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AN AUSTRALIAN CHÆTOGNATH.

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(Plate lxxi.)

The Chaetognatha of the South Pacific are very imperfectly known. Dr. G. H. Fowler¹ in his Monograph mentions "the amazing fact that between 160° E. and 80° W. we have not a single record of a Chaetognath" Dr. O. Steinhaus² recorded the capture of *Sagitta enflata*, Grassi, in 28° S., 160° E., that is west of New Caledonia, and Prof. F. J. Parker³ mentioned the finding of *Krohnia hamata*, Moebius, south of New Zealand. Mr. S. Kent's⁴ *Sagitta tricuspidata* from the South Pacific bears no definite locality and is now regarded as a variety of *S. hexaptera*, d'Orb. Excluding the important work of Mr. T. Aida⁵ on Japanese forms and of Dr. Fowler on specimens collected by the "Siboga"⁶ (East Indies), "Challenger"⁷ (Arctic and Sub-Antarctic waters), and "Discovery"⁷ (Antarctic Ocean), I do not know of any other references to Pacific forms. There has not been any record whatever of any Australian members, excepting the mention of *Sagitta*, sp., by Mr. T. Whitelegge,⁸ as occurring in Port Jackson.

This aberrant group appears to be well represented in New South Wales waters. In 1898 Mr. Whitelegge found some specimens washed up on Maroubra Beach, just south of Sydney. These were presented to the Sydney University (Biology Department), some of which were given to me by Dr. J. P. Hill. These are described in this paper. In 1906 Professor W. A. Haswell

¹ Fowler—Chaetognatha (Siboga Expd. Monogr., xxi., 1906, p. 67).

² Steinhaus—Die Verbreitung der Chaetognathen im Sudatlantischen und indischen Ozean, 1896.

³ Parker—Remarks on a Spadella from N.Z. waters. (Trans. N.Z. Instit., xxviii., 1895, p. 758.)

⁴ Kent—On a New Species of Sagitta from the South Pacific. (Ann. Mag. Nat. Hist., (4), v., 1870, p. 268.)

⁵ Aida—Chaetognaths of Misaki Harbour. (Annot. Zool. Japon., i., Parts 1, 2, 1897, p. 13.)

⁶ Fowler—*Loc. cit.*

⁷ Fowler—Chaetognatha (National Antarctic Expedn., iii., 1908.) The "Challenger" forms are recorded along with those obtained by the "Discovery."

⁸ Whitelegge—List of Marine and Freshwater Invert. Fauna of Pt. Jackson. (Journ. Roy. Soc. N. S. Wales, xxiii., 1889, p. 163.)

collected some about fifty miles east of Sydney; in 1907 Mr. J. H. Close secured a fair number of small forms in Port Jackson, and last year (1908) Mr. S. J. Johnston secured some more, also in Sydney Harbour. Besides *Sagitta serrodentata*, Krohn, several other species are represented in the above collections, all of which have been handed over to me.

Fowler⁹ and Michael¹⁰ state that the best preservative for these delicate organisms is weak formalin; spirit producing considerable distortion and the disappearance of the corona ciliata. Whitelegge's specimens were preserved in alcohol, hence the contracted state of the worms.

Many writers have mentioned the fact that insufficient descriptions have led to the establishment of many doubtful species. The limits of variation in this group being very considerable, the examination of a large number of specimens is necessary to firmly establish and accurately define a species. There were only a dozen at my disposal, all already mounted, and consequently I am giving as complete a description as possible, leaving authorities on this group to decide the validity of the proposed new species.

The main results are tabulated along lines similar to those in Fowler's papers. The headings are (a) length of animal in millimetres, (b) length of tail in mm, (c) length of tail as approximate percentage of total length, (d) number of jaws, (e) number of anterior teeth, (f) number of posterior teeth. The tail fin is not included in the following measurements:—

| a | b | c | d | e | f | |
|------|-----|------|----|------|-----|-------------|
| 12 | 2.1 | 17.5 | 9 | 6.7 | 9 | ova present |
| 13.5 | 2.5 | 18 | 9? | ? | ? | " " |
| 14.2 | 2.5 | 17 | 9 | 6.7 | 8.9 | " " |
| 15.0 | 2.7 | 18 | 9 | 8.12 | 7.9 | " " |
| 15.0 | 2.4 | 16 | 9 | 10? | 8.9 | adult " |
| 17.5 | 2.9 | 16.5 | 9 | 7? | 11 | ova present |
| 18.2 | 3.0 | 16.5 | 9 | 7 | 7 | " " |
| 18.5 | 3.4 | 18 | 9 | 7? | 8? | " " |
| 19.0 | 3.1 | 16 | 9 | 12 | 7 | adult " |
| 21.3 | 3.7 | 17 | 9 | ? | 9? | " " |
| 24.0 | 4.0 | 16.5 | 9 | 6? | 11 | " " |

⁹ Fowler—*Loc. cit.*, p. 2.

¹⁰ Michael—Notes on the Identification of Chaetognaths. (Biol. Bull. xv., 1908, No. 2.)

The last specimen is the most typical and has been selected as the type, the description referring mainly to it.

The head is fairly prominent, its breadth being about 1.8 mm. and its length one millimetre. The jaws are set fanwise, the animal being in a state of medium contraction. There is a neck constriction present, the breadth here being one mm. From the point the body widens rapidly to 1.2 mm. and then gradually to 2.7 mm. in the region of the ventral ganglion, finally reaching 3.2 mm. at about the middle of the body. The breadth is fairly well maintained almost to tail septum, where there is a sudden narrowing to 1.5 mm. The tail is four mm. long, thus being one-sixth of the total length of the animal (sixteen to eighteen per cent.). The extremity is rounded. There is no collarette present. The lateral fields are rather wide, and the longitudinal muscles moderately developed. Consequently the worm is transparent and flabby (Plate lxxi., fig.1).

There are two pairs of fins, the anterior being carried out of their normal position in most specimens, probably the result of preservation in alcohol. The relative position and size of the anterior and posterior fins have been determined by examining serial sections kindly lent by Professor Haswell. The two pairs are approximately equal in length. The anterior is perhaps slightly longer and extends from just in front of the ventral ganglion backwards for about five mm., its greatest width being at some distance behind the ganglion. It is not quite as wide as the posterior fin. Between the two fins on the same side there is a considerable interval amounting to about eight per cent. of the total length of the worm. The posterior fin is somewhat triangular, the apex being rounded. The greatest width is just behind the tail septum. The anterior end does not extend as far forwards as the front of the ovary in some specimens, while in others it reaches beyond it. The posterior extremity of this fin is 1.3 mm. distant from the vesicula seminalis. The tail fin is bilobed and prominent. It does not extend as far forwards as the seminal vesicles. Rays are present in all fins.

A characteristic feature of the Chaetognatha is the possession of jaws, the number varying within the species. If the table be referred to, it will be noticed that there are nine pairs in every specimen examined, though the animals vary in size from twelve to twenty-four millimetres. The presence of nine pairs may be specifically constant. They are rather strongly curved, the back of the "point" of the jaw being a little more bent than the back of the "shaft." The inner edges of point and shaft are evenly curved. The jaws of *Sagitta furcata*, Steinhaus, and *S. enflata*,

Grassi, possess certain characters noted by Dr. T. Krumbach,¹¹ which are very similar to what occurs in this species. *S. sibogæ*, Fowler, judging from a sketch of the tip of a jaw, seems to approach even more nearly. The base of the point is oval, and the pulp is situated nearer the back than the front edge, but not as closely as in *S. furcata*. The pulp reaches further towards the tip than is figured in other species. The shaft bears neither crest nor serrations. The outermost jaws are longest, being nearly a millimetre in length, and most curved. Their bases are relatively small. The youngest are only about 0.25 mm. long, and are least curved. They possess a large basal part (Pl. lxxi., figs. 2, 3, 4).

There are two rows of teeth, the anterior containing from six to twelve, the posterior seven to eleven. These teeth are fairly long and strong, the points being small and sharp, especially in the case of those belonging to the posterior row. The inmost tooth of this row measured .079 mm. long, .013 mm. being the greatest breadth (Pl. lxxi., fig. 2).

The vestibular ridge is rather high and bears a number of low rounded papillæ. It ends in a prominent lateral process. The whole structure does not extend as far outwards as the tooth row, two posterior teeth being situated quite externally to it (Pl. lxxi., fig. 5).

A satisfactory account of the nervous and sensory systems cannot be given here, on account of the imperfect preservation. Neither optic nerves nor eyes are recognisable with any degree of certainty. The position of the brain is outlined on Pl. lxxi., fig. 2. The buccal nerves could be traced only a little distance. The ventral ganglion is rather long and broad. It lies between the epidermis and the muscle layer. The corona ciliata has disappeared from all specimens. One specimen shows a structure which may be a remnant of that organ.

The body wall consists of the usual layers, (a) epidermis, (b) muscle layer, and, internally, (c) the cœlomic epithelium. There is a very delicate basement membrane between (a) and (b). The muscles are arranged in four bundles, two dorso-lateral and two ventro-lateral, each pair being separated along the mid-dorsal and mid-ventral lines respectively by the mesentery. The individual muscle fibres are easily recognisable. The oblique and transverse muscles of the head, whose function is to move the jaws, are powerful.

¹¹ Krumbach—Zoolog. Jahrb. Abth. Syst., xviii., 1903, p. 579.

The cœlomic epithelium lines the inner surface of the muscle as a single celled layer. It is present on the mesentery and forms the cœlomic lining of the alimentary canal.

This canal extends as a simple wide tube from the slit-like longitudinal mouth to the anus situated just behind the junction of the body and tail. There are no diverticula in the neck region. The mouth and anus are both ventral. The wall of the digestive tube consists of a single layer of columnar cells, the enteric epithelium covered on the outer side by the cœlomic epithelium.

The intestine is suspended by the dorsal and ventral mesenteries. Thus the body cœlome is divided into two parts longitudinally. The tail cœlome is similarly divided. The anterior septum, dividing the head cœlome from that of the body, passes forwards laterally. The tail septum is well marked and projects behind the anus into the tail, consequently it appears in a transverse section of the anterior end of the tail (Pl. lxxi., fig. 8).

The gonads are well developed in the type, but are longer in one of the smaller specimens. The ovaries extend forwards about as far as the anterior end of the posterior fin, a little beyond it in some cases. They are apparently not attached along the middle of the lateral border but just ventrally to it. This may be the result of some distortion, though I do not think so. The oviduct is on the outer edge of each ovary, and terminates laterally at the junction of the body and tail. The mature ova are spherical, measuring 0.24 mm. in diameter.

The testes are located in the anterior and lateral part of each tail cœlome, their length being about 1.5 millimetres. Sperm morulae averaging 0.04 mm. in diameter fill this cœlome. The vasa deferentia are small, but each terminates in ripe animals in a large prominently projecting vesicula seminalis. As mentioned before, neither the posterior fins nor the tail fin reach these structures, which are situated about 1.1 mm. in front of the extremity of the tail.

The detailed histological structure of some Chaetognaths is described fully by Dr. O. Hertwig.^{1 2}

The main characters of this species, for which the name *Sagitta australis* is proposed, may be summed up thus:—Head rather small; neck distinct; no collarette; body transparent and flabby, thickest in the posterior third, tapering gradually for-

^{1 2} Hertwig—Die Chaetognathen. (Jenaische Zeitschr. Med. und Naturwiss., xiv., 1880, p. 196.)

wards but very rapidly near the tail septum ; tail segment rather narrow, between sixteen and eighteen per cent. of total length of animal ; anterior fins long and narrow, extending to about the middle of the ventral ganglion ; posterior fin shorter and somewhat broader than the anterior, being widest at about the plane of the tail septum, it does not reach vesicula seminalis ; tail fin very deeply bilobed and not extending forwards to reach vesicula ; jaws nine, strong, most are well curved, youngest with very strong base but nearly straight ; anterior teeth six to twelve ; posterior seven to eleven ; vestibular ridge bearing short, rounded papillæ and ending in a prominent process laterally ; ridge shorter than posterior row of teeth.

Its nearest allies appear to be *S. bedoti*, Beraneck,¹³ *S. furcata*, Steinhaus,¹⁴ and *S. sibogæ*, Fowler.¹⁵ It differs from *S. bedoti* in that the latter has a firm body, five to seven jaws, five to thirteen anterior teeth and from ten to thirty-two posterior teeth, a much longer tail segment (twenty-one to thirty-five per cent.), and posterior fins reach the vesiculæ. *S. furcata* differs from it in the absence of a well marked neck ; in the position of the widest part of the posterior fin, and in its greater length ; in the distance between the two fins ; the number of jaws (six to nine) and anterior teeth (three to eight). In *S. sibogæ*, there are large head ; short collarette ; firm, rather opaque body ; longer tail segment (twenty-one to thirty-three per cent.) ; tail fin reaching vesiculæ ; slender and comparatively straight jaws. In the above comparisons, only the points of difference from *S. australis* have been mentioned.

I wish to express my indebtedness to Professor Haswell for the loan of literature and specimens, and to Dr. C. H. Fowler's Monograph of the Siboga Chaetognaths.

Type presented to the Australian Museum. The sections are the property of the Biology Department, Sydney University.

All drawings were made using a Zeiss camera lucida.

¹³ Beraneck—Rev. Suisse Zool., iii., 1895, p. 137.

¹⁴ Steinhaus—*Loc. cit.*

¹⁵ Fowler—"Siboga," *loc. cit.*, p. 21.

EXPLANATION OF PLATE LXXI.

SAGITTA AUSTRALIS, *Justn.*

- Fig. 1.—Entire specimen.
 „ 2.—Head.
 „ 3.—Jaw.
 „ 4.—End of a jaw.
 „ 5.—Vestibular ridge.
 „ 6.—Transv. sect. in region of ventral ganglion.
 „ 7.— „ „ „ „ ovary.
 „ 8.— „ „ „ „ „ anus.
 „ 9.— „ „ „ „ „ testes (tail).
 „ 10.— „ „ „ „ „ vesiculæ seminales.
 „ 11.— „ „ „ „ „ tail fin.

In the drawing of sections, the muscle is lined, the epidermis plain; the intestinal and cœlomic epithelium dotted.

References to lettering:—a.f, anterior fin; a.t., anterior teeth; b., base of point; b.n., buccal nerve; b.p, back of point; br., brain; c., cœlome; c. ep., cœlomic epithelium; d.l.m., dorso-lateral muscle; d.m., dorsal mesentery; e., edge of point; ep., epidermis; e.s., edge of shaft; f., fin; f.r., fin ray; g., insertion of base of point; h., head; int., intestine; i.e., intestinal epithelium; i.t., inmost tooth of posterior row; j., jaw; k., anus; l.p., lateral process of vestibular ridge; m., muscle; mo., mouth; o., ovary; o.d., oviduct; o.o., external opening of oviduct; o.m., oblique muscles; o.t., outermost posterior tooth; ph., pharynx; p., pulp; p.r., posterior row of teeth; pt., point of jaw; p.f., posterior fin; s., shaft of jaw; s.m., sperm morulæ; t., tail; t.c., tail cœlome; t.f., tail fin; t.g., testes; t.m., tail mesentery; tr.m., transverse muscle; t.s., tail septum; v.g., ventral ganglion; v.l.m., ventral longit. muscles; v.m., ventral mesentery; v.r., vestibular ridge; w., anterior septum; x., posterior extension of body cœlome behind anus; y, œsophagus.

