

THE DISTRIBUTION AND BIOLOGY OF POLYNEMIDS CAUGHT  
BY BOTTOM TRAWLING IN INDIAN SEAS BY THE  
R/V ANTON BRUUN, 1963

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INTRODUCTION

BOTTOM trawling surveys were conducted in 1963 by the R/V ANTON BRUUN in the Bay of Bengal (cruise 1) and in the Arabian Sea (cruise 4B) as part of the U.S. Programme in Biology of the International Indian Ocean Expedition. As part of this programme, various investigators were to work on the systematics and biology of various families in the collection. This study of the threadfins, family Polynemidae, delineates their distribution and includes notes on their biology. Interest in the threadfins was aroused in the field, where it proved difficult to identify even the predominant species and variations in the counts of free pectoral fin rays and extensive hermaphroditism were observed.

*Polydactylus indicus* (Shaw), *P. plebeius* (Broussonet), *P. xanthonemus* (Valenciennes), *P. sextarius* (Bloch), and *Polynemus paradiseus* (Linnaeus) were represented in our samples. These species were among the eight threadfins listed by Day (1958) from Indian seas. *Polydactylus sextarius* var. *mullani* (Hora), which was not listed by Day, was also caught during the surveys.

GEAR AND METHODS

Throughout the surveys, a Gulf of Mexico shrimp trawl (Schaefers and Johnson, 1957) was used. The trawl had a stretched mesh size of 3.8 cm. and measured 13 m. along the footrope. Bridle lines 46 m. long connected the trawl to a single towing warp. Rectangular otterboards 0.8 by 1.5 m., weighing 73 kg. each, were attached to the wings of the trawls when trawling was at depths less than 366 m. Boards with the same dimensions, but weighing 118 kg. each, were used when trawling was at greater depths. The trawl was towed off an A-frame on the starboard side and was set out at vessel speeds of 6 to 8 knots. The cable was payed out at 40 to 60 m. per minute. Attempts were made to keep the trawling speed at 2 to 3 knots. The scope ratios were consistent with those found satisfactory in exploratory trawling with the same type of gear in the north-eastern Pacific Ocean by Pereyra (1963). Barring equipment failures, 'hang-ups', or unfavourable bottom conditions, the trawl was usually fished 30 to 45 minutes on cruise 1, and 45 minutes (in depths less than 183 m.) to 1 hour (at greater depths) on cruise 4B.

Water samples for oxygen, phosphate, and salinity determinations and temperature readings were obtained before each drag of the trawl by lowering a Nansen bottle to a few meters off the bottom. Bottom sediment samples were collected with a Dietz-LaFond snapper at nearly all of the trawling stations.

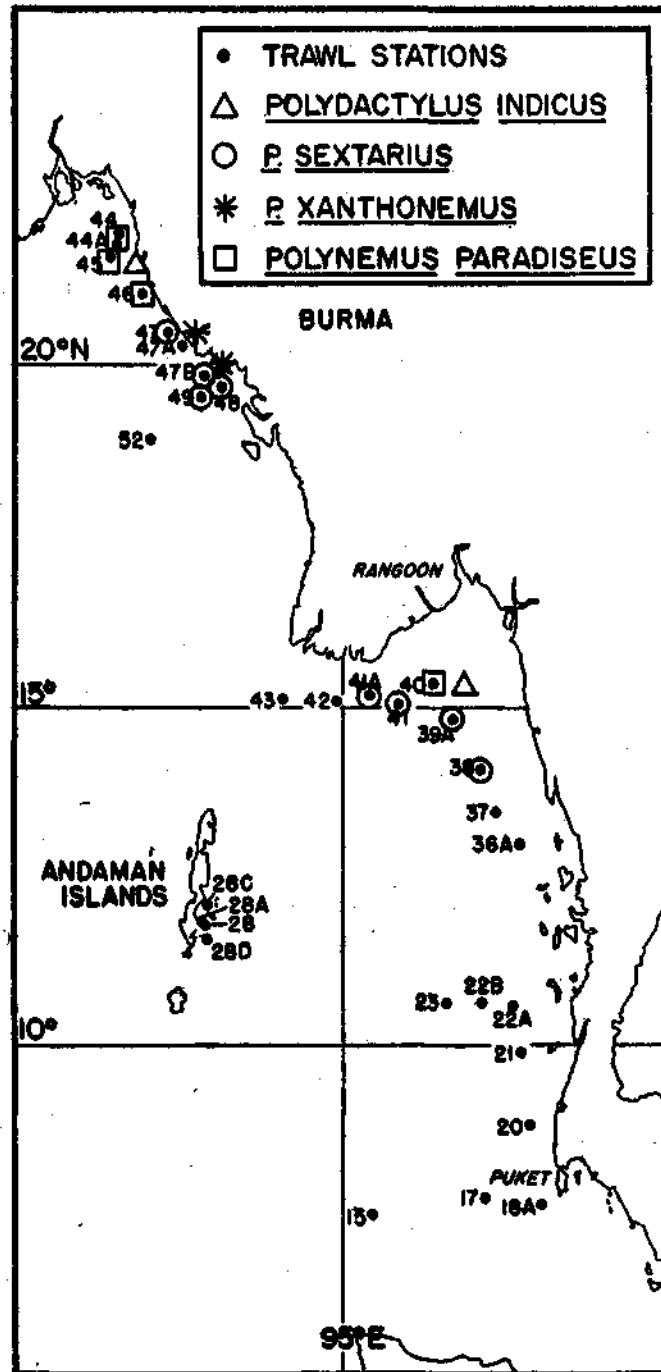


FIG. 1. The distribution of threadfin species caught in the Bay of Bengal on cruise 1 of the ANTON BRUUN.

The fish collected were preserved in the field in 10 per cent formalin, and were later sent to the Smithsonian Oceanographic Sorting Center where they were separated by families, transferred to alcohol, and shipped to the various investigators.

The threadfins were identified to species, measured, and sexed. The stomach contents from a small number were examined. Gonads from which sex could not be readily determined were sectioned and prepared as slides for microscopic examination. The data from the two cruises were analyzed separately. The results are presented under the headings of the two major ocean areas surveyed.

#### BAY OF BENGAL

The survey in the Bay of Bengal was conducted from 12 March to 11 April 1963 on cruise 1 of the *ANTON BRUUN*. Of 31 trawl hauls attempted, 27 were successful, and threadfins were taken in 13. Trawling depths ranged from 15 to 516 m., but most hauls were made on the Continental Shelf in depths shallower than 183 m. Four species of threadfins, 1 to 174 individuals per tow, were caught in depths of 15 to 73 m. The fish ranged from 2 to 94 cm. in standard length<sup>1</sup>; most were shorter than 20 cm. The localities of collection of threadfin species caught on cruise 1 are shown in Figure 1. The station data are given in Table I. The results of this study are presented in the following sections by species.

##### *Polydactylus sextarius* (Bloch)

This small, golden-brown species, though caught in small quantities, occurred very frequently. It is known to inhabit the east coast of Africa, the seas of India, and the Malay Archipelago to China. Day (1958) reported it to be numerous along the coasts of India. It was readily identified by descriptions given by Day (1958) and Weber and de Beaufort (1922). The number of free pectoral fin rays, an important character for identification of the species, varied slightly from the normal 6-6; counts for 168 specimens are given in Table II.

*Size and Sex*: Day (1958) reported this species to attain total lengths up to 19 cm. The fish collected in the present survey ranged from 5.0 to 14.5 cm., standard length. A standard length of 14.5 cm. approximates 19 cm. in total length. Similarly, a length range of 2.5 to 15.2 cm. (average, 9.2 cm.), was reported by Naumov (1961) for this species off the east coast of India. The length-frequency distribution of 168 specimens is shown in Figure 2 after smoothing by threes. Modes are at 6.5 cm. and 10.0-10.5 cm.; a possible third mode is at 13.5 cm.

Of 140 specimens examined, 112 were hermaphroditic, 27 were mature females, and 1 was a male. The lone male was probably a hermaphrodite whose ovaries had deteriorated and were not recognized. Many of the gonads showed signs of deterioration, which probably took place before preservation in the field. The ovo-testis was divided longitudinally; both the ovary and testis extended the full length of the gonad. Nayak (1959a) described the ovo-testes in hermaphroditic *Polydactylus heptadactylus* as consisting of closely juxtaposed milky white testes ventral to transparent (immature) ovaries that rest against the body wall. The ovo-testes in *Polydactylus sextarius* fit Nayak's description very well. The hermaphrodites

<sup>1</sup> The fish lengths were measured to the nearest 0.1 cm and are given in standard length (tip of the snout to the tip of the hypural fan) unless indicated otherwise.

TABLE I

Data for stations where Polynemidae were collected during cruise 1 of the ANTON BRUUN, Bay of Bengal, 1963

[Asterisks indicate estimated catches]

Station No.	Date 1963	Latitude N	Longitude E	Time (LCT) <sup>1</sup>	Depth m.	Number caught	Bottom				
							Type <sup>2</sup>	Temp. °C	Salinity (‰)	Oxygen (ml./l)	Phosphate (µgA/l)
<i>Polydactylus sextarius</i>											
38	3/30	14°07'	97°05'	2308-2338	69-73	1	S	24.12	33.88	1.71	0.31
39A	3/31	14°52'	96°39'	0714-0759	48-64	20	M	23.98	34.00	1.99	1.11
41	3/31	15°03'	95°50'	1810-1855	44-46	58*	NS	25.85	33.32	3.03	0.36
41A	3/31-4/1	15°13'	95°23'	2318-0003	29-33	22	NS	—	—	—	—
47	4/5	20°27'	92°20'	0738-0823	19-20	59*	M	26.61	32.99	4.43	2.43
47B <sup>3</sup>	4/5	19°50'	92°55'	1507-1552	22-30	1	R,M	—	—	—	—
48	4/5	19°41'	93°08'	2017-2047	38-42	4	M	26.16	33.27	3.27	0.53
49	4/6	19°32'	92°52'	0123-0153	53	4	M	25.52	33.59	3.01	0.63
<i>Polynemus paradiseus</i>											
40	3/31	15°20'	96°24'	1148-1233	26-27	29	M	27.82	31.94	3.97	0.57
44	4/4	21°52'	91°36'	1400-1445	15	92*	M	27.64	26.56	4.16	0.92
44A <sup>4</sup>	4/4	21°43'	91°33'	1610-1620	15	4	NS	—	—	—	—
45	4/4	21°32'	91°29'	1800-1845	17	6	NS	26.09	31.74	1.99	0.76
46	4/5	21°00'	91°59'	0050-0135	23-25	2	S,M	26.68	32.60	4.86	0.11
<i>Polydactylus xanthonemus</i>											
47	4/5	20°27'	92°20'	0738-0823	19-20	115	M	26.61	32.99	4.43	2.43
47B <sup>3</sup>	4/5	19°50'	92°55'	1507-1552	22-30	1	R,M	—	—	—	—
<i>Polydactylus indicus</i>											
40	3/31	15°20'	96°24'	1148-1233	26-27	2	M	27.82	31.94	3.97	0.57
45	4/4	21°32'	91°29'	1800-1845	17	1	NS	26.09	31.74	1.99	0.76

<sup>1</sup> Estimated time the trawl was on the bottom<sup>2</sup> M=mud; R=rock; S=sand; NS=not sampled.<sup>3</sup> The trawl was badly torn; not quantitative.<sup>4</sup> Rudder jammed; a 10-minute circular tow.

TABLE II

Counts of free pectoral fin rays of threadfins caught in the Bay of Bengal and Arabian Sea on cruises 1 and 4B of the ANTON BRUUN

Species	Region of collection <sup>1</sup>										
		5L-5R	5L-6R	6L-5R	6L-6R	6L-7R	7L-6R	7L-7R	7L-8R	8L-7R	
<i>Polydactylus sextarius</i> .. ..	BB	2	1	..	165	..	..	..	..	..	
<i>Polydactylus xanthonemus</i> .. ..	BB	1	1	1	110	..	2	..	..	..	
<i>Polydactylus indicus</i> .. ..	BB, AS	6	..	..	..	..	..	..	..	..	
<i>Polydactylus sextarius</i> var. <i>mullani</i> ..	AS	..	..	..	9	9	10	534	1	1	
<i>Polydactylus plebeius</i> .. ..	AS	10	..	..	..	..	..	..	..	..	
<i>Polynemus paradiseus</i> .. ..	BB	..	..	..	..	..	..	133	..	..	

<sup>1</sup>BB=Bay of Bengal; AS=Arabian Sea

ranged from 5.0 to 13.4 cm. ; most of them had a preponderance of primordial ova and a few had ovaries in the early developmental stages. The hermaphrodites with

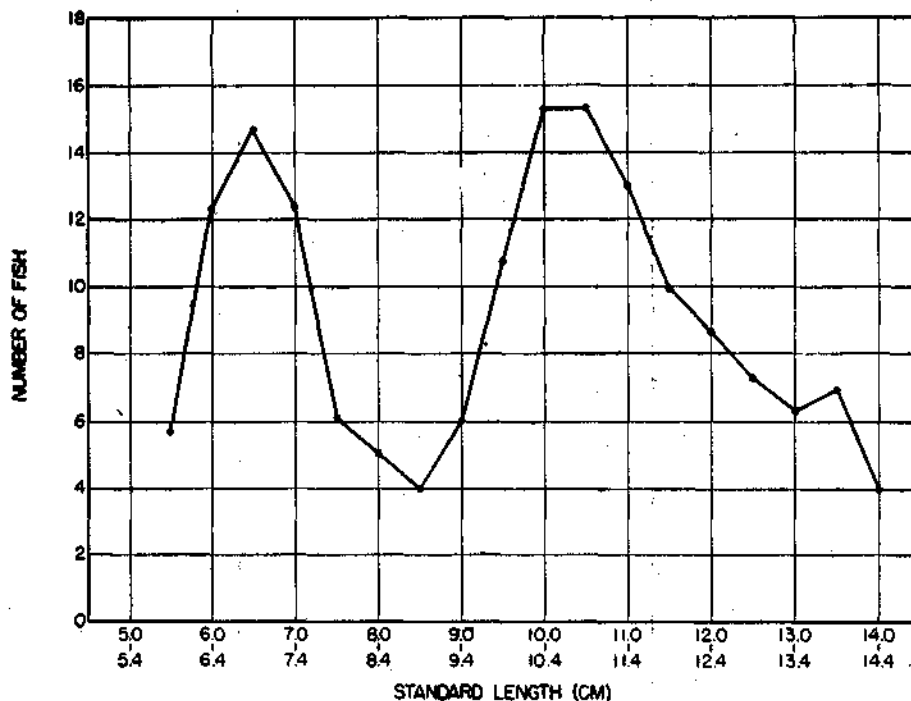


FIG. 2. Length-frequency distribution of 168 *Polydactylus sextarius* collected in the Bay of Bengal in 1963 on cruise 1 of the *ANTON BRUUN* (data smoothed by threes).

relatively large testes (classified as mature males) were 9.0-13.4 cm. long ; those with granulated ova about 0.3-0.5 mm. in diameter (classified as mature females) ranged from 10.5 to 14.9 cm. (fig. 3). *P. sextarius* undergoes a protandrous change through a juvenile-hermaphrodite-female progression. This species first reached sexual maturity as a functional male hermaphrodite ; there was no evidence that females developed directly from juveniles. In his study of the West African polynemids, Longhurst (1965) reported a protandrous change for *Galeoides decadactylus*, which passed through a juvenile-male-hermaphrodite-female progression. He also reported that some fish developed directly from juveniles to females.

**Food:** The stomach contents of 10 *P. sextarius* from station 41 (south of Rangoon) and 15 from station 47 (south of Chittagong) were examined. These stations were chosen to obtain a representation of organisms in the diet of fish from slightly different environments (see Table I). The results are shown in Table III and discussed in the following paragraphs.

**Station 41**—Shrimps and amphipods were in all of the stomachs ; other important forms (in 50% or more of the stomachs) were crabs, mysids, fish, and polychaetes. Shrimps, ranging from a few millimeters to about 2 cm. long and from 1 to 30 per stomach, were considered the most important food item. *Solenocera indicus* (?), *Penaeus indicus* (?), and members of the family Processidae were some

of the shrimps. *Gammarus*, *Jassa*, *Cheiriphotis*, and *Harpinia* were among the amphipod genera represented. The gammarids were very tiny and considered of minor

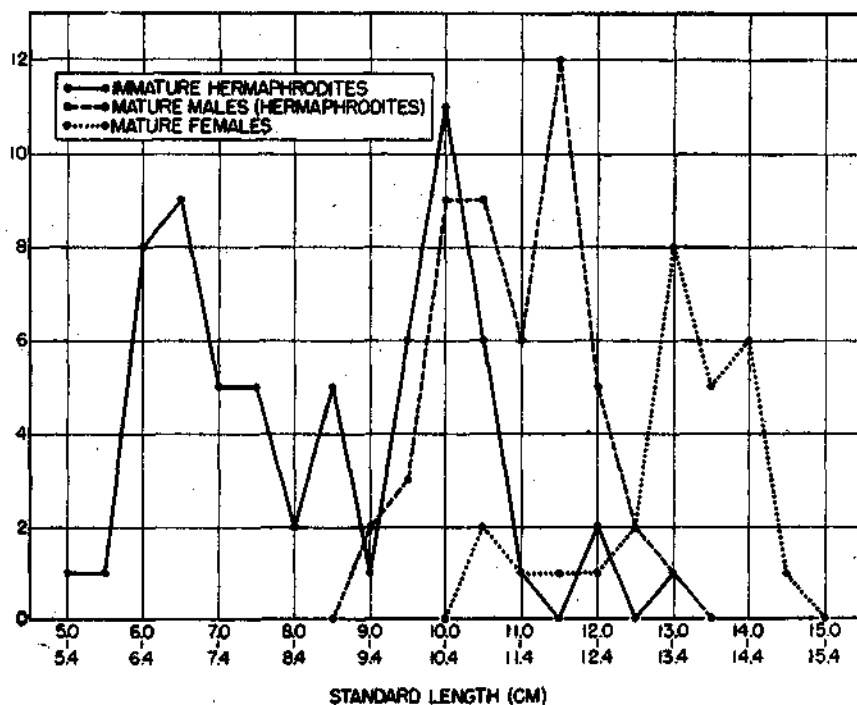


FIG. 3. Length-frequency distribution of *Polydactylus sextarius*, by sex and maturity.

dietary importance. The tiny swimming crabs, which were only a few millimeters long, were *Charybdis callianassa* and species of the genus *Neptunus*. A crawling type was not identified. The mysids were represented by *Erythrops minuta*, *Neomysis indica*, and *Hypererythrops spinifera*. Other organisms included *Squilla oratoria inornata* (stomatopod), Bothidae (flatfish), *Cirolana* (isopod), *Eucalanus* (copepod), Scyllaridae (squat lobster) and Callianassidae (anomuran).

*Station 47*—Shrimps were in all the stomachs and were the most important food. They were a few millimeters to 3 cm. long and included members of the families Pandalidae, Alpheidae, Penaeidae, and Sergestidae (*Lucifer hansenii*). Gammarid amphipods were common, but again were considered of little importance because of their minute size. Also present was a portunid megalops and a mysid, *Acanthomysis indica*.

Principal food differences between fish from the two stations were the absence of fish and polychaetes and the low incidence of mysids and crabs in the specimens from station 47. This species fed on a wide variety of organisms, but seemed to prefer small crustaceans, especially shrimps. Mookerjee, Ganguly, and Mazumdar (1946), who examined the stomach contents of 10 *P. sextarius*, reported that the food consisted mostly of crustaceans.

***Polynemus paradiseus* (Linnaeus)**

This was the only species in the genus *Polynemus* sampled during the two ANTON BRUUN surveys. Day (1958) reported that it inhabited the Bay of Bengal and

TABLE III

Frequency of occurrence (%) of organisms in the stomachs of three species and one subspecies of threadfins from the Bay of Bengal or Arabian Sea, collected during cruises 1 and 4B of the ANTON BRUUN.<sup>1</sup>

Item	<i>Polydactylus sextarius</i>	<i>Polynemus paradiseus</i>	<i>Polydactylus xanthonemus</i>	<i>Polydactylus sextarius</i> var. <i>mullani</i>
Station No.	41	47	40	44
Number examined	10	15	10	33
Food item				
Protozoa :				
Foraminifera	..	20.0	..	..
Annelida :				
Polychaeta	50.0	..	..	..
Arthropoda :				
Cladocera	..	6.7	..	..
Ostracoda	10.0	..	..	..
Copepoda	10.0	..	20.0	24.2
Cirripedia	..	..	..	40.0
Mysidacea	70.0	6.7	30.0	..
Cumacea	..	..	10.0	..
Isopoda	30.0	6.7	..	..
Amphipoda	100.0	46.7	60.0	6.1
Decapoda :				
Shrimp	100.0	100.0	100.0	90.9
Macrura	10.0	..	..	..
Anomura	20.0	..	..	..
Brachyura	80.0	6.7	10.0	24.2
Stomatopoda	40.0	6.7	10.0	..
Mollusca :				
Gastropoda	10.0	..	..	..
Pelecypoda	30.0	..	..	..
Echinodermata :				
Ophiuroidea	..	..	..	..
Chaetognatha	..	..	..	..
Pisces	50.0	..	90.0	..

<sup>1</sup>Stations 40, 41, 44, and 47 were in the Bay of Bengal; the stations where *P. sextarius* var. *mullani* was taken were in the Arabian Sea; station locations are shown in figures 1 and 6.

the coasts of Burma and the Malay Archipelago. He also described the pectoral fins as gray and the free pectoral fin rays as about twice the length of the fish. All of our specimens had 7-7 free pectoral fin rays. Many of the free pectoral fin rays were broken, but those intact measured nearly twice the body length. The pectoral fins were either light tan or gray, and at times with less than 50 per cent of their outer edges black. This difference in coloration was not due to sexual dimorphism, but was believed to be the result of fading. This observation was made since *P. hilleri* (Fowler) closely resembles *P. paradiseus* but differs mainly by having more than two-thirds of the outer edges of its pectoral fins black.



**Size and Sex:** The length-frequency distribution of *P. paradiseus* is shown in Figure 4 after smoothing by threes. Two modes were apparent—one at 8.5 cm. and the other at 12.0 cm. Of 125 fish sexed, 86 (66.7%) were females and 39 (33.3%) were males. The percentage of males and females was about equal in the first modal group at 8.5 cm., but nearly all of the fish in the modal group at 12.0 cm. were females. Only two females, 12.2 cm. and 14.3 cm. long, were classified as mature. Hermaphroditism was not displayed. Jones and Menon (1953) reported that this species supports a minor fishery in India, especially from April to June, when the fish ascend the rivers to breed. These collections included young of the year, juveniles up to 7 cm. long and fish 12.5-17.5 cm. long, but lacked fish between these two size groups. They also mentioned that males predominated in the bottom setline catches, which were of the largest size group, and surmised that females did not bite while in spawning condition.

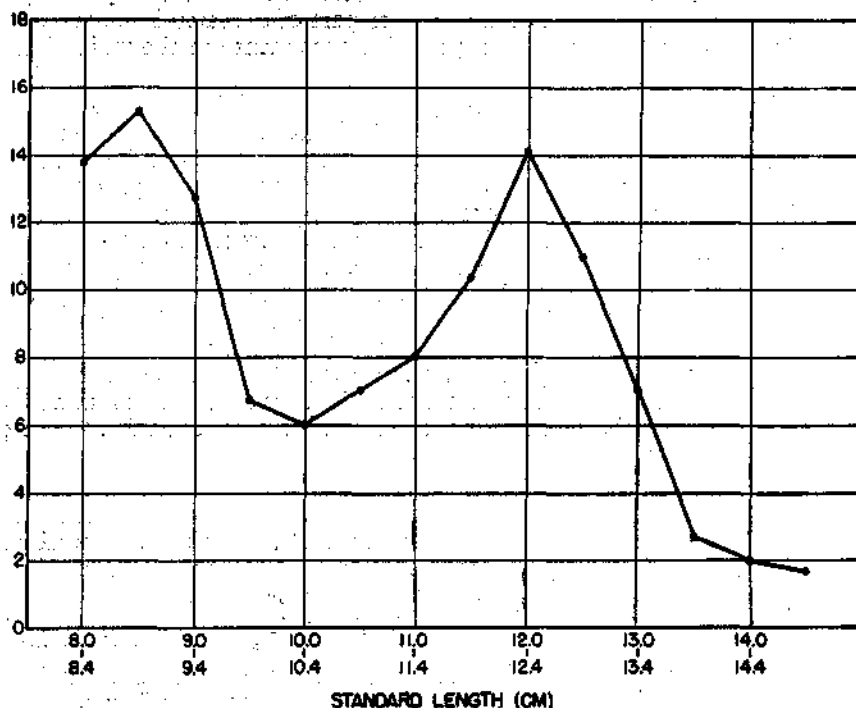


FIG. 4. Length-frequency distribution of 133 *Polynemus paradiseus* caught in the Bay of Bengal on cruise 1 of the ANTON BRUUN (data smoothed by threes).

**Food:** The stomach contents of 43 *P. paradiseus* from two localities with slightly differing environments were examined. The results are shown in Table III and discussed below.

**Station 40**—In the 10 specimens, shrimps occurred most frequently, followed by fish and amphipods. The shrimps were represented by *Solenocera indicus* (?) and others belonging to the families Penaeidae and Alpheidae; they were from 0.5 to 1.5 cm. long. The fragmentary skeletal remains of fish could not be identified. Tiny gammarid amphipods were frequent. Other organisms included *Paracalanus* sp. (copepod), *Neomysis hodgarti*, (mysid), and *Squilla oratoria inornata*.

**Station 44**—In the 33 individuals, shrimps were the most important food. Copepods and crabs ranked next in importance. Among the shrimps, which measured from a few millimeters to 4 cm., were *Parapeneopsis styliifera*, *P. uncta*, *Metapenaeus brevicornis*, and *Penaeus indicus*. The crabs were the tiny *Charybdis callianassa*. *Calanopia elliptica* was the only copepod recognized.

The differences in food between the two localities were the lack of fishes and mysids and the low incidence of amphipods in the specimens from station 44. Crustaceans were the most important food, as Jones and Menon (1953) also found.

#### ***Polydactylus xanthonemus* (Valenciennes)**

This small species, caught at only two stations, was reported by Day (1958) to inhabit the seas from India to China. It resembled *P. sextarius* very closely, but differed in lacking a black blotch at the anterior part of the lateral line and a swim bladder. Counts of free pectoral fin rays of 115 specimens are shown in Table II.

**Size and Sex** : The length-frequency distribution of 115 specimens ranging from 9 to 12 cm. collected at station 47 is shown in figure 5. A single mode appeared at 10 cm. Of 109 fish for which sex was determined, 49 were males (with large testes), 42 were maturing or mature females, and 18 were hermaphroditic. The gonads of 16 of the hermaphrodites consisted of large mature testes and small immature ovaries; the two other hermaphrodites had small, immature ovo-testes. The males ranged from 9 to 11 cm., with a peak at 10 cm.; the females ranged from 10.0 to 11.5 cm., with a peak at 10.5 to 11.0 cm.; and the hermaphrodites ranged from 9.0 to 11.5 cm., with a peak at 10 cm. (Fig. 5). Since it is difficult to imagine that this species undergoes a protandrous change within such a narrow size range, it could be hypothesized that: (1) the females grow faster than the males; (2) the mortality among the males is greater than among females after the fish attain sizes greater than 10 cm.; or (3) the males of larger size were not available to the gear at the time of sampling.

**Food** : Mysids occurred most frequently (Table III) and were the most abundant form in the stomachs of 15 *P. xanthonemus* from station 47. *Acanthomysis indica* was the predominant mysid; others were *Gastrosaccus muticus*, *Pleuerythrops inscita*, and *Mysidopsis kempfi*. Penaeid and sergestid shrimps were less frequent, but were considered to be of primary dietary importance because they were much larger than mysids. Included were the sergestid, *Lucifer hanseni*, and the penaeid, *Processa aequimana* (?). Also present were gammarid amphipods, barnacle cyprides, and copepods. Copepods were represented by *Temora turbinata* and members of the genera *Calanopia*, *Oncaea*, and *Labidocera*.

#### ***Polydactylus indicus* (Shaw)**

This species was the largest of the threadfins caught during the 1963 surveys and the only one caught in both the Bay of Bengal and the Arabian Sea. It was readily identifiable from the description given by Day (1958). Since only three specimens were caught, food was not studied. The findings of several authors who reported on this species in the Arabian Sea are mentioned later in the discussion of collections in the Arabian Sea.

**Size and Sex** : A 94-cm. mature female and a 4.5-cm. juvenile were caught on station 40. The sex of an 85-cm. fish caught on station 45 could not be determined.

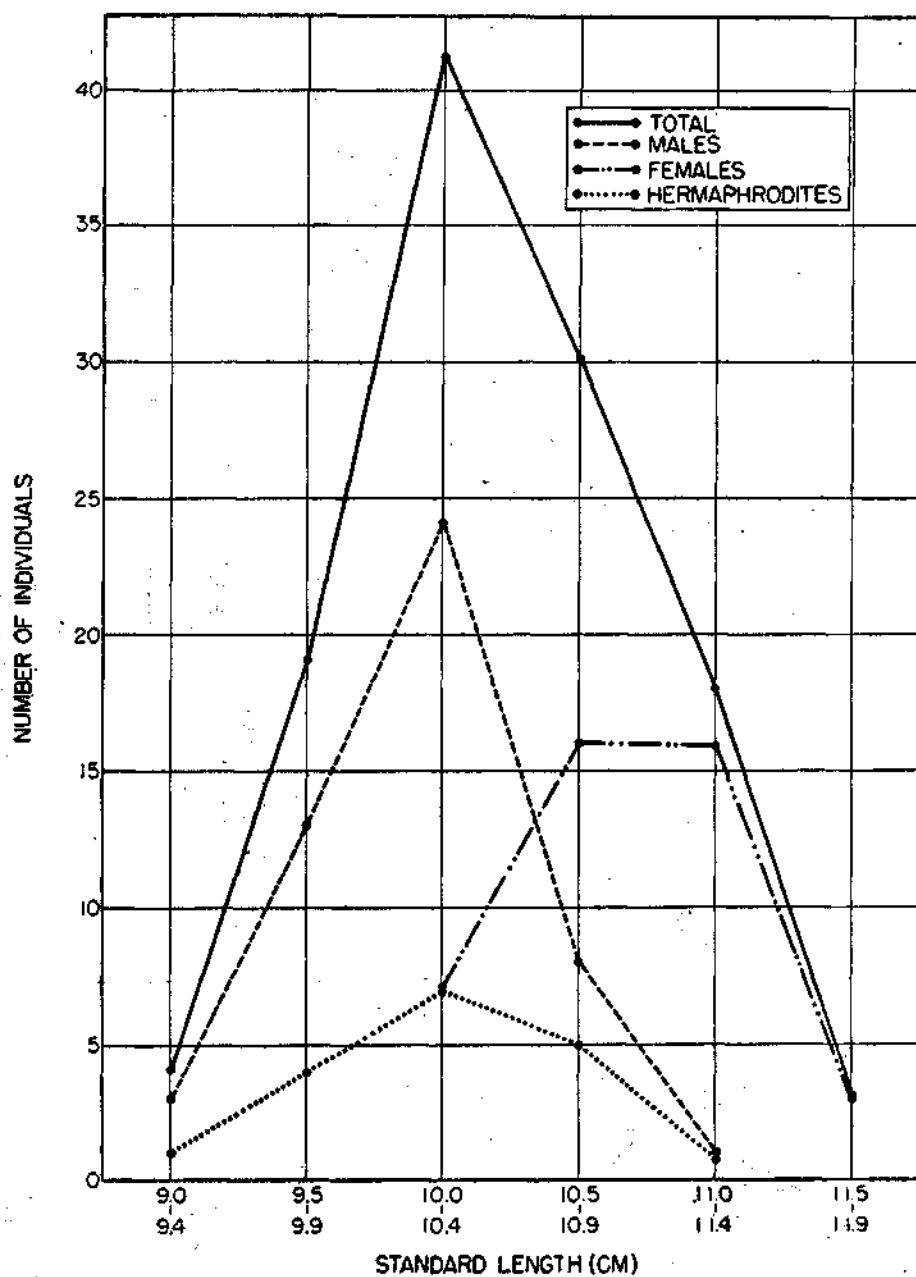


FIG. 5. The length-frequency distribution of 115 *Polydactylus xanthonemus* sampled in the Bay of Bengal during cruise 1 of the *ANTON BRUUN*. Six fish included in the graph for all fish were not included in the graphs for fish of different sex categories.

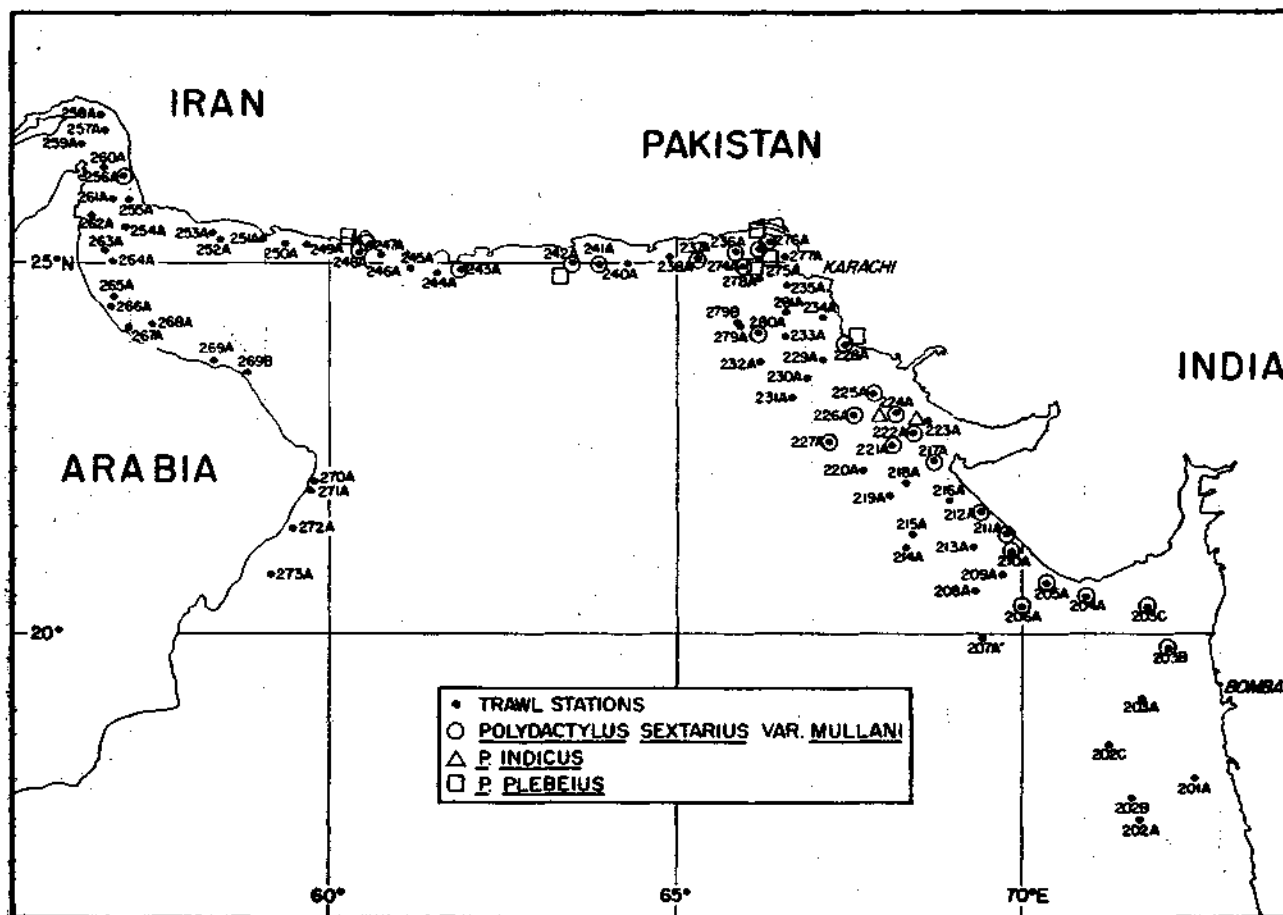


FIG. 6. Distribution of polynemids caught in the Arabian Sea on cruise 4B of the *ANTON BRUUN*, 1963.

The small catch would indicate that this species was scarce in the area surveyed. Since two large individuals were caught, however, more may have been present; probably representative samples were not taken by the trawls that were used.

#### ARABIAN SEA

The Arabian Sea survey was conducted from 12 November through 10 December 1963 on cruise 4B of the *ANTON BRUUN*. Of 77 successful trawl hauls (out of 86 attempted) in depths of 15 to 366 m., 28 hauls at depths of 18 to 122 m. took one or more threadfins (ranging up to an estimated 3,700 in a single haul). The specimens ranged from a few centimeters to 74 cm. in length; most were less than 20 cm. The localities of collection are shown in figure 6 and the pertinent station data are presented in Table IV. A total of 577 specimens, representing three species, was collected and examined. The results are discussed by species in the following sections.

#### *Polydactylus sextarius* var. *mullani* (Hora)

This small subspecies was caught at scattered stations from Bombay to the Gulf of Oman and was the most common threadfin sampled during the survey. Hora (1925) identified it and reported that the description given by Weber and de Beaufort (1922) for *P. sextarius* would, for the most part, suffice for the subspecies. He also reported it from Bombay and Sind. It was usually caught in small numbers—less than 100 per haul—but hundreds were taken in a few hauls and an estimated 3,700

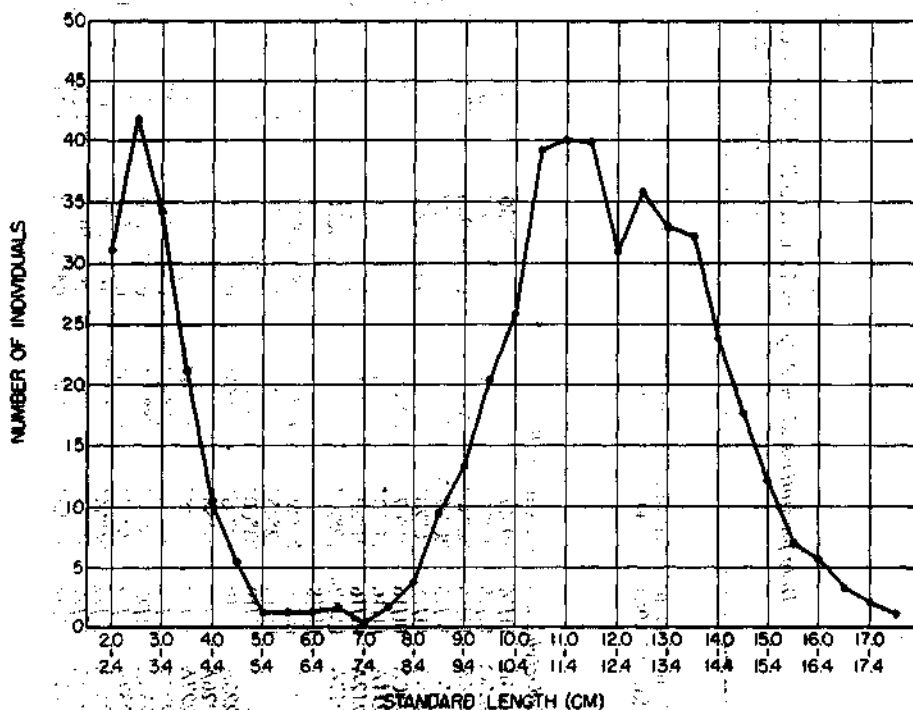


FIG. 7. Length-frequency distribution of 564 *Polydactylus sextarius* var. *mullani* caught in the Arabian Sea on cruise 4B of the *ANTON BRUUN* (data smoothed by threes).

TABLE IV

Data for stations where *Polynemidae* were collected during cruise 4B of the ANTON BRUUN, Arabian Sea, 1963  
[Asterisks indicate estimated catches]

Station No.	Date 1963	Latitude N	Longitude E	Time (LCT) <sup>1</sup>	Depth m.	Number caught	Bottom				
							Type <sup>2</sup>	Temp. °C	Salinity (‰)	Oxygen (ml./l)	Phosphate (µgA/l)
<i>Polydactylus sextarius</i> var. <i>mullani</i>											
203B	11/14	19°47'	72°04'	2050-2130	27-29	134*	M	22.95	36.01	0.83	2.17
203C	11/15	20°22'	71°47'	0203-0248	26	26	M	22.95	36.01	0.83	2.17
204A	11/15	20°30'	70°54'	0815-0900	33	3,700*	M	25.13	36.10	0.48	1.58
205A	11/15	20°42.5'	70°18.8'	1252-1337	43	1	M	25.49	36.25	1.72	1.30
206A	11/15	20°23'	70°00'	1710-1743	71-79	16	M,S,Sh	22.91	36.18	0.99	1.50
210A	11/16	21°07'	69°48'	1426-1511	34-37	12	M	25.66	36.31	2.31	0.96
211A	11/16	21°23'	69°46'	1801-1831	18	4	M	27.97	36.05	3.33	0.41
212A	11/16	21°29'	69°27'	2110-2155	35-37	13	M	26.59	36.31	2.82	0.72
217A	11/17- 11/18	22°21'	68°42'	2345-0030	26-33	5	M,S	25.84	36.14	3.94	1.64
221A	11/18	22°32'	68°07'	1822-1907	58	37	M,S	24.05	36.25	0.79	1.92
222A	11/18	22°45'	68°24'	2208-2253	26	3	M	25.93	36.12	4.46	2.16
224A	11/19	23°00'	68°10'	0455-0540	24	150*	M	25.56	36.10	3.93	1.15
225A	11/19	23°16'	67°50'	0852-1005	24-25	41	M,S	25.37	36.20	4.53	0.94
226A	11/19	22°58'	67°32'	1257-1342	28-30	128*	M	25.41	36.08	4.46	0.69
227A	11/19	22°38'	67°11'	1717-1802	110	75*	M,S	22.39	36.23	0.77	0.61
228A	11/20	23°45'	67°26'	0822-0915	23-25	32	M	24.89	36.33	3.66	1.15
236A	11/22	25°10'	65°50'	0005-0050	22-24	52*	M	25.74	36.54	4.18	0.72
237A	11/22	25°04'	65°26'	0345-0430	26	18	M	25.84	36.54	4.38	0.84
241A	11/22	24°54'	63°52'	1932-2017	90-101	32	M,Sh	22.36	36.20	0.71	1.75
242A	11/27	25°00'	63°30'	1840-1925	35-37	37	M	25.40	36.56	4.99	0.73
243A	11/28	24°54'	61°54'	0458-0602	109-115	2	M,S	23.80	36.21	1.41	1.73

TABLE IV (Continued)

Data for stations where *Polynemidae* were collected during cruise 4B of the ANTON BRUUN, Arabian Sea, 1963  
 [Asterisks indicate estimated catches]

Station No.	Date 1963	Latitude N	Longitude E	Time (LCT) <sup>1</sup>	Depth m.	Number caught	Bottom				
							Type*	Temp. °C	Salinity (‰)	Oxygen (ml./l)	Phosphate (µgA/l)
247A	11/28	25°06'	60°45'	2115-2205	110-122	5	M,Sh	22.56	36.13	0.98	1.58
248A	11/29	25°10'	60°27'	0103-0148	65-82	6	M,Sh	25.00	36.38	4.30	1.24
256A	11/30	26°10'	57°02'	1847-1932	55-64	8	M	25.56	36.55	3.61	0.89
274A	12/7	24°57'	65°56'	2001-2046	23-26	132*	M	24.89	36.52	4.72	1.11
275A	12/8	25°11'	66°11'	0200-0245	97-101	96*	M	23.83	36.63	5.03	0.89
276A	12/8	25°16'	66°20'	0457-0542	121-122	18	M	23.54	36.71	4.38	1.01
280A	12/9	24°03'	66°10'	0625-0710	75-79	2	M,S,Sh	23.89	36.27	2.04	1.29
<i>Polydactylus plebeius</i>											
228A	11/20	23°45'	67°26'	0822-0915	23-25	1	M	24.89	36.33	3.66	1.15
242A	11/27	25°00'	63°30'	1840-1925	35-37	4	M	25.40	36.56	4.99	0.73
248A	11/29	25°10'	60°27'	0103-0148	65-82	1	M,Sh	25.00	36.38	4.30	1.24
274A	12/7	24°57'	65°56'	2001-2046	23-26	3	M	24.89	36.52	4.72	1.11
275A	12/8	25°11'	66°11'	0200-0245	97-101	2	M	23.83	36.63	5.03	0.89
276A	12/8	25°16'	66°20'	0457-0542	121-122	1	M	23.54	36.71	4.38	1.01
<i>Polydactylus indicus</i>											
222A	11/18	22°45'	68°24'	2208-2253	26	2	M	25.93	36.12	4.46	1.15
224A	11/19	23°00'	68°10'	0455-0540	24	1	M	25.56	36.10	3.93	0.94

<sup>1</sup> Estimated time the trawl was on the bottom.

\* M=mud ; S=sand ; Sh=shells.

were caught in one haul at station 204A on 15 November 1963. The subspecies differs from *P. sextarius* in having 7 free pectoral fin rays and a large swim bladder. Hora (1925) found a specimen with 6 free pectoral fin rays on the left and 7 on the right. In the present collections, the free pectoral fin rays of 564 individuals were counted, since variations had been noticed in the field; 30 (5.3%) had counts other than 7-7 (Table II). Marathe and Bal (1958) found the skeletal systems of *P. sextarius* and *P. sextarius* var. *mullani* to be very similar and suggested that they could be called one species. Using their skeletal key, they separated *P. sextarius* and the subspecies by the number of free pectoral fin rays—7-6 for the subspecies and 6-6 for *P. sextarius*. The criterion they used suggests that they had only one specimen of the subspecies, which had unequal free pectoral fin ray counts.

**Size and Sex:** The length-frequency distribution is shown in figure 7 after smoothing by threes. Modes were at 2.5, 11.0, and 12.5 cm. The peak at 2.5 cm. was probably the result of gear selection; the peak at 11.0 cm. was formed by hermaphrodites (length range, 6.0-16.4 cm.); and the peak at 12.5 cm. was formed by mature females with large granulated ova (length range, 10.0-18.4 cm.), as shown in figure 8. Of 401 fish dissected to determine sex, 231 were hermaphrodites, 144 were mature females, 25 immature females, and 1 was a doubtful immature male. (Three specimens could not be sexed, because their gonads had been removed in the field, and the sex of 160 juveniles less than 5 cm. long could not be determined). Of the hermaphrodites, 122 (52.8%) had large testes that occupied more than one-half of the ovo-testes, 67 (29.0%) had ovaries (containing mostly primordial and early developing ova) that occupied more than one-half of the ovo-testes, and 42 (18.2%) had about equal amounts of ovaries and testes. The 25 immature females and

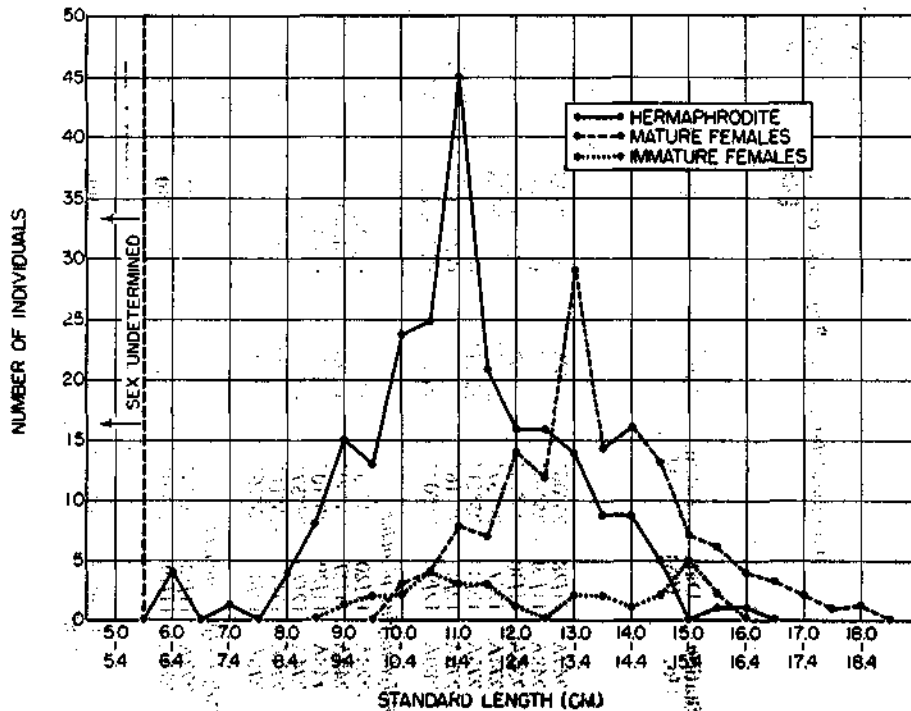


FIG. 8. Length-frequency of *Polydactylus sextarius* var. *mullani* by sex categories.



the lone presumed male were scattered between 9.0 and 15.9 cm. The data indicated that this subspecies undergoes the same type of protandrous change found in *P. sextarius*.

The pathologist who supervised the preparation of the gonad slides examined some specimens which were classified as mature females and was of the opinion that they were females because he could find no trace of testes. Verification was difficult because some of the cells were deteriorated and not identifiable.

**Food :** Shrimps occurred most frequently in the stomachs of 86 specimens examined (Table III). Most of the shrimp remains were fragmentary exoskeletons and could be identified only as penaeids or carideans. They were relatively large (1-3 cm. long) and were considered to be of primary dietary importance. Fish and crustaceans such as amphipods, ostracods, and copepods only a few millimeters long, were also found. The amphipods were mostly gammarids of the genus *Ampelisca*; caprellids occurred less frequently. Cynoglossids, bothids, synodontids, and the gadid, *Bregmaceros* sp., were fishes recognized in the contents. The copepods were represented by *Candacia bradyi*, *Undimula vulgaris*, *Acartia amboinensis*, *Calanopia elliptica*, *Euchaeta concinna*, and *Temora turbinata*, and the genera *Labidocera*, *Eucalanus*, *Macandrewella*, *Oncaea*, and *Pseudodiaptomus*. *Erythrops minuta* was the most common mysid; others were *Neomysis indica*, *Hypererythrops spinifera*, *Pleuerythrops inscitta*(?), and *Anchialina typica*(?). Other organisms included *Squilla oratoria inornata*, *Acetes* sp., *Turritella* sp., *Operculina* sp., *Sagitta bedoti*, *Charybdis callianassa*, and a few pagurids, palinurids, and isopods.

#### ***Polydactylus plebeius* (Broussonet)**

Twelve of this species were caught along the coast of West Pakistan during the survey. They were readily identifiable from the description given by Day (1958). Weber and de Beaufort (1922) reported this species to range from Madagascar, through the seas of India and Malay Archipelago, north to Japan, and eastward in the South Pacific to Samoa and Tahiti. Qureshi (1959) reported it to be caught commercially in West Pakistan in the surf, which, in part, may explain the poor catches made during this survey of deeper areas.

**Size and Sex :** Smith (1961) reported this species to attain lengths up to 45 cm. The 10 specimens preserved in the present study were not fully grown. They ranged from 18.0 to 26.4 cm. One was a hermaphrodite, one an immature male, eight were immature females.

**Food :** Fish and crabs were the most common food items in the stomachs of six *P. plebeius* examined. Several *Bregmaceros* sp. 5-6 cm. long, and a *P. sextarius* var. *mullani*, estimated to be longer than 5 cm., were found. The crabs were tiny portunids, probably of the genus *Charybdis*. Penaeid shrimps, sergestids, octopods, and gastropods were also present. Venkataramam (1960), who examined stomachs of 42 *P. plebeius* reported that 15 were empty and that the rest were gorged with *Emerita asiatica*. His specimens measured 9.9 to 18.5 cm. and were caught from the inshore water off Calicut on the Malabar coast.

#### ***Polydactylus indicus* (Shaw)**

This was the only species caught in both the Bay of Bengal and the Arabian Sea, but only three specimens were caught in each survey. Deshpande (1963) reported this species to be caught principally by bottom-drift nets along the Gulfs of

Cambay and Kutch. Nayak (1959a) and Karekar and Bal (1960) reported on the biology of this species, and Nayak (1959b) and Deshpande (1963), gave detailed reports on the fisheries.

*Size and Sex*: The three specimens from the Arabian Sea were 20.3, 26.2, and 71.0 cm. long. The sex of the 20.3 cm. individual could not be determined. The 26.2 cm. fish was an immature male and the 71.0-cm. one an immature female. The two smaller fish fell below the first year class of Nayak (1959a) and the largest one into the third year class. Nayak (1959a) reported that this species seems to spawn twice a year, from April to June and from October to December.

*Food*: Karekar and Bal (1958) who examined the stomach contents of 669 *P. indicus*, reported that the juveniles, 7.0-50.0 cm., fed primarily on shrimps such as *Caridea*, *Acetes*, etc., and stomatopods and that *Bregmaceros maclellandi*, *Harpodon nehereus*, *Coilia dussumeri*, . . . , were important fishes in their diet. They also reported that the adults larger than 50.0 cm. fed mainly on fishes such as *C. dussumeri*, *H. nehereus*, *Polydactylus heptadactylus*, . . . , and that crabs, prawns and stomatopods were also important.

The stomach contents of two individuals examined in the present study included *Squilla oratoria inornata* and shrimps—including *Solenocera indicus* and members of the family Alpheidae and the genera *Parapeneopsis* and *Penaeus*.

#### CONCLUDING COMMENTS

Many of the trawl stations of the present surveys were in waters deeper than 70 m., whereas most of the previous fishery work in Indian Seas has been conducted in shallower waters. The distribution of the species was not fully determined by the 1963 surveys, however, because the fishing efficiency of the shrimp trawl used was limited, and fishing was done only on flat, soft bottoms (to ensure effective bottom trawling). Sampling with other gear, such as gill nets, handlines, and bottom setlines, in rocky areas and sampling in shallower areas will undoubtedly extend the known distribution of the species.

Comprehensive studies of growth and reproductive cycles were not carried out because sampling was inadequate.

#### SUMMARY

Five species, *Polydactylus indicus*, *P. plebeius*, *P. xanthonemus*, *P. sextarius*, and *Polynemus paradiseus*, and one subspecies, *P. sextarius* var. *mullani*, of threadfins, family Polynemidae, were caught by bottom trawling in the Bay of Bengal and the Arabian Sea by the Research Vessel *ANTON BRUUN* in 1963. The bottom trawling surveys were part of the U.S. Programme in Biology of the International Indian Ocean Expedition. The distribution of the threadfins and notes on their size, sex, and stomach contents are presented. Most of the threadfins were smaller than 20 cm. and were caught on the Continental Shelf at depths of 15-122 m. Hermaphroditism was widespread in *Polydactylus sextarius* and *P. sextarius* var. *mullani*, which undergo a protandrous change through a juvenile-hermaphrodite-female series of progressions. Hermaphroditism was also found in *P. plebeius* and *P. xanthonemus*. Crustaceans, especially shrimps, were the most important item in their diet.

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