

NOTES ON SOME SPECIES OF THE ISOPOD FAMILY  
SPHÆROMIDÆ, FROM THE SOUTH AUSTRALIAN COAST.

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PLATES III. TO X.

In presenting these notes I must acknowledge the great assistance I have had from Dr. Hansen's paper entitled "The Propagation, Structure, and Classification of the Family Sphæromidæ," in the "Quarterly Journal of Microscopic Science," n. series, vol. 49, pt. 1, 1905. Without it it would have been quite impossible for me to treat with any degree of success species of this acknowledged difficult family which have come under my notice from our coast. At the same time it will be seen that my observations do not quite agree with statements in Dr. Hansen's paper regarding the parts occupied by the developing young in some genera.

In studying the species of this family, the thing that strikes one most is their great variability—this, indeed, is the main cause of the confusion which has held sway in their classification so long; but a general statement may be made, namely, that the young of both sexes resemble each other, the deviation occurring in adult males and females; that of the young-bearing females of many genera has been shown by Dr. Hansen in the above-mentioned paper. As an instance with the males, to take the case of *Cymodoce tuberculosa*, Stebbing. In this species there are two conspicuous processes on the anterior division of the pleon which are not figured or mentioned by the author or by Mr. Whitelegge, who refers at length to the same species from New South Wales; the inference, of course, is that they were not present in the specimens examined by them, although Mr. Whitelegge speaks of his as being adult males. Another instance will be seen in the case of *Ciliccia curtispina*, Haswell, later on.

With regard to the young-bearing females, whose mouth parts and viscera have been so much altered, one fails to see how the animal recovers itself after rearing a brood, and is driven to the conclusion that the individual perishes in the effort, and is probably, in some cases at least, perhaps eaten by the brood. In the female of a species of *Cymodoce* which, as yet, I have not been able to identify, I have observed the transverse slits in the sternal plates referred to by Dr. Hansen, and have seen well-formed young emerge from under the marsupial plates; these were somewhat har-

dened. The young ready to emerge from the body through the slits are very soft, and can consequently squeeze through a small space; the slits, however, in this species are large.

The following descriptions are from the male in each case, except where otherwise stated.

Family SPHÆROMIDÆ.

Subfamily SPHÆROMINÆ.

Group HEMIBRANCHIATÆ, Hansen.

Genus *Cymodoce*, Leach.

*Cymodoce longicaudata*, n. sp.

Plate iii., figs. 1 to 11.

The body is little convex, the tendency to curl up much reduced, becoming slightly narrow towards the head.

The head is arcuate in front, and considerably longer than the first thoracic segment. The eyes are large, prominent, and wedge-shaped. There is a median rostral projection, which is rather large and terminally obtuse.

The first thoracic segment is rather shorter than those which follow, the rest are short and subequal in length. The epimera, except the ones belonging to the last segment of the thorax, project laterally, and are very conspicuous viewed from above. They are sickle-shaped backward and very acute, and are all—except the first—marked off from their respective segments by distinct sutural lines. The last segment has epimera rounded and scarcely projecting.

Four fused segments are indicated on the anterior portion of the pleon; the first terminates laterally under the side of the preceding segment; the second has an acute lateral projection, similar to those of the thoracic segments; the fourth has the median portion of the posterior margin slightly arcuate, with the usual notch on each side. The terminal segment of the pleon is dome-shaped, and has an acute lateral projection; behind this the surface is strongly depressed until the basal portion of the median posterior spine is reached. The posterior notch is bounded by two acute projections, with the median spiniform process large and reaching much beyond them; this process is dorsally carinate and very acute.

The epistome is well developed; its lateral limbs are subacute.

The rather large basal joint of the antennule has the anterior side of the distal notch scarcely produced, but on the posterior side the projection is very acute, curved, and reaches nearly to the end of the second joint, as in *Circeis*. The second joint is more than half the length of the first



to the base of notch of the first; it is distally obliquely truncated, and has below a very prominent and acute keel. The third joint is very slender, and shorter than the second, and is articulated to it in a small cavity. The slender flagellum has about 24 joints. The flagellum of the antenna has from 26-32 joints.

In the right mandible the spine row is well developed, consisting of 7-8 coarsely pectinate spines; a small tubercle faintly toothed lies between these and the molar tubercle, which is well developed; the incisory plate is distally entire. The left mandible has a secondary plate divided into three teeth. The first two joints of the palp are subequal in length.

The maxillæ and maxillipeds are of the usual type. The lobes of the palp of the maxillipeds are long, with their setæ well developed.

The first gnathopods are robust, the basis subequal in length to the two following joints, taken together, the fourth, fifth, and sixth joints are posteriorly spined. The dactylus is rather long, robust, and two-clawed. The legs following the first pair are sparsely spined; the pads, so much in evidence in other species of this family, are here represented by soft plumose setæ.

The sternal filaments of the male are rather long. The *appendix masculina* is longer than the ramus which bears it, and is very slender. The exopods of the third, fourth, and fifth pleopods have each a division; a few distal setæ are on the exopods of the fourth pleopods.

The uropods are long and slender; the peduncle has a small spine below the insertion of the outer ramus; the outer ramus is narrow lanceolate, and reaches beyond the inner ramus; the inner ramus is also narrow, carinate below, with the inner margin slightly curved, reaching beyond the terminal spine of the pleon. The margins of the uropods and pleon are sparingly clothed with very short hairs.

The female does not differ from the male in any noteworthy respect, except, of course, when bearing young; then the mouth parts and viscera are modified in the usual way. In what appears to be an old female there are no ova or young, but there are the remains of marsupial plates; the viscera seem to have disappeared, as the sternites are sunken in or wanting; the pleopods, however, are intact.

#### *Cymodoce tuberculosa*, Stebbing.

Plate iii., figs. 12 to 15.

The epistome has two projecting teeth transversely placed on the anterior portion, similar to the rostral teeth, and inclined to be bifid.

There are five teeth on the anterior border of the first peduncular joint of the antennule, with a sixth smaller outermost.

The posterior notch of the pleon is wide and deep.

The male has two prominent posterior projections on the anterior portion of the pleon.

The internal ramus of the uropod has three terminal teeth, one larger above, two below. The external ramus is shorter and narrower, with two terminal teeth.

The body is minutely pubescent, but the hairs are coarser on the pleon and uropods.

The female of this species has not been identified.

*Cymodoce hamata*, n. sp.

Plate iv., figs. 1 to 11.

Body moderately convex, covered with a furry tomentum, which entangles much foreign matter, with longer scattered hairs. It is conspicuously contracted at the seventh thoracic segment.

The head is evenly rounded and anteriorly very obtuse, with two very obscure median projections. The eyes are prominent and subcircular.

The first segment of the thorax is about as long as any two together of those which follow; these are narrow, prominent, and scarcely differ in length. The epimera slightly project outwards; their lower outline, taken together, is very irregular, the individual apices being more or less obtuse; that of the seventh segment is much shorter than the rest.

The sides of the anterior part of the pleon project downwards, much in contrast to that of the seventh thoracic segment, but the antero-lateral angle is subacute; this portion of the pleon bears one small tubercle each side of the median line, whilst the posterior portion has also two tubercles, which are more or less spiniform, and situated on a dome, which is granular; between these two tubercles is a longitudinal depression. The posterior notch is wide, with a strong median process, which projects beyond the sides, is obtuse, and slightly turned up or tuberculate at its end.

The basal antennular joint is large, about twice as long as broad, with the distal notch shallow. There is a small keel on the underside of the second joint. The flagellum has 11 joints.

The flagellum of the antenna has 16 joints.

The epistome is slightly lobulate, the upper lip externally convex.

The maxillipeds have the plate of the second joint shorter than the joint itself, with the distal spines well deve-

loped, several of them strongly pectinate; the coupling spine is rather near the end. The lobes of the palp are long.

The legs are of the usual type, and spiniform.

In the first and second pleopods the exopods are areolate, or apparently covered with scale-like markings. The *appendix masculina* is thick and concave, or semi-cylindrical for its whole length. The exopods of pleopods three, four, and five have divisions; that of the fifth has two lobes on the distal end, and two, at the inner side on the angle of the proximal division.

The uropods have a short inner ramus, the end of which is subacute, and projects backwards, it does not nearly reach the notch. The external ramus is long, cylindrical, curved, and ends in a recurved hook, with two or more less curved.

In a female, whose mouth parts are modified in the usual way, the size is the same as that of the male; the more posterior segments of the thorax are very short. The posterior notch of the pleon is roofed over by a process which projects far behind, and is turned up at the end and bifid. The uropods are weaker than in the male, the inner rami more acute, the outer more hooked.

In an unmodified female which I have figured the external rami of the uropods are very strongly hooked, there being three other curved spines on each. The inner ramus is very acute. The legs are rather slenderer than in the male.

In both sexes the limbs are dotted with black spots.

South Australian coast, found in sponges.

Genus *Cilicæa*, Leach.

*Cilicæa curtispina*, Haswell.

Plate iv., figs. 12 to 17; and plate v., figs. 1 to 8.

The body is strongly convex, smooth, with areolate markings; glabrous, with one or two lateral tubercles on each side of the sixth and seventh segments of the thorax. Obscure tubercles are also indicated on the posterior margins of more of the segments in some males.

The head is evenly rounded anteriorly, the margin being slightly thickened; it is narrower than the first segment of the thorax, and more than twice as long. The rostral portion is broad and distally truncated, meeting the anterior part of the epistome by a transverse sutural line.

The segments of the thorax are short, and do not differ much in length. The epimera are nearly vertical in direction, somewhat sculptured, and at their junctions, with their respective segments, are raised, forming an interrupted longitudinal ridge, which also is marked on the first seg-

ment; the individual plates approach gradually to the quadrate shape behind; that of the first segment projects behind and before to an equal degree, and is deeper than the others; that of the seventh is not so deep as the others. The plates, being slightly excavate, show ridges on the free margins.

The sides of the anterior portion of the pleon show three faint lines crowded together, marking coalesced segments; this portion is deeper than the epimera of the thorax, and its anterior border carries a small tooth-like projection, usually hidden by the last plate of the thorax. Posteriorly there is a large median projection, which is vertically compressed, and far exceeds the end of the pleon; its end is obtuse and rounded. The posterior portion of the pleon bears a conical tubercle on each side of the median projection of the anterior part, with two or three small granules above each, and its antero-lateral parts have oblique ridges extending to the insertions of the uropods. The posterior notch is vertically excavated, moderately deep, its roof projecting behind very slightly, and there is only the faintest indication of three teeth on this.

The first joint of the antennular peduncle is about three times longer than broad; its distal end has two projections, the posterior one projecting outwards, the anterior upwards. The second joint, which reaches out to the level of the anterior end of the eye, is about one-third the length of the first, and is distally bifid and ridged above and below; the third joint, which is considerably narrower, is cylindrical, and is articulated under the bifid projection of the second. The flagellum has 15 or 16 joints.

The antenna has the last two joints of the peduncle subequal in length; the flagellum is not much longer than the peduncle, and consists of 18 short joints.

The mandibles are massive, without dark tips to the incisory plates, and with no distinct division into incisory plates and molars, and there are no secondary plates or spine rows. The palp is rather feeble.

The spines on the outer branch of the first maxillæ are dark.

The second maxillæ are narrow, all the lobes reaching the same distance.

In the maxillipeds the distal end of the plate of the second joint is sparingly setose; the lobes of the palp are long.

The legs are rather slender.

In the first gnathopods the ischium is shorter than the basis; the merus, carpus, and propodus are spined in the

usual manner, and together they are subequal in length to the ischium.

In the second gnathopods the basis and ischium are subequal in length, the merus a little longer than the carpus, the propodus longer than the carpus. The spines on this limb and three following pairs are mostly replaced by furry pads.

The first pleopod has the inner margin of the endopod folded at right angles to the other part, as shown in the figure. In the second pleopod the *appendix masculina* reaches farther than the fringe of the endopod, and there is also a less pronounced fold on the inner margin. The proximal end of the *appendix* is bent down quite to the base of the peduncle, as is seen in *C. latreillii*. The exopod of the third pleopods has a division; its endopod has some curious minute crowded teeth on the inner margin; its external distal angle is abrupt. The exopod of the fifth pleopods has six denticulate lobes, four of which are on the distal division.

The two sternal filaments are long.

The uropods have the internal ramus much reduced; the outer ramus is strong, rounded externally, flattened internally, curved, and slightly bifid at the end, projecting well beyond the dorsal process.

The female differs considerably from the male; in it the anterior portion of the pleon has two short median longitudinal ridges, but no large projection. The posterior portion has, besides the two large conical projections, two small tubercles a short distance above each. The posterior notch is deeper than in the male, and has a roofing projection more or less tridentate at its apex.

The inner ramus of the uropod is bifid at its apex; the outer ramus also is bifid, with an external projection, and an inferior keel terminating abruptly short of the bifid end. The inner uropod is channelled to receive part of the outer one when folded.

Sometimes none of the ambulatory legs are padded.

In the specimen examined the marsupial plates were well developed and overlapping; the mouth parts were modified, although the external appearance of the mandibles closely resembled those of the male.

A young female, which I take to be a variety of this species, has the following distinctions:—The posterior segments of the thorax are narrower, and all are more or less provided with small tubercles arranged transversely. The two ridges on the anterior part of the pleon are more converging behind. There are more small tubercles above the



larger projections on the posterior portion. There is a large tubercle above the uropods. The posterior prolongation which roofs the notch is strongly tridentate, and a small median tubercle is just above it. The ridge formed by the upper parts of the epimera of the thorax is more pronounced. There is a conical tubercle on the underside of the peduncle of the uropod.

A common species.

Group EUBRANCHIATÆ, Hansen.

Genus *Dynamene*, Leach.

*Dynamene ramuscula*, n. sp.

Plate v., figs. 9 to 20.

The body is strongly convex, rather narrow, covered sparsely with long, harsh hairs, which are more numerous on the pleon and uropods.

The head is a little longer than the first segment of the thorax, convex, and rather abruptly declivous anteriorly.

The first segment of the thorax is declivous anteriorly, and is longer than either of the four which follow, but not so long as the sixth, which bears two posteriorly projecting processes, which reach nearly as far as the end of the pleon; each of these processes has a slightly sinuous shape and a small branch near the end, which projects downwards. The apices of the epimera are nearly in the same curve, and are without distinct sutural lines marking them off from their respective segments. The seventh segment of the thorax is short, and its small epimera fall short of the preceding ones. The anterior portion of the pleon is only distinctly indicated at the sides, where its anterior angles are nearly right angles. The posterior portion of the pleon is convex, rough, and hairy, having five tubercles; one large median is obscurely cleft apically, two lateral on each side, the more anterior pair larger and nearer the middle; there is also a low tubercle just above the insertion of each uropod. Behind the median tubercle the surface descends abruptly to the posterior notch, which is situated on a conical projection, is a circular foramen with the inferior slit quite closed for its whole length underneath, and showing a very slight median projection behind at the extremity.

The eyes are subcircular.

The antennular peduncle is rather long, projecting distinctly beyond the eyes when raised; the notch on the first joint, which holds the second, is not deep, and inferiorly there is a small projection. The second joint is rather more than half the length of the first, and projects obtusely beyond

the articulation of the third joint; it has also an inferior keel-like projection. The third joint is a little curved; the flagellum consists of about 8 joints, which are longer than those usually met with in other species.

The antennal flagellum has 11 joints.

The maxillipeds are of the usual type, the lobes of the palp rather long, the distal setæ rather short, the last joint is subequal in length to the penultimate, apart from the projecting lobe of that joint.

The second gnathopods and the last pereopods are subequal in length, and are longer and slenderer than the rest of the legs; the last pair bears irregularly disposed long hairs, as also do the others in a less degree; the spines are poorly developed.

The first pleopod has the endopod much broader than long. The second pleopod is without *appendix masculina*, and in both pairs the fringes of the exopods are very long. In the third pleopods the endopod is much larger than the exopod; the exopod is without division, and its fringe is long. The third pleopods as a whole are larger than the others, including the peduncle.

The external ramus of the uropods is straight and lanceolate, much narrower and longer than the inner ramus, and terminally subacute. The inner ramus is obtuse, and slightly curved outwards.

The female is narrow-ovate in shape, the posterior part of the body being conspicuously narrowed; the legs are much shorter and slenderer than in the male; there are no processes on the sixth segment of the thorax, the posterior notch is an inverted triangular-shaped foramen, almost closed behind. The uropods are subcylindrical and small; the posterior part of the pleon has a low median tubercle.

There are well-developed marsupial plates, and the young, most of which were well advanced in the specimen observed—I counted 50 in somewhat varying degrees of development—occupied the whole of the body cavity, and were seen close beneath the marsupial plates, as well as away back near the dorsum; the body seemed to be reduced to a shell, the viscera having apparently disappeared. The mouth parts were highly modified. A second female had eggs scarcely more advanced than a round or slightly elongated shape would suggest; these showed to be directly under the marsupial plates, and also to occupy the body, as in the other female.

Length of parent, about 5 mm.; that of the largest young, about 1 mm.

Gulf St. Vincent, found on sponges. Three specimens only.

Genus *Amphoroidea*, M. Edw.

*Amphoroidea angustata*, n. sp.

Plate vi., figs. 1 to 10.

The body is narrow, smooth, moderately convex, with the epimera not distinctly marked off from their respective segments, and are almost vertical in direction. The head is moderately depressed, and is longer than the first segment of the thorax; there is a slight excavation of the margin on each side of a small rostral process. The eyes are rather small and slightly prominent. The first segment of the thorax is rather shorter than the rest, which are subequal in length. The posterior margins of the fourth, fifth, sixth, and seventh project slightly behind in an increasing degree serially. The anterior portion of the pleon shows the median portion of a first segment; the second forms the whole of the lateral portions; the others are obscure. The posterior portion is dome-shaped, tapering behind, with an obtuse rounded end, having a very faint insinuation, representing a notch, scarcely visible from above.

The basal joints of the antennules are expanded into broad sub-lamellar ovate plates, projecting in front of the head, with their inner margins diverging. The second joints are slightly expanded. The third joints much narrower, and short. The flagellum has 7 joints, the two terminal ones very minute.

The antennæ have their third and fourth peduncular joints rather more expanded than usual. The flagellum has 11 joints.

The epistome is large, quite like that in *A. australis*, Dana.

The maxillipeds have the joints of the palp with small lobes sparingly setose.

The legs are in a single series, and—except the first gnathopods—subequal; they are all hairy, and almost devoid of spines. The basal joints are short.

The first gnathopods are somewhat twisted, the basis and ischium are subequal in length, the merus is strong and much broader than long, the carpus is insignificant, the propodus is compressed—being flattened on the inner side—to a narrow posterior edge, which, besides the hairs, has two pectinate spines; the inner surface of the joint also bears short hairs, which are not numerous. The dactylus is strong with a terminal curved claw, and in place of the secondary claw there are three strong teeth close together, followed by a short series of very short teeth inwardly. The dactylus moves at right angles to the plane surface of the propodus.

The second gnathopods are scarcely twisted, and are a little longer than the following legs.

The pleopods are rather narrow. The first pair has the endopod much smaller than the exopod, and is about twice as long as broad; the inner margin is straight and slightly thickened; the outer insinuate, with a small turned-up point near the proximal end. There is a "shelf," on which rests the inner margin of the exopod. The exopod is broadly-ovate. Areolate structure is well marked.

The second pleopods have an elongate endopod nearly twice as long as the exopod. The *appendix masculina* is as long as the lamina; on the lamina is a faint "shelf" on which the appendix rests. The exopod is narrow-ovate, with a much longer fringe than that of the endopod.

The third pleopods are shorter than the second; in them the exopod is shorter and narrower than the endopod, and has a nearly straight inner margin, and is without division.

The fourth pleopods have both rami branchial.

The exopod of the fifth pleopods has two lobes at the distal end, and two on the inner margin, one above the other, a short distance; a division is not plain; the external margin is almost devoid of setules.

The uropods are broadly lamellar, ovate, the inner rami projecting beyond the end of the pleon, the outer projecting a little beyond the inner. The outer ramus is a little smaller than the inner.

Gulf St. Vincent, shallow water. One male specimen and two immature.

*Amphoroidella*, new sub-genus of *Amphoroidea*.

*Amphoroidella elliptica*, n. sp.

Plate vi., figs. 11 to 18.

The body is ovate, convex in both directions above, concave beneath, covered with a kind of skin that can easily be scraped off, the "skin" thrown into a median dorsal fold or thickening, rendering each segment of the thorax apparently tuberculate in the larger specimens. First and second joints of the antennules, segments of the thorax, anterior and posterior divisions of the pleon, with the uropods, much expanded, so that only the head and extremity of the pleon are not concerned in the outline.

Head short, somewhat depressed; anteriorly there is an insinuation each side of a small rostral projection not more developed than is usual.

The lateral expansions of the first thoracic segments approach those of the second joints of the antennules; there is,

however, a much wider gap between these than between any of the other side expansions, the ends of the two uropods excepted. The margins of all the expansions have a dense membrane-like fringe, with projecting hairs. The head and all the segments of the thorax do not differ much in length. The epimera of all except the first are separated by distinct sutures from their respective segments, and project nearly in the same curve as the segments.

The anterior portion of the pleon is short, marked with the usual lines, which do not extend on to the lateral plates, showing probably that only the more anterior segment bears the expansion. The posterior portion of the pleon is convex, and has anteriorly a median low convexity; it tapers quickly to a narrow rounded end, which is without notch, being only channelled below in the faintest manner; the sides and ends are thin.

The third joint of the antennule is of the usual size, the flagellum short, with 8 or 9 joints.

The epistome is arcuate and very distinct, without an anterior prolongation. The upper lip is large.

In the mandibles the molar is much reduced; on the left mandible the spine row and secondary plate are not distinctly differentiated; in the right the spines also are coalesced. The incisory plates of both are well developed and dentate. In the male the mandibles are normal.

The maxillipeds have the lobes of the joints of the palp short, especially that of the penultimate, which is subequal in length to the last. The setæ are rather scanty.

The legs are in a simple series, and all are similar—except the first gnathopods—and do not differ much in size. The carpus of each, except the first, has an insinuation on one side; all are nearly spineless. The dactyli are short, but the principal claw is rather long and acute.

The endopod of the first pleopods is much longer than broad; it has a ridge, or shelf, on which the inner margin of the exopod lies. The exopod of the third pleopod is ovate, and is without division; the endopod is much longer than broad. In the male the rami of the fourth pleopods are very thin, but both are well marked with branchial folds. The exopod of the fifth pleopods has a division and two lobes on the distal portion, and two at the inner distal angle of the proximal part opposite each other on each side. There are no small setæ on the external margin of this ramus.

In the uropods the peduncle and endopod are fused, and the exopod occupies a notch in the side. The end of the endopod slightly exceeds the end of the pleon.



The description and figures are taken chiefly from female specimens; the males I possess, which appear to be full grown, are much smaller.

This genus bears much external resemblance to *Chitinopsis*, Whitelegge.

Gulf St. Vincent, shallow water.

*Moruloidea*, n. gen.

*Moruloidea lacertosa*, n. sp.

Plate vii., figs. 1 to 10.

The body is expanded, moderately convex, the epimera of the thorax extending obliquely, and form, with their segments each side, a longitudinal shallow groove, which converges a little behind, continuing a similar groove extending round the pleon.

The head is short, with a small depressed rostral projection; much narrower than the first segment of the thorax; nodular and abruptly declivous in front.

The eyes are small.

The first segment of the thorax is broad and longer than any of the others which follow, rather nodular, its sides showing three faint tubercles on each margin; it is depressed anteriorly rather deeply; the extreme antero-lateral angles beneath the eyes are bifid or emarginate. Of the epimera of the following segments the fourth is longer fore and aft than the rest, the last is very short; they (six) are slightly accentuated at each posterior angle by a slight nodule or tubercle.

The anterior portion of the pleon, which is produced to a pointed plate laterally, is short, with the sutural lines scarcely showing. The posterior portion is dome-shaped and tuberculate, with its anterior angles also produced to points, the sides are slightly insinuate, thin, ending posteriorly in acute teeth, which do not reach the level of the sides of the posterior notch, the margins between which are insinuate. The notch is oblique in direction, rather deep, rectangular, its base slightly convex.

The basal antennular joints are not much expanded; they are uneven, rounded, and project very little beyond the head; the distal end of the first joint is not notched, or scarcely so; the second joint is short, small, and has a backward direction; the third joint is narrower and longer than the second; the flagellum short and slender, with 11 joints.

The antennæ are unusually large, all the joints of the peduncle are robust, the second has a distal obtuse tooth

on the inner side, the fifth joint is a little longer than the preceding one, slightly curved, and bent back at an angle with it. The flagellum, the first four joints of which are robust, is turned in the opposite direction; it bears 11 joints, the terminal ones being very small.

The epistome is short, broader than long, with the small anterior surface nearly at right angles to the posterior part; it is rough, and tapers quickly to an acute point beneath the rostral projection; the upper lip is slightly convex.

In the maxillipeds the lobes of the palp are rather long, resembling those in the *Cymodocinae*.

The first gnathopods are very robust in contrast to the rest of the legs, a short thick basis is subequal in length to the ischium; the three following joints are sparsely provided with spines (3 each), which are not serrate, but are apically split. The dactylus is strong, not forming with the propodus a subchelate or prehensile organ, but being somewhat inclined that way.

The first pleopods are smaller than the rest; the exopod is nearly oblong, and, lying obliquely, projects at its base beyond the edge of the peduncle; the endopod is slightly longer than broad. The second pleopods have the endopod a good deal longer than broad, with a thick *appendix masculina*, which reaches as far as its fringe; the exopod is ovate and smaller than the endopod. In the third pleopods the exopod is longer than the endopod, with an oblique suture ending in a small notch on the inner margin. The exopod of the fifth pleopod has the division very near the end; terminally there are two lobes nearly on the same level, and two small or rudimentary at the inner end, one above the other, below the suture.

The uropods are placed on the edge of the pleon, they are sublaminar; the peduncle has an anterior projection slightly over-reaching that of the antero-lateral angle of the pleon; the inner ramus is broad, curved, and distally bifid, its end scarcely reaching the posterior tooth of the pleon; the outer ramus is shorter and narrower, and has its upper surface slightly carinate, with its outer side nearly straight, the inner convex, the end acute.

One male specimen.

This genus seems to differ considerably from any others of the group that I am acquainted with. The much-developed antennæ and the large first pair of gnathopods are, as far as I know, unique.

Gulf St. Vincent.

Genus *Dynamenopsis*, new gen.

*Dynamenopsis obtusa*, n. sp.

Plate vii., figs. 11 to 17; and plate viii., figs. 1 to 7

The body is smooth, except on the pleon, which is rather rough, glabrous, very convex, becoming slightly wider at the end of the thorax.

The head is anteriorly rounded, without a transverse anterior ridge, longer than the first segment of the thorax. The eyes are rather small.

Of the segments of the thorax the first and seventh are longer than the rest, and subequal in length. The seventh almost completely covers the anterior portion of the pleon; its posterior border has four short lobes, the two median ones projecting somewhat behind. The epimeral plates of the thoracic segments are vertical in direction; that of the first segment is well produced anteriorly, but posteriorly very little; the following four are subquadrate; that of the sixth is wedge-shaped and produced behind, more than overlapping that of the seventh segment and the lateral portion of the anterior part of the pleon.

The posterior portion of the pleon is dome-shaped, and has a conical tubercle each side of the median line, with a smaller one posteriorly just above the posterior notch. The posterior notch is a transversely-ovate foramen, a closed slit below forming a funnel-shaped tube, the two sides form a small notch at the immediate end, while the sides of the pleon are turned under, enclosing the pleopods much more than is usual.

The first joint of the antennular peduncle is not very broad; it is about twice as long as the second, and is without distal notch or produced angle. The second joint has a slight keel; the third joint is as long as the second, expanding a little distally. The flagellum is as long as the last two joints of the peduncle together, and has 8 short joints. The antennal peduncle is only a little longer than that of the antennule; its flagellum has 11 joints.

The anterior part of the epistome is not separated from the depressed rostral projection; this fits into a notch of the epistome with a sutural line marking the union, the whole being in the same curved surface with the front of the head. The labrum is quadrate.

The mandibles are abnormal, without distinct incisory plates, secondary plate, and spine rows, neither is there a distinct molar, but the part corresponding to the posterior edge of the molar bears a few brown recurved spines.

The maxillipeds are rather slender.

The first pair of gnathopods are robust, the ischium has an anterior lobe, the merus is short and wide, with a small distal spine behind, as also has the wedge-shaped carpus and the propodus; the dactylus is robust. The remaining legs are robust, with a few spines, but with the furry pads on the usual joints. The dactyli are well developed in all.

The endopod of the first pleopod is considerably longer than broad, thickened on its inner margin, with the outer margin slightly insinuate, but with a proximal angle or projection. The exopod is much larger, although reaching the same distance as the endopod; it lies obliquely, and the fringes of both are long. The outer end of the peduncle of this limb narrows out somewhat. In the second pair the exopod is much shorter and smaller than the endopod; the appendix exceeds the length of the endopod, including its fringe; there is a short ridge on the inner side of the endopod. The third pleopod has the peduncle much longer at its inner side; the exopod is divided near its end.

The uropods are lamellar, subequal in size, rounded on their distal margins, the outer one being slightly concave above.

The two processes of the seventh sternite of the thorax are short.

This species, represented by only one male, is from Denial Bay, and was collected by Drs. Verco and Torr in January, 1908.

Genus *Circeis*, M. Edw.

*Circeis tridentata*, M. Edw.

Plate viii., figs. 8 to 16.

This species is the type of the genus, and is here noted for purposes of comparison.

The body is shaped typically, being somewhat vertically compressed, with the head gradually declivous and narrowing considerably, and is very like *C. acuticaudata*, Haswell; in fact, the females are hard to distinguish from those of that species.

The posterior notch of the pleon in the male is deep, narrow, widening inwardly, the median process slightly raised, broadly triangular, obscuring the base in a dorsal view, not projecting as far as the arms of the notch, which are terminally obtuse.

The distal end of the first joint of the antennule has the posterior limb of the notch curved, and projecting much more than the anterior limb, but not quite reaching the end of the second joint.

The exopod of the first pleopod has 11 strong teeth.

The exopod of the second pleopod has 21 teeth.

The exopod of the third pleopod with a division and 10 teeth.

The exopod of fifth pleopod with two lobes on the distal portion, and two on the inner margin, near the middle of the lamina.

The legs in both sexes are provided with the furry pads so common in this group.

The female is more convex than the male, with a more ovate outline. The posterior portion of the pleon is more dome-shaped, the small median tubercle less marked, and this portion is less hairy. The posterior notch is simple, narrow, rather deep, cut nearly vertically, U-shaped. The uropods are similar in shape to those of the male, but smaller. The legs are less robust, and the teeth on the pleopods smaller.

The eggs I have found deep in the body, quite to the dorsal surface, and the usual modifications of the mouth parts and viscera occur.

#### *Circeis trilobata*, n. sp.

Plate viii., figs. 17 to 20; and plate ix., figs. 1 to 7.

The body of the male narrows anteriorly, as seen in other species of this genus; it is smooth—except on the posterior portion of the pleon, where there are a few small granules—and glabrous.

The head is longer than the first thoracic segment and narrower, with a very small depressed rostral projection.

The eyes are large, and slightly projecting.

The first segment of the thorax and the seventh are subequal in length, and are longer than the remaining segments. The epimeral plates are marked off from their respective segments by faint longitudinal grooves; the anterolateral angle of the first segment projects forward very much, but not much posteriorly; the succeeding plates project behind each in a slightly increasing degree, except the last, which also is not so deep.

The anterior portion of the pleon is subequal in length to the seventh thoracic segment, and it is slightly raised in the middle. The posterior portion bears three bosses, the median one of which is somewhat triangular and abrupt behind, the lateral ones less so; behind these is a semicircular depression, but the immediate region of the posterior notch is tumid. The notch is simple, cut nearly vertical, quadrate, with a convex base, but no real process.

The epistome is long, anteriorly appearing thickened, but actually slightly turned upward at the tip, occupying



most of the interantennular space. When viewed in profile the two posterior limbs each show two small projections, one above the other, on the inner borders.

The basal antennular joint is rather short, its posterior distal angle produced, reaching nearly to the end of the second joint; the anterior angle is scarcely produced. The second joint is distally truncated, and does not show a slight notch or insinuation above, as in *C. tridentata* and *C. acuticaudata*. The under keel is well marked. The third joint is much narrower and about as long as the second; the flagellum has 10-11 joints.

The antenna has a flagellum of 13 joints, and is slightly longer than its peduncle.

The legs are of the usual type, rather robust, sparingly spined, their places being occupied by furry pads, even in the first pair of gnathopods. The dactyli are short.

The mandibles have incisory plates, moderately strong and dentate; the left mandible has a secondary plate, tridentate. The spine row and molar of each are well developed.

The filaments of the male on the seventh thoracic sternite are short.

The endopod of the first pleopods is nearly twice as broad as long; the exopod has a row of well-marked teeth on the external border. The exopod of the second pleopod has a row of teeth and a row of small simple setæ close to the external border; the fringes of the usual setæ are very dense. The *appendix masculina* is short, and proceeds from about the middle of the inner border of the endopod. The exopod of the third pleopod has a suture rather near the end, and 5 or 6 distal teeth, also a row of small simple setæ near the external border. The exopod of fifth pleopod has a distal suture very obscure; the two lobes which this carries are rather distant from each other. A third small lobe is on the proximal division, rather far down on the inner side.

The uropods are lamellar.

The female resembles the male when not young-bearing. The young-bearing female is broader or more ovate and shorter, and the legs are much slenderer; the posterior notch is similar in shape, but rather deeper; the greatest difference is found in the uropods, the shape of which is seen by reference to the figure. The marsupial plates are large and overlapping, and the young and eggs are found deep in the body. The mouth parts are strongly modified. The young males and females bear great resemblance to the females of *Haswellia emarginata*.

Gulf St. Vincent, from jetty piles.

*Circeis obtusa*, n. sp.

Plate ix., figs. 8 to 17.

The body is rather broad, convex, the surface is rather rough, with granules becoming well developed on the pleon, glabrous.

The head is not so pointed as in other species of this genus; rather short, anteriorly strongly declivous, with an anterior faint transverse ridge.

The eyes are well developed.

The opimeral plates of the thoracic segments are not distinctly marked off from the segments. They are vertical in direction.

The anterior portion of the pleon is short. The posterior portion dome-shaped, with a very slight depression each side of a median faint elevation. The posterior notch is well marked, narrower at its apex than at its base, with a V-shaped median lobe, which reaches about halfway to the end. In a side view the end appears slightly turned up.

The epistome has its anterior portion slightly convex.

The basal joint of the antennular peduncle has a distal notch whose posterior limb does not reach the end of the second joint; the anterior limb is nearly as long as the posterior, and is slightly turned forward at its apex. The third joint is narrow and slightly longer than the second; the flagellum has 11-12 short joints of a moniliform appearance.

The flagellum of the antenna has 13 longer joints.

The mandibles are large, the primary plates are well developed and dentate; the secondary plate also is well developed, as also are spine rows and molars.

The maxillipeds have the plate of the second joint as long as the joint itself; the palp is well developed.

The legs are strong. The first gnathopods have well-developed spines on fourth, fifth, and sixth joints. In the other legs the spines are replaced mostly by the furry pads.

The first pleopods have short endopods, much broader than long. The exopod is without marginal teeth, or with only one or two faint ones. Internally, from the usual row of marginal setæ, there is a row of setules, as noticed in other species. Second pleopods, with the endopods also short, bearing the *appendix*, nearly halfway along its internal border. The appendix is thick, and nearly of the same diameter its whole length. The exopod has 4-5 small teeth on its external border and a row of setules. The exopod of the third pleopods has a division and a row of setules, as in the others. The exopod of the fifth pleopods has three lobes, which are slender, the most distal one projecting horizontally, the most proximal close to the inner margin. The division is very obscure.

The uropods are lamellar, rather broad, the inner ramus distally truncate and exceeding the end of the pleon. The outer ramus rather ovate, slightly exceeding the inner, the margins of both faintly and irregularly serrate.

This species is represented by two males, the females being unknown.

Gulf St. Vincent.

### *Haswellia emarginata*, Haswell.

Plate ix., fig. 18; and plate x., figs. 1 to 11.

The body becomes narrower anteriorly, smooth, with very few hairs towards the lateral margins.

The head is slightly longer than the first segment of the thorax, with a well-marked rostral projection very acute at the tip.

The eyes are large, and project slightly.

The segments of the thorax behind the first increase in length successively behind, while the seventh tapers to a long process, which extends beyond the end of the pleon, and is terminally truncated and notched or emarginate.

The epimeral plates of the thoracic segments are produced subacutely behind, except that of the seventh, which is large and rounded; sutures marking off these plates are not evident.

The anterior portion of the pleon is covered, except at the sides. The posterior portion is depressed and slightly granular. The posterior notch is very deeply cut, its median process projecting well beyond the sides, is truncated, and slightly notched.

The first joint of the antennular peduncle is rather broad; there is a deep distal notch, the arms of which are equal in length, and do not reach the end of the second joint; the anterior one is curved outwards a little at the end. The second joint has a prominent keel below, ending distally in an acute tooth. The flagellum has 17 small joints.

The antennal flagellum has 17 joints.

The mandibles are rather slender, the incisory plates are entire, the other parts are well developed.

The legs are similar to those found in the genus *Circeis*.

The exopods of the first and second pleopods are toothed, as also in the genus mentioned. The *appendix masculina* is small, and originates rather far along the inner margin of the endopod of the second pleopods. In the third pleopods the transverse suture is near the end; the setules noticed before are present.

The uropods are broad and very rigid. The exopod has the inner margin more convex than the outer; this is minutely serrate. The inner ramus is large and slightly

sigmoid, its inner margin has a slight prominence near the distal acute end; both are densely fringed with short setae, as well as having hairy surfaces, and project slightly beyond the median process of the seventh thoracic segment.

In an egg-bearing female the first and second pleopods are areolate in both rami; the exopods in both instances have teeth, but they are less numerous and weaker than in the males. The setules near the margin are present.

The marsupial plates are large and overlapping, the eggs are internal in densely packed masses up to the dorsal region, and even amongst the muscles which control the pleopods. The mouth parts are very much modified.

The end of the pleon has a deep vertical notch with its roof slightly projecting behind; this is rather obtusely pointed and conspicuous from the side.

Females without brood and young males approach each other, though at an early stage the young male has a short developing process to the seventh thoracic segment. In both these cases the posterior notch, though not so deep, is more roofed over by the triangular process than in the female with brood, and the process is more acute.

I have repeated the observation with regard to the eggs with *Circeis acuticaudata*, Haswell, and have found the young deep in the body apparently as well developed as those immediately under the marsupial plates; few were in that position, the majority—very numerous—were within the body, even over the pleopods.

As Dr. Hansen remarks, *Haswellia* is closely allied to *Circeis*, there being, as far as I am aware, only the character of a dorsal process separating them.

Gulf St. Vincent; a common species.

### *Haswellia cilicioides*, n. sp.

Plate x., figs. 12 to 23.

The body is very convex, gradually narrowing towards the anterior end; smooth, except on the pleon and uropods, which are granulate and glabrous, except the margins of the uropods, which are slightly hairy.

The head is obliquely declivous and rounded in front. The eyes are scarcely raised above the surface.

The first and sixth thoracic segments are subequal in length, the seventh produced as a process which is rather broad, curved downwards, and distally obtusely rounded, over-reaching the end of the pleon and excavated a little underneath. The epimeral plates of the thorax are vertical in direction, not forming with their respective segments a perceptible longitudinal groove.

The anterior portion of the pleon, with its two transverse sutures, are well seen at the sides. The posterior portion has three lobes, the middle one slightly projecting behind more than the others; below these the surface is slightly excavated medianly, and then descends obliquely to the posterior notch. The posterior notch is shallow, the channel becoming deeper inwardly; there is a median triangular process which over-reaches the sides, is oblique in direction, and subacute.

The first peduncular joint of the antennule has the usual distal notch, the posterior limb of which is longer than the anterior, but does not reach the end of the second joint. The third joint is longer and narrower than the second. The flagellum has 14 joints.

The antenna has the last peduncular joint longer than the one which immediately precedes it; its flagellum has 16 joints.

The epistome shows very slight projections in the corresponding positions as in *Circeis trilobata*.

Mandibles well developed, with the usual features well marked.

The first gnathopods are shorter and stouter than any of the legs which follow, though not markedly so; the basis is thickened, the ischium subequal in length to the three succeeding joints taken together, these are posteriorly spined; the dactylus is moderately developed.

The following pairs of legs are moderately long, and differ only in the relative length of the joints; they are poorly or scarcely at all spined. The furry pads are present on the usual joints.

In the first pleopods the endopod is much broader than long. The exopod has 6-7 marginal teeth; both rami are areolate. The exopod of the second pleopod has areolate markings, and the row of setules near the outer margin; on the same margin there are 12 teeth. The *appendix masculina* is short and thick, and is attached to about the middle of the inner margin of the endopod. The endopod is broader than long, and has a few areolate markings. The third pleopods are larger than the two pairs which precede them without marginal teeth on the exopod, but with the row of setules as in the others. The division is near the end, and there are indistinct areolæ. The endopod is distally truncate. The exopod of the fifth pleopod has three lobes, the two distal ones well developed and well apart, the third on the inner margin also well marked.

The uropods have the inner ramus much reduced, the outer one strongly developed, subcylindrical, curved inwards,



fringed with fine hair, and over-reaching the median process of the seventh thoracic segment.

The female of this species has not been recognized.  
Gulf St. Vincent.

DESCRIPTION OF PLATES.

All figures are from adult males, except where otherwise mentioned.

The legs are drawn to approximate proportion in each individual.

PLATE III.

- Fig. 1. *Cymodoce longicaudata*, n. sp., magnified  $2\frac{1}{2}$  diameters.  
 " 2. " " " side view of male.  
 " 3. " " " pleon from below.  
 " 4. " " " antennula, antenna, and epistome.  
 " 5. " " " left mandible.  
 " 6. " " " maxilliped.  
 " 7. " " " first gnathopod.  
 " 8. " " " second gnathopod.  
 " 9. " " " fourth pereopod.  
 " 10. " " " second pleopod.  
 " 11. " " " exopod of fifth pleopod.  
 " 12. " " *tuberculosa*, Stebbing, magnified 4 diameters.  
 " 13. " " " pleon from below.  
 " 14. " " " antennula, antenna, and epistome.  
 " 15. " " " second pleopod.

PLATE IV.

- " 1. *Cymodoce hamata*, n. sp., magnified 4 diameters.  
 " 2. " " " female, magnified 4 diameters.  
 " 3. " " " side view of male.  
 " 4. " " " pleon from below.  
 " 5. " " " female pleon from below.  
 " 6. " " " antennula, antenna, and epistome.  
 " 7. " " " maxilliped.  
 " 8. " " " first gnathopod.  
 " 9. " " " second gnathopod.  
 " 10. " " " fifth pereopod.  
 " 11. " " " second pleopod.  
 " 12. *Cilicæa curtispina*, Haswell, magnified  $2\frac{1}{2}$  diameters.  
 " 13. " " " side view of male.  
 " 14. " " " female, magnified  $2\frac{1}{2}$  diameters.  
 " 15. " " " pleon from below.  
 " 16. " " " female pleon from below.  
 " 17. " " " antennula, antenna, and epistome.

PLATE V.

- " 1. *Cilicæa curtispina*, Haswell, left mandible, with palp.  
 " 2. " " " maxilliped.  
 " 3. " " " first gnathopod.  
 " 4. " " " second gnathopod.  
 " 5. " " " fifth pereopod.  
 " 6. " " " endopod of first pleopod, anterior and posterior aspect.  
 " 7. " " " exopod of fourth pleopod.  
 " 8. " " " exopod of fifth pleopod.  
 " 9. *Dynamene ramuscula*, n. sp., magnified 6 diameters.  
 " 10. " " " side view of male.

- Fig. 11. *Dynamene ramuscula*, female, magnified 6 diameters.  
 " 12. " " pleon from below.  
 " 13. " " female pleon from below.  
 " 14. " " antennula, antenna, and epistome.  
 " 15. " " maxilliped.  
 " 16. " " first gnathopod.  
 " 17. " " second gnathopod.  
 " 18. " " fifth pereopod.  
 " 19. " " second pleopod.  
 " 20. " " third pleopod.

## PLATE VI.

- " 1. *Amphoroidea angustata*, n. sp., male magnified 4 diameters.  
 " 2. " " pleon from below.  
 " 3. " " antennula, antenna, and epistome.  
 " 4. " " maxilliped.  
 " 5. " " first gnathopod right.  
 " 6. " " second gnathopod right.  
 " 7. " " third pereopod right.  
 " 8. " " first pleopod.  
 " 9. " " second pleopod.  
 " 10. " " exopod of fifth pleopod.  
 " 11. *Amphoroidella elliptica*, n. sub-gen., n. sp., magnified  $2\frac{1}{2}$  diameters.  
 " 12. " " oral region from below.  
 " 13. " " pleon from below.  
 " 14. " " right mandible.  
 " 15. " " second gnathopod.  
 " 16. " " fifth pereopod.  
 " 17. " " first pleopod.  
 " 18. " " second pleopod.

## PLATE VII.

- " 1. *Moruloidea lacertosa*, n. gen., n. sp., magnified  $3\frac{1}{2}$  diameters.  
 " 2. " " side view.  
 " 3. " " antennula, antenna, and epistome.  
 " 4. " " maxilliped.  
 " 5. " " first gnathopod.  
 " 6. " " second gnathopod.  
 " 7. " " fifth pereopod.  
 " 8. " " first pleopod.  
 " 9. " " second pleopod.  
 " 10. " " exopod of fifth pleopod.  
 " 11. *Dynamenopsis obtusa*, n. gen., n. sp., magnified 5 diameters.  
 " 12. " " side view.  
 " 13. " " antennula, antenna, and epistome.  
 " 14. " " pleon from below.  
 " 15. " " left mandible.  
 " 16. " " right mandible.  
 " 17. " " maxilliped.

## PLATE VIII.

- " 1. *Dynamenopsis obtusa*, n. gen., n. sp., first gnathopod inside view left.  
 " 2. " " second gnathopod left.  
 " 3. " " fifth pereopod left.  
 " 4. " " first pleopod.  
 " 5. " " second pleopod.  
 " 6. " " third pleopod.  
 " 7. " " exopod of fifth pleopod.

- Fig. 8. *Circeis tridentata*, M. Edw. magnified  $2\frac{1}{2}$  diameters.  
 " 9. " " female, magnified  $2\frac{1}{2}$  diameters.  
 " 10. " " side view of male.  
 " 11. " " antennula and epistome.  
 " 12. " " maxilliped.  
 " 13. " " pleon from below, male.  
 " 14. " " first gnathopod.  
 " 15. " " fourth pereopod.  
 " 16. " " second pleopod.  
 " 17. " *trilobata*, n. sp., magnified 4 diameters.  
 " 18. " " side view of male.  
 " 19. " " pleon from below, male.  
 " 20. " " female pleon (egg-bearing) from below.

## PLATE IX.

- " 1. *Circeis trilobata*, n. sp., antennula, antenna, and epistome.  
 " 2. " " maxilliped.  
 " 3. " " first gnathopod.  
 " 4. " " second gnathopod.  
 " 5. " " fifth pereopod.  
 " 6. " " second pleopod.  
 " 7. " " exopod of fifth pleopod.  
 " 8. " *obtusa*, n. sp., magnified  $3\frac{1}{2}$  diameters.  
 " 9. " " side view.  
 " 10. " " pleon from below.  
 " 11. " " antennula, antenna, and epistome.  
 " 12. " " maxilliped.  
 " 13. " " first gnathopod right.  
 " 14. " " second gnathopod right.  
 " 15. " " fourth pereopod right.  
 " 16. " " second pleopod.  
 " 17. " " exopod of fifth pleopod.  
 " 18. *Haswellia emarginata*, Haswell, magnified 3 diameters.

## PLATE X.

- " 1. *Haswellia emarginata*, Haswell, pleon from below.  
 " 2. " " young female, magnified 3 diameters.  
 " 3. " " female pleon from below.  
 " 4. " " pleon of young male from above.  
 " 5. " " pleon of egg-bearing female.  
 " 6. " " antennula, antenna, and epistome.  
 " 7. " " mandible of young female.  
 " 8. " " exopod of second pleopod young female.  
 " 9. " " exopod of second pleopod egg-bearing female.  
 " 10. " " second pleopod.  
 " 11. " " exopod of fifth pleopod.  
 " 12. " *cilicioides*, n. sp., magnified  $3\frac{1}{2}$  diameters.  
 " 13. " " side view.  
 " 14. " " pleon from below.  
 " 15. " " epistome.  
 " 16. " " antennula.  
 " 17. " " left mandible.  
 " 18. " " maxilliped.  
 " 19. " " first gnathopod.  
 " 20. " " second gnathopod.  
 " 21. " " fifth pereopod.  
 " 22. " " second pleopod.  
 " 23. " " exopod of fifth pleopod.

SECONDARY  $\gamma$  RADIATION.

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[Read July 17, 1908.]

## INTRODUCTION.

As a result of the passage of  $\gamma$  rays through matter, secondary rays of two types make their appearance. As it will be necessary to distinguish between the secondary rays which proceed from the sides at which the original  $\gamma$  rays enter and emerge from the plate which they penetrate, we shall refer to these as the "incidence" and "emergence" rays respectively.

The secondary radiation consists of  $\beta$  and of  $\gamma$  rays.

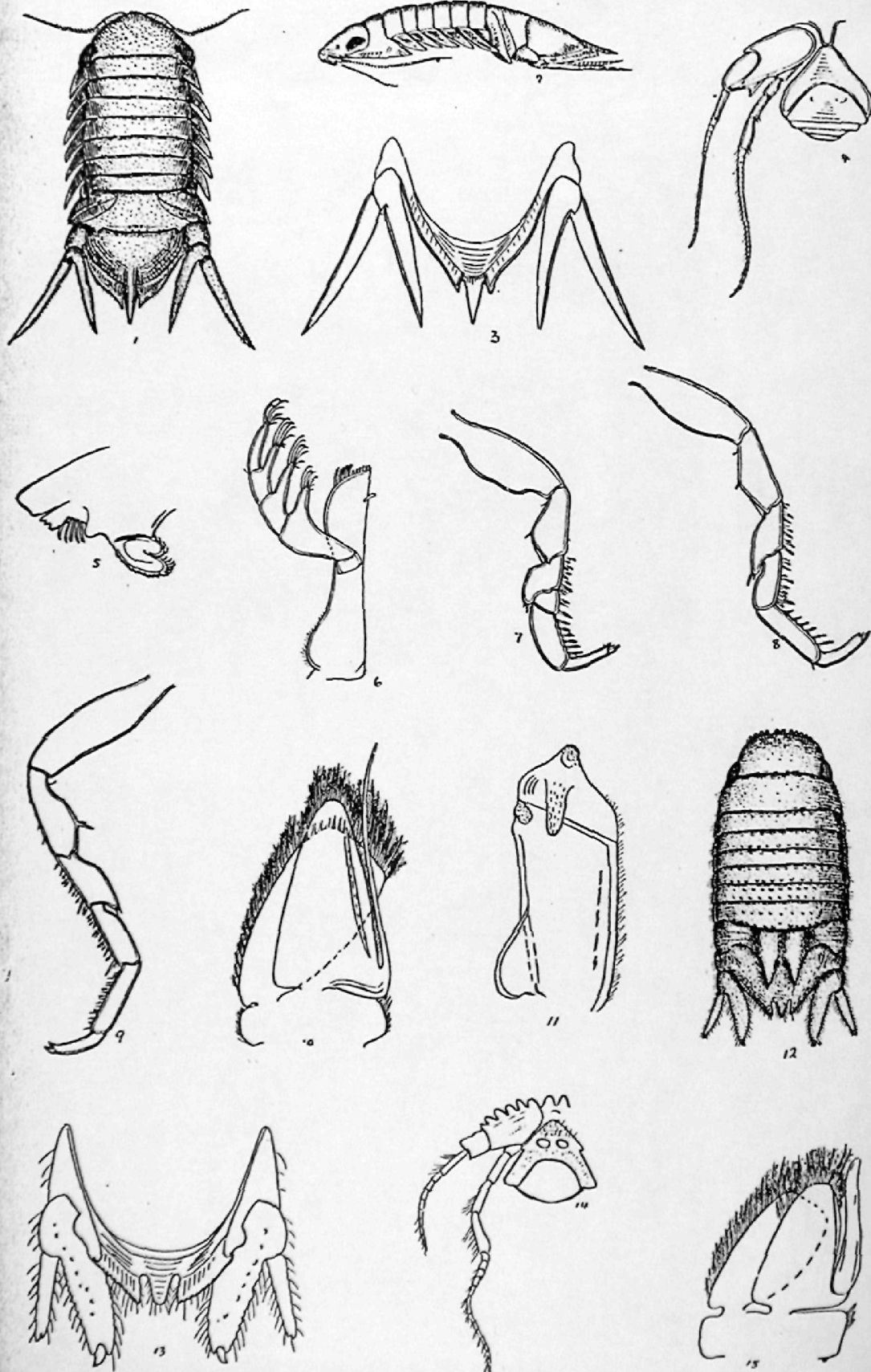
The former appear on both sides of the plate; the "incidence"  $\beta$  rays have been recently investigated in some detail by Kleeman (Phil. Mag., Nov., 1907) and by Eve (Phil. Mag., June, 1908).

In papers by Professor Bragg and myself (Phil. Mag., May, 1908; Trans. Roy. Soc., S. Aus., v. xxxii., 1908) it is shown that most of the experimental results so far obtained with these rays can be very simply explained on the "material" theory, if we suppose that the  $\beta$  radiation is produced directly from the  $\gamma$  particle and at the outset moves in the direction of the original  $\gamma$  radiation, subsequently undergoing scattering in the ordinary manner of  $\beta$  rays.

The second type of secondary radiation resulting from the primary  $\gamma$  rays, viz., the secondary  $\gamma$  rays, have been investigated on the incidence side of plates of different material by Kleeman (Phil. Mag., May, 1908), and later by Eve (Phil. Mag., Aug., 1908).

It was a deduction made by Professor Bragg (Trans. Roy. Soc., S. Aus., Jan., 1908) from the theory of the material nature of X- and of  $\gamma$  rays previously propounded by him, that "the existence of modified or softened  $\gamma$  rays might be suspected, since there is an analogous effect in the case of X-rays; and probably they would be found more at the back of the penetrated plate than in front of it." The back and front sides spoken of here refer of course to the sides of emergence and incidence respectively.

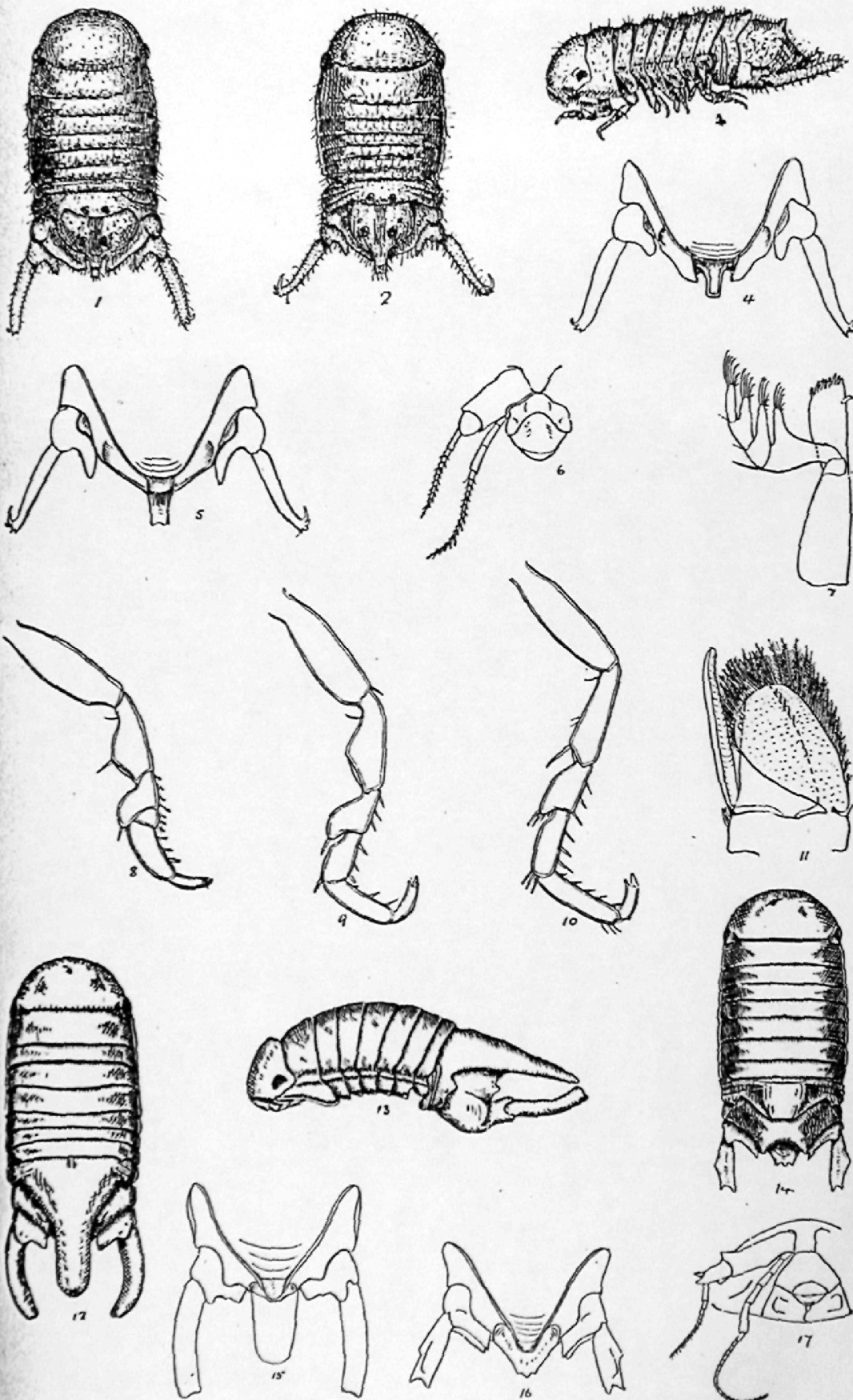
It will be shown in the present paper that this prediction is fulfilled very exactly; that the want of symmetry in the amount of radiation from the two sides of the plate is very marked, that a softening of the original rays is effected,



CYODOCE LONGICAUDATA, *n. sp.*

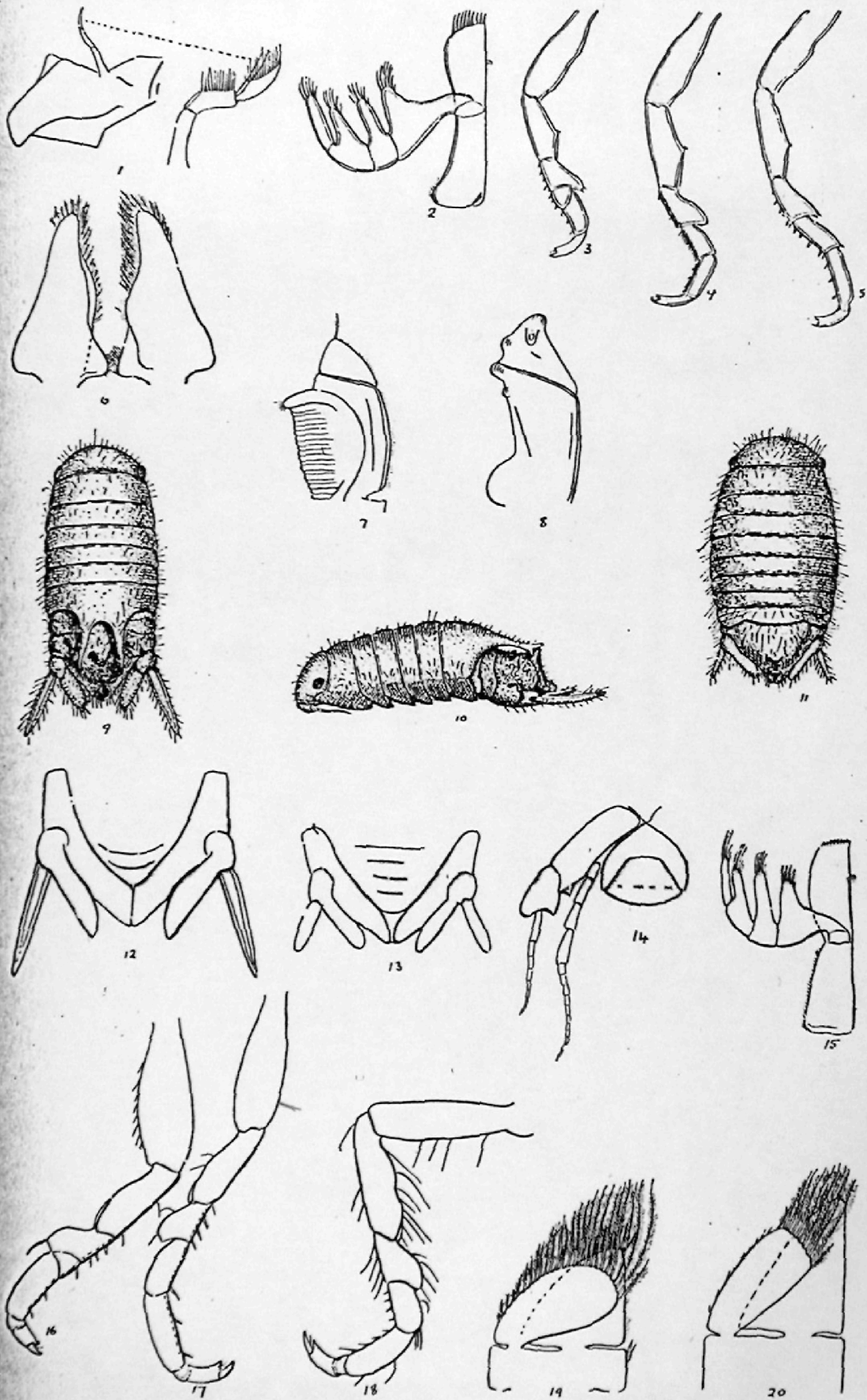
CYODOCE TUBERCULOSA, *Stebbing.*





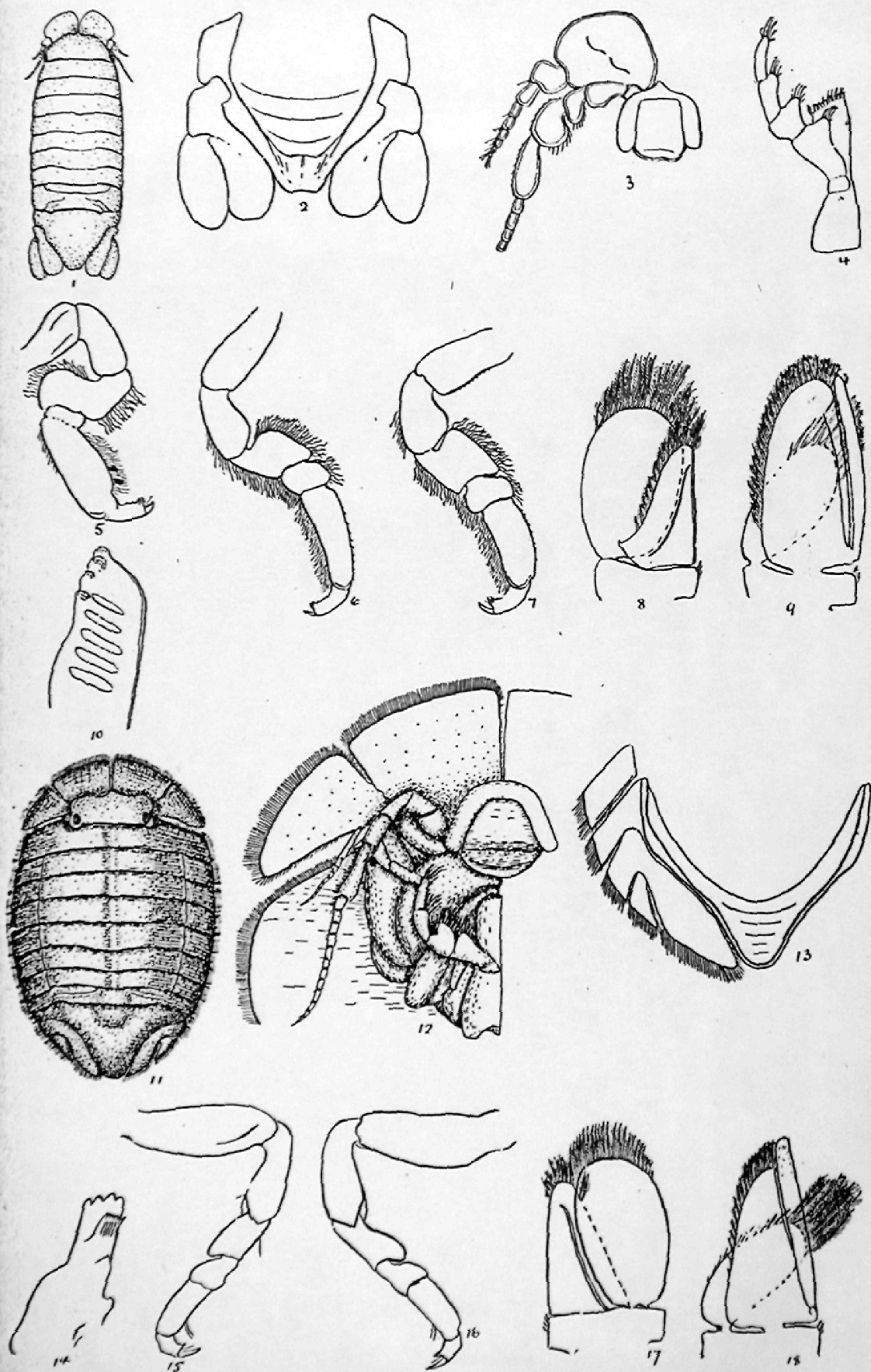
CYMODOCE HAMATA, *n. sp.*

CILICÆA CURTISPINA, *Haswell.*



CILIOCÆA CURTISPINA (continued)

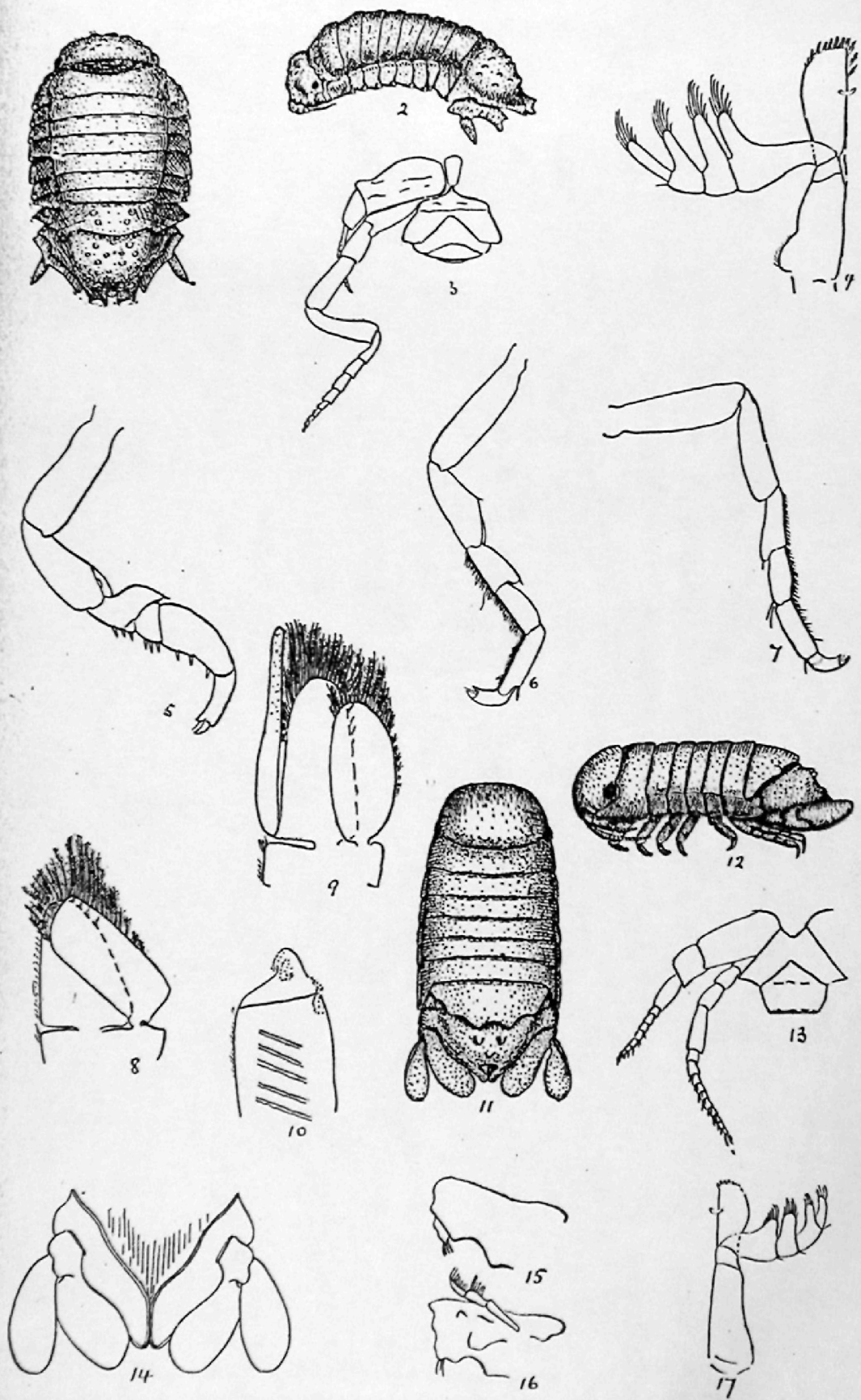
DYNAMENE RAMUSCULA, n. sp.



AMPHOROIDEA ANGUSTATA. n. sp.

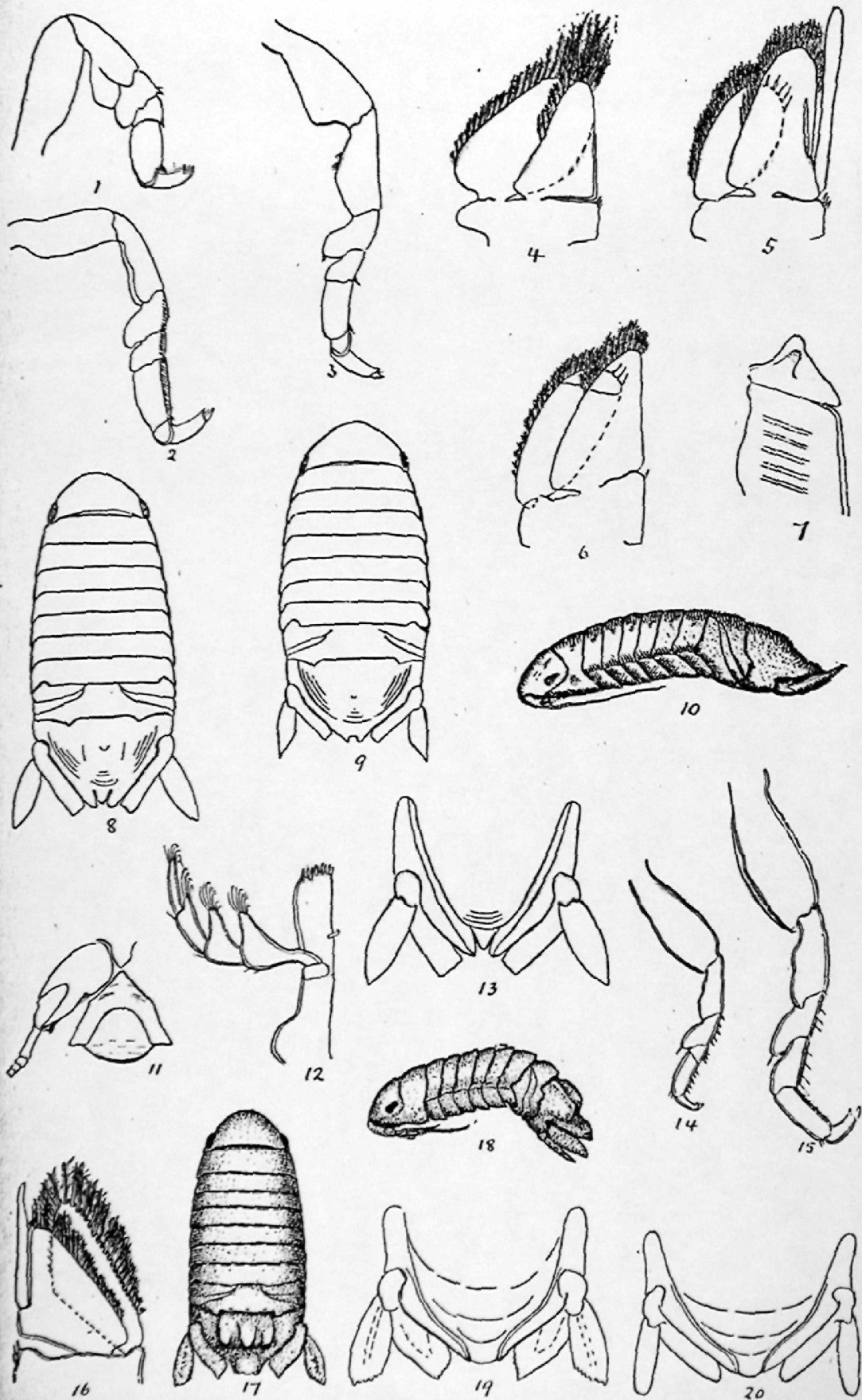
AMPHOROIDEA ELLIPTICA, n. sub. gen., n. sp.





MORULOIDEA LACERTOSA, n. gen., n. sp.

DYNAMENOPSIS OBTUSA, n. gen., n. sp.

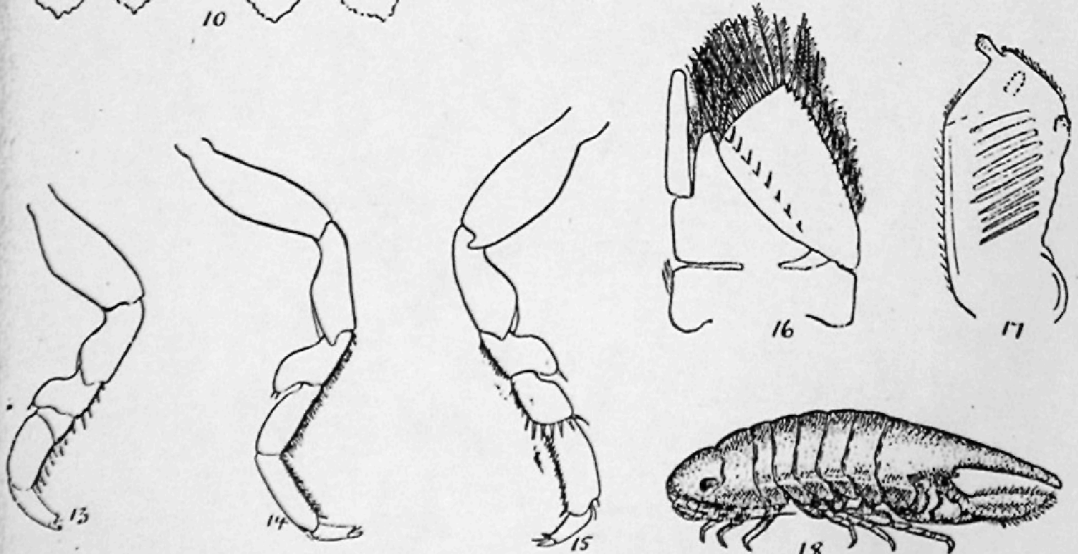
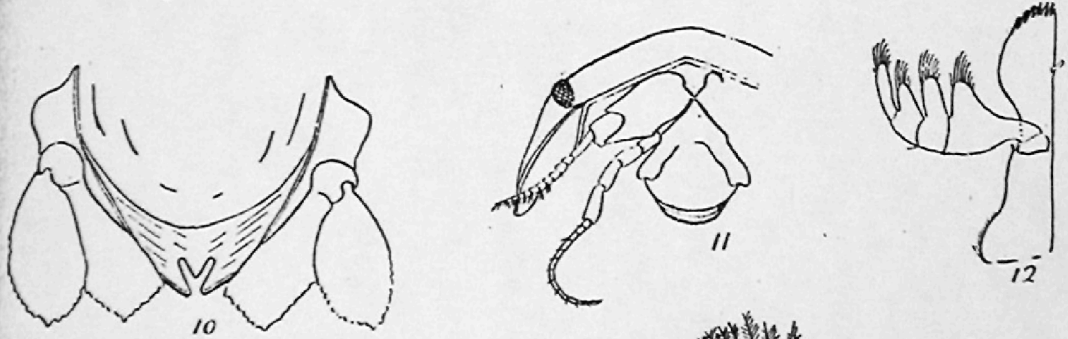
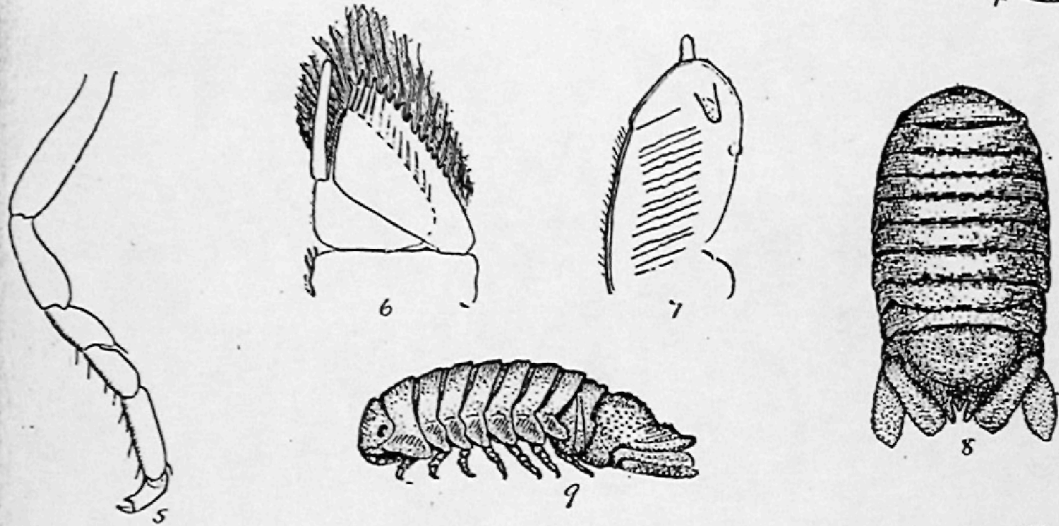
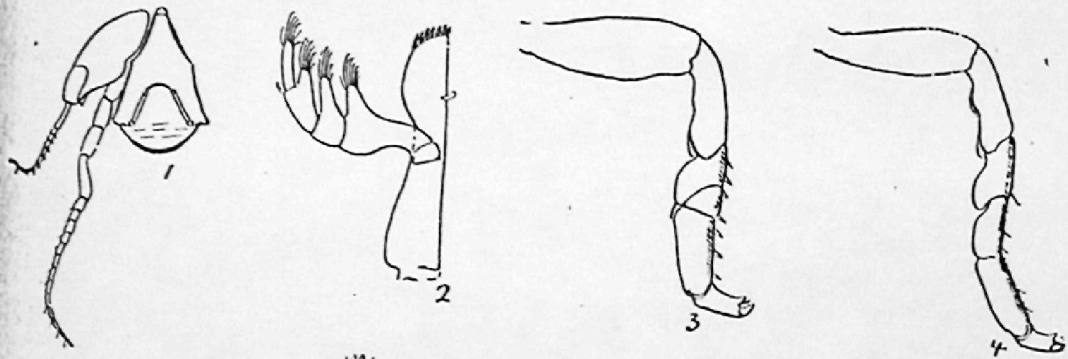


DYNAMENOPSIS OBTUSA (continued).

CIRCEIS TRIDENTATA.

CIRCEIS TRILOBATA, n. sp.

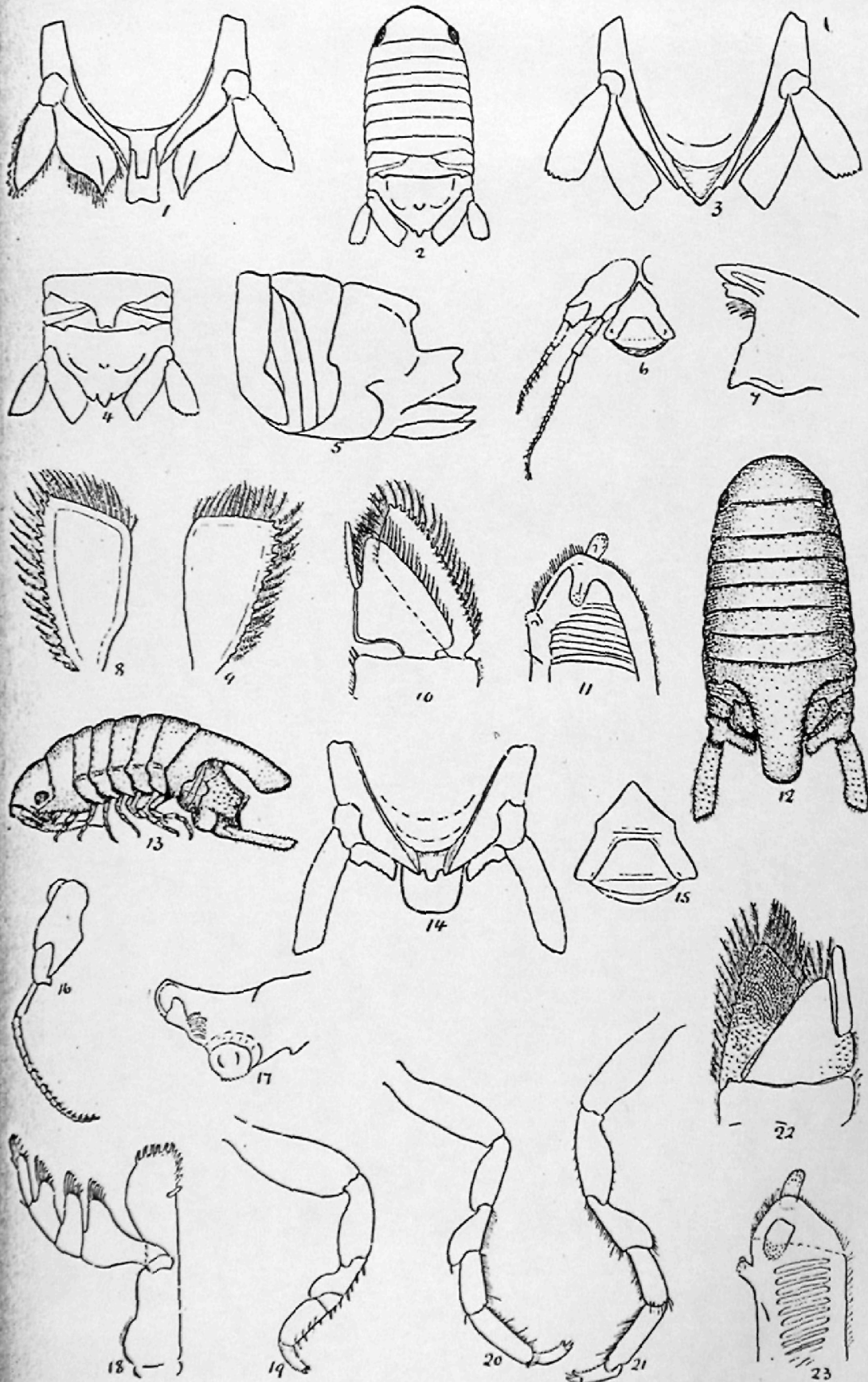




CIRCEIS TRILOBATA (continued)

CIRCEIS OBTUSA, n. sp.

HASWELLIA EMARGINATA, Haswell.



HASWELLIA EMARGINATA (continued.)

HASWELLIA CILICIOIDES, n. sp.