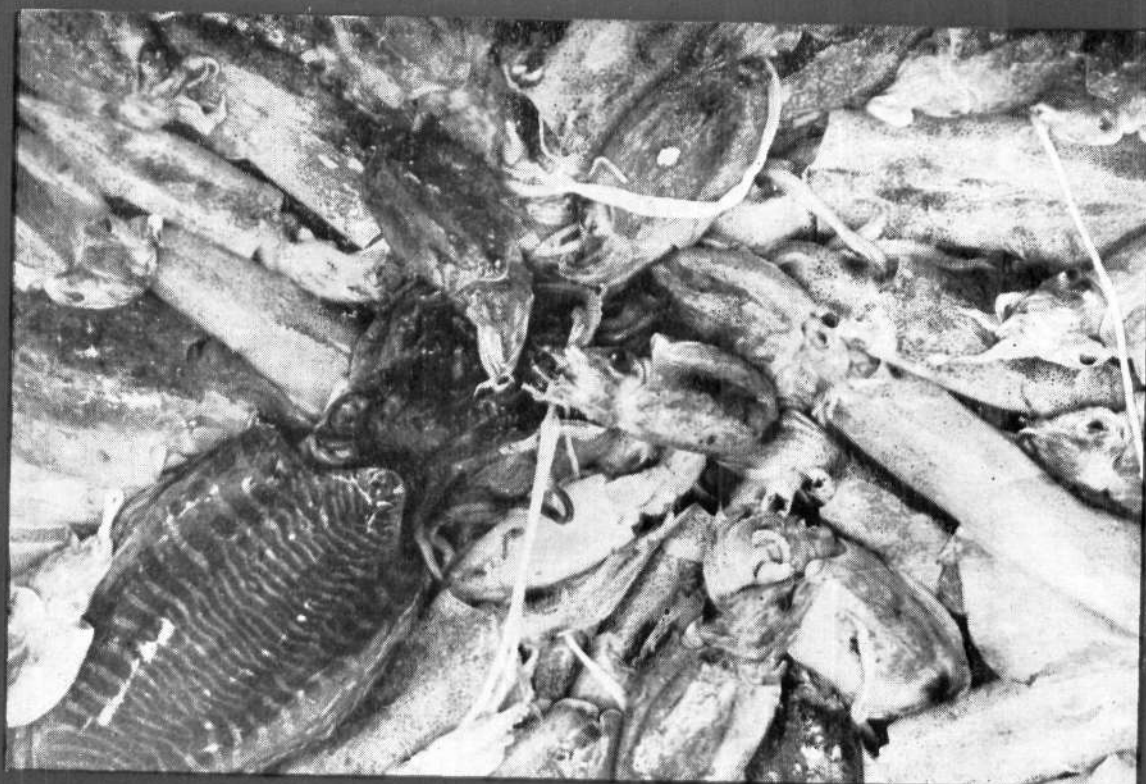




# MARINE FISHERIES INFORMATION SERVICE



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**THE MARINE FISHERIES INFORMATION SERVICE** : Technical and Extension Series envisages the rapid dissemination of information on marine and brackish water fishery resources and allied data available with the Fishery Data Centre and the Research Divisions of the Institute, results of proven researches for transfer of technology to the fish farmers and industry and of other relevant information needed for Research and Development efforts in the marine fisheries sector.

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Cover photo : A collection of squids and cuttlefishes

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**Cover photo : A collection of squids and cuttlefishes**

# THE EXPLOITED SQUID AND CUTTLEFISH RESOURCES OF INDIA :

## A REVIEW\*

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### 1. THE PROBLEM

Squids and cuttlefishes are one of the important marine fishery resources of India, ranking next only to finfishes and crustaceans (shrimps and lobsters). At present they are landed mostly as incidental catches in the traditional fisheries in gears such as shore-seines, boat seines, stake nets and hooks and line and in the mechanised boats operating trawl nets. Their exploitation is confined to the coastal waters extending to about 45 m depth on the east and west coasts. Till recently the squids and cuttlefishes have met the limited demand in coastal areas as food and as bait in the hooks and line fishery. In 1973 the export of squids and cuttlefishes commenced, and their growing demand in foreign trade as a valuable seafood served as an impetus for increased landings in the country. However, this rise in production is not substantial, as efforts have not been made to adopt specialised gear suitable for the capture of squids and cuttlefishes. Although the cephalopod fishery has shown an upward trend, there is vast scope for stepping up production by employing modern fishing methods.

Exploratory fishing conducted recently (Silas 1968, 1969; Filippova 1968; Anon. 1979) have revealed the existence of squid and cuttlefish resources in the continental shelf and oceanic areas. With the declaration of the Exclusive Economic Zone there are vast stretches of fishing areas where fishing for squids and cuttlefishes could be carried out profitably. Recognizing the importance of these resources, the Central Marine Fisheries Research Institute initiated investigations on the fisheries, resources characteristics and biological aspects of cephalopods at important fishing centres along the east and west coasts for a better management of the resources. The synoptic information presented in this paper is mainly based on the results obtained on the fishery and biological investigations conducted during 1976 to 1980 which are reported in detail in a separate publication of the Institute (Silas *et al.*, MS).

### 2. EARLIER WORKS ON CEPHALOPODS IN INDIA

The identity and systematics of cephalopods of the seas around India have been studied by Hoyle (1885), Goodrich (1896), Massy (1916), Robson (1921), Adam (1939 a, b) and Adam and Rees (1966). Silas (1968) has given a catalogue of the known species from the Indian Ocean together with an account of the distribution and abundance of larvae and juveniles of cephalopods collected from the continental shelf and continental slope off the west coast of India. The common species of squids and cuttlefishes and their fisheries have been briefly dealt with by Homell (1917), Rao (1954, 1958, 1969, 1973), Jones (1969), Sarvesan (1974) and Silas *et al.* (1976). Rao (1954) has given an account of the biology and fishery of one of the economically important species of squid *Sepioteuthis arctipinnis* (= *lessoniona*) which forms a fishery in Palk Bay and Gulf of Mannar along the southeast coast of India. Silas (1969) has recorded schools of *Symplectoteuthis ovalaniensis*, an important oceanic squid, from the continental shelf and beyond in drift net catches off Kerala and Karnataka and Lakshadweep Sea. He also reported on the catch rates of cuttlefishes from the continental shelf along the southwest coast of India based on exploratory trawl surveys. Filippova (1968) has reported on the distribution and latitudinal zonality of oceanic squids in the Indian Ocean. Oommen (1977) has studied the food and feeding and fishery of some cephalopods of the west coast of India.

### 3. BIOLOGY

The biology of the commercially important squids and cuttlefishes of India are dealt with below.

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\*For the Project Programme, field collections have been carried out at different centres along the coast. S/Shri Kuber Vidyasagar, P. V. Sreenivasan, Y. Appanna Sastry and B. Narayana Rao have helped in collecting from Bombay, Portonovo, Kakinada and Waltair respectively.

### 3.1. *Loligo duvaucelii* d'Orbigny (Plate II)

#### 3.1.1. Distribution

This is a neritic species of squid, widely distributed in the Indo-Pacific region along the coasts of India, Andaman Islands, Sri Lanka, Burma, South Africa, Red Sea, Malaysia, Hongkong, Indonesia, Philippines and Taiwan.

##### *Distribution of juveniles*

Juveniles measuring 20-40 mm have been collected off Sriharikota, Pulicat and Waltair on the east coast and Bombay on the west coast from the trawl net catches, and from shore seine and boat seine catches off Vizhinjam on the west coast.

##### *Distribution of adults*

Being a neritic species, the adults occur in shallow waters upto depths of 80 m on the continental shelf of the east and west coasts of India.

#### 3.1.2. Bionomics and life-history

##### 3.1.2.1. Reproduction

###### *Sexuality*

This squid is heterosexual as all other cephalopods. Males are distinguishable from the hectocotylization of the left ventral arm. The males grow to a larger size than females.

###### *Sex ratio*

The sex ratio was almost equal in squids of Waltair and Madras Coasts during 1976-80. At Cochin males were dominant in 1978 and 1980 (M 60 : F 40), while both the sexes were in almost equal proportion in 1976, 1977 and 1979. At Vizhinjam the two sexes were in about equal ratio in 1976, while in 1977-80 females outnumbered males (F 60 : M 40).

###### *Maturity*

On the east coast, the males attain maturity in the size range of 50-119 mm with 50% reaching maturity at a size of 76 mm. Females mature in the size range 70-139 mm with 50% being mature at 86 mm. On the west coast, males have been observed to be mature in the size range 90-169 mm with 50% maturing at 113 mm, while females mature when they are in the size range of 90-169 mm with 50% becoming mature at 118 mm (Fig. 1 A-G gives biological data and catch trends of this species at Cochin, one of the ten selected centres for detailed biological studies on squids and cuttlefishes).

###### *Spawning*

Mature and partly spawned individuals are found all round the year on both coasts and spawning is intensive

in February and June-September at Madras, January, July and September at Waltair and February-March, May-July and September-October at Cochin.

##### 3.1.2.2. Adult history

###### *Size*

The commercial catches consist of squids 60-289 mm in size. The species grows to a larger size on the west coast; the maximum size recorded on the east coast is only 179 mm.

###### *Food*

This species feeds on prawns, other crustaceans and fish. Among prawns, *Acetes* was the dominant food item along Waltair Coast. Cannibalism was also noticed.

###### *Growth*

It grows to a size of 64-83 mm at the end of six months and 113-125 mm at the end of one year on both the coasts. But as it grows to a larger size on the west coast, a size of 208-220 mm is attained by the end of two years and 263 mm by the end of three years.

###### *Length-weight relationship*

The length-weight relationship of this species on Cochin Coast has been studied. The rate of increase in weight in relation to length has been found to differ significantly in males and females. The allometric growth formula has been observed to be as follows:

$$\text{In males, } W = 0.00103 L^{2.2408}$$

$$\text{In females, } W = 0.0005655 L^{2.3985}$$

### 3.2. *Sepioteuthis lessoniana* Lesson (Plate I)

#### 3.2.1. Distribution

This is a neritic squid which is very widely distributed in the Indo-Pacific, Red Sea, Arabian Sea, Bay of Bengal, Sri Lanka upto Japan.

##### *Distribution of juveniles*

Young ones 20-60 mm in size are common in the shallow littoral waters in Palk Bay near Mandapam and Rameswaram. Occasionally they are met with in Vizhinjam area also in very small numbers.

##### *Distribution of adults*

Adults of 60-335 mm are caught in coastal waters of Palk Bay and Gulf of Mannar in Mandapam area in shore seines and hand jigs. Moderate sized ones 120-180 mm are caught in trawling grounds around Mandapam. At Vizhinjam Bay they occur in very few numbers in shore seine and boat seine catches.

#### 3.2.2. Bionomics and life-history

##### 3.2.2.1. Reproduction

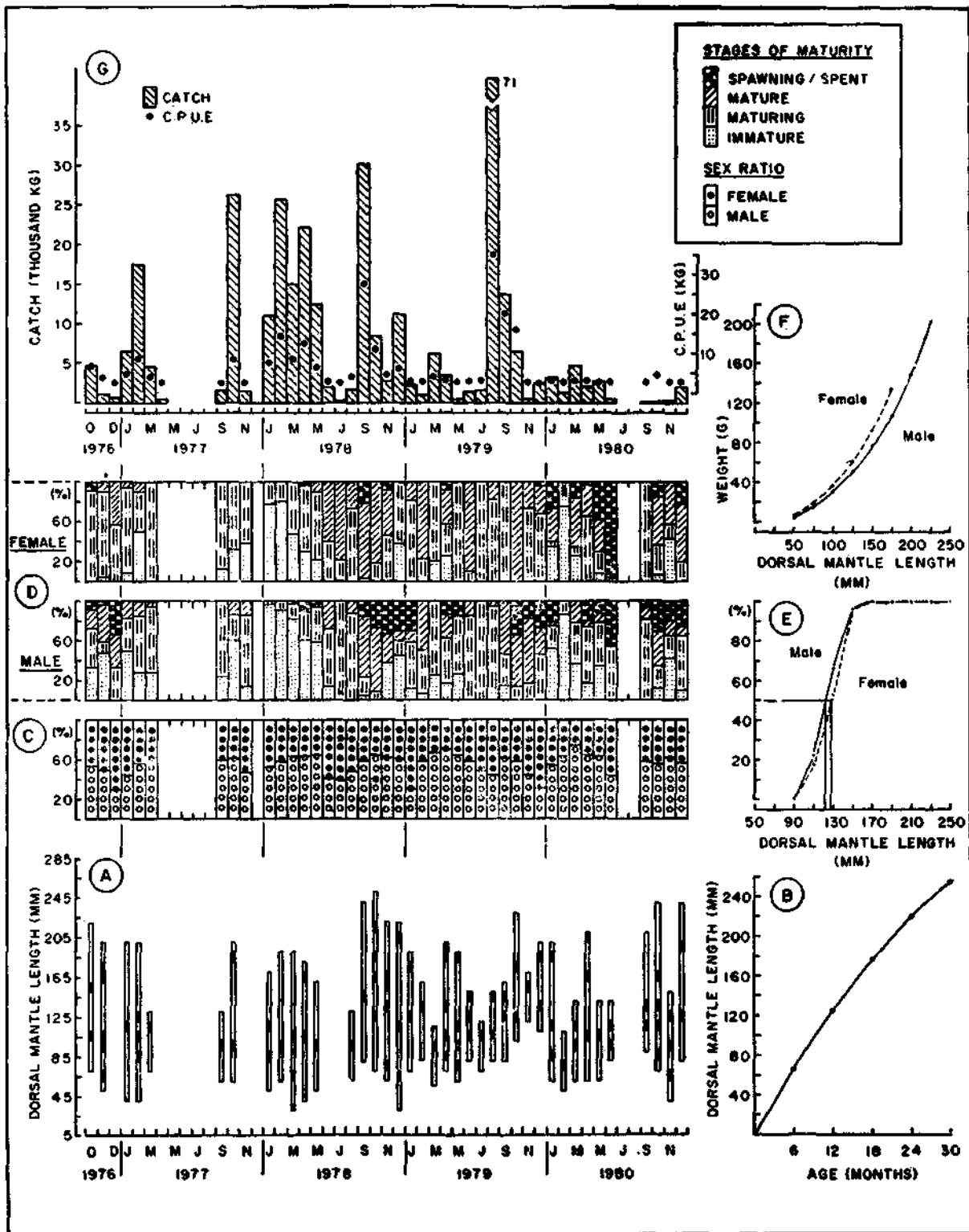


Fig. 1. Biological data and catch trends of *Loligo duvaucelii* off Cochin coast. A. Size range and modes. B. Growth curve. C. Sex ratio. D. Stages of maturity. E. Size at first maturity. F. Length-weight relationship. G. Trawl net landings.

### *Sexuality*

Males can be recognised by the hectocotyisation of left ventral arm; transverse stripes on the dorsal side of mantle are more conspicuous than in females.

### *Sex ratio*

In 1973 and 1974 the males were the dominant sex (M 61 : F 39 and M 58 : F 42 respectively).

### *Maturity*

Males mature within a size range of 60-199 mm with 50% of the squids maturing at a size of 102 mm. Females reach mature stage in the size range 80-199 mm.

### *Spawning*

Mature and spawning squids were found in the periods January-March and August-October. In some years mature ones were seen in October and December also. During spawning period which extends from January to June in Palk Bay and Gulf of Mannar the squids migrate to shallow waters to deposit their egg capsules (Rao 1954).

The egg capsules are finger-shaped and are attached as clusters to substrata such as algae, twigs, stones and corals. Each egg capsule measuring 62-68 mm in length 10-11 mm in breadth, contains 6 to 7 eggs 6 mm long and 4.6 mm in breadth arranged in a well spaced single row (Nagaraswami 1966).

The newly hatched youngones resemble the adult and measure 7.5 mm in length and 5.0 mm in width. They are transparent and have chromatophores on the mantle, head, arms and dorsal surface of fins.

#### *3.2.2.2. Adult history*

### *Maximum size*

The largest size observed in Mandapam area is 335 mm.

### *Food*

Prawns and fish are the main food items. Stomatopods and crabs also form food in small percentage. A few instances of cannibalism were noticed.

### *Growth*

This species grows to a size of 129 mm at the end of first year, 217 mm at the end of second year and 265 mm at the end of 2½ years.

## **3.3. *Doryteuthis* sp. (Plate II)**

### *3.3.1. Distribution*

#### *Distribution of juveniles*

Juveniles of 20 mm size and above occur in coastal waters at Vizhinjam in January-February and

sometimes up to June.

#### *Distribution of adults*

Adults measuring 80-205 mm are found in coastal waters at Vizhinjam and are caught in sone seines, boat seines and the larger individuals in hooks and lines.

### *3.3.2. Bionomics and life-history*

#### *3.3.2.1. Reproduction*

### *Sexuality*

In addition to hectocotyization of left ventral arm, the males are larger than females, have generally slender body with ventro-medial concentration of chromatophores on the mantle.

### *Sex ratio*

During 1976, 1978 and 1980 the females were in more numbers in the F : M ratio 60 : 40, 55 : 45 and 57 : 43 respectively but in 1979 males were dominant (M 59 : F 41), while 1977 both the sexes were in equal ratio.

### *Maturity*

Males mature in the size range 85-189 mm with 50% of them attaining maturity at 126 mm. Females reach mature stage in the size 85-175 mm with 50% attaining the stage at 135 mm.

### *Spawning*

Mature females occur in January-March, October and December. Mature males are found from January to April and October to December.

#### *3.3.2.2. Adult history*

### *Maximum size*

The maximum sizes of males and females recorded were 205 mm and 165 mm respectively.

### *Food*

The food of this species consists of fish, cephalopods and crustaceans.

### *Growth*

This species attains a size of 113 mm at the end of the first year and 182 mm at the end of the second year at Vizhinjam. The longevity appears to be over two years.

## **3.4. *Sepia aculeata* Ferussac and d'Orbigny (Plate I)**

### *3.4.1. Distribution*

This is an Indo-Pacific species occurring in India, Sri Lanka, Singapore, Malaysia, Hongkong, Philippines and Taiwan to Japan. It is quite common along the east and west coast of India.

#### *Distribution of juveniles*

Juveniles measuring 20-50 mm in size occur in the

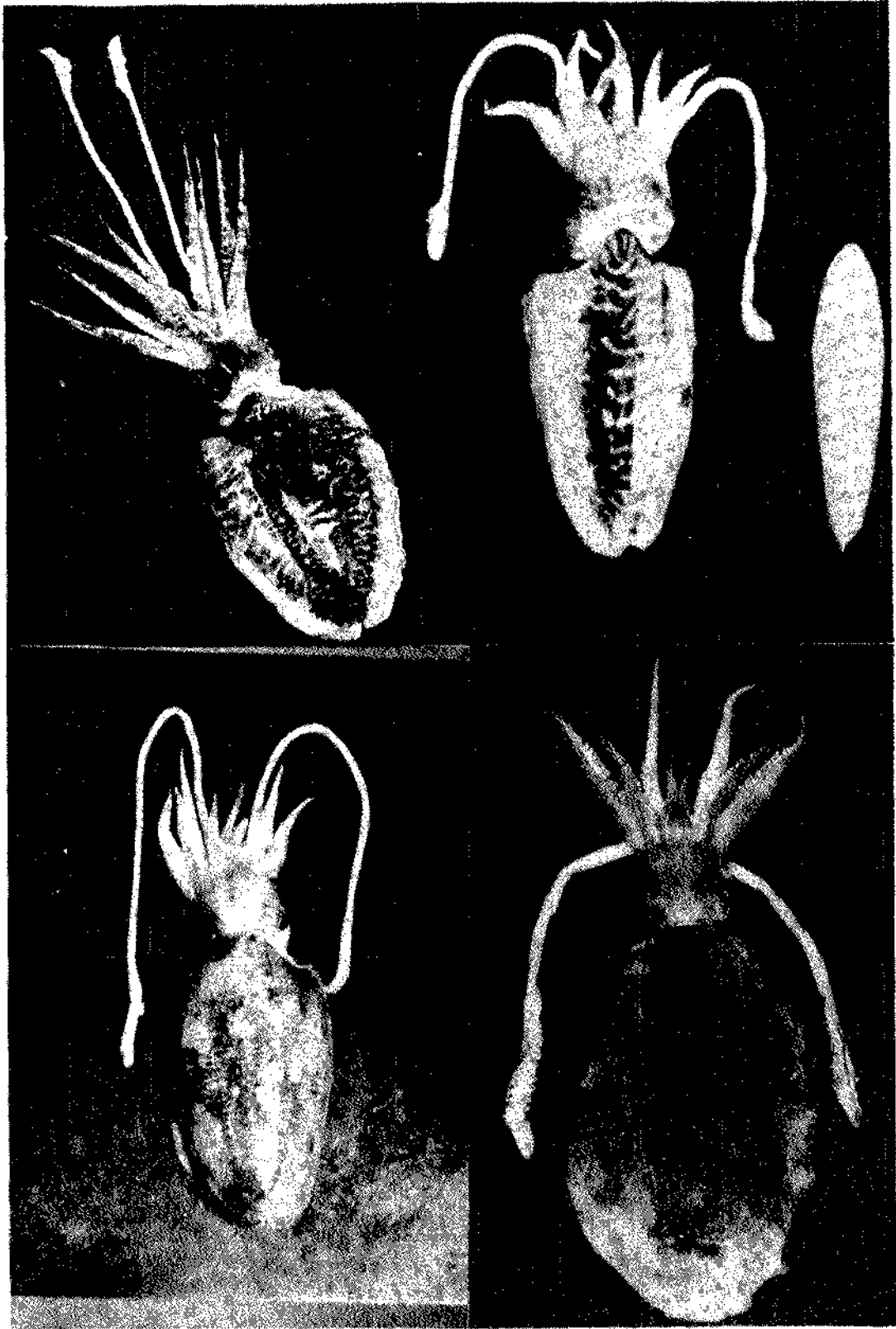


Plate I. Top left : *Sepia pharaonis*, top right : *S. prashadi*,  
bottom left : *S. aculeata* and bottom right : *Sepeioteuthis lessoniana*.



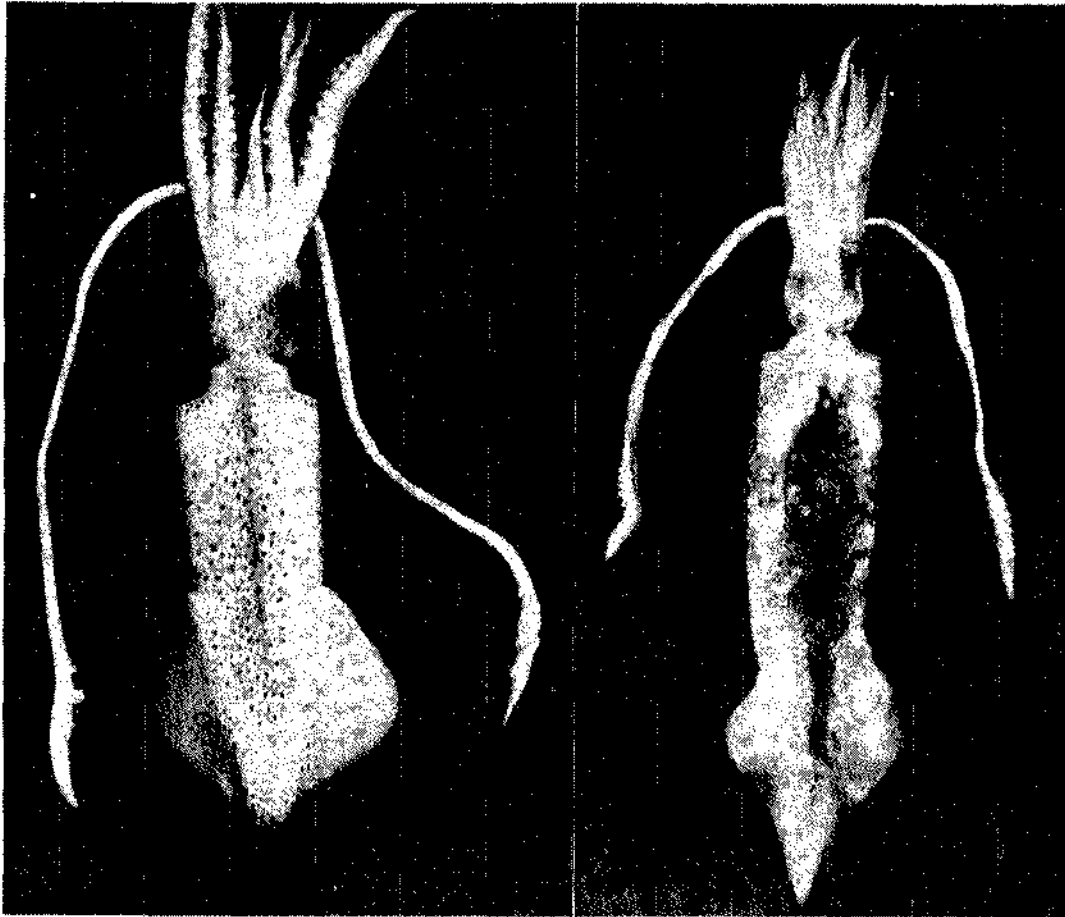


Plate II. Left : *Loligo duxiuceli* and right : *Doryteuthis* sp.

trawling grounds upto a depth of 40 m on the east and west coasts of India.

#### *Distribution of adults*

Adults in the size range of 60–190 mm support the fishery at Waltair, Kakinada, Madras, Mandapam and Cochin. Larger individuals measuring upto 245 mm have been recorded in the trawl landings at Bombay.

#### 3.4.2. *Bionomics and life-history*

##### 3.4.2.1. *Reproduction*

#### *Sexuality*

The male and female look more or less similar in external appearance except that in males the left ventral arm is hectocotylised.

#### *Sex ratio*

The sex ratio of males and females was almost equal at Mandapam and Waltair. The trend was similar at Madras except in 1976 (F 59 : M 41), 1978 (F 57 : M 43) and 1980 (F 58 : M 42) when the females were dominant. In Cochin during 1978, for which data were available, the male : female ratio was 67 : 33. In Bombay area also male dominance was observed in two years (1978–M 72 : F 28, 1979–F 52 : M 48 and 1980–M 58 : F 42).

#### *Maturity*

Individuals with gonads in maturing and mature stages are met with in all seasons of the year. Males mature at lengths of 70 mm onwards and the sizes at which 50% of them mature are 77 mm at Waltair, 100 mm at Madras and 83 mm at Mandapam along the east coast, and 124 mm at Cochin on the west coast. Females also mature 70 mm upwards. The size of 50% maturity of females has been estimated to be 102 mm at Waltair, 118 mm at Madras, 110 mm at Mandapam, 130 mm at Cochin and 132 mm at Bombay. Males attain maturity at the age of 7–9 months and females at 10–12 months along the east coast. In Bombay the females attain maturity at the end of one year.

#### *Spawning*

Spawning takes place in females throughout the year at Mandapam with peak activity from August to March. At Portonovo, spawning takes place in March, April, June and November. At Madras the spawning period extends from February to December with peak activity in February, June–August and October–December. At Waltair the season is from November to July with peaks during April, July, November and December. On the west coast spawning takes place in November–December at Cochin and in May, August, September and December at Bombay.

#### *Eggs*

During the spawning season egg clusters are

commonly obtained in trawl nets on the east coast. Clusters of egg capsules attached to gorgonids have been collected from trawl catches off Ennore in fishing area 13–80/1C, at a depth of 25–40 m where the bottom has shells and gorgonids. They are also common in shallow coastal waters of Mandapam area, and are often obtained in shore seines and trawl nets from both Palk Bay and Gulf of Mannar.

##### 3.4.2.2. *Adult history*

#### *Maximum size*

As mentioned earlier, cuttlefish upto a size of 245 mm were obtained in the trawl landings at Bombay, whereas in the catches at other centres the maximum size recorded was less, being 190 mm at Cochin, 199 mm at Mandapam, 155 mm at Portonovo, 180 mm at Madras and 185 mm at Kakinada and Waltair.

#### *Food*

Prawns and other crustaceans such as crabs and *Squilla* are the dominant food of *Sepia aculeata*. They also feed on fishes, polychaetes and other cephalopods.

#### *Growth*

This species grows to a size of 50–74 mm at the end of 6 months, 96–123 mm at the end of one year and 158–202 mm at the end of the second year. On Bombay Coast it grows upto three years, at the end of which a size of 236 mm is attained.

### 3.5. *Sepia pharaonis* Ehrenberg (Plate I)

#### 3.5.1. *Distribution*

This is the largest among cuttlefishes and is widely distributed in the Indo-Pacific from Red Sea to Japan and Australia. In Indian waters it is abundant on both the coasts and supports commercial fisheries at many centres.

#### *Distribution of juveniles*

Juveniles are generally found in inshore waters and are caught in small numbers in shore seines, boat seines and among the miscellaneous catch in trawl nets from depth upto to 40 m, especially on the east coast. They are easily distinguishable from the juveniles of other cuttlefishes especially by the cuttlebone in which all the characteristic features of the species are apparent.

#### *Distribution of adults*

The adult individuals occurring along the west coast are larger in size as compared to those of the east coast. In general, the cuttlefish supporting the fishery on the east coast range between 110 and 189 mm as against those in the west coast where the range is 145–215 mm.

##### 3.5.2. *Bionomics and life-history*

##### 3.5.2.1. *Reproduction*

## Sexuality

In the male, the ventral arm of the left side is hectocotylied. Besides this, sexual dimorphism exists in the colouration of the body in that the male has conspicuous brown stripes across the mantle, fins, head and arms. Males are relatively narrower than females, which are more muscular and robust.

## Sex ratio

Females are dominant in catches obtained in hooks and line fishery at Vizhinjam in all the years, the maximum difference in the ratio being in 1976 (F 71 : M 29). The distribution of sexes in the commercial trawl landings at Madras also shows a preponderance of females. The F : M ratios for 1976-80 were 53 : 47, 62 : 38, 58 : 42, 60 : 40 and 53 : 47 respectively.

## Maturity

There is variation in the sizes at which the males and females attain sexual maturity at different centres. The males become mature at a length range of 90-110 mm on the east coast and at 130 mm on the west coast. The size at which 50% of the males become mature is about 120 mm at Waltair and Madras when they are 8 months old. At Vizhinjam the corresponding size for males is about 145 mm when they are 6 months old and at Cochin it is about 154 mm.

The females attain sexual maturity at a size of 90-110 mm on the east coast and 130-150 mm on the west coast. The size at which 50% of the females become mature is 120 mm at Waltair and 138 mm at Madras when they are 9 months old while this value on the west coast is 160 mm (8 months) at Vizhinjam and 157 mm at Cochin.

Individuals with gonads in immature and maturing stages are also obtained during the entire fishing seasons.

## Spawning

The data gathered from different centres during 1976-80 indicate that mature and spawning females occur in February, April, June, October and December in Cochin waters and January, March-April, September-October and December at Vizhinjam on the west coast. On the east coast, their occurrence is in January-February, April and September-December at Waltair, and almost throughout the year at Madras. Intensive spawning activity appears to take place during October-December and March-April along the west coast and in September-December, February and April-June on the east coast.

Spawning grounds of *Sepia pharaonis* have been reported to exist off Orissa and Visakhapatnam (FAO/UN, 1961) and egg capsules of this species have been collected from fishing grounds off Vizhinjam.

## 3.5.2.2. Adult history

### Maximum size in the fishery

The maximum size of this cuttlefish observed in the commercial fishery was 334 mm in dorsal mantlelength on the west coast and 265 mm on the east coast. This species is the largest cuttlefish contributing to the cephalopod fishery in India.

### Food

An active carnivore preying on fish and crustaceans, this species also feeds on cephalopods occasionally. Scales, eyeballs, otoliths and bones of fish, macerated and partly digested flesh and hard parts of crustaceans are the usual components of the stomach contents.

### Growth

This cuttlefish grows to a size of 100 mm in 6 months and 165 mm in one year on the east coast; it is estimated that it takes about 16 months to reach a length of 197 mm. On the west coast, a higher growth rate is observed; at Vizhinjam it is estimated that a length of 138 mm is reached in 6 months, 211 mm in 12 months, 260 mm in 18 months and 294 mm in 24 months. To reach a size of 334 mm, the largest size observed in the fishery, it may take 36 months. The longevity thus appears to be upto about 2 years on the east coast and 3 years on the west coast.

## 3.6. *Sepia brevimana* Steenstrup

### 3.6.1. Distribution

This is a small sized cuttlefish of neretic habitat distributed in the Indian Ocean and the Western Pacific Ocean. In Indian waters it occurs in the fishery off Bombay on the west coast; Puri, Waltair and Madras on the east coast; and Port Blair, Andaman Islands.

### Distribution of juveniles

Juveniles of the size range 20-40 mm at Waltair and 30-40 mm at Madras have been recorded in the trawl catches.

### Distribution of adults

Adult cuttlefishes of the size range 45-95 mm occur in the trawl fishery off Madras and Waltair.

### 3.6.2. Bionomics and life-history

#### 3.6.2.1. Reproduction

### Sexuality

In addition to the hectocotyliation of the left ventral arm in the male, the shell is less broader and less acuminate and the tubercles on the dorsal surface of the shell are more prominent when compared to the shell of the female.

### Sex ratio

On the Waltair Coast the males and females were in almost equal proportions during 1977, 1978 and 1980, but in 1976 and 1979, females were dominant (F 58 : M 42 and F 57 : M 43 respectively). In Madras, the females were numerically more except in 1979, when males slightly dominated (M 58 : F 42).

### Maturity

The males mature within the size range of 45–89 mm with 50% of them attaining maturity at 56 mm at Madras and 62 mm at Waltair. The corresponding size range for females is 55–95 mm with 50% maturity at 63 mm and 59 mm respectively at the two centres. At these sizes the cuttlefishes are 11–13 months old.

### Spawning

Mature individuals occur in waters off Madras and Waltair almost throughout the year. Spawning females were observed in January–February and July–December indicating a prolonged spawning period.

#### 3.6.2.2. Adult history

#### Maximum size in the fishery

The maximum sizes of the species recorded in the landings at Waltair and Madras are 95 mm and 85 mm respectively.

### Growth

This small sized squid attains a mantle length of 29–34 mm at the end of 6 months, 56–58 mm at the end of 12 months and 75–76 mm at the end of 18 months.

## 3.7. *Sepia elliptica* Hoyle

### 3.7.1. Distribution

This species is distributed in the neritic regions of the Indian Ocean and the Western Pacific. Its occurrence has been reported from Ganjam on the east coast of India and Cochin on the west coast.

#### Distribution of adults

Adult cuttlefish 70–129 mm in mantle length are obtained in trawl catches off Cochin where it forms a fishery throughout the year. This species is caught at depths of 30–40 m.

### 3.7.2. Bionomics and life-history

#### 3.7.2.1. Reproduction

### Sexuality

In males the left ventral arm is hectocotyised.

### Sex ratio

The males were dominant during 1976 and 1979 (M 52 : F 48 and M 55 : F 45 respectively) but the females were

numerically more than males in 1977 (F 56 : M 44), 1978 (F 58 : M 42) and 1980 (F 54 : M 46).

### Maturity

Both males and females attain sexual maturity in the size range of 75–115 mm with 50% of them reaching mature stage at 93–96 mm.

### Spawning

Mature males have been observed from October to June and in August and females from August to April and in June off Cochin. Spawning individuals have been noticed in the last quarter of the year.

#### 3.7.2.2. Adult history

#### Maximum size in the fishery

The largest sizes of males and females recorded are 129 mm and 119 mm respectively.

## 3.8. *Sepia prashadi* Winckworth (Plate I)

### 3.8.1. Distribution

This species is distributed in the Indian Ocean : India, Mauritius, Madagascar, Gulf of Oman and Gulf of Suez. In India it has been recorded from Madras and Waltair on the east coast and Veraval on the west coast.

#### 3.8.1.2. Bionomics and life-history

Cuttlefish ranging in size from 50 to 109 mm are obtained in the trawl nets operated off Waltair during the early months of the year and upto June and again from October to December in some years. They also appear in the trawl catches off Madras from January to April in some years. At both the places the species occur beyond 40 m. At Madras this particular species is caught in small quantities from January to April along with upwelled deeper water fishes such as *Psenes indicus* and *Priacanthus* sp.

## 3.9. *Sepiella inermis* (Ferussac and d'Orbigny)

### 3.9.1. Distribution

This is a small sized Indo-Pacific cuttlefish distributed widely in the Red Sea, India, Malaya and Indonesia to Vietnam. In India it occurs along the east and west coasts in shallow waters.

#### Distribution of juveniles

Juveniles ranging from very small size to 35 mm are commonly caught in indigenous gear such as shore seines and boat seines on the east coast, especially at Mandapam, Portonovo, Madras and Waltair.

#### Distribution of adults

The adult populations are distributed in shallow inshore waters upto about 40 m depth. Adults in the size

range 40–94 mm on the east coast and 55–124 mm on west coast are caught in trawl nets and other gears. The size of the cuttlefish is larger on the west coast measuring upto 124 mm while on the east coast the maximum size observed is 112 mm.

### 3.9.2. *Bionomics and life-history*

#### 3.9.2.1. *Reproduction*

##### *Sexuality*

Sexual dimorphism is apparent in the external morphology. In males there is a row of small pale white patches along the fins at their base and this feature is very distinct in fresh specimens. The left ventral arm in the male is hectocotylised; at the basal portion of the arm the suckers are very minute and a series of transverse ridges and grooves are present. Males are smaller in size than the females.

##### *Sex ratio*

In Kakinada the sexes were almost equally represented. At Portonovo females were always dominant.

At Waltair the males dominated in 1976 and 1979 and in other years females were more dominant. The greatest variation was in 1977 when the ratio was F 70 : M 30. In Madras both the sexes were in equal proportion in 1979 while in all other years females dominated. In Cochin males were more in 1976, 1978 and 1979, while in 1977 and 1980 females outnumbered males with the ratio F 52 : M 48 and F 54 : M 46 respectively.

##### *Maturity*

Individuals in different stages of maturity are encountered throughout the year. The males and females attain maturity at a size of 45–105 mm, and the size at which 50% of the individuals mature is found to differ for two sexes at different centres. It is 53–56 mm for males at Waltair, Madras and Portonovo and 81 mm at Cochin; for females the size at 50% first maturity is 52 mm at Waltair, 61 mm at Madras, 50 mm at Portonovo and 83 mm at Cochin. It is estimated that the individuals of both the sexes mature when they are 9–12 months old on the east coast and about 18 months old on the west coast.

##### *Spawning*

Off Waltair spawning takes place in April, June to September and November to December. At Madras spawning is in February–March and from July to December with peaks in September, December and March. At Kakinada spawning individuals are encountered from April to November while at Portonovo it extends from March to October. On Cochin Coast, spawners occur in April and from September to December with peak spawning activity in September and

October. Spawning takes place almost in inshore waters where egg capsules and juveniles are usually caught in fishing nets as at Madras and other centres.

#### 3.9.2.2. *Adult history*

##### *Maximum size in the fishery*

On the east coast 112 mm is recorded as the maximum size of this cuttlefish in trawl landings whereas on the west coast it attains 124 mm.

##### *Food*

The food of this species mainly consists of fish and crustaceans; however, cephalopods also seem to be ingested to a very small extent.

##### *Growth*

Analysis of size frequency data shows that this species grows to a length of 29–35 mm in 6 months along the east coast. At the end of one year it reaches a size of 57 mm at Waltair, 53 mm at Kakinada, 60 mm at Madras and Portonovo and 61 mm at Cochin. The sizes attained at the end of 18 months is 73 mm at Waltair, 74 mm at Kakinada and 82 mm at Madras. On Cochin Coast this species lives longer and grows to 81 mm at the end of 1½ years and 101 mm at the end of 2 year. Females are larger than males.

## 4. SQUID AND CUTTLEFISH FISHERIES OF INDIA

### 4.1. *Fishing craft and gear*

The cephalopods are taken as a bye-catch of fish and prawns in many type of gear operated from a variety of craft. Apart from mechanisation of the craft which is on an increase in recent years, the fishing craft and gear used throughout the country are indigenous, operating in the inshore waters, designed to suit the sea conditions peculiar to each locality.

#### 4.1.1. *Fishing craft*

##### *Catamaran*

This is probably the simplest form of a fishing craft and is used on the east coast from Orissa to Kanyakumari and part of South Kerala on the west coast (Anon. 1962). The catamaran is made of 3–5 logs of wood tied together in the fashion of a raft. Though the basic design is the same, the number and size of the logs vary in different areas. This is operated by 2–4 fishermen.

##### *Canoes*

There are many types of canoes operating along the west coast of India. The dug-out canoes, common on the Kerala and Karnataka Coasts, are made by scooping out the inner portion of a single log of wood. These canoes are 6.10–12.50 m long and from these 4–8 men operate gear like shore seines, boat seines, and gill nets. Apart from this type of craft, plank-built canoes, out-rigger

canoes and flat-bottom canoes are also in use in some areas. The use of outboard and inboard engines are catching up for canoes operating in Kerala.

#### *Plank-built boats*

Used in the northern part of both the coasts, this craft is very sturdy and is most suited for mechanisation without altering the design. Depending on the local operational requirements, various types of plank-built boats are indigenously evolved. They are of the size 6.5-13 m and are generally manned by 7-12 men.

#### *Mechanised craft*

The high returns from prawn fishery and the liberal aid given by Government agencies have provided great impetus to the pace of mechanisation of the fishing craft in the country. Over 18,000 mechanised boats have been constructed in the country which operate a wide variety of gears. Of these, trawlers which account for a substantial portion of the cephalopod landings, number more than 10,000. They are 6 to 13 m long and fitted with engines of 10-60 HP. About 60 steel trawlers (23 m upwards) with 90-300 or higher HP engines and refrigerated fish holds operate from our bases.

#### *4.1.2. Fishing gear*

Of the many types of gear that are in use at present, only the trawl nets and the traditional indigenous gears such as shore seines, boat seines, fixed bag nets (*dol net*) and hooks and line are the gear in which cephalopods are captured.

#### *Shore seine*

This is a beach seine operated in inshore waters on both the coasts. There are variations in the design and size like the *karavalai* or *penavalai* of the east coast and the large *rampani* of the west coast. This net is payed out from canoes or catamarans and dragged to the shore by groups of men. Squids and cuttlefishes of the shallow coastal waters are taken in this gear. In Ramanathapuram area on the southeast coast a special type of shore seine called *ola valai* is used to capture the squid *Sepioteuthis lessoniana*. In this net, split palmyrah leaves are tied to wings as flares to drive the squids into the net.

#### *Boat seine*

There are many kinds of boat seine that are used all along the coasts. They are conical bag-shaped nets without wings and are operated with the help of two canoes or catamarans. These nets are well suited to capture shoaling pelagic fishes. Fairly good quantities of squids come in this gear.

#### *Fixed bagnets*

This is a type of bag net widely used on the Gujarat and Maharashtra Coasts where it is called *dol net*. The size of

the net varies considerably from 12 to 200 m in length. This net is operated by fixing it in water by means of stakes or buoys, where there are strong currents which help in keeping the net in horizontal position. The *dol net* is an important gear for prawns and Bombay-duck but squids are also caught in some quantities in Maharashtra.

#### *Hooks and line*

There are many types of hooks and line such as long line, hand line, etc. depending upon the number and size of hooks, length of line and the nature of the fish that are to be hooked. This gear is in use in many parts of the country, but cephalopods are caught mostly on Tamil Nadu and South Kerala Coasts. In Vizhinjam and neighbouring areas, a modified type of hand-line (hand jigs) is operated upto a depth of 35-40 m for capturing cuttlefish. In Mandapam area also the hand-jigs are used on a very small scale to hook the squid *Sepioteuthis lessoniana*.

#### *Trawl nets*

With the increase in mechanisation of the fishing craft, together with the high returns from prawn fishing, trawl nets have emerged as one of the most important gear in recent years especially along the west coast. Otter trawls which are the most common, vary in size with headline length of 7-27 m, depending upon the size of the trawler from which they are operated. The size and weight of the otter boards also vary according to the dimensions of the net and the towing power required. Several designs of trawls have been introduced during the last few years. Furseam trawl, bulged belly trawl and out-rigger trawls are being increasingly used.

### *4.2. Trend of cephalopod fisheries*

#### *4.2.1. Cephalopod production of India*

The estimated annual cephalopod production of India during 1978, 1979 and 1980 was 15,931 tonnes, 15,032 tonnes and 11,335 tonnes. The landings have increased to this level from catches as low as 349 tonnes in 1959 and 93 tonnes in 1961 and are the result of steady increase in effort over the years. Until 1973, the production did not exceed 1,700 tonnes and in 1974 there was a spurt in the catch and from then onwards, an increasing trend concomitant with the development of an export market for specially cuttlefish. The average triennial landings during 1978-80 show a rise by 7 times as compared to the landings in the triennium 1972-74 and 65 times those in the triennium 1960-62 (Fig. 2).

It is our assessment that the increase in production of squids and cuttlefishes seen after 1974 reflects to a very large extent the retention of a part of the by-catch in the trawl fishing for prawns. The bulk of the cuttlefish landings is from the prawn trawling grounds, and the earlier tendency among fishermen was to discard them to

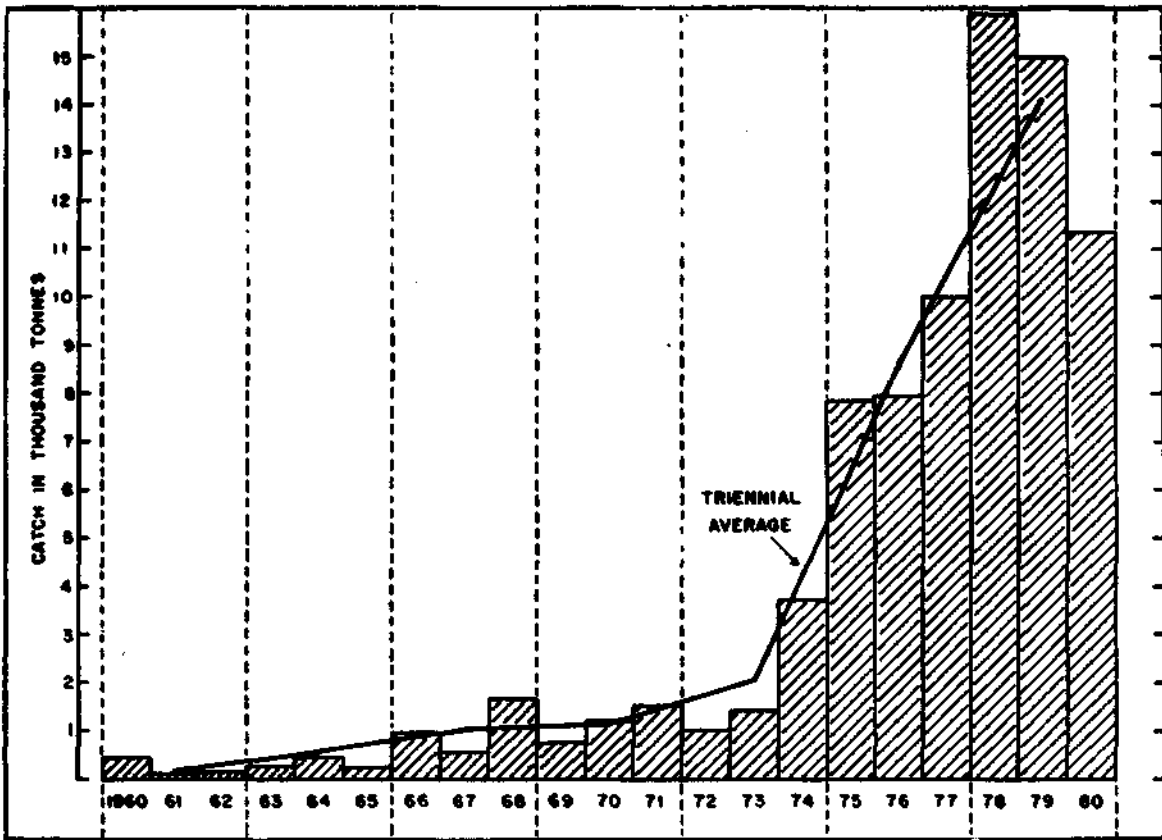


Fig. 2. Annual cephalopod landings and trend of triennial averages in India during 1960-80.

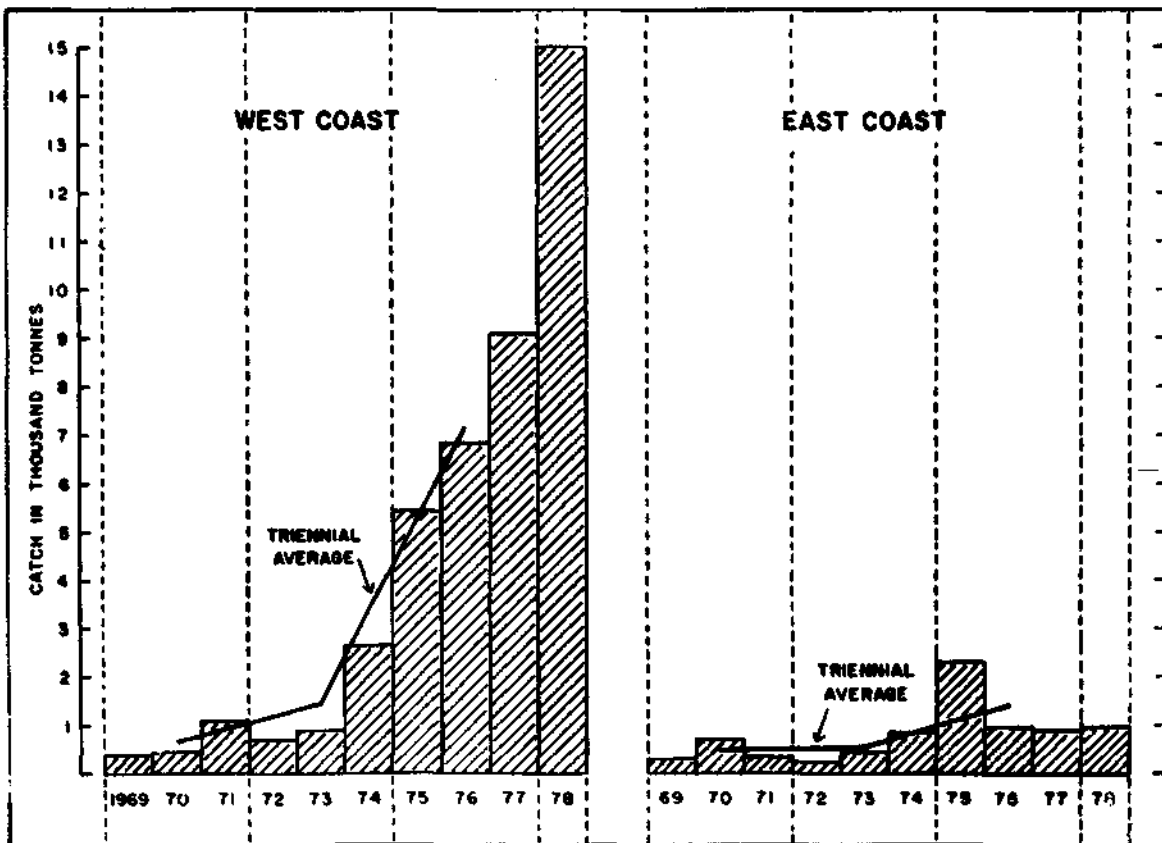


Fig. 3. Annual cephalopod landings and triennial averages along the west and east coasts of India during 1969-78.

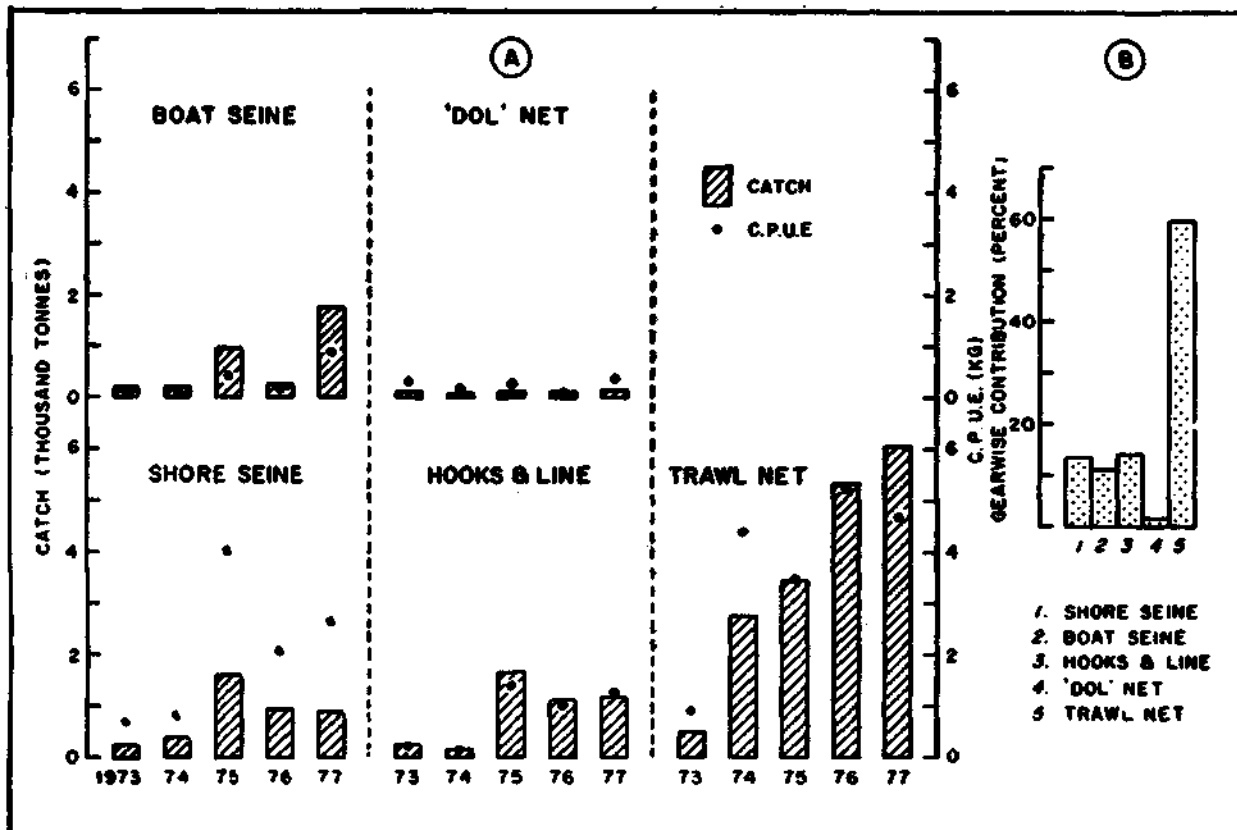


Fig. 4. Gearwise cephalopod landings in India during 1973-77. A. Catch and catch per unit effort. B. Percentage contribution by different gears.

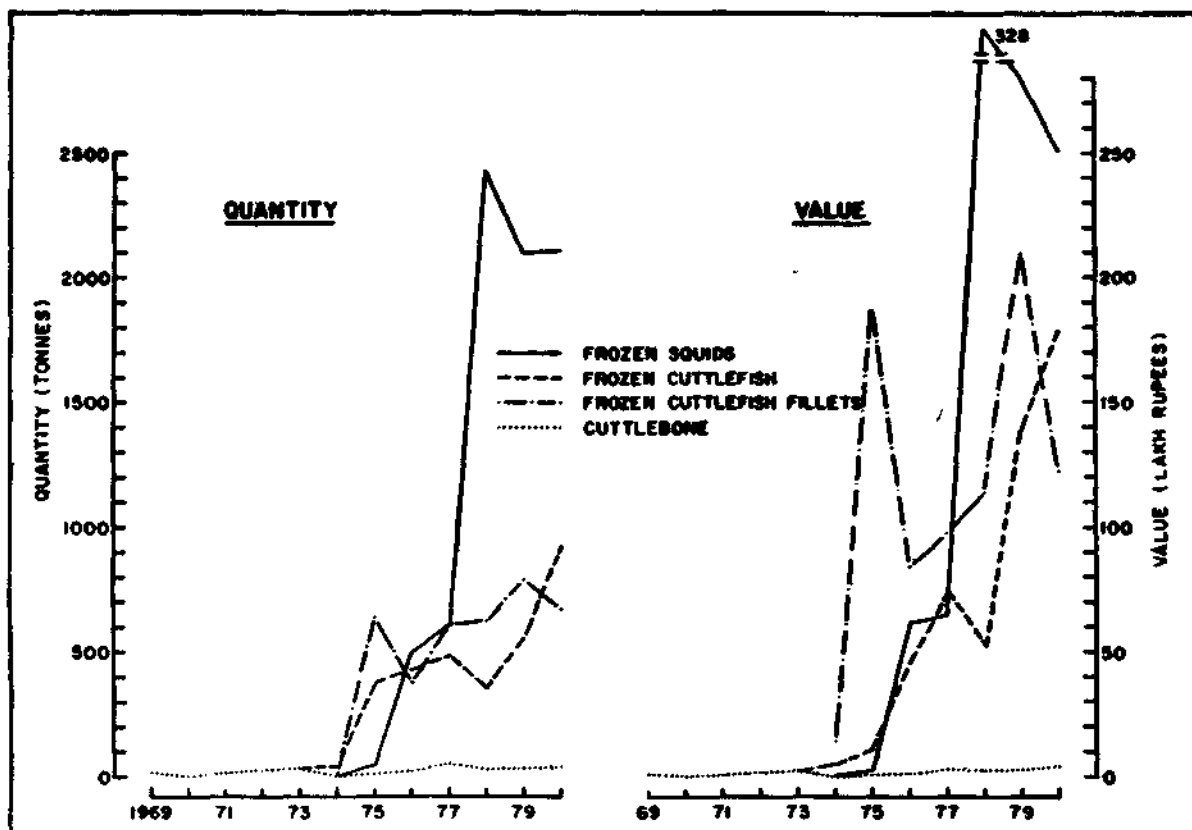


Fig. 5. Export of cephalopod products from India during 1969-80 (Source: M.P.E.D.A.).



the moment they are landed on the deck to prevent staining of prawn catch by the cuttlefish ink. Upto now no special fishery or effort is being expended specially for the capture of squids and cuttlefishes, except for the traditional subsistence fishing at Vizhinjam and Mandapam areas.

#### 4.2.2. Cephalopod production on east and west coasts of India

The cephalopod landings along the east coast of India increased from 685 tonnes in 1970 to a peak of 2,292 tonnes in 1975 and later declined and stabilized at 915-960 tonnes during 1976-78. The landings along the east coast contributed 25 to 59% of the total cephalopod production of India in the period 1969-73 but in later years they accounted for only to 30%. The triennial average production during 1975-77 shows a three-fold rise over 1969-71 and there is fall in 1978 (Fig. 3). During 1973-77 more than half (56.6%) of the east coast cephalopod landings were obtained in trawl nets and the rest (43.4%) in non-mechanised gear of which shore seines accounted for 24.8%, boat-seines 15.5% and hooks and lines 3.1%.

The bulk of the cephalopod landings of India are taken from the west coast, the annual production constituting 41 to 94%. During 1969-73 the landings varied between 416 tonnes and 1056 tonnes and in the succeeding years there has been progressive rise with peak landings of 14,977 tonnes in 1978. Unlike on east coast there has been continuous increase in landings along the west coast. The average triennial landings in 1975-77 were 11 times those of in 1969-71 and those in 1978 were 23 times over 1969-71 (Fig. 3). On this coast 60.4% of the landings were obtained in trawl nets, 16.7% in hooks and lines, 10.1% in shore seines, 10% in boat seines and 3.7% in stake nets.

#### 4.2.3. Cephalopod production in maritime States

Kerala, Maharashtra and since 1979 Gujarat are the leading States in cephalopod production, the three states together contributing 77% of the country's total cephalopod landings (Table 1). During 1977-80 the estimated annual catches of Kerala varied between 2,976 t and 4,973 t (20 to 50% in country's production), that of Maharashtra between 596 t and 4,557 t (6%-29%) and that of Gujarat between 1,439 and 5,351 t (14%-36%). Tamil Nadu ranked fourth with landings of 1,042 to 1,903 t (7-13%) in the same period. Kamataka's share of cephalopod production amounts to 68-1,346 t (0.5-8%). The rest of the landings come from Andhra, Goa, Pondicherry and other States.

#### 4.2.4. Species comprising the fisheries

Four species of squids *Loligo duvaucelii* d'Orbigny, *Sepioteuthis lessoniana* Lesson, *Doryteuthis* sp. and *Loliolus investigatoris* Goodrich and seven species of

cuttlefishes, *Sepia aculeata* Ferussac and d'Orbigny, *S. pharaonis* Ehrenberg, *S. brevimana* Steenstrup, *S. prashadi* Winckworth, *S. elliptica* Hoyle, *Sepiella inermis* (Ferussac and d'Orbigny) and *Euprymna stenodactyla* (Grant) occur in the neritic zone and form fisheries in India.

#### 4.2.5. Gearwise landings

The analysis of the gearwise landings of cephalopods in the country during 1973-77 indicates that the major portion of the catch amounting to 60% comes in trawl nets, 14% in hooks and lines, 13% in shore seines, 11% in boat seines and 2% in dol nets (Fig. 4).

In shore seines 255 to 1,606 tonnes of cephalopods were obtained annually during the period 1973-77 with an average of 816 tonnes (Table 2). In the same period average annual landings of 337 tonnes and 295 tonnes are taken in this gear in Kerala and Tamil Nadu respectively, and in other states the catches were very low. The squids *Loligo duvaucelii*, *Sepioteuthis lessoniana*, *Doryteuthis* sp. and the cuttlefishes *Sepia aculeata*, *S. pharaonis* and *Sepiella inermis* are the component species of cephalopods obtained in this gear. In Ramanathapuram district on the southeast coast of India the squid *Sepioteuthis lessoniana* is caught in *Ola valai* (Rao, 1954).

Moderate catches of cephalopods amounting to an average of 387 tonnes and 225 tonnes in a year are obtained in boat seines in Kerala and Tamil Nadu, these two states accounting for almost the entire catch taken by this gear. *Loligo duvaucelii*, *Doryteuthis* sp. and *Loliolus investigatoris* among squids and *Sepiella inermis* among cuttlefishes are caught in this gear.

Though hooks and lines are operated in many parts of the east and west coasts of India, only in Vizhinjam (Kerala) and Kanyakumari and Colachel (Tamil Nadu) areas where modified hand lines (hand jigs) are used exclusively for cephalopods, especially cuttlefish. Of the annual average catch of 866 tonnes of cephalopods, the landings in Kerala amount to 456 tonnes and those in Tamil Nadu 409 tonnes. The species contributing to the fishery is the cuttlefish *Sepia pharaonis*; the squids *Loligo duvaucelii* and *Doryteuthis* sp. also are obtained occasionally. In Ramanathapuram District of Tamil Nadu hand jigs are used to a small extent to catch the squid *Sepioteuthis lessoniana*.

The fixed bag nets (dol nets) operated along the Maharashtra Coast take small fraction of the cephalopods landed in India. Though this gear is in operation in Gujarat also, no cephalopods are obtained there. In Maharashtra the annual average catch is slightly less than 100 tonnes. The species that are caught in this gear are *Loligo duvaucelii* and to a small extent *Sepiella inermis*.

Table 1. Estimated cephalopod landings in maritime States of India (in tonnes)

Years	West Bengal	Orissa	Andhra Pradesh	Tamil nadu	Pondicherry	Kerala	Karnataka	Goa	Maharashtra	Gujarat	Andamans	Laksha-dweep	Total landings of India
1959	-	-	1	18	-	417	14	-	12	-	-	-	349
1960	-	-	-	5	-	28	1	-	53	-	-	-	462
1961	6	-	-	5	-	17	7	-	53	-	-	-	93
1962	12	-	5	2	-	180	13	-	27	-	-	-	97
1963	1	-	10	29	-	340	-	-	22	1	-	-	260
1964	5	-	22	74	-	174	1	-	7	1	-	-	464
1965	-	-	-	82	-	714	1	-	26	1	-	-	265
1966	1	-	13	195	-	374	-	-	2	1	-	-	951
1967	-	-	4	140	-	1,122	13	-	101	1	-	-	521
1968	19	-	101	268	9	164	57	-	147	1	-	-	1,636
1969	2	-	70	293	25	86	11	-	326	-	-	10	769
1970	3	-	663	77	9	473	7	-	368	-	-	9	1,184
1971	89	-	114	389	52	350	25	5	282	3	-	13	1,505
1972	7	-	67	248	22	339	19	-	501	1	-	17	1,026
1973	7	-	61	426	20	2,175	20	14	298	7	-	20	1,394
1974	-	-	165	955	28	3,342	175	96	482	611	-	15	3,677
1975	2	-	151	2,953	58	872	186	142	2,488	2,286	-	19	7,889
1976	-	27	242	1,451	211	4,973	965	164	596	1,439	-	40	7,945
1977	-	-	408	1,375	62	6,516	1,346	124	4,557	1,959	-	23	10,005
1978	30	4	297	1,042	36	2,976	68	173	3,959	5,351	-	20	15,931
1979	-	14	523	1,903	50	4,244	122	210	1,191	3,471	-	15	15,032
1980	4	98	470	1,472	40	-	-	-	-	-	-	13	11,335

Table 2. Gearwise cephalopod landings in India during 1973-77  
(Effort in number of units, catch in tonnes and C.P.U.E. in kg/unit/day)

Gear		1973	1974	1975	1976	1977	Average	Gearwise percentage of total cephalopod catch
SHORE SEINE	Effort	369,404	478,234	397,240	462,385	336,214	408,695	13.44
	Catch	254.96	375.95	1,606.42	957.28	886.53	816.23	
	C.P.U.E.	0.69	0.79	4.04	2.07	2.64	2.00	
BOAT SEINE	Effort	2,267,494	2,339,380	2,468,492	1,418,355	2,026,765	2,104,097	10.98
	Catch	213.21	197.17	946.73	244.37	1,730.01	666.30	
	C.P.U.E.	0.10	0.10	0.38	0.17	0.85	0.32	
HOOKS & LINE	Effort	1,231,434	1,107,657	1,161,869	1,135,497	915,481	1,110,388	14.26
	Catch	255.19	155.13	1,630.38	1,127.04	1,162.69	866.09	
	C.P.U.E.	0.21	0.14	1.40	1.00	1.27	0.78	
DOL NET	Effort	379,417	330,913	389,082	1,600,645	333,967	606,805	1.62
	Catch	119.69	51.33	90.4	108.62	124.07	98.83	
	C.P.U.E.	0.32	0.16	0.23	0.07	0.37	0.16	
TRAWL NET	Effort	553,283	627,855	977,900	1,030,244	1,301,479	898,152	59.70
	Catch	489.48	2,754.92	3,446.65	5,352.51	6,076.91	3,624.09	
	C.P.U.E.	0.88	4.39	3.52	5.20	4.67	4.04	

The annual production from trawl fishing has increased remarkably from 489 tonnes in 1973 to 6,077 tonnes in 1977 with a rise in effort by 235% in the period (Table 2). The c.p.u.e. (catch per boat trip) has increased from 0.88 kg. in 1973 to 4.67 kg. in 1977. The squid *Loligo duvaucelii* and four species of cuttle fishes, viz. *Sepia aculeata*, *S. pharaonis*, *S. brevimana* and *Sepiella inermis* are the commercially important species fished in trawl nets. In addition species such as *Doryteuthis singhalensis* in small numbers in certain months are caught off Waltair and Madras. *Sepia prashadi* is landed occasionally on both the coast while *Sepia elliptica* forms a small fishery along the Cochin Coast. *Loligo duvaucelii* is fished throughout the year on both the coast, the peak fishing seasons being January to May at Bombay, January to March and August to October on the south west coast and April to May and August to November on the east coast. Good catches of *Sepia aculeata* are obtained from September to January on the west coast and January to June and September to November on the east coast. The best seasons for *Sepia pharaonis* are October to December on the west coast and March, June to August and November on the east coast.

#### 4.2.6. Off-shore fisheries

Exploratory fishing conducted by large sized trawlers of Exploratory Fisheries Project, Government of India indicate that cephalopods are caught in appreciable quantities off Vishakhapatnam and Madras along the east coast and off Goa, Bombay and Gujarat along the west coast (Rao 1971; Anon. 1979). Squids and cuttlefish are obtained from shallow waters upto depths of 90 m on the east coast and 145 m on the west coast. The annual catch rates vary from 1 to 4 kg/hr at depths of 10-89 m off Waltair, from 1.5 to 9 kg/hr at depths of 20-109 m off Bombay and upto 10 kg/hr at 10-70 m off Goa. Recently good catches of cephalopods have been reported from Gujarat. The catch rates obtained off Gujarat at depths of 48-145 m are up to 139 kg/hr with the higher catches got in some areas like 21/68 and 22/68 at depths of 95/112 m in June-September 1979. The species netted by the trawlers are the squid *Loligo duvaucelii* and the cuttlefishes *Sepia aculeata*, *S. pharaonis*, *S. brevimana* and *Sepiella inermis*, the last two occurring in small quantities.

### 5. OCEANIC SQUIDS

The oceanic squids occurring in the Indian Ocean are *Symplectoteuthis oualaniensis*, *S. luminosa*, *Ommastrephes bartrami*, *Todarodes sagittatus angolensis* and *Notadarus sloani (gouldi?)* of the family Ommastrephidae, *Thysanoteuthis rhombus* of the family Thysanoteuthidae, and *Onychoteuthis banksi* of the family Onychoteuthidae have been recorded from the Indian Ocean (Filippova 1968). Many of these species are Indo-Pacific species which are commercially

exploited in the Pacific Ocean by Japan (Clarke 1966; Voss 1973; Okutani 1977). *Symplectoteuthis oualaniensis* is most abundant and predominant species in the northern and central parts of the Indian Ocean and its southern boundary is limited to lat. 20° S. There is no quantitative information on the resources potential of the various species of oceanic squids in the Indian Ocean except for a few studies. Silas (1969) has recorded that *Symplectoteuthis oualaniensis* is fairly abundant on the continental shelf edge and slope off the west coast of India at depths beyond 180 m in Lat. 7°-14° N and Long. 72°-77° E. The squids were attracted towards the ship by lights and captured in drift nets. The Fishery Agency of Japan (1976, 1977) has reported the occurrence of *S. oualaniensis* at depths beyond 200 m in the Indian Ocean and Arabian Sea between Lat. 4° S and 25° N and Long. 61°-67° E in oxygen deficient layers. There is need to survey the oceanic areas of Indian Ocean for exploiting them.

### 6. EXPORT OF CEPHALOPODS

#### Quantity and value

The growth of export of cephalopod products from India has been spectacular. The trade which stood at 421 kg valued at Rs. 11,000 in 1963, and 11 tonnes of cuttlebones worth Rs. 74,000 in 1969 has reached an all-time high of 3,818 tonnes valued at Rs. 55.8 millions in 1980 (Fig. 5). Upto 1974 the upward trend in export has been gradual but from 1975 onwards there is a steep rise both in quantity and value.

#### Products of export

The products of cephalopods that are exported from India are frozen squids, frozen cuttlefish, frozen cuttlefish fillets and cuttlebones. In 1980 the frozen squid was the predominant item forming 57% and the cuttlefish products account for the rest.

#### Frozen squids

The first export of frozen squid was to Australia in 1974 with 0.5 tonne and subsequently there has been very good demand for this product in several countries. In 1980 the export was 2,179 tonnes worth Rs. 25 millions which is less than that in 1978 (2,428 tonnes and Rs. 32.8 millions). Among over a dozen countries that import Indian frozen squid the major importers are the U.A.E., France, the Netherlands, Greece, Belgium and Algeria.

#### Frozen cuttlefish fillets

Among cephalopod products frozen cuttlefish fillets fetch the highest price. During the period 1974-75 the annual export of frozen cuttlefish fillets ranged between 92.6 tonnes (Rs. 1.46 millions) in 1974 and 788 tonnes (Rs. 21 millions) in 1979. After a good export in 1975, there has been a decline in the subsequent years till it recovered in 1979. In 1979 more than 516 tonnes (over

65%) of fillets were exported to Japan realising Rs. 16.5 millions (78%). All through the years Japan had been the major importer of Indian frozen cuttlefish but in 1980 France was the largest buyer, taking 381 tonnes (56%) valued at Rs. 5.6 millions. Other buyers include Belgium, Hongkong, the Netherlands, Italy and U.S.A.

#### Frozen cuttlefish

From 1973 onwards this product is being exported. The total annual export varied from 13 tonnes in 1973 to 926 tonnes valued at Rs. 17.9 millions in 1980. There has been steady increase in exports except in 1976 and 1978 when there has been a decline both in quantity and value. The largest single importer is Japan which lifted 381 tonnes valued at Rs. 11 millions. The other countries include Algeria, France, Italy, the Netherlands, U.K., Spain, Belgium, U.S.A. and Kuwait.

#### Cuttlebones

The cuttlebones have been among the export commodities much earlier than other cephalopod products. In 1980 a total of 36 tonnes of cuttlebones were exported realising an earning of Rs. 0.4 million. Though this is being exported to over a dozen countries including Canada, New Zealand, Saudi Arabia, Federal Republic of Germany, Thailand, U.K., and U.S.A. offer a steady market from 1969 onwards (Source : M.P.E.D.A., Cochin).

### 7. CONSTRAINTS

One of the constraints for the development of the cephalopod fishery has been the general tendency to discard at sea squids and cuttlefishes occurring as bye-catch. They form a sizable bye-catch in the shrimp trawling grounds and the present trend of bringing part of the bye-catch ashore is on account of the recent growth of an export market. It is unlikely that production could be increased using existing methods of fishing except through saving all that comes in as bye-catch. Squid jigging, light fishing, mid-water trawling and encircling nets have to be developed to suit the conditions in Indian waters. Exploratory fishing should also be conducted in the deeper neritic waters for the assessment of resources of known and additional species. This will involve expansion of commercial fishing using larger vessels. A more streamlined system of estimation of squid and cuttlefish landings from traditional fishing grounds as well as data on component species are needed. It is essential that the catch data are also collected for small sized cephalopods of genera such as *Euprymna* and *Loliolus*.

There are many lacunae in the knowledge of the biology of squids and cuttlefishes of the tropical waters and therefore a concerted effort has to be made to study the commercially important species.

Post-harvest technology is a major area where attention and improvements are necessary, especially for promoting exports. The better utilisation of residual materials after processing, such as heads and arms, and cuttlebones has to be attempted.

In 1980 there was a fall in the export trade of cephalopod products which was immediately reflected in a decline of their catches as part of the catch was discarded at sea due to a lack of market demand. Due to some temporary setback in procurement for processing, a tendency to discard a portion of the catches at sea may again arise. To avoid such a situation a steady local market has to be developed to take in additional catches. At present only a small section of the coastal populations consumes cephalopods. Therefore, there is an urgent need to popularise squid and cuttlefish as food through a well planned extension programme.

### 8. PRODUCTION POTENTIAL AND PROSPECTS

There are no proper estimates of exploitable yield of cephalopods from the continental shelf of India based on resource data. Based on present production, some workers have forecast the yield potential of the shelf areas of the Indian Ocean. Gulland (1970) has stated that the production from the Indian Ocean could be several hundreds of thousands of tonnes. Voss (1973) estimated the production potential of the region to be 500,000 tonnes. Yet another estimate of the production potential is 200,000 tonnes (Anon. 1977). George *et al.* (1977) have in passing mentioned the exploitable production from the continental shelf waters of India to be around 180,000 tonnes of which 55% is to come from the upper east coast, 11% each from lower east coast and north west coast and 20% from the south west coast. These figures are very arbitrary.

The progressive rise in yearly cuttlefish landings obtained as bye-catch of shrimp trawlers clearly indicate that there are extensive cuttlefish resources of the species *Sepia aculeata*, *S. pharaonis*, *S. brevimana* and *Sepiella inermis* in the outer shelf waters particularly at depths of 25 to 75 m. Among squids, *Loligo duvaucelii* is commercially important, occurring along both east and west coasts, while *Doryteuthis* sp. is caught in good quantities along the southern Kerala Coast. At present, the inshore fishery of *Sepioteuthis lessoniana* is not actively pursued on the southeast coast. Efforts have to be made to revive the fishery. There are very good possibilities for stepping up squid as well as cuttlefish production from the neretic waters of India by adopting suitable fishing methods and increasing effort.

Until now the oceanic cephalopod resources of the Indian Ocean have not been exploited by India. Studies conducted so far show that *Symplectoteuthis ovalariensis* is common in the oceanic waters. The

occurrence of larvae and juveniles of oceanic squids in various parts of the Indian Ocean and the indirect evidence of occurrence of adult squids from the presence of beaks and other remains of squids in the stomachs of Cetaceans are indicators of the large scale distribution of squids in the Indian Ocean. A beginning has to be made in the exploitation of oceanic squids by developing and using appropriate methods of fishing. There are also rich fishing grounds of cuttlefish *Sepia pharaonis* in the Arabian Sea. Exploratory fishing programmes to chart the distribution of this species and oceanic squids are also to be undertaken in this connection. Japan and Taiwan are exploiting *Symplectoteuthis oualaniensis* found off Okinawa and

Taiwan in the Pacific Ocean; (Okutani 1977). India could similarly develop a fishery for this resource in the Indian Ocean which has not been hitherto exploited.

Thus, it will be seen that we have only an indicative idea of the resources of squids available from our deep neretic and oceanic waters. This is an area which will need a feasibility study of working out an effective operational method for harvesting the resources. We will also need expertise in the operational side of fishing as squid jigging has never been carried out in this country. These constraints and prospects may be taken into consideration for planning a rational development programme for squid and cuttlefish fishery in India.

## BOOKS

*Fisheries Oceanography and Ecology*: By Taivo Laevastu and Murray L. Hayes, Fishing News Book Ltd. England, pp 199, 1981.

This is the third revised edition of a book summarizing the knowledge of the relations between fish and its ocean environment published by the same publisher. This book summarizes in a semi-popular manner the principal results of research in the field of fisheries oceanography during the last eight decades. It also shows how to apply facts and principles of oceanography and marine meteorology to fisheries problems. Emphasis has been placed on the description of subjects where the interest of biologists and oceanographers must cross. These subjects are especially illustrated in the summery reviews on fish behaviour and fishery resources. Brief reviews are given of ocean analysis and forecasting and of possible fisheries diagnostic and prognostic services. Some background of modern fisheries management on the basis of ecosystem approach is given. Even though it is primarily meant for fisheries biologists, it will be easily understandable by and useful to skippers and administrators in the fisheries industries.

*Energy at the surface of the earth* : By David H. Miller, Academic Press. London, pp 516, 1981.

This is the 27th volume in *International Geophysics Series*. It presents one way of looking at the manner in which the biological, physical and cultural system that mantle the landmasses of our planet receive, transform, and give off energy, which is an essential condition of

existence that takes many forms. The principal forms of energy that are converted at the ecosystem scale include radiant, latent, mechanical, chemical, fossil and thermal. The author starts with radiant energy absorbed by ecosystems, a phenomenon that is independent of their surface temperature and that can be looked on as a burden or a gift depending on circumstances. The temperature dependent flumes of energy are discussed. The final chapters deal with vertical stratification and areal contrasts in energy budgets.

*Man and Fisheries on an Amazon Frontier* : By Michael Goulding, Dr. W. Junk Publishers. The Hague, pp. 137, 1981.

This book represents an attempt to describe and quantify the nature of the Rio Madeira fisheries within the framework of the Rondonia frontier. The author investigated for five years the fish ecology, fisheries and human geography of the region to understand the Rio Madeira as a whole to elucidate the natural history of the region as part of the larger Amazon basin. This work will serve as a trial run for a much larger treatise that will deal with all the Amazon basin and its aquatic resources. The book starts with physical, biological and cultural portraits of the Rio Madeira valley followed by the discussion of commercial fisheries found in the region. The next chapter gives quantitative data in terms of fishing effort and yield followed by an overview of the natural history of the Rio Madeira food fishes, and each of the species is discussed in some detail, accompanied by a photograph. The final chapter views the problems and prospects of the Rio Madeira fisheries.

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