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## A NEW SPECIES OF *EUKROHNIA* FROM THE INDIAN SEAS WITH NOTES ON THREE OTHER SPECIES OF CHAETOGNATHA\*

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### INTRODUCTION

BETWEEN 1963 and 1966 during the research cruises of R.V. *VARUNA* off the west coast of India and the Laccadive Sea, the Indian Ocean Standard Net was used for taking a series of deep-water vertical open tows from depths upto 1,300 metres (Table XII). The collections have brought to light interesting material which will considerably add to our understanding of the biogeography of the area. The chaetognatha is well represented by about 44,000 specimens belonging to 14 species, one of which is described here as new to science. Three other species, namely *Eukrohnia fowleri* Ritter-Zahony (1909), *Sagitta hispida* Conant (1895), and *Sagitta lyra* Krohn (1853) are interesting distributional records for the Indian Seas, and brief descriptions of these species are also given here. The species in the collection are :

#### Genus *Sagitta* Quoy and Gaimard (1827)

1. *Sagitta bedoti* Beraneck (1895)
2. *Sagitta decipiens* Fowler (1905)
3. *Sagitta inflata* Grassi (1881)
4. *Sagitta hispida* Conant (1895)
5. *Sagitta lyra* Krohn (1853)
6. *Sagitta pacifica* Tokioka (1940)
7. *Sagitta pulchra* Doncaster (1903)
8. *Sagitta regularis* Aida (1897)
9. *Sagitta robusta* Doncaster (1903)

#### Genus *Pterosagitta* Ritter-Zahony (1911)

10. *Pterosagitta draco* (Krohn) (1853)

#### Genus *Krohnitta* Ritter-Zahony (1911)

11. *Krohnitta pacifica* (Aida) (1897)
12. *Krohnitta subtilis* (Grassi) (1881)

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Genus *Eukrohnia* Ritter-Zahony (1909)

13. *Eukrohnia fowleri* Ritter-Zahony (1909)
14. *Eukrohnia minuta* sp. nov.

For recent works relating to Chaetognatha from Indian Seas reference is invited to John (1933, 1937), George (1949, 1952), Rao (1958, 1966), Rao and Ganapati (1958) and Rao and Kelly (1962). Alvarino (1965) has critically reviewed the Chaetognatha and codified the nomenclature of some of the species described or recorded by these earlier authors from Indian Seas. According to her, *Sagitta robusta* of George (1952) and Rao and Ganapati (1958) refers in part to *Sagitta ferox* Doncaster. *Sagitta serratodentata* variety *pacifica* of Rao (1958) is identical with *S. pacifica* Tokioka (1940). The description of *Sagitta hispida* as given by George (1952) corresponds to *S. bipunctata* Quoy and Gaimard. John's (1933) diagnosis of *Sagitta tenuis* is very much in agreement with that of *S. neglecta* Aida. The description of *S. tenuis* given by George (1952) corresponds to *S. decipiens* Fowler. Alvarino also remarks that the records given by Varadarajan and Chacko (1943), Menon (1945) and Chacko (1950) of *S. tenuis* are mis-identifications of some other well known species. Prasad (1954) and Sudarsan (1963) have listed *S. tenuis* as occurring in the plankton of the Gulf of Mammur and Palk Bay. As known at present (Alvarino, 1965) *S. tenuis* Conant is found only in the Atlantic Ocean. Thus it would appear that there is no definite record of this species from the Indo-Pacific. *Sagitta hexaptera* d'Orbigny (1843) was recorded from the waters of Visakhapatnam (Bay of Bengal) by Rao (1966). Recently Silas and Srinivasan (1968) have given a redescription of *Sagitta bombayensis* Lele and Gae, originally described from Bombay Harbour, and later reported also from Waltair (Rao and Kelly, 1962).

The benthic species *Spadella cephaloptera* (Busch, 1851) has been recorded from the Krusadi Islands, Gulf of Mannar (Varadarajan and Chacko, 1942), Palk Bay (Sudarsan, 1963), and the Trivandrum Coast, Kerala, (Menon, 1945). Thus in addition to the species in the present collection, the following species are also known from the Indian Seas : *Sagitta bombayensis* Lele and Gae (1936), *S. bipunctata* Quoy and Gaimard (1827), *S. neglecta* Aida (1897), *S. ferox* Doncaster (1903), *S. hexaptera* d'Orbigny (1843), and *Spadella cephaloptera* (Busch, 1851). This brings the total number of species known from Indian Seas to 20 belonging to four pelagic genera (*Eukrohnia*, *Krohnia*, *Pterosagitta* and *Sagitta*), and one benthic genus (*Spadella*).

REMARKS ON THE SPECIES OF THE GENUS *EUKROHNTA*

Only two species of the genus *Eukrohnia* were known until recently, *E. fowleri* Ritter-Zahony, and *E. hamata* (Möbius), the latter having as synonyms *E. richardi* Germain and Joubin (1912), and *E. hamata* var. *antarctica* Johnston and Taylor (1921). Tokioka (1965) has also listed *Krohnia hama* var. *borealis* Moltschanoff as a synonym of *E. hamata*.

Recent investigations on the genus *Eukrohnia*, notably by David (1958, 1965), Alvarino (1962, 1964, 1965, 1967), and Furnestin and Ducret (1965) have resulted in the addition of three more species to this genus :

- Eukrohnia bathyantartica* David (1958)
- Eukrohnia bathypelagica* Alvarino (1962)
- Eukrohnia proboscidea* Furnestin and Ducret (1965)

Though placed as a synonym of *E. hamata*, the systematic position of *E. hamata* var. *antarctica* is problematic as Johnston and Taylor (1921) have described this as having a collarette in the neck region—a character not shared by any other known member of the genus. On this ground, Alvarino (1962) has indicated the desirability of considering *E. bathypelagica* as different from *E. hamata* var. *antarctica* though in both species during maturity the tip of the ovaries are coiled, which character as far as we know is specific for *E. bathypelagica*. The description of var. *antarctica* given by Johnston and Taylor (1921) is deficient in many characters which we consider as being of taxonomic importance in the genus. The rediscovery and redescription of this variety from Australian waters is necessary. The present records show a disjunct pattern of distribution for *E. bathypelagica* in the Indo-Pacific.

In our material of *Eukrohnia* from the west coast of India and the Laccadive Sea, we are able to recognise only two species, namely *E. fowleri* and a second species showing affinities to *E. hamata* and to *E. bathypelagica* but markedly differing from both in size and several other diagnostic characters and hence described here as *Eukrohnia minuta* sp. nov. The distinguishing characters between the six known species of the genus are indicated in the key to their identification given elsewhere in this paper.

***Eukrohnia minuta* sp. nov.**

(Plate I, Figs. A-C ; Text-figs. 1 : A-L, 2 : 1-M, 3, 4, 5 and 6)

**Material :** 708 specimens of *E. minuta* were obtained in 31 deep-water plankton hauls made during research cruises of R. V. *VARUNA* as indicated in Table XII.

**Holotype :** CMFRI Reg. No. 109. 11.6 mm. long in IOS Net open tow from 1000-0 m. at Stn. 3375 (10°04' N, 74°38' E) on 15-2-66 at 0735 Hrs.

**Paratypes :** CMFRI Reg. No. 110-A to 110-Y : In the paratype series 400 specimens in good state of preservation from 26 stations have been deposited along with the Holotype in the Research Collections of the Central Marine Fisheries Research Institute, Mandapam Camp. The station number followed by the number of paratypes is given here and for further details reference should be made to Table XII. Stn. 2007 (21) ; 2012 (22) ; 2013 (8) ; 2014 (19) ; 2015 (21) ; 2016 (53) ; 2022 (22) ; 2023 (27) ; 2034 (1) ; 2035 (2) ; 2036 (7) ; 2037 (3) ; 2054 (14) ; 2112 (27) ; 2113 (16) ; 2115 (18) ; 2131 (10) ; 2168 (16) ; 2933 (21) ; 3319 (4) ; 3345 (11) ; 3375 (15) ; 3376A (17) ; 3376B (6) ; 3377B (19) ; 3378 (10).

**Comparative Material :** For comparison with the new species, material of *E. hamata* and *E. bathypelagica* have been examined from the plankton collections made by the Senior Author during his participation in the Vth cruise of the U.S. Research Vessel *ANTON BRUUN* in the Indian Ocean from two stations given below :

Stn. No.	Date	Position	Depth (m)	Depth of haul (m)	Net	No. of specimens	
						<i>E. hamata</i>	<i>E. bathypelagica</i>
307	9-3-64	35° 42'S. 55° 15'E.	3804	860	‡ m ring net. Mesh 0.33 mm	260	13
309	5-4-64	42° 23'S. 74° 54'E.	3371	1200	..	350	45

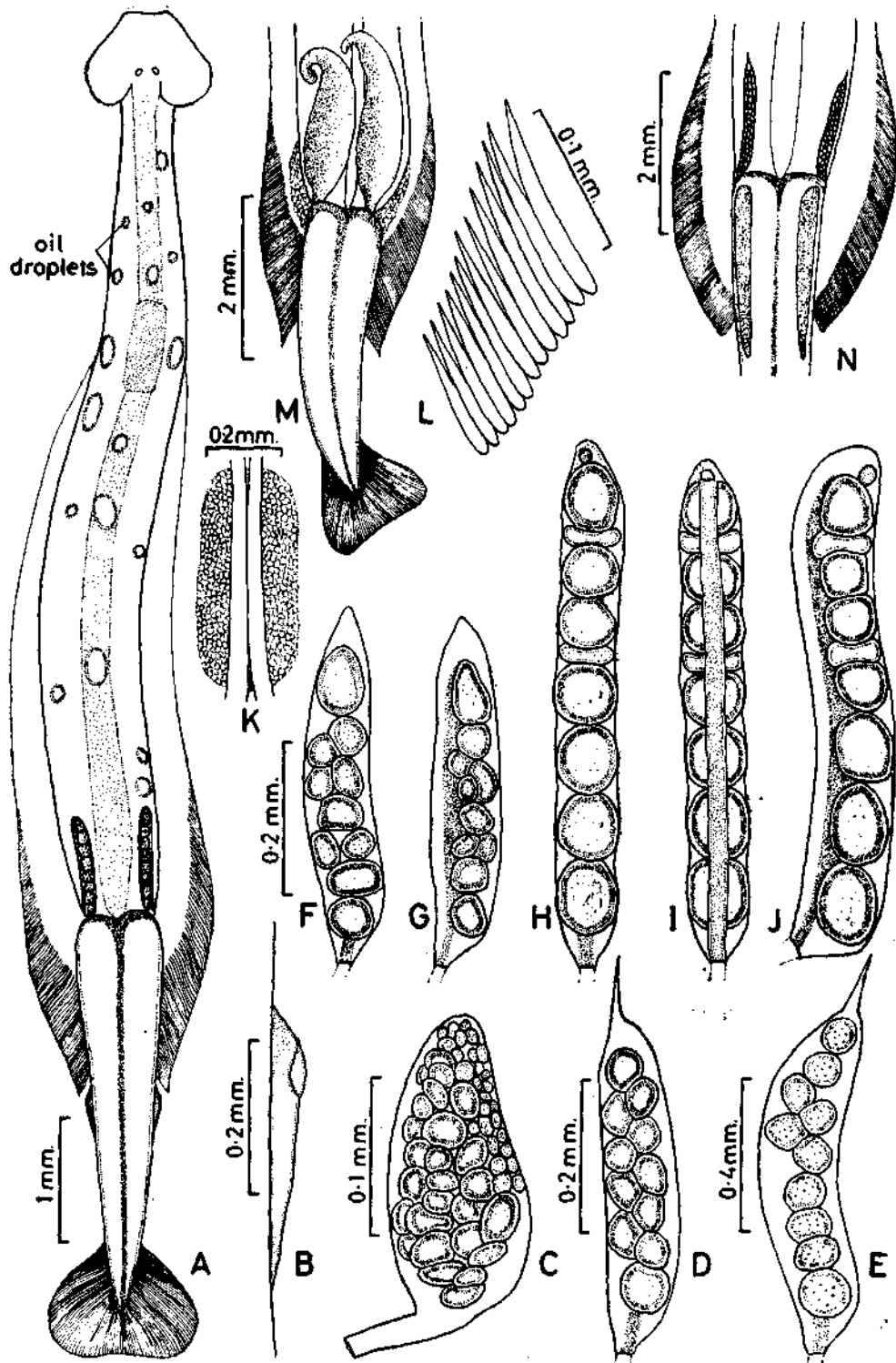


FIG. 1.—*E. minuta* sp. nov. A. Dorsal view; B. Seminal vesicles; C-J. Condition of ovaries during the stages of maturity—C. Dorsal view (stage-I); F & G. Laterointernal and dorsal-views (stage-II); D & E. Laterointernal views (stage-III); H, I & J. Laterointernal, latero-external and dorsal views (stage-IV); K. Ventral ganglion; L. Teeth; M. *E. bathypelagica* posterior part of body showing ovaries with curved tips. N. *E. hamata* showing developing testes and ovaries (stage-II).

**Diagnostic Characters of *E. minuta* sp. nov.**

Body slender, opaque and firm due to strong wavy (zigzagging) longitudinal muscles; tail segment robust with distinct constriction at tail septum; eyes minute, closely placed, without pigments and each with less than 20 ommatidia; jaw hooks 7 to 9 with tips almost straight and not curved or hooked; teeth 8 to 14; intestine pigmented and conspicuously broad, its width anteriorly (in pre-ganglion region) being distinctly more than 35% of width of body; ventral ganglion large, its length greater than width of body in ganglion region; intestine and body generally with numerous oil droplets of various sizes; collarette inconspicuous occurring as a thin layer at origin of tail fin and also on tail segment, but absent on other parts of body; ovaries short, straight, with tips never curled and mature ova arranged in single row; seminal vesicles inconspicuous, covered by thickening of epidermis and separated from origin of tail fin by wide gap.

*Description*: While describing the new species in detail, opportunity is also taken to draw attention to its affinities as well as differences from other species of the genus, especially *E. hamata* and *E. bathypelagica*, specimens of which we have examined for this purpose.

1. *Size*: The 708 specimens of *E. minuta* vary in total length (inclusive of tail fin) from 5.6 to 12.0 mm., some specimens over 9.5 mm. being fully mature (Stage-IV). That the new species is considerably smaller in size than its congeners can be seen from the data on sizes of other species given by various authors. Alvarino (1965) has given the size of *E. hamata*, *E. bathypelagica* and *E. fowleri* as 43 mm., 23 mm., and 40 mm. respectively. David (1958), has given the length of *E. bathyantartica* to be up to 31 mm. The maximum length for *E. proboscidea* described by Furnestin and Ducret (1965) is 25 mm. Our specimens of *E. hamata* and *E. bathypelagica* from the Southern Indian Ocean vary in total length from 10 to 23.2 mm. and 12.8 to 21.2 mm. respectively. In this case even the largest specimens of *E. hamata* are immature being in Stage-II of maturity, while the larger specimens of *E. bathypelagica* are fully mature. The specimens of *E. fowleri* from the west coast of India and the Laccadive sea vary in total length from 7.5 to 23 mm.

In this connection Colman's (1959) record of small specimens of *E. hamata* from tropical Atlantic, especially from the *ROSAURA* Expedition station 15 (1 specimen between Cuba and Jamaica); station 42 (7 specimens off NE Brazil); and station 46 (6 specimens south west of Dakar) are of considerable interest. Seven of these specimens are indicated by him to be in maturity stages I to V (Stage-V representing 'spent' specimen) as shown below:

Size range (mm)	Stage	No. of specimens
7.2	0	1
9.4-16.1	I	2
8.8-11.2	II	3
9.5	IV	1
13.3	V	1

When compared to the Arctic material of *E. hamata* (size range 19.5-34.0 mm. from off Greenland) and the temperate specimens (size range 10.7-25.2 mm. from

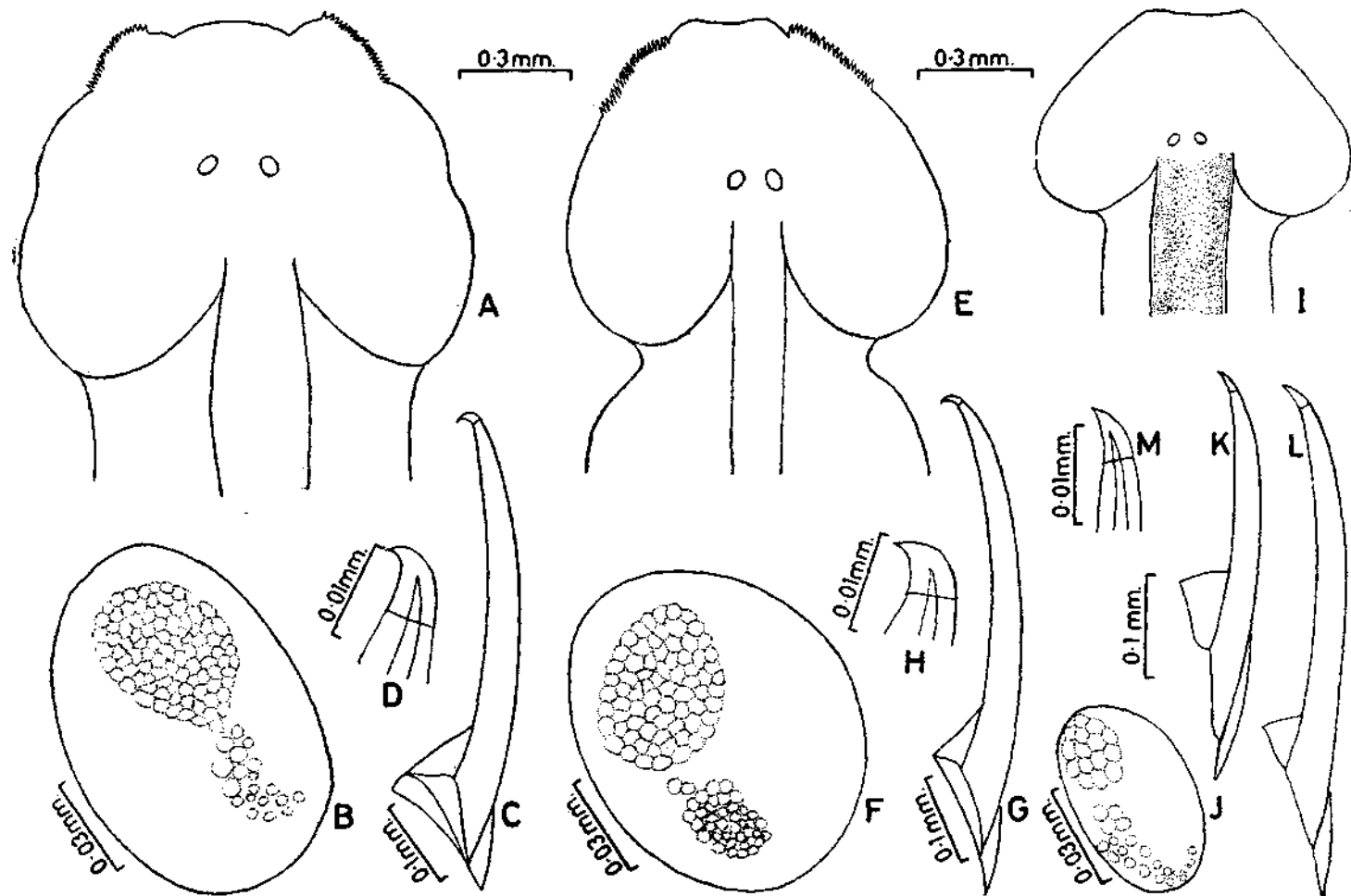


FIG. 2—*E. hamata* (A-D) A. Head; B. Right eye; C. Hook; D. Detail of point of hook. *E. bathypelagica* (E-H) E. Head; F. Right eye; G. Hook and H. Detail of point of hook. *E. minuta* sp. nov. (I-M) I. Head; J. Right eye; K. First hook; L. Typical hook and M. Detail of point of hook.

off C. Hatteras, eastern United States), the aforesaid tropical specimens are much smaller which led Colman to opine 'That tropical specimens were somewhat more contracted than the others, but never so much so as to make it possible that they were as large when alive.' Alvarino (1965, Table V) has also remarked that most of Colman's material had suffered severe shrinkage. Apparently Kramp's (1917) observation that sexual maturity in *E. hamata* may be reached when individuals are more than 30 mm. long (although he found specimens 37 mm. long are still immature), might have led towards considering the possibility of excessive shrinkage in tropical material of this species. However, we feel that the problem is far from solved, especially as one fully mature specimen (Stage-IV) of 9.5 mm. is reported by Colman. Reference may also be made to the 'Discussion' given at the end.

2. *The Body*: The body is slender, opaque and firm. The longitudinal muscles are strong and wavy (zigzagging). The transverse muscles occur as regular closely placed rings distinctly visible from the neck to the posterior end of the ventral ganglion. As the head is broad, the neck is conspicuous. The tail segment is characterised by a well defined constriction which is more marked than in *E. hamata*. Such a constriction is wanting in *E. bathypelagica* in which species the body is flabby due to the thin weak longitudinal muscles which also makes the body translucent. Thus in general body form the affinities of *E. minuta* are more to *E. hamata*.

3. *The Head*: The head is conspicuously wider than long, its width being 1.5 times or more its length. The latero-posterior corners of the head generally extend outwards to give the appearance of a broad triangle (Fig. 2, 1), and often the basal part appears to be at right angles to the neck. On account of this, the eyes come to occupy a position much behind the mid-length of the head. Papillae are present on top of the head as in other species of the genus. The neck appears to be fragile, as in many specimens the head is broken off (such specimens are not included in the Paratype series). A similar condition has also been reported for *E. fowleri*.

4. *The Tail Segment*: The constriction at the tail septum clearly demarcates the tail segment which when filled with sperm is robust and anteriorly bulges in the body as two lobes. The length of the tail segment (including tail fin) varies from 27.35% to 35.00% (Mean 29.4%) of total length. In our specimens of *E. hamata* and *E. bathypelagica* the tail segment varies between 22% to 24.2% and 26.4% to 31.3% of the total length respectively (Fig. 1: A and Tables I & II). The proportions given above fall well within the known range of this character as given by Alvarino (1967) for the two species. According to her, the tail segment of *E. hamata* varies between 19 and 24 per cent, while it is 25.8 to 34 per cent in *E. bathypelagica*. In *E. bathyantartica* it is 19.3 to 25 per cent (David, 1958). The range of 20 to 35 per cent given for *E. hamata* by Colman (1959) is another indication that his material was probably not homogenous.

In smaller specimens of the new species 5 to 7 mm. in total length the tail segment is relatively longer. Although specimens of *E. bathypelagica* of comparable size are not available for drawing comparisons, it may be noted that in the length of the tail segment the new species is more akin to it than to *E. hamata* or *E. bathyantartica*.

TABLE I

Per cent of tail segment in total length in three species of *Eukrohnia* from the Indian Ocean

T.L. (mm)	<i>E. minuta</i> sp. nov.		<i>E. hamata</i>			<i>E. bathypelagica</i>			No. of specimens
	Tail segment		No. of specimens	Tail segment		No. of specimens	Tail segment		
	Range	Mean		Range	Mean		Range	Mean	
5	32.14-34.48	33.31	2	..	..	..	..	..	..
6	30.88-35.00	33.33	3	..	..	..	..	..	..
7	29.73-30.55	30.20	4	..	..	..	..	..	..
8	28.57-31.25	29.55	14	..	..	..	..	..	..
9	27.35-30.61	28.94	33	..	..	..	..	..	..
10	27.50-30.77	29.19	38	24.0	24.0	1	..	..	..
11	28.00-30.50	29.37	5	23.2-24.2	23.7	2	..	..	..
12	29.16	29.16	1	23.2-24.1	23.7	3	31.3	31.3	1
13	..	..	..	23.1-24.2	23.8	8	30.2-30.8	30.5	2
14	..	..	..	23.6-24.0	23.8	2	29.2	29.2	2
15	..	..	..	22.0-22.8	22.4	3	29.0-30.8	29.8	6
16	..	..	..	22.9-23.9	23.3	6	29.8-30.9	30.1	13
17	..	..	..	22.7-23.5	23.0	3	27.3-30.0	28.6	8
18	..	..	..	22.0-23.3	22.8	7	27.9-31.1	29.4	5
19	..	..	..	22.9-23.4	23.2	3	28.6	28.6	1
20	..	..	..	22.0-22.4	22.2	2	27.5-28.0	27.8	2
21	..	..	..	22.2-23.3	22.7	6	26.4	26.4	1
22	..	..	..	22.2-22.7	22.5	3	..	..	..
23	..	..	..	22.4	22.4	1	..	..	..

TABLE II

Percentage of tail segment in total length in three species of *Eukrohnia* from the Indian Ocean

Species	Percentage														
	22.0	23.0	24.0	25.0	26.0	27.0	28.0	29.0	30.0	31.0	32.0	33.0	34.0	35.0	
No.	..	..	..	..	..	14	20	34	26	1	1	..	2	1	
<i>E. minuta</i> %	..	..	..	..	..	14.0	20.0	34.0	26.0	1.0	1.0	..	2.0	1.0	
No.	23	20	7	..	..	..	..	..	..	..	..	..	..	..	
<i>E. hamata</i> %	46.0	40.0	14.0	..	..	..	..	..	..	..	..	..	..	..	
No.	..	..	..	..	1	3	8	11	16	2	..	..	..	..	
<i>E. bathypelagica</i> %	..	..	..	..	2.4	7.3	19.5	26.8	39.0	4.9	..	..	..	..	



Some confusion in the identity of the species of *Eukrohnia* in the Indian Ocean is bound to arise on account of the work of Burfield and Harvey (1926) who have unfortunately not given a proper description of *E. hamata*. We agree with Alvarino (1962) that *E. hamata* of these authors involves more than one species, one of which is most probably what we now consider as *E. bathypelagica*. The proportion of the tail segment given by them for some of the specimens agree with this species. In view of this, the data relating to *E. hamata* given by Burfield and Harvey cannot be relied on for drawing comparisons with the new species. In the same category we also place Fowler's (1906) description of *Krohnia hamata*. He has indicated the percentage of tail length as 22 to 34 per cent, this being most unusual for *E. hamata*.

5. *The Jaw Hooks*: The jaw hooks number 7 to 9, each ending in an almost straight tip (Fig. 2 : L, M). In this character, the new species differs markedly from both *E. hamata* and *E. bathypelagica*. In the latter two species the tips of the hooks are curved or 'hooked' and set almost perpendicular to the shaft (Fig. 2 : C, D, G, H). Such 'hooked' tips are present even in smaller specimens of *E. hamata* and *E. bathypelagica* measuring 10.00 mm. and 12.8 mm. respectively, which indeed are comparable sizes with *E. minuta* in the collection.

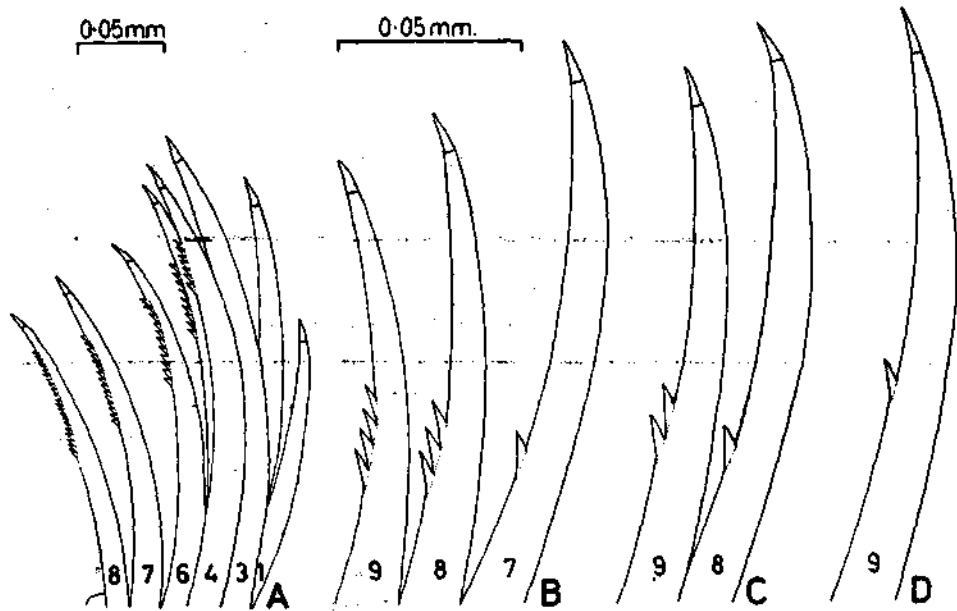


FIG. 3—*E. minuta* sp. nov. Variation in the number of serrated hooks and serrations in specimens; A. 5.6 mm. with 5 serrated hooks; B. 8.6 mm. with 3 serrated hooks; C. 10.8 mm. with 2 serrated hooks and D. 11.6 mm. with 1 serrated hook. Number of the hook is indicated on the hook.

The number of jaw hooks in these three species show considerable overlap (Table III), but they differ from *E. bathyantartica* which has a larger number of hooks (11-14). From Table IV, it will be seen that the modal count of jaw hooks in *E. minuta* and *E. hamata*, the latter from the Southern Indian Ocean differ, being 9 and 8 respectively.

TABLE III

Number of jaw hooks in relation to total length in three species of the genus *Eukrohnia*

T.L. (mm)	<i>E. minuta</i> sp.nov.			<i>E. hamata</i>			<i>E. bathypelagica</i>		
	Jaw Hooks		No. of specimens	Jaw Hooks		No. of specimens	Jaw hooks		No. of specimens
	Range	Mean		Range	Mean		Range	Mean	
5	8-9	8.00	2	..	..	..	..	..	..
6	8-9	8.33	3	..	..	..	..	..	..
7	8-9	8.25	4	..	..	..	..	..	..
8	8-9	8.57	14	..	..	..	..	..	..
9	7-9	8.42	33	..	..	..	..	..	..
10	8-9	8.64	37	8	8	1	..	..	..
11	8-9	8.80	5	8	8	2	..	..	..
12	9	9.00	1	7-8	7.66	3	8	8.00	1
13	..	..	..	8-9	8.30	8	8	8.00	2
14	..	..	..	8-9	8.50	2	7-9	8.00	2
15	..	..	..	8-9	8.33	3	7-9	8.00	6
16	..	..	..	8-9	8.16	6	7-10	8.30	13
17	..	..	..	8-9	8.33	3	8-10	9.00	8
18	..	..	..	8-9	8.57	7	8-9	8.20	5
19	..	..	..	8-9	8.33	3	9	9.00	1
20	..	..	..	9	9.00	2	9-10	9.50	2
21	..	..	..	8-9	8.33	6	10	10.00	1
22	..	..	..	9	9.00	3	..	..	..
23	..	..	..	8	8.00	1	..	..	..

TABLE IV

Frequency of occurrence of jaw hooks in three species of *Eukrohnia* from the Indian Ocean

Name of species		No. of jaw hooks				No. of specimens
		7	8	9	10	
<i>E. minuta</i> sp.nov.	No.	3	40	56	..	99
	%	3.0	40.4	56.6	..	
			(Mean=8.5 hooks)			
<i>E. hamata</i>	No.	1	31	18	..	50
	%	2.0	62.0	36.0	..	
			(Mean=8.3 hooks)			
<i>E. bathypelagica</i>	No.	6	17	13	5	41
	%	14.6	41.5	31.7	12.2	
			(Mean=8.6 hooks)			

We have earlier commented on Colman's (1959) material of *E. hamata* from the Atlantic. The variations in the jaw hooks he has given for this species is 7 to 10 with the modal count of 9. Alvarino (1962) has given the modal count of hooks to be 9 for the type series of *E. bathypelagica*. It is known that jaw hook counts may vary with age and in Table III the variability seen in *E. minuta* is indicated.

For 28 specimens of *Krohnia hamata* of the SIBOGA material in the size range 8.0 to 26 mm., Fowler (1906) has given the jaw hook counts as 8 to 13. As far as is known, higher counts of 11 to 13 are not met with in *E. hamata*. It will be desirable if the SIBOGA material of *E. hamata* could be re-examined.

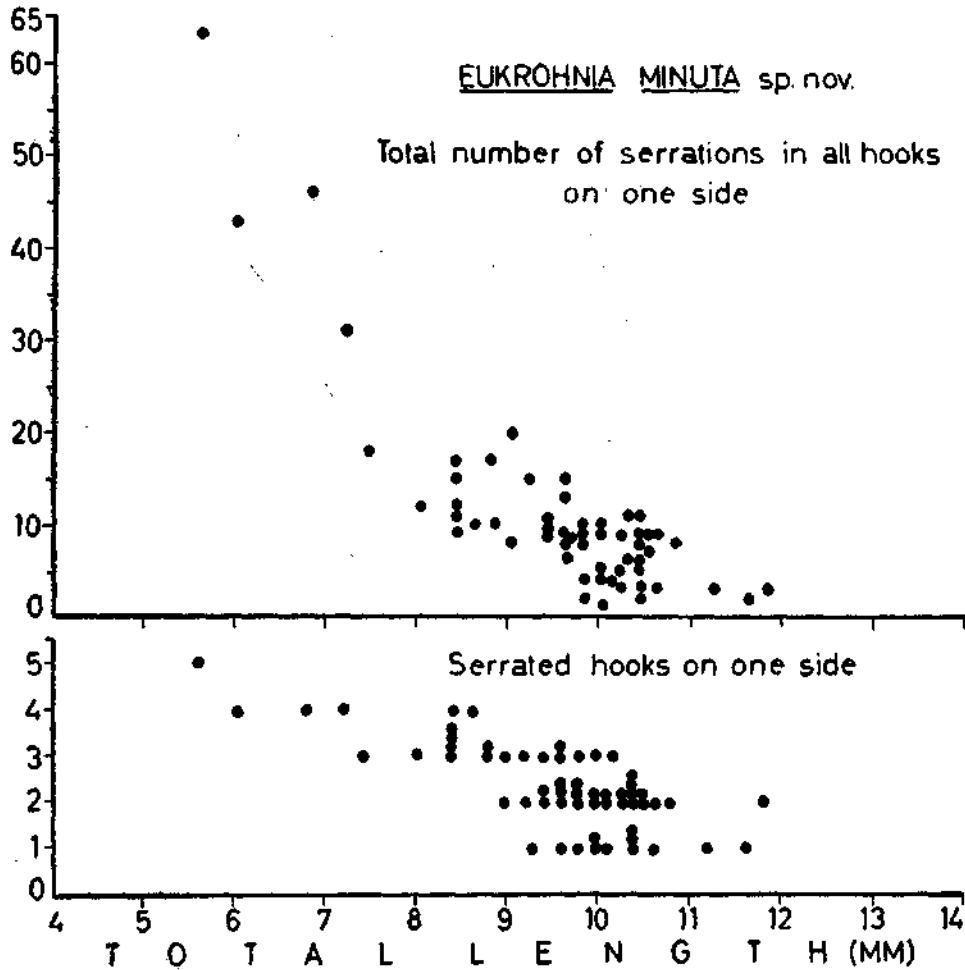


FIG. 4—*E. minuta* sp. nov. Frequency of occurrence of serrated hooks and reduction in number of serrations seen during growth.

The number of serrated hooks and the number of serrations on these hooks in *E. minuta* vary according to age. As the animal grows a decrease is seen in their numbers and this will be clear from Table VII and Figs. 3: A-D, and 4. In fully

mature specimens of *E. minuta* one or two serrated hooks may be seen, usually each with one to three serrations. Serrated hooks in matured specimens of *E. fowleri* has been reported by Furnestin (1965).

6. *The Teeth*: The teeth are arranged in one set (Fig. 1 : L) on either side as in the genus and vary from 8 to 14 (Tables V and VI). In our specimens of *E. hamata* the teeth in each set varies from 8 to 25 and in *E. bathypelagica* from 14 to 24. Alvarino (1967) has given the maximum teeth count in each set in these two species as '... up to 23 to 25' and '17 to 22' respectively. In *E. bathyantartica* a maximum count of 16 teeth in one specimen 26 mm. in length has been recorded by David (1958). While drawing attention to these meristic differences between the new species and its congeners, we are aware that variability in number of jaw hooks and teeth need not necessarily be interspecific, as these can be brought about by age, biological competition and ecological variables. Nevertheless, such meristic variabilities when present in conjunction with reliable morphological differences merit consideration. The data on teeth and jaw hooks given here which shows the new species to differ in modal counts in one or the other characters from *E. hamata* and *E. bathypelagica* cannot be ignored.

It may be seen from Table V that the maximum teeth count of 14 is seen in specimens between 8 and 12 mm., while this number is seen in specimens of *E. hamata* 15 mm. or longer in total length. Alvarino (1962) has given the teeth count of a 12 mm. specimen of *E. bathypelagica* to be 17, while for this size in our material we have recorded a count of 16.

7. *The Corona Ciliata*: The shape is not known.

TABLE V

Table showing increase in teeth number with size increase in three species of Eukrohnia from the Indian Ocean

T.L. (mm)	<i>E. minuta</i> sp. nov.			<i>E. hamata</i>			<i>E. bathypelagica</i>		
	Range	Mean	No.	Range	Mean	No.	Range	Mean	No.
5	8	8.00	2	..	..	..	..	..	..
6	8-9	8.66	3	..	..	..	..	..	..
7	8-11	9.25	4	..	..	..	..	..	..
8	8-14	10.85	14	..	..	..	..	..	..
9	9-14	11.63	33	..	..	..	..	..	..
10	9-14	12.00	37	10	10.00	1	..	..	..
11	11-14	12.20	5	8-9	8.50	2	..	..	..
12	13	13.00	1	8-10	9.30	3	16	16.00	1
13	..	..	..	10-12	11.50	8	15	15.00	2
14	..	..	..	10-13	11.50	2	17	17.00	2
15	..	..	..	13-15	13.66	3	17-20	17.50	6
16	..	..	..	12-18	14.66	6	14-20	16.92	13
17	..	..	..	16-17	16.66	3	14-24	17.30	8
18	..	..	..	18-22	19.57	7	14-21	17.40	5
19	..	..	..	20	20.00	1	22	22.00	1
20	..	..	..	20-22	21.00	2	17-20	18.50	2
21	..	..	..	21-25	22.50	6	22	22.00	1
22	..	..	..	21-24	22.33	3	..	..	..
23	..	..	..	25	25.00	1	..	..	..

8. *The Eyes*: Several of the earlier workers have not utilised the eye characteristics in specific determination of species of *Eukrohnia*, but its usefulness has been recently stressed by Alvarino (1962, 1967). In the new species, the eyes are minute, unpigmented, almost ellipsoidal with its length more than 1.5 times its width. In the anterior inner side of each eye, a closely packed cluster of large more or less hexagonal convex ommatidia numbering about 20 are present. This is separated from an inferior smaller batch of 3 to 5 similar ommatidia, behind which are sparsely arranged in an arc of two or three irregular rows about 15 to 20 ommatidia-like features (Fig. 2: J). In the structure of the eye the new species differs markedly from *E. hamata*, and *E. bathypelagica*.

TABLE VI

Frequency of occurrence of number of teeth in three species of the genus *Eukrohnia* from the Indian Ocean

Species	Number of teeth in each set																		
	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	
<i>E. m.</i>	No.	5	11	7	28	20	18	10	..	..	..	..	..	..	..	..	..	..	
	%	5	11.1	7	28.4	20.2	18.2	10.1	..	..	..	..	..	..	..	..	..	..	
(Mean=10.7 teeth)																			
<i>E. h.</i>	No.	2	1	5	3	5	4	1	1	3	2	3	2	5	3	6	1	1	2
	%	4	2	10	6	10	8	2	2	6	4	6	4	10	6	12	2	2	4
(Mean=15.9 teeth)																			
<i>E. b.</i>	No.	..	..	..	..	..	..	5	8	3	7	5	5	3	2	2	..	1	..
	%	..	..	..	..	..	..	12.2	19.5	7.3	17.1	12.2	12.2	7.3	4.9	4.9	..	2.4	..
(Mean=18 teeth)																			

*E. m.*=*E. minuta* sp.nov.; *E. h.*=*E. hamata*; and *E. b.*=*E. bathypelagica*

In our material of *E. hamata* (Fig. 2: B), the eyes are oval in shape with a 'morula-shaped' cluster of 80 to 100 ommatidia, with the inferior part of the eye having 3 or 4 rows of ommatidia like features of different sizes. The length of the eye is less than 1.5 times its width, which character is also shared by *E. bathypelagica*. However, in the latter species, the anterior cluster of hexagonal convex ommatidia number over hundred. In addition, a compactly arranged inferior patch of ommatidia-like features is present in five or six rows (Fig. 2: F).

The number of the ommatidia and the ommatidia-like features of the eye in the new species shows hardly any variations with age. Similarly, in *E. hamata* and *E. bathypelagica* also, the eye in the smallest and largest specimens show hardly any difference in the number and disposition of the ommatidia and ommatidia-

like features. This leads us to confirm Alvarino's (1962) opinion that the structure of the eye is a reliable character in species differentiation in the genus *Eukrohnia*.

9. *The Intestine* : The intestine lacks a diverticulum and is pigmented. It is markedly broad and between the head and the ventral ganglion its width is nearly 40% of the width of the body (Fig. 2 : I). In *E. hamata* the intestine is moderately broad, but is hardly 30% of the width of the body (Fig. 2 : A). In *E. bathypelagica* the intestine is narrow, almost thread-like, its width behind the head being hardly 20% of the width of the body (Fig. 2-E). In this species the intestine is also unpigmented.

One of the conspicuous features of the new species is the presence of numerous oil droplets of olive green colour and of varying sizes in the intestine and the body (excluding the tail segment) (Plate I, Fig. A). In this, the new species shows affinities to *E. hamata*. Among the remaining species of the genus, oil droplets in the intestine have been reported in *E. bathypelagica* and *E. proboscidea*. In our material of *E. bathypelagica* there are specimens completely devoid of oil droplets in the intestine, while the others have only one or two droplets.

10. *The Ventral Ganglion* : In *E. minuta* this is large and more than twice as long as broad (Fig. 1 : K). The length of the ventral ganglion is greater than the width of the body in the ganglion region. It has not been possible to trace the course of the sympathetic nerve cords posterior to the ventral ganglion.

11. *The Lateral Fins* : The lateral fins commence opposite to the posterior third of the ventral ganglion and extend backwards to about the anterior one-third of the tail segment. They are broadest opposite the tail septum. The fins are diaphanous, very delicate and are damaged or lost in preserved specimens. The posterior rayed portion of the fin is very fine and delicate, with the rays not closely arranged. In some specimens the rayed portion which may be folded inwards is found to extend upto a point midway between the posterior end of the ventral ganglion and the tail septum. The posterior tips of the fins are free from the tail segment. The rayless parts of the fins are wrinkled (Plate I, Fig. C) giving this portion of the fin a reticulate appearance.

In *E. bathypelagica* the rayed portion of the laminar area of the lateral fins and the rays in the posterior part of the fins are more developed than in *E. minuta* (Plate I, Fig. F). The rays are long and tend to fold dorsally in preserved specimens, and are also liable to be easily damaged. However, in *E. hamata* the rayless portion extends to almost the posterior end of the fin and the rays of the fin are relatively short, but very well developed and not easily lost in preservation. The lateral fins in the new species are more like in *E. bathypelagica*.

12. *The Collarette* : The collarette is present as a thin layer on tail segment and in a small patch on either side at the origin of the tail fin on the rays (Plate I, Fig. B). This can be made out only under careful scrutiny. In this character the new species is akin to *E. hamata*. In specimens of *E. hamata* from the Indian Ocean, the collarette is present as distinct patches at the origin of the tail fin on the tail segment (Plate I, Fig. D, E) and extend on to part of the fin. In *E. bathypelagica* the collarette is present as a thin layer extending from behind the ventral ganglion to the anterior part of the tail segment, and also present near the tip of the tail segment on the tail fin. In *E. bathyantartica* the collarette is absent. The Collarette in *E. fowleri* is very characteristic as it occurs as a distinct covering round the region

of the ventral ganglion and extends backwards as a thin layer on to the tail segment where it thickens again behind the seminal vesicles. It is also present on the tail fin.

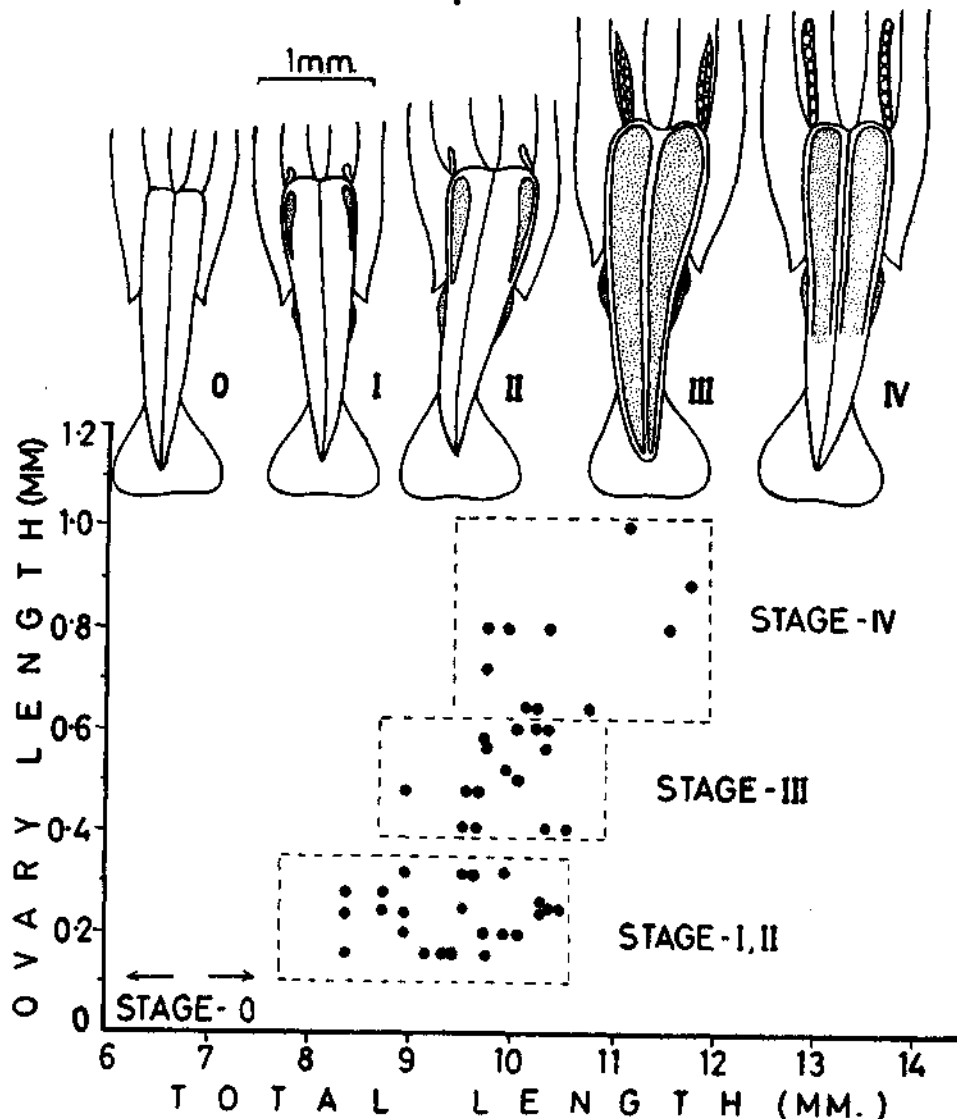


FIG. 5—*E. minuta* sp. nov. showing stages of maturity. Considerable overlap in total length of the different stages may be noted.

13. *Female Gonads*: The specimens of *E. minuta* in the collection were in different stages of maturity from Stage 0 to Stage-IV, as shown in Tables VII and VIII, and Fig. 1: C-J & Fig. 5. The shape and size of the ovary during the different stages of maturity are very characteristic for the species. In Stage-IV, the ovaries are short, less than 10% of total length or less than 14% of trunk length. At no stage of development they are curled even at the distal end, nor do the ovaries

TABLE VII

Changes in some body characters seen in different sizes of immature and mature specimens of *E. minuta* sp. nov.

T.L. (mm)	Total No. of jaw hooks	No. of serrated hooks	No. of serrations in each hook	Total No. of serrations	Length of ovary (mm) and (% of ovary length in T.L.)	Remarks
5.6	8	5	21, 15, 11, 9, 7	63	Ovary not developed	Stage-0
6.0	8	4	19, 12, 7, 5	43	-Do-	-Do-
6.8	9	4	17, 13, 10, 6	46	-Do-	-Do-
7.2	8	4	16, 8, 5, 2	31	-Do-	-Do-
7.4	8	3	9, 6, 3	18	-Do-	-Do-
8.0	8	3	7, 3, 2	12	-Do-	-Do-
8.4	8	3	4, 3, 2	9	0.28 mm (3.3 %)	Ovary 'bean-shaped', short, with numerous ovulae irregularly arranged. Stage-I.
8.8	8	3	7, 6, 4	17	0.24 mm (2.7 %)	-Do-
9.0	9	3	10, 6, 4	20	0.32 mm (3.5 %)	-Do-
9.2	9	2	6, 4	10	0.16 mm (1.72 %)	-Do-
9.4	8	3	5, 3, 2	10	0.16 mm (1.66 %)	-Do-
9.6	9	1	6	6	0.40 mm (4.16 %)	Ovary short batch of larger ovulae differentiating. Stage-II.
9.8	9	2	2, 2	4	0.58 mm (5.9 %)	-Do-
10.0	9	1	4	4	0.52 mm (5.2 %)	Eleven ovulae arranged alternating each other in almost two rows. Stage-III.
10.2	9	1	3	3	0.64 mm (6.27 %)	Ovulae 8, large in single row. Stage-IV.
10.4	8	2	5, 1	6	0.80 mm (7.7 %)	Ovulae 8, large in single row. Stage-IV.
10.8	9	2	2, 1	3	0.64 mm (5.9 %)	-Do-
11.2	8	1	3	3	1.04 mm (9.28 %)	Longest ovary in collection, with 8 large ovulae, the largest having the dimensions : length 0.012 mm, width 0.016 mm. Stage-IV.
11.6	9	1	1	1	0.80 mm (7.0 %)	Ovulae large, 10 arranged in single row. Stage-IV.
11.8	9	2	2, 1	3	0.88 mm (7.4 %)	-Do-



of either side cross or overlap each other. The ovulae in Stage-IV are uniserially arranged and is not found to number more than 11 in each ovary. The oviducts open dorso-laterally.

In *E. bathypelagica* on the other hand the ovaries are coiled in the maturing stages, with the coiling remaining towards the tip of the ovary with progressive maturity (Fig. 1 : M). Fully mature ovaries are long and bluntly rounded at the tip, and contain numerous ovulae arranged in two rows and, the ovaries measuring about 50% of trunk length. In *E. hamata* the ovaries are straight and cylindrical with mature ovaries reaching about 50% of trunk length. The ovulae are small,

TABLE VIII  
Maturity stages in *E. minuta* sp. nov.

Stages of Maturity	Male organ	Female organ	Text-figure reference
0	Testes not developed	Ovaries not developed	Fig. 5
I	Testes beginning to appear as thin tubes along sides of body wall in anterior part of tail segment, enlarging slightly at anterolateral corners of segment. Seminal vesicles make their appearance as thickening of epidermis just behind lateral fins, but widely separated from origin of tail fin.	Ovaries are very short, (length hardly one fifth of width of body at tail septum), and bean-shaped. Ovulae small of variable sizes and irregularly arranged in several rows.	Figs. 1: C & 5
II	Testes slightly more developed, extending backwards to almost level of seminal vesicles; latter incipient appearing as slightly more elongate and elevated thickening of epidermis easily detectable as a darker patch which is again widely separated from origin of tail fin.	Ovaries short and straight, (length between one-third to one fourth width of body at tail septum); larger ovulae arranged in two or three irregular rows.	Figs. 1: F, G & 5
III	Tail segment filled with sperms; seminal vesicles full and open anterolaterally and discharging. Seminal vesicles widely removed from origin of tail fin.	Ovaries short, straight, with tip drawn into a point; length of ovaries equal or slightly greater than width of body at tail septum; ovulae large, those in centre of ovaries arranged in almost two rows, while ovulae in anterior and posterior parts of ovaries are in single row.	Figs. 1: B, D, E & 5
IV	Tail segment partly or fully discharged; region of seminal vesicles covered by thickened epidermis.	Ovaries short, straight with round tip; length of ovaries not exceeding twice width of body at tailseptum, and less than 10 per cent of total length; Ovulae large, less than 12 in each ovary and arranged in single row.	Figs. 1: H, I, J & 5

numerous and arranged in four rows in each ovary. The condition of a specimen in Stage-II of maturity is shown in Fig. 1 : N. In *E. bathyantartica* the ovaries are said to be short and the ovulae arranged in two rows (David, 1958, Alvarino, 1967). In *E. proboscidea* the ovaries which are about 15% of the total length in Stage-III, have about 14 ovulae each arranged in two rows. The ovaries of *E. fowleri* are very short with few large ovulae in two rows. Thus in the new species it would be seen that the length of the ovaries and the arrangement of the ovulae are quite different than in its congeners.

14. *Male Gonads* : As compared to *E. bathypelagica* and *E. fowleri*, the seminal vesicles are inconspicuous and are as in *E. hamata*. Their early appearance is as a slight thickening of the epidermis behind the posterior end of the lateral fin, but far removed from the origin of the tail fin. Details regarding the stages of maturity and the development of the male gonads are given in Table VIII. We have found some difficulty in determining stages I and II, but when considered along with changes in the female gonads, the differences become clear.

#### KEY FOR THE IDENTIFICATION OF SPECIES OF THE GENUS *Eukrohnia*

In the light of the present studies it is possible to draw up a Key for the identification of the known species of the genus *Eukrohnia* which is given below :

- |  |   |   |
|--|---|---|
| 1. Eyes pigmented .. .. .  | 3 |   |
| 2. Eyes without pigment .. .. .  | 5 |   |
| 3. Head conical with papillae on anterior part of head protruding to form 'snout' ; collarette absent on trunk ; oil droplets present in intestine ; tips of jaw hooks curved .. .. .  |   | <i>E. proboscidea</i> Furnestini and Ducret |
| 4. Head anteriorly truncate with papillae on head not protruding to form 'snout' ; collarette present as conspicuous band surrounding body in region of ventral ganglion and extends backwards as thin layer on to tail segment, thickening behind seminal vesicles ; oil droplets in intestine or body absent ; tips of jaw hooks almost straight .. .. . |   | <i>E. fowleri</i> Ritter-Zahony             |
| 5. Collarette absent ; jaw hooks 11 or more (11-14) .. .. .  |   | <i>E. bathyantartica</i> David              |
| 6. Collarette present ; jaw hooks less than 11 (7-10) .. .. .  | 7 |   |
| 7. Tail segment less than 25% (19-25%) of total length including tail fin ; ovulae in Stage IV ovaries small and in four rows .. .. .  |   | <i>E. hamata</i> (Mobius)                   |
| 8. Tail segment 25% or more (25-35%) of total length including tail fin ; Ovulae in Stage IV ovaries moderately large and arranged in one or two rows .. .. .  | 9 |   |
| 9. Ovaries short, hardly 10% of total length ; ovulae in Stage IV arranged in single row ; maturing ovaries cylindrical and straight ; eyes with less than 20 ommatidia ; tips of jaw hooks almost straight ; teeth 8-14 .. .. .   |   | <i>E. minuta</i> sp. nov                    |
| 10. Ovaries long, 30% or more in total length ; ovulae in Stage-IV arranged in two rows ; maturing ovaries coiled, especially towards tip ; eyes with about 100 ommatidia ; tips of jaw hooks curved at almost right angles to shaft ; teeth 14-24 .. .. .   |   | <i>E. bathypelagica</i> Alvarino            |

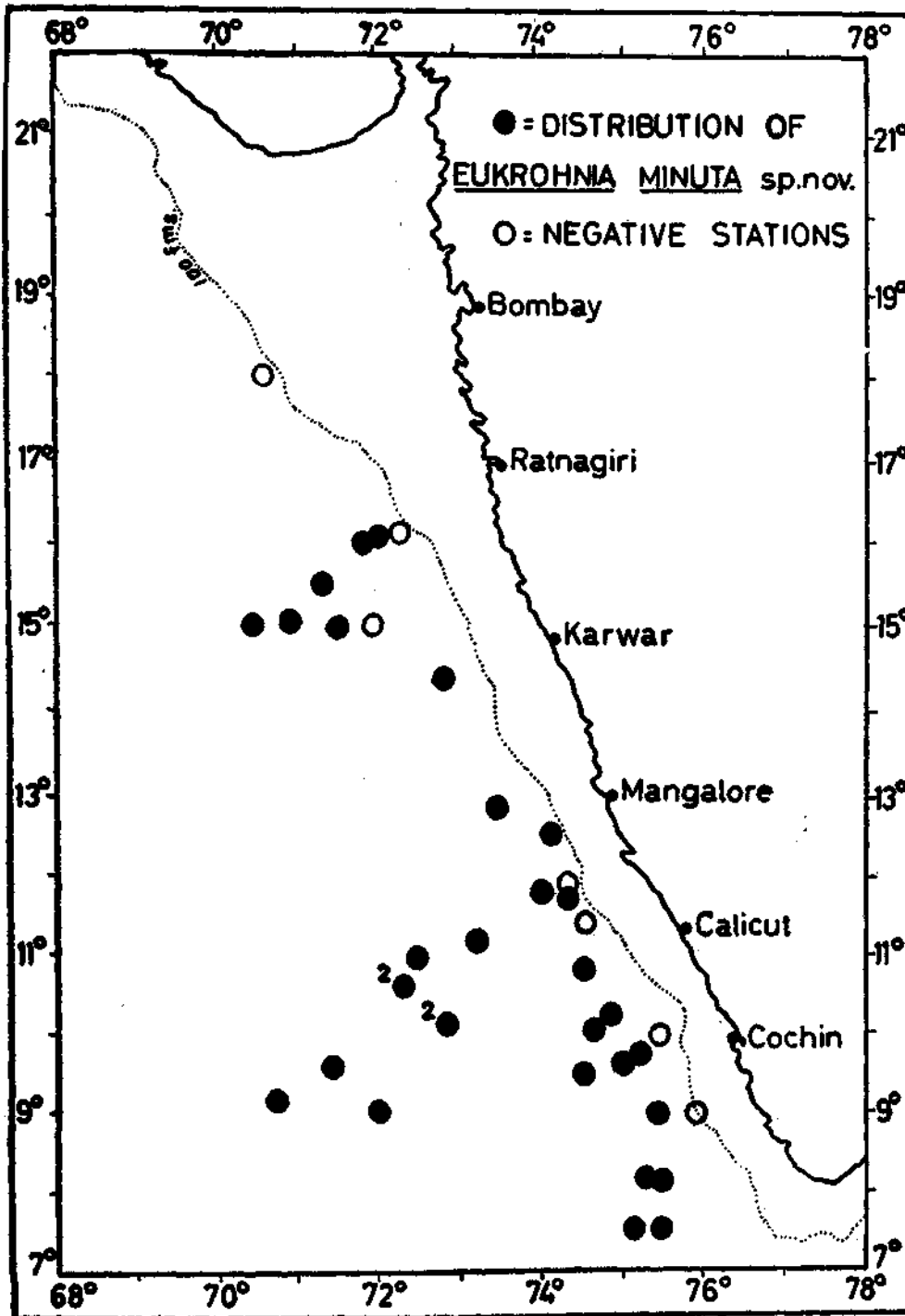


FIG. 6—*E. minuta* sp. nov. Map showing occurrence in deep water plankton hauls taken with Indian Ocean standard net.

## NOTES ON THREE SPECIES OF CHAETOGNATHA

Brief descriptions and notes on the three species recorded here for the first time from Indian Seas are given below :

***Eukrohnia fowleri* Ritter-Zahony, 1909**

(Text-fig. 7 : G-K)

## Synonyms :

*Eukrohnia richardi* Burfield and Harvey (1926).

*Eukrohnia hamata* (partim) Thomson (1947).

For detailed list of references relating to records of this species from the various oceans reference is invited to Alvarino (1967).

*Records from Indian Ocean :*

Burfield and Harvey (1926) recorded this species from the Chagos Archipelago, Amirante and Seychelles as *E. richardi*. Alvarino (1964 c, d) reported *E. fowleri* from south of Java.

*Material :*

552 specimens were obtained from 27 deep-water stations during cruises of R. V. VARUNA as shown in Table XII.

*Description :* (Fig. 7 : G-K).

Total length including tail fin varies from 7.5 to 23.0 mm. Body long, stout and firm due to strong longitudinal muscles ; colour orange ; head is larger than body and consequently neck is well defined ; length of tail segment varies between 22.22 to 27.77 (mean 25.4) per cent of total length ; eyes conspicuous, oval, with small pigment fleck towards one side surrounded by numerous ommatidia in many rows ; jaw hooks vary from 10 to 13 and are long with straight tips and are orange coloured ; teeth vary in each set from 16 to 25 and are long, slender and compactly arranged ; collarette is very characteristic, being present as a band surrounding region of ventral ganglion and spread backwards on body and on to tail segment as a thin layer thickening around tail septum and at origin of tail fin ; intestine pigmented and wanting in diverticulum ; lateral fins extend from about one-third distance from anterior end of ventral ganglion to seminal vesicle ; fins rayless anteriorly, rayless portion extending to slightly behind tail septum ; seminal vesicles situated close to posterior end of lateral fins and separated from tail fin origin by a small gap ; ovaries are short and stumpy ; ovulae spherical and arranged biserially in specimens in Stage IV of maturity ; major part of ovary filled with fat ; remnants of brood sac attached to opening of oviduct present in specimens with spent ovaries (Fig. 7-K).

*Remarks :*

*Eukrohnia fowleri* is a bathyplanktonic species recorded from the Atlantic and Pacific Oceans from the Arctic to the Antarctic and from some oceanic areas in the Indian Ocean.

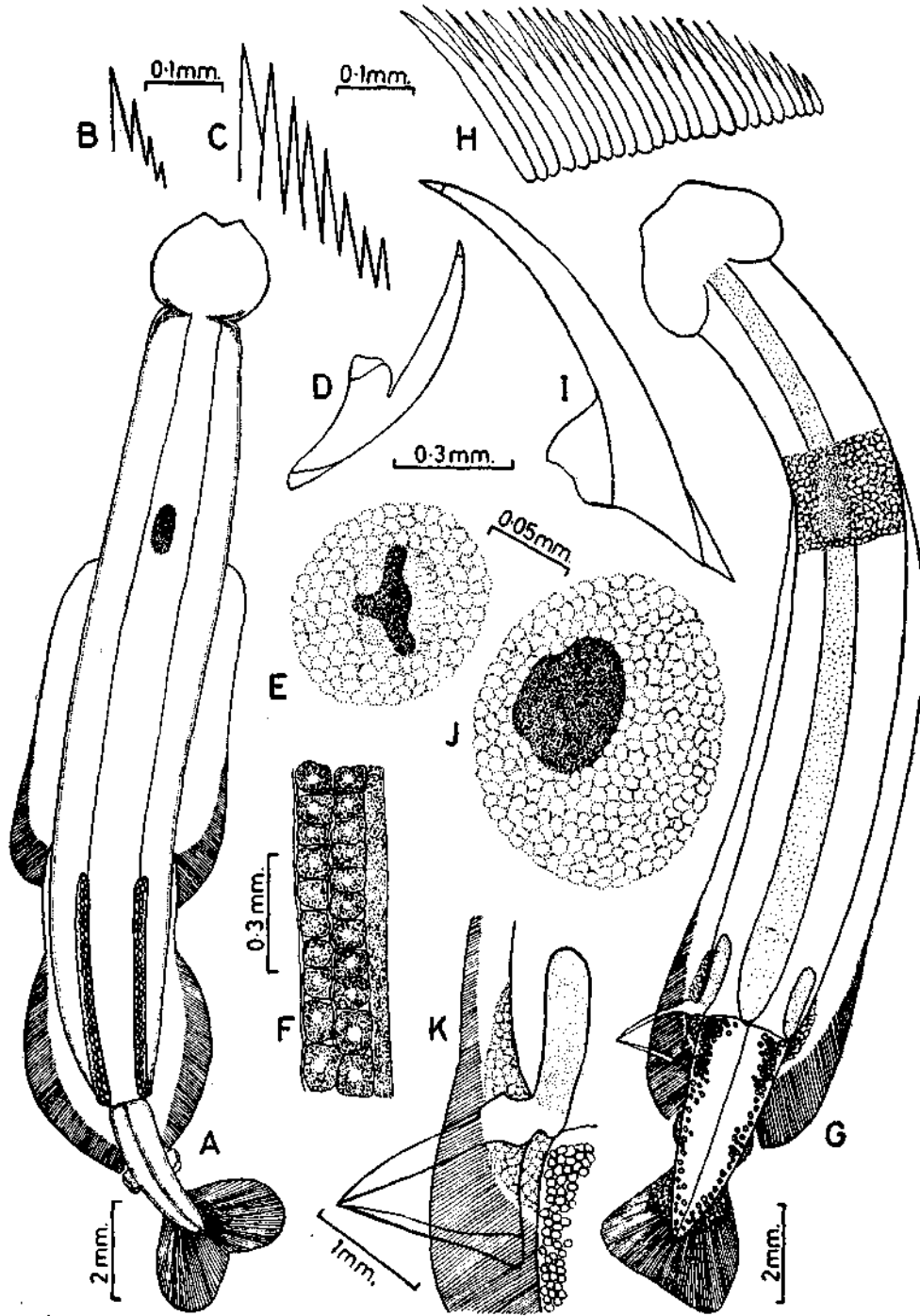


FIG. 7.—*S. lyra* (A-F) A. Dorsal view; B. Anterior teeth; C. Posterior teeth; D. Hook; E. Detail of eye; F. Dorsal view of part of ovary showing arrangement of ovulae, 2 out of 4 rows being visible. *E. fowleri* (G-K) G. Dorsal view; H. Teeth; I. Hook; J. Detail of eye and K. Tail septum region showing the spent ovary and brood sac.

TABLE IX

*Measurements in Eukrohnia fowleri in selected specimens of different sizes to show changes with growth*

No.	Total length (mm.)	Tail length (mm.)	Per cent of tail length in T.L.	Hooks	Teeth
1.	7.50	1.75	23.33	11	18
2.	11.25	2.50	22.22	11	16
3.	11.50	2.70	23.47	12	21
4.	12.00	2.80	23.33	11	18
5.	12.50	3.00	24.00	11	18
6.	13.50	3.30	24.44	11	20
7.	14.75	3.60	24.40	11	18
8.	15.00	3.75	25.00	11	20
9.	15.50	3.90	25.16	11	20
10.	15.75	3.90	24.76	11	21
11.	16.00	4.00	25.00	12	23
12.	16.20	4.10	25.30	12	20
13.	16.50	4.20	24.45	11	21
14.	17.00	4.25	25.00	11	19
15.	17.25	4.40	25.50	13	20
16.	17.50	4.75	27.50	10	23
17.	17.75	4.90	27.60	11	21
18.	18.00	5.00	27.77	12	22
19.	18.50	5.00	27.00	11	20
20.	19.00	5.10	26.84	12	22
21.	19.50	5.20	26.66	12	25
22.	20.00	5.40	27.00	11	21
23.	21.00	5.50	26.19	11	25
24.	22.00	5.70	25.90	11	24
25.	23.00	5.80	25.21	11	24

**Sagitta lyra** Krohn, 1853

(Text-figs. 7 : A-F ; and 8)

Synonyms :

*Sagitta furcata* Krumbach (1903).

*Pseudosagitta grimaldi* Germain and Joubin (1912).

*Sagitta lyra typica* Ghirardelli (1950).

*Sagitta lyra gazellae* Ghirardelli (1950).

*Records from the Indian Ocean :*

This species has been recorded from the Indian Ocean by Burfield and Harvey (1926) from Chagos Archipelago, Mauritius to Saya de Malha Bank, Amarantie and Seychelles ; Tokioka (1956) from south-west of Maldiva Archipelago ; David (1959) from Southern Indian Ocean from subtropical Sector to close to the Sub-tropical convergence ; and Alvarino (1964 c, d) from Western Indian Ocean. According to Alvarino (1965) the species is more abundant on the western than on the eastern side of the Indian Ocean.

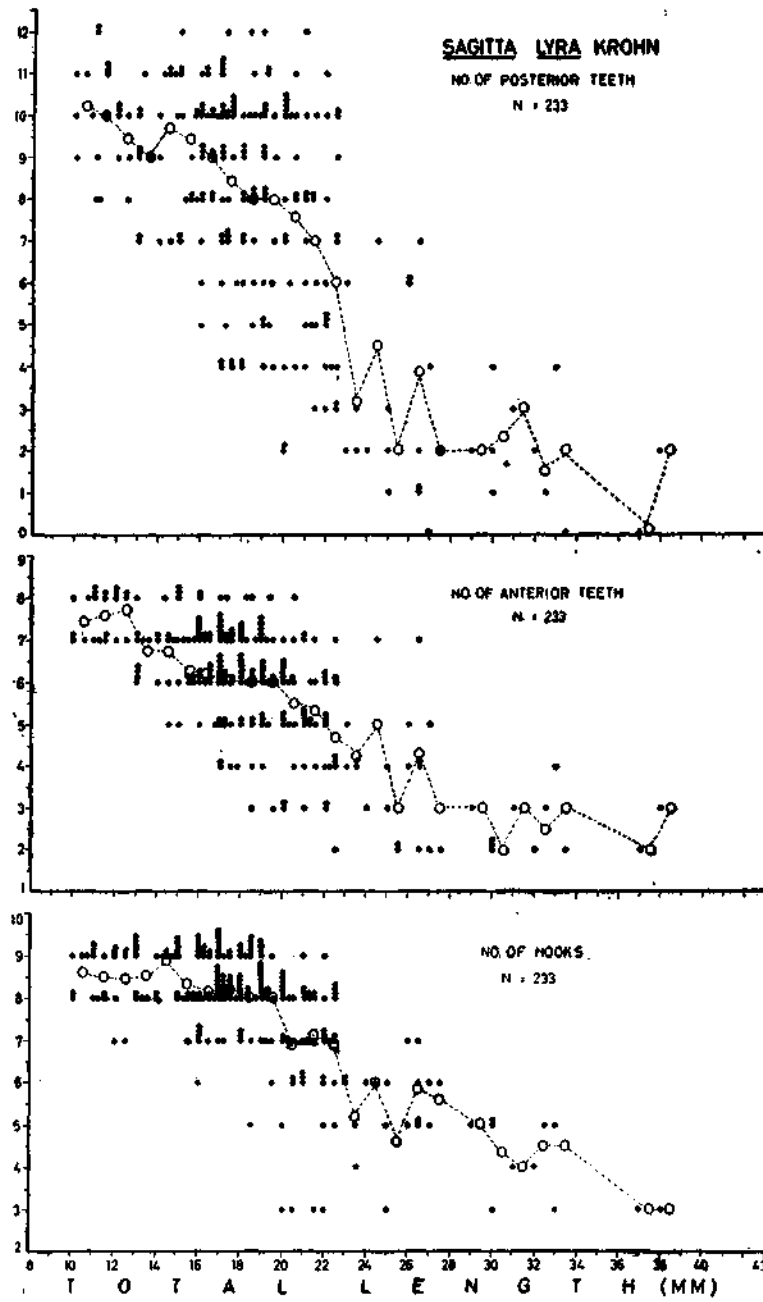


FIG. 8.—*S. lyra* Krohn. Frequency of occurrence of hooks and teeth. The mode for each mm. size group is indicated in open circles and connected with broken lines.

*Material :*

288 specimens from 32 deep-water hauls obtained during the cruises of R. V. *VARUNA* as shown in Table XII.

*Description :*

One of the larger species of the genus, specimens in the collection measure from 10 to 38 mm. including tail fin.

Body translucent and somewhat flabby with greatest width at about mid-length ; longitudinal muscles weak ; constriction present at tail septum ; head large, being wider than long and neck generally well defined (In specimen shown in Fig. 7 : A, details of head are not very clear) ; length of tail segment varies between 16.66 to 18.82 (mean 18.1) per cent of total length ; eyes oval and pigmented with numerous ommatidia arranged in three or four rows ; jaw hooks highly variable, decreasing in number with maturity from 9 to 3 (Fig. 8) ; hooks are short and slightly curved with straight tips ; anterior teeth in each set varies from 2 to 8, these again showing decrease in numbers with maturity ; same trend is also seen in posterior teeth which vary from 12 to 0 (Fig. 8) ; collarete absent ; intestine without a diverticulum ; anterior and posterior lateral fins connected by narrow fin-bridge ; anterior lateral fins longer than posterior fins, and rayed marginally in about posterior one-third of fin, basal part being rayless ; anteriorly fins extend to just behind posterior end of ventral ganglion ; posterior fins wider than anterior fins with three-fourths their length lying on trunk and marginally rayed throughout ; tail fin almost lobate posteriorly ; seminal vesicles are oval in shape and placed close to posterior end of posterior lateral fins and do not extend to origin of tail fin ; ovaries are elongate and in our specimens extend to posterior end of anterior lateral fins (Fig. 7 : A) ; ovulae numerous arranged in four dorso-ventral rows, two rows clearly seen at a time in dorsal view (Fig. 7 : F).

*Remarks :*

*Sagitta lyra* is a mesoplanktonic species and is closely related to *S. maxima* (Conant), *S. gazellae* Ritter-Zahony, and *S. scrippsae* Alvarino, in view of which Alvarino (1967) considers them as belonging to the 'maxima'—Group of the genus. It is also known from the warm and temperate regions of the Atlantic Ocean (from 42° N to 48° S). Its distribution in the Pacific Ocean is patchy, definite records being only from the Kuroshio waters and the South China Sea (Alvarino, 1965).

***Sagitta hispida* Conant, 1895**

(Text-fig. 9 : A-K)

*Synonyms :*

*Sagitta neglecta* Germain and Joubin (1916).

*Sagitta robusta* (partim) Burfield (1930).

*Sagitta gloriae* Almedia Prado (1960).

*Records from the Indian Ocean :*

Alvarino (1965) has shown that previous records of this species from the Indian Ocean (Burfield and Harvey, 1926 ; George, 1952) refer to *S. bipunctata*. Rao (1958)



TABLE X

*Measurements of Sagitta hispida* Conant (1895)

Size group mm.	No.	Tail length (%) Range and (Mean)	Anterior fin (%) Range and (Mean)	Posterior fin (%) Range and (Mean)	Hooks (Mean)	Anterior teeth (Mean)	Posterior teeth (Mean)
5.5-5.9	3	29.8-31.9 (31.0)	20.2-21.6 (20.9)	24.1-25.0 (24.6)	6-8 (7)	5-8 (6)	10-12 (10.7)
6.0-6.4	11	30.5-33.3 (31.9)	20.0-21.9 (20.8)	23.3-26.7 (25.4)	6-7 (6.5)	5-8 (6.0)	9-12 (10.1)
6.5-6.9	25	29.0-32.4 (31.0)	20.0-21.7 (20.9)	24.2-25.8 (25.0)	6-8 (6.8)	5-9 (6.0)	9-14 (11.4)
7.0-7.4	27	30.0-32.4 (31.3)	20.5-22.2 (21.6)	24.4-26.4 (25.5)	6-8 (6.9)	5-8 (6.2)	10-15 (12.3)
7.5-7.9	18	30.1-32.0 (31.3)	20.8-22.4 (21.7)	25.3-27.0 (26.2)	6-8 (7.1)	6-9 (7.4)	10-14 (13.0)
8.0-8.4	7	30.0-31.2 (30.7)	20.3-22.6 (21.3)	25.0-26.3 (25.9)	6-8 (7.1)	5-8 (6.6)	13-14 (13.4)
8.5-8.9	7	29.5-32.2 (30.5)	20.9-22.1 (21.5)	25.6-26.1 (25.8)	6-8 (6.9)	5-9 (7.1)	12-14 (13.2)
9.0-9.4	2	29.8-30.0 (29.9)	21.8-22.0 (22.0)	26.0-26.6 (26.3)	7 (7.0)	9 (9.0)	13-15 (14.0)

listed *S. hispida* from the plankton of Lawson's Bay, Waltair, but gave no description of the species. Rao and Ganapati (1958) recorded this species from the waters off Visakhapatnam remarking that 'This is easily identifiable by virtue of its possessing a 'hispid' body; collarette is short but distinct; anterior fins are shorter than posterior . . .' but have not given any details of morphometric and meristic characters. As regards the first character mentioned by these authors, the 'hispid' condition is not a peculiarity of this species alone. Alvarino (1965) remarks that 'Species other than *S. hispida* present the "hispid" appearance when well preserved, but this character alone is quite unreliable for identification.' Similarly we may state that the condition of the collarette and the anterior fins mentioned by Rao and Ganapati (1958) for *S. hispida* is also shared by a number of other species. However, the outline figure of *S. hispida* given by Rao and Ganapati (1958, pl. 1, fig. 10) though lacking in details shows the posterior lateral fins to extend on to the tail segment for more than 50 per cent of their length. This is a character in which *S. hispida* differs from *S. bipunctata* with which it has been confused by some workers. We feel that there is a possibility that *S. hispida* could occur in the waters off Visakhapatnam, but more diagnostic details of the material from that area is needed for confirming this. Thus it will be seen that there is no description of *S. hispida* available from the Indian Ocean. Although Alvarino (1965) has given the distribution of *S. hispida* as 'Tropico-equatorial Atlantic', we are now in a position to definitely record and give a description of the species from Indian Seas.

*Material :*

558 specimens from 27 stations of R. V. *VARUNA* as listed in Table XII.

*Description :* (Fig. 9 : A-K).

*S. hispida* is one of the smaller epiplanktonic species of chaetognatha. Total length including tail fin varies from 5.7 to 9.2 mm.

Body stout, rigid and opaque; longitudinal muscles well developed and strong; head is wider than body, but without a distinct neck; length of tail segment varies between 29.0 to 33.3 (mean 31.13) per cent of total length; eyes moderately large with pigmented area branched as shown in Fig. 9-K; jaw hooks relatively short and gently curved varying from 6 to 8 on each side with tips of hooks straight; teeth small, anterior teeth varying from 5 to 9 in one set, and posterior from 9 to 15; Collarette present and well developed from neck to ventral ganglion; intestine with a conspicuous diverticulum; lateral fins fully rayed; anterior fins shorter and narrower than posterior fins and originate just behind ventral ganglion; length of anterior fin 20.00 to 22.63 (mean 21.3) per cent of total length; about two-thirds or more of posterior fin lies on tail segment and posterior tip of fin is separated from tail segment; length of posterior fin 23.33 to 27.00 (mean 25.3) per cent of total length; distance between anterior and posterior fins does not exceed 1.25 times width of body; seminal vesicles situated close to posterior end of posterior fins and separated from tail fin origin by wide gap; seminal vesicles well developed and more swollen anteriorly, bursting laterally more towards anterior half (Fig. 9 : B-E indicates different stages of development); ovaries elongate with subequal lobes which in fully mature specimens in the collection extend anterior to the ventral ganglion; ovulae large and arranged in single row in Stage IV; postero-lateral corners of trunk where oviducts open bulge slightly outwards.

*Remarks :*

For a description of the species from the Atlantic Ocean and contiguous seas reference is invited to Scaccini and Ghirardelli (1941), Ghirardelli (1948, 1950), Pierce (1951), Tokioka (1955), Furnestin (1957), and Legare and Zoppi (1961).

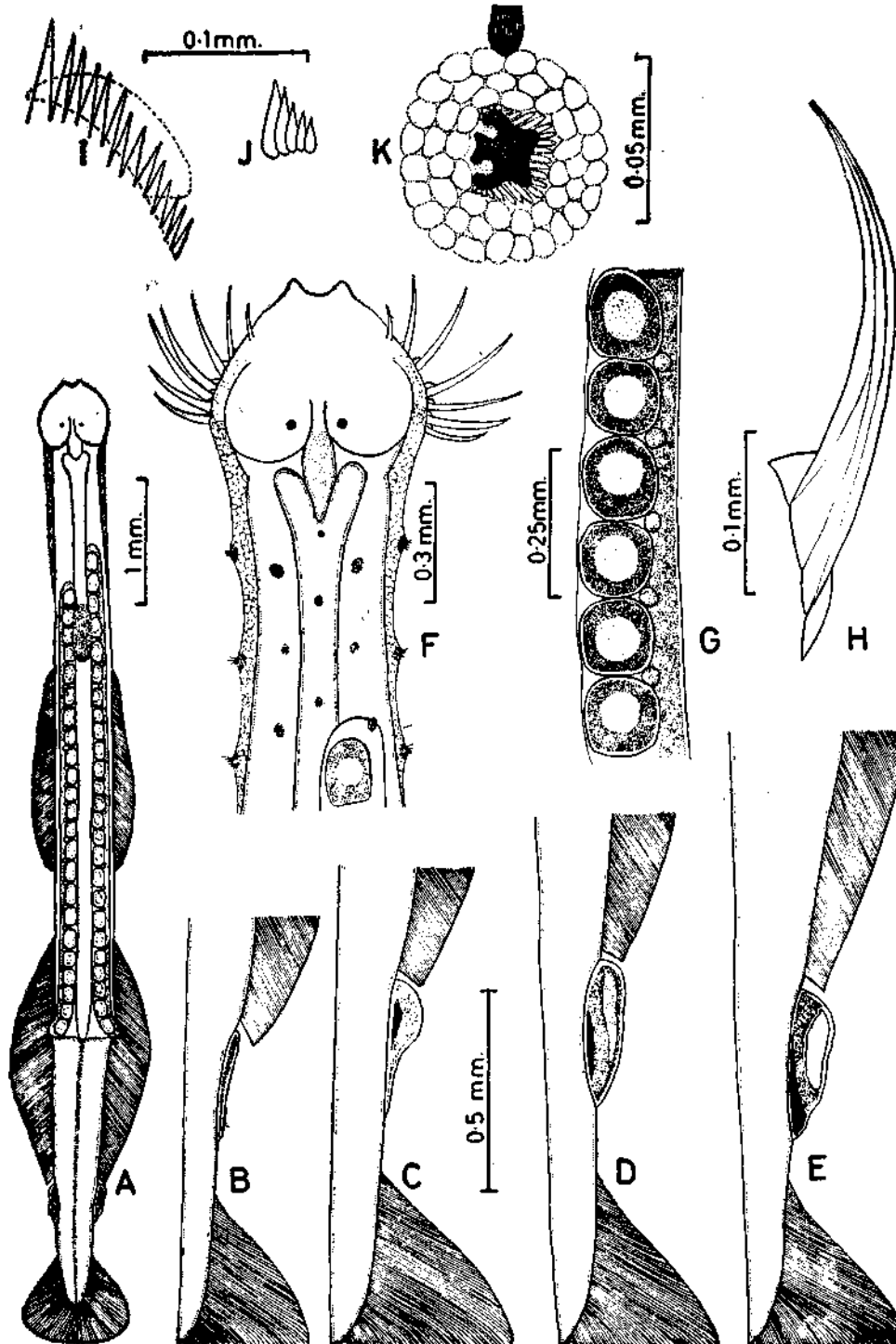


FIG. 9—*S. hispida* Conant A. Dorsal view; B-E. Part of tail segment showing the development of seminal vesicles from earlier stage to ruptured condition in specimens of 6.6 mm., 7.2 mm., 7.6 mm., and 7.8 mm. respectively; F. Detail of head and anterior part of body; (Note well developed diverticulum, collarette and the 'hispid' condition); G. Dorsal view of ovary showing fully developed ovulae arranged in single row; H. Hook; I. Posterior teeth; J. Anterior teeth; K. Detail of eye.

TABLE XI  
Occurrence of species of *Chaetognatha* in the deep-water hauls

No.	Species	Number	Per cent (%)	Negative hauls (D=Day ; N=Night)	Positive hauls		Number of specimens in :	
					Day	Night	Day hauls Range (Mean)	Night hauls Range (Mean)
1.	<i>S. bedoti</i>	1250	2.90	(D=13; N=2)	20	15	1-111 (25)	4-235 (50)
2.	<i>S. decipiens</i>	6046	13.70	—	21	17	38-330 (151)	10-305 (169)
3.	<i>S. inflata</i>	19206	43.70	—	21	17	92-1295 (484)	48-1009 (532)
4.	<i>S. hispida</i>	558	01.30	11 (D=6; N=5)	15	12	1-87 (21)	1-99 (21)
5.	<i>S. lyra</i>	288	00.65	6 (D=3; N=3)	18	14	1-22 (8)	2-30 (9)
6.	<i>S. pacifica</i>	6076	13.80	—	21	17	1-495 (166)	12-300 (152)
7.	<i>S. pulchra</i>	248	00.60	2 (D=1; N=1)	20	16	1-43 (7)	1-27 (7)
8.	<i>S. regularis</i>	2635	06.00	—	21	17	1-195 (74)	3-230 (64)
9.	<i>S. robusta</i>	772	01.80	5 (D=3; N=2)	18	15	1-150 (25)	1-90 (22)
10.	<i>P. draco</i>	4466	10.15	1 (N=1)	21	16	2-437 (112)	9-240 (132)
11.	<i>K. pacifica</i>	828	01.90	1 (D=1)	20	17	1-88 (18)	4-120 (28)
12.	<i>K. subtilis</i>	140	00.30	4 (D=2; N=2)	19	15	1-12 (4)	1-14 (5)
13.	<i>E. fowleri</i>	552	01.30	11 (D=6; N=5)	15	12	3-41 (19)	1-44 (22)
14.	<i>E. minuta</i> sp. nov.	708	01.60	7 (D=4; N=3)	17	14	1-65 (22)	2-74 (24)
	Unidentified & damaged	127	00.30					

## DISCUSSION

On the basis of spatial as well as bathymetric distribution, the fourteen species of *Chaetognatha* in the collection can be grouped as follows :

1. *Cosmopolitan* : (Common to Atlantic, Indian and Pacific Oceans) :
  - a. *Epiplanktonic* : *S. inflata*, *K. pacifica*, *K. subtilis*, and *P. draco*.
  - b. *Mesoplanktonic* : *S. lyra* and *S. decipiens*
2. *Tropical-equatorial and restricted to Indian and Pacific Oceans (Epiplanktonic)* : *S. bedoti*, *S. pacifica*, *S. pulchra*, *S. regularis* and *S. robusta*.
3. *Tropical-equatorial and restricted to Indian and Atlantic Oceans (Epiplanktonic)* : *S. hispida*.

TABLE XII

*R.V. VARUNA* Station details of deep-water plankton tows, with total number of chaetognaths at each station as well as numbers of the four species described in this account.

Station No.	Date	Depth (m)	Depth of haul (m)	Time (Hrs)	Position		Total No. of Chaetognatha	Number of specimens of :			
					Latitude	Longitude		<i>E. minuta</i> sp.nov.	<i>E. fowleri</i>	<i>S. lyra</i>	<i>S. hispida</i>
2007	4-11-63	2100	750	15.00-17.35	09° 02'N	75° 20'E	742	45	20	15	1
2012	6-11-63	3200	1000	06.40-09.40	09° 00'N	72° 00'E	560	34	21	5	..
2013	6-11-63	4200	1250	12.20-15.35	09° 35'N	71° 20'E	1190	12	22	3	..
2014	6-11-63	4400	750	20.15-23.00	09° 10'N	70° 40'E	1625	25	4	4	..
2015	16-11-63	2180	1200	12.00-14.25	10° 43'N	74° 35'E	1040	65	38	11	..
2016	16-11-63	1600	1200	16.35-19.00	10° 15'N	74° 51'E	1566	74	44	10	..
2022	17-11-63	2460	1200	16.15-18.40	09° 41'N	75° 10'E	1530	50	20	15	25
2023	17-11-63	1600	1200	20.40-23.05	09° 45'N	75° 26'E	1340	62	40	30	18
2033	7-12-63	750	700	18.10-	16° 10'N	72° 25'E	1415	..	..	..	2
2034	7-12-63	1660	1000	05.45-	16° 06'N	72° 10'E	1175	1	13	5	4
2035	8-12-63	2000	1000	04.25-	16° 01'N	71° 56'E	1020	2	33	2	10
2036	8-12-63	2600	1000	09.40-	15° 36'N	71° 22'E	1200	10	25	5	20
2037	9-12-63	1650	1000	04.25-	15° 00'N	70° 31'E	1275	3	14	4	7
2038	9-12-63	2240	1000	11.45-	15° 00'N	71° 00'E	820	1	4	..	12
2039	9-12-63	2000	1000	19.00-	15° 03'N	71° 32'E	1150	2	..	8	4
2040	10-12-63	920	700	12.15-	15° 01'N	72° 00'E	1634	..	..	8	2
2054	12-12-63	1920	1000	12.40-	14° 23'N	72° 52'E	1340	21	22	8	..
2112	5- 3-64	1800	950	13.15-15.15	07° 30'N	75° 30'E	1072	40	19	22	75
2113	5- 3-64	2800	1000	17.05-20.00	07° 30'N	75° 10'E	1757	16	33	9	99
2115	6- 3-64	2380	700	05.00-08.05	08° 10'N	75° 20'E	1220	26	3	10	87
2131	8- 3-64	2400	650	07.15-09.15	09° 30'N	74° 30'E	688	12	11	18	22
2138	18- 3-64	3200	300	10.15-11.00	09° 00'N	75° 58'E	1815	..	..	..	32
2168	5- 4-64	1800	1000	15.45-17.00	08° 10'N	75° 20'E	1038	20	..	15	3
2702	26-10-64	975	300	10.35-11.20	11° 56'N	74° 20'E	1471	..	..	3	..
2725	6-12-64	800	250	19.00-19.30	18° 00'N	70° 40'E	85	..	..	..	..
2864	25- 2-65	1200	500	21.30-22.45	10° 00'N	75° 30'E	475	..	..	..	5
2881	27- 2-65	1100	300	16.30-17.10	11° 28'N	74° 36'E	420	..	..	..	..
2933	20- 3-65	360	350	08.45-09.45	12° 38'N	74° 10'E	379	21	..	1	4
3311	27-11-65	1000	800	19.00-20.00	12° 50'N	73° 30'E	741	8	11	2	..
3319	28-11-65	1600	600	18.00-19.05	11° 45'N	74° 03'E	968	6	1	6	..
3345	9- 1-66	1400	800	04.25-05.40	11° 45'N	74° 25'E	1075	21	..	14	1
3375	15- 2-66	2500	1000	07.35-	10° 04'N	74° 38'E	2220	18	23	4	9
3376A	15- 2-66	1900	1000	18.45-	10° 07'N	72° 52'E	955	19	31	10	25
3376B	16- 2-66	1900	1000	06.05-	10° 07'N	72° 52'E	1340	10	16	4	30
3377A	16- 2-66	1750	600	21.00-	10° 40'N	72° 22'E	1370	8	1	15	10
3377B	17- 2-66	1750	800	06.35-07.10	10° 40'N	72° 22'E	1015	19	14	10	2
3378	17- 2-66	1600	1300	13.40-14.25	11° 01'N	72° 32'E	1080	17	41	2	9
3380	18- 2-66	1920	1000	22.40-23.30	11° 13'N	73° 16'E	2094	40	28	10	40
Total	..	..	..	..	..	..	43900	708	552	288	558

4. *Deep-water (Mesoplanktonic and Bathyplanktonic) :*a. Cosmopolitan : *E. fowleri*.b. Endemic (?) in Arabian Sea and Laccadive Sea (Indian Ocean) :  
*E. minuta* sp. nov.

It will be seen from Table XI that *S. inflata* is the most abundant species in the collections followed by *S. pacifica*, *S. decipiens*, *P. draco* and *S. regularis*, all other species adding up to less than 13 per cent. Of the species mentioned above, but for *P. draco* the other four occur in all the 38 day and night hauls.

The mean for the number of specimens in day and night hauls would indicate that more specimens of *S. pacifica*, *S. regularis* and *S. robusta* were obtained during the day hauls. The reason for this is not clear. There is hardly any work relating to the abundance of Chaetognaths in day and night collections in planktological investigations undertaken earlier in this region and as such comparisons are not possible.

It is interesting that *E. hamata* has not been recorded from the deep waters of the central and northern parts of the Indian Ocean and contiguous Seas. Alvarino (1965) opines that 'It appears that *E. hamata* does not extend northward from the boundary of the subtropical convergence in the Indian Ocean, or if it does the population is either scarce (and hence the individuals are missed by sampling) or it inhabits layers deeper than those sampled.' Perhaps the last two factors may account for the absence of *E. hamata* in our deep-water collections. Nevertheless the existence in this area of a small species showing affinities to *E. hamata* is most interesting suggesting the replacement of the latter species in the equatorial belt and northwards in the Indian Ocean. Confirmation of this should await more intensive collections and examination of collections from still greater depths. The very small eyes with fewer ommatidia without pigments in *E. minuta* is suggestive that the species is bathyplanktonic like its congeners *E. fowleri*, *E. bathypelagica* and *E. bathyantartica*. It has not been met with in the IOS Net open tows taken in the same area from 200 metres to surface and the least depth from which it has been collected is in a haul operated from 350 metres to surface.

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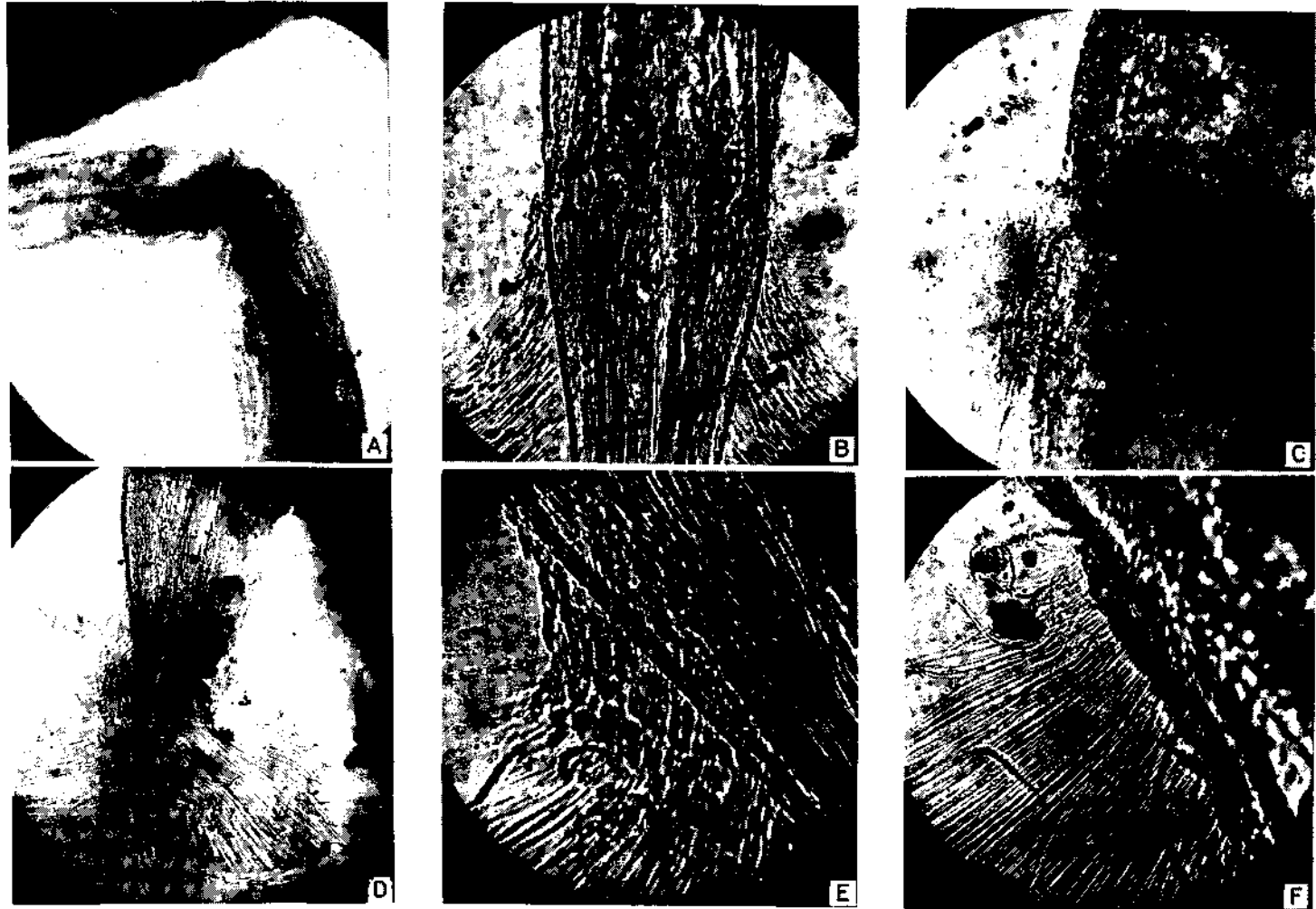


PLATE: *Eukrohina minuta* sp. nov. A. Part of trunk showing occurrence of oil droplets; B. Part of tail segment showing origin of tail fin; C. Tail septum region showing wrinkled condition of rayless part of lateral fin; *E. hamata*. D. and E. Posterior part of tail segment showing presence of distinct collar on part of segment as well as fin; *E. bathypelagica*. F. Posterior part of lateral fin showing fine and delicate rays.

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