

XVIII.—The Chætognatha of the Scottish National Antarctic Expedition of 1902–1904. By A. Pringle Jameson, B.Sc. *Communicated by* Dr W. S. BRUCE.

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A considerable number of Chætognatha were collected on the Scottish National Antarctic Expedition of 1902–1904. Some two or three hundred tow-nettings were examined, and about ninety yielded some of these forms. Beside the tow-netting samples there were twelve tubes of these animals taken in the vertical net or the trawl.

It will thus be seen that most of the material consists of tow-nettings which, almost without exception, were taken at the surface of the water. If we accept Dr BRUCE's definition of the Antarctic Regions,* namely, the area to the south of the *average* limit of floating ice according to the British Admiralty Ice Chart, No. 1241 (*vide* text-map), we may expect Antarctic forms there. Chætognatha were taken by the *Scotia* at ten stations south of this line, including only four out of the many surface tow-nettings taken by the *Scotia* south of this line, whilst a fifth, although taken in latitude 39° 48' S. (Station 468), is in close proximity to it, and actually within the *extreme* limit of floating ice. The ten stations are Nos. 273, 280, 325, 346, 398, 414, 416, 422, 448, 450, and besides the eleventh above mentioned, viz. 468.

The Antarctic species are :—

1. *Sagitta gazellæ* (Ritter-Zahony).
2. *Sagitta maxima* (Conant).
3. *Sagitta planctonis* (Steinhaus).
4. *Eukrohnia hamata* (Möbius).
5. *Heterokrohnia* sp. ? (Ritter-Zahony).

The catches of the vertical net and the trawl were, with one exception—namely, the trawling made on April 29, 1904, in 39° 48' S., 2° 33' E.—taken south of 40° S. and south of the *average* limit of floating ice. Thus this one catch is hardly an exception, so that practically we may say all these catches belong to the Antarctic series. All the other Chætognatha captured were taken north of this line as far north as 36° N. latitude.

The tropical and sub-tropical species are :—

1. *Sagitta hexaptera* (d'Orbigny).
2. *Sagitta enflata* (Grassi).
3. *Sagitta serratodentata* (Krohn).
4. *Sagitta bipunctata* (Quoy and Gaimard).
5. *Sagitta robusta* (Doncaster).
6. *Pterosagitta draco* (Krohn).
7. *Krohnitta subtilis* (Grassi).

* "Antarctic Birds," by WILLIAM S. BRUCE, *Knowledge*, September 1, 1894, p. 208.

Thus the collection is divided into two sections, one a general collection from the colder waters of the South Atlantic and Antarctic Seas, the other a series of surface tow-nettings made in tropical and sub-tropical Atlantic waters. These two sections

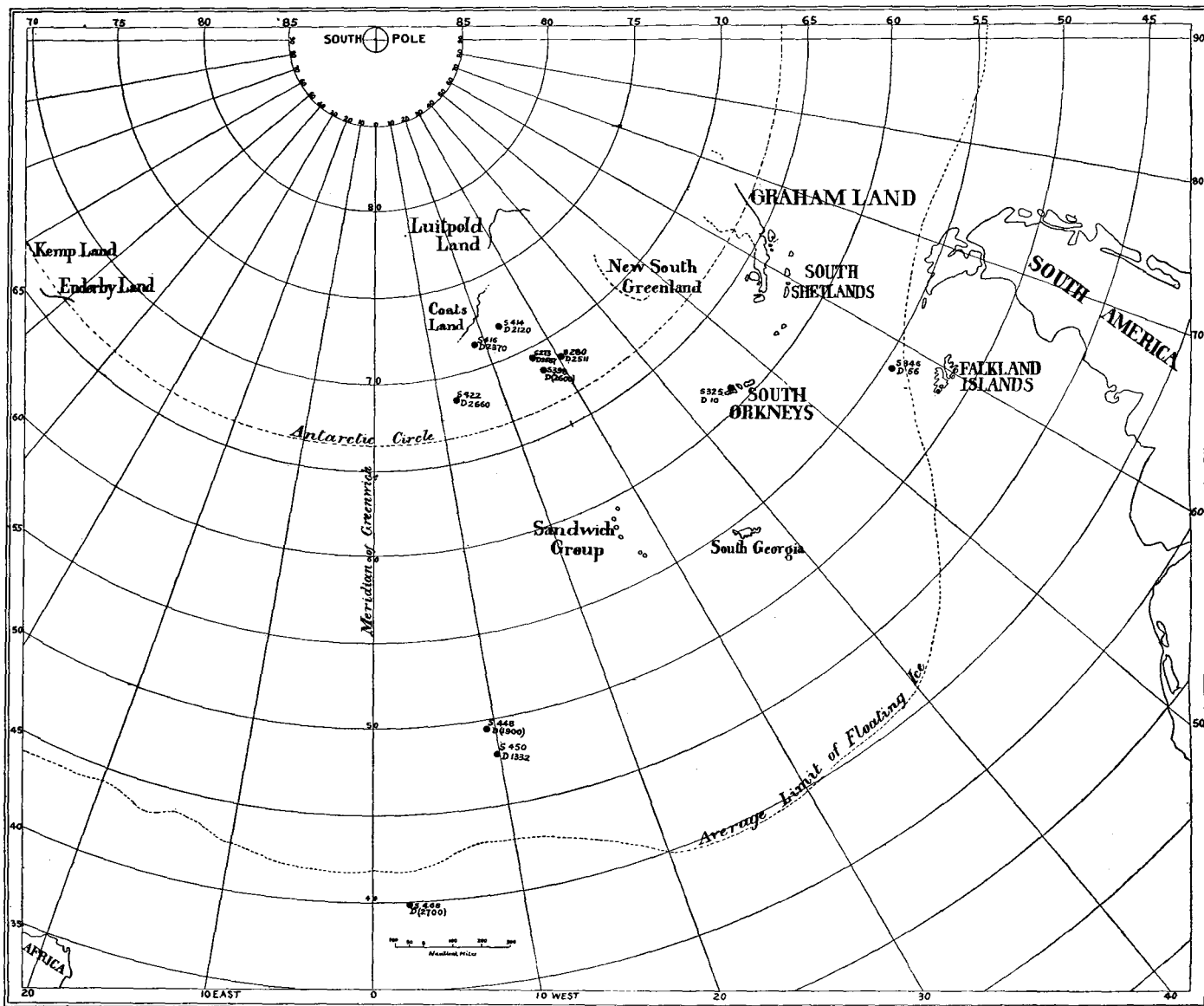


Chart showing average limit of floating ice in the Atlantic Ocean and Stations to the south of which Chætognatha were obtained.
S = Station. D = Depth in fathoms.

prove on examination to be more than a merely convenient grouping of the methods of capture—they form two distinct sets of species: the species which occur in the Antarctic samples not occurring in those from the warmer seas, and those taken in the warmer waters of the Atlantic never being found in the Antarctic collections. Doubtless the fact that only a small number of Chætognatha were obtained from

these colder waters is responsible for this very sharp division, and it must also be remembered that if collections had been made from the depths of the tropical and sub-tropical Atlantic these would naturally have yielded cold-water forms. Yet, despite these facts, this sharp line dividing the present collection into two distinct groups serves as a very clear example of how great a part temperature plays in the distribution of plankton organisms.

In the *Scotia* collections made south of 40° S. there are found five species of Chætognatha — *Sagitta gazellæ*, *Sagitta maxima*, *Sagitta planctonis*, *Eukrohnia hamata*, and possibly a species of *Heterokrohnia*. These are all typically cold-water forms; their presence in these latitudes was to be expected, and adds nothing to our knowledge of their distribution, all these species having been found by the German South Polar Expedition (1901-03) under very much the same conditions. *Eukrohnia fowleri* is a type which one might have expected to meet with, but it was not present in this collection. *Sagitta hexaptera*, *Sagitta serratodentata*, and *Krohnitta subtilis* have all been reported from the seas south of 40° S., but they do not seem to be typical Antarctic species, only occasional specimens being got. None of these was present in the *Scotia* material from this area.

The remaining species, seven in number, were all taken between roughly 36° N. lat. and 38° S. lat., and were thus living under tropical and sub-tropical conditions. Many of the specimens were small and evidently immature, thus supporting GUNTHER'S view that large, mature individuals occur at some distance below the surface, only small and mostly immature specimens being obtained from the very uppermost layers of the sea.

No species new to science was discovered, the only noteworthy feature of the collection being the very large size of four specimens of *Sagitta gazellæ*. These four specimens seem to be the largest recorded for the species, and the largest of all is probably the largest "Arrow Worm" that has been captured up to the present time. Detailed measurements of this specimen are given under the notes of this species.

The difficulty of identifying Chætognatha has within recent years been considerably lessened by the excellent papers of FOWLER and RITTER-ZAHONY on this class. These have been of the greatest service, and I desire to express my great obligation to these two authors. In selecting features for aid in identification FOWLER has been followed in his introduction to the Chætognatha of the Biscayan Plankton (1905), where a most helpful discussion of this difficult subject is given. As a rule, tables of measurements and numbers of jaws and teeth have been given only when the species has not been frequently described, or where there might be any doubt as to the identification. It seemed to be fruitless to expand these notes unduly by including figures which had been given frequently before, and which were quite typical and did not add to our knowledge of the species in any way. It may be mentioned that the measurement of length does not include the tail fin; as this was so frequently damaged, it seemed to be

more accurate to omit this altogether, and indeed it seems to be the custom of many investigators not to include this fin in their measurements.

As alcohol was the fluid in which the specimens were usually preserved, the identification has in many cases been attended by some considerable difficulty, for, as is now well known, the only successful method of preserving Chætognatha is by using formalin, as alcohol causes these animals to shrink very greatly and become opaque.*

Sagitta hexaptera (d'Orbigny).

This very well-marked species was taken at fifteen stations in the warmer Atlantic waters. It seems to be undoubtedly a tropical and sub-tropical species, as pointed out by RITTER-ZAHONY (1911), no specimens occurring in the Antarctic collections. Probably the forms of this species reported from the Antarctic are to be referred in great part to the somewhat nearly related species *S. gazellæ*.

Horizontal distribution: 22° 19' N., 22° 07' W.—15° 54' S., 4° 59' W.

Vertical distribution: surface.

Temperature range: 72·2°–80·5° F.

Stations: 12, 13, 14, 17, 19, 36, 54, 56, 59, 60, 62, 69, 498, 501.

Sagitta gazellæ (Ritter-Zahony).

This was the most abundant Antarctic form found; over a dozen easily identified specimens were got, and a considerable number of fragmentary or badly distorted forms are probably to be referred to this species.

It seems somewhat strange that this species, which is well marked and apparently abundant, should have been recorded so rarely. The species was first established by RITTER-ZAHONY in 1909 from the material of the *Gazelle* expedition, and it was also found very abundantly in the collections made by the German South Polar Expedition (1901–1903). Some of the forms described by FOWLER (1907) as *S. hexaptera*, from the material of the British Antarctic Expedition (1901–1904), and others unnamed, from New Zealand (FOWLER, 1908), have been assigned to this species by RITTER-ZAHONY (1911).

The most characteristic features of this species are undoubtedly those which suffer most in preservation. Among the smaller forms the tail-percentage and the number of teeth and jaws are sometimes very similar to those of young *S. hexaptera*, consequently immature specimens of the two species are very likely to be confused. With larger forms these features become extremely characteristic for both species, and all likelihood of confusion disappears. The diagnostic features which seem to be of most assistance in identifying the species are the following:—The tail-percentage is characteristically low, about 12–14 per cent. for the larger specimens; the anterior fin is comparatively

* Alcohol was used as a preserving medium on account of its suitability over formalin for the majority of organisms in the plankton.—W. S. B.

large, very much longer in proportion than that of *S. hexaptera*, and almost touching the posterior fin; the anterior teeth are small, somewhat conical in shape, and overlap one another, quite unlike the long divergent teeth of *S. hexaptera*; the teeth are few in number in young forms and more numerous in older ones, the reverse being true with *S. hexaptera*; the anus is situated well in front of the tail septum. In the *Scotia* specimens the position of the seminal vesicles is a little different from that described by RITTER-ZAHONY; they hardly extend as far forward as the posterior fin, and the tail fin is only slightly removed from them.

Some of the specimens in this collection are noteworthy on account of their very large size; indeed, one of them seems to be the largest "Arrow Worm" that has been taken up to the present time. Five specimens were over 70 mm. in length, the largest of all being no less than 90 mm. long. Some measurement of this relatively enormous animal may help to give an idea of its size. The length exclusive of the tail fin is 88 mm., the tail fin being at least 2 mm. long, but as it is damaged rather badly it was very probably somewhat longer than this. In any case the total length of the animal is certainly not less than 90 mm. The tail portion, exclusive of the fin, is 11 mm. The size of the head is of little importance, as this varies so much according to the state of contraction, but it may be mentioned that in this specimen the head is 4 mm. long and 6 mm. broad. The broadest part of the body is 8 mm. in width, and this point is in the region of the ventral ganglion, 22 mm. from the tip of the head. From this point the body tapers gradually towards the tail and somewhat more abruptly towards the head, the body being 3 mm. in width at the tail septum and 4.5 mm. at

Length.	Tail-percentage.	Jaws.	Ant. Teeth.	Post. Teeth.
88	12.5	5	5	?
80	12.5	6	7	9
79	12.6	6	5	?
78	12.9	5	7	9
72	12.5	6	7	5+
65	11.5	6	9	10
60	14	5	8	9
59	13	5+	5+	?
58	? 15.5	7	7	11
51	13	8	5	9
50	14	8	8	9
47	12.8	7	7	9
42	13	7	4	8
40	12	10	6	?
33	15	7	4	5

the neck. The anterior fin commences 5 mm. behind the posterior end of the ventral ganglion—the ganglion itself is 2 mm. long—and extends backwards for about 29 mm.; there is a space of about 5 mm. between the anterior and the posterior fins; the posterior fin is about 17 mm. long, and lies almost entirely on the trunk portion of the

body, there being only 3 mm. of the fin on the tail. As the fins are rather badly damaged it is impossible to be quite certain of the accuracy of these measurements, and no idea of the breadth of the fins can be formed. The jaws are 3 mm. long. The reproductive organs are prominent, but they do not seem to be quite mature; the ovaries extend forward for a length of 16 mm.

Horizontal distribution: 39° 48' S., 2° 33' E. (depth 2772 fathoms), Station 468. 71° 22' S., 18° 15' W. (depth 2370 fathoms), Station 416.

Vertical distribution: surface (3 fathoms)—2772 fathoms.

Temperature range: 31°–41°·8 F. (only 3 records).

Most of the specimens were obtained from deep water ranging in depth from 600–2772 fathoms. In Scotia Bay, South Orkneys, Station 325, one medium-sized specimen was obtained in a tow-net at 3–10 fathoms; while on Burdwood Bank, Station 346, another medium-sized specimen was obtained from 56 fathoms. These are the only "surface-water" records; all the rest, as far as data are given, are from deep water, and with one exception were from south of 50° S.

Sagitta maxima (Conant).

Two specimens which seem to be referable to this species were obtained, one in the trawl, the other in a vertical net. The tail-percentage and the number of jaws are a little lower than those usually given for this species, but otherwise these two specimens agree very closely with the descriptions of *S. maxima*. The somewhat widely separated, slightly curved anterior teeth, the prominent vestibular ridge with large mammiform papillæ, the fins without fin rays in the inner portions, and the very considerable distance between the anus and the tail septum, all seem to be minor features which taken together are characteristic of the species and help considerably in its identification.

Length.	Tail-percentage.	Jaws.	Ant. Teeth.	Post. Teeth.
53	18	5	? 3+	6
39	21	5	6	7

The vertical plankton-net haul was made at Station 414, 71° 50' S., 23° 30' W., and the net was lowered to a depth of 1000 fathoms and raised to the surface. The dredged specimen was obtained from Station 450, 48° 00' S., 9° 50' W., at a depth of 1332 fathoms.

Sagitta enflata (Grassi).

This very typical tropical and sub-tropical species was obtained from twenty-nine stations distributed over the warmer parts of the Atlantic. It was rather interesting

to note that, although this animal has a very delicate and rather flaccid body, it seems to suffer from the effects of preserving fluids less than most of the Chæto gnatha.

The specimens were all very typical and call for no comment.

Horizontal distribution : 26° 23' N., 20° 20' W.—30° 5' S., 45° 28' W.

Vertical distribution : surface.

Temperature range : 72°—81·5° F.

Stations : 7, 12, 15, 18, 19, 21, 25, 26, 27, 29, 32, 33, 35, 36, 37, 39, 44, 46, 47, 64, 66, 73, 86, 93, 506, 515, 525, 526.

Sagitta serratodentata (Krohn).

The above widely distributed and well-marked species was found in fifty-nine tow-nettings. It was thus present in more samples than any other species, and, in addition, it was very frequently more abundant than the other species in the haul; indeed, the only species which was ever as numerous as this was *S. bipunctata*, but this last was only occasionally obtained in considerable numbers, so that on the whole *S. serratodentata* was the form most typically found in the surface tow-nettings. It is to be noted, however, that no specimens of this species were taken south of 40° S., although it has been found by other expeditions as far south as Magellan Straits and the Falkland Islands.

Horizontal distribution : 26° 23' N., 20° 20' W.—38° 6' S., 14° 32' E.

Vertical distribution : surface.

Temperature range : 64·9°—81·5° F.

Stations : 7, 11, 12, 13, 14, 15, 17, 18, 19, 20, 21, 22, 25, 26, 27, 28, 29, 31, 32, 33, 35, 36, 37, 38, 39, 41, 44, 46, 47, 49, 54, 55, 56, 58, 59, 60, 61, 62, 63, 64, 71, 87, 88, 90, 93, 94, 95, 473, 476, 498, 501, 502, 504, 506, 515, 519, 524, 526, 529.

Sagitta bipunctata (Quoy and Gaimard).

This common species was fairly frequently met with, having been found in fifty-four samples. On one occasion only was it taken in very considerable numbers; this was at a point eight miles from Cape Peninsula, South Africa, where a surface haul of some ten minutes' duration captured several hundred specimens. As a rule, however, the specimens taken in any individual haul were not numerous, and were rather small in size. It has been found impossible to determine exactly what stations might be called coastwise, so that this collection can throw but little light on the question put forward by STEINHAUS (1896) as to whether this is mainly a neritic form or not. *Sagitta bipunctata* seems certainly to be found under oceanic conditions; but it may be noted that in the only haul mentioned as being taken very near land—the one above—this species appeared to the exclusion of all others, and the specimens captured were larger than most of those taken at other stations. As far as can be judged, also, the members of this species caught on the high seas were usually rather small in size and immature.

Horizontal distribution : $36^{\circ} 5' N.$, $30^{\circ} 50' W.$ — $34^{\circ} 43' S.$, $17^{\circ} 15' E.$

Vertical distribution : surface.

Temperature range : 61.3° — $81.5^{\circ} F.$

Stations : 7, 8, 13, 17, 18, 20, 21, 22, 25, 26, 27, 28, 30, 31, 35, 37, 38, 39, 41, 42, 44, 47, 49, 59, 65, 66, 69, 70, 72, 82, 85, 86, 87, 90, 91, 93, 94, 95, 476, 477, 498, 501, 502, 506, 510, 511, 515, 522, 524, 525, 526, 529, 533, 540.

Sagitta robusta (Doncaster).

Considerable difficulty was experienced in identifying this species, and even yet the results do not seem to be quite satisfactory, for young forms of *Sagitta robusta* are rather liable to be confused with *Sagitta bipunctata* on account of a certain correspondence between the tail-percentages and the numbers of the jaws and teeth of these two species. This confusion, of course, does not arise when the specimens are in good order, and when all the features are clearly seen; but damaged and strongly contracted specimens of *S. robusta* are frequently very like *S. bipunctata*, and require some care in determination. The features on which I have relied for the identification of this species have been the small number of the jaws, never more than seven—RITTER-ZAHONY (1911) in his monograph admits species with eight jaws, but under the circumstances I have thought it best to fix seven as the typical number; the presence of a distinct collarette; and an opaque body, all the parts of which, including the teeth and the jaws, are of a stout build. An important feature would seem to be the position of the seminal vesicles near or touching the posterior fins, but unfortunately seminal vesicles were not observed in any of the specimens.

Length.	Tail-percentage.	Jaws.	Aut. Teeth.	Post. Teeth.
? 14	?	7	8	12
13.5	26	7	7	? 10
12	25	7	6 or 7	12
11	27	7	7	12
8	28	7	6	13

Horizontal distribution : $32^{\circ} 11' N.$, $34^{\circ} 10' W.$ — $23^{\circ} 8' S.$, $39^{\circ} 40' W.$

Vertical distribution : surface.

Temperature range : 74° — $81.5^{\circ} F.$

Stations : 15, 18, 19, 26, 29, 33, 39, 60, 73, 85, 526, 538.

It may be noted that *S. robusta* is said to have a smaller temperature range than *S. bipunctata*, or at all events that it does not range so far to the north and south. So far as my results go they bear out this statement.

Sagitta planctonis (Steinhaus).

Three specimens, taken at one station in the Antarctic Ocean, are probably to be referred to this species. The tail-percentage and the numbers of the teeth and jaws agree with those given by RITTER-ZAHONY, and the general habit—the stiff opaque body—seems to be the same. A very characteristic feature of these specimens is the size and arrangement of the anterior teeth: these are long towards the inner end and considerably shorter towards the outer end of each row; they do not overlap, but each tooth is distinctly seen in every part; these features are all admirably seen in a figure given by RITTER-ZAHONY (1911). As the specimens are small and young, the collarette is only slightly developed.

Length.	Tail-percentage.	Jaws.	Ant. Teeth.	Post. Teeth.
12	25	9	5	10
8	25	10	4	8

This species is given by FOWLER (1906) as a tropical surface form, but it was repeatedly taken in the Antarctic on the German South Polar Expedition, even as far south as 66° S. (RITTER-ZAHONY, 1911), so that its occurrence in the *Scotia* Antarctic collections is not an isolated case. Its furthest south range is, however, extended by about three degrees.

Station: 280, 68° 40' S., 30° 18' W. Between surface and 500 fathoms.

Temperature: 32·65° F.

Pterosagitta draco (Krohn).

Only a few specimens of this apparently common and typical tropical and sub-tropical form were obtained at seven stations. This scarcity is probably due to the fact that *P. draco* does not commonly occur at the very surface of the sea, but usually at some little depth. This point would seem to be in agreement with the results of the German South Polar Expedition (RITTER-ZAHONY, 1911), where this species was got only twice in the surface tow-nets, whereas it frequently occurred in the vertical nets.

Horizontal distribution: 26° 23' N., 20° 20' W.—38° 6' S., 14° 32' E.

Vertical distribution: surface.

Temperature range: 64·9°–78·6° F.

Stations: 7, 11, 12, 14, 26, 56, 473.

Eukrohnia hamata (Möbius).

It might have been expected that this form would have been taken very frequently in the higher latitudes, but, strange to say, it has been found in only six samples. The specimens found were in every way typical.

Horizontal distribution : 49° 25' S., 9° 21' W.—69° 22' S., 26° 36' W.

Vertical distribution : 800 fathoms—surface.

Temperature range : 28·9°—39° F.

Stations : 273, 280, 448, 325 (2) vertical net 23/3/04, 422.

? *Heterokrohnia* sp. (Ritter-Zahony).

A single specimen taken in a vertical-net haul might possibly belong to this genus; the state of preservation, however, will not admit of any certain determination.

The body is slender and firm. Transverse muscles are developed both in the trunk and in the tail. The lateral fins are almost totally destroyed, but there does not seem to have been more than one pair. The tail fin is also much damaged, but it appears to have been somewhat rounded and is very full of fin-rays. The percentage of tail to body length is probably about 25·6; the lowest percentage given by RITTER-ZAHONY (1911) is 32·3. The head is not well expanded, so that the teeth and anterior portion are not well seen. There are certainly not fewer than 14 posterior teeth. There are at least 11 jaws, rather long, slender, and knife-like, and only slightly curved, in general somewhat like a scythe blade.

On the whole, these features are those given by RITTER-ZAHONY in his diagnosis of this new genus *Heterokrohnia*. Indeed, the presence of transverse muscles in both trunk and tail would seem to be enough to determine the genus. It is, however, impossible to determine the species. The only species described is *H. mirabilis*, characterised by a high tail-percentage, and very numerous anterior and posterior teeth. This specimen does not show these features clearly enough to warrant any statement being made as to the species.

Length.	Tail-percentage.	Jaws.	Ant. Teeth.	Post. Teeth.
22·5	25·6	11	?	? 14

Taken in a vertical net on February 29, 1904, at Station 398, 68° 25' S., 27° 10' W. Surface temperature 30° F., and temperature at 1000 fathoms probably about 32° F.

Krohnitta subtilis (Grassi).

Specimens of this species were not abundant; it was found in only seven samples, and there only in small numbers. The explanation of this apparent rarity is probably to be found in the fact, pointed out by FOWLER (1906), that this is a species which has its habitat in cooler waters of the "lower epiplankton and upper mesoplankton," seeming to avoid "the warmer surface water." One would naturally expect that such a form would be taken only rarely in surface tow-nettings. Further, the specimens obtained were all very evidently young forms, the largest being 5·5 mm. in length.

FOWLER (1906) gives the most southerly point at which *K. subtilis* had been taken in the Atlantic up to that date as 25° 39' S., 36° 51' W., but since then RITTER-ZAHONY (1911) reports one specimen taken as far south as 60° S.; the furthest south record for the *Scotia* collection is 30° 25' S., 45° 45' W.

Horizontal distribution : 23° 50' N., 21° 34' W.—30° 25' S., 45° 45' W.

Vertical distribution : surface.

Temperature range : 73°–81° F.

Stations : 11, 17, 32, 33, 38, 94, 519.

LITERATURE.

Full bibliographies are given by FOWLER (1906) and RITTER-ZAHONY (1911). The following have been mentioned specially in the preceding text:—

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