The Chaetognatha of the Monsoon Expedition in the Indian Ocean[1]

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THIS REPORT deals with the chaetognaths collected by the "R/V Argo" during the Monsoon Expedition in the Indian Ocean in 1960 and 1961. The Monsoon collections extended from about 8° S to 42° S (Fig. 1); that is, the region roughly limited by the Equatorial Countercurrent and the Subantarctic West Wind Drift (the Indian Central waters extending to the Subtropical Convergence); and also the Indonesian seas and the South Australian waters. This report includes only data from the Indian Ocean. Data from collections made by the same Expedition in the Pacific have been added to the study of the chaetognaths of the Pacific. However, data derived from the Pacific are used here also in discussing the distribution of the species. The Monsoon Expedition covered in part the regions surveyed for chaetognaths by the Gazelle, Gauss, Sealark, Siboga, and Snellius expeditions, with the following exceptions: the Bay of Bengal, west coast of Ceylon, and waters of Somalia and eastern Africa.

The samples were taken with a 1-m open net, towed obliquely from a depth of 200 or 360 m to the surface; and several mid-water trawls are also included (see Table I).

It is well known that the hydrographic changes taking place in the Indian Ocean are influenced by the monsoon regime. The sampling extended from November 1960 to January 1961. This is the season of the northeast monsoon (Mattheus, 1926).

Two well-defined zoogeographical boundaries were indicated in the Indian Ocean by the study of the Chaetognatha population: (1) the equatorial boundary extending south of the equator (from about 5° S in the West to 15° S in the East), and (2) the Subtropical Convergence region (at about 40° S). These well-defined boundaries frame latitudinally three main regions: Equatorial, Central, and Subantarctic.

Typical equatorial species of the Pacific that occur also in the Indian Ocean appear to be restricted to the Equatorial waters. Warm-water species that are cosmopolitan in distribution, extend along the Equatorial and Central Indian waters, while cold-water species do not extend to the Central waters. The Subtropical Convergence appears to be the fluctuating northern boundary for the latter.

The data obtained aid in filling the gap that existed in the zoogeography of the chaetognaths by adding information from the Indian Ocean. These observations make it easy to compare the relationships found in the distributional pattern shown by each of the species in the Indian Ocean and their respective allies in the Atlantic and Pacific oceans.

The Indian Ocean collection contains 23 oceanic species of chaetognaths, already known from the Atlantic and the Pacific oceans.

The following species were observed in the samples from the Monsoon Expedition in the Indian Ocean:

Eukrohnia bathypelagica Alvariño
E. fowleri Ritter-Zahony
E. hamata (Möbius)
Krohnitta pacifica (Aida)
K. subtilis (Grassi)
Pterosagitta draco (Krohn)
Sagitta bedoti Béraneck
S. bipunctata d'Orbigny
S. decipiens Fowler
S. enflata Grassi
S. ferox Doncaster
S. gazellae Ritter-Zahony
S. hexaptera Quoy and Gaimard
S. lyra Krohn
S. minima Grassi
S. neglecta Aida
S. pacifica Tokioka

[1] Contribution from the Scripps Institution of Oceanography, University of California, San Diego.
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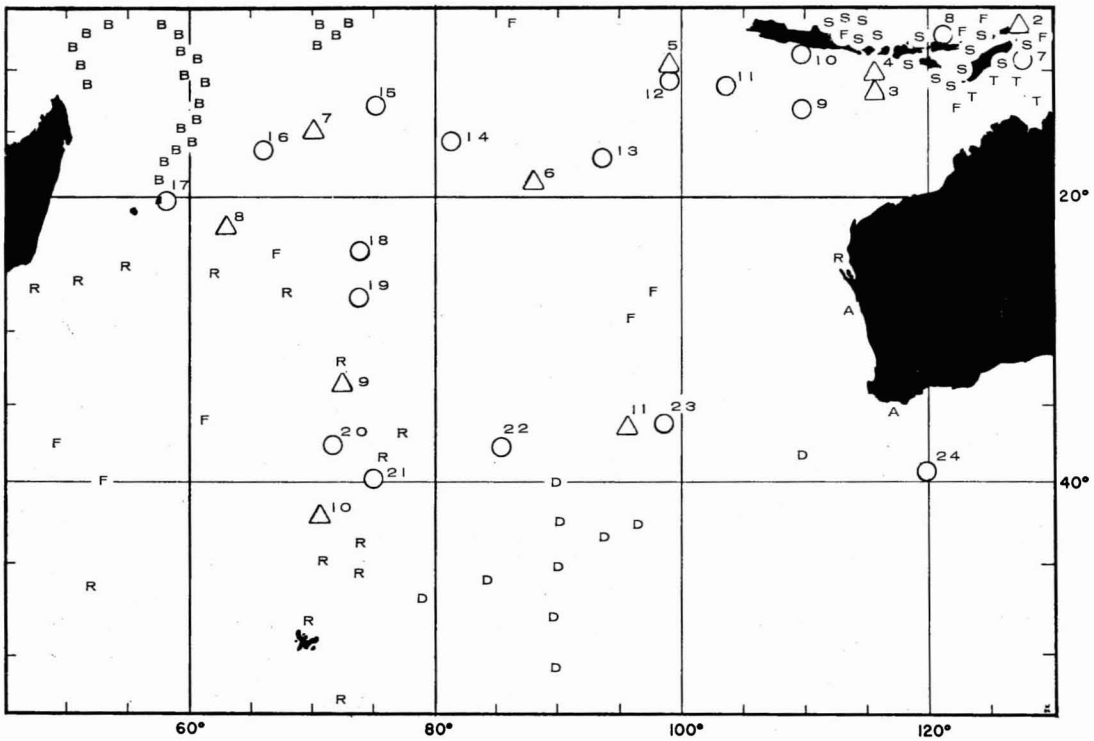

FIG. 1. Stations plan for the zooplankton collections of the Monsoon Expedition in the Indian Ocean.
O — 1–m net
Δ — mid-water trawl

Stations corresponding to previous work in this region are:
F — Siboga Expedition (Fowler, 1906)
R — Gazelle Expedition, Fauna Southwestern Australia, Deutsche Südpolar Expedition (Ritter-Zahony, 1909, 1910, 1911)
B — Sealark Expedition (Burfield and Harvey, 1926)
S — Snellius Expedition (Schilp, 1941)
T — (Tokioka, 1956*b*)
D — (David, 1958, 1959)

S. planctonis Steinhaus
S. pulchra Doncaster
S. regularis Aida
S. robusta Doncaster
S. tasmanica Thomson
S. zetesios Fowler

Seventeen of the 23 species recorded are epiplanktonic. Ten of these are cosmopolitan and seven are Indo-Pacific. Fifteen of the 17 epiplanktonic species in the Indian Ocean connect with their respective regions of distribution in the Pacific Ocean along the Indonesian seas. The mesoplanktonic species *S. decipiens* and *S. zetesios* apparently connect with the Pacific population along the same route, while *S. planctonis* extends into the Pacific following the South Australian waters. These mesoplanktonic species are also cosmopolitan. However, *E. bathypelagica,* obtained previously only in the Pacific at great depths, was recorded here once at the northern part of the region covered by the "R/V Argo" in the Indian Ocean (mid-water trawl no. 3, at 11° 56′ 42″ S—115° 22′

TABLE 1

LIST OF STATIONS OF THE MONSOON EXPEDITION IN THE INDIAN OCEAN

STATION NUMBER	DATE	1 M OPEN NET OBLIQUE TOW				
		Time		Position		Depth (meters)
		Start	End			
	1960					
7	X–22	1745	1811	9° 11.5′ S	127° 33.5′ E	305
8	X–26	2109	2135	7° 47.0′ S	121° 16.5′ E	200
9	XI–7	2012	2037	13° 19.5′ S	109° 35.5′ E	240
10	XI–11	0437	0501	8° 53.0′ S	109° 38′ E	271
11	XI–20	2203	2227	11° 15′ S	103° 32′ E	297
12	XI–22	1929	1950	10° 30.0′ S	98° 59.0′ E	339
13	XI–25	2300	2327	17° 01′ S	93° 28.6′ E	278
14	XI–29	2213	2249	15° 51.0′ S	81° 10.3′ E	335
15	XII–1	2108	2134	12° 57.9′ S	75° 13.6′ E	356
16	XII–5	0319	0346	16° 24.5′ S	66° 02.4′ E	235
17	XII–11	1753	1819	20° 18.9′ S	58° 09.6′ E	328
18	XII–15	0044	0109	23° 59.4′ S	73° 57.5′ E	283
19	XII–17	0313	0342	27° 48.6′ S	73° 51.5′ E	273
20	XII–20	0435	0507	37° 40.1′ S	71° 41′ E	283
21	XII–22	1150	1216	39° 50′ S	75° 03.7′ E	362
22	XII–26	0509	0540	37° 49.6′ S	85° 21.7′ E	283
23	XII–30	0013	0041	36° 18.7′ S	98° 41.1′ E	235
	1961					
24	IX–1	1733	1806	39° 18′ S	119° 51′ E	269
	MID-WATER TRAWLS					
2	24–25–X–1960	2339	0259	7° 10′ 00″ S 7° 09′ 00″ S	127° 22′ 00″ E 126° 58′ 54″ E	2121
3	29–30–X–1960	2157	0359	11° 56′ 42″ S 12° 15′ 30″ S	115° 22′ 12″ E 115° 30′ 06″ E	2179
4	2–XI–1960	0121	0451	10° 10′ 00″ S 10° 43′ 00″ S	115° 17′ 12″ E 115° 14′ 54″ E	1721
5	22–23–XI–1960	2239	0235	10° 39′ 00″ S 10° 50′ 00″ S	98° 50′ 36″ E 98° 43′ 42″ E	1408
6	27–XI–1960	1817	2300	18° 49′ 24″ S 18° 41′ 06″ S	88° 05′ 42″ E 87° 51′ 30″ E	1643
7	3–XII–1960	1649	2128	14° 54′ 00″ S 15° 01′ 24″ S	70° 12′ 00″ E 69° 52′ 00″ E	2000
8	12–XII–1960	1910	2342	22° 04′ 18″ S 22° 15′ 30″ S	63° 02′ 00″ E 63° 19′ 00″ E	2000
9	19–XII–1960	0324	0829	33° 19′ 18″ S 33° 38′ 06″ S	72° 34′ 24″ E 72° 31′ 00″ E	1878
10	21–22–XII–1960	2326	0415	42° 03′ 48″ S 42° 01′ 06″ S	70° 39′ 54″ E 71° 00′ 18″ E	2060
11	28–XII–1960	1738	2312	36° 35′ 00″ S 36° 32′ 18″ S	95° 28′ 00″ E 95° 52′ 30″ E	2000

12″ E, from 2179 m depth). No typical Indian Ocean species was found. The sampling only covered the oceanic regions, and it is assumed that some neritic species of chaetognaths may be restricted to the Indian waters.

Important previous works on the Chaetognatha in the Indian Ocean and adjacent waters include:

Authority	*Number of valid species observed*
Béraneck (1895), Bay of Amboine	5
Burfield and Harvey (1926), Indian Ocean	15
Doncaster (1903), Maldive-Laccadive Archipelago	11
Fowler (1906), Indian Ocean	18
George (1952), Indian coastal waters	12
Lele and Gae (1936), Bombay harbor	3
Oye (1918), Java Sea	12
Rao (1958), Lawson's Bay, Waltair, Bay of Bengal	13
Rao and Ganapati (1958), off east coast of India and Ceylon	12
Ritter-Zahony (1909), southern Indian Ocean	6
(1910), southwest Australia	10
(1911), Deutsche Südpolar Expedition	17
Schilp (1941), Indian Ocean	19
Tokioka (1940), New South Wales	8
(1955), NE Indian Ocean	13
(1956), Central Indian Ocean	13
(1956), Arafura Sea	9

The chaetognaths observed in the Indian Ocean can be grouped as follows:

a) Cosmopolitan (common to Atlantic, Indian, and Pacific oceans): *S. lyra, S. enflata, S. hexaptera, S. minima, S. bipunctata, K. subtilis, K. pacifica, P. draco, S. gazellae, S. tasmanica.*

b) Cold-water representants: *S. gazellae, S. tasmanica, E. hamata.*

c) Tropical–equatorial, and restricted to the Indo-Pacific waters: *S. ferox, S. robusta, S. pacifica, S. pulchra, S. neglecta, S. bedoti, S. regularis.*

d) Mesoplanktonic: *S. decipiens, S. planctonis, S. zetesios.*

e) Deep water: *E. hamata* (in low latitudes), *E. fowleri, E. bathypelagica.*

It is important to notice that *Sagitta macrocephala* Fowler was not recorded here. The absence of this species from the samples may be due to its scarcity and to the small number of deep samplings. It was previously recorded in the Indian Ocean by Fowler (1906), Burfield and Harvey (1926), and Schilp (1941).

Sagitta gazellae, an oceanic species with a circumpolar distribution in the Antarctic and Subantarctic waters, enters the Atlantic, Indian, and Pacific oceans up to the Subtropical Convergence, often extending further north in deep levels in the Atlantic and Pacific (Alvariño, 1964*b*). In the Monsoon collections (Fig. 2), *S. gazellae* occurred as far north as 36° S—98° E and 37° S—71° E; whereas David (1958) reported it extending along the 90° E meridian from 63° S to approximately 41° 30′ S (Fig. 2), and David (1959) from 66° 35′ S to 42° 35′ S (south of the Indian Ocean). The specimens of *S. gazellae* recorded in the Monsoon region might very well represent penetrations of the Subantarctic waters below the Subtropical. The penetration apparently does not extend farther north, because none were recorded at the mid-water trawl station 9 situated north of the septentrional boundary of this species in the Indian Ocean, although the sampling went to 1878–2000 m deep. The northernmost records of *S. gazellae* in the Indian Ocean (David, 1955) were at 40° 30′ S—90° E, and in the Pacific at 39° 20′ S—180° E and 38° 30′ S—126° W.

At station 22 (37° 49.6′ S—85° 21.7′ E) only young specimens 28–30 mm long at early maturity stage 1 were found; while at station 25 (57° 43′ S—169° 12′ E) some were 50–60 mm long and still at maturity stage 1. In the Pacific, at station 29 (40° 37′ S—164° 08′ W) the specimens were 20–30 mm in length, and at station 32 (28° 35.3′ S—158° 57.5′ W) they were 20–30 mm long and at maturity stage 1.

David (1955) points out that *S. gazellae* was occasionally taken north of the Subtropical Convergence at 41° 49.7′ S—18° 49.9′ E, and that the hydrographical data showed a northward extension of the Subantarctic waters. The observations in the Pacific (Alvariño, 1964*b*) showed the progression of the Subantarctic waters at deep levels far north of the Subtropical Con-

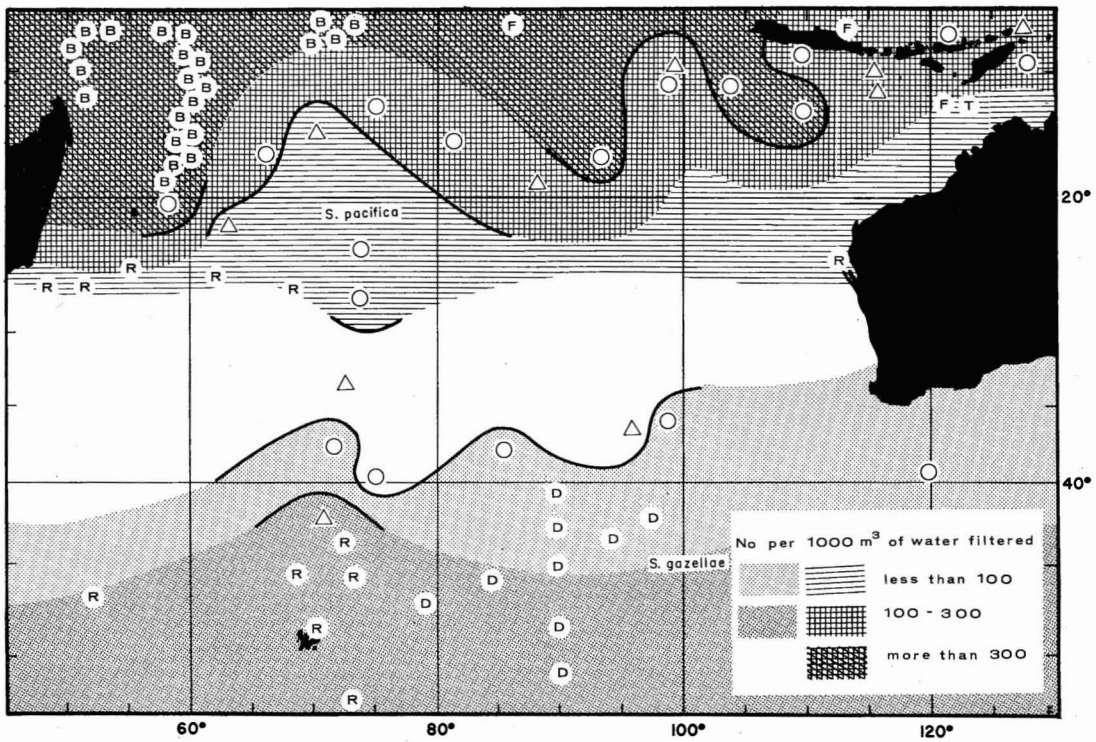

FIG. 2. Distribution of *S. gazellae* and *S. pacifica* in the Indian Ocean, including positive records from previous expeditions.

vergence. In the Pacific (Alvariño, loc. cit.), at about 35° S—21° S, there is an overlapping of the populations of *S. gazellae* and *S. pacifica* at about 200–400 m depth. In the Indian Ocean, the northern boundary of *S. gazellae* and the southern boundary of *S. pacifica* did not overlap, and do not even appear well juxtaposed. However, this pattern cannot be admitted as definitive; it may be due to scarcity of sampling in these localities. More data from this region will eventually show if this distributional pattern persists, or if both species occur in a pattern similar to that shown in the Pacific.

S. lyra recorded by Tokioka (1940) is most probably *S. gazellae* because of the geographic localities of the records (33° and 35° S and 151° E); and the *S. lyra* recorded by David (1959) and by Johnson and Taylor (1921) may also be *S. gazellae*.

S. pacifica populations of the Pacific and Indian oceans connect along the Indonesian seas (author's records; Tokioka, 1955, 1956*b;* and possibly also the report of Béraneck, 1895). It appears to extend with the South Equatorial Current to the Indonesian seas and then into the Indian Ocean (Fig. 2). It cannot be ascertained if some representatives of this species enter the Agulhas Current, since they have not yet been observed in the Atlantic.

Previous records of *S. serratodentata* in the Indian Ocean by Burfield and Harvey (1926), Doncaster (1903), Fowler (1906), John (1937), Ritter-Zahony (1910, 1911), and Schilp (1941), could be considered to be *S. pacifica.* Baldasseroni (1915) was the first to distinguish Atlantic specimens of *serratodentata* from those of the Pacific; he gave a short diagnosis and published drawings of the seminal vesicles of the species. Tokioka (1940) published a complete diagnosis and named the species. Cleve's (1901) records of *S. serratodentata* Krohn should correspond to *S. pacifica.* The John (1937),

Rao (1958*a, b*) Rao and Ganapati (1958), and Ritter-Zahony (1910, 1911) records of *S. serratodentata* correspond to *S. pacifica.* Other records of *S. pacifica* in the Indian Ocean are given by Tokioka (1940, 1955, 1956*a, b*).

S. tasmanica populates the Atlantic and the southernmost part of both the Indian and Pacific oceans up to the Subtropical Convergence. The northern boundary follows a pattern similar to that of *S. gazellae,* although it does not progress northward in deep layers as *S. gazellae* does. More data are needed to establish the extension of the distribution.

This species extends along southern Australia into the Pacific (Alvariño, 1964*b*); and it appears from the *S. tasmanica* records in the Pacific and Indian oceans that the Subtropical Convergence acts as a barrier which interrupts the distribution of the species northward from that boundary. With these findings in mind, and the fact that this species is recorded widely in the Atlantic, more data are needed before definitive conclusions may be drawn (Fig. 3).

Unfortunately, some of the expeditions in the Indian Ocean did not cover the distributional region of *S. tasmanica,* and most of the data from the Atlantic are difficult to interpret, because this species has been recorded together with *S. serratodentata* under Krohn's synonymy.

David's (1958, 1959) records of *S. serratodentata* Krohn refer probably to both *S. tasmanica* and *S. pacifica* and to *S. tasmanica* respectively.

S. lyra, a typical Atlantic chaetognath, appeared in small numbers and only in the West-Central Indian waters (Fig. 3). Other records are given by Baldasseroni (1915), Burfield and Harvey (1926), Fowler (1906) as *S. furcata,* Oye (1918), Ritter-Zahony (1911), Schilp (1941), and Tokioka (1956*a*).

S. enflata extends along the Indian Equatorial waters. It is heavily distributed in the eastern

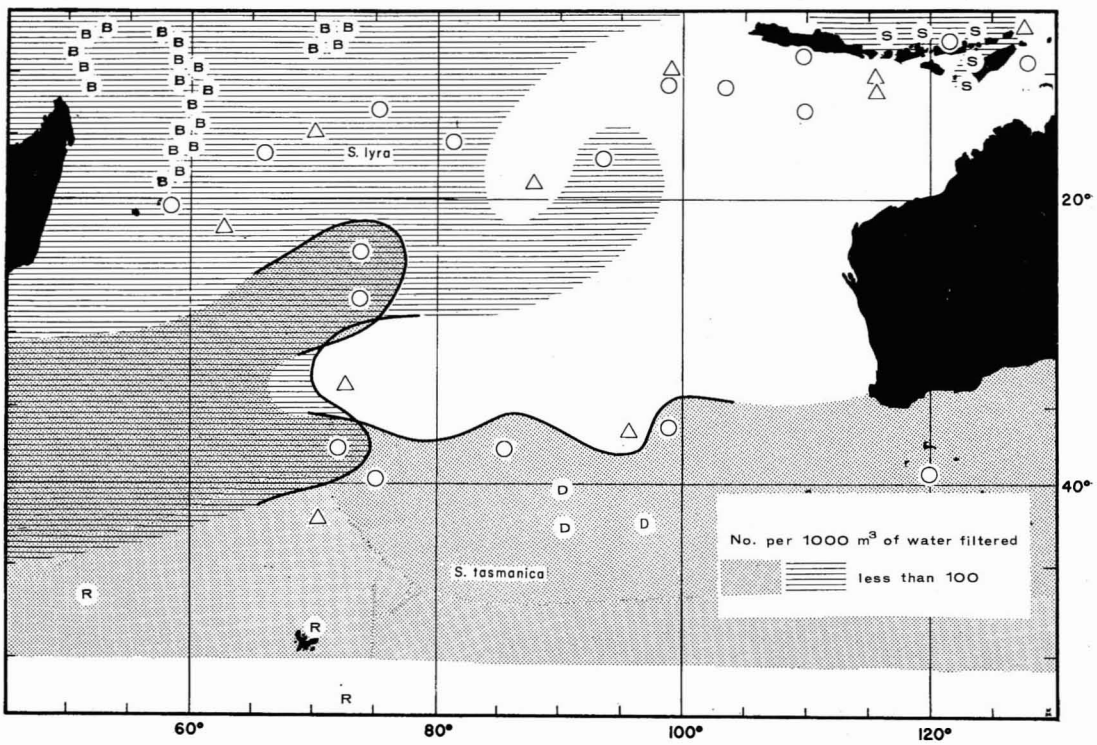

FIG. 3. Distribution of *S. lyra* and *S. tasmanica* in the Indian Ocean, including positive records from previous expeditions.

part of these waters and in the Sunda Sea. I suspect that it will also extend along the Indian Central waters, but lack of sampling in the East-Central Indian Ocean does not permit a complete picture of the distribution of this species (Fig. 4). Other records in the Indian Ocean: Baldasseroni (1915), Béraneck (1895), Burfield and Harvey (1926), Chacko (1950), Cleve (1901), Doncaster (1903), Fowler (1906), George (1952), John (1933, 1937), Lele and Gae (1936) as *S. gardineri,* Menon (1945), Oye (1918), Pillai (1944), Rao (1958*a, b*), Rao and Ganapati (1958), Ritter-Zahony (1909, 1910, 1911), Schilp (1941), Tokioka (1940, 1955, 1956*a, b*), and Varadarajan and Chacko (1943).

S. hexaptera was observed at each of the stations of the Monsoon Expedition in the Indian Ocean and the Indonesian seas, though it was less abundant in the southernmost stations. As in the Pacific, this species extends into colder regions than does *S. enflata* (Fig. 4), (Alvariño, 1964*a* and other unpublished data; Bieri, 1959). Other records in the Indian Ocean: Baldasseroni (1915), Burfield and Harvey (1926), Doncaster (1903) as *S. tricuspidata* and *S. magna,* Langerhans, Fowler (1906), Oye (1918), Ritter-Zahony (1909, 1910, 1911), Schilp (1941), and Tokioka (1940, 1955, 1956*a*).

S. robusta was observed in the Indonesian seas and at the northeastern stations in the Equatorial Indian Ocean. It apparently remains (Fig. 5) restricted to the Equatorial waters, whereas *S. ferox* (also an Equatorial species) spreads further south into the Tropical region. A similar pattern was observed in the Pacific (Alvariño, 1962*b*). It is obvious that the populations of both the Pacific and the Indian oceans connect along the Indonesian seas. Other records in the Indian Ocean: Baldasseroni (1915, *S. robusta*), Doncaster (1903), and Fowler (1906), recorded both species. Burfield and Harvey

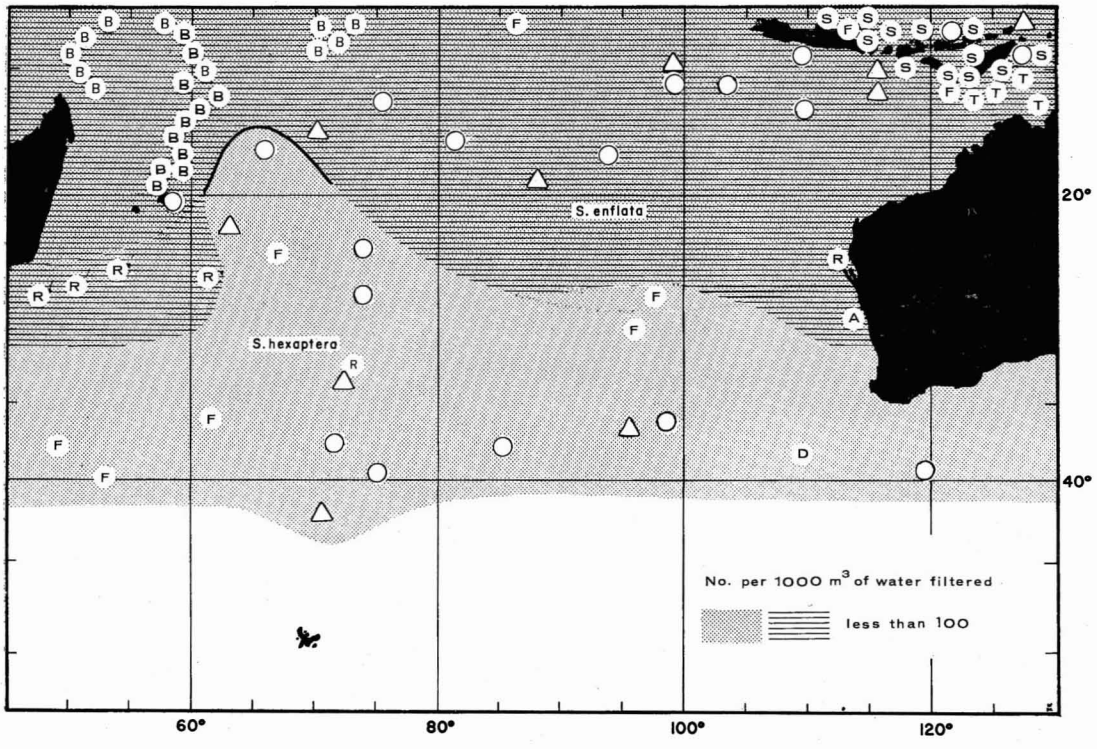

FIG. 4. Distribution of *S. enflata* and *S. hexaptera* in the Indian Ocean, including positive records from previous expeditions.

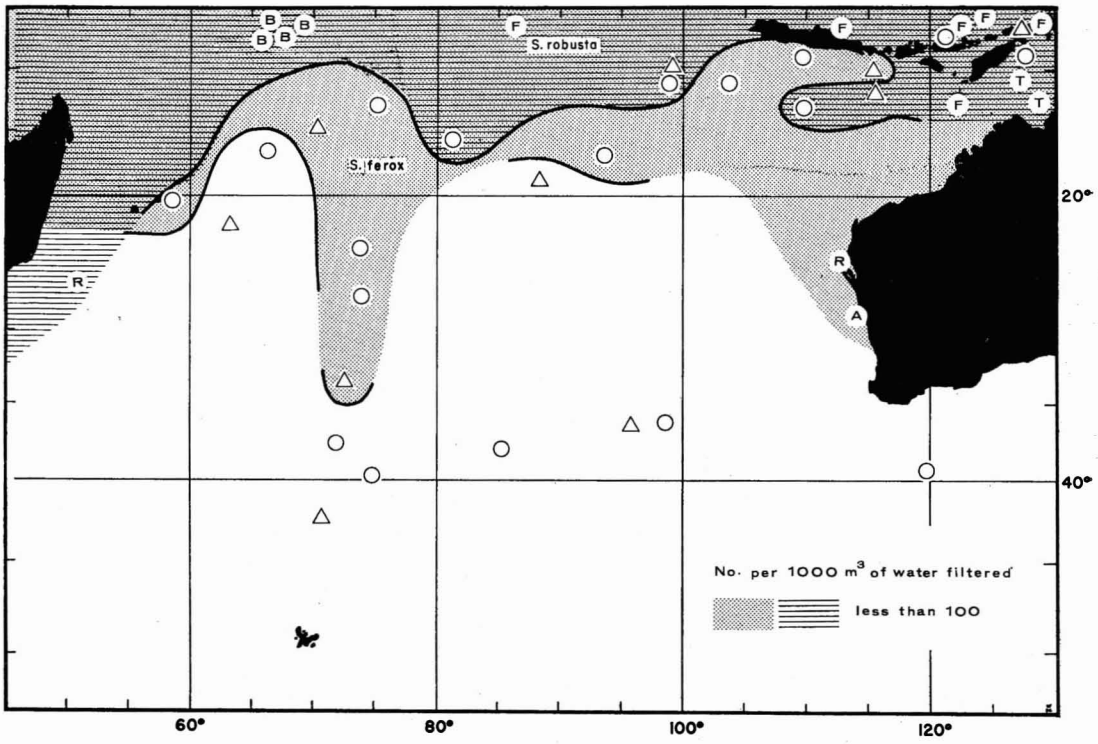

FIG. 5. Distribution of *S. robusta* and *S. ferox* in the Indian Ocean, including positive records from previous expeditions.

(1926), George (1949, 1952), Oye (1918), Ritter-Zahony (1909, 1910, 1911), and Schilp (1941) recorded both under the *S. robusta* synonymy. Rao (1958*a, b*) and Rao and Ganapati (1958) records of *S. robusta* probably correspond to *S. ferox* and those of *S. hispida* to *S. robusta.* Tokioka (1940) recorded both species in 1955, and in 1956*b* only *S. robusta,* in 1956*a*, both species, although *S. ferox* is recorded under the *S. ai* Tokioka synonymy. Other records: Chacko (1950), John (1933, 1937), and Varadarajan and Chacko (1943).

S. bipunctata was abundant in the stations north of 30° S. According to the data obtained, it appears that the populations of *S. bipunctata* of the Indian and Pacific oceans connect along the Indonesian seas, as no *S. bipunctata* was observed south of parallel 30° S; while the 35° S parallel appears to be the southern boundary for this species in the Pacific (Alvariño, 1964*a,* and other unpublished data; Bieri, 1959). It inhabits the Tropical Equatorial and Central Pacific waters. Other records in the Indian Ocean: Baldasseroni (1915), Béraneck (1895), Cleve (1901), Oye (1918), Rao (1958*a*), Rao and Ganapati (1958), Ritter-Zahony (1910, 1911), Schilp (1941), Thomson (1948), and Tokioka (1940, 1955, 1956*b*). The Burfield and Harvey (1926) and George (1952) drawings of *S. hispida* are more likely to be of *S. bipunctata.*

S. bedoti appeared abundantly in the Indonesian seas to the southwest of Java, a position between Cocos Keeling Isl. and the Christmas Islands. Other records in the Indian Ocean: Baldasseroni (1915), Béraneck (1895), Burfield and Harvey (1926), Doncaster (1903, as *S. polydon*), Fowler (1906), George (1952), Lele and Gae (1936), Pillai (1944), Rao (1958*a*), Rao and Ganapati (1958), Ritter-Zahony (1910) Schilp (1941), Subramanian (1940), and Tokioka (1955, 1956*a, b*).

S. neglecta was recorded only at station 11 (11° 15′ S—103° 32′ E). Other records in the Indian Ocean: Baldasseroni (1915), Burfield

and Harvey (1926), Chacko (1950), Doncaster (1903, as *S. septata*), Fowler (1906), George (1949, 1952), John (1933, 1937), Oye (1918), Rao (1958*a*, *b*), Rao and Ganapati (1958), Schilp (1941), Tokioka (1955, 1956*b*), Varadarajan and Chacko (1943).

S. pulchra was observed in the Indonesian seas and in the Equatorial Indian waters as far as the Mauritius Islands. Other records in the Indian Ocean: Baldasseroni (1915), Burfield and Harvey (1926), Doncaster (1903), Fowler (1906), George (1949, 1952), Oye (1918), Rao (1958*a*, *b*), Rao and Ganapati (1958), Ritter-Zahony (1910), Schilp (1941) and Tokioka (1955).

S. minima, cosmopolitan in the warm and temperate waters, should be expected in the Central Indian Ocean waters. However, it was only observed in very small numbers at stations 11, 13, 15 (11° 15′ S—103° 32′ E, 17° 01′ S—93° 28.6′ E, 12° 57.9′ S—75° 13.6′ E) respectively. The samples studied showed an abundance of *S. bipunctata* and a scarcity of *S. minima,* whereas the opposite was found by Tokioka (1956*a*). The samples examined by Tokioka (loc. cit.) were taken on December 11, 1954—January 16, 1955, and the Monsoon samples from October 22, 1960—January 9, 1961, which is practically during the same monsoon regimen. Therefore, no speculation could be made based on the monsoon influence in the distribution of these species. In the samples from the Naga Expedition in the South China Sea and the Gulf of Siam (Alvariño, unpublished data), *S. bipunctata* appeared also more abundant than *S. minima,* unlike the quantitative pattern shown by both species in the North Pacific. Other records of *S. minima* in this ocean: Ritter-Zahony (1910, 1911), Schilp (1941), Thomson (1948), and Tokioka (1955, 1956*a*).

S. regularis extended in the Equatorial waters as far as the Mauritius Islands. Although no specimens of *S. regularis* were observed at the stations in the Indonesian seas, it is reasonable to assume that the species extends along those paths to the Pacific. Large numbers of *S. regularis* were observed in the samples of the Naga Expedition, from the Gulf of Thailand and the South China Sea (Alvariño, unpublished data). The lack of positive records in regions where the presence of this species is to be expected, is likely due to the small size of the *S. regularis* which could easily escape owing to the size of the mesh used in the nets. The species has been recorded by previous workers in the Indonesian region. Other records in the Indian Ocean: Burfield and Harvey (1926), Doncaster (1903), Fowler (1906), George (1952), Menon (1945), Oye (1918), Rao (1958*a*, *b*), Rao and Ganapati (1958), Ritter-Zahony (1910, 1911), Schilp (1941), and Tokioka (1955, 1956*a*, *b*).

S. decipiens extended along the strata below 250 m from the northern part of the region covered in the Indian Ocean to 37° S. In the Pacific it extended along those strata from 40° S (Alvariño, 1964*b;* Bieri, 1959). Other records in the Indian Ocean: Burfield and Harvey (1926), David (1958), Fowler (1906) as *S. sibogae,* Rao and Ganapati (1958), Ritter-Zahony (1911), and Schilp (1941).

S. planctonis was observed along the northern part of the Subantarctic West Wind Drift extending into the Subtropical Convergence in the Indian Ocean. It was found below the 200-m level up to 36° S, and in deeper waters up to 22° S (mid-water trawl from 2000 m deep, one specimen). The connection of the populations of *S. planctonis* of the Indian and Pacific oceans evidently occurs along the south Australian seas. Its distribution in the Pacific was also found limited by the Subtropical Convergence towards the north (Alvariño, 1964*b*). *S. zetesios,* a species closely related to *S. planctonis,* extends along the mesoplanktonic domain of the Tropical, Equatorial, and Central Indian waters. The two-dimensional pattern of distribution for *S. zetesios* overlaps that of *S. planctonis* at mid-water trawl station 8 (22° 04′ S—63° 02′ E), where one specimen of *S. planctonis* and two of *S. zetesios* were observed in a haul taken from 2000 m. At mid-water trawl 9 (33° 19′ S—72° 34′ E) taken from 1878 m, 38 specimen of *S. zetesios* were recorded with only three specimens of *S. planctonis.* The *S. planctonis* domain, then, extended south of that boundary.

The Burfield and Harvey (1926), George (1952), and John (1937) records of *S. planctonis* are most likely to be *S. zetesios* in view of the location of the observations and the drawings and descriptions of the species included in the

respective publications. David's (1959) records of *S. zetesios* should have included *S. planctonis*. Fowler (1906) recorded *S. zetesios* and, in species "incertae," *S. planctonis*. Schilp's (1941) records of *S. planctonis* may apply to *S. zetesios*. Ritter-Zahony (1911) observed *S. planctonis* at about 44° S in the Southwest Indian Ocean and in the Subantarctic-Antarctic waters of the Southwest Indian Ocean. Tokioka's (1940) records of *S. planctonis* from Australian waters are accurate, but those of *S. planctonis* from Japanese waters may apply to *S. zetesios*. The discrepancy Tokioka refers to in relation to the percentage of the length of the tail segment to the total length between those populations indicates that he was dealing with two different species: *S. zetesios* in the Japanese waters and *S. planctonis* in the New South Wales region. This is also understood when observing the drawings that appear on page 374 (loc. cit.): Fig. 8A is *S. planctonis* (the anterior end of the anterior fins reaches the level of the middle of the ventral ganglion); and Fig. 8D is *S. zetesios* (the anterior end of the anterior fins reaches the level of the posterior end of the ventral ganglion). (See original descriptions of Steinhaus, 1896, and Fowler, 1905.)

Krohnitta subtilis populates the Equatorial and Central Indian Ocean, and does not reach the boundaries of the Subtropical Convergence. The Indo-Pacific populations connect through the Indonesian seas. Other records in the Indian Ocean: Burfield and Harvey (1926), Fowler (1906), George (1952), Rao (1958*a*), Ritter-Zahony (1910, 1911), Schilp (1941), and Tokioka (1940, 1955, 1956*a, b*).

K. pacifica was observed only at station 8 (north of Flores Island). This species is not so widely distributed as is its congeneric *K. subtilis*, and is for the most part restricted to the Equatorial waters. This is the only equatorial-tropical species of chaetognath common to these regions in the Atlantic, Indian, and Pacific oceans. The presence of this species in the Equatorial-Tropical Atlantic suggested one of two hypotheses: either it is conveyed by the Agulhas Current into the Benguella Current and assimilated by the Equatorial Current, or the populations of *K. pacifica* at both sides of Central America, although long isolated, still somehow remain unchanged morphologically, but the process of divergence is noticed. There are no conveniently available samples and data from the Atlantic to explain this problem. However, Heydorn (1959) did not observe it in the Benguella region.

Other records in the Indian Ocean: Burfield and Harvey (1926) under the *K. subtilis* synonymy; Chacko (1950), Doncaster (1903), Fowler (1906), George (1952), Oye (1918) as *K. kerberti*; Pillai (1945), Rao (1958*a, b*) Rao and Ganapati (1958), Ritter-Zahony (1910), Schilp (1941), Tokioka (1955, 1956*a, b*), and Varadarajan and Chacko (1943).

Pterosagitta draco inhabits the Equatorial and Central Indian waters, and its extension southward is apparently limited by the Subtropical Convergence. Other records in the Indian Ocean: Baldasseroni (1915), Béraneck (1895), Burfield and Harvey (1926), Doncaster (1903), Fowler (1906), George (1952), Rao (1958*a, b*), Rao and Ganapati (1958), Ritter-Zahony (1910, 1911), Schilp (1941), and Tokioka (1940, 1955, 1956*a, b*).

Eukrohnia hamata was recorded at the stations along the southernmost part of the region sampled, in hauls taken from 283 and 268 m deep, and the records taken in the central gyral were from 1878 m deep. There are two possible alternatives: (1) *E. hamata* does not progress northward from the boundary of the Subtropical Convergence in the Indian Ocean, or (2) if it does progress northward it is not very abundant and hence is missed by the sampling, or it may appear in layers deeper than those mostly sampled. Other records in the Indian Ocean: Burfield and Harvey (1926), Fowler (1906), Ritter-Zahony (1911), and Schilp (1941).

E. fowleri was recorded at the mid-water trawls 2, 3, 4, and 10, taken from 2121, 2179, 1721, and 2060 m deep, respectively. In all probability, *E. fowleri* populates the deep layers (below 1600 m) of the Indian Ocean, as it does in the Pacific and Atlantic. The species *E. fowleri* was only recorded at the boundary of the Indian Ocean and the Indonesian seas. A peculiarity of this species is that it emerges to higher levels in the Equatorial regions than in others in the Pacific (author's unpublished data), and that the populations extend along deeper levels in other parts of the oceans. Other records

in this region: Ritter-Zahony (1911), and Schilp (1941).

E. bathypelagica was represented by only one specimen at mid-water trawl 3 (11° 56′ S—115° 22′ E) taken from 2179 m. This single record could be considered as a stray of the population extending along deeper levels. This is the first record of the species occurring other than in the Pacific Ocean (Alvariño, 1962*a*). This species could not be the spent stage of *E. hamata,* in view of the morphological characteristics and the size reached at maturity (*E. bathypelagica* 23 mm, and *E. hamata* 43 mm).

Sagitta hexaptera is the most common species in the region of the Indian Ocean covered by the Monsoon Expedition, followed by *P. draco, S. pacifica, S. ferox, S. bipunctata,* and *K. subtilis.* The species appearing in the highest number relative to the frequency were, in regressive order: *S. gazellae, S. bedoti, S. enflata, S. pacifica,* and *S. tasmanica.*

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