

PRESENT STATUS OF EXPLOITATION OF FISH AND SHELLFISH RESOURCES : SQUID AND CUTTLEFISH

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ABSTRACT

A great bulk of the cephalopods exploited in India, mostly as by-catch, is landed on the west coast with the three maritime States of Kerala, Maharashtra and Gujarat accounting for the lion's share. Over 70% of this is obtained in trawl, while the rest is taken in artisanal fisheries, besides some exclusive fisheries of localised nature. During February 1984 to August 1988, on the west coast as a whole, the post-monsoon season (September-February) is the best period for cephalopod landings accounting for an average of 63% of the annual production, while premonsoon season (February-May) is the next productive and the monsoon season (June-August) is the least. Fishery in the monsoon season is active only at Vizhinjam with the operation of large number of artisanal gear; however the cephalopod catch is much less than in other seasons. *Loligo duvauceli* is the single species that constitutes the squid fishery on the west coast, while *Sepia pharaensis* and *Sepia aculeata* mainly form the cuttlefish fishery. There is no significant variation in size range or maturity conditions of the component species of squid and cuttlefish in relation to the seasons. The possible effect of fishing during monsoon on cephalopod resources is discussed.

INTRODUCTION

Cephalopods, which have gained great importance in recent years due to the increasing demand (next only to shrimp) in the export trade, are obtained as by-catch in good quantities in trawl fishing; also a small portion is taken in many types of indigenous gear. The present production has crossed the 50,000 t mark. About three-fourths of this is taken on the west coast, with three maritime States - Kerala, Maharashtra and Gujarat accounting for the lion's share. At present no special gear is exclusively used for the capture of cephalopods, except for a type of hand-jig (anchor hook) which is employed for obtaining cuttlefish at Vizhinjam, the Japanese hand-jig for squid in the Palk Bay area and the spear for the octopus fishing in Minicoy. Though cephalopods are caught throughout the year, there are striking seasonal variations in the catches.

Observations on the fishery characteristics at different centres (Vizhinjam, Cochin, Mangalore, Bombay and Veraval) more or less reflect the nature of the cephalopod fishery of the west coast as a whole. However, there are certain variations in the craft and gear employed, catch and effort, seasonal abundance and species composition. For example, the fishery at Vizhinjam is peculiar in that there is

no trawling or other mechanised fishing, but only artisanal fishery. On the other hand, it is by trawling that most of the fishing is done at all other centres. This paper deals with the cephalopod fishery as a whole and at different centres based on the data collected for the period 1984-88 and attempts to examine whether there is any effect of fishing during the monsoon period on the stock of cephalopods, species and size composition, and other related aspects.

DATA BASE

The catch and effort data on cephalopods presented here in respect of the maritime States of the west coast (Kerala, Karnataka, Goa, Maharashtra and Gujarat) were obtained from the Fishery Resources Assessment Division of CMFRI. These data pertain to the period (1985-88) (upto August) and include the Statewise, seasonwise fishing effort, cephalopod and total catch by gear, except in the case of Maharashtra for which gearwise data were not available.

Apart from these, the data pertaining to the local fishery, environmental parameters for the period 1984-88 (upto August) were collected at different centres. At all centres the catch and effort data collected at random on fixed days were raised

to each day's total, and the total for all the observation days to the month to arrive on the monthly estimates. Biological studies were based on specimens taken by random sampling. The length of squid and cuttlefish refers always to the dorsal mantle length (DML) which is the standard measurement for all cephalopods. The seasons recognised are the premonsoon (February-May), the monsoon (June-August) and the postmonsoon (September-January).

OBSERVATIONS

West coast

From the gearwise data for the period February 1985 to August 1988, it was observed that over 77% of the total cephalopod catch was taken by trawl net and the rest by many other types of gears like boat-seine, drift gillnet, hooks and line, shore seine, *dol* (fixed bag net) and ring seine. Trawl was operated in all the States; a variety of indigenous gears (boat seine, shore seine, hooks and line, drift/gill net and ring seine) was used in Kerala. In Maharashtra and Gujarat the *dol* net took very small quantities of cephalopods.

Of the total cephalopods landed on the west coast, an average of 63% was taken during the postmonsoon season, 29% during the premonsoon season and 8% during the monsoon season. Fig. 1 shows the seasonwise landings on the west coast during the years 1985-87; in the year 1988, as the postmonsoon season was not originally included in the study, the average catch for the postmonsoon seasons of the three previous years is shown for comparison. In all the years the catches during the postmonsoon seasons were the highest, accounting for 54-71% of the annual landings and the lowest catches during the monsoon seasons, ranging from 3% to 18%.

Fig. 2 shows the seasonwise fishing effort by trawl, the cephalopod catch by trawl and the catch by all the other categories of gear put together in respect of the maritime States except Maharashtra. The fishing effort by other categories of gear is not shown, as it was by more than one type of gear in small numbers. There were also no data for the postmonsoon period of 1988. In Kerala the cephalopod catch by trawl during the postmonsoon seasons in all the years was the highest, though the fishing effort was slightly more during the premon-

soon season. But in the case of other categories of gear, the catch in the postmonsoon season of 1986 was much higher (7,175 t) than that by trawls (5,096 t). This was due to the very good catches obtained in boat seine (5,446 t), shore seine (993 t) and hooks and line (579 t), owing to the unusual incursion of squid into the inshore waters during the season, especially in the southern parts of the State where the artisanal gear operating closer to the shore were more in operation than trawls. The fishing effort by trawl as well as artisanal gear was minimum during the monsoon seasons.

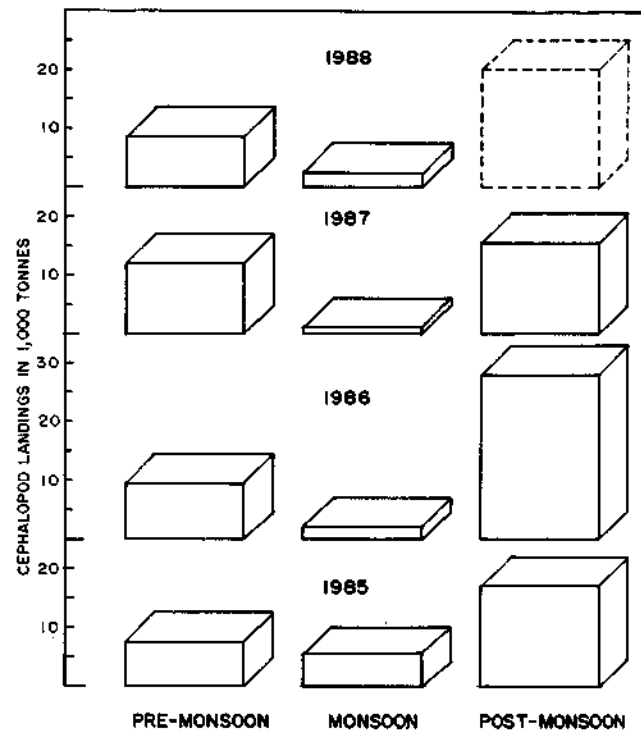


Fig. 1. Seasonwise landings of cephalopods on the west coast of India. Since the landings during postmonsoon season of 1988 were not originally included, the average of preceding three years' postmonsoon seasons is shown for comparison.

More or less similar trend was noticed in Karnataka and Goa, but variation in fishing effort and cephalopod catch during premonsoon and postmonsoon seasons was not as pronounced as in Kerala. Both effort and catch were uniformly low during the monsoon seasons.

In Gujarat, the fishing effort by trawlers during each of the premonsoon and postmonsoon seasons was low when compared to other States. But the corresponding cephalopod catches were

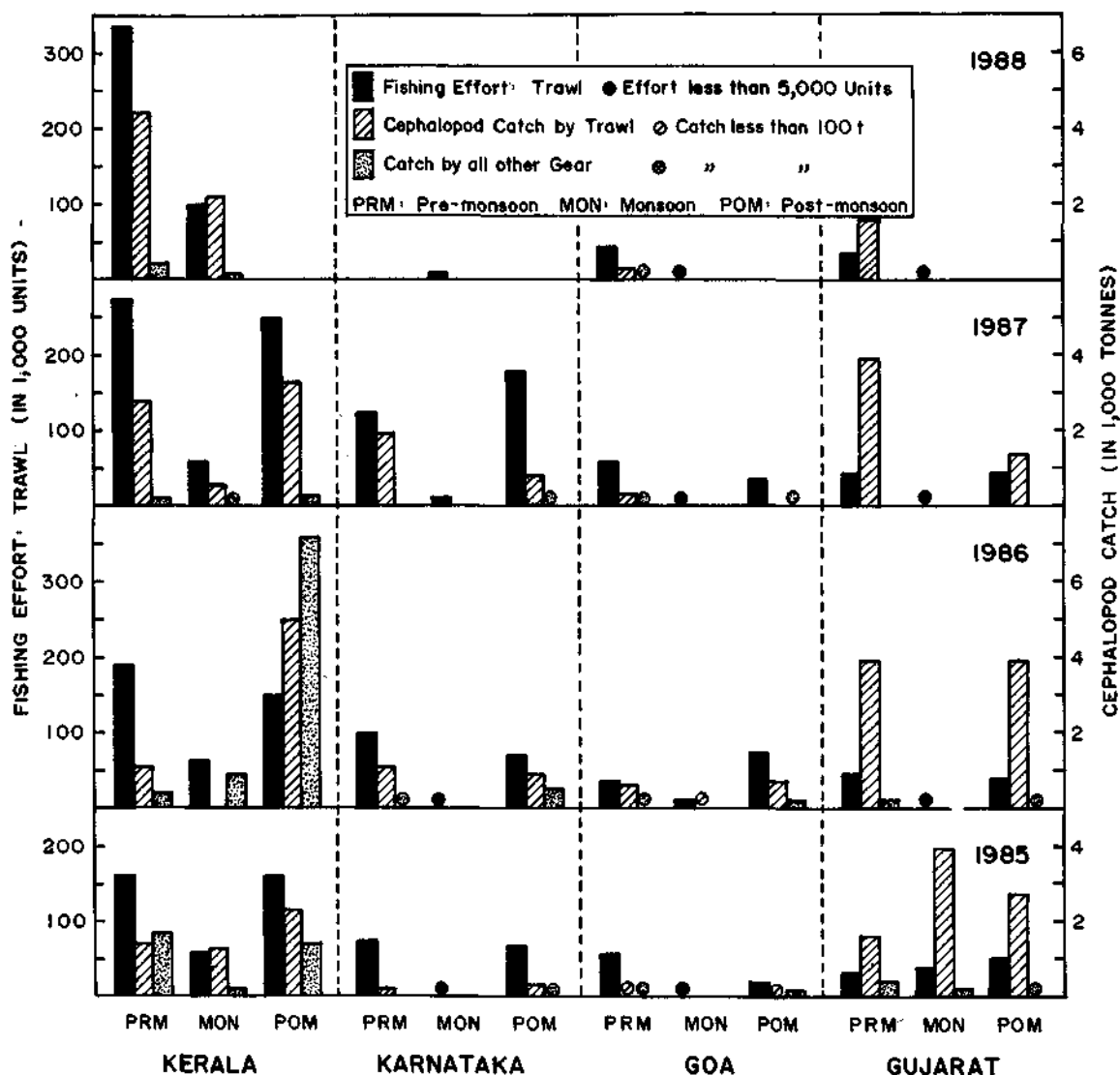


Fig. 2. Statewise, seasonwise fishing effort by trawl and cephalopod catch by trawl and by all other gears. Gearwise data for Maharashtra not available.

high. In 1985, the postmonsoon catch was higher than that in the premonsoon, but in 1986 it was almost equal and in 1987, the premonsoon catch was much higher (3,852 t) than in the postmonsoon. Trawling operations and the catch were the minimum during the monsoon seasons in most years, but in 1985, the effort was slightly more than that in the premonsoon and the catch was much higher, 3,901 t by trawl and 152 t by other types of gear.

The seasonwise landings of cephalopods in Maharashtra are given in Table 1. Here also the landings during the postmonsoon seasons were the highest, with the least during the monsoon seasons.

The postmonsoon catches in this State were much higher than those in Kerala during 1985 and 1987, but in 1986 the catch in Kerala was slightly higher, 12,271 t as against 10,047 t in Maharashtra.

TABLE 1. Seasonwise cephalopod landings (tonnes) in Maharashtra for the years 1985-88 (Postmonsoon season of 1988 not included)

Season	1985	1986	1987	1988
Premonsoon	2,327	2,426	3,016	1,870
Monsoon	59	118	112	187
Postmonsoon	10,349	10,047	9,550	-

Vizhinjam

The cephalopod catch at Vizhinjam was composed of three species viz., the squids *Loligo duvauceli* Orbigny and *Doryteuthis sibogae* Adam and the cuttlefish *Sepia pharaonis* Ehrenberg. Besides these species, stray occurrence of squids *Doryteuthis singhalensis* (Ortman) and *Sepioteuthis lessoniana* Lesson and the cuttlefish *Sepia aculeata* (Orbigny) and *Sepiella inermis* (Orbigny) has been noticed; none of these species formed any fishery, except for *Sepioteuthis lessoniana* which was occasionally taken in small quantities.

Annual catch trend : In 1984 (February 1984 to January 1985) the total cephalopod catch was 267 t, but during the next year it increased to 532 t. In 1986 there was a bumper catch of 1,752 t of cephalopods and this was more than thrice the highest annual landings ever recorded at Vizhinjam. Such a peak was due to the sudden spurt in the squid catch throughout the southern part of the southwest coast of India in September that year. This was followed by a dismal fall in the catch next year with a total of only 37 t, the lowest record of annual cephalopod landings.

Monthly catch trend : The average monthly catch data for five years from February 1984 to August 1988 (Table 2) show that squids were landed in all the months. In the case of cuttlefish, the peak landings were in October-November with the catch coming down towards the end of the year or the beginning months of the next year. There were absolutely no landings of cuttlefish from May to July.

TABLE 2. Average monthly squid and cuttlefish landings (tonnes) at Vizhinjam during 1984-1988

Month	Squid	Cuttlefish	Total
February	10.9	1.8	12.7
March	16.3	3.5	19.8
April	0.1	0.5	0.6
May	3.0	-	3.0
June	4.4	-	4.4
July	1.1	-	1.1
August	122.8	0.8	123.6
September	352.7	11.8	364.5
October	4.6	33.9	38.5
November	0.1	20.5	20.6
December	26.2	14.1	40.3
January	0.8	6.4	7.2

Seasonal catch trend : During the period of observation as a whole, the cephalopod catch was the maximum (74%) in the postmonsoon period, followed by the monsoon period (20%) and premonsoon period (6%). In 1987 and 1988, the fishery itself was very poor to show any seasonal trend; however, the catches in the premonsoon were slightly better than in other season (Fig. 3). In 1985 the catch in the monsoon season dominated, but in the remaining two years (1984 and 1986) the postmonsoon landings were the highest (78% and 80% respectively). It was also seen from Fig. 3 that the catches were always less in monsoon periods than in postmonsoon periods; annually they varied between 4% in 1988 and 45% in 1985.

Gearwise seasonal catch trend : (i) *Shore seine :* Of 1,985 units operated, the minimum (76) was during the monsoon period. There was no operation of shore seine during the monsoon months in some years. The maximum effort (1,052 units) was put in during the postmonsoon seasons as also the maximum catch (1.4 t). The average CPUE ranged from 1 kg in the premonsoon to 1.4 kg in the monsoon (Table 3).

(ii) *Boat seine :* About 82% of the total cephalopod landings and 94% of the squid landings at Vizhinjam were contributed by boat seine. Bulk of the squid catch by this gear (60%) came during the postmonsoon season, though only 19% of the fishing effort was put in; the CPUE was very high 56.2 kg. In the postmonsoon of 1986 the CPUE was as high as 127.1 kg (Table 3). More effort (75%) was put in during the monsoon season, but the catch was only 29%. Both effort and catch were the minimum in the premonsoon period.

Fig. 4 shows the fishing effort and cephalopod catch in each season of the year in respect of boat seine, and hooks and line; shore seine is not represented here as both effort and catch were very small. The boat seine effort was more in the monsoon season of all the years, but the catch was significant in the postmonsoon season of 1984 and 1986; 1,314 t of squids obtained during the latter year was the highest recorded so far at Vizhinjam. Only in 1985 and also in 1987 to a very small extent, the catch during the monsoon season was slightly higher than in the other seasons. In 1988 the premonsoon catch was much better than the catches in the corresponding seasons of other years, while the contribution of the monsoon season was negligible.

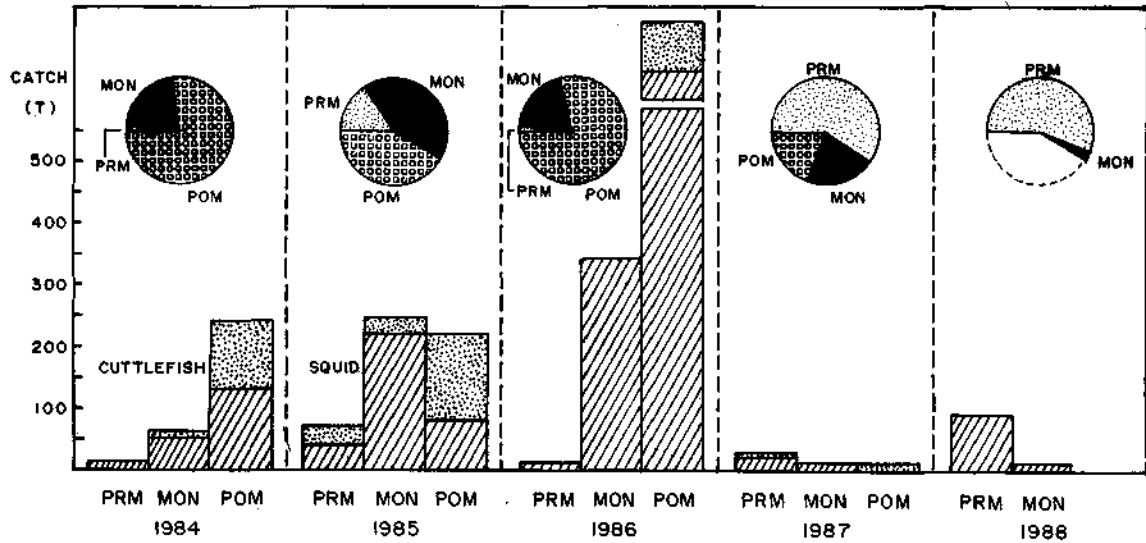


Fig. 3. Squid and cuttlefish landings at Vizhinjam during the premonsoon (PRM), monsoon (MON) and postmonsoon (POM) seasons of 1984-88. The pie-diagrams show the relative seasonal landings.

TABLE 3. Gearwise catch per unit effort (kg) during premonsoon, monsoon and postmonsoon seasons of 1984-'88 at Vizhinjam

Year	Premonsoon			Monsoon			Postmonsoon		
	SS	BS	HL	SS	BS	HL	SS	BS	HL
1984	0.3	0.1	0.1	1.7	2.6	0.1	3.3	22.3	3.1
1985	2.6	11.2	1.6	-	8.8	1.1	0.6	7.5	5.0
1986	1.4	1.0	N.C.	-	15.8	N.C.	1.2	127.1	4.2
1987	0.5	4.3	1.1	0.1	0.3	0.1	0.2	N.C.	0.4
1988	0.5	16.5	2.8	N.C.	0.1	N.C.	-Not included-		
Average	1.0	6.9	1.1	1.4	5.9	0.2	1.3	56.2	3.4

SS : Shore seine; BS : Boat seine; HL : hooks and line;
 -: no operation of gear; N. C. : no catch.

(iii) *Hooks and line* : This gear accounted for 18% of the total cephalopod catch. Unlike the boat seine, the effort was the minimum during the monsoon season in all the years. In the other two seasons the effort varied from 14,786 to 32,649. The catch was minimum during the monsoon seasons. In the postmonsoon seasons the hooks and line catch of cephalopod was high during the first three years varying from 95 t (1986) to 101 t (1984) and the bulk (88%) of the catch was cuttlefish. The fishery was moderate in the premonsoon seasons of 1985 (36 t), 1987 (19 t) and 1988 (63 t) and the catch was

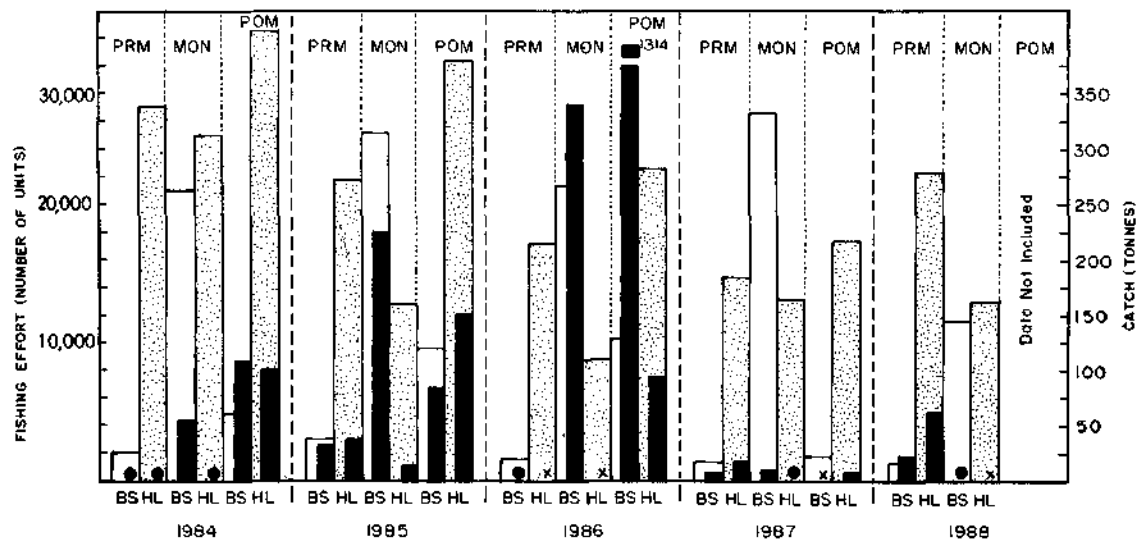


Fig. 4. Fishing effort (in number of units operated) and cephalopod catch (shaded bars) in respect of boat seine (BS) and hooks and line (HL) at Vizhinjam during the premonsoon (PRM), monsoon (MON) and postmonsoon (POM) seasons of 1984-88. O : catch less than 5 tonnes; X : no catch.

composed of 75% of squids and 25% of cuttlefish. The CPUE was low during the premonsoon and monsoon seasons of all the years, but in the postmonsoon seasons the values were better, with the average of 3.4 kg.

There was progressive mechanisation of the fishing craft for operation of the hooks and line through the years. In 1984 the ratio of fishing effort of non-mechanised craft to mechanised craft was 1 : 0.2, which has increased to 1 : 4.9 in 1987. The corresponding ratios of the cephalopod catches were 1 : 0.4 and 1 : 5.4, indicating that there was increased returns for the fishing effort expended from mechanised craft.

Catch composition

Fig. 5 shows the relative abundance of the squids *Loligo duvauceli* and *Doryteuthis sibogae* and the cuttlefish *Sepia pharaonis* in different seasons. The landings of *Loligo duvauceli* were the lowest, less than 2 t, in the premonsoon periods of the first four years and there was no catch in 1988. The catches were much better in the monsoon seasons (8-341 t), but the highest seasonal catch of 1,314 t was in the postmonsoon period of 1986. This was due to the bumper catches in September that year when there was unusual large scale shoreward migration of schools of squids. As a whole, about three-fourths of the catch of this squid were taken in the postmonsoon period and almost the rest in the monsoon period, with very insignificant catch in the premonsoon season.

Doryteuthis sibogae was landed in all the premonsoon periods in all the years with the catch varying from 1 to 85 t. There was no fishery in the monsoon months except in 1985. In the postmonsoon period of 1984 there was a good catch of 96 t, but in subsequent two years the catches were very insignificant. As a whole, the fishery was minimum (7%) during the monsoon season and maximum (57%) during the premonsoon period.

The cuttlefish *Sepia pharaonis* showed a trend different from those of the squids. Bulk of the catch (75%) was taken during the postmonsoon, followed by the landings in the premonsoon (26%); in the monsoon season there was either no catch or the catches were less than 2 t.

Catch and rainfall

In general it is observed that higher catches were obtained when there was low rainfall (Fig. 6 A). For example in December 1984 the catch was 110 t and the rainfall 3 mm. In August 1983 there was a catch of 216 t and in September 1986 the catch was 1,314 t. The rainfall in the two months was 62 mm and 78 mm respectively. The maximum rainfall of 539 mm was recorded in June 1988 but there was no cephalopod catch. In June 1985 the rainfall recorded was 424 mm and the catch 19 t; in October 1987 the rainfall was 415 mm whereas the catch was only 6 t.

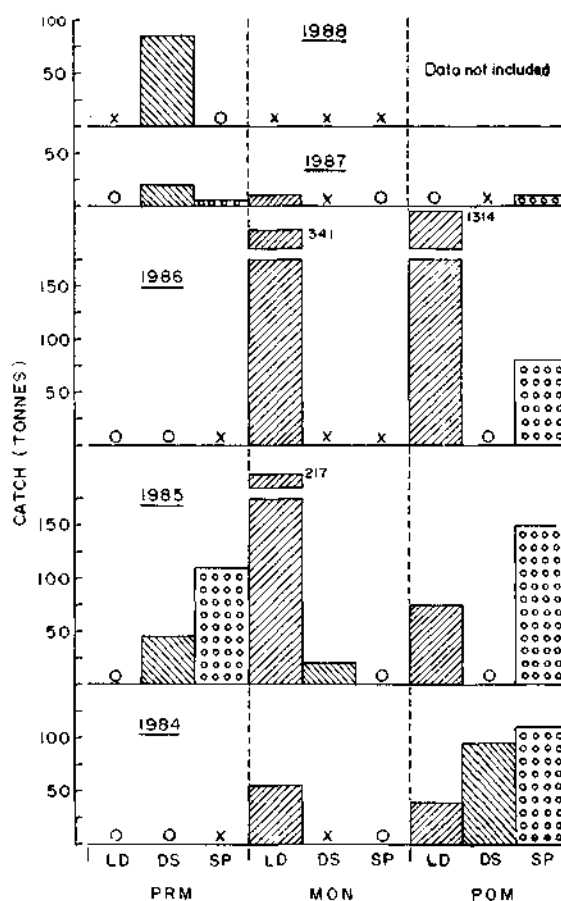


Fig. 5. Relative abundance of the squids *Loligo duvauceli* (LD) and *Doryteuthis sibogae* (DS), and cuttlefish *Sepia pharaonis* (SP) during the premonsoon (PRM), monsoon (MON) and postmonsoon (POM) seasons of 1984-88.

Fig. 6 B shows the cephalopod catch in relation to the seasonal rainfall for the 5 years. Except in 1984 and 1987, the maximum rainfall was in the monsoon season, followed by that in the postmonsoon (which also includes the northeast mon-

soon); in 1984 the premonsoon total was 730 mm and in 1987 the rainfall during the postmonsoon was very high (1,109 mm). The monthly trend mentioned earlier is reflected in the seasons as a whole in that the catch was more with less rainfall.

Size composition

Loligo duvauceli : The size of males ranged from 20 mm to 330 mm; females had a smaller size range, 30-230 mm (Fig. 7). From the monsoon

season of 1984 to the postmonsoon of 1985, a large number of length groups (40-50 mm to 320-330 mm) were represented in the catch, but afterwards the size range became smaller. Upto the premonsoon period of 1986 the fishery was supported by adult squid above 110 mm which is the size at maturity for both the sexes. The same pattern was repeated during the monsoon season of 1988. The bumper catch during the postmonsoon season of 1986 was supported by squid with modal sizes of 145 mm (males) 155 mm (females). In the monsoon season of 1987 immature and mature squid were in almost equal proportion. In the premonsoon and postmonsoon period of 1987 juveniles constituted the fishery.

Doryteuthis sibogae : Males of this squid had a size range of 30-240 mm and females a smaller size range within 30-220 mm (Fig. 7). The fishery in general was supported by adult squid above 90 mm [According to Silas *et al.* (1986) the size at first maturity of male is 97 mm and that of female 84 mm]. Only in the premonsoon period of 1986 the juveniles constituted the fishery; in the postmonsoon of 1984 and premonsoon and postmonsoon of 1985 also they formed part of the landings.

Sepia pharaonis : As in the case of squids, the cuttlefish *Sepia pharaonis* also had a wide length range from 130 mm to 360 mm, which was also the range for male; the females were smaller, 130-290 mm (Fig. 7). In all the seasons when cuttlefish was landed, almost the entire catch was composed of adult individuals larger than 145 mm which was the size at first maturity for males (160 mm for females). Most of the male cuttlefish that formed the bulk of the catch were 250 mm and above and females larger than 200 mm.

Cochin

Premonsoon season : The estimated average cephalopod production (Table 4) during the season amounted to 257 t taken at a catch rate (CPUE) of 13.9 kg per trawler day. The monthly average landings varied from 40 t in February to 94 t in May with catch rates varying from 10.1 kg to 17.3 kg. Cephalopod contribution to all-fish production was 5%. The catch during May was higher than that in other months, contributing 36.6% to the season's total. The catch, effort and CPUE showed an increasing trend from February to May.

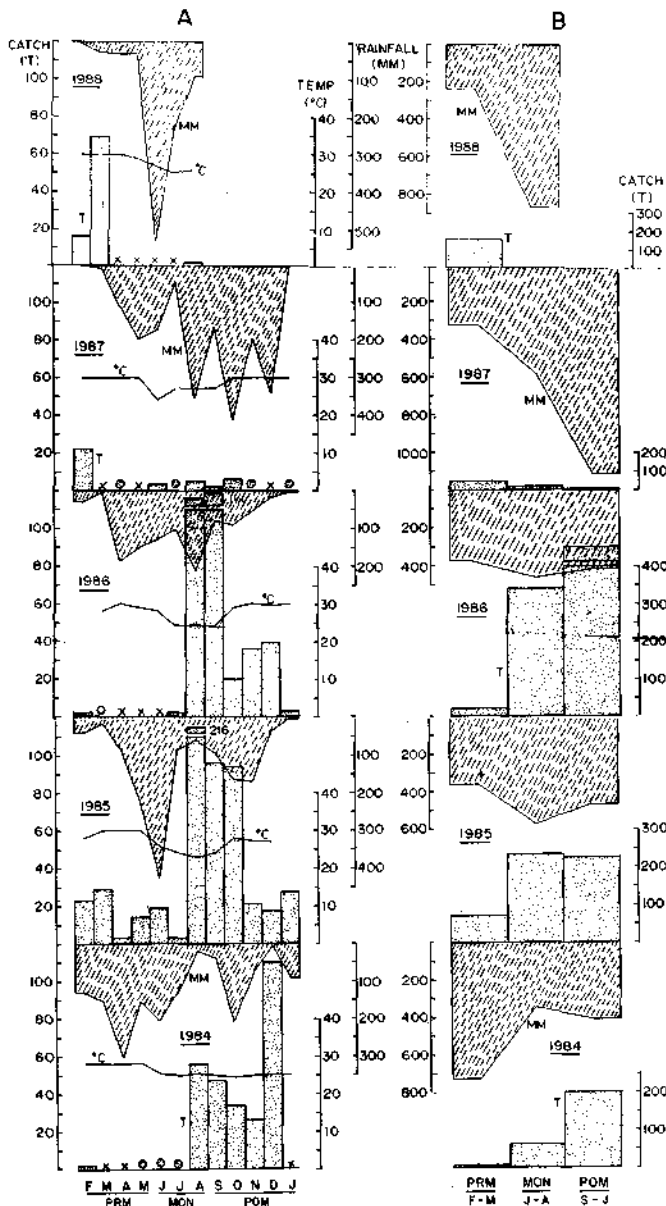


Fig. 6 A. Monthly rainfall, seawater temperature and cephalopod catch during 1984-88 and B. Seasonal rainfall and cephalopod catch. PRM : Premonsoon; MON : monsoon; POM : postmonsoon, O : catch less than 2 tonnes; X : no catch.

Squid, solely represented by *L. duvauceli* was dominant (79.7%) in the landings. Its catch increased from 27 t in February to 79 t in May. Among the cuttlefish, *S. pharaonis* which is commercially the most important species, accounted for 33.6%; the contribution by other species was :

elliptica 28.7%, *S. aculeata* 20.5% and *Septiella inermis* 17.2%. Cuttlefish landings were poor during February.

The size of males of *L. duvauceli* ranged from 30 to 250 mm and that of females from 30 to

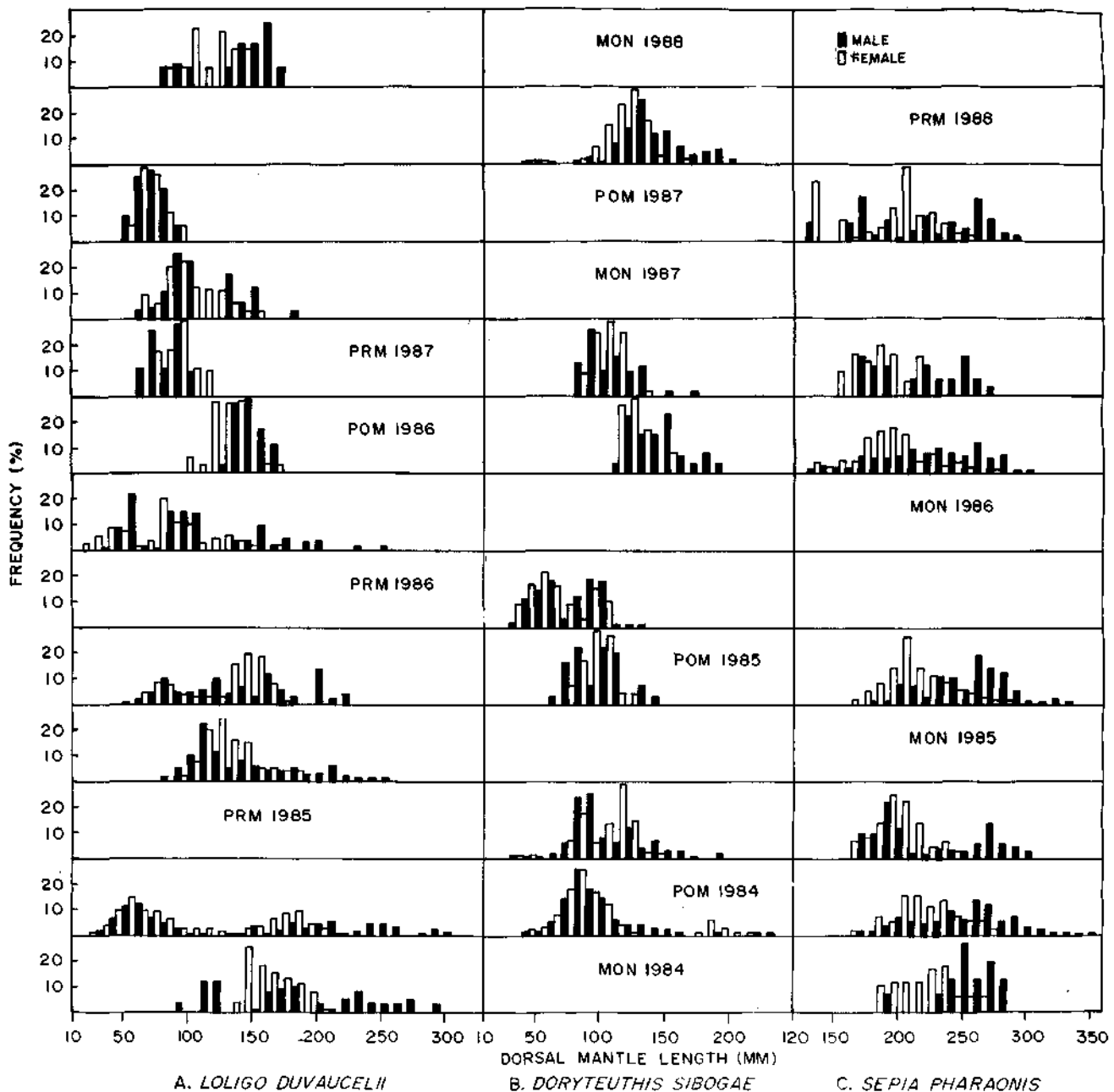


Fig. 7. Size composition of component species of cephalopods by premonsoon (PRM), monsoon (MON) and postmonsoon (POM) seasons of 1984-88, shaded bars : males; open bars : females.

190 mm. The fishery was mostly supported by squid in the size range of 60-150 mm. Sexes were almost equally represented during the season. Squid with maturing gonads were generally dominant, with mature and running gonads occurring in lesser numbers.

Monsoon season : The average landings during the season were estimated at 187 t, with a catch rate of 13.2 kg (Table 5). Though the catch rate was more or less the same as that during the premonsoon season, the catch and effort had decreased by 27.3% and 23.7% respectively. The landings ranged from 31 t in July to 106 t in June with their catch rates varying from 6.8 kg to 17.2 kg. About 57% of the season's production came in June. During the monsoon period the cephalopod contribution to all-fish production was just over 2%.

With a catch of 147 t, the cuttlefish accounted for 79% of the total cephalopod landings. Cuttlefish landings ranged from 28 t July to 80 t in June.

TABLE 4. Catch (tonnes), fishing effort (trawler days), CPUE (kg) and species composition of cephalopods during premonsoon season at Cochin (Average for 1984-'88)

	Feb.	Mar.	Apr.	May	Total
<i>Loligo duvauceli</i>	26.8	49.6	49.7	78.7	204.8
<i>Sepia pharaonis</i>	5.1	3.2	4.5	4.8	17.6
<i>Sepia aculeata</i>	2.0	1.3	3.7	3.8	10.8
<i>Sepia elliptica</i>	4.5	2.3	4.6	3.7	15.1
<i>Sepiella inermis</i>	1.6	1.6	2.6	3.3	9.1
Total squids	26.8	49.6	49.7	78.7	204.8
Total cuttlefish	13.2	8.4	15.4	15.6	52.6
Total cephalopods	40.0	58.0	65.1	94.3	257.4
Fishing effort	3,939	4,373	4,792	5,429	18,533
CPUE	10.1	13.2	13.6	17.3	13.9

S. pharaonis (55.9%), *S. aculeata* (32%), *S. elliptica* (11.4%) and *S. inermis* (less than 1%) constituted the cuttlefish landings. *L. duvauceli* contributed 99.4% to the squid production (39 t) and the rest by *Doryteuthis singhalensis*. The latter species was observed in the landings at Cochin for the first time during August 1988.

The size range of *L. duvauceli* was 30 mm to 260 mm for males and 40 mm to 180 mm for females. Squid in the size groups 60-150 mm supported the fishery. During this period also the

gonadial conditions of the squid were almost similar to those observed during the premonsoon period.

Postmonsoon season : During this season 213 t of cephalopods were landed with a CPUE of 20.2 kg (Table 6). The production varied from 7 t in September to 110 t in November. Cephalopods contributed 7% to all-fish landings. The effort spent during September and October was 247 and 560 trawler days, but it increased to a maximum of 4,268 in January. The monthly catch rates varied from 11 kg in January to 54.3 kg in November. The fishing effort during this season decreased by 43% from the premonsoon period and by 25% from the monsoon period.

Cuttlefish *S. pharaonis* (44.6%), *S. aculeata* (28.9%), *S. elliptica* (22.5%) and *Sepiella inermis* (4.0%) were dominant in the catches contributing 55% to cephalopod production. The squid *L. duvauceli* accounted for the rest of the catch. Squid landings were comparatively more during December and January.

TABLE 5. Catch (tonnes), fishing effort (trawler days), CPUE (kg) and species composition of cephalopods during monsoon season at Cochin (Average for 1984-'88)

	June	July	August	Total
<i>Loligo duvauceli</i>	26.7	3.0	9.7	39.4
<i>Doryteuthis singhalensis</i>	-	-	0.2	0.2
<i>Sepia pharaonis</i>	50.1	12.3	20.0	82.4
<i>Sepia aculeata</i>	26.7	9.4	11.0	47.1
<i>Sepia elliptica</i>	2.2	5.5	9.0	16.7
<i>Sepiella inermis</i>	0.7	0.4	-	1.1
Total squids	26.7	3.0	9.9	39.6
total cuttlefish	79.7	27.6	40.0	147.3
Total cephalopods	106.4	30.6	49.9	186.9
Fishing effort	6,177	4,472	3,488	14,137
CPUE	17.2	6.8	14.3	13.2

The size ranges of males and females of *L. duvauceli* were 30-290 mm and 30-190 mm respectively. There was not much variation either in the size groups supporting the fishery or in the maturity conditions of the gonads from the earlier two seasons.

Mangalore

Species composition : The cephalopod fishery at Mangalore was constituted by squid represented by a single species *Loligo duvauceli* and the cuttlefish composed of *Sepia aculeata* and *Sepia pharaonis*, besides other species in very small numbers. The specieswise relative abundance during different seasons of 1984-88 is given in Table 7.

TABLE 6. Catch (tonnes), fishing effort (trawler days), CPUE (kg) and species composition of cephalopods during postmonsoon season at Cochin (Average for 1984-'88)

	Sep.	Oct.	Nov.	Dec.	Jan.	Total
<i>Loligo duvauceli</i>	0.7	4.2	29.1	27.4	35.6	97.0
<i>Sepia pharaonis</i>	2.7	1.3	37.2	5.9	4.8	51.9
<i>Sepia aculeata</i>	1.7	0.7	26.5	3.5	1.2	33.6
<i>Sepia elliptica</i>	1.4	0.8	15.9	3.5	4.6	26.2
<i>Sepiella inermis</i>	0.1	0.4	1.4	2.1	0.7	4.7
Total squids	0.7	4.2	29.1	27.4	35.6	97.0
Total cuttlefish	5.9	3.2	81.0	15.0	11.3	116.4
total cephalopods	6.6	7.4	110.1	42.4	46.9	213.4
Fishing effort	247	560	2,029	3,446	4,268	10,550
CPUE	26.5	13.1	54.3	12.3	11.0	20.2

Premonsoon season : During this period the cephalopod catches varied from 290 t in 1985 to 875 t 1987 (Table 8). The cephalopod contribution to the total catch ranged between 4.7% in 1984 and 8.7% in 1986. The CPUE varied from 11.1 kg in 1985 to 30.3 kg in 1987. The squid *Loligo duvauceli* was the most dominant species forming about 90% of the total cephalopods in 1984 to 95% in 1987. *Sepia aculeata* was the dominant cuttlefish, contributing to 2-10%. *Sepia pharaonis* was observed in the premonsoon catches during 1986 and 1987, contributing 5% and 3% respectively during the above two years. On an average, the contribution of cephalopods during premonsoon period was 6.2%, with a CPUE of 21.6 kg.

Monsoon season : There was no fishing during monsoon period. However, fishing was conducted in the first week of June in 1987 due to late onset of monsoon. During this period the cephalopod catch was negligible (Table 8).

Postmonsoon season : During this period the cephalopod catch varied from 167 t in 1986 to 342 t in 1984, while the CPUE ranged from 10.4 kg in 1986,

to 20.9 kg in 1985 (Table 8). The contribution of cephalopods to the total catch varied between 3.1% in 1987 and 9.5% in 1985. The catches of *Loligo duvauceli* ranged from 147 t in 1986 to 226 t 1987, forming 55-88% of the total cephalopods taken in the postmonsoon seasons (Table 7). The catches of cuttlefish ranged from 20 t in 1986 to 153 t in 1984

TABLE 7. Seasonal specieswise cephalopod landings (tonnes) at Mangalore during 1984-87

	1984	1985	1986	1987
Premonsoon				
<i>Loligo duvauceli</i>	338	262	661	829
<i>Sepia aculeata</i>	40	26	62	21
<i>Sepia pharaonis</i>	-	-	35	25
Others	-	2	-	-
Total	378	290	758	875
Monsoon				
<i>Loligo duvauceli</i>	-	-	-	(*)
<i>Sepia aculeata</i>	-	-	-	-
<i>Sepia pharaonis</i>	-	-	-	-
Total	-	-	-	(*)
Postmonsoon				
<i>Loligo duvauceli</i>	189	213	147	226
<i>Sepia aculeata</i>	146	84	15	45
<i>Sepia pharaonis</i>	2	8	5	3
Others	5	8	-	-
Total	342	313	167	274
Annual				
<i>Loligo duvauceli</i>	527	475	808	1,055
<i>Sepia aculeata</i>	186	110	77	66
<i>Sepia pharaonis</i>	2	8	40	28
Others	5	10	-	-
Total	720	603	925	1,149

(*) Catch negligible

forming 12-45%. *Sepia aculeata* and *Sepia pharaonis* were the important species, besides *Sepiella inermis* in very small quantity. On an average the cephalopods formed 4.5% of the total trawl landings during the postmonsoon period with a catch rate of 14.4 kg. The contribution of *Loligo duvauceli* was 70.8%, *Sepia aculeata* 26.5% *Sepia pharaonis* 2% and *Sepiella inermis* 0.7% February, 1984 to August, 1988.

TABLE 8. Monthly and seasonal cephalopod landings (tonnes) and seasonal effort (number of boats per day), CPUE (kg) and percentage of cephalopods in total landings at Mangalore during 1984-87

Month	1984	1985	1986	1987
<i>Premonsoon</i>				
February	88	107	208	167
March	112	48	408	261
April	78	79	119	343
May	100	56	23	104
Total	378	290	758	875
Effort	23,433	26,198	27,942	28,919
CPUE	16.2	11.1	27.1	30.3
Percentage	4.7	6.2	8.7	7.1
<i>Monsoon</i>				
June	-	-	-	(*)
July	-	-	-	-
August	-	-	-	-
Total	-	-	-	(*)
Effort	-	-	-	100
CPUE	-	-	-	0.2
Percentage	-	-	-	0.4
<i>Postmonsoon</i>				
September	-	-	-	-
October	5	1	-	-
November	44	41	(*)	35
December	144	162	47	125
January	149	109	119	114
Total	342	313	167	274
Effort	24,266	14,992	15,019	45,290
CPUE	14.1	20.9	10.4	13.1
Percentage	4.9	9.5	3.3	3.1

* Catch negligible

Bombay

The total cephalopod landings in the 5-year period amounted to 42,137 tonnes forming 10.4% of all-fish catch.

Monthwise catch : The monthly catch, CPUE and percentage of cephalopod in all-fish catch are shown in Fig. 8. The catch was 22 tonnes in July and it gradually increased in subsequent months, reaching 3,707 tonnes in December. The CPUE was the lowest (10 kg) in July and the highest (800 kg)

in December. The same trend was observed in the percentage of cephalopods in all-fish catch also. In all the three monsoon months catches were poor. From February to August the catches were mainly dominated by squid, whereas from September to January, cuttlefish dominated.

Seasonal catch trend : The fishing effort, catch, CPUE and percentage of cephalopods during the premonsoon, monsoon and postmonsoon seasons of 1984-88 are given in Table 9.

Premonsoon season : The catch of cephalopods varied from 1,303 t in 1984 to 2,676 t in 1987 with an average of 2,118 t. The CPUE ranged from 90 kg in 1984 to 153 kg in 1987 with an average of 130 kg. The cephalopod catch was composed of 69.5% of squid and 30.5% of cuttlefish. The highest CPUE (67 kg) of cuttlefish was recorded in 1988 and that of squid (79 kg) in 1984. During the premonsoon season cephalopods formed 7% of the total fish catch.

Monsoon season : The catch of cephalopods varied from 51 t in 1984 to 277 t in 1988. The CPUE was the highest (35 kg) in 1988 and the lowest (9 kg) in 1985. The average catch and CPUE were 139 t and 21 kg respectively. Squids dominated in the catch with 64.3%. The percentage of cephalopods in total fish catch for the season as a whole was very low (1.4%).

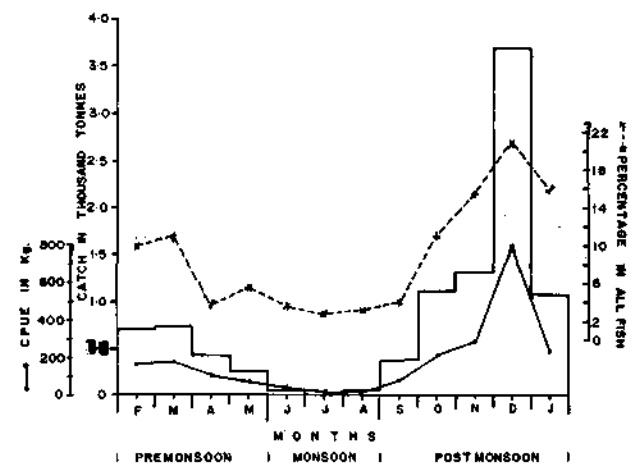


Fig. 8. Monthly catch (tonnes) and CPUE (kg) of cephalopods and their percentage in all-fish catch at Bombay (Pooled data for 1984-'88).

Postmonsoon season : The period in all the years was the best for cephalopod fishery. The catch varied from 4,727 t in 1984 to 8,899 t in 1987 with an average of 7,727 t. The highest CPUE (397 kg) was

TABLE 9. Seasonwise fishing effort and catch particulars of cephalopods at Bombay during 1984-'88 (Fishing effort in number of units, catch in tonnes and CPUE in kg)

Years	Units	Squids	% of squid in cephalopod	CPUE	Cuttle fish	% of cuttlefish in cephalopod	CPUE cephalopod	CPUE	% of cephalopod in all fish	All fish	
<i>Premonsoon (February-May)</i>											
1984	14,480	1,033	79.3	71	270	20.7	19	1,303	90	2.7	48,944
1985	14,983	1,733	73.5	115	626	26.5	42	2,359	157	11.5	20,558
1986	17,305	1,640	74.2	95	570	25.8	33	2,210	127	7.3	30,162
1987	17,486	2,070	77.4	118	606	22.6	35	2,676	153	10.8	24,777
1988	17,190	890	43.5	52	1,155	56.5	67	2,045	119	7.3	27,900
Average	16,290	1,473	69.5	90	645	30.5	40	2,118	130	7.0	30,468
<i>Monsoon (June-August)</i>											
1984	6,344	69	72.1	11	27	27.9	4	96	15	0.9	9,972
1985	5,585	27	52.6	5	24	47.4	4	51	9	0.7	6,965
1986	6,510	84	66.2	13	43	33.8	6	127	20	1.3	9,837
1987	6,077	78	54.1	13	67	45.9	11	145	24	1.6	9,041
1988	7,955	189	68.2	24	88	31.8	11	277	35	2.2	12,423
Average	6,494	89	64.3	14	50	35.7	8	139	21	1.4	9,648
<i>Postmonsoon (September-January)</i>											
1984	23,719	1,073	22.7	45	3,654	77.3	154	4,727	199	11.6	40,707
1985	22,157	857	9.7	39	7,947	90.3	359	8,804	397	22.1	39,810
1986	24,434	2,520	29.9	103	5,900	70.1	241	8,420	345	11.0	76,592
1987	26,003	980	11.0	38	7,919	89.0	305	8,899	342	18.8	48,183
Average	24,078	1,357	17.6	56	6,355	82.4	264	7,712	320	15.0	51,323

obtained in 1985 with the lowest (199 kg) in 1984 which was much higher than the highest value in other seasons. The average CPUE was 320 kg. Cuttlefish catch was higher (82%) than that of squids (18%). The cephalopods accounted for 15% of the all-fish catch during this season, which was the highest for all seasons.

Species composition

Loligo duvauceli was the only species that formed the squid fishery. The squids were more abundant in premonsoon months than in other seasons and the seasonal average CPUE was 90 kg. Postmonsoon months recorded a CPUE of 56 kg and the lowest value of 14 kg in the monsoon period. The length of *Loligo duvauceli* ranged from 20 to 319 mm, with 90-99 mm and 180-189 mm as the two prominent modal size groups. During monsoon months 50-219 mm size squids were netted. The sex ratio was 1 : 1. Mature females were common from January to May and spawning females occurred along with mature ones from September to November.

Cuttlefish were mainly landed during postmonsoon period with an average CPUE of 264 kg. The lowest CPUE (8 kg) was in monsoon season, while it was 40 kg during the premonsoon season.

Sepia aculeata : The size of this cuttlefish ranged from 30 to 249 mm with two prominent modal groups of 100-109 mm and 180-189 mm. The male : female ratio was 3 : 2. Mature and spawning individuals have been observed during February-March and September-November periods.

Sepia pharaonis : This is a less abundant, but larger cuttlefish. The size ranged from 150 to 359 mm. The common modal size groups were 240-249 mm and 290-299 mm. Smaller individuals were not represented in the catches.

Veraval

Monthly and seasonal catch trend : The monthwise and seasonwise total cephalopod landings at Veraval, their CPUE and percentage in total fish

landings are given in Table 10. It could be noted that in general the average catch of cephalopod was more during the postmonsoon period, with almost 36% increase over the premonsoon period. There was concomitant increase in the CPUE also. The average CPUE during the premonsoon period was 3.9 kg whereas it was 4.4 kg during the postmonsoon. During the premonsoon period the cephalopod catch ranged from 427 t in 1984 to 1,535 t in 1987, whereas in the postmonsoon period the range was from 934 t in 1987 to 2,136 t in 1986. Although there was steady increase in the annual cephalopod landings from 1984 onwards, a sharp peak of 2,136 t during the postmonsoon period of 1986 and a sudden decline to 984 t during the corresponding period of subsequent year could be noted. The CPUE of cephalopods during the premonsoon season ranged from 1.4 kg in 1984 to 6 kg in 1987; in the postmonsoon season the range was from 2.8 kg in 1987 to 7.5 kg in 1986.

Species composition

The cephalopod fishery at Veraval was constituted by one species of squid (*Loligo duvauceli*) and one species of cuttlefish (*Sepia elliptica*.) The specieswise monthly and seasonal landings and CPUE are given in Table 11. It was seen that the squid and the cuttlefish had definite seasonal abundance. In the premonsoon of all the years the squid catches were much higher than the cuttlefish, accounting for about 90% of the total cephalopod landings during that period. The reverse was the trend during the postmonsoon; cuttlefish formed over 70% of the entire cephalopod catch.

Length frequency: The length frequencies of *Loligo duvauceli* for the premonsoon and postmonsoon period of 1986 and 1987, showed that the dorsal mantle length ranged from 30 mm to 280 mm, but majority of the squid were less than 150 mm in length. During the premonsoon period, the main mode was at 120 mm in 1986, 90 mm in 1987 and 110 mm in 1988. In the case of postmonsoon, the modes were almost identical, 70 mm in 1986 and 80 mm in 1987. Squids of larger lengths occurred in very small numbers. The length of *Sepia elliptica* ranged from 20 mm to 140 mm, but most of them were between 40 mm and 100 mm. In the premonsoon season of 1986 the cuttlefish had a modal size of 50 mm, while it was 60 mm in 1987 and 1988. In the postmonsoon seasons of 1986 and 1987, the important modes were at 80 mm and 60 mm respectively.

TABLE 10. Monthly and seasonal cephalopod landings (tonnes) and percentage (in parenthesis) in total landings at Veraval during 1984-87

	1984	1985	1986	1987	1988
<i>Premonsoon</i>					
February	97 (2.0)	350 (6.7)	212 (6.5)	761 (19.2)	182 (4.4)
March	178 (1.1)	258 (5.4)	387 (4.8)	580 (1.6)	543 (8.0)
April	110 (0.9)	192 (6.6)	361 (6.4)	162 (4.6)	250 (5.0)
May	42 (0.8)	3 (0.3)	40 (1.0)	31	260 (6.2)
Total	427 (1.1)	803 (5.7)	1000 (4.8)	1535 (910.4)	1,235 (6.1)
CPUE	1.4	3.7	3.6	6.0	4.8
<i>Monsoon</i>					
June					
July				No Landings	
August					
<i>Postmonsoon</i>					
September	3 (0.3)	-	416	8 (0.4)	
October	402 (6.1)	90 (1.6)	946	245 (3.7)	
November	114 (2.5)	401 (6.0)	95	328 (6.1)	
December	349 (3.4)	362 (8.1)	252	242 (6.5)	
January	391 (7.5)	197 (4.6)	427	161 (2.9)	
Total	1,259 (4.5)	1,050 (5.0)	2,136 (9.4)	984 (4.1)	
CPUE	3.5	3.9	7.5	2.8	

DISCUSSION

From the foregoing account it was seen that cephalopods were obtained as by-catch mainly in trawl fishing aimed at fish and prawns. However, they were caught exclusively in anchor-hooking for cuttlefish at Vizhinjam, hand-jigging for squid in the Palk Bay and spearing for octopus in Minicoy. The great bulk of the all-India cephalopod catch was taken on the west coast. According to Silas *et al.* (1986) the west coast contribution of cephalopod, during the period 1968-75 was 41-81% annually and during the subsequent years it was as high as 84-94% with an average of 89%.

TABLE 11. Specieswise monthly and seasonal cephalopod landings (tonnes) at Veraval; the seasonal CPUE (kg) is also given

	1984		1985		1986		1987		1988	
	sq	cf	sq	cf	sq	cf	sq	cf	sq	cf
<i>Premonsoon</i>										
February	73	24	304	46	197	15	723	39	171	11
March	156	22	229	29	237	50	553	27	531	12
April	100	10	167	25	333	28	139	23	230	20
May	34	8	3	*	32	8	256	5	206	54
Total	363	64	703	100	899	101	1,441	94	1138	97
CPUE	1.2	0.2	3.3	0.5	3.2	0.4	5.7	0.4	4.4	0.4
<i>Monsoon</i>										
June										
July	No landings									
August										
<i>Postmonsoon</i>										
September	3	*	-	-	32	384	3	5		
October	43	359	28	62	15	931	118	127		
November	11	103	208	193	29	66	100	228		
December	53	296	129	233	26	226	48	194		
January	123	268	105	92	324	103	122	39		
Total	233	1,026	470	580	426	1,710	391	593		
CPUE	0.7	2.8	1.7	2.1	1.5	6.0	1.1	1.7		

Sq : Squid, cf : Cuttlefish,
* catch less than 1 tonne

The postmonsoon was the best period for cephalopod landings on the west coast (Fig. 1). An average of 63% of the annual catch was taken in this period within the range of 54-71% annually. The period of least abundance was the monsoon season when the landings formed an average of 8% of the total within a range of 3-18% annually.

The most important gear by which the cephalopods were landed was trawl, accounting for over 77% of the total catch. During the period 1973-77, trawls contributed 31-80% of the annual cephalopod catch, the rest having been shared by shore seine, boat seine, hooks and line and dol net (Silas *et al.*, 1986). In all the States the fishing effort by trawl and the cephalopod landings during the monsoon season were uniformly low when compared to other seasons, except in Gujarat, where the highest seasonal cephalopod catch in 1985 was obtained in the monsoon season (Fig. 2). This was

due to the minimum fishing activity during the monsoon. Another reason that could be attributed was the ban on trawling during certain period in the monsoon season in some areas. Such a ban was not in force for other types of gear which continued to operate during the monsoon season especially in Kerala, though in lesser number than in other seasons. Kerala's higher catches during monsoon seasons when compared to other States was due to this; moreover there was no ban on trawling till 1989.

The fishery trend on the west coast in relation to the three seasons was more or less reflected by the fishery characteristic observed at different centres. At all the centres except Cochin the postmonsoon season was the best period for cephalopods and in Cochin it was the premonsoon season.

While the fishing activity was at its minimum during the monsoon seasons at other centres, it was active at Vizhinjam with many fishing units from nearby fishing villages shifting to this place for safe launching. Since trawling was not practised here, other types of gear such as boat seine and hooks and line were operated in good numbers. However, the cephalopod catch was minimum indicating that they were not available in the fishing grounds during the monsoon season. During the postmonsoon seasons they were obtained in good quantities. This shows that they migrate to the fishing grounds during postmonsoon period making them available for exploitation.

Loligo duvauceli was the single species that almost constituted the squid fishery of India. This species was landed all along the coast. Studies indicated that mature squid were present throughout the year and the size groups that supported the fishery were more or less the same during all the seasons (Silas *et al.*, 1986). At Vizhinjam the fishery in most of the seasons was supported by adult squid above 110 mm. Only in the premonsoon and postmonsoon seasons of 1987 the juveniles contributed to the bulk of the fishery, whereas in the monsoon season of the same year, juvenile and mature squid were in almost equal proportions. At Cochin, the fishery in all seasons was supported by squid in the size range of 60-150 mm with maturing and mature gonads. For Mangalore and Bombay centres there was no information on this aspect. At Veraval a large number of length groups within 40-250 mm were represented during all the premon-

soon and postmonsoon seasons; no squid was obtained during the monsoon period (Table 12).

Apart from *Loligo duvauceli*, *Doryteuthis sibogae* contributed to the squid fishing at Vizhinjam to a small extent. This squid was caught only during the premonsoon and postmonsoon seasons.

The cuttlefish fishery was mainly constituted by two species *Sepia pharaonis* and *Sepia aculeata*. At Vizhinjam, *Sepia pharaonis* formed the fishery mostly during the postmonsoon seasons; only in one year there was catch during the monsoon season. Since the anchor-hooks were found to be highly selective, only medium and large sized cuttlefish were caught, without affecting the juvenile populations. At Cochin, the cuttlefish fishery was mostly constituted by *Sepia pharaonis* and *Sepia aculeata* and supported by less important species such as *Sepia elliptica* and *Sepiella inermis*. At Mangalore, *Sepia aculeata* was the dominant species followed by *Sepia pharaonis*. At Bombay the highest cuttlefish catches came in postmonsoon seasons of all the years with the high average catch rate of 264 kg (Table 9). *Sepia aculeata* was the dominant species with modal sizes of 105 mm and 185 mm; *Sepia pharaonis* was less abundant, but had larger size, with the modal lengths of 245 mm and 295 mm. At Veraval, none of these cuttlefish was available and the fishery was constituted by a single species *Sepia elliptica*, which was much smaller and less commercially important.

The rainfall data available were restricted to Vizhinjam and Veraval. At Vizhinjam, the monsoon rainfall seemed to have no direct relation with the cephalopod fishery. During the months and seasons of very high rainfall, there were either no cephalopod catches or the catches were small (Fig. 6). At Veraval, an increase in cephalopod catch was observed after good monsoon. The observations of Nair *et al.* (1987) suggested that the postmonsoon period was biologically more productive with high zooplankton population. However, it is yet to be studied how this aspect is related to cephalopod abundance.

The sea surface temperature was comparatively lower in the postmonsoon period. Temperature has been attributed as one of the factors for the distribution and migration of each species of cephalopod, which in turn is helpful for their commercial exploitation (Young, 1972; Okutani and Murata, 1983). Although the temperature preferences of cuttlefish and squid occurring in the Indian waters are not understood, high catches of cephalopods during the postmonsoon period indicate their probable preference of lower temperature in those periods.

Since trawling is not done in Vizhinjam area at present, there is no controversy over trawling in monsoon season. There is also no conflict at this centre between the non-mechanised and mechanised sectors (mechanisation is limited to propulsion of craft). In general there is good and congenial atmosphere, in spite of some recent conflicts between the Vizhinjam fishermen and those from elsewhere over their alleged encroachment. The present study showed that there is no adverse effect on the cephalopod stock due to fishing in monsoon season. On the other hand, the catch can be increased by operating artisanal gear during this season as being done at Vizhinjam at present.

As cephalopods appear to be opportunistic animals capable of rapidly expanding their population size to occupy niches left unoccupied by the depletion of other resources (Caddy, 1983) and as the present level of exploitation as by-catch is considered to be very nominal, the depletion of their stock through increased fishing activity does not seem to be a possibility.

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