only feature that recalled the Shrew being the long, cylindrical, twitching snout. They were also quite like rodents in their quadrupedal gait, the ground being traversed by the ordinary running action or by lightning-like leaps from point to point. They did not raise their fore-quarters from the ground more frequently than is the custom with typical rodents, and were never seen to hop on the hind legs alone, like Jerboas and Kangaroos, as they have been declared to do in some natural histories.

In appearance the two examples of *Macroscelides proboscideus* differed considerably from the one representative of *Elephantulus rupestris*. In the former the eyes were smaller and the ears more widely separated and more concealed in the hair of the sides of the head. In *Elephantulus rupestris* there was a conspicuous light ring round the large eye, the ears were more erect, and separated by a much narrower space on the top of the head. It was noticeable, too, that, whereas the Rock Elephant-Shrew lay hidden beneath a heap of hay during the daytime, the two Common Elephant-Shrews preferred to huddle together in the open part of the cage, evincing a dislike to push beneath the hay and refusing to remain under it when it was placed over them. The differences between the living animals, indeed, quite bore out the view, based upon the structure of the skull, that the two species belonged to different genera.

PAPERS.

10. The Freshwater Crayfishes of Australia.

By GEOFFREY SMITH, M.A., Fellow of New College, Oxford*.

[Received October 20, 1911: Read November 21, 1911.]

(Plates XIV.–XXVII.† and Text-figure 18.)

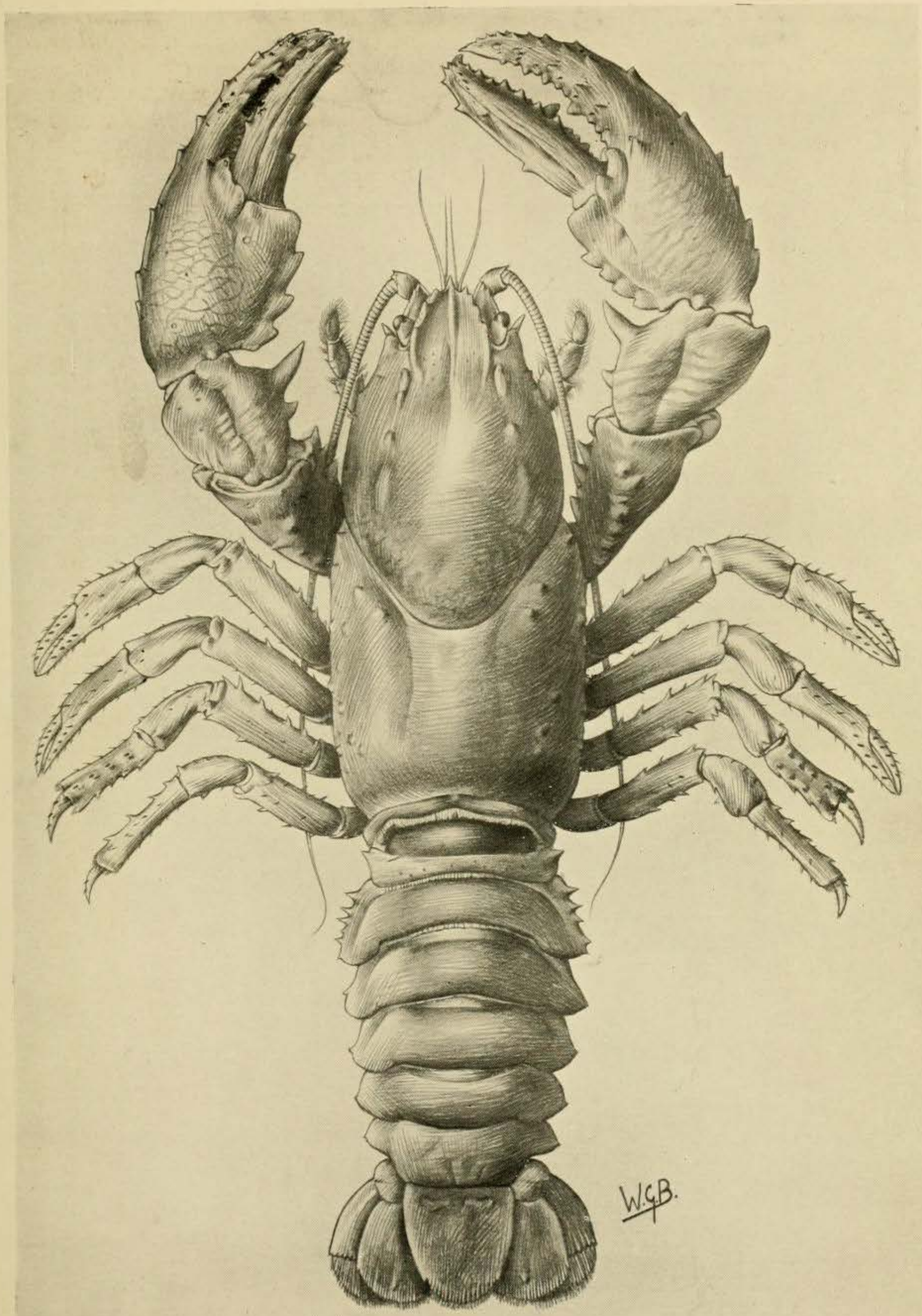
I. *Introduction.*

The study of Freshwater Crayfishes has been distinguished by the labours of Huxley; the detailed work of Ortman and Faxon has made us acquainted with the North-American species of *Astacus* and *Cambarus*, and Faxon has reduced the South-American genus *Parastacus* and the New Zealand *Paranephrops* to order, but what Huxley wrote in 1879 concerning the Australian Crayfishes, "that their nomenclature requires thorough revision," is almost as true to-day as thirty years ago.

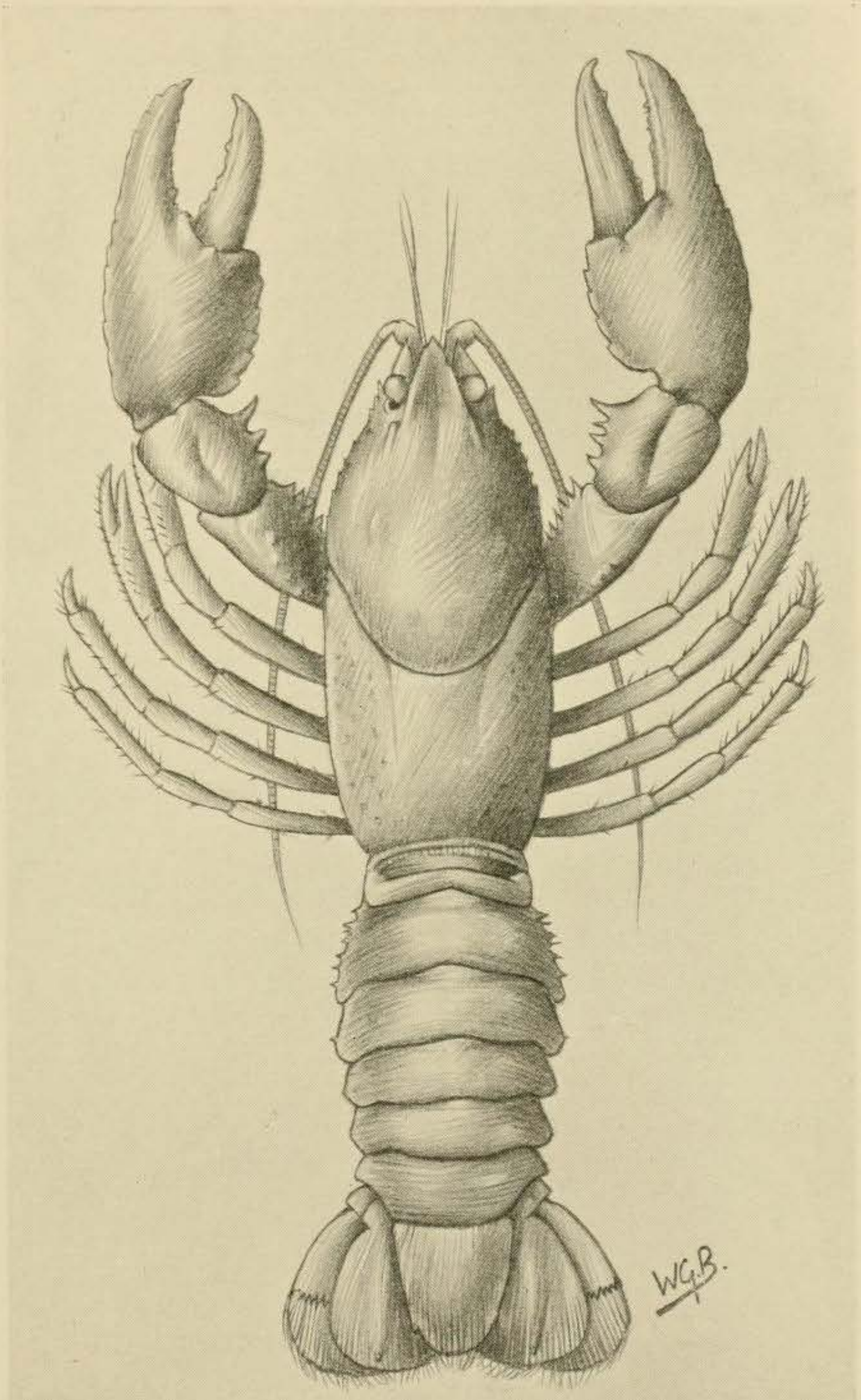
The following memoir does not pretend to be an exhaustive monograph of the anatomy or of the systematic classification of the Australian Crayfishes, but by publishing the series of accurate

* Communicated by the Secretary.

† For explanation of the Plates see pp. 170–171.



ASTACOPSIS FRANKLINII. ♂.



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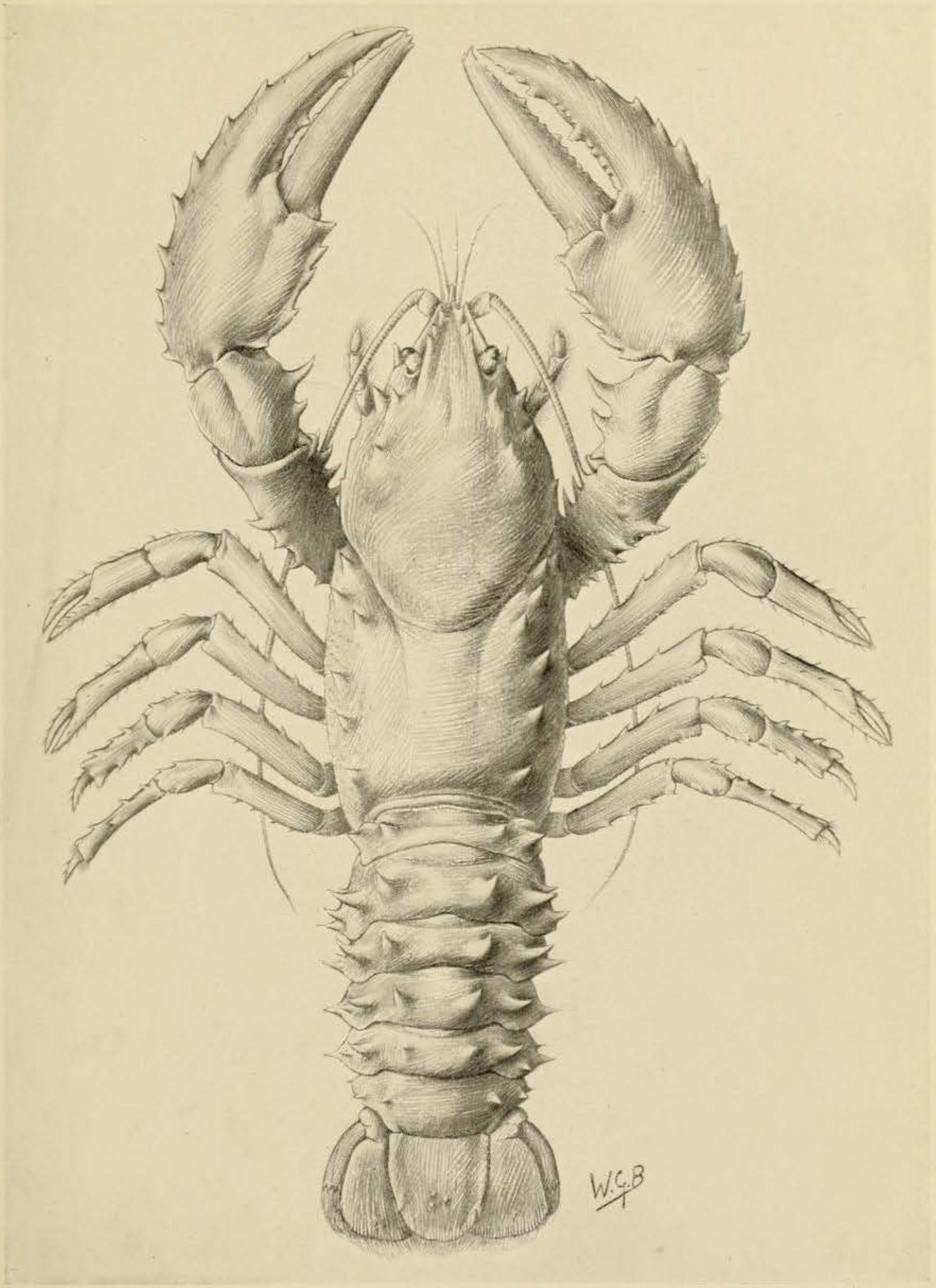

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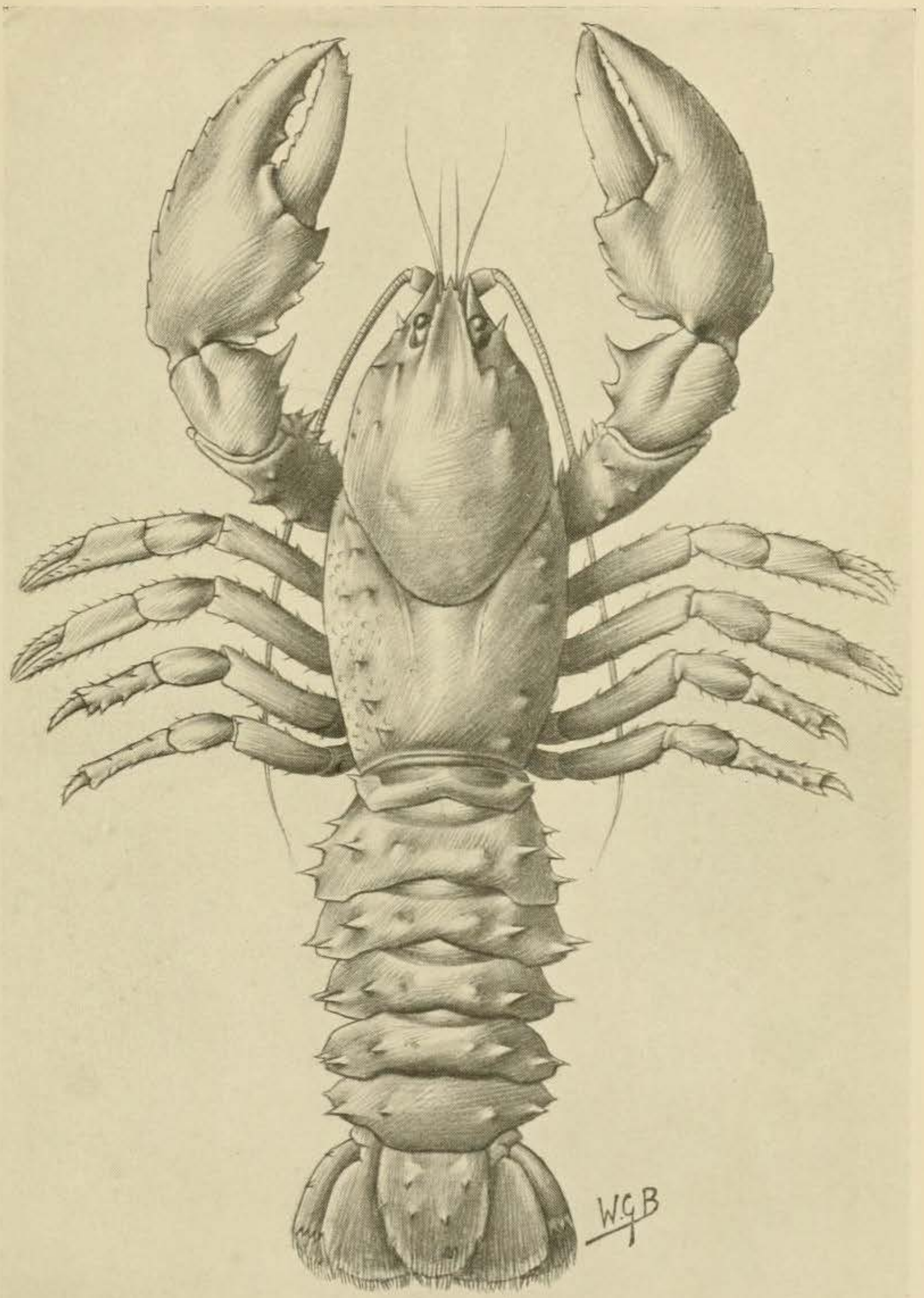

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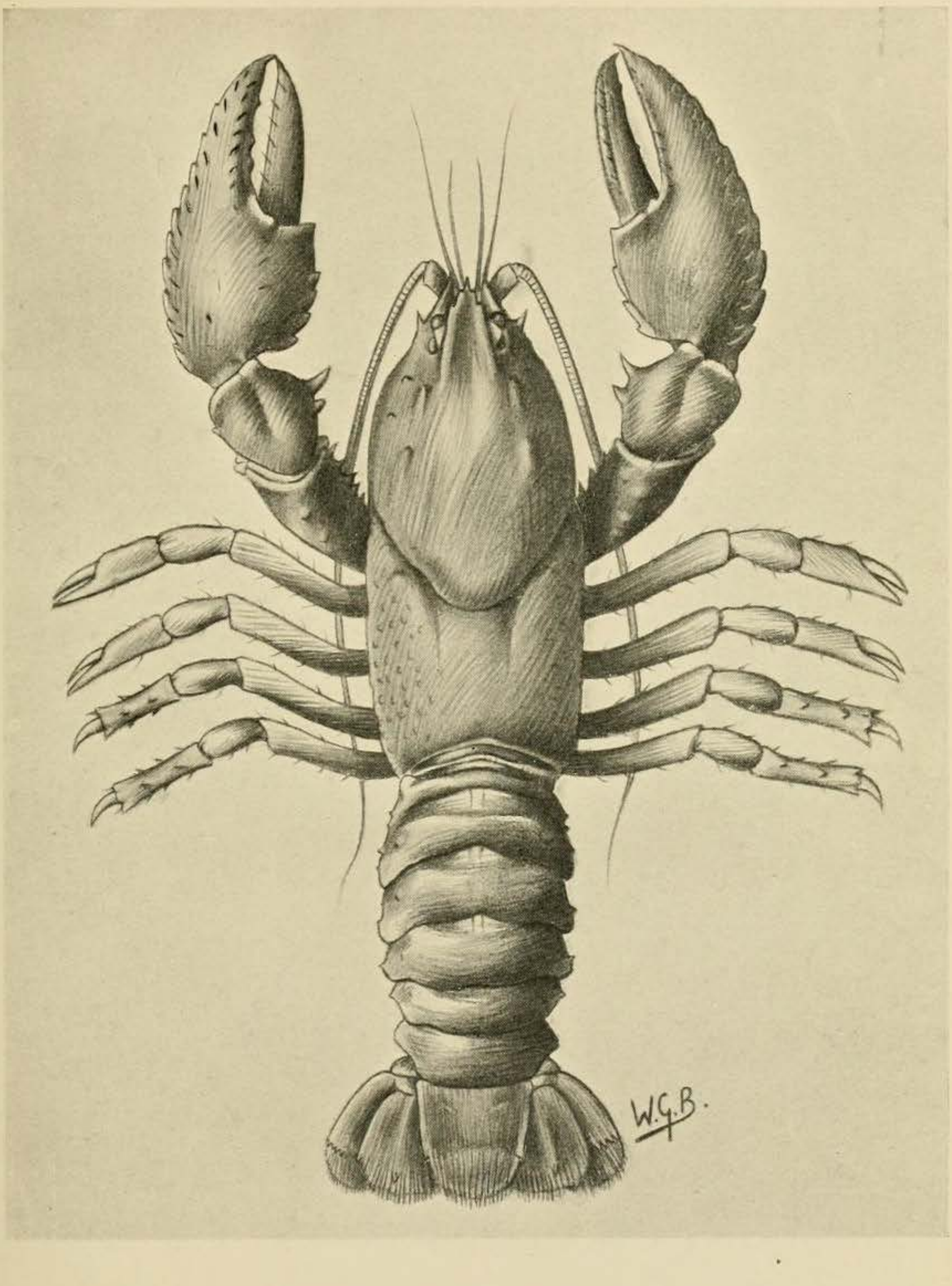

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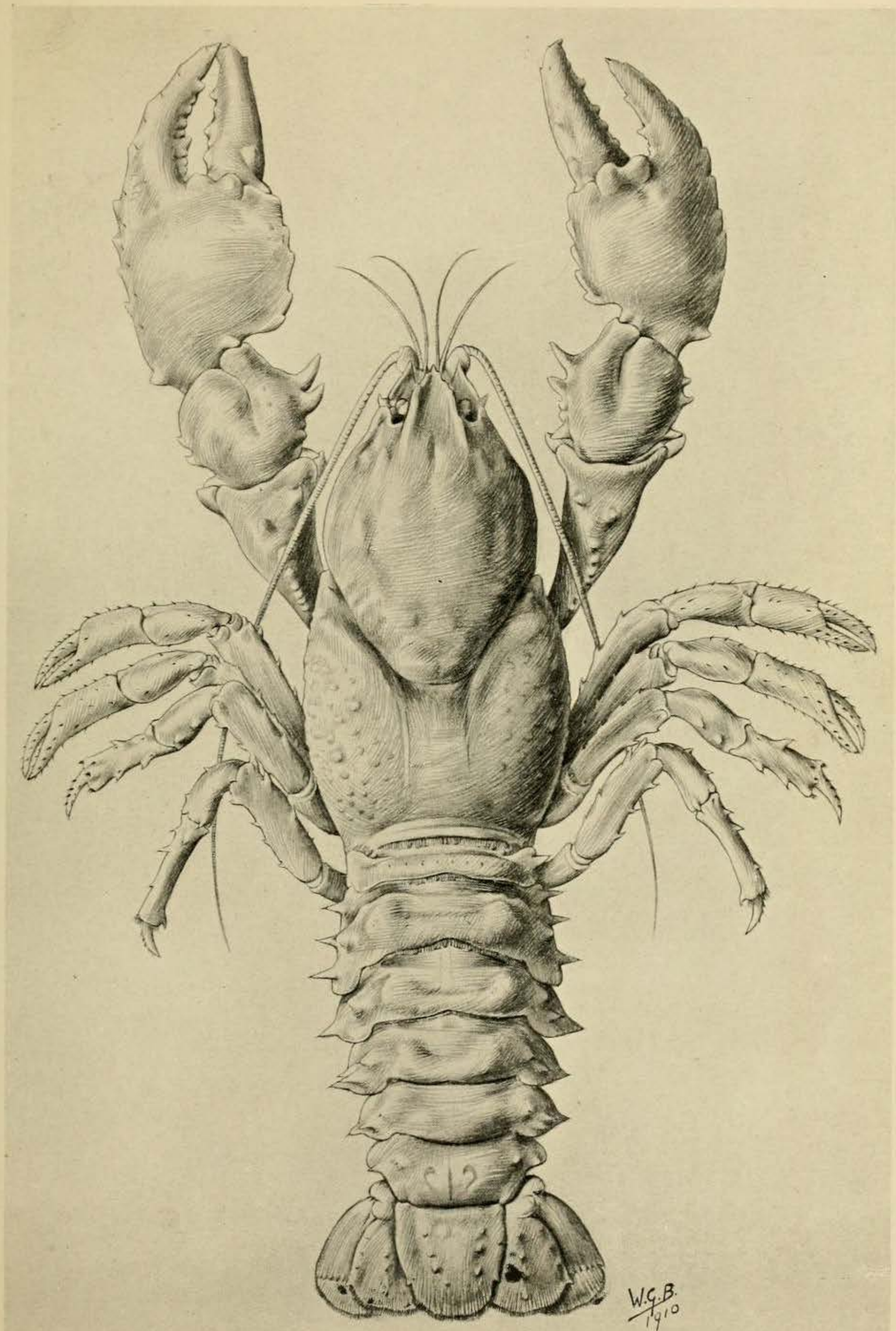
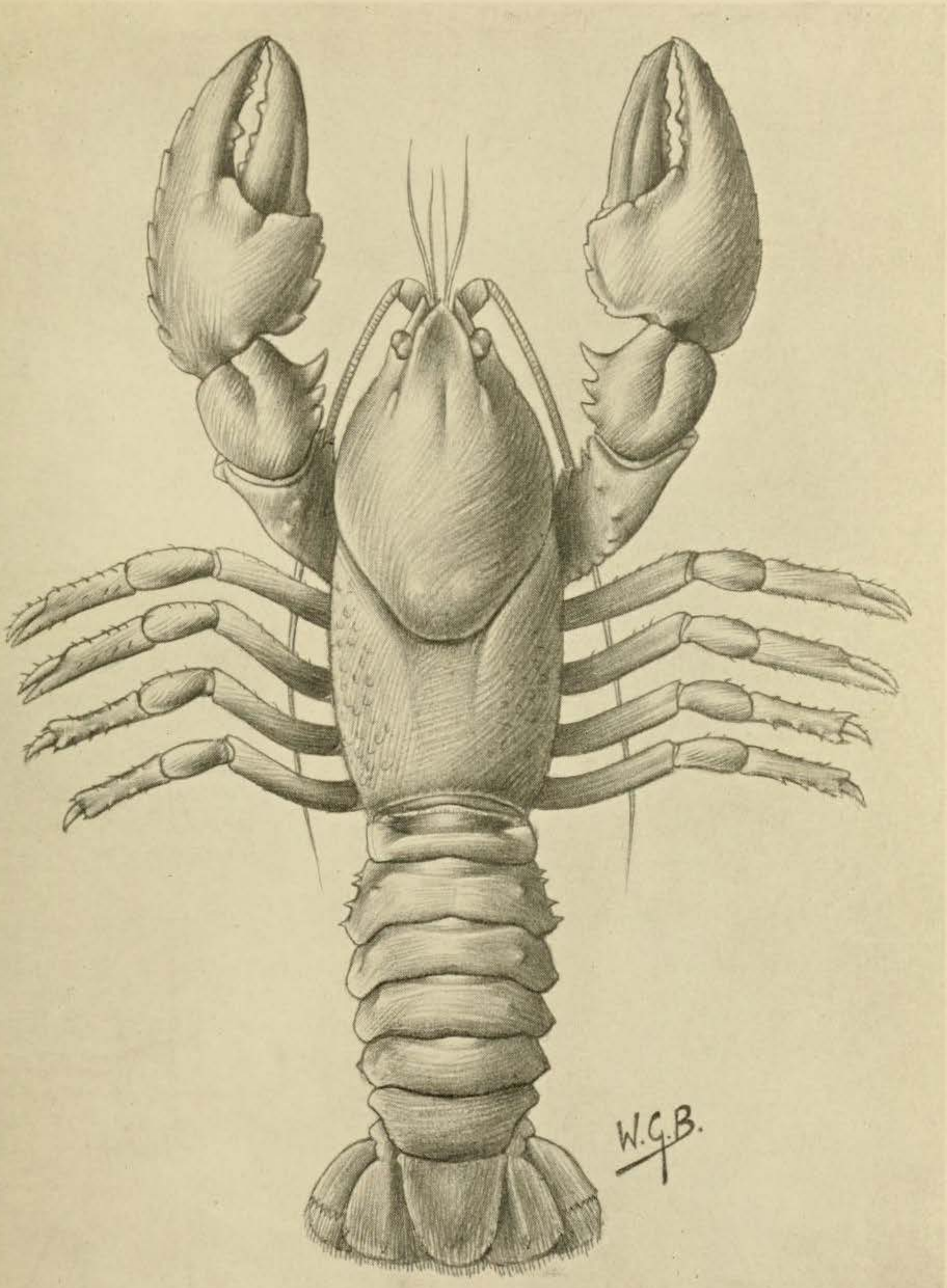


ASTACOPSIS KERSHAWI. ♂.



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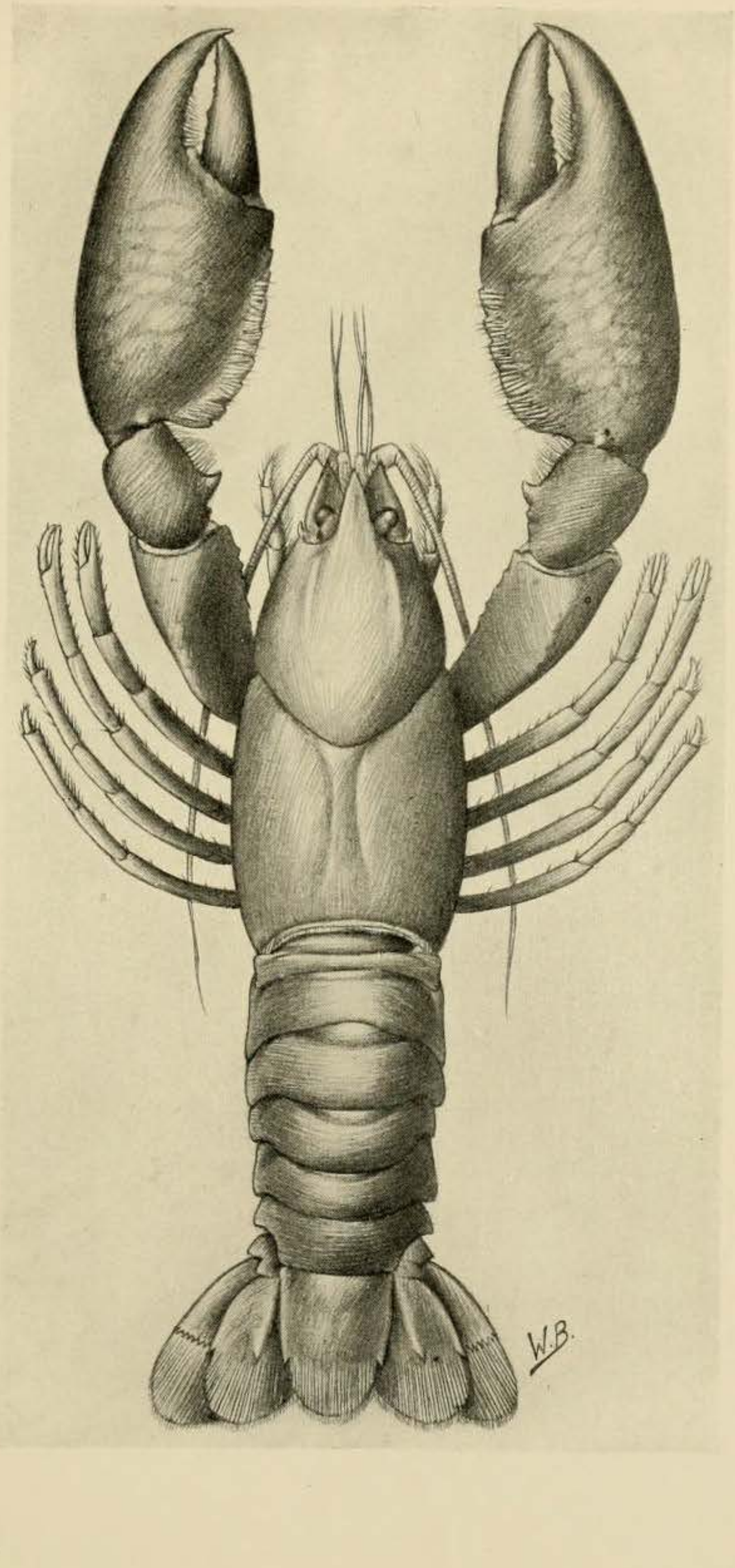
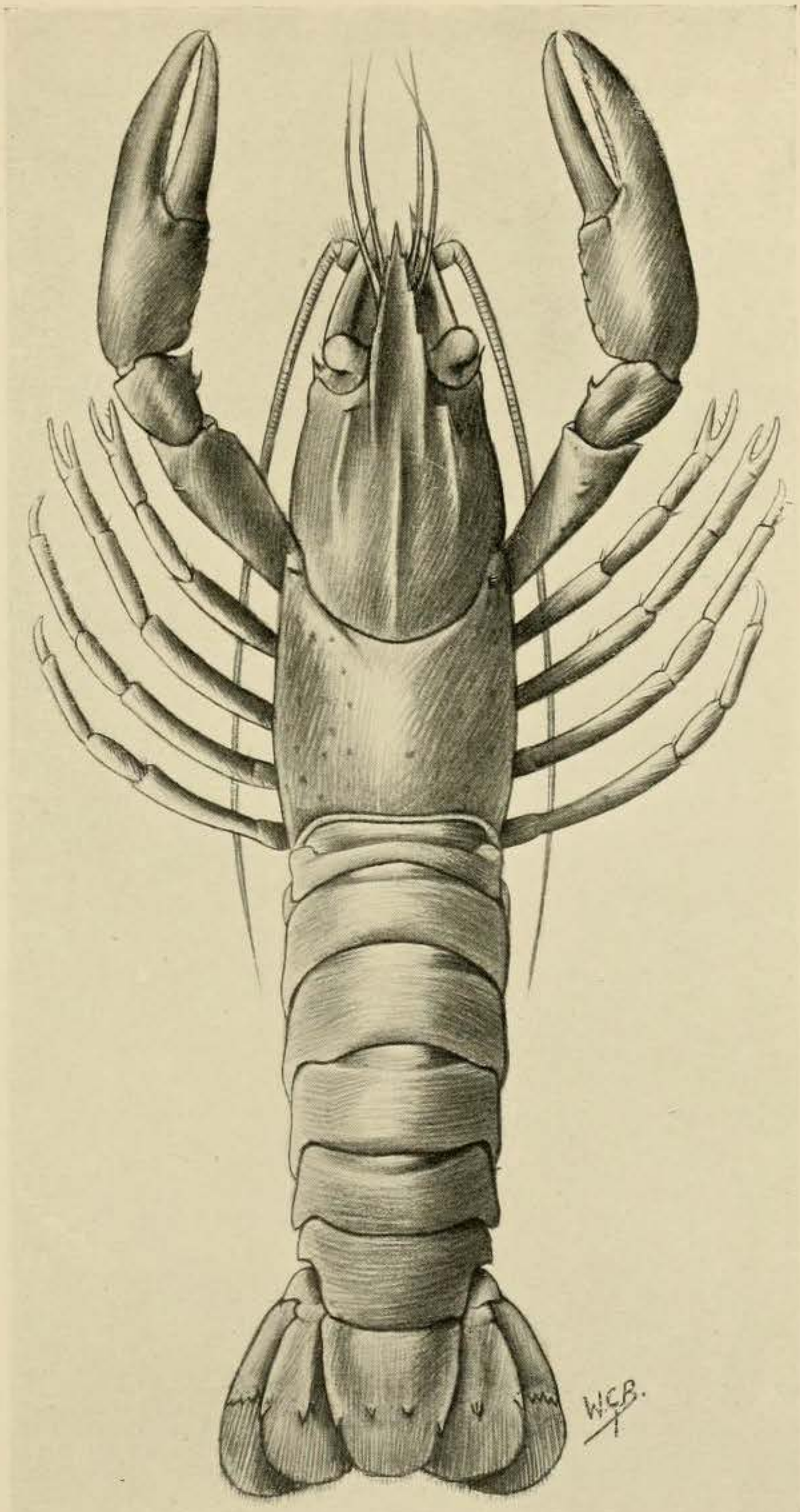
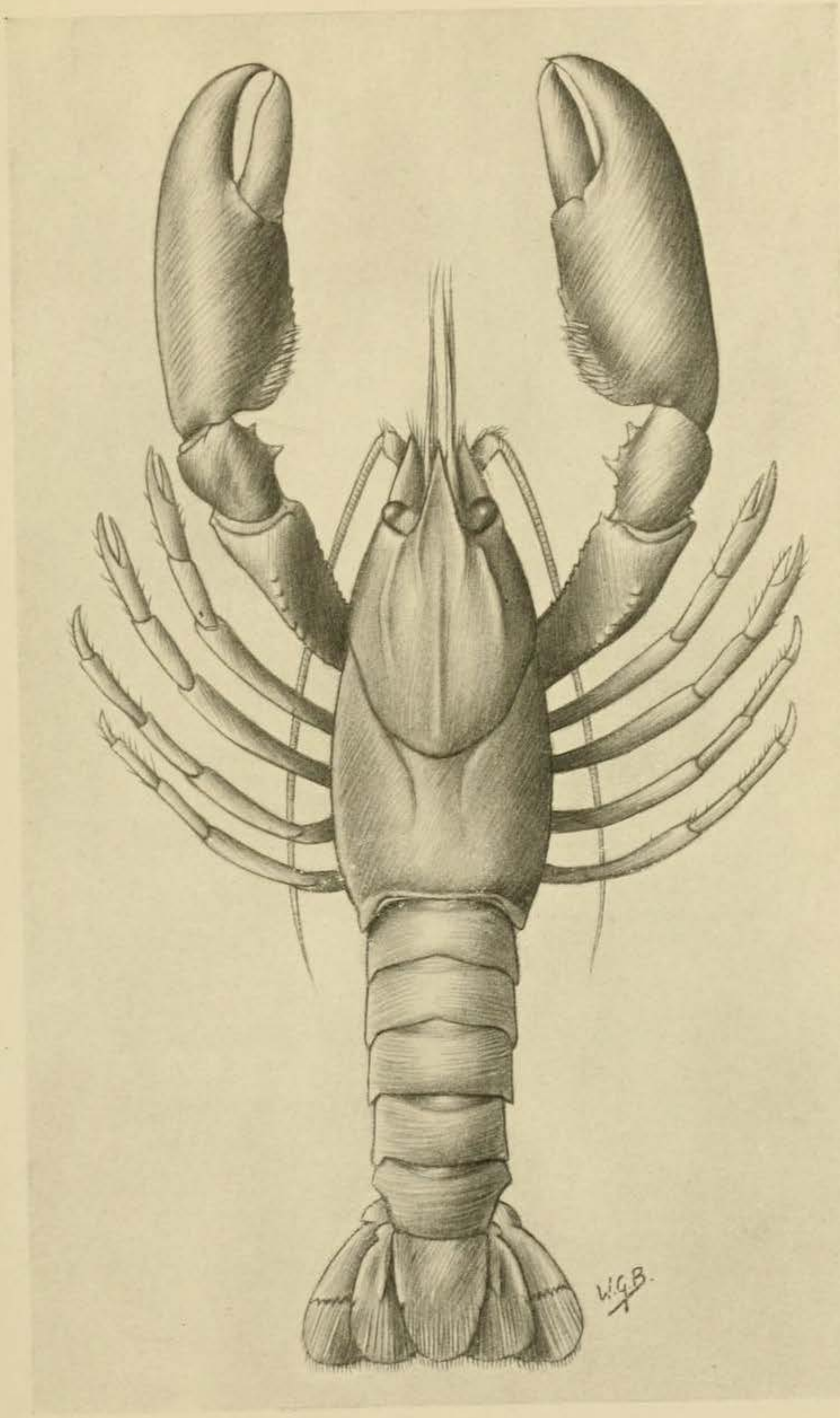


PARACHÆROPS BICARINATUS. ♂.



CHÆROPS TENUIMANUS. ♂.



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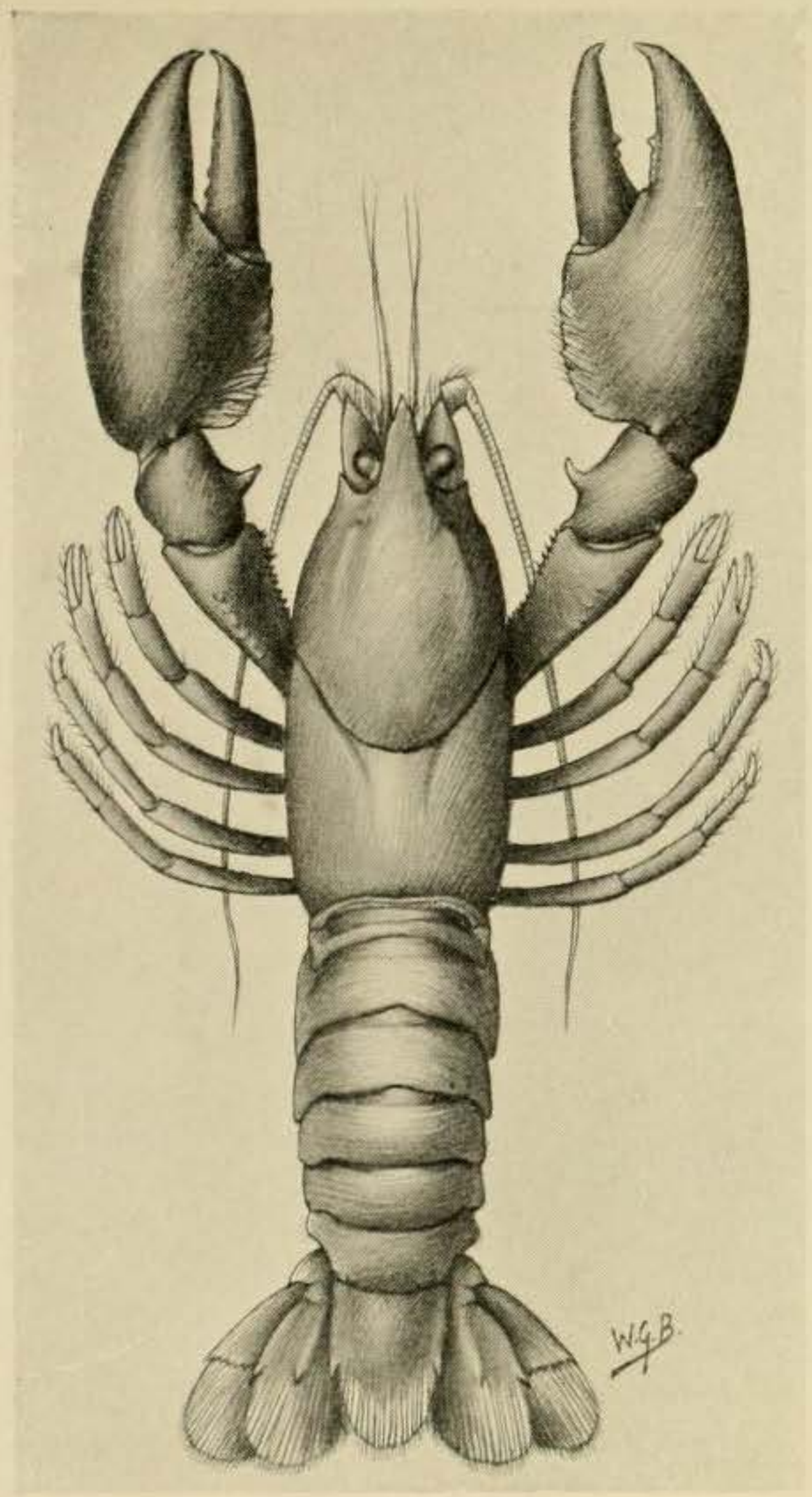

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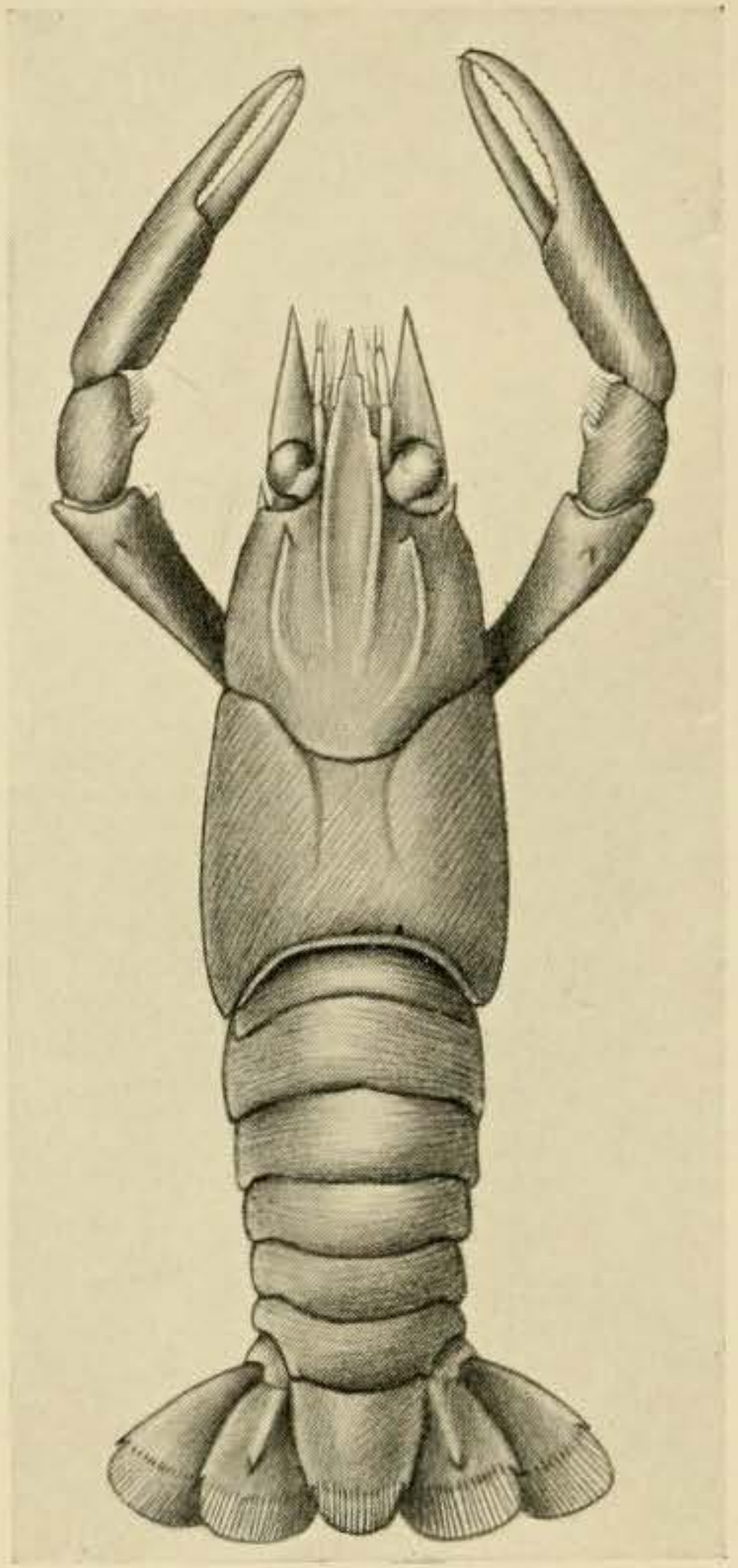

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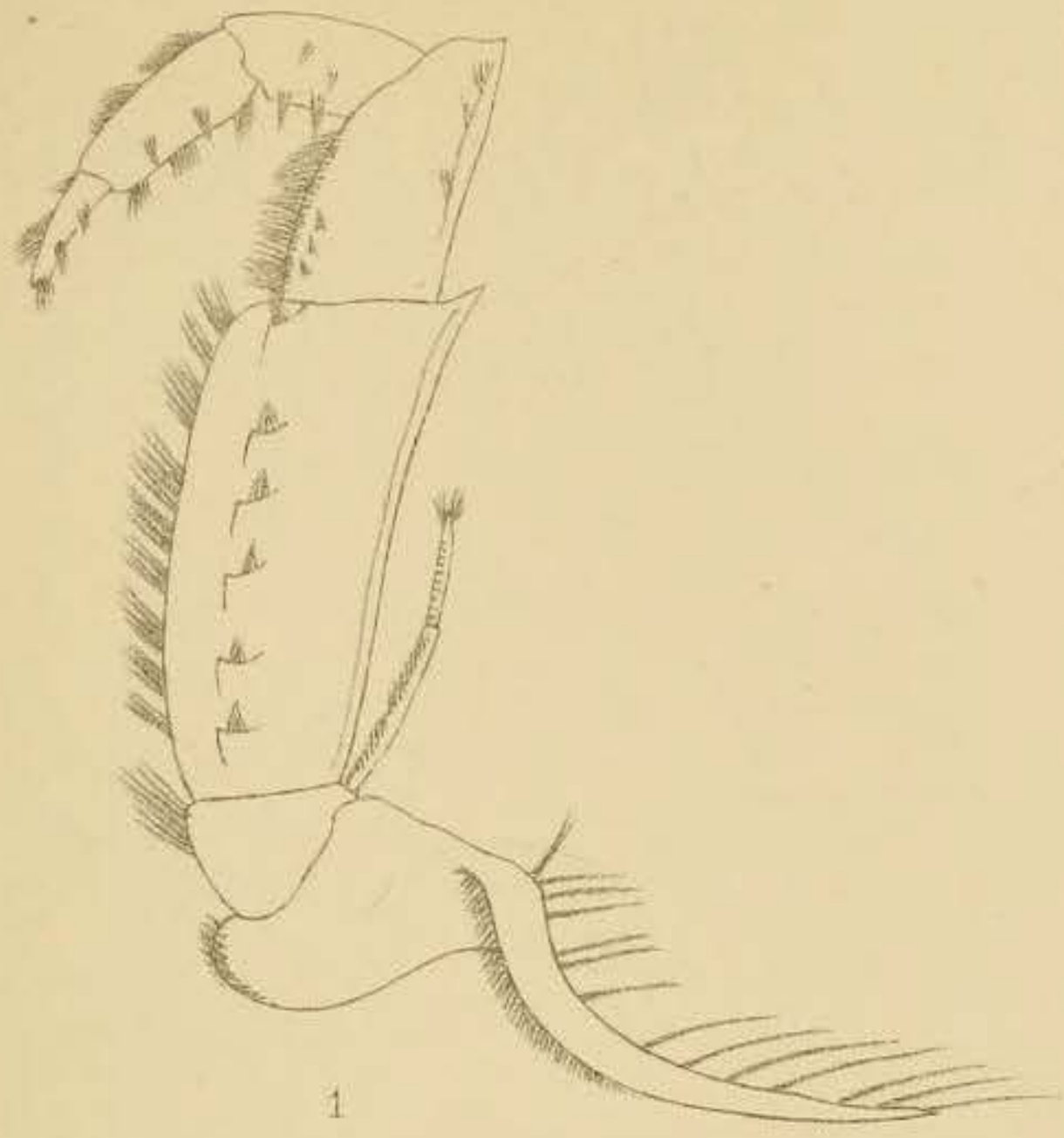
1. CHÆROPS QUADRICARINATUS ♂. 2. C. INTERMEDIUS. ♂.



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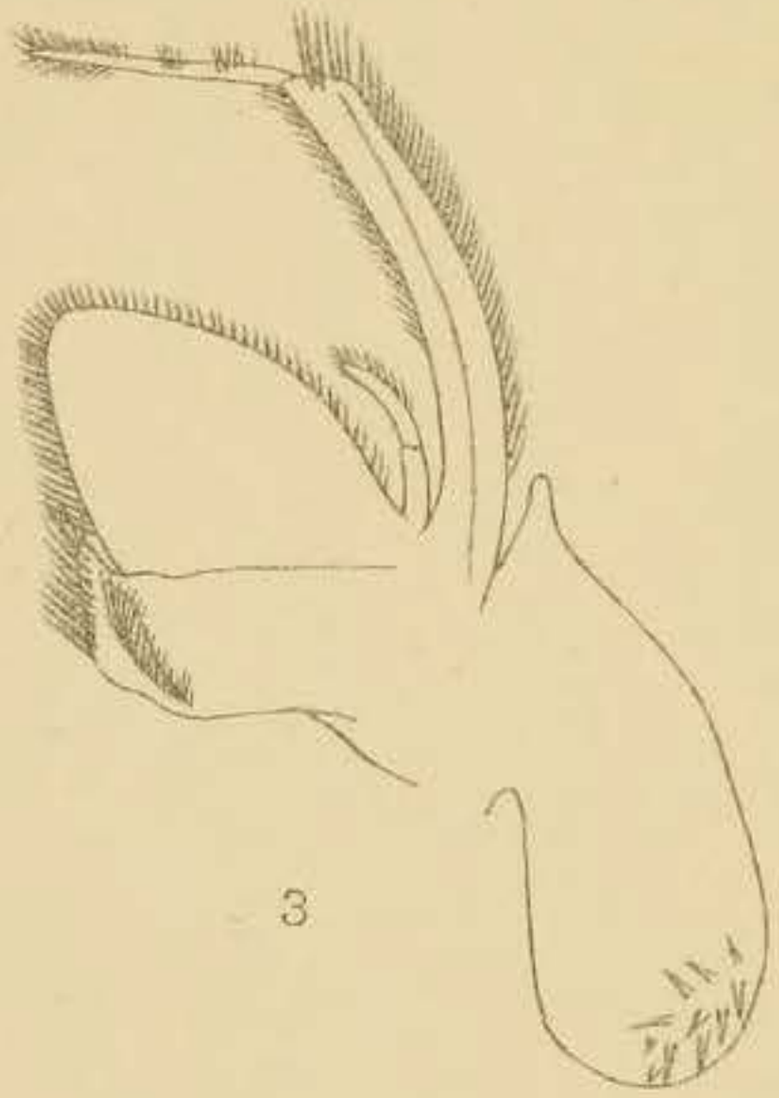

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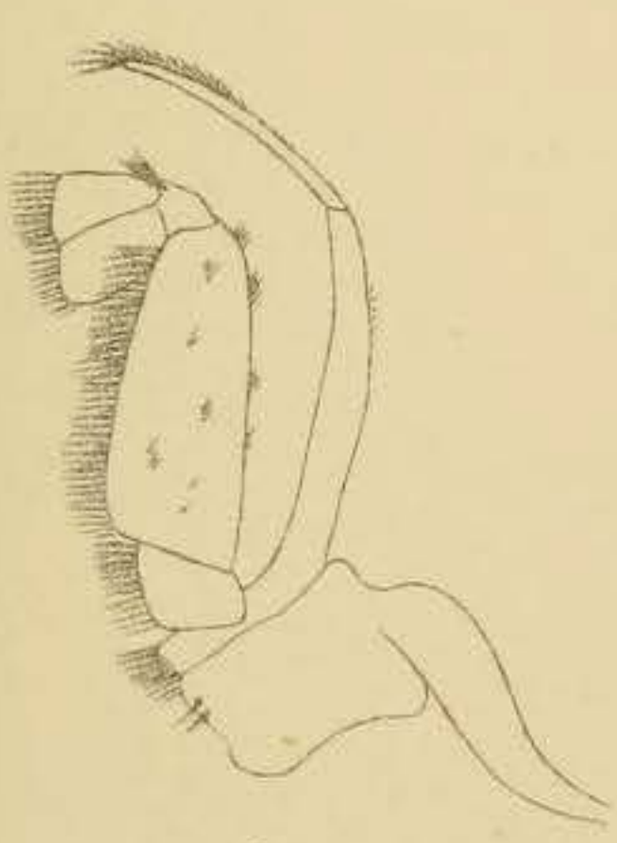

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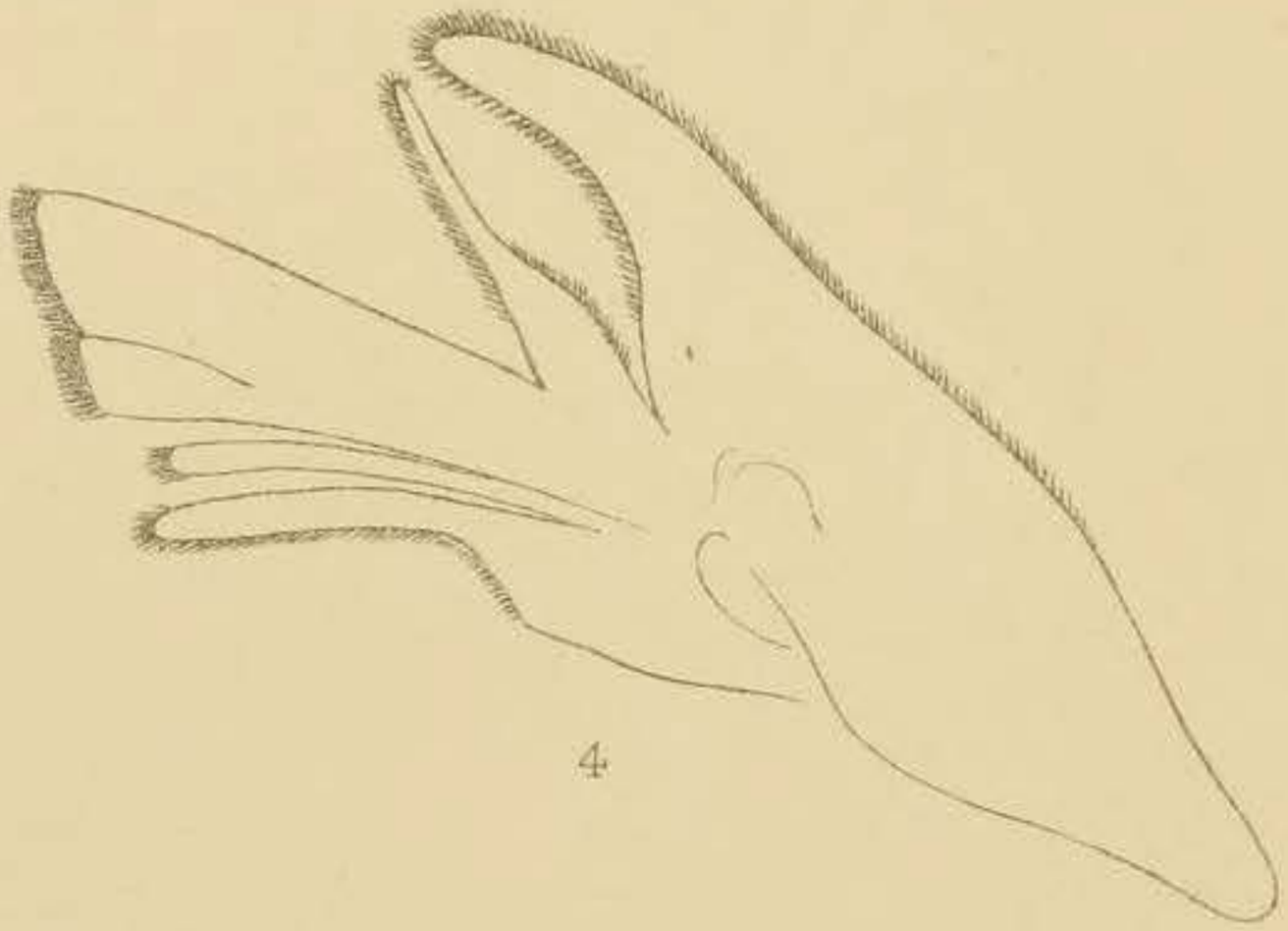

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West, Newman lith.

ASTACOPSIS FRANKLINII.

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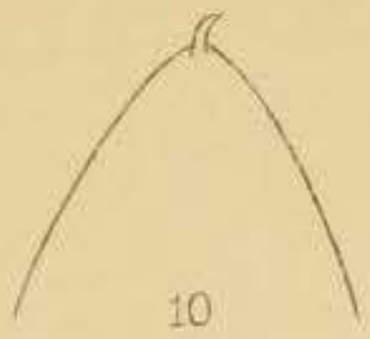

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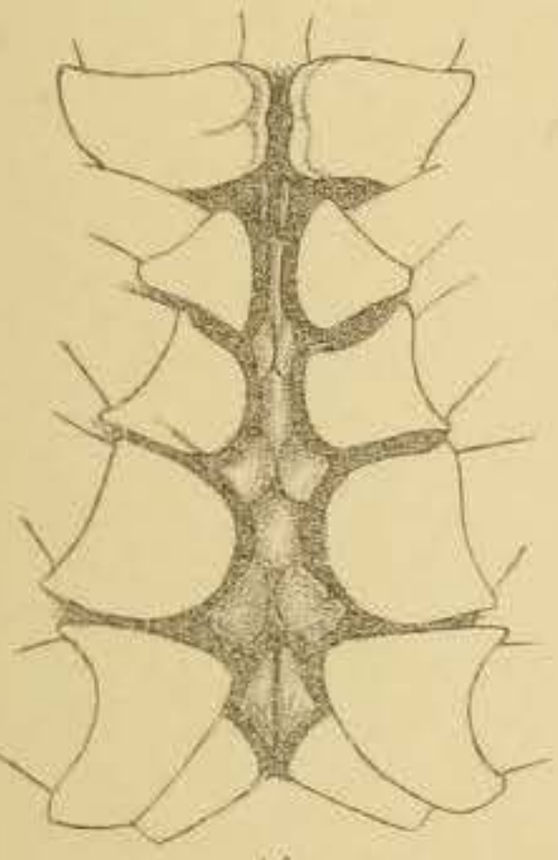

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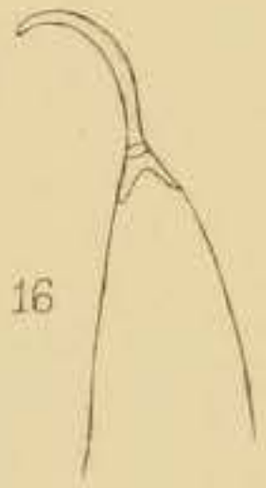

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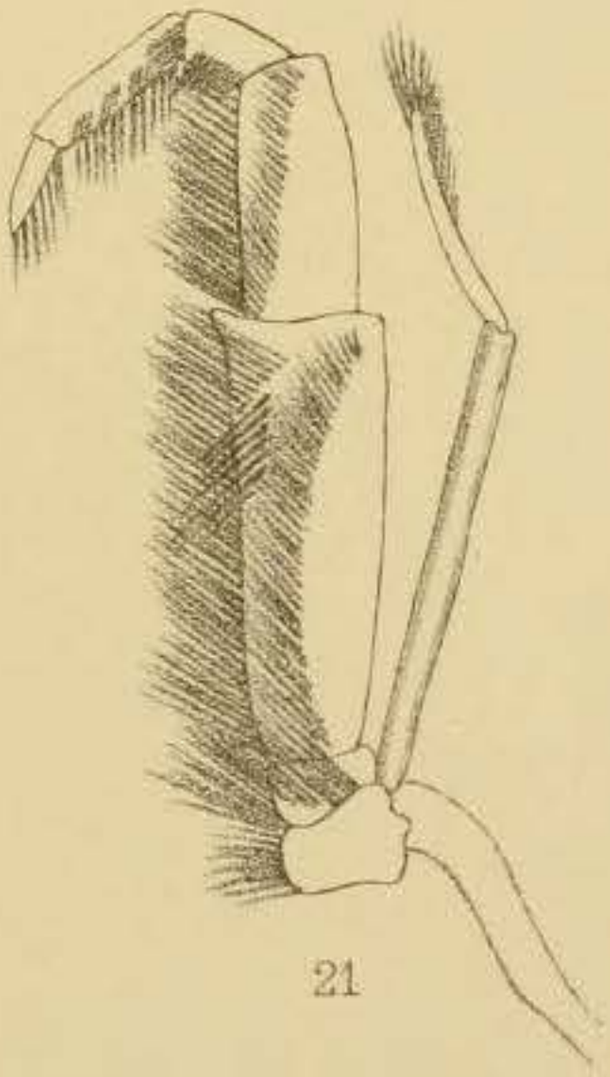

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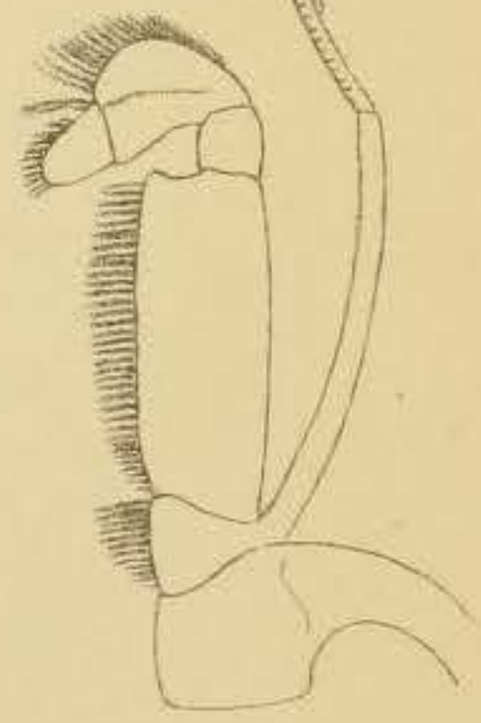

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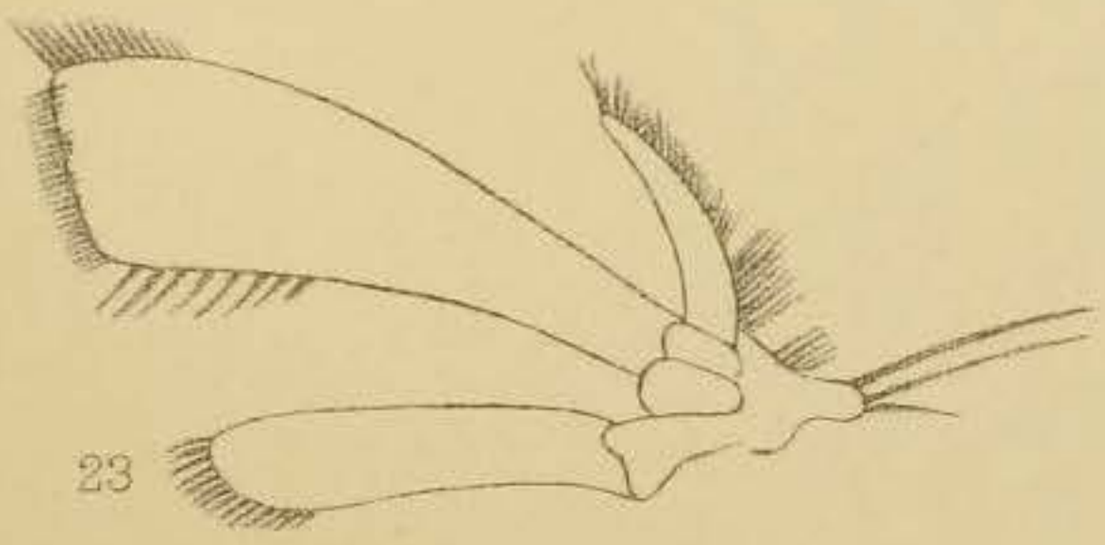

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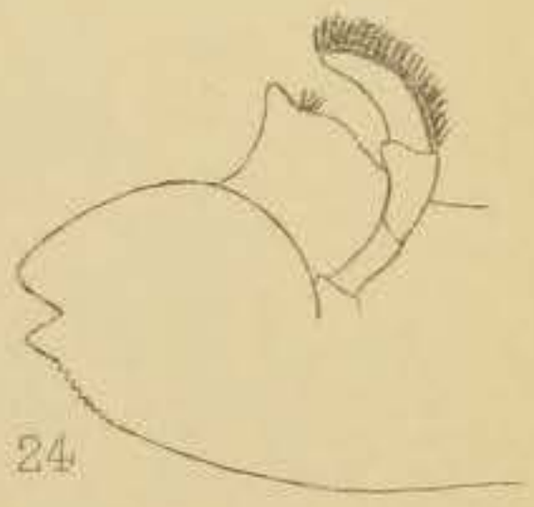

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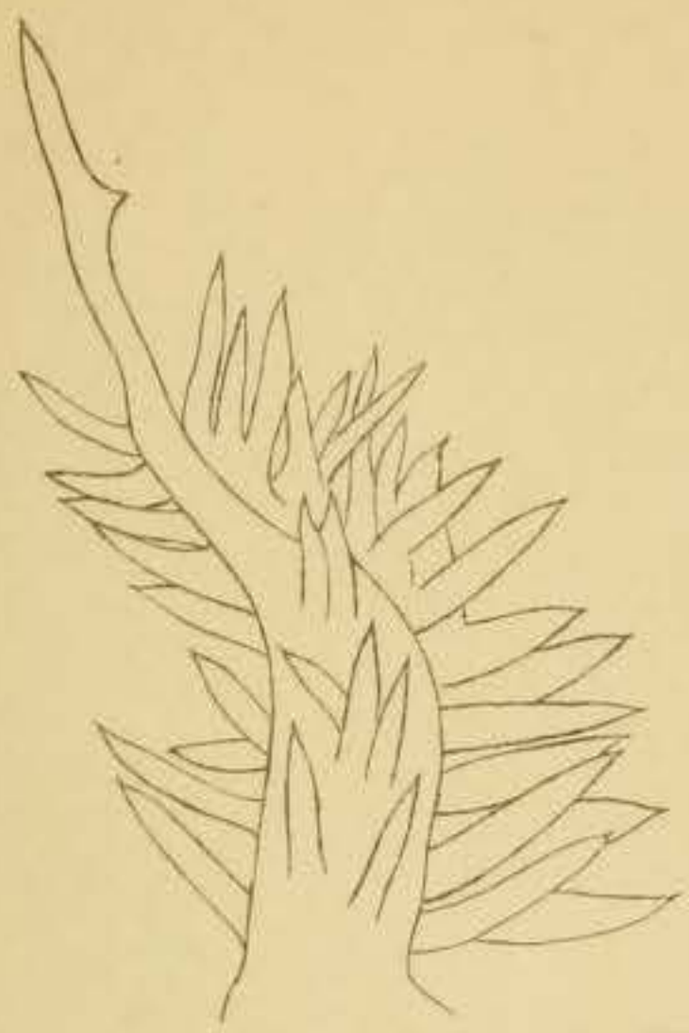
West, Newman lith.

7-11. ASTACOPSIS FRANKLINII. 12-14. A. SERRATUS.
15-24. PARACHÆRAPS BICARINATUS.



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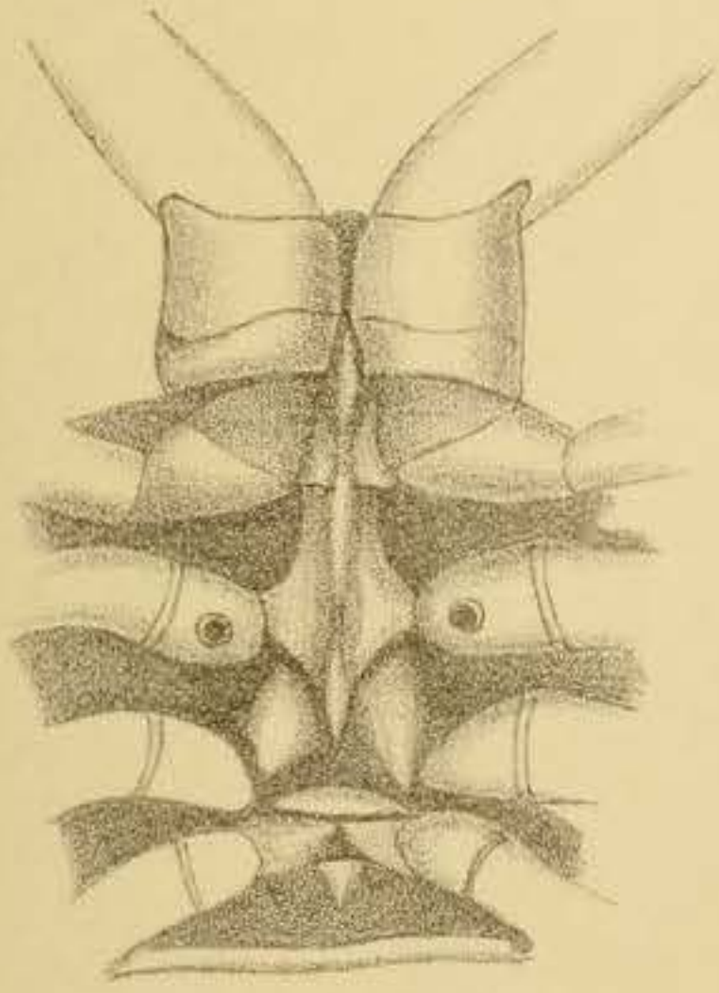

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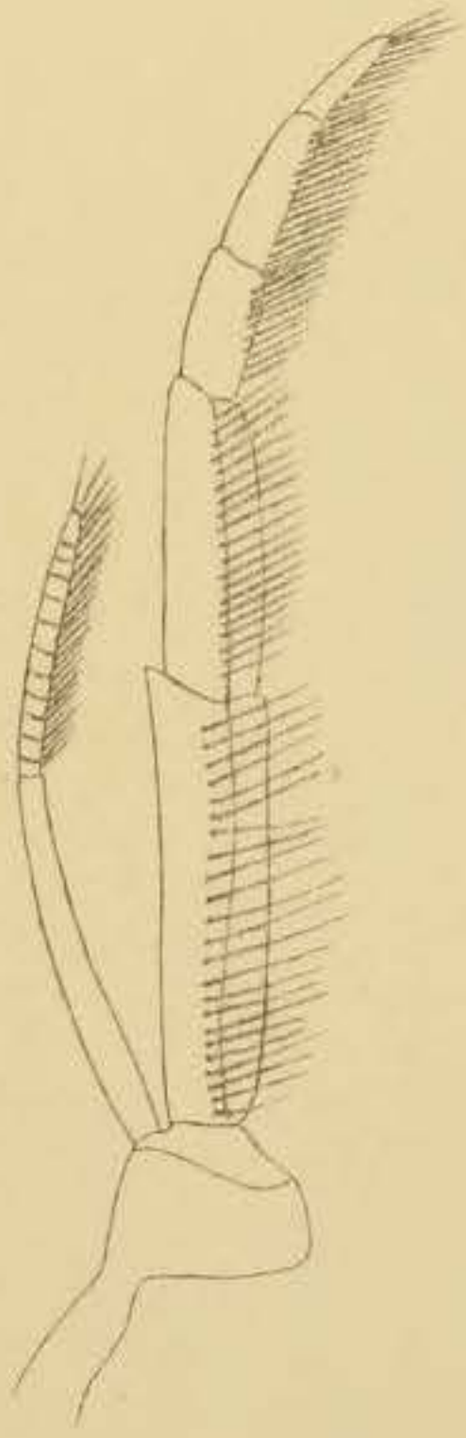

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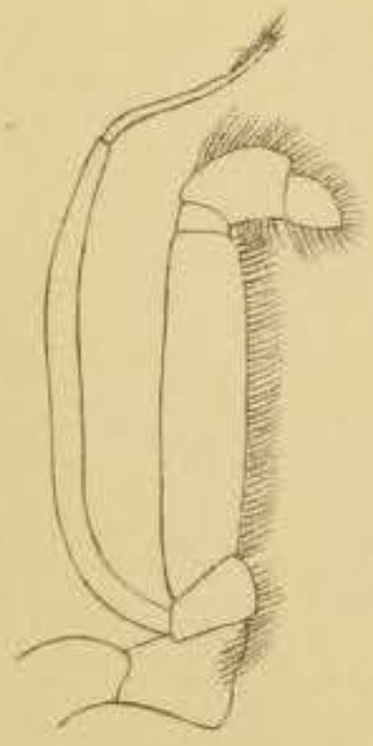

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West, Newman lith.

25–29. CHÆRAPS QUINQUECARINATUS. 30. C. TENUIMANUS.
31–33 C. QUADRICARINATUS. 34. C. INTERMEDIUS.

and beautiful drawings made by Mr. W. G. Browning under my direction, illustrating the forms and chief varieties of all the known species, by arranging these species in systematic genera according to their structural affinities, by recording, as far as is known, their geographical distribution, and by indicating the light which they throw upon the geographical problems of Australia, it is hoped that a secure foundation may be laid on which local naturalists can build. In this memoir, only the Freshwater forms are dealt with, comprising the genera *Astacopsis*, *Chæraps*, and *Parachæraps*, the treatment of the land-Crayfishes of Australia included in the genus *Engæus* being postponed to a future paper. These land-Crayfishes, which are a highly specialised group, probably derived from the freshwater form *Parachæraps bicarinatus*, are confined in their distribution to the Victorian Highlands, Gippsland, and Tasmania.

The material on which this memoir is founded was in part collected by myself in Tasmania and Australia during my visit to those countries in the years 1907–8, but by far the largest number of specimens are derived from the very fine collection belonging to the Melbourne Museum, which Professor Baldwin Spencer entrusted to me for description. This collection, which has been gradually accumulated during twenty years by the efforts of a number of Victorian naturalists, especially Mr. Kershaw and Mr. Fulton, is particularly representative of Victorian forms, though specimens from other States are not altogether absent. I have been able to supplement this collection by specimens from New South Wales, through the kindness of Professor Haswell, from Western Australia, through Mr. Woodward of Perth, and from New Guinea, through Dr. Gestro of Genoa.

It appears probable that as the population of Australia increases, the Freshwater Crayfishes might assume as much importance, as an article of food, as the lobster in America or England. There is no true lobster in the Australian seas; its place is taken by a form allied to our Rock Lobster (*Palinurus*), which is altogether inferior as an article of diet. In the first place, it possesses no large claws and the flesh is altogether coarser than in the lobster. The Australian Freshwater Crayfishes, on the other hand, are, on the whole, superior in flavour and texture to our marine lobsters. Several of the forms, notably *Astacopsis serratus* of the Murray River and *A. franklinii* of the North-Tasmanian streams, attain a very large size indeed (Pls. XIV., XVI.), the body reaching a foot in length and the whole animal weighing as much as eight or nine pounds, thus rivalling a fine lobster. These animals not very frequently reach the Melbourne market, and the Tasmanian Crayfish, which is the finest of all, is, I believe, only occasionally caught and eaten by settlers in the bush or a few prospectors. The labour of obtaining these large Crayfishes, for they are not very abundant, has hitherto prevented their becoming an article of commerce. It would probably be

practicable to farm these animals artificially in ponds supplied with running water, such as are used at trout-hatcheries. In the case of the marine lobster this is impossible, since the young hatch out as larvæ which at first live a pelagic existence; but this difficulty is absent from the culture of the Freshwater Crayfish, since the young leave the egg in a condition similar to the adult and pass a certain amount of time after hatching attached to the swimmerets under the tail of the parent. Much work would have to be done upon the habits, food, rate of growth, etc., before the undertaking could be placed upon a practical footing, but the enquiry would be well worth undertaking. It may be suggested that the best form for experimenting with would be the large Tasmanian Crayfish (*Astacopsis franklinii*), which occurs in the neighbourhood of Launceston, and in this town there is already a Government trout-hatchery which has been very successful. One further suggestion may be made: the Freshwater Crayfish industry in Germany, Russia, France, and England has from time to time been seriously damaged and in places extinguished by the occurrence of a plague, probably of bacterial nature; it would therefore be well to investigate the parasites of the form to be cultivated and the best means of protecting it against bacterial diseases.

There is a curious fact connected with the occurrence and nature of the large Crayfishes of Australia and Tasmania. The genus *Astacopsis* is represented by three distinct species, each of which occurs under two forms, a large and a small, which appear to occupy different areas of distribution.

Thus in Tasmania there is the large *A. franklinii* (Pl. XIV.), which is found only in the streams on the north and north-west coast, near their entrance to the sea, and in these situations it appears impossible to obtain small specimens. The small Tasmanian Crayfish (Pl. XV.) (var. *A. tasmanicus*), which cannot be separated from the large form by any important characters, save that of size, occurs in the mountain streams of the southern and central part of the island, where it breeds, but never grows to more than about five inches in length. Parallel facts occur in *A. serratus* (Pl. XVI.), which occurs as a large form in the Murray and Paramatta Rivers but is represented by smaller, less spiny forms further inland (Pls. XVII., XVIII.). *A. kershawi* l as a large form in the Moe River of Gippsland (Pl. XIX.) and a small form in the Narracan (Pl. XX.) and smaller streams.

The most obvious explanation of this phenomenon is that the large form, *e. g.* the large Tasmanian Crayfish, really does breed in the north coast streams and that its young stages in growth are passed there and could be found by assiduous search. The only other alternative is that the young of the large form are always destroyed near the mouths of the rivers by Blackfish and other predaceous forms which prey upon them, and that their numbers are recruited by a few individuals of the small mountain forms which find their way from the inland streams to the mouths

of the rivers. The species, in this case, would be always recruited from the small inland forms. Whether this suggestion holds good or not, the problem of why small individuals have not hitherto been found in the streams where the large Tasmanian and Murray River Crayfishes occur requires settling one way or the other.

Since this question at present remains open and I have found it impossible to discover morphological points of any value between the large and small forms of these species, I have not treated them as distinct species. This leads to the inclusion under one specific name of the very widely distributed form *A. serratus*, which occurs in the Murray River and its tributaries, in the Victorian rivers such as the Yarra, Plenty, and Bunyip Rivers, again in the Paramatta River at Sydney and in the Blue Mountains. This is a truly immense range for a species such as this to occupy, which, so far as we know, never forsakes the water for any length of time and has been presumably slowly distributed by the slow alteration and communication of different river-systems. Many of these widely separated communities of Crayfishes cannot have interbred for centuries, almost for geological periods, and yet they have retained the common specific characters with remarkable constancy. It is true that an immense range of variation in size and in the degree to which the spines are developed is met with in these local groups, but these characters show graduations, and the development of the spines is so variable, being often asymmetrical on the two sides of one specimen, that they do not offer constant specific characters for separating the various groups. It appears to me certain that it is impossible to separate the large Paramatta Crayfish from the large Murray River form, and yet these two large rivers belong to two different systems, their nearest point of approach being in the Blue Mountains on different sides of the watershed. With the material at my disposal I am unable to split up these various local specimens of *A. serratus* into a number of subspecies, although I do not wish to prejudice the work of some future investigator who, with more material at command, may feel himself competent to do so.

II. *The Relationships of the Australian Crayfishes and their Geographical Distribution.*

The Crayfishes of Australia, Tasmania, and New Guinea belong, in common with those of New Zealand, South America, and Madagascar, to the family Parastacidæ, which differs from the Crayfish family of the Northern Hemisphere, the Astacidæ, in a number of important characters which were first pointed out clearly by Huxley. The diagnostic features of the Parastacidæ given by Huxley (P. Z. S. 1878, p. 775) are as follows :—

"The podobranchiæ are devoid of more than a rudiment of a lamina, though the stem may be alate. The podobranchia of the first maxillipede has the form of an epipodite; but in almost

all cases it bears a certain number of well-developed branchial filaments.

"The first abdominal somite possesses no appendage in either sex; and the appendages of the four following somites are large. The telson is never completely divided by a transverse suture.

"More or fewer of the branchial filaments are terminated by short hooked spines; and the coxopoditic setæ, as well as those which beset the stems of the podobranchiæ, have hooked apices."

The Astacidæ possess the converse of these diagnostic characters.

The Astacidæ and Parastacidæ, the one family occurring in the Northern Hemisphere, the other in the Southern, are therefore separated by important characters, and it is very probable that they have been independently evolved from marine lobster-like ancestors which already differed in these characters before they took to a freshwater life.

The occurrence of Parastacidæ in Australia, New Zealand, and South America, with an aberrant genus (*Astacoides*) in Madagascar—that is to say, in countries which are now separated by wide stretches of ocean—is a striking fact in geographical distribution, but it does not stand alone, the distribution of many freshwater fish, crustacea, molluscs, etc., having a similar character in the Southern Hemisphere.

These facts, taken in conjunction with geological evidence, have led many naturalists to assume a much greater extension of the Antarctic Continent in past times which is supposed to have been connected with South America, Australia, and New Zealand, and possibly at a very remote period with Madagascar, thus permitting the migration of land and freshwater animals to and from those countries. In the case of the Parastacidæ the only alternative theory is that the South-American, Australian, and New Zealand genera have been independently derived from some common marine ancestor.

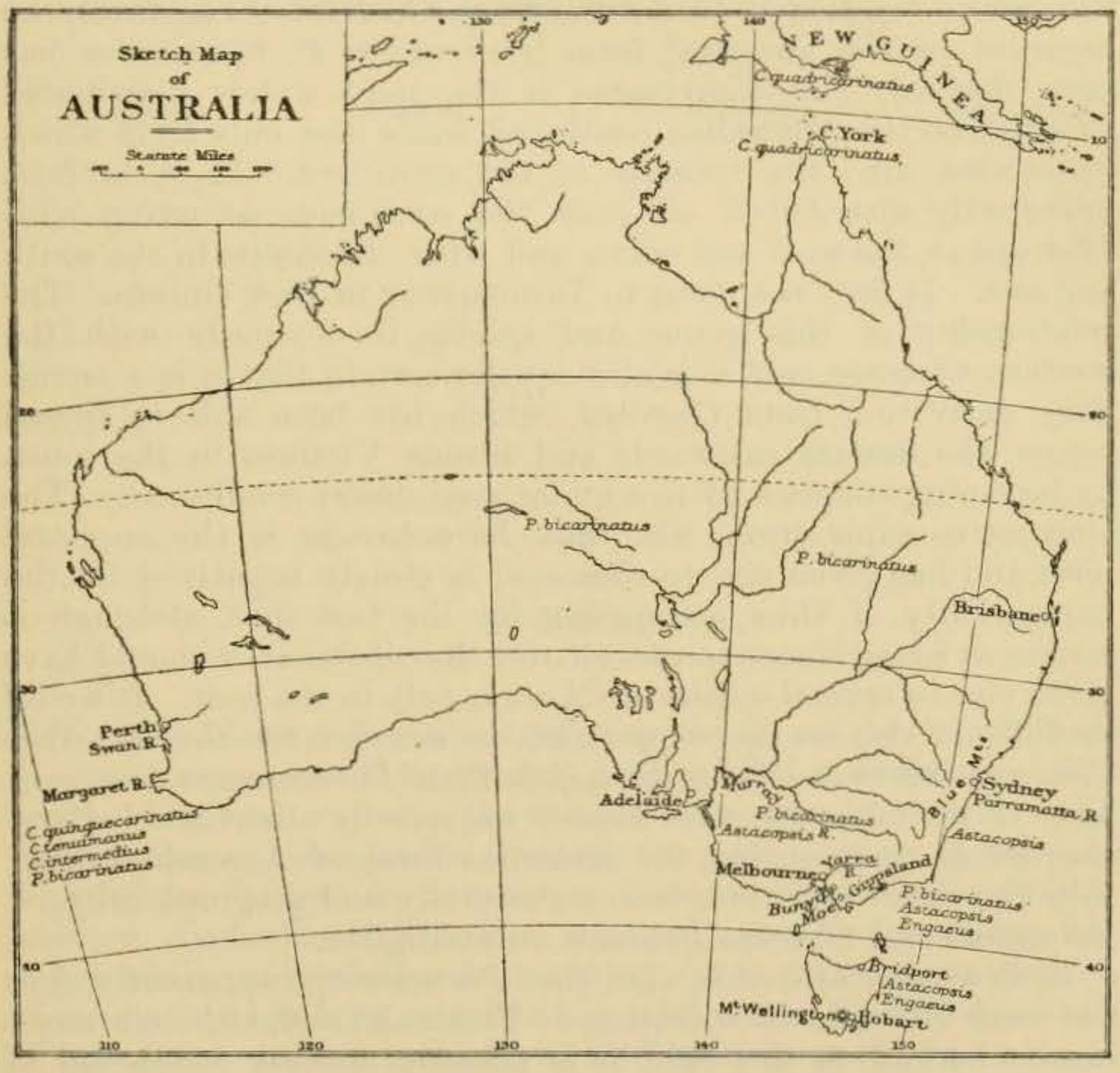
Our concern here, however, is not so much with the origin of the Parastacidæ in the remote past, but with the inter-relationships of the Australasian genera and their probable evolution and migrations.

We can distinguish four genera of Australasian Crayfishes—*Astacopsis*, *Parachæraps*, *Chæraps*, and *Engæus* (the last-named genus we will consider as a single entity, though it may be found convenient hereafter to split it up into several subgenera).

The members of the genus ASTACOPSIS are characterised by the development of spines or tubercles upon the body and limbs, and by certain features in the gills and appendages which are fully set forth in the diagnosis of the genus on p. 154. They inhabit swift-moving streams and rivers; they are not found in ponds and water-holes, and they are not known to forsake the water for any period of time. Their distribution is as follows:—In Tasmania there occurs *A. franklinii* (Pls. XIV., XV.), the largest Crayfish in the world. It is confined to the rivers and streams upon the

north and west coasts. In the highland streams of the south and centre a small form occurs (var. *tasmanicus*) which may or may not be reckoned as a separate species (see p. 156). *A. serratus* (Pls. XVI.–XVIII.) occurs as a large form in the Murray River and in the Paramatta River at Sydney. As a small or medium-sized form it occupies the Victorian Highlands, and as a small form it also occurs in the Blue Mountain streams. *A. kershawi* (Pls. XIX., XX.), which is, in many respects, intermediate between the above two species, lives in a few Gippsland rivers, thus occupying also an intermediate geographical station. The genus *Astacopis* therefore runs from the mouth of the Murray River southwards to Gippsland and Tasmania and up the east coast to Sydney. Its centre of distribution would appear to be the Murray River and its tributaries, and it is confined to the south-eastern corner of Australia and to Tasmania, where the climate is temperate and clear swift-running streams are abundant.

Text-fig. 18.



Map of Australia showing areas of distribution of Crayfishes.

The genus CHÆRAPS (see p. 165 and Pls. XXII.–XXIV.), although departing in many important features from *Astacopsis*, yet shows a trace of agreement with this genus, especially in the

fact that the last posterior arthrobranch is not rudimentary. Its members inhabit running water, and they are confined in distribution to the west and north coasts and to New Guinea, being entirely absent from the southern and eastern districts occupied by *Astacopsis*. In the south the arid coast-line, fringing the Great Australian Bight, constitutes a wide and insurpassable barrier between the genera *Astacopsis* and *Cheraps*. On the east coast *Cheraps* is absent and *Astacopsis* does not appear to occur much north of Sydney.

The species *C. intermedius* (Pl. XXIV. fig. 2) from Western Australia is of great interest, because it forms a perfect transition to the genus *Parachæraps*. *C. intermedius* retains the diagnostic features of a *Chæraps*, but it presents a remarkable approach in general facies and in a number of points to *Parachæraps bicarinatus*.

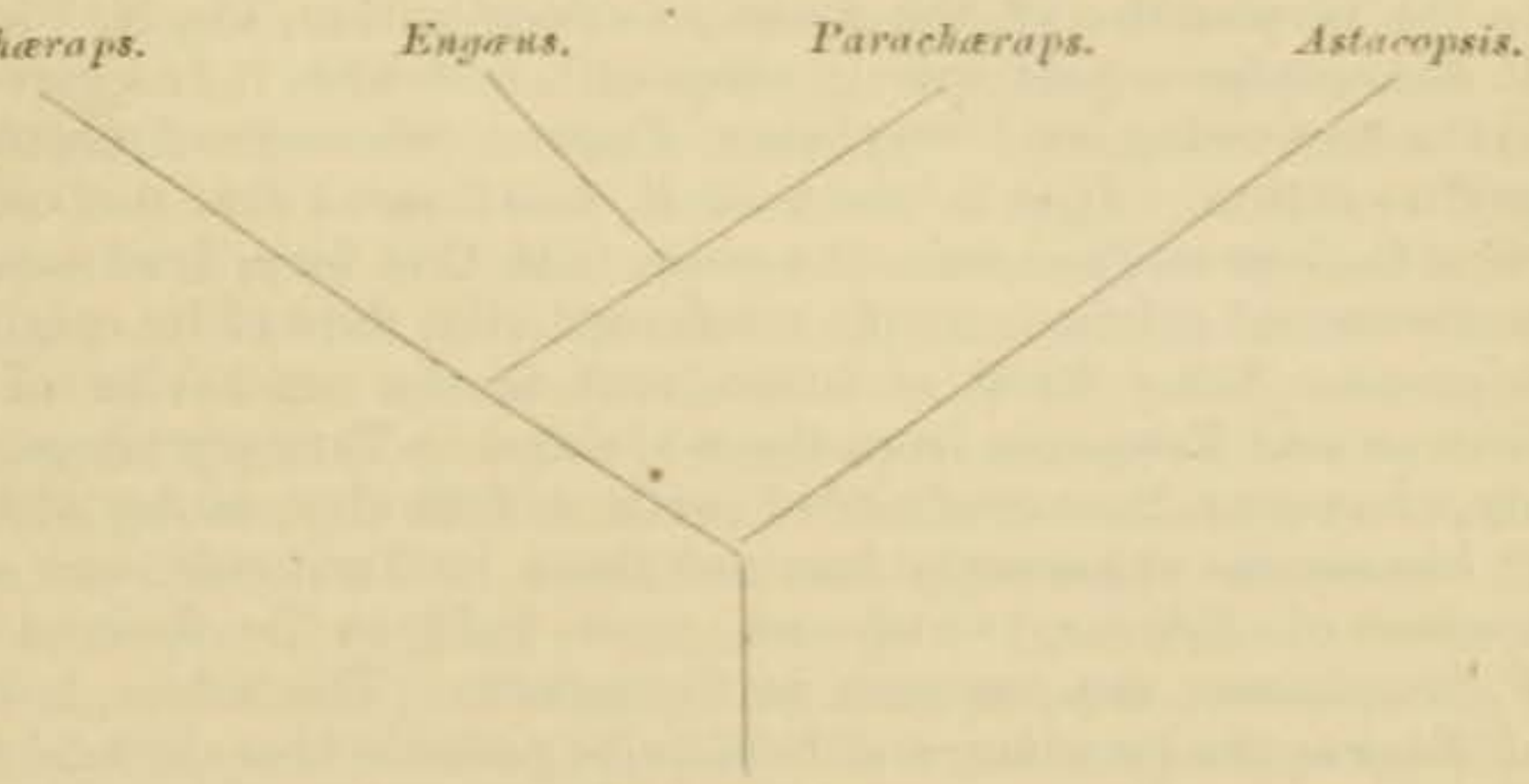
The genus PARACHÆRAPS, consisting of the single species *P. bicarinatus* (Pl. XXI.), is closely allied in all its features to *Chæraps*, and the alliance is made more obvious by the existence of the before-mentioned *C. intermedius*, which may reasonably be regarded as the ancestral form from which *P. bicarinatus* has been derived. *P. bicarinatus* is the most widely distributed Crayfish on the Australian continent, being the only form which penetrates into the interior of the continent. It is, in fact, universally distributed all over the continent, occurring with *Chæraps* in the west and north and with *Astacopsis* in the south and east. It does not occur in Tasmania or in New Guinea. The relationship of this genus and species is obviously with the western *Chæraps*, and it is also equally certain that it is a secondary derivation from *Chæraps*, which has been able to spread across the deserts eastwards and invade Victoria in the south by becoming adapted to live under semi-desert conditions. The alternative supposition, viz. that *Parachæraps* is the ancestral form and has given rise to *Chæraps*, is clearly negatived by the impossibility of thus accounting for the fact that, although it ranges as a continuous species all over the continent, it should have given rise to several species of *Chæraps* only in the west. It would be difficult also on this supposition to account for the fact that *Chæraps* differs less from *Astacopsis* than *Parachæraps* does. In fact, if we take the now almost universally distributed *Parachæraps* as representing the ancestral form of Australian Crayfish, the entire isolation, both structurally and geographically, of *Astacopsis* and *Chæraps* becomes unintelligible.

It is worthy of notice, also, that *Parachæraps* apparently does not occur either in New Guinea or Tasmania, and, although stress cannot be laid on this fact, it is possibly another indication of the modern origin of *Parachæraps*, after the separation of New Guinea and Tasmania from the mainland of Australia.

The genus ENGÆUS, comprising the land-burrowing Crayfishes, which have gone a step beyond *Parachæraps* in their independence of water, are confined to Victoria, Gippsland, and Tasmania. From

their habits and anatomical structure they have probably been derived directly from *Parachæraps*, some of the species graduating very perfectly into the latter genus. The burrowing land-Crayfishes are therefore the most modern product of all. Although it is not my intention to give any description of the genus *Engæus* in this paper, certain of their characters may be mentioned which point to their high degree of specialization. Their whole appearance and form are very different from the other Crayfishes, the thorax being extremely deep dorso-ventrally, a character which is correlated with the very great size of the gastric mill. The abdomen is much reduced in size. Certain of the species show a peculiar reduction in the gill-formula, the last pleurobranch being entirely absent, while in some species the exopodite of the maxillipede is completely absent. The body is entirely free from spines or ridges.

The above survey and an examination of the diagnoses of the several genera afford a remarkably clear picture of the evolutionary relationships of the genera described, which we may represent in the form of a table, thus :—



We may attempt to reconstruct also the means by which these genera have reached their present geographical distribution. The outstanding fact is clearly the complete isolation in structure and distribution of the western *Chæraps* from the eastern *Astacopsis*. This sharp distinction between a South-eastern and a North-western Australian fauna does not apply only to Crayfishes, but is practically universal, and in looking for a cause the attention of naturalists has been called to the existence in Central Australia of Cretaceous deposits, which are held to indicate the existence of a sea in Cretaceous times dividing Australia into a western and an eastern island. We may therefore start with the hypothesis that the separation and divergent evolution of *Astacopsis* and *Chæraps* dates from the separation of Eastern and Western Australia by the Cretaceous sea. It would appear that, with the

filling in of this sea and the junction of the eastern and western islands, no feasible passage was formed by means of which the eastern *Astacopsis* could invade the territory of the western *Chæraps* or *vice versa*. The nature of this early barrier is uncertain, but when once the desert condition was established, the central deserts have consituted a barrier against a direct eastern or western migration : on the south-west coast the desert and semi-tropical region of the Australian Bight prevents a northern passage of *Astacopsis* into the territory of *Chæraps*, while to the north-east the semi-tropical coastal streams do not appear to have been colonized either by *Chæraps* moving southwards or *Astacopsis* migrating northwards. *Astacopsis*, in fact, remains a typically temperate genus, *Chæraps* a semi-tropical or tropical one, and the barrier of temperature seems to determine the distribution of these two forms with complete rigidity.

An offshoot from *Chæraps*, however, viz. *Parachæraps bicarinatus*, on the filling in of the Cretaceous sea, has gradually extended its range from the west eastwards, invading the central districts of Australia and penetrating thence southwards and eastwards so as to become almost coterminous in distribution with *Astacopsis*. In the very centre of the *Astacopsis* distribution, viz. in Victoria, *P. bicarinatus* is particularly abundant, and here it has given rise to the burrowing land-Crayfishes, *Engæus*, whose headquarters are in this region. If it is true that *P. bicarinatus* does not occur in New Guinea or Tasmania, the view that this form is of comparatively recent origin is amply confirmed, the date of its origin and migration being fixed as subsequent to the separation of New Guinea and Tasmania from the mainland in Tertiary times. We are, however, here confronted with a difficulty, since, although *P. bicarinatus* apparently does not occur in Tasmania, one or two species of *Engæus*, which we must hold to be derived from *P. bicarinatus*, are common in Tasmania. The habits, however, of *Engæus* are peculiar, and it is quite possible that individuals of this genus have been carried across Bass's Straits from Gippsland in floating tree trunks, at the roots of which the "land-crabs" frequently make their burrows.

Without unduly pressing this hypothesis, it nevertheless offers an explanation of the curious fact of the occurrence of *Engæus* in Tasmania and the absence of its parent form, *P. bicarinatus* from that island.

The occurrence of *A. kershawi* in Gippsland, related by many of its features, *e. g.* the absence of spines on the abdomen and the truncated shape of the rostrum, to *A. franklinii* in Tasmania, cannot be passed over without reference. It is apparently confined to Gippsland, but it is surrounded and in close contact with the much more widely distributed *A. serratus*. Its relationship to the Tasmanian form indicates a close connection at some not very remote time between Gippsland and Tasmania, a connection which may be detected in the similar geological and

physiographical characters of these two countries. It seems probable that when the two countries were in actual continuity they together formed a zoological district with many features in common, distinct from the surrounding countries of Victoria and New South Wales.

By the foregoing lines of argument we are able to establish on a secure basis the general course of evolution and the routes of dispersal of the Parastacine Crayfishes of Australia. We are able to establish with certainty that the widely distributed *Parachæraps bicarinatus* is a comparatively recent derivation from the Western-Australian *Chæraps*, and that the land-Crayfishes, *Engæus*, are a still more modern derivative from *Parachæraps*. We are left, therefore, with *Chæraps* and *Astacopsis* as the two primitive representatives of Australian Crayfishes, which, both by their complete isolation from one another and by their wide distribution, betray a great antiquity. The question as to which of these two primitive genera is the most primitive and represents to the greatest extent the original ancestor of the group is a very obscure question. We may, however, make some suggestions for the solution of this problem.

Since Crayfishes in general are emphatically not tropical forms, and since the Australian Crayfishes are only represented in Northern Australia by a single species, *C. quadricarinatus*, it is certain that this form is only a northern straggler, and that New Guinea and North Australia are not the centre of distribution of the group. Granted that the centre of distribution is somewhere in the south of the continent, have we any light to guide us in choosing between *Chæraps* or *Astacopsis* as occupying most nearly the original area of distribution? The genus *Astacopsis*, on the whole, now lives under conditions more generally characteristic of Freshwater Crayfishes than *Chæraps*. It is characteristic of cooler regions and is particularly abundant in mountain streams of great rapidity and clearness; while the western *Chæraps* inhabits rivers, more sluggish and clouded in nature, which rather fitfully irrigate a parched country. It seems that *Chæraps* is already in the grip of those circumstances attendant on a lack of water which have finally resulted in the production of such specialized forms as *Parachæraps* and *Engæus*. This is no more than a suggestion, but if it is true we are led to the conclusion that the more southern *Astacopsis*, inhabiting the temperate and well-watered mountainous regions of South and South-eastern Australia, retain to the greatest extent the original characteristics and distribution of the ancestral form. If this is so, and if the Bassian Subregion is really the centre of distribution of the Australian Parastacidæ, we may perhaps include these animals in the array of alpine plants and animals characteristic of this region, which were probably once distributed across the Antarctic Continent and reached their present distribution in South America, South Australia, and New Zealand by this means.

III. *Systematic Account of the Genera and Species of Australian* Parastacidæ.

Genus Astacopsis Huxley (P. Z. S. 1878, p. 764).

Arthrobranch of last leg but one not rudimentary or even much reduced. Ala of podobranchs small and inconspicuous. Short and stout hooks only present at the end of a few branchial filaments fringing the stem of podobranchs (Pl. XXVI. fig. 10), being absent in all other gills.

Hooked setæ on coxopodites and on gill-stems not very sharply recurved (Pl. XXVI. fig. 11).

Mandibles with three prominent teeth and smooth lower ridge (Pl. XXV. fig. 6).

First maxilla with endopodite consisting of base and distinct flagellum united on to it (Pl. XXV. fig. 5; Pl. XXVI. fig. 9).

Second maxillipede with penultimate segment bearing an upper lobe, which projects forwards as far as terminal segment (Pl. XXV. fig. 2).

Third maxillipede with serial row of bristles on outer face of third and fourth segments, and a sparse fringe of bristles on inner face. Exopodite does not equal third segment in length (Pl. XXV. fig. 1).

Great chela with the carpus rather short and stout; much tuberculated, with a row of tubercles on its outer border as well as on the inner (Pls. XIV.–XX.).

Succeeding legs with terminal and subterminal joints well provided with pencils of bristles. Opening of vas deferens situated on a short simple papilla.

The lateral keels of rostrum are spiny or tuberculated. Lateral carina on carapace is also spiny or tuberculated. Carapace and branchiostegites tuberculated or spiny. The sternal keel is depressed and blunt (Pl. XXVI. fig. 14).

The first abdominal segment carries lateral spines; the succeeding segments are spiny, tuberculated, or setose.

The membranous portion of telson and uropods is short compared to the upper calcified portion, and the median spine on the endopodites of the uropods is, in consequence, situated distally.

Astacopsis franklinii. (Pls. XIV., XXV., & XXVI., figs. 7–11.)

The Large Tasmanian Crayfish.

(Gray, Eyre's Journals of Expeditions of Discovery into Central Australia, i. p. 409, 1845.)

The rostrum is rather broad and tumid, and ends in a short median spine; the lateral keels are rounded, and each keel carries four or five blunt spines or tubercles.

On the carapace immediately lateral to the posterior outer border of the rostral carina, a tubercle, often double, is present, and posteriorly in a line with this tubercle is another rounded tubercle, and behind this again a rounded boss. The disposition of these tubercles is subject to some variation. Laterally and anteriorly, the cephalothorax has a few blunt spines and tubercles, and there are numerous blunt tubercles on the branchiostegites.

Ventrally the interantennal spine is rather long and narrow, and not produced laterally at the base. The chitinous margin of upper lip has large lateral arches and a small median arch (Pl. XXVI. fig. 7).

The inner border of the antennal scale widens rather suddenly at the base of the terminal spine (Pl. XXVI. fig. 8).

The sternal keel is of the usual *Astacopsis* type, but is sharper than in succeeding species.

The first abdominal segment bears laterally a prominent forwardly directed spine.

The second abdominal segment has a varying number (4–7) of small sharp spines on each lateral border.

The succeeding abdominal segments are smooth, but laterally each segment is produced into a small sharp spine, often with another smaller spine just above it.

The exopodite of the uropod has a row of teeth between the hard and membranous portions, which graduates internally into a row of bristles. The endopodite has a small spine close to the distal border in the middle line.

The telson has two lateral serrations, but is otherwise smooth.

The great chela has the pincer studded with tubercles and a few brushes of setæ. Two tubercles in the pincer, one on the upper or outer and one on the inner pincer, are greatly enlarged, especially in the larger specimens. The inner edge of the carpopodite has three or, at most, four serrations. The surface of the carpopodite is not greatly pitted.

The two anterior walking legs have only a few spines, but numerous brushes of bristles. The two posterior legs have more numerous spines, which are not very long or conspicuous.

The colour is uniform dark green.

The largest specimen obtained by me weighed just under eight pounds, and measured 16 inches from rostrum to telson. Small specimens less than 8 inches are very rarely obtained, and have not been seen by me.

Localities.—Several specimens were taken by me from the Brid and Muddy Creek, Bridport, Tasmania—the latter stream being a very small muddy rivulet. They are also reported from numerous streams and rivers along the north coast, and from the Gordon River on the west coast, but they are unknown from the south, east, or central districts of Tasmania.

The Small Tasmanian Crayfish, Var. TASMANICUS. (Pl. XV.)

(Erichson, Archiv für Naturgeschichte, 12 Jahrg. p. 94.)

This species (?), which occurs on Mount Wellington and the southern and central ranges of Tasmania, reproduces on a small scale almost all the characters of the large northern and western *A. franklinii*, so that it may perhaps be considered as only a small variety of the large form. The following characters, which may, however, be merely differences due to growth, may be referred to. There is a great reduction of the tubercles upon the carapace and branchiostegites. The upper margin of the carpopodite of the great chela has about six serrations; there is no pronounced enlargement of two tubercles in the pincer. The inner border of the meropodite has about six spines. The surface of the carpopodite is greatly pitted. The spines on the walking-legs are reduced to very minute points.

The colour is green.

The length of fully adult specimens is never more than 5 inches.

Localities.—Streams on Mount Wellington, Tasmania (1907). A small specimen with the tubercles more prominent than usual, measuring 100 mm., from Traveller River, Lake St. Clair, Tasmania (1893). Two small specimens from Zeehan, West Coast of Tasmania.

Remarks on the above two species.—There are, in reality, no distinctive characters, beyond those due to size, by which the above two forms can be separated. The fact, however, that the small and large forms occupy different stations in different parts of the island appears to preclude the possibility of the small specimens being merely not fully-grown individuals of the large form. A most curious fact is that I was unable to obtain the young stages in growth of the large *A. franklinii* in the rivers and streams, where the large individuals were fairly common. The localities from which the large *A. franklinii* have been obtained are invariably in the mouths of the streams near the sea, and in these localities it is impossible, apparently, to obtain small specimens. The small *A. tasmanicus*, on the other hand, is always found inland in mountain-streams, often near their sources. It is therefore within the bounds of possibility that the large *A. franklinii* represents those individuals of the small *A. tasmanicus* which have succeeded in reaching the mouths of the rivers, but that the young which they produce at these situations do not arrive at maturity, owing to the presence of predatory fish, e. g. *Gadopsis marmoratus*. The species would then be entirely recruited from the young of the small form, which breeds up in the mountains. Exactly parallel facts are met with in the other species of *Astacopsis* now to be described. A careful examination of this question should be undertaken by a local naturalist.

ASTACOPSIS SERRATUS. (Pls. XVI.–XVIII. & XXVI. figs. 12–14.)

The Murray River Crayfish.

(Shaw, Zoology of New Holland, vol. i. p. 407, pl. iii., 1843.)

Nomenclature.

Names given to Murray River form :—

Cancer serratus Shaw, *loc. cit.*

Gray, Eyre's Journals of Expeditions of Discovery into Central Australia, vol. i. p. 409, 1845.

Astacus armatus Von Martens, Ann. Mag. Nat. Hist. ser. 3, vol. xvii. p. 359, 1866.

Astacoides spinifer Heller, Novara Reise, Crustaceen, p. 102, Taf. ix., 1865.

Astacoides serratus McCoy, Prodromus of the Zoology of Victoria, vol. i. pl. 15, 1885.

Names given to Paramatta River and other forms :—

Astacopsis spinifer Spence-Bate, 'Challenger' Reports, vol. xxiv. pl. xxviii., 1888. (Large Paramatta form.)

Astacopsis nobilis Dana, United States Exploring Expedition —Crustacea, Part I. p. 526, pl. xxxiii., 1852. (Locality given as New South Wales. A not very clear figure of a 5-inch specimen.)

Astacus australiensis Milne-Edwards, Hist. Nat. Crust. vol. ii. p. 332, pl. xxiv. (Small Paramatta type.)

Astacopsis paramattensis Spence-Bate, *loc. cit.* p. 202, pl. xxiii. (Small Paramatta specimen.)

A. sydneyensis Spence-Bate, *loc. cit.* p. 204, pl. xxiii. (Very small Paramatta specimen.)

Astacoides plebeius Hess, Archiv für Naturg. xxxi. p. 164, Taf. 7, 1865. (From Sydney. Small Paramatta (?) form.)

Rostrum elongated ; spines on rostral keel sharp and long : posterior border of keel tumid.

A sharp spine is present on carapace just posterior and lateral to the end of rostral keel, and another sharp spine is present posterior to this and confluent with a rounded boss.

There are a few blunt tubercles and two or three sharp spines on the antero-lateral part of the carapace, and the branchiostegites are not only tuberculated, but carry a superior row of very large spines.

The interantennal spine is rather short and broad, with produced lateral angles at the base (Pl. XXVI. fig. 12).

The chitinous margin of the upper lip has small lateral arches and a large concave median arch (fig. 12).

The inner border of the antennal scale does not suddenly expand at the base of the terminal spine (fig. 13).

The sternal keel is depressed and blunt (fig. 14).

The first abdominal segment has two very large spines on each dorso-lateral margin.

The second abdominal segment has two (sometimes three) smaller lateral and two large dorso-lateral spines on each side.

The next three abdominal segments have two large dorso-lateral spines, and one (sometimes two) small lateral spine on each side.

The sixth abdominal segment carries two small lateral spines or tubercles on each side.

The telson has two (sometimes more, a variable number) median spines.

The number and arrangement of the above spines is sometimes variable and even asymmetrical.

The great chela has two enlarged tubercles in the pincers, both on the biting-edge of carpopodite. The lower external border of the carpopodite has a row of sharp and large spines continued right down to the posterior border. The upper internal border has about five marked serrations. The carpopodite is flattened, and does not carry any tubercles on its other surfaces. The mesopodite has three large spines on its inner border and two on its outer.

The first two walking-legs are nearly free from spines, but the last two carry long and prominent spines, especially on the last joint but one.

Colour (as given by McCoy).—The anterior legs, the middle of the back, and the apices of the spines and tubercles rich creamy white or ivory-coloured; the ground-colour of the other legs, the sides of the carapace, and the abdomen pale Prussian-blue of varying intensity in different individuals, or sometimes mottled with dull olive-green. Semicorneous flexible edges of tail-fin brownish.

Largest specimen obtained measured 10 inches (about 230 mm.); the smallest 7 inches.

Locality of type specimens.—Murray River.

Local Varieties.

From Victoria.

(*a*) Bunyip River. One specimen, January 1880, measuring 140 mm. It resembles the Murray River form, except that the spines on carapace and branchiostegites tend to be replaced by blunter tubercles, also the dorsal spines on abdominal segments. On second abdominal segment there are four lateral spines on left side, three on the right, thus illustrating the variability and frequent asymmetry of these spines.

(*b*) Yarra River. Several specimens, 1905. A large specimen (Pl. XVII.), measuring 150 mm., has a single spine on each side of first abdominal segment, three lateral spines on second, and the dorsal spines on abdominal segments clearly marked but reduced. The smaller specimens, about 100 mm. in length, have, in some cases, a single spine on first abdominal segment, in others two; there is a great reduction of dorsal spines on the

abdominal segments. The Yarra River Crayfish has been described and figured by McCoy ('Prodromus of Zoology of Victoria,' vol. ii. pl. 160) as *Astacopsis serratus* var. *yarraensis*, and he refers to its brilliant blue colour, but he otherwise regards it as merely a variety of *A. serratus* from the Murray River.

(*c*) Kennedy's Creek, a tributary of Curdie's River. Two specimens (1897), one measuring 135, the other 100 mm. Both very similar to above. There are four spines on second abdominal segment in one specimen, three in the other. The dorsal abdominal spines are well marked, but reduced.

(*d*) Plenty River. One specimen (1896), measuring 160 mm., has two spines on right side of first abdominal segment, one on the left. There are four spines on right side of second abdominal segment, three on the left. The dorsal abdominal spines and those on carapace are rather reduced.

From New South Wales.

(*e*) Paramatta River, Sydney. The *Large Paramatta River Crayfish* has been figured by Spence-Bate ('Challenger' Reports, vol. xxiv. p. 194, pl. xxviii.) under Heller's name of *Astacopsis spinifer*. He regards it, in common with McCoy and others, as identical with the Murray River form. I have not seen the large Paramatta Crayfish, but from the excellent figure given by Spence-Bate I cannot detect any difference between it and the Murray River form.

(*f*) Paramatta River. The *Small Paramatta Crayfish* described and figured by Spence-Bate (*loc. cit.*) as *Astacopsis paramattensis*. It is about 100 mm. long, and is distinguished from the large form (*e*) by complete reduction of spines on carapace and abdomen to similarly situated small tubercles. It is, however, very probable that this specimen, coming as it does from the same river as the large form, only represents a stage in growth of the large Paramatta Crayfish. Dana's *A. nobilis* and Milne-Edwards's *A. australiensis* both probably belong here.

A very small specimen (about 50 mm.), described and figured by Spence-Bate (*loc. cit.*) as *A. sydneyensis*, is also probably only a very young Paramatta River form.

(*g*) *The Blue-Mountain Crayfish* (Pl. XVIII.), found in small streams in the Blue Mountains. The largest specimen obtained by me measured 110 mm. It resembles in every particular Spence-Bate's small Paramatta Crayfish (*f*). The spines on the carapace, branchiostegites, and abdomen are reduced to small blunt tubercles. This is particularly clear if we compare a specimen of this Crayfish with a similarly sized Victorian specimen, *e. g.*, from the Yarra River. In the latter the dorso-lateral and lateral abdominal spines are far better developed than in the Blue-Mountain or small Paramatta forms. The practical identity of the Blue-Mountain Crayfish with the small Paramatta form described by Spence-Bate seems to me to make it undesirable to invent another name for it.

Note.—Nobili, in his paper in the 'Annali del Museo Civico di Genova,' vol. xl. p. 244, 1901, describes a specimen of *Astacopsis* identical with Milne-Edwards's *A. australiensis*, as coming from Sorong, New Guinea. The occurrence of an *Astacopsis* in New Guinea is so utterly at variance with all the known facts of the distribution of Australian Crayfishes that I am unable to accept the locality of this single specimen as correct, especially as all the subsequent expeditions to New Guinea have failed to find any *Astacopsis* there, although *Chœraps* in abundance have been obtained. Dr. Calman has suggested to me that Sorong was probably wrongly read for Sydney, or else that the label for this specimen had been somehow transposed. Until further evidence is forthcoming as to the occurrence of an *Astacopsis* in New Guinea, the locality given for this single specimen, which is identical with the small Paramatta form of *A. serratus*, must be received with the greatest scepticism.

Remarks on the above species.—For including all the above forms under one species, *A. serratus*, ranging from the Murray River to Sydney, I shall be blamed by many systematists, but the problem is one of peculiar difficulty. The Freshwater Crayfishes, like so many of the large Decapods, begin breeding long before they have attained their limit of size; we are therefore often puzzled to know whether a particular set of specimens represents a separate species, or only not fully-grown individuals of a species which progressively alters as it grows older. It seems undoubted that the large Murray River and the Paramatta River Crayfishes are identical. It is true that the geographical separation of the Murray and Paramatta is not so great as it looks, as the Lachlan River, a tributary of the Murray, rises in the Blue Mountains on the other side of the watershed to that on which the Paramatta rises. The Yarra, Bunyip, and other rivers of the Victorian Highlands are similarly divided from the Murray tributaries, and here, although the differences are very slight, it may be possible to separate a true variety of Crayfish inhabiting these rivers from the Murray River form. The small Blue-Mountain Crayfish bears much the same relation to the big Paramatta form as the small Tasmanian Crayfish to the big one.

Unlike the genera *Chœraps* and *Engœus*, they are not known to leave the water and migrate across the land, so that the various races of this species must have been isolated from one another for very long periods.

Astacopsis kershawi, sp. n. (Pls. XIX., XX.)

The Large Gippsland Crayfish. (Pl. XIX.)

The rostrum is broader than in *A. serratus*, with blunter tuberculated spines on its keels, thus approaching *A. franklinii*.

The spines on the carapace are replaced by blunt, rounded tubercles and ridges. Similarly, the sharp spines present on the

branchiostegites of *A. serratus* are replaced by blunt, often tumid tubercles.

The interantennal spine, the margins of the upper lip, and the antennal scales approach the condition found in *A. franklinii*, and the sternal keel is sharper than in *A. serratus*.

The first abdominal segment has only one lateral spine (in two out of the three specimens this spine was absent on one side). The second abdominal segment has three lateral spines on each side and one dorso-lateral; the dorsal spine present in *A. serratus* is replaced by a very large tumid tubercle which is joined by a ridge to its fellow of the opposite side.

The succeeding three segments have one to three lateral spines on each side and a dorso-lateral, the dorsal spine of *A. serratus* being replaced by a tumid tubercle. The sixth abdominal segment, telson, and uropods are provided with several small spines. The chela is less elongated and more stoutly built than in *A. serratus*, and very often carries spines or tubercles on the dactylopodite and on the surfaces of the carpopodite which are non-tuberculous in *A. serratus*.

The largest specimen was 10 inches long.

Locality.—Moe River, Gippsland. Three specimens collected by Mr. Kershaw.

Local Variety.—The Small Gippsland Crayfish. (Pl. XX.)

Several rather small specimens from the Narracan River and a number of other small Gippsland streams (largest specimen 5 inches in length) agree with *A. kershawi* in the broad truncated form of the rostrum, sharpness of sternal keel, and replacement of spines by blunted tubercles, thus differing in diagnostic characters from the smaller specimens of *A. serratus* from the Victorian Highlands. Except in point of size, it is impossible to separate these specimens from the large *A. kershawi*, of which they are probably only the not fully grown individuals.

Remarks on the above species.—There can be no doubt that this Gippsland Crayfish is specifically distinct from *A. serratus*. It is of considerable interest to observe that it approaches in many respects the Tasmanian *Astacopsis* with which it is geographically related, being separated by the comparatively modern Bass's Straits.

Genus Parachæraps, gen. nov.

Arthrobranch of last leg but one rudimentary, consisting of a stout fleshy peduncle tipped with a few minute filaments which end in long curved hooks (Pl. XXVI. figs. 16, 18). Ala on anterior podobranchs is broad and conspicuous, and carries small filaments. The majority of gill-filaments attached to the stems of all the gills are furnished with long recurved hooks at their ends. The other filaments are frequently pointed at the end.

The hooked setæ on coxopodites and on gill-stems are very sharply recurved (fig. 17).

The antennal scale is broad, with the inner margin widening suddenly after the terminal spine (fig. 20).

Mandibles with two prominent teeth and a serrated lower edge (fig. 24).

First maxilla with endopodite consisting of a basal segment and a minute terminal segment (figs. 15, 23).

Second maxillipede with penultimate segment bearing an upper lobe which does not project forwards nearly so far as the tip of the terminal segment (fig. 22).

Third maxillipede without a serial row of bristles, but with the face of the third and fourth segments provided with a double fringe of slender crowded hairs. The exopodite exceeds the third segment of endopodite in length (fig. 21).

Great chela with the carpus long and stout, especially in the male; on the underside a longitudinal ridge is present, often with slight excavations on either side of it. The surface is smooth; there is no row of tubercles on the outer border, but there is a conspicuous fringe of downy hairs on the inner border.

Succeeding legs with terminal and subterminal joints smoother, with very few bristles.

Opening of vas deferens situated on a long projecting and complicated papilla.

The keel of the rostrum is flat and smooth; the lateral carina on carapace also continuous and smooth; there is no median carina.

The distance between the tip of the rostrum and the cervical suture is shorter than between the cervical suture and posterior border of carapace.

The carapace is smooth; the abdominal segments are smooth and non-setose.

The sternal keel is fairly prominent and sharp.

The interantennal spine is rounded, and does not end in a sharp point (fig. 19).

The membranous portion of telson and uropods is long compared to the upper calcified portion, and the median spine on the endopodites of the uropods is in consequence situated mesially.

Remarks on the above genus.—In creating the above genus for the reception of the single species, *P. bicarinatus*, I have been influenced by the following facts. Although *P. bicarinatus* does not differ in any very striking characters from the species which I retain in Erichson's genus *Cheraps*, yet if it were included in this genus it would occupy an altogether isolated position, both as regards structure, geographical distribution, and the fact that from it has probably been derived the large and varied genus *Engaeus*. For convenience' sake, therefore, and for the purpose of bringing out its peculiar importance in the evolutionary history of the Australian Crayfishes, I have after much hesitation decided to separate it off from the related forms retained in the genus *Cheraps*. Since *P. bicarinatus* is one of the oldest-known species from Australia, I had originally intended keeping the

name *Chæraps* for it, and placing the Western-Australian species in a new genus, *Parachæraps*. But, as M. Roux, of the Basle Museum, pointed out to me, the term *Chæraps* was first used by Erichson (Arch. f. Naturg. xii. 1846, p. 101) for the species *C. preissii*, which, whatever it may be, does not seem to be identical with *P. bicarinatus*. From Erichson's diagnosis of the genus *Chæraps* and of the single species *C. preissii*, which he includes in it, I find it quite impossible to discover what species of Australian Crayfish he was dealing with. No figures are given, and the only characters mentioned which are of the slightest diagnostic value are the facts that the animal came from Western Australia, that the tail-fan was in part membranaceous, and that the antennal scale was "egg-shaped and pointed." No mention whatever is made of any keels on the carapace, a point noticed by Haswell in his 'Catalogue of the Stalk- and Sessile-eyed Crustacea of the Australian Museum,' who gives as a character of *C. preissii* "the absence of keels on carapace (?)."

The balance of evidence seems favourable to the idea that Erichson's really worthless description of *C. preissii* does refer to a species of *Chæraps* and not to *Parachæraps bicarinatus*, so that the term *Chæraps* must be kept for the Western-Australian species.

PARACHÆRAPS BICARINATUS Gray. (Pls. XXI. & XXVI. figs. 15–24.)

The Yabber.

(Eyre's Journals of Expeditions of Discovery into Central Australia, vol. i. 1845.)

Nomenclature:—

Astacus bicarinatus Gray, *loc. cit.* p. 410, pl. iii. fig. 2.
Chæraps bicarinatus Von Martens, Monatsbericht Akad. Wiss. Berlin, 1868, p. 617.
Astacopsis bicarinatus Haswell, Australian Museum Catalogues, v. Crustacea.
Astacoides bicarinatus McCoy, Prodromus of the Zoology of Victoria, vol. i. pl. 29, 1885.

The rostrum is without pronounced keels; it terminates in a spine, just below which two small lateral spines indicate the beginning of the much-reduced keel.

The lateral carina on the carapace is a continuous blunt ridge. There are no other tubercles or spines on the carapace or body and there are no hairs except at the lateral borders of the carapace and abdominal segments and on the limbs. The surface of the carapace is, however, usually pitted superficially.

The telson is broadly ovate, and there are two small spines laterally at the junction of the hard and membranous portions. There are no median spines.

In the great chela the dactylopodite is not larger than the

carpus; there is a row of about 8–10 tubercles on the inner border of the carpus and just above this row there is a thick carpet of downy hair. An inconspicuous tuberculation and a certain amount of downy hair is present between the pincers. The meropodite has three tubercles and a certain amount of down, and the inner border of the ischiopodite has the usual double row of tubercles.

The succeeding legs are remarkably smooth and free from hairs, though the last two joints of the last two legs are fairly hairy.

The sternal keel is fairly sharp, but not very prominent, and the basal joints of the legs in the neighbourhood of the keel are hairy.

The interantennal spine is rounded and does not end in a sharp point (Pl. XXVI. fig. 19).

The largest specimen is 6 inches in length.

Colour (McCoy).—The whole body and abdomen is dull pale olive, varying in some specimens to greenish horn-colour; membranous part of tail-flaps pale brown; anterior part of legs bright blue; basal and outer portion of hand mottled with scale-shaped spots of dull ochreous yellow; skin of joints bright red.

Locality.—The type specimens are from the pond in the Melbourne University Grounds. Similar forms from various localities in Victoria and also from the mud-flats on Murray River. The species is also widely distributed all over Central, Northern, and Western Australia and in Queensland. It is, so far as is known, absent from Tasmania and New Guinea.

Local Varieties:—

(*a*) Queensland. One specimen measuring $4\frac{3}{4}$ inches found (Oct. 1891) in a field on a hillside at Cooran. The rostrum is rather blunt and truncated; the dactylopodite is longer than carpus; and there are very well-marked pits on the great chela and on the carapace.

(*b*) Central Australia. Specimens collected during the Horn Expedition are described by Spencer and Hall ('Report of the Horn Expedition to Central Australia,' Part II. Zoology: Crustacea, p. 244) as being similar to ordinary Victorian species. Slight differences are found in size of chela (a very variable character according to growth and sex), absence of lateral spines on rostrum, and the rostral keel is rather well marked. The authors do not, however, propose making a new species for this form.

Remarks on the above species.—If we take into account the habits of this species, which lives in the banks of ponds, quarry-holes, and other stagnant waters, and is occasionally found walking about in fields, there is no difficulty in understanding its wide distribution all over the continent of Australia. It was found in abundance by the Horn Expedition in Central Australia, where it is said to be eaten regularly by the wandering tribes of blacks, who know it as the Yabber. It is not easy to see how it can survive in these arid and desert regions, liable to the most

prolonged droughts, where all except the deepest water-holes dry up, but presumably its burrowing habits save it. It seems probable, from an examination of the anatomical features of the land-Crayfishes of Victoria and Tasmania belonging to the genus *Engœus*, that this latter genus has been derived from *Chœraps* by an intensification of the burrowing habit and of the structures associated with it.

Genus Chæraps.

(Erichson, Arch. f. Naturg. xii. 1846, p. 94.)

Arthrobranch of last leg but one somewhat reduced, but without fleshy peduncle and consisting of fairly numerous small filaments springing from a very short base. These filaments are pointed at the end (Pl. XXVII. fig. 25). The ala on the podobranchs is broad as in *Parachœraps*. Many of the gill-filaments attached to stem of podobranchs carry long curved hooks as in *Parachœraps*; the filaments on the other gills are either round or pointed, but do not carry hooks (fig. 26).

The hook-setæ on coxopodites are sharply recurved.

The antennal scale is not broad as in *Parachœraps*, but broadens gradually after terminal spine (fig. 28).

The lateral keels of the rostrum are usually very sharp and conspicuous, but they may be absent (*C. intermedius*).

The lateral carina on carapace is well marked, and may be very sharp and prominent, and there may also be a well-marked median carina.

The distance between the tip of the rostrum and the cervical suture is distinctly longer than that between the cervical suture and the posterior border of carapace.

The sternal keel is sharp and very prominent (fig. 31).

The interantennal spine ends in a sharp point (fig. 27).

The great chela has the carpus either very long and slender, and unprovided with a carpet of downy hairs, or else provided with hairs and stoutly built.

In all other respects the generic characters, *e. g.* of the mouth-parts, telson, and uropods, etc., agree exactly with *Parachœraps*.

Remarks on the above genus.—The diagnostic characters by which *Chœraps* may be distinguished from *Parachœraps* are (1) the nature of the posterior arthrobranch, (2) the antennal scale, (3) the distance between cervical suture to rostrum and cervical suture to posterior border of carapace, (4) the interantennal spine, and (5) the sternal keel.

Chæraps quinquecarinatus. (Pls. XXIII. & XXVII. figs. 25–29.)

The Gilgil.

(Gray, Eyre's Central Australia, vol. i. p. 410, pl. iii.)

The rostrum is moderately excavated, with rather prominent

keels; it ends in a sharp spine, with two lateral serrations on each side.

The lateral keel on the carapace is prominent and arched outwards; anteriorly it does not terminate in a prominent spine. There is a well-marked median keel.

There is no prominence on the carapace behind the postorbital spines, nor are there any tubercles upon the carapace, branchiostegites, or abdomen; nor are there any bunches of hairs.

The first maxilla has the terminal segment or flagellum of the endopodite entirely repressed (Pl. XXVII. fig. 29).

The third maxillipede has its inner borders abundantly clothed with hair.

On the telson there are two lateral spines, but no mediolateral ones.

The great cheliped is long, but not slender; the carpus is very long, but stout; the dactylopodite is only about one-third as long as the carpus. The pincer is slightly tuberculated internally and there is a carpet of fine hairs upon the inner margin of the carpus. There is a row of small tubercles upon the upper ridge of the ischiopodite.

Greatest length $4\frac{1}{2}$ inches.

Locality.—Western Australia, in streams tributary to the Swan River.

CHÆRAPS TENUIMANUS, sp. n. (Pls. XXII. & XXVII. fig. 30.)

The rostrum is deeply excavated in the middle, with sharply upstanding lateral keels. The rostrum ends in a sharp spine, and there are three lateral serrations on each side.

The lateral keel on the carapace is prominent and arched outwards, ending anteriorly in a prominent spine. The median keel is also much pronounced.

There is a distinct prominence on the carapace running back from the postorbital spine, on which a few small tubercles are situated. There are also a few small tubercles on the branchiostegites, and the body is covered with numerous groups of short inconspicuous hairs.

The first maxilla has the endopodite consisting of a broad basal segment, with the flagellum represented by a small conical segment, the base of which is much smaller than the top of the segment with which it articulates (Pl. XXVII. fig. 30).

The third maxillipede is only sparsely provided with hairs.

On the telson, besides the two lateral spines at the junction of the calcified and membranous portions, there are two median spines.

The great cheliped is fairly long and very slender. The carpus is long and slender; the dactylopodite is more than half as long as the hand. There are no enlarged tubercles on the pincer and there is no carpet of fine hairs on the inner margin of the carpus. The row of tubercles on the upper ridge of the ischiopodite is reduced to one or two small tubercles.

The largest specimen measures $6\frac{1}{2}$ inches. Specimens in British Museum about 11 inches.

Locality.—Margaret River, Western Australia.

CHÆRAPS QUADRICARINATUS. (Pls. XXIV. fig. 1; XXVII. figs. 31–33.)

(Von Martens, Monatsbericht Akad. Wiss. Berlin, 1868, p. 617.)

Nomenclature:—

Chæraps quadricarinatus Von Martens.

Astaconephrops albertisii Nobili, Annali del Museo Civico di Genova, xl. 1899 (1901), p. 244.

The keels of the rostrum are well marked and continued far backwards on to the carapace; the rostrum ends in a sharp spine, and there are three sharp lateral serrations on each side of the rostrum.

The lateral keels on the carapace are well marked and sharp; they are arched outwards and end anteriorly in a sharp spine. There is no median keel.

The carapace and branchiostegites are smooth, except for the presence of three sharp spines laterally on each branchiostegite just posterior to the cervical suture.

The first maxilla has the endopodite consisting of a base and a fairly distinct flagellum jointed on to it.

The third maxillipede has the third and fourth segments sparsely fringed on the inner and outer face with bristles (Pl. XXVII. fig. 32).

The great cheliped is very slender and small, with slender carpus; the carpus is smooth except for a fine serration on inner border, and there is no carpet of downy hairs upon it. A pad of fine hairs is, however, present on the inner face of the meropodite between the spines. The row of tubercles upon the upper ridge of the ischiopodite is represented by a single spine.

The succeeding two chelate legs are provided with a few hairs on the terminal segment. The two posterior non-chelate legs have a fringe of hairs on the last two segments.

The telson is without median spines.

Length about 4 inches.

Locality.—From Cape York, N. Australia (*Von Martens*), and Katau, New Guinea (*Nobili*). Also from Aru Islands (var. *aruanus*) and Mainikion, Baie Etna and Sabang, New Guinea (var. *lorentzi*) (*Roux*).

Remarks.—Through the kindness of Dr. Gestro, of Genoa, I have been able to examine the single New Guinea specimen described by the late Dr. Nobili. In the characters of the gills, coxopoditic setæ, mouth-parts, antennal scale, interantennal spine, sternal keel, and general structural features it falls clearly within the diagnosis of our genus *Chæraps*. Dr. Nobili, in regarding it as allied to the New Zealand *Paranephrops*, was apparently led astray by not having ever seen any of the Western Australian

Parachæraps. My identification of the New Guinea form with Von Martens's *Chæraps quadricarinatus* appears to me certain from his description of the keels, tail-fan, and chelipeds of his Cape York specimens.

Since the above was written, Dr. Jean Roux, of Basle, has described certain specimens belonging to the genus *Chæraps* which are evidently closely allied to *Chæraps quadricarinatus*. He has also re-examined the specimen described by Nobili as *Astaconephrops albertisii*, and comes to the same conclusion as myself that this specimen is an undoubted *Chæraps*, practically identical with *C. quadricarinatus*. Dr. Roux remarks, however, that Nobili's specimen has three serrations on the rostrum, whereas *C. quadricarinatus* only possesses two, and he therefore proposes to keep Nobili's species as valid. Since no other differences are to be observed, it seems to me desirable to examine many more specimens of both varieties before accepting Nobili's species on this single difference.

Dr. Roux also creates two new species, separate from *quadricarinatus*, for his specimens from the Aru Islands and for those from other localities in New Guinea. Here, again, he admits the practical identity of his forms with *quadricarinatus*, but calls attention to certain differences in the proportions of the cheliped, especially in the male. He also finds in the males of his *C. aruanus* and *C. lorentzi* that the internal border of the carpus of the cheliped in the male possesses smooth soft areas, which have not been observed in *C. quadricarinatus* or *albertisii*. It seems possible that these areas may be only developed periodically, as Calman suggests, and that they do not represent specific characters. Without venturing to dogmatise on the subject, it seems premature to accord these varieties of *C. quadricarinatus* more than subspecific rank, especially as the variability of the cheliped in the Crayfish according to age and individuality is notorious. (See Dr. Jean Roux (**15**, **16**), Zoologischer Anzeiger, Bd. xxxvii. Nr. 5, p. 104, Feb. 1911, and Notes from the Leyden Museum, vol. xxxiii. p. 81, 1911.) Calman (**17**) has examined a number of specimens from the Mimika River, New Guinea, and has observed soft areas on the claws of the male identical with those observed by Roux, and he also notices variations in the proportions of the chela, which, however, graduate into one another. He is emphatically of the same opinion as myself that all these specimens from New Guinea and the adjacent islands hitherto described are not sufficiently distinct to warrant their separation into more than one species.

I am therefore all the more inclined for the present to preserve the name *quadricarinatus* for all these forms.

CHÆRAPS INTERMEDIUS, sp. n. (Pls. XXIV. fig. 2; XXVII. fig. 34.)

The rostrum is flat and quite unexcavated, without any lateral

keels upon it. It ends in a spine and there are two inconspicuous lateral serrations on each side. It closely resembles the rostrum of *Parachæraps bicarinatus*.

The lateral keels on the carapace are blunt and deepened, ending posteriorly in a rounded boss. There are no other tubercles, prominences, or groups of hairs upon the body. So far the external features are practically identical with *P. bicarinatus*, but it can be at once distinguished by the generic character of the length between tip of rostrum and cervical suture being greater than that between cervical suture and end of carapace.

The first maxilla has a very small pointed terminal segment on the endopodite, which articulates by a broad base on to the basal segment (Pl. XXVII. fig. 34).

The third maxillipede is fairly well provided with hairs on its inner borders.

There are no median spines on telson.

The great cheliped is stout and broad; the hand itself being broad and rather flattened; the dactylopodite is about equal in length to the inner border of the carpus. The finger is definitely tuberculated internally, often with two enlarged tubercles. There is a small carpet of fine hairs on the inner margin of the carpus. On the under side the carpus has a pronounced longitudinal ridge with marked excavations on either side of it.

The upper ridge of the ischiopodite has a row of small round tubercles upon it.

Length 4 inches.

Locality.—Two specimens from Western Australia, April 30th, 1880. No further locality given.

Remarks on the above species.—This species is of considerable interest, as it forms a transition from the genus *Chæraps* to *Parachæraps bicarinatus*. In general appearance, in the features of the claws, carapace, rostrum, etc., it agrees exactly with *Parachæraps*; in the fact that the posterior arthrobranch is not rudimentary, the sternal keel is sharp and very prominent, the interantennal spine is pointed and not rounded, the antennal scale is not conspicuously broad, and in the length between tip of rostrum and cervical suture being greater than between latter and end of carapace, it exhibits the characteristic features of the genus *Chæraps*.

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EXPLANATION OF THE PLATES.

Pl. XIV.

Astacopsis franklinii, male. Large form. ½ nat. size. North Tasmania.

Pl. XV.

Astacopsis franklinii, female. Small *tasmanicus* form. Nat. size. South Tasmania, Mt. Wellington.

Pl. XVI.

Astacopsis serratus, male. Large form. ½ nat. size. Murray River.

Pl. XVII.

Astacopsis serratus, female. Small form. ¾ nat. size. Yarra River.

Pl. XVIII.

Astacopsis serratus, male. Small form. Nat. size. Blue Mountains.

Pl. XIX.

Astacopsis kershawi, male. Large form. ½ nat. size. Moe River, Gippsland.

Pl. XX.

Astacopsis kershawi, male. Small form. Nat. size. Narracan River, Gippsland.

Pl. XXI.

Parachæraps bicarinatus, male. ¾ nat. size. Melbourne University pond.

Pl. XXII.

Chæraps tenuimanus, male. ¾ nat. size. Margaret River, Western Australia.

Pl. XXIII.

Chæraps quinquecarinatus, male. ¾ nat. size. Swan River, Western Australia.

Pl. XXIV.

Fig. 1. *Chæraps quadricarinatus*, male. ¾ nat. size. From Katau, New Guinea. Thoracic legs not represented. From a specimen lent by Dr. Gestro.
Fig. 2. *Chæraps intermedius*, male. Nat. size. Western Australia, locality not known.

Pl. XXV.

Fig. 1. Third maxillipede of *A. franklinii*.
Fig. 2. Second maxillipede of ditto.
Fig. 3. First maxillipede of ditto.
Fig. 4. Second maxilla of ditto.
Fig. 5. First maxilla of ditto.
Fig. 6. Mandible of ditto.

Pl. XXVI.

Fig. 7. Head of *A. franklinii* from ventral view. To show interantennal spine and upper lip.
Fig. 8. Antennal scale of *A. franklinii*.
Fig. 9. Endopodite of first maxilla of *A. franklinii*.
Fig. 10. Termination of branchial filament of *A. franklinii*.
Fig. 11. Termination of coxopoditic seta of *A. franklinii*.
Fig. 12. Head of *A. serratus* from ventral view. To show interantennal spine and upper lip.
Fig. 13. Antennal scale of *A. serratus*.
Fig. 14. View of sternum of thorax from ventral surface, showing sternal keel and attachment of thoracic legs in *A. serratus*.
Fig. 15. Endopodite of first maxilla of *Parachæraps bicarinatus*.
Fig. 16. Termination of branchial filament of *P. bicarinatus*.
Fig. 17. Termination of coxopoditic seta of *P. bicarinatus*.
Fig. 18. Terminal portion of the last arthrobranch of *P. bicarinatus*.
Fig. 19. Interantennal spine of *P. bicarinatus*.
Fig. 20. Antennal scale of *P. bicarinatus*.
Fig. 21. Third maxillipede of *P. bicarinatus*.
Fig. 22. Second maxillipede of *P. bicarinatus*.
Fig. 23. First maxilla of *P. bicarinatus*.
Fig. 24. Mandible of *P. bicarinatus*.

Pl. XXVII.

Fig. 25. Last arthrobranch of *Chæraps quinquecarinatus*.
Fig. 26. Termination of branchial filament from pleurobranch of *C. quinquecarinatus*.
Fig. 27. Interantennal spine of *C. quinquecarinatus*.
Fig. 28. Antennal scale of *C. quinquecarinatus*.
Fig. 29. Endopodite of first maxilla of *C. quinquecarinatus*.
Fig. 30. Endopodite of first maxilla of *C. tenuimanus*.
Fig. 31. View of sternum of thorax from ventral surface, showing sternal keel and attachment of thoracic legs in *C. quadricarinatus*.
Fig. 32. Third maxlilipede of *C. quadricarinatus*.
Fig. 33. Second maxillipede of *C. quadricarinatus*.
Fig. 34. Endopodite of first maxilla of *C. intermedius*.