XL.—TWO NEW SAND-DWELLING ISOPODS FROM THE MADRAS SEA-SHORE.

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Contents.

I. Introduction.

The microfauna living in the wet sand of freshwater and marine beaches of different parts of the world have received attention only recently. Mr. S. Krishnaswamy, M.Sc. of the laboratory, who is engaged in the study of the copepods of the Madras coast, drew the attention of the author to the occurrence of isopods. This was of interest since isopods have been recorded more often from the capillary waters of freshwater shores than from marine beaches. Karaman (1933) constituted the two new families Microparasellidae and Microcerebridae to contain three new isopods from the interstitial habitat of fresh waters of Europe. Chappuis (1944) described two more new genera and species. Levy (1950) and Chappuis (1952) found four new isopods from marine beaches of Italy. The two marine isopods *Brevipleonida gracilis*, gen. et sp. n. and *Robustura predatoris*, gen. et sp. n., described in the present paper, are treated as the type species of two new genera belonging to the two new families established by Karaman. They are therefore described fully. Notes on gross anatomy and bionomics have also been added.

The types of the two new isopods have been deposited in the Indian Museum, Calcutta, and have been accessioned thus: (1) *Brevipleonida gracilis*—C.3119/1 type; (2) *Robustura predatoris*—C.3120/1 type.

II. Material and Methods.

These sand-dwelling isopods appear to live a couple of inches below the surface and avoid sand deeper than a foot and are more common in areas where the sand grains are coarser than where they are finer in texture. These limits are doubtless related to the greater quantity of water required for these creatures which are far larger in size than the copepods and the nematodes—the major groups of the sand fauna. Washing a quantity of sand with sea water in a glass bowl usually makes

the isopods swim out into the water. The author has, however, found Mr. Krishnaswamy's method of collecting copepoda much easier. A tube of about a fourth of an inch diameter is pushed vertically into the sand as far as necessary and the water in the soil is sucked into a container and examined. These isopods, not being very good swimmers, crawl on the bottom of the container and can be pipetted out. These active creatures can be examined under high power, after narcotization with menthol. They are best killed with strong formalin, washed with water and stored in 5 per cent formalin. Temporary mounts between long coverslips facilitate examination of both the dorsal and ventral sides of the creatures as there is a risk of damaging them in turning them over. Aqueous hæmatoxylin and picro-carmine were found preferable to alcoholic stains.

III. External Morphology.

Brevipleonida gracilis, gen. et sp. n.

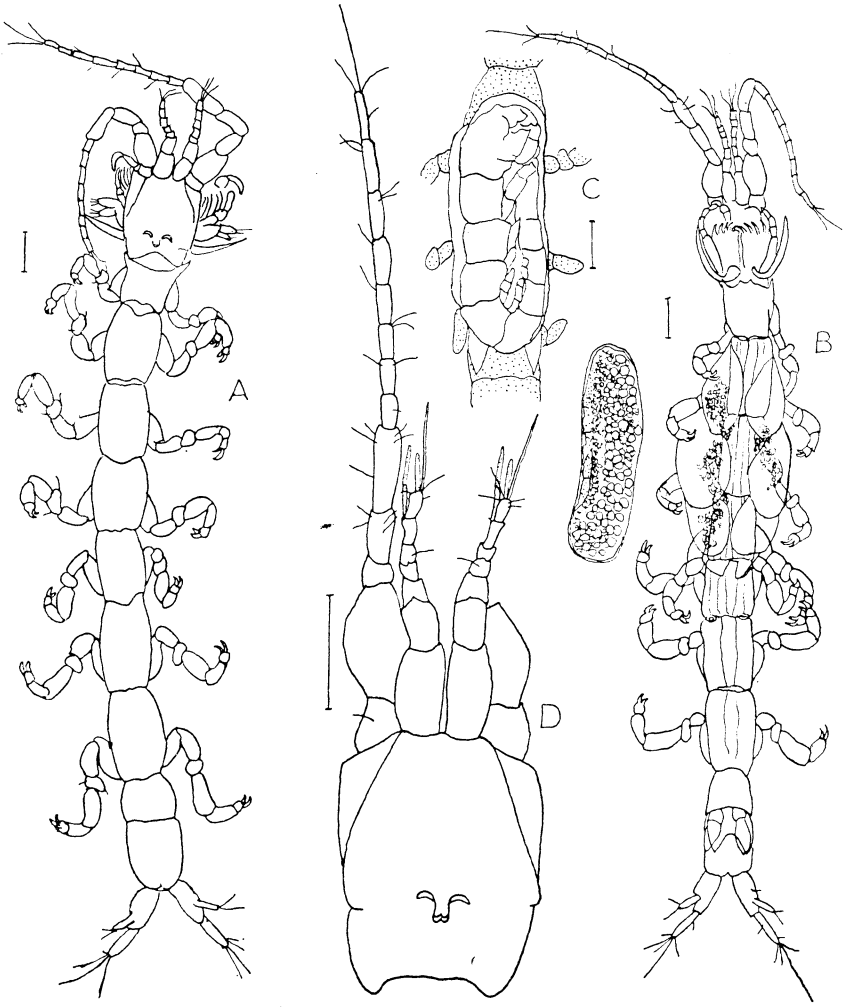
Nearly a hundred of this isopod can be collected from a square foot of the sand between the tide marks along the coast opposite to the laboratory. Of the hundreds collected and examined, there were young and adults of both sexes. Over a dozen were found pairing and many were berried.

General appearance.—The creatures are transparent, free of pigment and of surface markings and spines. The body is elongate, cylindrical and consists of seven free thoracic segments and two abdominal segments. The males averaged from 0·9 mm. to 1 mm. in length, exclusive of uropods and antennæ. The females found copulating were 0·65 mm. long while the berried ones ranged from 0·85 mm. to 1·2 mm. in length. A full-grown adult is about 0·1 mm. across the head and about 0·07 mm. across the mesosoma and about 0·05 mm. deep. If the head measured 25 units long, the neck-like first free thoracic segment measures only 10 and is the shortest and narrowest part of the body. The other segments of the thorax measure 21, 21, 17, 18, 23 and 23 units long. The abdomen is a little longer than the head and its two segments are 11 and 18 units long. All the body segments are narrower than the head. There is no trace of a telson or caudal plate. The uropods are terminal and are held at 45° to each other.

The front margin of the *head* is slightly concave where the antennules spring and is free of any rostral projection. Anterolaterally the ocular area is marked off by an oblique ridge, though there is no trace of an eye. About two-thirds behind, a pair of small narrow elliptical thickenings occur on the cuticle and in most a second pair of smaller thickenings also occur. The location, size and arrangement appear to vary in different individuals. Under very high magnification, small isolated hairs and textural markings may be seen. The sides of the head are protected by the long epipodites of the maxillipedes. The first thoracic segment has its front lateral corners produced into forwardly oblique spurs. The marsupium occurs on the second, third and fourth free thoracic

segments. At the slightest pressure on the coverslip, the egg mass leaves the marsupium as one body with its covering intact. It is possible that the entire body represents a single egg. When so emptied, the brood pouch can be seen to be formed of three pairs of oostegites

Fig. 1.

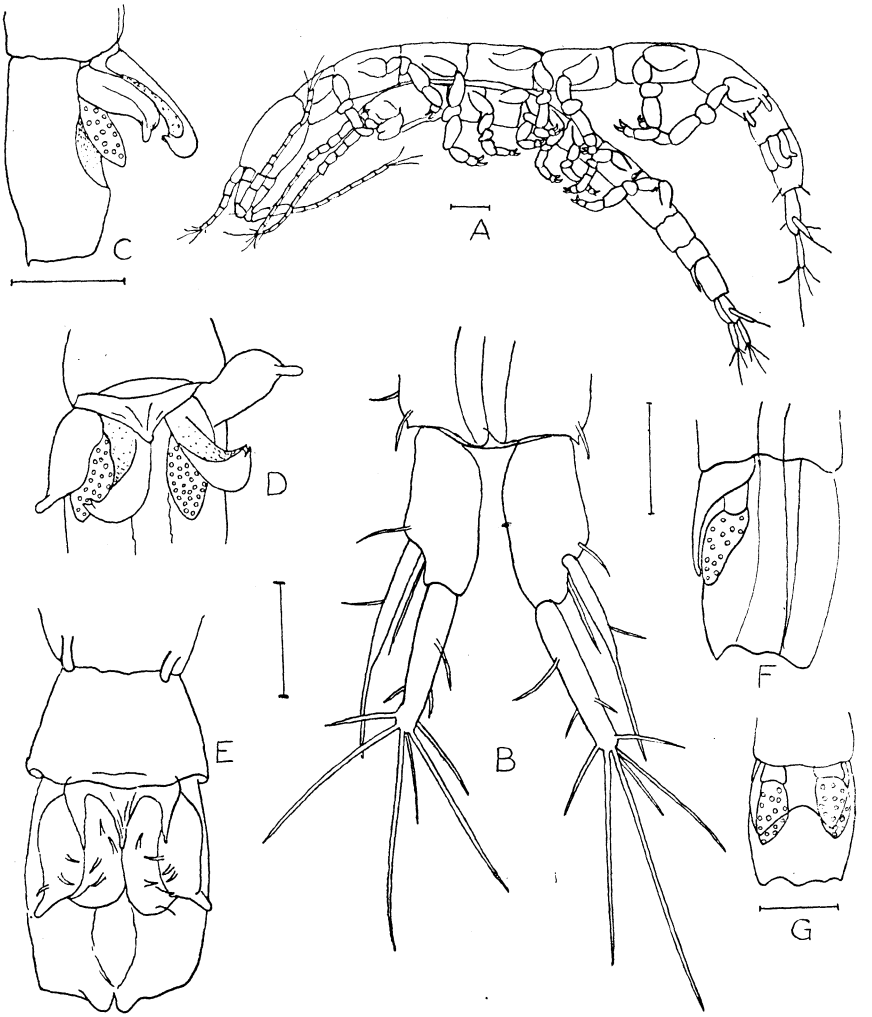


Brevipleonida gracilis. A. Dorsal view of male. B. Ventral view of female with brood pouch opened and the egg-mass dislodged. C. Fully formed embryo within brood pouch. D. Dorsal view of head. Scale: 0·05 mm.

springing from the coxal region of the legs. These plates are folded ventrally into distinct lobes forming the floor of the brood chamber. As the marsupium is always found complete and is present only in gravid forms, it is probable that it makes its appearance fully formed after a

moult and not by stages and that it disappears at the next moult. As the gravid forms were of different sizes, it is probable that several broods are formed during the life-time of a single female. It would appear that

Fig. 2.

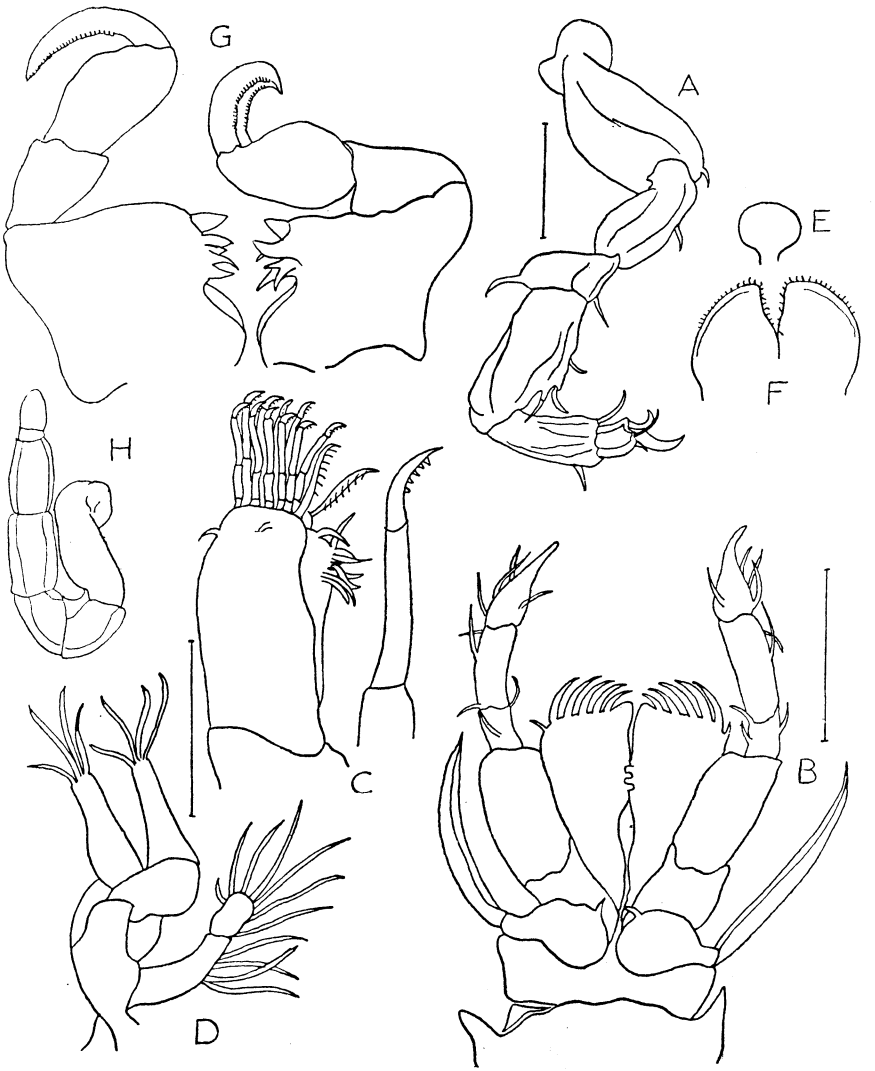


Brevipleonida gracilis. A. Male and female "pairing". B. Dorsal view of uropods. C. Lateral view of pleopods of male. D. and E. Ventral views of same. F. Lateral view of pleopods of female. G. Ventral view of same. Scale: 0·05 mm.

only a single young one is hatched from a brood pouch, each time. In advanced stages of incubation the single embryo occupies the entire space and lies doubled up. It has all the appendages except the last

pleopod. Relative to the size of the mother, the young one is large. In a female 0·8 mm. long, the embryo measured 0·6 mm. while in other

Fig. 3.



Brevipleonida gracilis. A. Leg. B. Ventral view of maxillipedes. C. Maxillule with one of the spines enlarged. D. Maxillæ. Scale: 0·05 mm. E. and F. Labrum and labium. ×1,200. G. Mandibles ×1,800. H. Last pereiopod of an immature form.

females, the embryos were found to grow to even 0·67 mm. in length and the youngest form collected from the sand measured only 0·7 mm.

As some of the copulating females were 0·65 mm. in length it is probable that they copulate soon after leaving the parent's body. The external genital openings of the female are on the membrane connecting the fifth free thoracic segment (i.e., 11th segment of the body) with the segment behind. They are large and have thick lips. The genital openings of the male are borne at the tips of the two penial styles on the hind margin of the seventh free thoracic segment of the male. The styles are finger-like processes.

Appendages.—The *antennule* is shorter than the antenna, being slightly longer than a third of it. It is seven-jointed and tapers to the distal joint which bears at its tip four short spines, a long spine and a narrow, flat æsthete. A longer æsthete is borne by the penultimate segment. The *antennæ* are slightly longer than a third of the length of the body. Nearly half the length of this appendage is formed by the peduncle which is five-articled. The flagellum is much narrower and is eight-articled and tapers distally, ending in three spines. There are a few spines on each of the segments. The labrum is a small orbicular flap while the labium is a much larger plate of a bilobed form and is fringed with short hairs. The *mandibles* are alike. The incisor edge has four strong teeth. There is a broad-surfaced molar lobe posterior to the teeth. The palp is of three joints, the claw-like terminal joint having finely toothed edges. The *first maxilla* has two endites. The inner endite bears eight spines on its distal edge while the outer endite has twelve setose spines and two plumose spines on its distal edges. The *second maxilla* has three endites. The proximal endite bears a fringe of nearly eleven spines while the other two, which are very movably articulated with the base, bear four spines each. The *maxillipedes* of the two sides form a broad interlocked plate covering the ventral surface of the head. Each has a short coxa bearing a spine on the inner edge and a long lamellar epipodite on the outer edge. This plate is capable of being swung outwards, to allow lateral movement of the mouth appendages. A large broad plate-like five-toothed endite is borne by the basipod. The endites of the two sides are joined together by two coupling hooks on each side inter-digitating into each other. The palp is four-jointed, exclusive of the basipod, the dactylose terminal joint bearing four spines. The large number of spines on the maxillæ and the toothed endites of the maxilli-pedes suggest a filtratory and scraping mode of feeding.

The *pereiopods* are alike, unguiculate and ambulatory. The dactylus is short and bears two claw-like spines, one more recurved than the other. There are also two hair-like spines. The first leg is slightly shorter and more slender. In the male it is also used to tightly clasp round the head of the female during copulation.

Of the *pleopods* there are two pairs. In the male there is, in addition, a flap-like structure attached to the posterior edge of the first abdominal segment. This may be taken as the vestige of the first pleopod not represented in the female. The second pair modified for copulation in

male is biramous. The basipods are not in evidence and the single-jointed endopod and exopod appear to be attached on each side, directly to the anterior end of the second abdominal segment. The exopod is cylindrical, stout and bears a finger-like process which probably helps to hold the body of the female in position during copulation. From the different positions in which the exopods were found in different specimens, it is inferred that these rami are capable of being rotated outwards and downwards. The endopod also appears equally mobile. The distal part of the endopod is hollow and sheaths the tip of the exopod. The extreme tip of the endopod is three-pronged. In some males, two sac-like structures were seen within the hollow of the endopod. In the female, both the anterior and posterior pairs of abdominal appendages are uniramous. The anterior of these has the protopods of opposite sides fused and presents an opercular appearance. Its resembling the flap-like first pleopod in the male is no indication of its homology, as Needham has pointed out in *Asellus* (1940). Therefore this appendage corresponds most probably to the second pleopod of the male, the first pleopod being lost. The third pair of pleopods is uniramous and similar in both sexes—being a flat laminate structure, most probably the endopod, attached to a short protopod. The *uropods* are as long as the last segment of the pleon. Each uropod is biramous. It consists of a large protopod armed with two spines. The endopod is stout, long and bears three spines laterally and six long spines terminally. The exopod is relatively shorter and more slender. It is produced into a long spine and bears a single lateral spine. It is to be concluded that as the abdomen is two-segmented, four segments of the pleon have been suppressed, though only two pairs of appendages are lost in the male and three are left unaccounted for in the female.

Taxonomic remarks.—The first pereiopod not being cheliform, the uropods not being hinged like doors, nor being lateral, the mouth parts not being suctorial, and the body not being laterally compressed, this small marine isopod cannot be readily pronounced as belonging to any of the known suborders. However, the maxillæ, the maxillipede, the pereiopod and the endopod of male are definitely similar to those of the Asellota. The form and position of the uropods, the body being cylindrical and there being no rostrum strengthen the resemblance. Within the Asellota, the new isopods *Microparasellus* sp. and *Microcharon* sp. constituting the new family Microparasellidae of Karaman, resemble the present form in the reduction of the pleopods and in the abbreviation of the pleon, though the descriptions and sketches Karaman has furnished are not so informative as to facilitate a more detailed comparison. Chappuis (1952) has described a third microparasellid *Angeliera phreaticola*, gen. et sp. n. Though this marine isopod is characterized by sex dimorphism, absent in the present form, yet the mandible, the maxillipede, the seven-jointed antennule and the first two pleopods of male are not dissimilar. It must, however, be mentioned that the peduncle of the

antenna is five-articled in the present form while in the three microparasellids described so far, as well as in all asellotes, it is six-articled. Nevertheless, in view of the general resemblances to the microparasellids, the present form is treated as belonging to this family but to a new genus and species, *Brevipleonida gracilis*, gen. et sp. n.

BREVIPLEONIDA, gen. nov.

Abdomen two-segmented, pereiopods all alike; antenna longer than twice the length of the antennule, and has a peduncle of five joints; the brood pouch is external and is formed of three pairs of oostegites; first pleopod of male opercular, reduced; second pleopod of male has two single-jointed rami modified for copulation; uropods long, biramous. *B. gracilis* type species.

Antennule seven-jointed, carries two æsthetes; flagellum of antennæ has eight joints but no æsthete; epipodite of maxillipede large, bract-like; endites of maxillipedes, interlocked by two pairs of retinacula; brood pouch carries single embryo; male has three pairs of pleopods, while female has only two.

Robustura predatoris, gen. et sp. n.

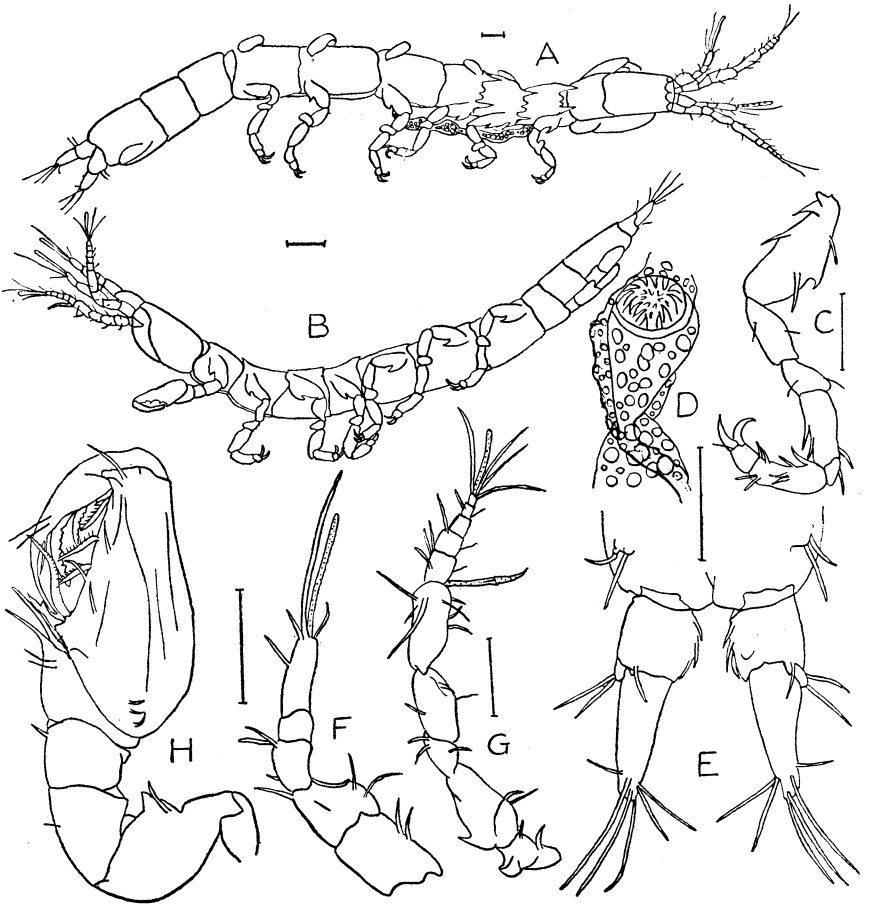
During September 1952, twenty-five specimens of this isopod were collected from the Madras beach in the region of the sand bar laid across the mouth of the river Cooum. This freshwater stream flows into the sea for about three months in the year when it is swollen with rain-floods but is sand-locked into a brackish backwater for the rest of the year. It is probable that these isopods really belong to the shallow sea bottom and are deposited on the shore when the sand bar is formed across the mouth of the stream by the action of the waves and that these isopods survive in typical interstitial conditions of a shore habitat. The isopods were found in the company of copepods, nematodes and other microfauna of marine origin. Of the twenty-five specimens collected, only three were males—one immature and two mature. Among the females only one appeared to be gravid, many being immature.

General appearance.—The creature is colourless and transparent. The largest measured 1·4 mm. long, exclusive of the antennæ and the uropods. The body is long and cylindrical but slightly constricted about the third peræon segment. It widens to its maximum in the sixth free segment and continues to be as wide behind. If the width of the head measured 22 units, the succeeding seven free thoracic segments measured 22, 17, 19, 20, 25, 27 and 26 units wide, while the three segments of the abdomen measured 26, 26 and 25 units wide. As regards length there is no uniformity in the different regions. If the head measured 25 units long, the segments of the thorax and abdomen measured 21, 21, 23, 20, 36, 36, 32, and 21, 21, 28 units, respectively.

The head is longer than broad and appears as deep in front as behind. The frontal margin is transverse, entire, extending forward slightly over the bases of the antennæ. Two faint grooves obliquely delimit the

subocular areas from the dorsal. There is, however, no trace of an eye. Relative to the premandibular region of the head, the hind region appears shortened, with the maxillæ and the maxillipedes crowded round the mouth. As a result, the oral cavity, or the food basin, appears circular, bounded by the labrum in front and labium behind, and is directed

Fig. 4.

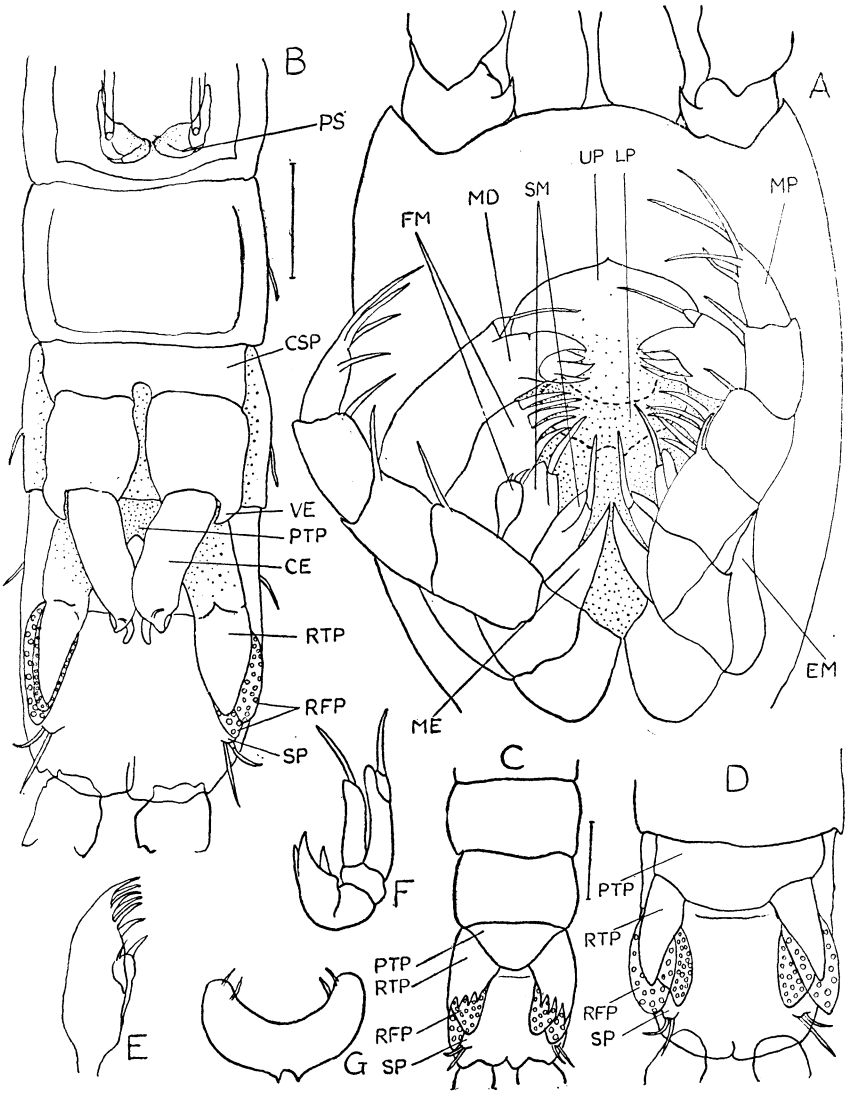


Robustura predatoris. A. Female. B. Male. C. Leg. D. External opening and funnel-like end of oviduct. E. Uropods. F. Antennule. G. Antenna. H. Gnathopod. Scale : 0·05 mm.

ventrally. Dorsally the carapace is free of markings and spines except for a pair of semi-circular thickenings of chitin near the posterior edge.

In the peræon, the sternal plates are so far larger than the tergal that the articulation of the legs is within a fourth of the depth of each segment and the articulations of all the legs, except the first chelate leg,

Fig. 5.



Robustura predatoris. A. Ventral view of mouth parts ×1,200. EM. Epipodite of maxillipede. FM. First maxilla. LP. Lower lip. MD. Mandible. ME. Endite of maxillipede. MP. Palp of maxillipede. SM. Second maxilla. UP. Upper lip. B. Ventral view of last thoracic segment and abdomen of male. CE. Copulatory endopod. CSP. Fused coxæ of second pleopods. PS. Penial styles. PTP. Fused protopod of third pleopod. RTP. Ramus of third pleopod. RFP. Ramus of fourth pleopod. SP. Spinose papilla. VE. Vestigial exopodite. C. Abdomen of young female. D. Hind region of abdomen of adult female. Scale: 0·05 mm. E. F. and G. Maxillule, maxilla and labium ×1,200.

are visible on the dorsal side of the body. If the width of the segments vary from 17 to 26 units, the tergal plates are uniformly as narrow as 10 units. The tergum of the first free thoracic segment is broader than the segment and is shield-like. Its front margin is produced laterally into sharp ventrolateral projections. The terga of the second, third and fourth free thoracic segments have their anterior edges produced into a pair of lobes on either side of the mid-dorsal line. Ventrally the sternum of each segment is thickened into slightly raised areas, elliptical in the anterior and rectangular in the posterior thoracic region. The last thoracic segment bears, in the male, a pair of penial styles turned in opposite directions. Each is sharp-pointed, armed with two spines. In the fifth thoracic segment (11th body segment) of the female, the oviducts from the ovary dilate in a funnel-like manner and open ventrally through two large openings provided with chitinous rims and a large flap. The funnel-like dilatations are not temporary formations for the reception of sperms, appearing at the time of copulation but are present in all adult females. In none of the females was there any trace of an external brood pouch fully or partially formed. It is possible that the marsupium is internal as in some Sphaeromidae (*vide infra*). However, in one female a long, egg-case-like structure was found attached ventrally without any protecting oostegites.

The pleon is stouter, being broader and deeper and has a more cylindrical form. It is distinctly three-segmented, the third segment being faintly grooved into a fourth. There is no trace of a telson. The uropods are attached terminally to the posterior convex end in such a way that they extend behind, diverging at an angle of 30° to each other.

Appendages.—The antennule is shorter than the peduncle of the antennæ and is of two large proximal joints and three smaller distal joints. The terminal joint bears a long narrow scale-like æsthete, a long stout spine and three shorter spines. The antennæ are less than a fourth of the body in length. The five-jointed peduncle forms four-fifths of the length while the short flagellum is made up of five very short segments tapering to the tip. There are four long spines and an æsthete on the terminal joint. There are a few shorter spines on other joints. A long articulated æsthete is seen at the base of the flagellum. The proximal joint of the peduncle bears a short thick recurved lobe. The *mandible* has a long, bent body ending in an incisor lobe bearing four stout teeth. It bears a palpal vestige in the form of a small cushion-like joint bearing a long spine. In front of the mandibles, the *labrum*, a semi-circular plate, forms the anterior border of the circular oral cavity, while behind the mandibles the narrow horseshoe-shaped *labium* forms the posterior margin. The *maxillule* has a small rounded proximal endite bearing two curved spines and a much larger distal endite armed with six stout spines. The *maxilla* is three-lobed. The proximal lobe bears a claw with a spine on either side of it. It is more posterior and ventral and is usually hidden by the bract-like epipodite of the maxillipede. The other two lobes are more medial and anterior, each bearing

a stout spine. The *maxillipede* has a short cushion-like coxa which bears a short broad epipodite sheathing laterally the base of the palp as far as its second joint and also covering the proximal endite of the maxilla. The basis is shorter and bears a spine as well as a long narrow endite united to its fellow, medially. Distally the basis bears the four-jointed palp. The terminal joint tapers and bears at its tip four long stout curved spines, while each of the other three bears a spine on the inner edge.

The first pereiopod is chelate and is similar in both sexes. The basis has a toothed lobe and a seta as in the other thoracic legs. The propodus is large and forms nearly half the appendage. Besides a long spine near the base and four on its distal end, it bears two more spines near the outer edge. The edge of the propodus, and the large claw-like dactylus are heavily armed. The finger closes down on an articulated spiny tubercle which bears a branched spine. In front of it is a long, stout spine which is finely toothed. It is possible that this is a modified setose spine like the three others in front of it. These are of decreasing size. The dactylus is a huge curved claw, behind whose sharp tip there are two other denticulated spines. Such a powerfully armed gnathopod may be of use in capturing prey. The carnivorous nature of this isopod is evidenced by the contents of the gut consisting of dismembered appendages of copepods visible through the transparent body-wall. The remaining six pereiopods are uniform, similar in both sexes and resemble those of the previous form except in details of setation. The basis is the largest joint and bears a toothed lobe and a spine. The propodus bears four spines on the inner edge and as many on the outer. The dactylus is short and bears a hair-like spine and two stout claws of which one is larger. In the very young form the last pereiopod is absent and is grown by stages. At the stage preceding the adult, the dactylus is conical and has no claws, which evidently appear only in the adult.

The pleopods differ in the sexes. In the male the most anterior pair is best developed and arise close together medially from the hind edge of the first abdominal segment. The coxopodites appear fused into a broad plate while the bases remain separate. Each basis bears a vestigial exopod and a large endopod. The endopods being far longer than their bases, they extend beyond the next segment. Each bears a small finger-like process subterminally while ending in an acute tip. Behind the tip on the outer aspect is found a deep circular cavity for the reception of sperms. Comparison with the copulatory endopods of other isopods will show that this front pair of pleopods is homologous with the second pair of abdominal appendages. Therefore, it is legitimate to infer that the first segment of the pleon and its appendages are suppressed in this species. The next pair of pleopods (the third) also have a broad fused protopod but is uniramous. This ramus, probably the endopod, is a single-jointed plate-like structure which in the young forms has a four-toothed edge but is entire in adults. While the protopod of this third pleopod is attached to the hind-edge of the second abdominal segment,

the next pleopod, the fourth pair, is attached to the anterior region of the third segment. This pair consists of two single-jointed flat plates, attached one on either side in a sessile manner, their being no protopod. A little behind the articulation of this pair, the third abdominal segment exhibits a faint groove traversing its entire breadth. Towards the postero-lateral corners of the abdomen a small fleshy papilla on either side can be seen bearing two long stout spines. It is possible that these are the vestiges of yet another pair of appendages, the fifth pleopods. The uropods, the sixth pair of pleopods, appear short, stout and stumpy. Each has a protopod bearing four spines, of which three are arranged one behind the other on the inner edge with which they are adnate. The exopod is a short reduced lobe bearing two spines. The endopod is far larger, nearly twice the length of the protopod. It tapers and bears six spines. Except for the absence of the second copulatory pair of pleopods found in the male, the female resembles the male in all other respects.

Taxonomic remarks.—The first pereiopod being chelate, the abdomen being three-segmented, the antennules the antennæ and the uropods being relatively shorter make the present form resemble *Microcereberus stygius* described by Karaman (1933) as the type species and genus of a new family Microcerebridae, under the suborder Flabellifera. Unfortunately, further comparison is not made easy because Karaman's description is scanty and his sketches few. His statement on p. 167, " Bei manchen exemplaren fehlt der Dactylus am letzten Pereiopoden," makes one suspect that his description is based on immature forms as well. Further the five-articled mandibular palp, the pleopod with three plate-like rami, the uropod with two-jointed protopod, he has figured, are features which are unusual. However, by adding two more species *Microcereberus Ramanei* and *M. arenicola*, Chappuis has further delineated the family as well as the genus. Though the descriptions and sketches of these two new species are by no means full and complete, yet a comparison will show that the present form is so distinct, in the structure of the uropods, the pleopods, the gnathopod as well as the head appendages, that it may be described as the type species of a new genus of the family Microcerebridae. Hence it is described as *Robustura predatoris*, gen. et sp. n. and can be defined as follows :—

ROBUSTURA, gen. nov.

The pleon consisting of three segments is wider than the anterior thoracic segments. The antennule is of five segments. Both the peduncle as well as the flagellum of the antenna are five-segmented. The mandibular palp is reduced to a single spine. The first pereiopod is a well-armed gnathopod. The first pleopod is absent in both sexes while the second is absent in the female. The third pleopod is united at base and is uniramous. The fourth pleopod consists of a single sessile ramus. The uropod is short and stout, with exopod reduced and endopod as long as the protopod. There is no external marsupium and the genital openings of female are large.

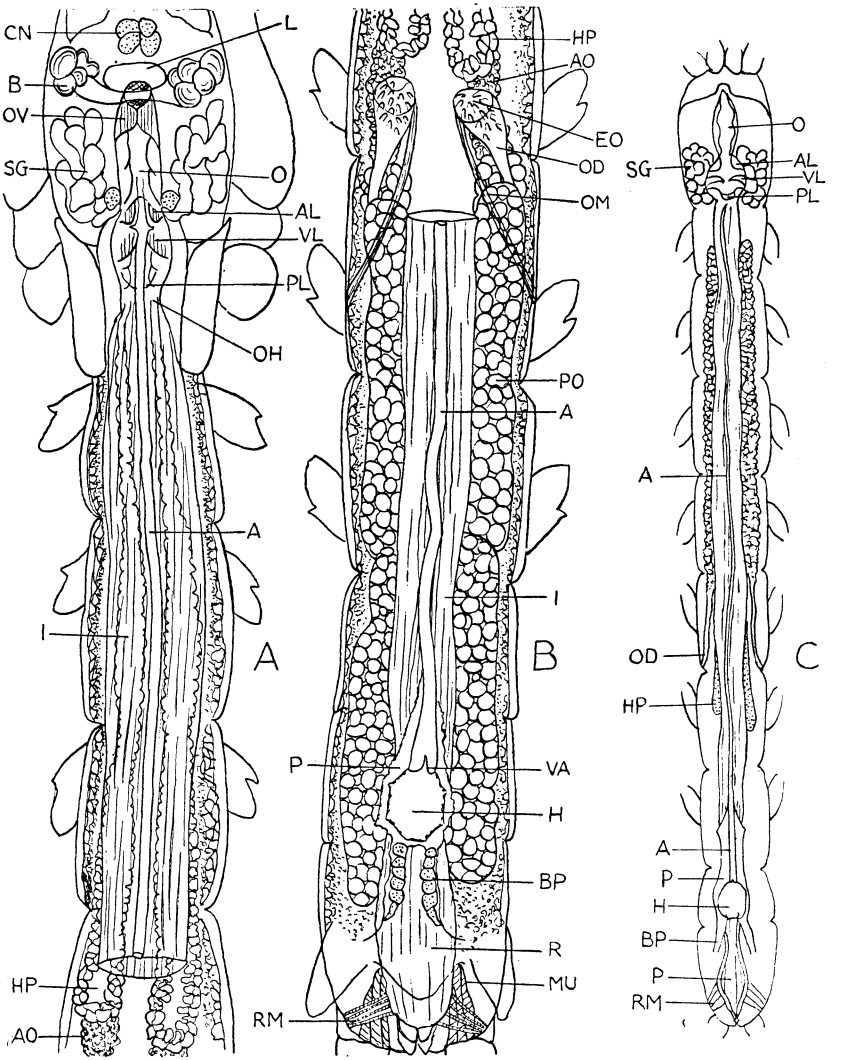
Robustura predatoris, sp. n.

Body nearly circular in cross-section. Antennule with a single, long æsthete; antenna with two æsthetes. Labrum large, semi-circular; labium, horseshoe-shaped with two spines on each limb. The maxillule bears eight spines while the maxilla bears a single, long spine on each of the two inner endites. The palp of the maxillipede is five-jointed and has a tapering terminal segment bearing four spines. Endopod of the second pleopod of male is stout, cylindrical, with a small finger-like process and a cavity.

IV. Internal Anatomy.

Correlated no doubt with their long body and cylindrical form, these two sand-living isopods belonging to two different suborders present several resemblances in their internal organization. The internal organs of *Robustura predatoris* are more easily visible than those of *Brevipleonida gracilis*. The *gut* is a straight tube. The ventral mouth leads up into a short œsophagus which appears closable by a pair of very contractile muscular lobes or valves. The œsophageal wall is also contractile because of its thick muscular walls. There are faint indications of the presence of extrinsic muscles as well. The convoluted salivary gland on each side opens into its hind end dorsally. Near the posterior limits of the head the œsophagus leads into the slightly wider but shorter stomach characterized by a number of gastric lamellæ. The hepato-pancreas occurs as two long cæcæ extending from the middle of the eleventh segment behind to the hind limits of the stomach in front. They are applied to the intestine ventrally and are continued anteriorly as narrow ducts which open into the stomach. The stomach leads into the intestine about the middle of the first free thoracic segment. The intestine runs straight behind, constricts in the second abdominal segment and dilates into the rectum. The hind region of the rectum has its walls attached by four strands of muscle on either side. The anal opening is controlled by two pairs of contractile muscular lips. As in several small crustacea, sea water is periodically taken into the rectum by muscular dilation of its walls. The *heart* is a small spherical organ located dorsally in the second abdominal segment directly above the commencement of the rectum. When expanding it assumes an octagonal outline, suggesting the presence of a pair of ostia on either side opening into the heart from the pericardium. This is a thin-walled chamber round the heart extending forwards on either side of the aorta. The commencement of the aorta from the heart is guarded by a pair of valves. The aorta runs mid-dorsally to the hind limits of the head where two lateral arteries spring from it and run ventrally. Posteriorly, behind the heart, the pericardium ends in two sinuses leading into the bases of the pleopods on either side. Close to each branchio-pericardial sinus lies a tapering strand of six cells. These cells, which are not syncytial but have clear cell-limits, are probably branchial *nephrocytes*. Four cells lying medially in front of the labrum near the base of the antennules are probably cephalic nephrocytes. The

Fig. 6.



Internal structure of *Robustura* sp. and *Brevipleonida* sp. A. Aorta. AL. Anterior lamella of stomach. AO. Anterior half of ovary. B. Brain. BP. Branchio-pericardial sinus and branchial nephrocytes. CN. Cephalic nephrocytes. H. heart. HP. Hepatopancreas. I. Intestine. MU. Muscles of uropod. O. Œsophagus. OD. Oviduct with dilatation. OH. Opening of hepatopancreas. OM. Oviducal muscle. OV. Oral valves. P. Pericardium. PL. Pyloric lamellæ of stomach. PO. Posterior part of ovary. R. Rectum. RM. Rectal muscles. Sa. Salivary glands. VA. Valves of aorta.

body *muscles* are intersegmental and consist of four sets of muscle strands, two dorso-lateral and two ventro-lateral. The fibres of each set spring from about the middle of one segment and end in the middle of the adjacent segment, running beyond the origin of the bundles in that segment. Each pereiopod has three flexor and three extensor bundles having their origin in the median region of the anterior edge of the tergum and their insertion on either side of the articulation of the pereiopod with the body. In the case of the anterior three pairs of legs, these muscles have their origin on the posterior edge of the tergum. There are too long *ovaries* extending from the first free thoracic segment to the last segment of the abdomen. Up to the middle of the eleventh segment, where the large external openings lie, the ovaries appear as narrow organs with small follicles, but posteriorly they dilate into wide tubes packed with fat globules. The oviducts start near the anterior ends of these wide ovarian tubes and, running forward, dilate into funnel-like receptacles which open to the exterior. It is probable that the posterior part of each ovary is s[illegible]ile and serves as a wide sac within which the ova shed by the anterior ovary become fertilized by the sperms from the oviducal funnels and receive their store of yolk. It is possible that the eggs may even undergo development within these sacs—for neither an external nor an internal brood chamber was seen in the females examined. However, even in females in which these posterior ovarian sacs were large and distended, no trace of an embryo was observed. It remains to be seen if the eggs are extruded after a certain stage of development along with yolk, in the form of a long string-like mass attached to the ventral side of the body between the legs. In the male the testes extend only as far as the twelfth segment and are continued as *vasa efferentia* to the penial styles on the thirteenth segment. They do not extend into the abdomen.

The internal structure of *Brevipleonida* sp. is remarkably similar. The small spherical heart is located in the anterior of the two abdominal segments. The pericardium extends round the base of the aorta, to a greater extent. In the gut, the stomach has two stout lateral lamellæ working against each other in the middle. Two other lamellæ at the anterior end and a median pyloric lamella are also seen. The ovaries are uniformly narrow throughout their length and they do not extend behind the twelfth segment and open on the hind edge of the eleventh segment.

V. Bionomics.

Brevipleonida gracilis is far more active than *Robustura predatoris* which is sluggish and often rests motionless at the bottom of the container. It appears as if the relatively longer and thicker abdomen were too heavy for the comparatively weak legs to carry. The elongated cylindrical form of these isopods suits their crawling through the interstices between the sand particles, using the claws to grip the surfaces of the particles. Water held in these small capillary spaces must be in a

state of constant and rapid motion. Evaporation from surface and capillarity will draw the water upwards while the receding waves and tides will draw the water in the opposite direction.

Hence like other micro-fauna living in the sand, the isopods are thigmotropic and cling to sand grains or even the tip of the pipette. They, however, can be shaken loose into the water. When disturbed they curl their bodies downwards into a coil. The extreme mobility of the segments should help the transfer of sperms from the penial styles on the last thoracic segment to the second pleopod as well as in the process of copulation. As has been mentioned before, the females appear to copulate as soon as they emerge from the parental brood pouch and not thereafter. It is likely they receive enough sperms for all the eggs they will ever lay. The male crawls over the female and clasps round the head of the female with his first legs. If the female moves backward the hold slips on to her antennæ. The rest of the body of both the creatures are free to move in all directions. The creatures remain together and creep about for hours. Copulation has not been observed in *Robustura*. Though these blind forms do not move away from the direction of light in an open glass container, yet when subjected to bright light, as in the field of the microscope, even the most sluggish creature becomes restless and keeps crawling away, unless it is narcotized.

VI. Summary.

1. The external morphology of two marine sand-living isopods *Brevipleonida gracilis*, gen. et sp. n. and *Robustura predatoris*, gen. et sp. n., is briefly described.

2. Their relationships to other new genera belonging to the new families Microparasellidae and Microcerebridae are discussed.

3. Brief notes on internal anatomy are given. The close resemblances exhibited by the different systems of the one belonging to the asellote family Microparasellidae with those of the other belonging to the flabelliferan family Microcerebridae, must be due to convergence.

4. Brief notes on bionomics are given. The darkness and the swift currents in the capillary waters of the interstitial habitat, influence the mode of life of these sand-living isopods.

VII. References.

Barnard, K. H. 1925. A revision of the family Anthuridae. *Journ. Linn. Society Lond.* **36**, 100–130.

Calman, W. T. 1909. Crustacea. Pt. VII, Lankester's *Treatise on Zoology*.

Chappuis, P. A. 1944. *Die grundwasser fauner Derkoros und Des szamos Math. Termes Kozlemenyek Budapest.* 40, **1**, 5–44.

Chappuis, P. A., & Delamere Debouttéville, C. 1952. Nouveaux isopodes. *C.R. des Sciences de l'academie des sciences*, t. **234**, 1014–2016.

Hansen, H. J. 1904. On the morphology and classification of the Asellota group of Crustacea II. *P.Z.S. Lond.* **2**, 302–331.

——. 1906. On the propagation, structure and classification of the family Sphaeromidae. *Q.J.M.S.* **49**, 69–135.

HEWITT, C. G. 1907. Ligea. *L.M.B.C. Memoirs* XIV.
KARAMAN, S. 1933. Neue Isopoden aus unterirdischen Gewässern Jugoslaviens. *Zool. Anz.* Bd. **102**, 16–22. *Microcereberus stygius, ibid.*, 165–169.
LEVY. 1950. *Microcharon Teissieri. Arch. Zool.* exp. et gen., N.R., 37.
NEEDHAM, A. E. 1940. Abdominal appendages of Asellus. *Q.J.M.S.*, **81**, 127–150.
PENNAK, R. B. 1951. Comparative ecology of interstitial fauna of Freshwater and marine beaches. *La Anne' Biol.* T.27. Fasc. 6.
ZIMMER, C. 1926. Isopoda. *Handbuch der Zoologie von W. Kukenthal*, Bd. III, I. W. de Gruyter, Berlin.