

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 *Plakarthrium* 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 *Cæcosphæroma* (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 *Cymodocella* 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 clypeus, and rarely fused with the upper surface