of characters and classification; every student who will take the trouble to read the three following chapters and look through the diagnoses of sub-families, groups, sections, and genera may easily perceive the principles of classification. Yet it may be added that in *Isopoda*—and in other orders of *Arthropoda*—I dislike a modern tendency manifesting itself in splitting up orders into a very large number of families; wishing to procure a view of the relationships, I collected at

an earlier occasion Cirolanidæ, Ægidæ, etc., as sub-families of the Cymothoidæ (sens. lat.), and to-day I cancel the family Limnoriidæ, referring it as a sub-family to the family Sphæromidæ.

II. ON THE PROPAGATION.

Even among a very large material of *Sphæroma* (Bosc) and *Cymodoce* (Leach) it is next to impossible to find a single specimen with eggs or young in the marsupium, though it is generally easy to find numerous specimens with the marsupium well developed. It is, in my opinion, a testimony of the want of study of the family that this curious feature has been overlooked by all authors excepting Leichmann, who observed and explained it in one species of *Sphæroma*, but did not examine any other form of the family. I shall now give a very brief abstract of some selected points of Leichmann's paper, adding a few remarks, and then proceed to my own observations on numerous other genera of the family; it may, however, be added that some interesting questions I am certainly able to point out, but, for want of sufficient material, not to solve in any satisfactory way.

Leichmann published a preliminary note in 'Zoologischer Anzeiger' for 1890—the chief paper, "Beiträge für Naturgeschichte der Isopoden," in 'Bibliotheca Zoologica,' 1891. He studied specimens of *Sphæroma rugicauda* (Leach) gathered near Dantzig. He describes and figures the marsupial lamellæ as so small that the lamellæ from the two opposite sides do not touch each other with their margins. This statement is quite incomprehensible. I have examined specimens of the same species from the coasts of Denmark, even from Vordingborg at the Baltic, and in animals carrying brood the lamellæ from the two halves always overlap each other considerably. An erroneous determination is excluded, as *S. rugicauda* is the only species of the Sphærominæ known from the Baltic and even from Denmark; furthermore, in *S. serratum* (Fabr.) and in the other species of the genus in its restricted sense (see below) I have always found the

lamellæ overlapping each other. But Leichmann has made the important discovery that the eggs are enclosed and developed, not in the marsupium itself, but in four pairs of pouches; the openings to these pouches are rather large transverse slits found on the lower surface of thorax at some distance from the mesial line between the sternites, the first pair of slits between the second and third, the last pair between the fifth and sixth sternites. According to Leichmann these pouches are large, elongated, two-branched invaginations of the ventral skin of the animal; they proceed upwards and a little inwards, terminating beneath the tergites near the mesial line. The eggs are laid in the usual way; from the marsupium they must instantly be transported into the internal pouches, because it is impossible to find any specimen with eggs in the marsupium. The eggs are proportionately large, their diameter being .44 mm., but the young ready for leaving the pouches are exceedingly large, measuring 1.44 mm. in length, .65 mm. in breadth, and .22 mm. in depth; the volume of such a young one is therefore between four and five times (Leichmann thinks five times) larger than that of an egg; the mother measures only 5.2 mm. in length and 2.9 mm. in breadth. Leichmann states that the larvæ perform lively movements within the pouches a long time before they leave them, which takes place through the eight slits. He has observed that generally two larvæ slip out, not simultaneously, but shortly after each other; they remain a short time, rarely more than an hour, in the marsupium. But frequently a considerably longer time passes away before the birth of the two next larvæ, so that the entire act takes up some days. This abstract may be sufficient; the question as to the nutrition of eggs and larvæ is omitted in this preliminary paper.

In nearly one third of the genera of the family adult females are unknown to me; of a few genera I have seen only a single female with the marsupium well developed; but, at least without dissection, no brood could be detected. Marsupial plates I have seen in representatives of the two small sub-families, and in all sections of the large sub-family Sphærominæ but

one, viz., Cassidinini. Their number is always three pairs; they belong to the second, third, and fourth pairs of legs. In three genera—*Exosphæroma* (Stebb.), *Isocladus* (Miers), and *Zuzara* (Leach)—all belonging to the hemibranchiate Sphærominæ, they are so small that they are far from reaching each other from the two opposite sides; in all other genera they overlap each other at least somewhat, and generally considerably, or sometimes very much along the mesial line. In the forms with brood of the section Cassidinini seen by me the marsupial lamellæ are wanting; this curious feature is discussed in the sequel.

Of the sub-family Limnoriinæ *Limnoria lignorum* (Rathke) has been examined. The number of eggs is rather moderate (twenty-nine were found in one specimen); the eggs are enclosed in the marsupium itself. The volume of each full-grown young one is very considerably larger than that of an egg; the marsupium containing such larvæ is accordingly exceedingly distended, more than twice as deep as in a female with eggs recently laid. The marsupial lamellæ are exceedingly large; the marsupium covers the whole lower surface of thorax.

Of the sub-family Plakarthriinæ, a single small female of *Plakarthrium typicum* (Chilt.) has been examined. The marsupium reaches nearly to the base of abdomen, but its lamellæ overlap each other only very moderately. It contains in my specimen five very large eggs still nearly circular; there is plenty of room for their development in the flat marsupium. Judging from the shape and the biology of the animal, this shape of the marsupium is scarcely much altered during the development of the brood. The third sub-family, the Sphærominæ, present various modes of development of the brood.

Of the hemibranchiate Sphærominæ I have seen adult females of eight genera; of two genera, *Hemisphæroma* (n. gen.) and *Cassidinella* (Whitel.), they are unknown, but the former genus is closely allied to *Sphæroma* (Bose); *Cassidinella* seems to be only a sub-genus of *Cymodoce*

(Leach) and it is therefore most probable that, as to propagation, they agree respectively with *Sphæroma* and *Cymodoce*. *Sphæroma rugicauda* (Leach) is mentioned above; *S. serratum* (Fabr.) has the same number of pouches with large slits, and all species of the genus in its restricted sense (see below) probably agree closely with each other. I examined a rather large specimen of *S. serratum* with the young nearly full-grown, being greyish with black eyes; I counted ninety-one young, which occupied by far the largest part of the inner space of thorax and, besides, a good deal of abdomen, as the internal organs of the body, excepting musculature, were scarcely discernible. In the other genera of hemibranchiate *Sphærominæ*, as in *Sphæroma*, the brood is developed in internal pouches; but, nevertheless, various deviating features are observed. In *Cymodoce pilosa* (M.-Edw.) five pairs of large slits—first pair between first and second, last pair between fifth and sixth sternites—are observed; the slits are placed at some distance from the mesial line. Of *Bregmocerella Grayana* (Woodw.) I have seen two females with the marsupium well developed, and the mouth-parts metamorphosed as in *Cymodoce*. One of them has no eggs; on the lower surface of thorax I found five pairs of small, very low sub-cylindrical tubercles placed, as are the slits in *Cymodoce*, at some distance from the mesial line, each tubercle with a minute aperture on the end. In the other female the black eyes of a rather small number of young are visible through the quite membranous ventral skin, on which it is possible, with some difficulty, to find the same thickenings with their central hole. That these tiny apertures correspond with the slits in *Sphæroma* and *Cymodoce* is certain, but it is difficult to understand how the eggs can pass in, and quite incomprehensible how the young are able to pass out through them. I suppose that at the birth of the young the skin must split at the apertures, but perhaps some other resource may exist. As mentioned above, the marsupial lamellæ are small and far from reaching each other at the mesial line in *Exosphæroma* (Stebb.),

Isocladus (Miers), and *Zuzara* (Leach). In a specimen with marsupium, but without brood, of an undetermined species of *Exosphæroma* from Victoria, I find, very distant from the mesial line and rather near the base of the marsupial lamellæ, four pairs of low tubercles at the hind margin of second to fifth sternites; each tubercle has a small longitudinal slit at its outer side. Being acquainted with this structure, it was possible with 30 degrees of enlargement to find in *Zuzara integra* (Hasw.) at least three pairs of nearly microscopical rounded apertures in the same situation as the small slits in the *Exosphæroma* mentioned, but in some specimens with brood of *Exosph. lanceolatum* (White) and *Isocladus spiniger* (Dana) it was impossible to discern apertures with any reasonable degree of certainty, though they must be present. While the structure and the wandering of eggs and young are easily understood in *Sphæroma* and *Cymodoce*, the minuteness of the apertures of the pouches in the other genera mentioned is a serious difficulty, perhaps connected with some undiscovered structural feature.

Among the eubranchiata *Sphærominæ* some genera, viz. *Scutuloidæa* (Chilt.), *Paracerceis* (n. gen.), and *Cassidinopsis* (n. gen.) have their brood in internal pouches, but the number and position of the apertures has not been examined. Of *Dynamene* (Leach) (sens. strict)¹ I have seen three females of two European species. The marsupium, which covers the entire lower surface of thorax, is filled either with eggs or with young not arrived at maturity; the marsupial lamellæ, especially the posterior pair, are exceedingly large. The whole arrangement is nearly as in *Limnoria lignorum* (Rathke); the number and size of eggs and young evidently differ little from those in the last-named species. *Næsicopea*

¹ Not being able to decide whether *Næsa* (Leach) or *Dynamene* (Leach) ought to be used for the European genus, I applied to my friend the Rev. T. R. R. Stebbing, who is specially versed in such questions. He sent me, most courteously, a very detailed exposition, but as he added that he was working on *Sphæromidæ*, and his results are to be published, I accept his decision that *Dynamene* must be preferred, and refer the reader to the proofs to be found in his future paper.

(Stebb.) (*N. abyssorum* [Bedd.]) is so closely allied to one of my European species of *Dynamene* that the same arrangement is to be expected. In *Cerceis* (M.-Edw.) (an undescribed species rather allied to *C. tridentata* (Hasw.) has been examined) the marsupium and the development of the brood is completely as in *Dynamene*; *Haswellia* (Miers) is so closely allied to *Cerceis* that the development is in all probability quite similar.—In *Cymodoce* a somewhat different arrangement is found; some specimens of *C. egregia* (Chilt.) have been examined. The marsupial lamellæ are only so long that they overlap each other rather little with their ends. The brood is developed anteriorly in the marsupium, posteriorly in an enormous external pouch; the upper wall of this pouch is the ventral surface of thorax behind the origin of fourth pair of legs, while its lower wall is a rather thin lamella fixed inside the base of the four posterior pairs of legs and in front of abdomen, with its free margin extended between the base of the two legs of fourth pair. That this wall is a folding of the skin from behind goes without mention. At least one half of the eggs or young are found in this pouch; the other portion is covered by the marsupial lamellæ, which also, seen from below, overlap the front part of the wall mentioned. In a female I counted thirteen rather large oblong eggs. From want of females with brood of *Amphoroidea* (M.-Edw.) and *Dynamenella* (n. gen.) nothing can be stated on the propagation in these genera.

Of the twelve genera belonging to the platybranchiate *Sphærominæ* I have been able to study the propagation in only five genera, but these are fortunately representatives for the four sections constituting the group.

Of the section *Campecopeini* *Parasphæroma prominens* (Stebb.) has been examined. The marsupial lamellæ overlap each other somewhat at the mesial line; the marsupium is empty, the brood being enclosed in pouches, the entrances to which are longitudinal slightly oblique slits situated at the base of first and second pairs of marsupial lamellæ. As far

as could be ascertained with transmitted light the number of young is very low—about eight; one of them was removed and proved to be large.

Of the section Monolistrini *Vireia berica* (Fabiani) has been examined. The marsupial lamellæ are very large, but not quite as large as in *Dynamene*; the brood is formed in the marsupium itself; the eggs are very large, the young nearly ready for birth exceedingly large, and their number very low. The genera *Monolistra* (Gerst.) and *Cœcosphæroma* (Dollf.) are so closely allied to *Vireia* that their propagation is in all probability completely as in the latter genus. Of the section Ancinini, *Ancinella profunda* (n. gen., n. sp.) has been studied; the structure is nearly as in *Cymodocella*. An enormous external pouch occupies the lower side of the four posterior thoracic segments; its aperture, which is directed forward, is as broad as the marsupium, and its front end is near the posterior margin of third segment. The space of this pouch is somewhat larger than that occupied by the brood in the marsupium itself. The marsupial lamellæ not only overlap each other very considerably, but also cover about the front half of the wall of the pouch. In one female I found fourteen, in another eleven large oblong eggs.

Of the section Cassidinini I have seen two females with brood and three adult females without brood of *Cassidinidea ovalis* (Say), besides one specimen with brood of a new species of *Leptosphæroma* (Hilg.) The structure met with in these forms differs in the most astonishing degree from that observed in any other section, but as it is very difficult to understand and the animals very small my material is insufficient, and I can make out only a part of the features. With transmitted light it is easily seen that the specimen of *Leptosphæroma* has eight oblong somewhat curved eggs (or rather half-developed young) apparently enclosed in a marsupium, which occupies almost the whole area between the thoracic legs, but is slightly vaulted and not visible from the side, because the lower side of the animal is rather concave; in *Cassidinidea* the "marsupium" is somewhat more

vaulted than in *Leptosphæroma*, in the two specimens mentioned with about ten or twelve large half-developed young. In the females of these two genera it is, however, impossible to detect even the slightest vestige of marsupial lamellæ. In *Cassidinidea* a transverse lobe is observed occupying nearly the area between third and fourth pairs of thoracic legs; its free anterior margin is situated about in the transverse line between the two legs of third pair, while laterally it is curved backwards, originating at the insertion of fourth pair; in *Leptosphæroma* this lobe is somewhat shorter. This lobe is the front end of the lower wall of an external pouch occupying, as in *Ancinella*, somewhat more than the posterior half of the lower surface of thorax, but the wall is much thicker than in the last-named genus, in accordance with the fact that it is not overlapped by marsupial lamellæ. The anterior part of the incubatory chamber seems to be a rather similar pouch, which is smaller, closed in front, and without any free lobe behind. But now we come to a serious difficulty. I lifted the free lobe mentioned, which at its base seems to be rather firmly connected with the posterior margin of the lower wall of the front part of the incubatory chamber; I could not with any certainty discover apertures in the junction between the two walls, but pulling more vigorously on the free lobe, the junction named was broken, and a broad entrance to the incubatory chamber was formed. The posterior half of this chamber is a pouch formed as in *Cymodocella* and *Ancinella*, but what may the anterior half be? Is it formed by a folding of the skin from in front backwards—as the posterior half is formed by folding in the opposite direction—or by the fusion of the marsupial lamellæ with each other and with the lower surface of thorax along the insertions of the legs? I think the first alternative to be the right interpretation, but I cannot understand the fact that the posterior margin of its wall seems to be connected with the upper surface of the lower wall of the posterior pouch at the base of the free lobe. The animals examined are very small, and my material quite insufficient

for solving the problem ; I suppose, however, that the same structure is found in *Chitinopsis* (Whitelegge) and in *Cassidina typa* (M.-Edw.), and the latter form being comparatively large, a study of a rich material of females in various stages will be the best material for a future study of the anomalous and interesting mode of construction of the incubatory chamber in the section Cassidinini.

The perusal of the preceding pages will convey an idea of the astonishing variation met with not only in the family Sphæromidæ but even in the sub-family Sphærominæ as to the structure of the chamber for the development of the brood. Let us give a brief abstract. In some genera, as *Limnoria*, *Dynamene*, and *Vireia*, the room is formed only by the usual lamellæ, which are very or exceedingly large ; in *Plakarthritis* the same arrangement is found, but the lamellæ are of moderate size. In *Sphæroma* and *Cymodoce* the brood is developed in four or five pairs of pouches proceeding into the animal and opening with rather long transverse slits at some distance from the mesial line, while the marsupial lamellæ overlap each other ; in *Bregmocere* la we find the same arrangement, but the openings of the pouches are minute ; in *Exosphæroma*, *Isocladus*, and *Zuzara* the marsupial lamellæ are small and far from reaching each other at the mesial line, while the apertures of the inner pouches are small or minute, situated near the base of the lamellæ, or even impossible to discover. In *Parasphæroma* two pairs of apertures of internal pouches are longitudinal slits at the base of the lamellæ. In *Cymodocella* and *Ancinella* the major posterior part of the incubatory chamber is formed by a single external exceedingly large pouch with a very broad aperture directed forwards, while the anterior part of the chamber is formed by the marsupial lamellæ. In *Cassidinidea* and *Leptosphæroma* the marsupial lamellæ are wanting and the chamber is formed by a posterior and an anterior external pouch united with each other.

But the structure is still more complicated and varied. In the following chapter it is shown that in a little more than

two thirds of the genera the mouth-parts are similar in both sexes and in immature specimens, but in nearly one third of the genera the adult females have the basal half of the maxillipeds exceedingly expanded, being adapted for producing a current of water through the marsupium, while the distal part of the same appendages and all other mouth-parts are strongly reduced. One is apt to suppose that this metamorphosis must be associated with one of the modifications of the incubatory chamber, but it is far from being so. Some instances may be enumerated. *Vireia* and *Dynamene* have a normal chamber formed only by the very large lamellæ, but the mouth-parts are normal in the females of the former, exceedingly metamorphosed in those of the latter genus. *Sphæroma* and *Cymodoce* have marsupial lamellæ of the same size, but in the former genus the mouth-parts are normal, in the latter metamorphosed. The metamorphosis or non-metamorphosis of the mouth-parts is, on the contrary, connected with and even dependent on the shape of the end of abdomen, as will be shown in Chapters III and V.

III. METAMORPHOSIS OF MOUTH-PARTS IN FEMALES OF SEVERAL GENERA.

In all genera the mouth-parts in adult males and immature specimens of both sexes of the same species are always completely alike. In the sub-families *Limnoriinæ* and *Plakarthriinæ* and in the major part of the genera of the sub-family *Sphærominæ* the mouth-parts in females with brood are similar to those in the males, but in some genera the mouth-parts in such females are metamorphosed in a very peculiar way. In *Limnoria* (Leach), *Sphæroma* (Bosc), *Exosphæroma* (Stebb.) *Isocladus* (Miers), *Zuzara* (Leach), *Cymodocella* (Peff.), *Cassidinopsis* (n. gen.), *Parasphæroma* (Stebb.), *Vireia* (Dollf.), *Cassidinidea* (n. gen.), *Leptosphæroma* (Hilg.), *Ancinella* (n. gen.), and *Plakarthrium* (Chilt.), the mouth-parts of females carrying eggs or young are—according to my investigations—shaped as in immature speci-

mens or males; of four other genera, viz. *Dynamenella* (n. gen.) *Amphoroidea* (M.-Edw.), *Campecopea* (Leach), and *Tecticeps* (Richardson), I have seen females with the marsupium well developed but no brood was perceived, and in all the mouth-parts did not deviate from those in the males. I venture to state that among the genera of which females with brood or marsupium are unknown to me, at least *Hemisphæroma* (n. gen.), *Monolistra* (Gerst.), *Cæcosphæroma* (Dollf.), *Cassidina* (M.-Edw.), *Chitinopsis* (Whitelegge), and probably *Spelæosphæroma* and *Ancinus* (M.-Edw.), have the mouth-parts similar in males and in females with brood. Of *Cymodoce* (Leach), *Cilicæa* (Leach), *Cilicæopsis* (n. gen.) and *Bregmocerella* (Hasw.), *Dynamene* (Leach), *Paracerceis* (n. gen.), and *Cerceis* (M.-Edw.) the females carrying brood have the mouth-parts metamorphosed; I have examined at least one species of each of these genera, of some genera two, three, or more species, always with the same result. I am confident that in *Cassidinella* (Whitelegge), *Næsicopea* (Stebb.), and *Haswellia* (Miers), the female mouth-parts will in the future be found to be altered in the same way.

Let us now look at the differences between the mouth-parts of an egg-bearing female and a male (or an immature specimen) of one of the European species of *Cymodoce*. In the male the major distal portion of the incisive process of the mandibles (fig. 1 *a*) is dark brown or black, lacinia mobilis is well developed, with a plate on the left mandible, the molar process is thick and moderately long (fig. 1 *b*). In the egg-bearing female the incisive process is rounded and yellowish, which shows that it is less hard, lacinia mobilis has disappeared (fig. 2 *a*), while the molar process is very low, scarcely developed, and without equipment for trituration. The female maxillulæ (fig. 2 *b*) have been altered in a corresponding way; the distal half of the inner lobe is much narrower than in the male (fig. 1 *c*), its end rounded and the stiff setæ lost; the outer lobe has gained a number of fine hairs, but its end is rounded and of the strong terminal spines at most a rudi-

ment and generally nothing remains. The lobes of the maxillæ (fig. 2 *c*) have lost all their numerous setæ found in the male (fig. 1 *d*) and in immature specimens, and the bifid outer lobe has been shortened. Besides, all these mouth-parts have the muscles considerably or much reduced; but the muscles to the mandibular palps, still shaped as in the males, have been preserved. The hypopharynx has been very reduced (fig. 2 *e*), being only about half as large as in the male (fig. 1 *f*). The maxillipeds are still more interesting; in the female with brood (fig. 2 *d*) the four distal joints have been reduced in size, especially the lobes are much shorter and have lost all the setæ found in other specimens (fig. 1 *e*); the lobe from second joint has lost its distal setæ, but the two proximal joints with the epipod are, on the contrary, expanded to such a degree that their joint surface is between twice and three times larger than in the male of the same size; some of the muscles in the palp have been reduced in size and all are lighter in aspect, while the musculature moving the expanded proximal portions is well developed. As in Cymothoidæ the first joint of the female maxillipeds has a thin free ciliated plate directed backwards; the second joint is shorter than in the male, but much expanded outwards, and the free outer margin furnished with long plumose setæ not found in the other sex. We can therefore not say that the mouth-parts as a whole have been reduced in adult females; the proximal half of the maxillipeds has, on the contrary, been developed as a special instrument for producing a current of water through the marsupium, while the distal half of the maxillipeds and the outer mouth-parts, the mandibular palps excepted, have been strongly reduced, and are even unfit for use. The direction of the current must, of course, be observed in living animals; judging from various reasons, I am, however, convinced that it goes from behind forward.

The genera in which the females with brood have the mouth-parts metamorphosed are enumerated above. The alterations are essentially as in *Cymodoce*, but it must be men-

tioned that in *Cerceis* and especially in *Dynamene* (*Næsa*) *bidentata* (Mont.) I find the differences between mouth-parts in adult females (figs. 4 *a*–4 *e*) and other specimens (figs. 3 *a*–3 *d*) still more astonishing. In both genera more than the proximal half of the lower outer surface of the female mandibles is so completely fused with the skeleton of the head that even a suture cannot be detected when the mandible with the adjoining firm portion of the head is taken out and examined under the microscope, while the outer margin itself of the mandible protrudes above the skeleton mentioned and is indicated on figs. 4 *a* and 4 *c* by dotted lines. Furthermore, the distal half of the mandible has not only lost every vestige of an incisive dark-coloured part, lacinia and molar process, but it shows a very different shape (figs. 4 *a* and 4 *b* as compared with fig. 3 *a*), being distally rounded, with fine and short hairs at the margin. Maxillulæ and maxillæ have not only lost all setæ or spines, but have been much reduced in size (figs. 4 *c* and 4 *d* as compared with figs. 3 *b* and 3 *c*). The maxillipeds (fig. 4 *e*) have the expansions from epipod and from first and second joints much larger than in *Cymodoce*, while the lobe from second joint has been strongly reduced in size, the joints of the palp somewhat reduced but yet with some short setæ on the lobes.

It is easy without dissection to perceive whether the maxillipeds of an egg-bearing female belonging to this family have been altered or have preserved their normal size and shape. The question whether the mouth-parts have been metamorphosed can generally be decided without difficulty by looking at the end of the mandibles, whether they are very dark or yellowish. But an anomaly must be mentioned here. Of ten females with marsupium of *Cymodoce pilosa* (M.-Edw.) eight had all their mouth-parts altered as described above, but in two specimens the curious feature was observed that the maxillipeds and maxillæ had been completely metamorphosed, while the alterations in the two anterior pairs of appendages were less complete. In one of these specimens the end of the mandibles had kept their dark colour and the

outer lobe of both maxillulæ their spines, while lacinia mobilis, etc., had disappeared; in the other specimen only a little of the dark colour on the end of the mandibles and the spines on one of the maxillulæ were preserved.

Giard and Bonnier have shown that in the Bopyrinæ the females have the first joint with its epipod and second joint of the maxillipeds strongly expanded and adapted for producing a current of water. Schiödte and Meinert pointed out that in the Æginæ (Æga, Rocinela) the marsupial plates cover the entrance to the mouth, so that egg-bearing females cannot take any nourishment; females with marsupium have never been found on fishes, but are not uncommonly captured with dredge or trawl. In 1890 the present author showed that in the Æginæ and in all other Cymothoidæ, sens. lat. (Cirolana, Corallana, Æga, Nerocila, Cymothoa, etc.) the adult females have the two proximal joints—with the epipod—of the maxillipeds strongly expanded and evidently adapted for the same purpose as the corresponding part in female Bopyrinæ, but in no form any real reduction of the other mouth-parts was observed. In several genera of Sphæromidæ we have a similar expansion of the proximal half of the maxillipeds, but their distal half and all the other mouth-parts are reduced in a most peculiar way, and so strongly that the animals cannot take any food at all. Such metamorphosis of the mouth-parts in females carrying brood is, as far as I know, without parallel, not only among other Arthropods, but among animals of every other series.

Finally, there is the question as to the systematic value and biological bearings of this metamorphosis. In Limnoriinæ, Plakarthriinæ, and probably in all platybranchiate Sphærominæ (I have examined females with brood of representatives for the four sections constituting this group) the mouth-parts are similar in both sexes; in all these animals the end of abdomen has either a rather shallow notch (Plakarthrium) or a notch not visible from above (Campecopea) or, generally, no notch. The hemibranchiate Sphærominæ are naturally divided into two sections, Sphæromini and Cymodocini; in

Sphæromini the females have no notch at the end of abdomen and the mouth-parts normal as in the males, while in Cymodocini the same sex has a distinct, most frequently bilobed notch at the end of abdomen, and the mouth-parts metamorphosed; it may be added that no other distinguishing character between the two sections could be discovered. In the eubranchiata Sphærominæ the case is more difficult. In this group the end of abdomen is a little emarginate in one genus, *Cassidinopsis* (n. gen.), in all other genera furnished with a notch of very different shape; in some of the genera the female mouth-parts are normal, in others highly metamorphosed. Nevertheless, there is evidently a connection between the presence of metamorphosis of the mouth-parts and the development of the abdominal notch. In the female *Dynamene bidentata* (Mont.), and especially in another species of the same genus, a species constituting a transition stage to *Næsicopea* (Stebb.), the mouth-parts are metamorphosed and the abdominal notch very deep and looking much upwards (it is, besides, widened at the bottom and very constricted in the distal part); in *Cerceis* (M.-Edw.) the notch is rather deep and turned upwards, in *Paracerceis* (n. gen.) moderately large and deep and turned backwards, but the end of abdomen is somewhat produced. In both these genera the mouth-parts are metamorphosed. In *Scutuloidea* (Clilt.) the notch is less deep than in the preceding genera, in *Cassidinopsis emarginata* (Guér.) only a rather slight emargination is found; in both these genera the mouth-parts are normal; in a female of *Amphoroidea falcifer* (Thoms) with the marsupium well developed, but without brood, the mouth-parts are normal and the notch as in *Scutuloidea*. Difficulties are found in *Cymodocella* (Pfeff.) and *Dynamenella* (n. gen.); in the former genus the notch is very well, though peculiarly, developed, and the mouth-parts normal; in *Dynamenella* the female notch is about as in *Paracerceis*, but the mouth-parts seem to be normal. For want of material I cannot further prosecute this topic, but in spite of the difficulties mentioned it can be stated that in the

genera with the notch rather feebly or very feebly developed the mouth-parts are normal, in the genera with the notch rather deep or very deep and looking upwards the mouth-parts are metamorphosed, while in a few genera with the notch looking essentially backwards and at least of moderate depth the mouth-parts vary as to the feature in question. Considering the whole family, we arrive at the result that in all forms with the abdominal notch shallow or wanting in the females the mouth-parts are not metamorphosed; in the large majority of forms with the notch well developed, and in all forms having either a rather deep or very deep notch looking essentially upwards, or a notch divided by a mesial process, the mouth-parts are metamorphosed; while only at most two genera with the notch well developed remain as being—at least for the present—apparent exceptions from the rule. Some remarks on the significance of the notch and on the remarkable connection between the shape of the end of the abdomen and the development of the mouth-parts in egg-bearing females are set forth in Chapter V.

IV. SEXUAL DIFFERENCES.

In most genera the adult males are larger, sometimes even much larger, than the females, in some nearly of the same size; in *Cassidinidea ovalis* (Say) I have found the ovigerous females larger than an adult male. Of *Plakarthritis typicum* (Chilt.) I have seen several specimens of very different sizes from the same locality; among the smaller specimens I found an adult male and a female with the marsupium complete, while a considerably larger specimen had rudimentary marsupial lamellæ.

The adult males of all genera, *Dynamene* (*Næsa*) (Leach) and *Ancinella* (n. gen.) excepted, possess an oblong or very elongate, generally narrow, flat stylus, the "appendix masculina," proceeding from the inner margin—either near its base or sometimes at the end—of the endopod of plp.²;¹

¹ On the following pages some abbreviations are generally used, viz. plp.¹, plp.², plp.⁵, for first to fifth pairs of pleopods, endp. for endopod, exp. for exopod, urp. for uropods.

this stylus is in reality (compare my paper on the "Asellota," 1905) the second joint of that endopod. On endp. of plp.¹ no trace of an auxiliary stylus is found; in *Campecopea hirsuta* (Mont.) I found a short process, not marked off by articulation, proceeding from endp. of plp.³ near its end, while the appendix on plp.² is exceedingly long, and originates at the base of endp. Of three European species of *Dynamene* (Næsa) (Leach) I have inspected in all several adult males, but in none of them an appendix masculina was found, and the inner margin of the endopod of plp.² is simple, not thickened. In adult males of *Ancinella profunda* (n. gen., n. sp.) no appendix masculina is found, but the inner margin of endp. of plp.² is considerably thickened, with a longitudinal groove on the inner side of this thickening; in the female this margin is of normal inconsiderable thickness without any groove.

At least in the sub-family Sphærominæ, the appendix masculina does not appear before the animals are nearly full-grown, but it is easy by another character to distinguish males even when not half-grown from immature females. As is known, the males have two processes close together on the seventh thoracic sternite; these processes, which are tubes containing the terminal portion of the ducts from the genital organs, are sometimes rather short (*Tecticeps*), sometimes rather long (*Dynamene*), very long (*Cymodoce pilosa*), or even exceedingly long (*Dynamenella bermudensis*); they are found in all genera. Of *Cymodoce pilosa* (M.-Edw.) I collected at Siracusa a rich material consisting of both sexes in very different size and age; an unusually small adult male measures 10·7 mm., the largest male 15 mm. in length, but in numerous immature males measuring from 9·7 to 13·7 mm. no vestige of the appendices on endp. of plp.² can be found, while the processes at seventh thoracic sternite are shorter than in the adults, but yet very distinct. The marsupial lamellæ are mentioned above. The length of flagellum of antennulæ and antennæ in the two sexes has not been specially examined, but at least sometimes differences are well marked.

In several genera, viz. *Sphæroma* (Bosc), *Cymodocella* (Pfeff.), *Scutuloidea* (Chilt.), *Amphoroidea* (M.-Edw.), *Cassidinopsis* (n. gen.), *Cassidinidea* (n. gen.), *Leptosphæroma* (Hilg.), *Limnoria* (Leach), and *Plakarthritis* (Chilt.), there are at most rather slight sexual differences in shape of thorax, abdomen, thoracic legs or uropoda; but in some of them the males are larger than the females. In other genera, as *Isocladus* (Miers), *Zuzara* (Leach), *Cymodoce* (Leach), *Cilicæa* (Leach), *Ciliacæopsis* (n. gen.), *Bregmocerella* (Hasw.) *Dynamene* (Leach), *Paracerceis* (n. gen.), adult specimens of the two sexes differ exceedingly from each other in various respects; the males are distinguished by processes on sixth or seventh thoracic segments or on the first portion of abdomen, shape of uropoda, frequently shape of the end of abdomen, etc., in *Bregmocerella* even processes on the head. Leach established some genera on adult males, referring the majority of females and young specimens to *Sphæroma* or *Dynamene*, the latter of which was established exclusively on such specimens. Similar confusion is still found in papers published in the last six years. In 1873 Hesse stated the species of *Sphæroma* are female of *Cymodoce*, *Dynamene* females of *Næsa*. As to the European forms of *Dynamene* it is quite correct (exotic forms referred to *Dynamene* cannot remain in this genus), but regarding *Sphæroma* the case is more complicated; among the European forms referred to the latter genus, those without terminal notch are well-founded species—with males and females—of *Sphæroma* itself, while those possessing an abdominal notch are females or young males of *Cymodoce* or other genera. Miers has correctly referred females and males of some exotic species of *Cymodoce*, but he did not undertake a special study of the family. It is scarcely necessary to give here a detailed account of the sexual differences alluded to in these genera; the notes in the systematic chapters may be sufficient. But one thing must be added. At Sicily I collected a rich material of three species of *Cymodoce*; while the adult males were not difficult to separate, it was only after a

prolonged examination that I could separate females, and especially half-grown specimens of the three species; the males will be far from easy to describe and figure well, but the specific characters in immature forms and females will be very difficult to describe and figure, so that even a careful student may be able to determine specimens when he has only a small material at his disposal. I should advise carcinologists not to establish species on females or immature specimens belonging to *Cymodoce*, *Cilicæa*, *Cilicæopsis*, *Dynamene*, *Dynamenella*, or *Paracerceis* if males be not at hand from the same locality.

In some genera, as *Cerceis* (M.-Edw.) and *Dynamenella* (n. gen.), the shape of the abdominal notch differs generally very considerably in adult males, immature males, and females. In *Parasphæroma* (Stebb.) there is a marked sexual difference in thickness and equipment with hairs and spines of some of the joints of second and third thoracic legs (a more detailed description is found in Chapter VII). In *Monolistra* (Gerst.), *Vireia* (Dollf.), and probably the other genera of the section *Monolistrini* the second thoracic legs are simple in the females, while in the males they terminate in a prehensile hand. In the section *Ancinini* (*Ancinus*) (M.-Edw.), *Ancinella* (n. gen.), *Tecticeps* (Richardson), the second legs are simple in the female, and terminate in a prehensile hand in the male, but in one of these genera, *Tecticeps*, we find besides a remarkable sexual difference in length and shape of sixth joint in seventh thoracic legs, and differences in the end of abdomen, length of exp. of urp., etc.

V.—REMARKS ON STRUCTURAL FEATURES AND CHARACTERS.

The head.—While in *Cirolana* and many other genera of *Cymothoidæ* (sens. lat.) a frontal plate is very distinct and well marked off from clypeus, we find in *Sphæromidæ* only one plate, which has been named "epistome." This epistome is always broad behind, its posterior margin at least conspicuously and frequently so strongly concave that a deep rounded incision is formed; in such cases the posterior part

of the epistome encompasses the anterior half of labrum. In several genera the anterior part of the epistome protrudes as a plate or a process in front of the margin of the head. The epistome is generally well marked off from the front mesial triangular end of the upper surface of the head, but in *Ancinus* (M.-Edw.) both are completely fused.

The peduncle of the antennulæ is always three-jointed; the two proximal joints afford sometimes generic differences. Flagellum of antennulæ and antennæ show differences of minor importance. The mouth-parts are rather reduced in *Plakarthriinæ* (see the diagnosis of this sub-family); in all other forms they are well developed. In the small section *Ancinini* the mandibles are without molar process; in *Limnoria* besides *lacinia mobilis* is at most rudimentary; in all other genera both *lacinia mobilis* and the molar process are well developed, but lesser differences are observed. Maxillulæ and maxillæ are uniform; the maxillipeds vary much in relative length and breadth of second and following joints, and in length of the lobes frequently proceeding from fourth, fifth and sixth joints. But excepting the few genera mentioned the mouth-parts in this rich family are so uniform that descriptions of their shape in various genera are nearly worthless if not accompanied with numerous figures. The most important features are mentioned below in the diagnosis of the family, the sub-families, the section *Ancinini*, and the genus *Hemisphæroma*. The metamorphosis of the mouth-parts in the females of several genera is treated in Chapter III.

The thorax.—It is a feature probably unique among Isopoda that in *Plakarthrium* the so-called epimera are developed as movable plates not only on the six posterior segments—which also is the case in *Limnoria*—but even on the first segment. The fusion of these plate-shaped joints of the legs with their segment in the *Sphærominæ* needs no special mention.

In most genera the legs are uniform as to main points; the seven pairs of the same animal and the corresponding

pairs in various forms show numerous minor differences as to relative length and thickness of joints, equipment with hairs, etc., but the differences must be exhibited in figures. Three or four legs from the same side representing the essential deviations found between the pairs of the same animal ought to be selected for illustrations to be done with the same degree of enlargement; the same legs from the same half of different animals must be drawn so that if, for instance, the seventh left leg of one species is seen from below (from in front), this leg of all the other animals ought to be shown from the same side. The most interesting differences in the legs shall be enumerated here. In *Amphoroidea typa* (M.-Edw.) the three anterior pairs are slender, but especially the three following pairs exceedingly thick and short; in *A. falcifer* (Thoms), the difference is not so highly developed, but still remarkable. In *Sphæroma* (Bosc.) and *Hemisphæroma* (n. gen.) the three anterior pairs are equipped with very long, stiff, plumose notatory setæ on the outer side of some joints; this feature I have not observed in any other genus. In the three genera constituting the section *Ancinini* the first pair terminates in a robust prehensile hand, the sixth joint being much thickened, and the seventh with its claw folded back along the lower margin of the sixth, quite as in numerous *Amphipoda*. The sexual difference found in the legs in *Parasphæroma* (Stebb.) and the genera constituting the sections *Monolistrini* and *Ancinini* are mentioned in the preceding chapter.

The abdomen.—In *Limnoria* all six abdominal segments are free and movable, in *Plakarthritis* all are fused with each other. But some difficulty is met with as to the *Sphærominæ*. In all forms of this sub-family (*Vireia burgunda* (Dollf.) and *Cœcosphæroma* (Dollf.) excepted) the abdomen consists of two movable parts, and the question arises as to the number of segments constituting each part. But a comparison of the two posterior segments and the articulation between them in *Limnoria* with the structure in *Sphæroma* gives the result that in the latter genus the

posterior part of abdomen consists of only one segment, the sixth; the anterior part must consequently correspond with the five anterior segments in *Limnoria*. In *Sphæroma*, *Cassidinopsis*, and numerous other genera, this anterior part has on the upper surface three sutures as rudiments of division into segments; the anterior of these sutures is entire, the two other completely vanished at the middle. Four segments are thus traceable, but as the part corresponds with five segments we must conclude that one segment, perhaps the first, has completely disappeared. In *Vireia burgunda* (Dollf.) (but not in *V. berica* (Fabiani)) and in *Cœcosphæroma Virei* (Dollf.) the two parts of abdomen are immovably fused with each other.

The pleopods are mentioned by various authors in the descriptions of some genera or species; it has been observed that the five pairs of an animal are not similar and that, for instance, fourth and fifth pairs are not uniformly built in all forms. But no author has undertaken a real comparative study of these appendages, which in reality afford characters, not only for genera, but for groups of genera; the omission of this study is a principal reason, not only for the complete want of grouping of the numerous genera, but for a good deal of the confusion as to the reference of species to genera. In the following I use the most important differences in the pleopods as characters in the diagnoses of the sub-families, and especially as the base for dividing the *Sphærominæ* into groups of genera; other differences are used in establishing sections of genera or in the analytical keys, sometimes even in the diagnoses of genera. In this paper I omit here a more detailed account of these appendages, thinking that a perusal of the diagnoses in the next chapter may convey sufficient knowledge of their structure and the numerous differences observed. It may, however, be added that, for instance, the thickened areas or real protuberances—clothed with spines—on the exp. of plp.⁵ in almost all *Sphærominæ* afford more characters than those mentioned in the following treatment; further elucidation of this and other topics must be postponed to the illustrated paper.

It is well known that the end of abdomen is shaped very differently in the genera. In *Sphæroma*, *Hemisphæroma*, and the section *Monolistrini* the posterior margin of abdomen is broadly rounded, without trace of longitudinal excavation below or of any terminal notch. In other genera the lateral walls of the terminal part of abdomen are bent less or more downwards and sometimes even a little inwards, so that the lower side shows a longitudinal excavation (*Isocladus*), and when in this case the end of abdomen is cut off we have the dorsal half of a kind of tube (*Ancinus*). In *Cymodoce* the distal lateral walls mentioned are so strongly curved that their lower margins touch each other below in the mesial line; the lower distal surface of abdomen is in this case the inner wall of a tube formed by that curvature, and the tube terminates behind in a nearly circular aperture. In other genera the end of abdomen has a real notch; sometimes this notch is very deep, its distal portion narrowed, being only a linear slit, while the proximal part is a rounded or transverse foramen. Such differences have been seen and described by all authors; they have generally been used as specific characters, but they are always of generic value; nobody seems to have noticed that the want of a notch or the essential shape of the notch is of importance as to the biology of the animal. The best instances are the genera *Leptosphæroma* (Hilg.) and *Plakarthrium* (Chilt.). In these forms the uropods surround the end of abdomen; the animals are very depressed, with the lower surface concave, the outline continuous, and all parts participating in forming the outline are much expanded. According to Chilton *Plakarthrium typicum* (Chilt.) lives on the seaweed *Eklonia radiata*, "to which it closely adheres." Both genera are evidently adapted for clinging closely to firm and flat or regularly rounded surfaces just as is a female *Coccus* on a *Nerium*. The end of abdomen terminates in *Plakarthrium* in a notch; in *Leptosphæroma* the most distal small portion of abdomen is turned somewhat upwards and has a longitudinal groove below; in both genera a small aperture is thus formed

between the terminal abdominal margin and the uropods, with the result that the animals can live closely clinging to a firm body, and by movement of the pleopoda produce through that aperture a current of water to the rami adapted for respiration.

Næsicopea abyssorum (Bedd.) has a round foramen on the end of a protuberance considerably above the posterior margin of abdomen, and this foramen is the upper part of an exceedingly deep incision or transformed notch, but the major distal and lower part of this incision looks like a suture in the mesial line to the lower margin of abdomen. The result of this structure must be that this rather large animal can walk on very soft muddy bottom with the lower margin of abdomen touching the mud, but yet get pure water through that foramen to the branchiæ; according to Beddard the two specimens known were taken in a depth of 1070 fathoms, and the bottom was "blue mud." In a species of *Dynamene* from the Mediterranean I find about the same: a foramen on the end of a protuberance above the end of abdomen, but the distance between this end and the foramen is proportionately shorter than in *Næsicopea*. In some forms (*Dynamenella*, *Cerceis*, etc.) there is considerable difference in the shape of the notch in the two sexes, which suggests that some difference in the biology of the sexes may exist. *Hemisphæroma pulchrum* and all species of *Sphæroma* have no trace of a notch, and the posterior margin of abdomen is broadly rounded, but in these forms the three anterior pairs of thoracic legs are furnished with very long and stiff natatory setæ not met with in any other genus; their habits are, therefore, probably more natatory than those of other marine genera; they can easily get pure water to the branchiæ from below, which agrees with the total absence both of notch and of groove on the lower distal part of abdomen. According to all these examples (*Plakarthrium*, *Leptosphæroma*, *Næsicopea*, *Dynamene*, *Hæmisphæroma*, *Sphæroma*) we must assume that the shape of the end of abdomen is an important feature, being developed in various ways according

to the normal habits of the forms and the quality of bottom on which they live.

In Chapter III it is shown that, speaking broadly, the mouth-parts of egg-bearing females are almost always metamorphosed in the genera possessing a well-developed notch, while they are generally normal in all other forms. Having now shown the use of the notch, it is possible to understand a part of that curious connection between the mouth-parts and the shape of abdomen in the females with brood. When a notch is deep and especially when it turns much upwards the nature of the habitat offers hindrances to an easy supply of water to the branchiæ and from thence to the brood in the marsupium or the pouches; in this case the proximal half of the maxillipeds is developed as an auxiliary instrument for bringing fresh water to the brood, while in the other forms the current is produced only by the movements of the pleopods. These statements support strongly the assumption set forth above (p. 84) that the current produced by the maxillipeds runs from behind forwards. One remarkable feature remains, viz. that when the proximal half of the maxillipeds is strongly expanded all the other parts of the mouth are reduced, but this I cannot explain.

VI. CLASSIFICATION.

The family Sphæromidæ is more allied to Cymothoidæ (sens. lat.), and especially to Serolidæ than to any other family of Isopoda; in the following characterisation generally only those characters are inserted by which it is distinguished from the two other families. The diagnoses of the sub-families are as complete as possible. The three "Conspectus" of the sub-families are analytical only to a certain extent, because it has been the intention to give all essential characters for subdivisions of every degree and to avoid unessential particulars.

Characterisation of the Family Sphæromidæ.

Head with a well-developed epistome, not divided into frontal plate and clypens, and rarely fused with the upper surface

of the head. Peduncle of antennulæ three-jointed, of antennæ five-jointed. Mouth-parts, biting or gnawing, never really suctorial; second joint of maxillipeds at least in males and immature specimens without external expansion; mouth-parts in females with brood rather frequently strongly metamorphosed and useless for nutrition. Thoracic segments seven, all free; marsupial lamellæ only on second, third, and fourth "epimera," rarely wanting (section Cassidinidi). All pleopods lamellar; all endopods, and at least the exopods of first and second pairs unjointed; at least both rami of plp.¹ and plp.² fringed with long plumose setæ, and at least in all two rami of the posterior pairs (both rami of plp.⁵ or the endp. of plp.⁴ and plp.⁵) without such setæ, and specially adapted for breathing. Sixth segment large. Uropods with the rami unjointed, these, at least in the females, generally depressed, sometimes one of them wanting; in *Vireia* the uropods are wanting. The body can be rolled more or less completely into a ball or can be folded.

The family is divided into three sub-families:

1. *Limnoriinæ*.—Mandibles stout; lacinia mobilis at most rudimentary, without plate on the left mandible; molar process wanting; palp three-jointed. Maxillulæ with the inner lobe well developed; maxillæ with the three distal lobes very short, but yet well developed. Maxillipeds with a single hook on the lobe from second joint; epipod large, longer than broad. Epimera not marked off from first thoracic segment; second to seventh epimera a little movable. Abdomen consists of six movable segments. Plp.³ and plp.⁴ have both rami furnished with long plumose marginal setæ, as have also plp.¹ and plp.²; rami of plp.⁵ without marginal setæ, respiratory; exp. of plp.⁵ without squamiferous areas or tubercles. Endopod of urp. movable. (The brood in the marsupium itself; no sexual difference in the mouth-parts.)

2. *Sphærominæ*.—Mandibles, at least their basal half, stout; lacinia mobilis well developed, with plate on left mandible; molar process generally well developed (wanting in the section *Ancinini*); palp three-jointed. Maxillulæ with

the inner lobe moderately or, generally, very well developed; maxillæ with the three distal lobes moderately long. Maxillipeds with a single hook on the lobe from second joint; epipod very small, broader than long, or not discernible. Epimera not marked off from first thoracic segment; second to seventh epimera immovably fused with their segments, but generally some of them marked off by very fine, or nearly inconspicuous, furrows or lines. Five anterior abdominal segments completely fused with each other, but, on the upper surface, transverse furrows—at most three and the two posterior broadly interrupted at the middle—are generally seen as traces of divisions into segments. Last segment generally movable (immovably fused with the preceding part in *Vireia burgunda* and *Cœcosphæroma Virei*). Rami of plp.⁵ without plumose marginal setæ; endp. of plp.⁴ generally without setæ, in rare cases with a few short plumose setæ, at least endp. of plp.⁴ and plp.⁵ respiratory; exp. of plp.⁵, generally with some—at least three—thickened areas or protuberances densely clothed with minute scale-like spines (in *Ancinella* without spines, in *Tecticeps* wanting). Endp. of urp. fused with the sympod, or wanting. (The brood most frequently develops in pouches; mouth-parts in ovigerous females often strongly metamorphosed.)

3. *Plakarthriinæ*.—Mandibles very slender; lacinia mobilis well developed, with plate on left mandible; molar process wanting; palp rudimentary, one-jointed. Maxillulæ with the inner lobe rudimentary; maxillæ reduced, showing only a narrow oblong plate terminating in three spines and some setæ. Maxillipeds without any hook on the lobe from second joint; epipod not discernible. All seven pairs of thoracic epimera movable, large. Abdomen has all segments fused together, on the surface two interrupted furrows as rudiments of division. Exp. of plp.³, plp.⁴, and plp.⁵ pellucid, scarcely respiratory, with numerous plumose setæ along their distal margin; endp. of the same three pairs opaque, respiratory, without marginal setæ; exp. of plp.⁵ without squamiferous areas or protuberances. Both rami of urp. movable.

(The brood in the marsupium itself; no sexual difference in the mouth-parts.)

It may be preferred first to deal with the genera of the two very small sub-families before proceeding to the rich sub-family, the Sphærominæ.

Sub-family Limnoriinæ.

Only one genus is known, the diagnosis of which may be as follows: Antennulæ and antennæ very short, freely protruding, their proximal joints not fitting in excavations on the head. Endp. of plp.¹ more than three times longer than broad; exopods of all pleopods unjointed. Last abdominal segment with the posterior margin equally rounded, without terminal notch. Urp. with exp. much shorter than endp.

Limnoria (Leach).

Sub-family Plakarthriinæ.

This sub-family is established on a single genus, the diagnosis of which is given here. Two proximal joints of each antennula, and third and fourth joints of the antennæ exceedingly expanded in front, with their anterior margin cut off. All thoracic legs simple. Endp. of plp.¹ nearly four times longer than broad; exopods of all pleopods unjointed. Abdomen terminates in a nearly semicircular notch. Head and abdomen quite excluded from partaking in forming the outline of the animal; this outline is continuous, regularly oval, formed exclusively by the front margin of first and second joint of the antennulæ, third and fourth joints of the antennæ, the outer margin of the thoracic epimera, and the distal margin of the uropods. Animals very depressed, the lower surface concave.

Plakarthrium (Chilton) (*Chelonidium* (Pfeffer)).

Sub-family Sphærominæ.

This rich sub-family is divided into three sharply defined groups.

(A) *Sph. hemibranchiatæ*: Plp.⁴ and plp.⁵ have the

endopods thick, of fleshy aspect, with deep, essentially transverse folds, the exopods submembranaceous and rather pellucid, two-jointed; both rami of both pairs without plumose marginal setæ; exp. of plp.⁵ has the subapical squamiferous protuberance on the lower surface very high. Plp.³ have both rami closely set with long plumose setæ, at least on the distal margin. Endp. of plp.¹ at least rather broad, scarcely ever half again as long as broad.

(B) *Sph. eubranchiatæ*: Plp.⁴ and plp.⁵ have both rami subsimilar, with deep, essentially transverse folds, often of fleshy aspect, without plumose marginal setæ; exp. of plp.⁵ generally distinctly two-jointed, with the subapical squamiferous protuberance on the lower surface very high. Plp.³ have both rami closely set with long plumose setæ at least on their distal margin. Endp. of plp.¹ at least rather broad, scarcely ever half as long again as broad. (End of abdomen at least emarginate, generally with a notch or with a slit terminating in a foramen.)

(c) *Sph. platybranchiatæ*: Plp.⁴ and plp.⁵ have both rami completely without transverse folds, and their exopods are unjointed; endp. of plp.⁴ at most with a few short terminal plumose setæ, exp. of same pair rarely with numerous long marginal plumose setæ (*Tecticeps*), in most genera both rami without plumose setæ; both rami of plp.⁵ without plumose marginal setæ, and the exp. has the squamiferous protuberances slightly in relief, and in rare cases without spines or even wanting. Plp.³ have sometimes plumose marginal setæ on both rami as plp.², sometimes with endp. nearly naked or with both both rami naked. Endp. of plp.¹ rarely broad, most frequently narrow. (End of abdomen sometimes with a rounded notch, often truncate, rounded, or acute.)

Group A. *Sphærominæ hemibranchiatæ*.

This group comprises a very large number of forms, but in spite of much difference in aspect great uniformity is met with in the large majority of more important features. The

proximal joints of the antennæ never protrude with free expansions in front of the head; they are fitted in oblique excavations. In the mouth-parts only the development of the incisive process of the mandibles and the "palp" of the maxillipeds show noteworthy generic differences, excepting the metamorphosis in the females in half of the forms. The thoracic legs are all simple, without sexual difference. The pleopods in the different genera are so uniform that scarcely more than the exopods of plp.³ and plp.⁵ present generic differences. The exopod of the uropods is always present, but sometimes exceedingly small. The brood is developed in internal pouches. The body is never strongly depressed, the faculty of rolling excellently developed, the lateral margin of thorax not continuous.

The group is divided into two sections about equal in number of genera.

(a) *Sphæromini*.—End of abdomen in the female without notch, rounded or somewhat produced and more or less acute; in the male generally as in the female, in some forms the end much produced with a pair of lateral notches, so that the mesial part is shaped as a process narrowed at the base.¹ Mouth-parts similar in both sexes.

(a) Maxillipeds with the lobes from fourth, fifth, and sixth joints low or rudimentary. Three anterior pairs of thoracic legs closely set with exceedingly long stiff plumose setæ on the outer margin of third and fourth joints. Exp. of plp.³ unjointed. Marsupial lamellæ overlap each other at the mesial line (they are unknown in *Hemisphæroma*, which probably does not differ from *Sphæroma* in this respect).

† Mandibles normal, the cutting process not elongate, its

¹ In a species from Simon's Bay, at Cape, closely allied to or identical with *Sphæroma scabriculum* (Hell.), the end of abdomen in the female is as in *Exosphæroma*, while in the male a notch, as in the male *Dynamenella* (compare the diagnosis below) is observed; the specimen described by Heller is evidently a male. The female of the species seen by me cannot be separated from *Exosphæroma*, while the structure in the male alluded to is very curious. For various reasons I omit this form from the conspectus, hoping to obtain more material of allied species.

end obtuse or with some small teeth. Side of abdomen not expanded below the lateral margin of thorax. Tip of abdomen rounded.

(1) *Sphæroma* (Bosc).

(++) Mandibles aberrant, having the cutting process very elongate (fig. 5 *a*), its distal part widened and divided by a deep triangular incision into two oblong, plate-shaped, distally acute processes. Lateral wall of abdomen considerably expanded, directed downwards, and extending a good deal below the lateral margin of thorax. Tip of abdomen triangular, acute.

(2) *Hemisphæroma* (n. gen.).

(β) Maxillipeds with the lobes from fourth, fifth, and sixth joints at least rather long. Three anterior parts of thoracic legs without stiff natatory setæ. Exp. of plp.³ two-jointed. Marsupial lamellæ small, far from reaching each other at the mesial line.

(†) ¹Last thoracic segment unarmed in both sexes. End of abdomen at most somewhat produced, but not acute.

(3) *Exosphæroma* (Stebb.).

(++) Last thoracic segment in the male with a slender mesial process. End of abdomen somewhat or very considerably produced, subacute. (In the male both rami of the uropods are exceedingly large plates.)

(§) End of abdomen subsimilar in both sexes, very considerably produced, with a real groove on the lower side of the produced part.

(4) *Isocladus* (Miers).

(§§) End of abdomen in the female somewhat produced, in the male strongly produced with a pair of lateral notches, so

¹ The genera *Exosphæroma*, *Isocladus*, and *Zuzara* (with *Cycloidura* as a synonym) are so closely allied that the females can scarcely be separated, while it is easy to refer the adult males to their respective genera. When more species are known it will probably be necessary to unite them, preserving the name *Zuzara* for the genus. If that be not done it will be necessary to establish a new genus for *Sphæroma scabriculum* (Hell.), and perhaps some other species.

that the mesial part is shaped as a process narrowed at the base; an oblong groove is scarcely developed.

5. *Zuzara* (Leach) (incl. *Cycloidura* (Stebb.)).

(b) *Cymodocini*.—End of abomen in both sexes with a notch, which sometimes is semicircular, most frequently bilobed, being divided by a mesial process; in rare cases (especially in *Bregmocerella*) this process is so large that it overlaps the lateral teeth limiting the notch, so that these teeth are only visible from the side. Mouth-parts strongly metamorphosed in the females. Maxillipeds with long lobes on fourth, fifth, and sixth joint. Exp. of plp.³ always two-jointed. Marsupial lamellæ always overlap each other at the mesial line.

(a) Epistome without any free process in front (exp. of urp. generally well developed).

(†) ¹Abdominal notch at least with a vestige of mesial lobe; generally this lobe is well-developed, frequently large or even very large.

(§) In the male the anterior part of abdomen is without mesial process, and the endp. of urp. is generally moderately developed.

(6) *Cymodoce* (Leach).

(§§) In the male the anterior part of abdomen has a large mesial process, and the endp. of urp. is very short or quite rudimentary.

(7) *Cilicæa* (Leach).

(††) Abdominal notch semicircular, without any vestige of mesial lobe. Endp. of urp. rudimentary in the male.

(8) *Cilicæopsis* (n. gen.).

(β) Epistome produced into a process which, in the female, reaches somewhat beyond the front margin of the antennulæ while it is exceedingly long in the male (Exp. of urp. rudimentary in

¹ In Chapter VII the slight value of *Cilicæa* (Leach) and *Cilicæopsis* (n. gen.) as separated from *Cymodoce* (Leach) is discussed in the treatment of the last-named genus.

both sexes. End of abdomen produced, with a deep groove below; the mesial lobe large, sub-triangular, its lateral walls bent downwards, so that the longitudinal groove is continued on the lower side of the process, while the two teeth—in *Cymodoce* constituting the lateral limits of the notch—are situated on the lower margins of abdomen at the base of the process, and quite invisible from above.)

(9) *Bregmocerella* (Hasw.).

The genus *Cassidinella* (Whitelegge), which is unknown to me, belongs probably to this section; in the following chapter it is mentioned in the treatment of the genus *Cymodoce*, and discussed as the tenth genus of the hemibranchiate *Sphærominæ*.

Group B. *Sphærominæ eubranchiatæ*.

This group comprises as many genera as group A, but the number of species is much less. Mouth-parts—excepting the metamorphosis in the females of several genera—and pleopods are very uniform in all points of importance; the end of abdomen is at least a little emarginate (*Cassidinopsis* (n. gen.)), but otherwise with a real notch or a tube or foramen connected by a slit with the end itself. The basal joints of the antennulæ afford sometimes a fine generic character. The thoracic legs are always simple, the two anterior pairs without prehensile hands, and in no case has any special equipment with natatory setæ or any sexual difference been observed; the strong thickening of some pairs in *Amphoroidea* is the most noteworthy feature discovered. In some genera, containing animals of moderate or considerable size, the rami of plp.⁴ and plp.⁵ are thick, of fleshy aspect, while they are thinner in small forms, but in all species the folds are well developed. An articulation on exp. of plp.⁴ could generally not be perceived, but it is very distinct in *Scutuloidea*; exp. of plp.⁵ is generally divided rather near the end, but this articulation is not always easily observed; this exp. has three bosses, two of which on the

second joint, but while the largest of them, which is a high protuberance, is situated on the lower surface of second joint, the others vary as to place. The arrangements for the brood differ greatly in various genera.

The character used for dividing all the genera of the group into two portions, viz. the absence or existence of an articulation of exp. of plp.³, is certainly practical, but scarcely very important; the two portions arising from this division can scarcely be considered natural sections. But on the other hand, it is impossible to give a better division, because at least three genera—*Cymodoce* (Peff.), *Amphoroidea* (M.-Edw.), and *Cassidinopsis* (n. gen.)—are not very closely allied either to each other or to the other genera. For these reasons I do not attempt to sub-divide this group into sections with names, while such division is most natural in the two other groups of the sub-family.

a. Exp. of plp.³ unjointed. (Not seen in *Næsicopea*, but this genus is closely allied to *Dynamene*.)

(*a*) Basal joint of antennulæ of usual shape, not expanded in a free plate.

(†) Urp. always with an exp. at least half as long as endp. and sometimes (in males) very elongate.

(§) Male with a pair of processes from sixth thoracic segment, its abdomen with a circular foramen (sometimes situated on a low cone) connected with the end by a short narrow slit; uropods have exp. much longer than endp.; no appendix masculina on endp. of plp.² Female without processes, abdomen with a foramen connected with the end either by a slit which is only somewhat narrower than, and not marked off from, the foramen, or by a quite linear slit; rami of urp. lamellar, subsimilar in length; mouth-parts exceedingly metamorphosed, marsupial lamellæ exceedingly large and the brood in the marsupium itself.

(1) *Dynamene* (Leach) (*Næsa* (Leach)).

(§§) Both sexes without processes on thorax, but the last abdominal segment with two blunt "processes situated one

behind the other"; the end of the posterior one, situated considerably above and a little beyond the end of abdomen, bears the respiratory circular foramen which is connected with the end by a long linear slit; urp. has exp. in both sexes styliform, narrowing towards the acute end, in the male more than twice as long as endp., curved, in the sub-adult female a little longer than endp., straight.¹

(2) *Næsicopea* (Stebb.).

(§§§§) Both sexes rather similar in aspect, without real processes; abdomen with a notch which is semicircular or oblong in the female, in the male narrow in the distal part, while the proximal part constitutes a transverse foramen; urp. sub-similar in both sexes, with the rami lamellar. Mouth-parts similar in both sexes; male with appendix masculina on endp. of plp.²; marsupial lamellæ overlap each other somewhat, but the propagation is unknown.

(3) *Dynamenella* (n. gen.).

(§§§§§) Both sexes similar, without processes. Distal part of abdomen somewhat produced, with the lateral walls bent strongly downwards and inwards, constituting a rather long tube open at both ends and with a slit on the lower surface; urp. similar in both sexes, rami lamellar, exp. considerably shorter than endp. Mouth-parts similar in both sexes; male with appendix masculina on endp. of plp.²; marsupial lamellæ overlap each other somewhat; the brood in an exceedingly large external pouch and in the marsupium.

(4) *Cymodocella* (Pfeff.).

(††) Urp. without exp., but endp. large, lamellar. Both sexes similar, without processes; end of abdomen with a semi-circular notch. Mouth-parts similar in both sexes; marsupial lamellæ overlap each other considerably, and the brood is developed in internal pouches.

(5) *Scutuloida* (Chilt.).

¹ The diagnosis is deficient, because mouth-parts and pleopods had been removed before my examination from the two specimens hitherto known, a female with rudimentary marsupial lamellæ and a male.

(β) Basal joint of antennulæ expanded, protruding as an exceedingly large, free, horizontal, angular plate in front of the head. Both sexes similar, without processes; end of abdomen with a semicircular or triangular notch; urp. with the rami well developed, lamellar. Especially fourth, fifth and sixth pairs of thoracic legs short and very thick, much thicker than the anterior pairs. Mouth-parts similar in both sexes; marsupial lamellæ as in Scutuloidea, but the propagation unknown.

(6) Amphoroidea (M.-Edw.).

(b) Exp. of plp.³ with an articulation rather near the end.

(a) Head of normal size. Basal joint of antennulæ has its distal posterior angle produced into an acute process lying close to the hind margin of second joint. Abdomen with a well-developed notch. Exp. of urp. about as large as or much larger than endp.

(†) Male without any mesial process on sixth thoracic segment. Female with the abdominal notch semicircular, the mouth-parts strongly metamorphosed (the mandibles coalesced with the head).

(§) Male has paired denticles in the abdominal notch, urp. strongly altered, with exp. very elongate, curved. Female has the brood in internal pouches.

(7) Paracerceis (n. gen.).

(§§) Male has a mesial lobe, but no paired denticles in the abdominal notch; urp. not much altered, their exp. straight. Female carries the brood in the marsupium itself.

(8) Cerceis (M.-Edw.).

(††) Male with a large mesial process on sixth thoracic segment. (Female unknown.)

(9) Haswellia (Miers).

β. Head small, narrow in proportion to largest breadth of thorax. Basal joint of antennulæ without process from the distal posterior angle. End of abdomen feebly emarginate.

Uropoda similar in both sexes; endp. laterally expanded, very much broader and a little longer than exp. Both sexes similar, without processes; female with normal mouth-parts and the brood in internal pouches.

(10) *Cassidinopsis* (n. gen.).

Group C. Sphærominæ platybranchiatae.

This group is sharply defined from the two preceding ones, but its twelve genera show much variation, not only in general aspect, but in several structural features. It is, however, not necessary to produce here a more detailed account of the differences, because the group is divided into four sections which are natural and sharply limited by a set of characters, and a perusal of the diagnoses of these groups may convey a sufficient idea on the points essential. It may be added that the arrangements for the development of the brood differ strongly in the sections, but the mouth-parts seem never to be metamorphosed in the female.

It is an interesting fact that some of the genera of the eubranchiate Sphærominæ comprise three or four and some of the hemibranchiate genera a large number of species, but each of the platybranchiate genera comprises at most two and the majority only one species hitherto described. Most of the genera are, besides, very rare in collections.

The characterisations of the four sections are given before the diagnoses of the genera in order to facilitate comparison.

(a) Section *Campecopeini*.—Body rather vaulted; thorax and abdomen not expanded laterally, without any row of short hairs on the lateral margin. Eyes well developed. The two proximal joints of the antennulæ fitted in excavations on the head and not expanded plate-like in front. Mandibles with the masticatory process well developed. Anterior pairs of legs without prehensile hands. Endp. of plp.¹ at most somewhat longer than broad. Both rami of plp.³ with long plumose setæ on their distal margin; exp. two-jointed. Plp.⁴ and plp.⁵ subsimilar in aspect, with their rami respiratory;

rami of plp.⁴ naked or with a few very short terminal setæ. Abdomen terminates in a notch (sometimes visible only from below). Marsupial lamellæ overlap each other somewhat at the mesial line.

(b) Section Monolistrini.—Body rather vaulted; thorax and abdomen not expanded laterally, without any row of short hairs on the lateral margin. Eyes wanting. The two proximal joints of the antennulæ fitted in excavations on the head, not expanded plate-like in front. Mandibles with the masticatory process well developed. First pair of legs simple; second pair in the male terminating in a prehensile hand. Endp. of plp.¹ very narrow, more than three times longer than broad. Both rami of plp.³ and of the following pairs without marginal setæ; exp. of plp.³ unjointed; endp. of all three pairs opaque, respiratory, while exp. is vitreous and at least not so well adapted for respiration. Abdomen without notch, posteriorly broadly rounded. Marsupial lamellæ very large; the brood in the marsupium itself.

(c) Section Cassidinini.—Body much or exceedingly depressed; thorax considerably or strongly expanded; margin of thorax, anterior part of abdomen, uropods and sometimes the two proximal joints of antennulæ constituting a nearly continuous border ciliated with a less or more conspicuous rim of short protruding hairs. Eyes well developed. The two proximal joints of the antennulæ with the anterior part protruding, visible from above in at least almost their whole length, frequently much expanded in front, depressed. Mandibles with masticatory process well developed. Anterior pairs of legs without prehensile band. Endp. of plp.¹ at least somewhat longer than broad, sometimes very narrow. Both rami of plp.³ with several plumose setæ on the terminal margin; exp. unjointed or two-jointed. Both rami of plp.⁴ and plp.⁵ without setæ, subsimilar in aspect, respiratory. Posterior margin of abdomen short; a real notch always wanting. Marsupial lamellæ wanting; the brood in a chamber formed by two external pouches (see p. 80).

(d) Section Ancinini.—Body depressed; thorax some-

what or considerably expanded, but a rim of marginal hairs feebly developed or wanting. Eyes at least discoverable. Antennulæ vary as to shape and insertion, but never fitted in excavations on the head. Mandibles without masticatory process.¹ First thoracic legs with a robust prehensile hand in both sexes; second legs in the female ambulatory, in the male terminating in a prehensile hand differing much in shape or size from that of first pair. Endp. of plp.¹ broader than long. Endp. of plp.³ with a few short terminal setæ, exp. with numerous long setæ. Exp. of plp.⁴ with or without marginal setæ; both rami of plp.⁵ without setæ. End of abdomen truncate or less or more triangular. Marsupial lamellæ overlap each other very considerably (at least in one of the genera, *Ancinella*, the brood is developed in an enormous external pouch and in the marsupium).

The section *Campecopeini* comprises two genera.

(a) *Epistome* considerably longer than broad, protruding in front as a rounded process visible from above. Second and third thoracic legs show peculiar sexual differences (see the notes below). Endp. of plp.¹ broader than long; endp. of plp.³ nearly as broad as long; exp. of plp.³ with the articulation rather near the end; endp. of plp.⁴ with a few very short terminal setæ. Urp. with both rami well developed. Marginal portion of abdomen visible from above. Last thoracic segment unarmed in both sexes. (Brood in internal pouches.)

(1) *Parasphæroma* (Stebb.).

(β) *Epistome* much broader than long, without any free frontal process, not visible from above. Second and third thoracic legs not showing sexual differences. Endp. of plp.¹ somewhat longer than broad; endp. of plp.³ much longer than broad; exp. of plp.³ with the articulation near the middle; endp. of plp.⁴ naked at the end. Urp. with exp. elongate and endp. wanting. Marginal portion of the wall of abdomen bent not only downwards but much inwards, not visible from above.

¹ Of the genus *Ancinus*, (M.-Edw.). I have only examined a dried specimen from the outside, but having dissected specimens of the two other genera, I think it allowable to draw up this diagnosis of the section.

Last thoracic segment unarmed in the female, in the male with a mesial process.

(2) *Campecopea* (Leach).

The section *Monolistrini* comprises three (probably four¹) genera closely allied to each other, but distinguishable by at least one practical character.

(a) Urp. consists of the sympod and an elongate movable exp.

(3) *Monolistra* (Gerst.).

(β) Urp. consists only of a very small oblong-triangular joint.

(4) *Cæcosphæroma* (Dollf.).

(γ) Urp. wanting.

(5) *Vireia* (Dollf.).

The section *Cassidinini* comprises four genera, three of which are exceedingly characteristic, while the fourth, *Chitinopsis* (Whitel.), has only sub-generic value.

(a) Seen from above, the epistome protrudes as a rather or very long process separating the antennulæ. Two proximal joints of the antennulæ considerably or exceedingly expanded in front of the head. Lobe of fifth joint of the maxillipeds rather long, proceeding only from the proximal part of its inner (front) margin (fig. 6 a). Endp. of plp.¹ oblong, but not fully twice as long as broad. Exp. of plp.³ two-jointed. Terminal margin of abdomen freely exposed, rounded without notch.

(†) Body rather broad. Two proximal joints of the antennulæ considerably expanded. Endp. of plp.¹ only somewhat longer than broad.

(6) *Cassidina* (M.-Edw.).

(††) Body oblong-oval. Two proximal joints of the antennulæ exceedingly expanded. Endp. of plp.¹ almost twice as long as broad.

(7) *Chitinopsis* (Whitel.).

¹ The genus *Spelæosphæroma* belongs probably to this section, but is omitted, as not only the animal, but the recently published description is unknown to me.

(β) Seen from above, the epistome protrudes as a broad but very short plate separating the antennulæ. Two proximal joints of the antennulæ protrude as a narrow rim in front of the head. Fifth joint of maxillipeds short and broad, with a low lobe occupying nearly the whole interior (front) margin and reaching its distal end. Endp. of plp.¹. about three times as long as broad at the base. Exp. of plp.³ unjointed. Terminal margin of abdomen freely exposed, sub-truncate.

(8) Cassidinidea (n. gen.).

(γ) Epistome very short, invisible from above. Two proximal joints of the antennulæ strongly expanded, forming a broad rim in front of the head; the inner margin of the expansion of one antennula touches that of the opposite antennula in the mesial line. Fifth joint of maxillipeds short, with a moderately developed lobe proceeding from the whole interior (front) margin. Endp. of plp.¹ exceedingly narrow, four times as long as broad. Exp. of plp.³ two-jointed. Terminal margin of abdomen completely surrounded by the very long endopods of the uropods; the end turned somewhat upwards, vaulted, with a longitudinal groove below, so that an aperture, visible from behind, is found between the margin of abdomen and the uropods. Body exceedingly flattened; the two proximal joints of the antennulæ, both rami of urp. and the lateral parts of the thoracic segments and of the anterior section of abdomen are strongly expanded, and their margin constitutes a continuous outline with the fringe of ciliæ very dense, regular, and conspicuous; head and last abdominal segment totally excluded from partaking in forming the outline of the animal.

(9) *Leptosphæroma* (Hilgendorf).

The section Ancinini comprises three genera, one of which is founded on a new form described in the notes below. The diagnosis of the genus *Ancinus* (M.-Edw.) is incomplete from want of material.

(a) Eyes conspicuous, dark. Antennulæ inserted on the front end of the head, their two proximal joints rather broad,

entirely visible from above. Epistome produced, reaching to the front margin of first joint of the antennulæ, separating these as a sub-quadrangular plate. Last segment of abdomen has the lateral part of the wall bent downwards and somewhat inwards, constituting near the end the sides of a groove; the end itself truncate. Urp. without endp., exp. long, slender.

(10) *Ancinus* (M.-Edw.).

(β) Eyes colourless; feebly developed. Antennulæ inserted on the front end of the head; their basal joint much produced; about as broad as long, depressed; entirely visible from above. Epistome produced into a triangular process, reaching about to the middle of the inner margin of the first antennular joint. Lobes on fourth, fifth, and sixth joints of maxillipeds very low. Exp. of plp.³ two-jointed. Plp.⁴ and plp.⁵ have their rami sub-similar; endp. of plp.⁴ with a single terminal seta; exp. of plp.⁴ without setæ; exp. of plp.⁵ with the bosses feebly developed, without spines. Last abdominal segment with the distal lateral part of the wall not bent inwards, the end narrowly rounded or nearly acute. Urp. has the sympod directed outwards and somewhat forwards, without endp.; exp. long, narrow. Male with the inner margin of endp. of plp.² much thickened, longitudinally canaliculated on the inner side, and appendix masculina is wanting.

(11) *Ancinella* (n. gen.).

(γ) Eyes well developed, black. Antennulæ inserted on the lower side of the head, their basal joint longer than broad, and quite concealed by the protruding front border of the head. Epistome reaches scarcely the middle of the inner margin of the basal joint of the antennulæ; its end is broadly rounded. Lobes of fourth, fifth, and sixth joints of maxillipeds long. Exp. of plp.³ unjointed. Exp. of plp.³ and plp.⁴ closely set with plumose setæ along their distal and outer margin. Endp. of plp.⁴ with a few plumose terminal setæ. Exp. of plp.⁵ without bosses. Last abdominal segment has not the distal lateral part of the wall bent inwards; the end

acute in the male, rather obtuse in the female. Urp. with both rami long, in the female sub-equal in length, in the male exp. is elongate, considerably longer than endp. Male with appendix masculina on endp. of plp.²

(12) *Tecticeps* (Richardson).

VII. NOTES ON THE GENERA AND THEIR SPECIES.

The genera are here dealt with in the same consecutive order as in the preceding chapter. As to the enumeration of the species I refer to the "Introductory Remarks."

Sub-family *Limnoriinæ*.

Limnoria (Leach).—The type is *L. lignorum* (Rathke). On the three other species known see Stebbing in 'Fauna Maldive and Laccadive Archip.,' vol. ii, p. 714.

Sub-family *Plakarthriinæ*.

Plakarthrium (Chilt.)—The type is *P. typicum* (Chilt.) Whether *P.* (*Chelonidium*) *punctatissimum* (Peff.) be a closely allied species or only a synonym I am unable to decide. Pfeffer published (1887) a very detailed, and as a whole useful account of his form, but some of his anatomical statements and morphological interpretations are incorrect, and his opinion on the systematic position of the genus is without foundation.¹

Sub-family *Sphærominæ*.

A. *Sphærominæ hemibranchiataæ*.

(1) *Sphæroma* (Bosc).—To the characters given above it may be added that in all species the end of abdomen, even if moderately narrow, is really rounded, not triangular or subacute; its marginal part, seen from below, shows scarcely any trace of a longitudinal mesial excavation, not to speak of a longitudinal groove as in *Isocladus*. According to my own examination the following species belong to this genus:

¹ Pfeffer establishes it as the type for a new family, and adds "Die Fa mili scheint mit den Onisciden am nächsten verwandt."

S. serratum (Fabr.), *S. rugicauda* (Leach), *S. Hooker* (Leach), *S. siciliense* (Leach), *S. trigonum* (Risso), *S. verrucauda* (White), *S. quadridentatum* (Say) (types or co-types of the six latter species in the British Museum), *S. Bolivari* (de Buen) (co-types from Canon A. M. Norman), *S. destructor* (Richardson) (co-types from U.S. Nat. Mus.), the latter, according to Stebbing, a synonym, as is also *S. vastator* (Bate), to *S. terebrans* (Bate); finally *S. marginatum* (M.-Edw.) (Copenhagen Museum). Of the other species described in the literature *S. chilense* (Dana) and *S. pentodon* (Richardson) seem to belong to this genus.

Most of the remaining very numerous species established in the literature as members of the genus *Sphæroma* belong to other genera. Some of them have been or must be referred to *Exosphæroma* (Stebb.), viz. *S. gigas* (Leach), *S. lanceolatum* (White), *S. leucura* (White) (types of these three species were seen in the British Museum), *S. Stimpsonii* (Hell.) (Copenhagen Museum), and probably *S. calcareum* (Dana); *S. scabriculum* (Hell.) is mentioned in the footnote on p. 102. *S. armatum* (M.-Edw.) has been established as type for the genus *Isocladus* (Miers), to which besides *S. spinigerum* (Dana) has been referred. *S. dicanthum* (Péron, M.-Edw.) must be a *Zuzara* (Leach); *S. integrum* (Hell.) is probably a species of *Zuzara* (Leach), or perhaps of *Isocladus* (Miers). Many species referred to *Sphæroma* are in reality females or immature specimens of the genus *Cymodoce* (Leach); according to typical specimens in the British Museum, *S. spongiosum* (White) is the female of an Australian *Cymodoce*, while *S. Prideauxianum* (Leach), *S. Dumerilii* (Leach), *S. Griffithsii* (Leach), *S. curtum* (Leach), and *S. spinosum* (Risso) belong to *Cymodoce truncata* (Leach), and the specimens of *S. Ritchianum* (Leach) to two species of *Cymodoce*; judging from descriptions or figures in the literature, *S. Lesueuri* (Risso), *S. graulatum* (M.-Edw.), *S. pubescens* (M.-Edw.), *S. Gaimardii* (M.-Edw.), and *S. yucatanum* (Richardson) have been established on females or young

males of animals belonging to *Cymodoce*. *Sphæroma gibbosum* (M.-Edw.) and *S. micracanthum* (Tristan, M.-Edw.) are young males of *Dynamene* (Leach), probably of *D. bidentata* (Mont.); *Sphæroma*? *egregium* (Chilt.) and *S. algoense* (Stebb.) must be referred to the genus *Cymodocella* (Pfeff.); *S. orientale* (Dana) is a young specimen of the genus *Cerceis* (M.-Edw.). *Sphæroma perforatum* (M.-Edw.) and *S. globicauda* (Dana) are probably species of *Dynamenella* (n. gen.); if not so, one of them is or both are to be referred to the same genus as *S. scabriculum* (Hell.) (see the footnote on p. 102). *Sphæroma Jurinii* (Sav.), *S. Savignii* (M.-Edw.), *S. tristense* (Leach), *S. anomalum* (Hasw.), *S. asperum* (Hasw.), *S. amplicauda* (Stimps.), *S. rhombura* (Richardson), *S. octoncum* (Richardson), *S. plumosum* (Whitelegge), and *S. latifrons* (Whitelegge) do not belong to *Sphæroma*, but I cannot refer them to genera, because the descriptions and figures are too defective in some respects. On *S. Quoyanum* (M.-Edw.), *S. oregonense* (Dana), *S. obtusum* (Dana), *S. lævinsculum* (Hell.), *S. triste* (Hell.), *S. læve* (Hasw.), *S. crenulatum* (Richardson), and *S. australe* (Whitelegge) I have no opinion.

(2) *Hemisphæroma* (n. gen.).—The type is *H. pulchrum* (n. sp.), of which I have seen an adult male and an immature female. To the diagnosis of the genus on p. 103 a short description of the species may be added. The epistome has a rather deep longitudinal groove and two pairs of marginal processes; first pair, placed near the middle of the margin, is low; second pair, situated near the proximal end, is rather long, vertical. Antennulæ essentially as in *Sphæroma*. The three anterior pairs of thoracic legs are moderately slender and furnished with a large number of exceedingly long stiff setæ along the whole outer margin of the long third joint and along the distal two thirds of the same margin of fourth joints, besides some rather long setæ on the most distal part of the outer margin of fifth joint. The three following pairs of legs are much shorter and more robust, seventh pair as

long as the second, rather slender and strongly compressed; all four pairs along the margins and on a portion of the sides very densely set with fine hairs; most of the marginal hairs long or exceedingly long. Last abdominal segment is broad behind, the posterior margin as a whole rather flatly convex with a very obtuse angle, but the tip of this angle is feebly produced, acute; the posterior margin is very broad on the lower surface, constituting a rather broad rim, which has a longitudinal mesial carina. The rami of the uropods similar in shape, reaching in the male completely, in the female scarcely, to the apex of abdomen. Length of the male 13.5 mm., of the female without marsupium 8.5 mm. Locality: Sourabaya, Java. Collected by Captain Andréa (Copenhagen Museum).

(3) *Exosphæroma* (Stebb.).—The genus has been established on *Sphæroma gigas* (Leach) and *S. lanceolatum* (White). In these species the end of abdomen is either rather convex, subangular, or constitutes an angle with the tip rounded; the terminal margin is, seen from below, rather sharp and the excavation containing the pleopods produced a little backwards, but no real longitudinal groove is formed. According to an examination of dried typical specimens of *Sphær. leucura* (White) in the British Museum this species must be referred to *Exosphæroma*; *Sphæroma Stimpsonii* (Hell.) (specimens in the Copenhagen Museum) belongs also to the present genus. Several of the nearly twenty species enumerated above as referred to *Sphæroma* by earlier authors, but whose systematic position I am unable to settle, will certainly prove themselves to belong to *Exosphæroma*. On the other hand, of the three species established in 1902 by Stebbing as species of *Exosphæroma*, *E. validum* (Stebb.) is the immature male and *E. setulosum* (Stebb.) the female of the same species of *Cymodoce*, while *E. amplifrons* (Stebb.) is the adult male of an aberrant species of *Cymodoce* (see below under this genus).

(4) *Isocladus* (Miers).—The genus comprises two closely allied species, *I. armatus* (M.-Edw.) and *I. spiniger*

(Dana), both originally referred to *Sphæroma*. *Sphæroma integrum* (Hell.) may perhaps be an *Isocladus*, but more probably it is a species of *Zuzara* (Leach).

(5) *Zuzara* (Leach).—According to my examination of types in the British Museum and animals received from Dr. Chilton, *Zuzara semipunctata* (Leach), *Z. diadema* (Leach), *Z. integra* (Hasw.), and *Cycloidura venosa* (Stebb.) belong to this genus, while *Zuzara emarginata* (Hasw.) must be referred to the genus *Haswellia* (Miers). *Sphæroma integrum* (Hell.) is probably a species of *Zuzara*, perhaps an *Isocladus*; *Cymodoce armata* (M.-Edw.) has been transferred to *Zuzara* by Haswell, but this reference seems to me to be rather dubious.

(6) *Cymodoce* (Leach).—This genus, *Cilicæa* (Leach) and *Cilicæopsis* (n. gen.) are very closely allied; *Cassidinella* (Whitelegge), which is imperfectly described as to one of the most important features and unknown to me, belongs probably to the *Cymodocini*, and if so it is scarcely distinguishable from certain forms of *Cymodoce*. The male of *Cymodoce*, *Cilicæa*, and *Cilicæopsis* are easy to separate, but the females of *Cymodoce* cannot be distinguished from those of *Cilicæa*; in adult females of certain species of *Cymodoce* the mesial lobe of the notch is scarcely distinguishable, and the notch therefore rather similar to that in *Cilicæopsis*, but the females of the latter genus differ in aspect from those of *Cymodoce* and have the end of the exopod of urp. produced and very acute, a feature not observed in *Cymodoce*. It might perhaps have been advisable to cancel *Cilicæa* and not to establish *Cilicæopsis*, thus including all species of hemibranchiate *Sphærominæ* possessing an abdominal notch—*Bregmocerella* excepted—in the genus *Cymodoce*. But, on the other hand, it is always difficult to suppress a genus as a mere synonym, when it comprises a certain number of species, and is allied to another very rich genus: if *Cilicæa* be suppressed the genus *Cymodoce* will be extremely large. When *Cilicæa* is maintained it is necessary to establish *Cilicæopsis*, and in the future two or three new genera of similar quality must be erected.

But after the removal of *Cilicæa* and *Cilicæopsis* the genus *Cymodoce* comprises still a very good number of species described in the literature, and, according to my experience, numerous undescribed species from the Indian Ocean and the Pacific (from Japan to Australia) are found in various European collections. I propose, therefore, to accept *Cilicæa*, and consequently to establish *Cilicæopsis*, but to consider both these genera—and probably *Cassidinella*—as having only sub-generic value.

The genus *Cymodoce* and its sub-genera are exceedingly difficult to deal with. The difference between adult species of the two sexes is generally very large; the adult males are adorned with tubercles, bosses, or processes, which are wanting or low in the females; when a mesial lobe is present the abdominal notch differs considerably in shape in the two sexes; finally, the uropods show nearly always striking sexual differences. In the females the rami of the uropods are plate-shaped, often nearly similar in size and shape, but sometimes the exp. is rather small, in rare cases even very small; in the male the exp. is frequently elongate, sometimes very long, while the endp. either has preserved the same size as in the female and immature specimens, or has been reduced in size, or is even quite rudimentary. Several females or immature specimens have been established as species of *Sphæroma*, while the males were described as forms of *Cymodoce* or *Cilicæa*.

From the coasts of England, France, Italy, and Tripoli I found in the British Museum animals belonging to the genus *Cymodoce* labelled with the following names: *C. truncata* (Leach), *C. Lamarchii* (Leach), *C. emarginata* (Leach), *Sphæroma Dumerilii* (Leach), *Sph. Ritchianum* (Leach), *Sph. Prideauxianum* (Leach), *Sph. curtum* (Leach), *Sph. Griffithsii* (Leach), *Sph. tridens* (Spinola), *Sph. spinosum* (Risso), *Cymodoce spinosa* (White); furthermore, H. Milne-Edwards establishes *C. pilosa* from the Mediterranean. But at least *C. truncata* (Leach), *S. Dumerilii*, *S. Prideauxianum*, *S. curtum*, *S. Griffithsii*, *S. tridens*, and *S. spinosum* belong to the same species,

for which I—at least provisionally—apply the name *C. truncata* (Leach); some specimens of *S. Ritchianum* and one of the specimens of *C. Lamarchii* belong besides to *C. truncata*, while other specimens referred to the two last-named forms are identical with *C. pilosa* (M.-Edw.); on *C. emarginata* (Leach) I shall not express an opinion. *Sphæroma Lesueuri* (Risso) has been transferred to *Cymodoce* by M.-Edwards, and I suppose it to be correct; it is probably an immature specimen of one of the Mediterranean species. Gourret has established two species from the Mediterranean of *Dynamene*, *D. corallana*, and *D. setosa*, but according to the shape of maxillipeds and abdominal notch, they are females of *Cymodoce*. I am acquainted with three European species, but the sum of these statements shows that it will be a most difficult task to name them correctly, and an attempt must be postponed.

In the British Museum I saw besides typical specimens (or co-types) of the following species correctly established as forms of *Cymodoce*, viz. *C. bifida* (Leach), *C. trilobata* (Miers), *C. longistylis* (Miers), *C. convexa* (Miers), *C. aculeata* (Hasw.), *C. coronata* (Hasw.), and *C. granulata* (Miers). (The last-named form is similar to *Cerceis trispinosa* (Hasw.) in the shape of first joint of the antennulæ, surface of thorax and abdomen, shape of seventh thoracic epimera, which are produced and curved as a hook with the apex turning upwards, shape of the abdominal notch and uropoda, but it differs sharply from *Cerceis trispinosa* in the structure of plp.,⁴ and certainly of plp.⁵: according to kind communication from Dr. W. T. Calman—who at my request examined several details of a male from Flinders Isl.—the exp. of plp.⁴ is sub-membranaceous, not plicated as in the named species of *Cerceis*, of which I have examined specimens from Port Victoria forwarded me by Dr. Chilton.) In the same Museum I saw the type of *Sphæroma spongiosum* (White) and specimens of *Sphæroma Gaimardii* (M.-Edw.), both referred correctly to *Cymodoce* by Miers. *Cymodoce abyssorum* (Bedd.) has with good reason been

established by Stebbing of the type for a new genus, *Næsicopea*, which belongs to the eubranchiata *Sphærominæ*. Among the species not seen by me, *Cymodoce tuberculosa* (Stebb.), *C. uncinata* (Stebb.), and *C. bicarinata* (Stebb.) have been correctly referred. *Cym. armata* (M.-Edw.) has been transferred to *Zuzara* by Haswell, but this reference is, in my opinion, rather dubious, though I cannot offer any better interpretation. Above it is mentioned that *Exosphæroma validum* (Stebb.) and *E. setulosum* (Stebb.) are respectively the young male and the female of a species of *Cymodoce*. *Exosphæroma amplifrons* (Stebb.), of which I have inspected a fine typical specimen kindly forwarded me by Mr. Stebbing, is the male of an interesting species of *Cymodoce*; in the shape of the terminal part of abdomen it is much alike to *Bregmocerella*, but it differs from this genus and agrees with *Cymodoce* as to the number of spiniferous protuberances on exp. of plp.⁵, and the exp. of urp. is as large as the endp. Judging from the descriptions in the literature Haswell has correctly referred *Sphæroma pubescens* (M.-Edw.) to *Cymodoce*, and above it is mentioned that *Sphæroma granulatum* (M.-Edw.) and *S. yucatanum* (Richardson) must be transferred to the same genus. Of the other forms established in the literature as species of *Cymodoce*, *C. bidentata* (Hasw.), *C. tuberculata* (Hasw.), and *C. inornata* (Whitelegge) belong probably to this genus, while *C. bermudensis* (Ives), according to my examination of specimens from the U. S. National Museum, is the female (and immature male) of a species of *Paracerceis* (n. gen.) (belonging to the eubranchiata *Sphærominæ*). *Cilicæa linguicauda* (Richardson) is probably, *Cil. granulosa* (Richardson) perhaps, a species of *Cymodoce*; both differ from the other species of the last-named genus in having the endp. of urp. very short. The description of *Cymodoce cordiforaminialis* (Chilton) I have not seen, but judging from the name the species can scarcely belong to the present genus.

(7) *Cilicæa* (Leach).—The type is *C. Latreillei* (Leach).

Specimens in the British Museum of *Cil. crassa* (Hasw.) and *Cil. tenuicaudata* (Hasw.) show that these species have been correctly referred; according to Haswell's descriptions of the abdominal notch, the same is the case with *Cil. crassicaudata* (Hasw.), *Cil. hystrix* (Hasw.) and *Cil. curtispina* (Hasw.), while I am unable to decide whether *Cil. spinulosa* (Hasw.) belongs to *Cilicæa*, or to the following sub-genus *Cilicæopsis*. The three species established by Whitelegge as belonging to *Cilicæa* are dealt with under *Cilicæopsis*. According to the examination of specimens forwarded me by Dr. Chilton, *Næsa canaliculata* (Thoms.) belongs to *Cilicæa*. On the other hand, *Cilicæa caudata* (Say) (originally established as a *Næsa* by Say, but referred to *Cilicæa* by Harriet Richardson) and *Cilicæa caudata* (Moore) are species of *Paracerceis* (n. gen.); *Cilicæa caudata* Gilliana (Richardson), and *C. cordata* (Richardson) are certainly also species of *Paracerceis*.

(8) *Cilicæopsis* (n. gen.).—As the type I take *Cilicæa granulata* (Whitelegge); from the East Indian and Australian regions I have seen some unnamed species more or less allied to that form. Whitelegge describes and figures two aberrant species established on males, *Cilicæa styliifera* (Whitel.), and *C. ornata* (Whitel.), which differ strongly from *C. granulata* (Whitel.) as to the shape of the upper side of abdomen, but agree with it in possessing a semicircular abdominal notch and rudimentary endp. of urp., while exp. of urp. is extremely elongate; I think that these two species can be referred to *Cilicæopsis*, but without an examination of any of them, or, at least, of closely-allied species, I cannot decide the question.

(9) *Bregmocerella* (Hasw.).—Only one species, *B. Grayana* (Woodw.), is known; it has been described by Woodward, Haswell, Beddard, and Whitelegge, and figured by the two first-named of these authors. It is in reality, in spite of its aberrant aspect, closely allied to *Cymodoce*. To the characters pointed out on pp. 104, 105, may be added that exp. of plp.⁵ has not only the three usual protuberances, but besides a protuberance at the inner margin somewhat before

the end of the first joint; this protuberance is wanting in even very large species of *Cymodoce* examined for comparison. The shape and number of the entrances to pouches with brood are mentioned on p. 76.

(10) *Cassidinella* (Whitelegge).—This genus has been established on a single male specimen. In the diagnosis the author writes: "Pleopoda foliate; all except the last pair densely ciliate." If that be correct, the genus must belong to the platybranchiate *Sphærominæ*, and besides disagree with these as to plp.⁴; according to the sentence quoted plp.⁴ and plp.⁵ would even agree with those in *Limnoria* and differ from all *Sphærominæ*. But his eight figures of the typical species, *C. insisa* (Whitel.), show an animal which is rather alike to two unnamed forms seen by me and belonging to *Cymodoce* (sens. lat.); in reality, antennulæ, mandibles, maxillipeds, thoracic legs, and end of abdomen do not show any difference; exp. of urp. is several times smaller than endp., but in one of the species alluded to the exp. is still smaller; the upper surface of abdomen has no processes, but this character is of slight value, and processes are, besides, not found in males of all species of *Cymodoce*. Judging from these facts, I insert *Cassidinella*, at least provisionally, on this place.

B. *Sphærominæ eubbranchiatæ*.

(1) *Dynamene* (Leach) (*Næsa* (Leach¹)).—The type is *D. bidentata* (Mont.). Leach established the genus *Næsa* on the adult male of this species, while *D. viridis* (Leach), *D. Montagui* (Leach), and *D. ruber* (Mont.) are the female and immature specimens of the same species; above it is mentioned that *Sphæroma gibbosum* (M.-Edw.) and *Sphærom. micracanthum* (Tristan) are young males of *Dynamene*, probably even of *D. bidentata*. Hesse established (1873) nine new species of *Næsa* from the western coast of France, but they are probably all unrecognisable and are

¹ As to the synonymical question on the use of either *Dynamene* or *Næsa* for the present genus, I refer to the footnote on p. 77.

omitted here. Gourret established (1891) on females two new species of *Dynamene*, viz. *D. corallana* and *D. setosa* from the southern coast of France, but according to kind information from the zoological authorities at the Museums in Marseille his typical specimens could not be found; judging from the shape of the maxillipeds and the abdominal notch, the animals are females of the genus *Cymodoce*, and the descriptions and figures given by him will scarcely allow recognition of the species. It may be added that I am acquainted with males and females of two fine species from the Mediterranean; one of these constitutes as to the situation of the respiratory foramen to a certain degree a transition stage to the genus *Næsicopea* (Stebb).

Of exotic species referred to *Næsa* no one belongs to the present genus. *Næsa caudata* (Say) I take as the type for the genus *Paracerceis* (n. gen.); *Næsa ovalis* (Say) is my type for *Cassidinidea* (n. gen.) belonging to the platybranchiate Sphærominæ; *Næsa canaliculata* (Thoms.) is, as mentioned above, a species of *Cilicæa* (Leach); *Næsa depressa* (Say) is the type for the genus *Ancinus* (M.-Edw.). Of exotic species referred to *Dynamene* scarcely any one can remain in this genus. *D. Eatoni* (Miers), established on immature animals, seems to be a species of *Dynamenella*. According to kind information from Dr. Calman, *D. Darwinii* (Cunningham) has exp. of plp.³ divided by an articulation; the species must, in my opinion, be established as a new genus near *Paracerceis*. *Dynamene perforata* (Moore) I establish as the type for *Dynamenella* (n. gen.); *Dynamene bermudensis* (Ives) is, according to my examination of specimens from the U. S. National Museum, females of a species of *Paracerceis* closely allied to *P. caudata* (Say); *Dynamene angulata* (Richardson), *D. Benedictii* (Richardson), and *D. glabra* (Richardson) are probably females and immature specimens either of *Dynamenella* or *Paracerceis*, but as the structure of the pleopods, etc., is unknown it is, of course, impossible to refer them to genera with certainty. On *D. tuberculosa* (Richardson) I have no

opinion, and *D. dilatata* (Richardson) must, judging from the aberrant shape of the antennulæ, probably be established as the type for a new genus.

(2) *Næsicopea* (Stebb.).—The type is *Cymodocea abyssorum* (Bedd.).

(3) *Dynamenella* (n. gen.).—As the type I take *Dynamene perforata* (Moore), of which I have examined an adult male and an immature male from the U. S. National Museum. Besides, I have seen specimens of two undescribed species, respectively from St. Thomas and Valparaiso. On other forms perhaps belonging to this genus see my notes on *Dynamene*. Above (p. 117) it is stated that *Sphæroma perforatum* (M.-Edw.) and *Sph. globicauda* (Dana) are not improbably species of *Dynamenella*.

(4) *Cymodocella* (Pfeff.).—The genus has been established on *C. tubicauda* (Pfeff.). I have examined specimens from Dr. Chilton of his *Sphæroma? egregium*. The two species are identical, and the type must, therefore, be named *C. egregia* (Chilt.). According to description and figures *Sphæroma algoense* (Stebb.) belongs to the same genus.

(5) *Scutuloidea* (Chilt.).—Only the typical species, *S. maculata* (Chilt.), is known.

(6) *Amphoroidea* (M. Edw.).—This beautiful and easily recognisable genus was established on *A. typa* (M. Edw.). Two other species have been described, viz. *A. australiensis* (Dana) and *A. falcifer* (Thoms.).

(7) *Paracerceis* (n. gen.).—The type is *P. caudata* (Say), referred by Say, Milne-Edwards, and White to the genus *Næsa* (Leach), by Ives to *Cymodocea* (Leach), by Moore and Harriet Richardson to *Cilicæa* (Leach). According to examination of a typical specimen from Say in the British Museum, material from Cuba in the Copenhagen Museum, and specimens from Florida sent me by U. S. National Museum, at least some of the specimens referred by American authors to *P. caudata* (Say) belong to an unnamed and closely allied species. *Dynamene bermudensis* (Ives) is (see my notes on *Dynamene*) a female of that new species.

Cilicæa cordata (Richardson) and *Cil. caudata* Gilliana (Rich.) are certainly males of species of *Paracerceis*; on some forms established by H. Richardson as species of *Dynamene* I refer to the notes on this genus.

(8) *Cerceis* (M.-Edw.).—*C. tridentata* (M.-Edw.) is the type; according to my study of a rich material of this genus the species named is a male, while *C. bidentata* (M.-Edw.) is the female, either of the same or of a closely allied species. To this genus belong besides *C. trispinosa* (Hasw.) (I have examined specimens from Dr. Chilton) and *C. acuticauda* (Hasw.), but the reference of *C. nasuta* (Whitelegge) is doubtful, the basal joint of the antennulæ, the abdominal notch, and the pleopoda being imperfectly known. *Sphæroma orientale* (Dana) is a young specimen of *Cerceis*. This genus is closely allied to *Paracerceis* and *Haswellia*; at least at present I am not able to point out reliable difference in the structure between the females of *Paracerceis* and *Cerceis*, but, as already mentioned, *Paracerceis* has the brood in internal pouches, *Cerceis* in the marsupium itself; the females of *Haswellia* are unknown. It may be mentioned that the outer margin of exp. of plp.² is coarsely serrate in *Paracerceis caudata* (Say) and at least in some species of *Cerceis*, but in *C. trispinosa* (Hasw.)—which besides in the shape of the abdominal notch occupies a rather isolated position—serration is visible only at the end of the margin and even feebly developed.

(9) *Haswellia* (Miers) (*Calyptura* (Hasw.)).—The type is *H. carnea* (Hasw.), of which only the male is known. According to the examination of a male (forwarded me by Dr. Chilton) of *Zuzara emarginata* (Hasw.), this species must be transferred to *Haswellia*; in *H. carnea* the long plate from seventh thoracic segment is broad in the whole length, while in *H. emarginata* only the proximal third of the process is plate-shaped, the long distal part narrow. Of *H. carnea* I have examined two adult and two immature males (all from Dr. Chilton); the adult males measure respectively 10·4 and 8·5 mm., the immature speci-

mens 8.0 and 6.4 mm. in length ; in these two young specimens the processes at seventh thoracic sternite are very short, but yet distinct, while no trace of appendix masculina on endp. of plp.² could be perceived in any of them. These immature specimens resemble *Cymodoce* in general aspect ; in both seventh thoracic tergite has a broad but very short protuberance as a rudiment of the plate in the adult male ; in the larger of these two specimens the mesial process of the abdominal notch is broadly triangular and reaches beyond the lateral angles of the notch, but in the smaller specimen the notch is almost rectangular, with the basal margin a little convex, the mesial lobe being very low. Judging from these features, I suppose that the notch in the adult female be rounded as in the two preceding genera.

10. *Cassidinopsis* (n. gen.).—The type is *Cassidina emarginata* (Guér.), which in many important points—structure of plp.⁴ and plp.⁵, shape of epistome, mandibles, fifth joint of maxillipeds, end of abdomen—differs strongly from the type for the genus *Cassidina*, *C. typa* (M.-Edw.). *C. latistylis* (Dana) has generally been referred to *C. emarginata* as a synonym, but Dana's figure of the end of abdomen does not agree well with the shape observed in *C. emarginata*; a detailed account of this species is given by Pfeffer (1887). No other species referred to *Cassidina* belongs to *Cassidinopsis*.

C. Sphærominæ platybranchiatæ.

1. *Parasphæroma* (Stebb.).—The type is *P. prominens* (Stebb.). I have examined two females with brood in internal pouches ; they are co-types kindly forwarded me by Mr. Stebbing, who describes and figures a male specimen. The two abdominal protuberances are scarcely as high in the female as in the male ; the exp. of urp. has the outer margin convex in almost more than three quarters of its length, but its distal fourth is more concave than on Mr. Stebbing's figure, so that the apex of the ramus is less produced, but directed

more outwards than in the male. In the female third thoracic legs are about as slender as fourth legs, and without brushes on any joint, while in the male third to sixth, and especially third to fifth, joints are conspicuously thicker than in the female, and third to fifth densely clothed with brushes of short hairs on their lower surface. Second legs are in the female only a little shorter and thicker than third, and their fifth and sixth joints have a few scattered spines; in the male (according to Stebbing's figure) fourth to sixth joints are much thicker, fifth and sixth with a peculiar armament. First legs are similar in both sexes. No other species is known.

(2) *Campecopea* (Leach).—The type is *C. hirsuta* (Mont.); *C. Cranchii* (Leach) is the female of the same species. In certain features, viz., the shape of epistome and uropods, the marginal part of abdomen being bent inwards, etc., it constitutes to a certain degree a transition to *Monolistra*. White referred *Næsa ovalis* (Say) to this genus, but I take *N. ovalis* as the type for *Cassidinidea* (n. gen.). *Camp. bicolor* (Rathke) (referred incorrectly by Milne-Edwards to *Næsa*) and *C. versicolor* (Rathke) (referred by Milne-Edwards to *Cymodoce*) cannot remain in *Campecopea*, but I have no opinion on their real relationship.

(3) *Monolistra* (Gerst.).—The type is *M. cæca* (Gerst.). From the Berlin Museum I received an adult male of this species and besides an immature male of an undescribed form. According to kind information from Dr. Joh. Thiele the female of *M. cæca* has second thoracic legs simple, without prehensile hand.

(4) *Cæcosphæroma* (Dollf.).—The type is *C. Vireia* (Dollf.), of which I have seen a single specimen, kindly presented me by Mr. A. Viré. As to this form and the two species of the following genus the reader is referred to a future paper by Mr. A. Dollfus.

(5) *Vireia* (Dollf.).—To this genus Mr. Dollfus refers two species, *V. burgunda* (Dollf.) and *V. berica* (Fabiani). (See the future paper by Mr. Dollfus).

(6) *Cassidina* (M.-Edw.).—The type is *C. typa* (M.-Edw.),

apparently not recognised by any zoologist since it was established in 1840. Among numerous marine animals from Akaroa Harbour, New Zealand, I found several specimens of a species of Cassidina, determined it as *C. neo-zealanica* (Thoms.), examined its structure, and worked out a set of analytical figures. When I, more than a year after, studied the literature on Sphæromidæ and looked on the figures given by Milne-Edwards in 1840, I was struck by the similarity as to certain points between these and my own drawings. I was speedily convinced that *C. neo-zealanica* must be either a species closely allied to *C. typa* or only a synonym. Professor E. L. Bouvier kindly lent me a specimen of *C. typa* marked "Type, Ouoy and Gaimard, Nouv. Zélande"; it agrees completely with my specimens of *C. neo-zealanica*, and the latter name must therefore be considered a synonym. It may be added that the mandibles are unusually short and peculiarly bent. Besides *C. typa* and *C. neo-zealanica* five other species have been referred to Cassidina. *C. emarginata* (Guér.) differs strongly from *C. typa* in epistome, antennulæ, mandibles, maxillipeds, and pleopods; it is established above as the type for *Cassidinopsis* (n. gen.) belonging to the eubranchiate Sphærominæ. *C. latistylis* (Dana) is with a little doubt considered a synonym to *C. emarginata*. *C. maculata* (Studer) cannot remain in Cassidina if Studer's figure, showing the proximal joints of the antennulæ as invisible from above, be tolerably correct, but as to the real relationship of this species I have no opinion. *C. lunifrons* (Richardson) must probably be referred to *Cassidinidea* (n. gen.) (see below). *C. laticauda* (Whitelegge) differs, according to description and figures published by that author, in shape of epistome, palps of maxillipeds, and rami of plp.¹ strongly from *C. typa*; it must therefore be removed from Cassidina and is very remote from *Cassidinidea* (n. gen.), but in spite of the lengthy description with five figures—occupying three pages—it is impossible for me to refer this species, not only to any genus, but to any section or group of the Sphærominæ.

The result is that of seven species referred to the genus *Cassidina* (M.-Edw.) at least one, and probably two, must be cancelled as synonyms, while the five others, having only a broad body and a reduced exopod of the uropods in common, must be referred to at least four genera, and two of these, established respectively in 1887 and 1901, have been so imperfectly described that reference to genus or to group of genera is impossible. This state of things illustrates excellently the confusion arising from extreme want of guiding principles of investigation, etc., in the study of the family.

(7) *Chitinopsis* (Whitelegge).—The type is *C. spatulifrons* (Whitel.), of which I have not seen any specimen. No other species has been established, but I have inspected a new form allied to the type. The two species have a curious aspect, but the genus is in reality so closely allied to *Cassidina* that it can only be considered a sub-genus, and ought perhaps to be cancelled. It seems to be impossible to find any character of some importance; the characters used in the conspectus are, I hope, tolerably practical.

(8) *Cassidinidea* (n. gen.).—This genus is established on *Næsa ovalis* (Say). In the British Museum I saw three specimens presented by Thomas Say; the Copenhagen Museum possesses a few specimens from Grenada, and one specimen from Cincinnati. *Cassidina lunifrons* (Richardson) belongs probably to the same genus; according to a figure published by Miss Richardson, it is very closely allied to *N. ovalis*, if it may be assumed that a portion of the basal joint of both antennulæ in reality is the front end of the broad epistome. It may be useful to add a few notes on *C. ovalis*, as nothing has been published on this species since the description of Say in 1878. An adult female measures 6 mm. in length and 3.3 mm. in breadth; judging from Miss Richardson's figure, *C. lunifrons* is proportionately a little broader, and its head somewhat broader than in our species. The body is very depressed, its upper surface grey-mottled with brown and dark brown. The epistome is a little more than twice as broad as long at the mesial line,

its anterior part is broad, cut off transversely, and protrudes as a narrow transverse band in front of the head. The two proximal joints of the antennulæ somewhat depressed, oblong, with the margins sub-parallel; third joint slender, as long as the first; flagellum five-jointed. Uropods about as in *C. lunifrons* (compare Miss Richardson's figure). The single male seen is adult, a little smaller than the female, but the uropods are proportionately a little broader. In both sexes the end of abdomen is cut off transversely.

(9) *Leptosphæroma* (Hilgendorf).—The type is *L. Gottschei* (Hilg.), of which I received three typical specimens from the Berlin Museum. No other species referable to this interesting genus has been described, but I have seen specimens of a new, very small form from Singapore. The genus shows in aspect a certain similarity to *Plakarthrion* (Chilt.), but the agreement is, however, only superficial, which is easily seen by a perusal of the diagnoses of the sub-families *Sphærominæ* and *Plakarthriinæ*.

(10) *Ancinus* (M.-Edw.).—The type is *A. depressus* (Say), referred by Say to the genus *Næsa* (Leach). The British Museum possesses a single exsiccated specimen presented by Thomas Say; in 1902 I examined its external structure. The figures (Pl. XXXII, figs. 17–20) in H. Milne-Edwards' 'Hist. Nat. Crust.' convey a rather good idea of the outline of the animal and of the shape of the hands of first and second legs of the male. The specimen named seems to be the only one existing in any zoological Museum; at least, I have asked for material of this form in Paris and in American Museums, but with negative result. No other species is known.

(11) *Ancinella* (n. gen.).—This interesting genus I establish on a new species, *A. profunda* (n. sp.), of which a large number of specimens were found in bottom material secured by Dr. Joh. Schmidt in 1904 during the cruise of "Thor," the Danish ship in the service of the International Commission for marine investigations. The locality is lat. 61° 15' N., long. 9° 35' W., 900 meter. As supplement to the diagnosis of the genus a short description of the species may be inserted here.

The body is much depressed, similar in both sexes; an adult female measures 4.5 mm. in length and 2.8 mm. in breadth, broadest at the end of thorax; the largest females are a little larger than the males. Third joint of antennulæ is very slender, as long as the sum of the two proximal joints. Prehensile hand of first thoracic legs large, oblong-oval, in the male a little longer and narrower than in the female; prehensile hand of second legs in the male very much smaller than that of first pair, but rather similar in shape; the "claw" as long as the hand. Last abdominal segment triangular, at the base less broad than the broad but very short anterior part of abdomen; the upper side of the last segment with a raised semicircular ridge sub-parallel with the lateral margin and at the mesial line a little longer from the end than from the anterior margin; parallel with and rather near the whole lateral and posterior margin a sublinear impression is found; the margin itself is finely serrate. Exp. of urp. reaches slightly beyond the abdomen; it is rather narrow, flat, especially on its outer margin finely serrate; the end is bifid, its inner process several times smaller than the outer.

(12) *Tecticeps* (Richardson).—The type is *T. alaskensis* (Richardson); a few years after the same author established a second species, *T. convexus*. The U. S. National Museum has favoured me with several specimens from the same locality ("Albatross," Stat. 3307), labelled *T. alaskensis*. At a closer examination the majority turned out to be males, but two of them adult females. In the male second thoracic legs terminate in a rather small prehensile hand; the sixth joint ("propodus") is oblong, with a short process on the lower side at the broader base; seventh joint, which is adduced along the lower margin of the sixth, is rather considerably longer than the latter and besides sinuate; sixth joint of seventh thoracic legs is considerably longer and thicker than the corresponding joint of sixth legs, and its proximal half is somewhat curved; the end of abdomen is acute and exp. of urp. considerably longer than endp. In the female second legs are simple as third pair; sixth joint of seventh legs is

slightly shorter and a little more slender than that of sixth pair; the end of abdomen is rather obtuse, and exp. of urp. not longer than endp. But while these remarks on seventh thoracic legs, end of abdomen, and urp. agree well with Miss Richardson's description of *T. alaskensis*, my remarks on the female agree with description and figures of *T. convexus*; the latter species must, therefore, be cancelled as established on females of *T. alaskensis*. The male is, besides, larger than the female; in Miss Richardson's paper some differences between length of antennulæ and antennæ in the two "species" are noted; a difference in the place of the eyes is also mentioned. The eyes are nearly equal in size in the two sexes and they occupy exactly the same place, but the area between the front end of the eyes and the anterior margin of the head is broader in the male than in the female.

EXPLANATION OF PLATE 7.

(1) *Cymodoce pilosa* (M.-Edw.).

Mouth-parts of an adult male (small specimen); all $\times 18$.

FIG. 1 *a*.—Left mandible, from below.

FIG. 1 *b*.—Distal half of same mandible, obliquely from below and from the inner side.

FIG. 1 *c*.—Left maxillula, from below.

FIG. 1 *d*.—Left maxilla, from below.

FIG. 1 *e*.—Left maxilliped, from below.

FIG. 1 *f*.—Hypopharynx (paragnatha), from below.

(2) *Cymodoce pilosa* (M.-Edw.).

Mouth-parts of an ovigerous female (specimen of about the same size as the male shown in figs. 1 *a*-1 *f*); all $\times 18$: same enlargement as in the male.

FIG. 2 *a*.—Left mandible, from below.

FIG. 2 *b*.—Left maxillula, from below.

FIG. 2 *c*.—Left maxilla, from below.

FIG. 2 *d*.—Left maxilliped, from below.

FIG. 2 *e*.—Hypopharynx, from below.

(3) *Dynamene bidentata* (Mont.).Mouth-parts of an adult male, all seen from below; $\times 35$.FIG. 3 *a*.—Left mandible.FIG. 3 *b*.—Left maxillula.FIG. 3 *c*.—Left maxilla.FIG. 3 *d*.—Left maxilliped.(4) *Dynamene bidentata* (Mont.).Mouth-parts of an ovigerous female, seen from below; all $\times 38$, thus nearly the same enlargement as in the male.FIG. 4 *a*.—Left mandible; the dotted line indicates the outer margin of the mandible situated beneath the firm skin by which the mandible is united with the head.FIG. 4 *b*.—Right mandible.FIG. 4 *c*.—Left maxillula.FIG. 4 *d*.—Left maxilla.FIG. 4 *e*.—Left maxilliped.(5) *Hemisphæroma pulchrum* (n. gen., n. sp.).FIG. 5 *a*.—Left mandible of an immature female, seen obliquely from the inner side and from below; $\times 24$.(6) *Cassidina typa* (M.-Edw.).FIG. 6 *a*.—Left maxilliped, from below; $\times \frac{2.5}{2}$.