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PRELIMINARY STUDIES ON THE CEPHALOPODS COLLECTED FROM THE DEEP SCATTERING LAYERS OF THE INDIAN EXCLUSIVE ECONOMIC ZONE AND ADJACENT SEAS

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ABSTRACT

Results of the preliminary studies on the cephalopods collected from the operation of Isaacs - Kidd Midwater Trawl net in the Deep Scattering Layers of the Indian Exclusive Economic Zone and adjacent seas during the cruises 1-15 of FORV *Sagar Sampada* are presented in this paper. Spatial, monthly and seasonal distributions of cephalopod biomass and its abundance in the DSL have been discussed. Differences in the biomass during day and night periods are also given.

INTRODUCTION

The early juveniles belonging to the cephalopod families Sepiolidae, Sepiidae, Loliginidae and Octopodidae and juveniles and adults of Enopteuthidae, Onychoteuthidae, Ommastrephidae and Cranchiidae are pelagic in habit. Some of these organisms which were caught in the plankton and midwater trawl collections are dealt with by Issel (1908), Pfeffer (1912), Allan (1945), Aravindakshan and Sakthivel (1973), Clarke (1966), Clarke and Lu (1974 and 1975), Okutani (1965), Okutani and McGowan (1969), Silas (1968, 1969), Sakthivel and Aravindakshan (1971), Roper (1977), Roper and Young (1975) and Roper *et al.* (1984). The present paper deals with the data on the collections of cephalopods by Isaacs - Kidd Midwater Trawl operated from FORV *Sagar Sampada* in the Indian EEZ and contiguous seas during February, 1985 to May, 1986.

DATA EXAMINED

The data on cephalopods collected by the Isaacs - Kidd Midwater Trawl (IKMT) during the cruises 1 to 15 are considered here. These pertain to the west coast of India including the Lakshadweep Sea (6° to 23°N), east coast (6° to 21°N), Andaman and Nicobar Islands (5° to 15°N) and the central equatorial region of the Indian Ocean (0° to 3°N and 0° to 3°S). Based on the location of the Deep Scattering Layer (DSL), the depth of operation of IKMT varied from 10 to 500m on the west coast, east coast and the Andaman and Nicobar Islands and 501 to 1000 m in the central equatorial region. The

duration of each haul was 30 minutes. The present study pertains to the numerical data available for each haul from all the four regions.

Irrespective of cruise numbers, the data were pooled together to study the regionwise and seasonwise distribution. To understand the distribution and abundance of cephalopods in relation to DSL, the hauls taken from each region were grouped on a 3-hour interval basis and the average number per haul was calculated accordingly. The average number of cephalopods per haul is taken as the index of abundance.

OBSERVATIONS

Regionwise distribution

The details of the number of hauls made and the number of cephalopods obtained are given in Table 1. A total of 472 hauls were made in the four areas studied, the maximum being on the west coast (57.6%), followed by east coast (25.2%), Andaman and Nicobar Islands (8.7%) and the minimum in the central equatorial region (8.5%); however, the percentage of hauls which contained cephalopods in the total number of hauls was 44.1, 36.1, 56.1 and 52.5% respectively in these regions. In the pooled data, the maximum abundance (18 number per haul) came from the Andaman and Nicobar Islands, followed by the west coast (12/haul), central equatorial region (8/haul) and the east coast (5/haul). However, 345 numbers per haul from 18°55'N and 69°30'E in the west coast and 172 number/haul from 9°03'N and 94°03'E in the Andaman and Nicobar

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islands were also obtained.

TABLE 1. *Regionwise abundance of cephalopods*

Area	Total number of hauls	Number of haul with cephalopod	Total number of cephalopod	No. /haul
West coast	272	120	1,423	12
East coast	119	43	206	5
Andaman & Nicobar Islands	41	23	425	18
Central equatorial region	40	21	172	8
For all region	472	207	2,226	

Seasonal distribution

The occurrence of cephalopods in different months in the four regions studied is illustrated in Fig. 1.

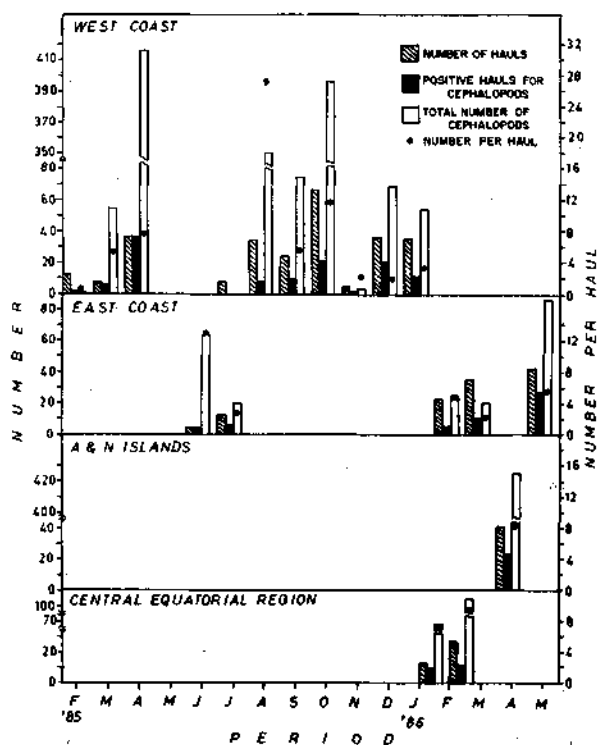


Fig. 1. Distribution of cephalopods (number/haul) in different months during February, 1985 to May, 1986.

West coast

The collection period was February- April, 1985 and July, 1985 - January, 1986. Out of 272 hauls, 120 contained cephalopods; only in March and April, 1985, all the hauls were positive. In other months of observation 15 to 57% of hauls yielded cephalopods. The number per haul varied from 1 to 44. Maximum number per haul of 8 in April, 44 in August and 12 in October, 1985, indicate the premonsoon, monsoon and postmonsoon occurrence of cephalopods with peak abundance in the monsoon period.

East coast

The collections were made only during June-July, 1985 and February, March and May, 1986. Out of 119 hauls, 43 hauls yielded 206 cephalopods. All the hauls made during June, 1985, were positive but only 22-46% of hauls in the other months contained cephalopods. The number per haul varied from 3 to 13 during June-July, 1985 and 2 to 5 during February -May, 1986. Since the data were discontinuous, no picture of the peak occurrence could be obtained.

Andaman and Nicobar Islands

Only one cruise was made in the oceanic waters of the islands (April, 1986) during which 41 hauls were taken; 23 hauls yielded cephalopods amounting to 425. The average number per haul was 18.

Central equatorial region

A total of 40 hauls were made in a single cruise during January-February, 1986, of which 21 hauls netted 172 number of cephalopods. The average number per haul was 8.

Diurnal variation in distribution

The number of cephalopods obtained in day and night hauls from the four regions are illustrated in Fig. 2. On the west coast, exceptionally high number of cephalopods were recorded in two hauls: 278 in April and 345 in August, 1985. The reasons for this concentration are not known. Without regard to these high numbers, as they were exceptional, the number per haul was more in the day hauls as a whole (1-78) than in the night hauls (1-15) as shown in the Figure. The day hauls were richer during March and August-November, 1985; the night hauls were negative in November, 1985,

and in other months the number per haul was either equal or more.

On the east coast the number per haul ranged from 2 to 12 during day and from 2 to 13 during night, indicating that the night hauls were slightly richer. In the Andaman and Nicobar waters the highest number of 24 per haul was taken in the night with the average night catch of 12; the average for day hauls was only 5. In the central equatorial region the variation was from 5 to 10 for day hauls and from 8 to 9 for night hauls. In this case also the night catches on an average were a little better than those taken during the day.

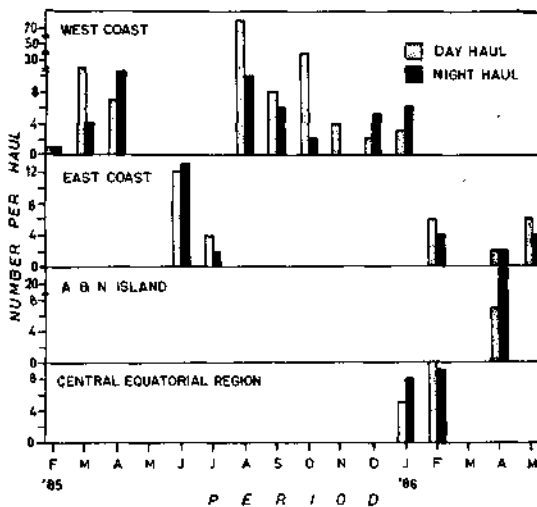


Fig. 2. Distribution and relative day-night abundance of cephalopods (number/haul) in four regions.

Depthwise abundance

The number of cephalopods caught from different depth zones of the four regions is given in Table 2. The depth of operation of the gear on the west coast ranged from 10 to 500 m with some gaps in between. The maximum number per haul (139) came from 101-150 m depth zone, followed by 18 and 12 from 251 - 300 m and 301 - 350 m respectively. On the east coast, the depth of operation was confined to 10 - 250 m, and the maximum number per haul (6) came from 51-100 m and the least (3) from 10-50 m. In the Andaman and Nicobar Islands also the same depth range was covered. The maximum number of 29 cephalopods per haul came from 51-100 m, followed by 12 from 10-50 m. In the central equatorial region, the depth of operation ranged from 10 to 200 m and from 501 to 1000 m. The number per haul was more (11) in the 10-50 m

depth and varied from 2 to 4 in the other depth zones. In general, the cephalopods were found concentrated in the upper water column ranging from 10 to 150 m in all the regions, and again in 251 to 300 m on the west coast and in 501-1000 m in the central equatorial region.

TABLE 2. Depthwise distribution (number per haul) of cephalopods

Depth range (m)	West coast	East coast	Andaman & Nicobar Islands	Central equatorial region
10-50	4	3	12	11
51-100	5	6	29	3
101-150	139	5	3	2
151-200	8	—	—	4
201-250	4	-	-	-
251-300	18	-	-	-
301-350	12	-	-	-
351-400	-	-	-	-
401-450	-	-	-	-
451-500	6	-	-	-
501-1000	-	-	-	4

Distribution in relation to Deep Scattering Layer

An attempt was made to study the distribution of cephalopods in relation to the position of the Deep Scattering Layer (DSL). The depths of the DSL and the number of cephalopods per haul at 3-hour intervals during day and night are given in Table 3. These are based on the regionwise pooled data for the entire period of observation. It was seen that on the west coast the position of the DSL during day time (0600-1800 hours) ranged from 35 m depth to 540 m; during night hours (1800-0600) it has moved up, occupying the water column from surface to a depth of 110 m. Similar trend was noticed in other regions also. In the central equatorial region the DSL has descended up to 1000 m during day time, and has moved up to 500 m during night.

The distribution of cephalopods in the DSL and their relative abundance in 3-hour duration show that on the west coast the number per haul varied from 3 to 12 during day with the average of 6, and from 6 to 20 during night with an average of 11. The maximum of 20 cephalopods per haul came during 2100-2400 hours when the position of the DSL was at 0-100 m.

On the east coast and in the Andaman and Nicobar waters the day hauls contained more

TABLE 3. *Distribution of cephalopods in relation to Deep Scattering Layer*

Time (hours)	Depth of DSL (m) cephalopods (No./haul)	West coast	East coast	A & N Islands	Central equatorial region
0600-0900	DSL Cephalopods:	35-440 3	70-110 24	40-500 3	100-275 15
0900-1200	DSL Cephalopods:	30-410 12	60-100 —	100-150 27	250-1000 —
1200-1500	DSL Cephalopods:	50-540 5	90-125 5	130-500 5	100-900 3
1500-1800	DSL Cephalopods:	40-410 3	40-160 2	100-470 6	60-500 4
1800-2100	DSL Cephalopods:	0-120 6	0-100 5	20-72 2	35-500 6
2100-2400	DSL Cephalopods:	0-100 20	0-100 4	0-225 25	45-300 10
0000-0300	DSL Cephalopods:	0-80 8	0-80 5	0-330 4	20-125 13
0300-0600	DSL Cephalopods:	0-110 9	0-100 2	0-500 5	40-160 9

number of cephalopods than the night hauls. But in the central equatorial region a reverse order was noticed, with the average of 6 cephalopods per haul during day and 10 during night. However, taking all the regions as a whole, more number of cephalopods were obtained during night than during day.

GENERAL REMARKS

The analysis of data on cephalopods taken by IKMT from the Deep Scattering Layers of the Indian Exclusive Economic Zone and the central equatorial region has shown their distribution and relative abundance in different areas, seasonal availability and diurnal variations. Earlier studies on the abundance of juvenile cephalopods in the Indian Ocean based on plankton net collections by Aravindakshan and Sakthivel (1973) have indicated that the area off Gujarat on the west coast, the Bay of Bengal including the Andaman waters and the equatorial waters are rich nurseries for cephalopods. This finding is confirmed by the present

record of a maximum number of 12 per haul on the west coast and 18 per haul in the Andaman and Nicobar waters. Silas (1968) has recorded a catch rate of 2 to 6 per haul in the IKMT collections made along the west coast of India.

In the present study, the peak abundance was noticed during March-April and August-October in the west coast, February-June in the east coast, April in the Andaman and Nicobar waters and January-February in the central equatorial waters. This is in agreement with the observations made by Aravindakshan and Sakthivel (1973), who recorded the peak occurrence of cephalopods during November and June-July in the northern Arabian Sea, April-September in the Bay of Bengal and July-August and January in the equatorial waters. Silas (1968) recorded greater number of cephalopods during June and December-April in the plankton net collections made from the southwest coast of India.

Roper (1977) has studied the efficiency of different types of midwater trawl either with or without a closing device and recorded a catch rate of 4 per haul in the closed-type IKMT and 6 per haul in the midwater trawl without a closing mechanism. In the present study the IKMT used was devoid of a closing device, and yielded a catch rate of 5 to 18 cephalopods per haul. Silas (1968, 1969) also employed a net similar to the present one, in which the number of cephalopods obtained varied from 2 to 6 per haul.

Among the collections made during the day and night, those made during the night contained more number of cephalopods. According to Roper *et al.* (1984), oceanic cephalopods undergo diel vertical migrations, abounding in 400-1000 m depth during the day and in the uppermost 200 m during the night. Moreover, the present data on depthwise distribution also have indicated the greater abundance of cephalopods in 10-150 m zone. The distribution of cephalopods in relation to the Deep Scattering Layers has shown that they occur in more numbers during the dark hours. Silas (1969) recorded greater representations of the major constituents of zooplankton including cephalopods in the night-time IKMT hauls taken in the Lakkshadweep waters.

Clarke (1966) and Clarke and Lu (1974, 1975) are of the opinion that the occurrence and abundance of oceanic cephalopods in the columnar waters in relation to different depths is species-specific. Only a qualitative study of the material collected by IKMT will throw some light on this aspect of the distribution of planktonic cephalopods in our waters.

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