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I. Wissenschaftliche Mittheilungen.

1. Some biological and anatomical facts concerning *Parastacus*.

By Dr. Emar Lön nberg, Upsala Sweden.

(Schluß.)

The antennae of the females are also, contrary to what could be supposed, comparatively a trifle longer than those of the males, at least this is the case with the specimens I have examined. In those the tips of the antennae reach, when laid back, to the posterior margin of the second abdominal somite, but in the males only to the first.

One of the males being an exception, it is possible that a comparison of a greater number of specimens will give a different result.

The females also seem as a rule, to be smaller to judge from my specimens.

When the sexual dimorphism is so plainly developed it was not to be expected that these *Parastaci* after a closer examination of the genital organs would turn out as hermaphrodites. After removing the carapace I found in the female specimens a large ovary with well developed reddish looking eggs, and in the males a testis of normal size and colour. Both testis and ovary extend anteriorly to the stomach, posteriorly the ovary ends in the last thoracic somite, but the testis in the one next to the last. Both genital glands may be said to be composed of two portions of nearly the same size and placed in a straight angle to each

other, namely one anterior vertical, and one posterior horizontal, which latter is longer in the most developed glands. The former is laterally, the latter ventrally imbedded in the liver. The genital glands receive their shape from their situation behind the stomach beneath the heart and above the intestine, the heart being situated between the horizontal portion of the gland and the carapace. The ovary consists of two distinct halves or different glands which however in the median line lie so close together that they appear as one. They are connected by connective tissue, and between the lower half of the vertical portion seems to be a communication between them. I have not however seen any egg in that bridge so it may not be formed by sexual elements. The ventral surface of the ovary is concave to make place for the intestine. It is more difficult to get an exact idea about the shape of the testis with the material on hand. The two lateral parts are however more closely connected and the intestine seems to pierce through the organ.

The greatest interest is connected with the fact that, although these animals seem to be completely dioic, with regard to the appearance of their generative glands, every individual of both sexes is provided with two pairs of genital ducts, namely, two anterior ones leading to the »orifices« on the coxopodites of the third pair of legs, and two posterior to those of the fifth pair. In the male specimens (see Fig. 1)

Fig. 1.



the posterior ducts have their origin on the upper lateral surface of the gland about 3 mm from the posterior end and extend in a lateral backward and downward direction in an almost straight line to the opening on the fifth pair of legs. These ducts correspond to the vasa deferentia of the common crayfish, but are very much shortened in comparison with them and do not make any convolutions. Dr. von Ihering has observed these and expressed the same opinion about them. The ducts of the anterior pair take their origin close to each other in the median line near the angle between the vertical and horizontal portions of the testis. From this starting point they extend, as

is seen on the figure, along and close to the lateral surface of the gland, almost straight downwards to the genital »orifice« of the third pair of legs. It is possible that von Ihering has also seen traces of these ducts as he says: »Il m'a paru qu'un conduit très délicat se dirigeait plus en avant, à l'ouverture du 3ème coxopodite, mais je ne puis l'affirmer.« Both ducts are however, in their upper parts, of nearly the same size and it was rather easier to find the anterior ones. But the ducts to the fifth pair of legs become gradually a good deal stouter when they have entered the upper part of the leg which portions of the ducts correspond to the ductus ejaculatorius. Their width is however on my material never more than about 1 mm and hardly that much. The situation of the origin of the anterior ducts is similar to that where the vasa deferentia of the common crayfish begin. The question might therefore arise whether both pairs are able to act as spermducts. This could however hardly be discerned on this material without sections, and hardly anyway if the constitution of the genital »orifices« did not give the answer (see below).

In the females (see Fig. 2) the ducts of the anterior pair are much larger. They take their origin at the upper lateral surface of the ovary, close to the angle between the vertical and horizontal portion of the gland, and lead from there almost straight down to the orifices on the third coxopodites. These are, of course, identical with the oviducts of the common crayfish, and in one of the examined specimens I have seen an egg enter-

Fig. 2.



ing the upper part of these ducts, so there can be no doubts whatever with regard to its function. The ducts of the posterior pair begin laterally and not far from the posterior end of the ovary, as can be seen on the figure. They are much smaller than the anterior ducts and much too narrow to allow the passage of an egg. Thus they cannot act as oviducts, but are only rudiments. But it is of importance to let the genital »orifices« undergo a closer examination. It has been said above, that there are two pairs of genital orifices, namely on the third and fifth pairs of legs and it really seems to be so. If we now first select a male specimen we find the genital orifices on the coxopodites of the fifth pair of legs situated on prominent warts and about them there can be no doubt that they really are openings.

But the »orifices« on the third pair of legs, which at first seem to

be very plain, show themselves, when closer examined, to be only sham. They are but shallow grooves the appearance of which agrees very closely with the usual shape of the genital orifices of the other sex on this place. The chitinous shell is, however just about as firm on this spot as any where else on the coxopodite. Although the male *Parastacus* has two pairs of genital ducts it has only one pair of true orificies, namely, on the fifth pair of legs. If we now examine a female specimen we see at once the conical warts on the fifth coxopodites but these warts do not show, even under a lens, any opening in the tops neither can any opening be felt with a fine needle. They are sometimes provided with a groove in the top, but even then there seems to be no opening, and even if it was, this must be too small to permit the passage of an egg. On the third coxopodite of the female the genital opening is large and easily seen, but it seems to be closed by comparatively thin chitinous membrane. If we however press that membrane, only a little, it falls back and opens on the median side thus showing itself to be only a valve. The female too has thus only one pair of true genital orifices. I have made sections through the ducts to the third pair of legs of the male, as well as through the ducts to the fifth pair of the female and have found both provided with an open and well limited lumen. The former ducts have thin walls and comparatively how epithel. The latter have comparatively thick muscular walls showing most plainly circular fibres. The epithel of these »masculine ducts« of the female is different in different parts, in some it is comparatively low, in others it consists of high, cylindrical cells. The cells are always larger in these ducts than in the »feminine ducts« of the male. The state of preservation of my material does not make it advisable to go into further details. It seems, however, as if the structure of these supernumerary ducts was rather similar to that of the normal ones.

We have now seen that the above mentioned supernumerary ducts really are such, and provided with a lumen, although they cannot have any function because the exterior opening is closed. But what is the condition of the genital glands? Do they show any traces of hermaphroditism? In the females the ovaries contain large reddish looking eggs with mean diameter of 2 mm. They lie densely crowded and do not seem to leave room for anything else but eggs in this organ. But when I have taken of the substance of the testis and macerated the same in glycerine I have seen some comparatively large bodies of a very dense structure, resembling eggs. The same is the case when I have prepared sections through this organ. Here and there I have ne found the same bodies sometimes singly, sometimes in a small number

forming a group. They are perfectly distinct from the surrounding tissue of the testis, and stain very darkly. It cannot be decided on the material I have whether these bodies are eggs or not. I can only say that they very much resemble young eggs and there is a striking likeness in structure between them and the true eggs taken from an ovary.

Although I am perfectly aware that the above notes are not as satisfactory as could be wished, partly owing to the state of preservation of the specimens which certainly are good enough as objects for a museum, but not for anatomical researches. I think, however, that they ought not to be withheld because they contain certain facts which seem to be of great interest. These might be summed up as follows: 1) the supernumerary genital »orifices« on the third pair of legs in the male *Parastacus Hassleri* Faxon, and fifth of the female, are closed, 2) both sexes can be discerned on an examination of the outer parts, 3) in both sexes a pair of supernumerary 'genital ducts (thus 4 ducts in all) are present, corresponding to those of the opposite sex, 4) it seems at least possible that the masculine genital gland contains female elements (eggs), although I do not think it probable that these can be fully developed, still less be of propagative use.

Thus it may be said that in *Parastacus Hassleri* a partial hermaphroditism is prevailing, but male and female organs are not functionary in the same individual, neither are ripe elements of both sexes produced by the same specimen. The hermaphroditism could thus be called rudimentary. It can also be supposed, with all probability, that the conditions and structure of the reproductive organs of the other species of *Parastacus* in which two pairs of genital »orifices« have been observed are similar to those described above. The same might also be the case with the species »*Cheraps plebejus*« from Adelaide, the male of which von Martens has found to be provided with sexual orifices also on the third pair of legs. The author mentioned did not however find any rudiments of oviducts, but that might depend upon the state of preservation of his material. Ortmann³ and Faxon⁴ which have written later about species of *Cheraps* do not mention anything about the genital organs or openings of these forms. Our knowledge about this subject is thus very restricted, and it is not easy to draw any conclusions at present. I should however not be surprised if further investigations would reveal facts of a similar kind concerning other Decapoda Macrura.

A couple of times I have believed to have seen rudimentary ducts

³ Zool. Jahrb., Abth. Syst. VI. 1892.

⁴ l. c.

to the third pair of legs in male specimens of *Cambarus fallax* Hagen, but my material was not in such a state of preservation that I dare to affirm or to deny anything. Faxon mentions in his »Revision of the Astacida«⁵ (p. 12—14) that among all the crayfishes he has examined, he has »noted four specimens, all of them *Cambari*, that combine external structures of the two sexes«⁶. These were *C. propinquus* var. *Sanbornii* Faxon, 1 *C. Diogenes* Girard and 1 *C. propinquus* Girard. But he says that their state of preservation did not admit any closer examination of the structure of the internal generative organs. The question concerning the *Cambari* is therefore still open. In the common European crayfish *Astacus astacus* Lin. it has often been observed that females are provided with masculine looking appendages on the first abdominal somite. Dr. Bergendal has made investigations on this subject and published his observations in a paper: »Über abnorme Formen der ersten abdominalen Anhänge bei einigen Krebsweibchen«⁷ but in all cases recorded by him the abnormal crayfishes were females and true females without any trace of hermaphroditism in the internal organs and I have myself come to a similar result. The only known case of complete hermaphroditism among the Decapoda seems thus to be the lobster described by Nicholls 1730 which was provided with masculine organs on one side and feminine ones on the other. This was of course certainly a teratological case of singular kind not dependent on any heredity.

New and more extensive investigations on well preserved and fresh material especially of *Parastacina* are however needed before the last word can be said concerning the rudimentary hermaphroditism of these animals.

The crayfishes treated above belong, as is already mentioned to the species *Parastacus Hassleri* Faxon and are collected by Mr. P. Dusén (1./10. 1896) at Taleahuano which is the same place from which Faxon's specimens originated. They are thus topotypes to them. They agree also in every respect with the description given by Faxon except when he says: »The median carina of the inner branch of the posterior pair of abdominal appendages ends near the hind margin without developing a spine.« I have namely seen a small spine there in some of my specimens, but this character seems to be variable and is not even a sexual characteristic.

The sides of the carapace covering the branchial chamber are

⁵ Mem. Mus. Comp. Zool. Vol. X. Cambridge, Mass. 1885.

⁶ On the same page is also a quotation from Desmarest and Rousseau about a female *Astacus astacus* with branched oviducts..

⁷ Bih. K. Sv. Vet. Akad. Handl. Bd. 14. Stockholm 1888. *ibid.* Bd. 15. 1898.

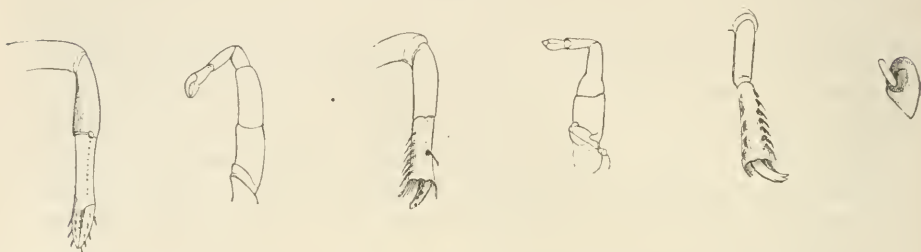
beset with numerous seta, each implanted at the anterior margin of a granule: and between these granules a large number of tiny grooves are seen. The posterior margin of the cervical groove is armed with a dense row of setae (see Fig. 1). It seems probable that these features stand in connection with some biological peculiarities of these crayfishes. The structure of the carapace on the branchial chamber seems to be apt to retain the humidity longer on this place than if it was smooth and this might be of use if the crayfishes should make any excursions on dry land. The inner surface of the carapace covering the branchial chamber is also very densely hairy which also serves the same purpose to retain the water. The armature of the cervical groove would help to carry water (rain?) from the back to the anterior branchial opening along the cervical groove.

I am indebted to Mr. P. Dusén for the following interesting information concerning *Parastacus Hassleri*. The places, where these crayfishes lived, were slightly sloping, moist meadows. The humidity on the surface was however not greater than that Mr. Dusén could walk there with dry shoes. It was no open water whatever, lake or river, in the neighbourhood. Here they crayfishes had made vertical holes in the earth and round these holes they had erected »mudchimneys« out of the clayey material which they had carried up from their burrows. These chimneys had often a height of 2—3 decm; but were sometimes lower and sometimes there was only a heap of earth like a small molehill round the opening. In the latter case Mr. Dusén expressed as his opinion that possibly the rain had broken down the »chimney« because there were often heavy rains while he visited these parts. The crayfish is edible and offered for sale in the market. It is caught by the native boys which thrust their arms in the above mentioned holes and by making pumping motions they soon draw up water and with that the crayfish. It is apparent from this description that these crayfishes lead a subterranean life in the groundwater. But I hardly think that they can find sufficient food in their burrows. It seems therefore probable that they leave their homes during night time and in the rainy season and make excursions on the surface. Such habits would explain the above described structure of the carapace. There are however many biological features of these and related animals which need to become better known and explained. *Parastacus* is not alone in its subterranean habits. Faxon in his mentioned papers gives references from different authors which have observed similar habits in species of *Cheraps*, *Cambarus* a. o.; some *Cambari* even building »mudchimneys«. In Florida I sometimes saw *Cambari* in holes which were quite remote from the nearest lakeshore but the holes had usually reached the

groundwater. They lived thus however in water or could at least reach water, but in moist places *Cambari* can live quite well without being submerged in water. This can, for instance, be proved by the fact that the late Capt. C. Eckman at Savannah Ga. collected *Cambari* (*Blandingii*) in the hollow trunk of a fallen tree two english miles from any open water. The inner side of the carapace covering the branchial chamber of these *Cambari* was also very hairy, so this adaption seems to be common to several crayfishes with similar habits.

Parastacus Hassleri Faxon seems to be a good fighter but when it comes to a tight squeeze it sometimes saves itself by sacrificing one or more of its legs. The autotomy seems nearly always to take place at

Fig. 3.



the joint between the second and third segments of the legs. Only once have I seen this at other joints and then the reproduction seems to follow rather quickly as can be seen on Fig. 3. This shows namely the normal ends of the third (III), fourth (IV) and fifth (V) pairs of legs as well as the reproduced parts of corresponding legs (III, IV, V) which have not yet attained either normal shape or full size.

2. Flügelrudimente bei den Caraben.

Von Jaroslav R. v. Lomnicki, Lemberg.

eingeg. 25. April 1895.

Große Laufkäferarten, welche der Gattung *Carabus* Linn. angehören, werden von den Entomologen schlechtweg als ungeflügelt betrachtet. Es wird natürlich das Fehlen des zweiten Flügelpaares gemeint, da das erste Paar als Flügeldecken, welche bei allen Formen groß genug sind, ja meistens ungefähr zwei Drittel der ganzen Körperlänge einnehmen, wohlbekannt sind. Es wird zwar von einigen¹ Formen berichtet, daß unter flügellosen, manchmal geflügelte

¹ Ludwig Ganglbauer, Die Käfer von Mitteleuropa. Wien, 1892. Im ersten Bande, p. 40, spricht der Verf.: Geflügelt sind nur in sehr seltenen Fällen einzelne Individuen weniger Arten (*clathratus*, *granulatus*).

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