On some

Australian Cladocera,

raised from Dried Mud.

By

G. O. Sars.

With 8 Autographic Plates, coloured from Living Specimens.

(Christiania Videnskabs-Selskabs Forhandlinger 1885. No. 8).

Christiania.
I Commission hos Jacob Dybwad.
A. W. Brøggers Bogtrykkeri
1885.

On some Australian Cladocera, raised from Dried Mud.

By

G. O. Sars.

With 8 Autographic Plates, coloured from Living Specimens.

(Read at the Meeting held 30th January 1885. — Section for Mathematics and Natural Science).

Introduction.

Last winter I received, thanks to the kindness of the Norwegian traveller, Mr. Lumholtz, a considerable quantity of dried mud from a fresh-water lake in the tropical part of Australia. When requesting Mr. Lumholtz to forward me such material, it had been my intention to institute, during the spring and summer of the following year, a series of experiments, with a view to obtain the ova of Entomostraca, probably enclosed within the mud, artificially hatched, and thus become enabled to examine some of the entomostracous forms occurring in that remote tract of the globe.

As well known, a great number — perhaps all — of our indigenous freshwater Entomostraca, and more particularly the Cladocera, exhibit two essentially different modes of propagation, viz., the parthenogenetical and that generally observed in Crustacea — by means of fertilized ova. During the spring and fore-summer, our Cladocera are invariably found to bring forth egg-like germs, — the so-called summer-eggs, — which immediately, without the intervention of males, develop to new individuals, these propagating in like manner, and so on for numerous genera-

tions, whereas at a later period, and more particularly when the physical conditions of their habitat become less favourable, either from the evaporation of the water or a considerable fall in the temperature, true ova are finally produced, which have been fertilized by the males, and, besides being furnished with a strong egg-shell, in many cases become even enclosed within peculiar capsuliform envelopes, derived from the carapace of the parent individual. These ova, generally called winter-eggs, are thus enabled to retain their developing power even when completely dried up during a long period, or exposed to the severe cold of winter, as a rule not developing in our climate till the next spring.

I could not but assume, that a similar mode of propagation might also distinguish the fresh-water Entomostraca of Australia. There, it is true, occurs no cold winter season, but, on the other hand, a very marked and protracted period of drought, during which most of the ponds and ditches, constituting the habitat of numerous Entomostraca, dry up completely for a considerable time, until they finally again become filled with water during the heavy rain-fall that arrives at a later season of the year.

According to the statements of Mr. Lumholtz, the mud was taken from a rather large lake, called *Gracemere Lagoon*, situated at a distance of about 7 miles west of Rockhampton, in North Queensland. This lake measures in length somewhat more than a mile and in breadth half a mile, and has not anywhere a considerable depth. In 1856 the whole lake was entirely dried up, and continued so for the space of 9 months. During the rainy season the lake is supplied with water from an adjacent rill, which seldom wholly evaporates. The mud was collected at a depth of 5 and 10 feet beneath the surface of the water, at the commencement of March (or end of February) 1882, and immediately dried before being packed and forwarded.

On its arrival in Christiania, the mud resembled stone-like masses, of a dark greyish colour, with a crust of a somewhat lighter hue, and exhibiting numerous fissures and crevices coated with a ferruginous deposit. It was very hard and compact, so

as scarcely to admit of being broken except with a hammer. In water, on the other hand, it dissolved with comparative facility, the separate portions breaking up into numerous fragments and ultimately resolving into a finely dispersed muddy deposit, which at first gave to the water a very dark, cloudy appearance.

My first attempts to dissolve a portion of the mud in water at once convinced me, that it actually contained so-called winter-eggs of Cladocera; and more especially one kind of such ova, or rather their envelopes, was very frequently caught sight of and easily observed, by reason of their floating up to the surface on stirring about the mud. It was not difficult to recognize at a glance in these corpuscles the so-called ephippia of a species of *Daphnia*, each (see Pl. 1, figs. 1, 2) exhibiting the aspect of a diminutive pod, with two obliquely disposed receptacles for as many germs, or ova. Moreover, I could distinguish 4 other different kinds of ephippia, occurring however much more sparingly, one of which (fig. 11), like the aforesaid kind, with 2 egg-chambers, whereas the other 3 had a single chamber only. One of the latter (fig. 12) exhibited a form and structure readily determinable as the ephippium of a species of *Simocephalus;* the other two (fig. 13 & 14) I have found, by subsequent experiments in hatching, to be, respectively, the ephippia of a *Ceriodaphnia* and a *Moina*. Exclusive of the above-mentioned ephippia, occurred a considerable number of so-called statoblasts or winter-germs, of 2 different kinds of *Bryozoa*, one of which — apparently a *Plumatella* — was successfully hatched in the course of the summer.

In the beginning of May, when I thought the temperature was so far advanced as to admit of commencing the hatching operations, I portioned out some of the dried mud in small glass jars, pouring over it ordinary spring water. With a view to accelerate the hatching, I placed the jars, whenever possible, so as to expose them directly to the rays of the sun; but, owing to the situation of my laboratory, this was confined to a few hours only in the fore-noon. On examining from time to time the ephippia floating in the glass jars, I found in some

of them the ova in process of development; and, although the development certainly was very slow, on the 18th of May two small Daphniæ were successfully hatched in one of the jars, and moved about quickly in the water. They lived, however, but a few days, when they sunk to the bottom and died long before attaining their full growth. Thus, from the first series of my experiments, I succeeded only in tracing the development of the winter-eggs of a species of Daphnia, and in examining the earliest stage of the young of that form (se Pl. 1, fig. 10). The latter exhibited however an aspect so peculiar as at once to define them as a new and most interesting species.

The reason that precluded the experiments from being advantageously continued in the manner specified above, was found to be the water in the small jars becoming after some time putrid, thereby giving rise to an infinity of Bacterians, spreading over the surface like a thin film and thus preventing the necessary aëration of the water. With a view to prosecute my researches with greater certainty and more complete results, I found it indispensible to work with the aid of superior apparatus. In place of the small jars at first employed, I made choice of larger glasses and 3 quadrangular aquaries of different sizes, the largest of which had a length of nearly three feet by a breadth of one foot and a half. In this latter aquary I placed the greater quantity of the mud received, and in the others correspondingly smaller portions. Into all I poured a sufficient quantity of water, taking care that none of them should be more than half-full. Very soon, however, I found that even with this improvment putrification of the water, combined with a rapid development of Bacterians, could not be prevented, and of course it was absolutely necessary without delay to devise some remedy against this fatal detriment. By placing in the aquaries fresh-water Confervæ and other plants known to thrive in water, I felt sure of thus putting a quick stop to the progress of putrification; and, although the accidental introduction into my aquaries of ova of indigenous Entomostraca could hardly with absolute certainty be avoided, I had little fear this would cause any

serious impediment, possessing as I did an intimate knowledge of all our indigenous species. The favourable results of this method were soon apparent, the necessary aëration of the water being now effected, and thus any further development of Bacterians at once obviated.

But the difficulties attending my experiments were as yet however far from surmounted. Another quite unlooked for and most perplexing obstacle had next to be encountered, viz., the remarkably rapid increase of the Confervæ and other fresh-water plants introduced into my aquaries, pushing, as they did, their luxurious growth in all directions, and crowding up the sides of the aquaries, so as very shortly, it would seem, to choke up the water, and thus leave the aquaries wholly unfit to serve as a habitat for any species of Entomostraca. As a means of obviating this serious drawback, I placed in each of my aquaries a few specimens of our indigenous fresh-water snails (Limnæa), which soon were found eagerly to feed on the Confervæ, thrived exceedingly well, and ere long began to propagate, depositing their egg-cakes on the walls of the aquaries.

Thus, after much trouble I at length succeeded in arriving at what I deemed relatively favourable conditions for the breeding and subsequent development of Australian Cladocera, the ova of which were contained in the mud; and notwithstanding a great part of the ova had in all probability been destroyed in the course of my experiments, yet the final result must on the whole be regarded as comparatively successful, since I am now enabled to lay before the Society descriptions and figures of as many as 5 different species of Australian Cladocera, all of which have been carefully examined from living and full-grown specimens domesticated in my aquaries. Moreover, of Copepoda, a species of the genus *Diaptomus*, and of Ostracoda, a species of *Cypris*, have been successfully hatched, finally the forementioned fresh-water *Bryozoan*. The 3 last-named forms I purpose describing in a subsequent Memoir; here, I shall restrict myself to a detailed Report on the 5 species of Australian Cladocera, raised from the mud.

These forms exhibit a great interest, more especially from their perplexing resemblance to certain northern species of Cladocera. For not only do all of the 5 species belong to well-known northern genera, but most of them are even so closely allied to some of our indigenous forms, that I have found it a matter of no little difficulty to settle with full certainty their specific distinctness. This fact, indeed, is the more surprising, since the region whence they were derived, not only lies thousands of miles distant from our country, located, as it is, in the southern hemisphere, but is also in its climatological and biological relations totally dissimilar from any in our latitudes, both the fauna and flora exhibiting, as is well known, in that part of the globe, quite a peculiar character.

The facts detailed above force upon us the very difficult question, in what manner the distribution of these minute animals can be supposed to have taken place, and by what means it is still effected. Any possibility of a true active migration, such as might be assumed for the several marine forms, cannot of course be admitted as regards the animals in question; and moreover, as a great part of the Cladocera are confined to small stagnant ponds and ditches, with no direct connexion whatever, even a passive distribution, by the aid of rivers or streams, may to a great extent be precluded. To explain the distribution of such forms, zoologists have assumed, that the ova in the ponds having dried up during the summer season, might possibly in some cases be carried abroad to some distance by the wind along with the finely crumbling mud. Such may, indeed, very often occur; and, considering the tenacious germinative power of the winter-eggs and the rapid reproduction of the individuals during the spring and fore part of the summer, a partial dissemination of the species may very reasonably be assumed to take place in this manner. But, on the other hand, I opine that the very extensive range of geographical distribution characterizing certain species of Cladocera, as shown by later investigations, is not sufficiently explained by such an assumption. It has long been known, that at least throughout northern and middle Europe the

Cladoceran Fauna is quite uniform; and of late years it has, too, been clearly shown by the investigations of Sign. Pavesi, that even the Cladocera of Italy are represented by precisely the same species as those occurring in Norway and existing under conditions in every respect similar, some of them being restricted to small ponds, whereas other forms are met with in lakes, swarming in the middle water and thus presenting a counterpart to the so-called pelagic animals of the Ocean. To afford a sufficient explanation of so wide and extraordinary distribution of fresh-water species, we must, I think, admit the accidental transmission of winter-eggs, by the aid of migratory birds of the orders Grallatores and Natatores, essential importance. Considering the great facility with which eggs of Entomostraca will adhere to the feet of such birds along with some portion of mud from the ponds or lakes they frequented immediately previous to commencing their long migratory flight, we may in truth be fully entitled to admit the great probability of such transmission of ova from far-off tracts. Now, we meet in all parts of the world — let alone stationary birds — with such that undertake at least short flight of passage; and hence it should seem not altogether improbable, that at times there is, or has been, a certain continuity between the faunas of Cladocera even in two localities so widely distant as Norway and the tropical part of Australia, though at present, in all probability, none of the species occurring in the latter region can, in a strict sense, be specifically indentified with any Norwegian forms.

As is well known, our acquaintance with the Cladocera has been almost exclusively derived from investigations instituted in Europe; whereas the contributions to the natural history of these interesting little Crustaceans yielded from other quarters of the globe[1] are for the most part both very scant and the

[1] As regards the Cladocera of Australia, some notices have been published by Mr. King in the Proceedings of the Roy. Society of Van Diemensland for 1853, on the species occurring in New South Wales. I do not myself know this Memoir except from an abstract given by Schoedeler in his paper: „Zur Naturgeschichte der Daphniden" (1877), in which also some of the figures

descriptions and figures given so imperfect as not to admit of any satisfactory definition of the species. The method here adopted, viz., that of raising the forms artificially in aquaries from dried mud, does, I certainly think, give promise to extend in a most essential degree our knowledge of the exotic fresh-water Entomostraca; and I hope to be still enabled to prosecute these investigations, which for a zoologist are connected with peculiar interest and delight, and may perchance lead to important biological results.

---

given by Mr. King have been reproduced. None of the species however, are apparently identical with those examined by myself, a fact to be accounted for perhaps from their having been collected in small ponds only, whereas the species described in the sequel are derived from mud taken from a comparatively large lake, lying, moreover, in a wholly different region of Australia.

I.

On the Structure of the Ephippia and the Development of the Ephippial Eggs in Daphnia Lumholtzii, n. sp.

(Pl. 1, figs. 1—10).

It has been mentioned above, that one kind of ephippia occurred in great numbers in the Australian mud, and that these ephippia could at once be recognized as belonging to a peculiar species of Daphnia, subsequently domesticated with success in my aquaries. This species, which I have named after the Norwegian traveller, Mr. Lumholtz, whose kindness enabled me to prosecute these investigations, will further on be described in detail. Here, I purpose merely describing the structure of the ephippia of the species together with the development of the so-called winter-eggs, having found that former investigations do not give satisfactory information concerning these points in the natural history of the Cladocera.

The ephippia of the present Australian Daphnia differ in certain respects not a little from those of most of our indigenous species. In but one species, *Daphnia magna* Strauss, do we meet with a similar arrangement of the two ova contained in the ephippium, their ampullæ having an obliquely transversal position to the axis of the ephippium. The size of the ephippia found in the mud was somewhat variable, the length of the valves measuring from 1,00 mm to 1,50 mm. In a lateral aspect (Pl. 1, fig. 1), they exhibit an oblong-oval, or rather irregular-quadrilateral form, the dorsal side being the longer and the two opposite angles rounded off. Along the dorsal edge occurs a

highly chitinized corneous rod, constituting the hinge of the ephippium, and posteriorly projecting as a short mucroniform spine, anteriorly as two rather narrow and slightly curved riband-shaped processes, diverging a little at their extremities. This rod, moreover, is armed, throughout its entire length, with a double row of small, posteriorly directed denticles, those at the end of the anterior processes assuming the shape of recurved hooks, by means of which the ephippium readily affixes itself to extraneous objects. Viewed from above (fig. 2), the ephippium is found to be strongly compressed and, as it were, constricted in the middle. The two valves of the ephippium fit close together round the edges, and exhibit, each of them, two succeeding umboniform prominences, placed obliquely to the longitudinal axis of the ephippium, so as to be nearly parallel to the posterior margin. These prominences indicate the chambers, in which the ova are lodged. The colour of the ephippia, except the corneous hinge, was a uniform dirty grey, much the same as that of the mud in which they lay imbedded.

With two fine needles it is not very difficult to open the valves from the ventral side, especially when the ephippium has been for some time immersed in water. This effected, another capsule (fig. 4) is found to lie within the ephippium, connected but loosely therewith and exhibiting a somewhat elliptic form. The structure of this internal capsule is very delicate, forming, as it does, a soft and flexible envelope for the ova, and, moreover, projecting at its periphery to a thin rim, developed most along the ventral face. Also this inner capsule is composed of two symmetrical valves fitting close together round the periphery, and in the centre lie imbedded the two ova, side by side, in two corresponding chambers (see fig. 3), much as seed in the pod.

As regards the microscopical structure of the ephippium, it exhibits everywhere, saving the dorsal rod, or hinge, an exceedingly dense net-work of minute polygonal cells, that easily become filled with air and thus contribute in buoying up the ephippium on the surface of the water. These cell-like cavities are

much more numerous in the outer capsule, lying crowded together in several layers, whereas in the inner capsule (see fig. 5) only a single layer of considerably larger cells can be observed.

The ova contained in the ephippia (see figs. 3, 6) are of a regular oblongo-ovate form, and measure 0,03 mm in length. They exhibit a very strong, but elastic and perfectly translucent, egg-shell (chorion), quite structureless and of a smooth and lustrous appearance, conspicuously contrasting with the dull aspect of the surrounding parts (see fig. 3). The yolk-mass is of a light bluish green, and throughout uniformly and finely granulous without exhibiting any distinct oil-globules, as is the case in the so-called summer-eggs.

Respecting the formation and further development of the embryo, no essential difference from that known in the summer-germs can be detected, as appears on comparing the figures (6 – 9) here annexed. Nevertheless, a very marked peculiarity in the development of the winter-eggs may be stated, viz., the fact that the chorion, or egg-shell, is retained during the whole embryonal development, while in the summer-germs, as is well known, the exceedingly thin egg-membrane very soon, and long before the embryo has attained its full development, is cast off and found in the „matrix" or incubatory cavity, of the parent animal, along with the embryos, as minute, curly cuticles.

During the progress of development the ova increase rapidly in volume, attaining in the last stage (fig. 9) almost double their original size. Owing to this increase, the valves of the ephippium, together with those of the inner capsule, become gradually forced apart, opening along the ventral side, so as to expose a part of the enclosed ova. I have often found the development to proceed unequally in the two eggs, and, when such is the case, the ephippium assumes a somewhat irregular form, appearing much more tumid at the one extremity (generally the hinder) than at the other. When the embryo has attained its full development, the egg-shell becomes very thin and finally bursts, whereupon the embryo drops off into the water through the widely gaping valves of the ephippium, generally with

the head forward. It still, however, continues enveloped in a thin embryonal cuticle, within which not only lie all the bristles of the limbs, but also the large frontal process, so characteristic of the present species, this process being folded back along the ventral margin of the head, thus giving the frontal part in this stage (see Pl. 1, fig. 9; Pl. 4, fig. 1) an evenly rounded contour, as in the ordinary species of Daphnia. Moreover, the large spine, jutting forth posteriorly from the carapace, lies at first folded up along the ventral face of the body, the latter exhibiting, too, a well-marked embryonal curvature. Very soon, however, after birth this embryonal cuticle is cast off; the body then exserts itself, and the young Daphnia at once appears (see Pl. 1, fig. 10), with the habitus so characteristic of the present species, moving quickly about in the water by the aid of its natatory antennæ.

II.

Description of the Species, with Observations on Vital Phenomena.

Family: — *Sididæ.*

1. *Diaphanosoma excisum*, n. sp.

(Pl. 2).

Specific Character. — Female: — General form of body very similar to that in D. brachyurum. Head obtusely truncate anteriorly, without any distinct sinus beneath the eye; dorsal margin faintly arched. Carapace oblong, truncate posteriorly, with upper angle almost a right one, valves inflected in the middle and wide-open posteriorly, having a well-marked angular emargination at the junction of the ventral and posterior margins. Eye comparatively large, with a light, brownish pigment. Antennæ, when reflexed, not reaching posterior margin of carapace. Tail of usual structure, caudal setæ exceedingly elongate. Body highly pellucid, with a faint yellowish tinge. Length of full-grown female reaching 1,30 mm.

Remarks. — This Australian species exhibits in its general habitus a very striking resemblance to the well-known northern form, *D. brachyurum*, Liévin, but has also a certain affinity to the closely allied species, *D. brandtianum*, Fischer, and would seem, as it were, to occupy an intermediate rank between the two. From both, however, it may be readily distinguished by the peculiar angular emargination of the valves posteriorly, a cha-

racter not found in either of the northern species, and which therefore gave rise to the specific denomination. A fourth species of the genus, *D. angustum*, has been described by Dana, but the description and figures are so imperfect as to preclude any concise definition of the specific characters.

Description of the Female. — The form of the body (see Pl. 2, figs. 1, 2), as in the other known species, rather elongate, with the height and breadth about equal.

The head, occupying about $^1/_8$ of the total length, is comparatively narrow and, as usual, without the slightest trace of either rostrum or fornix. It is marked off from the carapace by a distinct dorsal impression, at the bottom of which a transversal suture passes to either side, joining the upper end of the mandibles. Viewed from the side (see fig. 2), the head exhibits a somewhat oblongo-quadrilateral form, being obtusely truncate anteriorly and having the dorsal margin slightly arched, whereas the ventral appears almost straight, with but a very slight convexity in the middle, and not presenting a trace of the frontal sinus immediately beneath the eye, so distinctly marked in D. brachyurum. In a dorsal or ventral aspect (see fig. 1) the head appears obtusely conic, with the front part rounded off.

The so-called shell, or more properly the carapace, exhibits a form very similar to that in the two northern species, being oblong-oval and abruptly truncate posteriorly, with the upper angle somewhat projecting and well-nigh a right one, whereas the lower is obsolete. It appears more or less tumid, and exhibits a varying dorsal convexity, according to the number of ova, or embryos, contained within the incubatory cavity, or matrix; when these are very numerous, a slight sinus is formed immediately in front of the postero-superior angle by the bulging out of the dorsal face. The free parts of the carapace, or valves, occur comparatively small and narrow, being deeply emarginate anteriorly, and thus leave all of the oral appendages uncovered. Seen in a lateral aspect (see fig. 2), their ventral margins appear almost straight, forming at the antero-lateral corners a sharp curve, whereas at their junction with

the obliquely curved posterior margins, a slight angular projection occurs. Viewed from below (fig. 1), the valves appear strongly inflected along the ventral side, and provided at their edges with long and delicate, inward bending bristles. At the point, too, where, in a lateral aspect, the fore-mentioned angular projection occurs, is observed a very conspicuous emargination, causing the valves to be wide open in the posterior part, even should their ventral parts be closely pressed together. The posterior edges of the valves are armed in their inferior part (see fig. 4) with a few strong denticles, succeeded by a very delicate ciliation, which, however, disappears at about the middle of their length.

No sculpture whatever, neither on the carapace nor on the shell of the head.

The eye, placed in the frontal portion of the head, close to its lower face, is comparatively large, and furnished with numerous crystalline cones, forming a clear zone round the light, brownish pigment. No trace of any ocular spot, or ocellus, can be detected.

The antennulæ do not exhibit any difference from those in our northern species.

The antennæ are, as usual, very powerfully developed, though not of quite so remarkable a size as in D. brachyurum. When reflexed (see fig. 2), they do not reach the posterior margin of the carapace, but for the rest fully agree in structure, as also in the number and arrangement of the natatory setæ, with our Northern forms.

In regard to the oral parts and the branchial legs, those organs would seem to be of precisely the same structure as in the other known species.

Also the terminal portion of the body, or tail (see fig. 3), has a very similar form, being exceedingly short and conically tapered, without any trace of anal denticles, whereas the apical claws are very strong and armed at the base with 3 secondary teeth. The caudal process is oblongo-mamilliform, and the two

setæ originating thence exceedingly elongate, well-nigh equalling the whole carapace in length.

The so-called shell-gland, and the several internal organs, bear so close a resemblance to those parts in our 2 Northern species as hardly to need a detailed description.

As regards colour, the whole body is highly transparent, almost hyaline, exhibiting in large specimens only a faint yellowish or greenish tinge. The summer-eggs, when just deposited in the matrix, are oblong in form, and exhibit a rather vivid yellowish yolk-mass, in the centre of which a single, very small, and hyaline oil-globule lies imbedded. During the progress of development, the colour of the eggs fades away, the yolk-mass becoming gradually absorbed; and finally, a minute residue only is found in the anterior part of the embryo.

Observations. — The movements of the animal, as observed in my aquaries, would seem on the whole to agree with those of our indigenous species. The specific weight of the body being nearly that of the water, it very often happens, that the animal will keep itself for some time in about the same place, with its antennæ immovably extended on either side, balancing the body, so as to retain it suspended in the same position. On closer examination, with the aid of a hand-lens, the branchial legs are found to move during this apparent inactivity in a rapid and rythmical manner, this movement serving however, as is well known, merely for respiration and procuring food. If the animal is disturbed or would change its place, locomotion is effected by a few strong propelling strokes of the antennæ, nay even one such stroke, causing it to pass through the water with as many sudden jerks, mostly in different directions. These movements are so rapid as to make it a matter of no little difficulty to catch the animal with an ordinary dipping-tube. But after a short interval, the animal invariably again assumes its former quiescent position. On the whole, its movements would seem to be somewhat irregular and abrupt, more so apparently than are those of our Northern species.

When placed under the microscope in a small quantity of

water, the animal at first invariably presents itself to the observer either in a dorsal or ventral aspect, the strongly diverging antennæ preventing its turning in a lateral position. Not till the antennæ are reflexed or forced back along the sides of the carapace, — a movement, as a rule, performed by the animal after some time spontaneously — is it possible to turn the body over, and thus obtain a lateral view. Often, however, it will soon suddenly again extend its antennæ, and thus instantly reassume its original position. Moreover, when under the microscope, the animal curves, as a rule, the free part of its body strongly downward, so as to force it out from the valves, the eye being then often forcibly retracted from the frontal margin. But after a while it generally stops its exertions, remaining quite immobile, and thus admits of being accurately figured with the aid of a camera lucida while still living, any special means for restricting possible movements being superfluous.

The first specimen of this form appeared in one of my aquaries on the 30th of June, but, at that time, was so very small as to be hardly visible except with the aid of a strong magnifier. Subsequently, several other specimens developed in the same aquary, and about the middle of July most of the specimens were full-grown and provided with numerous summer-eggs and embryos. At this time, however, I was obliged to break off my observations, having to leave Christiania on a scientific excursion. On my return, late in September, I found this form to have entirely disappeared in the said aquary, its place being taken up by large shoals of another Australian Cladoceran, *Daphnia Lumholtzii*, of which I had observed a few young examples only before proceeding on my excursion. On the other hand, some few specimens of the same *Diaphanosoma* had appeared in the largest of my aquaries, along with the *Moina* to be described in the sequel. But these specimens were of rather inferior size, with but few (rarely more than two) eggs, or embryos, in the matrix. In some of them, also, an incipient production of winter-eggs could be detected; and hence, in all probability, male individuals had now likewise become developed. Meanwhile, I did not succeed

in taking any of the diminutive males, and as, after a few days, from some unknown cause, a sudden mortality occurred in this aquary, affecting all the Cladocera therein, every chance of securing the male of this species for examination was lost.

True, I have not been able to find in the mud sent me winter-eggs of the fore-described form — a fact easily accounted for by their not being enclosed within any true ephippium; — but as to this species having been veritably raised from the mud, I can testify from another observation, detecting, as I did, easily determinable remains (antennæ and parts of the carapace) of the same form in the ventricles of certain small fresh-water fishes caught in the lake from which the mud was derived, and kindly forwarded to our University Museum by Mr. Lumholtz.

Family: — *Daphnidæ.*

2. *Daphnia Lumholtzii*, n. sp.

(Pl. 1, figs. 1—10, Pl. 3, 4).

Specific Character. — Female: — Head defined from carapace by a distinct dorsal impression, and jutting out anteriorly as a very large lanceolate prolation pointing obliquely downward (in some cases however much reduced in size); frontal margin straight or slightly arched; rostrum distinctly projecting; fornix very prominent and exserted on either side to an acute spiniform point. Carapace (lateral aspect) broadly oval, free edges of valves evenly curved, and armed with unusually elongate and distant denticles. Spine of carapace exceedingly strong and elongate, pointing obliquely upward. Eye rather large, with numerous refracting corpuscles; ocular spot exceedingly minute. Antennulæ small, but distinctly projecting. Tail with terminal part gradually tapering, dorsal margin almost straight and armed with comparatively small and well-nigh uniform denticles; apical claws without any secondary teeth at base. Ephippium having the hinge produced both anteriorly and posteriorly, and with obliquely disposed ampullæ.

Male: — Head somewhat depressed, not prolonged anteri-

orly, front obtusely rounded, rostrum wanting. Carapace oblong, with ventral margins incurved and densely hispid, antero-lateral corners projecting. Spine of carapace comparatively short. Antennulæ greatly produced, with peduncle and flagellum uniform in length. Tail without any dorsal process, anal margin slightly incurved and with very few denticles.

Body in both sexes rather pellucid, having merely a faint greenish tinge. Length of female (including spine) reaching 3,90 mm, of male 1,60 mm.

Remarks. — This would seem to be the most striking form among the Cladocera raised from the mud, and may easily be distinguished from all other known Daphniæ by the prodigiously developed lanceolate prolongation of the head, the peculiar shape of the fornix, the distinct dorsal impression between head and carapace, and the remarkably long and distant marginal denticles of the valves. Moreover, as shown above, the ephippium differs somewhat in form from that in most other Daphniæ.

Description of the Female. — The total length of the largest specimens examined was 3,90 mm, the spine of the carapace measuring 1,65 mm; hence the species somewhat exceeds in size the larger form of our common *D. longispina*, Müller.

The general form of the body (see Pl. 3, figs. 1, 2) is somewhat compressed, the greatest breadth scarcely exceeding half the height.

The head, unlike what occurs in the known species of this genus, is well defined from the carapace by a distinct dorsal impression. In a lateral aspect (see fig. 1), it exhibits a somewhat triangular form, the top of the triangle being drawn out to a very large spear-shaped prolation, pointing a trifle downward. The dorsal margin of the head is gently arched posteriorly, whereas it anteriorly becomes almost straight, adjoining without any interruption the upper edge of the frontal prolation. The ventral margin of the head, on the other hand, forms, along with the lower edge of the prolation, a distinct sinus, and is very slightly arched, running out posteriorly as an acute-angled projection — the so-called rostrum. The fornix occurs very prominent

in its posterior part (see fig. 2), forming, as it were, a triangular shield, arching over the bases of the antennæ; moreover, it is drawn out on either side to a sharp and freely projecting spiniform point, jutting almost at right angles to the axis of the body.

The carapace, as viewed from the side (see fig. 1), exhibits a broadly oval form, with the dorsal margin more or less arched — according to the number of eggs, or embryos, in the matrix — and the free edges of the valves forming an even curve throughout. At the junction between the two posteriorly, projects the very strong spine of the carapace, pointing invariably somewhat obliquely upward, even should the matrix be greatly distended with eggs, or embryos. Generally, it equals in length the whole of the carapace, and is, as usual, armed with 4 rows of small appressed denticles, the two upper continuing along the dorsal edge of the carapace well-nigh as far as the dorsal impression. The free edges of the valves are in the most anterior part quite smooth, but, for the rest, armed with a series of from 16 to 20 unusually slender and distant denticles, largest in the middle and diminishing a trifle in length both forwards and backwards.

As to the sculpture of the shell, it appears very faint and difficult to detect, but would seem to resemble that in other Daphniæ, two systems of delicate striæ crossing each other at equal intervals and thus forming a very close and regular network. The shell-gland is easy to examine and of the usual structure, constituting an S-shaped assemblage of canals in the anterior part of the valves.

The eye occurs comparatively large and provided with numerous refracting corpuscles, from 8 to 10 of which project at the periphery from the edges of the black pigment. The ocular spot, or ocellus, on the other hand, is exceedingly small, so as to be easily overlooked.

The antennulæ are, as in other female Daphniæ, very small and quite immobile, though in this species distinctly projecting with their extremities from a small rounded prominence just

behind the rostrum. They are provided at the apex with a bunch of minute, clear, sensory papillæ, besides a single delicate bristle.

The antennæ agree in all essential characters with those of other Daphniæ, being comparatively feeble in structure. The natatory setæ are rather elongate, and have no pigmentary spot at the base of the terminal joint.

The oral parts and the branchial legs would not seem to exhibit any marked difference from what is known to characterize other species of the genus.

The tail (fig. 3) is provided with 4 well-marked dorsal processes, the two anterior of which are very large and not connate at the base. The terminal section tapers evenly toward the apex, the dorsal margin being almost straight. The anal denticles, about 12 on either side, occur comparatively small and well-nigh uniform in size. The apical claws are gently curved, and do not exhibit the slightest trace of secondary teeth at the base, whereas a very delicate ciliation may be traced along their sides well-nigh to the tip. The caudal setæ are rather short and of the usual structure.

The inner organs, which, in the living animal, admit of being traced with great distinctness through the transparent integuments, would seem to agree in all essential characters with those of other Daphniæ. The arrangement of the dorsal muscles moving the antennæ, is almost precisely as in *D. magna* Strauss, and somewhat dissimilar from that in other species of the genus, the median being quite narrow and placed in close approximation to the posterior muscle.

The eggs, when recently deposited in the matrix from the ovaries (see fig. 1), are almost globular in shape and furnished with a large central oil-globule, of a light, yellowish colour; the yolk-mass is of a clear bluish-green.

The above-given description has been worked up from individuals domesticated in my aquaries during the summer-months.

No essential difference in the general habitus could in any case be detected on comparing the specimens of these generations. On returning from my excursion at the end of September, I found however, that a very conspicuous alteration had taken place with the individuals swarming in one of my aquaries, apparently arising from a less complete nutrition along with an incipient formation of ephippia. The size of these individuals was, as a rule, somewhat inferior to that of the summer-generations, and their reproduction by no means so great, more than two eggs, or embryos, being rarely found in the matrix. Meanwhile, a very striking deviation in the form of the head was observed, giving to the individuals (see Pl. 4, fig. 2) a physiognomy very different from that in the earlier generations. Thus, the enormously developed frontal prolation, apparently so characteristic of the present species, had become to that extent reduced in size as to be well-nigh obsolete, the head having assumed a form agreeing more closely with that, as a rule, found to occur in the typical species of the genus, though still exhibiting in front a slight angle. Moreover, the spine of the carapace had comparatively become both much shorter and feebler than in the earlier examined individuals. In some of the specimens, too, as mentioned above, a most conspicuous formation of ephippia had supervened, the dorsal part of the carapace having been so modified as to receive the two winter-eggs. As will appear on comparing fig. 2, Pl. 4 with figs 1, 2, 3, Pl. 1, the recently developed ephippium, which still forms part of the carapace in the specimen figured here, agrees in every respect with the ephippia found in the dried mud, and described more in detail in the first part of this Memoir. Now, it may be easily seen, that the valves of the ephippium merely represent peculiarly modified segments of the dorsal part of the carapace limiting the so-called matrix, and that the hinge is formed by the inspissated dorsal edge, which still retains its armature of denticles.

The presence of individuals provided with ephippia naturally induced me to seek for male specimens, knowing, as I did, that the development of male Cladocera is mostly simultaneous with

that of ephippia bearing females. And I did succeed, after some little trouble, in lighting among the numerous female specimens upon a few fully developed males, the examination of which has enabled me to give a more complete description of the present interesting species.

Description of the Male (Pl. 3, fig. 3). — The size of the full-grown male, is, as usual, much inferior to that of the female, not exceeding 1,60 mm, and its general habitus, as also the structure of certain of its limbs, very dissimilar.

The head appears much more depressed, the frontal part being obtusely rounded off and somewhat projecting inferiorly, with only a very slight knob-like rudiment of the frontal prolation. The ventral part of the head is, as it were, cut off, not forming even a trace of a rostral projection.

The carapace occurs comparatively much narrower than in the female, the dorsal part not the slightest arched, nor the free edges of the valves exhibiting any regular curve. A little in front of the middle the latter appear strongly inflected, forming anteriorly a salient angular projection. This projection, as also the inflected part of the valves, are edged with a dense fringe of delicate plumous setæ. The spine of the carapace, finally, is somewhat short and obliquely upturned.

The eye would appear to be a trifle larger than in the female, almost filling up the rounded frontal part.

The antennulæ are very dissimilar from those in the female, and comparatively stronger developed than in the males of our Northern species, fully attaining, as they do, the length of the head. They are very mobile, and articulated with two small rounded prominences at the infero-posterior part of the head, being, as a rule, directed straight downward, and somewhat diverging. Their basal part, or peduncle, is narrow-cylindric, and contain within its proximal part a strong muscle; at the end, it exhibits posteriorly a rounded prominence, to which are affixed the usual sensory papillæ, whereas, in front of the prominence, protends the slender setiform flagellum, composed of two articulations, the outer very delicate and finely ciliated along one of

its edges. The length of the flagellum about equals that of the peduncle.

The 1st pair of legs exhibit the usual structure, being modified to act as powerful claspers, with which the male grasp the female during copulation. Their terminal part, with the strong, curved hook and the slender bi-articulate seta, is often seen exserted beyond the valves, wide-open in their anterior part.

The tail is without any distinct dorsal processes, and has the terminal part somewhat curved, with the anal margin slightly incurved in the middle. Both the apical claws and the anal denticles are relatively less fully developed than in the female.

The testes are distinctly visible through the carapace, as two narrow and somewhat flexuous tubes on either side of the intestine, placed a little ventrally, and reaching forward to about the insertion of the 3rd pair of legs.

As regards colour, the body of both male and female is exceedingly pellucid, with but a very faint greenish or yellowish tinge. The developing ephippium appears at first rather translucent, but very soon becomes quite opaque and of a dull greyish colour, appearing in transmitted light almost black.

Observations. — The movements of the animal would appear to deviate somewhat at the different seasons of the year. In the animals belonging to the earlier (summer) generations, they are rapid comparatively, and without, in a strict sense, being distinguished by that jerking or jumping peculiarity observed in most other Daphniæ, but have more properly the character of an even run through the water. During this movement the animal retains its body in a somewhat oblique position, with both the frontal spine and that of the carapace pointing well-nigh horizontally. By rapid and quickly repeated strokes of the antennæ, the animal propels itself with considerable speed through the water, in the direction of the frontal spine, and no perceptible deviation from the straight line can be detected. Several times I watched specimens domesticated in the largest of my aquaries, and invariably found them scudding about, in the manner described above, through the whole

extent of the aquary, changing only their course when striking against the walls of the aquary. Both the frontal prolation and the spine of the carapace, as also, perhaps, the peculiarly exserted fornix, serve no doubt as a balancing and steering apparatus, and thus the present species is, it would seem, admirably adapted for living in lakes of considerable extent. However, in individuals of the later generations, this apparatus becomes, as we have shown, very much reduced, and such reduction also occasions a corresponding and very conspicuous alteration in the movements of the animal, these being now rather slow and abrupt, or jumping, as in our well-known species, *D. pulex* (de Geer). Moreover, the animal is found to keep its body, when moving, in a more vertical position, precisely as with the forementioned Northern species. It is obvious, that the movements of the animal at such time merely serve to keep the body suspended in the water, whereas any true locomotion does not, as a rule, occur. A great number of specimens I saw from day to day crowded in the same corner of the aquary, forming there a dense assemblage, that retained its place well-nigh unaltered. The development of the ephippium would seem to restrict still further the agility of the animal, the weight of its body thereby being considerably increased; and such individuals I found too, as a rule, congregated near the bottom of the aquary. — The movements of the males are a triffe more rapid, though made in a similar jerking or jumping manner, and they often keep their bodies obliquely horizontal when in pursuit of the females.

This Daphnia was the Cladoceran first hatched; and in all my aquaries a few individuals at first appeared; but in one only they continued multiplying sufficiently to attain sexual differentiation. In all the other aquaries, after some time the individuals disappeared. This fact I found to be in all probability caused by the presence of another Australian Cladoceran, *Moina propinqua* (to be described further on) this form being much more tenacious of life and its power of reproduction truly marvellous, so as to occupy after some time most of the space in the

aquaries, and thus preventing the full development of any feebler species.

3. *Ceriodaphnia cornuta*, n. sp.

(Pl. 5, figs. 1—3).

Specific Character. — Female: — Head much depressed, with frontal part slightly dilated, and jutting out as two acute processes, the on constituting a kind of rostrum, the other a corniform projection of the front. Carapace broadly oval, and rather tumid, jutting out posteriorly as a short bifurcate prolation. Whole of shell distinctly reticulate, with comparatively large, polygonal meshes; free edges of valves smooth. Eye of moderate size, ocular spot exceedingly small. Antennulæ rather short, fusiform, tentacular seta affixed about in the middle. Antennæ comparatively feeble in structure. Tail provided with 2 distinct dorsal processes, posterior very broad, and having at hinder part a fascicle of fine hairs, terminal section evenly tapered, with dorsal margin well-nigh straight, and exhibiting about 8 pairs of rather small denticles; apical claws without secondary teeth at base. Body pellucid, with but a faint greenish tinge. Length of ovigerous female 0,60 mm.

Remarks. — This form may be easily distinguished from all hitherto known species by the two peculiar projections of the frontal part, the anterior of which has the appearance of a small, anteriorly directed cornicle: hence the specific denomination. The *C. textilis* of Dana would appear to exhibit a similar rostral projection, but wants every trace of the characteristic frontal cornicle. Of our Northern forms, *C. quadrangula* Müller, is that most nearly related to the present species.

Description of the Female. — The specimen examined measures in length 0,60 mm only, and thus ranks among the smaller species of the genus.

The general form of the body (see Pl. 5, fig. 1) appears, as in the other species, rather short and thickset, also somewhat tumid, though the breadth does not fully equal the height.

The head is very much depressed, and marked off from the

carapace by a rather deep dorsal impression. Its dorsal margin is rather convex in the upper part, but farther down forms a slight concavity above the eye. The frontal part projects a little inferiorly, jutting out as two acute processes, that point in opposite directions. The posterior and larger process represents a kind of rostrum, projecting in front of the antennulæ; the anterior, which issues from the foremost part of the front, has the form of a small cornicle, pointing straight forward, much as in the cornigerous variety of our common *Scapholeberis mucronata*. The fornix would appear to project a little above the bases of the antennæ, and is there produced on either side as a short triangular lappet.

The carapace — lateral aspect — exhibits a comparatively regular, broadly oval shape, both with the upper and lower margins gently arched, and the posterior part, a little above the middle, produced as a short spiniform process, that, on viewing the animal from above, appears bifurcate, or to jut forth with two acute and diverging points (see fig. 2).

The sculpture of the carapace, as also of the cephalic shell, is very distinct, forming over the whole surface a net-work of most conspicuous polygonal meshes, those on the valves occurring larger and more regular in form than elsewhere. The free edges of the valves are quite smooth, without any trace of bristles or denticles.

The eye is of moderate size, and, as usual, placed within the frontal region of the head, not by far, however, filling up that part. The ocular spot is distinctly visible, though very minute, punctiform, and placed at a short distance from the insertion of the antennulæ.

The antennulæ are rather small, not reaching by far to the tip of the rostral projection, and well-nigh fusiform in shape, having the tentacular seta affixed about in the middle of the anterior margin.

The antennæ appear somewhat less powerfully developed than in most of the other species, and with the outer branch considerably shorter than the inner; for the rest exhibiting the usual structure.

The tail (fig. 3) is provided with 2 well-marked dorsal processes, the anterior narrowly conic, whereas the posterior occurs very broad, subtriangular, and furnished at its hinder part with a bunch of delicate hairs. The terminal section is not expanded, — tapering, as is does, evenly toward the apex, which is bluntly rounded, with a somewhat projecting anterior angle bearing the apical claws. The dorsal margin is well-nigh straight, and armed in its exterior part with about 8 pairs of denticles, almost equal in size. The apical claws are gently curved, and want every trace of secondary teeth at the base. The caudal setæ are of moderate length, and distinctly bi-articulate.

The matrix of the specimen described above contained 4 rather large summer-eggs, disposed in pairs, and of a regular oval form, exhibiting also a large central oil-globule.

The body was semi-transparent, with a faint greenish tinge — the yolk-mass of the eggs of a clear bluish-green.

Observations. — The movements of the animal were most unusually slow, and somewhat jumping in character, from the abrupt and well-nigh rhythmical strokes of the antennæ. The attitude of the body during these movements was almost vertical, and but very little, if any, locomotion was effected, the strokes of the antennæ serving, it would seem, merely to keep the animal suspended in the water. I watched the same specimen for some days together, and was always sure to find it precisely in the same place in the aquary, — about the middle of the water.

Only a single specimen of this pretty little species was raised from the mud. It made its appearance in one of my aquaries in the first days of June, and at first was so very small as scarcely to be visible save with the aid of a strong magnifier. Soon, however, it increased in size, and after some days became full-grown and ovigerous, whereupon the specimen was submitted to a careful microscopic examination and then preserved in spirit. To the best of my judgment, the small ephippium figured in Pl. 1, fig. 13 belongs to this species, its dimensions being exactly such as would agree with the size of the specimen described above.

4. *Moina propinqua*, n. sp.

(Pl. 5, figs. 4, 5; Pl. 6).

Specific Character. — Female: — General habitus very similar to that of *M. brachiata*. Head with dorsal margin only slightly concave above the eye, front somewhat projecting and narrowly rounded, ventral margin well-nigh straight. Carapace with dorsal part in gravid specimens often enormously expanded, valves comparatively small, sculptured with distinct transversal flexuous striæ, and fringed along the inferior edges with short setæ. Eye of moderate size. Antennulæ densely fringed with cilia posteriorly. Antennæ powerfully developed, with usual number of natatory setæ. Tail having terminal section rather produced, its distal part gradually tapering and armed with nearabout 9 pairs of lateral denticles, the most exterior bidentate; apical claws without any secondary teeth at base. Ephippium with a single ampulla.

Male having frontal part of head evenly rounded off, and antennulæ armed at extremities with 3 strong incurved hooks.

Body diaphanous, with a faint violet tinge along ventral side of intestine. Length of adult female 1,14 mm; of male 0,63 mm.

Remarks. — This form exhibits a perplexing similarity to our common European species, *M. brachiata*, Jurine (= M. rectirostris, Zaddach), so as readily to be confounded with it at the first glance. However, on closer examination it presents certain constant differences that undoubtedly should be regarded as specific. Thus, the contours of the head, both in the female and the male, would seem to differ a little from those in M. brachiata, the front being less produced and the sinus above the eye less distinctly marked. Moreover, the antennulæ in the female are densely ciliate posteriorly, and in the male armed with only 3 apical hooks. Finally, the terminal claws of the tail want every trace of secondary teeth at the base. Another Australian Moina, *M. Macleana*, has been described by Mr. King, differing however materially, to judge from the description and

figure reproduced by Mr. Schoedeler, from the present form, alike as regards its general habitus and the number of natatory setæ on the antennæ. The *M. micrura* of Kurz, from South Germany, has the antennulæ, as in the present species, densely ciliate posteriorly, but differs, let alone other characters, in the terminal part of the tail being far less produced and armed with a much smaller number of lateral denticles.

Description of the Female. — The largest specimen examined had a length of 1,14 mm, or nearly that of the Northern species. The general form of the body (see Pl. 5, figs. 4, 5) is much the same as in *M. brachiata*, being, more especially in gravid specimens, rather short and clumsy.

The head is marked off from the carapace by a distinct dorsal impression, from which proceeds a well-defined transversal suture, joining the upper ends of the mandibles. In a lateral aspect (fig. 4), it appears somewhat depressed, with the dorsal contour strongly arched behind, whereas anteriorly it becomes a trifle concave, forming an indistinct sinus above the eye. The front projects a little, but still less than in *M. brachiata*, and is narrowly rounded, with the ventral margin well-nigh straight. No true rostrum is present, the posterior part of the head forming beneath but a slight convexity previous to its joining the labrum. As seen from above (fig. 5), the head tapers very slightly toward the apex, which is obtusely rounded. A slight trace only of the fornix is seen projecting on either side just above the bases of the antennæ.

The carapace is much broader than the head, and, in gravid specimens, expanded on the dorsal side in a truly remarkable manner, to form a most capacious, well-nigh globular matrix (see figs. 4, 5), marked off, it would appear, from the valves inferiorly by a curved chitinous fillet, projecting from its inner face (see fig. 3). Posteriorly, the carapace juts out as a short and obtuse prolation, below which the free parts, or valves, take their origin. The latter are comparatively small, so as not to obtect fully either the oral parts or the tail. Anteriorly, they exhibit in their upper part a well-marked sinus, leaving uncovered

a great part of the mandibles, and inferiorly form a broadly rounded corner. The ventral edges are almost straight, and fringed with short hairs; they are not distinctly marked off from the posterior, which are slightly incurved in their upper part.

As regards the sculpture of the shell, no trace can be detected in other places, except on the valves, where delicate, obliquely transversal striæ, somewhat flexuous and partly anastomosing with each other, may be readily observed. The shell-gland forms a simple coil of canals in the anterior part of the valves.

The eye — placed within the anterior projecting part of the front — is comparatively large, though somewhat smaller than in M. brachiata. It is provided with numerous refracting corpuscles, forming a clear zone round the dark pigment. Of the ocular spot, no trace whatever can be detected.

The antennulæ exhibit the structure characteristic of the genus, projecting freely, and very movably jointed to the inferior part of the head. They are narrowly fusiform, and densely fringed along the posterior border with rather long and delicate cilia. The tentacular seta, affixed about in the middle of the anterior margin, is rather long, whereas the apical sensory papillæ are exceedingly small.

The antennæ are very powerfully developed, and agree precisely in their structure with those in M. brachiata, the number and arrangement of the natatory setæ being exactly the same.

This would also appear to be the case with the oral parts and the legs.

The tail (see Pl. 6, fig. 1), as in the other species of the genus, cannot be entirely retracted within the carapace, a more or less considerable part of its terminal section being invariably exposed behind. As to form, it corresponds very nearly with that in M. brachiata. A single conical dorsal process occurs somewhat far out anteriorly, admitting of being closely applied against an internal crest of the carapace, and thus closes up the matrix posteriorly. The terminal section is rather produced, tapering rapidly toward the apex, which is conically pointed. Its dorsal margin constitutes, a little beyond the middle, a broadly

rounded prominence, on which the anal opening is situated, and exhibits above another process, whence the very long caudal setæ originate. The distal part of the tail beyond the anal opening is very narrow, and, on either side, armed with about 9 denticles, the exterior of which is non-ciliate and bifid, with the outermost point the longer, whereas the remaining denticles are simple and very delicate, as also densely ciliate along both edges. The apical claws are comparatively small, and want every trace of secondary teeth at the base, whereas at the anterior edge 3 slight serrations may be observed.

As regards the internal organs, no essential differences can be found from those in M. brachiata. The ova, when recently deposited in the matrix, are exceedingly small and transparent, of a faint rosy or violet hue, and globular in form. They rapidly, however, increase during the embryonal development, dilating the dorsal part of the carapace in the fore-described extraordinary manner. On removing the numerous embryos, the so-called alimentary layer („Nahrboden"), described more fully by Prof. Weissman, and apparently affording a nourishing substance for the embryos during development, is seen to project from the dorsal face of the body wall.

As stated above with regard to Daphnia Lumholtzii, also of the present form the individuals belonging to the later generations, developing at the end of September, proved far less productive than were those of the earlier generations, more than 2 or 4 embryos being rarely found in the matrix. Apparently by reason hereof, the carapace of adult specimens exhibited at that period a somewhat different aspect, its dorsal part being not by far so expanded, and its form occurring more regularly quadrangular. In some specimens, too, a distinct formation of ephippium had taken place (see Pl. 6, fig. 2). The structure of the latter was very similar to that in M. brachiata, containing, as it did, but a single ovum.[1] It also exhibited, alike as to size and structure, the most perfect agreement with a kind

[1] In *M. paradoxa*, Weissman, there are 2 transversely disposed egg-chambers, as in the genus Daphnia.

of ephippium not uncommonly found at first in the dried mud, and one of which is represented in Pl. 1, fig. 14.

Description of the Male. — The size of the full-grown male of this species is very much inferior to that of the female, measuring only 0,63 mm in length.

The general form of the body (see Pl. 6, fig. 3) appears somewhat dissimilar from that of the female, being by far not so clumsy, and rather slender and compressed.

The head is comparatively more erect and elongate, with the dorsal face less arched and the sinus above the eye shorter. The front is evenly rounded, and the ventral margin exhibits at the point of insertion of the antennulæ a gentle curve.

The carapace has the dorsal part not in the least expanded, and is abruptly truncate posteriorly, with the upper angle well-nigh a right one, the lower corner rounded.

The antennulæ are enormously developed, attaining about the length of the head, and are exceedingly mobile. They appear, as it were, geniculate, the slender distal part forming a slight angle with the proximal, without however being marked off by any perceptible suture. At the junction of the two, are affixed anteriorly two unequal setæ, the one very small, whereas the other is rather elongate, and would appear to correspond to the tentacular seta in the female antennulæ. The distal part being almost twice as long as the proximal, bears at the apex, exteriorly, a small bunch of sensory papillæ, and interiorly, 3 strong incurved hooks (see fig. 4). Of any true flagellum no trace whatever can be detected.

The 1st pair of legs (fig. 5) are modified in the usual manner as powerful claspers, the exterior part being incrassated and containing several converging muscles, that move the very strong anteriorly curved hook. At the base of this hook, is seen anteriorly a very short seta, and posteriorly, a thin plate bearing 3 plumous setæ of equal length.

The tail would not seem to exhibit any marked difference from that in the female.

The testes occupy their usual place, and agree in struc-

ture exactly with those of M. brachiata, the zoospermes being likewise of a similar character.

Respecting colour, both the male and female are, as a rule, highly pellucid, almost hyaline, having however, invariably, along the ventral side of the intestine, a more or less distinct rosy or violet tinge. In gravid females, the prodigiously expanded dorsal part of the carapace often exhibits a faint yellowish tinge, the embryos occurring of a bluish-grey. In most specimens, numerous strongly refracting oil-globules, belonging to the so-called adipose tissue, are dispersed along the ventral face of the body, being especially numerous within the tail, where they occur on both sides of the terminal section of the intestine (see Pl. 6, fig. 1). The recently developed ephippium exhibits an opaque brownish-red colour.

Observations. — Individuals belonging to the summer-generations move through the water with comparative rapidity in a clearly jumping manner, their bodies retaining a somewhat prone attitude. True, the movements of gravid females become to a certain extent encumbered by the heavy burden of embryos, but are yet sufficiently vigorous to render it rather difficult to catch them with an ordinary dipping-tube. In the latter part of the summer and autumn, these animals become much less agile, keeping mostly near the bottom of the aquary, though moving about in the same jumping manner as before.

The present form made its appearance in most of my aquaries at about the same time, viz., in the first days of June, a very few individuals only having at first been observed. Meanwhile they rapidly increased, and, when full-grown, they continued multiplying to such a remarkable extent, that in the course of a few weeks, shoals of these little creatures literally filled up the aquaries. To prevent their choking out, so to speak, all the other Cladocera, I was obliged on several occasions to remove a considerable number of the individuals from the smaller aquaries, whereas in my largest aquary I left the animals to multiply undisturbed. On returning from my excursion, I found this aquary filled up with immense swarms of this form, so as to give quite a turbid aspect

to the water. The number of individuals had now become far too great in proportion to the size of the aquary, and from this cause apparently, after some days a sudden mortality ensued, occasioning all of the animals to disappear in comparatively a very short time. Previous to this occurrence, I had fortunately submitted to examination some of the females in which ephippia were developing, as also a few individuals of the diminutive male observed at that time, and thus I could trace with comparative completness the lif-history of the present form.

As is well known, the Northern species of Moina are, as a rule, met with in very small turbid ditches, generally appearing only at certain seasons of the year (in our country mostly in the latter half of summer), whereas no species of this genus has ever been found in lakes of any extent. Thus, it may seem somewhat strange to find this form among the Cladocera derived from one of the larger Australian lakes. We must however bear in mind, that the lake in question is very shallow, and that some years ago it even completely dried up, having thus, apparently at least for some time, presented conditions eminently favourable to the existence of the present form.

Family: — *Lynceidæ.*

5. *Leydigia australis*, n. sp.

(Pl. 7, 8).

Specific Character. — Female: — General habitus very similar to that of L. acanthocercoides. Head comparatively erect, with rostral projection curved but very little, if at all at apex. Carapace without any distinct sculpture, compressed, broadly quadrangular, dilated behind and very obliquely truncate, with upper angle obtuse, lower corner projecting and rounded off. Eye very small. Ocular spot enormously developed, at least three, times the size of the eye, and irregular-angulous in form. Antennulæ reaching scarcely to apex of rostrum. Inferior expansion of labrum delicately ciliate at edge. Tail with 3 bunches of hairs

above, terminal section very large, lamellar, scarcely however dilated towards apex, dorsal edge gently arched and terminating with a well-marked angle, lateral spines very slender, increasing in length towards apex, about 20 on either side, exclusive of 2 or 3 small denticles, obliquely disposed in a series at base of each spine. Apical claws slender and well-nigh straight, without any secondary tooth at base. — Male much smaller than female, with antennulæ larger and 1st pair of legs armed with a strong hook. Body of female amber-coloured. Length of full-grown female 0,84 mm, of male 0,46 mm.

Remarks. — This species, although very similar in its general habitus to the 2 European forms, — *L. acanthocercoides* Fischer, and *L. quadrangularis* Leydig, can at once be distinguished by the remarkable development of the eye-spot. It may also be easily recognized — at least from the species occurring in Norway (L. quadrangularis) — by a somewhat different form of the terminal section of the tail, as also by its apical claws being wholly unarmed.

Description of the Female. — The length of the full-grown female measures 0,84 mm; and this animal ranks accordingly among the larger forms of Lynceidæ.

The body (see Pl. 7, figs 1, 2) occurs, as in the other species, much compressed, its breadth scarcely attaining half its height.

The head (see fig. 1) is comparatively erect, with the dorsal contour gently curved to the very apex of the rostrum. The edges of the fornix appear slightly flexuous, and join the carapace at a very acute angle. Viewed from beneath (fig. 2), the head, owing to the greatly developed fornix, assumes the form of an obtusely triangular vaulted shield, posteriorly about as broad as the carapace. The rostrum, formed, in a strict sense, by the edges of the fornix running together in front, appears, when viewed from the dorsal or ventral face, obtusely rounded.

The carapace, viewed laterally (fig. 1), is very broad, and irregular-quadrilateral in form, the ventral side being by far

the longest. It expands somewhat posteriorly, and is there very obliquely truncate, with the upper angle obtuse, the lower corner rather produced and evenly rounded off. The dorsal margin forms, along with that of the head, an uninterrupted and gentle curve, whereas the ventral edges of the valves are comparatively straight, and constitute a somewhat projecting corner on joining the anterior edges.

The surface of the shell appears quite smooth, without the slightest trace of any striæ or other sculpturing, and the inferior edges of the valves are, as usual, fringed throughout their whole length with rather long and dense cilia. The shell-gland (see Pl. 8, fig. 1) is comparatively simple in structure, forming merely a single short loop just behind the mandibles, its upper extremity reaching to about the place where the heart occurs located.

The eye (see Pl. 7, figs. 1, 2; Pl. 8, fig. 1) is comparatively very small, with only a few, rather minute refracting corpuscles in its anterior part.

The eye-spot, or ocellus, (ibid.), on the other hand, is of quite a remarkable size, being more than three times as large as the eye itself. It is placed a little nearer to the eye than to the apex of the rostrum, and exhibits an irregular-quadrilateral form, the lower side being the broadest and quite straight, whereas the upper is slightly emarginate with the anterior corner produced to an acute point. Viewed from below (Pl. 7, fig. 2), the ocellus appears deeply incised posteriorly, and thus, as it were, consisting of two symmetrical halves. Along the anterior and posterior edges occurs, moreover, a clear, somewhat vaulted border, representing apparently some kind of refracting corpuscles.

The antennulæ (see Pl. 8, fig. 1) are rather small, reaching, when extended hardly to the tip of the rostrum, and appear to a great extent concealed beneath the anterior part of the fornix. They exhibit a somewhat conical form, tapering, as they do, toward the apex, and are furnished round the edges with small spinules. The apical sensory papillæ are very short, and the tentacular seta is affixed to the outer side at a short distance from the apex.

The antennæ (Pl. 7, fig. 5), as compared with those in other Lynceidæ, are rather powerfully developed, the basal part strongly curved and composed of 2 distinctly marked segments, of which the distal is the larger and provided anteriorly with a transverse row of delicate spinules. Both of the branches are tri-articulate, the exterior a trifle longer than the interior, and having only 3 natatory setæ, proceeding from the apex, besides 2 strong spines, the largest of which is affixed to the end of the 1st joint exteriorly, whereas the other proceeds from the last joint. The inner branch has likewise at the tip of the last joint 3 natatory setæ and a spine, but, in addition, each of the two other joints is provided interiorly with a short natatory seta, and exteriorly, with a transverse row of slender spinules.

The anterior lip, or labrum (see Pl. 8, fig. 1), projects inferiorly, in front of the carapace, as a broad and compressed securiform lamella, the inferior edge of which is densely fringed with very small cilia.

The mandibles (Pl. 7, fig. 3) exhibit the usual structure, with the molar extremity broadly truncate and presenting an uneven and, as it were, fluted surface, being furnished, moreover, at the periphery with a dense clothing of hairs and some few strong denticles.

The maxillæ (fig. 4) are very small, and exhibit at their extremities 3 incurved plumous setæ, the median being much the longest.

Of legs, 5 pairs only are present, somewhat dissimilar in appearance, and, as a rule, becoming more delicate in structure posteriorly. As no detailed description has previously been given of these organs in the true Lynceidæ, save in the anomalous genus *Eurycercus*, I have sought to determine as closely as possible the structure of the said limbs in the present species, having for that purpose carefully dissected several specimens. As will appear from figs. 2—6, Pl. 8, they exhibit on the whole a somewhat approximate resemblance to those in the genus *Acantholeberis*, first described by Schoedeler, and more recently by the Danish naturalist Lund.

The 1st pair of legs (fig. 2) are comparatively powerful in structure, and strongly curved, forming anteriorly a geniculate bend, whence a faint line may be traced crossing the trunk, and, as it were, dividing it into two segments. Along the anterior border, occur several bunches of delicate curved bristles, and a little within the margin 2 strong, anteriorly curving spines are found to project from the base of the distal segment. At the apex, the leg divides into 2 irregular branches, the inner of which (endopod) constitutes a rather broad and semi-membranous plate, fringed with 9 strong plumous setæ, arranged in 3 sets. The outer branch (exopod) is more slender, and exhibits 2 unequal lobes, the posterior being much the larger and conically produced, as also bearing at the tip an exceedingly long bi-articulate seta, somewhat bent anteriorly and denticulate along the front edge. The anterior lobe is comparatively small, but provided with 3 setæ, 2 of which exhibit a similar aspect to that of the inner lobe, though much smaller in size, whereas the 3rd seta is quite smooth and curved anteriorly in a hook-like manner. All of the setæ on the exopod project, as a rule, beyond the valves of the carapace anteriorly (see Pl. 7, fig. 1), and would seem to be prehensile in character. Moreover, on the exterior face of the proximal segment of the leg, is affixed a small rounded vesicular corpuscle, representing apparently the epipod, and morphologically corresponding to the gill in other Crustacea. Of the so-called maxillary process — so distinctly developed on the succeeding pairs of legs — I have failed to detect any trace whatever.

The 2nd pair of legs (fig. 3) are much shorter, and have the distal segment of the trunk very broad and appressed, as also exhibiting on the edge 7 strong bi-articulate and, as it were, digitiform spines, diminishing successively in size inwards, all of them with the outer joint densely ciliate along one of the edges. At the exterior corner of this segment, — properly representing the endopod, — is affixed a simple conical lobe (apparently the exopod) bearing at the tip an exceedingly strong and curved seta, of a similar appearance to that originating from the exopod

of the 1st pair. The inner corner, too, is produced as a well-marked triangular maxillary process, provided on the inner side with a row of 7 strong falciform setæ, curving inward, the tip itself exhibiting 2 small denticles and a single recurved seta. The epipod is perfectly similar in form and structure to that on the 1st pair.

The 3rd pair of legs (fig. 4) have the endopodal portion much reduced in size, and furnished with about 7 plumous setæ; it juts forth inward, as a well-marked maxillary process, of a similar structure to that of the 2nd pair, save that 4 strong curved denticles are affixed on the outer margin, in place of the delicate cilia occurring there on the 2nd pair. The exopod constitutes a thin membranous plate, tapering somewhat toward the end, and furnished with 4 strong plumous setæ, two of which proceed from the somewhat expanded outer margin, whereas the other 2 are affixed to the apex; one of the latter is exceedingly long, and indistinctly bi-articulate. The epipod has the same appearance as that on the 2 preceding pairs.

The 4th pair of legs (fig. 5) do not exhibit any distinct demarcation between the endopod and the maxillary process, forming together, as do those parts, a triangular, inward-curving lobe, furnished along the inner edge with 6 short and thick setæ, of which the 4 middle ones are somewhat unguiform in appearance and distinctly bi-articulate, with the terminal joint pectinately ciliate at one of its edges. Along the inner face, too, occurs a series of close upon 8 setæ, the 4 interior falciform, as in the two preceding pairs. The exopod is very large, and expanded, constituting a broad oval plate, densely ciliate along the inner edge, and provided in addition with 6 plumous setæ, 3 of which proceed from the outer edge, the other 3 from the rounded apex; of the latter, the 2 innermost are much smaller than the outer seta. Moreover, immediately above the sac-like epipod, a very thin and pellucid, narrow linguiform lobe is seen to project, delicately ciliate at the tip.

Finally, the 5th pair of legs (fig. 6) are membranous throughout, and very delicate in structure. The endopodal portion con-

stitutes a pellucid triangular lobe, without any armature of setæ or spines, finely ciliate along the inner edge only. The exopod, on the other hand, is prodigiously developed, in the form of an exceedingly large rounded plate, finely ciliate round the edges, and provided also in the exterior part with 4 strong plumous setæ of nearly equal length. As in the preceding pair, a thin ciliated lobe projects immediately above the small rounded epipod.

The tail (see Pl. 7, fig. 1; Pl. 8, fig. 7) has the dorsal part, where it is connected with the trunk, strongly projecting — to close up the matrix behind, and exhibits posterior to this projection, 3 bunches of delicate bristles, affixed to the end of as many separate segments. The terminal section, connected as usual with the proximal part of the tail by a very mobile articulation, is exceedingly large, forming a broad vertical plate, the dorsal margin of which is evenly arched. It tapers a little toward the apex, which exhibits an angular incision bounded anteriorly by a short conical process (to which the caudal claws are affixed), — posteriorly, by a well-marked, almost right-angled corner. The dorsal edge of the caudal plate is quite unarmed, being furnished merely with a very delicate ciliation. On the other hand, a lateral series of close upon 20 very slender, well-nigh setiform spines occur at some distance from the edge, increasing successively in length toward the apical angle, and projecting more or less beyond the dorsal edge. At the base of each spine, is observed moreover an oblique series of 2 or 3 much smaller spinules, and in some examples there would even appear to be several such series. But, when such is the case, it may be safely alledged that, on closer examination, such specimens will be found about to moult, and also that the apparent increase in the number of spines arises simply from those in process of development — to take the place of the old ones after moulting — becoming visible beneath the integument. The apical claws are very long and slender, only slightly curved, and quite smooth, without the slightest trace of a basal tooth. The caudal setæ, affixed to a short process close to the joint connecting the caudal plate with the

proximal part of the tail, are of moderate length and distinctly bi-articulate, with the outer joint densely ciliate.

The intestine forms, as usual, in the posterior part of the trunk, a double loop (see Pl. 7, fig. 1), and becomes somewhat dilated before joining the rectum, without, however, exhibiting any distinct cœcal appendage. The anal orifice occurs on the dorsal side of the caudal plate, near its base.

The ova in the matrix would seem not to exceed two in number. They are both of a regular oval form, and, as a rule, disposed one behind the other.

The male (Pl. 7, fig. 6) is very much smaller than the female, scarcely exceeding 0,46 mm in length, and may easily be distinguished from the latter by the relatively greater size of the antennulæ, projecting, as they do, considerably beyond the apex of the rostrum, as also by the structure of the 1st pair of legs (fig. 7), armed with a powerful, anteriorly curved hook originating on the trunk between the exopod and endopod, and extending as a rule beyond the valves of the carapace anteriorly.

The body of the full-grown female is amber-coloured, with a more or less distinct reddish tinge, that of the male being much paler and well-nigh colourless. The eggs recently deposited in the matrix of the female are of a dark-greenish colour.

Observations. — This is a true limicole form, its habitat generally occurring within the loose bottom deposit, through which it forces its way partly by means of its antennæ, partly and principally by its powerful tail, the very mobile terminal section of which acts as a most effective organ of locomotion. At times, the animal also moves about freely through the water; but this mode of locomotion is never found to last for any length of time. It swims on its back; and by rapidly repeated strokes of the antennæ the body is propelled through the water, till it reaches some object which, as a rule, it succeeds in climbing up by means of the curved bristles affixed to the exopod of the 2 first pairs of legs.

I first observed this form on returning from my excursion at

the end of September, when I found it rather abundant in two of the aquaries. Nay, in one — a comparatively small cylindric glass — it swarmed about in such profusion through the mud, that I could always make sure of securing several specimens by taking up with a small dipping-tube a very trifling quantity only of the mud. In some of the specimens, winter-eggs had been deposited in the matrix — easily distinguished from summer-eggs by their dark-yellowish colour. Only 2 such eggs occurred in each individual, and no perceptible modification of the dorsal part of the carapace was ever observed in such cases. Of males, only a few specimens were found at that time.

Explanation of the Plates.

Pl. 1.

Fig. 1. Ephippium of *Daphnia Lumholtzii*, picked out from the dried mud, lateral aspect. × 43.

„ 2. Same, from above.

„ 3. Ephippium opened, and its two valves spread out on either side; inner capsule likewise opened, to show the two ova lying in situ within the left valve. × 62.

„ 4. Inner capsule separated from ephippium; viewed from right side. × 78.

„ 5. A small portion of this capsule, magnified 345 diameters.

„ 6. Ephippial ovum in which no embryonal development has yet taken place. × 78.

„ 7. Another ovum, with embryo enclosed, ventral aspect. × 78.

„ 8. Same, viewed from right side.

„ 9. Ephippial ovum, containing an almost fully developed embryo, lateral aspect. × 78.

„ 10. Young of Daphnia Lumholtzii, recently hatched, viewed from right side. × 78.

„ 11. Ephippium of Daphnia? sp?, picked out from the dried mud. × 43.

„ 12. Ephippium of Simocephalus sp? × 62.

„ 13. Do. of Ceriodaphnia cornuta. × 62.

„ 14. Do. of Moina propinqua. × 62.

Pl. 2.

Fig. 1. *Diaphanosoma excisum*, n. sp.; adult female with summer-eggs in matrix, ventral aspect. × 72.

„ 2. Same from left side, with antennæ reflexed.

„ 3. Posterior part of carapace, along with tail, last pair of legs, and a few of the ova, lateral aspect. × 165.

Pl. 3.

Fig. 1. *Daphnia Lumholtzii*, n. sp.; adult female with summer-eggs in matrix, lateral aspect. × 62.

„ 2. Another specimen with greatly developed ovaries, from above.

„ 3. Tail from left side. × 78.

Pl. 4.

Fig. 1. *Daphnia Lumholtzii*, n. sp.; embryo in last stage of development, extracted from matrix, lateral aspect.

„ 2. Same; adult female with ephippium, viewed from left side. × 62.

„ 3. Same; adult male, from left side. × 62.

Pl. 5.

Fig. 1. *Ceriodaphnia cornuta*, n. sp.; adult female with summer-eggs in matrix, lateral aspect. × 140.

„ 2. Same; posterior extremity of carapace, from above.

„ 3. Same; tail viewed from left side.

„ 4. *Moina propinqua*, n. sp.; adult female, matrix greatly expanded and replete with almost fully developed embryos, lateral aspect. × 72.

„ 5. Same specimen, viewed from above.

Pl. 6.

Fig. 1. *Moina propinqua*, n. sp.; posterior part of carapace of a female specimen, along with tail, lateral aspect. × 140.

„ 2. Same; adult female with ephippium, lateral aspect. × 72.

Fig. 3. Same; adult male, from right side. × 110.
„ 4. Same; extremity of male antennulæ. × 290.
„ 5. Same; male leg (left) of 1st pair, from outer face. × 290.

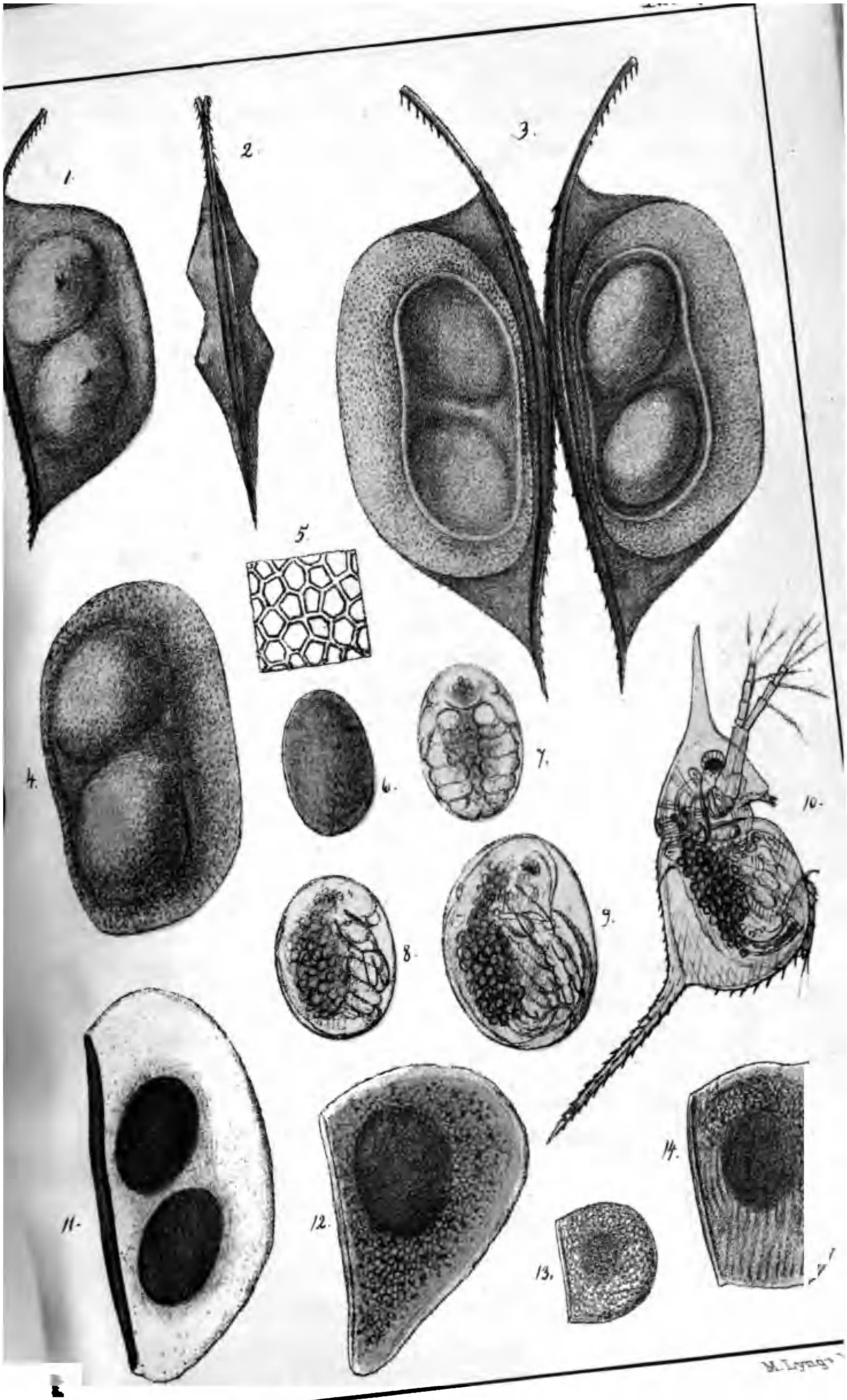
Pl. 7.

Fig. 1. *Leydigia australis*, n. sp.; adult female with summer-eggs in matrix, lateral aspect. × 110.
„ 2. Same specimen, from below.
„ 3. Same; mandible, from inner face. × 205.
„ 4. Same; maxilla. × 205.
„ 5. Same; right antenna, from outer face. × 205.
„ 6. Same; adult male, from right side. × 110.
„ 7. Same; male leg (left) of 1st pair, from outer side. × 290.

Pl. 8.

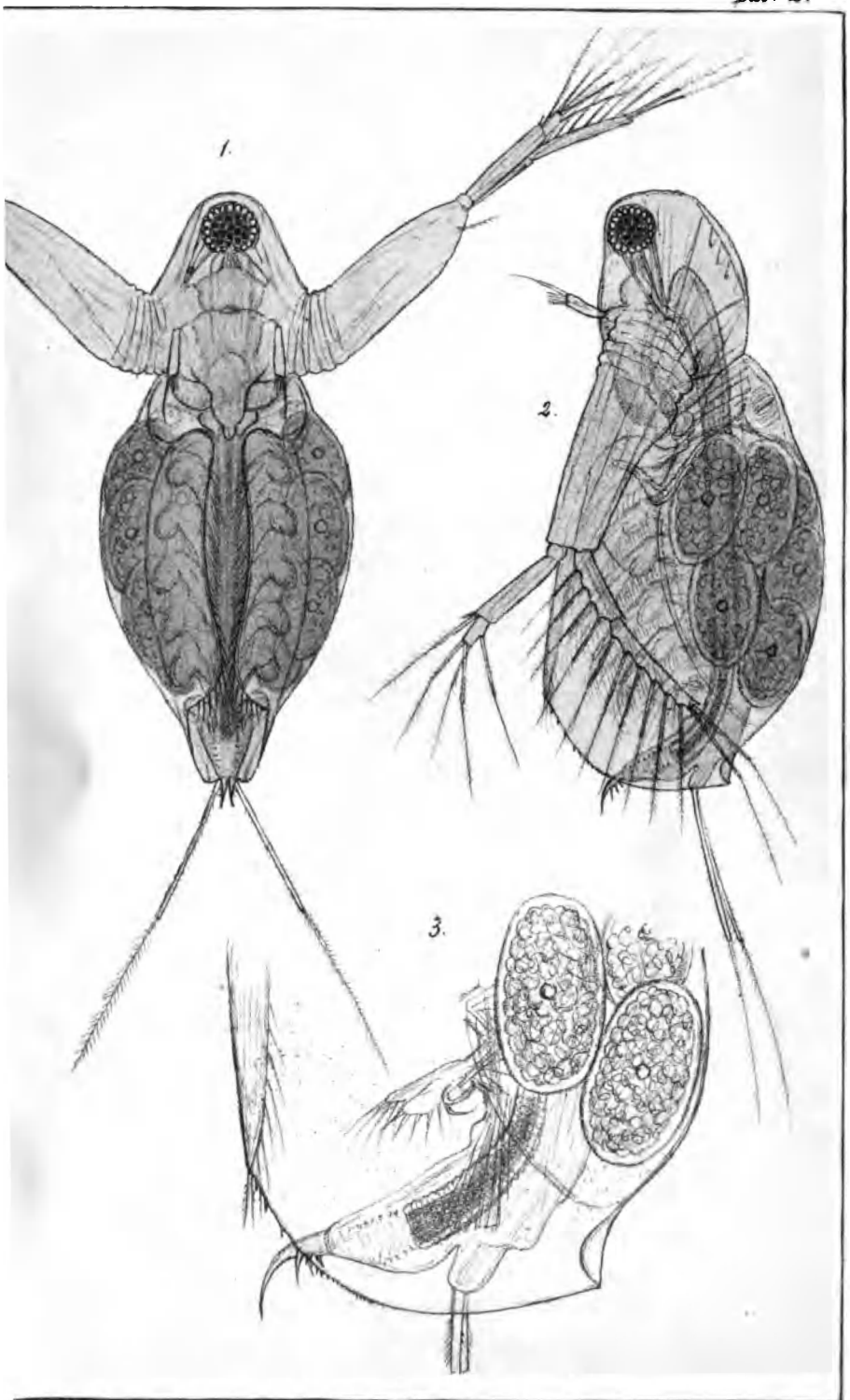
Fig. 1. *Leydigia australis*, n. sp.; anterior part of body of adult female, lateral aspect. × 250.
„ 2. Same; 1st leg.
„ 3. Same; 2nd leg.
„ 4. Same; 3rd leg. } × 205.
„ 5. Same; 4th leg.
„ 6. Same; 5th leg.
„ 7. Same; tail, from right side. × 205.

Printed 23. IV. 1885.



G. Sars autogr.

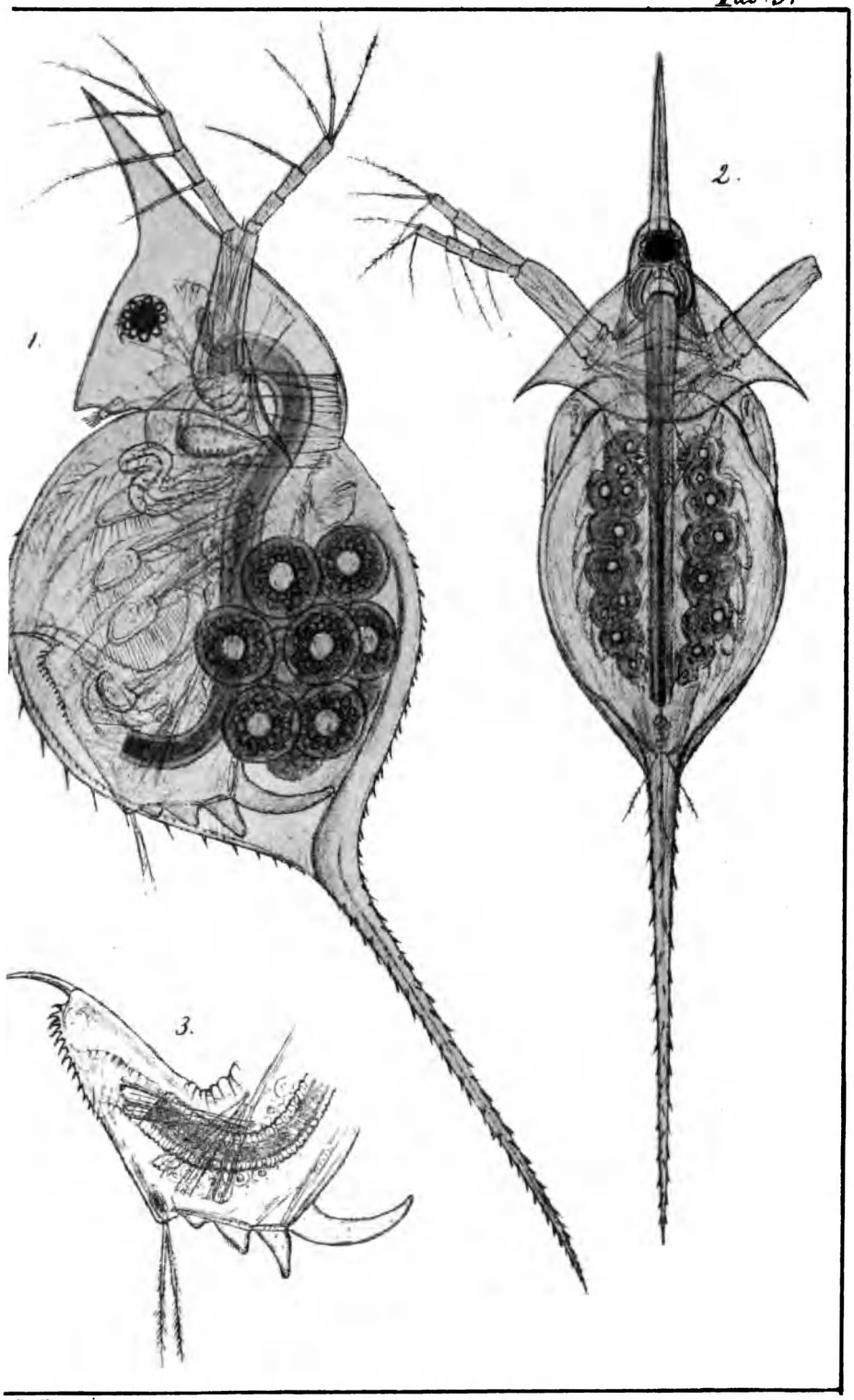
M. Lyng



.rs autogr.

Diaphanosoma excisum, n. sp.

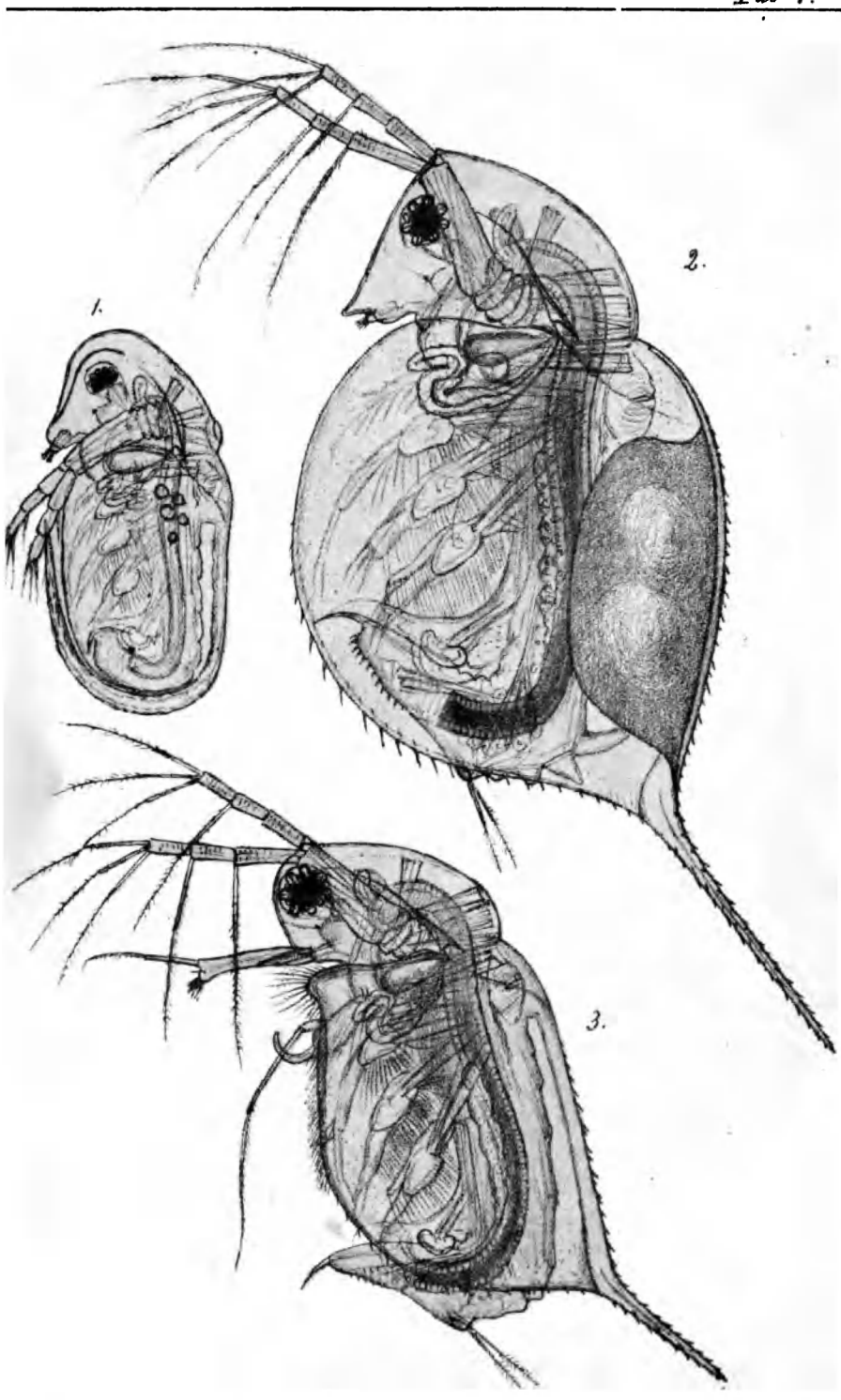
Tab. 3.



O. Sars autogr.

M. Lyng - Trib. Arct.

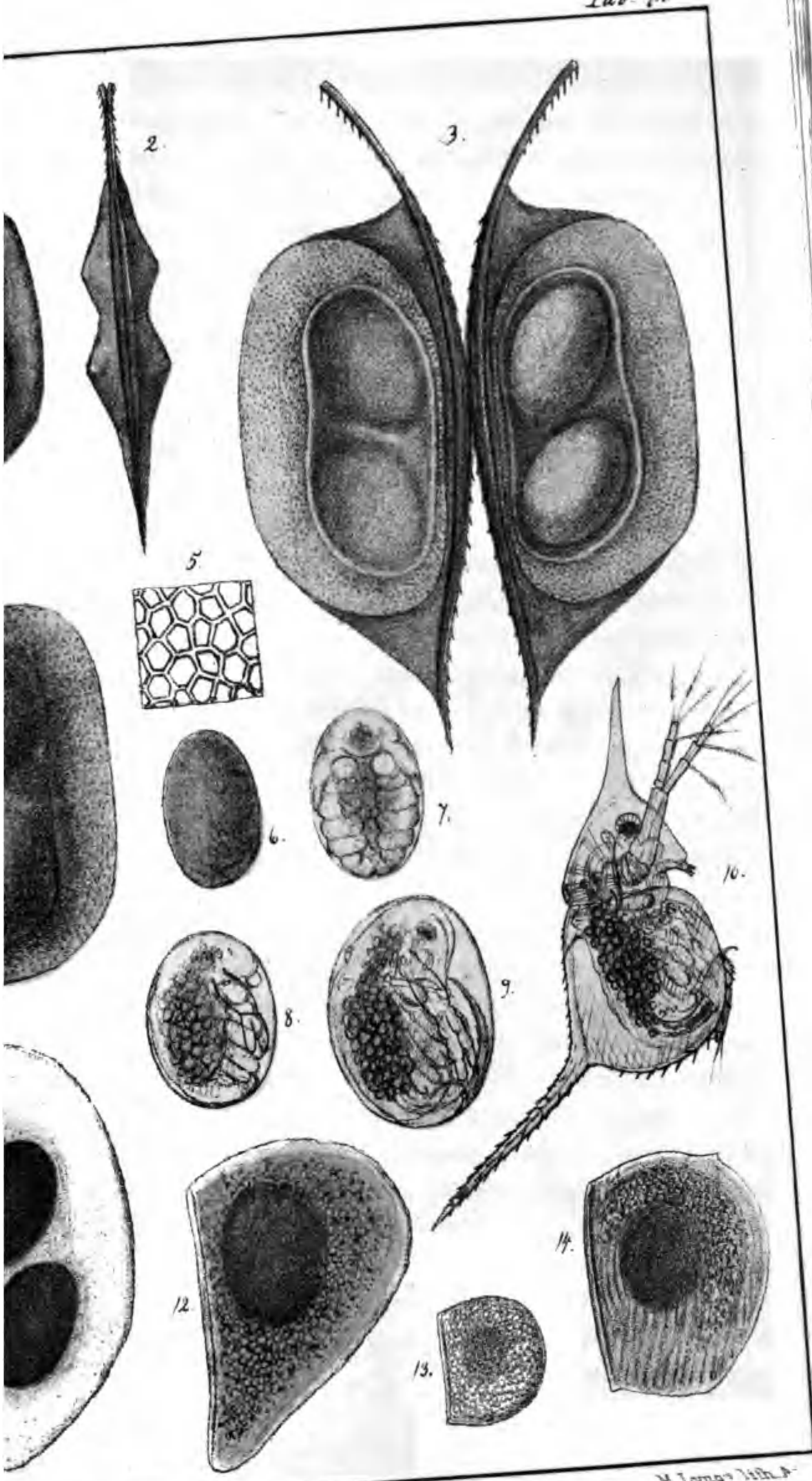
Daphnia Lümholtzi, n. sp.



O. Sars autogr.

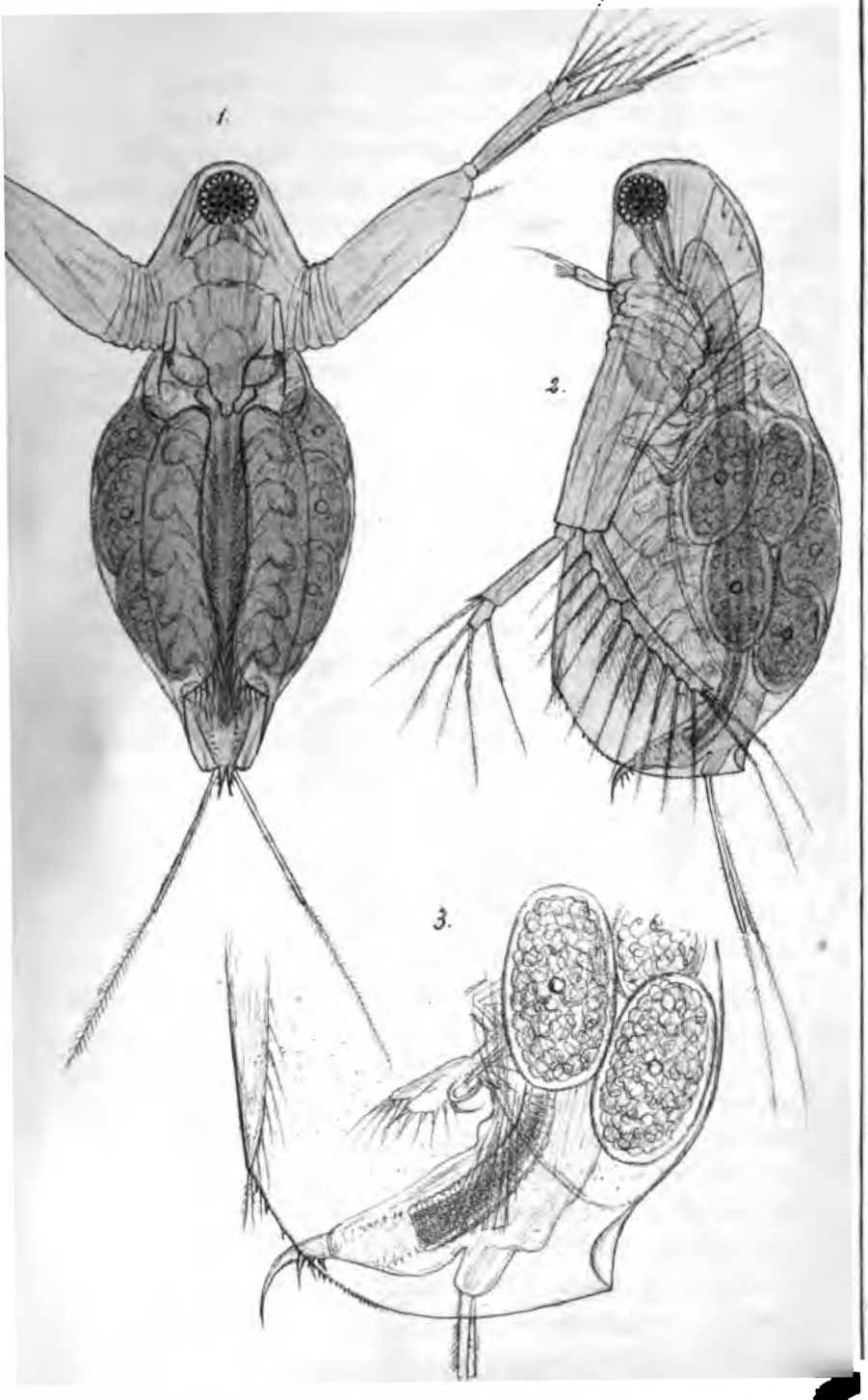
Daphnia Lümholtzi, n. sp.

Tab. I.



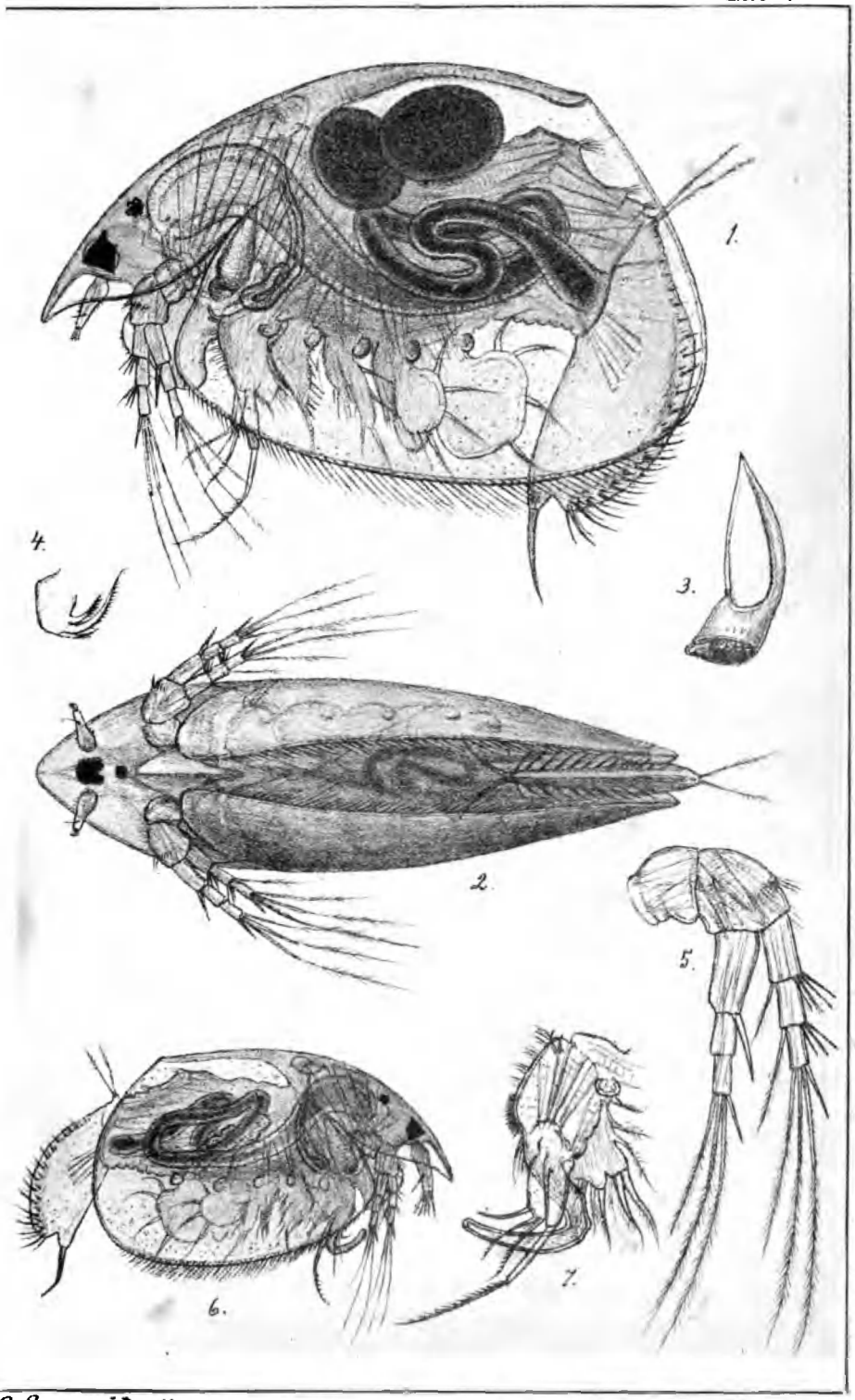
...autogr.

M. Lyngs lith. A.



s autogr.

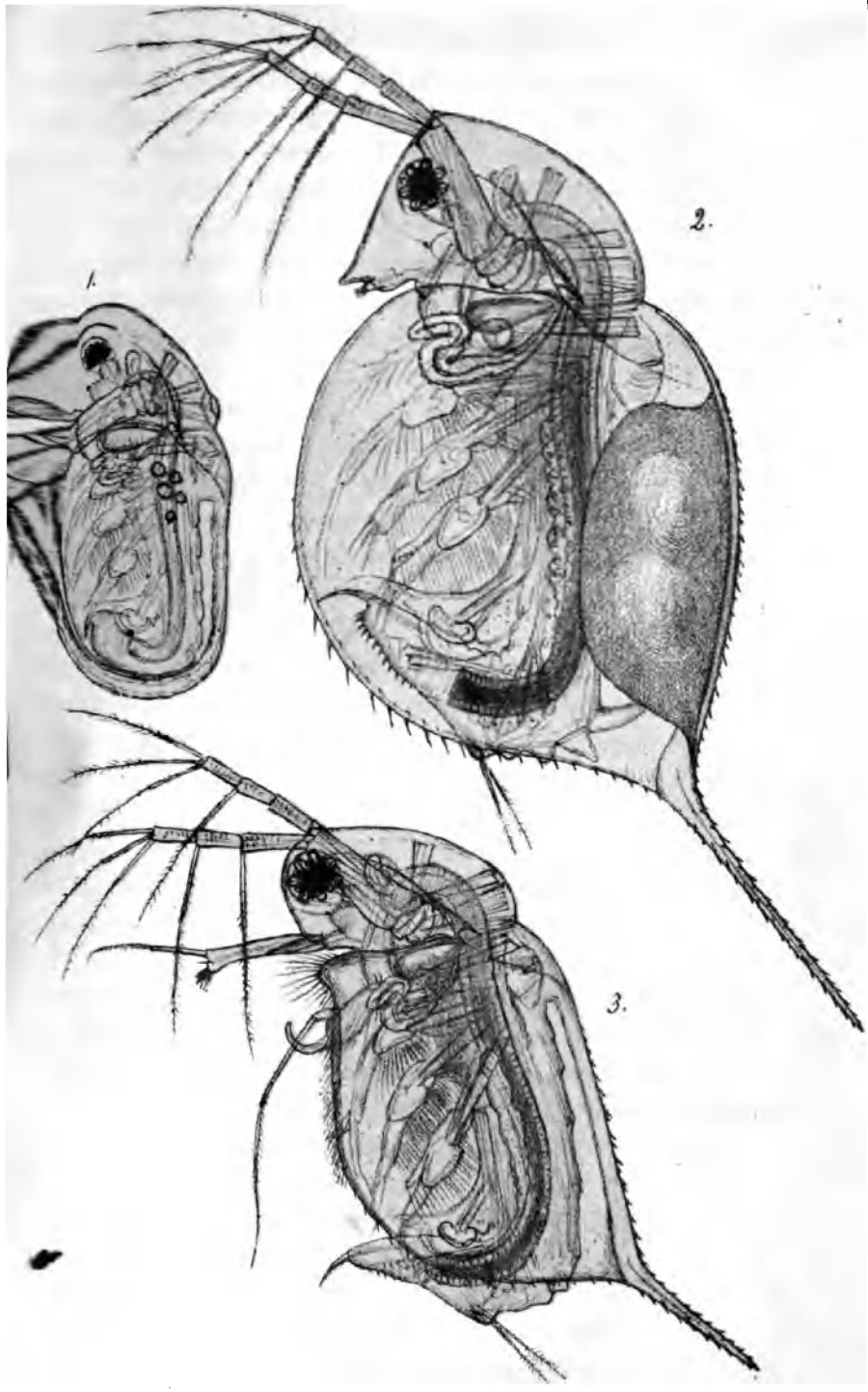
Diaphenosoma excisum, n. sp.



O. Sars autogr.

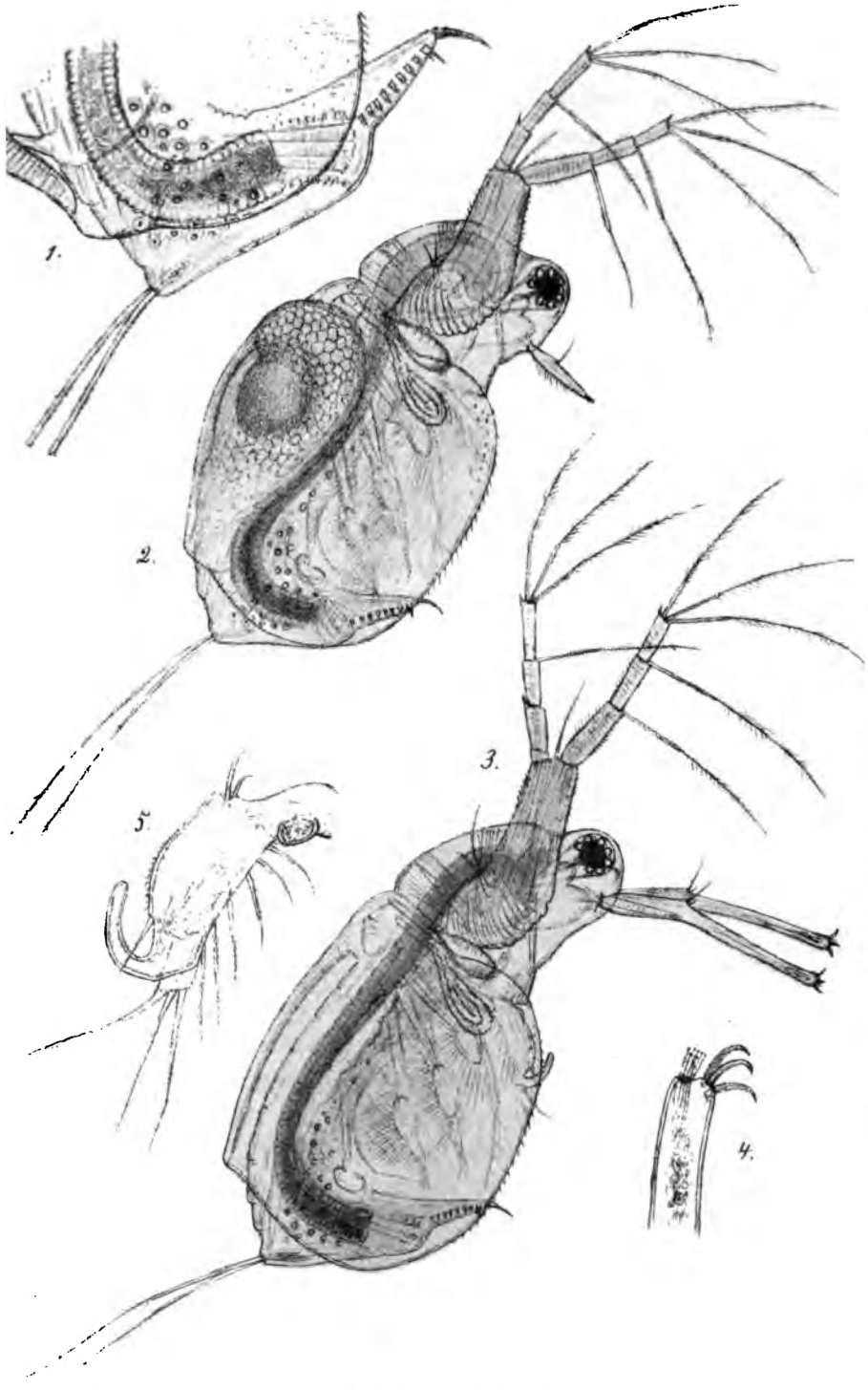
M. Lyng - lith. Anst.

Leydigia australis, n. sp.



G. O. Sars autogr.

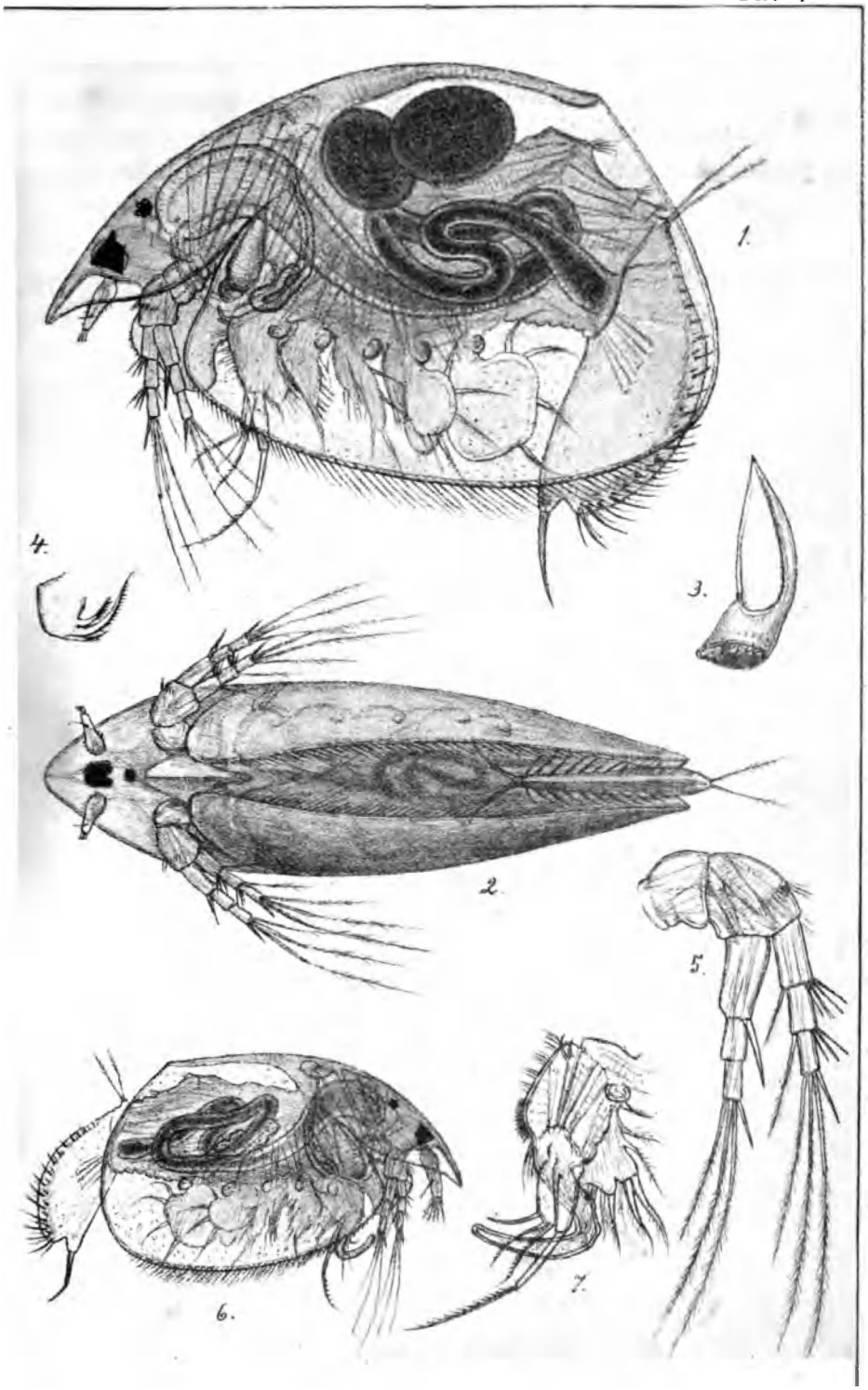
Daphnia Lümholtzi, n. sp.



G. Sars autogr.

M. Imag. ...th Anc.

Moina propinqua, n. sp.

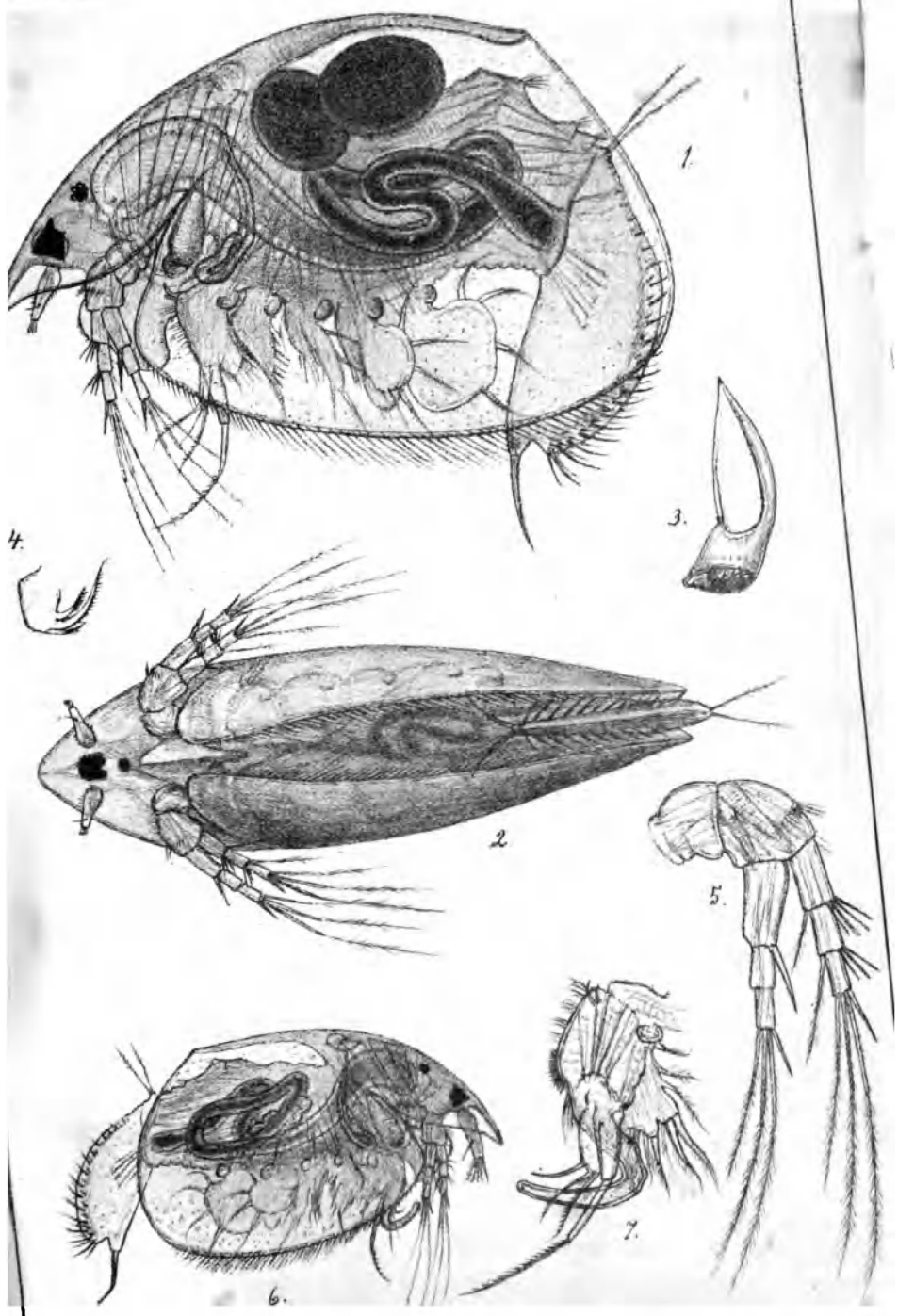


G. Sars autogr.

Lith. Anst. v. J. G. Bach, Wien.

Leydigia australis, n. sp.

Tab. 7.



G.O. Sars autogr. Leydigia australis, n. sp.