XXXI.—*On a new Species of Coral-infesting Crab taken by the R.I.M.S. 'Investigator' at the Andaman Islands.*

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[Plate VIII.]

The species described below is an interesting addition to a small family of crabs which take up their abode on living corals, thereby causing abnormal growth in the latter, with the production of a partially closed chamber or cavity in which the crab is finally imprisoned. For its discovery we are indebted to Major A. R. Anderson, I.M.S., formerly Surgeon-Naturalist of H.M. Indian Marine Survey Steamer 'Investigator,' who as far back as 1899 forwarded specimens to the present writer.

The new species exhibits very striking sexual dimorphism; the dwarfed male, which is less than one fourth the size of the female, reaching a total length of 1·25 mm., a length which probably constitutes a record for diminutive size among adult Decapod Crustacea. Another unique peculiarity of the male is his habit of attaching himself to the ventral surface of the female, thus suggesting a comparison with the condition existing in so many of the parasitic Crustacea belonging to lower groups, though the more or less temporary nature of this attachment has not led to any degeneration in the case of the male crab. In some at any rate of the parasitic Crustacea, e. g. *Bopyrus*, the great reduction of the male has perhaps arisen as a result of the female taking up her abode in a confined space, and here, as in so many other animal groups, similar habits have produced similar structural peculiarities in genera not connected by near relationship.

There can be little doubt that the coral-infesting crabs are more common than the published records of their occurrence would lead one to suppose, and both their small size and peculiar habitat have led to their being overlooked by collectors. They have hitherto only been recorded from the Hawaiian Is. (*Stimpson, Verrill*), Red Sea (*Heller*), Réunion (*A. Milne-Edwards*), Philippine Is., and an undescribed form from the West Indies (*Semper*), and Torres Straits (*Calman*). On the other hand, deformities on coral attributed to these crabs, which were first aptly compared to plant-galls by Ehrenberg*, have been described by numerous writers from

* Ehrenberg, in his work on the Corals of the Red Sea, refers to a small "Pagurus" which forms "galls" on *Seriatopora*. The only

widely separated localities in the Indo-Pacific region. The previously known species are two in number, viz. *Hapalocarcinus marsupialis*, Stimpson, and *Cryptochirus coralliodytes*, Heller; and Semper, who has studied both alive, has given, in 'The Natural Conditions of Existence as they affect Animal Life' (1881), an account of the malformations which they produce on living coral.

Hapalocarcinus was originally described, somewhat imperfectly, by Stimpson (Proc. Boston Soc. Nat. Hist. vol. vi. 1856–59) from specimens "found clinging to the branches of living Madrepores, at the depth of one fathom in the harbour of Hilo, Hawaii, March 1856." It is roughly figured by Semper, who describes the "galls" which it produces on branching corals belonging to the genera *Sideropora*, *Seriatopora*, and *Pocillopora*. An upward growth of coral is formed on either side of the crab, and in time the latter becomes surrounded and enclosed so that it cannot escape. Two fissures or slits at opposite ends of the "gall" serve for the entrance and exit of water, and remain open so long as the crab is alive. More recently *Hapalocarcinus* has been fully described and figured by Calman (Trans. Linn. Soc., ser. 2, Zool. vol. viii. 1900), who gives a valuable *résumé* of previous work on the coral-crabs.

Cryptochirus was first described by Heller from the Red Sea ("Beitr. z. Crust. Fauna d. roth. Meeres," SB. Akad. Wien, xliii. (1) 1861), where it was found inhabiting holes in coral. According to Semper it lives only in massive corals, such as *Goniastræa*, *Astræa*, and *Trachyphyllia*, on which it does not form "galls," but lives simply in funnel-shaped cavities or cylindrical pits due to arrested upward growth in the coral. With regard to the habits of the crab, Semper makes the interesting statement that the cavities or pits "are never closed during the lifetime of the crab, so that it certainly would be able to quit its position. Nevertheless it as certainly does not do so; but the species I have observed living thrust the fore part of their bodies very far out of their peculiar cave-dwellings, so that only their pouches, *i. e.* the hind part of the body, remained within." The species described by A. Milne-Edwards under the name of *Lithoscaptus paradoxus* (in Maillard's 'Notes sur l'Isle de la Réunion,' 2e éd. 1863, ii. Annexe F, p. 10) is apparently, as has been pointed out by both Paulson and Calman, identical

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Pagurid which, so far as I know, inhabits coral is *Troglopagurus manaarensis* of the present writer (Trans. Linn. Soc., ser. 2, Zool. vol. v. pt. 10, 1893); but I am unable to state if it causes abnormal growth.

with or closely allied to *Cryptochirus coralliodytes*. Calman has shown that *Hapalocarcinus* and *Cryptochirus* must be placed in the same family, and for this has proposed the name Hapalocarcinidæ, in place of A. Milne-Edwards's term "Lithoscaptes," as the latter is based on a synonym of *Cryptochirus*, the later described of the two genera.

The females of *Hapalocarcinus* and *Cryptochirus* agree in their elongated form, and in the possession of a more or less extended semi-membranous abdomen, which forms a brood-pouch for the eggs; in the former genus the abdomen is loosely bent under the cephalothorax, while in the latter, owing to its greater extension, the eggs are freely exposed below. In both genera there are striking peculiarities in the external (third) maxillipedes, which are widely separate, and thus leave a considerable portion of the enlarged buccal cavity exposed. The ischial joint is wide and has a large rounded internal lobe, while the merus is greatly reduced and resembles the three terminal joints; the exopod is reduced to a rudiment. In spite of superficial resemblances to certain of the Anomura, the position of the female sexual openings on the sternum shows that the family must be relegated to the Brachyura. The general elongation of the body is evidently an adaptation to the narrow space in which the crab is confined, and the greater exposure of the eggs than is usual in the Brachyura, is perhaps due to the increased difficulties which would be experienced in their aeration, and diminished need for protection in such an unusual dwelling-place. The general softness of the integument, more particularly of the abdomen, in both genera, is a feature which they share with many of the burrowing or specially protected forms.

While the male of *Hapalocarcinus* is still unknown, that of *Cryptochirus* is noteworthy for the great reduction in size which it has undergone, and this is particularly the case in the new species about to be described, a reduction which is probably an adaptation to the peculiar habitat. With the female ensconced in a tunnel-like cavity closed at one end, from which she is unable to escape, reduction in the size of the male would obviously be of great advantage to the species; but so little is known as to the relation of the female crab to the dwelling, that her inability to exhibit free movement in the tunnel can only be conjectured. Further observation is necessary to determine whether or not each female is generally accompanied by a male, but it seems highly probable that the male, on account of his small size, is able to pass freely from one tunnel to another. While

the two sexes have thus simultaneously undergone modification in different directions, the general appearance of the male suggests that he is less modified than the female, and consequently any attempt to determine the relationships of the anomalous family Hapalocarcinidæ will probably have to be based largely on the characters of the male.

In more than one account these crabs have somewhat loosely been referred to as parasites on the living corals, whereas there is no reason to suppose that the condition is one other than that of commensalism. There is nothing to indicate that they obtain any part of their nutriment at the expense of the coral colony, though doubtless the crab deprives the polyps of many food-particles which would otherwise have fallen to their portion. Stimpson's suggestion that *Hapalocarcinus* feeds upon the coral polyps is negatived by the observation of Semper that colourless polyps exist on the inner surface of the "gall."

Family Hapalocarcinidæ.

Cryptochirus dimorphus, sp. n. (Pl. VIII.)

Characters of the female.—The carapace is elongated and practically four-sided, with the length less than twice the breadth; the surface is everywhere roughened by short acute spinules with rather broad bases, which are more crowded together posteriorly, but somewhat reduced in size near the hind margin; in some cases on the posterior fourth or so of the carapace the spinules are represented by small crowded granules. The regions of the carapace are not defined, and the surface is practically level, with the exception that the gastric region is sometimes slightly circumscribed, and a slight hollow on either side, in which the spinules are comparatively few, separates it from the hepatic regions. The carapace is slightly convex from side to side and distinctly convex from end to end; when the crab is viewed from the lateral aspect, the greatest height is seen about the middle of the branchial regions or a little behind the middle of the carapace. The anterior or frontal margin has four subequal, equidistant, rounded, spinule-capped lobes; the two submedian or, properly speaking, frontal lobes project forwards to a slightly greater extent than the other pair situated at the antero-lateral angles of the carapace. The amount of projection of the four lobes, or, to state the same fact in another way, the extent of the three intervening indentations, varies in different individuals; in most cases

the indentations which lodge the eyes extend further into the carapace than the median indentation. All four lobes, but especially the frontal ones, carry moderately large spinules on their upper surface. The gap between the frontal and antero-lateral lobe on either side is occupied by the eye, which carries several spinules on the inner surface of the stalk, near the corneal margin. Immediately in front of the frontal lobes are seen the prominent and spinulose basal joints of the antennules, with their folded terminal joints nearer the middle line. In the comparatively narrow interval, seen from above, between the basal antennular joint and the eye on each side is found the small antenna with its rudimentary flagellum. The lateral margins of the carapace, which form a continuous line on either side, are subparallel for the first third or so of their length, but have an outward convexity in the branchial regions; the posterior margin is about the same width as the frontal margin, and has a slight forward curve. The lateral margins of the carapace are everywhere spinulose, but spinules are scarcely represented on the posterior margin. The pterygostomial regions are without spinules and terminate below each eye-stalk in a pointed angle.

Viewed from below the large basal antennular joints lie parallel to one another, separated by an interval in which the two terminal joints of each antennule are perpendicularly folded; spinules are present on the basal joints and reach a comparatively large size towards their apices. The antenna occupies a narrow interval between the basal antennular joint and the eye on each side; the peduncle is composed of three free joints, of which the first, articulated to the edge of the epistome, is longer and stouter than the other two, and carries two or three small spinules at its lower distal end; the flagellum is represented only by the merest rudiment and terminates in a few minute setæ. The eyes are placed immediately external to and practically parallel to the antennæ; the inner surfaces of the stalks are spinulose, and the spinules extend as far as the corneal margin. The edge of the pterygostomial region, contiguous to the insertion of the eye-stalk, shows a distinct indentation, but otherwise the orbit is deficient below. The epistome is somewhat hollowed out, owing to the projection of the pterygostomial angle on each side; the renal tubercle is distinctly visible below the first free joint (second true joint) of the antennal peduncle.

When the eyes, antennæ, and antennules are completely removed, a comparatively deep and continuous cavity

extends from side to side, the median portion of which lodges the antennules, which are incompletely separated by a projecting median spine springing from the epistome, while the outer portions represent the orbits. The orbit, as now seen, is a cavity with somewhat rounded outline, continuous internally with the space or fossette in which the antennule is lodged; the upper orbital margin is the rounded indentation between the submedian and outer lobe on the frontal margin of the carapace; the posterior and lower margin is formed by the notch in the pterygostomial edge already referred to, and terminates in the pointed pterygostomial angle or spine which lies immediately external to the basal antennal joint. The eyes, as already indicated, are not completely retractile into these orbits, for when viewed from below a large portion of their stalks is always visible. The antennular fossettes are continuous, and a separation is only faintly indicated by the median epistomial spine.

The epistome, which is not sharply demarcated from the palate, appears somewhat deeply excavated, owing to the prominence of the pterygostomial angles. The external or third maxillipedes are separated by a considerable median space, in the upper part of which the mandibles are partly exposed; the ischium is broad and suboperculiform, produced internally into a rounded lobe which extends well beyond the insertion of the merus; the merus is greatly reduced in size, being even slightly shorter though a little broader than the carpus, and it springs from a notch at the antero-external angle of the ischium. The exopod of the external maxillipedes is not visible in its usual position at the outer side of the appendage, and in more than one specimen no trace of it could be found; in one preparation, however, a minute filament was found concealed behind the coxal joint, which probably represents the missing exopod. The first and second pairs of maxillipedes are normal, with well-developed exopods.

The chelipedes and ambulatory legs are of moderate length, with a few spinules on the upper surface of the meral and carpal joints. The chelipedes are slightly longer than the first pair of ambulatory legs, as a result of the lengthening out of the four terminal joints; the propodus is more slender than the carpus, and its palmar portion is about one fourth longer than the dactylus; the fingers are slender, acutely pointed, and distinctly incurved. The ambulatory legs are moderately stout, and there is no such special diminution in thickness of their propodi as is noticeable in the chelipedes. The legs gradually diminish in size on passing backwards,

but there is no special reduction in regard to one or other of the last two pairs; the dactyli are short, stout, and strongly curved, with a yellow horny apex to each.

The sternal plastron is subpentagonal in outline, and is not specially excavated mesially; the posterior margins of the sternal pieces opposite the penultimate pair of legs meet together in the middle line, and thus isolate the small triangular sternal pieces of the last pair of legs, as the latter sternites do not reach the middle line. The openings of the oviducts are seen towards the inner limits of the sternal pieces belonging to the third pair of legs.

The abdomen is semi-extended and composed of seven distinct segments, including the telson, of which the first five are visible from above in the natural condition; in some cases the abdomen viewed from above is almost equal in length to the carapace. The first two segments are about equal in width to the posterior margin of the carapace, but from the third onwards there is a gradual increase up to the fifth, which is broader than the broadest part of the carapace. All the segments are smooth and semimembranous; their free edges form a thin continuous membrane which bounds a deeply concave subabdominal cavity or brood-pouch, in which the eggs are placed. The eggs are of large size for so small a species.

The average total length of the body, including the semi-extended abdomen, is about 5·5 mm.

Characters of the male.—The carapace is roughly four-sided, with the length about one and a half times the breadth; it is regularly arched, or convex, from end to end, less so from side to side, and the downward slope of the convexity is most marked at the extreme anterior end. The surface is glabrous and without spinules, but roughened by very minute tubercles; the margins are entire, with the exception of a few minute spinules near each antero-lateral angle and on the edge of the frontal lobes. In some individuals, though not in all, the submedian frontal lobes project further forwards than the antero-lateral angles of the carapace, and are somewhat closer together than in the female, with the result that the orbital notches are relatively wider; the frontal notch is shallow. The posterior margin of the carapace is straight in its median portion, while the lateral margins of the carapace have practically the same course as in the female. The lateral or protogastric portions of the gastric area are slightly elevated. The arrangement of the antennules, antennæ, and eyes, as seen from above, is similar to that in the female, with the exception that the spinules are almost obsolete on the basal antennular joints

and reduced on the eye-stalks; the eyes are relatively large.

The chelipedes and ambulatory legs are relatively better developed than in the female, but the spinules on the meral and carpal joints are almost obsolete; a few very minute spinules are visible on the upper surface of the palm. The propodus of the chelipedes is slightly wider than the carpus; the fingers are incurved, with acute apices, and are about equal in length to the palmar portion of the propodus. The ambulatory dactyli are strongly incurved, doubtless for attachment to the female, and their horny apices are very slender and acute; they are more than half the length of the relatively stout propodi.

The arrangement of the antennules, antennæ, eyes, and external maxillipedes, seen from below, is similar to that in the female. The basal antennular joint is somewhat laterally compressed, and, when viewed from the side, exhibits five or more terminal spinules.

The sternal plastron is somewhat similar in outline to that of the female. The male sexual openings are seen on the small sternal pieces belonging to the last pair of legs, and these pieces, as in the case of the female, do not meet together in the middle line; no grooves are visible in the neighbourhood of the openings.

All seven abdominal segments (including the telson) are distinct, and they gradually diminish in width from the third backwards to the telson, so that the general outline of the abdomen is triangular. The first abdominal segment, which is distinctly narrower than the hind margin of the carapace, and a portion of the second segment, are alone visible from above. Both pairs of sexual appendages are well developed, and the first pair extend as far forwards as the sternal pieces of the first pair of ambulatory legs.

The average total length is about 1·25 mm.

The species described above differs in the following important respects from *C. coralliodytes*, Heller. In Heller's species, which is of much larger size, the female measuring about 17·5 mm. in total length, and the male about 6·5 mm., the entire body is narrower; the regions of the carapace are more distinctly circumscribed, and the frontal lobes more prominent, with acuter apices. The chelipedes are more slender, and are shorter than the first pair of walking-legs; the propodal joint of the chelipedes is very short, and, judging from Heller's figure, is apparently not larger than the carpus; the last pair of legs are longer than the penultimate pair. The male abdomen is narrow and linear, with the proximal segments not wider than the distal ones. The

ischial joint of the outer maxillipedes is narrower, and the merus, which is almost double the length of the carpus, is prolonged at its antero-external angle into an almost spinose point; the exopod is a small leaf-like lobe distinctly seen in the usual position. In other respects the two species agree more or less closely. It may be that some of the above differences, more particularly those in the external maxillipedes, relative length of the different pairs of legs, and male abdomen, are of generic value, and that the new species may eventually require a new genus for its reception. At present, however, it seems safer to include it in *Cryptochirus*.

Locality.—Living in cylindrical holes in growing reef-coral, at a depth of 12 fathoms, on Invisible Bank, 40 miles off the east side of the southern extremity of the Andaman Islands.

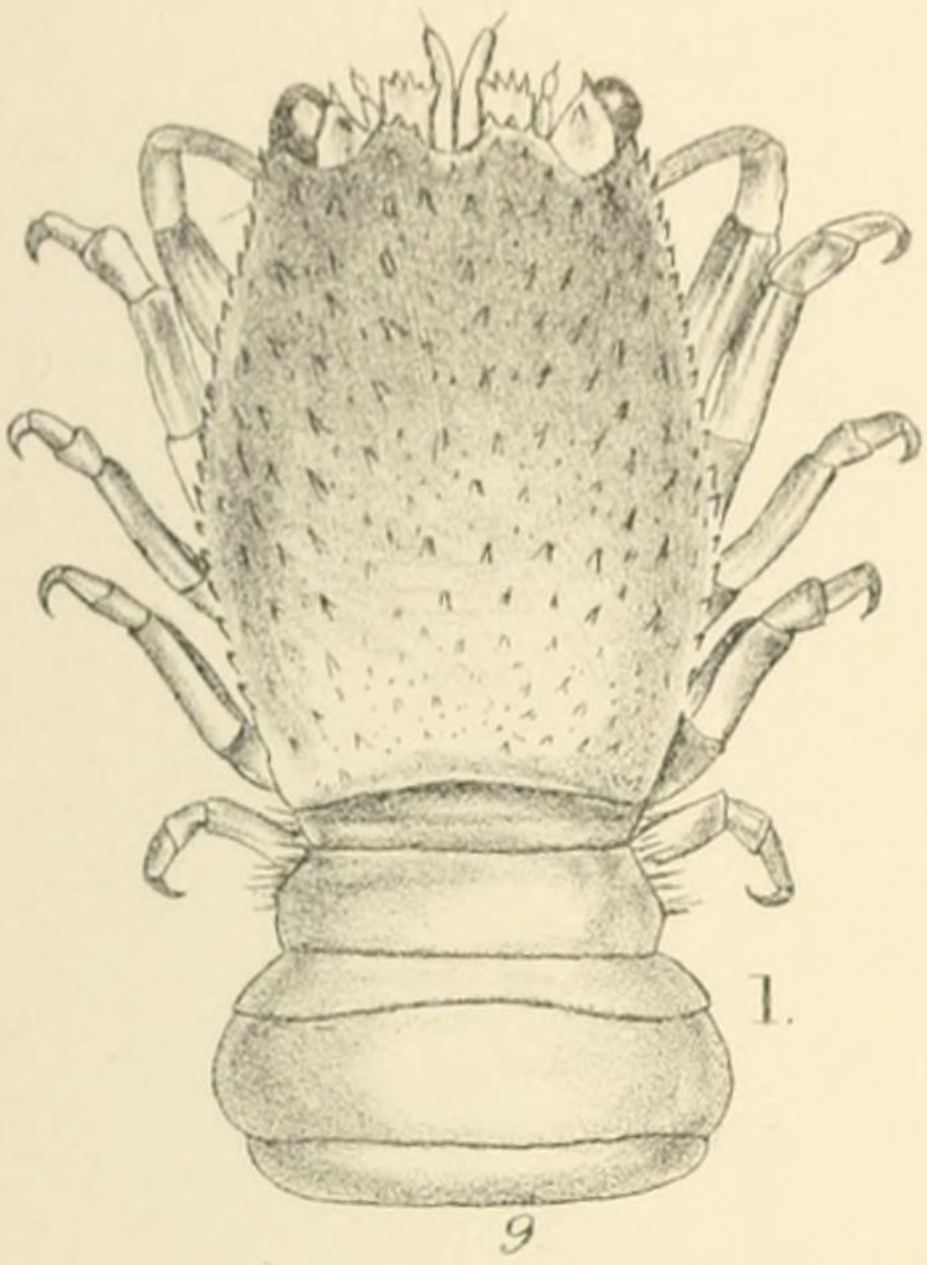
The following particulars were noted by Major Anderson at the time of capture. The crabs were found living in a large branching Madrepore, in cylindrical cavities, somewhat wider at the closed end than at the mouth, which latter was too narrow to permit of the exit of the female. The holes were most numerous near the extremity of the coral branches, but also frequently occurred at the points where the branches bifurcated. In the great majority of the cavities the two sexes were found together, the male generally sheltering under the female, attached to her ventral surface, but in some cases free. In a very few cavities careful searching revealed only the female, but as the crabs were obtained by fracturing the coral with a hammer, it was possible that some of the males disappeared during the process. The colour of the female during life is a dull yellow, while the male shows a mixture of dull brown and yellow.

In conclusion I would thank my friend Major Anderson for the opportunity thus afforded me of examining this interesting species.

EXPLANATION OF PLATE VIII.

Cryptochirus dimorphus, sp. n.

Fig. 1. Dorsal view of female. × 9.
Fig. 2. Ventral view of female showing male *in situ*. × 12.
Fig. 3. Cephalic region of female from below.
Fig. 4. Left external (third) maxillipede of female.
Fig. 5. Left chelipede of female.
Fig. 6. Second left leg (first ambulatory leg) of female.
Fig. 7. Sternum of female.
Fig. 8. Sternum of male.
Fig. 9. Abdomen of male.



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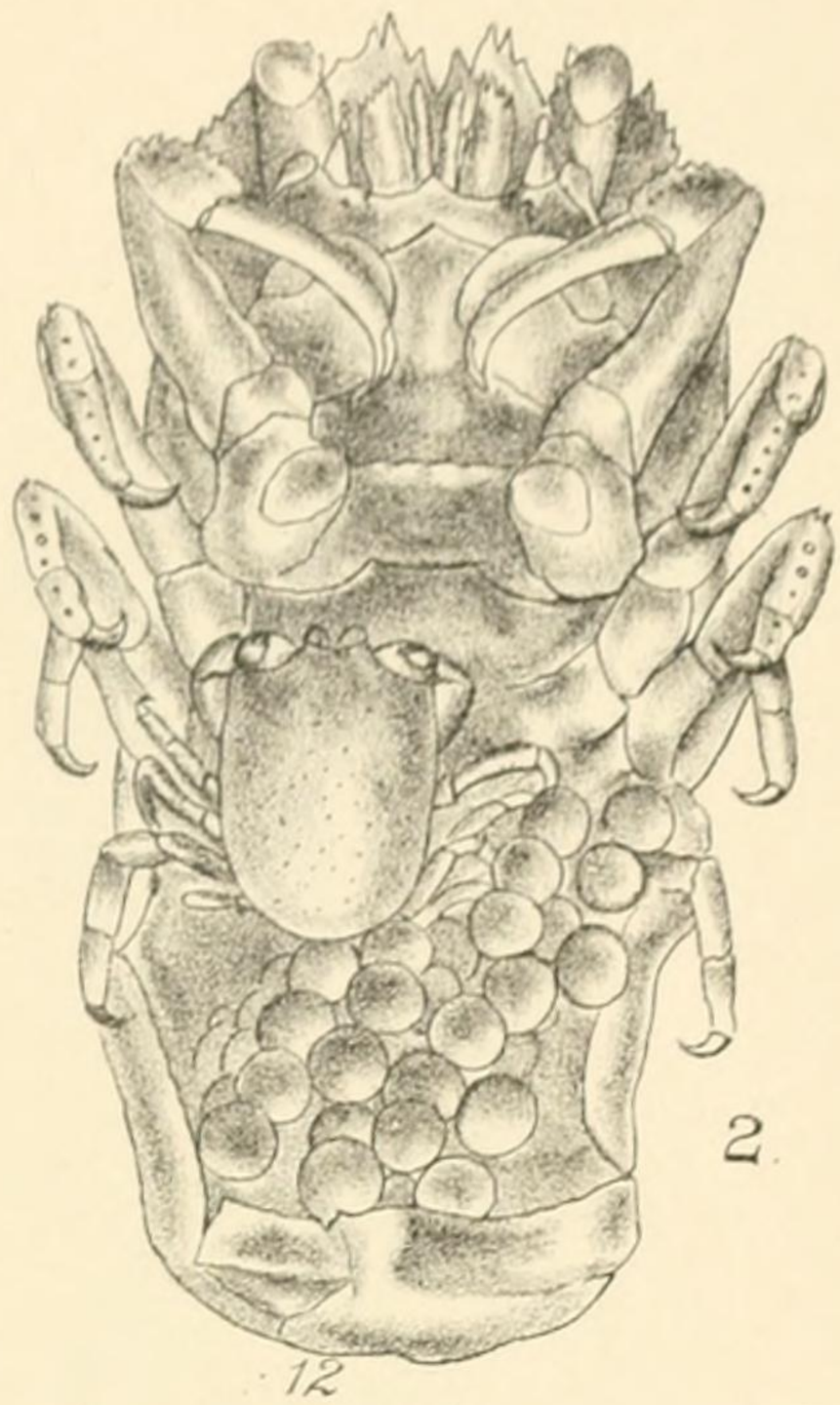

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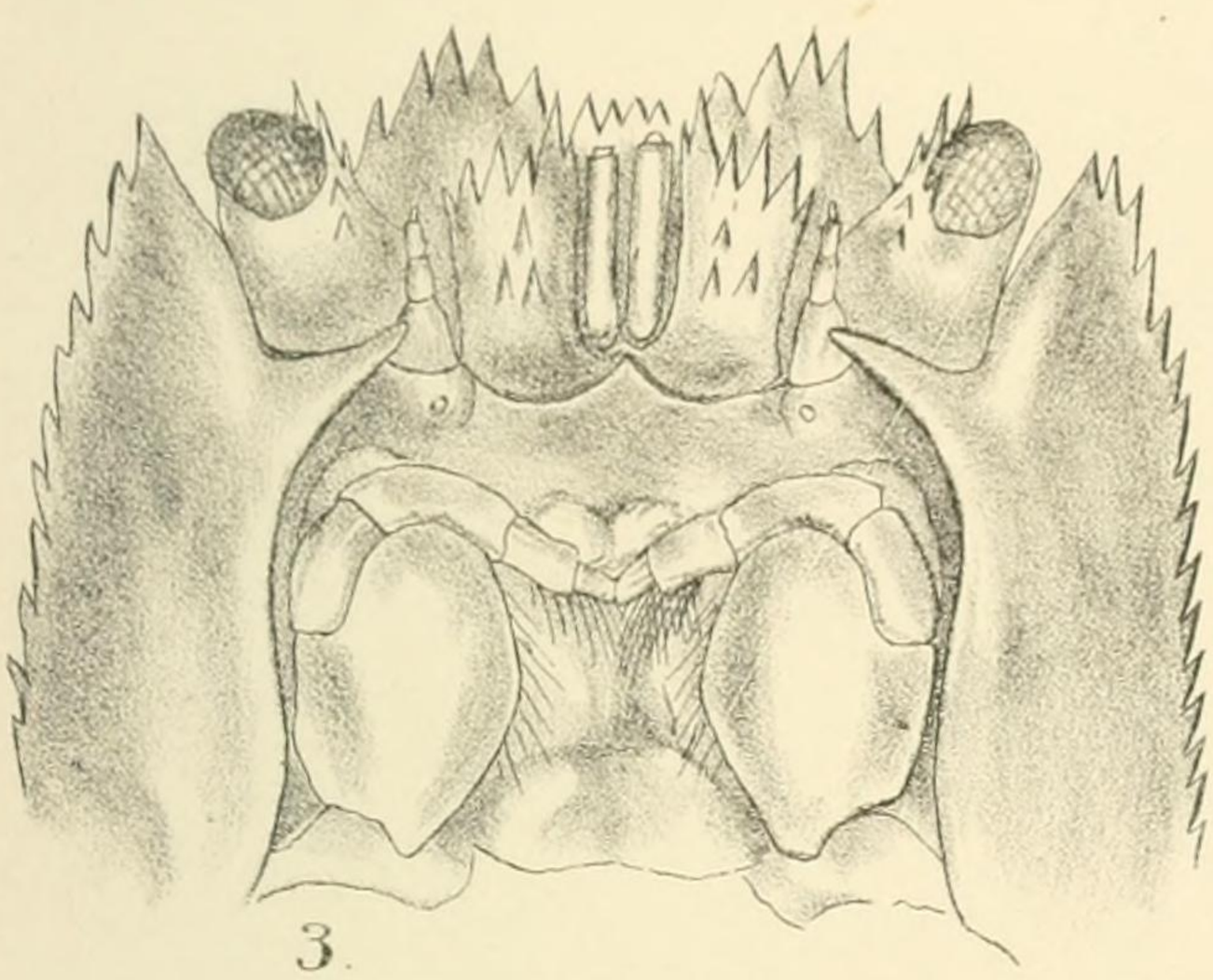

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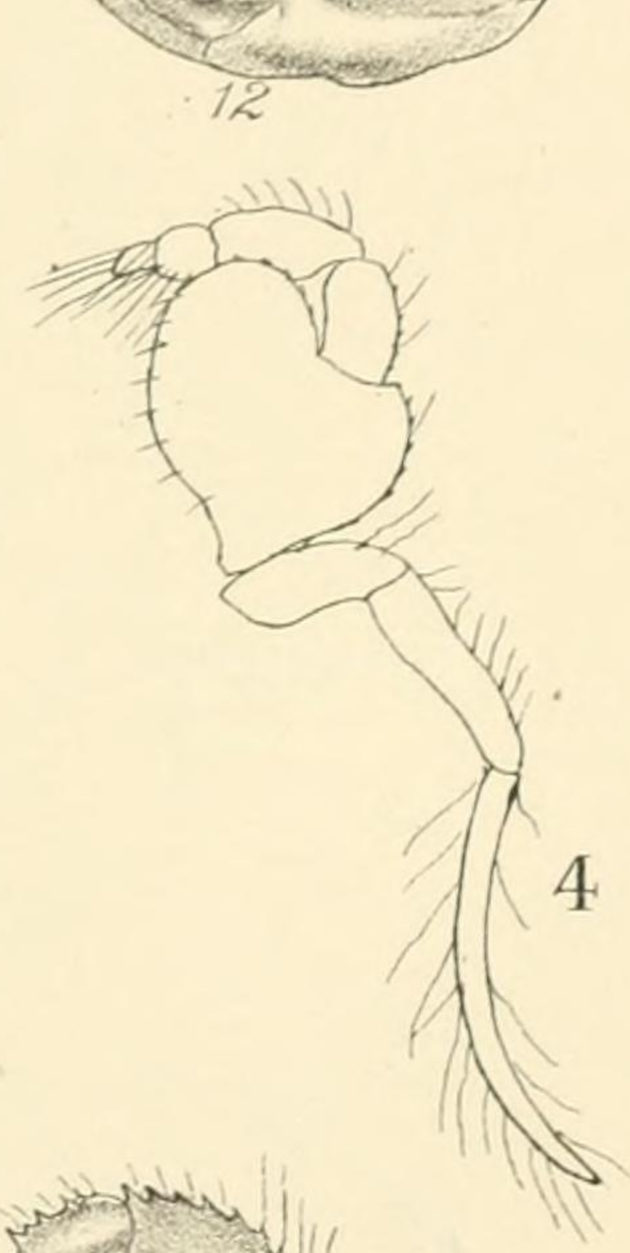

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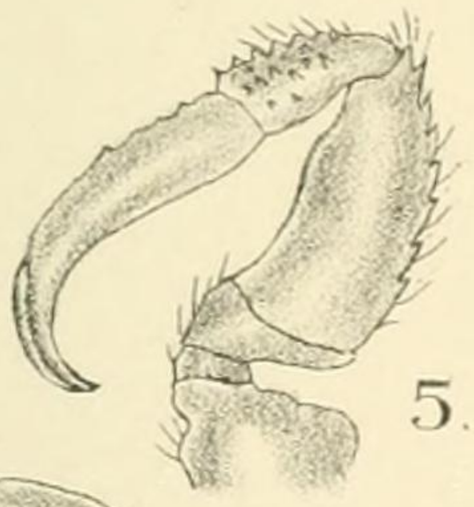

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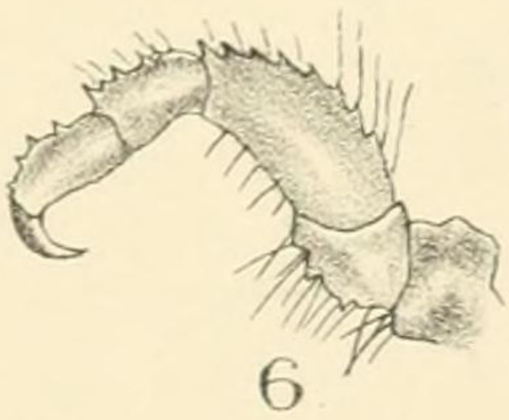

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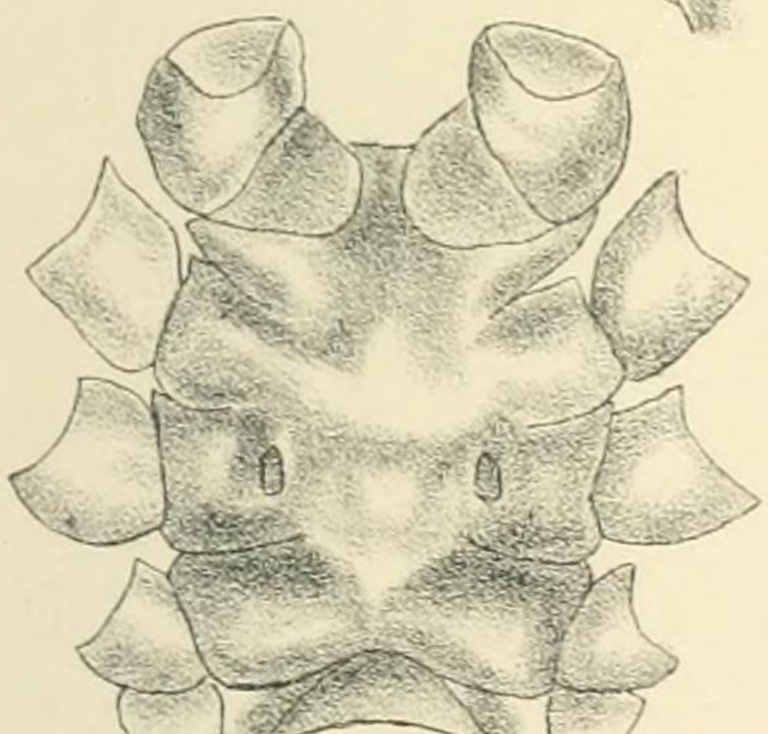

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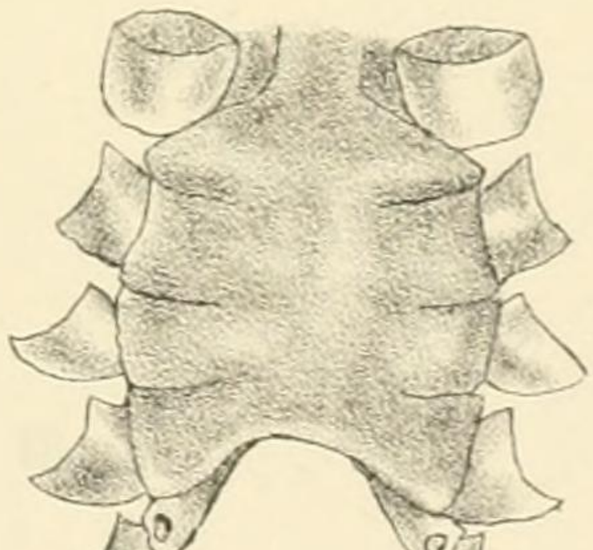

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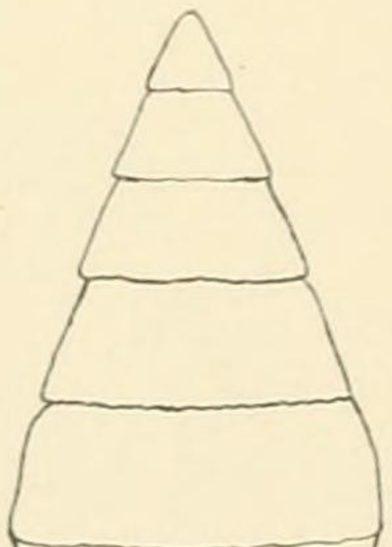

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J.R.H. delt.