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CEPHALOPOD BIONOMICS, FISHERIES AND RESOURCES OF THE EXCLUSIVE ECONOMIC ZONE OF INDIA

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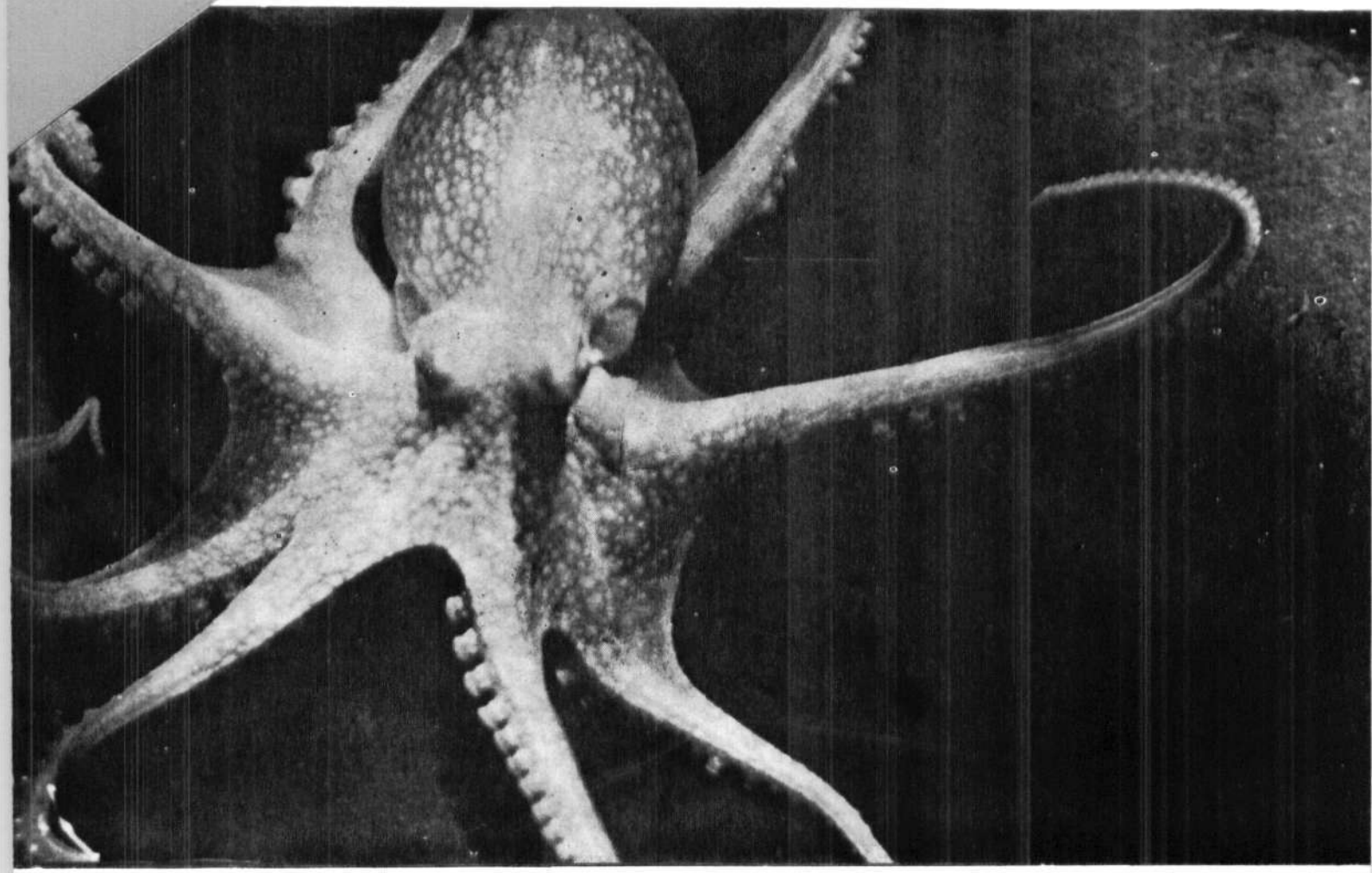

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CEPHALOPOD RESOURCES REVEALED BY EXPLORATORY SURVEYS IN INDIAN SEAS

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ABSTRACT

The areawise and depthwise cephalopod catches of fishing vessels of Government of India and some Agencies which conducted exploratory fishing in offshore areas have been presented and discussed. The exploratory fishing by Government of India vessels in Bombay-Gujarat region during 1977-80 yielded a maximum of 7,609 kg of cephalopods a year at a catch rate of 6.8 kg/h. The highest catch rates were recorded from the area 19-70 and the depth zone 80-89 m. In Visakhapatnam region the cephalopod catch was poor during 1968-75 but during 1977-80 the annual catch increased to 3,283 kg. The most intensively fished area was 17-83. The catch was composed of four species of cuttlefishes and three species of squids. The results of trawl surveys in other parts of Indian waters are also dealt with.

INTRODUCTION

Although cephalopods would have formed a part of the general trawl catch, their inclusion in the list of components has come into vogue only in very recent years. Earlier they had been thrown overboard or later recognised and included in the miscellaneous catch. On account of this, our present knowledge of this group as a trawl fishery resource is quite inadequate. Whatever little information is available at present is mainly from the trawling data provided by the erstwhile Exploratory Fisheries Project (now the Fishery Survey of India), Government of India. Catch particulars are available for the Bombay-Gujarat region from 1977 onwards and for the Visakhapatnam region from 1968 onwards, besides some data from areas off Goa and the Wadge Bank.

BOMBAY-GUJARAT REGION

Three trawlers, viz., MEENA BHARATHI (22.5 m, 262 b.h.p.), MEENA PRAPI and MEENA SANGRAHAK (each 17.5 m and 200 b.h.p.) conducted exploratory trawling from Bombay base during 1977-80.

From 1977 onwards there was steady increase in the annual cephalopod catch and catch rate (CPUE) from 4,497 kg and 2.56 kg/h in 1977 to 7,609 kg and 6.79 kg/h in 1979 but the values came down to 2,749 kg and 2.77 kg/h in 1980. The fishing effort showed a progressive reduction from 1,751.87 h in 1977 to 989.90 h in 1980.

Ten areas (each 1° square) were covered during this period, of which six areas were fished in all the four years. The maximum effort (2,277.53 h) was expended in the area 18-72 which also contributed the maximum catch (6,552 kg).

Trawling was done in nine depth zones (each having 10-metre interval) from 20-29 m to 100-109 m. Except for the 100-109 m depth zone, all the others were covered during all the years.

Fig. 1 shows the areawise and depthwise distribution of cephalopods, based on the annual average catch-per-hour returns during 1977-80. The areas 19-70 and 17-71 have yielded cephalopods at the rate of 18.86 kg/h and 10.19 kg/h respectively in 1977, and the area 18-71 at the rate of 10.92 kg/h in 1978 ; in 1977 no area contributed more than 10 kg/h. In general, catch rates were below 10 kg/h from most of the areas and in a few cases it was less than 1 kg/h or nil. On an average the area 19-70 yielded 11.75 kg/h but this area was poorly fished, since the effort spent was only 40.16 h during the entire 4-year period. The most intensively fished area was 18-72 from where the average catch rate recorded was 3.80 kg/h with a minimum of 2.31 kg/h in 1978 and a maximum of 7.50 kg/h in 1979.

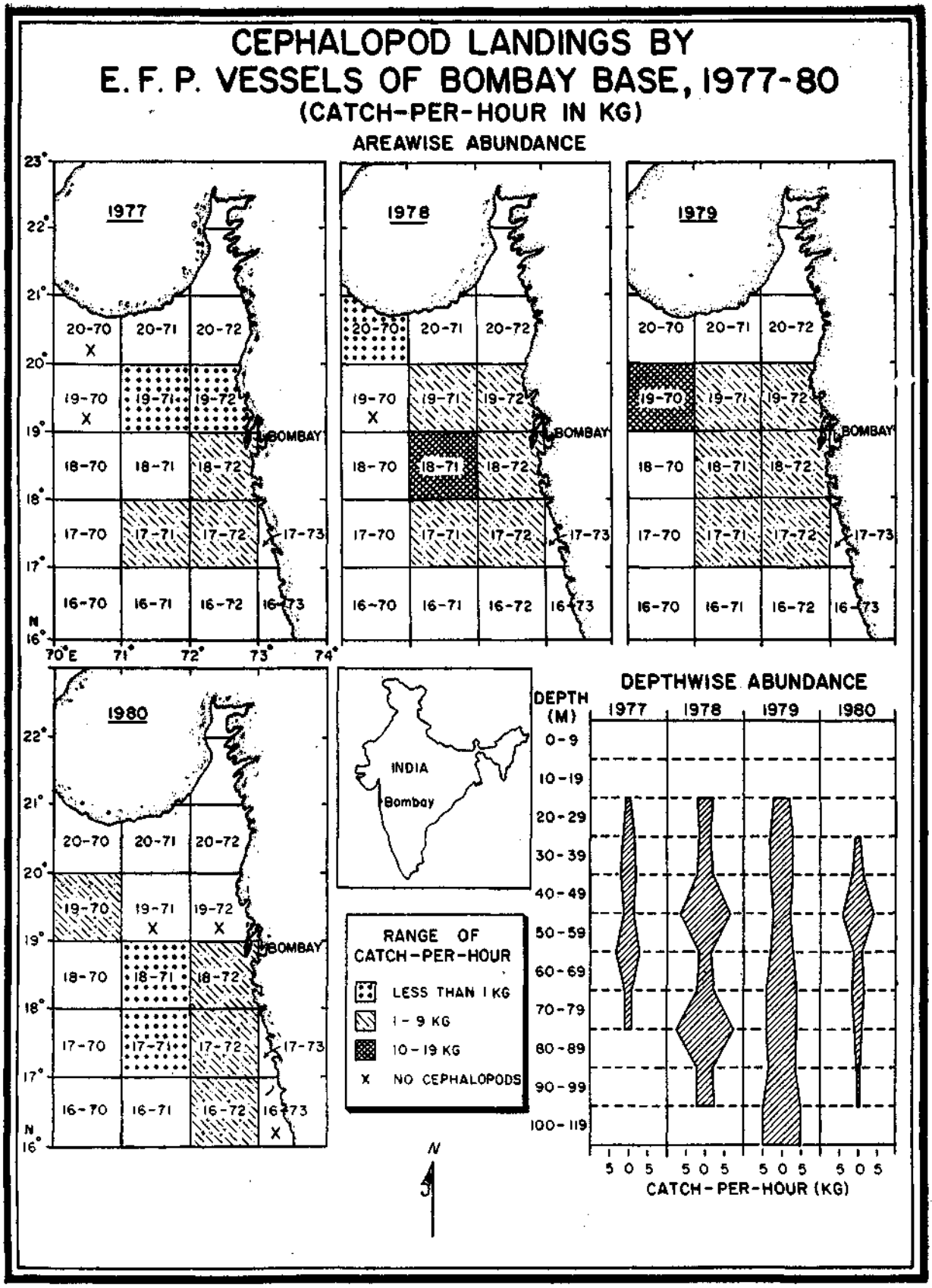

FIG. 1. Areawise and depthwise abundance of cephalopods caught by E.F.P. vessels of Bombay base during 1977-'80 off Bombay-Gujarat Coast.

Cephalopods were obtained from six of the nine depth zones covered during 1977, and the maximum catch rate of 6.28 kg/h was obtained from 60-69 m. In 1978 more depth zones yielded cephalopods and the highest return (15.68 kg/h) was from 80-89 m. In 1979 trawling was extended upto 100-109 depth zone which also accounted for the maximum catch rate of 10.28 kg/h ; in other depth zones the catch rate ranged from 3.90 kg/h to 7.92 kg/h. In the subsequent year no cephalopods were obtained from 20-29 m, and the 100-109 m depth zone was not fished ; among other depth zones 50-59 m gave the highest catch rate of 7.98 kg/h. The maximum fishing effort (1,077.05 h) was put in the depth zone 30-39 m during the 4-year period, and the average catch rate from here was 3.54 kg/h. During this period the highest average catch rate (7.03 kg/h came from the 50-59 m depth zone.

Fig. 1 gives the areawise seasonal availability of cephalopods based on the average values calculated from pooled monthly effort, catch and catch-per-hour for the period 1977-80. Except for the areas 17-71, 17-72, 18-71 and 18-72, all the other areas were not regularly trawled. Even in the above mentioned areas there was little fishing during the monsoon months of June, July and August. From area 17-72 moderate to high catch rates of 7.78 kg/h and 17.96 kg/h were obtained in April and November respectively. March to June, October and December were the good months for cephalopods (8.63 kg/h to 22.50 kg/h) from the area 18-71. The catch rates from the area 18-72 were between 2.10 kg/h and 6.90 kg/h. The highest monthly catch rate (33 kg/h) came from the area 19-71 during the month of October ; in all the other months when there was fishing, the catch rates were very poor, except in March (7.30 kg/h).

The seasonal depthwise distribution of cephalopods is given in Fig. 1. The depth zones 20-29 m, 30-39 m and 40-49 m only were fished in all the months, and most of the other depth zones were not covered during the monsoon months of June, July and August. In many of these depth zones there was a general increase in catch rates from January to April, and to May in some cases. Such a trend was not perceptible from October to December, though good catch rates were obtained from some of the depth zones : 7.40 kg/h to 18.20 kg/h from 50-59 m, 8.86 kg/h to 12.77 kg/h from 80-89 m. The maximum catch rate (21.23 kg/h) was obtained from 90-99 m depth zone in the month of November.

M. T. MURAENA (69.34 m, 1,620 b.h.p.) has conducted trawl survey in the areas between 15° N and 24° N at a depth of 55-360 m off the northwest of India during the year 1977 (Bapat *et al.*, 1982). A quantity of 1,015 kg of cephalopods was caught and this formed 0.2% of the total catch. Of this, 761 kg came in bottom trawl and 254 kg in pelagic trawl. In both the cases the maximum catches of cephalopods were obtained from the depth range 55-90 m. The highest catch rate of 23.45 kg/h was recorded during January-February. Seven species were represented in the landings : *Sepia aculeata*, *Sepia esculenta*, *Sepia pharaonis*, *Septella inermis*, *Loligo duvaucelii*, *Argonauta argo* and *Octopus vulgaris*. Of these, *Sepia aculeata*, *Sepia pharaonis* and *Loligo duvaucelii* constituted the bulk of the catch. While cuttlefishes were obtained from almost all the depth ranges upto 360 m, squids were restricted to the depth range 55-90 m.

The exploratory surveys in the northwestern region off Bombay-Saurashtra coasts by vessels operating from Porbander, Veraval and Bombay bases during 1978-79 showed that cephalopods were obtained from the areas 20-69 at a catch rate of 81.70 kg/h, 21-68 at 120.40 kg/h, 21-69 at 88.60 kg/h, 21-70 at 116 kg/h, and 22-68 at 96.60 kg/h (EFP, 1979a). One small square (2E) in the major area 21-68 gave a catch rate of 138.89 kg h during June-September 1979, and this came from a depth of 95-96 m ; the average from the major area for this period was 54.61 kg/h (EFP, 1979b). These high catch rates were obtained by MATSYA NIREEKSHANI (40.6 m, 2,030 b.h.p.). The depth zone 50-59 m yielded the maximum catch rate of 110 kg h. The catch rates from other depth zones were 50 kg/h (40-49 m) and 76.40 kg/h (60-69 m). The smaller vessels (17.5 m) recorded lesser catch rates from these areas and depth zones.

Visakhapatnam Region

Sekharan *et al.*, (1973) have recorded small quantities of squids in the trawl catches off Visakhapatnam and Orissa coasts. These came from the areas 17-83, 18-84, 19-85 and 19-86 between a depth of 9 m and 128 m. According to Muthu *et al.*, (1975), cephalopods formed 0.95% of the total catch taken in commercial trawling off Kakinada during 1968-70 by trawlers of the size 9.14 m, 9.75 m and 11.41 m. In subsequent operations in the same area during 1971-74 period they accounted for 1.22% of the total catch (Narasimham *et al.*, 1979).

The Exploratory Fisheries Project operated seven vessels from Visakhapatnam base during 1968-80 : M. T. ASHOK (200 b.h.p.), M.F.V. CHAMPA (165 b.h.p.), M. V. MEENA SHODHAK, M. V. MEENA JAWAHAR, M. V. MEENA PRADATA (each 17.5 m and 200 b.h.p.), M. V. MATSYA SHIKARI (39.8 m and 1,740 b.h.p.) and M. V. MATSYA DARSHINI

(36.5 m and 1,160 b.h.p.). The data in respect of trawl fishing conducted by these vessels are available, the analysis of which revealed the following results :

During the period 1968-75 the annual cephalopod catch varied from a very negligible 31 kg to a maximum of 881 kg. Almost the entire catch came from a single area, 17-83, which alone was fished during all the years. During 1968-71 only this area was fished. The area 16-82 was trawled in 1973 and 1975 but there was no cephalopod catch ; the area 17-82 was fished in 1972, 1974 and 1975 but only in 1975 there was small catch of cephalopods. The areas 18-83 and 18-84 yielded cephalopods in 1972 and 1975 and there was no catch in 1974. The area 19-85 was trawled in 1975 but did not yield cephalopods.

Of the six depth zones explored during the period, 30-39 m and 40-49 m depth zones yielded cephalopods throughout ; no catch was obtained from 20-29 m depth zone in 1970 and 1973. The maximum catch and catch rates were recorded from 40-49 m depth zone.

The areawise average monthly catch particulars for the period 1968-75 showed that the area 17-83 yielded cephalopods in all the months. The higher catch rates from this area came during April, May, November and December. Other areas were not fished in all the months. Some of these areas gave high catch rates but the monthly effort put in was very small, 0.72 h to 1.20 h. Except the depth zones 10-19 m and 60-69 m, all the other depth zones were fished all through the months. Of these, 20-29 m depth zone did not yield any cephalopods in some months. The maximum average monthly catch came from 40-49 m (34 kg and 1.27 kg/h) and 50-59 m (24 kg, and 1.75 kg/h) during April, and from 30-39 m (29 kg and 0.8 kg/h) during May.

During the period 1976-80, the cephalopod landings increased from 1,449 kg forming 1.20% of the total fish catch in 1976 to 3,283 kg (2.50%) in 1977, but afterwards there was decrease to a minimum of 885 kg (0.31%) in 1980. The catch rates also showed similar trend : from 0.87 kg/h in 1976 it increased to 2.79 kg/h in 1977 and decreased in the subsequent three years to 2.18 kg/h, 0.82 kg/h and 0.52 kg/h. The effort put in was the maximum (1,946.74 h) in 1979.

Nine areas were covered during the period 1976-80, of which only three areas, viz. 17-83, 18-83 and 18-84 were fished in all the five years ; 16-81, 16-82 and 17-82 were fished in four years, and 15-80, 15-81 and 17-84 in one year Fig. 2. Of these, the most intensively fished area was 17-83, where a total effort of 4,318.30 h was put in for a return of 5,990 kg during the 5 year period at an average catch rate of 1.39 kg/h. Five depth zones, 20-29 m, 30-39 m, 40-49 m, 50-59 m and 60-69 m, were fished in all the years. The depth zone 10-19 m was fished in three years and 70-79 m and 80-89 m in one year.

Fig. 2 shows the areawise and depthwise distribution of cephalopods, based on the annual average catch-per-hour returns during the 5-year period 1976-80. The area 18-84 yielded cephalopods at the rate of 4.64 kg/h during 1977 and 3.65 kg/h during 1978. The catch rates from the area 18-83 were 2.14 kg/h in 1977 and 2.66 kg/h in 1978. Besides these, the only other area which gave catch rates above 2 kg/h was 17-83 (2.71 kg/h in 1977). In all the other years the areawise catch rates were less than 2 kg/h in many cases and less than 1 kg/h in most cases.

The most intensively fished depth zones were 40-49 m and 30-39 m, where the efforts put in were 2,279.73 h for a realisation of 3,246 kg of cephalopods at the rate of 1.42 kg/h, and 2,273.60 h for a catch of 3,370 kg at the rate of 1.48 kg/h, respectively. The depth zones 20-29 m, 50-59 m and 60-69 m yielded catch rates between 2.46 kg/h and 8.07 kg h in 1977, and between 1.27 kg/h and 4.10 kg/h in 1978.

Fig. 3 gives the areawise seasonal distribution of cephalopods based on the averages calculated from pooled monthly effort and catch-per-hour for the period 1976-80. Only the area 17-83 was fished all through the months. Maximum number of areas were fished in March ; during June to August the coverage was the minimum. In general, the catch rates did not show much monthly variation.

The seasonal depthwise distribution (Fig. 2) indicates that the depth zones 20-29 m to 50-59 m, fished in all the months, have yielded cephalopods at catch rates varying from 0.49 kg/h in March (50-59 m) to 4.75 kg/h in the same month (20-29 m). The maximum catch-per-hour (12.43 kg/h) was recorded from 60-69 m depth zone in July but the average effort put in was only 1.13 h. On the whole the higher catch rates were obtained from many depth zones during January, March, April, May, July, August, November and December.

The cephalopods obtained in exploratory trawling were composed of the squids *Loligo duvaucelii* and the cuttlefishes *Sepia aculeata, Sepia pharaonis, Sepia brevimana* and *Sepilla inermis*. Besides these species, stray numbers of the squids *Doryteuthis singhalensis* and *Loliolus investgatoris* also contributed to the catch to a very small extent. The monthly landings of squids

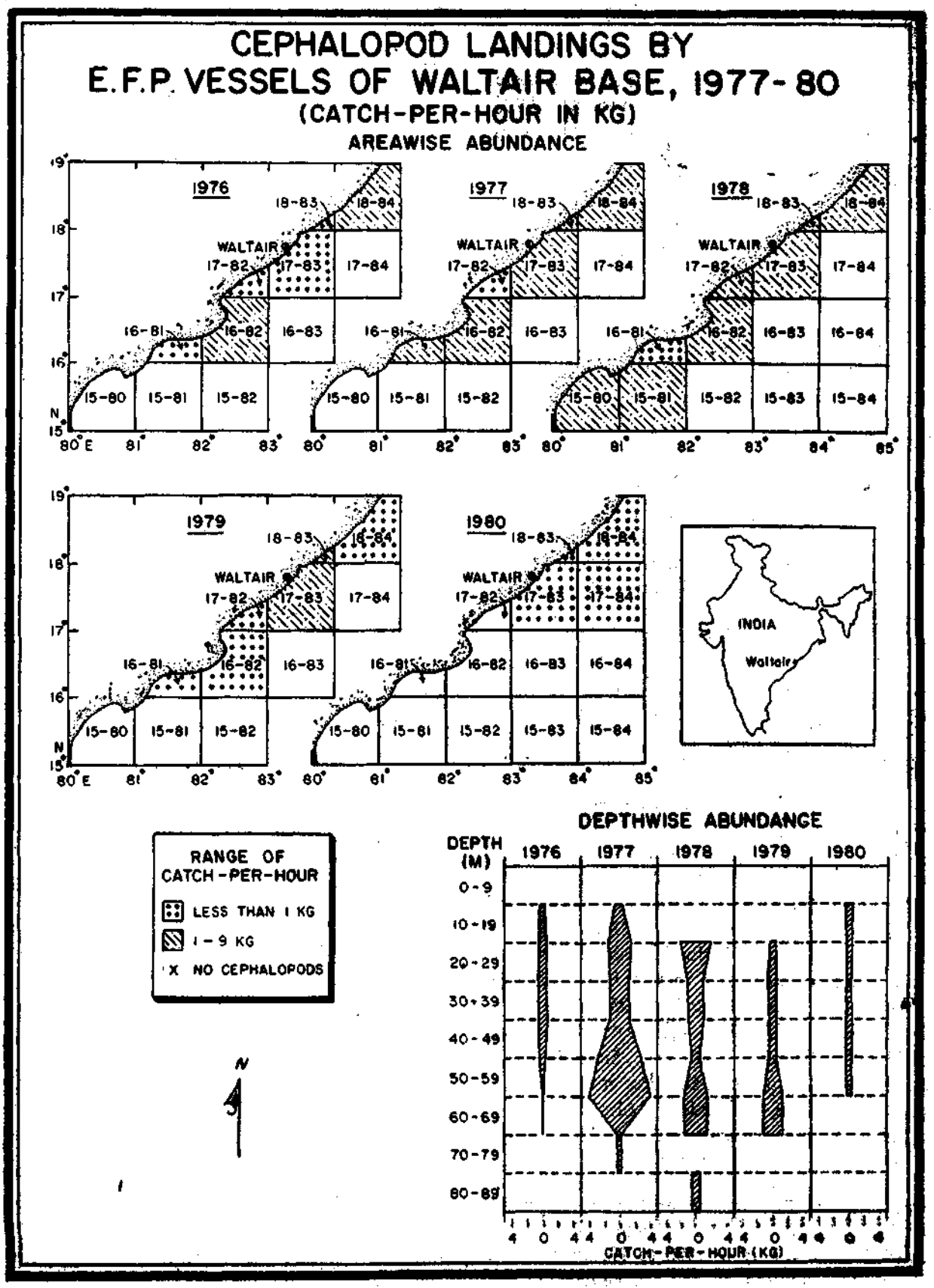

FIG. 2. Areawise and depthwise abundance of cephalopods caught by E.F.P. vessels off Waltair (Visakhapatnam) base during 1977-'80.

and cuttlefishes, their gross catch-per-hour and the annual species composition of the landings are shown in Fig. 3.

In all the years, except 1978, cuttlefishes were more in quantity than squids, forming as much as 67.9% in 1976, 55.2% in 1977, 61.6% in 1979 and 76.7% in 1980. In 1978 the squids and cuttlefish were in almost equal proportions (50.4% and 49.6% respectively). The highest monthly catch rate for squids was 2.94 kg/h recorded in March 1977. During the years 1977 and 1978 the catch rates of 1-2 kg/h were obtained in 11 months. During the rest of these two years, and during the other years the monthly catch rates were less than 1 kg/h. For cuttlefish the highest catch rate was 3.68 kg/h in July 1977, followed by 2.49 kg/h in November 1980. In 20 months during the 5-year period the catch rates were between 1 kg/h and 2 kg/h.

Loligo duvaucelii: This is the single species that constituted almost the entire squid fishery. The higher catch of 1,468 kg was obtained in 1977 forming 44.7% of the total cephalopod landings that year. The maximum monthly catch (265 kg) was in March at a catch rate of 2.94 kg/h. The catch rates in other months varied between 0.49 kg/h and 1.60 kg/h. In 1978 the catch came down to 1,203 kg at a catch rate of 1.05 kg/h forming 48.3% of the total cephalopods. The monthly catch rates ranged from as low as 0.10 kg/h to 1.90 kg/h. In 1976, 1979 and 1980 the catches were low, being 452 kg, 610 kg, and 206 kg respectively.

The length frequency distribution of *Loligo duvaucelii* for 1976-80 ranged from 20 mm to 169 mm, and in the individual years the size ranges were : 20-169 mm (1976), 30-169 mm (1977, 1978), 30-139 mm (1979) and 50-159 mm (1980). In most of the months the frequency distribution was unimodal, and only in a very few months there were more than one mode. The monthly modal values ranged from 45 mm to 145 mm. The annual length frequency distribution shows that the maximum frequency was at 75 mm in 1976 and 1977 at 85 mm in 1978 and 1979, and at 105 mm in 1980. It is noticed that the bulk of the squid catch is compose of individuals below about 100 mm. Since the sized at which 50% of the squids in this area reach maturity is 76 mm for males and 108 mm for females (see Chapter 4) the mainstay of the fishery is the squids that are maturing or have attained maturity.

Sepia aculeata ; This was the most important cuttlefish obtained in exploratory trawl fishing. The annual catch varied from 417 kg in 1980 to 937 kg in 1977. The annual contribution to the cephalopod fishery varied from 28.5% in 1977 to 48% in 1976. The highest monthly catch rates during the first three years were 1.12 kg/h in December 1976, 1.47 kg/h in July 1977 and 1.42 kg/h in November 1978. In other years the monthly catch-per-hour returns were very low.

The length frequency distribution of *Sepia aculeata* ranged from 30 mm to 179 mm in 1976, 20 mm to 169 mm in 1977, 40 mm to 169 mm in 1978, 50 mm to 169 mm in 1979, and 70 mm to 169 mm in 1980. The data for April-December 1978, and the whole years of 1979 and 1980 were meagre. In 1976 there were three modes, at 75 mm, 115 mm and 145 mm, and in 1977 there was only one mode, at 95 mm. Most of the cuttlefish were maturing or mature.

Sepia pharaonis: During the 5-year period 1976-80 the annual landings of this cuttlefish formed 12.3%, 18%, 3.9%, 26% and 14.4% of the total cephalopod landings in the respective years. The monthly catch rates were uniformly low, except in July 1977 (2.28 kg/h) and November 1980 (1.74 kg/h). The size of this cuttlefish ranged from 60 mm to 249 mm, with majority within the range of 140-179 mm.

Sepia brevimana: This cuttlefish formed 3.9% to 14.2% of the annual cephalopod landings. The highest annual catch was only 279 kg (1978) obtained at a catch rate of 0.24 kg/h forming 11.2% of the total cephalopods. This species was caught in small quantities in all the months of that year. In size this is a small cuttlefish ; in trawl catches it ranged between 35 mm and 104 mm.

Sepiella inermis: The catch of this cuttlefish, was very negligible, the annual landings varying between 9 kg and 123 kg. The highest annual contribution to the total cephalopod catch was only 4.9% (1978). Except in March and April this cuttlefish was obtained in very small quantities in all the months of 1978. One of the smallest among commercial species of cuttlefishes, in the surveys this had a size range of 35-75 mm.

Other Areas

In the exploratory survey off Goa by M. T. KALYANI IV and V in 1967-68, two major areas, 15-73 and 16-73, have yielded cephalopods which formed 1.03% of the total trawl landings (Rao and Dorairaj, 1968). The catch rates were 11-20 kg/h in 15-73(2E, 4B and 5D ; 6-10 kg/h in 15-73/3A, 3E, 4A, 4D, 5B, 5C, 6C, 6D and 16-73 3B ; upto 5 kg/h in 15-73(2C, 2D, 3B, 3C, 3B, 4C, 4E, 6B, 16-73 1B, 2B, and 2C. The depth from which they were fished was 10-70 m, with maximum catch rates coming from 30-39 m depth zone. In the survey off Goa during 1978-1979 very small quantities of cephalopods were obtained from

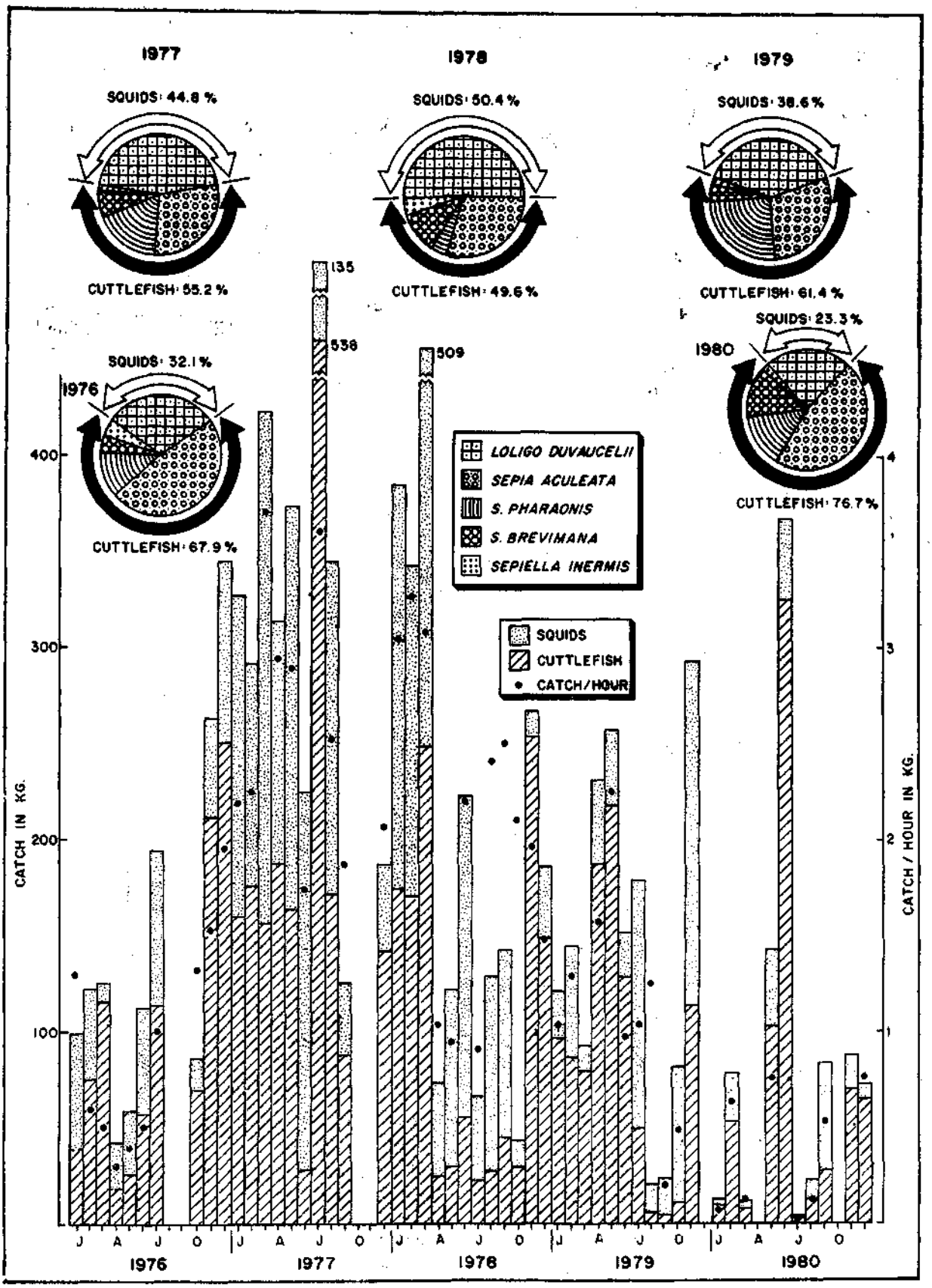

FIG. 3. Monthly cuttlefish and squid catches, catch/hour and annual percentage composition of cephalopods caught by E.F.P. vessels based at Waltair, Visakhapatnam during 1976-'80.

the areas 14-73 and 15-73 at catch rates of 0.80 kg/h and 1.10 kg/h respectively. In these areas the catches were recorded from a depth range of 20-59 m (EFP, 1979c).

In the trawl survey off Karwar by three small vessels (8.5m, 10.6 m and 13.1 m) of the Indo-Norwegian Project, cuttlefish formed 1.33% of the total fish catch. The survey was carried out during 1963-66 in areas between 14° 30'-15° N and 73°40'-74°20' E upto a depth of 20 fathoms (36 m) (Bapat *et al.*, 1972).

During the exploratory trawling off Alleppy and Ponnani in Kerala by M. F. V. KALAVA in 1963 300 kg of squids forming 1.9% of the total catch were taken from a depth of 274-329 m (Tholasilingam *et al.*, 1968). During 1978-79 period, the 17.5 m trawlers of the Exploratory Fisheries Project operated off Kerala coast. The areas 8-76, 9-75, 9-76, 10-75, 10-76 and 11-75 have yielded cephalopods at catch rates varying from 0.40 kg/h to 5.30 kg/h. They were trawled from a depth of 20-89 m the maximum catch rate of 6.3 kg/h coming from 50-59 m. The areas 12-80 and 13-80, off Tamil Nadu have yielded cephalopods from a depth range of 40-69 m but the catch rates were very insignificant (0.10 kg/h to 0.20 kg/h) (EFP, 1979c). According to Sulochanan and John (1982) exploratory survey during 1979-'81 on the southwest coast indicates that productive grounds for cephalopods occur off Calicut and Quilon and in the Wadge Bank.

In the exploratory trawling by R. V. VARUNA and other vessels in the neritic deep waters and the upper continental slope on the southwest coast of India during 1966-68, cephalopods formed a part of the trawl net and drift net catches obtained from a depth of 75-450 m (Silas, 1969a). The cephalopods in trawl landings included small quantities of the octopod *Berrya keralensis* besides the cuttlefish *Sepia*. In the exploratory drift net fishing on the southwest coast of India and in the Laccadive Sea during August 1965 to January 1968, the oceanic squid *Symplectoteuthis oualaniensis* was found to occur in most of the shelf and oceanic areas. Silas (1969a) has charted out the areas of occurrence and the areas of abundance of this squid, pointing to the need to collect more information on the economically important oceanic squids for exploring the possibilities of developing a fishery.

The UNDP/FAO Pelagic Fisheries Project Surveys in the southwest coast and part of the Gulf of Mannar showed that the cephalopods formed one of the components of the catches taken in the pelagic and bottom trawls (UNDP/FAO 1974a, 1974b, 1976a, 1976b. 1976c, 1976d, 1977). Squids formed an average of 1.60% (range 0.60-13.30%) of the total catch taken in pelagic trawl from the areas between 8° N and 15° at N a depth of 20-39 m. In the subsequent operations of this gear at depths 20-80 m, squids formed 3.34% of the total catch in Quilon-Kanyakumari area and the Gulf of Mannar area. In Quilon-Mangalore area they accounted for 1.50% of the total catch obtained from depths up to 80m, whereas in Mangalore-Ratnagiri area, they formed 2-25%. In bottom trawling the percentage contribution of cephalopods to the total catch was 5-50% from Quilon to Kanyakumari and Gulf of Mannar, 1-30% from Quilon to Mangalore and 1% from Mangalore to Ratnagiri.

The exploratory survey of the Wadge Bank carried out by MATSYA NIREEKSHANI during October-December, has revealed good grounds for cuttlefish (EFP, 1982). The areas 7-77, 7-78, 8-76, 8-77 and 8-78 yielded cuttlefish at catch rates upto a maximum of 176 kg/h. This catch rate of cephalopods, the highest recorded so far from any area in our waters, was obtained from the area 8-78 at a depth of 34-42 m in November 1981. In this area the cephalopods formed 87.8% of the total trawl catch. In the area 8-77 the depth zone 20-39 m yielded cuttlefish at a rate of 75.40 kg(h. The present survey, though very short, has indicated the richness of Wadge Bank area for cephalopods comparable to, or even better than, that of the northwestern region.

The liberalised charter policy of the Government of India has resulted in issue of licence to a good number of Taiwanese trawlers to operate under charter agreement in our shelf waters. Bull-trawling (pair-trawling) has been the main method of fishing. The vessels have a fish hold capacity of 150 t or more and were mainly fishing off the Saurashtra-Maharashtra coast. Special effort was expended for cuttlefishes and squids. It is estimated that 30% or more of the catches stored in the hold were cuttlefishes and another 10-20% squids, and the rest finfish species of preference in the eastern markets. The details of the number of chartered vessels operating in the grounds and the number of voyages each vessel undertook yearwise are not available with us. However, the species of cuttlefishes and squids thus harvested in large quantities from this continental shelf area are mainly *Sepia pharaonis, Sepia aculeata, Sepia elliptica* and *Loligo duvaucelii.*

The chartered vessels are expected to operate beyond 40 fathoms (73 m) but there have been several infractions and some have been impounded for fishing in shallower inshore waters. It is understood that due to indiscriminate slaughter fishing by the chartered pair-trawlers infringing also into waters less than 40 fathoms the charter arrangement for such operations is being phased out.

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