EXPLANATION OF THE PLATES.

Talitriator eastwoodæ, gen. et sp. nov.

All the figures have been drawn with the aid of a Camera lucida.

Plate X.

Fig. 1. Antennule.
2. Antenna.
3. Upper lip.
4. Lower lip.
5. Maxillipeds.
6. Gnathopod 1.
7. Gnathopod 2.

Plate XI.

Fig. 8. Pereiopod 3.
9. Branchial appendage of Pereiopod 4.
10. Pereiopod 5.
11. Pleopod 3.
12. Sketch of pleon, showing comparative size of appendages.
13. Dorsal aspect of posterior part of body.
14. Uropod 3.
15. Telson.

9. The Genus *Engæus*, or the Land Crayfishes of Australia.

By G. W. Smith, M.A., Fellow of New College, Oxford, and E. H. J. Schuster, M.A., D.Sc., F.Z.S., Fellow of New College, Oxford.

[Received August 8, 1912: Read November 26, 1912.]

(Plates XII.–XXV.*)

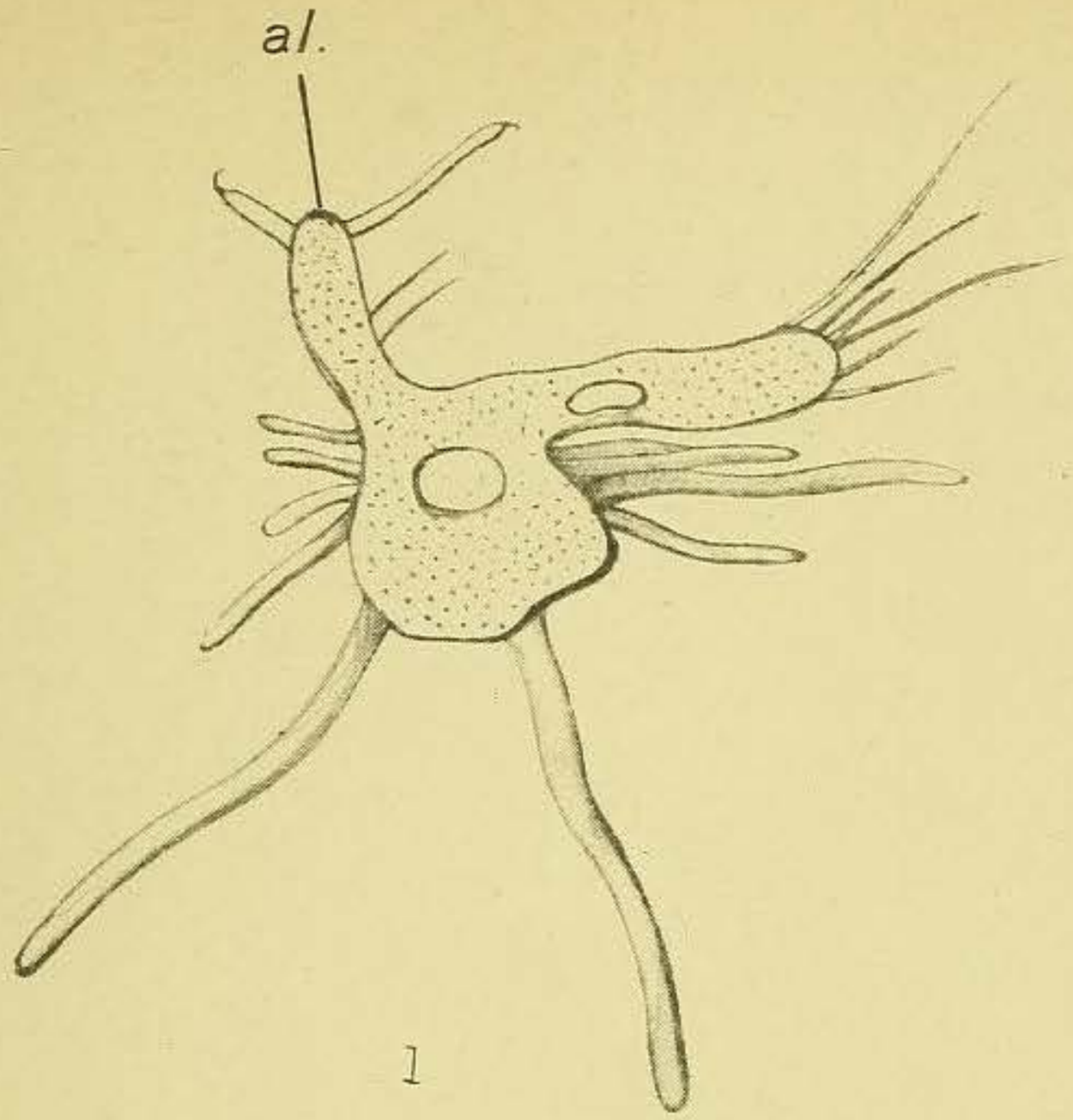
Index.

Introduction.

The existence of burrowing forms of Australian Crayfish, which live in underground tunnels excavated in damp soil, was first made known by Erichson, who described two species from Tasmania and placed them in a new genus, *Engæus*†. Besides the two Tasmanian species, a very large collection of these burrowing Parastacidæ from Victoria has gradually accumulated in the collection belonging to the Melbourne Museum, chiefly through the activity of Messrs. Kershaw and Fulton, and the present memoir is founded on this large collection and also on specimens which one of us obtained in Tasmania in 1907–8.

Before proceeding to the description and classification of this

* For explanation of the Plates see pp. 126, 127.
† Archiv f. Naturg. vol. xii. 1846, p. 102.



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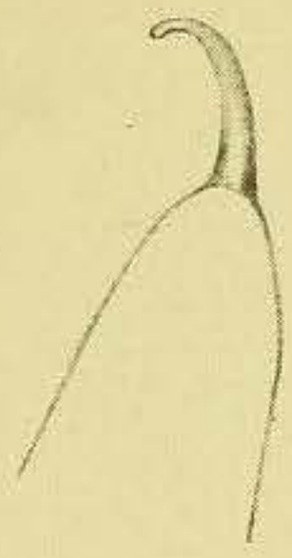

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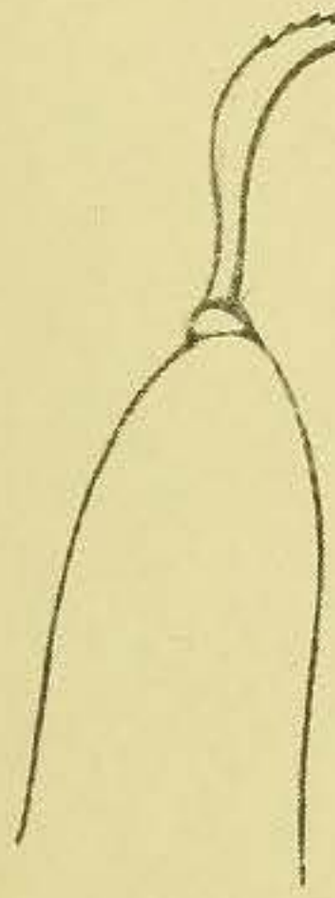

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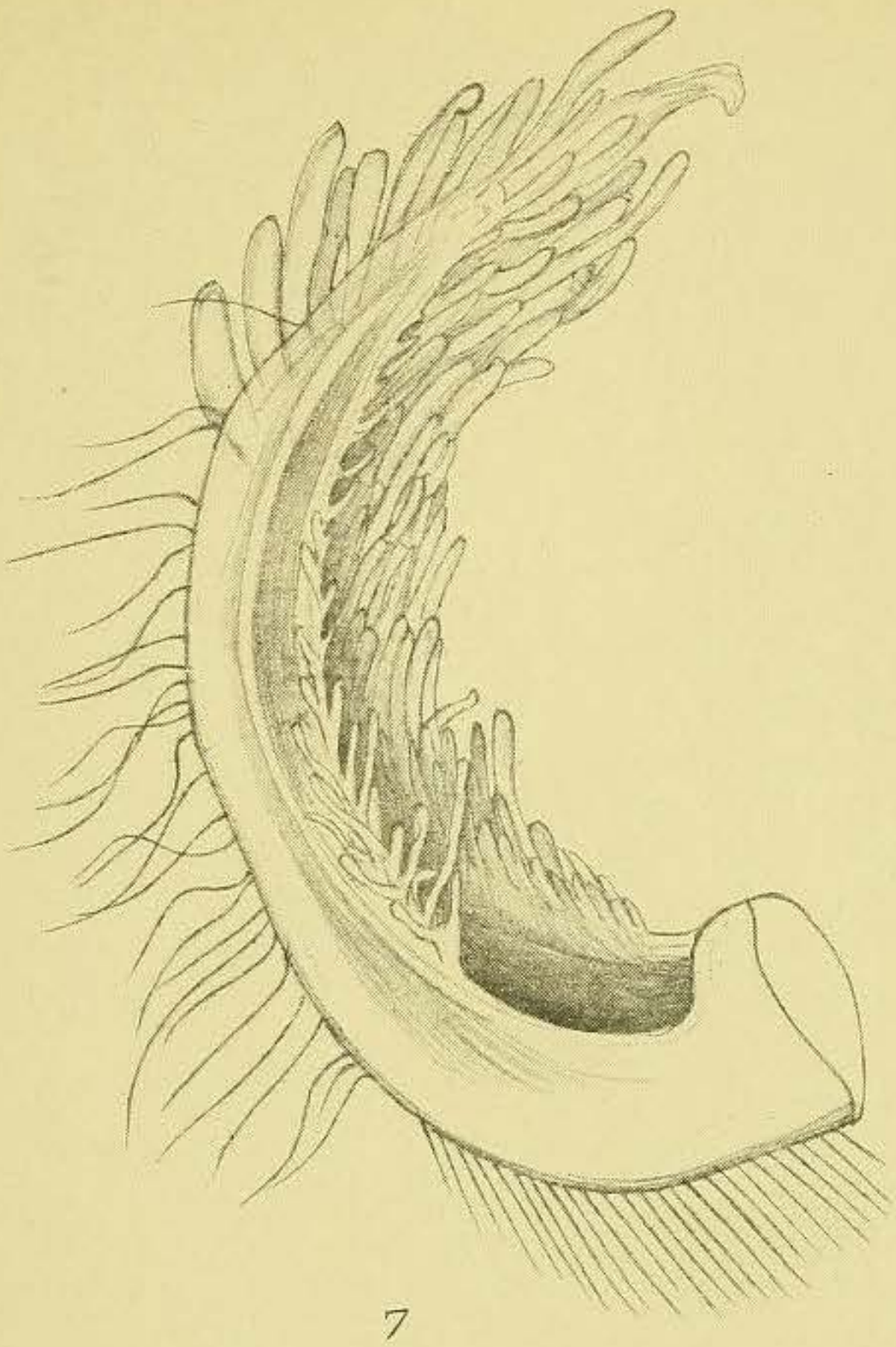
GILLS OF ASTACOPSIS AND PARACHÆRAPS.



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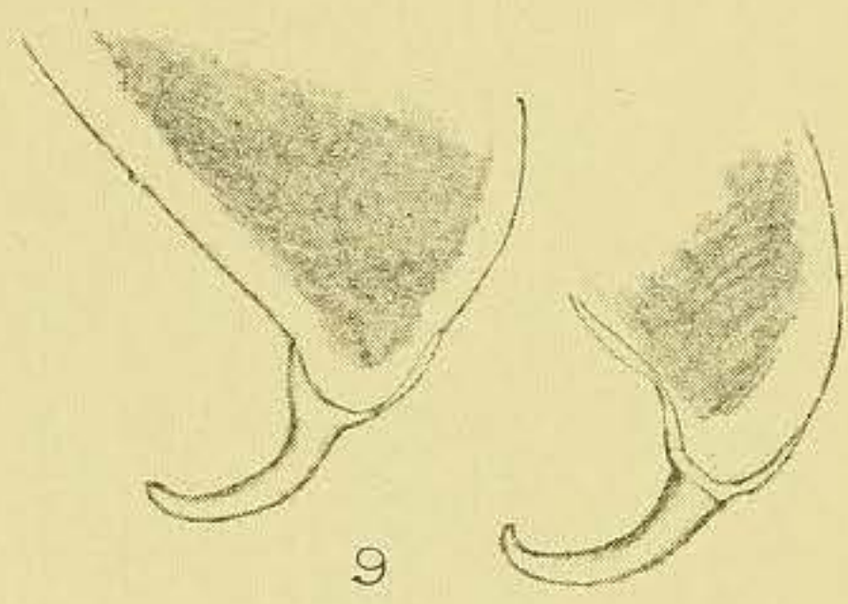

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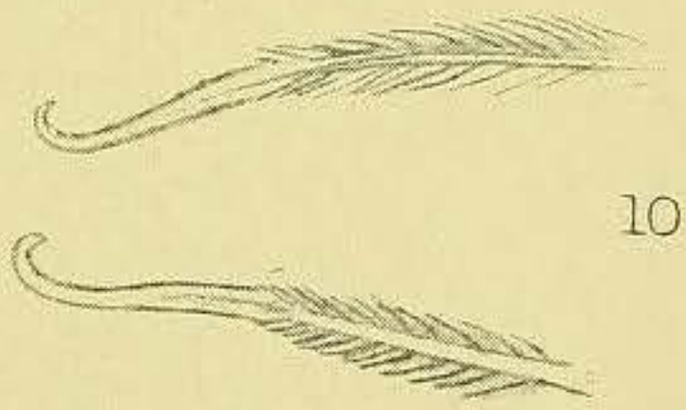

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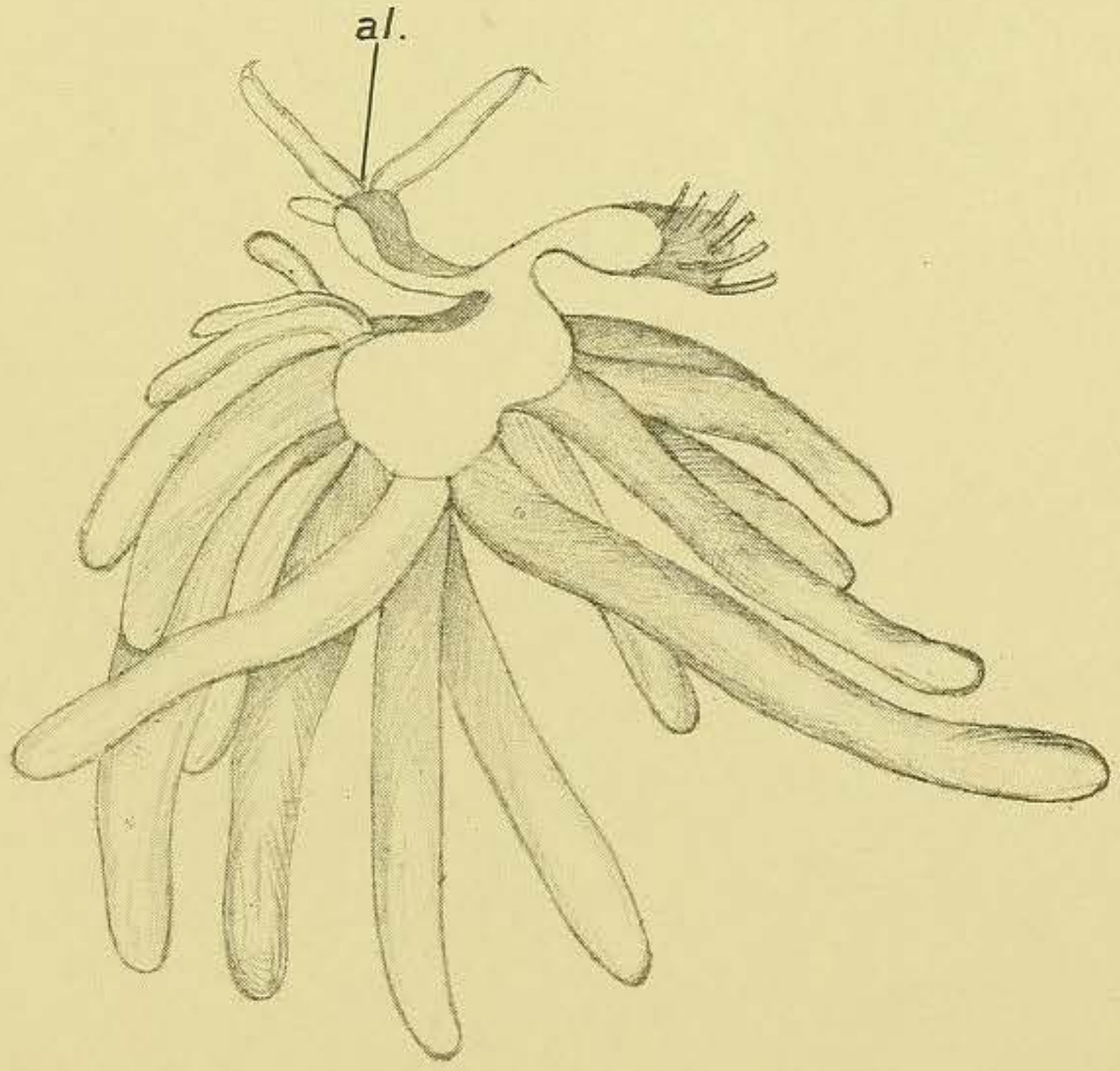

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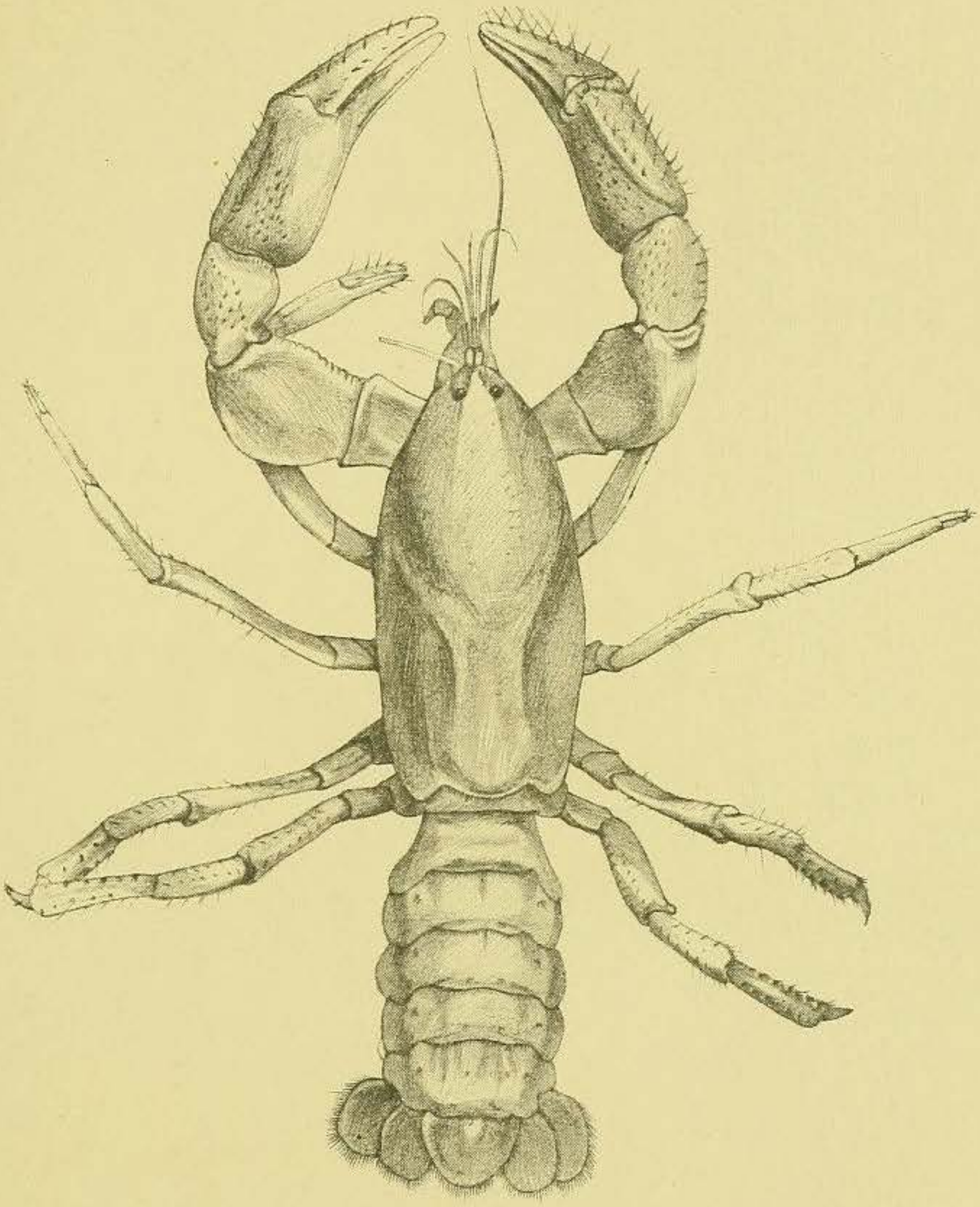
GILLS OF ENGÆUS CUNICULARIUS.



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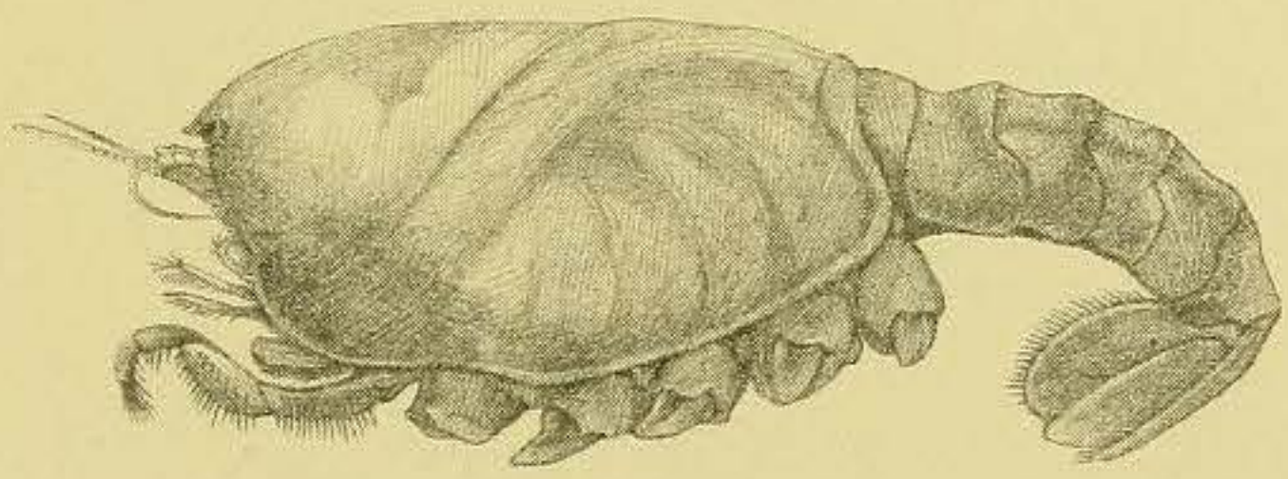

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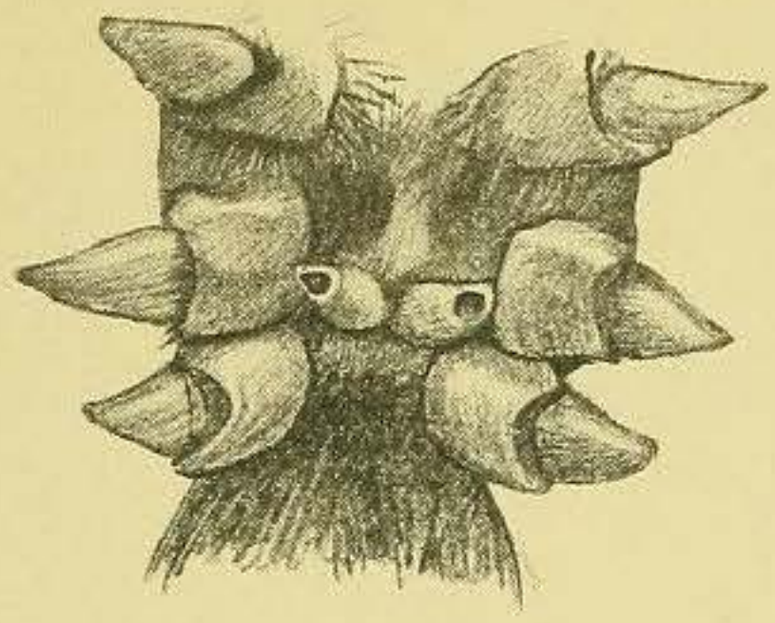
ENGÆUS FOSSOR.



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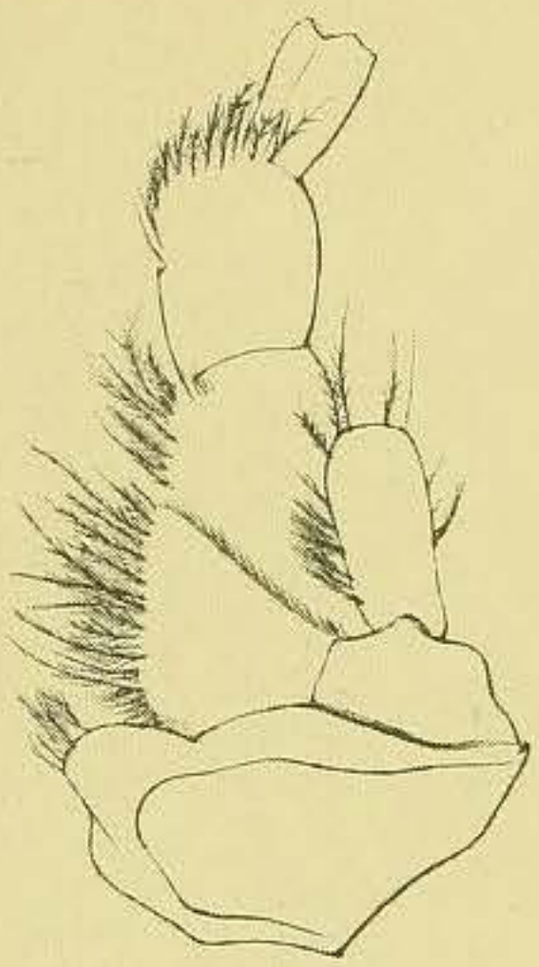

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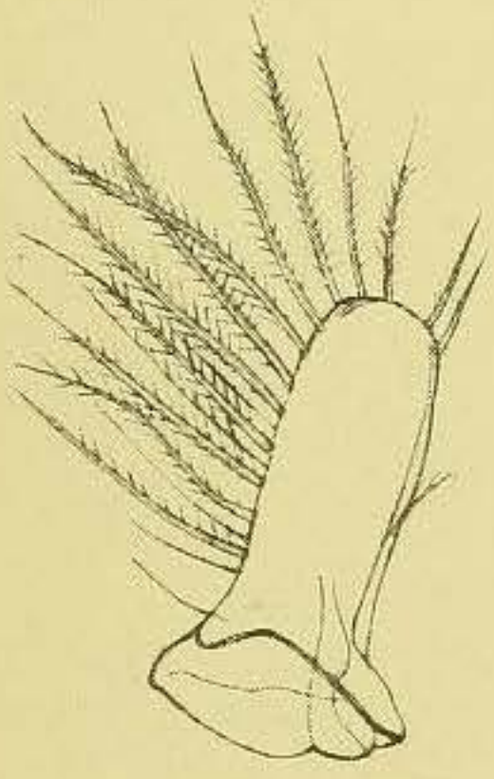

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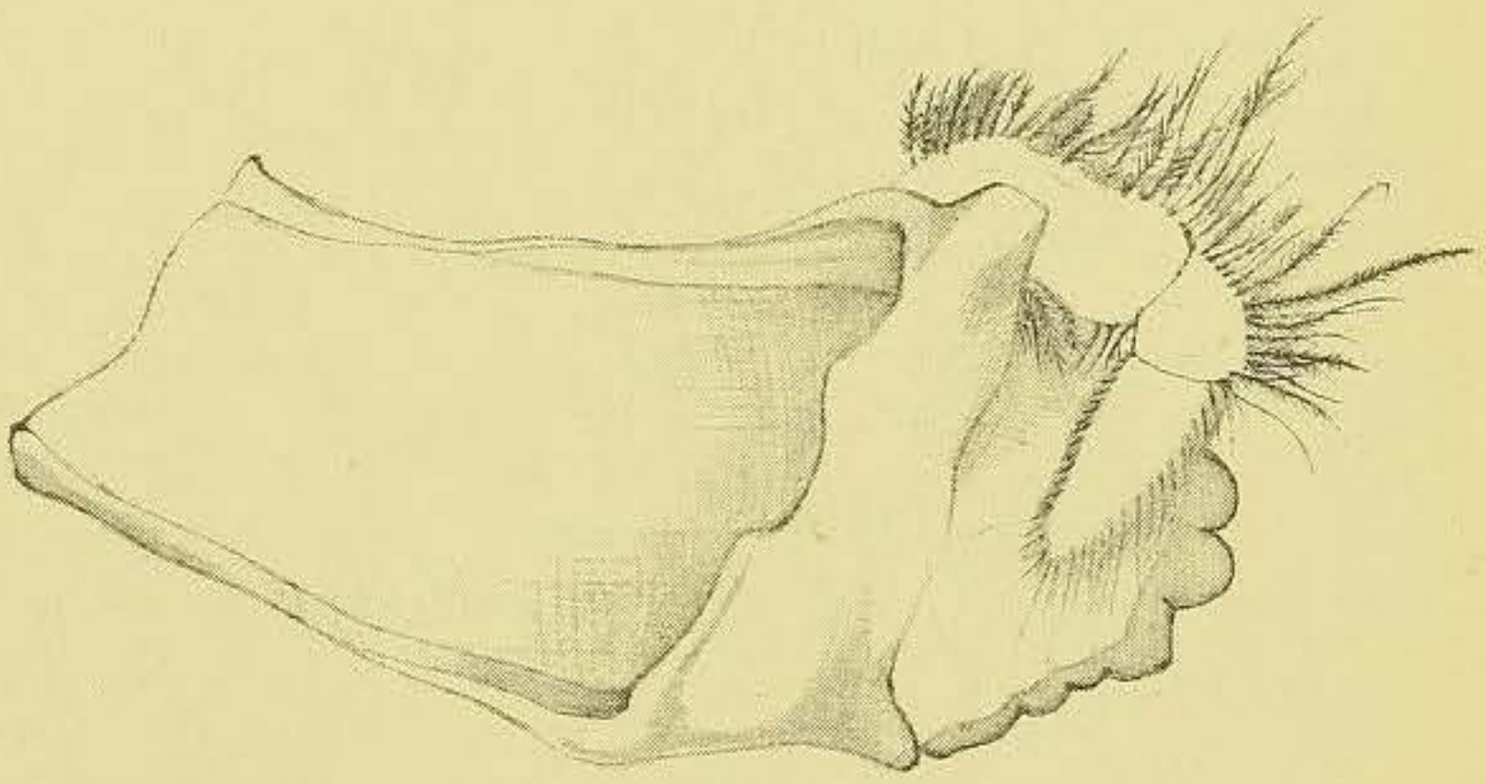

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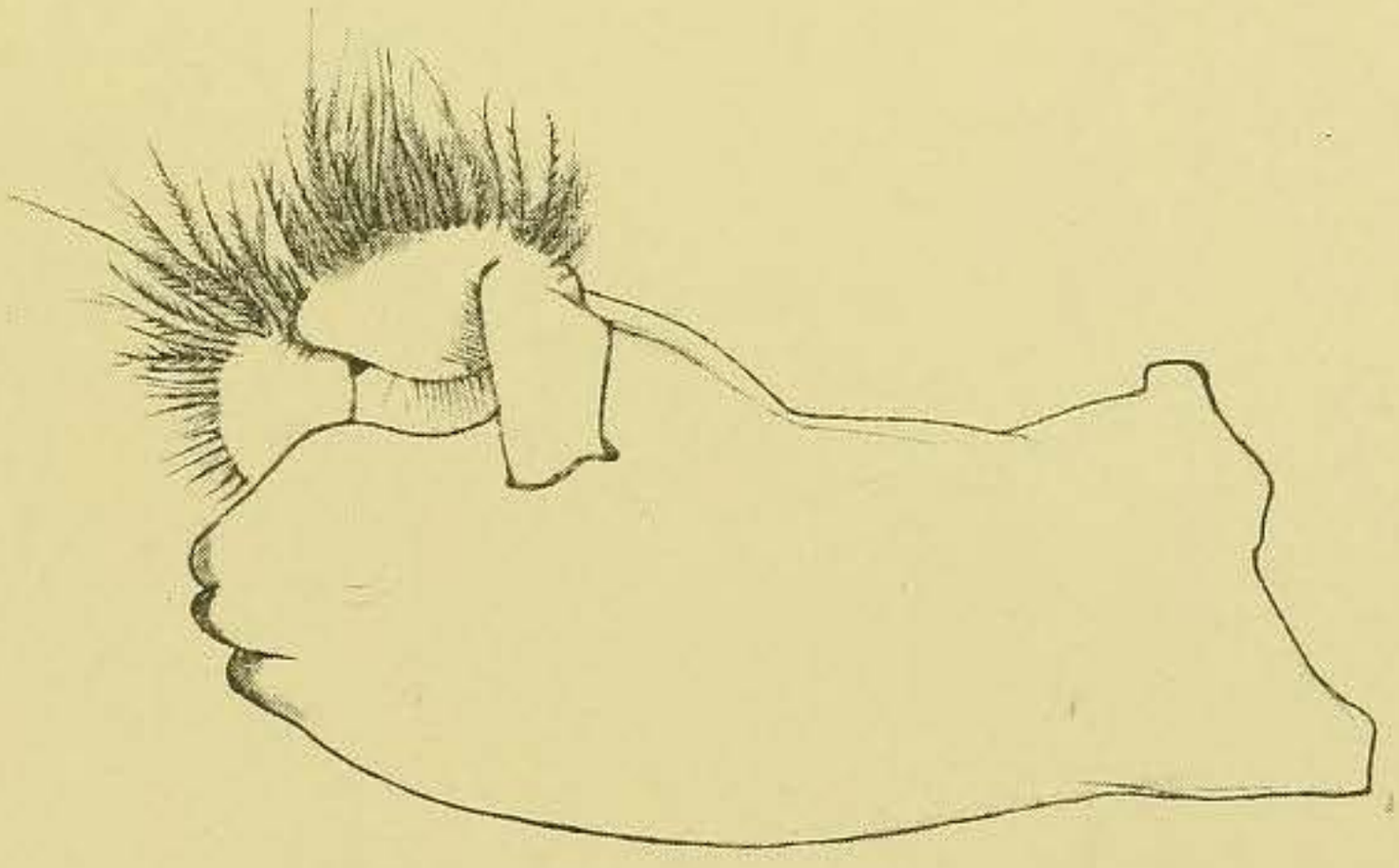

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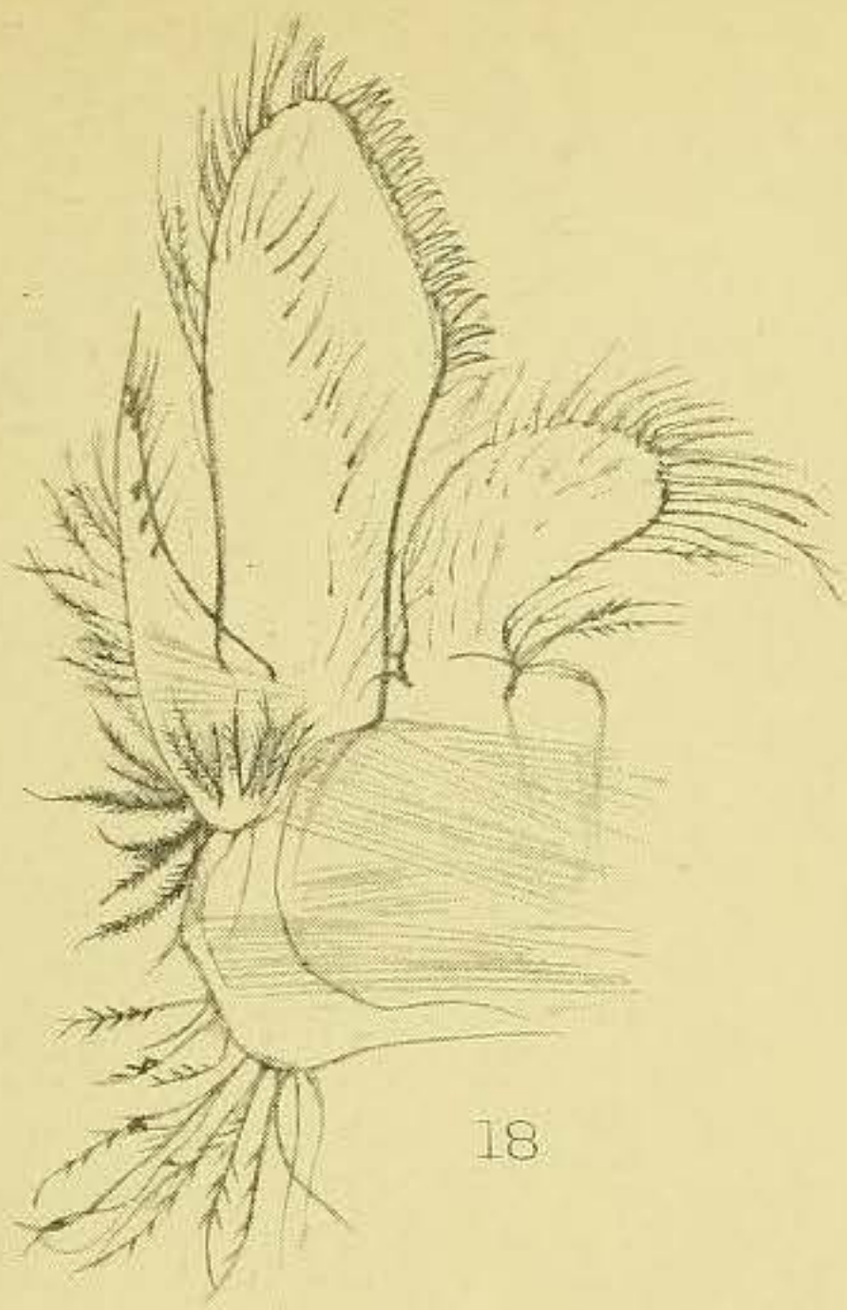
ENGÆUS FOSSOR.



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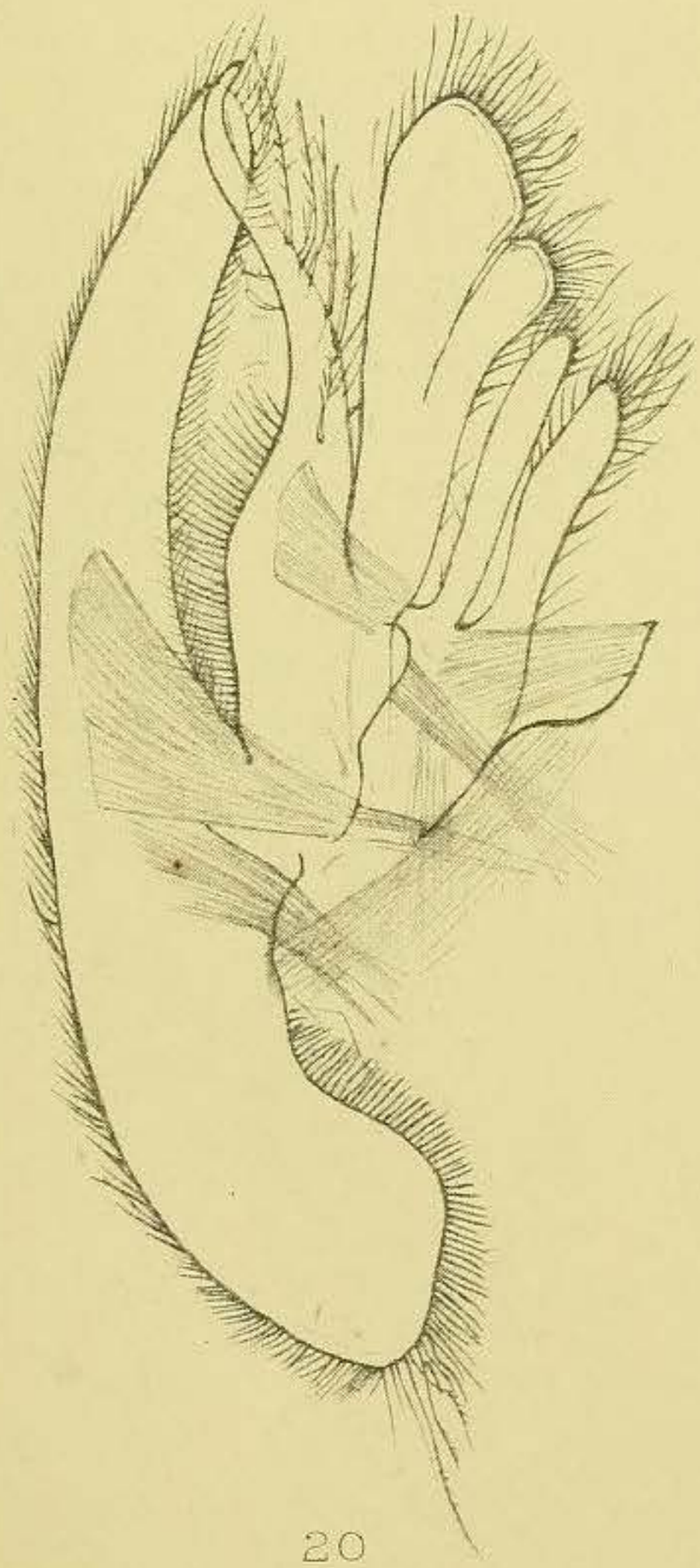

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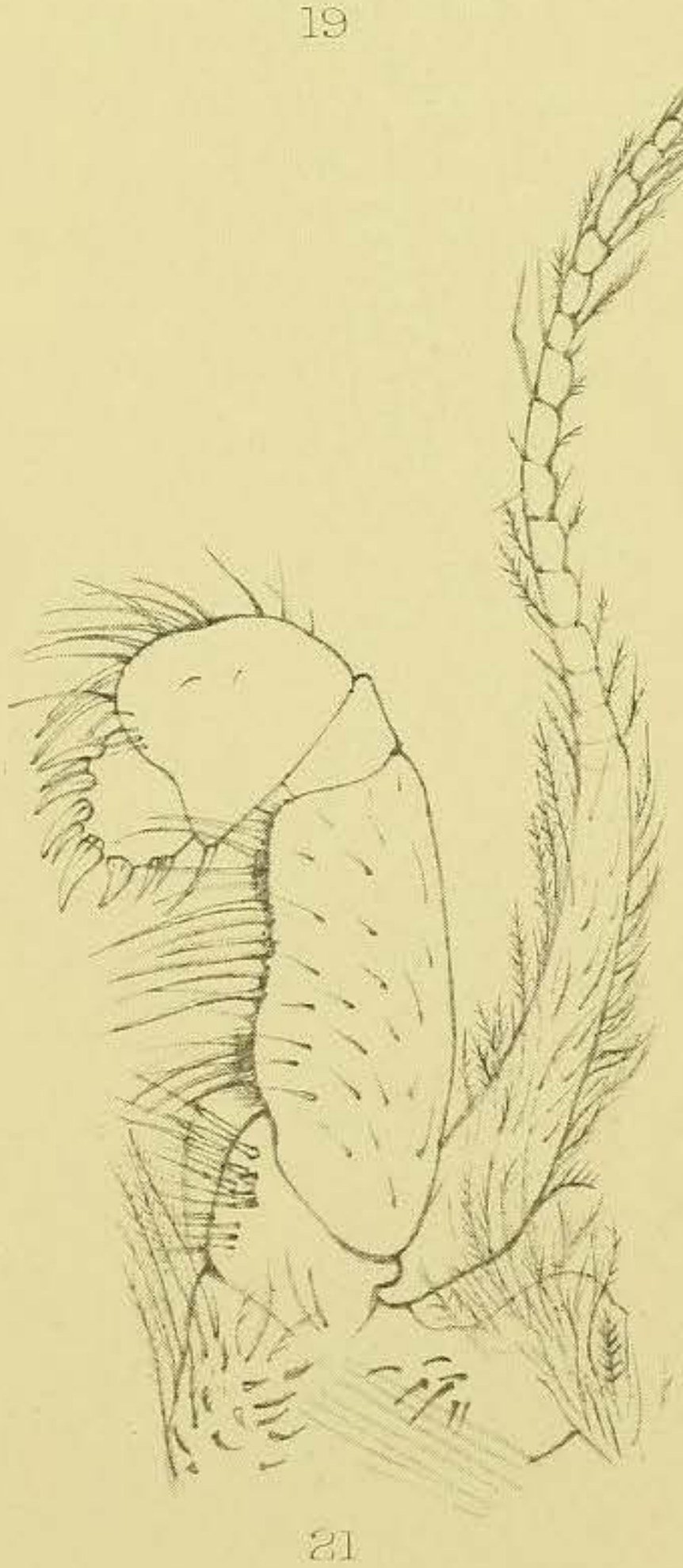

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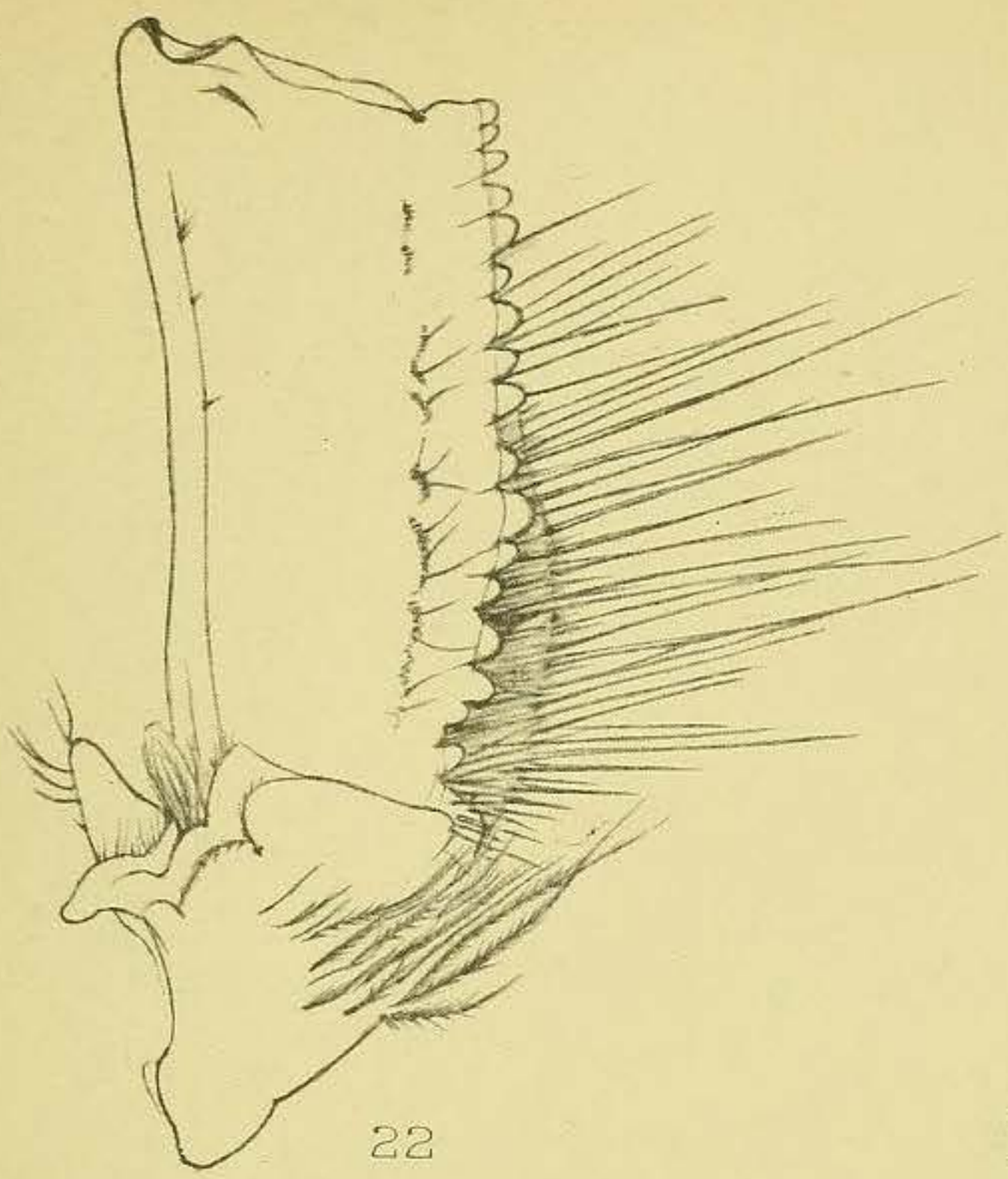
ENGÆUS FOSSOR.



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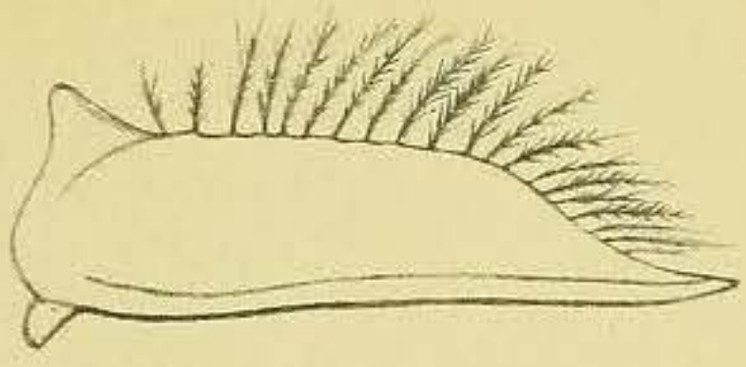

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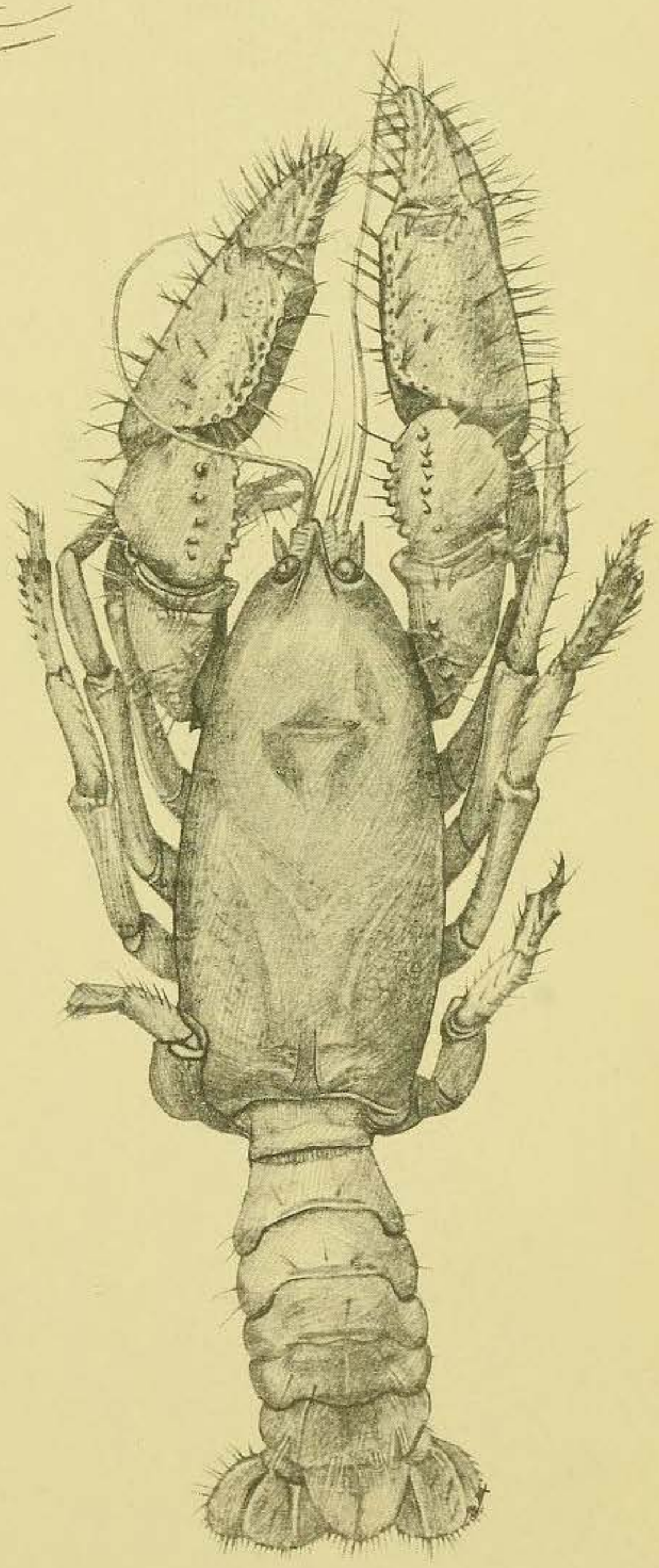

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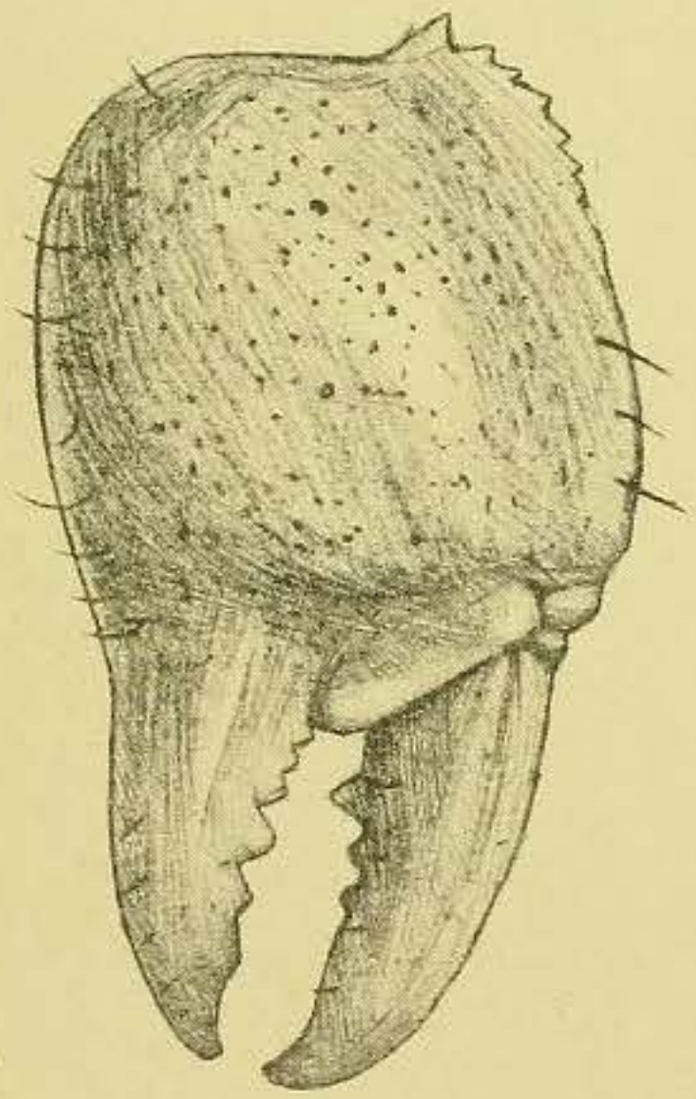

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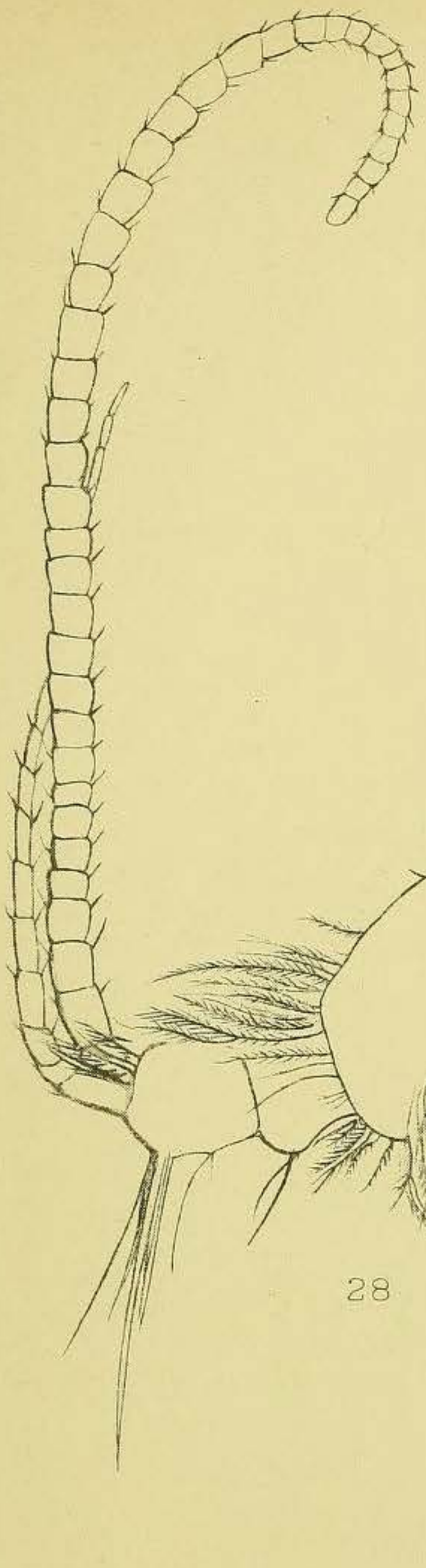
22. ENGÆUS FOSSOR. 23-25. E. AFFINIS.



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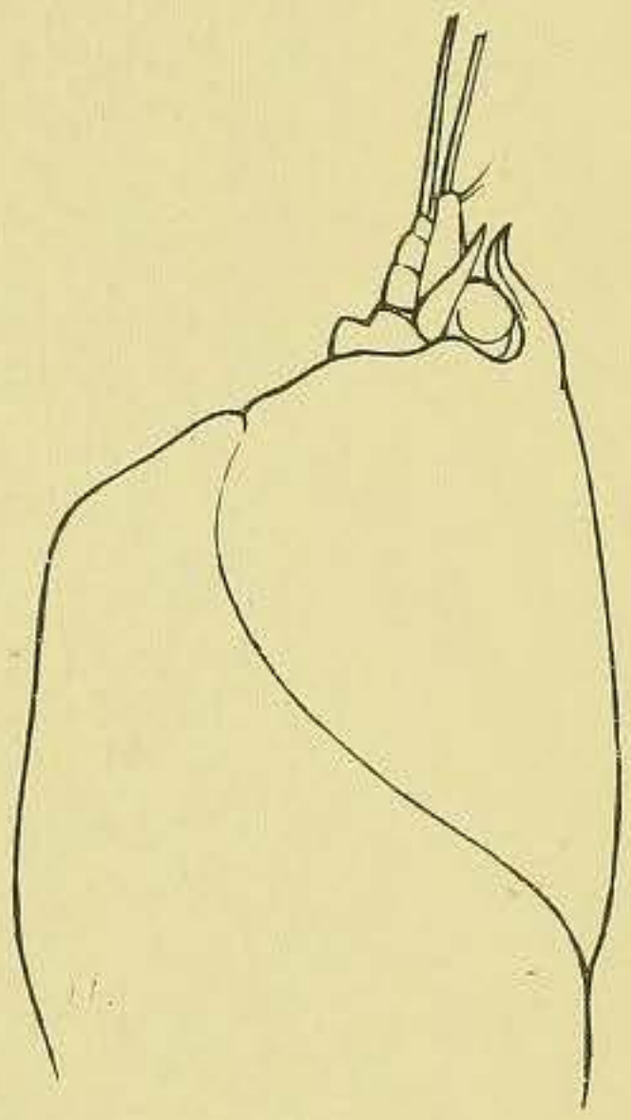

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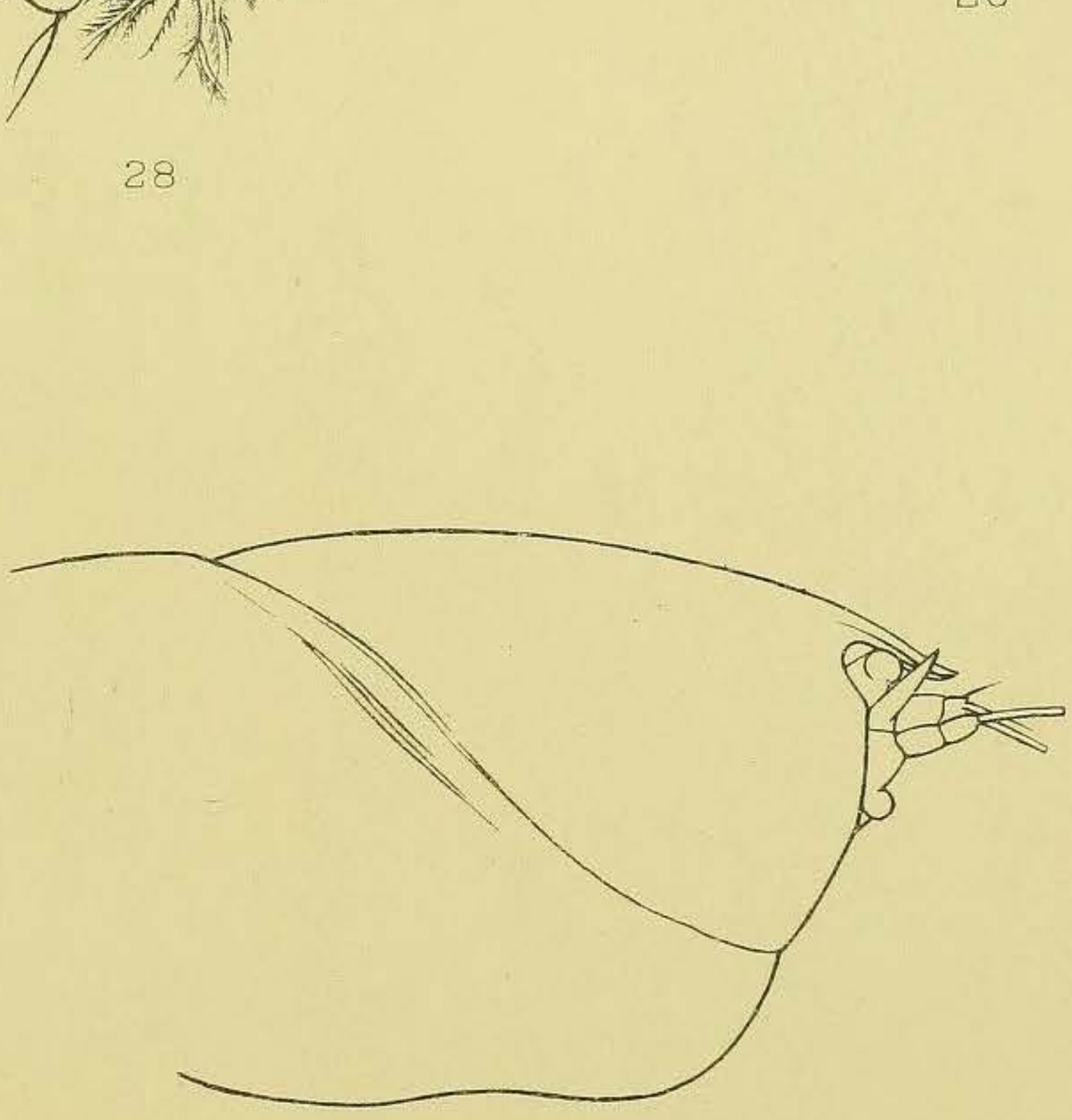

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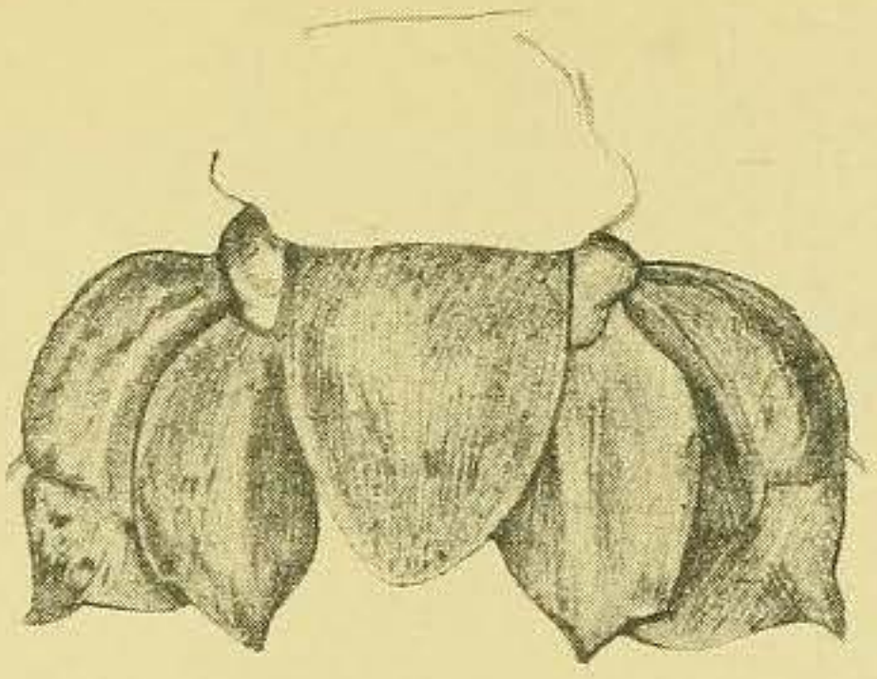
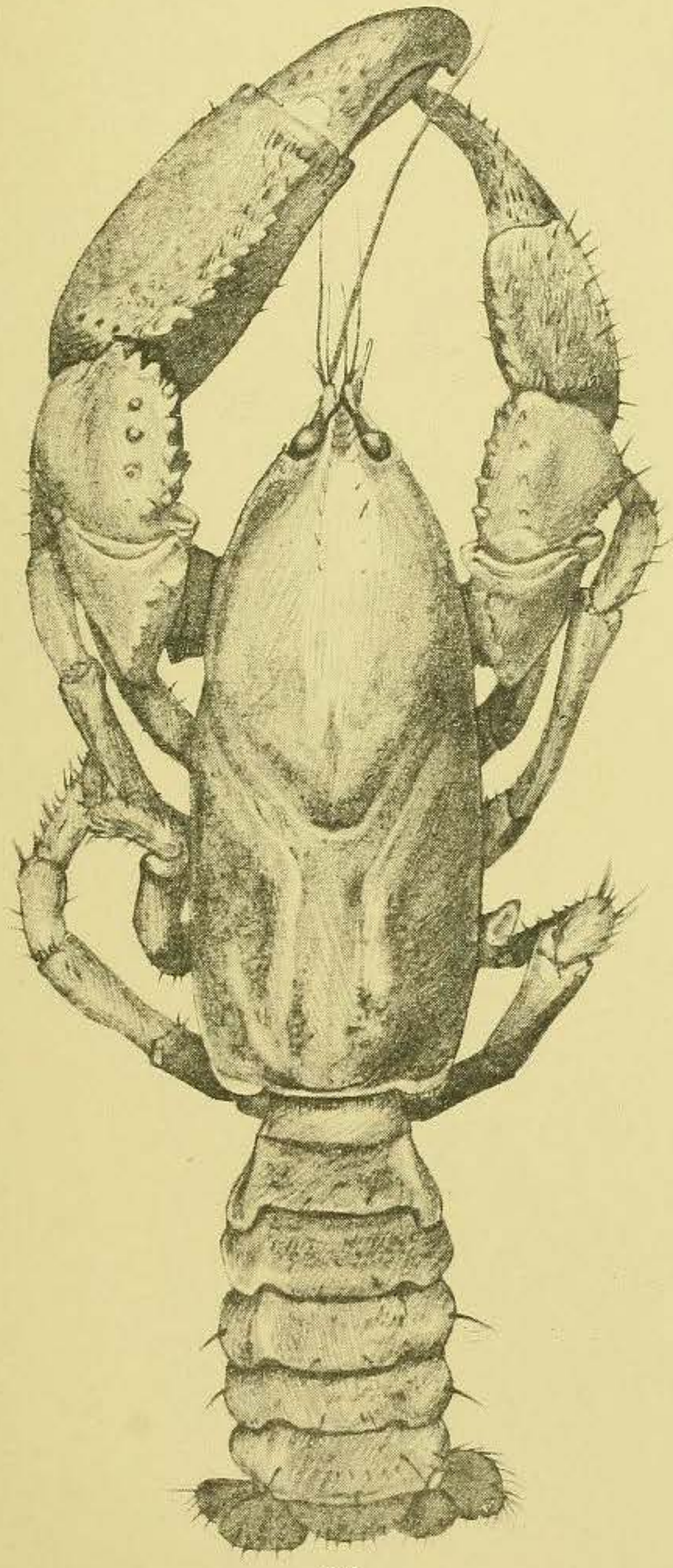
26. ENGÆUS AFFINIS. 27, 28, E. VICTORIENSIS.





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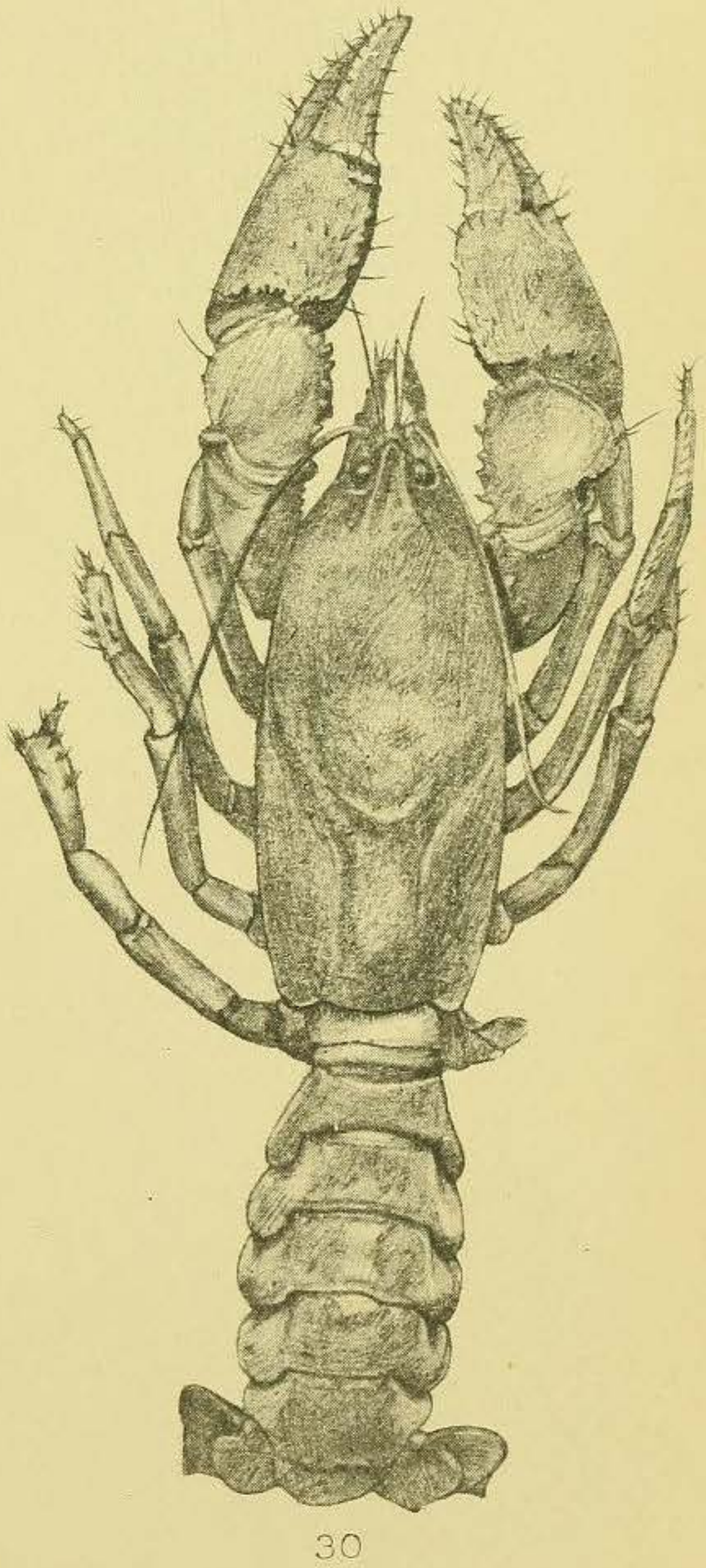

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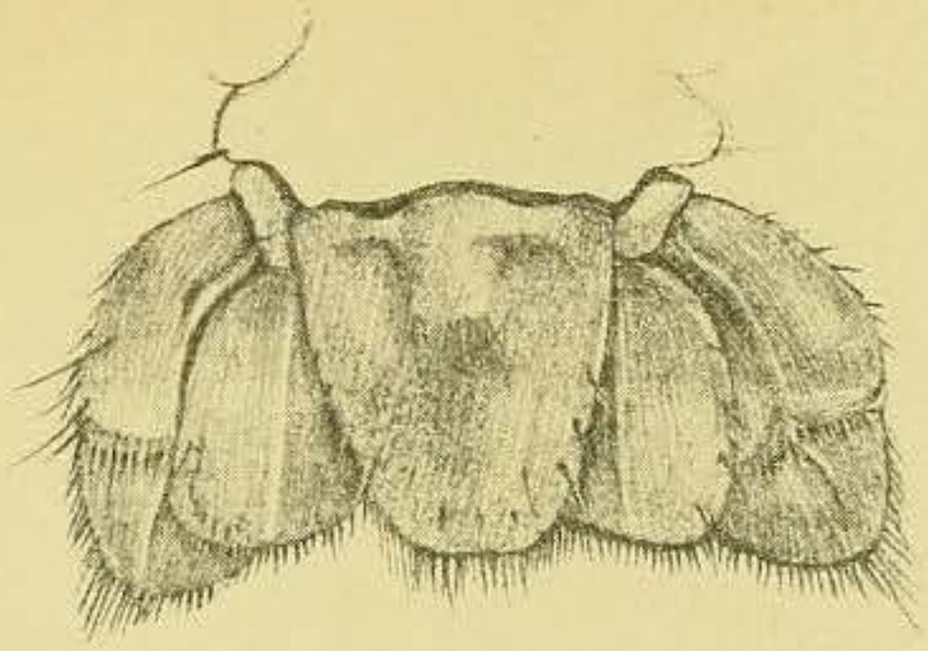
29. ENGÆUS VICTORIENSIS. 30, 31. E. PHYLLOCERCUS.



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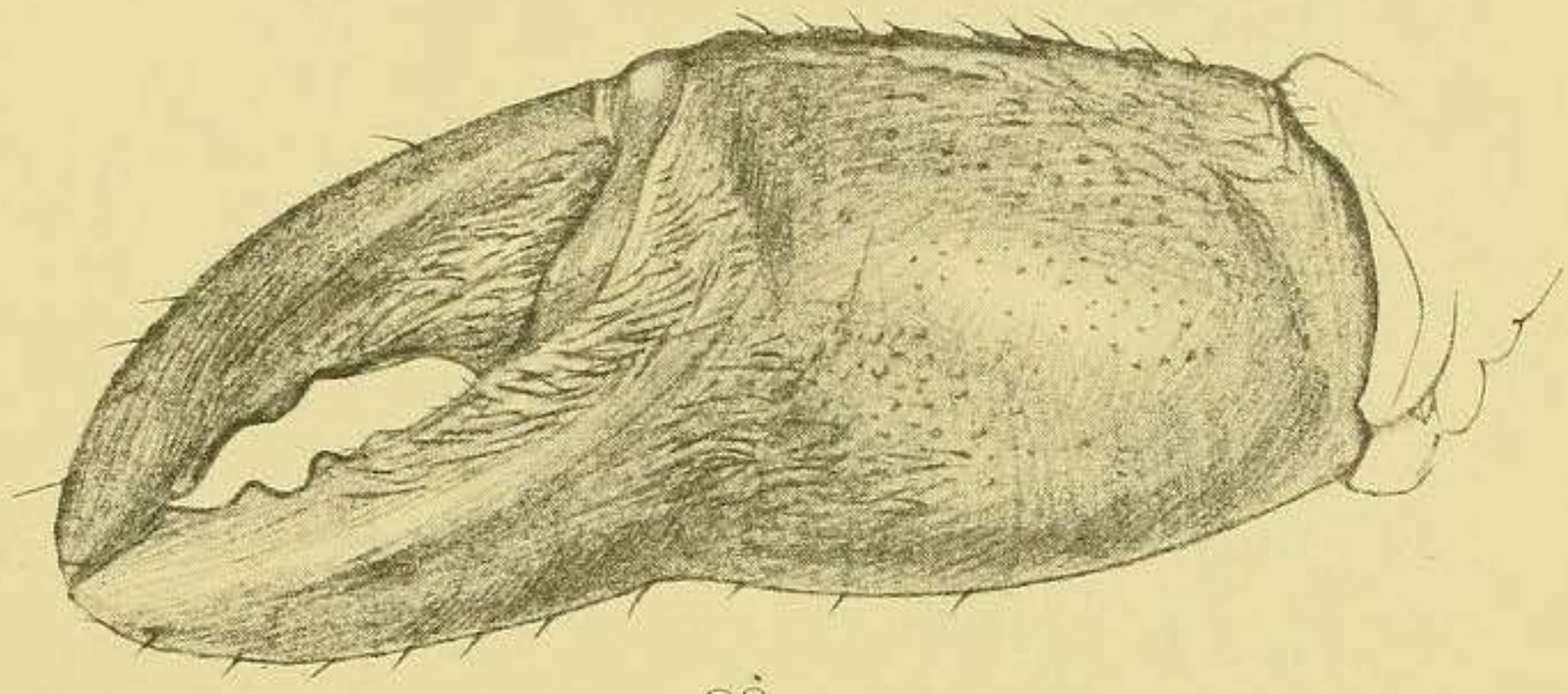

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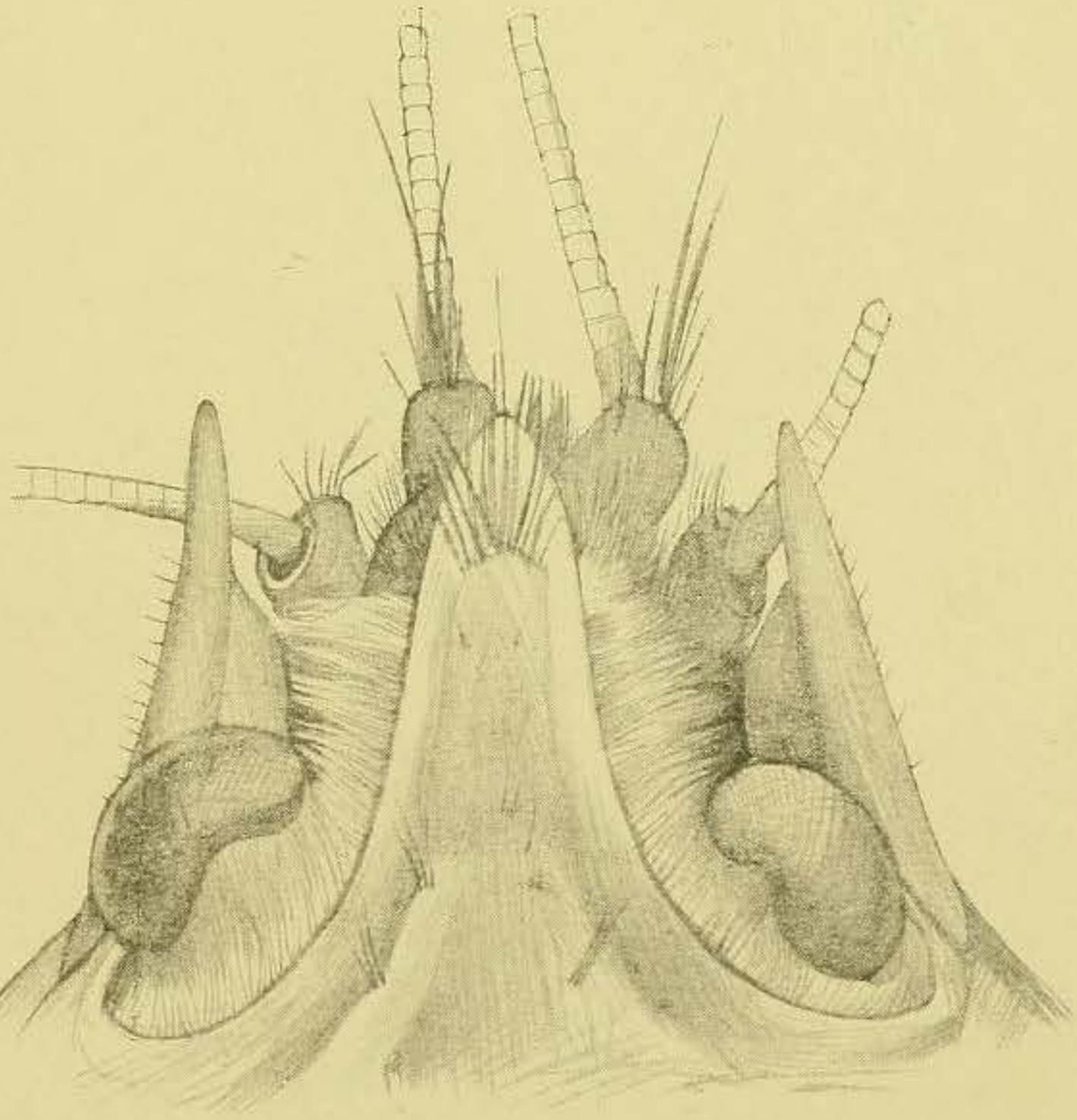

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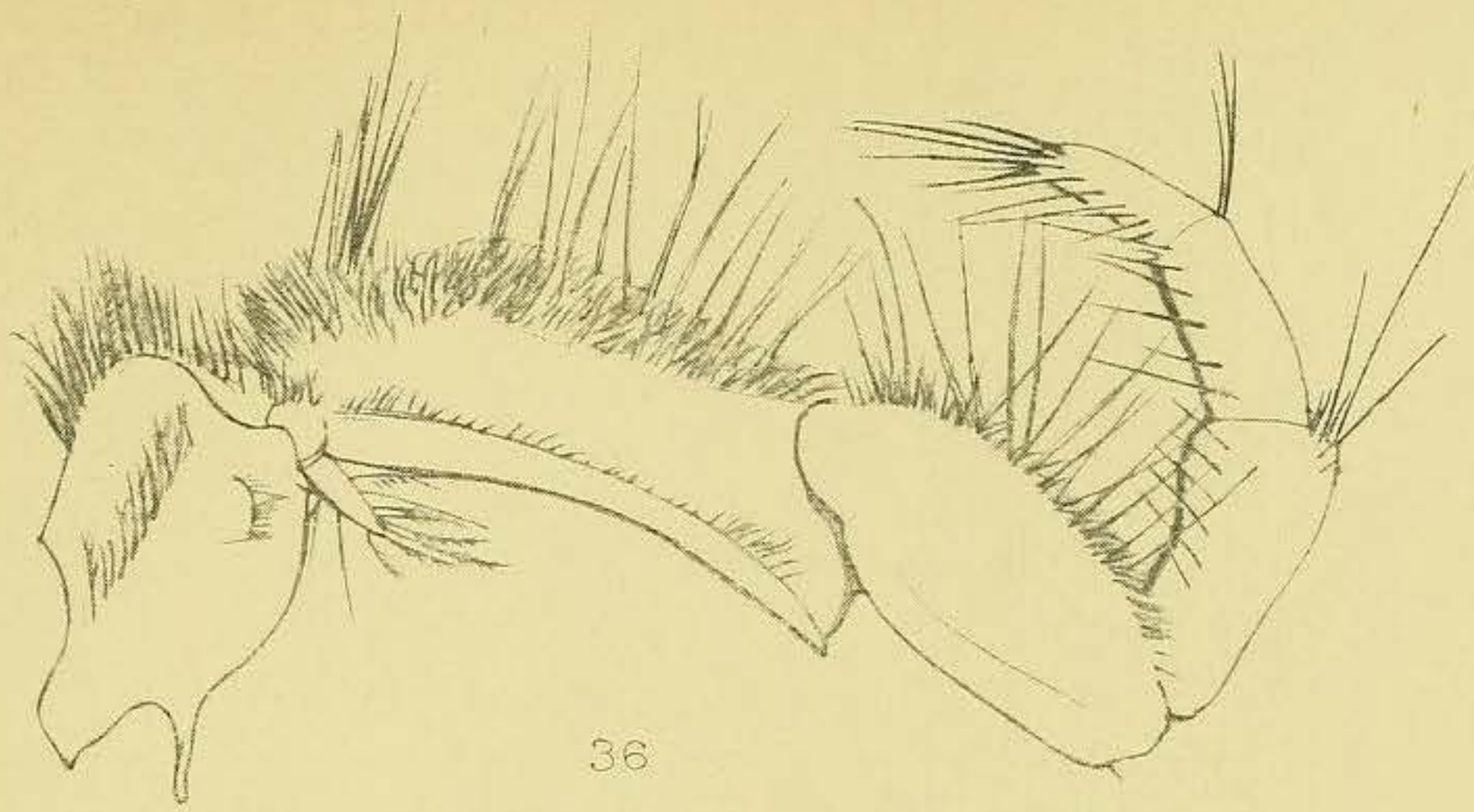
32, 33. ENGÆUS VICTORIENSIS. 34. E. HEMICIRRATULUS.



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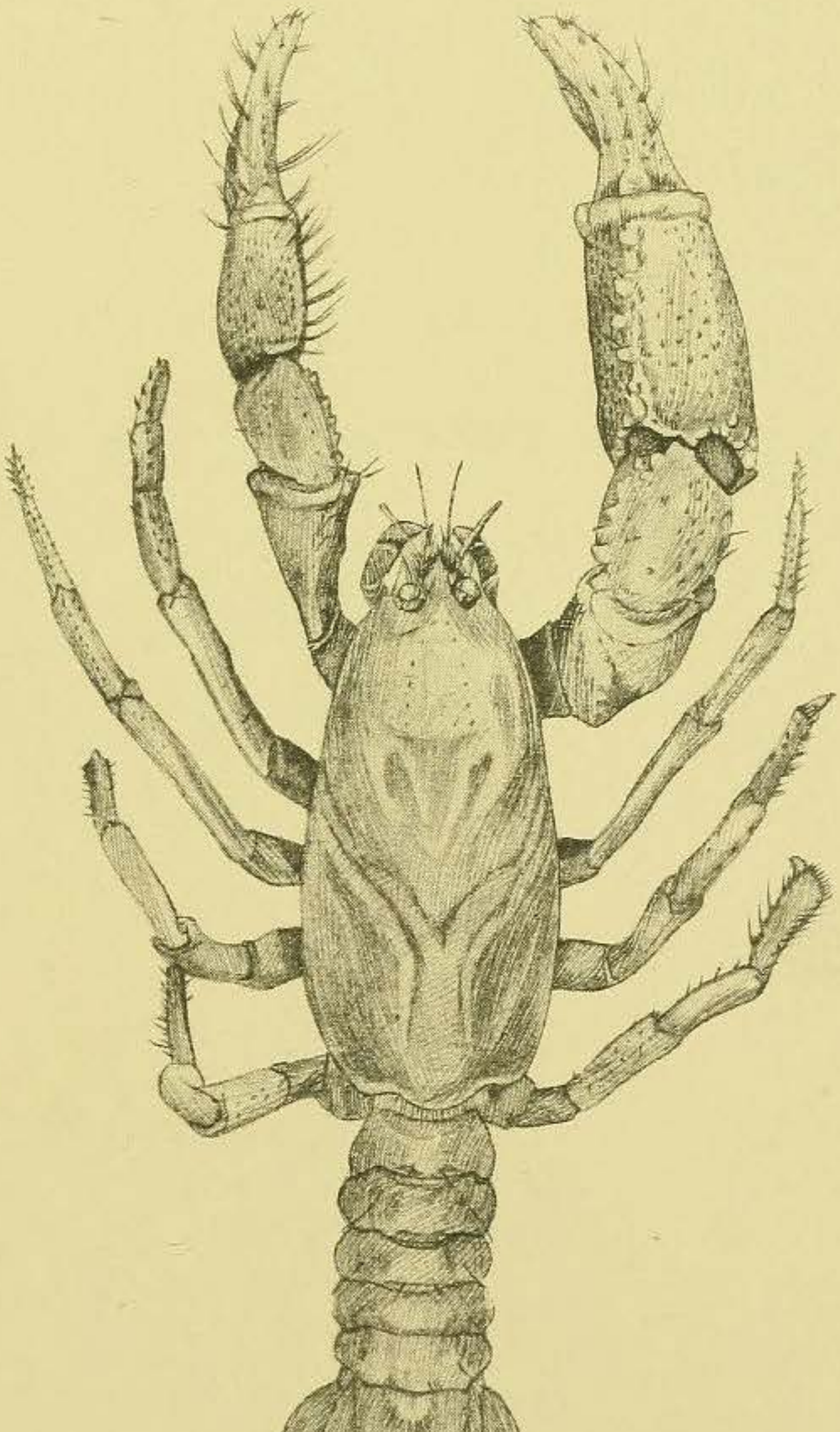

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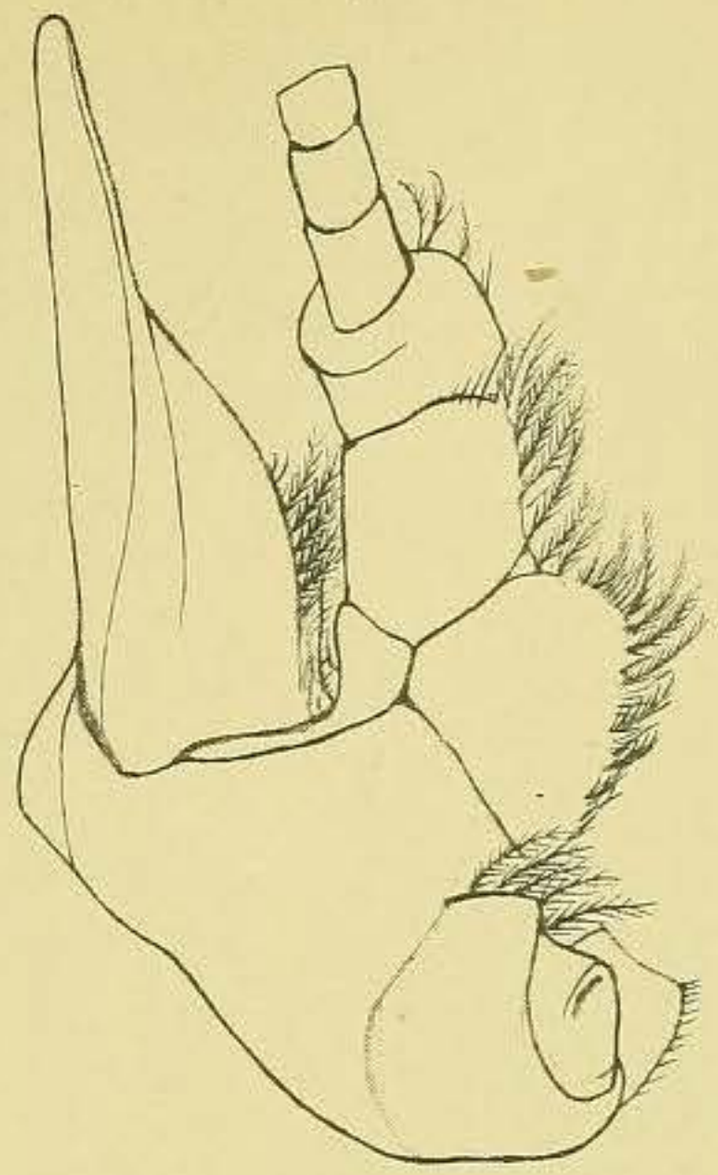
35. ENGÆUS HEMICIRRATULUS. 36. E. PHYLLOCERCUS.



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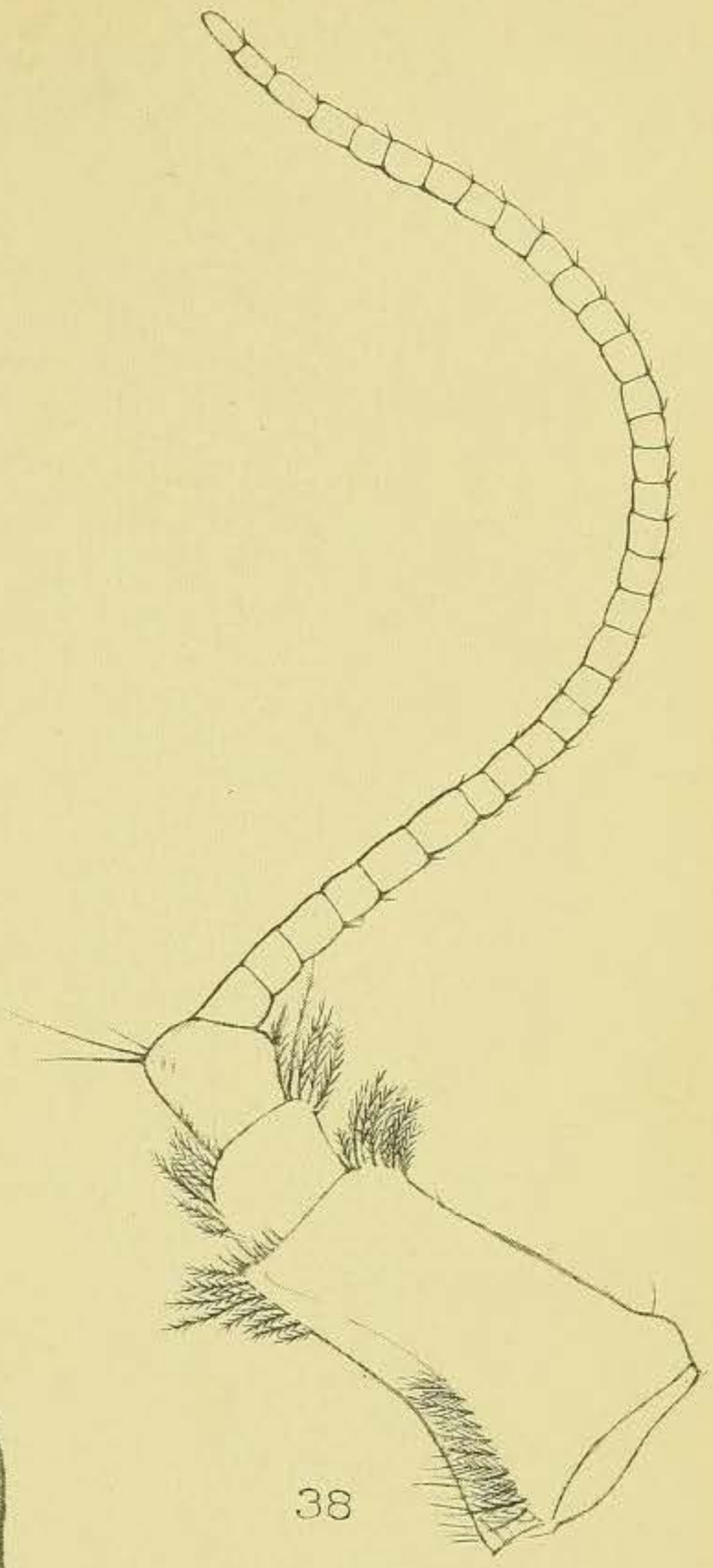

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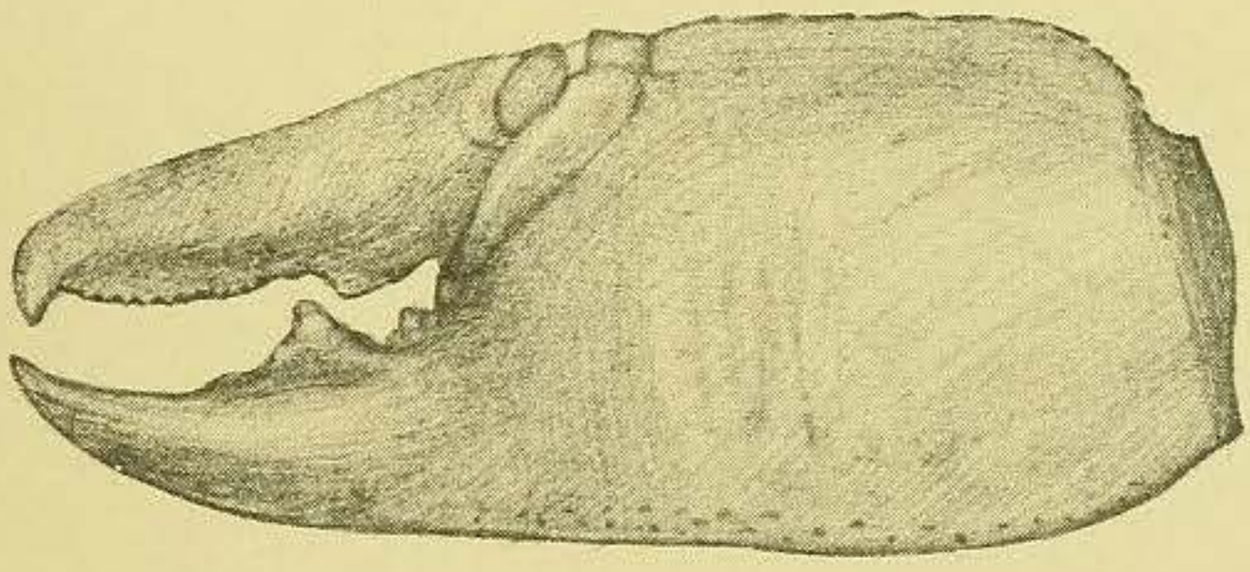

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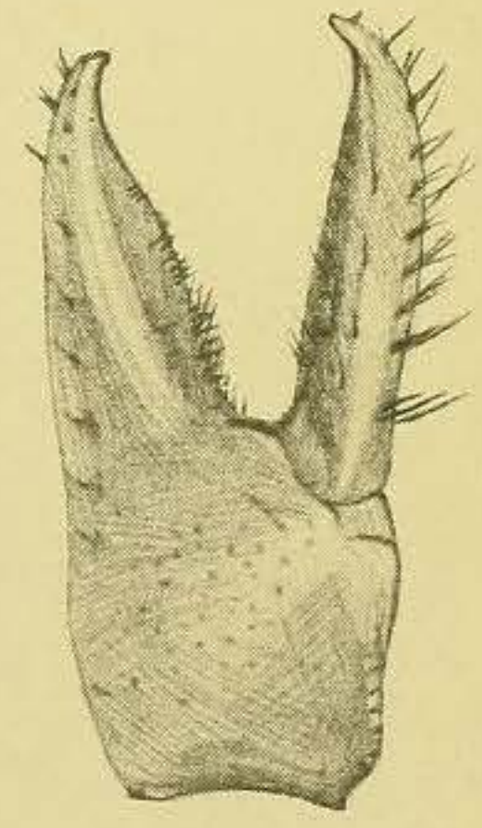

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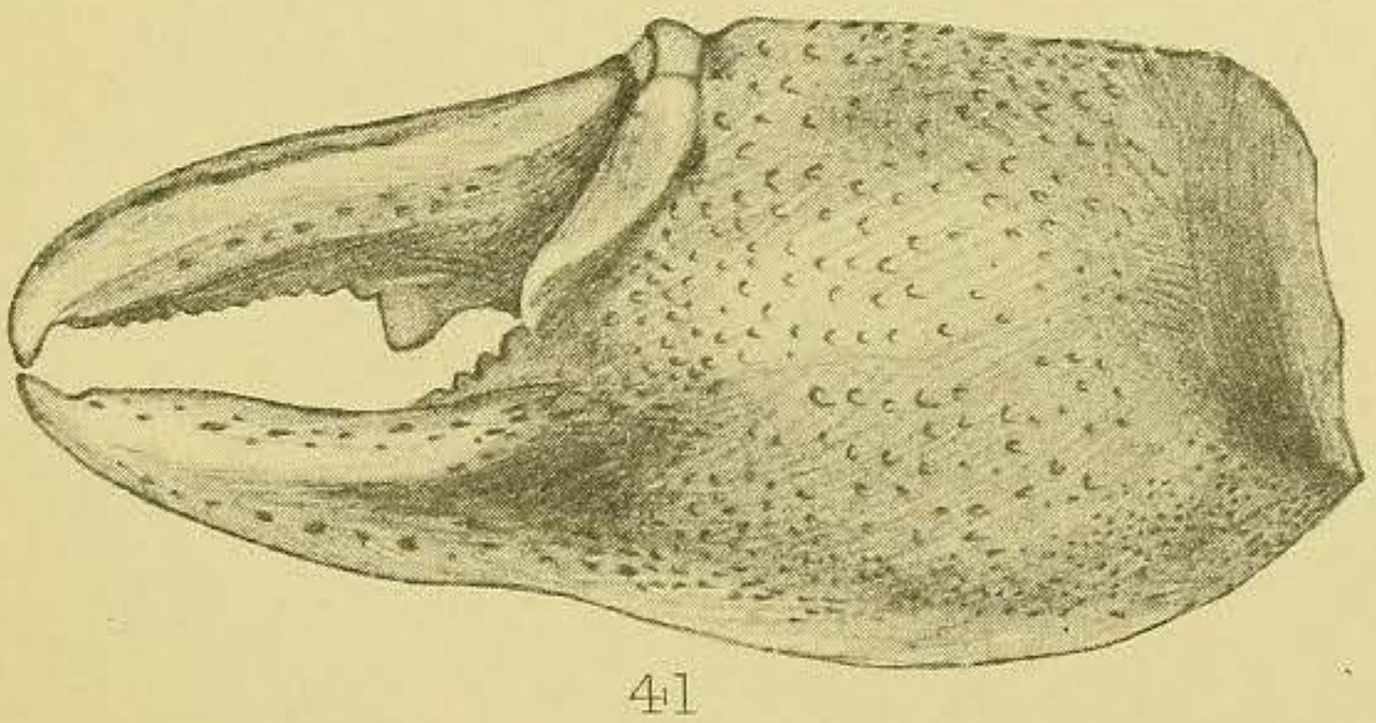

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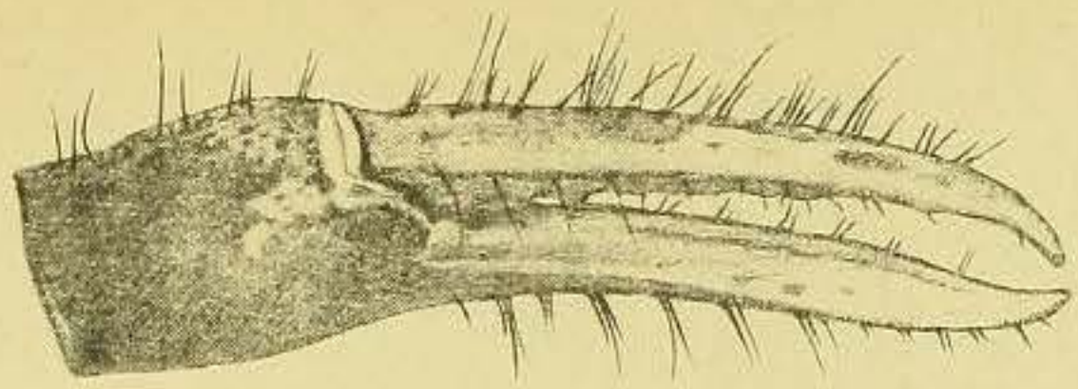
37, 38. ENGÆUS HEMICIRRATULUS. 39-41. E. CUNICULARIUS.



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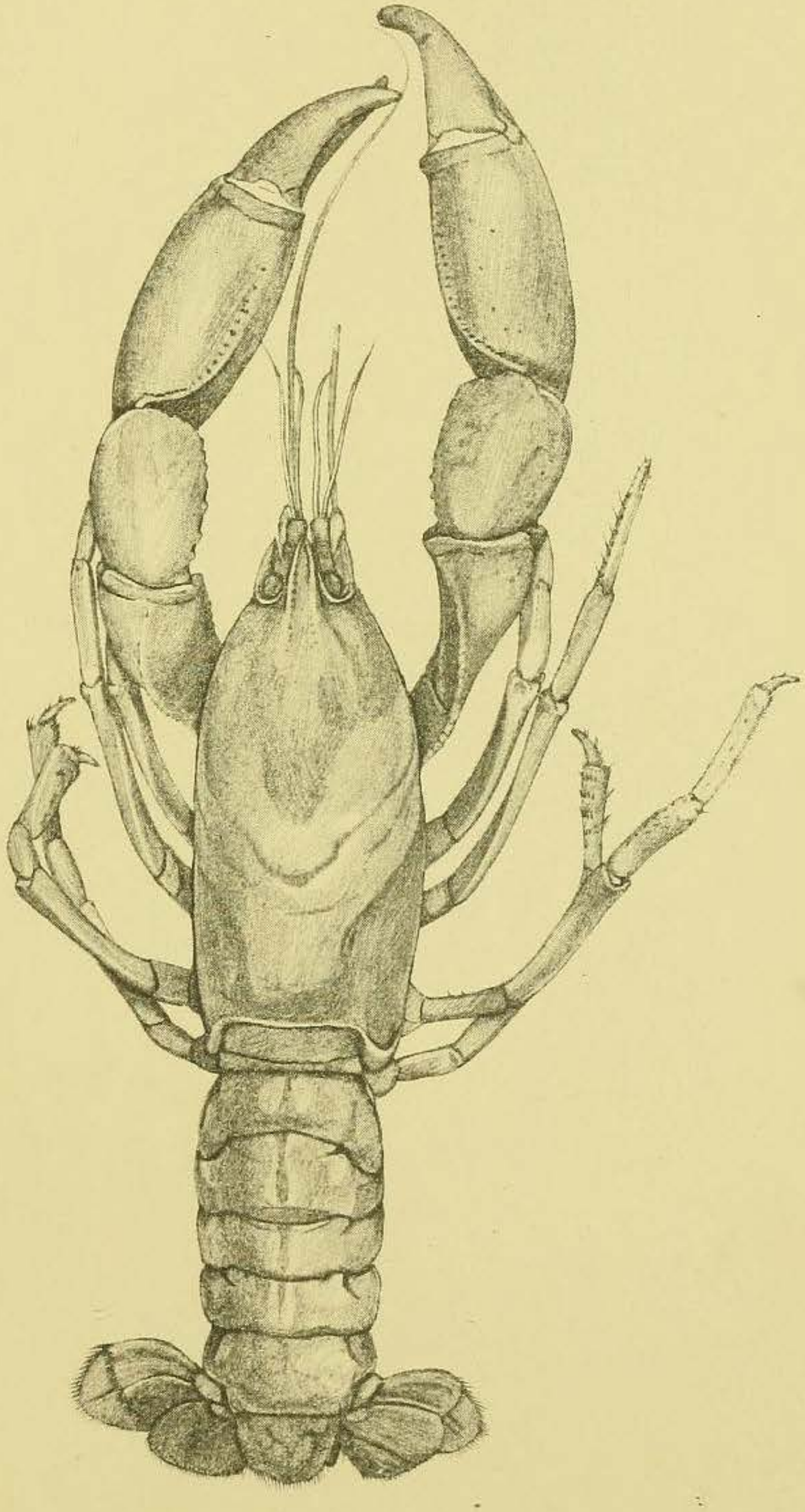

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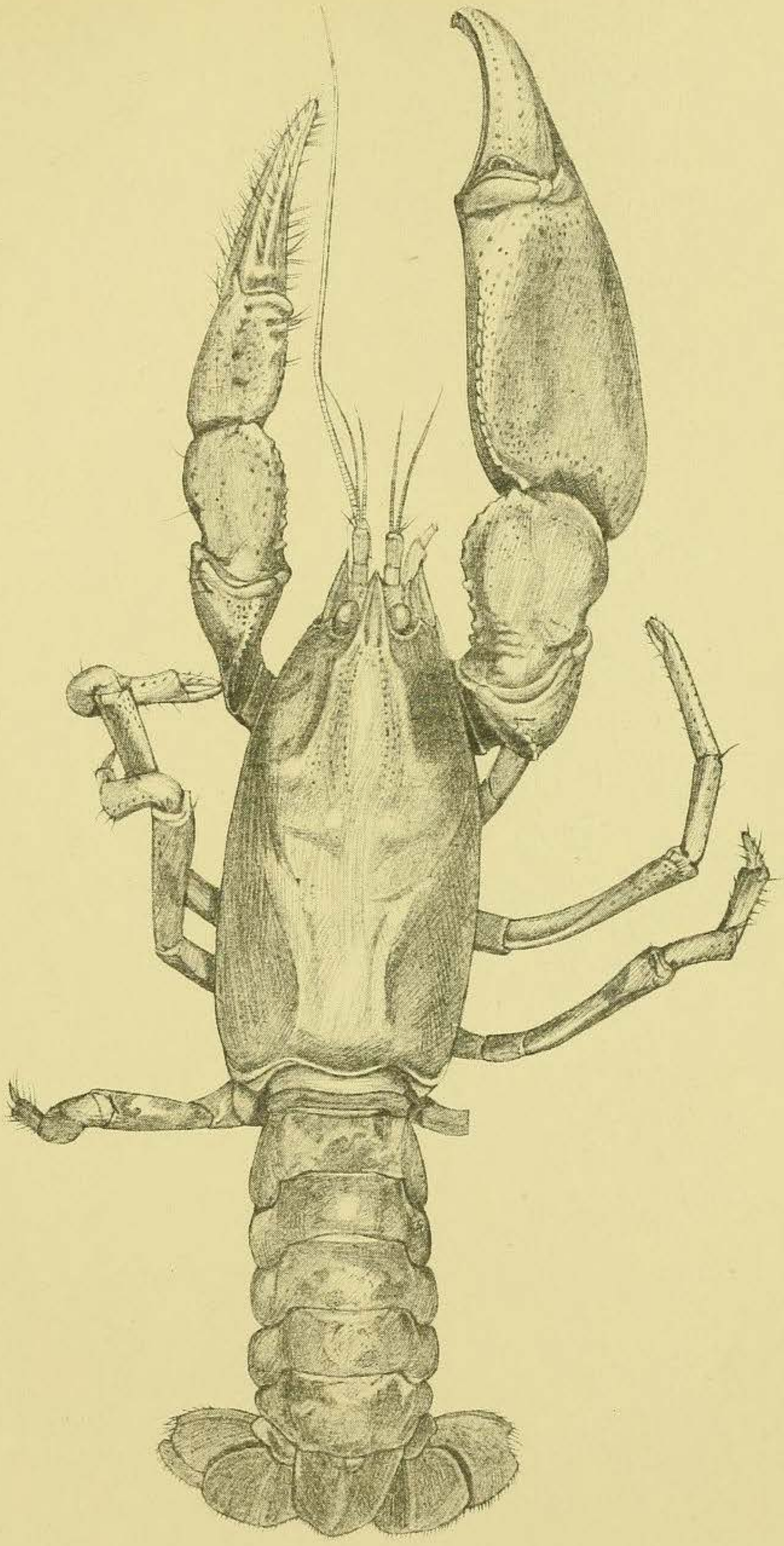
ENGÆUS CUNICULARIUS.



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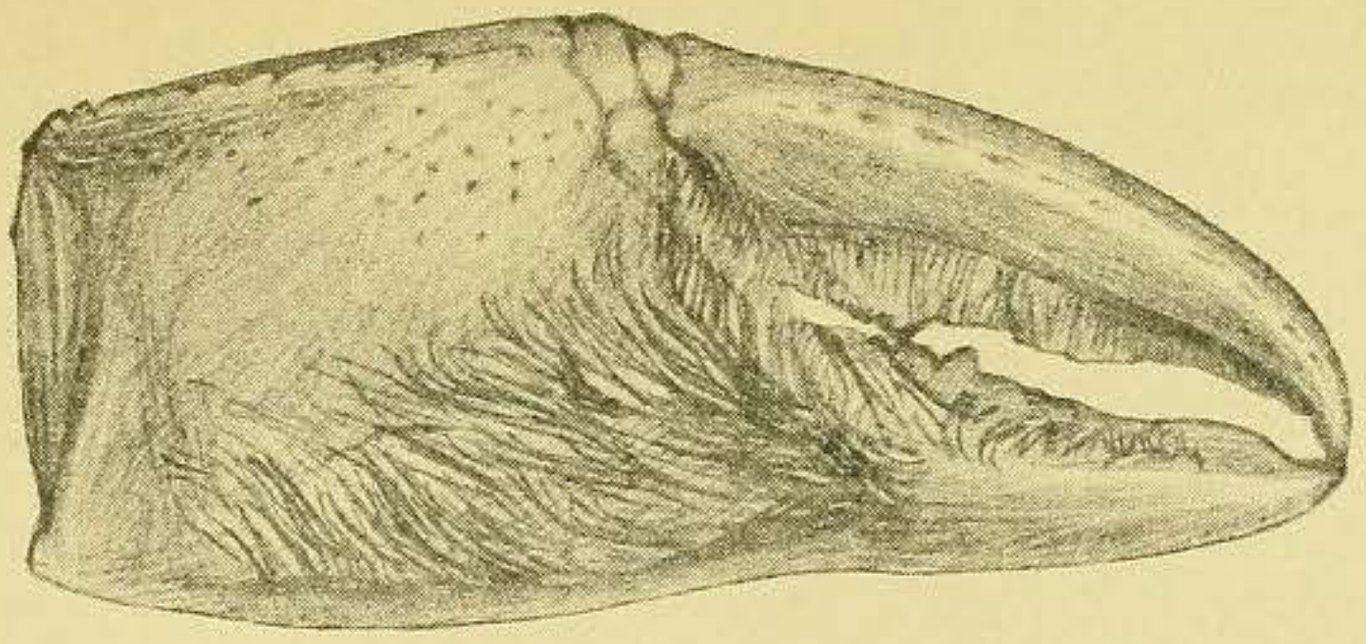
ENGÆUS CUNICULARIUS, (WARRAGUL, GIPPSLAND).



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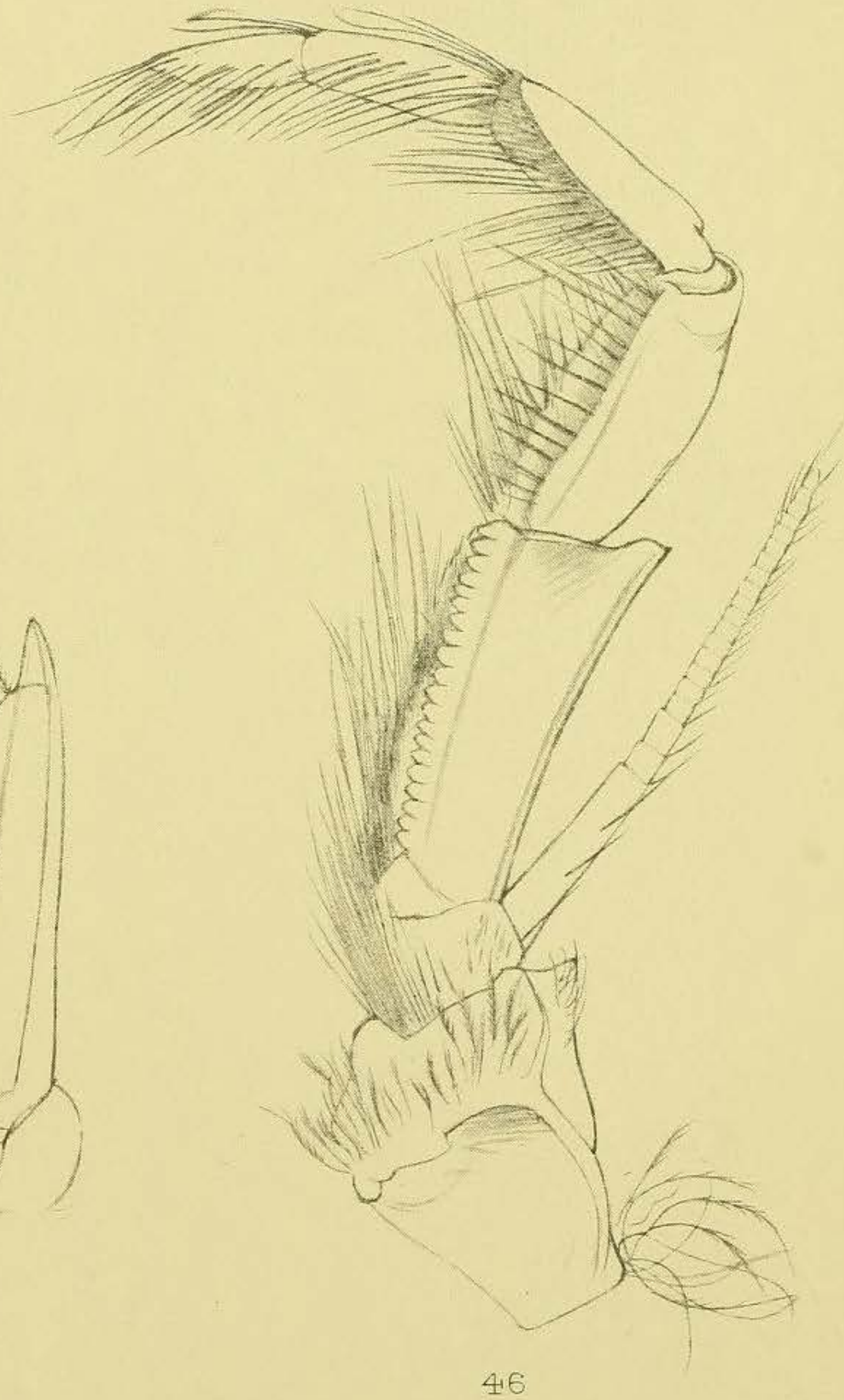

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ENGÆUS CUNICULARIUS.

material, it is necessary to correct an error of interpretation, published in the account which one of us gave of the Freshwater Australian Crayfishes in the 'Proceedings of the Zoological Society' for March 1912 (p. 144). This account did not pretend to deal with the Land Crayfishes of the genus *Engæus* except in a very general manner, but in treating of the geographical distribution and relationship of the Australian Crayfishes as a whole, certain statements were made as to the probable derivation of *Engæus* from the freshwater form *Parachæraps bicarinatus*, which a more detailed study of *Engæus* has shown to be entirely mistaken. Since the rectification of this error has an important bearing on the geographical distribution of the group, and clears up certain puzzling and unsatisfactory features of the problem, we feel it right to give it some prominence, in order to prevent the misconception spreading any further. In the memoir referred to, it is pointed out that there exist in Australia two distinct groups of Freshwater Crayfishes, the genus *Astacopsis* occupying Victoria, Tasmania, and New South Wales, *i. e.* the South-eastern portion of Australia, and the genus *Chæraps* occupying Western and Northern Australia and New Guinea, but nowhere mingling in its range with *Astacopsis*. In addition to *Chæraps* and *Astacopsis* with their distinct and limited distributions, there is a single form, the common *Parachæraps bicarinatus*, which is closely allied to *Chæraps* in all its anatomical features and is evidently a derivative from *Chæraps*. This form has spread from the West right into and across the Central Australian deserts, and is now found all over the Australian continent, mingling with *Astacopsis* in Victoria and New South Wales. It has not, however, penetrated into Tasmania or New Guinea, which is strong evidence in favour of its being a comparatively modern derivative from *Chæraps*.

As *P. bicarinatus* is accustomed to live in small water-holes in the desert, it has taken on a wandering and burrowing habit, and is frequently found walking about in fields in search of some moist ditch or water-hole.

Now, it seemed probable that the genus *Engæus*, containing the burrowing land forms, and confined in its distribution to Victoria and Tasmania, had been derived from *Parachæraps bicarinatus*, through an intensification of the habit of leaving the water and burrowing in damp soil. This idea was further confirmed by the curiously close resemblance which some of the *Engæus* bear to *Parachæraps bicarinatus* in external appearance. It was therefore too confidently stated in the memoir referred to that *Engæus* was probably a derivative of *Parachæraps*. Nevertheless, there was a very puzzling feature pointed out, supposing this derivation to be true, viz., that whereas *Engæus* is represented in Tasmania by two species, the supposed parent form, *Parachæraps bicarinatus*, is entirely absent from that island, so that it was necessary to introduce one of two rather improbable hypotheses, either that *P. bicarinatus* once existed in Tasmania and is now extinct, or

else that the two species of *Engæus* have been somehow transported across Bass' Straits by accidental means.

Now, it transpires as the result of a detailed examination of the various species of *Engæus*, especially in respect to the structure of their gills, that the derivation of *Engæus* from *Parachæraps* is entirely false, and that the superficial resemblance of these forms to one another is due to convergence. On the other hand, it is abundantly evident from the gill characters that *Engæus* is a derivative of *Astacopsis*, and has nothing to do with either *Chæraps* or *Parachæraps*. The reasons upon which this conclusion is based are as follows. In *Astacopsis* the podobranchia do not possess a broad ala or wing-like expansion of the stem of the gill; the ala is, on the contrary, reduced to a mere rudiment, as shown in the transverse section (Pl. XII. fig. 1). Attached to this rudimentary ala of the podobranchs are a few gill-filaments, which are furnished at their tips with characteristically shaped hooks (fig. 2). All the other gills in *Astacopsis*, exclusive of the podobranchs, *i. e.* the arthrobranchs and pleurobranchs, have their filaments entirely free from terminal hooks. The peculiar hooked setæ present on the bases of the podobranchs in *Astacopsis* also have a constant and characteristic shape, the terminal hooks being not sharply recurved (fig. 3). Now all the above characters are absolutely constant for the various species of *Astacopsis*. In *Chæraps* and *Parachæraps*, on the other hand, we have a totally different series of gill characters which are just as constant and characteristic for all the species of these two closely related genera. In these forms the podobranchia possess a very broad ala (fig. 4) which is furnished with numerous filaments, whose hooks have a characteristic sickle shape (fig. 5). In all the other gills, besides the podobranchs, numerous filaments are provided with these terminal hooks. Finally, the hooked setæ (fig. 6) on the podobranchs have an entirely different shape compared with those of *Astacopsis*, being sharply recurved at the ends.

Now, the distinctive character and absolute constancy of these gill-structures force us to attach especial taxonomic importance to them, far more importance than external appearance or other characters which fluctuate from species to species, so that an examination of the gills of *Engæus* should give us the key to its relationship with the other genera. *The gills of* Engæus *agree in all the above particulars with those of* Astacopsis, *and differ entirely from those of either* Chæraps *or* Parachæraps (Pl. XIII. figs. 7–10). Thus the podobranchs possess a rudimentary ala (figs. 7, 8) which carries a few filaments, and these filaments terminate in hooks (fig. 9) shaped like those of *Astacopsis*. The gills other than the podobranchs have their filaments unprovided with hooks; the hooked setæ (fig. 10) on the podobranchs are not sharply recurved at the end, but are shaped as in *Astacopsis*.

Now, apart from the gills, *Engæus* differs so widely from both *Astacopsis*, *Chæraps*, and *Parachæraps* in the characters of its bodily structure, appendages, etc., that these no longer serve as a

guide, and the resemblance to *Parachœraps*, which proved at first deceptive, consists merely in the absence of spines and ridges on the body and the hairiness of the mouth appendages, which are evidently due to convergence following on the similar mode of life.

As a matter of fact, in a certain number of anatomical features, besides the gills, *Engæus* agrees rather with *Astacopsis* than with the other two genera: thus the penultimate segment of the second maxillipede projects nearly as far forward as the terminal segment, and the vas deferens is situated on a short simple papilla.

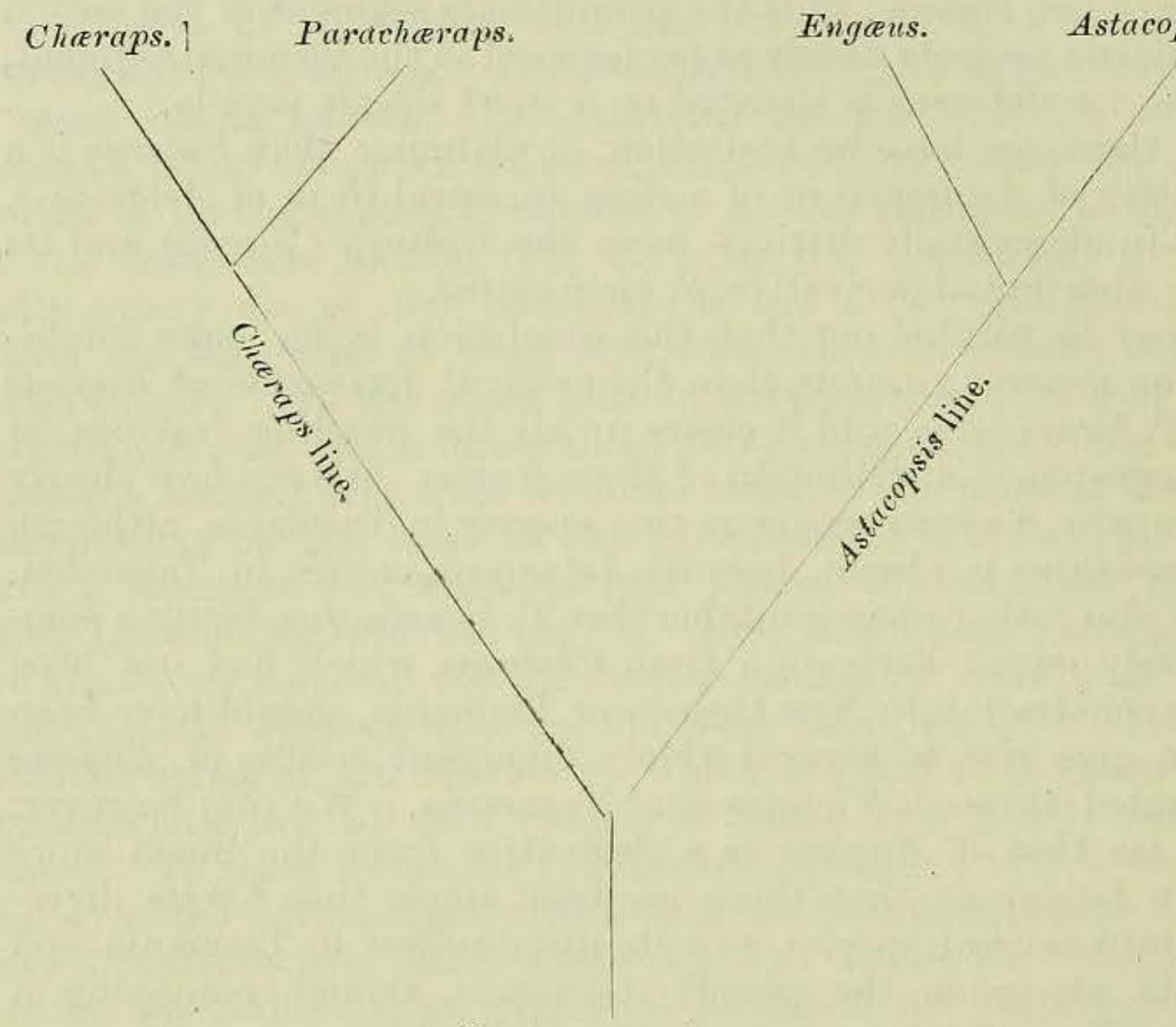
We therefore have no hesitation in claiming that *Engæus* is a derivative of *Astacopsis* or of a close ancestral form of *Astacopsis*, and is fundamentally distinct from the western *Chœraps* and its widely distributed derivative *P. bicarinatus*.

It may be pointed out that this conclusion is far more intelligible, on general grounds, than the original derivation of *Engæus* from *P. bicarinatus*, and it clears up all the puzzling features in the geographical distribution of these forms. We can now clearly explain why *Engæus* occurs as two species in Tasmania, although *P. bicarinatus* is absent, because *Astacopsis* occurs in Tasmania. It was also rather unaccountable that *P. bicarinatus*, being a comparatively recent derivation from *Chœraps*, which had not been able to penetrate into New Guinea or Tasmania, should have been able to give rise to several widely divergent species of *Engæus* distributed through Victoria and Tasmania. We can, however, easily see that if *Engæus* is a derivative from the much more ancient *Astacopsis*, that there has been ample time for its divergence into several species, and its distribution in Tasmania and Victoria alongside the parent *Astacopsis*, though occupying a totally different station, is perfectly intelligible.

To sum up the relationships of the Australian Crayfishes as a whole. The western and northern genus *Chœraps* and the south-eastern genus *Astacopsis* have been isolated from one another completely since a very ancient date, and at the present time they nowhere intermingle. *Chœraps* sent a northern straggler into New Guinea and the Aru Islands at a time when these islands were connected with the mainland (*C. quadricarinatus*), and *Astacopsis* has a typical representative in Tasmania, so that this genus in very much its present condition must have been present in Southern Australia at any rate when Tasmania was joined to the mainland. During this period, namely, when Tasmania was joined to the mainland, *Astacopsis* gave rise to the burrowing Land Crayfishes, *Engæus*, which are now represented by several species in Victoria and by two species in Tasmania. Subsequently to the separation of New Guinea and Tasmania from Australia, the western *Chœraps* gave rise to an offshoot, *Parachœraps bicarinatus*, which, forsaking the rivers as a necessary habitat, took to its wandering, pond and water-hole frequenting mode of life, and was thus enabled to spread across the desert regions and invade the territory of *Astacopsis* in the south

and east. Thus *P. bicarinatus* is now found everywhere on the Australian continent, but it has not been able to reach New Guinea or Tasmania, since these countries were cut off from the mainland when *P. bicarinatus* arrived.

The relationships of the Australian Parastacidæ should therefore be expressed as follows, in place of the diagram given in the former memoir:—



2. *Structure, Habits, and Interrelationships of the Species of* Engæus.

The several species of *Engæus* are characterised by the great depth of the carapace, measured dorso-ventrally, and by its arched roof-shaped form. The eyes are small, and the abdomen tends to be reduced in size. We also note a greater hairiness of the mouth-parts and neighbouring regions, a feature probably correlated with the necessity of filtering the water in their burrows, which is usually very muddy. The gills, especially the arthrobranchs, tend to be reduced in size, and though the gill formula may be the same as in the other Australian Parastacidæ, yet in certain forms the last pleurobranch is altogether suppressed. This entire suppression of a gill, which is unknown in any of the other Australian Crayfishes, is only one example of the very striking morphological changes which the species of *Engæus* may exhibit; and it may be truly said that the species of this genus are often separated from one another by greater differences than those which distinguish the genera of the Parastacidæ from one another.

Thus, in one series of forms, *E. fossor*. *affinis*, *victoriensis*, *phyllocercus*, *fultoni*, and *hemicirratulus*, the exopodite of the third maxillipede may be rudimentary or entirely suppressed; in another series the outer flagellum of the first antenna is absent (*E. hemicirratulus*), while the antennary scale and the uropods undergo striking changes in certain species.

It is difficult to find the reason for these marked aberrations of structure, but it may be pointed out that all of them are in the nature of losses or suppressions, *e. g.* the loss of the pleurobranch, the loss of the exopodite of the third maxillipede, the loss of a flagellum on the antennule, the reduction of the antennary scale, and the abortion of the eyes; and it may be plausibly argued that the underground, burrowing habit which removes the animal from active competition with other water forms has permitted degenerative changes which have no special adaptive meanings.

Another interesting point is the extraordinary variability of the large chelæ in these forms, and their frequent asymmetry. It appears to us extremely doubtful whether these variations indicate specific or only individual differences, since hardly two forms coming from the same locality and identical in other respects are ever quite alike in regard to their chelæ, and very often they differ fundamentally in this respect, independently of sex and size.

Unfortunately, we do not know very much about the habits of these burrowing crayfish, and the only personal observations were made by one of us in Tasmania on the smaller Tasmanian *Engœus*, *E. fossor*.

This species is widely distributed in Tasmania, being found on the southern mountain ranges, on the north coast, and in the forests on the west coast. The burrows of the animal could be recognised as little round holes in the damp ground, sometimes near the banks of a stream or water-course, but very frequently far removed from any water in the middle of the forest in some damp situation. The burrow descends vertically into the ground, or if it is in a bank it is frequently horizontal, and after passing inwards for a foot or two it ends in a circular chamber which is always full of water. *Engœus fossor*, when freshly taken from its burrow, has a rather soft whitish skin with brilliant blue patches and an occasional tinge of red. In one place near the Magnet Mine on the west coast of Tasmania, the banks of an artificial water-course which was used in the mining operations were completely riddled by the burrows of *Engœus fossor*, and the foreman of the mine told me that these creatures were a source of continual damage and danger in works of this kind.

It is stated in Erichson's original memoir, on the authority of Herr Schayer, who collected the specimens, that *Engœus* if kept in water soon dies. In view of the fact that there is always water at the bottom of the burrows, and also from what I have heard from people in Tasmania who have kept the animals in captivity, this statement may be received with some scepticism.

Since the animals are never seen out of their burrows in the day-time, very little is known as to their food or the means they employ to obtain it, but it is probable that they are mainly carnivorous in diet, as the remains of earthworms, insect larvæ, and probably land Crustacea have been found in their stomachs. As has been pointed out elsewhere ('A Naturalist in Tasmania'), the evergreen beech forests in Western Tasmania support a very rich terrestrial fauna of land Amphipods (*Talitrus*) which swarm under the fallen beech leaves and timber, and numerous Myriopods and insect larvæ occur as well, affording abundant food in exactly the situations which *Engæus* chooses for its burrows.

The young are brought into the world and tended by the female parent in the same way as in the ordinary crayfish, and I have obtained females from their burrows with their young ones still attached to the swimmerets under the abdomen. At this stage the young ones have all the characteristic features of the adult, showing the same vaulted carapace and reduced abdomen.

The interrelationships of the various species of *Engæus* may be gathered from the key for the determination of the species given on p. 119.

The least modified and specialised species is *E. cuniculariius* from Tasmania, Gippsland, and Victoria. This species has the general form of the thorax and abdomen in a less aberrant condition than the other species, and it is also more normal in its other characters, possessing the last pleurobranch, the exopodite on the third maxillipede, and the two flagella on the first antenna in a fully developed condition. *E. fultoni* from Victoria is closely related to this species, but the exopodite of the third maxillipede is rudimentary.

The Tasmanian *E. fossor* and the Victorian species *E. affinis*, *victoriensis*, and *phyllocercus* are all closely related, and exhibit to the full the peculiarly roof-shaped thorax and reduced abdomen; while *E. hemicirratulus* is the most highly specialised, having lost not only the exopodite of the third maxillipede but also the posterior pleurobranch and the inner flagellum of the first antenna.

Genus Engæus.

Erichson, Archiv f. Naturg. vol. xii. p. 102 (1846); Huxley, P. Z. S. 1878, p. 769.

The gill-formula is the same as in *Astacopsis*, *Chæraps*, and *Parachæraps*, except that the last pleurobranch may be entirely absent. The posterior arthrobranchs are reduced in size.

The ala of the podobranchs (Pl. XIII. figs. 7 & 8 *al.*) is small and inconspicuous as in *Astacopsis*, and it carries a few filaments with terminal hooks which are shaped as in *Astacopsis*.

None of the other gill-filaments carry terminal hooks.

The hooked setæ on coxopodites and podobranchs are not sharply recurved, but resemble those of *Astacopsis*.

The mandibles (Pl. XV. figs. 16 & 17) have two prominent

median teeth and one smaller tooth in front, and a row of smaller serrations behind.

The first maxillæ (Pl. XVI. figs. 18 & 19) have the endopodite without any trace of a flagellum.

The second maxillipede has the penultimate segment broad, projecting nearly as far as the terminal segment (fig. 21).

There is an entire absence of filaments from the epipodite of the first maxillipede.

The third maxillipede may have the exopodite normal, reduced, or absent. There is a great development of filtering apparatus of bristles and hairs on this and on all the mouth-parts.

The great chelæ show an immense range of variation, being symmetrical or asymmetrical, serrated or smooth, hairy or comparatively hairless.

The vas deferens is situated on a simple short papilla.

The rostrum is reduced, and its lateral keels are either smooth or feebly tuberculated. There are no keels on the carapace, nor are there any spines on the carapace or abdomen. The abdomen is reduced, sometimes markedly so, and it may be hairy.

The eyes are reduced in size.

The carapace is very deep (Pl. XIV. fig. 12) measured in a dorso-ventral direction, and the distance from the tip of the rostrum to the cervical groove is always longer than that from the cervical groove to the posterior border of the carapace.

Key to the Species of the Genus Engæus.

(1) Last pleurobranch present, two flagella on 1st antenna.
  (A) Exopodite of 3rd maxillipede absent or rudimentary.
    Antennal scale rounded at end without spine ..... *E. fossor.*
    Antennal scale pointed, last pleurobranch large ..... *E. affinis.*
    Antennal scale pointed, last pleurobranch reduced ..... *E. victoriensis.*
    Uropods produced into pointed apices ..... *E. phyllocercus.*
    Rostrum straight and large with prominent keels ..... *E. fultoni,*
  (B) Exopodite of 3rd maxillipede well developed ..... *E. cuniculariu*s.
(2) Last pleurobranch and exopodite of 3rd maxillipede absent and only one flagellum on first antenna..... *E. hemiairratulus.*

Engæus fossor Erichson. (Pls. XIV.–XVII. figs. 11–22.)

Astacus (*Engæus*) *fossor* Erichson, Arch. f. Naturg. vol. xii. p. 102 (1846).

Astacus fossor Von Martens, Monatsber. Akad. Wiss. Berlin, 1868, p. 618.

Engæus fossor Haswell, Cat. Australian Museum, Stalk- and Sessile-eyed Crustacea, p. 178 (1882).

The posterior pleurobranch is present, and is larger than the others. The anterior pleurobranch is very small.

The posterior arthrobranchs are all very small, consisting of a stalk bearing not more than four or five filaments.

The exopodite of the third maxillipede is reduced to a very small tubercle (Pl. XVII. fig. 22).

The antennal scale is rounded at the end and carries no terminal spine (Pl. XV. figs. 14 & 15).

The inner flagellum of the first antenna is slenderer than the outer one and about two-thirds its length.

Tubercles on propodite and ischiopodite of chela very inconspicuous.

The great chela always has a row of tubercles on the upper border of the propodite, the lower border being generally smooth and rounded. There is one prominent tooth on the inner surface of the dactylopodite, while there are three teeth on the lower part of the pincer. In some specimens the chelæ are equal in size and shape, in others one chela is more slender and hairy, and with the pincer more delicate and elongated.

In the female there is a pair of sperm-receptacles with conspicuous openings on penultimate segment (Pl. XV. fig. 13).

The eyes are small, and the rostrum is short with rather prominent keels. Contour of forehead shown in fig. 12 (Pl. XIV.).

The thorax is laterally compressed and highly arched. It is fairly free from hairs, but the abdomen is rather hairy.

The tail-fan is rounded without conspicuous spines or ridges.

Colour. Ground-colour ivory with blue and red blotches irregularly disposed.

Length 38 mm.

Locality. Magnet Mine, West Coast of Tasmania. Also reported to occur on the southern ranges. Confined to Tasmania.

Local Variety. Some specimens obtained from burrows near Muddy Creek, Bridport, on the north coast of Tasmania, while agreeing essentially with the above description, show certain variations. The whole body and limbs are more hairy, and this is especially marked on the chelæ. The propodites of the great chelæ are slightly tuberculated on their lower as well as on the upper border, and the chelæ tend to be slightly more elongated than in the type specimens. The keels on the rostrum are slightly more pronounced, and the eyes are a little larger.

ENGÆUS AFFINIS, sp. n. (Pls. XVII. & XVIII. figs. 23–26.)

All the pleurobranchs are of approximately the same size, the posterior pleurobranch being well developed.

The exopodite of the third maxillipede is absent.

The antennal scale ends in a well-developed terminal spine and an inner lobe which is not markedly produced (Pl. XVII. fig. 25).

First antenna is formed as in *E. fossor*.

There are two conspicuous rows of tubercles on the inner surface of the carpopodite of the great chela, and a row of marked tubercles on the meropodite. There is a row of tubercles on the upper border of the propodite, the lower border being smooth and rounded.

There is, as usual, great variability in the size and shape of the chelæ, in some specimens the two chelæ being similar and equal in size, while in others one chela, either the right or left, is

greatly enlarged. It is a general rule that the enlarged chela (fig. 24) in this species has a broad and short propodite if compared with that of the next species, *E. victoriensis* (Pl. XX. fig. 33).

There are no sperm-receptacles with conspicuous openings in the female.

The eyes are rather larger than in *E. fossor*, and the rostrum is longer and ends in an upwardly directed spine. The contour of the forehead (Pl. XVIII. fig. 26) is much less steep than in *E. fossor* (Pl. XIV. fig. 12).

Thorax, abdomen, and tail-fan much as in *E. fossor*.

Length. Specimen figured from tip of rostrum to end of telson, 60 mm.

Localities:—

1. Several specimens from Warburton, Victoria, 13. xi, 05. One specimen with equal-sized claws figured (fig. 23). Four other specimens similar to this one in the matter of shape of claws, though varying greatly in hairiness. One specimen with one very large and stout chela (fig. 24), not hairy; the other chela of this specimen was unfortunately missing.

2. Two specimens from the Upper Yarra, collected by Mr. Williams in 1869 and 1871. In both the chelæ are equal in size and rather slenderly built.

3. Two specimens from the top of Black Spur, Fernshaw, 1880. In both these specimens the right chela is much larger and more massive than the left, which is elongated and narrow. One other small specimen from Fernshaw has the chelæ similar and equal. Another specimen, simply labelled "Victoria," resembles the last-named.

4. One very large specimen from Healsville, Victoria, 5. vi. 82, has the right chela enlarged and massive, the left chela narrow and elongated.

ENGÆUS VICTORIENSIS, sp. n. (Pls. XVIII.–XX. figs. 27–29, 32 & 33.)

The penultimate pleurobranch is more than double the size of the last pleurobranch, the latter being greatly reduced in size.

The exopodite of the third maxillipede is absent.

The antennal scale ends in a well-developed terminal spine and an inner lobe which is not markedly produced.

First antenna (Pl. XVIII. fig. 28) as in *E. fossor*.

The chelæ resemble those of *E. affinis*, save that when one is enlarged the propodite is not so broad and short, but is rather more elongate in shape than in *E. affinis*. There is, as usual, great variability in size, shape, and symmetry of the claws.

The rostrum resembles essentially that of *E. affinis*, but the contour of the forehead (fig. 27) is a little steeper.

The abdomen of both sexes is rather broader than in *E. affinis*.

Length of specimen figured from tip of rostrum to end of telson, 65 mm.

Localities:—

1. One specimen from the top of the Dandenong Ranges, Victoria (*Kershaw*, ii. 72) (Pl. XIX. fig. 29). Left chela enlarged, right slender.

2. One specimen, S. Gippsland, July 1891, exactly similar to above.

3. One specimen, Boxhill, near Melbourne, has right chela enlarged, left slender.

4. Two small specimens, Emerald, Victoria (*E. Jarvis*, viii. 04). Left chela enlarged, right slender, the other with chelæ subequal.

5. Several (small) from Fern Tree Gully, Victoria. Some with right chela enlarged, some with left.

6. One specimen from Croydon, Victoria (*F. P. Spry*, 1. xi. 04). Right chela enlarged.

7. One specimen from Ringwood, Victoria (*E. H. Hennell*, xi, 90). Left chela enlarged.

8. Several specimens, simply labelled "Victoria." Some with right chela, some with left enlarged; a few with chelæ subequal or equal.

9. One very large specimen from the Launching Place, Victoria (*J. Coghill*, 15. i. 07), with left chela enlarged.

Remarks on the above two species, E. affinis *and* victoriensis.

These two species, which are very widely distributed in Victoria, are clearly distinguishable from the Tasmanian *E. fossor* by a number of characters, and from the succeeding species, *E. phyllocercus*, by the remarkable shape of the uropods in the latter form. But the characters distinguishing *E. affinis* and *victoriensis* are very slight, and it may be possible at some time to merge them together in one species, *victoriensis*. The only really satisfactory character is the size of the last pleurobranch, which is reduced in *victoriensis* and well developed in *affinis*. The only other character which is of use in separating the two forms is the shape of the enlarged chela, which is shorter and broader in *affinis* than in *victoriensis*; but since the enlarged chela is not always developed, this character is an unsatisfactory one.

Engæus phyllocercus, sp. n. (Pls. XIX. & XXI. figs. 30, 31, & 36.)

All the pleurobranchs are of approximately equal size, the last one not being reduced.

The exopodite of the third maxillipede is reduced, but is clearly to be seen, and it is tipped with several plumose hairs (Pl. XXI. fig. 36).

The antennal scale ends in a spine which is less elongated than in the preceding two species.

The first antenna is similar to that of preceding species.

The great chela has both the upper and lower borders of the

propodite serrated. There is a single row of tubercles on the upper and inner border of the carpopodite, and a row of tubercles on the upper border of the meropodite. The shape of the chelæ is somewhat elongated, and one is generally enlarged, the other remaining slender.

The rostrum ends in a rather blunt upcurved spine, which is shorter and blunter than in the two preceding species.

The uropods exhibit a peculiar and highly characteristic modification, in that both endopodite and exopodite are produced distally into pointed apices, giving the tail-fan a leaf-like appearance (Pl. XIX. fig. 31).

Length of specimen figured from tip of rostrum to end of telson, 59 mm.

Localities. Narracan River, Thorpdale, Trafalgar. All these are Gippsland localities to which the species appears to be confined.

Variety. The rudimentary exopodite of third maxillipede varies in size in the different specimens, and in one specimen from a small stream near Thorpdale, Gippsland, collected by Mr. Kershaw in March 1890, the exopodite is reduced to a small papilla.

ENGÆUS HEMICIRRATULUS, sp. n. (Pls. XX.–XXII. figs. 34, 35, 37, 38.)

The posterior pleurobranch is entirely absent.

The exopodite of the third maxillipede is absent.

The antennal scale ends in a prolonged curved and blunt spine, and the inner lobe is small (Pl. XXII. fig. 37).

The first antenna has only one flagellum, the inner flagellum being entirely absent (fig. 38).

The upper and under and posterior borders of the propodite of the chela are studded with marked tubercles, as are also the borders of the carpopodite, so that the chela as a whole has a more tubercular appearance than in any of the other species. One chela is generally more stoutly developed than the other, sometimes on the right side and sometimes on the left. The pencils of hairs on the chelæ are more conspicuous than in preceding species.

There are no sperm-receptacles with conspicuous openings in the female.

The eyes are not markedly reduced. The rostrum has a conspicuous rounded hump at its base, but is flat and keelless distally and ends in a blunt spine. Just proximal to the point of the spine is a conspicuous bunch of hairs. The contour of the forehead is not at all steep.

The thorax is vaulted and deep as in the preceding species; the abdomen is reduced and hairy. The tail-fan is normal in shape, but the pencils of hairs upon it are particularly conspicuous.

Colour. (From coloured figures by McCoy.) Carapace dull purple. Chelæ reddish. Legs and abdomen brownish grey.

Length 51 mm.

Localities :—

1. Three female specimens and one male from a hill near Thorpdale, Gippsland (*W. Kershaw*, iii. 90), with left chela larger than right. These range in size from 70 mm. to 31 mm. Four small specimens, ranging in size from 30 mm. to 18 mm., had the chelæ equal or subequal.

2. Several specimens from Warragul, Gippsland. A large female, 80 mm. in length, with right chela enlarged, 3. ix. 92; and several specimens, some with right chela enlarged, others with left, and some with equal chelæ (*Prof. B. Spencer*).

3. A large male, measuring 65 mm., with equal chelæ, from Moyarra, near Oultrim, S. Gippsland (*Kitson*, 1905).

4. A male, measuring 50 mm., with right chela enlarged, from Kongwak, near Jumbanna, S. Gippsland (*Kitson*, 1902).

Remarks. This species was partly described and figured by McCoy in MS. as *Hemicirratulus hystrix*. Since it does not fit in with the scheme of this memoir to place this species in a separate genus, we have retained McCoy's MS. generic name, *hemicirratulus*, as the specific name. The species is a constant and easily recognised one; the chelæ, as usual, are variable in development, and the rostrum differs somewhat in the different specimens. In the specimens from S. Gippsland the rounded hump at the base of the rostrum extends rather further along the rostrum than in the specimens from other parts of Gippsland.

ENGÆUS CUNICULARIUS Erichson, (Pls. XXII.–XXV. figs. 39–47.)

Erichson, Archiv f. Naturg. vol. xii. p. 102 (1846); Von Martens, Monatsber. Akad. Wiss. Berlin, 1868, p. 619; Haswell, Cat. Australian Mus., Stalk- and Sessile-eyed Crustacea, p. 179 (1882).

The posterior pleurobranch is present, and is the largest of all four pleurobranchs, which increase in size from before backwards.

The third maxillipede has a well-developed exopodite (fig. 46).

The scale of the second antenna has a short terminal spine and a well-developed inner lobe (fig. 47).

The two flagella of the first antenna are nearly equal in length, the outer flagellum being slightly longer than the inner.

The upper or inner border of the propodite of the chela has a row of five tubercles; the lower or outer border is smooth. There is a row of feeble serrations on the inner border of the carpopodite and on the upper border of the meropodite, but the chela on the whole is very feebly tuberculated and comparatively free from hairs. There is, however, great variability in the chelæ.

There are no conspicuous sperm-receptacles in the female.

The eyes are large and comparatively unreduced.

The rostrum is straight, well-developed, and ends in a blunt spine. There are two highly-developed tumid keels on its sides, which are continued a little way back on to the carapace.

The thorax is less highly vaulted and more normal in shape than in the foregoing species.

The abdomen is very large and unreduced; the telson is broad and the tail-fan rounded, well developed, and normal in shape. The abdomen and tail-fan are not at all conspicuously hairy.

The *colour* varies from reddish brown to olivaceous grey, while parts of the chela and thorax may be picked out in bright blue and red.

Localities:—

1. Tasmania. In one specimen, a male, both chelæ are large and equal in size and shape. There is a peculiar compound tooth on each jaw of the pincer (Pl. XXII. fig. 39). This specimen comes from Glenore, near Hageley, Tasmania (*Bartholomew*, 29. v. 89). In one male specimen from Launceston, Tasmania (*Bartholomew*, 1890), the left chela is enlarged and resembles that of the above specimen; the right chela is toothless, small, and slender. A similar specimen, but a female, comes from Mundan Farm, Longford, Tasmania (*Bartholomew*, 1889).

2. Warragul, Gippsland. Three male specimens (*Kershaw*, 1887, 1888), two with left chela enlarged, one with right. There is a prominent peg-like tooth on the dactylopodite part of the enlarged pincer; the compound tooth on fixed jaw of pincer is reduced (Pls. XXII., XXIII. figs. 41 & 42).

3. Near Lake's Entrance, Gippsland. One female specimen (*Kershaw*, 1887) with two similar chelæ without teeth (fig. 40). This type of chela is intermediate in character between the large and small chela of the specimens from Warragul (figs. 41 & 42).

4. Derby River, Wilson's Promontory (*Kershaw*, 1905). Three specimens, all with similar and equal chelæ. Teeth are present in the pincer, but are reduced in size. The chelæ are rather elongated in shape.

A note appended to these specimens states that they build conical mud towers, about 8 to 10 inches high, on the flats.

5. From banks of Fraser Creek, Oberon Bay, Wilson's Promontory (*Kershaw*, 1905). Similar to the last mentioned, but pincer tends to be less elongated.

6. Male specimen from Croydon, Victoria (*Fulton*, 1907), with left chela enlarged. Interior of pincer is hairy and without any enlarged teeth.

7. Female specimen from Fern Tree Gully, with left chela enlarged and small teeth in pincer.

8. Numerous specimens from Croydon, Victoria, and unnamed Victorian localities, characterised by the presence of a thick pad of fine downy hairs on the inner surface of the chela (Pl. XXV. fig. 45), and also a thick covering of downy hairs on the third maxillipedes. This constant character is possibly of specific value, and it might be advisable to separate these forms as a distinct species; but they do not apparently show any other differences to distinguish them from the typical *E. cunicularius*. It is a remarkable fact that an exactly similar downy pad occurs in some species of *Chæraps*.

ENGÆUS FULTONI, sp. n.

This species agrees with *E. cunicularius* in all its characters, save that the exopodite of the third maxillipede, instead of being large and normally developed, is reduced to a small papilla as in *E. phyllocercus*. The teeth in the pincer of the chela are not fused to form a compound tooth, but there are several, about three, small teeth on the lower jaw of the pincer and two on the upper. The lower border of the propodite of the chela has a distinct serrated keel.

Localities :—

1. Two specimens from Fern Tree Gully, Victoria, one being a female measuring 53 mm., with both chelæ large and equally developed; the other a small female measuring 35 mm., with the left chela enlarged and the right slender.

2. One male from Cape Otway Forest, Victoria (collected by W. Fulton, 28. v. 07), with both chelæ similar, fairly stoutly built, and markedly hairy.

EXPLANATION OF THE PLATES.

PLATE XII.

Fig. 1. Semidiagrammatic cross-section of podobranch of *Astacopsis*. *al.* = ala. Only a few of the gill-filaments are shown.
2. Terminal hook from gill-filament on ala, taken from the podobranch of *Astacopsis*.
3. Ends of hooked setæ from podobranch of *Astacopsis*.
4. Semidiagrammatic section of podobranch of chela in *Parachæraps*.
5. Terminal hook from gill-filament of *Parachæraps*.
6. End of hooked seta from podobranch of *Parachæraps*.

PLATE XIII.

Fig. 7. Podobranch of great chela from *Engæus cunicularius*. ×4½.
8. Semidiagrammatic transverse section of do. ×12. *al.* = ala.
9. Tips of hooked gill-filaments from ala of do. ×250.
10. Tips of hooked setæ from podobranch of do. ×250.

PLATE XIV.

Fig. 11. *Engæus fossor*. From dorsal surface. ×1½.
12. „ „ Side view, with limbs removed. ×1½.

PLATE XV.

Fig. 13. *Engæus fossor*. Sperm-receptacles on penultimate segment of thorax in the female. ×2¼.
14. „ „ Basal portion of right antenna from above. ×6½.
15. „ „ Scale of antenna. ×12.
16. „ „ Left mandible from above. ×6½.
17. „ „ Do. from below.

PLATE XVI.

Fig. 18. *Engæus fossor*. First maxilla (left) from above. ×6½.
19. „ „ End of exopodite of first maxilla. ×65.
20. „ „ Second maxilla (left) from above. ×6½.
21. „ „ Second maxillipede (left) from below. ×6½.

Plate XVII.

Fig. 22. *Engæus fossor.* Basal portion of third maxillipede (left) from above. ×6½.
23. „ *affinis*, ♀. Dorsal view. ×1½.
24. „ „ Great chela. ×2¼.
25. „ „ Scale of antenna (left). ×6½.

Plate XVIII.

Fig. 26. *Engæus affinis.* Contour of forehead. ×2¼.
27. „ *victoriensis.* Contour of forehead. ×2¼.
28. „ „ First antenna (left). ×6½.

Plate XIX.

Fig. 29. *Engæus victoriensis*, ♀. Dorsal view. ×1½.
30. „ *phyllocercus*, ♀. Dorsal view. ×1½.
31. „ „ Telson and uropods. ×2.

Plate XX.

Fig. 32. *Engæus victoriensis.* Telson and uropods. ×2.
33. „ „ Great chela. ×2⅓.
34. „ *hemicirratulus.* "Face."

Plate XXI.

Fig. 35. *Engæus hemicirratulus.* Dorsal view. ×1¼.
36. „ *phyllocercus.* Third maxillipede (left) from below.

Plate XXII.

Fig. 37. *Engæus hemicirratulus.* Base of right first antenna from below. ×6½.
38. „ „ First antenna. ×6½.
39. „ *cuniculariius.* Chela of male from Glenore, near Hageley, Tasmania (fig. 43). ×2¼.
40. „ „ Right chela of female found near Lake's Entrance, Gippsland. ×2.
41. „ „ Right chela of male specimen from Warragul, Gippsland. ×2.

Plate XXIII.

Fig. 42. *Engæus cuniculariius.* Left chela of male specimen from Warragul, Gippsland. Companion to fig. 41.
43. „ „ ♂. From Glenore, near Hageley, Tasmania. ×1½.

Plate XXIV.

Fig. 44. *Engæus cuniculariius*, ♂. From Warragul, Gippsland. ×1½.

Plate XXV.

Fig. 45. *Engæus cuniculariius.* Left chela of specimen from Croydon, Victoria.
46. „ „ Third maxillipede (right) from above. ×4½.
47. „ „ Scale of left antenna. ×6½.