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ACCOUNT

OF THE

POSTEMBRYONAL DEVELOPMENT

OF

PANDALUS BOREALIS

KRØYER

WITH REMARKS ON THE DEVELOPMENT
OF OTHER PANDALI, AND DESCRIPTION OF THE ADULT
PANDALUS BOREALIS

BY

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WITH 10 AUTOGRAPHIC PLATES, COLOURED FROM LIFE.

KRISTIANIA
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INTRODUCTION.

Among the several Decapodous larvæ abounding during the summer-months in the sea at the Biological Station of Drøbak there is a form, which at once attracts attention by its strange appearance, differing, as it does, rather markedly from the usual larvæ met with. I have observed this peculiar larva also in many other places of the Norwegian coast until Vadsø, and have examined it in several successive stages; but it is only recently that I have been aware of its true parentage. Although I have not yet observed its escape from the ova of the parent, nor have succeeded in witnessing its last metamorphosis, I regard it at present as beyond doubt that it is the larva of the deep-water prawn *Pandalus borealis* Krøyer, which according to the recent investigations of Dr. Hjort occurs in great abundance in the deeper parts both of the Christiania-Fjord and in other Fjords of our coast. It is, however, very strange that the larva of this form in several points differs very markedly from the larvæ of the type species, *Pandalus Montagui* Leach, as also from those of *P. brevirostris* Rathke, and it is indeed for this reason that I had not before recognised it as a Pandalus-larva. It would seem, however, that several generic types are contained within the old genus *Pandalus*, and that perhaps *P. borealis* constitutes such a type. Its nearest ally is undoubtedly *P. Bonnieri* Caullery (= P. leptorhynchus G. O. Sars, not Kinahan), and this form was indeed by the said author referred to a particular subgenus, *Dichelopandalus*, chiefly on account of the 1st pair of legs having a minute chela, whereas in other Pandali, this pair is described as simple styliform. As recently shown by Mr. Calman, however, the same minute chela is, on a closer examination, found to be present in all our other Pandali, and the character upon which the genus *Dichelopandalus* was based, is accordingly a spurious one. Yet there is another character by which this species prominently distinguishes itself from all our other Pandali (also from P. borealis) viz., the presence of a distinct exopodite on the 3rd pair of maxillipeds, and perhaps therefore the genus of Caullery ought to be supported, though a new name would be highly desirable. As will be shown further below, the supposed larva of this species differs in some particulars very conspicuously from the other Pandalus-larvæ, yet exhibiting a closer approach to the larvæ of *Pandalus borealis* than to those of *P. Montagui.* It may here be mentioned that Mr. Calman recently has established a new genus, *Pandalina*, for the reception of our comman *Pandalus brevirostris* Rathke.

In the following pages I propose to give a full account of all the larval stages of *P. borealis*, with which I am acquainted, restricting myself to some brief remarks on the development of the other Pandali. At the close of the paper a description of the adult *Pandalus borealis* is given from specimens recently collected by Dr. Hjort in the Brevik-Fjord, south coast of Norway.

The plates accompanying this paper have been prepared by the autographic method applied by the author in most of his recent papers, and have subsequently been printed in colours. All the habitus-figures are copied from coloured drawings made by the author from fresh and still living specimens, and they accordingly exhibit the natural attitude of the body, the exact distribution of the pigment and partly also the inner organs shining through the pellucid integuments.

I.

Development of Pandalus borealis Kr.

The larval development of this form comprises numerous successive stages, during which a considerable increase of size take place. In its earliest stage the larva has only a length of 3 mm., measured from the tip of the rostrum to the end of the caudal plate, whereas the last stage observed measures no less than 13 mm. in length. The differences between these 2 stages (comp. Pl. I, figs. 1—2 with Pl. V fig. 7) are very great, both as regards the outward appearance and structure of the several appendages, so that it hardly should be opined that they belonged to the same species, if the intermediate stages were unknown. I have, however, studied the whole series of stages occurring between them, and am thus enabled to point out the successive changes which take place. No less than 8 different stages may be distinguished, each characterised by some more or less conspicuous transformations, partly in the general form of the body, partly in the structure of the several appendages Each of these stages is accompanied by a complete exuviation, and it is even very probable that the number of such exuviations is rather greater than the stages here described.

1st larval stage.

(Pl. I.)

As above stated, the length of the larva in this stage does not exceed 3 mm., measured from the tip of the rostrum to the end of the caudal plate. The body (see figs 1, 2) is very slender in form, being broadest in front and rapidly tapering behind. The anterior division of the body, exclusive of the rostrum, is scarcely more than $^1/_3$ the length of the posterior, and is covered by a very thin, mantel-like carapace, the lateral parts of which extend below so as to include between them the true oral parts and the bases of the postoral appendages (maxillipeds). Dorsally the carapace exhibits 2 small rounded prominences, the one occurring close to the slightly emarginated posterior edge, the other at a short distance behind the base of the rostrum. The latter is very slender, spiniform, and horizontally projected, with a very slight curvature downwards. It is about the length of the carapace, and is quite simple, without any traces of denticles, terminating in a sharp point.

The posterior division of the body is composed of 6 well defined segments, and gradually tapers distally. It is generally angularly bent at the junction between the 3rd and 4th segments (see fig. 2), showing at once the larva to belong to the great division *Eukyphota* of Boas. The 1st segment is slightly emarginated in front, and between it and the likewise emarginated hind edge of the carapace is left uncovered a small part of the mesosome dorsally. Its lateral parts (epimeral plates) are somewhat exstant, and overlap the posterior lobes of the carapace. The 3rd segment has the posterior edge angularly produced dorsally, so as to advance over the base of the succeeding segment, thereby forming the abrupt bend of the tail characteristic of the division *Eukyphota*, The 5th segment is longer than any of the preceding ones, and projects at the end on each side to an acute appressed lappet. The last segment is fully as long as all the others combined and very narrow, expanding however at the end to a broad bilobed horizontal lamella, the caudal plate. This plate (see also fig. 14), which subsequently becomes transformed to the caudal fan (the telson and the uropoda), does not yet exhibit any distinct limit in front, being the immediate continuation of the last segment. It is deeply emarginated behind, and each of the lateral lobes is fringed with 7 densely ciliated spines, 3 of which issue from the posterior edge, 3 from the obtusely truncated tip, and 1 from the outer edge, at some distance from the tip. Of the spines the middle apical one is the longest, the innermost and outermost the shortest. Between the spines of the hind edge a fine ciliation is observed, but this ciliation does not extend to the bottom of the emargination.

The compound eyes (see figs. 1 and 2) are in this stage quite immobile, forming 2 large and somewhat applanated expansions immediately in front of the carapace. They are contiguous in the middle, and extend laterally, somewhat surpassing the sides of the carapace. Their outer, evenly rounded part is regurlarly facetted and contains a comparatively small assemblage of a dark pigment, from which the visual elements radiate. The remaining part of the eyes, constituting their pedicles, is filled with a fleshy mass, in which the large optic ganglion is imbedded. Between the compound eyes in the middle a smal dark spot is easily observable. This is the simple eye or ocellus, which is contained within a particular lobe projecting in front immediately below the bases of the compound eyes.

Of limbs as yet only 8 pairs are present, viz., the 2 pairs of antennæ, the mandibles, the 2 pairs of maxillæ, and the 3 pairs of maxillipeds. The true legs, as also the appendages of the posterior division of the body are only developed in later stages.

The inner, or superior antennæ, more properly termed «antennulæ», consist each (see fig. 3) of a simple undivided cylindrical stem carrying at the tip outside a smal conical joint, which represents the outer flagellum. This joint is tipped with 5 delicate sensory filaments, and carries inside them a short ciliated seta. The inner flagellum is replaced by a strong plumose seta extending forwards and almost equalling in length the stem.

The outer, or inferior antennæ (fig. 4), which may simply be termed «antennæ», have the basal part comparatively short and simple, with a smal denticle at the end inside. The scale is freely mobile, admitting of being spread outwards at any angle to the basal part. When extended forwards, it somewhat exceeds the inner antennæ, or reaches about as far as the tip of the rostrum. It is of a narrow, sublinear form, and has the outer part divided by distinct transversal sutures into 4 or 5 joints, each of which sends off inside a long ciliated seta. From the narrowly truncated tip 3 similar, but somewhat shorter setæ issue and outside them moreover a short spine. The proximal, undivided part of the scale, which is about 3 times as long as the distal part, has near the end inside a comparatively short seta and outside a slender spine, and a similar spine is likewise found on the succeeding joint. The flagellum is represented by a simple styliform joint slightly exceeding half the length of the scale and tipped with 2 ciliated setæ, the inner of which is much the longer, and extends considerably beyond the terminal seta of the inner antennæ.

The oral opening is limited in front by a rounded anterior lip and behind by a bifid posterior lip (see fig. 5). Between these two lips the mandibles are wedged in, their masticatory parts being partly covered by the rather protuberant anterior lip.

The mandibles (ibid) are very unlike those in the adult animal, each forming a simple oblong navicular piece, without any trace of palps, and with the masticatory parts but slightly expanded, and almost transversely truncated at the end (see figs 6, 7). In front these parts project in a narrow process divided at the tip into 3 small teeth and carrying at the base 2 minute spinules. This process undoubtedly answers to the cutting part in the adult animal. Behind it the inner edge is nearly straight and sharpened, without any distinctly defined molar expansion, though the posterior, somewhat thickened and slightly angulous part of the edge may answer to this expansion. On a closer comparison, a slight difference is, as usual, found to exist in the form of the masticatory part on the 2 mandibles (see figs 6, 7).

The anterior maxillæ (fig. 8) are rather small, and exhibit each 3 successive segments, the 2 first constituting the basal part, the last the palp or endopodite. Each of the 2 basal segments projects inside to a conical lobe, the distal one representing the masticatory lobe, the proximal one the basal lobe. Both these lobes are of about the same size, but have a somewhat different armature, the basal lobe carrying 5 densely ciliated setæ, whereas the masticatory lobe is armed at the tip with 2 rather strong spines and 2 simple bristles. The palp is generally extended forwards and carries 5 ciliated bristles, 3 of which issue from the tip, the other 2 from a ledge on the internal margin. The outermost of the apical bristles is rather elongated.

The posterior maxillæ (fig. 9) consist each of a broad, lamellar basal part, a terminal palp, and a scale-like exopodite. The basal part projects inside into 4 short setiferous lobes, the 2 anterior of which answer to the single masticatory lobe of the anterior maxillæ, the 2 posterior ones to the basal lobe. The proximal lobule of the latter is rather broad and rounded, being fringed with 6 strong plumose setæ curved forwards. The other lobule is much smaller, conical in form, and only provided with a limited number of setæ. The palp is considerably broader than that of the anterior maxillæ, lamellar in structure, and is divided into 2 imperfectly defined joints, the proximal of which is rather short and provided inside with 2 slender setæ. The distal joint carries 5 similar setæ, 2 of which issue from the tip, the other 3 from the inner edge. The exopodite, which is attached to the end of the basal part outside, has the form of a rounded oval lamella extended forwards, and scarcely larger than the palp. It is only provided with 5 densely plumose setæ, 2 of which issue in close juxtaposition from the posterior part of the lamella, and point in different directions. Of the large posterior expansion, present in the adult animal, and probably constituting the epipodite, no trace is as yet to be found.

The 1st pair of maxillipeds (fig. 10) consist of the same chief parts as the posterior maxillæ, though of a rather different appearance. The basal part is slightly dilated, and divided into 2 imperfectly defined segments, the 1st of which carries inside at the end a single seta, whereas the 2nd has 8 such setæ issuing in pairs from the inner edge, which does not form any projecting lobes. The palp or endopodite, unlike what is the case in the adult animal, forms the immediate continuation of the basal part. It is about as long as the latter, rather slender, subpediform, and composed of 4 joints, which however are not very sharply defined. The 1st joint carries inside 2 slender setæ, each of the 2 succeeding ones but one such seta, and the last joint 3 apical setæ. The exopodite forms a slender movable ramus attached to a projecting knob of the 2nd basal joint outside the endopodite, and extends far beyond the latter. It carries at the tip 4 long natatory setæ and a much shorter one at some distance from the tip outside. Of an epipodite no trace is as yet visible.

The 2nd pair of maxillipeds (fig. 11) resemble in structure the 1st pair; but both the endopodite and the exopodite are more fully developed. The former, as in the 1st pair, is divided into 4 joints, the outer 2 forming together a terminal part, which with the proximal one form a more or less pronounced angle. The joints of this part are quite simple and very unlike those in the adult animal, in which they forms together a large securiform plate. From the last conically tapering joint a long spine and 3 slender setæ issue, and some few setæ are also found on the preceding joints. The exopodite is more than twice as long as the endopodite, and carries a greater number of natatory setæ than on that of the 1st pair. The basal part, as in the 1st pair, wants any trace of an epipodite and has inside only a limited number of setæ.

The 3rd pair of maxillipeds (fig. 12) are very much larger than any of the preceding limbs and subprehensile in character, being used by the larva as a pair of praying organs. They are generally (see figs 1 & 2) extended laterally, with the endopodite curving forwards, but the latter may be more or less strongly inflexed, so as to come in contact with the true oral parts. As to structure, they consist of the same chief parts as the 2 anterior pairs of maxillipeds; but the endopodite is very largely developed, beeing fully twice as long as the carapace (exclusive of the rostrum). Its 1st joint is imperfectly defined from the basal part, whereas between the 2nd and 3rd joints there is a very movable articulation, marking of a well defined terminal part. The 1st joint of the latter is very much dilated, fusiform, and in all the larvæ richly coloured with orange and crimson. It is nearly as long as the proximal part of the endopodite, and exhibits at the end inside a slight nodiform prominence tipped with 2 slender setæ. The terminal joint is rather small and narrow, digitiform, and carries at the tip a slender spine accompanied by 2 setæ. The exopodite is of same structure as in the 2nd pair of maxillipeds, but considerably larger, though not attaining the length of the endopodite. There is no trace of any epipodite.

Just behind the above-described appendages a slight bulging of the ventral face may be observed (see fig. 2), and within this bulging, on a closer examination, 2 small, juxtaposed bud-like bodies are found to occur. These bodies (fig. 13), which are the first intimation of the succeeding pair of appendages (the 1st pair of true legs), are however covered by the larval skin, and will only in the next stage become freely exposed.

On the posterior division of the body not the slightest trace of any appendages is as yet observable.

Of inner organs the intestine is easily traced through the pellucid integuments, traversing the body as a narrow duct and debouching beneath the base of the caudal plate (see fig. 14). In the living animal it exhibits uninterrupted peristaltic movements passing from before backwards. The liver is as yet only represented by a few coecal appendages issuing from the anterior dilated part of the intestine (the stomach). The heart is easily observable in the living animal by its rapid pulsations, being located dorsally beneath the posterior part of the carapace. The nervous chord likewise appears rather distinctly, on viewing the animal from the ventral face. It forms in the anterior division of the body a large, undivided nervous mass extending along the middle between the bases of the appendages. In the posterior division the ganglia are, on the other hand, distinctly defined and connected by rather long commissures.

The body is, in the living state of the animal, highly pellucid and almost colourless, with only a faint reddish shade on the anterior part. The oral parts are, however, deeply tinged with crimson, and the terminal part of the 3rd pair of maxillipeds, as above stated, exhibits a very conspicuous colouring, being mottled with orange and crimson. On the dorsal face of the 3rd caudal segment there are constantly 2 juxtaposed yellow patches, and another patch of a similar colour is seen at the base of the caudal plate.

The larva, as a rule, moves rather slowly by the aid ot the exopodites of the 2 posterior pairs of maxillipeds, but may at times make more rapid jerks by abruptly bending the tail, whereby the broad caudal plate serves as a most efficient repulsive apparatus. During the normal swimming movements this plate may serve for keeping the body in balance.

2nd larval stage.

(Pl. II, figs 1–3).

This stage is prominently distinguished by the compound eyes having become freely mobile and separated in the middle by a rather long interspace (see fig. 1). They are now distinctly pedunculated and pyriform in shape, projecting considerably beyond the sides of the carapace. The frontal part of the latter has become well defined, and has given origin, on each side of the base of the rostrum, to a strong anteriorly-pointing spine not found in the 1st stage, and present in all the succeeding stages. Between the eye-stalks a rounded lobe is seen to project containing at the base the ocellus.

The structure of the several appendages agrees very closely with that in the 1st stage. The only perceptible difference is that in the antennulæ a slight constriction has appeared in the outer part of the stem indicating an incipient subdivision, and that in the 3rd pair of maxillipeds a short joint (the carpal one) has been formed between the terminal and proximal parts of the endopodite. The 1st pair of true legs are now in process of formation, but as yet are not functionally developed, being rather small, with the endopodite and exopodite still in the form of simple sausage-shaped appendages (see fig. 3). They are partly hidden by the preceding limbs, being curved forwards and bent in against the ventral face of the animal (see fig. 2). Close behind them, moreover, on each side a smal knob-like prominence is traced, the first indication of the succeeding pair of limbs (the 2nd pair of legs).

The caudal plate is still simple, as in the 1st stage, but has acquired an additional pair of small marginal spines inside the others (see fig. 1). On a closer examination, a narrow cellular band is traced just within the lateral edges of the plate, indicating the incipient formation of the uropoda.

The larva in this stage attains a length of 4 mm., and exhibits a similar colouring to that of the 1st stage.

3rd larval stage.

(Pl. II, figs 4—8).

In this stage the larva has a length of 5 mm., and on the whole resembles in outer appearance the preceding stage. On a closer examination, however, several essential changes are found to have taken place, especially as regards the several appendages.

The antennulæ have lengthened considerably, so that they now project beyond the tip of the rostrum, and a distinct terminal joint has been cut off from the peduncle (see fig. 5). At the junction with this joint, the proximal part of the peduncle sends off inside a strong plumose seta, and another shorter seta is also seen at some distance from the former. The outer flagellum has preserved its form unaltered; but the inner flagellum is now well defined, though very small, forming a simple knob-like joint tipped by a long seta. Another seta projects in front between the 2 flagella.

The antennæ (see fig. 6) also exhibit some minor changes. The scale is slightly dilated in the middle, and its outer articulated part has considerably shortened, being now only composed of 2 articulations (see fig. 7). Of the 2 outer setæ found in the 2 preceding stages, only the proximal one is left, and indicates the place where subsequently the terminal spine of the outer edge will be formed. The flagellum is still only composed of a single slender joint carrying at the tip but slight rudiments of the 2 plumose setæ found in the 2 preceding stages.

The 1st pair of true legs are now functionally developed, and of exactly same structure as the 3rd pair of maxillipeds, carrying outside well-developed natatory appendages (exopodites) (see fig. 4, 5). Behind them the 2nd pair of legs are in process of formation, and also a slight rudiment of the 3rd pair may be traced (see fig. 4).

The simple caudal plate found in the 2 preceding stages is now replaced by a distinct caudal fan (see fig. 8), composed of a median plate (the telson) and to each side of it a double plate (uropod). The median plate is well defined from the last caudal segment, which on each side of its base projects in a tooth-like appressed lappet. It still exhibits a very broad laminar form, gradually expanding distally, and terminating in 2 diverging lobes. Each of the lobes is fringed with 7 ciliated spines, 3 of which issue from the obtusely truncated tip, the other 4 from the posterior edge. The latter gradually diminish in length inwards, the innermost spine being very small. On the outer edge of each lobe, moreover, at some distance from the tip, a small unciliated denticle is secured. The lateral plates of the caudal fan, or the uropoda, are considerably shorter than the median plate and are movably articulated to the end of the last caudal segment beneath the base of the median plate. They consist each of a short, imperfectly defined basal part and 2 terminal lamellæ, the outer of which is much the larger and obliquely rounded at the tip, carrying 6 marginal setæ. The inner lamella is scarcely half as large as the outer and oblong oval in form, with only 2 apical setæ.

4th larval stage.

(Pl. III).

In this stage the larva has grown to about twice the size of the 1st stage, measuring in length 6 mm. The general form of the body has but slightly changed; but the appendages are much more fully developed. In some specimens a single very small denticle is found on the rostrum in about the middle of its upper edge (see fig. 2); but otherwise the rostrum has not undergone any perceptible change, being still extremely narrow, spiniform, and horizontally projected, with a very slight ventral curvature. It reaches as far as to the terminal joint of the antennular peduncle. On the latter may be observed an incipient separation of an intermediate joint of about same size as the terminal one (see fig. 3), and at this place a fascicle of very delicate bristles projects outside and a plumose seta inside. The joint itself carries inside 2 similar setæ and another at the end outside. The proximal joint of the peduncle is about twice as long as the other 2 combined, and its outer edge is somewhat angularly bent at some distance from the base, indicating the incipient formation of the basal lobe. The flagella are still very small and simple, though a little longer than in the preceding stage. Between them a plumose seta projects and another inside at the base of the inner flagellum.

The antennal scale (ibid.) is still very narrow, but has lost some of its larval characters, and more approaches that of the adult animal. Thus the outer edge is produced at the end to the usual tooth-like process, and on the terminal lobe projecting inside this process there is no trace of any articulations. The scale, moreover, carries a greater number of marginal setæ, those of the inner edge being arranged at regular intervals, whereas the setæ along the outer edge of the terminal lobe are more irregurlarly arranged, tbe outermost being secured close to the tooth-like process and at some distance from the others (see fig. 3). The flagellum (see fig. 3) is still considerably shorter than the scale, uniarticulate, and gradually tapering to a simple point.

The postoral appendages have increased in number, the 2nd pair of true legs being now functionally developed, and, like the preceding pair, provided with well-developed natatory exopodites. The endopodite of this pair is however shorter than that of the 2 preceding pairs of limbs, and has the propodal joint less dilated (see figs 1 & 2). Behind these legs 2 additional pairs have appeared; but they are both in process of formation, being very small and incurved beneath the ventral face (see fig. 2).

The caudal fan (see fig. 5) has somewhat changed its form, the uropoda being more fully developed, whereas the telson has become somewhat reduced in width. It is, however, still rather large and laminar, gradually widening distally, and terminating in 2 diverging lobes separated by an angular cleft. Of the marginal spines the 2 outermost on each lobe have been reduced to small denticles similar to that occurring farther in front on the outer edge. The uropoda now are fully as long as the telson, and have the basal part well defined. The outer plate has acquired a small dentiform projection at the end outside, and the rounded tip and inner edge are fringed with a considerable number of setæ amounting to about 16 in all. The inner plate is considerably larger than in the preceding stage, though somewhat smaller than the inner, and carries 9 setæ, 3 of which issue from the tip, the other 6 from the inner edge.

5th larval stage.

This stage is not figured, because it only differs from the 4th in the functional development of the 3rd pair of legs, which exactly agree in structure with the preceding ones.

6th larval stage.

(Pl. IV).

In this stage the larva has attained a length of 7 mm., and all the appendages of the anterior division of the body have now become functionally developed, except the last pair, which are still in process of formation. On the upper edge of the rostrum 2 small successive denticles may now be observed; but its form and relative length is still unaltered.

The compound eyes are very long and narrow, claviform, with the pedicle twice as long as the facetted part (see fig. 1). The ocellus is well distinguishable beneath the base of the rostrum within the interocular lobe.

The antennulæ (fig. 3) have now the peduncle divided into 3 well defined joints, the 1st of which is about twice as long as the other 2 combined, and projects at the base outside to an angular prominence. Along the inner edge of the peduncle a series of 8 strong plumose setæ occurs, 2 on each of the 2 first joints and 4 of the last one. Moreover, each of the 2 first joints carries at the end outside a fascicle of very delicate bristles. Both flagella are still uniarticulate; but on the outer one a distinct ledge carrying 2 sensory filaments has appeared inside, and the tip is conically produced beyond the apical fascicle of sensory filaments. The inner flagellum exceeds somewhat half the length of the outer and is very narrow, carrying at the tip a slender bristle.

On the antennæ (fig. 4) the basal part appears now divided into 2 well-defined segments, and also the flagellum exhibits at the base an incipient separation of the peduncular part, the flagellum itself being considerably produced and reaching beyond the scale. The latter has the terminal lobe less prominent, and is of uniform breadth throughout.

The postoral appendages are now present in the normal number, viz., 3 pairs of maxillipeds and 5 pairs of true legs. Of the latter the 4 anterior pairs are functionally developed, whereas the 5th pair are still imperfect and inflexed inside the others (see fig. 5). All the functionally developed postoral appendages are provided with natatory exopodites, by the aid of which the larva moves rather quickly through the water. The endopodites of these appendages serve chiefly for prehension of the food, and are therefore more as less strongly incurved (see fig. 1). As to structure (see fig. 5), the propodal joint of the 3rd pair of maxillipeds has somewhat contracted, exhibiting now a nearly cylindrical form, whereas that of the 2 succeeding pairs of limbs (the 2 first pairs of true legs) appears greatly dilated, subfoliaceous. The 2nd pair of legs are the longest of all, the 2 succeeding pairs rapidly diminishing in size. The still imperfectly developed 5th pair of legs form each a quite simple incurved stem, without any external ramus or exopodite.

Of pleopoda there is not yet any trace to detect externally; but within the somewhat protruding ventral integument may be traced in each of the 5 anterior segments of the tail a small cellular mass (see fig. 2), which on a closer examination, is found to consist of 2 juxtaposed knob-like buds, representing the first intimation of these appendages. It is, however, only in the next stage that these buds will become freely exposed.

The caudal fan (fig 6) has undergone some rather conspicuous changes. Thus the median plate, or telson, has considerably contracted, and is now but very slightly dilated distally; but still it exhibits a deep apical sinus dividing it into 2 diverging terminal lobes. The marginal spines are as in the 2 preceding stages. Both plates of the uropoda have increased in size, and are now fringed inside and at the tip with a great number of ciliated setæ.

7th larval stage.

(Pl. V. figs 1—6).

This stage is chiefly distinguished from the preceding ones by the functional development of all the appendages belonging to the anterior division of the body, as also by the first apparition of the pleopoda. The length of the body has increased to about 9 mm.; but in its general form (see fig. 1) it does not much differ from the next preceding stages, though the tail appears somewhat more strongly built.

The rostrum still exhibits the spiniform appearance and slight ventral curvature found in the preceding stages; but on its upper edge now 3 distinct denticles have appeared. The supraocular spines are unaltered.

The compound eyes are somewhat more dilated distally than in the preceding stage, but otherwise of a very similar appearance, and the ocellus is easily observable in its normal place.

On the antennulæ (see fig. 2) the external angle of the basal joint is more strongly marked, and both flagella have somewhat increased in length, the inner one being still simple, whereas the outer has been divided into 3 articulations.

The antennal scale (ibid.) is nearly unaltered, whereas the flagellum has considerably increased in length, so as now to project far beyond the scale. It has the peduncular part well defined, though still only composed of a single joint, and the terminal part has become divided into several short articulations, some of which however still are imperfectly defined.

The postoral appendages (see fig. 3) exhibit a similar structure to that in the preceding stage, except that the last pair of legs now has become functionally developed and divided into the normal number of joints. This pair is, however, considerably shorter than the preceding ones, and, whereas all of the latter have well-developed natatory exopodites, no trace of such appendages is seen on this pair.

Above the bases of the legs the gils are now distinctly traced; but only a single series is as yet present on each side, constituting the pleurobranchiæ, the arthrobranchiæ being still absent.

The pleopoda are present on all the 5 anterior caudal segments (see fig.1), but are still very small and quite immobile, forming smooth anteriorly curving buds (fig. 4).

On the caudal fan (fig. 5) the median plate, or telson, is now almost linear in form, being scarcely at all expanded distally. It is, however, still deeply emarginate at the tip, terminating in 2 diverging lobes. The marginal spines on the latter are present in the same number as in the preceding stage; but the apical spine has considerably increased in length and has lost its ciliation. Both plates of the uropoda are more fully developed and densely fringed with setæ.

8th larval stage.

(Pl. V, figs 7–9, Pl. VI).

This is the most fully developed of the larval stages observed; but it is very probable that it is not the final one, and that another larval stage exists between it and the postlarval stages. The largest specimens of the present stage attain a length of no less than 13 mm., a rather large size for a larval form.

The general form of the body (see Pl. V, fig. 7) now approaches that of the adult animal, the posterior division being rather more powerfully developed than in any of the preceding stages, and exhibiting very pronouncedly the characteristic bend between the 3rd and 4th segments.

The rostrum has considerably increased in size, somewhat exceeding the length of the carapace and projecting beyond the antennular peduncles Its upper edge is now divided into several successive denticles, the number of which somewhat vary in different specimens, amounting in the largest specimens to 7 in all, and on the lower edge a single denticle has appeared at some distance from the acutely produced tip of the rostrum. On the carapace itself the knob-like dorsal prominence found in the preceding stages just behind the base of the rostrum, has assumed the character of a denticle; but no other dorsal denticles are as yet visible on the carapace. The supraocular spines, which in the adult animal are wholly absent, have preserved their appearance quite unaltered.

The compound eyes, as in the preceding stages, are oblong claviform, with the pedicles very much elongated, and the ocellus is easily observable on its usual place.

As to the several appendages, they are still very different in structure from those of the adult animal, preserving on the whole their larval character, though they be rather more fully developed than in the preceding stage.

The antennulæ (Pl. VI, fig. 1) have the proximal part of the basal joint rather broad and flattened, and produced outside to an acute anteriorly-pointing process. Along the inner edge of the peduncle 12 plumose setæ can be counted, 6 on the basal joint, 2 on the middle joint, and 4 on the terminal joint. Both flagella have considerably increased in size, so that they now exceed half the length of the peduncle. They are about of equal length; but the outer one is much thicker than the inner, and is now divided into 6 articulations, the 2 proximal of which, however, are still imperfectly defined. The inner flagellum is rather slender, and composed of 3 wel-defined articulations, the 1st of which is much the longest, the last being tipped with 2 unequal bristles.

The antennal scale (see fig. 2) is comparatively broader than in the preceding stages, and obliquely truncated at the tip, its outer edge being quite smooth and terminating in a strong spiniform projection, whereas the inner edge and the tip are fringed with a dense row of plumose setæ. Outside the scale, the basal part projects in an acute appressed lappet. The flagellum is now of considerable length (see Pl. V, fig. 7), about half that of the body, and consists of a well-defined 3 articulated peduncular part and a mutliarticulate terminal filament.

The oral parts (see Pl. VI, figs 3—5) have not much changed in their structure, and are still very unlike those in the adult animal.

On the mandibles (fig. 3) no trace of palps has as yet appeared, and their masticatory parts are almost exactly as in the 1st stage (comp. Pl. 1, figs 6, 7).

The anterior maxillæ (fig. 4) are likewise of a much similar appearance, the only difference being, that the masticatory lobe has several, instead of only 2 apical spines, and that the basal lobe is provided with a greater number of setæ.

The posterior maxillæ (fig. 5) likewise resemble very much those in the 1st stage as regards the basal part and the endopodite; but the exopodite is much more fully developed, constituting a large plate densely fringed with plumose setæ and sending off behind a narrow lappet likewise fringed with setæ.

The 1st pair af maxillipeds (fig. 6) do not yet exhibit any distinctly defined masticatory lobe, though the inner edge of the 2nd basal segment is somewhat arcuate and densely fringed with setæ, and the endopodite still forms the immediate continuation of the basal part. Neither has the exopodite, undergone any appreciable change; but behind it the epipodite has appeared as an oval, sacciform dilatation of the 1st basal segment.

The 2nd pair of maxillipeds (fig. 7) likewise look very like those in the 1ste stage. On a closer examination, however, an additional joint (the carpal one) has been formed on the endopodite between the terminal and proximal parts, and outside the 1st basal segment a sacciform epipodite has appeared.

The 3rd pair of maxillipeds (fig. 8), as in the preceding stages, are pronouncedly pediform, and are, like the 2 preceding pairs, provided with well developed natatory exopodites. They are somewhat shorter than the succeeding appendages, and have the propodal joint simple cylindrical, and clothed on both edges with scattered fascicles of slender spines. The dactylar joint is well defined, conical, and tipped with a slender spine and 2 small bristles.

Of the succeeding appendages, the true legs, the 2 anterior pairs slightly differ in structure from the 3 posterior; but all, except the last, are provided with natatory exopodites similar to those on the 3rd pair of maxillipeds.

The 1st pair of legs (fig. 9) are considerably shorter than the others, and have developed from the end of the propodal joint a well-defined thumb-like process reaching about to the middle of the dactylar joint and tipped with a single bristle. The cheliform nature of these legs thus appears rather pronouncedly in this stage.

The 2nd pair of legs (fig. 10), on the other hand, have still preserved their larval character unaltered, and are very unlike those in the adult animal, the carpus being still quite short and simple, whereas the propodos is rather large, fusiform dilated, and without any trace of a thumb.

The remaining 3 pairs of legs (figs 11, 12), constituting the true pereiopoda, are very slender and of essentially the same structure, except that the last pair (fig. 12), as above stated, are without any trace of exopodites.

The pleopoda (see Pl. V, figs 7, 8, 9) now appear composed of the same parts as in the adult animal, viz., of a basal part and 2 terminal lamellæ, the inner of which is the shorter and in the 1st pair (fig. 8) is very small. They are, however, still not functionally developed as natatory organs, being quite devoid of setæ and also scarcely at all mobile.

Tbe caudal fan (Pl. VI, fig. 13) now approaches in appearance that of the adult animal, the telson being considerably narrowed, with the greatest width in front of the middle. The tip (fig. 14) is, however, still emarginated, through the emargination is rather shallow and the terminal lobes obtuse. The marginal spines on the latter are present in the same number as in the preceding stage; but the 3 denticles of the outer edge are more widely separated. The uropoda are more fully developed, both plates reaching somewhat beyond the tip of the telson.

The colouring is about as in the preceding stages, the body itself being highly pelucid and almost devoid of pigment, whereas the oral parts are tinged with crimson, and the outer part of the postoral appendages mottled with yellow and pink.

Postlarval stage.

(Pl. VII, figs 1—3).

The earliest postlarval stage I have observed, is that here represented; but it is very probable that in fact there exist another still earlier stage between the larval and postlarval periods. Yet even in the present stage there is found a very obvious remnant of the larval existence in the presence of exopodites, though in a much reduced state, not only on the 3rd pair of maxillipeds, but also on the 3 anterior pairs of true legs, the 2 posterior pairs being, on the other hand, quite devoid of such appendages (see fig. 1).

The animal in this stage is easily recognized as a young *Pandalus borealis* by the slenderness both of the body itself and of its several appendages. It has a length of 17 mm., and is, in the living state, highly pellucid, being almost wholly devoid of pigment.

The rostrum (see figs. 1 & 2) is of considerable length, being even somewhat longer than the carapace, and is horizontally projected. It is very slender and has the upper edge divided into 15 denticles, 4 of which more properly belong to the carapace. Only the hindmost denticle is movably attached; the others do not exhibit any trace of a defining suture at the base. On the lower edge of the rostrum 5 very small denicles may be traced, the tip itself being still simple, mucronate. The supraocular spines, so conspicuous in the larvæ, have wholly disappeared; the antero-lateral lobes of the carapace, however, exhibit a distinct antennal and pterygostomial spine.

The tail is abruptly bent at the junction between the 3rd and 4th segments, and has the epimeral plates still rather small. Its last segment is very narrow and elongated, equalling in length half the preceding part.

The compound eyes are still rather elongated, claviform, with the ocular pigment very dark. The ocellus is easily observable also in this stage.

The postoral appendages (see fig. 1) have now assumed their definitive structure, the 1st pair of legs terminating in an apparently simple styliform joint, though, on a closer examination, a minute imperfect chela may be stated to exist. The 2nd pair of legs, as in the adult animal, are extremely slender and flexible, and also very unequal, the left leg being much longer than the right, and having the carpus divided into a much greater number of articulations, both legs terminating with a minute but very distinct cheliform hand. The 3 posterior pairs of legs are now pronouncedly ambulatory in character, being much elongated and terminating with a slender claw. As above stated, the anterior pair of pereiopoda, like the preceding pairs, are provided with exopodites, though in a much reduced state and not at all natatory.

The latter function is now wholly transferred to the pleopoda, which are strongly developed, with both plates densely fringed with setæ.

The telson is very long and narrow, and has the tip obtusely truncated, without any trace of the original emargination, the posterior edge being on the contrary slightly produced in the middle (see fig. 3). It has only 6 apical spines, 2 of which issue from the produced end, 2 on each side from the lateral corners; of the latter the outer one is rather short, whereas the inner is the longest of all. Along the outer edges of the telson, moreover, a number of short denticles are secured.

II.

Development of Pandalus Montagui, Leach.

The larval development of this well-known species agrees in the more essential points rather well with that of *P. borealis* as described above, yet exhibiting some rather conspicuous differences. Thus the penultimate pair of legs never develop any exopodite, and in the more advanced larval stages therefore the number of natatory appendages is a smaller one than in the corresponding stages of P. borealis.

As to outer appearance, the larvæ of the present species are easily recognizable from those of *P. borealis* by the less slender form both of the body itself and especially of its appendages, and also by the much shorter rostrum.

On Pl. VIII is given a dorsal view (fig. 1) of a larva of this form in one of the intermediate stages, answering to about the 5th stage of *P. borealis.* It will be seen from this figure that the general form of the body on the whole agrees with that in the larvæ of *P. borealis,* though the anterior division appears somewhat broader in proportion to the posterior.

The rostrum is, however, much less produced, scarcely reaching beyond the middle of the basal joint of the antennular peduncles, and as yet is quite simple, subulate. The supraocular spines are well marked, but rather smaller than in the larvæ of *P. borealis.* The compound eyes also are less elongated, though considerably projecting beyond the sides of the carpace.

The antennulæ and antennæ exhibit a similar structure to that in the corresponding stage of *P. borealis,* but both pairs are comparatively much shorter.

This is still more the case with the postoral appendages, which appear rather short and robust, as compared with those in the larva of *P. borealis.* It will be seen from fig. 2, which represents the left series of postoral appendages from the same larva more highly magnified and viewed from the inner side, that none of the legs as yet exhibit any cheliform structure, the 3 anterior pairs, which in this stage are functionally developed, being of a similar structure to that of the 3rd pair of maxillipeds, though somewhat shorter and stouter. In none of these pairs the propodal joint exhibits the peculiar foliaceous structure found in the larvæ of *Pandalus borealis*, and the natatory exopodites are also comparatively shorter, rapidly diminishing in size posteriorly. The 2 posterior pairs of legs are in this stage imperfectly developed, being just in process of formation and inflexed inside the others. They are both quite simple, without any trace of exopodites.

The telson (see fig. 1) is still rather broad, laminar, and gradually expanded distally, with the hind edge distinctly emarginate, though the emargination is shallower than in the corresponding stage of *P. borealis.* The number of marginal spines is the same as in the larvæ of that species. On the uropoda the inner plate is less fully developed than in the corresponding stage of *P. borealis*, it being still very small and without any marginal setæ.

The length of the larvæ in the above-described stage scarcely exceeds $5^1/_2$ mm., whereas in the corresponding stage of *P. borealis* it amounts to about 7 mm. In the living state the body is highly pellucid and almost colouress, with only a faint bluish tinge and some few very small patches of a light yellow pigment. The postoral appendages are slightly mottled with a similar pigment, but do not exhibit the rich coloration of the outer part found in the larvæ of *P. borealis.*

On Pl. VII the *1st postlarval stage* of this species is represented, viewed from the right side (fig. 4), and accompanied by some detail-figures (figs 5—11).

The length of the animal in this stage is about 12 mm.

As in the larval stages, the whole body is highly pellucid, and almost without pigment, though exhibiting a faint bluish tinge.

The rostrum (see figs 4 and 5) is still rather short, as compared with that in the adult animal, not even reaching to the end of the antennular peduncles, and has the upper edge divided into 7 denticles, 3 of which more properly belong to the carapace. The denticles do not extend to the middle of the rostrum, and only the hindmost is movably articulated. On the lower edge 3 extremely small denticles may be traced occuring beyond the middle, the tip being simple, subulate. The supraocular spines, which also in the adult state of this species are wanting, are still present, though in a rather reduced state (see also fig. 6). On the antero-lateral lobes of the carapace the antennal and pterygostomial spines are easily observable.

The posterior division of the body exhibits the characteristic flexure at the junction between the 3rd and 4th segments, and has the last segment rather narrow and elongated, though somewhat less so than in the young of *P. borealis*.

The compound eyes (see fig. 6) are very narrow, almost cylindrical, with much elongated pedicles, and the ocellus is distinctly traced, being imbedded within the rounded interocular lobe.

The antennulæ and antennæ (ibid.) resemble in structure those in the more advanced larval stages of *P. borealis*.

This is also the case with the oral parts.

The postoral appendages, on the other hand, have assumed a structure more approaching to that of the adult animal, though they all, except the 2 last pairs, still carry well developed natatory exopodites, (see fig. 9). The 2 anterior pairs of true legs are very unlike the 3 posterior and also much smaller, even not attaining the length of the 3rd pair of maxillipeds. They both terminate in a chela, which however in the 1st pair is very small and still imperfectly developed, the thumb being conciderably shorter than the dactylus (see fig. 10). In the 2nd pair, on the other hand, the chela is normally developed (see fig. 11), resembling that in the adult animal. The carpus is in this pair considerably longer than in the other pairs, but is still simple, not, as in the adult animal, divided into short articulations, nor is as yet any appreciable difference in length of the 2 legs to be observed. The 3 succeeding pairs of legs (see fig. 9) are pronoancedly ambulatory in character, terminating with a strong claw of moderate length, and being on the whole much more robust than in the young of P. borealis. As above stated, the 1st of these pairs have outside a well developed natatory exopodite, whereas in the last 2 pairs no trace of such an appendage is observable.

The pleopoda (see fig. 4) are now functionally developed and mobile, assisting the natatory exopodites during the motion of the animal. They all terminate in 2 unequal lamellæ fringed with a still restricted number of setæ.

The caudal fan (fig. 7) still somewhat differs from that of the adult animal, especially as regards the structure of the median plate or telson. The latter is about the length of the last caudal segment, and exhibits an oblong linear form, being scarcely at all narrowed distally. The tip (see fig. 8) is transversely truncated and armed with a series of 10 spines, the outermost on each side being considerably longer than the others. Laterally there are 3 or 4 extremely small denticles, the hindmost of which is attached close to the tip.

III.

Development of Pandalus (Pandalina) **brevirostris,** Rathke.

(Pl. VIII, figs 3, 4).

The larval development of this very commen form agrees very closely with that of *P. Montagui.* Yet the larvæ of this species are easily distinguishable by their much smaller size and by the very short rostral projection. Moreover the body is of somewhat less slender form, and is ornamented with scattered yellow and pink pigment-stars.

The stage here figured (Pl. VIII, fig. 3) answers to the 6th stage of *P. borealis,* all the legs, except the last pair, being functionally developed (see fig. 4), and yet the larva scarcely attains a length of 5 mm.

The compound eyes are of enormous size, projecting far beyond the sides of the carapace, and exhibit a somewhat fusiform shape, the pedicle being slightly dilated on the middle, and the facetted part not at all expanded.

The rostrum is so very small as easily to escape attention, not even projecting beyond the interocular lobe, within which the ocellus is very distinctly seen. The supraocular spines are present, but are much smaller than in the larvæ of *P. borealis.*

As to the several appendages, they so closely resemble in structure those of the corresponding stage of *P. Montagui*, that a detailled description of them is not needed. The only perceptible difference is that the postoral appendages are somewhat more slender (see fig. 4). The caudal fan, too, does not exhibit any peculiarity in its structure.

The earlier postlarval stages likewise agree very closely with those of *P. Montagui*, but are easily distinguished by the much inferior size and by the poor development of the rostrum.

IV.

Development of Pandalus (Dichelopandalus) **Bonieri,** Caullery.

(Pl. VIII, figs 5—6).

Besides the larvæ of the 3 above-mentioned species, I have found off the south coast of Norway (Mærdø) some stages of another Pandalus-larva highly remarkable by the presence of 2 very conspicuous, horn-shaped processes arising from the upper face of the carapace. These larvæ, the most developed of which is figured on the accompanying plate, belong, I believe, to the rare species at first noticed by the present author as *Pandalus leptorhynchus* Kinahan, but regarded by Mr. Calman as a new species, for which the specific name *Bonnieri* subsequently given to it by Mr. Caullery ought to be retained. It has been noticed above, that this species differs from all our other Pandali by the presence, in the adult state, of distinct exopodites on the 3rd pair of maxillipeds; but otherwise it undoubtedly approaches nearest to *P. borealis*. This is confirmed by the larval development, which agrees with that of *P. borealis* in the presence of natatory exopodites on all the legs, except the last pair (see fig. 5). The larvæ of the present species are, however, easily distinguished from those of *P. borealis,* not only by the peculiar armature of the carapace, but also by several other characters, to be treated of below.

As to the above-named horn-shaped processes (see figs 5 and 6), they are about half the length of the carapace, and arise from about the middle of its dorsal face on each side of the median line, extending upwards, with the tip curved forwards in a hook-like manner. They are highly chitinized and may serve as a kind of balancing apparatus.

The rostrum is rather produced, reaching even in the youngest stage observed considerably beyond the middle of the antennular peduncles. It is very narrow and quite simple, without any traces of denticles, and projects horizontally, the tip being abruptly curved downwards in a hook-like manner (see fig. 6). The antero-lateral lobes of the carapace exhibit the usual antennal and pterygostomial denticles; but of supraocular spines no trace is found in any of the stages observed.

The posterior division of the body exhibits the usual flexure between the 3rd and 4th segments, and gradually tapers distally, the last segment being very slender and elongated.

The compound eyes are long and narrow, claviform, projecting far beyond the sides of the carapace, and have the facetted part comparatively small and but slightly expanded. The ocellus occupies its usual place within the interocular lobe.

The antennulæ do not exhibit any essential difference in their structure from those in the corresponding stage of *P. borealis*.

The antennæ, on the other hand, are highly distinguished by the strong development of the flagellum. In the stage here represented it almost attain the length of the whole body and is very distinctly articulated, but even in the youngest stage observed, which about answers to the 3rd stage of *P. borealis*, this part projects far beyond the scale, being about twice its length and exhibiting a rather robust structure. In all the stages observed it was deeply tinged with crimson.

The postoral appendages, on the whole, resemble those in the corresponding stages of *P. borealis*, being very slender and elongated; but in none of them the propodal joint exhibits a such pronouncedly foliaceous structure as in that species, though their outer part is tinged in a much similar manner. In the stage here figured, which answers to the 7th stage of *P. borealis,* they were all functionally developed and provided with well-developed natatory exopodites, with only the exception of the last pair, which are simple, as in the larvæ of *P. borealis,* and somewhat shorter than the preceding pairs.

The pleopoda in this stage were in process of formation, though still immobile and without setæ.

The caudal fan agrees nearly in structure with that in the corresponding stage of *P. borealis*, the median plate, or telson, being at first very broad and spatulate in form, but gradually contracting, so as in the more advanced stages to assume an almost linear form. The tip in all the stages observed is deeply emarginated and fringed with the usual number of spines.

The length of the larva in the stage here figured, is 9 mm., or exactly the same as that of the corresponding stage of *P. borealis*. As in the latter, the body is highly pellucid, with only a few scattered patches of a clear yellow or pinkish colour. The oral parts and antennal flagella are, however, deeply tinged with crimson, and the outer parts of the postoral appendages exhibit a similar ornament of orange and red tinges to that in the larvæ of *P. borealis*.

V.

Adult state of Pandalus borealis, Kr.

(Pl. IX &X).

In succession to the above notes on the larval development of the *Pandali,* I think it may be appropriate to give below an account of the adult state of *P. borealis*, accompanied by carefully drawn figures, both habitus and detail.

This species was first briefly characterized by Krøyer from Greenland specimens, and figures of it were given by the same author in the well-known work, «Gaimard's voyage en Scandinavie». A more detailled description was subsequently given by Krøyer in the «Naturhistorisk Tidsskrift», but not accompanied by any figures. In recent times this species has been mentioned by several authors; but no other description and figures than those originally given by Krøyer as yet exist, and for this reason a renewed description may not be superfluous.

The length of the largest Norwegian specimens, measured from the tip of the rostrum to the end of the telson, amounts to about 136 mm., and this form accordingly grows to a considerably larger size than *P. Montagui.*

As compared with the latter species, the general form (see Pl. IX fig. 1) appears rather more slender, and this applies both to the body itself and to its several appendages.

The rostrum is very slender and almost horizontally projecting, with only a very slight dorsal curvature. It is not fully twice as long as the carapace, and far less deep at the base than in *P. Montagui.* The denticles of the upper edge, including those of the dorsal crest of the carapace, vary in number from 12 to 16. Of these 4 to 5 belong to the carapace. The outermost denticle, as a rule, is not far remote from the tip of the rostrum, whereas in *P. Montagui* the outer half of the dorsal edge is always naked. The greater number of the denticles, as in other species of the genus, are distinctly articulated to the rostrum, only the 2 or 3 outermost being not distinctly defined at the base. The tip of the rostrum is said by Krøyer to be simply acuminate. This may indeed have been the case in the specimen dissected by Krøyer; but it is certainly not the usual appearance; for in the far greater number of specimens I have examined, I have found the tip of the rostrum, as in most other species, distinctly bidentate, the lower denticle being the more prominent. The lower edge of the rostrum is cut of into 7 strong teeth, somewhat diminishing in size distally. Between the denticles both of the upper and lower edges a dense ciliation occurs. The rostrum has on each side a slight longitudinal keel, which gradually disappears towards the tip, and at the base immediately passes into the anterior edge of the carapace forming the ocular notch. Above this notch no trace of any spine is found, but beneath it the usual antennal spine projects, and farther below, at the antero-lateral corner, a small pterygostomial spine occurs. In younger specimens, as a rule, the rostrum is comparatively longer than in fully adult ones, not seldom attaining fully twice the length of the carapace (see fig. 2).

The posterior division of the body, or tail, about equals in length the anterior, including the rostrum, and exhibits at the junction between the 3rd and 4th segments the usual abrupt flexure. The epimeral plates of the 2nd segment are, especially in female specimens, rather large, rounded oval in form, and overlap both those of the preceding and succeeding segments. The 3rd segment has dorsally an obtuse keel, which sometimes projects as a slight gibbosity beyond the middle of the segment, but which I newer have found to be produced in the form of a true denticle, as insisted upon by Krøyer. The posterior edge, however, of both this and the succeeding segment projects in the middle in a took-like manner. The 5th segment is the smallest, and has the epimeral plates acutely produced behind. The last segment is about the length of the 2 preceding ones combined, and projects at the end, on each side of the base of the telson, to a dentiform appressed lappet.

The compound eyes (see fig. 3) are short and thick, almost globular in form, and are widely separated, so that they project somewhat beyond the sides of the carapace. The pigmented and facetted part, or the eye-ball proper, occupies the greater part of the eye, and has a somewhat greater extent ventrally than dorsally. On the dorsal face, just at the inner edge of the facetted part, a well-defined small circular area of a very dark colour is seen, containing a fascicle of peculiarly modified visual elements. This is the so-called accessory eye described by Mr. Sp. Bate in some of the Carida from the Challenger Expedition, and occurring also in several of our indigenous forms. The interocular lobe is still present; but I have not been able to detect within it any trace of the ocellus.

The antennulæ (see fig. 3) have the peduncle rather short and thick, scarcely attaining half the length of the carapace, and densely clothed with partly cilated bristles. The 1st joint is about the length of the other 2 combined, and is somewhat flattened, forming outside at the base a large rounded expansion edged with delicate bristles. The flagella are very slender, filiform, and about of equal length, extending considerably beyond the tip of the rostrum. The outer flagellum has the proximal part somewhat thickened and clothed below with dense fascicles of delicate sensory bristles. This thickened part somewhat exceeds the peduncle in length and is very sharply defined from the slender terminal part, both being, like the inner flagellum, divided into numerous short articulations.

The antennal scale (ibid.) is oblong linear in form, almost twice as long as the antennular peduncle, and but slightly narrowed distally. The tip is obliquely rounded beyond the dentiform projection in which the outer smooth edge of the scale terminates. From this projection an oblique suture extends for some distance, without, however, crossing the scale. The setæ of the inner edge and terminal lobe are very numerous, forming a dense fringe. The antennal flagellum (see fig. 1) is exceedingly long and slender, even exceeding in length considerably the whole body; but, as it is very brittle, it is rather seldom to get specimens in which it is quite entire.

The oral area (fig. 4) is somewhat protuberant, though scarcely projecting beyond the lower edges of the carapace. It is limited in front by a rather large, fleshy prominence, constituting the anterior lip. This lip is somewhat trigonal in form, terminating in front in an obtuse point, whereas its hind edge, limiting the oral aperture, is nearly straight.

The posterior lip (ibid.) is composed of 2 juxtaposed lobes separated in the middle by a narrow fissure. Each lobe expands at the end in a securiform manner, the outer corner being rather much produced, so as to partly cover the body of the mandibles. Along the anterior and interior edges of the lobes a fine ciliation may be observed.

The mandibles (ibid. and figs 5, 6) are rather strong, and have the masticatory part divided into 2 very sharply defined rami separated by a deep incision. The anterior ramus, constituting the cutting part, is slightly curved and somewhat compressed, being squeezed in between the anterior and posterior lips, so that, by the action of the adductor muscle of the mandibles, it may be approached to the median line and thus be brought in contact with that of the other side. It is highly chitinized, of a more or less brownish colour, and has the cutting edge divided into 5 coarse teeth of about same appearance on the two mandibles. The posterior ramus, or the molar process, stands off from the body of the mandible at nearly a right angle, and exceeds somewhat in length the anterior. It is cylindrical in form, and terminates with a finely fluted triturating surface accompanied by a few blunt teeth. On a closer examination, this ramus is found to be somewhat different in the two mandibles. In the right mandible (fig. 5) it is almost transversely truncated at the tip, and exhibits inside the triturating surface 3 coarse brownish-coloured teeth. In the left mandible (fig. 6) the tip is much more oblique, and has only 2 teeth inside the triturating surface. The palp is well developed, though rather short, being scarcely longer than the cutting ramus, and is densely clothed with bristles. It is composed of 3 joints, the 1st of which forms inside a narrowly rounded laminar expansion (see fig. 7). The last joint is about as long as the other 2 combined and of oblong oval form, with numerous bristles, giving it a brush-like appearance.

The anterior maxillæ (see figs 4 & 8) exhibit each a thickish basal part, form which 3 differently formed lobes issue extending in different directions. The median lobe is much the largest, and constitutes the true masticatory lobe. It is considerably expanded, securiform in shape, and armed along the inner straight edge with numerous short spines. The innermost lobe, or basal lobe, is conically tapered andsomewhat curved anteriorly, carrying numerous bristles, which at the tip assume a spiniform character. It is by dissection easily detached from the rest of the maxilla, and thus seems to be movably attached to the basal part. The outermost lobe, constituting the terminal part, or palp, is rather small and somewhat bent in the middle, curving anteriorly. The tip is slightly bilobular, each lobule carrying 2 unequal bristles.

The posterior maxillæ (Pl. X, fig. 2), as usual, are lamellar in structure, and exhibit, in addition to the parts present in the anterior maxillæ, a greatly developed lamelliform exopodite. The masticatory lobe is rather prominent, and is divided by a narrow incision into 2 lobules, the anterior of which is the larger, both densely clothed at the inner edge with bristles. The basal lobe is much less prominent, and likewise divided into 2 lobules; but the anterior one is so very small as easily to escape attention. The palp is somewhat more slender than that of the anterior maxillæ, exhibiting, however, a much similar structure. The exopodite forms a very large oblong plate, considerably produced both in front and behind, being movably attached to the outer side of the basal part in about the middle of its length. The anterior part of the plate is narrow linguiform and densely fringed all round with plumose setæ. The posterior part, which perhaps more properly represents the epipodite, is very obliquely truncated at the end, the outer corner being drawn out to an acute point, whereas the inner corner is nearly right-angular. Between both are attached to the posterior edge numerous very slender bristles increasing in length towards the outer corner, the outermost being exceedingly long and flexuous. As is well known, this plate serves as a ventilating apparatus, to regulate the current of water bathing the gills.

The 1st pair of maxillipeds (fig. 3) are likewise pronouncedly laminar in structure, and it is not difficult to recognize in them the same chief parts as in the posterior maxillæ, though of a rather different appearance. Both the masticatory and basal lobes are undivided, the latter being scarcely at all prominent, whereas the former terminates in front in a rather large rounded expansion clothed along the straight inner edge with numerous slender bristles. The palp, or endopodite, issuing outside this expansion, is considerably more elongated than in the maxillæ, and exhibits slight traces of a segmentation. The exopodite is composed of a pronouncedly lamellar proximal part extending as far as the palp, and a slender and flexible terminal lash extending somewhat inwards, so as to form with the proximal part an obtuse angle. The latter is fringed at the outer, somewhat projecting corner with long plumose setæ, which also extend for some distance along the outer edge. The terminal lash is about as long as the proximal part, but much narrower, and is divided into numerous short articulations carrying slender setæ. The epipodite is well defined from the exopodite, forming a rather large smooth plate of a peculiar spongious structure, and conically produced both in front and behind, so as to assume a securiform shape.

The 2nd pair of maxillipeds (fig. 4) look rather different from the 1st pair, owing to the strong development of the palp or endopodite. The latter forms the immediate continuation of the basal part, the 2 segments of which do not form any distinct masticatory or basal lobes. It is composed of 5 well defined joints, the outer 2 of which are peculiarly modified, forming together a securiform dilated terminal part doubled upon the proximal one. The penultimate joint in particular is very large and expanded, carrying numerous unequal spines along the inwards curved edge. The last joint, on the other hand, is rather small and immovably connected with the penultimate one along a very oblique suture, looking merely as a narrow border. It is also armed with numerous spines, which form a continuation of the row clothing the preceding joint. The exopodite, which is movably articulated to the end of the 2nd basal joint outside, is very slender, with the proximal part not distinctly defined from the terminal one. The epipodite forms an oval lamella carrying inside a well developed, bipartite gill.

The 3rd pair of maxillipeds (fig. 5) are so perfectly pediform, that it is only by analogy with other Decapods that they are so termed. According to structure they, in reality, agree with the true legs and, like them, project freely beneath the carapace, being as a rule extended straight forwards (see Pl. IX, fig. 1). They each form a slender stem apparently divided into 5 joints only. On a closer examination, however, a small terminal joint may be easily stated to occur (see fig. 5 a), so that in reality the number of joints are 6. Of these joints the 1st is very thick, irregularly globular in form, and, as in the 4 succeeding pairs of true legs, carries outside a small recurved epipodite of linguiform shape. The 2nd joint is rather small and together with the 1st constitutes the basal part. It does not exhibit outside any trace of an exopodite, whereas a such appendage is constantly found in the nearly allied species, *P. Bonnieri*. The next joint is very much elongated, being about as long as the remaining part of the stem, and is somewhat bent on the middle. It is generally described as the ischial joint; but it may be easily proved, that in reality it is formed by the junction of this joint and the meral one, both being wholly coalesced. The succeeding part of the stem is composed of the carpal, propodal and dactylar joints, and, as in the true legs, has a very movable articulation with the preceding part. Of the joints the propodal one is somewhat longer than the carpal one, both, but especially the former, being densely clothed with short bristles intermingled with slender spines. The dactylar joint is very small, and partly hidden by the bristles and spines issuing from the preceding joint. It is, however distinctly defined from it by a well-marked transversal suture (see fig. 5 a), and carries 3 spines, the apical one being somewhat longer than the 2 lateral ones.

The 1st pair of true legs (fig. 6) are scarcely as long as the 3rd pair of maxillipeds and considerably more slender, being also less richely setiferous. They are generally described in the species of *Pandalus* to be 6-articulate, with the last joint simple, styliform. On a closer examination, however, as shown by Mr. Calman, in all the Pandali an exceedingly minute, but perfect chela is found at the tip of this joint (see fig. 6 a), exhibiting 2 closely applied digiti of equal length, the one distinctly defined at the base, and constituting the 7th or dactylar joint. The ischial and meral joints in these legs are well defined from each other, and connected by a very oblique articulation, the meral joint being the longer. They are both slightly dilated and fringed inside with a row of delicate bristles. The carpal joint is very slender, sublinear, and about the length of the meral joint. The propodal joint is scarcely more than half as long and slightly tapers towards the tip, terminating, as above stated, with a very small chela, which, however, is only distinctly seen on applying a rather powerful magnifying power.

The 2nd pair of legs (figs 7 & 8) are, as in the other species of this genus, very unequal, the left leg (fig. 8) being much longer than the right (fig. 7), and, when fully extended, almost equalling half the length of the body (comp. Pl. IX, fig. 1). Both legs are extremely slender and flexible and but very sparingly setiferous, with the ischial joint onger than the meral one. The carpal joint is very much prolonged especially in the left leg, and is divided into numerous short articulations, amounting on the right leg to about 24, in the left leg to nearabout 50 in all. In the latter leg (fig. 8) also the adjacent part of the meral joint is divided into similar short articulations, which, however, are less distinctly defined. Both legs terminate with a well-defined hand composed of the propodal and dactylar joints, which together form a complete chela, with the digiti about the length of the palm. In the left leg (fig. 8) this hand is considerably smaller than in the right (fig. 7).

The 3 succeeding pairs of legs (fig. 9) are essentially of equal structure, and represent the true pereiopoda, or ambulatory legs. They are in this species much more slender and elongated than in our other indigenous forms, exceeding even, when fully extended, $^1/_3$ of the length of the body. Of the joints, the meral one is much the largest, equalling in length the 2 succeeding joints combined, and is connected with the comparatively short ischial joint by an oblique articulation. It is armed along the lower edge with several strong spines, and a single such spine is also found on the ischial joint below. The carpal joint is very movably articulated to the meral one, forming, as a rule, with it an abrupt geniculate bend (comp. Pl. IX, fig. 1). It is rather short, somewhat constricted at the base, and carries in its outer part scattered spines. The propodal joint is twice as long as the carpal one and linear in form, with several fascicles of short bristles in both edges. The dactylus, or terminal claw, is in the anterior of these pairs, (fig. 9, 9 a) very long and slender, falciform, with several secondary denticles in its proximal part. In the 2 posterior pairs the dactylus (see fig. 10) is considerably smaller and partly hidden by a dense fascicle of bristles issuing from the end of the propodal joint.

The gills are present in the same number as in *P. Montagui,* and may easily be examined, on removing the lateral parts of the carapace (see fig. 1). They are arranged on each side in a double series, both pleurobranchiæ and arthrobranchiæ being present, the former being by far the larger. The branchial formula is as follows:

	Mxpd.^{2}	Mxpd.^{3}	Leg^1	Leg^2	Leg^3	Leg^4	Leg^5
Podobranchiæ	1 + ep.	ep.	ep.	ep.	ep.	ep.	—
Arthrobranchiæ . . .	—	2	1	1	1	1	—
Pleurobranchiæ . . .	—	—	1	1	1	1	1

The 2nd arthrobranchia of the 3rd maxilliped may easily be overlooked, as it generally is hidden by the epipodite of the 2nd maxilliped. By dissection it is, however, proved that in reality 2 branchiæ of exactly same appearance are present at the base of these appendages (see fig. 5). As to structure, each gill, as usual, is composed of a double series of densely crowded delicate lamellæ issuing from a common median stem, and giving the gill a feather-like appearance. The pleurobranchiæ are the most fully developed, and gradually increase in size from before backwards; the arthrobranchiæ are considerably smaller, and of nearly equal size. At the base of the last pair of legs no arthrobranchiæ occurs, nor is any trace of epipodites to be detected in this pair of legs.

The pleopoda exhibit the structure usually met with in the Carida, being somewhat more strongly developed in the male than in the female. On the 1st pair the inner plate differs conspicuously in the two sexes. In the female it is (see fig. 12) very densely clothed with slender hair, and is drawn out at the tip to a conical naked lappet. In the male it is (see fig. 11) much less hairy, oblong oval in form, and provided with a small subapical lobule carrying the usual *retinacula*.

The uropoda, which together with the telson form the caudal fan (see Pl. IX, fig. 9), have the outer plate considerably larger than the inner and obliquely rounded at the tip, with the outer edge perfectly smooth and produced at the end to a short dentiform projection, inside which a slender spine is secured; otherwise the edge of this plate is densely fringed with setæ. The inner plate is oblong lanceolate in form and all round setiferous.

The telson (ibid.) is very slender, and projects somewhat beyond the uropoda. It is gradually narrowed in its outer part, and carries on each side, somewhat dorsally, a row of strong denticles varying in number from 7 to 10. The tip itself is slightly produced in the middle, and carries 4 spines, the outer 2 being considerably larger than the inner ones.

Colour. In the living state of the animal the body is semipellucid and of a more or less deep red colour. This colour, which is caused by numerous very small pigment-stars, is rather uniform, and there is no traces of the characteristic oblique lateral patches present in *P. Montagui*. The antennal flagellum, as in the latter species, is ornamented with alternate red and white bands, and the legs, like the other appendages, exhibit more irregular transverse patches of crimson. The eyes are of a very deep black colour.

Occurrence. This species occurs along the whole Norwegian coast, from the Christiania Fjord to Vadsø, in greater deeps varying from 60 to 400 fathoms. In some places, for instance at the Lofoten islands, in the Foldenfjord at Appelvær, in the Trondhjemsfjord and in the outer part of the Hardangerfjord, I have taken it rather plentifully; but as generally but an ordinary dredge was applied, young specimens were more frequently captured. In the Drammens-Fjord, a narrow, but rather deep branch of the Christiania-Fjord, these prawns have from old time been captured by the fishermen during the winter-months by the aid of very primitive implements, and as the fishing places are located at some distance inside the village Svelvik, they are generally known under the name of «Svelvik-ræker» (prawns from Svelvik). These prawns being nearly twice as large as the ordinary prawns (Leander sqvilla), and having a very delicate flavour, they have always been very much estimated; but the quantity at disposal has of course been much to small for satisfying the demands. It has been the general assumption among our zoologists, that these «Svelvik-prawns» are derived from a local stock restricted to the Drammens Fjord, and forming a remnant of the original arctic fauna prevailing off our whole coast at the glacial period, and that some particular physical and biological features in this Fjord might have favoured the continued existence of this stock until now. As only a very narrow and quite shallow stream connects the Drammens Fjord with the Christiania Fjord, an immigration from outwards was supposed to be but little probable. Now, however, we know, that the larvæ of this deep-water prawn lead a free pelagic existence, and in these early stages an immigration may be assumed easily to take place through the above-mentioned stream. The recent investigations instituted by Dr. Hjort by the aid of the trawl have indeed proved, that this form not only occurs very plentifully throughout the whole Christiania Fjord in greater deeps, but also in many other places of our southern coast. In one place especially, a comparatively small but deep bay, named Brevik Fjord, these prawns were found in such great abundance, that in the course of half a day several bushels could be brought up by the aid of the trawl. They occur here in a depth of about 60 fathoms on a muddy bottom, and at present a rather lucrative regular fishery of these prawns has been instituted here. It is very probable that also many other places of our coast will be found to be suitable for such a fishery. Especially will no doubt the deep Fjords of our western coast afford good fishing-grounds for these valuable prawns.

Distribution. Though occurring plentifully as far south as in Skagerak, this species ought undoubtedly to be regarded as an original arctic form. It was, as above stated, first described by Krøyer from Greenland, and has subsequently been found in many other places of the arctic sea: at Spitsbergen, Beeren Eyland, Franz Josephs Land, the Barents Sea, the Kara Sea, the Behring Sea, the Ochotian Sea. Its distribution accordingly seems to be circumpolar. On the other hand, has it never been met with at the British Islands, nor off the adjacent Atlantic coast of Europe.

Explanation of the Plates.

Pl. I.

Pandalus borealis, Kr.

1st larval stage.

Fig.

1. Youngest larva found, dorsal view; magnified about 30 diameters.
2. Same, lateral view.
3. Antennula, magnified 80 diam.
4. Antenna.
5. Oral area, exhibiting the anterior and posterior lips, together with the mandibles; ventral view.
6. Masticatory part of left mandible, more highly magnified.
7. Same part of right mandible.
8. Anterior maxilla × 115.
9. Posterior maxilla.
10. First maxilliped × 80.
11. Second maxilliped.
12. Third maxilliped.
13. Rudiment of 1st leg.
14. Posterior extremity of body, with the caudal plate, ventral view.

Pl. II.

Pandalus borealis, Kr.

2nd and 3rd larval stages.

Fig.

1. Larva in 2nd stage, dorsal view × 30.
2. Same, lateral view.
3. Same, 1st and 2nd legs in process of formation × 52.
4. Larva in 3rd stage, lateral view × 26.
5. Same, dorsal view.
6. Same, anterior extremity of body, with rostrum, eyes, and left antennula and antenna; dorsal view × 56.
7. Same, extremity of antennal scale, more highly magnified.
8. Same, posterior extremity of body, with the caudal fan.

Pl. III.

Pandalus borealis, Kr.

4th larval stage.

1. Dorsal view of the larva × 21.
2. Same, lateral view.
3. Anterior extremity of body (right eye and antenna omitted), dorsal view × 56.
4. Extremity of antennal scale, more highly magnified.
5. Posterior extremity of body, with the caudal fan (outer plate of right uropod omitted); dorsal view.

Pl. IV.

Pandalus borealis, Kr.

6th larval stage.

Fig.

1. Dorsal view of the larva in this stage × 20.
2. Same, lateral view.
3. Antennula × 40.
4. Antenna.
5. Postoral appendages of right side (except the 1st maxilliped), viewed from inner face (exopodites not fully drawn). mp^2, mp^3 the 2 posterior maxillipeds; p^1 — p^5 legs.
6. Posterior extremity of body, with telson and right uropod, dorsal view.

Pl. V.

Pandalus borealis, Kr.

Last 2 larval stages.

1. Larva in 7th stage, lateral view × 16.
2. Same, anterior extremity of body (left eye not drawn), dorsal view × 30.
3. Same, postoral appendages of right side, viewed from the outer face (lettering as in Pl. IV, fig. 5).
4. Same, a pleopod, strongly magnified.
5. Same, posterior extremity of body, with telson and left uropod, dorsal view.
6. Same, extremity of telson, more highly magnified.
7. Larva in 8th stage, lateral view × 12.

Fig.

8\. Same, pleopod of 1st pair.
8\. Same, pleopod of 2nd pair.

Pl. VI.

Pandalus borealis, Kr.

8th larval stage. Anatomy.

1\. Right antennula × 32.
5\. Right antenna (flagellum not fully drawn).
3\. Right mandible and masticatory part of left × 62.
4\. Anterior maxilla.
5\. Posterior maxilla.
6\. 1st maxilliped.
7\. 2nd maxilliped.
8\. 3rd maxilliped × 52.
9\. 1st leg (exopodite not fully drawn).
10\. 2nd leg. do.
11\. 3rd leg. do.
12\. 5th leg.
13\. (not numbered in the plate) Posterior extremity of body, with telson and right uropod (marginal setæ omitted), dorsal view.
14\. (do). Extremity of telson, more highly magnified.

Pl. VII.

Pandalus borealis, Kr.

1. Youngest postlarval stage observed, lateral view × 10.
2. Same, anterior part of carapace with the rostrum, viewed from left side × 20.
3. Same, extremity of telson.

Pandalus Montagui, Leach.

Fig.

4. 1st postlarval stage, lateral view × 12.
5. Same, anterior part of carapace with rostrum, viewed from right side × 20.
6. Same, anterior extremity of body, dorsal view.
7. Same, posterior extremity of body, with telson and right uropod, dorsal view.
8. Same, extrimety of telson, more highly magnified.
9. Same, postoral appendages of right side, viewed from the outer face (lettering as in Pl. IV fig. 5 and Pl. V, fig. 3).
10. Same, extremity of 1st leg, more highly magnified.
11. Same, extremity of 2nd leg.

Pl. VIII.

Pandalus Montagui, Leach.

1. Larva in the 5th stage, dorsal view × 20.
2. Same, postoral appendages of right side, viewed from the inner face.

Pandalus (Pandalina) brevirostris, Rathke.

3. Larva in 6th stage, dorsal view × 20.
4. Same, postoral appendages of right side, viewed from the inner face.

Pandalus (Dichelopandalus) Bonnieri, Caullery.

5. Larva in 7th stage, dorsal view × 16.

Fig.

6. Same, carapace from left side.

Pl. IX.

Pandalus borealis, Krøyer.
Adult form.

1. Ovigerous temale, viewed from left side, natural size.
2. Anterior part of carapace with rostrum of a somewhat younger specimen, lateral view.
3. Anterior extremity of a fully grown specimen (without the rostrum), dorsal view × 4.
4. Oral area from below, showing the anterior and posterior lips, the mandibles and the right anterior maxilla × 6.
5. Left mandible with palp.
6. Masticatory part of right mandible.
7. Mandibular palp isolated.
8. Anterior maxilla.
9. Posterior extremity of body, with telson and right uropod, dorsal view × 4.
10. Outer part of telson, more highly magnified.

Pl. X-

Pandalus borealis, Kr.
Adult form
(continüed).

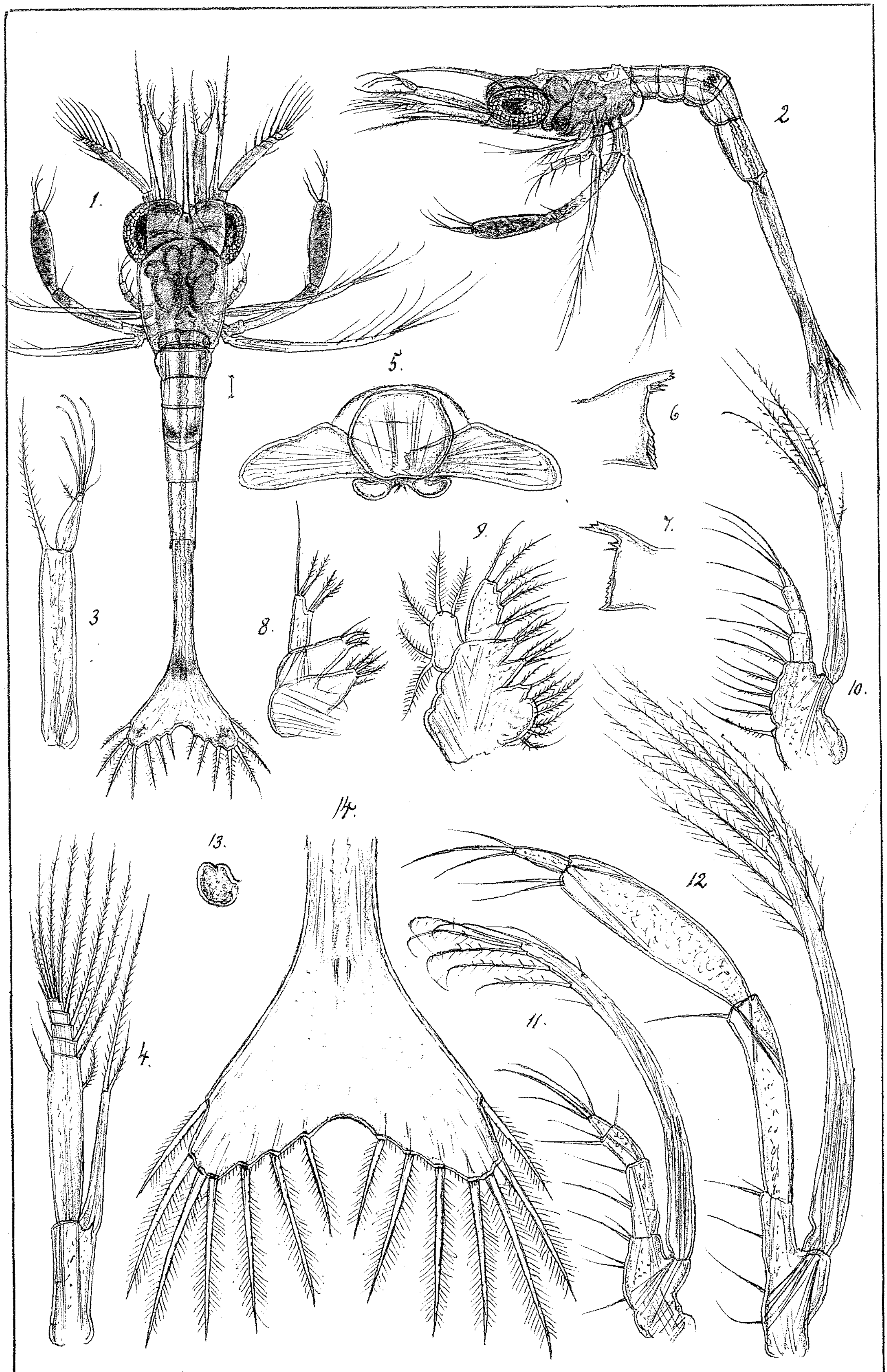
1. Left lateral face of mesosome, with the 2 anterior maxillipeds of same side and bases of the 3rd maxilliped and legs, showing the arrangement of the gills × 4.
2. Posterior maxilla × 8.
3. 1st maxilliped.

Fig.

4. 2nd maxilliped.
5. 3rd maxilliped × 4.
5 a. Extremity of same, more highly magnified, showing the small terminal joint.
6. 1st leg.
6 a. Extremity of same, more highly magnified, showing the small terminal chela.

Fig.

7. Right 2nd leg.
8. Left 2nd leg.
9. 3rd leg.
9 a Terminal claw of same, more highly magnified.
10. Extremity of 5th leg.
11. 1st pleopod of male.
12. Inner plate of 1st pleopod of female.



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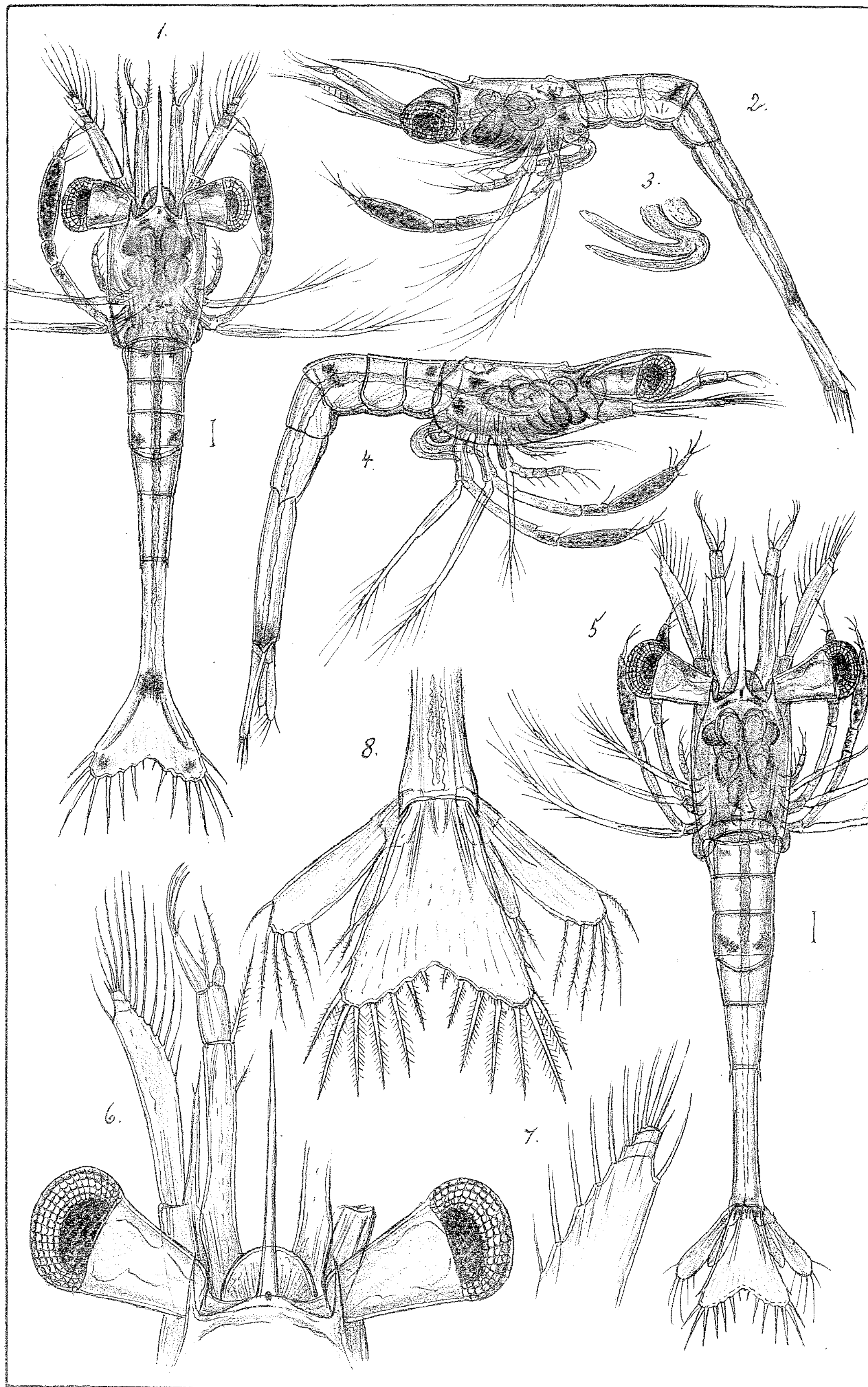

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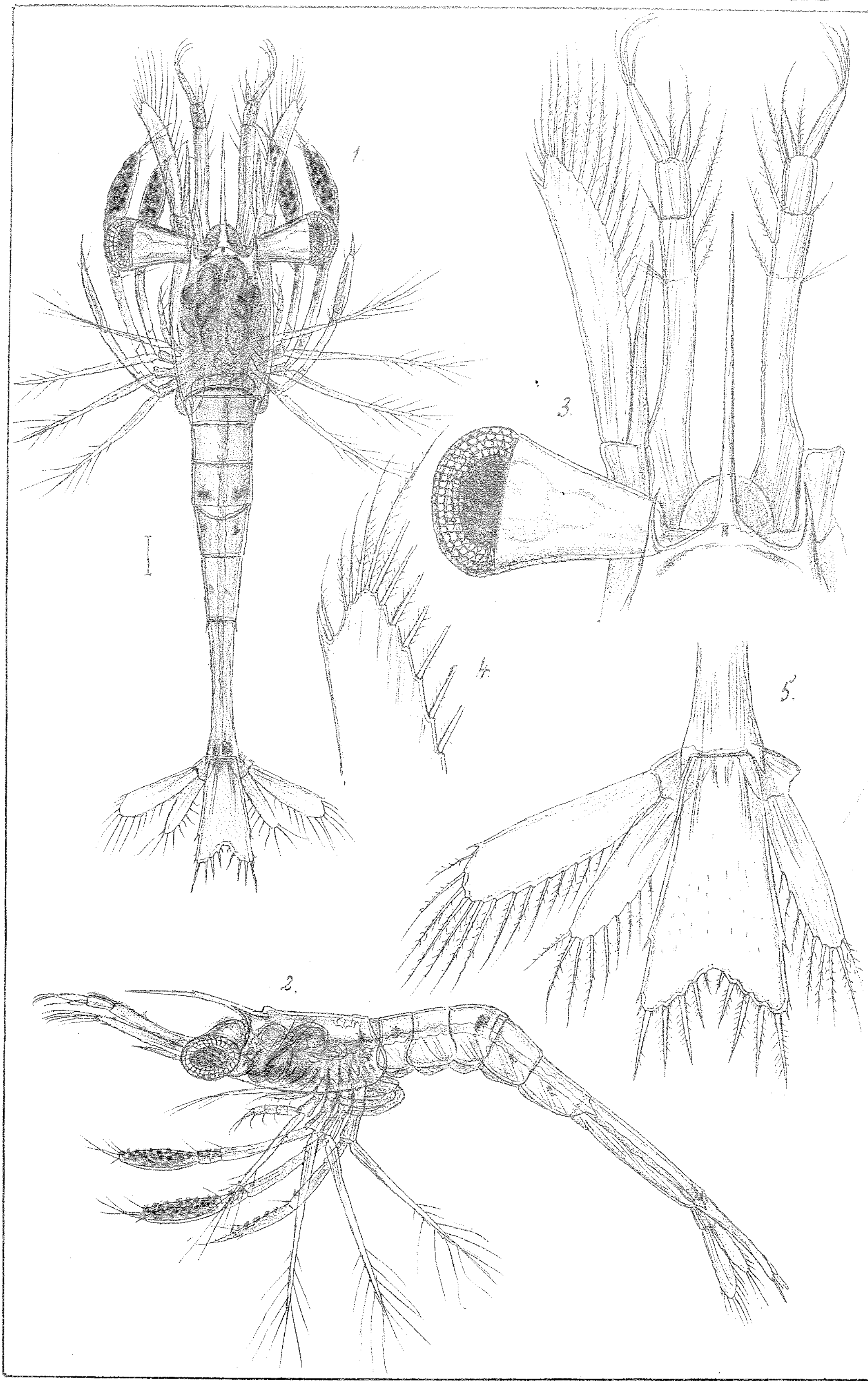

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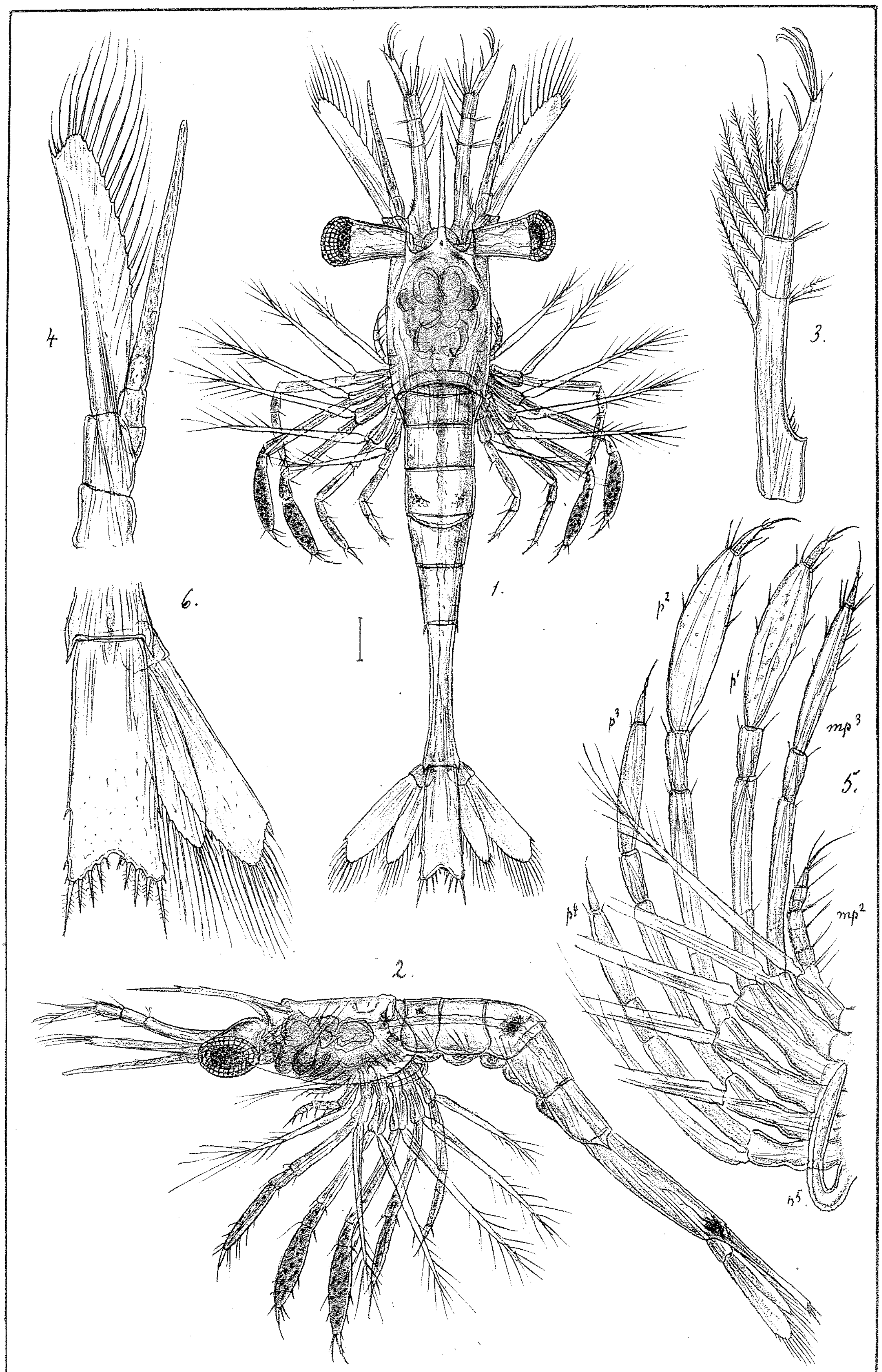

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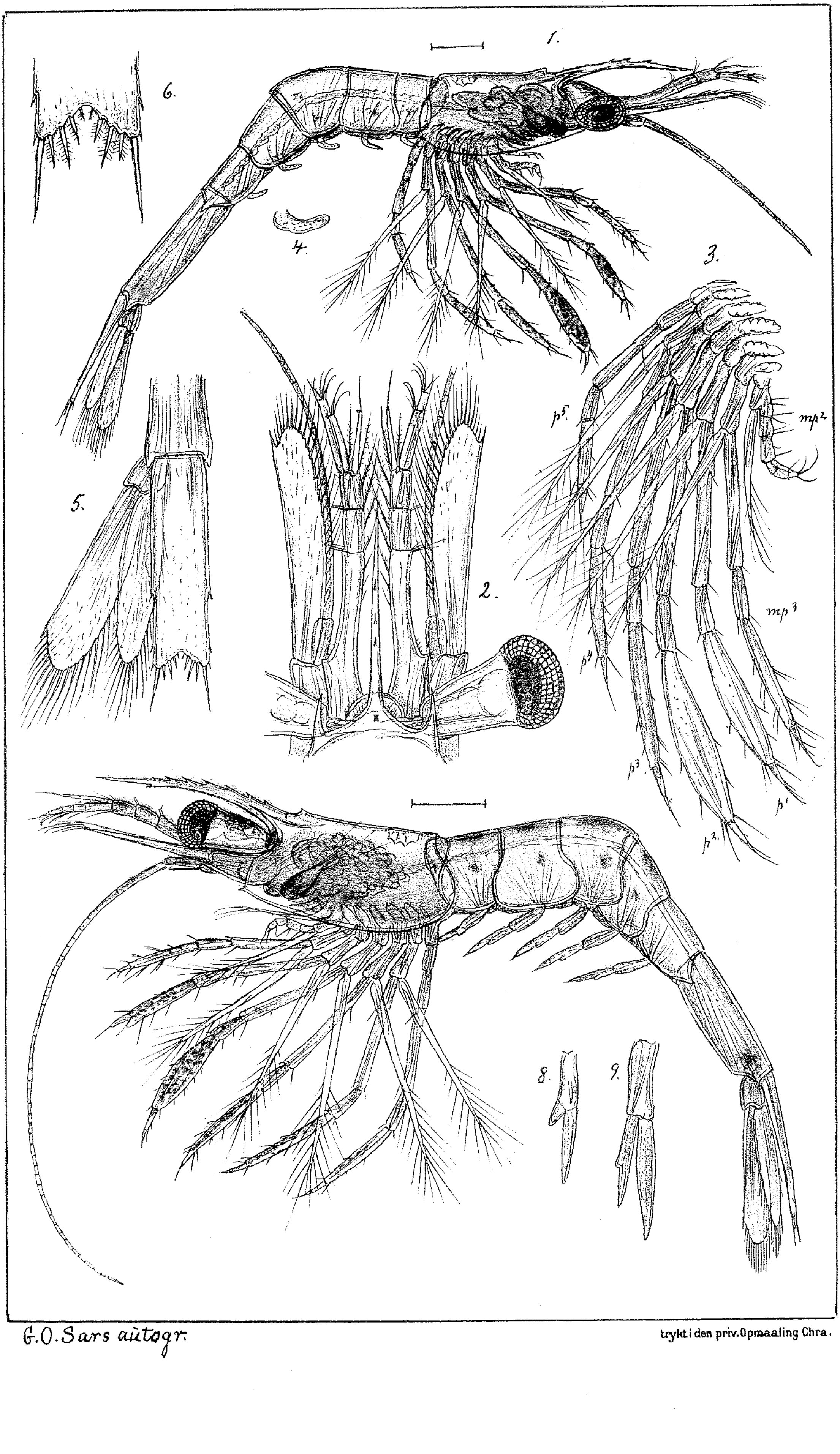

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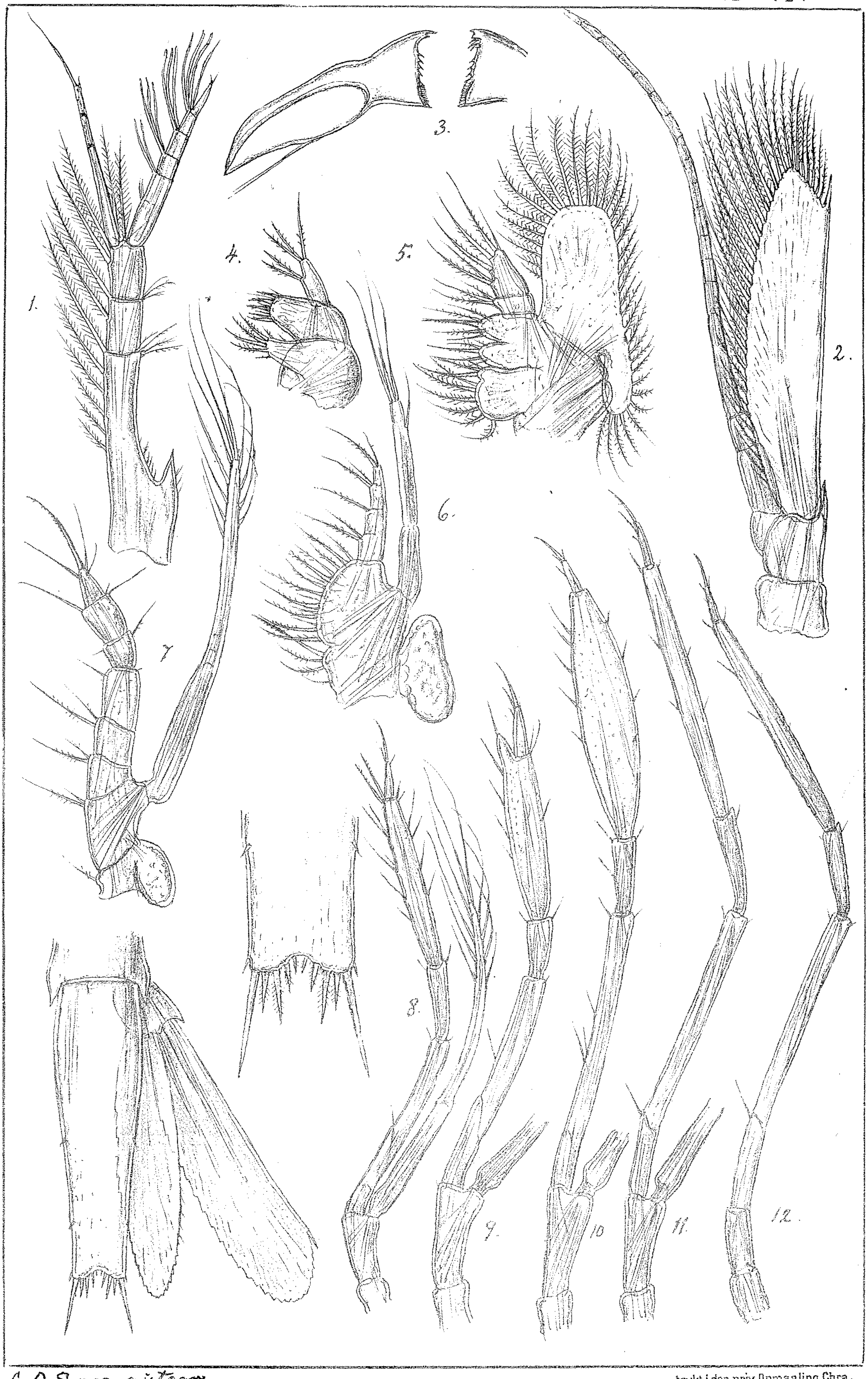

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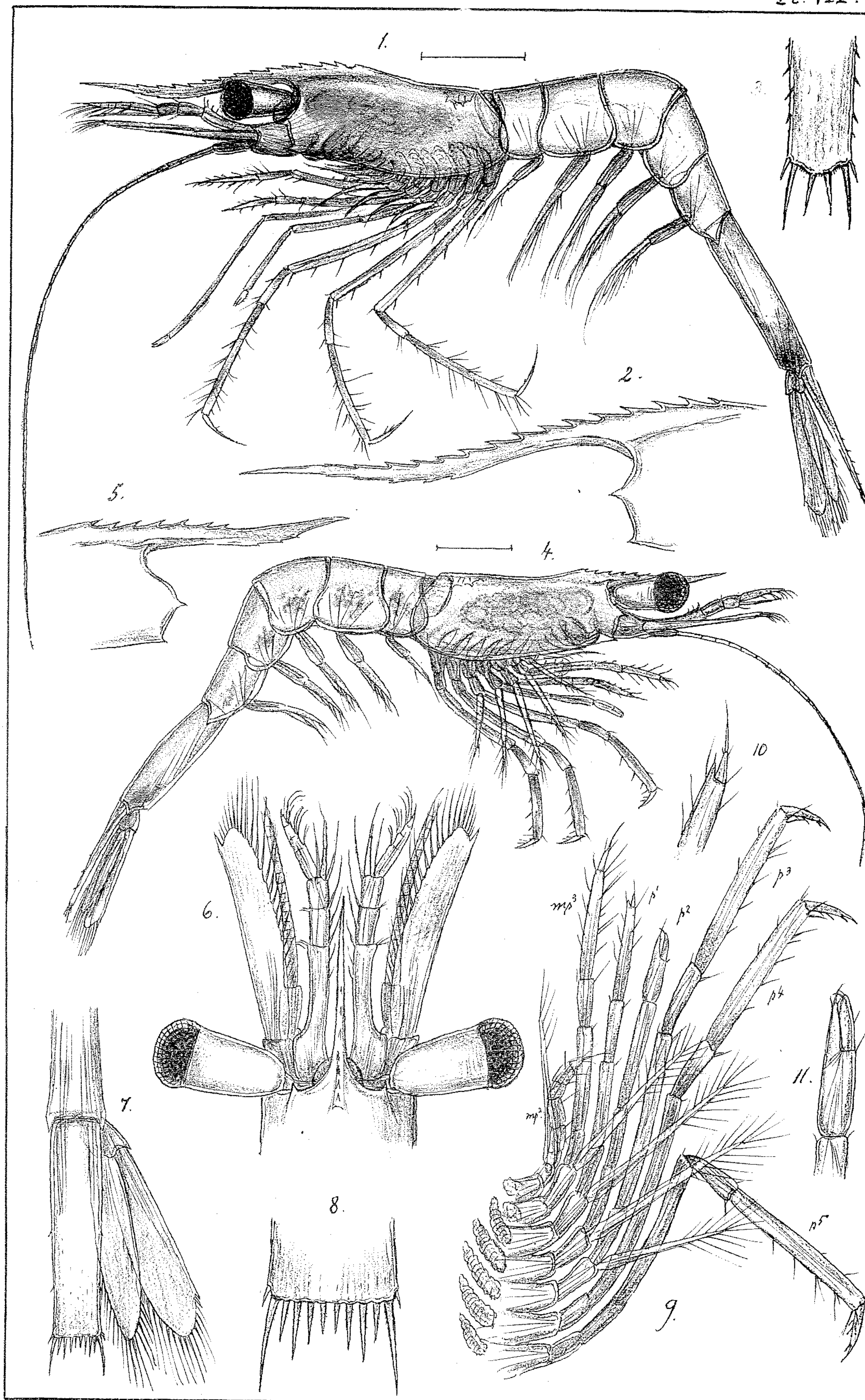

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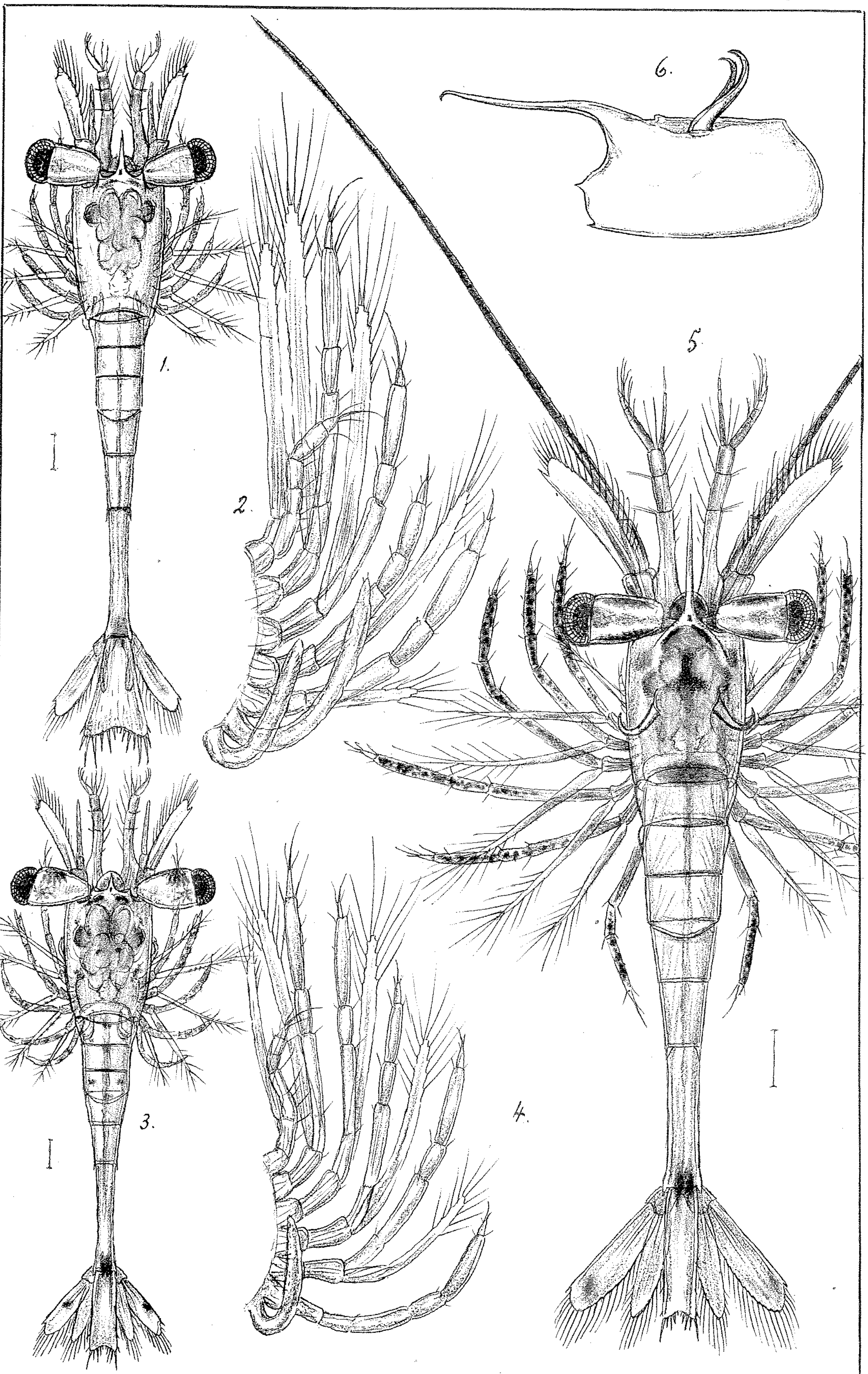

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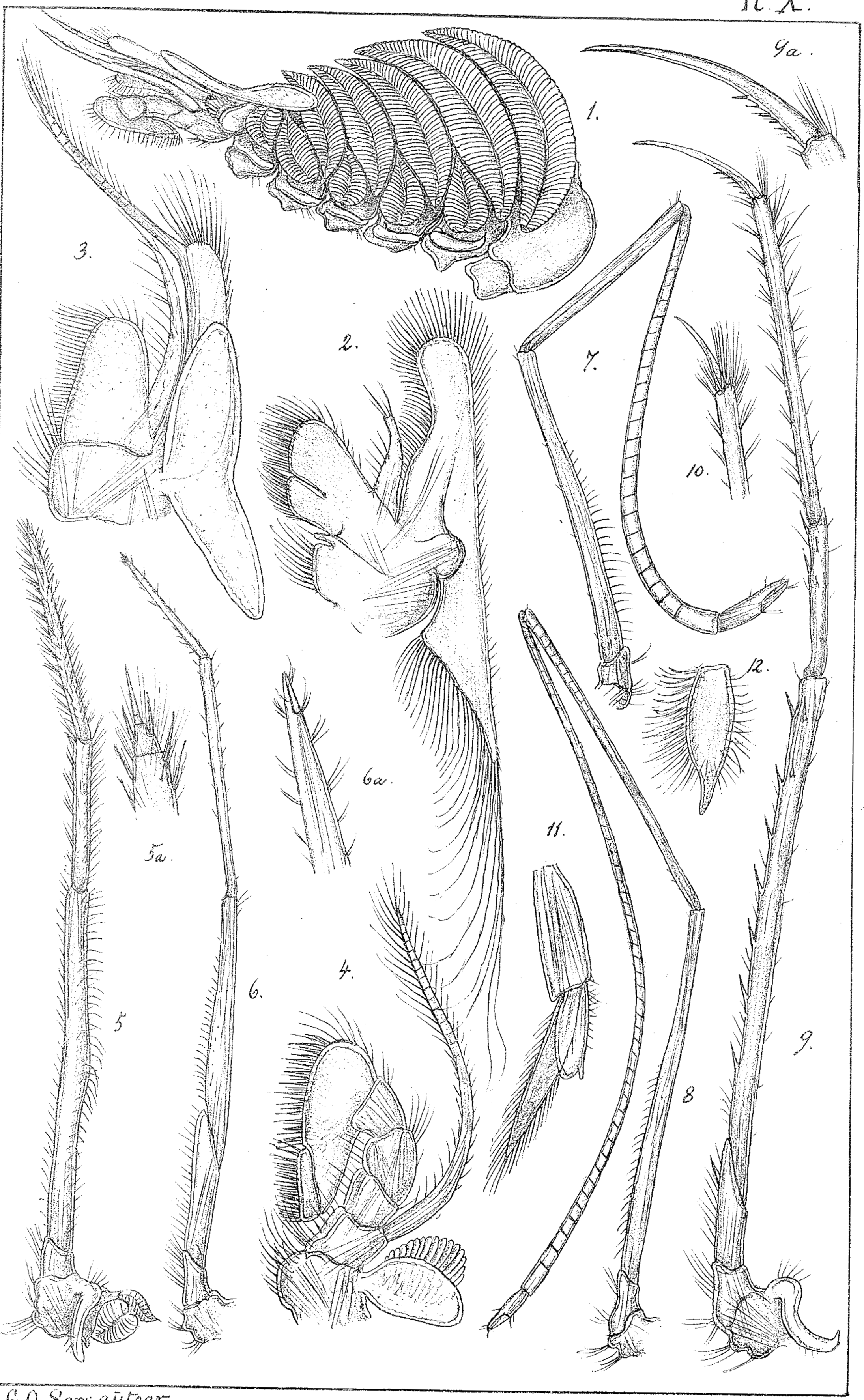

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