

REPORT ON THE CHAETOGNATHA COLLECTED BY THE  
UNITED STATES FISHERIES STEAMER "ALBATROSS"  
DURING THE PHILIPPINE EXPEDITION, 1907-1910.

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INTRODUCTION.

This paper is based upon the chaetognatha collected by the United States Bureau of Fisheries steamer *Albatross* during the Philippine expedition of 1907-1910. Chaetognatha were taken at 46 stations scattered between the parallels of 21° 31' north and 5° 36' south latitude, and between the meridians of 117° 53' east and 127° 44' east longitude. The collection is represented by 12 species of *Sagitta*, of which one, *Sagitta philippini*, is apparently new; one of *Pterosagitta*; two of *Eukrohnia*; and one of *Krohnitta*. The species of *Sagitta*, in order of the number of specimens obtained, are: *S. enflata*, (2,800); *S. hexaptera*, (700); *S. ferox*, (600); *S. pulchra*, (550); *S. neglecta*, (425); *S. bedoti*, (350); *S. decipiens*, (160); *S. serratodentata*, (100); *S. planktonis*, (85); *S. minima*, (2); and one each of *S. macrocephala* and *S. philippini*. *Pterosagitta* is represented by 32 specimens of *P. draco*; *Eukrohnia* by 6 specimens of *E. hamata* and 5 of *E. richardi*; and *Krohnitta* by 3 specimens of *K. subtilis*.

Most of the material was preserved in formalin and is in excellent condition. In some cases, however, alcohol was used. Specimens preserved with it are distorted and the tannin extracted from the corks of the containers has turned most of them quite black, rendering identification uncertain and, in some cases, impossible. But, in so far as the collection permits, tables of diagnostic measurements are given for each species, enough measurements being made on each individual to enable reconstruction of its outline. Otherwise, the species are not further described except for those concerning which need of description is indicated by the literature. In lieu of descriptions, however, references are given to those published in other reports, particularly to Ritter-Záhony's (1911) revision of the group, which, with two or three exceptions, is adopted as my basis of classification.

In order to make the report as serviceable as possible, keys are supplied for identifying not only those species obtained during the Philippine expedition but all the species in the group. Several new species and five new genera have been described since my last (1911) report. In addition, Ritter-Záhony (1911) has called attention to and admirably illustrated specificities in the presence and absence

of rays in the lateral fins. In devising the keys these specificities are used and, except for *Sagitta maxima* (Conant), which I still find impossible to separate from *S. lyra*, every species recognized as valid by Ritter-Záhony (1911) and several others described subsequent to his report are included. There is great need of keys for identifying poorly preserved material, but the minute structure of seizing jaws and other skeletal parts of the head, upon which such identification depends, is still undescribed in nearly half the species. The keys included in this report are therefore adapted only to the identification of well-preserved specimens.

The area covered by the expedition is too large and the hauls were too scattered to yield definite information concerning the distribution of the various species obtained. As pointed out elsewhere (1916, p. XVIII), variability in plankton distribution is enormous, and hydrobiological relations are too complex to be revealed without frequently repeated collections in very restricted areas and searching hydrographic observations corresponding in time and place to each net haul. Even though thousands of individuals of one species and none of another be obtained by a single haul, no conclusion is justified other than that the former species was obtained and that the latter was not obtained. Such data afford no adequate evidence for concluding that the former species is more abundant in or more typical of that particular locality than is the latter. Had 20 or 30 hauls been made at each station with nets of similar filtering capacities, sufficient evidence for such conclusions might have been obtained. But rarely more than one haul was made at each station, so the data yield little else than records of occurrence. These records are given for each species.

In comparing the species occurring in the Philippine region with those obtained from the vicinity of San Diego (the only coastal region of the Pacific off either of the American continents from which chaetognaths have been described), two interesting and suggestive facts come to light: First, those species obtained in largest numbers from the Philippines are those which, as a rule, occur rarely, if at all, in the San Diego region, and the opposite. Second, of those species common to both regions, the number of teeth is greater in Philippine specimens.

This is contrary to what might have been expected. For, judging from the fact that chaetognatha collected under the auspices of the Scripps Institution from as far south as 23° north, off Lower California, are essentially like those within the San Diego region proper, and, realizing that this is but two degrees north of the northern boundary of the Philippine area from which chaetognatha were obtained, one would naturally infer a close relationship between the Philippine and San Diego faunas. To find it quite the reverse is therefore suggestive of a fundamental and far-reaching difference in

the other faunas, and so of the whole economic and fisheries situations of the coastal waters on opposite sides of the Pacific at corresponding latitudes. Extensive exploration of the Pacific, particularly of the coastal waters of Central and South America, is needed, however, to discover the full significance of what is here so clearly indicated, and it is regretted that no chaetognatha are described from these regions. But, in spite of this, it seems probable, from the meager data at hand, that conclusions reached through explorations in the western Pacific are largely inapplicable to the waters of the eastern Pacific, and the opposite. Some space is therefore taken at the close of the paper in briefly comparing the Philippine and San Diego chaetognatha. It is hoped this will emphasize the need of more extensive explorations, and that it may add its mite toward a better understanding of the fishery problems of the Pacific Ocean.

#### KEYS FOR THE IDENTIFICATION OF THE CHAETOGNATHA.

Ritter-Záhony (1911) has been the last investigator to thoroughly revise the chaetognatha. He recognizes six genera—*Sagitta*, *Pterosagitta*, *Spadella*, *Eukrohnia*, *Heterokrohnia*, and *Krohnitta*. Subsequently Germain and Joubin (1912) added two more—*Pseudosagitta* and *Krohnitella*. All are probably valid with the possible exception of *Spadella* and *Pseudosagitta*, the status of which is baffling. Most of the differences given by Ritter-Záhony (1911) between *Pterosagitta draco* and *Spadella cephaloptera* are certainly no greater than that between those species of *Sagitta* in which the skeletal part of the vestibular ridge is present and those in which it is absent, and this difference is clearly of subgeneric rather than generic value. On the other hand, Conant's (1895) description of *Spadella schizoptera*, although fragmentary and wholly unsatisfactory, reveals a close affinity between that species and *S. cephaloptera* and at the same time makes the genus to which it belongs unmistakably distinct from *Pterosagitta*. Furthermore I have seen specimens of neither *S. cephaloptera* nor *S. schizoptera*, and it seems best, therefore, to tentatively recognize *Spadella* as valid in spite of the fact that the characteristics by which its one well known species, *S. cephaloptera*, differs from *P. draco* seem of subgeneric value.

The validity of *Pseudosagitta* is ably discussed by Baldasseroni (1915, p. 101), who holds its single new species *P. grimaldi* to be synonymous with *Sagitta lyra*. The differential characters described by Germain and Joubin (1912, p. 6) are certainly such as to suggest this synonymy and I find myself in agreement with Baldasseroni.

In the following keys seven genera are therefore recognized, of which *Sagitta* is represented by 23 species, *Eukrohnia* by three, *Spadella* by two, and each of the others by one: *Pterosagitta draco* (see p. 264), *Heterokrohnia mirabilis* (Ritter-Záhony, 1911, p. 42),

*Krohnitta subtilis* (see p. 269), and *Krohnitella boureei* (Germain and Joubin, 1912, p. 133).

## KEY TO GENERA.

- |  |                        |
|--|------------------------|
| 1. Two pairs of rows of teeth.....   | 2                      |
| 1. Teeth entirely absent, or only one pair of rows present.....  | 4                      |
| 2. Two pairs of lateral fins, the posterior pair being partly on body and partly on tail. Fins completely or incompletely rayed; anterior and posterior pairs sometimes connected by narrow membrane.....  | <i>Sagitta</i> .       |
| 2. One pair of lateral fins, or two pairs of which the posterior one is entirely confined to the tail-segment. Fins completely rayed.....  | 3                      |
| 3. One pair of lateral fins confined entirely to tail-segment. Collarletta massive, extending to tail-septum and spreading out over fins. Greatest width slightly anterior to tail-septum, and exceeding half that of the body. Ventral transverse muscles absent. Anterior and posterior teeth both exceed six in number.....                                     | <i>Pterosagitta</i> .  |
| 3. One pair of lateral fins confined entirely to tail-segment, or two pairs the posterior one of which is confined to tail-segment. Collarletta present but not massive. Greatest width slightly behind head, less than half that of body. Ventral transverse muscles present in body-segment only. Neither anterior or posterior teeth exceed five in number..... | <i>Spadella</i> .      |
| 3. One pair of lateral fins partly on body and tail. Collarletta absent. Ventral transverse muscles present in both body and tail.....   | <i>Heterokrohnia</i> . |
| 4. Lateral fin begins at or in front of ventral ganglion and extends onto tail but never to seminal vesicles. Ventral transverse muscles present in anterior third of body. One pair of rows of teeth.....   | <i>Eukrohnia</i> .     |
| 4. Lateral fin begins about half-way between ventral ganglion and tail-septum, and extends fully to seminal vesicles. Ventral transverse muscles absent..  | 5                      |
| 5. Head small but wider than body. Less than 50 per cent of fin in front of tail-septum. Width of body less than 8 per cent of total length. One pair of rows of teeth. Seizing jaws delicate, but not filliform.....  | <i>Krohnitta</i>       |
| 5. Head small, narrower than body. More than 60 per cent of fin in front of tail-septum. Width of body exceeds 9 per cent of total length. Teeth absent. Seizing jaws filliform.....   | <i>Krohnitella</i> .   |

## KEY TO SPECIES OF SAGITTA.

- |   |                            |
|---|----------------------------|
| 1. Collarletta absent.....  | 2                          |
| 1. Collarletta present.....   | 13                         |
| 2. Shaft of seizing jaw serrated.....   | <i>S. serratodentata</i> . |
| 2. Shaft of seizing jaw not serrated.....   | 3                          |
| 3. Anterior and posterior fins confluent.....   | 4                          |
| 3. Anterior and posterior fins separated.....   | 5                          |
| 4. Both pairs of fins entirely rayless throughout at least their anterior thirds; tail usually exceeds 15 per cent of total length..... | <i>S. lyra</i> .           |
| 4. Fins only rayless adjacent to body but not along outer margins; tail usually less than 15 per cent of total length.....              | <i>S. gazelle</i> .        |
| 5. Anterior fins longer than posterior fins.....  | <i>S. philippini</i> .     |
| 5. Posterior fins longer than anterior fins.....  | 6                          |
| 6. Anterior fins entirely rayless; rays of posterior fin perpendicular to body.   | <i>S. minima</i> .         |
| 6. Anterior fins not entirely rayless; rays of posterior fin directed obliquely to body.....  | 7                          |
| 7. Anterior fins extend nearly if not quite to ventral ganglion.....  | 8                          |
| 7. Anterior fins never extend within half their length of ventral ganglion....  | 9                          |
| 8. Both pairs of fins with rays throughout; mature ovary short and thick, not reaching anterior limit of posterior fins.....            | <i>S. setosa</i> .         |

8. Anterior extremities of both pairs of fins rayless; anterior fin also rayless throughout a narrow strip adjacent to body; mature ovary long and narrow, extending nearly if not quite to ventral ganglion.....*S. serratodentata*
9. Tail 28-40 per cent of total length; posterior teeth 20-38, rarely as few as 17.  
*S. macrocephala.*
9. Tail less than 28 per cent of total length; posterior teeth rarely exceed 16.. 10
10. Posterior fins extend nearly if not quite to seminal vesicles; both pairs of fins rayed throughout..... 11
10. Posterior fins never extend more than  $\frac{3}{4}$  distance from tail-septum to seminal vesicles; both pairs of fins rayless throughout a narrow strip adjacent to body..... 12
11. Body very transparent; interval between anterior and posterior fins always less than half the length of posterior fin.....*S. setosa.*
11. Body semi-translucent but never transparent; interval between anterior and posterior fins usually greater than half the length of posterior fins....*S. elegans*
12. Vestibular ridge composed entirely of papillae; anterior teeth 0-4, rarely 5; posterior teeth 0-6.....*S. hexaptera.*
12. Vestibular ridge provided with usual skeletal parts; anterior teeth 5-12, rarely less than 6; posterior teeth 7-18, rarely less than 10.....*S. enflata.*
13. Collarlette short, not extending over half-way from neck to ventral ganglion. 14
13. Collarlette long, extending more than  $\frac{3}{4}$  distance from neck to ventral ganglion..... 22
14. Anterior fins longer than posterior fins..... 15
14. Posterior fins longer than anterior fins..... 18
15. Posterior fins never extend nearly to seminal vesicles.....*S. decipiens.*
15. Posterior fins extend nearly if not quite to seminal vesicles..... 16
16. Body transparent; anterior fins exceed 30 per cent of total length of animal.  
*S. pulchra.*
16. Body opaque or semi-translucent, but never transparent; anterior fins less than 30 per cent of total length of animal..... 17
17. Both pairs of fins rayed throughout.....*S. neglecta.*
17. Anterior extremities of both pairs of fins rayless.....*S. bedoti.*
18. Interval between anterior fins and ventral ganglion exceeds one-fifth length of fins.....*S. bipunctata.*
18. Anterior fins extend nearly if not quite to ventral ganglion..... 19
19. Collarlette inconspicuous, extending less than one-fourth distance from neck to ventral ganglion..... 20
19. Collarlette well developed, extending between one-fourth and one-half distance from neck to ventral ganglion..... 21
20. Pronounced constriction at tail-septum; sexually mature at a length of 5-6 mm.....*S. tenuis*
20. No constriction at tail-septum; never sexually mature under 9-10 mm..*S. frederici.*
21. Anterior teeth 10-18; exceeding number of posterior teeth.....*S. helenae.*
21. Anterior teeth 4-9; less than number of posterior teeth.....*S. hispida.*
22. Collarlette never extending to ventral ganglion.....*S. neglecta.*
22. Collarlette extending from neck to seminal vesicles.....*S. californica.*
22. Collarlette extending fully to ventral ganglion, frequently onto anterior fins, but never beyond anterior quarter..... 23
23. Posterior fins longer than anterior fins.....*S. regularis.*
23. Anterior fins longer than posterior fins..... 24
24. Less than 50 per cent of posterior fin in front of tail-septum.....*S. ferox.*
24. More than 50 per cent of posterior fin in front of tail-septum.....*S. planktonis.*

## KEY TO SPECIES OF SPADELLA.

1. One pair of lateral fins entirely on tail-segment. Ventral transverse muscles present throughout entire body-segment.....*S. cephaloptera.*

1. Two pairs of lateral fins, the posterior pair much larger and confined entirely to tail-segment, beginning directly behind seminal receptacle. Anterior pair extends throughout posterior third of body, beginning directly in front of seminal receptacles. Ventral transverse muscles present only in anterior half of body.....*S. schizoptera*.

## KEY TO SPECIES OF EUKROHNA.

1. Anterior two-thirds of lateral fins rayless. Posterior extremity of fins less than half-way from tail-septum to seminal vesicles. Width of body less than 8 per cent of total length of animal. Seizing jaws delicate; sometimes serrated..... 2
1. Lateral fins delicately rayed throughout. Posterior extremity of fins at least three-fourths way from tail-septum to seminal vesicles. Width of body exceeds 12 per cent of total length of animal. Seizing jaws massive; not serrated.....*E. richardi*.
2. Eyes without pigment. Seizing jaws 8-10, gently curved throughout. Points sickle-shaped.....*E. hamata*.
2. Eye with pigment. Seizing jaws 11-13, sharply curved in anterior quarter. Point slightly curved toward edge of jaw, but not sickle-shaped.....*E. fowleri*.

## SPECIES OBTAINED DURING THE PHILIPPINE EXPEDITION.

Genus *SAGITTA* Quoy and Gaimard.*SAGITTA PHILIPPINI*, new species.

Plate 34, figs. 1-4.

*General appearance*.—To the naked eye *S. philippini*, when placed in formalin upon a white background, appears white in color, scarcely distinguishable from the background. Its head and tail, and in less degree its ovaries, assume a brownish-yellow color in marked contrast to the body proper. On a black background the head, ventral ganglion, ovaries, tail, seminal vesicles, and to a less extent the intestine appear much more opaque than the body, which resembles ground glass. The lateral fins and tail fin are so transparent as to be invisible to the naked eye. In degree of opacity *S. philippini* resembles *S. decipiens* more than any other species, although it is perhaps less transparent.

*Characters*.—Collarette absent. Neck conspicuous. Lateral fields prominent. Body flabby, not retaining its form well; widest behind center, tapering gradually forward toward head and backward toward tail. No constriction at tail-septum. Ovaries, even when immature (pl. 34, fig. 1), extend beyond posterior end of anterior fin. Corona ciliata not observed.

*Anterior fins* (pl. 34, fig. 1) rayless throughout anterior half of fin. They are longer and narrower than posterior fins, and extend anteriorly beyond posterior end of ventral ganglion. Form triangular, the position of greatest width being in the caudal quarter of fin. Interval from anterior to posterior fins slightly greater than maximum width of body.

*Posterior fins* do not extend caudally to seminal vesicles. More than 50 per cent of fin in front of tail-septum. Form triangular, the position of greatest width being at or just behind tail-septum.

*Vestibular ridge* (pl. 34, fig. 3) well developed with large papillae. Wing of ridge covers all but the first two or three teeth, the notch extending to the fourth or fifth. External process long and blunt.

*Anterior teeth* (pl. 34, fig. 2), nine in number. They are short, broad, closely set, and diverge but little distally.

*Posterior teeth* (pl. 34, fig. 3), 20 in number. They are long, narrow, closely set, and diverge even less than do the anterior teeth.

*Seizing jaws* (pl. 34, fig. 4), six in number. Point with an oval base imbedded between 20 and 25 per cent of its height into shaft. Top of shaft and base of point converge toward edge of jaw. Edge of shaft provided with narrow crest. Pulp canal central and slightly swollen at base of point. Pulp evenly distributed.

Only a single specimen was obtained. Its measurements follow:

Length.....	13 mm.
Width.....	5.5 per cent of length.
Length of tail.....	23 per cent of length.
Tip of tail to posterior end of ventral ganglion.....	70.5 per cent of length.
Length of ventral ganglion.....	6.5 per cent of length.
Length of posterior fin.....	22 per cent of length.
Width of posterior fin.....	4.5 per cent of length.
Interval from anterior to posterior fins.....	6 per cent of length.
Per cent of posterior fin in front of tail-septum.....	60 per cent.
Length of anterior fin.....	30 per cent of length.
Width of anterior fin.....	2.5 per cent of length.
Anterior fin extends beyond posterior end of ventral ganglion by.....	2 per cent of length.
Ovary extends beyond posterior end of posterior fin by.....	14 per cent of length.
Anterior teeth.....	9-9
Posterior teeth.....	20-(?)
Seizing jaws.....	6-6

The single specimen (Cat. No. 17801, U.S.N.M.) was taken from the surface May 14, 1908, off Uanivan Island, at station D 5240, latitude 6° 49.5' north and longitude 126° 15' east. The same haul also yielded 130 *S. enflata*, 10 *S. ferox*, 6 *S. hexaptera*, 1 *P. draco*, and 75 *S. decipiens*.

*S. philippini* bears a strong resemblance to the latter species, but differs from it in several important details: In the first place, it has no trace of a collarette, although this structure, while not pronounced in *S. decipiens*, is conspicuous. Again, the ovaries of *S. philippini*, though not fully mature, extend nearly to the middle of the anterior fin, while in *S. decipiens* they do not, when mature, extend beyond the anterior limit of the posterior fin. Further, the posterior fin of *S. philippini* is rayed throughout, while in *S. decipiens* (pl. 35, fig. 8) the anterior fourth or fifth of the fin is rayless. Lastly, the seizing jaws of the two species are quite different (pl. 34, fig. 4, and pl. 37, fig. 22), the jaw in *S. philippini* being provided with a narrow but conspicuous crest, which is missing in *S. decipiens*.

Altogether, these differences would seem to justify the description of a new species, even though it may later prove to be synonymous with *S. decipiens*. Had more than one individual been obtained, I should feel certain of the validity of *S. philippini*, but as the matter stands this single specimen might with as much justification be regarded as an abnormal *S. decipiens*.

SAGITTA ENFLATA Grassi.

Plate 38, fig. 28.

*Sagitta enflata* GRASSI (1883), p. 13.—FOWLER (1906), p. 8.—RITTER-ZÁHONY (1911), p. 13.—MICHAEL (1911), p. 28.

This species is represented in the Philippine collection by approximately 2,800 individuals. They usually exceed 20 mm. in length, and the largest taken measures 31.5 mm. In the San Diego region, on the other hand, the specimens rarely exceed 18 mm. in length, the largest recorded (Michael (1911, p. 29)) measuring only 21 mm. Again, the anterior teeth number 6 to 11, typically 7 or 8, in the Philippine specimens, while they number 4 to 8, typically 6 or 7, in San Diego specimens. Similarly, the posterior teeth number 9 to 15 in the Philippine specimens, the usual number being 14, while they number 6 to 12 in San Diego specimens, the usual number being 10 or 11. In all other respects, however, specimens from the two localities are in agreement, and the Philippine specimens agree in size and number of teeth with specimens described by Fowler (1906 p. 8) from the *Siboga* region.

One puzzling fact is revealed by the Philippine collection. The ovaries in most of the larger specimens are barely approaching maturity, only one case of complete maturity having been discovered in individuals exceeding 20 mm. in length; but among individuals under 16 mm. in length many have mature ovaries (pl. 38, fig. 28). In my San Diego report (1911, p. 56) a table is given of specimens of *S. enflata* arranged in three groups according as their ovaries were mature, approaching maturity, or remote from maturity. In the first group the specimens varied in length between 12.5 and 19.5 mm., in the second between 15 and 17.5 mm., and in the third between 8 and 15.5 mm. Obviously, these facts are open to two interpretations: First, the ovaries in San Diego specimens attain maturity only once and that after a length of 12 mm. is reached; and, second, the ovaries in the same individual become mature periodically, first when the individual is not less than 12 mm. in length, and subsequently after it has grown larger. If the second interpretation is eliminated, how is the relation between length of individual and stage of maturity of the ovary in the Philippine specimens to be accounted for? It could, of course, be readily explained on the assumption that two species had been confused, but I am unable to discover any other differences even remotely indicative of more than one species. In Table 1, for



example, No. 9 alone had mature ovaries, but its measurements agree with the other larger and immature specimens.

TABLE 1.—Measurements of *Sagitta enflata*.<sup>1</sup>

Number.	Length in mm.	Width.	Length of tail.	Tail to ventral ganglion.	Length of ventral ganglion.	Posterior fin.					Anterior fin.			Number of anterior teeth.	Number of posterior teeth.	Number of seizing jaws.
						Length.	Width.	To anterior fin.	To seminal vesicles.	Tail-septum. <sup>2</sup>	Length.	Width.	To ventral ganglion.			
1	25.2	10.7	15.5	74.5	3.9	14.3	3.8	7.2	4.1	66.7	11.8	2.5	16	?-8	?-14	8-8
2	23.7	10.7	19.2	74	3.7	17.2	3.9	8.3	4.3	62.5	12.2	(?)	16	11-11	15-14	8-8
3	23.6	8.7	19.8	69.5	4	17.5	3.1	8.5	4.3	60.3	14.9	(?)	15.4	9-10	14-14	9-9
4	23.2	10.4	20	73	3.8	16.9	4.4	11.2	4.4	62	13.4	2.3	16.9	10-7	14-14	?-8
5	21.1	9.9	20.8	74.8	3.9	18.1	4.7	8.3	4.6	64.1	15.3	2.6	18.3	8-7	15-15	8-8
6	20.6	12.4	19.1	71.6	4.2	19.1	3.7	7.8	4	64.8	15.6	2.6	15.6	9-11	15-14	8-8
7	18.8	12.8	19.9	70.4	4.6	19.3	3.3	(?)	4.8	65	15.6	2.2	17.6	7-7	14-15	8-7
8	18.4	11.8	20	73.6	3.7	18.8	5.1	9.3	4.9	63.4	17.7	2.3	14.8	8-9	13-13	9-8
9	15.9	12.5	18.6	71	4.6	15.8	4.4	9.6	4.8	63.6	11.6	2.1	21.2	8-7	13-?	9-9
10	13.6	9.7	18.9	71.7	4.7	18.4	3.9	9.7	3.4	70	16.2	2.4	14.1	7-7	12-12	8-9
11	10.2	7.7	23	72.3	5.7	17.3	4.6	8.4	4.8	59.9	10.7	2.1	18.2	7-6	10-9	7-8

<sup>1</sup> All measurements made in per cent of total length of animal.

<sup>2</sup> Per cent of posterior fin in front of tail-septum.

*Distribution.*—*S. enflata* was collected from 39 stations, or 85 per cent of the 46 stations at which chaetognaths were taken, a total of approximately 2,800 specimens having been obtained. Of the 39 stations 8, or 21 per cent, were mesoplanktonic, while 31, or 79 per cent, were epiplanktonic, and 22, or 56 per cent, were surface stations. From the 8 mesoplanktonic stations a total of 247 specimens was obtained, or an average of 31 per station, while from the 31 epiplanktonic stations a total of 2,559 specimens, or an average of 83 per station, was obtained, and from the 22 surface stations a total of 1,476 specimens, or an average of 67 per station, was obtained. These data, together with the fact that all subsurface hauls were made with open nets, make it clear that *S. enflata* occurs typically in the upper epiplankton of the Philippine region.

The northernmost record of its capture during the Philippine expedition is 14° 21'.5 north and 120° 23'.3 east in the China Sea near southern Luzon. The southernmost record is 5° 36'.1 south and 127° 7'.6 east in Buton Strait. The easternmost and westernmost records are 127° 44'.0 east and 1° 3'.0 south, south of Patiente Strait, and 117° 53' east and 21° 31' north in the China Sea off Hongkong. The largest number (950) was taken February 7, 1908, at 8.05 in the morning from 25 fathoms by an open 0000 grit-gauze net towed horizontally 9 fathoms above the bottom of the Sulu Archipelago, near Basilan Island, at 6° 44'.2 north and 121° 47' east. Other species taken in the same haul are: 318 *S. bedoti*, 217 *S. ferox*, 116 *S. pulchra*, 2 *S. hexaptera*, and 19 *P. draco*. The complete records of its capture are given in table 2:

TABLE 2.—*Philippine records of occurrence of Sagitta eriflata.*

Station. <sup>1</sup>	Latitude.	Longitude.	General locality.	Date.	Time.	Depth in fathoms.		Number of specimens.	Cat. No. U.S.N.M.
						Haul.	Bottom.		
D. 5101	14 24.5 N.	120 23.3 E.	China Sea, near southern Luzon.	Jan. 6, 1908	1.16 p. m.	37	43	17	17802
D. 5128	9 52.1 N.	121 49.8 E.	Sulu Sea, near southern Panay.	Feb. 4, 1908	7.05 p. m.	Surf.	(?)	7	17803
D. 5129	7 41.5 N.	122 1.8 E.	Sulu Sea, off western Mindanao.	Feb. 5, 1908	2.23 p. m.	100	(?)	47	17817
D. 5134	6 44.2 N.	121 47 E.	Sulu Archipelago, near Basilan Island.	Feb. 7, 1908	8.05 a. m.	25	34	950	17805
			Samadaku.	Feb. 29, 1908	8.15 p. m.	Surf.	7	2	
			Verde Island Passage.	Mar. 24, 1908	7.01 p. m.	Surf.	260	11	
D. 5176	13 35.3 N.	120 53.3 E.	do.	do.	7.33 p. m.	25	260		
D. 5177	13 35 N.	120 54.6 E.	do.	do.	7.33 p. m.	Surf.	(?)	51	17804
D. 5185	9 53.5 N.	122 13.3 E.	Between Panay and Negros.	Mar. 30, 1908	8.01 p. m.	250	295	(?)	
D. 5190	10 8.3 N.	123 16.8 E.	Tanon Strait, east of Negros.	Mar. 31, 1908	3.39 p. m.	Surf.	(?)	53	17806
D. 5195	10 47 N.	124 6.5 E.	Off northern Cebu Island.	Apr. 3, 1908	7.03 p. m.	Surf.	(?)	3	
D. 5196	10 44.5 N.	124 7.5 E.	do.	do.	7.49 p. m.	Surf.	(?)	41	17807
D. 5223	13 36 N.	121 25.5 E.	Between Marinduque and Luzon.	Apr. 24, 1908	7.47 p. m.	Surf.	(?)	11	17808
D. 5224	13 34.8 N.	121 21.8 E.	do.	do.	8.24 p. m.	Surf.	(?)	10	
D. 5227	14 12.3 N.	120 32.4 E.	China Sea, south of Corregidor.	May 4, 1908	7.46 p. m.	290	322	46	17809
D. 5228	14 12.3 N.	121 52.5 E.	East of Mindoro.	May 5, 1908	1.30 p. m.	300	(?)	1	17810
D. 5233	10 0.4 N.	124 45.1 E.	Between Bohol and Leyte.	May 7, 1908	9.00 p. m.	15	(?)	130	17811
D. 5234	10 0.0 N.	124 46.1 E.	do.	do.	9.42 p. m.	115	145	1	
D. 5240	6 49.6 N.	126 46.1 E.	Pujada Bay.	May 14, 1908	1.33 p. m.	Surf.	(?)	4	
D. 5262	12 37.5 N.	121 37.5 E.	East of Mindoro.	June 4, 1908	7.40 p. m.	65	(?)	1	
D. 5288	13 43.5 N.	121 37.5 E.	do.	do.	8.17 p. m.	115	140	6	17814
D. 5319	21 31 N.	117 53 E.	East of Matocor Point, Luzon.	July 23, 1908	8.14 a. m.	20	(?)	54	17815
D. 5320	20 58 N.	120 3 E.	China Sea, off Hongkong.	Nov. 5, 1908	7.23 p. m.	500	1,804	34	17816
D. 5340	10 55.8 N.	119 14.2 E.	Malampaya Sound, Palawan Island.	Nov. 6, 1908	3.18 p. m.	20	1,25	3+	
			Endeavor Strait.	Dec. 22, 1908	8.22 a. m.	90	(?)	31	17822
D. 5436	14 22.6 N.	120 29.0 E.	East of Corregidor.	Dec. 23, 1908	8.00 p. m.	Surf.	(?)	451	17822
D. 5455	13 11.2 N.	123 51.9 E.	do.	May 7, 1909	7.09 p. m.	Surf.	32	152	17812
D. 5500	8 37.8 N.	123 36.8 E.	Southeast of Luzon.	June 4, 1909	12.55 p. m.	120	217	60	17813
D. 5570	9 26.8 N.	123 38.5 E.	East of Macabalan Point, Mindanao.	Aug. 4, 1909	11.25 a. m.	200	(?)	16	17822
D. 5571	9 27.5 N.	123 38.0 E.	Between Sulujujar and Bohol Islands.	Aug. 11, 1909	7.14 p. m.	Surf.	(?)	169	17819
D. 5579	9 3.2 N.	123 21.8 E.	do.	do.	7.49 p. m.	Surf.	(?)	9	17840
D. 5580	9 3.0 N.	123 21.8 E.	Between Sulujujar and Negros Islands.	Aug. 19, 1909	7.11 p. m.	Surf.	(?)	42	17821
D. 5540	5 51.0 N.	120 46.5 E.	do.	do.	7.42 p. m.	Surf.	25	55	17880
D. 5611	0 40.5 S.	121 50.0 E.	Near Jolo Island.	Nov. 17, 1909	7.28 p. m.	Surf.	(?)	33	17823
D. 5615	0 32.5 S.	126 31.5 E.	Tomini Bay, Celebes Island.	Nov. 22, 1909	7.47 p. m.	Surf.	1,021	111	17936
D. 5633	1 3.0 S.	127 44.0 E.	Molucca Passage.	Dec. 2, 1909	7.14 p. m.	Surf.	(?)	122	17824
D. 5639	5 36.1 S.	122 7.6 E.	South of Potiencio Strait.	Dec. 16, 1909	7.23 p. m.	Surf.	(?)	84	17825
D. 5669	2 19.5 S.	118 50.0 E.	Buton Strait.	Dec. 29, 1909	7.25 p. m.	Surf.	(?)	80	17826
D. 5672	0 29.0 S.	118 51.0 E.	Mannuju Island, in Macassar Strait.	Dec. 30, 1909	7.26 p. m.	Surf.	(?)		

<sup>1</sup> Reference to these stations in Dredging and Hydrographic Records of the Philippine Expedition (Bureau of Fisheries Report, 1910) will reveal details concerning collecting apparatus used, duration of hauls, distance of drift, etc., which are here omitted.

## SAGITTA HEXAPTERA d'Orbigny.

*Sagitta hexaptera* D'ORBIGNY (1843), p. 140.—FOWLER (1906), p. 11.—RITTER-ZÁHONY (1911), p. 7.—MICHAEL (1911), p. 30.

This species is the second most abundant and frequent obtained during the Philippine expedition, being represented by approximately 700 specimens. Most are large though immature, the largest specimen measuring 45 mm. in length. Curiously, both anterior and posterior teeth in many specimens are entirely missing. My first impression was that although not seen they must be present, but careful dissection of several heads has made it certain that the teeth are actually missing. This was not noticed in San Diego specimens, two being the smallest number of either anterior or posterior teeth recorded in my (1911) report. Again, Fowler (1906, p. 13) lists the number of teeth in 42 specimens, one being the smallest number of either anterior or posterior teeth recorded. Ritter-Záhony (1908, p. 10), however, while recording three as the smallest number of anterior teeth, gives four instances in which the posterior teeth in individuals 33, 34, 36, and 38 mm. in length were missing. In attempting to account for the peculiar variability in number of teeth, Fowler (1906, p. 14) explains their absence in the Philippine specimens. He says:

I believe the explanation to lie mainly (perhaps not entirely) in the length and slenderness of the teeth; many of them are probably torn out by the roots; certainly many are broken off short, for their bases may be seen still in place. As an additional weakness, the posterior teeth in older specimens often appear not to be attached to the bony bar with which they are united in other species, but to lie at some distance from it in a superficial plate of chitinous material.

TABLE 3.—Measurements of *Sagitta hexaptera*.<sup>1</sup>

Number.	Length.	Width.	Length of tail.	Tail to ventral ganglion.	Length of ventral ganglion.	Posterior fin.					Anterior fin.			Ovaries.			Anterior teeth.	Posterior teeth.	Seizing jaws.
						Length.	Width.	To seminal vesicles.	Tail-septum. <sup>2</sup>	To anterior fin.	Length.	Width.	To ventral ganglion.	Length.	Width.	To ventral ganglion. <sup>3</sup>			
1	42.1	.....	17.0	65.1	2.8	20.9	5.7	3.5	66.0	10.8	13.3	(?)	10.0	41.0	0.33	- 7.1	2-2	0-0	5-5
2	39.4	10.1	19.1	65.8	3.8	20.2	4.3	3.7	65	8.6	11.8	2.6	13.3	36.4	.89	-10.3	4-2	0-2	5-5
3	38.6	9.9	19.1	72	3.4	21.9	4.6	6	69	10.6	14.5	3	12.7	49.6	1.54	- 3.4	0-0	1-0	4-4
4	38.5	.....	20.2	72.5	2.8	23	5.7	4	66.5	9.6	15.5	3.3	12.1	42.3	.45	-10.1	0-0	0-0	4-4
5	36.4	.....	22.2	71.1	3.3	18.5	6.1	4.9	59.4	11.8	11.2	2.3	14.9	33	.77	-15.8	0-0	2-1	4-5
6	34.4	.....	21.4	70.9	3.5	24.5	5.4	5.1	69	7.2	14.3	2	11.1	58.4	1.32	+ 5.4	0-0	0-0	5-4
7	33.7	.....	22.3	67	3	19	5.7	4.9	57.5	14.1	15.2	2.1	14.9	39.2	.62	-16	0-0	0-0	5-5
8	32.4	10.2	19.6	67.6	3.2	20	5.2	3.7	64.8	6.9	13.6	3	14.6	55.5	2.16	+ 4.2	1-1	1-0	4-4
9	32	9.3	21.6	65.5	3.5	21.2	5.1	2.8	61.8	8.5	10.5	2.3	11.8	19.7	1.09	-23.2	1-0	4-0	7-6
10	31.4	9	23.1	66.7	3.2	21.4	5	5.5	64	6.1	12.3	3.2	11.4	24.5	1.12	-19.1	0-2	2-2	4-4
11	30.8	7.5	20.8	69.5	3.1	20.3	4.3	5.4	63.7	9.9	11.6	.....	11.7	24.7	.91	-21.6	1-1	4-3	5-4
12	30.5	8.6	21.7	71.5	3.2	20.8	4.5	4.2	55.5	10.4	13.5	.....	14.5	16.8	.46	-32.3	0-0	2-1	5-5
13	30.2	6.4	19.6	63.7	3.5	20.2	4.8	4.9	64.5	6.6	13.3	2.1	9.9	13.7	.46	-30.4	2-2	3-2	5-5
14	29.5	9.4	19.5	72.5	3.6	26.4	4.7	4.6	70.5	8.8	12.1	2.8	13.6	26.1	.71	-27	3-2	2-3	5-5
15	29.3	10.2	17.8	66.4	3.6	22.8	5.5	4.1	72.3	7.9	13.2	3.1	11	36.2	1.31	-12.4	2-3	2-1	4-4

<sup>1</sup> All measurements made in per cent of total length of animal.<sup>2</sup> Per cent of posterior fin in front of tail-septum.<sup>3</sup> The + signifies extension beyond anterior end of ganglion; the - signifies distance from posterior end of ganglion.

*Distribution.*—*S. hexaptera* was collected from 26, or 57 per cent, of those stations at which chaetognaths were captured. Of these, 8 were mesoplanktonic, while 13, or one-half, were surface stations. From the 8 mesoplanktonic stations a total of only 70, or an average of 9 to each station, was obtained, while the 18 epiplanktonic stations yielded 642, or an average of 36 per station, and the 13 surface stations yielded 491, or an average of 38 per station. It is evident, therefore, that *S. hexaptera* occurs typically in the upper epiplankton of the Philippine region.

*S. hexaptera*, often confused with *S. elegans* and with the large variety (*S. maxima*) of *S. lyra*, is a eurythermal, nearly cosmopolitan species found typically in the lower epiplankton and mesoplankton of the arctic, sub-arctic, north temperate, tropical, and south tropical Atlantic, the south temperate and tropical Indo-Australian, and the north temperate and sub-antarctic Pacific oceans. Its northern and southern limits of distribution are 74° north and 28° south, while the extremes of temperature recorded in connection with its capture are 29° C. and 6° C. A statement frequently encountered in the literature is that surface Chaetognatha of the arctic seas would be found, if at all, in the mesoplankton of temperate and tropical regions, the implication being that temperature plays the all-important part in delimiting the vertical distribution of a species. Obviously, the typical occurrence of *S. hexaptera* in the upper epiplankton during the Philippine expedition contradicts this statement, which contradiction is further supported by Ritter-Záhony (1911, p. 54), who says: "Es gibt keinen einzigen verbürgten Fundort der *S. hexaptera* aus dem Epiplankton der Meere nördlich von 40° N." Rather do the facts point in quite the opposite direction, that is that surface *S. hexaptera* of tropical and sub-tropical regions are found, if at all, in the lower epiplankton and mesoplankton of arctic and sub-arctic regions. However, until consistency of identification of the species obtained during the various expeditions is attained, and until the vertical distribution of the species in diversified regions is critically studied, no conclusion as to the part played by temperature or any other environmental influence, in controlling its distribution throughout the world, is justified.

The northernmost and westernmost record of its capture during the Philippine expedition is 21° 31' north and 117° 53' east in the China Sea, off Hongkong. Its southernmost record is 5° 36'.1 south and 122° 7'.6 east, in Buton Strait; and its easternmost record is 127° 44' east and 1° 3' south, south of Patiente Strait. The largest number (153+) was taken August 11, 1909, at 7.49 in the evening, from the surface between Siquijor and Bohol Islands, at 9° 27'.5 north and 123° 38' east. Other species obtained at the same station are: 169 *S. enflata*, 128 *S. pulchra*, 50 *S. ferox*, and 14 *S. bedoti*.

TABLE 4.—*Philippine records of occurrence of Sagitta hexaptera.*

Station.	Latitude.	Longitude.	General locality.	Date.	Time.	Depth in fathoms.		Number of specimens.	Cat. No. U.S.N.M.
						Haul.	Bottom.		
D. 5120	13 45.5 N.	120 30.3 E.	Verde Island Passage.....	Jan. 21, 1908	3-10 p. m.	350	393	2	17853
D. 5128	9 52.1 N.	121 49.8 E.	Sulu Sea, near southern Panay.....	Feb. 4, 1908	7-05 p. m.	Surf.	(?)	2	17855
D. 5129	7 41.5 N.	122 1.8 E.	Sulu Sea, off western Mindanao.....	Feb. 5, 1908	2-23 p. m.	100	(?)	127	17856
D. 5134	6 44.2 N.	121 47 E.	Sulu Archipelago, near Basilan Island.....	Feb. 7, 1908	8-05 a. m.	25		2	17857
D. 5177	13 35 N.	120 54.6 E.	Verde Island Passage.....	Mar. 24, 1908	7-33 p. m.	25		260	17858
D. 5185	10 5.8 N.	122 18.5 E.	Between Panay and Negros.....	Mar. 30, 1908	5-26 p. m.	550	638	28	17859
D. 5186	9 53.5 N.	122 15.5 E.	do.....	do.....	8-01 p. m.	Surf.	(?)	4	17855
D. 5195	10 47 N.	124 6.5 E.	Off northern Cebu Island.....	Apr. 3, 1908	7-03 p. m.	Surf.	(?)	48	17840
D. 5224	13 34.8 N.	121 21.8 E.	Between Marinduque and Luzon.....	Apr. 24, 1908	8-24 p. m.	Surf.	(?)	12	17854
D. 5240	10 0.0 N.	124 46.1 E.	Between Bohol and Leyte.....	May 7, 1908	9-42 p. m.	15	(?)	8	17841
D. 5243	6 49.6 N.	126 46.1 E.	Pulada Bay.....	May 14, 1908	1-33 p. m.	115	145	6	17842
D. 5283	12 38.5 N.	121 37.5 E.	East of Mindoro.....	June 4, 1908	7-40 p. m.	Surf.	(?)	6	17843
D. 5288	13 43.5 N.	121 0.0 E.	East of Matocot Point, Luzon.....	July 22, 1908	8-14 a. m.	115	140	2	17844
D. 5319	21 31 N.	117 53 E.	China Sea, off Hongkong.....	Nov. 5, 1908	7-23 p. m.	20	(?)	12	17845
D. 5320	20 58 N.	120 3 E.	do.....	Nov. 6, 1908	3-18 p. m.	500	1,804	4	17846
D. 5437	15 45.9 N.	119 42.7 E.	West of Luzon.....	Nov. 8, 1908	12-07 p. m.	450	(?)	9	17847
D. 5456	13 11.2 N.	123 51.9 E.	Southeast of Luzon.....	June 7, 1909	11-25 p. m.	120	142	1	17848
D. 5500	8 37.8 N.	124 36.8 E.	East of Macabalan Point, Mindanao.....	Aug. 4, 1909	11-25 a. m.	200		18	17853
D. 5530	9 26.8 N.	123 38.5 E.	Between Siquilor and Bohol Islands.....	Aug. 11, 1909	7-14 p. m.	Surf.	(?)	45	17849
D. 5531	9 27.5 N.	123 38 E.	do.....	do.....	7-49 p. m.	Surf.	(?)	153+	17850
D. 5539	9 3.2 N.	123 24.8 E.	do.....	do.....	7-11 p. m.	Surf.	(?)	32	17851
D. 5540	9 3 N.	123 24.5 E.	do.....	do.....	7-42 p. m.	Surf.	(?)	135	17852
D. 5543	1 3 S.	127 44 E.	South of Patiente Strait.....	Dec. 2, 1909	7-14 p. m.	Surf.	(?)	14	17854
D. 5649	5 36.1 S.	122 7.6 E.	Buton Strait.....	Dec. 16, 1909	7-23 p. m.	Surf.	(?)	30	17855
D. 5669	2 19.5 S.	118 50 E.	Mamuju Island, in Macassar Strait.....	Dec. 29, 1909	7-25 p. m.	Surf.	(?)	8+	17856
D. 5672	0 29 S.	118 51 E.	Macassar Strait.....	Dec. 30, 1909	7-25 p. m.	Surf.	(?)	2	.....

## SAGITTA MINIMA Grassi.

Plate 37, figs. 16-17; plate 38, fig. 29.

*Sagitta minima* GRASSI (1881), p. 213; (1883), p. 15.—KRUMBACH (1903), p. 637.—  
RITTER-ZÁHONY (1911), p. 25.

This species is represented by only two specimens (Cat. No. 17925, U.S.N.M.), both of which are apparently sexually mature. Both were obtained on April 3, 1908, from the surface at station D. 5195, off northern Cebu Island,  $10^{\circ} 47'$  north and  $124^{\circ} 6'.5$  east. Except for the mature ovaries they are almost inseparable to the naked eye from small *S. enflata*. Microscopic examination, however, reveals several marked differences. The species is redescribed on the basis of these two specimens.

*Collarette absent.* Body flabby and widest on a level with anterior end of posterior fins, tapering gradually toward head and tail. Constriction at tail-septum slight or absent. Ovary (pl. 38, fig. 29) short, not extending to anterior end of posterior fins. Ova large and arranged in a single row within the ovary. Corona ciliata not observed.

*Anterior fins* shorter and narrower than posterior fins and entirely rayless. They fall short of reaching the posterior end of ventral ganglion by nearly two-thirds the length of fins. Interval from anterior to posterior fins approximately equal to half the length of anterior fins.

*Posterior fins* (pl. 38, fig. 29) with rays arranged perpendicular to the body. Interval from fins to seminal vesicles 3 to 5 per cent of total length. More than 50 per cent of fins in front of tail-septum. Position of greatest width behind tail-septum.

*Vestibular ridge* (pl. 37, fig. 16) provided with low, regular papillæ, one for each tooth. Wing covers all except the first tooth, the second being just barely covered. Notch extends to fourth tooth. External process apparently missing.

*Anterior teeth*, 4 to 5 in number (2 to 5 according to Ritter-Záhony, 1911, p. 26). They are very closely set and not diverging much distally. *Posterior teeth* (pl. 37, fig. 16), 10 or 11 in number (6 to 14 according to Ritter-Záhony). They are not so closely set as the anterior teeth, but are more divergent distally.

*Seizing jaws* (pl. 37, fig. 17), 8 or 9 in number (7 to 8 according to Ritter-Záhony). Point with an oval base, inserted into shaft by less than one-fifth its height. Tip of point curved toward its edge. Base of point and top of shaft parallel. Pulp-canal central, with a swollen place below base of point. Pulp evenly distributed throughout canal.

Aside from the number of teeth and seizing jaws and length of tail, only one of the two specimens is well enough preserved to permit accurate measurements.

Length in mm.....	9.5.
Tail:	
Length.....	20.8 per cent of length.
To ventral ganglion.....	68.5 per cent of length.
Posterior fin:	
Length.....	17.6 per cent of length.
To seminal vesicles.....	3.2 per cent of length.
To anterior fin.....	9.1 per cent of length.
Proportion in front of tail-septum.....	59.1 per cent.
Anterior fin:	
Length.....	16.5 per cent of length.
To ventral ganglion.....	11.7 per cent of length.
Number of anterior teeth.....	5-4.
Number of posterior teeth.....	11-(?)
Number of seizing jaws.....	8-9.

The other specimen measured 8.9 mm.; its tail measured 20.7 per cent; the number of anterior teeth are 4-5; the number of posterior teeth, 10-10; and the number of seizing jaws, 9-8.

SAGITTA SERRATODENTATA Krohn.

*Sagitta serratodentata* KROHN (1853), p. 272.—FOWLER (1905), p. 58.—RITTER ZÁHONY (1911), p. 22.—MICHAEL (1911), p. 39.

Approximately 100 specimens were obtained, none of which is sexually mature. The number of anterior and posterior teeth is greater than recorded by Fowler (1905, p. 58) in specimens taken from the Bay of Biscay, or by myself (1911, p. 40) in specimens taken from the San Diego region. In specimens between 7 and 11 mm. in length Fowler records 3 to 6 anterior and 2 to 10 posterior teeth, while in Philippine specimens between the same lengths, the anterior teeth number 8 to 11 and the posterior teeth 13 to 24. The San Diego specimens are considerably larger, those recorded varying in length between 10 and 17 mm.; but the number of teeth is intermediate, the anterior teeth numbering 6 to 9 and the posterior teeth 13 to 19. The species appears to be unusually variable.

TABLE 5.—Measurements of *Sagitta serratodentata*.<sup>1</sup>

Number.	Length in mm.	Width.	Length of tail.	Tail to ventral ganglion.	Length of ventral ganglion.	Posterior fin.					Anterior fin.			Number of anterior teeth.	Number of posterior teeth.	Number of seizing jaws.
						Length.	Width.	To anterior fin.	To seminal vesicles.	Tail-septum. <sup>2</sup>	Length.	Width.	To ventral ganglion.			
1	10.6	4.5	26.0	62.0	7.5	26.0	3.0	.....	4.5	51.5	22.0	2.0	0.5	10-10	23-22	6-5
2	10.5	5	24	67	7	28	4	.....	2.5	51.5	24	3	2	11-11	24-23	6-6
3	10.3	5	25	65	7	27	1.5	.....	7	55	18.5	1.5	1	11-10	20-18	6-6
4	10.2	5	26	68	7	25	3.5	0.5	6.5	52	22.5	.....	.....	8-9	20-7	6-6
5	9.3	4.5	24.5	68.6	7.5	28	4.5	1	5.5	52	21	2.5	0.5	9-8	7-19	6-6
6	9	5	25	68	8	29.5	4.5	.....	4	50.5	23	3	.....	9-9	17-16	7-7
7	8.6	5	25.5	68.5	8.5	27.5	4	1.5	5.5	50	22.5	2.5	.....	9-8	15-14	6-6
8	8.4	5	27	72.5	8	31	4.5	0.5	3.5	50	26	3	.....	9-9	18-19	6-7
9	7.6	4.5	25.5	68	7	28	4.5	1.5	4.5	50	22	2.5	.....	9-7	15-7	6-6
10	7.5	5	25	69	8	28.5	4.5	1.5	4.5	50	21.5	2.5	.....	9-9	14-13	7-7

<sup>1</sup> All measurements made in per cent of total length of animal.

<sup>2</sup> Per cent of posterior fin in front of tail-septum.

TABLE 6.—*Philippine records of occurrence of Sagitta serratodentata.*

Station.	Latitude.	Longitude.	General locality.	Date.	Time.	Depth in fathoms.		Number of specimens.	Cat. No. U.S.N.M.
						Haul.	Bottom.		
D. 5120	13 45.5 N.	120 30.2 E.	Between Balayan Bay and Verde Island	Jan. 21, 1908	2.41 p. m.	350	393	1	17932
D. 5129	7 41.5 N.	122 1.8 E.	Sulu Sea, off western Mindanao	Feb. 5, 1908	2.23 p. m.	100	(?)	1	17828
D. 5185	10 5.8 N.	122 18.5 E.	Between Panay and Negros	Mar. 30, 1908	5.26 p. m.	550	638	2	17829
D. 5190	10 8.3 N.	123 16.8 E.	Tanon Strait, east of Negros	Mar. 31, 1908	4.39 p. m.	250	295	(?)	17830
D. 5319	21 31 N.	117 53 E.	China Sea, off Hongkong	Nov. 5, 1908	7.23 p. m.	20	(?)	19	17830
D. 5320	20 58 N.	120 3 E.	do.	Nov. 6, 1908	3.18 p. m.	500	1,804	5	17831
D. 5540	9 3 N.	123 24.5 E.	Between Siquijor and Bohol Islands	Aug. 11, 1909	7.49 p. m.	Surf.	(?)	1	17832
D. 5615	0 32.5 S.	126 31.5 E.	Molucca Passage	Nov. 22, 1909	2.37 p. m.	Surf.	1,021	73	17832

*Distribution.*—*S. serratodentata* was collected from only eight stations. All except three were mesoplanktonic, but the largest number of specimens (73) were taken from the surface. The records are given in Table 6:

## SAGITTA MACROCEPHALA Fowler.

*Sagitta macrocephala* FOWLER (1905), p. 65.—RITTER-ZÁHONY (1911), p. 31.

A single distorted specimen was obtained. Its measurements follow:

Length in mm.....	7.8 mm.
Width in per cent of length.....	14.4 per cent.
Tail in per cent of length.....	37.4 per cent.
Length of posterior fin.....	24.8 per cent.
Per cent of fin in front of tail-septum.....	45.5 per cent.
Width of posterior fin.....	7.7 per cent.
Interval from anterior to posterior fin.....	5.5 per cent.
Length of anterior fin.....	15.0 per cent.
Width of anterior fin.....	2.7 per cent.
Number of anterior teeth.....	7-7
Number of posterior teeth.....	25-26
Number of seizing jaws.....	11-11

Ventral ganglion, corona ciliata, and ovaries not observed.

The specimen differs conspicuously in width from those drawn by Fowler (1905, pl. 5, fig. 16) and Ritter-Záhony (1911, fig. 37). In width the Philippine specimen measures 14.4 per cent of the length, while Fowler draws it 7.8 per cent, and Ritter-Záhony 5 per cent. However, the Philippine specimen is clearly immature, neither ovaries nor seminal vesicles being visible. Moreover, it is poorly preserved, some portions of the body being distorted and others torn away. These facts are probably responsible for the excessive width. Unfortunately the points of all seizing jaws were broken off, so that their structure could not be determined.



The single specimen (Cat. No. 17926, U.S.N.M.) was obtained November 6, 1908, in the China Sea, in the vicinity of Formosa, at station D. 5320, 20° 58' north and 120° 3' east by an open 0000 grit gauze net towed at 3.18 in the afternoon in 500 fathoms for twenty minutes.

SAGITTA PULCHRA Doncaster.

Plate 35, fig. 5; plate 37, figs. 19, 23.

*Sagitta pulchra* DONCASTER (1902), p. 213.—FOWLER (1906), p. 17.—RITTER-ZÁHONY (1911), p. 21.

Approximately 500 individuals were obtained, and few, if any, are sexually mature. In body length and number of teeth they agree remarkably well with specimens described by Fowler (1906) from the *Siboga* region. He records 5 to 10 anterior and 9 to 15 posterior teeth in specimens between 9 and 22 mm. in length, and in Philippine specimens between 9 and 30 mm. in length, the anterior teeth number 5 to 9, and the posterior teeth 10 to 13. The Philippine specimens are, on the whole, so well preserved that the species is redescribed.

*Collarette* (pl. 35, fig. 5) conspicuous but short, varying in length from one-twentieth to one-tenth the length of the animal. Its length is less than twice the body width and it extends between one-fourth and one-half the distance from neck to ventral ganglion. Neck pronounced but rendered inconspicuous by the collarette. Muscles thin but strong. Lateral fields large. More transparent than any other species having a collarette, and similar in transparency to *S. enflata*. Its body, however, is firmer than that of *S. enflata* and is approximately half as wide. Width greatest between one-half and three-quarters the distance from head to tail-septum, tapering gradually forward and more rapidly backward. Slight constriction at tail-septum. Tail 18 to 25 per cent of total length of animal. Corona ciliata not observed.

*Anterior fins* (pl. 35, fig. 5) longer and narrower than posterior fins extending anteriorly beyond posterior end of ventral ganglion, frequently beyond its middle, and rarely beyond its anterior end. No rays except in posterior quarter of fin. Interval from anterior to posterior fins usually less than two-thirds width of body, varying from slightly less than one-half to slightly more than the width.

*Posterior fins* (pl. 35, fig. 5) rayless anteriorly. They extend posteriorly nearly if not quite to seminal vesicles, the interval never exceeding 2.5 per cent of total length of animal. More than 50 per cent of fin in front of tail-septum, varying from 50.5 to 64 per cent. Broadly triangular in form, and widest at or slightly behind tail-septum.

*Vestibular ridge* (pl. 37, fig. 19) provided with large regular papillae, the apices of which usually terminate in two minute spines. Wing of ridge covers all except first two or three teeth. Notch extends

to fourth or fifth tooth. External process one-third to one-half length of ridge and approximately four times longer than broad.

*Anterior teeth* 5 to 9, closely set and diverging distally. *Posterior teeth* (pl. 37, fig. 19) 10 to 13, not so closely set nor so divergent distally as anterior teeth.

*Seizing jaws* (pl. 37, fig. 23) 5 to 6 in number. Point with oval base inserted little more than one-tenth its height into shaft. Base of point and top of shaft parallel. Edge of shaft provided with broad thin crest. Pulp-canal central, with pulp evenly distributed throughout.

TABLE 7.—*Measurements of Sagitta pulchra.*<sup>1</sup>

Number.	Length in mm.		Length of tail.	Tail to ventral ganglion.	Length of ventral ganglion.	Posterior fin.				Anterior fin.			Collar-ette.		Number of anterior teeth.	Number of posterior teeth.	Number of seizing jaws.	
	Width.	Length of tail.				Length.	Width.	To seminal vesicle.	To anterior fin.	Tail-septum. <sup>2</sup>	Length.	Width.	To ventral ganglion.	Length.				To ventral ganglion.
1	29.3	5.5	18	70.5	4	25	5.5	1	2.5	64	37.5	3	+4.5	5	16	6-7	10-10	5-5
2	27.3	7	17.5	70	3.5	23	4	1.5	3.5	56	37.5	2.5	+1.5	6	16	5-6	11-12	5-6
3	21	6	19.5	72	4	24.5	5.5	1.5	2.5	63.5	36	2.5	+1.5	5	13.5	6-6	12-13	5-5
4	20.5	5.5	19.5	69	4	22	5	1	2	58.5	36	3	+1.5	7.5	14.5	7-6	10-11	5-5
5	20.2	6	20	71	4	24	5	1	3	59.5	32	2	+2.5	9.5	11.5	7-5	10-11	5-6
6	19.5	5.5	21	70.5	4.5	26.5	5.5	0	1.5	56.5	35	3.5	+2	8	13	6-6	7-12	6-6
7	19.4	6	19.5	70	4	23.5	5	1	4.5	59.5	33.5	3.5	+1.5	8.5	13.5	8-5	13-13	5-5
8	18.7	5.5	21	72	4.5	22.5	4	1	7	54	32.5	2.5	+1.5	7	12.5	7-6	12-12	5-6
9	18.4	6	20	71	4.5	23	5.5	1	3	58.5	36	3	+1.5	8	12.5	8-9	12-13	6-6
10	16.2	4.5	21	70.5	4.5	24	3.5	(?)	4.5	55.5	33	2	+1.5	8	12.5	7-7	11-?	6-6
11	15.2	5	20	67	5	22	4	2	3.5	60	32	3	+2.5	9.5	10.5	8-7	11-?	6-6
12	14.1	6	23.5	69	5	27	5.5	0	3	56	32	3.5	+1.5	8.5	13.5	5-6	12-11	6-6
13	10.5	7	27	68.5	6.5	23.5	5.5	(?)	3	62	32	3	+3.5	8.5	16.5	7-8	11-12	6-6
14	10.3	6	23	68.5	5	23.5	4.5	2	3.5	51.1	31.5	3	+2	7.5	12.5	7-6	10-9	6-6
15	9.6	5	25	69.5	6	27.5	5	(?)	1	50.5	32	3	+2	6	13	7-6	7-10	6-6

<sup>1</sup> All measurements made in per cent of total length of animal.

<sup>2</sup> Per cent of posterior fin in front of tail-septum.

*Distribution.*—*S. pulchra* was collected from 23 stations, or from exactly 50 per cent of those at which chaetognaths were taken. Of these only 5 were mesoplanktonic stations, and 14 of the remaining 18 were surface stations. There can be no question, therefore, that the species is typical of the upper epipelagic in the Philippine region. Its northernmost record of capture during the Philippine expedition is in the China Sea, near Hongkong, 20° 58' north and 120° 3' east; its southernmost record is in Buton Strait, 5° 36.1' south and 122° 7.6' east; its easternmost record is in the Gulf of Tomini, Celebes, 125° 17.1' east and 1° 13.2' north; and its westernmost record is in Macassar Strait, 118° 50' east and 2° 19.5' south. The largest number (128+) was taken August 11, 1909, at 7.49 in the afternoon by a 0000 grit-gauze net towed on the surface between Siquijor and Bohol Islands, at 9° 27.5' north and 123° 38' east. Other species taken at the same station are *S. enflata* (169), *S. lyra* (85), *S. ferox* (50), and *S. bedoti* (14).

TABLE 8.—*Philippine records of occurrence of Sagitta pulchra.*

Station.	Latitude.		Longitude.	General locality.	Date.	Time.	Depth in fathoms.		Number of specimens.	Cat. No. U.S.N.M.	
	°	'					Haul.	Bottom.			
D. 5101	14	24.5 N.	120	23.3 E.	China Sea, off southern Luzon.....	Jan. 6, 1908	1.16 p. m.	37	43	1	17857
D. 5129	7	41.5 N.	122	1.8 E.	Sulu Sea, off western Mindanao.....	Feb. 5, 1908	2.23 p. m.	100	(?)	21	17858
D. 5134	6	44.2 N.	121	47	Sulu Archipelago, near Basilan Island.....	Feb. 7, 1908	8.05 a. m.	25	34	116	17859
D. 5195	10	47	124	6.5 E.	Off northern Cebu Island.....	Apr. 3, 1908	7.03 p. m.	Surf.	(?)	29	17860
D. 5223	13	36 N.	121	25.5 E.	Between Matindague and Luzon.....	Apr. 24, 1908	7.47 p. m.	Surf.	(?)	3	17861
D. 5224	13	34.8 N.	121	21.8 E.	do.....	do	8.24 p. m.	Surf.	(?)	1	.....
D. 5226	14	12.3 N.	120	32.7 E.	China Sea, south of Corregidor.....	May 4, 1908	7.45 p. m.	Surf.	(?)	1	.....
D. 5258	10	27.8 N.	122	12.5 E.	Off southern Panay.....	June 2, 1908	7.08 p. m.	Surf.	(?)	1	.....
D. 5253	12	38.5 N.	121	37.5 E.	East of Mindoro.....	June 4, 1908	7.40 p. m.	Surf.	(?)	1	.....
D. 5288	13	48.5 N.	121	0.0 E.	East of Marocot Point, Luzon.....	July 22, 1908	8.14 a. m.	Surf.	115	63	17862
D. 5320	20	58 N.	120	3	China Sea, off Hongkong.....	Nov. 6, 1908	3.18 p. m.	500	1,804	29	17863
D. 5340	10	55.8 N.	119	14.2 E.	Malampaya Sound, Palawan Island.....	Dec. 22, 1908	8.22 a. m.	20	25	(?)	.....
D. 5436	14	22.6 N.	120	29	Endeavor Strait.....	Dec. 23, 1908	8.00 p. m.	Surf.	(?)	2	17874
D. 5456	13	11.2 N.	123	51.9 E.	East of Corregidor.....	May 7, 1909	7.03 p. m.	Surf.	32	8	17864
D. 5500	8	37.8 N.	124	36.8 E.	Southeast of Luzon.....	June 7, 1909	12.55 p. m.	120	142	45	17865
D. 5530	9	26.8 N.	123	38.5 E.	East of Macabalan Point, Mindanao.....	Aug. 4, 1909	11.25 a. m.	200	267	21	17866
D. 5531	9	27.5 N.	123	38	Between Siquijor and Bohol Islands.....	Aug. 11, 1909	7.14 p. m.	Surf.	(?)	8	17867
D. 5539	9	3.2 N.	123	38	do.....	do	7.49 p. m.	Surf.	(?)	128	17868
D. 5540	9	3.0 N.	123	24.8 E.	do.....	Aug. 19, 1909	7.11 p. m.	Surf.	(?)	5	17869
D. 5601	1	13.2 N.	125	17.1 E.	Gulf of Tomini, Celebes.....	Nov. 13, 1909	7.42 p. m.	Surf.	(?)	22	17870
D. 5649	5	36.1 S.	122	7.6 E.	Bucon Strait.....	Dec. 16, 1909	7.23 p. m.	Surf.	765	29	17872
D. 5669	2	19.5 S.	118	50	Mamuju Island, in Macassar Strait.....	Dec. 29, 1909	7.25 p. m.	Surf.	(?)	10	17873

## SAGITTA DECIPIENS Fowler.

Plate 35, fig. 8; plate 37, figs. 18, 22.

*Sagitta decipiens* FOWLER (1905), p. 70.—RITTER-ZÁHONY (1911), p. 27.*Sagitta sibogae* FOWLER (1906), p. 21.—RITTER-ZÁHONY (1909a), p. 5.—MICHAEL (1911), p. 74.

According to Ritter-Záhony (1911, p. 29), there is "keine spezifischen Unterschiede in Fowler's Diagnosen und Abbildungen der beiden Arten [*S. decipiens* und *S. sibogae*] und *S. sibogae* weist danach—als älteres Stadium!—gegenüber *S. decipiens* eigentlich nur bedeutendere Dimensionen und höhere Zahlen für die Vorder- und Hinterzähne auf."

Although the species is represented in the Philippine collection by more than 100 specimens, few are well enough preserved to permit accurate measurements and their identification is therefore not certain. They have more anterior and posterior teeth than recorded by Fowler (1905, p. 70) in his original description, 8 to 11 anterior and 19 to 22 posterior teeth against his records of 5 to 10 anterior and 12 to 18 posterior teeth. They agree, however, with his (1906, p. 21) records for *S. sibogae*, in which the anterior teeth number 7 to 10 and the posterior teeth 13 to 23. They also agree, not so well perhaps, with Ritter-Záhony's (1911, p. 28) records. He gives the number of anterior teeth as 7 to 9 and the number of posterior teeth as 12 to 20. The species is redescribed on the basis of the Philippine material.

*Collarette* (pl. 35, fig. 8) inconspicuous, varying in length from slightly less than one-quarter to slightly more than half the body width. Body flabby, seldom retaining its form well, and widest on level with posterior end of anterior fins, tapering gradually toward head and tail. No constriction at tail-septum. Ovary short, not extending beyond anterior limit of posterior fins. Corona ciliata not observed.

*Anterior fins* (pl. 35, fig. 8) rayless throughout anterior half, longer and narrower than posterior fins, and extending slightly beyond posterior end of ventral ganglion. Interval from anterior to posterior fins about equal to maximum width of body.

*Posterior fins* (pl. 35, fig. 8) rayless in anterior extremity. They never extend posteriorly to seminal vesicles, the interval varying in length from about 25 to 110 per cent of the maximum body width. More than 50 per cent of fin in front of tail-septum, varying from 54 to 65 per cent. Form irregular, the position of greatest width being at or just behind tail-septum.

*Vestibular ridge* (pl. 37, fig. 18) concealed by a thick cuticle. It is characterized by large fairly regular papillae extending internally beyond the teeth and terminating near the mouth. Wing covers all except the first one or two teeth, the notch extending to the third or fourth. External process not observed. According to

Fowler (1905, p. 70) it is "a very strong process; sometimes forked at the external edge."

*Anterior teeth* 8 to 11, short, broad, and diverging distally. *Posterior teeth* 19 to 22, longer, and more closely set than anterior teeth.

*Seizing jaws* (pl. 37, fig. 22), 5 to 7. Point inserted slightly less than one-third its height into shaft, with an irregular triangular projection at the middle of its base. Base of point and top of shaft converge toward edge of jaw. Edge of point and edge of shaft on a line with each other, but back of point and back of shaft intersect each other, forming an obtuse angle. Tip of point slightly bent toward edge of jaw. Pulp-canal displaced slightly toward back of shaft, with a swollen place below base of point. Pulp evenly distributed throughout canal.

TABLE 9.—*Measurements of Sagitta decipiens.*<sup>1</sup>

Number.	Length in mm.	Width.	Length of tail.	Tail to ventral ganglion.	Length of ventral ganglion.	Posterior fin.					Anterior fin.			Collarette.		Number of anterior teeth.	Number of posterior teeth.	Number of seizing jaws.
						Length.	Width.	To seminal vesicle.	To anterior fin.	Tail-septum. <sup>2</sup>	Length.	Width.	To ventral ganglion.	Length.	To ventral ganglion.			
1	12.4	5.0	23.5	70.5	7.0	20.0	4.0	5.5	7.5	64.5	27.0	1.5	+1.0	3.0	15.5	9-8	19-20	6-6
2	12.2	5.5	24	67	9.5	20.5	5	4.5	6	65	25	2.5	+1.5	3	15.5	9-9	21-20	6-6
3	11	5.5	25	72.5	8.5	21.5	4.5	1.5	4	58.5	29	2	+1.5	1.5	13	10-11	22-22	5-5
4	9.1	(?)	25.5	70	8.5	24	5	2.5	4.5	55	27	2.5	+1.5	1.5	14	11-10	19-21	7-7
5	8.8	5	24	69.5	8	22.5	(?)	2.5	3	58	23	2	+2	1.5	15.5	9-8	20-21	5-6

<sup>1</sup> All measurements made in per cent of total length of animal.

<sup>2</sup> Per cent of posterior fin in front of tail-septum.

*Distribution.*—*S. decipiens* was collected from only six stations, four of which were mesoplanktonic and two surface stations. According to the literature the species is typically mesoplanktonic, only the very young having been taken above 100 fathoms. Its records of occurrence during the Philippine expedition are given in Table 10.

#### SAGITTA BEDOTI Béraneck.

Plate 35, fig. 6; plate 37, figs. 20, 24; plate 38, fig. 30.

*Sagitta bedoti* BÉRANECK (1895), p. 137.—FOWLER (1906), pp. 6-8.—RITTER-ZÁHONY (1911), p. 20.—MICHAEL (1911), p. 75.

According to Fowler (1906, p. 6) *S. bedoti* has "a very slight thickening of the epidermis at the neck, but no real collarette." In my 1911 report those species not taken from the San Diego region were briefly described and, not having seen *S. bedoti*, I assumed Fowler's statement to be correct and placed this species among those in which the collarette was absent. Subsequently, however, Ritter-Záhony's (1911) report appeared in which he (p. 20)

TABLE 10.—*Philippine records of occurrence of Sagitta decipiens.*

Station.	Latitude.	Longitude.	General locality.	Date.	Time.	Depth in fathoms.		Number of specimens.	Cat. No. U.S.N.M.
						Haul.	Bottom.		
D. 5224	13 34.8 N.	121 21.3 E.	Between Marinduque and Luzon.....	Apr. 24, 1908	8.24 p. m.	Surf.	(?)	2	17875
D. 5240	6 49.6 N.	126 15 E.	Near Umanivan Island.....	May 14, 1908	1.49 p. m.	115	145	75	17876
D. 5288	13 43.5 N.	121 0.0 E.	East of Malocof Point, Luzon.....	July 22, 1908	8.14 a. m.	115	140	13	17877
D. 5436	14 22.6 N.	120 29 E.	East of Corregidor.....	May 7, 1909	7.03 p. m.	Surf.	32	3	.....
D. 5456	13 11.2 N.	123 51.9 E.	Southeast of Luzon.....	June 7, 1909	12.55 p. m.	120	142	6	17878
D. 5500	8 37.8 N.	124 30.8 E.	East of Macabalan Point, Mindanao.....	Aug. 4, 1909	11.25 a. m.	200	207	50	17879

says: "Collerette relativ kurz, nur bis etwa zur halben Corona reichend." The specimens collected during the Philippine expedition agree with Ritter-Záhony's statement. Every specimen has a collerette which, while narrow and short, is broader and longer than that of *S. bipunctata*. Owing to this confusion in the literature, *S. bedoti* is redescribed from the Philippine specimens:

*Collerette* (pl. 38, fig. 30) conspicuous but short, extending caudally a distance nearly equal to greatest width of body. Head small. Lateral fields large. Muscles strong, but narrow. Body firm, retaining its form well, widest slightly behind its middle, and tapering gradually toward head and more rapidly toward tail. No constriction at tail-septum. Tail 20 to 30 per cent of total length of animal. Corona ciliata not observed.

*Anterior fins* (pl. 35, fig. 6) longer and narrower than posterior fins, without rays in the anterior half or two-thirds. Fins extend nearly if not quite to posterior end of ventral ganglion, the exact limit being difficult to determine owing to absence of rays. In some individuals the fins may extend beyond posterior end of ganglion, but never to its anterior end. Form acutely triangular, the position of greatest width being in posterior quarter of fins.

*Posterior fins* (pl. 35, fig. 6) extend caudally to seminal vesicles. Rays absent in anterior extremity. Usually, but not always, less than 50 per cent of fin in front of tail-septum, the extremes being 40 and 52 per cent. Triangular in form, the position of greatest width being behind tail-septum. Interval from anterior to posterior fins varies from half to twice the maximum width of body.

*Vestibular ridge* (pl. 37, fig. 20) prominent and provided with regular and unusually acute papillae. Number of papillae

less than number of teeth. Wing of ridge covers all except the first and occasionally the second tooth. Notch extends to the fourth or fifth tooth. External process short and blunt, not, as described by Fowler (1906, p. 6), "terminating externally in a well-marked, rather sharp process." Its length is about two-sevenths that of entire ridge.

*Anterior teeth* 8 to 10 and *posterior teeth* (pl. 37, fig. 20) 20 to 28 in number in individuals 10 to 15 mm. long. Anterior teeth are closely set and diverging distally, while the posterior teeth are more closely set and only slightly divergent distally.

*Seizing jaws* (pl. 37, fig. 24) 5 to 7 in number. Points with curved tip, oval bases, and embedded about 25 per cent of their heights into shaft. Base of point and top of shaft parallel. Pulp-canal central, extending into point about 75 per cent of its height and converging markedly toward edge of point. Pulp evenly distributed throughout canal.

TABLE 11.—Measurements of *Sagitta bedoti*.<sup>1</sup>

Number.	Length in mm.		Tail to ventral ganglion.	Length of ventral ganglion.	Posterior fin.				Anterior fin.			Collarette.		Number of posterior teeth.	Number of seizing jaws.			
	Length.	Width.			Length of tail.	Length.	Width.	To seminal vesicle.	To anterior fin.	Trail-septum. <sup>2</sup>	Length.	Width.	To ventral ganglion.			Length.	To ventral ganglion.	
1	14.5	6.4	29.6	74.0	5.0	24.7	4.0	0	3.0	49.2	28.4	2.5	0+	3.4	14.4	9-10	24-22	7-7
2	14.5	5	25	70.5	6	24	4.5	0	6.5	43.5	28.5	2	0-	3	16	9-9	24-23	7-6
3	14.5	4.5	25	71.5	6.5	27	3	0	4	52.5	27.5	2	0-	5	14.5	9-10	27-28	7-6
4	14	4	25.5	70.5	5.5	23.5	4	0	7	42.5	28	1.5	0-	4	15	8-9	22-21	6-6
5	14	5	25	72	5.5	26	3.5	0	4.5	47.5	28.5	2.5	0-	4	14	8-8	24-25	6-6
6	13.5	5.5	25	75	6.5	29	4	0	4.5	50	29	2	0-	4	16	8-8	25-24	6-6
7	13	5	25.5	71	6	24	4	0	6	42.5	29	2	0-	4	15.5	9-8	22-21	6-6
8	12.5	6	26	73.5	6.5	27	4.5	0	5.5	51	28	2.5	0-	5	16.5	9-9	24-25	6-6
9	11.5	5	29	66	6.5	29	4.5	0	5	45.5	32	2	0-	7	16.5	9-9	23-22	6-6
10	10	5	26	70.5	6.5	27	3	0	3	49	28.5	2.5	0-	2.5	15.5	9-10	20-21	6-6

<sup>1</sup> All measurements made in per cent of total length of animal.

<sup>2</sup> Per cent of posterior fin in front of tail-septum.

*Distribution.*—*S. bedoti* was collected from only four stations, 352 specimens having been obtained. As shown by the following table all specimens were taken from the upper epiplankton. This indication that the species typically occurs near the surface is supported by other expeditions and collections. It has been taken near the surface in the region of Port Natal by the Gauss expedition; in the Maldive and Laccadive Archipelagoes by Doncaster (1902) under the name *S. polyodon*; in the Malay Archipelago by Béraneck (1895); in the *Siboga* region by Fowler (1906); in Misaki Harbor, Japan, by Aida (1897) under the name *S. bipunctata*; and in Sharks Bay, Australia, by Ritter-Záhony (1910). Altogether, the evidence warrants concluding that *S. bedoti* is characteristic of the upper epiplankton of the tropical Indo-Pacific region.

TABLE 12.—*Philippine records of occurrence of Sagittia bedoti.*

Station.	Latitude.	Longitude.	General locality.	Date.	Time.	Depth in fathoms.		Number of specimens.	Cat. No. U.S.N.M.
						Haul.	Bottom.		
D. 5129	9° 52.2' N.	121° 49.6' E.	Sulu Sea, in vicinity of southern Panay.....	Feb. 4, 1908	7.05 p. m.	Surf.	(?)	4	17885
D. 5134	6° 44.2' N.	121° 47' E.	Sulu Archipelago, near Basilan Island.....	Feb. 7, 1908	8.05 a. m.	Surf.	34	318	17886
D. 5185	10° 5.7' N.	122° 18.5' E.	Between Panay and Negros.....	Mar. 30, 1908	8.01 p. m.	Surf.	(?)	16	17887
D. 5531	9° 27.5' N.	123° 38' E.	Between Siquijor and Bohol islands.....	Aug. 11, 1909	7.49 p. m.	Surf.	(?)	14	17888

## SAGITTA NEGLECTA Aida.

Plate 35, fig. 9.

*Sagittia neglecta* AIDA (1897), p. 16.—FOWLER (1906), p. 15.—RITTER-ZÁHONY (1911), p. 23.—MICHAEL (1911), p. 46.

This species is represented by approximately 425 specimens (Cat. No. 17927, U.S.N.M.), many of which are mature. Curiously enough, all were taken by a single surface haul on November 22, 1909, in Molucca Passage at station D. 5615, 0° 32.5' south and 126° 31.5' east. Certain specimens obtained from five or six other stations were at first thought to be *S. neglecta*, but closer examinations proved them to be either young *S. serratodentata* or *S. bedoti*.

As in so many other cases, the Philippine specimens have more anterior and posterior teeth than those described from the San Diego region. In my former (1911, p. 48) report, the number of anterior teeth is given as 3 to 5 and the posterior teeth as 8 to 11 in individuals between 8 and 13 mm. in length. The Philippine specimens, however, are smaller, ranging as a rule between 6.5 and 8 mm. and the number of anterior and posterior teeth are 4 to 8 and 12 to 16, respectively. This agrees better with Fowler's (1906, p. 16) records for specimens from the *Siboga* region. He records 3 to 7 anterior and 7 to 15 posterior teeth in individuals between 5 and 10 mm. in length. Similarly, Ritter-Záhony (1911, p. 24) records 5 to 7 anterior and 11 to 18 posterior teeth in individuals from Port Natal between 6 and 7.5 mm. in length.

TABLE 13.—*Measurements of Sagittia neglecta.*<sup>1</sup>

Number.	Length in mm.		Length of tail.	Tail to ventral ganglion.	Length of ventral ganglion.	Posterior fin.			Anterior fin.			Collar-ette.		Number of anterior teeth.	Number of posterior teeth.	Number of seizing jaws.	
	Length.	Width.				Length.	Width.	To seminal vesicle.	To anterior fin.	Tail-sep-tum. <sup>2</sup>	Length.	Width.	To ventral ganglion.				Length.
16	32	6	30.5	68	8	25	4	5	40	21.5	3	0	12	6	6-5	15-14	6-6
37	32	5.5	31	69	7	25	28	5	33	21	2.5	0	13.5	4.5	6-5	15-14	7-6
47	32	5.5	31	68.5	7	26	26	5	33	23.5	2.5	0	14	5	7-7	14-13	7-6
57	32	5.5	31.5	67.5	8	25.5	25.5	4	32	22.5	2.5	0	14.5	4.5	7-7	14-13	7-5
67	32	5.5	32	66.5	8	26	26	5	32	22.5	2.5	0	15	5	8-8	16-15	7-7
77	32	5.5	31	68.5	8	26	26	4	30	22	2	-1.0	12	6.5	8-8	13-12	6-6
87	32	5.5	32	67.5	8	25	25	4	30	20.5	2	0	13.5	6	5-6	14-13	6-6
96.5	32	5.5	33.5	73.5	8	26	26	4	39	24	2.5	-1.0	15	5	6-5	7-14	7-7
106.5	32	5.5	33	74	7.5	31	3	3	38	24	2.5	0	15	5	4-5	12-?	7-7

<sup>1</sup> All measurements made in per cent of total length of animal.<sup>2</sup> Per cent of posterior fin in front of tail-septum.



## SAGITTA FEROX Doncaster.

Plate 35, fig. 7; plate 37, figs. 21, 25.

*Sagitta ferox* DONCASTER (1902), p. 212.—FOWLER (1906), p. 10.—MICHAEL (1911), p. 74.

*Sagitta robusta* (part) RITTER-ZÁHONY (1909a), p. 49; (1911), p. 16.

Ritter-Záhony (1909a, 1911) synonymises this species to *S. robusta* Doncaster and says (1909a, p. 49): "Ich glaube daher nicht fehlzugehen, wenn ich mich für die schon von Doncaster (1902, p. 212) als möglich hingestellte Identität dieser beiden Arten auspreche und *S. ferox* nur eine ältere *S. robusta* auffasse." Yet, although the two species closely resemble each other, the Philippine specimens do not indicate the slightest convergence with age in three important differential characters (see Table 14):

1. The collarette is much wider in *S. ferox* and nearly always extends beyond the anterior end of the ventral ganglion, while in *S. robusta* it never extends much over halfway from neck to ventral ganglion.

2. Anterior fins always extend beyond posterior end of ventral ganglion in *S. ferox*, while in *S. robusta* there is an interval between the fins and ganglion.

3. Anterior fins are longer than posterior fins in *S. ferox*, while the posterior fins are the longer in *S. robusta*.

These three persistent differences justify considering *S. ferox* valid until critical study of variations in these particulars can be made. The species is therefore redescribed from the Philippine specimens in hopes that this description may aid in establishing its valid or synonymical position:

*Collarette* (pl. 35, fig. 7) long and broad, extending past anterior end of ventral ganglion onto anterior fins. Head large. Lateral fields small. Body firm, opaque, and nearly of uniform width from in front of ventral ganglion to tail-septum. Tail 25 to 30 per cent of total length of animal. Corona ciliata not observed.

*Anterior fins* (pl. 35, fig. 7) longer and slightly narrower than posterior fins, always extending anteriorly beyond posterior end of ventral ganglion, frequently past its middle and occasionally to its anterior end. Form acutely triangular, the position of greatest width being in posterior quarter of fin.

*Posterior fins* (pl. 35, fig. 7) extend caudally to seminal vesicles. Interval from anterior to posterior fins 3 to 7, usually about 5 per cent of total length of animal. Less than 50 per cent (41 to 44) of fin in front of tail-septum. Triangular in form, the position of greatest width being about midway between tail-septum and seminal vesicles.

*Vestibular ridge* (pl. 37, fig. 21) strongly mamillated, the number of papillae corresponding to the number of teeth. Wing of ridge covers all except the first two teeth, the notch extending beyond the fourth or fifth. External process short, broad, and blunt.

*Anterior teeth* 5 to 9 in number. They are closely set, provided with broad bases, and diverging distally.

*Posterior teeth* (pl. 37, fig. 21) 10 to 14 in number. They are long, broad, closely set, and diverging distally.

*Seizing jaws* (pl. 37, fig. 25) 4 to 6 in number. Point with an oval base inserted into shaft between 15 and 20 per cent of its height. Base of point and top of shaft converge toward back of shaft. Edge of shaft provided with narrow crest. Pulp-canal central, and extending into point about 80 per cent of its height. Pulp evenly distributed throughout canal.

TABLE 14.—Measurements of *Sagitta ferox*.<sup>1</sup>

Number.	Length in mm.	Width.	Length of tail.	Tail to ventral ganglion.	Length of ventral ganglion.	Posterior fin.				Anterior fin.			Collarette.		Number of anterior teeth.	Number of posterior teeth.	Number of seizing jaws.
						Length.	Width.	To anterior fin.	Tail-septum. <sup>2</sup>	Length.	Width.	To ventral ganglion. <sup>3</sup>	Length.	To ventral ganglion. <sup>4</sup>			
1	15.6	7.5	27	70.5	6	25.5	2.5	5.5	43	32.5	2.5	+5	20	+2.5	5-5	10-11	5-5
2	15.4	6.5	26	70	6	15.5	1.5	5.5	44	30.5	2.5	+3.5	18.5	+4	7-8	?-12	5-5
3	15.2	7	29.5	71	6	26.5	3	5.5	41.5	31	2.5	+5	20	+4.5	?-3	?-2	5-5
4	15	6	29	70	6	26	2.5	7	40	27.5	2	+3	.....	.....	7-7	13-13	5-5
5	14.9	5.5	29	72	5.5	26.5	2.5	6	43	27	2.5	+3.5	20	+3	7-7	12-11	5-5
6	14.9	5.5	28	69	5.5	25	3.5	4.5	42.5	31	2.5	+4	19	+2	8-9	13-13	6-5
7	14.7	7.5	29.5	71.5	5	26	3	5.5	41.5	29	2.5	+3.5	18.5	+1	8-8	13-12	5-5
8	14.5	8.5	27.5	71.5	5	24.5	3	6.5	40.5	32	2	+4	19.5	+2	8-8	13-14	5-4
9	14.1	8	29	71	6.5	27	3	6	42.5	29	2	+4	21	+3.5	7-8	15-12	5-6
10	13.5	7	31	71.5	5	26.5	3	5.5	41	32.5	1.5	+5.5	20	+4	9-8	12-12	5-4
11	13.3	7	28	70	5.5	26.5	3	5.5	42.5	19	2.5	+4.5	19.5	+3	7-8	12-12	5-5
12	13.2	6.5	30	70	6.5	25	3	3	43	30	2.5	+6	17.5	+1.5	7-7	12-12	5-4
13	12.9	8.5	19.5	68	6	25	3	4.5	42.5	26	2.5	+2.5	21.5	+3	8-7	12-12	5-5
14	11	7	27	69	7	25	3	6.5	43	26.5	1.5	+2.5	.....	.....	7-6	12-?	5-5
15	10.9	6.5	29	68.5	6.5	26.5	3.5	5	42	27.5	2.5	+6.5	20	+3.5	5-6	10-12	5-5

<sup>1</sup> All measurements made in per cent of total length of animal.

<sup>2</sup> Per cent of posterior fin in front of tail-septum.

<sup>3</sup> The + indicates that the fin extends beyond posterior end of ganglion.

<sup>4</sup> The + indicates that the collarette extends beyond anterior end of ganglion.

*Distribution.*—*S. ferox* was collected from 22 of the 46 stations from which chaetognaths were taken, 598 specimens being obtained. It is difficult to decide whether the species is typically epiplanktonic or mesoplanktonic in the Philippine region. At 15 stations it was taken from above 100 fathoms. Five, or 33 per cent of the epiplanktonic hauls, and two, or 29 per cent of the mesoplanktonic hauls, obtained more than the average number of specimens (27). Again, the median number of those taken above 100 fathoms is nine, but nine is also the median number of those taken below 100 fathoms. Finally, the greatest number was taken from 25 fathoms, the second, third, and fourth greatest from the surface, and the fifth greatest from 500 fathoms.

All subsurface hauls, however, were made by various types of open nets. It is well to remember that such hauls, whether horizontal or vertical, afford no certain evidence of the depth from which specimens

were collected. This is true even when every haul is made with the same net, and when various types of nets are used the data are worse than useless for this purpose. For these reasons it may well be that, as indicated by other reports, *S. ferox* is typically epiplanktonic in the Philippine region. It was taken in abundance during the Siboga expedition from the surface, but only rarely from the mesoplankton.

Indeed the species appears to be restricted to the epiplankton of the Indo-Australian region, although, owing to its questionable synonymy with *S. robusta* Doncaster, this statement is made with some reservations. But, even assuming the two species to be synonymical, it is still restricted in distribution to the surface and upper epiplankton of tropical and subtropical regions. Thus, according to Ritter-Záhony (1911, p. 58), it is found "im Atlantischen Ozean zwischen 0° and 20° N., im Indischen zwischen 20° and 30° S. in Vertikalfängen und an der Oberfläche. . . ." He continues: "Auf der Westseite des Atlantischen Ozeans wird sie zwar durch den Floridaström wohl bis in die Gegend des 40° N. gebracht, auf der Ostseite gelangt sie jedoch kaum bis zum 35°. Breitengrad, da sie ja schon im Mittelmeer fehlt. Im Süden dürfte sie gerade noch um die Südspitze Afrikas herkommen. Im Stillen Ozean ist sie bisher nur fünf Fundorten, die sämtlich auf seiner Westseite liegen, bekannt geworden. . . . Ich glaube jedoch, dass die Verbreitung der *S. robusta* im Stillen Ozean der im Atlantischen völlig analog ist, d. h. das tropisch-subtropische Gebiet umfasst und nur auf der Westseite etwas weiter nach Norden reicht, wobei der Kuro-Siwo die Rolle des Floridaströms übernimmt." Clearly *S. ferox* is a warm water species, but is its absence in the eastern Pacific not more likely attributable to the abnormally cold water there due to upwelling? (see p. 271).

The northernmost and westernmost record of its capture in the Philippine region is 21° 31' north and 117° 53' east, or in the south China Sea, approximately halfway between the city of Hongkong and the island of Formosa. The southernmost record is 5° 36' south at 122° 7.6' east off the south end of the island of Celebes in Buton Strait. The easternmost record is 0° 32.5' south and 126° 31.5' east, or, less accurately, at the southern end of Molucca Passage east of Tomini Bay. The largest number of specimens (217) was taken February 7, 1903, at 8.05 in the morning, from 25 fathoms by an open 0000 grit-gauze net towed horizontally 9 fathoms above the bottom of the Sulu Archipelago, near Basilan Island, at 6° 44.2' north and 121° 47' east. The other records are given in the table following.

TABLE 15.—*Philippine records of occurrence of Sagittia feroc.*

Station.	Latitude.		Longitude.	General locality.	Date.	Time.	Depth in fathoms.		Number of specimens.	Cat. No. U.S.N.M.
	°	'					Haul.	Bottom.		
D. 5101	14	24.5 N.	120	23.3 E.	Jan. 6, 1908	1.16 p. m.	37	43	3	17889
D. 5120	13	45.5 N.	120	30.2 E.	Jan. 21, 1908	2.41 p. m.	350	393	3	17890
D. 5128	9	52.1 N.	121	49.5 E.	Feb. 4, 1908	7.05 p. m.	Surf.	(?)	9	17891
D. 5134	6	44.2 N.	121	48 E.	Feb. 7, 1908	8.05 a. m.	25	34	217	17892
D. 5195	10	47 N.	124	6.5 E.	Apr. 3, 1908	7.03 p. m.	Surf.	(?)	1	17893
D. 5223	13	36 N.	121	25.5 E.	Apr. 24, 1908	7.47 p. m.	Surf.	(?)	1	17894
D. 5233	10	0.4 N.	124	45.1 E.	May 7, 1908	9.00 p. m.	100	(?)	19	17895
D. 5234	10	0.0 N.	124	46.1 E.	.....do.....	9.42 p. m.	15	(?)	18	17896
D. 5240	6	49.6 N.	126	46.1 E.	May 14, 1908	1.35 p. m.	115	145	9	17897
D. 5288	13	43.5 N.	121	0.0 E.	July 22, 1908	6.00 a. m.	115	140	6	17898
D. 5319	21	31 N.	117	53 E.	Nov. 5, 1908	7.23 p. m.	20	(?)	21	17899
D. 5320	20	58 N.	120	3 E.	Nov. 6, 1908	3.18 p. m.	500	1,804	29	17900
.....	.....	.....	.....	.....	Dec. 23, 1908	8.00 p. m.	Surf.	(?)	75	17901
D. 5530	9	26.8 N.	123	38.5 E.	Aug. 11, 1909	7.14 p. m.	Surf.	(?)	9	17902
D. 5531	9	27.5 N.	123	38 E.	.....do.....	7.11 p. m.	Surf.	(?)	8	17903
D. 5539	9	3.2 N.	123	24.8 E.	.....do.....	7.42 p. m.	Surf.	(?)	6	17904
D. 5540	9	3.0 N.	123	24.5 E.	.....do.....	7.28 p. m.	Surf.	25	19	17905
D. 5553	5	51.0 N.	120	46.5 E.	Sept. 17, 1909	7.42 p. m.	Surf.	765	5	17906
D. 5601	1	13.2 N.	125	17.1 E.	Nov. 13, 1909	7.18 p. m.	765	765	5	17907
D. 5611	0	40.5 S.	121	50 E.	Nov. 19, 1909	5.37 p. m.	Surf.	1,021	79	17908
D. 5615	0	32.5 S.	126	31.5 E.	Nov. 22, 1909	7.23 p. m.	Surf.	(?)	6	17909
D. 5649	5	30.0 S.	122	7.6 E.	Dec. 16, 1909	7.23 p. m.	Surf.	(?)	2	17919

## SAGITTA PLANKTONIS Steinhaus.

*Sagitta planktonis* STEINHAUS (1896), p. 39.—RITTER-ZÁHONY (1911), p. 29.—MICHAEL, (1911), p. 44.

*Sagitta zetesios* FOWLER (1905), p. 67; (1906), p. 22.

Eighty-seven specimens were obtained, but unfortunately all except one were preserved in alcohol, with the result that they are so badly distorted as to prevent certain identification. Measurements of the single well-preserved specimen are:

Length.....	27 mm.
Width.....	8.5 per cent of length.
Tail:	
Length.....	24.5 per cent of length.
To central ganglion.....	68.0 per cent of length.
Ventral ganglion (length).....	4.0 per cent of length.
Posterior fin:	
Length.....	20.5 per cent of length.
Width.....	4.5 per cent of length.
To anterior fin.....	4.5 per cent of length.
Proportion in front of tail-septum.....	77.0 per cent.
Anterior fin:	
Length.....	23.0 per cent of length.
Width.....	2.5 per cent of length.
To ventral ganglion.....	0.0 per cent of length.
Collarette:	
Length.....	25.0 per cent of length.
To ventral ganglion.....	0.0 per cent of length.
Number of anterior teeth.....	8-7
Number of posterior teeth.....	17-18
Number of seizing jaws.....	8-8

The length, number of anterior and posterior teeth, and number of seizing jaws of a few other individuals are:

Length in mm.	Anterior teeth.	Posterior teeth.	Seizing jaws.
11.5	7-6	13-12	9-8
13	9-9	16-?	7-8
16.5	9-10	16-15	9-9
17	10-9	17-18	8-8
21	8-8	16-17	8-8
25	9-8	18-17	8-9

The number of teeth is greater than in specimens from the San Diego region (Michael, 1911, p. 45). San Diego specimens, ranging in length between 15 and 26 mm., have 4 to 7 anterior, and 11 to 15 posterior teeth. In the Biscayan report, however, Fowler (1905, p. 68) records a variation in number of anterior teeth from 5 to 9 and of posterior teeth from 11 to 19 in individuals between 11 and 21 mm. in length.

*Distribution.*—*S. planktonis* was collected from only seven stations. Of the 84 specimens obtained, 53 were taken from below 100 fathoms by open nets towed horizontally at four stations for approximately

TABLE 16.—*Philippine records of Sagitta planktonis.*

Station.	Latitude.	Longitude.	General location.	Date.	Time.	Depth in fathoms.		Number of specimens.	Cat. No. U.S.N.M.
						Haul.	Bottom.		
D. 5120	13 45.5 N.	120 30.3 E.	Off Sombrore Island, Balayan Bay.	Jan. 20, 1908	3. 10 p. m.	350	333	13	17910
D. 5129	7 41.5 N.	122 1.8 E.	Sulu Sea, off western Mindanao.	Feb. 5, 1908	2. 23 p. m.	100	(?)	1	17911
D. 5185	10 5.7 N.	122 18.5 E.	Between Panay and Negros.	Mar. 30, 1908	8. 01 p. m.	550	638	33	17912
D. 5232	10 0.8 N.	124 44.1 E.	Between Bohol and Leyte.	May 7, 1908	8. 25 p. m.	Surf.	(?)	11	17913
D. 5233	10 0.4 N.	124 45.1 E.	do.	do.	9. 00 p. m.	100	(?)	25	17914
D. 5234	10 0.0 N.	124 46.1 E.	do.	do.	9. 42 p. m.	15	(?)	15	17915
D. 5288	13 43.5 N.	121 0.0 E.	East of Matocot Point, Luzon.	July 22, 1908	8. 14 a. m.	115	140	1	17916
D. 5500	8 37.8 N.	124 36.8 E.	East of Macabalan Point, Mindanao.	Aug. 4, 1909	11. 25 a. m.	200	267	6	17917
D. 5672	0 29.0 S.	118 51.0 E.	Macassar Strait.	Dec. 30, 1909	7. 26 p. m.	Surf.	(?)	8	17918

20 minutes at each. The 35 remaining specimens were taken from above 15 fathoms at the three remaining stations by 20-minute tows. These facts indicate that the species is typically mesoplanktonic in the Philippine region, which indication is supported by the results of many other expeditions. In the regions covered by the *Biscayan*, *Siboga*, and *Plankton* expeditions, as well as off the California coast, the species occurs abundantly below 100 fathoms, but is rarely found above that depth. It is common between 500 and 1,000 fathoms, and, as Ritter-Záhony (1911, p. 62) says: "*S. planktonis* ist unter allen Arten der Tiefsee am häufigsten in der Literatur erwähnt."

#### Genus PTEROSAGITTA Costa.

Syn. *Spadella* LANGERHANS (part 1).

#### PTEROSAGITTA DRACO (Krohn).

Plate 36, figs. 11, 12, 13.

*Sagitta draco* KROHN (1853), p. 273.

*Pterosagitta mediterranea* COSTA (1869), p. 55.

*Spadella draco* FOWLER (1906), p. 25.—

MICHAEL (1911), p. 54.

*Pterosagitta draco* RITTER-ZÁHONY (1911), p. 33.

Thirty-two specimens were obtained, of which only one has mature ovaries. These completely fill the body cavity (pl. 36, fig. 13), extending from tail-septum to neck. All other specimens are clearly immature, and in nearly one-half there is no trace of ovaries, and the seminal vesicles are barely visible (pl. 36, fig. 12). Fowler (1906, p. 26) records the tail as 41 to 57 per cent of total length in specimens between 6 and 9 mm. The Philippine specimens, however, vary only between 39.5 and 44.3 per cent. Otherwise Fowler's records agree exceptionally well with the Philippine material. He records 7 to 9 seizing jaws, 7 to

10 anterior teeth, and 11 to 16 posterior teeth; the Philippine specimens show 7 to 9 seizing jaws, 6 to 10 anterior teeth, and 10 to 16 posterior teeth.

Nearly half the Philippine specimens are devoid of the collarette, except for a narrow strip behind the head. This caused considerable trouble in identification until others were discovered in which the structure was partly missing. These (pl. 36, figs. 12 and 13) indicate that for some unknown reason the collarette has been torn off. Immature specimens in this condition bear a striking superficial resemblance to young *S. ferox*.

TABLE 17.—Measurements of *Pterosagitta draco*.<sup>1</sup>

Number.	Length in mm.	Width with collarette.	Width without collarette.	Length of tail.	Tail to ventral ganglion.	Length of ventral ganglion.	Lateral fin.			Ovary.		Number of anterior teeth.	Number of posterior teeth.	Number of seizing jaws.
							Length.	Width.	To seminal vesicles.	Length.	Width.			
1	7.7	.....	7.8	43.3	66.6	9.1	22.8	.....	0	24.6	2.3	9-8	13-13	8-7
2	7.6	16.0	6.9	44	66.5	8.7	23.4	6.4	0	24.8	2.7	9-8	(?)-14	8-8
3	7.4	15.2	7.1	42.8	65.6	9.1	22.4	5.7	0	25.7	1.9	9-8	15-16	8-9
4	7.2	.....	10.7	39.5	59.6	7.8	20	6.8	0	47.8	5.9	5-6	11-12	8-8
5	7	.....	8	44	66.9	8.5	23	5	0	21	4.5	8-7	14-13	8-9
6	6.9	.....	7.6	40.3	65.2	9.2	23	.....	0	10.7	.5	7-6	14-(?)	8-8
7	6.9	.....	6.6	43.1	66.5	8.1	22.3	4.6	0	20.8	1.5	8-8	13-14	8-8
8	6.7	16.2	6.8	41.4	65	10	23.1	6.3	0	9.5	1	8-7	13-14	8-8
9	6.7	13	7.8	40.5	64	9.9	21.3	5.7	0	.....	.....	10-9	15-(?)	8-8
10	6.6	13.3	8.5	40.9	62.7	10.6	21.8	5.3	0	.....	.....	7-7	14-15	8-8
11	6.6	.....	7.4	42	65	9.6	19.1	4.8	0	.....	.....	6-6	11-12	9-9
12	6.3	15.1	7.3	41.3	64.8	9.5	22.9	6.1	0	6.8	1.1	9-8	14-(?)	8-8
13	5.8	.....	7.9	40	63.6	9.7	21.8	5.5	0	.....	.....	6-7	11-11	9-9
14	5.8	.....	7.9	42.3	66.7	6.7	18.8	4.8	0	.....	.....	9-8	14-14	8-9
15	5.6	.....	9.3	41.6	66.5	8.7	16.8	5.6	0	18	5	8-7	12-11	9-8
16	5.4	15	7.2	42.5	65.5	9.8	20.2	6.5	0	.....	.....	8-7	14-15	8-9
17	5.4	.....	7.8	50.8	64.2	9.7	20.8	5.8	0	.....	.....	7-7	(?)-11	7-7
18	5.3	16	6.7	41.3	64.5	10.7	22.7	5.3	0	.....	.....	7-7	10-11	8-8
19	5.1	10.4	6.2	41.4	64.9	11	20.7	4.8	0	.....	.....	6-6	11-12	(?)-8
20	4.9	.....	7.1	44.3	68.5	10.7	21.4	.....	0	.....	.....	7-6	13-13	7-7

<sup>1</sup> All measurements made in per cent of total length of animal.

*Distribution.*—*P. draco* was obtained from only five stations, all of which were subsurface ones. Two were mesoplanktonic, but they only yielded four specimens. The remaining 28 were obtained from between the surface and 25 fathoms, indicating that in so far as the species occurs in the Philippine region it is typical of the upper epiplankton. This accords with what is known of its distribution generally. Although nowhere abundant it is apparently restricted to the upper epiplankton of tropical and subtropical regions. Says Ritter-Záhony (1911, p. 63): "Ihre Verbreitung dürfte sich mit der von *S. enflata* und *bipunctata* decken, doch ist die Art in den gemässigten Zonen, soweit sie überhaupt noch darin vorkommt, schon seltener als jene beiden. . . ." Its northernmost and southernmost records of occurrence are 42° north, 56° west; and 42° south, 36° east. Its records of capture during the Philippine expedition are given in the table following:

TABLE 18.—*Philippine records of occurrence of Pterosagittia draco.*

Station.	Latitude.	Longitude.	General locality.	Date.	Time.	Depth in fathoms.		Number of specimens.	Cat. No. U.S.N.M.
						Haul.	Bottom.		
D. 5134	6 44.2 N.	121 47 E.	Sulu Archipelago, near Basilan Island.....	Feb. 7, 1908	8.05 a. m.	25	34	19	17920
D. 5185	10 5.8 N.	122 18.5 E.	Between Panay and Negros.....	Mar. 30, 1908	5.23 p. m.	550	638	1	17921
D. 5240	6 49.6 N.	126 46.1 E.	Pujada Bay.....	May 14, 1908	1.33 p. m.	15	(?)	1	17922
D. 5319	21 31 N.	117 53 E.	China Sea, off Hongkong.....	Nov. 5, 1908	7.23 p. m.	20	(?)	8	17923
D. 5320	20 58 N.	120 3 E.	do.....	Nov. 6, 1908	3.18 p. m.	500	1, 804	3	17924

Genus *EUKROHNIA* Ritter-Záhony.Syn. *Krohnia* LANGERHANS (part).*EUKROHNIA HAMATA* (Möbius).

Plate 37, figs. 14, 27.

*Sagitta hamata* MÖBIUS (1875), p. 158.*Krohnia hamata* KRUMBACH (1903), p. 639.—FOWLER (1905), p. 74; (1906), p. 23.*Eukrohnia hamata* RITTER-ZÁHONY (1911), p. 39.—MICHAEL (1911), p. 51.

This species is represented by six poorly preserved and badly damaged specimens (Cat. No. 17928, U.S.N.M.). The heads of all but two are missing and in one of those it is torn away from the body. It is impossible, therefore, to accurately determine the length or to count the teeth and seizing jaws in four of the six specimens. The other two are 16 and 16.3 mm. in length; their tails are 28.3 and 30.2 per cent of their lengths; the number of teeth are 21–21 and 24–25, and the number of seizing jaws are 9–10 and 9–9.

The number of teeth (pl. 37, fig. 14) greatly exceed that recorded by Ritter-Záhony (1911, p. 39) for specimens taken from the Antarctic Ocean, as well as that recorded by me (1911, p. 52) for specimens from the San Diego region. Although Ritter-Záhony records a variation in number of teeth from 4 to 23, he gives 12 as the upper limit for specimens under 18 mm. in length. Similarly, in specimens from the San Diego region between 13 and 17.5 mm. in length, I have never found more than 13 teeth. Fowler (1906, p. 23), however, records 22 in specimens from the *Siboga* area that are only 13 mm. in length. It is evident, therefore, that the number of teeth vary according to the region in which the species occurs.

The points of the seizing jaws (pl. 37, fig. 27) are curved to an unusual extent, and the jaws are not serrated as described by Krumbach (1903). Otherwise, however, the structure of the jaws agree with his description.



The six specimens were all obtained November 6, 1908, in the China Sea in the vicinity of Formosa, at station D. 5320, 20° 58' north and 120° 3' east by an open 0000 grit-gauze net towed at 3.18 p. m. in 500 fathoms for 20 minutes.

## EUKROHNIA RICHARDI Germain and Joubin.

Plate 36, fig. 10; plate 37, figs. 15, 26.

*Eukrohnia richardi* GERMAIN and JOUBIN (1912), p. 2.

This species (pl. 36, fig. 10) is represented by five specimens, only two of which are well enough preserved to permit certain identification. Measurements of these two (*a* and *b*), and, for comparison, those taken from Germain and Joubin's drawing (*c*), are as follows:

	<i>a.</i>	<i>b.</i>	<i>c.</i>
Length in mm.....	27.7	27.8	27.8
Width in per cent of length.....	12.9	13.3	12.2
Tail:			
Length in per cent of total length.....	27.2	26.2	25.2
To ventral ganglion in per cent of total length.....	70.7	74.2	67.6
Length of ventral ganglion in per cent of total length.....	6.6	5.2	2.9
Lateral fin:			
Length in per cent of total length.....	73.1	69.3	68.4
Width in per cent of total length.....	4.9	6.5	6.5
Extends beyond anterior end of ventral ganglion, in per cent of total length.....	10.4	6.5	10.8
Proportion in front of tail-septum (per cent).....	82.7	86.4	74.4
Ovary:			
Length in per cent of total length.....	4.8	6.5	10.8
Width in per cent of total length.....	1.26	2.64	2.88
Number of teeth.....	22-21	25-24	24
Number of seizing jaws.....	10-11	10-10	8

It is questionable whether this species is valid or not. It closely resembles *E. hamata*, but according to Germain and Joubin (1912, p. 5), "il s'en distingue facilement, en dehors de sa coloration verte caractéristique et jusqu'à présent absolument unique chez tous les Chétognathes, par la forme très différente de sa tête, beaucoup plus nettement triangulaire allongée, par ses crochets plus étroitement allongés et par ses dents, au nombre de 24, alors qu'on en compte seulement de 20 à 22 chez *Eukrohnia hamata*." Of these distinctive features it is evident that differences in the number of teeth and shape of head are of no specific value, and it seems probable that the color, which is described (p. 2) as "d'un vert d'eau plus foncé à la région antérieure et s'atténuant régulièrement vers la queue," is also highly variable. In the Philippine material at least, specimens of *E. hamata* agree quite as well with this description as those of *E. richardi*. Both, although considerably faded by action of the formalin, are dark green and more so anteriorly than posteriorly.

Again, the various dimensions of the body recorded by Germain and Joubin (p. 4) do not agree with those taken from the drawing. The drawing measures 139 mm. in length. Assuming the recorded length of 27 mm. to be accurate, the magnification of the drawing is 5.15. This makes the length of tail 6.8 mm., or 25.2 per cent of

total length, but it is given as 6.5 mm., or 24 per cent of the total length. It is stated that the ovaries are 2.25 mm. in length, or 8.3 per cent of the length of animal, but in the drawing they measure 10.8 per cent, which is equivalent to 2.92 mm. The maximum width of body ("y compris la largeur des nageoires") is given as 2.5 mm., or 9.3 per cent of the length of animal, but in the drawing it measures 11.5 per cent, which is equivalent to 3.1 mm. Finally, it is stated that the lateral fin occupies "17/27 [63 per cent] de la longueur totale de l'animal," that it extends 5.5 mm. anterior to the ventral ganglion or "à environ 3 millimètres de l'extrémité du corps," but in the drawing it measures 68.4 per cent of the total length of animal and extends only 10.8 per cent, or 2.92 mm., anterior to the ventral ganglion.

Although these discrepancies are, for the most part, small, they make it impossible to depend with certainty upon either the descriptions or the drawing, and whether *E. richardi* is or is not synonymous with *E. hamata* must remain undecided until the type is more accurately described. In spite of this uncertainty there are several points that indicate its validity:

1. The seizing jaws (pl. 37, fig. 26) are more massive than those of *E. hamata* and their points are quite dissimilar. In *E. hamata* the points are always sickle-shaped (pl. 37, fig. 27), although they are not usually curved so much as in the Philippine material; the top of shaft and base of point converge upon approaching the edge of the jaw; the point has an oval base; and the pulp-canal is central and sparsely filled with pulp. In *E. richardi*, on the other hand, the points are not sickle-shaped; the top of shaft and base of point are parallel; the point has an irregular rather than an oval base; the pulp-canal is irregular in outline and is displaced toward the back of shaft; and the pulp is evenly distributed.

2. The body of *E. richardi* is between two and three times wider in proportion to the length of animal than is the case with *E. hamata*.

3. Lateral fins extend to, but rarely beyond, anterior end of ventral ganglion in *E. hamata*, while in *E. richardi* they extend beyond the anterior end of ganglion by 6 to 11 per cent of the length of animal.

4. Lateral fins in *E. hamata* with "fin-rays extending about as far in front of the septum as the fin does behind it, but the fin continued forwards as an expansion of the epidermis up to or to the middle of the ventral ganglion." [Fowler (1905, p. 74).] In *E. richardi* the fin, according to Germain and Joubin, is delicately rayed throughout, the rays making an acute angle with the body as illustrated by their drawing. This seems to be true of the Philippine specimens (pl. 36, fig. 10), although the rays are fewer and much finer toward the anterior end.

5. Lateral fins never extend more than halfway from tail-septum to seminal vesicles in *E. hamata*, while they extend three-quarters of the distance, according to Germain and Joubin's drawing, and quite to the anterior end of the vesicles in the Philippine specimens.

The Philippine specimens apparently differ from the type in two points:

(1) Germain and Joubin state that the ventral neck muscles are composed of longitudinal fibers, together with very fine transverse ones. The transverse fibers are absent in the Philippine specimens.

(2) The seminal vesicles are figured and described as very small disks lying within the anterior end of the caudal fin. In the Philippine specimens this is not the case, although the vesicles in all specimens were very immature. Their appearance, however, suggests that when mature their posterior extremities may touch the caudal fin.

The five specimens (Cat. No. 17929, U.S.N.M.) were all obtained at 12.07 in the afternoon, May 8, 1909, station D. 5437, off the west coast of Luzon,  $15^{\circ} 45'.9$  north and  $119^{\circ} 42'.8$  east, by an open 0000 grit-gauze net towed for 27 minutes in 450 fathoms.

#### Genus *KROHNITTA* Ritter-Záhony.

Syn. *Krohnia* LANGERHANS (part).

*Spadella* GRASSI (part).

*Krohnia* STRODTMAN (part).

#### *KROHNITTA SUBTILIS* (Grassi).

*Spadella subtilis* GRASSI (1883), p. 23.

*Krohnia subtilis* STRODTMAN (1892), p. 22.—FOWLER (1905), p. 78; (1906), p. 25.

*Krohnia pacifica* FOWLER (1906), p. 24.

*Eukrohnia subtilis* MICHAEL (1911), p. 52.

*Krohnitta subtilis* RITTER-ZÁHONY (1911), p. 44.

Only three specimens were obtained, all of which are immature. Only one is sufficiently well preserved to permit accurate measurements:

Length in mm.....	9.8.
Length of tail.....	35.9 per cent of total length.
Tail to ventral ganglion.....	63.5 per cent of total length.
Length of ventral ganglion.....	7.5 per cent of total length.
Length of fin.....	35.1 per cent of total length.
Width of fin.....	6.4 per cent of total length.
Proportion of fin in front of tail-septum.....	32.7 per cent.
Length of ovary.....	8.6 per cent of total length.
Width of ovary.....	2.1 per cent of total length.
Number of seizing jaws.....	8-8.

The teeth could not be counted, but in the two other specimens, which were about the same length, the number of teeth on the right and left sides are 11-10 in one and 12-13 in the other specimen. Similarly, the number of seizing jaws are 8-7 in the first specimen and (?) - 7 in the second.

Two of the specimens (Cat. No. 17931, U.S.N.M.) were obtained between Panay and Negros at station D. 5185,  $10^{\circ} 5'.8$  north and  $122^{\circ} 18'.5$  east, on March 30, 1908, at 5.26 in the afternoon, by an open 0000 grit-gauze net towed horizontally for 20 minutes in 550 fathoms. The third specimen (Cat. No. 17930, U.S.N.M.) was obtained in the China Sea in the vicinity of Formosa, at station D. 5319,  $21^{\circ} 31'$  north and  $117^{\circ} 53'$  east, on November 5, 1908, at 7.23 in the afternoon, by the same net towed for 27 minutes in 20 fathoms.

COMPARISON OF PHILIPPINE CHAETOGNATHA WITH THOSE FROM THE SAN DIEGO REGION.

Aida (1897) describes 10 species from Misaki Harbor, Japan, of which all except *S. regularis* and *S. hispida* (= *S. robusta* Doncaster) are represented in the Philippine collection. Again, Doncaster (1902) records 10 species from the Maldive Archipelago, of which all save *S. regularis* and *S. hispida* are present in the Philippine material. Likewise, Fowler (1906) describes 14 species from the "Siboga" area, of which all save *S. regularis* and *S. hispida* have been taken from the Philippines. Lastly, Ritter-Záhony (1910) lists 10 species from Sharks Bay, Australia, of which all except *S. regularis* and *S. bipunctata* are represented in the Philippine collection. The only species obtained from the Philippines which are not recorded from any of these regions are *S. philippini* and *E. richardi*, the former a new species represented by a single individual, and the latter a rare species represented by only five specimens. Obviously these facts strongly point toward a uniformity in the chaetognath fauna, especially the epiplankton, over the Indo-Pacific Ocean, notwithstanding the curious absence of *S. regularis* and *S. hispida* in the Philippine collection.

The situation is quite otherwise when the Philippine chaetognatha are compared with those from the San Diego region, for those species most characteristic of the Philippines are those that are either absent or least characteristic of the San Diego region, and the opposite. Thus, *S. enflata*, by far the most typical and abundant species about the Philippines, has been obtained in the San Diego region by less than 20 out of nearly 4,000 hauls. Conversely, *S. bipunctata* is by far the most typical and abundant species in the San Diego region, but not a single individual was obtained from the Philippines. Again, *Sagitta ferox*, *S. pulchra*, *S. bedoti*, *S. decipiens*, *S. minima*, *S. macrocephala*, and *Eukrohnia richardi* have not been taken from the San Diego region, although the first three are third, fourth, and sixth in order of abundance in the Philippine region. On the other hand, *Sagitta lyra* and *S. californica*, in addition to *S. bipunctata*, were not taken from the Philippine region, although the former is

the most characteristic mesoplanktonic species in California waters. Again, of those species common to both regions, *Sagitta hexaptera* and *S. serratodentata* are second and eighth in order of abundance in the Philippines and tenth and second in the San Diego region. Finally, aside from *S. neglecta*, which is rare in the San Diego region and obtained by only one haul from the Philippines, the order of abundance of the remaining species common to both regions is as follows: *S. planktonis*, *P. draco*, *E. hamata*, and *K. subtilis* in the Philippine region; and *E. hamata*, *K. subtilis*, *S. planktonis*, and *P. draco* in the San Diego region.

Taken in connection with what is known of the distribution of chaetognatha throughout the world, the above comparisons show that the Philippine species are characteristic of the Tropics and warm water, while those of the San Diego region are, on the other hand, more characteristic of the Arctics or sub-Arctics and cold water. As a matter of fact there is less difference between the California chaetognatha and those of the region about Spitzbergen than there is between the California and Philippine faunas.

Furthermore, this sub-Arctic nature of the California chaetognatha is not peculiar to that group. *Calanus finmarchicus*, the commonest copepod of the California coast is, according to Cleve (1900, p. 47), a "characteristic inhabitant of the Arctic regions, along the coast banks of Greenland, Iceland, etc." Similarly, *Eucalanus elongatus*, the second most typical copepod of California waters, is "noted from 60° north, 7° west in August and the Skagerak in February." [Cleve (1900, p. 63).] Likewise *Acartia clausii*, obtained in abundance off the pier of the Scripps Institution, is typical of the North Sea "and follows the coast of Norway to about 70° or 74° north." [Cleve (1900, p. 42).] Again, the most prevalent ctenophore of the California region, *Pleurobrachia bachei*, "is found in vast swarms in the cold water of Maine and Nova Scotia." [Esterly (1914, p. 28).] Lastly, among the diatomaceae, *Chaetoceros criophilum* is the commonest diatom in San Diego waters, although Cleve (1900, p. 295) states that it is a "decidedly Arctic, pelagic species." Another common San Diego *Chaetoceros* is *C. debile*, but Cleve (1900, p. 296) says that it is abundant along the south coast of Iceland and at the Faroes." Similarly with *Nitzschia seriata*, its "principal area of distribution is between Scotland, Iceland, and Greenland" [Cleve (1900, p. 336)], although it is among the common diatoms of the San Diego region.

So the list might be continued. To be sure, there are many tropical and semitropical species occurring in California waters, but they are not the characteristic and prevalent ones. These have their nearest allies, not in other parts of the world at corresponding latitudes, but in the Arctic and sub-Arctic regions. May this not be attributable in part to the marked upwelling of cold bottom waters

along the western coast of America? To establish this would require an extensive series of collections off the coast of Central and South America, and comparisons of the faunas at the same latitudes on the two sides of the Pacific. But, if it is true, it emphasizes the necessity of recognizing this fact in fisheries investigations and demonstrates an essential difference between the problems, economic and otherwise, of the coastal waters of the eastern and western Pacific.

That the chaetognath faunas of the two regions are fundamentally different is made more certain by the fact that in four of the five *Sagitta*<sup>1</sup> common to both Philippine and San Diego regions, the Philippine specimens have a greater number of both anterior and posterior teeth. The same is true with respect to *P. draco*, and in *E. hamata* the Philippine specimens have nearly twice as many teeth (21 to 25) as do the San Diego specimens (10 to 13). These differences are mentioned in the preceding pages in connection with the account of each species, but are better revealed, perhaps, in the following list:

Species.	Anterior teeth.		Posterior teeth.	
	Philippines.	San Diego.	Philippines.	San Diego.
<i>S. enflata</i> .....	6-11	4-8	9-15	7-12
<i>S. neglecta</i> .....	4-8	3-5	12-16	8-11
<i>S. serratodentata</i> .....	8-11	6-9	13-24	13-19
<i>S. planktonis</i> .....	6-10	4-7	12-18	11-15
<i>P. draco</i> .....	6-10	4-4	10-16	8-9

In the case of *P. draco* the differences may mean little, owing to the fact that only a single very immature specimen is recorded from the San Diego region. It is interesting, however, to note that it was 7 millimeters in length, whereas 15 of the 20 from the Philippine region recorded in Table 17 are smaller and quite as immature, the smallest being less than 5 millimeters in length, although it has 6 to 7 anterior teeth and 13 posterior teeth.

To demonstrate that the differences in number of teeth given for the four species of *Sagitta* are significant, from 10 to 30 or more individuals of each species were selected at random from the two collections, the number of teeth counted, and the mean number and corresponding probable errors computed. The results are entered in Table 19:

TABLE 19.—Comparison of mean number of teeth in specimens from the Philippines and from the San Diego region.

Species.	Anterior teeth.			Posterior teeth.		
	Philippines (P).	San Diego (S).	Difference (P-S).	Philippines (P).	San Diego (S).	Difference (P-S).
<i>S. enflata</i> .....	8.29±0.256	6.27±0.035	2.02±0.258	13.45±0.241	10.18±0.133	3.27±0.275
<i>S. neglecta</i> .....	5.61±0.160	3.80±0.243	1.81±0.291	13.75±0.184	8.96±0.135	4.79±0.228
<i>S. serratodentata</i> .....	9.32±0.133	7.22±0.114	2.10±0.175	18.24±0.536	15.44±0.203	2.80±0.573
<i>S. planktonis</i> .....	8.36±0.200	5.94±0.335	2.42±0.390	16.15±0.145	12.60±0.218	3.55±0.262

<sup>1</sup> *S. hexaptera* is not considered owing to loss of teeth. See p. 245.

Table 19 shows (1) that in every case the mean number of both anterior and posterior teeth in Philippine specimens exceeds that in San Diego specimens, and (2) that the magnitude of the excess is between 5 and 20 times the corresponding probable error. That this excess is not merely an expression of the larger size of the Philippine specimens is evident, for the counts were made on specimens of Philippine *Sagitta enflata* between 10 and 21 mm. in length and on San Diego specimens between 10 and 25 mm.; on Philippine *S. neglecta* between 6 and 8 mm., and on San Diego specimens between 8 and 13 mm.; on Philippine *S. serratodentata* between 7 and 11 mm., and on San Diego specimens between 10 and 17 mm.; and on Philippine *S. planktonis* between 13 and 27 mm., and on San Diego specimens between 17 and 26 mm. Obviously, some differential influence is at work in the two regions causing an excess of teeth in the Philippine fauna, or a deficiency in the San Diego fauna.

Unfortunately, a similar comparison of Philippine chaetognatha with those from other regions of the Pacific is impossible, owing to the fact that no one except Fowler (1906) has published a series of tooth counts, and he has not kept the individual counts distinct. The range of variation, however, in the *Siboga* material is much the same as that in Philippine specimens. This is pointed out in the foregoing pages for every species common to the two regions, but these data are brought together and amplified in Table 20:

TABLE 20.—Comparison of number of anterior and posterior teeth in Philippine species and those from the *Siboga* region.

SAGITTA ENFLATA.

Length of specimens in mm.	Anterior teeth.		Posterior teeth.	
	Philippines.	<i>Siboga</i> .	Philippines.	<i>Siboga</i> .
10-15	6-7	7-9	9-12	9-14
15-20	7-9	8-9	13-15	12-17
20-25	7-11	8-10	14-15	12-16
25-30	8	7-10	14	14-17

SAGITTA NEGLECTA.

6.5	4-6	4-5	12-14	9-10
7	5-8	4-6	12-16	9-12
7.5	5-6	4-5	14-15	10-13
8	5-6	4-6	14-15	9-14

SAGITTA SERRATODENTATA.

7-8	9	5-9	13-15	9-16
8-9	8-9	6-9	14-18	13-18
9-10	8-9	6-9	16-19	13-19
10-11	8-11	8-9	18-24	15-19

TABLE 20.—Comparison of number of anterior and posterior teeth in Philippine species and those from the Siboga region—Continued.

## SAGITTA PLANKTONIS.

Length of specimens in mm.	Anterior teeth.		Posterior teeth.	
	Philippines.	Siboga.	Philippines.	Siboga.
11-13	7-9	5-8	12-16	13-16
13-15	9	5-9	16	14-18
15-17	9-10	8-9	15-18	17-18
17-19	9-10	7-9	17-18	16-18
19-21	8	7-11	16-17	16-20
21-23	8	8-11	16-17	17-20
23-25	8-9	8-10	17-18	18
25-27	7-9	8-9	17-18	18-19

## SAGITTA PULCHRA.

10-15	5-8	6-10	9-12	10-14
15-20	6-9	6-10	11-13	10-15
20-25	6-8	7-10	10-13	12-15

## SAGITTA DECIPIENS.

9.0	9-11	8	19-21	16
11	10-11	7	22	16
12	9	8	20-21	15-17
12.5	8-9	8-9	19-20	15-18

## SAGITTA BEDOTI.

10-12	8-10	9-11	20-23	18-27
12-14	8-9	9-13	21-25	20-32
14-16	8-10	9-10	22-28	21-29

## SAGITTA FEROX.

10-12	5-7	4-8	10-12	9-13
12-14	7-9	7-9	12-15	10-14
14-16	5-9	6-9	10-14	10-14

## PTEROSAGITTA DRACO.

6.0	7-9	8	11-14	12
7	5-10	7-10	11-15	11-15
7.5	8-9	8-9	13-16	12-16

Inspection of this table reveals a pronounced similarity in number of both anterior and posterior teeth between Philippine and *Siboga* specimens of *Sagitta enflata*, *S. planktonis*, *S. pulchra*, *S. bedoti*, *S. ferox*, and *Pterosagitta draco*. In *S. neglecta*, *S. serratodentata*, and *S. decipiens* specimens from the two regions agree in number of anterior teeth, but those from the Philippines have a greater number of posterior teeth. Even in these instances the differences are slight and probably insignificant except for *S. decipiens*. In this species there seems to be no doubt that the Philippine specimens have more posterior teeth than *Siboga* specimens of the same length, although, as pointed out on page 254, where the length of animal was neglected, Fowler's records show a range of 13 to 23 posterior teeth as against that of 19 to 22 for Philippine specimens.



On the whole there is close agreement in number of teeth between specimens of species common to the Philippines and the *Siboga* region, while the same species are represented in the San Diego region, if at all, by specimens having markedly fewer teeth. In the face of this fact it is evident that, as formerly (1911, p. 68) stated, "variation in number of both anterior and posterior teeth in many species is not referable to specific differences, but probably to some distribution factor." When it is recalled that a subnormal ocean temperature characterizes the region adjacent to the western coast of America, due to pronounced upwelling of bottom water, and that the chaetognath fauna off southern and Lower California is representative of more northern latitudes, it suggests that one of these distribution factors is temperature. I believe the small number of teeth in San Diego specimens is an expression of the slower rate of metabolism due to a lower ocean temperature. This is not a new suggestion, but it is one that merits thorough investigation. Fowler (1906, p. 29), after stating that specimens of *Siboga Sagitta serratodentata* have nearly twice as many posterior teeth as specimens of the same length from the Bay of Biscay, says: "It is possible that this may be correlated with the respective temperatures at which the specimens live, but a long series of similar observations from different latitudes would be necessary before this could be regarded as even probable."

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## EXPLANATION OF PLATES.

[All figures drawn with camera lucida.]

## PLATE 34.

- FIG. 1. *Sagitta philippini*, new species.  $\times 18$ .  
 2. Anterior teeth and few of posterior teeth of *S. philippini*.  $\times 250$ .  
 3. Vestibular ridge of *S. philippini*.  $\times 250$ .  
 4. Seizing jaws of *S. philippini*.  $\times 800$ .

## PLATE 35.

- FIG. 5. *Sagitta pulchra* Doncaster.  $\times 8$ .  
 6. *Sagitta bedoti* Béranek.  $\times 8$ .  
 7. *Sagitta ferox* Doncaster.  $\times 8$ .  
 8. *Sagitta decipiens* Fowler.  $\times 18$ .  
 9. *Sagitta neglecta* Aida.  $\times 18$ .

## PLATE 36.

- FIG. 10. *Eukrohnia richardi* Germain and Joubin.  $\times 6$ .  
 11. *Pterosagitta draco* (Krohn).  $\times 25$ .  
 12. *Pterosagitta draco* with collarette partly torn away and with no vestige of ovary or seminal vesicle.  $\times 25$ .  
 13. *Pterosagitta draco* with fully mature ovaries and with collarette almost entirely missing.  $\times 25$ .

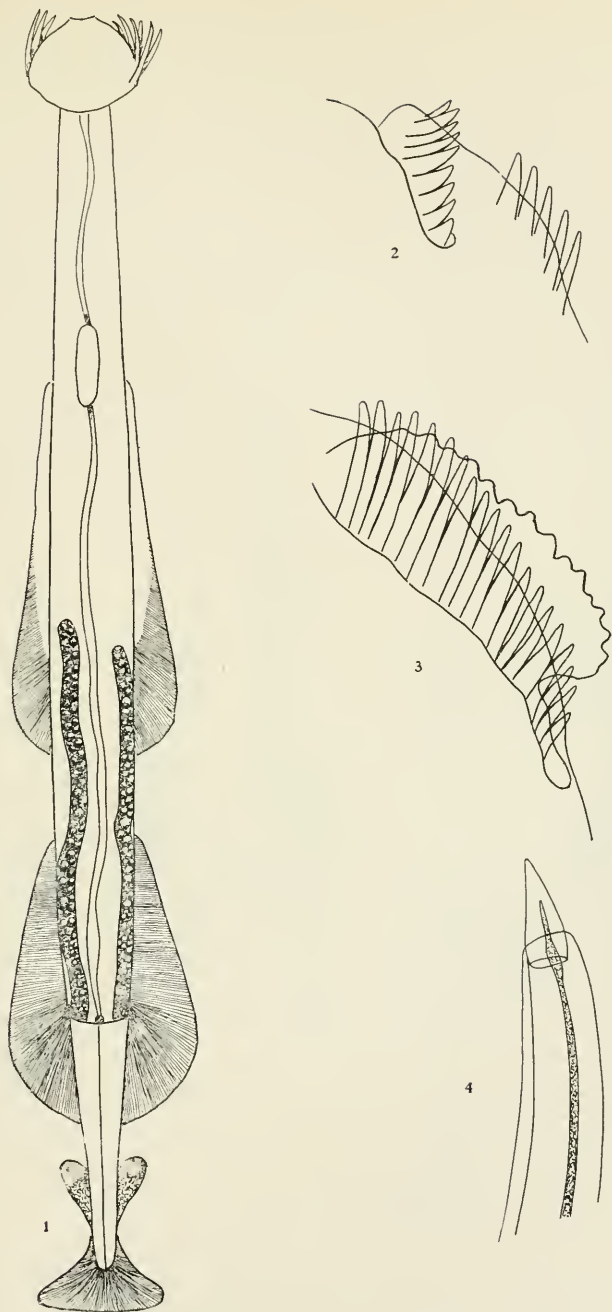
## PLATE 37.

- FIG. 14. Teeth of *Eukrohnia hamata* (Möbius).  $\times 100$ .  
 15. Teeth of *Eukrohnia richardi* Germain and Joubin.  $\times 100$ .  
 16. Vestibular ridge of *Sagitta minima* Grassi.  $\times 400$ .  
 17. Seizing jaw of *Sagitta minima*.  $\times 800$ .  
 18. Portion of vestibular ridge and posterior teeth of *Sagitta decipiens* Fowler.  $\times 400$ .  
 19. Vestibular ridge of *Sagitta pulchra* Doncaster.  $\times 400$ .  
 20. Vestibular ridge of *Sagitta bedoti* Béranek.  $\times 400$ .  
 21. Vestibular ridge of *Sagitta ferox* Doncaster.  $\times 400$ .  
 22. Seizing jaw of *Sagitta decipiens* Fowler.  $\times 800$ .  
 23. Seizing jaw of *Sagitta pulchra* Doncaster.  $\times 800$ .  
 24. Seizing jaw of *Sagitta bedoti* Béranek.  $\times 800$ .  
 25. Seizing jaw of *Sagitta ferox* Doncaster.  $\times 800$ .  
 26. Seizing jaw of *Eukrohnia richardi* Germain and Joubin.  $\times 800$ .  
 27. Seizing jaw of *Eukrohnia hamata* (Möbius).  $\times 800$ .

## PLATE 38.

- FIG. 28. Posterior extremity of a small mature *Sagitta enflata* Grassi.  $\times 25$ .  
 29. Posterior extremity of a mature *Sagitta minima* Grassi.  $\times 25$ .  
 30. Ventral view of anterior extremity of *Sagitta bedoti* Béranek.  $\times 50$ .

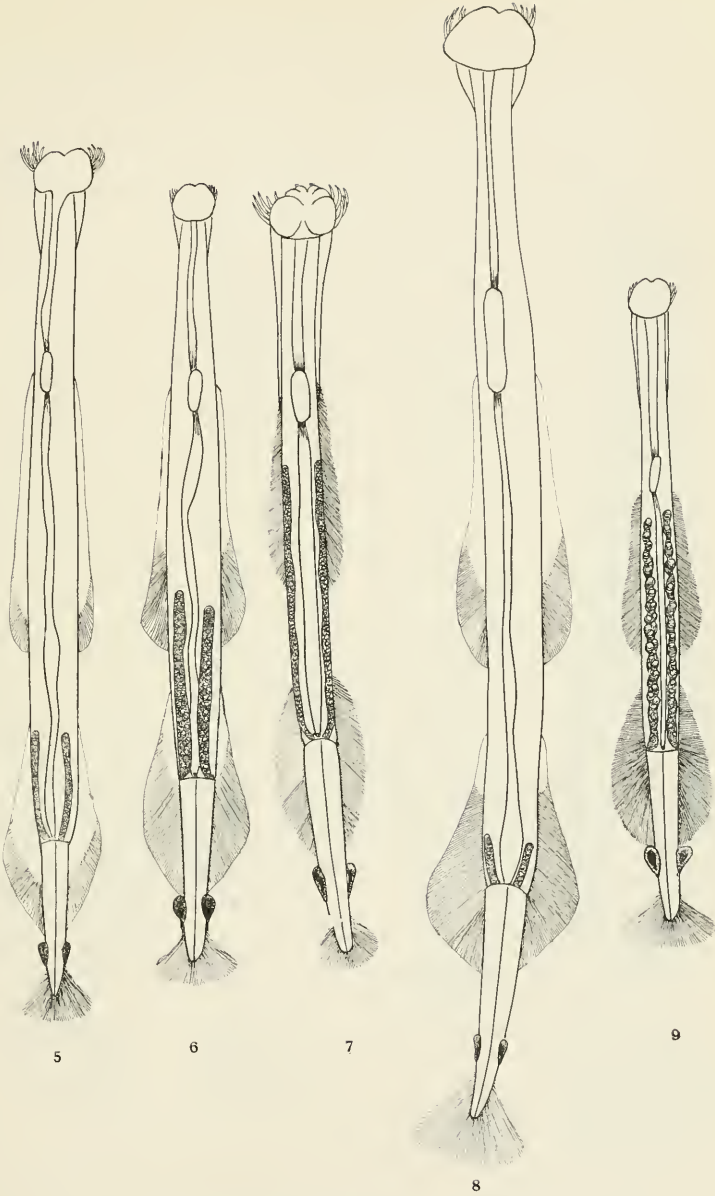




CHAETOGNATHA COLLECTED IN PHILIPPINE ISLANDS.

FOR EXPLANATION OF PLATE SEE PAGE 277.



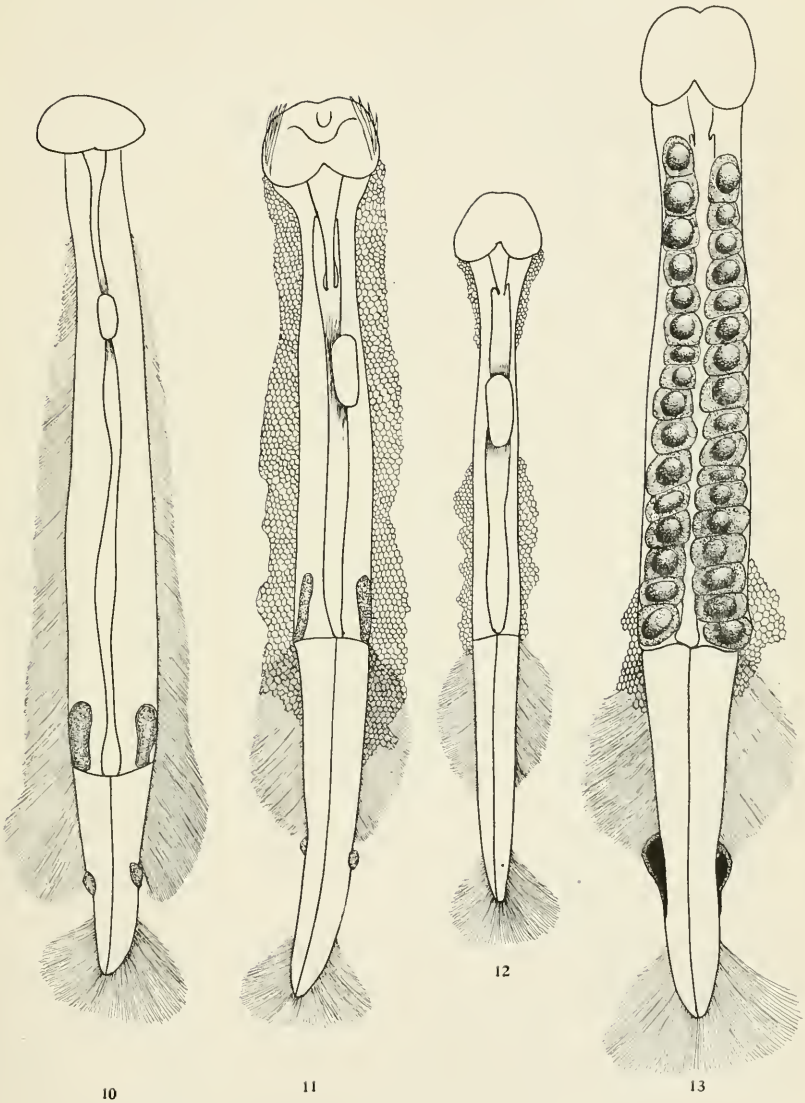


CHAETOGNATHA COLLECTED IN PHILIPPINE WATERS.

FOR EXPLANATION OF PLATE SEE PAGE 277.







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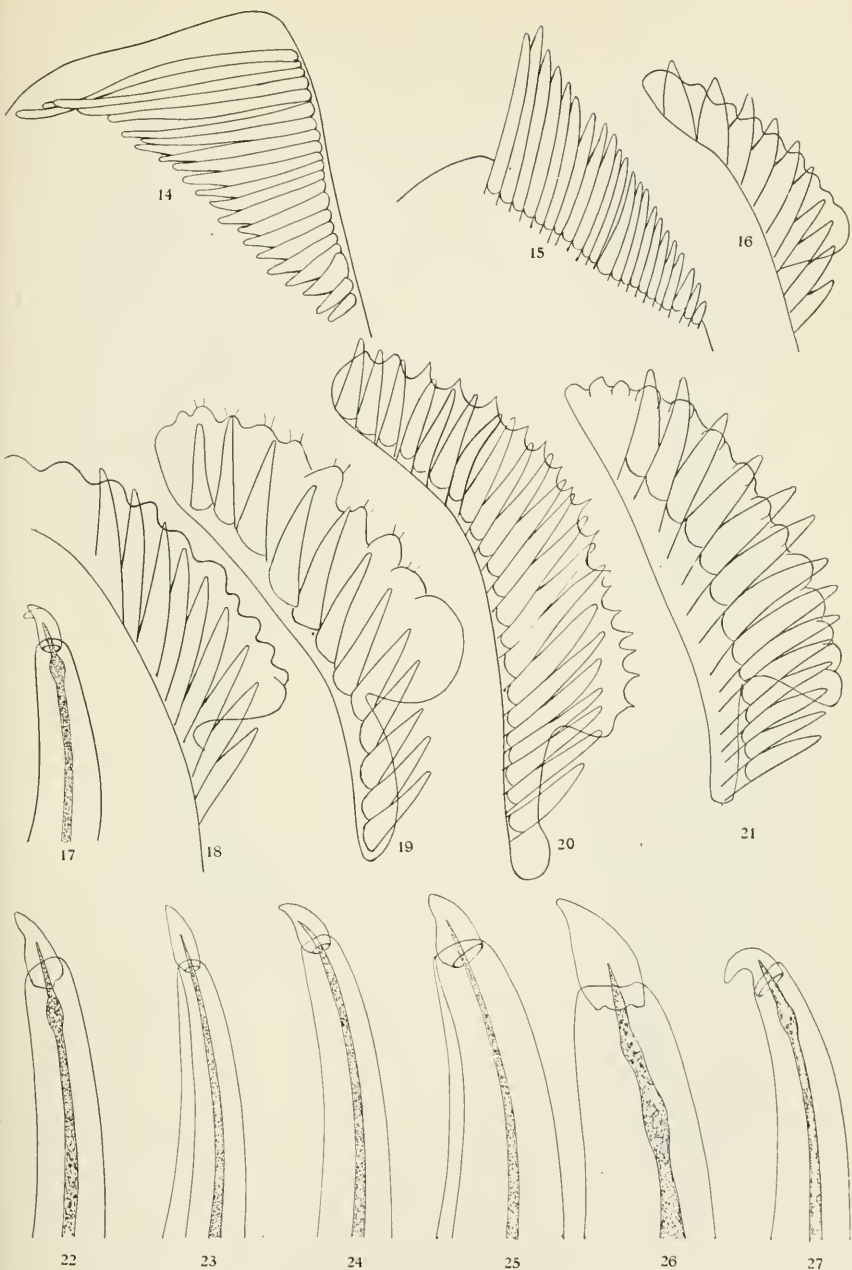
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CHAETOGNATHA COLLECTED IN PHILIPPINE WATERS.

FOR EXPLANATION OF PLATE SEE PAGE 277.

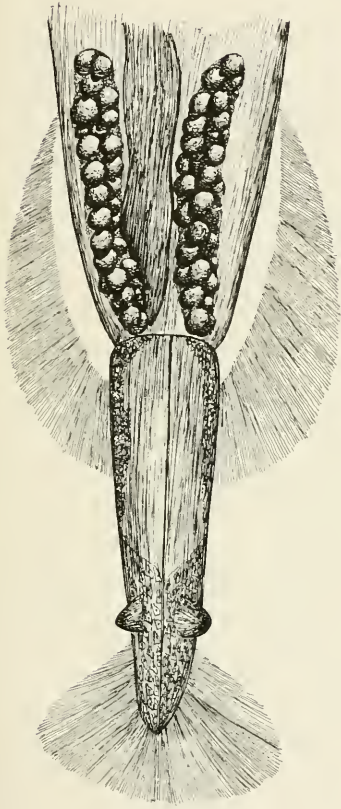




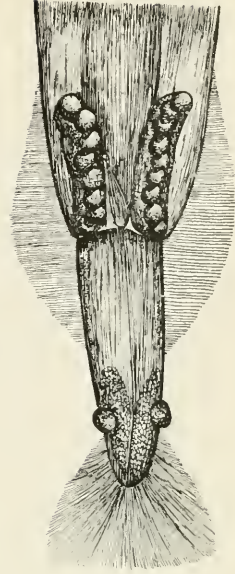
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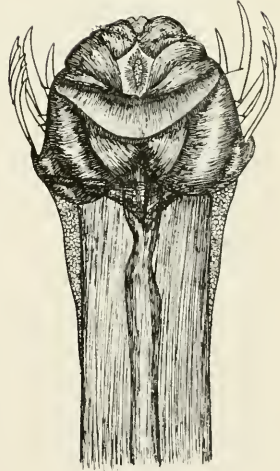




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FOR EXPLANATION OF PLATE SEE PAGE 277.