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Art. VIII.—*On Two New Species of Chaetogaster.*

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(With Plate IX).

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Introduction.

Chaetogaster is a genus of small, transparent worms, living on certain fresh-water snails, clinging to them by means of a posterior sucker, or as is sometimes found, crawling about right in the pulmonary chamber, into which it has worked it way through the pulmonary opening.

It does not seem to be confined to any one species of snail; I have found it on species of *Limnaea*, *Isidora* and on *Planorbis gilberti*.

On *Planorbis* it was quite abundant, and could be seen in the pulmonary chamber. This is worthy of note, as Dr. Annandale remarks of *C. bengalensis* that he saw "in one instance, in an aquarium in which snails were somewhat scanty, a solitary worm attempting to establish itself on a *Planorbis;* but the connection was only temporary, not lasting for more than a few minutes. The mouth of the shell in this genus is too constricted to be suitable for the worm, which is generally gregarious." On the other hand not only, as above remarked, did I find *C. australis* infesting species belonging to three genera of fresh water snails, but in some cases it even preferred *Planorbis* to either *Limnaea* or *Isidora*, when all three were present in the one jar.

The fact that the Australian *Chaetogaster* is found on these three genera is noteworthy. In Europe it is found on *Limnaea*, while here it is found on *Limnaea*, *Isidora* and *Planorbis*. In the same way in *Fasciola* the cercariae are found in Europe in *Limnaea*, while here they are found in several different genera; there is a question whether *Fasciola* has been introduced on some Limnaeae and spread here to other genera, and the same question, from analogy, may be raised with regard to *Chaetogaster*.

According to Beddard the genus *Chaetogaster* belongs to the Naidomorpha, a group of Oligochaetes which has already been recorded from Europe, America and Asia (India); but as far as I

can ascertain there has been no species of *Chaetogaster* hitherto recorded from Australia. During last year I found some of the pond snails I was keeping in vessels infested with this small parasite. These snails came originally from Merri Creek, Weeweerup, Yackandandah, and Geelong; and it is probable that the parasite also came from these several localities, as there does not seem to have been any possibility of infection between the separate jars. On examination there were found to be two species present. In most of the jars there was the form I shall describe as *Chaetogaster australis*, and this was present in very great numbers; but in one jar (from Merri Creek), and also on some snails in a pond in the University grounds, parasitic on a species of *Isidora* (*I. texturata*), were a few specimens of a much large species, which I shall describe as *Chaetogaster victoriensis*.

A great deal of the structure of *Chaetogaster* can be made out by examining the living animal, as it is very transparent. I also worked with sections, both transverse and longitudinal, and with preserved animals, stained and mounted whole. *Chaetogaster* is very difficult to kill satisfactorily, as it contracts rapidly and disintegrates very readily. The method I found most successful was to kill the animal by pouring on to it boiling 70 per cent. absolute alcohol. This acts as a fixing and preserving agent. I used several different stains; the most satisfactory were methyl blue for staining whilst alive, borax carmine for the specimens mounted whole, and acetic acid alum carmine for the sections.

Chaetogaster australis, sp. n.

External Characters.

Length.—The length varies from 0.88 mms. to 1.83 mms. Average individuals measure about 1.4 mms. The largest measured (1.83 mms.) was almost divided.

The prostomium is circular and sucker-like; this is most clearly seen in the living animal, which moves along with a looping movement, very much like a leech. The mouth is on the ventral surface; the anus is terminal. At the posterior end there is no definite sucker, but the animal seems capable of slightly flattening its body so as to somewhat resemble one.

The setae are arranged in bundles; typically there is a pair of bundles of setae in each segment; but after the first pair there is an interval without any setae; the second pair of bundles is in the sixth segment. Then they are arranged regularly, a pair in each segment, to the posterior end.

Dorsally there are little papillae, each with two or three fine short hairs; these are probably sensitive, and are only clearly seen when the living animal is treated with some foreign substance such as methyl blue. There are also a number of coarser hairs round the anterior and posterior ends.

There is no clitellum.

Asexual reproduction, by means of fission, is a marked characteristic of this animal; but in this species I could find no case of secondary fission as described in other species.

Segmentation.

Segmentation is marked externally by the setae; there being typically a pair of bundles of setae in each segment, but the second bundle marks the sixth segment, there being an asetigerous portion between the first and second bundle. The posterior segments are shorter than the anterior, and, consequently, the setae are closer together.

Internally segmentation is marked by the septa, and the ganglia of the ventral nerve cord. The number of segments varies, as new ones are constantly being added. Asexual reproduction takes place in consequence of this. The shortest animal I met with consisted of eleven segments.

In eighteen specimens examined :—

2	having	19	segments,	the	line	of	fission	was	between	10	and	11	
1	,,	15	,,	,,	,,	,,	,,	,,	,,	11	,,	12	
3	,,	15	,,	,,	,,	,,	,,	,,	,,	9	,,	10	
3	,,	14	,,	,,	,,	,,	,,	,,	,,	9	,,	10	
6	,,	13	,,	,,	,,	,,	,,	,,	,,	9	,,	10	
1	,,	12	,,	,,	,,	,,	,,	,,	,,	8	,,	9	
1	,,	12	,,	was not dividing.									
1	,,	11	,,	,,	,,	,,							

The above list seems to point to the formation of new segments on each side of the line of fission, and not only in the posterior segments, though the new segments seem to be formed more rapidly at the posterior end.

Setae.

The setae, as has been stated before, are arranged in bundles, and there are typically a pair of bundles in each segment. Each bundle is placed ventro-laterally, and consists of from 8 to 11 setae, arranged in a semi-circle (Fig. vi. C.), except in the first bundle, which is straight. (Fig. vi. B.) In connection with these setae

there are strong muscles so arranged that the setae are capable of rotary movement or up and down, or they can spread out like a fan. The setae of the first bundle are longer than those of the others, being approximately half as long again; they are situated at the level of the pharynx, while the second are at the level of the hinder end of the crop. Each seta is somewhat *f* shaped, bifurcated at one end, with two unequal prongs, and a swelling near the middle. (Fig. vi. A.) There are no dorsal setae.

Body Cavity.

The body cavity is divided up by the septa into segments. The septa are more clearly distinguished towards the anterior end, and by their aid we find the portion without setae consists of three segments. (Fig. i.). Each septum is very thin, with here and there a slight swelling caused by nuclei. The first septum is behind the pharynx, the second at the beginning of the crop, the third and fourth in the region of the crop, and the fifth at the posterior end of the crop. (Fig. i.)

I could not see any corpuscles in the body cavity.

Alimentary Canal.

The mouth, which is large and circular, opens on the ventral surface; the buccal cavity is somewhat globular anteriorly, but narrows posteriorly; (Fig. iv. BC) it is lined with indefinite cells without any clear nuclei, and its walls are very much strengthened by muscle bands.

The pharynx (Fig. iv. P.) is a wide tube leading from the buccal cavity to the oesophagus. Its walls are also very muscular. It extends back to the third segment.

After this the canal narrows to form the oesophagus (Fig. iv. O.; Fig. i. O.), lying in the third segment. This differs from the pharynx in being of much smaller size, not so muscular, and in having its inner lining thrown into more folds. The buccal cavity, pharynx, and oesophagus are, all three, attached to the body wall by numerous strong muscle bands.

The canal then, in the fourth, fifth and sixth segments, forms another dilatation, the crop. (Figs. i and iv. C.) This is about twice as long as the pharynx, is not attached to the body wall by well-defined muscle bands, and contains little muscular tissue, but has little blocks of muscle round the outside of its walls, and is lined by large distinct glandular cells, with very distinct nuclei and nucleoli. (Fig. iv. C.)

The stomach (Fig. i. S.) is marked off from the crop by a very definite constriction. The stomach and intestine (Fig. i. I.) are not clearly distinguishable in prepared specimens, but in the living animal the stomach can be distinguished by its refractive particles. Their walls are more muscular than those of the crop, and the lumen much smaller owing partly to the greater development of the lining cells. These cells are not nearly so distinct as in the crop, and their nuclei are not so clear. The stomach occupies the seventh and eighth segments, and the intestine runs from this to the posterior end, where the anus opens to the exterior.

Circulatory System.

The blood is colourless and has no corpuscles. There is a distinct dorsal contractile vessel running from behind forwards; its pulsations are very noticeable just about the junction of the oesophagus and the crop. Here it appears to form a dilatation, and a little in front of this a vessel runs down either side of the oesophagus, and the two unite to form a ventral vessel.

Excretory System.

The excretory system consists of paired nephridia. They are constantly found in the seventh and eighth segments (Fig.i. N.), and often in the tenth and eleventh, and sometimes immature ones more posterior still. They are not found in the newly-formed segments. The openings of the nephridia to the exterior are situated immediately in front of the bundle of setae of the same segment. Following back from the opening to the exterior, is a diverticulum, and beyond this a dilatation, then follows a coiled tube, which ends in a swelling near to the anterior septum of the segment, to which it seems to be attached by muscle fibres. (Fig. vii. A.)

Nervous System.

The nervous system consists of a dorsal cerebral ganglion (Fig. i. C.G.); from this nerve commissures run round either side of the alimentary canal to a ventral ganglion. Running from this there is, typically, a ventral nerve cord (Fig. i., N.C.), with a ganglion in each segment; but in the anterior segments the nerve cord is double; and in the asetigerous portion the ganglia somewhat irregular and ill-defined.

Reproductive System.

I could not discover any trace of reproductive organs in any specimen I examined. Asexual reproduction is, however, very common; in fact, a normal individual without any trace of fission is not at all common.

Asexual Reproduction.

Mr. H. Seddon, L.V.Sc., of the Veterinary School, and Mr. J. Brake, B.Sc., of the Biology School, were good enough to take some micro-photographs of *C. australis* during fission, and drawings from these are reproduced in Figs. viii. to xvi.

Normally, asexual reproduction begins to take place when the animal consists of about 12 segments. But actual fission does not take place till more segments have been added on each side of the line of fission. The process may be artificially hastened, is not actually brought about by heat, scarcity of water, or treatment with some foreign material, e.g., methyl blue in small quantities, or some other water stain, if very dilute solutions are used; if the solution be too strong, or the water begins to dry up through evavoration too quickly, the animal disintegrates at once. This had to be borne in mind while the photographs were being taken, and plenty of water given the animals.

The first indication that fission is about to take place, is a thickening and wrinkling of the body wall about the region of the eighth segment. At the same time outgrowths from the ventral nerve cord grow up either side of the alimentary canal, under the thickening, about the line of future fission, and finally form a nerve ring round the alimentary canal. The thickening is at first fairly wide (Fig. viii.), but later it narrows to form just a line across from side to side. For a long time the animal remains at this stage, indicated in Figs. x and xi.; this almost has the appearance of disintegration, but the actual animal these photographs were taken from divided after this stage, and formed two new individuals very like those represented in Fig. xvi. With regard to the organs, the canal becomes differentiated to form the new parts of the new individuals. That is, the intestine of the original individual lengthens, and finally becomes divided and differentiated to form the whole canal of one of the new individuals; and the stomach of the original individual, with a small part of the intestine, lengthens, and finally becomes stomach and intestine of the second new individual; so for a time the mouth and the anus of the two new individuals are in

contact. In Figs. xi. and xiv. it seems as if these organs actually function as such before complete fission takes place.

The nerve ring is formed by the outgrowths from the nerve cord, which have already been mentioned. New setae are formed very quickly. I was not able to make out the method of their formation. The nephridia are not formed until some time later. The portion between the first two bundles of setae after the line of fission lengthens out rapidly, and finally after the animal has been lying quiescent for some time, it gives a series of rapid contractions, and the two new individuals jerk themselves apart.

Figs. xii. and xiii. show an individual in which the line of fission is narrowing down.

Fig. xiv. shows another individual at the stage represented in Fig. x. This individual also divided afterwards.

Fig. xv. shows a stage between those represented in Figs. viii. and ix. Fig. xvi. shows two new individuals immediately after fission.

Chaetogaster victoriensis, sp. n.

External Characters.

Length.—The length varies from 6 to 9 mms. Average individuals measure about 8 mms.

The animal is much larger than *C. australis;* it is less inclined to disintegrate, contains more segments, and, consequently, the asetigerous portion seems comparatively shorter.

There is no clitellum.

C. victoriensis, like *C. australis*, reproduces asexually by fission, but differs in that in this species secondary fission takes place as a rule, before the primary fission is complete.

The prostomium is circular, the mouth ventral, the anus terminal. The setae are arranged in bundles as in *C. australis*. There are some fine hairs round the two ends of the animal.

An average animal consists of about 20 segments. I could find no individual in this species that had no trace of fission; in fact, each specimen not only showed signs of primary fission, but of secondary as well.

Movement takes place by means of a series of contractions and expansions with the aid of anterior and posterior suckers, somewhat like a leech.

The setae are arranged in bundles, and there are typically a pair of bundles in each segment. There is also the asetigerous portion followed by the bundle in the sixth segment. Each bundle consists of from 5 to 9 setae.

Segmentation.

Segmentation is marked externally by the setae, internally by the septa, nephridia and ganglia of the ventral nerve cord. The number of segments varies; the individuals I observed consisted of from 16 to 25 segments.

Setae.

The setae of the first bundle are longer than those of the others. Each seta is of the same general shape as in *C. australis*, but is much longer in comparison to the difference in the size of the animals, and the forked end is much shorter. There are also fewer in each bundle than in *C. australis*.

Body Cavity.

The body cavity is divided by the septa into segments. The septa are more clearly distinguished towards the anterior end. The first septum is behind the pharynx, the second behind the oesophagus, the sixth behind the crop, the ninth behind the stomach. (Fig. ii.)

Alimentary Canal.

The mouth (Fig. ii. M.) is large and circular; it is situated on the ventral surface, and opens into the buccal cavity (Fig. ii. B.C.), which leads to the pharynx. (Fig. ii. P.)

The pharynx is extremely muscular, and is attached to the body wall by muscle bands.

The oesophagus (Fig. ii. O.) is short and narrow, and leads into a large, thin walled sac, the crop (Fig. ii. C.), the walls of which appear to be only one cell thick.

A well-marked constriction separates the crop and stomach.

The stomach (Fig. ii. S.), lying in the seventh, eighth, and ninth segments, is better defined than in *C. australis;* it is a dilatation of the alimentary canal not so wide as the crop, and narrowing posteriorly to pass into the intestine (Fig. ii. I.), which runs to the anus.

Circulatory System.

The blood is colourless, and has no corpuscles. The course of the blood vessels is similar to that in *C. Australis.*

Excretory System.

The excretory system consists of a number of paired nephridia, and there are typically a pair of these in each segment. (Fig. ii. N.) They generally commence in about the seventh segment, being

absent in the more anterior ones. From this backwards there appears to be a pair in each segment, except in those segments across which future fission takes place. Here it would be hard to distinguish them if they were present, owing to the thickening of the body wall, and the outgrowths from the ventral nerve cord.

The openings of the nephridia to the exterior are situated immediately in front of the bundles of setae of the same segment; following back from this opening is a dilatation, and back from this a much coiled tube ending in a large swelling. (Fig. vii. B.)

Nervous System.

The nervous system consists of a dorsal bilobed cerebral ganglion (Fig. iii. C.G.); from this two stout commissures run down either side of the pharynx, and from a bilobed ventral ganglion (Fig. iii. A.V.G.); from this the ventral nerve cord (Fig. iii. N.C.) runs down, with typically a ganglion in each segment; but in the anterior segments the ganglia are somewhat irregular, and the nerve cord and ganglia are double. This is clearly seen in Fig. iii.

Reproductive System.

I could not discover a trace of reproductive organs in any specimen I examined. The animal reproduces asexually by fission; but it seems to be a much slower process than in *C. australis*. Also secondary fission before primary is complete seems to be the rule in this species. (Fig. ii. L.F.2.)

It is doubtful whether these species of Chaetogaster are truly parasitic. In some individuals small crustaceans were found in the alimentary canal, but in others it was almost empty. The fact that specimens were found in the pulmonary chamber also indicates that there may be another mode of nutrition. It certainly seemed to cause the death of a great many snails in my vessels; but this may have been due to suffcation by the blocking up of the pulmonary chamber and its opening by the worms. Some of the European species are said to be internal parasites, but most others seem to use the snail more as a means of progression and as a shelter.

C. australis appears to most resemble *C. bengalensis*. It differs from it in the number of its setae in each bundle, and their different arrangement; in its much smaller size and in several minor characteristics; *C. australis* also has a preference for crawling right into the pulmonary chamber of the snail rather than staying on the outside.

C. victoriensis appears very different. It resembles *C pellucidus* and *C. punjabensis*, etc., in secondary fission. It is much larger than *C. punjabensis*, and a little larger than *C. pellucidus*, being nearest *C. bengalensis* in this respect.

A very marked feature in *C. victoriensis* is the fact that the anterior portion of the nervous system is completely double (this is clearly seen by reference to Fig. iii.), while in *C. australis* only the cord itself is double.

In *C. victoriensis* I could not see any of the dorsal papillae and hairs as in *C. australis*. Both *C. australis* and *C. victoriensis* resemble *C. filiformis* in the absence of the dilatations of the oesophagus.

I should now like to thank Professor Spencer and Dr. Hall, under whom this work has been undertaken, for all their help and advice.

LITERATURE.

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EXPLANATION OF PLATES.

In all figures :—

A.	Anus.
A.V.G.	Anterior ventral ganglion.
B.C.	Buccal cavity.
C.	Crop.
C.G.	Cerebral ganglion.
C.T.	Coiled tube.
Com.	Commissure.
I.	Intestine.
L.F.	Line of fission.
L.F.1.	Primary line of fission.
L.F.2.	Secondary line of fission.
M.	Mouth.
Mus.	Muscle.

N.	Nephridium.
N.C.	Nerve cord.
N.C.O.	Outgrowth from nerve cord.
N.G.	Nerve ganglion.
N.O.	Opening of nephridia to the exterior.
O.	Oesophagus.
P.	Pharynx.
S.	Stomach.
Sp.	Septum.
Fig. i.	C. australis (living animal).
Fig. ii.	C. victoriensis (living animal).
Fig. iii.	C. victoriensis, head.
Fig. iv.	C. australis, longitudinal section of anterior portion.
Fig. v.	C. victoriensis, setae — A. Typical seta. B. Anterior group of setae.
Fig. vi.	C. australis, setae. — C. A typical group of setae.
Fig. vii.a.	C. australis, nephridium.
Fig. vii.b.	C. victoriensis, nephridium.
Figs. viii.-xi.	C. australis, different stages in the division of an individual A.
Figs. xii.-xiii.	C. australis, division of an individual B.
Figs. xiv.-xvi.	C. australis, stages in the division of three individuals C, D, E.