

# Two New Chaetognaths from the Pacific

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THE PRESENT PAPER deals with two species of chaetognaths observed when working on the distribution of this group in California waters, and on their relation to the hydrographic conditions of the area. The material was collected by the California Cooperative Oceanic Fisheries Investigations (CalCOFI) off the coast of California, a project sponsored by the Marine Research Committee of the State of California.

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space for me in the Marine Invertebrates Department to carry out my work on zooplankton. I am also greatly indebted to Dr. R. Revelle and Professor J. D. Issacs for their interest in providing an opportunity for me to work and continue my research at this Institution. I also offer my sincere thanks to Gail Holden Theilacker for doing the drawings contained in this paper.

## *Sagitta bierii* n. sp.

The body is rigid and slender, retaining its cylindrical shape. It is transparent, so that the ovaries are easily seen and the gut appears as a dark straight line along the body. The small head is attached to a long narrow neck which gradually broadens out into the body, which is widest at the level of the ovaries. The shape

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TABLE 1  
MEASUREMENTS OF *Sagitta bierii* n. sp.

| NUMBER OF SPECIMENS | TOTAL LENGTH, MM. | TAIL LENGTH, MM. |           | OVARY LENGTH, MM. |           | HOOKS |       | ANTERIOR TEETH |       | POSTERIOR TEETH |         |
|---------------------|-------------------|------------------|-----------|-------------------|-----------|-------|-------|----------------|-------|-----------------|---------|
|                     |                   | Median           | Range     | Median            | Range     | Mode  | Range | Mode           | Range | Mode            | Range   |
| 2                   | 17.0              | 3.5              |           | 3.5               | (3.0-4.0) | 6     |       | 6              |       |                 | (14-16) |
| 6                   | 16.0              | 3.2              | (3.0-3.5) | 2.5               | (1.3-4.5) | 6     |       | 6              | (6-8) | 14              | (12-16) |
| 18                  | 15.0              | 3.08             | (3.0-3.5) | 2.4               | (0.5-4.5) | 6     | (5-6) | 6              | (6-7) | 14              | (12-18) |
| 7                   | 14.5              | 3.01             | (3.0-3.5) | 2.6               | (1.0-4.0) | 6     | (5-6) | 6              | (6-7) | 14              | (12-16) |
| 30                  | 14.0              | 3.0              | (3.0-3.2) | 2.37              | (1.0-4.0) | 6     | (6-7) | 6              | (6-8) | 14              | (12-18) |
| 33                  | 13.5              | 2.9              | (2.8-3.5) | 1.9               | (1.0-4.0) | 6     | (6-7) | 6              | (6-8) | 14              | (12-18) |
| 42                  | 13.0              | 2.8              | (2.5-3.5) | 2.0               | (1.0-4.0) | 6     | (6-7) | 6              | (6-8) | 14              | (12-18) |
| 29                  | 12.5              | 2.7              | (2.5-3.0) | 1.3               | (0.8-3.0) | 6     | (6-7) | 6              | (6-7) | 14              | (12-18) |
| 40                  | 12.0              | 2.78             | (2.2-3.0) | 1.7               | (0.5-2.4) | 6     | (6-7) | 6              | (5-8) | 12              | (12-18) |
| 26                  | 11.5              | 2.6              | (2.5-2.9) | 0.9               | (0.2-2.0) | 6     | (6-7) | 6              | (5-6) | 12              | (12-14) |
| 29                  | 11.0              | 2.6              | (2.2-2.8) | 0.7               | (0.0-2.0) | 6     | (6-7) | 6              | (4-7) | 12              | (10-16) |
| 23                  | 10.5              | 2.3              | (2.2-2.6) | 0.3               | (0.0-1.0) | 6     | (6-7) | 6              | (4-6) | 12              | (10-14) |
| 20                  | 10.0              | 2.29             | (2.0-2.5) | 0.14              | (0.0-1.2) | 6     | (6-7) | 4              | (4-6) | 10              | (10-12) |
| 14                  | 9.5               | 2.1              | (2.0-2.5) | 0.16              | (0.0-0.5) | 6     | (6-7) | 4              | (3-6) | 10              | (10-13) |
| 18                  | 9.0               | 2.1              | (2.0-2.4) |                   |           | 6     | (6-7) | 4              | (3-6) | 10              | (8-12)  |
| 10                  | 8.5               | 2.08             | (2.0-2.2) |                   |           | 6     | (6-7) | 4              | (3-5) | 10              | (8-12)  |
| 11                  | 8.0               | 2.0              | (1.9-2.2) |                   |           | 6     | (6-7) | 4              | (3-4) | 10              | (10-14) |
| 7                   | 7.5               | 1.77             | (1.7-2.0) |                   |           | 6     | (6-7) | 4              | (3-5) | 10              | (8-10)  |
| 6                   | 7.0               | 1.75             | (1.6-2.0) |                   |           | 6     | (6-7) | 3              | (3-4) | 10              | (8-10)  |
| 5                   | 6.5               | 1.72             | (1.6-1.8) |                   |           | 6     | (6- ) | 3              | (3-4) | 8               | (8-10)  |
| 3                   | 6.0               | 1.6              | (1.5-1.7) |                   |           | 6     | (6-7) | 3              | (3-4) | 8               | (2-10)  |
| 1                   | 5.0               | 1.8              |           |                   |           | 7     |       | 3              |       | 6               |         |

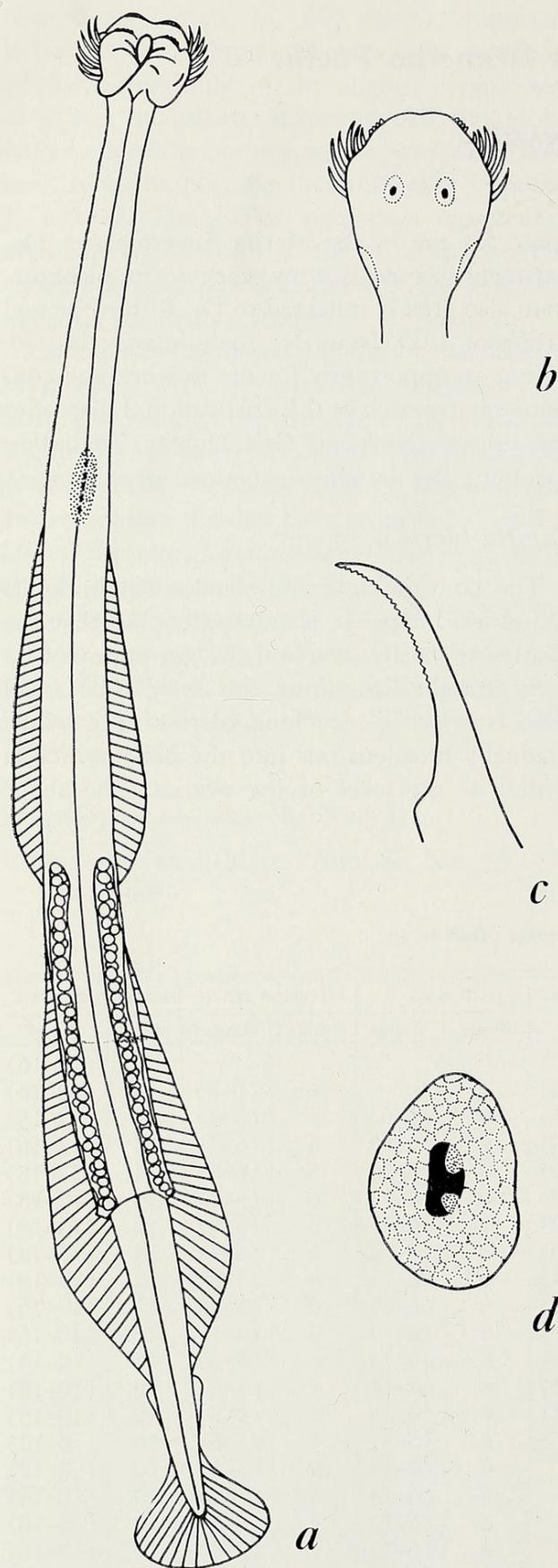


FIG. 1. *Sagitta bierii*. a, Ventral view; b, dorsal view; c, hook; d, left eye.

of the body resembles *Sagitta decipiens* Fowler. That species, however, is more transparent and flaccid and differs in the position of the fins and in having hooks without serrations.

The anterior fins begin at the level of the posterior end of the ventral ganglion. They broaden at their posterior end and are without a rayless zone.

The posterior fins begin at a short distance from the posterior end of the anterior fins and end at the level of the seminal vesicles. They are somewhat roundly triangular in shape and about the same or slightly longer than the anterior fins. They are broadest behind the tail septum, but their greatest length lies in the trunk region. They do not have a rayless zone (Fig. 1a).

The head is small, slightly elongated in the longitudinal axis, and thus differs from *S. decipiens* Fowler, which has a larger head (Fig. 1b).

The hooks have strong serrations as in other species of the "serratodentata group." The serrations are very conspicuous with low magnifications (Fig. 1c).

The eye pigment forms a kidney-shaped body which in the long axis is one-half the width of the eye, with the longitudinal diameter longer than the transverse (Fig. 1d).

The collarette is small.

The seminal vesicles are triangular to pear shape and not very conspicuous. The species is not as protandric as most chaetognaths (Figs. 2a, b, 3a). In about 60,000 specimens studied, less than a dozen appeared with the seminal vesicles well developed or undamaged. The seminal vesicles do not touch the tail fin.

The ovaries are long, fine tubes; when mature they reach to the posterior end or the middle of the anterior fins. The right ovary is usually shorter. Viewed laterally, the alternated position of the ovulae is clearly seen (Fig. 3b).

The number of ovulae in mature specimens is from 30 to 48.

LENGTH: In a well-mixed population the most abundant size is 12–14 mm. In April, 1958, from Monterey northwards, the prevailing size was from 14 mm. to 17 mm. The northern specimens all had stronger bodies and those from 13 to 15 mm. in length were mostly immature (Fig. 4).

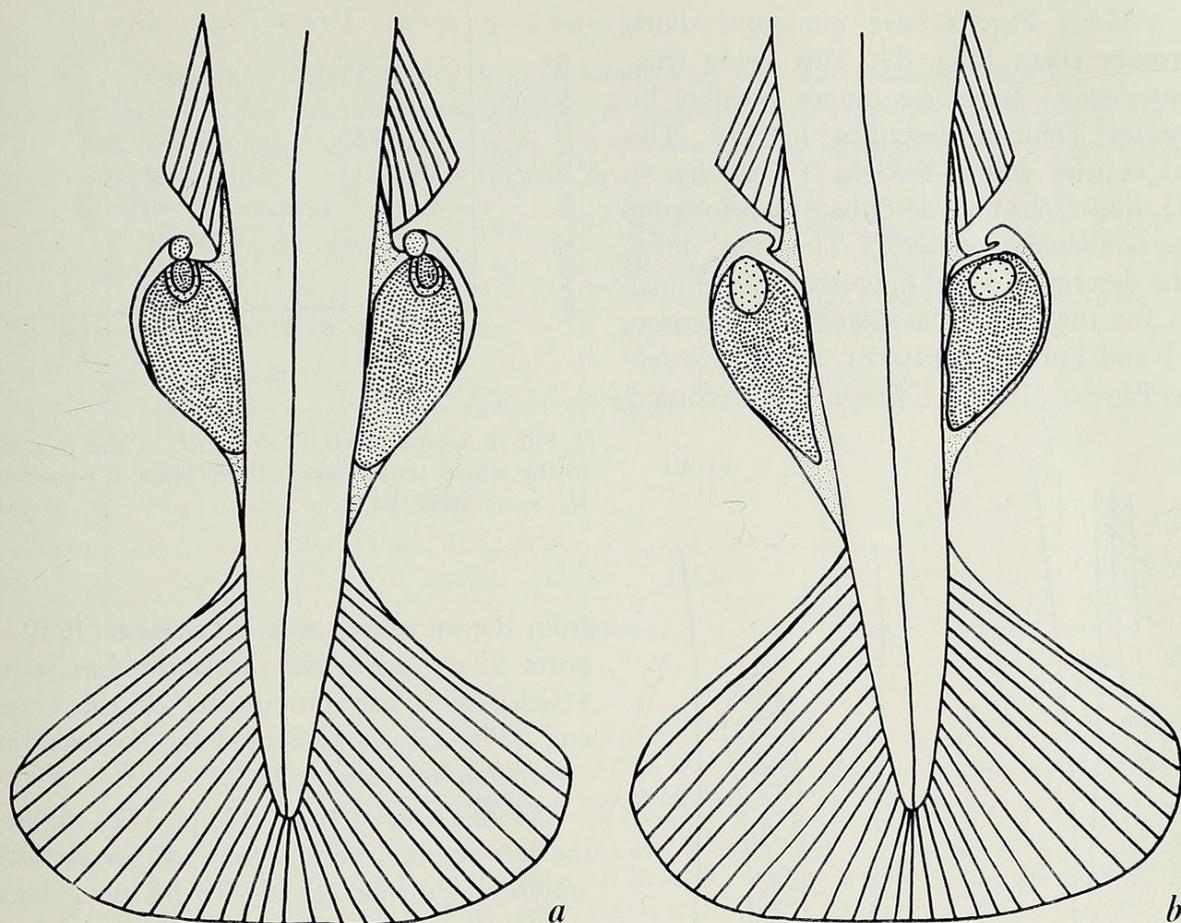


FIG. 2. *Sagitta bierii*. *a*, Seminal vesicles, dorsal view; *b*, ventral view.

Immature specimens 16 mm. long with almost no trace of ovaries were found. Others were observed with ovaries 1.0–1.5 mm. in length. A summary of measurements is given in Table 1.

**DISTRIBUTION:** The species was recorded by R. Bieri (1957) in Peruvian waters, from collections of the Transpacific Expedition, and from Cape Blanco to Punta Eugenia (Baja California) (Bieri, 1959). It was found in the CalCOFI collections of April, 1958, from Cape Mendocino, the northern limit of the sampling, down to the southern part of Baja California, as well as in the plankton samples from Peruvian waters taken by the Consejo de Investigaciones Hidrográficas del Perú in February and April, 1958.

*S. bierii* is found mainly from 100 to 580 mi. offshore, and hence it is not coastal in habitat.

**RELATIONSHIPS:** The shape of the seminal vesicles in the various forms of the "*serratodentata* group" is discussed by Ritter-Zahony, 1911*b*; Tokioka, 1939, 1940; Thomson, 1947; and Furnestin, 1953, 1957. In the present report, based on material from the Pacific and the Atlantic, the differences observed are given in Figures 5, 6, and 7 to compare with Figures 2 and 3.

*S. serratodentata tasmanica* reported by Tokioka (1959) apparently is *S. bierii* n. sp. for the following reasons:

He says that *S. selkirki* Fagetti, from Chilean waters "resembles most closely *tasmanica* in the appearance of the seminal vesicles." This is true and the species are certainly synonymous. The characteristic of the seminal vesicles as well as the other specific characters are identical for both. The anterior part of the seminal vesicles in both *S. serratodentata tasmanica* Thomson

and *S. selkirki* Fagetti have numerous short, soft protuberances (Fig. 6). This being true, *S. serratodentata tasmanica* cannot possibly be the species Tokioka describes (1959). The seminal vesicles which Tokioka (1959, fig. 7, p. 368) illustrated and described as belonging to *S. serratodentata tasmanica* Thomson, differ from the descriptions and figures of the seminal vesicles for this species as given by Thomson (1947) and Furnestin (1957), and for *S. selkirki* by Fagetti (1958). *S. bierii* n. sp., recorded

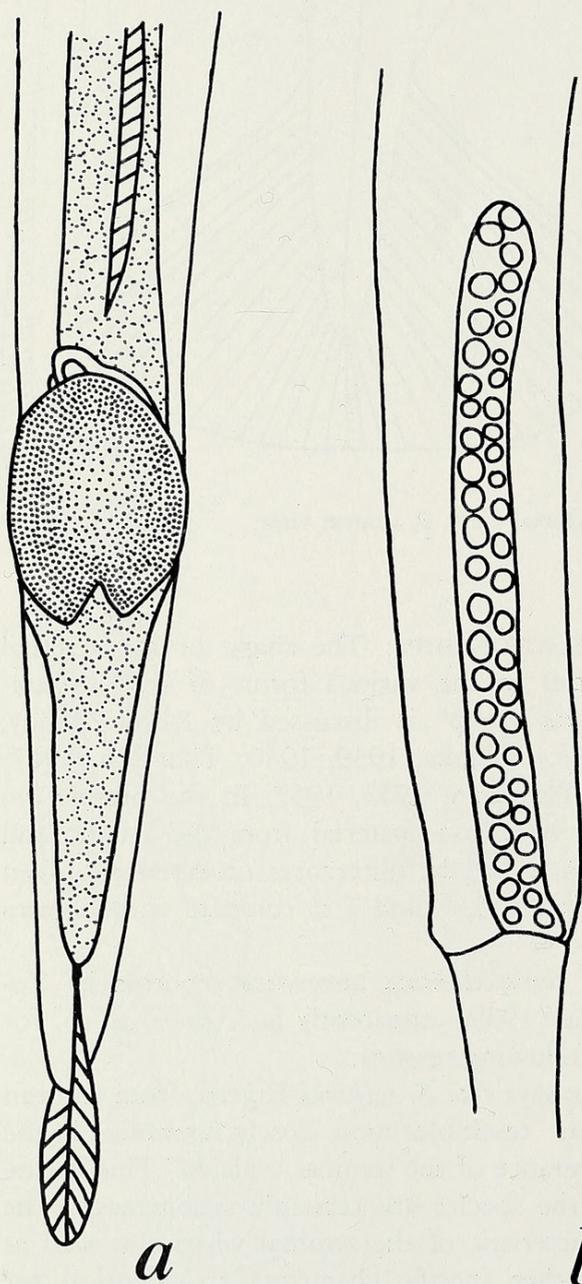


FIG. 3. *Sagitta bierii*. a, Seminal vesicles, lateral view; b, ovary, lateral view.

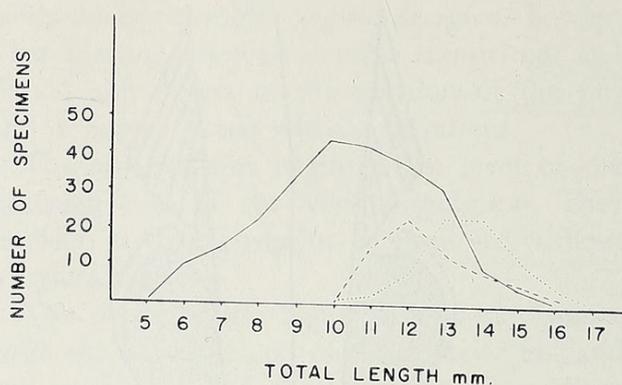


FIG. 4. *Sagitta bierii*. Distribution of size in relation to the sexual stages, April 1958. Stage I, —; Stage II, ----; Stage III, .....

from the same area where Tokioka (1959) reports *S. serratodentata tasmanica*, has seminal vesicles with one prominence at the anterior end (Fig. 2a, b) as figured by Tokioka for *S. serratodentata tasmanica*.

Tokioka's (1959, fig. 12, p. 372) figure of the left seminal vesicle for ? *S. serratodentata atlantica* does not agree with his own description of the seminal vesicles for this species (Tokioka, 1940, p. 373 and fig. 7d, p. 374) nor with that given by Furnestin (1957, fig. 53, p. 150). The seminal vesicle which Tokioka (1959) describes as belonging to ? *S. serratodentata atlantica* agrees with his drawing for *S. serratodentata tasmanica* in the same paper.

In revising the chaetognaths of the "*serratodentata* group" from both the Atlantic and Pacific, it was easy to separate specimens belonging to the different species. Since the characteristics for each species appear constant with no characteristics in common among the different species except for the serrations on the hooks, each one can be considered to rank as a species. The fact that each one of these species typifies different masses of water offers additional evidence for considering each one a good species. A revision of the name of each species appears at the top of each column in Table 2.

Named after Dr. Robert Bieri, who recorded it in his work as *Sagitta* sp. in the "*serratodentata* group."

HOLOTYPE: USNM no. 29919.

PARATYPES: USNM no. 29920.

TABLE 2  
PRINCIPAL DIFFERENTIAL CHARACTERISTICS OF THE "Serratodentata GROUP"

|                           | <i>S. serratodentata</i><br>Krohn 1853<br><i>S. serratodentata atlantica</i> Tokioka 1940,<br>Thomson 1947,<br>Furnestin 1953,<br>1957                                       | <i>S. pseudoserratodentata</i> Tokioka 1939   | <i>S. pacifica</i> Tokioka<br><i>S. serratodentata pacifica</i> , Tokioka 1940,<br>Thomson 1947,<br>Furnestin 1953,<br>1957 | <i>S. tasmanica</i><br>Thomson<br><i>S. serratodentata tasmanica</i><br>Thomson 1947,<br>Furnestin 1953,<br>1957<br><i>S. selkirki</i> Fagetti 1958   | <i>S. bierii</i> n. sp.  |
|---------------------------|--|---|---|---|--|
| Total length, mature, mm. | 10-13  | 7-10  | 12-14   | 15-20   | 14-17  |
| % tail                    | 23-26  | 26-29   | 23-26   | 22-26   | 20.5-23.3  |
| Body shape                | Same width from head to tail septum.   | Same.   | Same.   | Same.   | Neck region long, thin. Body widest at ovary region.                             |
| Collarette                | Well apparent.   | Smaller than in <i>S. serratodentata</i> .  | As in <i>S. pseudoserratodentata</i> .  | As in <i>S. serratodentata</i> .  | Very small, if present.  |
| Posterior fins            | Long, rounded. About same length on tail as on trunk. At level of tail, septum begins rayless zone which extends over anterior part of fin.                                  | Long, rounded, more on tail than trunk. Very close to posterior fins. Internal portion of fins on trunk is rayless.   | As in <i>S. pseudoserratodentata</i> . Very close to anterior fins. No rayless zone.  | Continuous with anterior fins by extremely narrow connexion, not visible with low power 10X and in badly preserved specimens. More on tail than trunk. Rayless zone begins at level of first third of tail extending over anterior part of fin as in <i>S. serratodentata</i> . | Triangular, rounded, more on trunk than tail. No rayless zone.                   |
| Seminal vesicles          | Separated from tail fin, close to posterior fins. Two prominences at anterior lateral corner. Thickening of collarette tissue in front of anterior end. Markedly protandric. | Close to posterior end of posterior fins and at longer distance from tail fin. One prominence at lateral anterior corner and small teeth at anterior end. Protandric. | Oval with thickening frothy tissue. 5-10 chitinous teeth at anterior end. Protandric.                                       | Close to posterior fins, separated from tail fin. Numerous short protuberances at anterior end. Notable thickening in front and behind vesicle. Markedly protandric.  | Pear shape. One prominence and no soft protuberances as in <i>S. tasmanica</i> . |
| Ovaries                   | Long tubes extending to anterior end of anterior fins. Ovulae small and in one row.  | Fine tubes extending to anterior end of ventral ganglion. Ovulae large for size of specimens, arranged in one row.  | Very fine tubes, extending up to neck. Ovulae in one row.   | Long tubes extending to ventral ganglion. Ovulae in two rows.   | Fine tubes extending to posterior end of anterior fins. Ovulae in two rows.      |

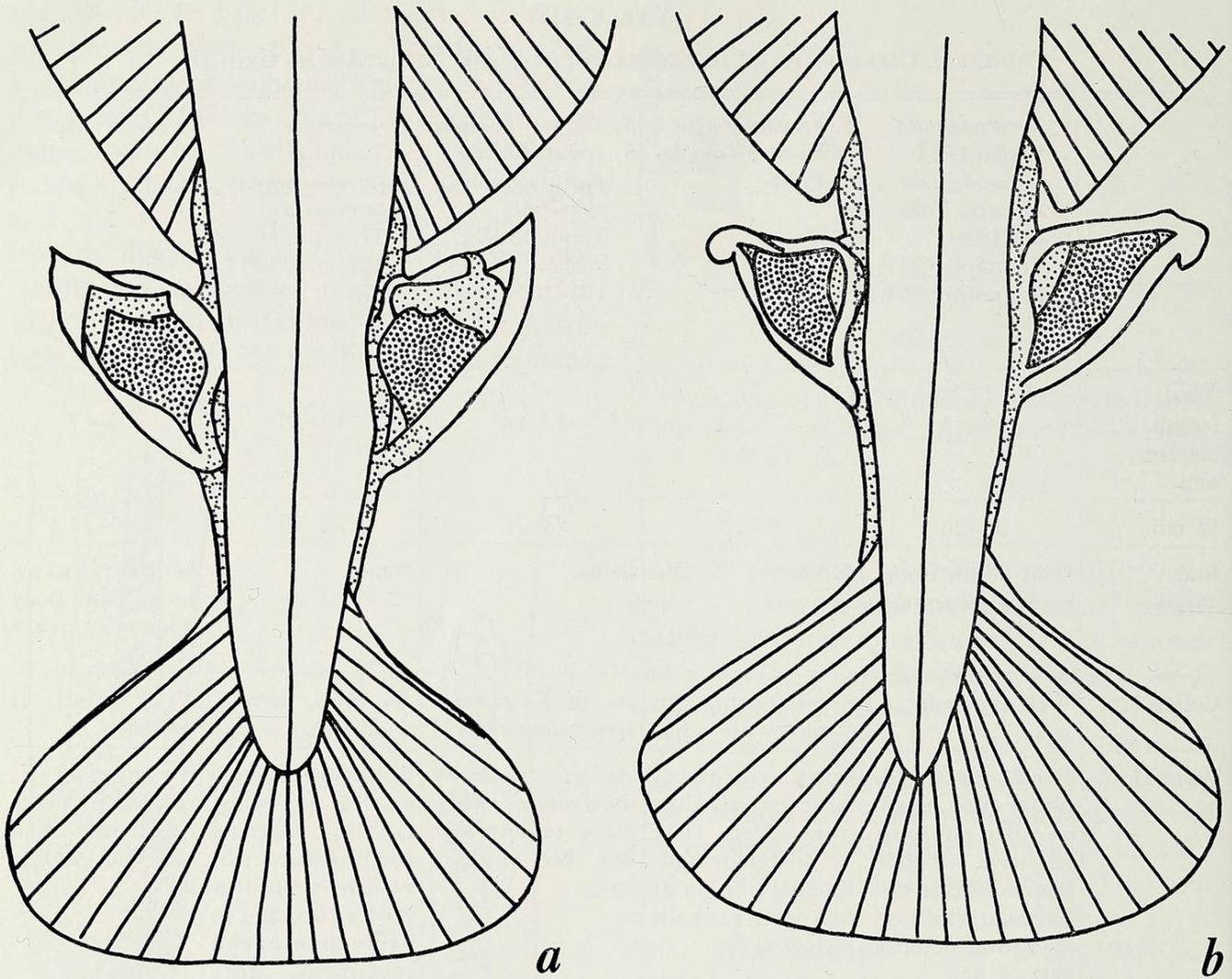


FIG. 5. *Sagitta pseudoserratodentata* Tokioka, seminal vesicles, two phases observed.

*Sagitta euneritica* n. sp.

The body is very translucent, almost transparent as in *Sagitta setosa* Müller; however, the larger specimens which mature at a size over 13 mm. in length appear less transparent. The body is uniform in width, narrowing at the head and at the tail ends. The rather poorly marked neck region is filled by a collarette. Viewed dorsoventrally on a dark background, the gut appears as a narrow white line extending from the head down to the body as in *S. setosa*.

The anterior fins do not reach the ventral ganglion. They are wider at the posterior end and have no rayless zone.

The posterior fins lie more on the trunk than on the tail. They are longer than the anterior fins, broadest behind the level of the tail septum,

and they end touching the seminal vesicles. They are without a rayless zone (Fig. 8a).

The head is somewhat square and regular in size.

The eye pigment is gathered into a rather perfect square with several clear spots which differ in position and shape from those of *S. setosa* and *S. euxina* Moltchanoff (Furnestin, 1958) (Fig. 8c, d).

The collarette is well developed with the characteristic structure of round cells in a network.

The sensorial cells are spread all over the body as they are in *S. setosa* and *S. friderici* Ritter-Zahony.

The seminal vesicles are in contact with the tail fin and with the posterior fins. They are not very prominent, being small and similar to

TABLE 3  
MEASUREMENTS OF *Sagitta euneritica* n. sp.

| NUMBER OF SPECIMENS | TOTAL LENGTH, MM. | TAIL LENGTH, MM. |           | OVARY LENGTH, MM. |           | HOOKS |       | ANTERIOR TEETH |       | POSTERIOR TEETH |         |
|---------------------|-------------------|------------------|-----------|-------------------|-----------|-------|-------|----------------|-------|-----------------|---------|
|                     |                   | Median           | Range     | Median            | Range     | Mode  | Range | Mode           | Range | Mode            | Range   |
| 2                   | 15.5              | 3.2              | (3.0-3.4) | 2.0               | (2.0-2.0) | 7-9   |       | 6-8            |       | 14-16           |         |
| 7                   | 15.0              | 3.2              | (3.0-3.4) | 1.6               | (1.0-2.2) | 8     | (8-9) | 6              | (5-7) | 14              | (10-16) |
| 7                   | 14.5              | 3.1              | (3.0-3.2) | 1.3               | (1.0-2.5) | 8     | (7-9) | 6              | (5-7) | 12              | (12-16) |
| 30                  | 14.0              | 2.9              | (2.5-3.2) | 1.59              | (1.0-2.3) | 8     | (7-8) | 6              | (6-7) | 14              | (10-16) |
| 34                  | 13.5              | 2.8              | (2.5-3.0) | 1.52              | (1.0-2.0) | 8     | (7-9) | 6              | (4-7) | 12              | (10-16) |
| 54                  | 13.0              | 2.58             | (2.5-3.2) | 1.5               | (0.4-3.0) | 8     | (7-9) | 6              | (5-7) | 12              | (10-16) |
| 16                  | 12.5              | 2.6              | (2.5-3.0) | 1.2               | (0.6-2.6) | 8     | (7-8) | 6              | (5-6) | 12              | (10-12) |
| 44                  | 12.0              | 2.7              | (2.3-3.0) | 1.2               | (0.0-2.5) | 8     | (7-9) | 6              | (4-7) | 12              | (10-16) |
| 16                  | 11.5              | 2.6              | (2.3-2.6) | 0.8               | (0.3-2.0) | 8     | (7-8) | 6              | (4-7) | 12              | (10-12) |
| 15                  | 11.0              | 2.2              | (2.0-2.6) | 0.66              | (0.3-1.3) | 8     | (7-8) | 6              | (4-6) | 10              | (10-14) |
| 10                  | 10.5              | 2.05             | (2.0-2.3) | 0.56              | (0.3-1.0) | 8     | (6-8) | 6              | (4-6) | 10              | (10-12) |
| 9                   | 10.0              | 2.0              | (2.0-2.2) | 0.54              | (0.3-1.1) | 8     | (7-8) | 6              | (4-6) | 10              | (10-12) |
| 7                   | 9.5               | 1.9              | (1.8-2.0) | 0.41              | (0.2-0.7) | 8     | (7-8) | 6              | (3-6) | 10              | (8-12)  |
| 6                   | 9.0               | 1.8              | (1.6-2.0) | 0.25              | (0.1-0.4) | 8     | (7-8) | 4              | (2-6) | 8               | (6-12)  |
| 7                   | 8.5               | 1.8              | (1.5-2.0) | 0.2               | (0.1-0.3) | 8     | (7-8) | 4              | (3-6) | 8               | (8-10)  |
| 6                   | 8.0               | 1.7              | (1.5-2.0) | 0.18              | (0.1-0.3) | 8     | (7-8) | 3              | (3-6) | 8               | (8-10)  |
| 6                   | 7.5               | 1.7              | (1.5-2.0) | 0.1               | (0.1-0.2) | 8     | (7-8) | 3              | (3-5) | 8               | (8-10)  |
| 4                   | 7.0               | 1.6              | (1.4-1.9) | 0.1               | (0.1-0.2) | 8     | (7-8) | 3              | (3-5) | 8               | (8-10)  |
| 5                   | 6.5               | 1.4              | (1.3-1.5) | 0.1               | (0.1-0.2) | 8     | (7-8) | 3              | (2-4) | 8               | (6-8)   |
| 5                   | 6.0               | 1.4              | (1.3-1.5) | 0.1               |           | 8     | (7-8) | 3              | (2-4) | 7               | (7-8)   |
| 2                   | 5.0               | 1.2              | (1.2-1.3) |                   |           | 7     |       |                | (2-3) |                 | (6-8)   |
| 1                   | 4.5               | 1.2              |           |                   |           | 8     |       | 2              |       | 6               |         |
| 1                   | 4.0               | 0.9              |           |                   |           | 7     |       | 2              |       | 6               |         |

TABLE 4

PRINCIPAL DIFFERENTIAL CHARACTERISTICS OF FORMS CLOSELY RELATED TO *Sagitta euneritica* n. sp.

|                           | <i>S. setosa</i> Müller   | <i>S. friderici</i> Ritter-Zahony  | <i>S. euneritica</i> n. sp.   |
|---------------------------|---|--|---|
| Total length, mm., mature | 10-14   | 10-15  | 10.5-15.5   |
| % tail                    | 16-21.7   | 22.6-27  | 19-22   |
| Anterior fins             | Begin somewhat behind ventral ganglion.   | Begin at posterior end of ventral ganglion.  | Begin a small distance behind posterior end of ventral ganglion.                |
| Posterior fins            | More on trunk than tail, and end at seminal vesicles.                               | More on tail than trunk, and extend to seminal vesicles.                               | More on trunk than tail, and extend to seminal vesicles.                        |
| Collarlette               | Very small.   | Noticeable.  | Well developed.   |
| Seminal vesicles          | Far from tail fin and close to posterior end of posterior fins.                     | Touching both tail fin and posterior fins.   | Touching both tail fin and posterior fins.                                      |
| Ovaries                   | Short, extend to anterior end of posterior fins. Ovulae large and in small numbers. | Extend forward of anterior end of posterior fins. Ovulae regular in size and numerous. | Short, extend to anterior end of posterior fins. Ovulae small, filling ovaries. |

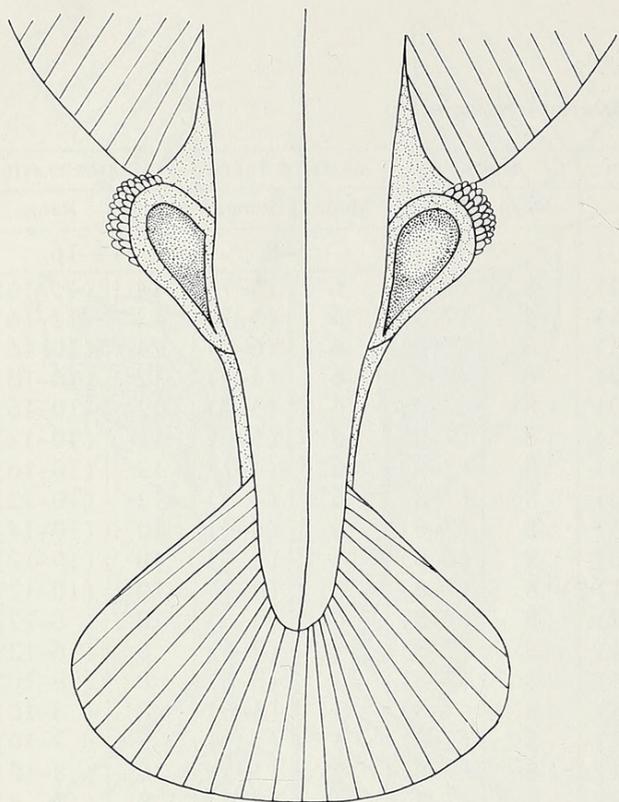


FIG. 6. *Sagitta tasmanica* Thomson, seminal vesicles, ventral view.

those of *S. neglecta* Aida (Fig. 9), and they belong to the "bedoti-type" (Tokioka, 1939). To compare the seminal vesicles of *S. euneritica* n. sp. with those of *S. friderici* Ritter-Zahony, see Tokioka, 1955, and Furnestin, 1953 and 1957; and to compare with *S. setosa* Müller see Furnestin, 1958.

The ovaries almost fill the width of the body and extend up to the anterior end of the posterior fins. The ovulae are not as large as those in *S. setosa* and they completely fill the ovaries.

The ecology of this species is very similar to *S. setosa* and *S. friderici* which are also found in coastal waters. In the California region *S. euneritica* n. sp. appears in large numbers (thousands per sample) in the neritic areas. In some places they are carried offshore by local superficial currents or eddies. In these cases the total number per haul gradually decreases as the distance from shore increases.

Table 3 gives the meristic characters and armature formulae.

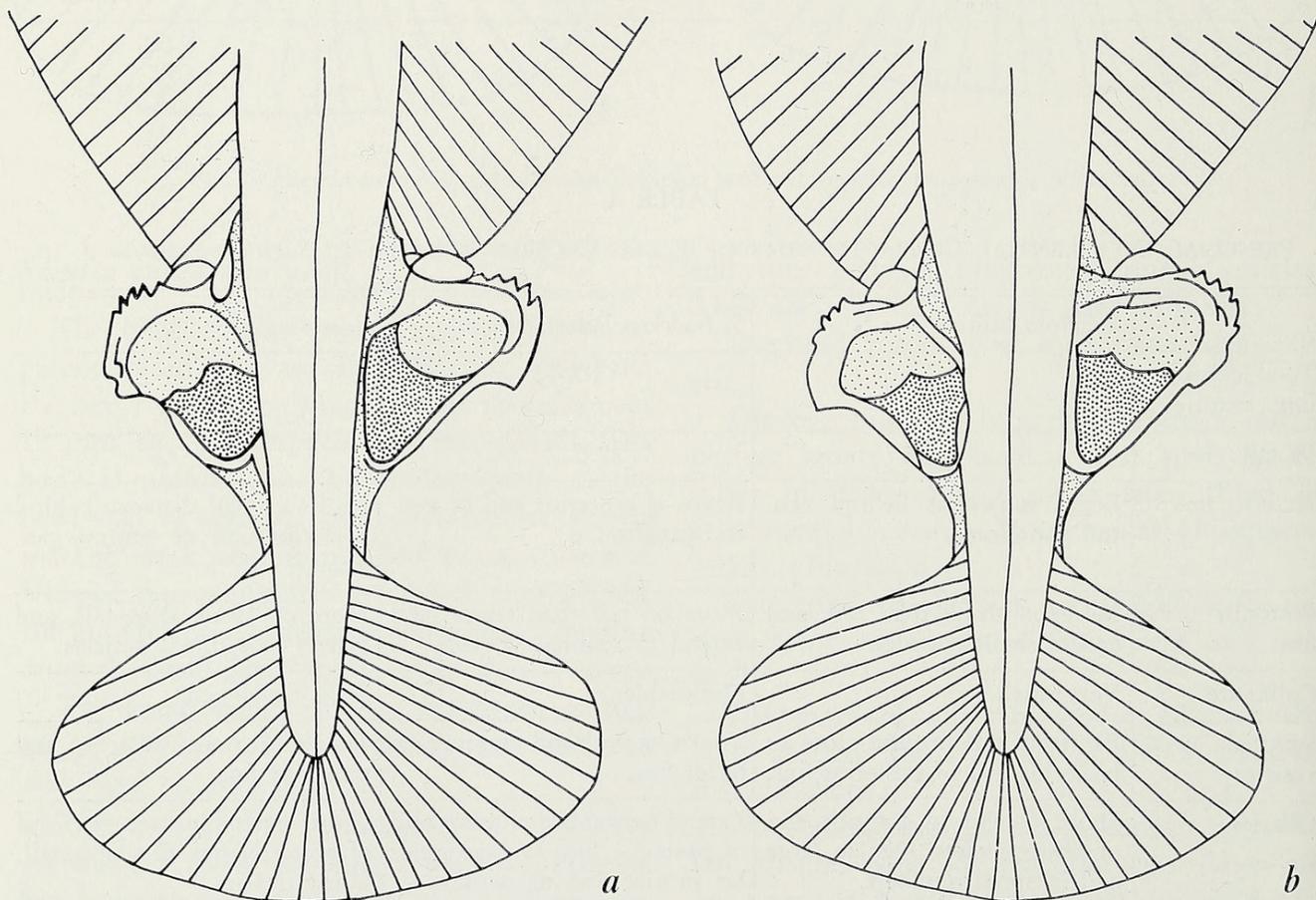


FIG. 7. *Sagitta pacifica* Tokioka. *a*, Seminal vesicles, dorsal view; *b*, ventral view.

It appears that *S. eumeritica* n. sp. is closely related to *S. setosa* Müller and *S. friderici* Ritter-Zahony, but there are several points of difference as shown in Table 4 and Figure 10.

**DISTRIBUTION:** In the collections studied, CalCOFI cruises 5405 and 5804, it occurred close to shore from Cape Mendocino to Punta Eugenia in Baja California. Dr. Fager of the Scripps Institution collected some specimens using a hand-operated dredge net, when diving off the Tijuana River mouth (June, 1958) at a 50-ft. depth and also south of Scripps Pier (August, 1958) at 20- and 26-ft. depths.

Bieri (1957 and 1959) recorded this species as *S. friderici*? in the same area along the coasts of North America extending south to the waters of Peru and Chile.

**HOLOTYPE:** USNM no. 29917.

**PARATYPES:** USNM no. 29918.

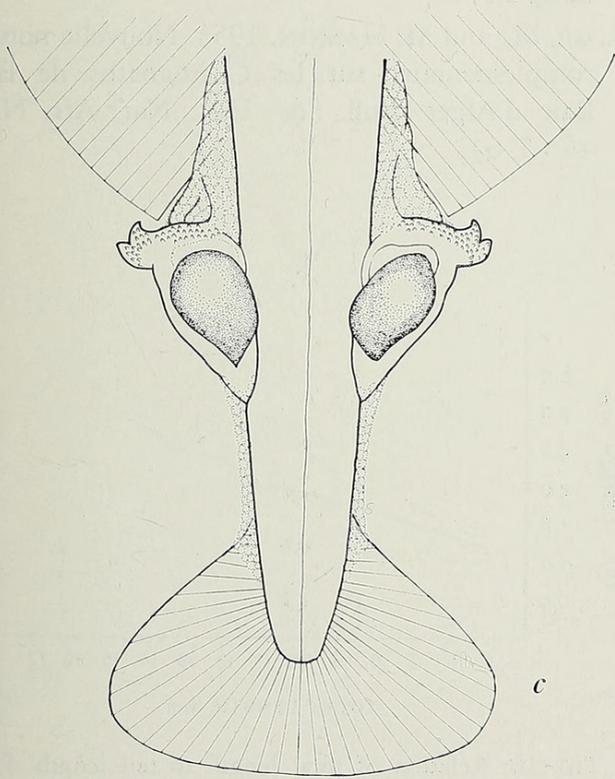


FIG. 7c. *Sagitta serratodentata* Krohn, seminal vesicles, dorsal view.

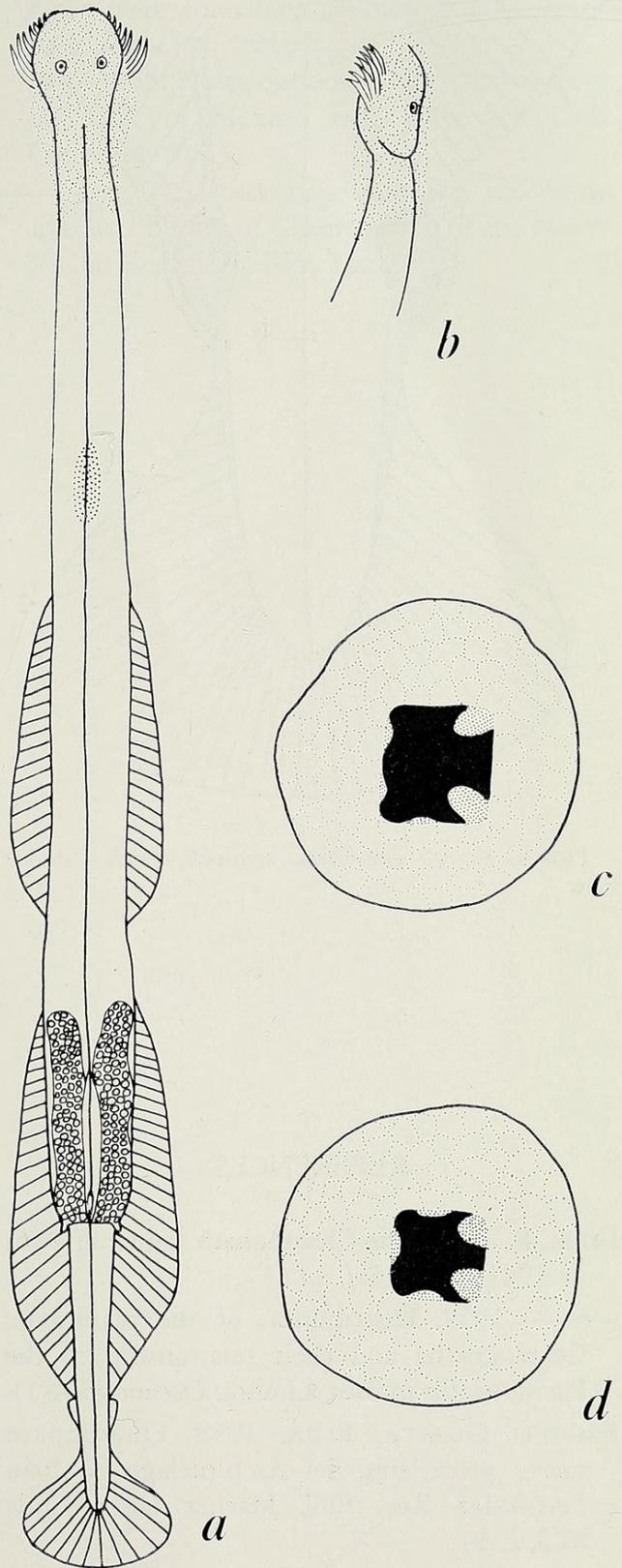


FIG. 8. *Sagitta eumeritica*. a, Dorsal view; b, lateral view; c, left eye, mature specimen; d, left eye, immature specimen.

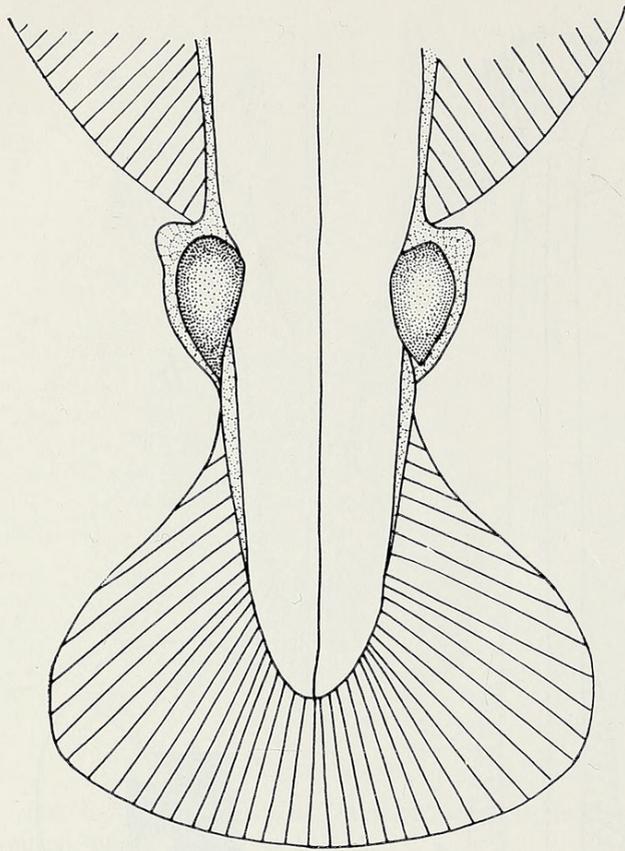


FIG. 9. *Sagitta euneritica*, seminal vesicles, dorsal view.

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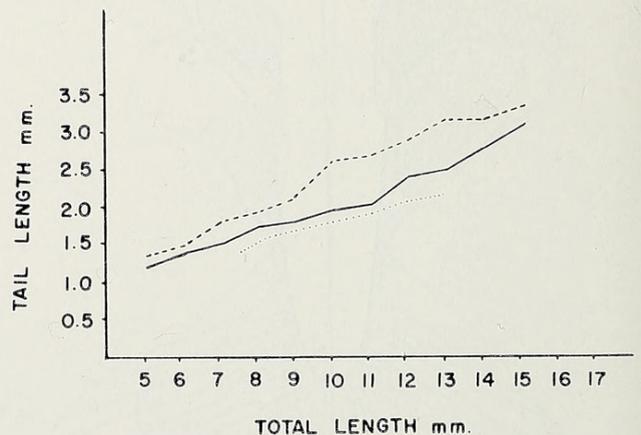


FIG. 10. Relation of total length to tail length. *S. euneritica*, —; *S. friderici*, - - - -; *S. setosa*, . . . . . According to records of Ritter-Zahony, 1911a, Faure, 1953, Tokioka, 1955, and Furnestin, 1958, for *Sagitta friderici* Ritter-Zahony. Furnestin, 1958, and Ritter-Zahony, 1911b, for *Sagitta setosa* Müller.



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