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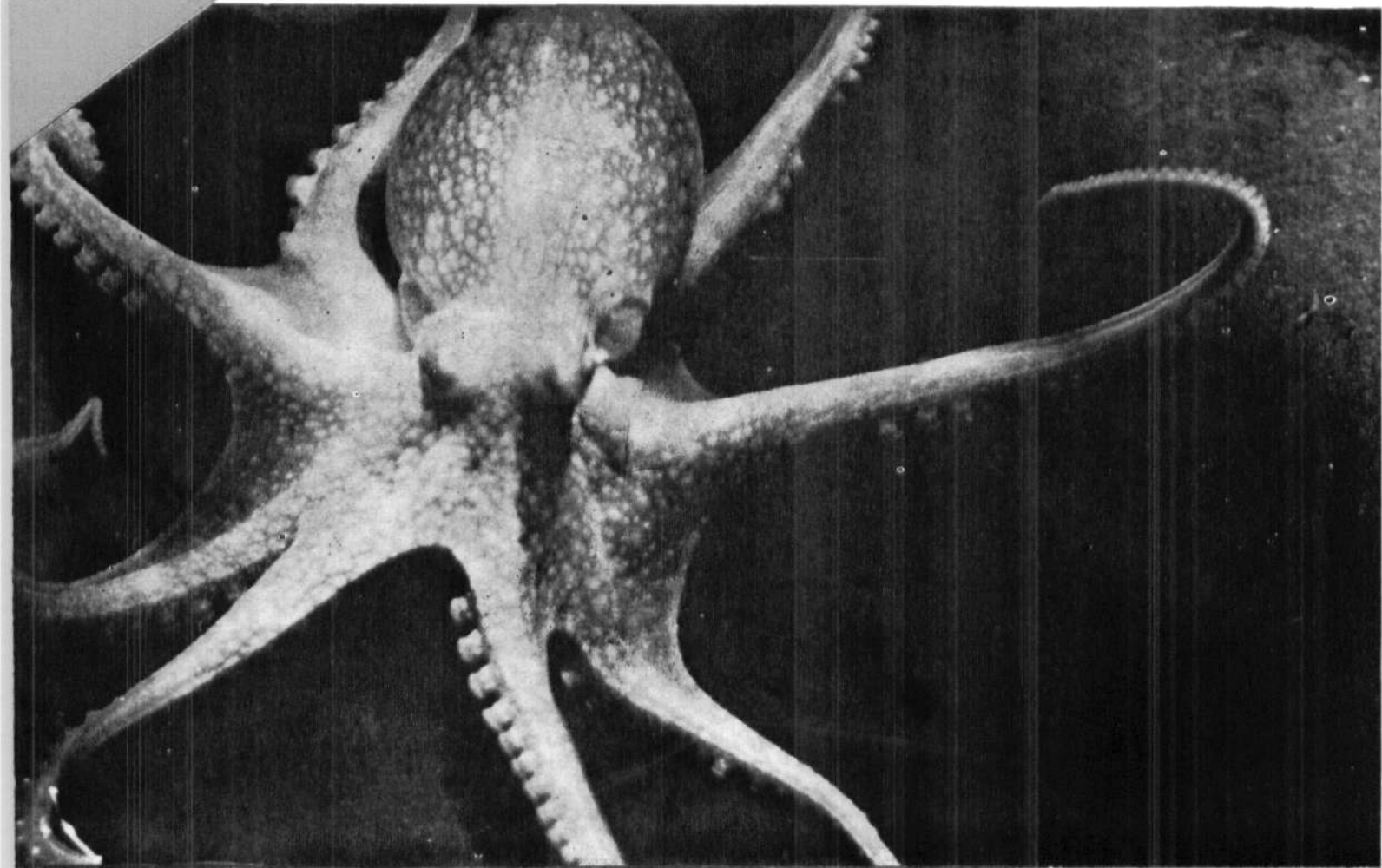
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CEPHALOPOD BIONOMICS, FISHERIES AND RESOURCES OF THE EXCLUSIVE ECONOMIC ZONE OF INDIA

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SOME ASPECTS OF THE BIOLOGY OF CUTTLEFISHES

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ABSTRACT

The biological aspects namely, sexuality, sex composition, size at first maturity, spawning, age and growth, distribution of adults, food and distribution of juveniles of six species of cuttlefishes *Sepia pharaonis*, *S. aculeata*, *S. elliptica*, *S. brevimana*, *S. prashadi* and *S. inermis* are discussed here. *Sepia pharaonis* showed differential growth and the rate of growth of females was higher than that of males. By contrast growth rate of *Sepia aculeata* was almost similar in both sexes.

Sepia pharaonis Ehrenberg

BIONOMICS AND LIFE-HISTORY

REPRODUCTION

Sexuality

The species is heterosexual. The left ventral arm is hectocotylized in males which are less broader than females that are more muscular and robust. The conspicuous stripes across the dorsal side of mantle, fins, head and arms are more prominent in males than in females.

Sex ratio

Data on sex composition of this species obtained in commercial trawl catches of this species off Waltair recorded during 1976-80 (Fig. 1) showed that females were generally the dominant sex (F 54 : M 46-F 90 : M 10). Only in a few months viz. November, 1978, February, March and December, 1979 and March, October and November, 1980 males outnumbered females (M 53 : F 47-M 75 : F 25). Only in four months October 1977, January 1978, May 1979 and February 1980, the two sexes were in equal proportion. There was dominance of females (in Madras area (F 52 : M 48-F 80 : M 20) in most of the months as along Waltair coast and only in five months February and April, 1976 and April, June and October, 1980 males formed the dominant sex (M 56 : F 44-M 71 : F 29).

On the west coast in the landings of hooks and line fishery at Vizhinjam also, the females were generally

dominant (F 53 : M 47-F 77 : M 23) and males outnumbered females on in five months January 1977, July 1978, February and March 1979 and January 1980 accounting for 52-100% (Fig. 2). The two sexes were in equal proportion only in a single month February 1977. In the trawl catches off Cochin coast male *S. pharaonis* dominated in March (M 58 : F 42 and July 1980 (M 57 : F 43) and in all other months except June, 1980 when the two sexes were in equal ratio, there was preponderance of females (F 54 : M 46-F 80 : M 20) (Fig. 3).

Maturity

Males and females of this species were found to mature from a minimum size of 90 mm onwards along Waltair coast (Fig. 4). The size at first maturity was 119 mm in males and 120 mm in females. Males and females of the sizes 150 mm and 170 mm and above were all mature. Maturation studies at Madras indicated that the size at first maturity is slightly higher compared to that at Waltair being 121 mm in males and 138 mm in females. In both sexes maturity was attained in the sizes 110-190 mm, all the cuttlefishes becoming mature by the time they grow to a size of 190 mm.

On the west coast this species reaches the mature stage at higher sizes in comparison to those along the east coast. At Vizhinjam the size at first maturity is 145 mm in males and 160 mm in females. The males attain sexual maturity within the size range of 130-220 mm and females in the range of 150-230 mm.

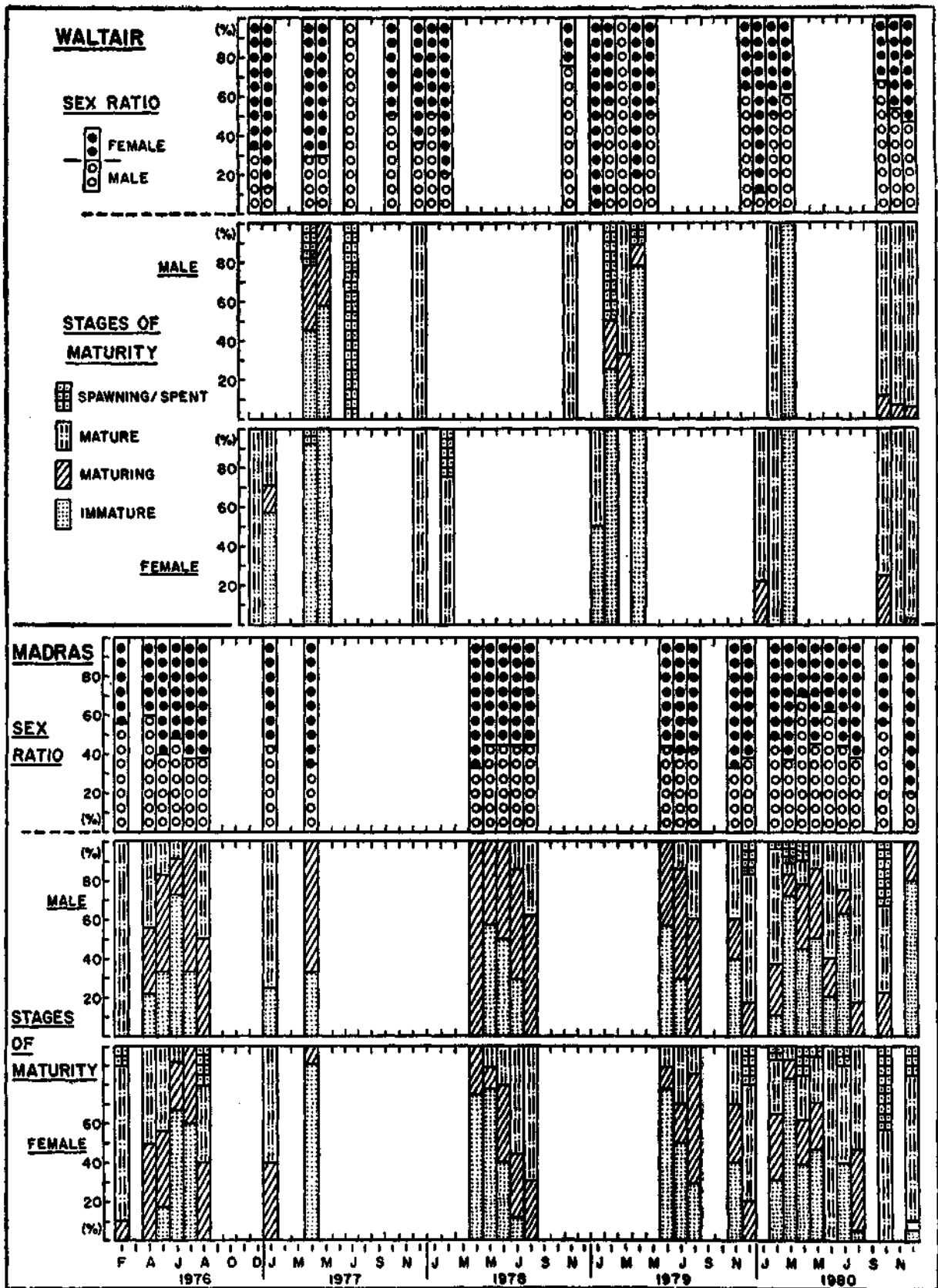


Fig. 1. Sex ratio and stages of maturity of *Sepia pharaonis* at Waltair and Madras.

In Cochin area the size at first maturity is more or less the same as at Vizhinjam in the two sexes, 154 mm in males and 157 mm in females. However, the size at 100% maturity is lower, being 190 mm in both sexes.

Spawning

In Waltair area mature females occurred from October to February and mature males from October to March (Fig. 1). Female spawners were observed

species is very much prolonged as in *S. aculeata* extending from October to August.

Along Vizhinjam coast, cuttlefish in maturing stage were noticed in January, March, April and August-November in hooks and line fishery (Fig. 2). Mature cuttlefish occurred (during January-April, July and September-December. Higher percentages of mature females with ripe ova were observed in three months January, April and December. Mature males were frequently observed in the catches over a longer

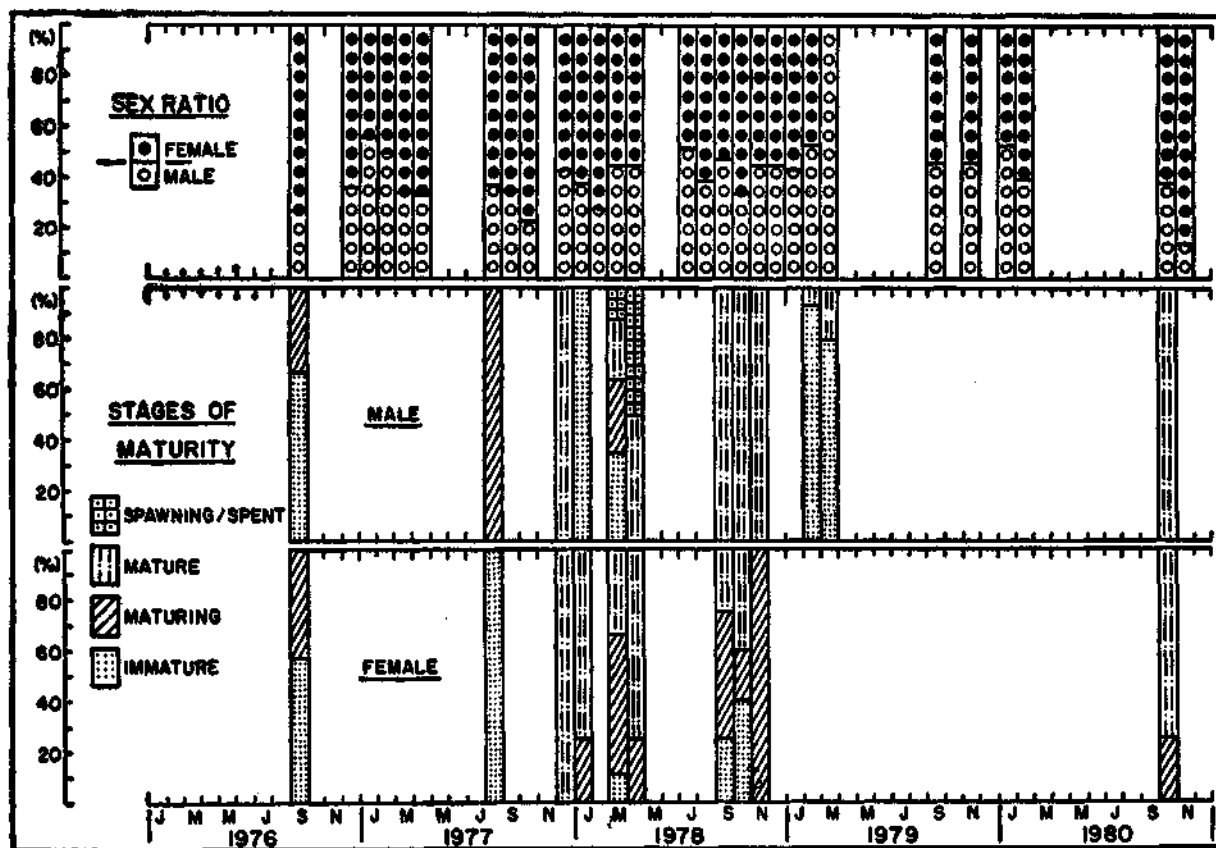


Fig. 2. Sex ratio and stages of maturity of *Sepia pharaonis* at Vizhinjam.

in the area in February and April and male spawners in February, April and July. This species appears to breed in the period October to April along the Waltair coast. Cuttlefish in all the maturity stages were found almost throughout the year off Madras coast (Fig. 1). In contrast to Waltair area, sexually mature females were observed from October to August and males in all months except September. Spawning females were seen in seven months viz., February, April, May, July, August, October and December and spawning males in March, April, October and December. The data on the occurrence of mature cuttlefish and spawners suggests that the spawning season of this

period during September-December, March, April, and July and male spawners during March-April. The seasonal abundance of mature and spawning cuttlefish suggest that the species breeds in this area from October to April.

In Cochin area maturing cuttlefish of this species were common throughout the year (Fig. 3). Sexually mature females were noticed in April, June and October and spawners only in December. Mature males occurred in April, July, October and December and spawners in September and December. Along both east and west coasts of India the species spawns over a long period extending from October to April and in

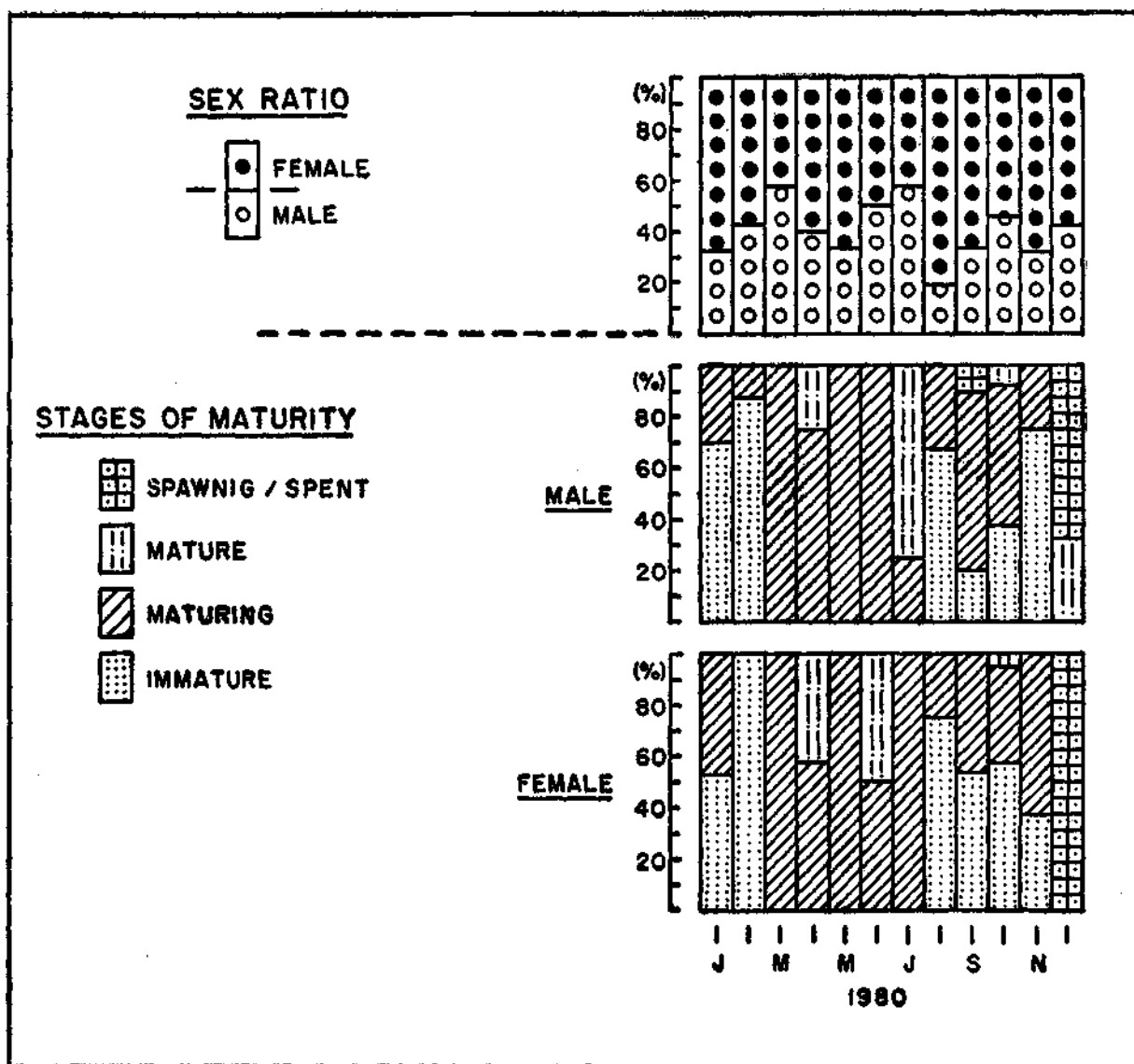


FIG. 3. Sex ratio and stages of maturity of *Sepia pharaonis* at Cochin.

some areas up to August. Voss and Williamson (1971) have stated that this species spawns in a restricted period March-May in Hong Kong area and the cuttlefish come to the coastal waters for the purpose. Spawning grounds of this species have been reported to exist off Orissa and Visakhapatnam coasts (FAO UN, 1961).

REPRODUCTION

ADULT HISTORY

Growth

Preliminary growth studies based on the length frequency distribution of both sexes of *S. pharaonis*

combined together from the commercial trawl catches off Madras coast show that the species attains a size of 100 mm in 6 months, 165 mm in one year and 197 mm in 16 months on the east coast.

A detailed study of the size frequency composition of males and females of *Sepia pharaonis* caught by hooks and lines off Vizhinjam coast indicated differential growth in the two sexes. The relative age and size was estimated to be as follows :

Relative Age	Male (mm)	Female (mm)
6 months	109.4	119.9
12 months	186.1	197.8
18 months	239.7	248.3
24 months	277.3	281.2
30 months	303.6	302.5
36 months	322.0	316.3

Distribution of adults

This is a widely distributed species contributing to the commercial fisheries along both coasts of India. Adults are caught in large quantities in hooks and lines in Vizhinjam area and in trawl nets in the other areas. Off northern Andhra adult males 90-150 mm and adult females 90-170 mm in size are caught in trawl nets. Off Madras coast trawlers obtain adult males and females of the size range 110-190 mm. On the west coast much larger sizes are obtained. The size ranges of males and females caught in the Cochin area by trawlers range from 130 mm to 190 mm while in Vizhinjam area adult males 130-210 mm and adult females 150-230 mm are fished.

In *Sepia pharaonis* of PDR Yemen also the rate of growth is faster in females but the ultimate size reached is higher in males and they survive longer due to high level of post-spawning mortality of females (Sanders, 1981).

Length-weight Relationship

Study of the length-weight relation of the species caught off Vizhinjam coast showed differences in the

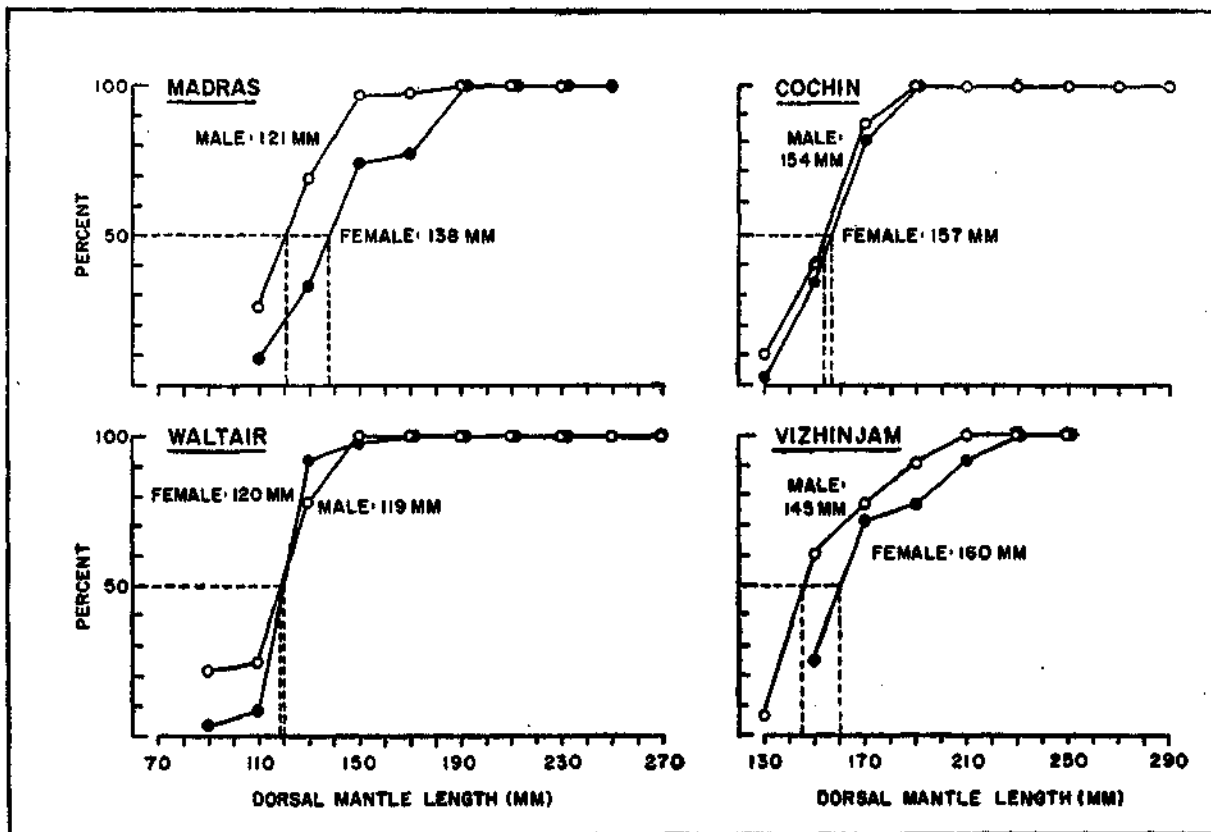


FIG. 4. Size at first maturity of *Sepia pharaonis* at Madras, Cochin, Waltair and Vizhinjam.

rate of increase in weight in relation to length in males and females. The allometric growth formulae for the two sexes are as follows :

$$\text{In males } W = 0.000988 L^{2.5058}$$

$$\text{In females } W = 0.000726 L^{2.5478}$$

Maximum size

The greatest sizes recorded for the males and females of this species on the east coast are 265 mm (at Waltair) and 245 mm (at Madras) respectively. As this species grows to a larger size on the west coast, the corresponding sizes for males and females along this coast are 334 mm and 320 mm (at Vizhinjam) respectively.

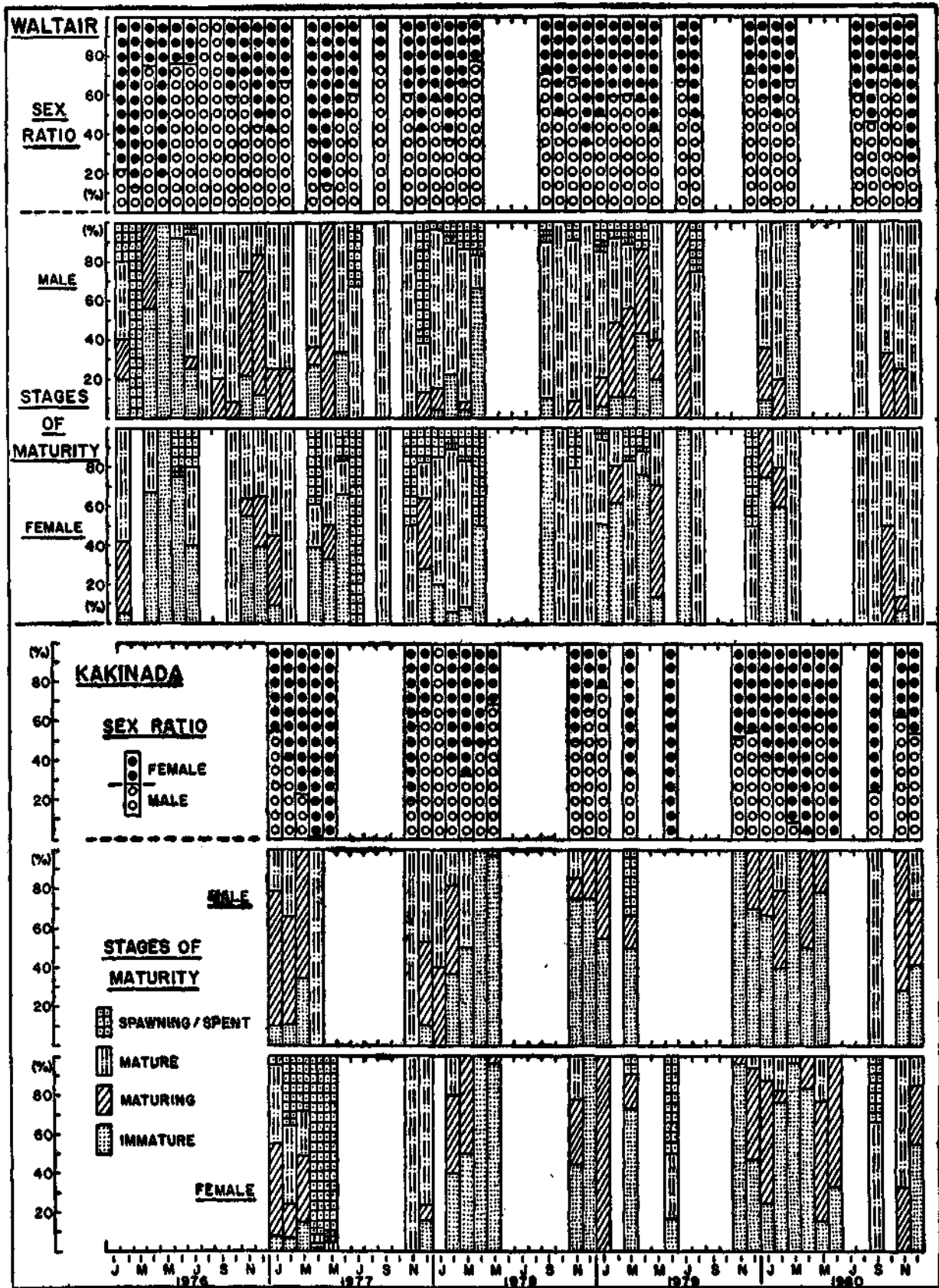


FIG. 5. Sex ratio and stages of maturity of *Septa aculeata* at Waltair and Kakinada.

Food

S. pharaonis is an active predator and exclusively carnivorous feeding on fish, crustaceans and sometimes on cephalopods. Scales, eye balls, otolith and bones of fishes, macerated and partly digested fishes and parts of crustaceans such as prawns, crabs and *Squilla* are found in the stomachs.

Eggs

Egg clusters of this species have been collected from the fishing grounds off Vizhinjam coast.

Distribution of juveniles

Juveniles of the species measuring up to 80 or 100 mm in size occur in the inshore waters and are caught in shore seines, boat seines and from depths up to 40 m in trawl nets particularly in Waltair, Madras and Mandapam areas. The juveniles are obtained from January to July in Waltair area and throughout the year with the exception of September in Madras area. Juveniles up to a maximum size of 120 mm are obtained in trawl nets in Cochin area all round the year except in June and December and in Vizhinjam area from January to April and in August.

Sepia aculeata Orbigny

BIONOMICS AND LIFE-HISTORY

REPRODUCTION

Sexuality

Sexes are separate. The mantle as well as the cuttlebone are less broader in males than in females and quadrilateral suckers in the hectocotylized left ventral arm are abruptly reduced in size as compared to normal suckers near the base of the arm. Females can be distinguished as in all cuttlefishes by the presence of nidamental glands which can be easily seen through the mantle opening by disengaging the funnel mantle locking device or by cutting open the mantle centrally.

Sex ratio

In the trawl catches off Waltair coast during 1976-80, generally males dominated (57-100%) except in some months when females were found in more numbers (F 54 : M 46-F 87 : M 13). The two sexes were found distributed in equal proportion only in five months—June 1977, October 1978, January and August 1979 and February 1980 (Fig. 5).

Females were usually the dominant sex along Kakinada coast in most of the months during 1977-80 with female : male sex ratios of 57 : 43-96 : 4 except in the months January and December 1977, May and

December, 1978, January, November and December, 1979 and May November and December, 1980 when males were the dominant sex (M 53 : F 47-M 79 : F 21). The two sexes were in equal proportion only in three months April, September and November, 1978 (Fig. 5).

The sex ratio of this species in the commercial trawl catches in Madras area showed a different trend (Fig. 6). In 1976, males dominated only in July (M 53 : F 47). In August both sexes were in equal ratio. In 1977 males outnumbered females in March and April and females were the dominant sex in February and November. In 1978 females dominated (F 57 : M 43-F 65 : M 35) in all months except June and August while in 1979 they were dominant only in two months viz., June and October (F 55 : M 45-F 67 : M 33). In 1980 the two sexes were in equal proportion in April. June and September and in several months females were the dominant sex (F 53 : M 47 and F 68 : M 32). The overall sex ratio for the entire period 1976-80 showed female predominance with a ratio of F 58 : M 42.

During the period 1976-78 males were the dominant sex along Porto Novo coast in most of the months when observations were made (Fig. 6). The two sexes were represented in equal ratio only in two months August, 1976 and January, 1977.

The sex ratio of the species in Mandapam area did not show any definite pattern (Fig. 7). In 1976 males were the dominant sex in a number of months such as January, March, May, August and November-December with sex ratios of M 52 : F 48:M 68 : F 32 while in the other months there was dominance of females. In 1977-78, only in four months viz., January, July and November 1977 and April 1978 males were dominant (M 51 : F 49 to M 70 : F 30). The overall sex ratio of males and females during 1976-78 did not indicate marked dominance of a single sex.

On the west coast females were dominant in trawl catches in Cochin area in six months in 1980 with sex ratios of F 53 : M 47-F 72 : M 28 (Fig. 8). In March and June 1980, the two sexes were distributed in equal proportion while in the other four months there was preponderance of males (M 59 : F 41-M 74 : F 26).

In Bombay area the sex ratios showed male dominance (M 53 : M 47-M 83 : F 17) in most of the months in 1978 and 1980 (Fig. 9). In the month of September in 1978 and 1979 the two sexes were in equal ratio or almost so while in September, 1980 females were dominant (F 65 : M 35). The average sex ratio during the period 1978-80 showed dominance of males (M 60 : F 40).

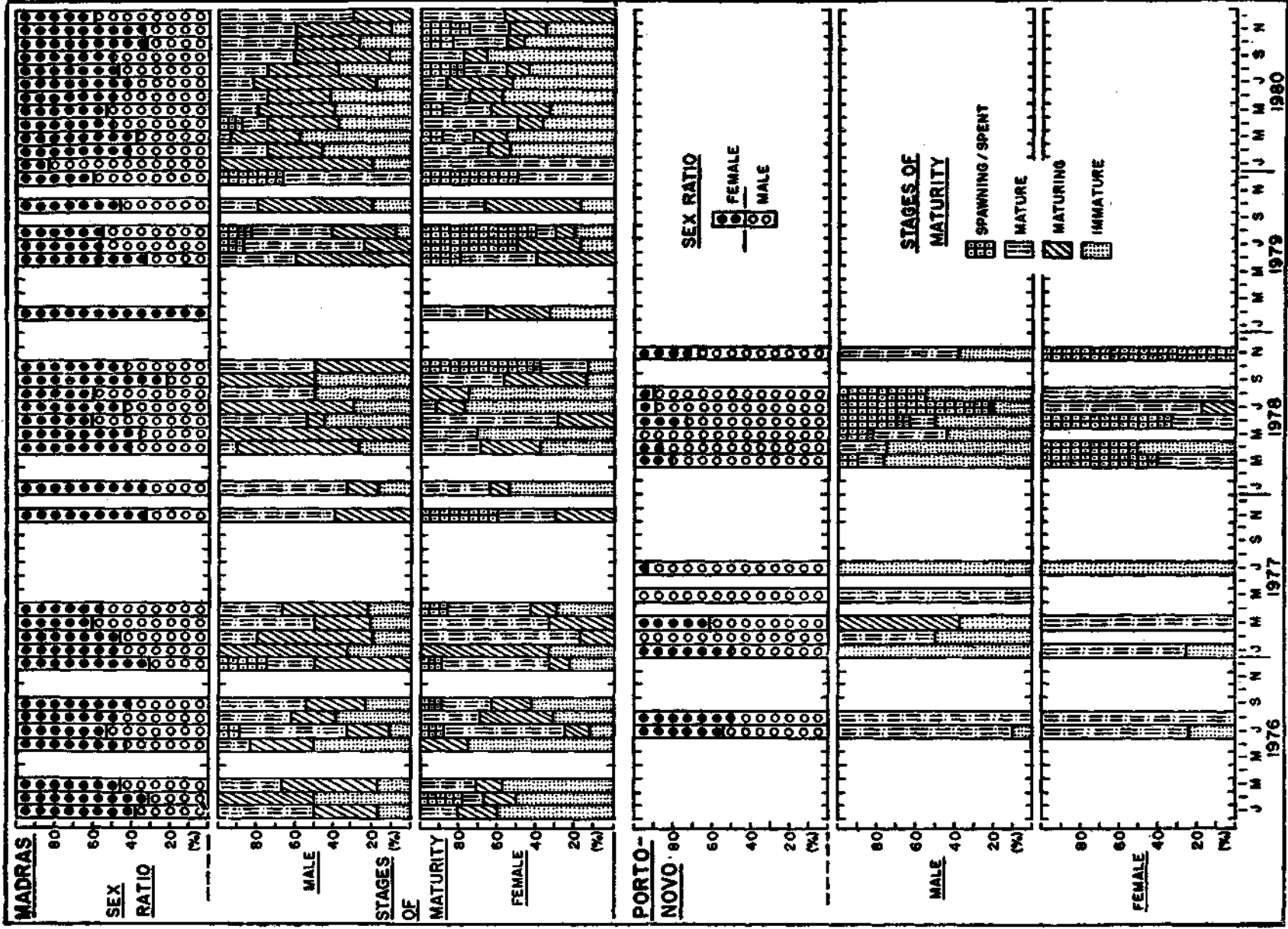


Fig. 6. Sex ratio and stages of maturity of *Sepia aculeata* at Madras and Portonovo.

Maturity

Along Waltair coast males and females were found to mature from the size of 70 mm onwards (Fig. 10). 50% of the males and females were mature when they attained sizes of 77 mm and 102 mm respectively. All the individuals of the two sexes were matured when they attained a size of 150 mm.

Along Madras coast the catches consisted of cuttlefishes in all stages of maturity. The frequency of

case of males and 130 mm in females in Cochin area. The cuttlefish of the two sexes become mature within the size ranges 90-170 mm and 110-170 mm with 100% maturity at 170 mm.

The onset of maturity was first observed in females of Bombay region at a size of 90 mm and all the females were mature by the time they grew to 150 mm. The size at 50% maturity of females in Bombay area was similar to that in Cochin area, being 132 mm.

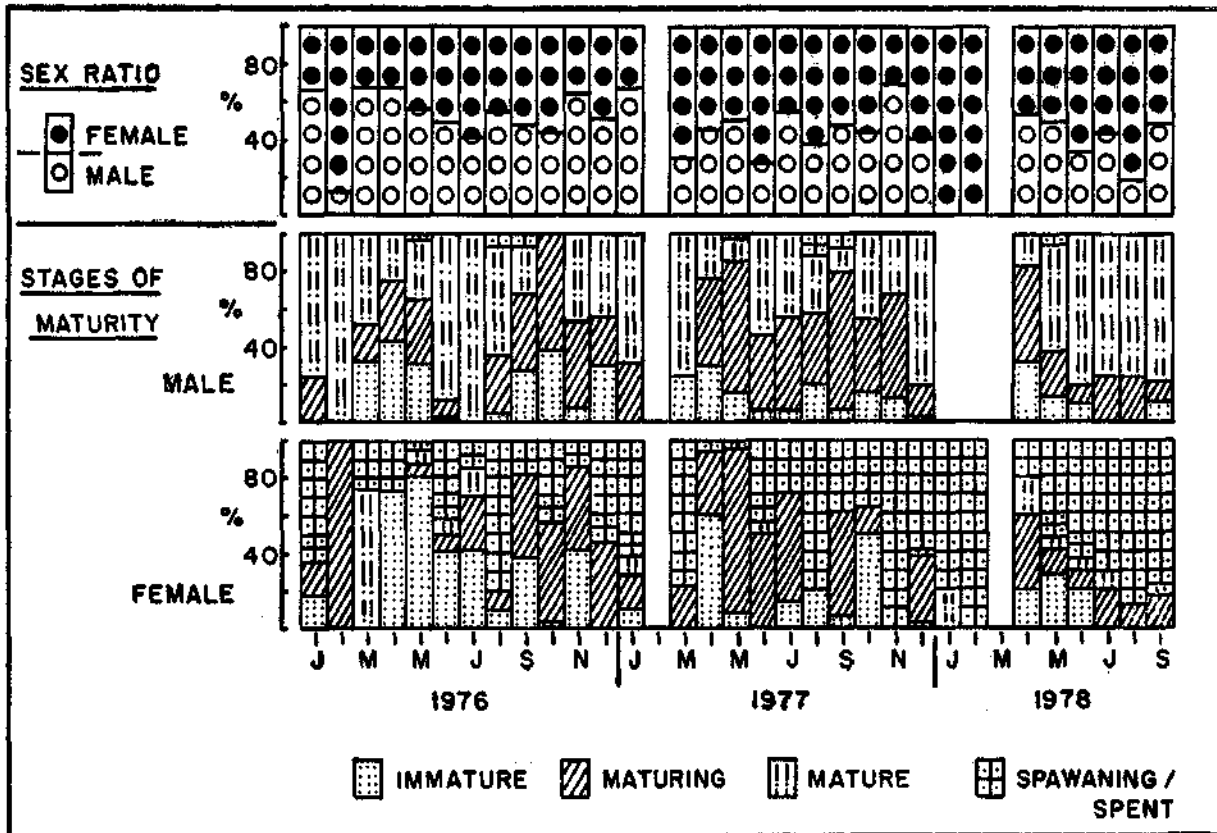


FIG. 7. Sex ratio and stages of maturity of *Sepia aculeata* at Mandapam.

maturity stages at different sizes indicated that the size of 50% maturity for males is 100 mm and that for females 118 mm. Males in the population attain the mature stage in the size range 70-130 mm and female in the range 90-170 mm. Both sexes became mature when they are 130 mm and 170 mm respectively. The size at 50% maturity is lesser viz., 83 mm for males at Mandapam and that for females is, however, similar 110 mm when 10 months old. In Mandapam area male and female cuttlefish reached maturity at a minimum size of 70 mm. All the males and females attained mature stage by the time they grow to sizes of 150 mm and 190 mm respectively.

On the west coast, study of the stages of maturity in relation to size revealed that the size of 50% maturity was higher than on the east coast viz., 124 mm in the

The data on the size at first maturity of *Sepia pharao-nis* and *Sepia aculeata* indicate that in these two species male cuttlefish attain sexual maturity at smaller size than females. Further in both these species the cuttlefishes of the two sexes become sexually mature at smaller size on the east coast than those along the west coast. The causative factors for the differences need to be studied. Durchon and Richard (1967) have observed that a secretion of the optic gland of *Sepia officinalis* controls maturation of reproductive organs. Defretin and Richard (1967) have reported that the optic gland of cuttlefish is controlled by photo-period, being active when day length is short and inhibited by long day length.

Spawning

Cuttlefish in maturing stage were found in greater or lesser numbers along both the coasts throughout the year indicating maturation in the species all through the year. Mature and spawning cuttlefish were also seen almost in all months clearly indicating breeding activity during a prolonged period.

out the year while males in these stages were noticed in good numbers almost around the year (Fig. 6). In Portonovo area females in advanced stages of maturity were noticed in good percentage in January, March-April, June-August and November and males of the stages in February, May-August and November (Fig. 6).

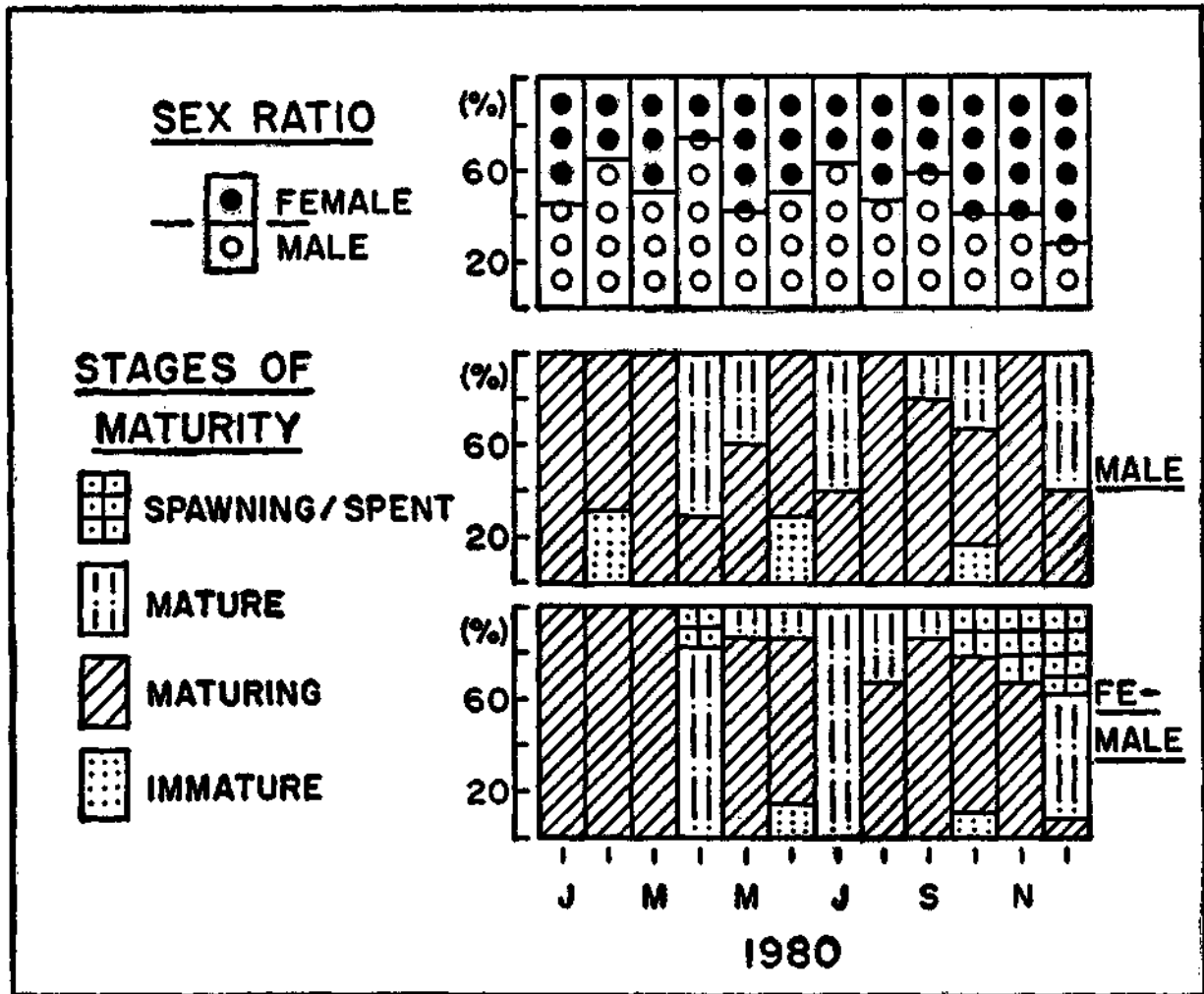


FIG. 8. Sex ratio and stages of maturity of *Sepia aculeata* at Cochin.

On the Waltair coast mature and spawning females were very common from January to April and from July to December (Fig. 5) and mature and spawning males were commonly observed throughout the year. Along the Kakinada coast females in mature and spawning stages were common in February, April-May, September and November (Fig. 5). Males in the same stages were in several months and were more common in April, September and November.

Mature and spawning females were common or very common in trawl catches off Madras coast through-

In the trawl catches in Mandapam area during 1976-78 mature and partly spawned females as well as males were common throughout the year (Fig. 7). Rahman (1967) reported that the species appears to breed biannually in neighbouring Thondi area the first season extending from February to April and the second one from July to August.

The observations at Cochin on the west coast in 1980 indicated occurrence of mature and spawning female *S. aculeata* in trawl catches off Cochin coast from April to December with dominance in three months

viz., April, July and December (Fig. 8). Sexually mature males were observed in several months viz. April, May, July, September, October and December with large numbers in April, May, July and December. Data collected on females of this species caught by trawlers off Bombay show that mature and spawning *S. aculeata* form high percentages in five months February, March and September-November (Fig. 9).

The data at seven centres presented above indicate breeding in the species during an extended period along both coasts of India.

Study of the age and growth of this species in Madras area showed that the growth rate is almost similar in both sexes. The relative age and size are as follows :

Relative age	Size (mm)
6 months	88.6
12 months	138.9
18 months	167.5
24 months	183.7

The observations made in Mandapam area indicate growth to sizes of 74 mm, 123 mm and 155 mm at the

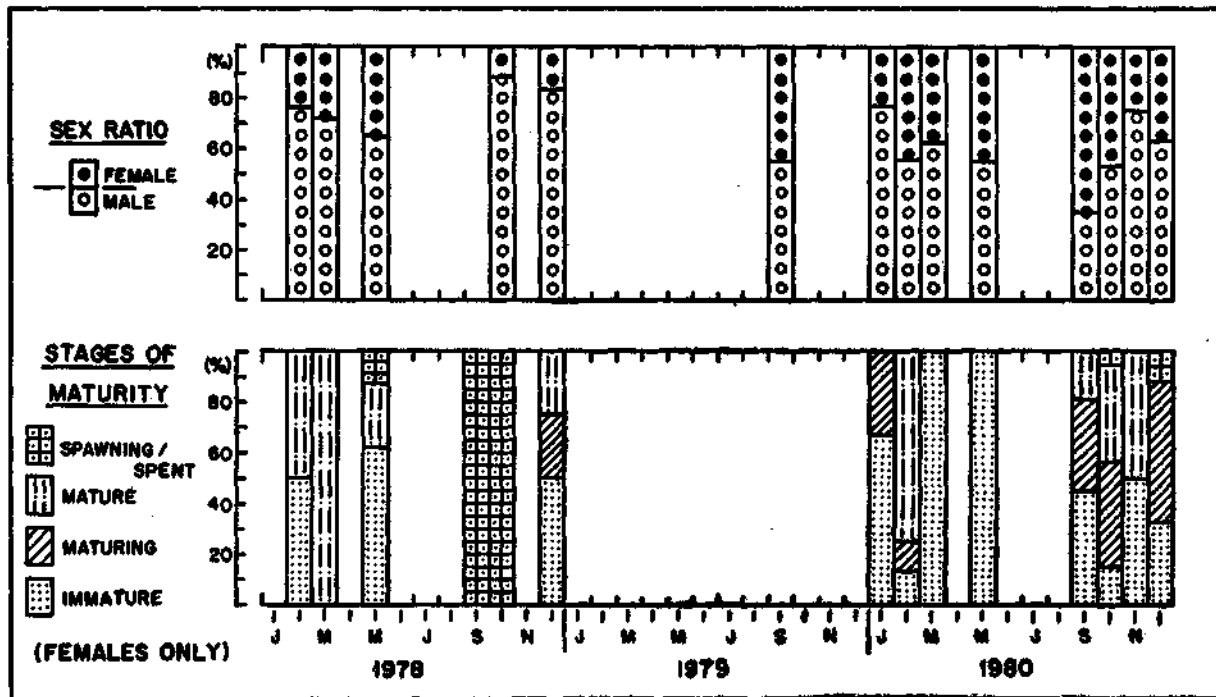


FIG. 9. Sex ratio and stages of maturity of *Sepia aculeata* at Bombay.

ADULT HISTORY

Growth

Progress of modal sizes was analysed for males and females together for growth studies at Waltair, Kakinada Mandapam and Bombay. At Madras the males and females were treated separately. Growth studies on this species at Waltair show that it attains a size of 59 mm at the end of 6 months, 103 mm at the end of one year, 135 mm at the end of one and half years, 158 mm at the end of two years and 165 mm at the end of 26 months.

Along Kakinada coast the growth is initially similar to that along Waltair coast and a size of 61 mm is reached at the end of six months but later there is a slight decrease in rate of growth, the size reached in one year and one and half years being 96 mm and 124 mm respectively.

end of six months, one year and one and half years respectively.

The growth of this cuttlefish in Bombay area is similar to that in Mandapam area in the first year of its life with a growth of 67 mm and 122 mm in six months and one year respectively, but in the second year the growth is faster in comparison to that on the east coast, and sizes of 164 mm and 202 mm are attained in one and half years and two years respectively.

Length-weight relationship

The study of length-weight relationship of the species of Madras coast indicated that the rate of increase in weight in relation to the dorsal mantle length differed in males and females. The allometric growth formulae for the two sexes are as follows.

$$\begin{aligned} \text{In males} & \quad W = 0.00045 L^{3.6671} \\ \text{In females} & \quad W = 0.000346 L^{3.7427} \end{aligned}$$

Distribution of adults

This is a common species in the continental shelf waters especially up to a depth of 60 m. Adults of the size ranges 50-150 mm and 70-190 mm support the trawl fishery along Waltair and Madras coasts. The sizes obtained in trawl catches on the southeast coast in Mandapam area are higher with a range of 70-190 mm. On the west coast adult females 90-200 mm are caught by trawlers off Cochin and Bombay coasts.

fishes and other organisms caught along with the species in trawl nets and identification of the prey organisms found in the stomach contents, Oommen (1977) reported in the stomachs of this species a number of fishes *Nemipterus japonicus*, *Platycephalus scaber*, *Opisthotarus tardoore*, *Saurida tumbil*, *Cynoglossus* sp., *Pseudohombus* sp., *Anchoviella* spp., *Sardinella* spp., *Plotosus* sp., *Scatophagus argus* and *Rastrelliger kanagurta*, the crustaceans, *Metapenaeus* sp., *Penaeus* sp., *Squilla holoschista*, and *Neptunus sanguinolentus*, the squid

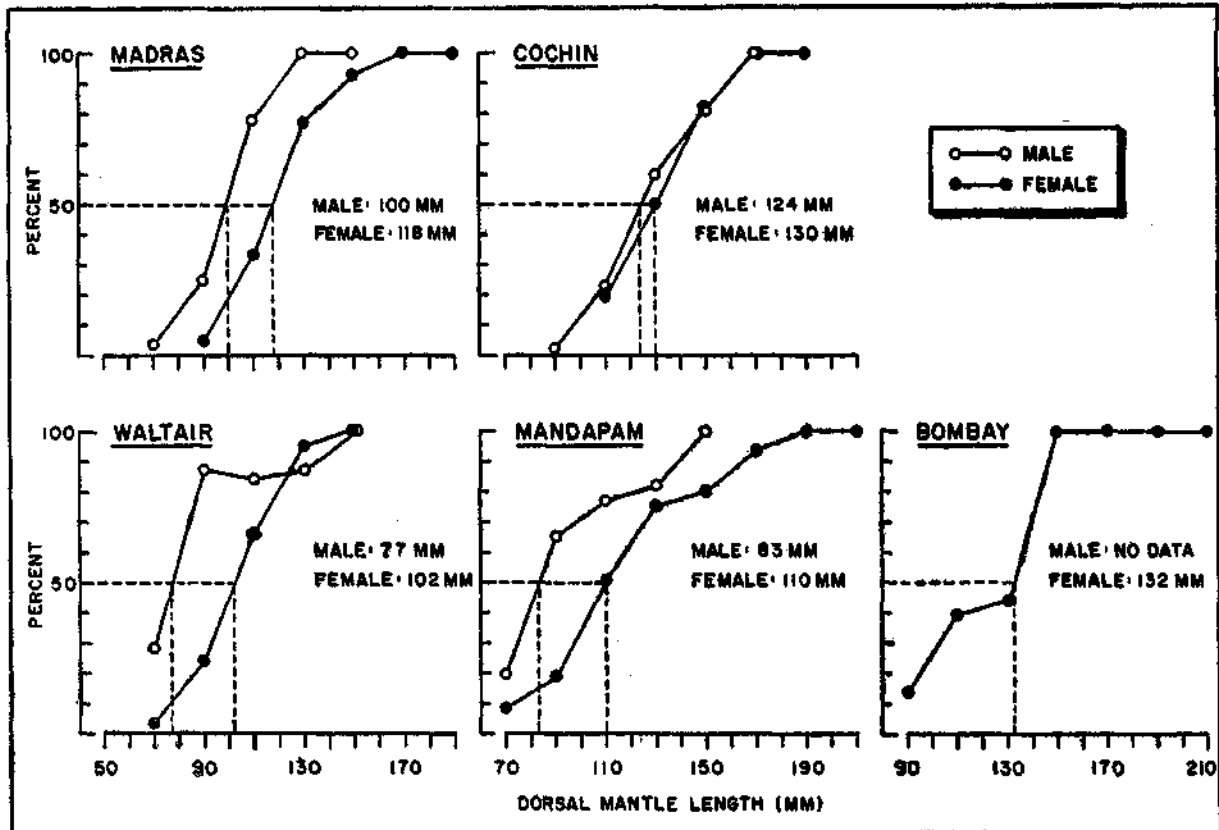


FIG. 10. Size at first maturity of *Sepia aculeata* at Madras, Cochin, Waltair, Mandapam and Bombay.

Maximum size

The largest sizes for males and females on the east coast are 190 mm and 200 mm respectively (at Mandapam) and on the west coast the maximum sizes for the two sexes are 245 mm and 200 mm (at Bombay).

Food

Like all other cephalopods this species is highly carnivorous and predatory. The common food items are fish and prawns. Crabs, stomatopods and polychaetes also form diet of this species to a small extent.

Oommen (1977) studied the structure of the alimentary canal, digestive enzymes and food and feeding habits of this species from the southwest coast of India. The stomach contents were usually found in well macerated condition. However, based on the occurrence of

Loligo duvaucelii and *Loliolus* sp. and the foraminiferans *Nonion sloanii* and *Entzia tetrastomella*. Oommen (1977) did not find any seasonal changes in the feeding intensity. Crustaceans were dominant food throughout the year with peaks in March and April followed by fishes which were very common in May and October. Cephalopods were rarely found in the stomach contents.

Eggs

During periods of intensive spawning egg clusters are commonly seen in trawl and shore seine catches in Palk Bay, Gulf of Mannar and other parts of east coast. Bunches of egg capsules are found washed ashore in the monsoon period October-December. On two occasions in September 1976, egg clusters of this species attached to gorgonids had been collected

from trawl catches off Madras in the fishing area 13-80/1C at a depth of 25-40 m where the bottom was muddy with shells. A brief account of the rearing and hatching of eggs is given by Sivalingam and Pillai (1983).

Distribution of juveniles

On the east coast juveniles 20-50 mm in size were found throughout the year along Kakinada and Mandapam coasts and from January to October off Madras coast. Along Waltair coast they were represented in January, February, April, May, August and December. Juveniles ranging between 20 and 70 mm were observed throughout the year in Bombay area and from January to August off Cochin on the west coast.

REPRODUCTION

Sexuality

Sepia elliptica is heterosexual and the two sexes can be distinguished externally from the hectocotylization of the left ventral arm in males. In addition females are broader than males.

Sex ratio

Data on sex ratio of cuttlefish caught by trawlers in Cochin area is inadequate for the period 1976-78 due to poor catches. During 1979-80 this species was obtained in good numbers and males were the dominant sex in March, May, July, September-December, 1979 and April, August and September, 1980 (M 52 : F 48—

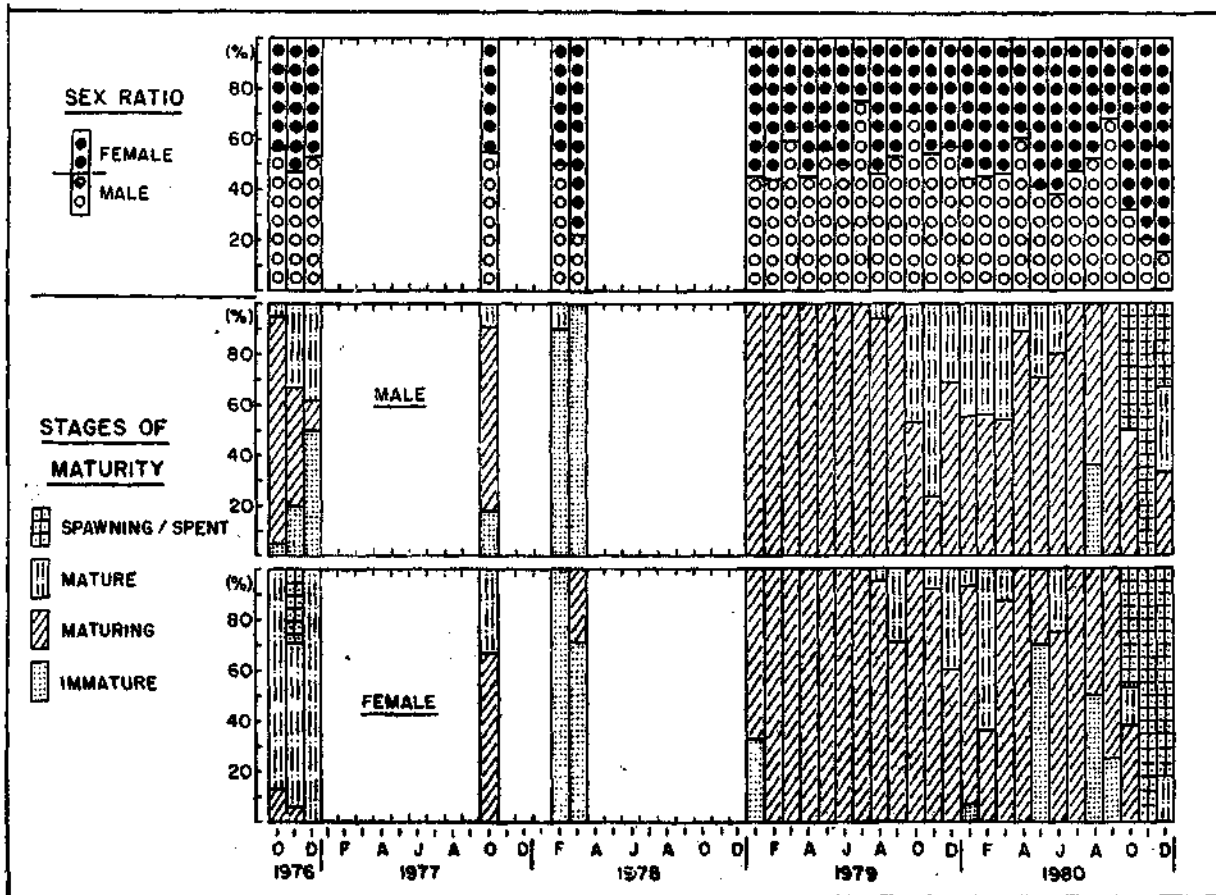


FIG. 11. Sex ratio and stages of maturity of *Sepia elliptica* at Cochin.

Sepia elliptica Hoyle

BIONOMICS AND LIFE-HISTORY

This is a small sized species supporting a fishery at Cochin and is caught in trawl nets almost throughout the year.

M 75 : F 25) (Fig. 11). Only in one month June, 1979 both sexes were represented in equal ratio and in all other months of the 1979-80 period females dominated in the population (F 53 : M 47—F 85 : M 15).

Maturity

Males and females of this species of Cochin area attain sexual maturity at a minimum size of 75 mm and

all individuals of the two sexes are mature when they reach a size of 115 mm (Fig. 12). The size of 50% maturity is 93 mm for males and 96 mm for females.

Spawning

Sexually mature females were represented in the trawl catches in several months of the year January-March, June and August-December (Fig. 11). Similarly mature males were also found in January-May,

Distribution of adults

Adult males and females 75-115 mm are commonly captured from the trawling grounds off Cochin coast at depths beyond 30-40 m.

Maximum size

The largest sizes recorded for males and females of *S. elliptica* caught in trawl nets in Cochin area are 129 mm and 119 mm respectively.

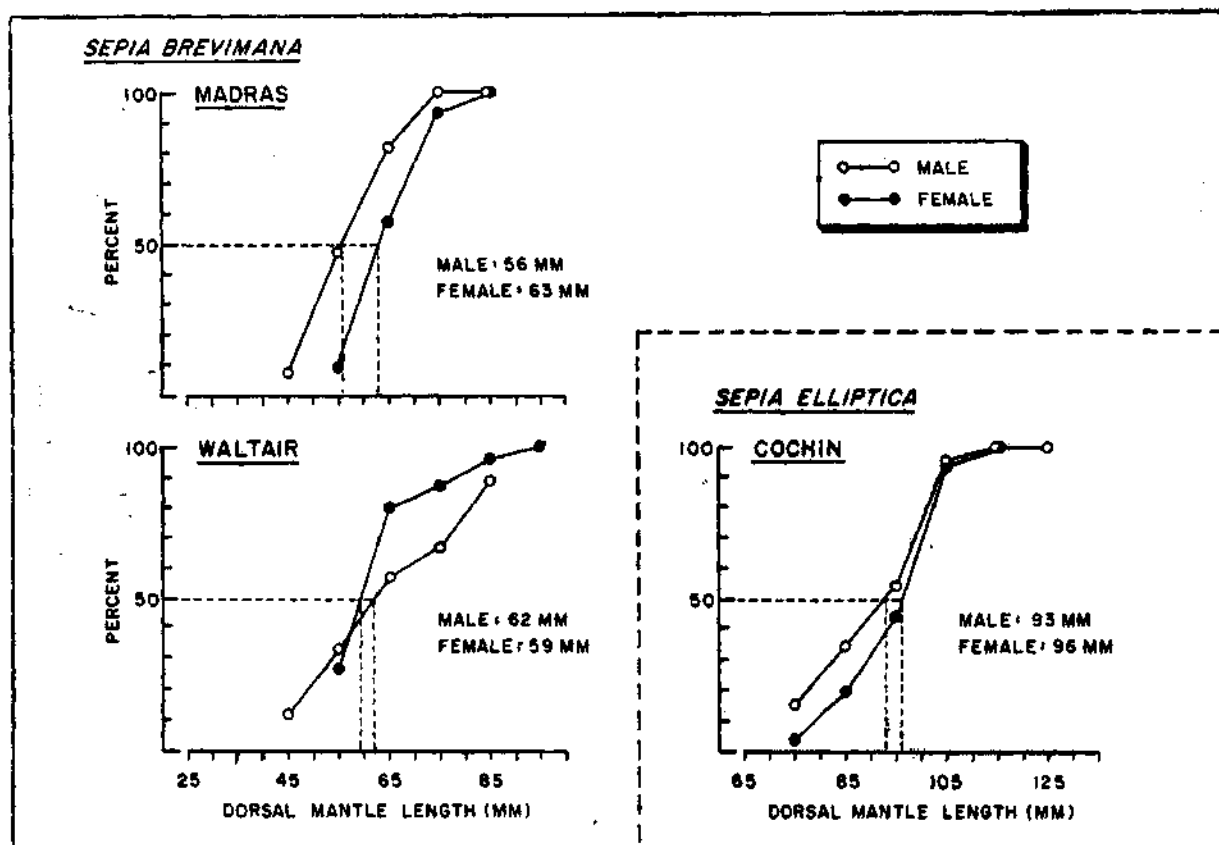


FIG. 12. Size at first maturity of *Sepia brevimana* of Madras and Waltair and *Sepia elliptica* at Cochin.

August and October-December. Spawning females and males were recorded from October to December. Spawners occur only in three months. But the presence of mature cuttlefish of both sexes in a number of months suggests that breeding activity extends over a long period in a year.

ADULT HISTORY

Growth

Study of the progression of modal sizes of males and females together showed a growth of 75 mm in six months and 117 mm in one year in this species.

Food

Penaeid prawns form the main item of food of this species and the other food items which occur in the stomachs are fishes, *Acetes*, crabs and stomatopods.

Distribution of juveniles

Juveniles measuring 36-74 mm are obtained in trawl catches in Cochin area in January-May and August-September.

Sepia brevimana Steenstrup

BIONOMICS AND LIFE-HISTORY

This is one of the small sized cuttlefishes which are landed in moderate quantities in trawl nets at Madras and Waltair.

REPRODUCTION

Sexuality

Sexes are separate and males can be distinguished from females by the hectocotylization of the left ventral arm. In females the mantle is broader and the cuttlebone acuminate anteriorly.

Sex ratio

Females were dominant on Waltair coast in several months (F 55 : M 45—F 86 : M 14) in 1976 and 1979 while in 1977, 1978 and 1980 females outnumbered males in some months (F 51 : M 49—F 75 : M 25) and *vice versa* in other months (M 51 : F 49—M 74 : F 26) (Fig. 13). The two sexes were represented in equal ratio only in four months May 1977, August 1978, May 1979 and March 1980. The annual sex ratios show that the two sexes were almost in equal proportion in 1977, 1978 and 1980 while females were dominant (F 58 : M 42 and F 57 : M 43) in the years 1976 and 1979.

On the Madras coast during 1976 and 1977 when data was available in a few months, females were dominant in March and August 1976 and February, March and November, 1977 (F 60 : M 40—F 65 : M 35) while in February and July, 1976 the two sexes were in equal or almost equal ratio (Fig. 13). During the period 1978-80, males predominated in the catches in February March and May 1978, March, June, July and September 1979 and January, February, May and November 1980 (M 53 : F 47—M 73 : F 27). The two sexes were in almost equal ratio in June, 1978. The overall annual sex ratios show preponderance of females during 1976-78 and 1980 (F 54 : M 46—F 57 : M 43) and only in one year, 1979 males were dominant (M 58 : F 42).

Maturity

Males and females of this species mature for the first time at sizes of 45 mm and 55 mm respectively on the Waltair coast and the sizes at 50% maturity of the two sexes are 62 mm and 59 mm respectively (Fig. 12). All the females and males mature at a size of 95 mm.

In Madras area also males and females of the species become mature at sizes of 45 mm and 55 mm respectively

(Fig. 13.) But the size of 50% maturity is 56 mm in males and 63 mm in females. All the males and females are found to mature at sizes 75 mm and 85 mm respectively.

Spawning

In Waltair waters maturing and mature females were observed throughout the year (Fig. 13). The latter were seen in large numbers in January-April, June-October and December. Partially spawned females were noticed in January, February, April, September, October and December. Mature males were found all round the year while spawners were noticed in January-May, September and December.

In Madras area mature females formed high percentages in February, May, July and November and spawning females in January, February and from July to November (Fig. 13). A similar trend is seen in males with high percentage of mature ones in January-March, May, July-September and November. The data indicate spawning activity during a very prolonged period in this species along Madras and Waltair coasts.

ADULT HISTORY

Growth

Preliminary study of the progression of monthly modes of males and females together showed that this species grows to sizes of 29 mm, 56 mm and 75 mm at the end of 6 months, one year and one and half years in Waltair area while in Madras waters it attains sizes of 34 mm, 58 mm and 76 mm respectively at the same ages.

Distribution of adults

Adult cuttlefishes of the size ranges 45-95 mm and 45-85 mm comprise the trawl catches in Waltair and Madras areas respectively.

Maximum size

The maximum sizes of males and females recorded at Waltair are 89 mm and 95 mm respectively whereas 85 mm was the largest size recorded for both the sexes at Madras. Voss and Williamson (1971) have observed 80 mm as the maximum size for this species in Hong Kong waters.

Food

Qualitative study of the stomach contents of this species of Waltair and Madras coasts showed that it feeds on various species of prawns, fishes and other crustaceans such as *Squilla* and crabs.

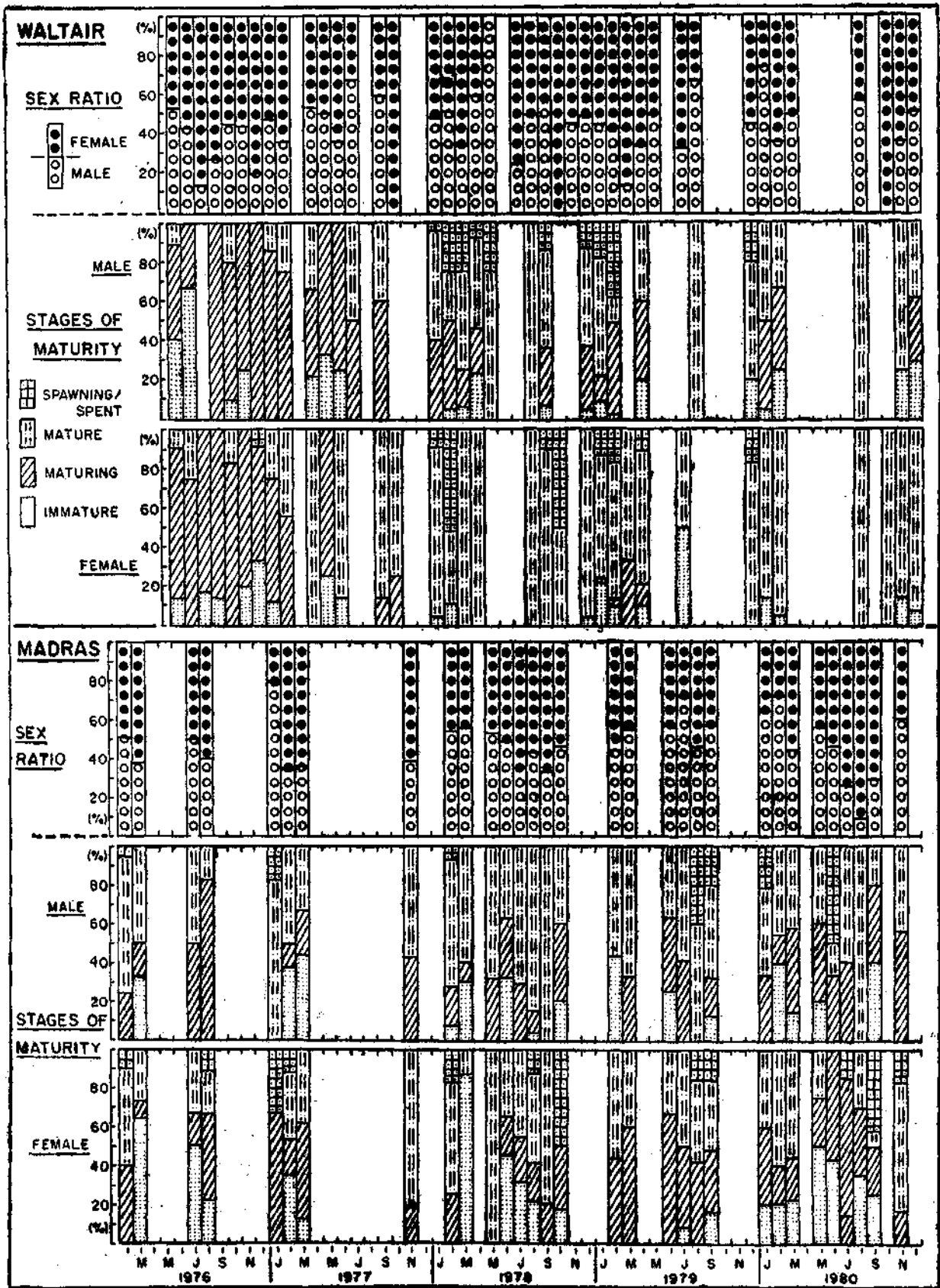


FIG. 13. Sex ratio and stages of maturity of *Sepia brevimana* at Waltair and Madras.

Distribution of juveniles

Juveniles of *S. brevimana* 20-40 mm in size were caught by trawlers along Waltair coast in April-May and November 1978, January-February and April 1979 and January, February, November and December 1980. Juveniles 30-40 mm have been recorded in trawl catches off Madras coast almost throughout the year.

Sepia prashadi Winckworth

BIONOMICS AND LIFE HISTORY

This is also a small-sized cuttlefish like *Sepia brevimana* and *S. elliptica* and looks like a small sized *S. pharaonis* due to the presence of horizontal stripes on the dorsal surface of the mantle. It has been recorded from Veraval on the northwest coast and Waltair and Madras on the east coast. This species is obtained in very small quantities in trawl catches off Waltair and Madras at depths beyond 40 m.

Very little information could be collected on this species due to the sporadic occurrence in the trawling grounds. On Waltair coast it has been observed in the months January-August and October-December and on Madras coast this species has been found from January to April along with upwelled deeper water fishes such as *Psenes indicus* and *Priacanthus* sp. Cuttlefish 50-109 mm in size contribute to the commercial trawl catches along Waltair coast. Preliminary studies on Waltair coast show that males and females of this species attain maturity at a minimum size of 67 mm and 72 mm respectively.

Sepiella inermis Orbigny

BIONOMICS AND LIFE-HISTORY

REPRODUCTION

Sexuality

In males the left ventral arm is hectocotylized with a series of transverse ridges and grooves and very minute suckers at the basal portion of the arm. In addition, there is a row of small oval, white patches along the fins at their base and this feature is distinctly seen in fresh condition.

Sex ratio

The studies carried out on the species caught in trawl nets off Waltair coast (Fig. 14) show that females were the dominant sex in most of the months during 1976-80 with sex ratios of F 52 : M 48—F 91 : M 9. Males outnumbered females in June, July, September and November 1976, May and October 1977, May and

September 1978, January, July and August 1979 and October 1980 when they formed 52-100%. The two sexes were almost in equal ratio only in two months in August 1978 and 1980. The overall sex ratio during 1976-80 showed dominance of females (F 56 : M 44).

Along Kakinada coast also (Fig. 14) there was generally dominance of females in trawl catches (F 52 : M 48—F 90 : M 10) and in August, October and November 1976, September-November 1977, February-April, June and September 1978, March and October 1979 and March, May and November 1980 males exceeded females (M 53 : F 47—M 72 : F 28). The two sexes were in equal ratio or in almost equal ratio in December 1977, August and October 1978, April and December 1979 and July and September 1980. The sex ratio of cuttlefishes in the entire period 1976-80 indicated almost equal ratio of the two sexes.

As in the preceding two northern areas there was female dominance in Madras area (F 55 : M 45—F 86 : M 14) (Fig. 15). Only in two months, August 1978 and July 1979, the two sexes were in equal proportion and in a few months in some years viz., November 1976, January, February and December 1977 and June, August, September and November 1980 males dominated in the catches (M 52 : F 48—M 80 : F 20). The overall sex ratio during 1976-80 revealed that females were dominant among the two sexes.

The data on sex ratio of this species of Portonovo coast during 1977-78 (Fig. 15) showed dominance of males in three months July and October 1977 and May 1978 (M 55 : F 45—M 63 : F 37) and in all the other months the percentage of females was higher (F 52 : M 48—F 92 : M 8). In Mandapam area also females were found to be the dominant sex from January, 1973 to May, 1974 except in two months (Unnithan, 1982).

In contrast to the ratio of the sexes with dominance of females in different areas along the east coast, males dominated in the trawl catches in most of the months in Cochin area on the west coast (M 56 : F 44—M 75 : F 25) (Fig. 16). Only in five months February and March 1977, February 1978, November 1979 and April 1980, females were dominant (F 56 : M 44—F 71 : M 29). The ratio of cuttlefishes of the two sexes in the period 1976-80 showed a distinct preponderance of males (M 58 : F 42).

Maturity

On the east coast males of this species were found to attain mature condition at a minimum size of 45 mm along Madras and Portonovo coasts while at Waltair males became mature at a minimum size of 35 mm

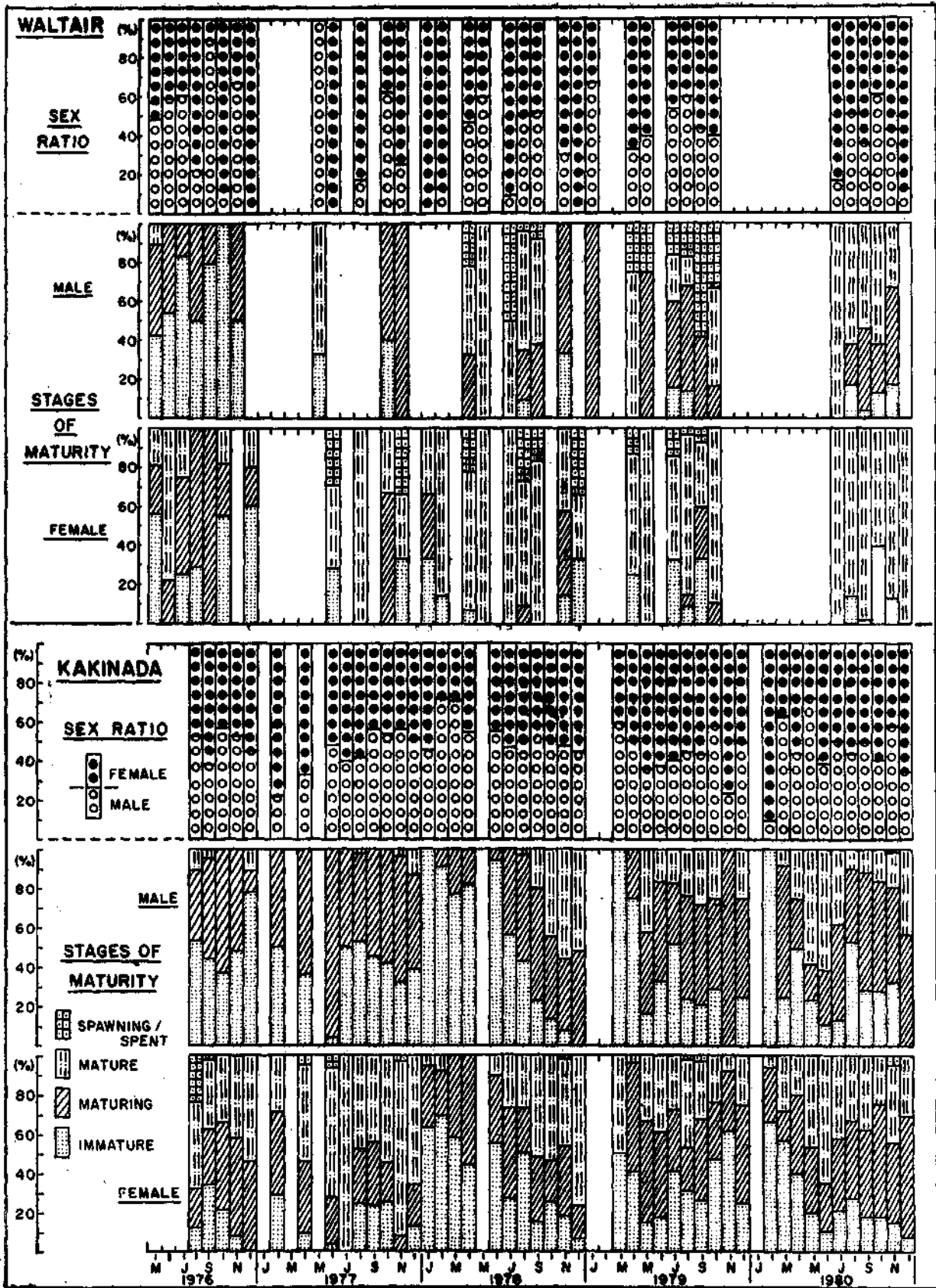


FIG. 14. Sex ratio and stages of maturity of *Septella inermis* at Waltair and Kakinada.

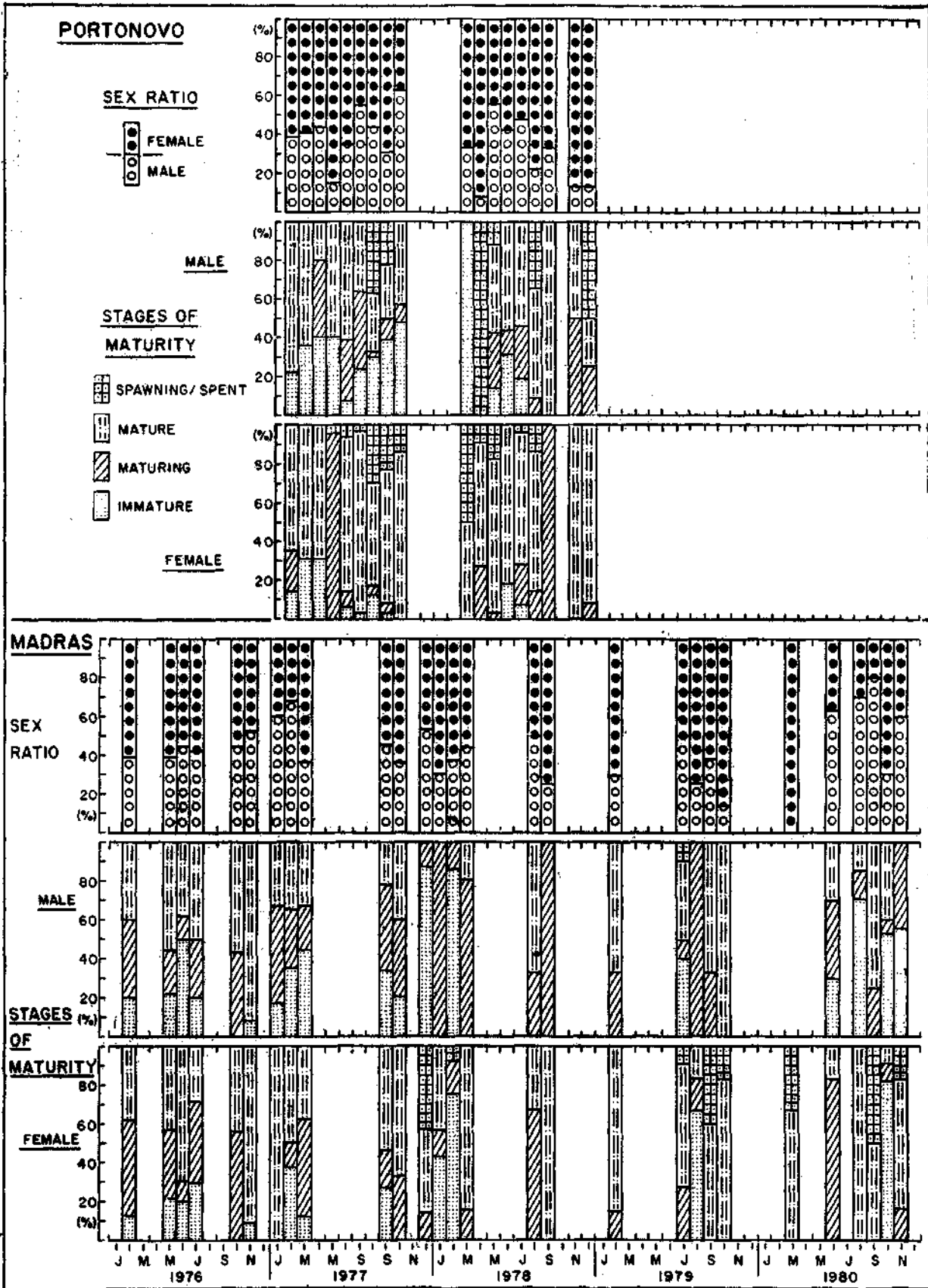


FIG. 15. Sex ratio and stages of maturity of *Sepiella inermis* at Portonovo and Madras.

(Fig. 17). However, the size at 50% maturity for males is similar at the above three centres being 53 mm, 56 mm and 54 mm respectively. All the males attained mature stage at sizes of 65 mm and 75 mm at Madras and Portonovo. Females of this species became sexually mature when they are 45 mm at Waltair and Portonovo and 55 mm at Madras. All the females reached mature stage at a size of 85 mm at Waltair

Spawning

On Waltair coast mature females were common throughout the year except March while spawners were recorded in April, June-September and November (Fig. 14). Mature males were observed in April, May and July-December and male spawners during April-May and July-October. At Kakinada mature females were very common in trawl catches throughout the year

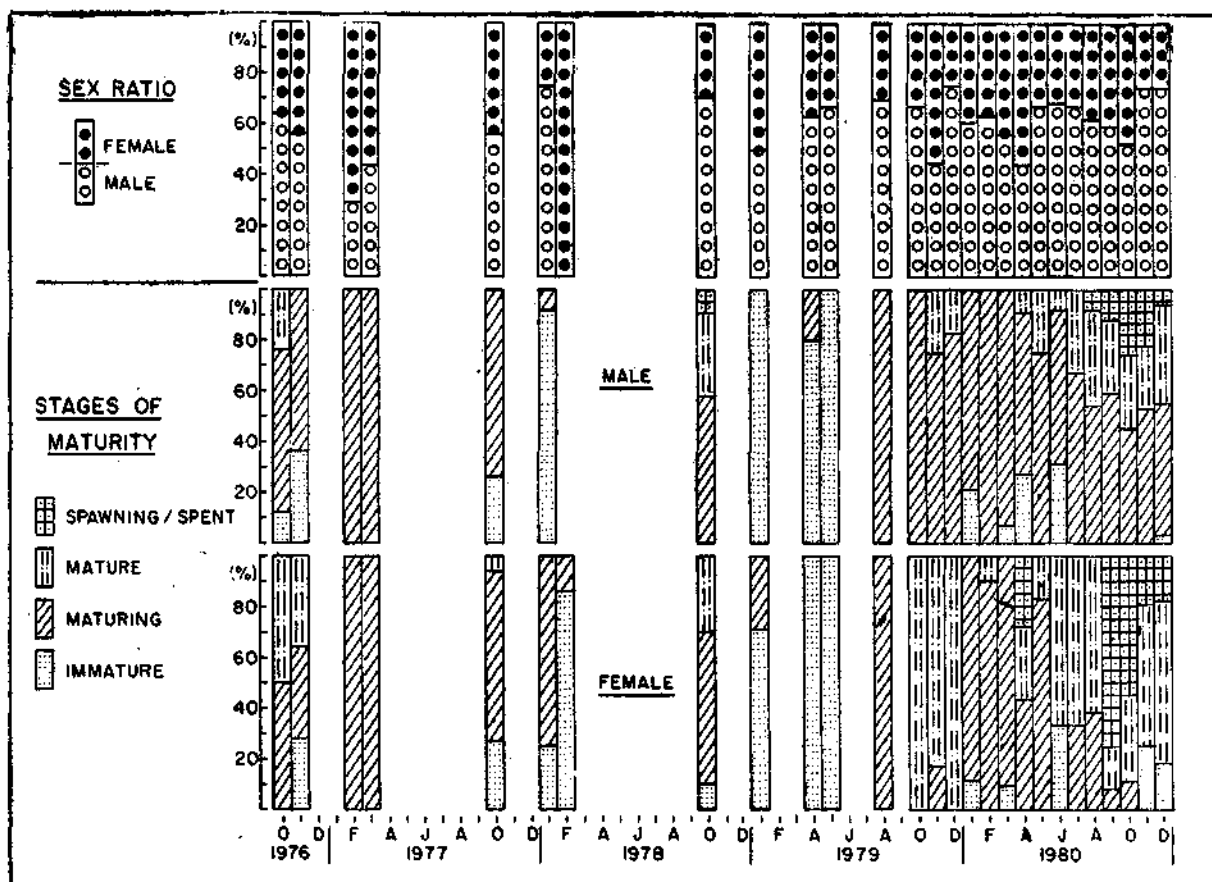


FIG. 16. Sex ratio and stages of maturity of *Sepiella inermis* at Cochin.

and Portonovo and at 75 mm itself at Madras. The size at first maturity was 50 mm at Portonovo, 52 mm at Waltair and 61 mm at Madras. In Mandapam area the size at first maturity is 51 mm for males and 31 mm for females (Unnithan, 1982).

In distinct contrast to the cuttlefish of the east coast the size at first maturity of males as well as female on the west coast in Cochin area are higher viz., 81 mm and 83 mm respectively. Males and females became mature for the first time when they are 55 mm and 65 mm in size respectively and all the individuals of the two sexes are mature on growing to a size of 105 mm.

except January-February when they were moderately common (Fig. 14). Spawning females occurred in small percentages in April, June and August-September and November. Mature males were observed in good numbers continuously from March to December while only small numbers of spawning males were noticed in one month, November, 1980. On Madras coast sexually mature females were very common throughout the year except April and spawners were recorded in all months but for January, April-June and August (Fig. 15). Mature males were very common all round the year except April and December when

they were not observed. Spawning males were noticed only in July, 1979. Along Portonovo coast mature females and males occurred from February to December with dominance in several months (Fig. 15). Spawners of both sexes were recorded on this coast in a number of months.

Along Cochin coast mature cuttlefish of both sexes occurred in commercial trawl catches from April to December with dominance of females in June-July and October-December (Fig. 16). Female spawners were common in April and September-December and

ADULT HISTORY

Growth

Study of the progression of modal sizes of males and females of this species together on Waltair coast shows that it grows to a size of 33 mm at the end of 6 months, 57 mm at the end of one year and 73 mm at the end of one and half years. The growth trend is almost similar at Kakinada with the 6 months, 12 months and 18 months old cuttlefish exhibiting sizes of 29 mm, 53 mm and 74 mm respectively. Along the Madras coast *S. inermis* showed a slightly faster

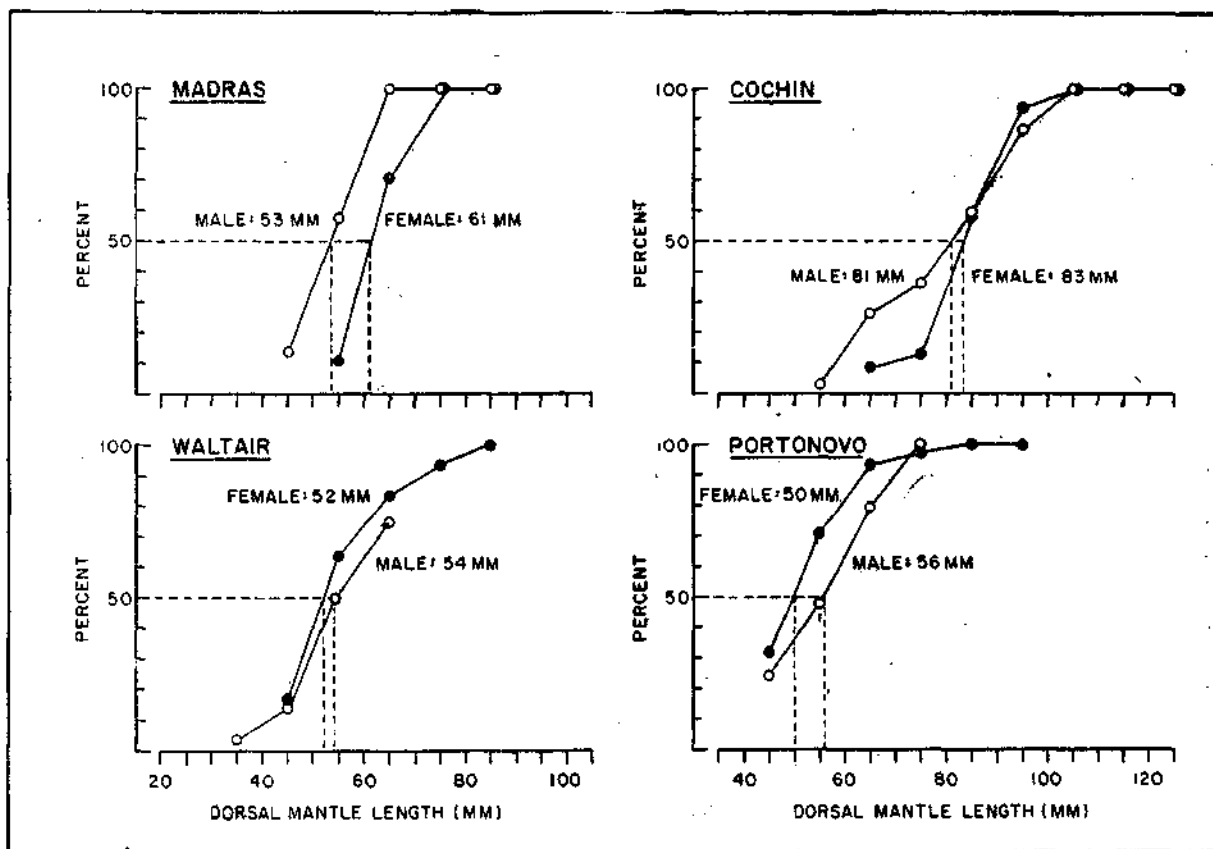


FIG. 17. Size at first maturity of *Sepiella inermis* at Madras, Cochin, Waltair and Portonovo.

male spawners were observed in the latter half of the year from August to December in low to moderate numbers.

The data on the occurrence of cuttlefish in advanced stages of maturity in several months at different centres along east coast indicates that breeding takes place in this species throughout the year. But at Cochin on the west coast the species breeds only from April to December as is evident from the occurrence of mature cuttlefishes.

growth as it attains a size of 35 mm in six months 61 mm in one year and 82 mm in 18 months. The rate of growth of this species in Portonovo waters is similar to that along the Madras coast. In Mandapam area this species has been found to grow to a size of 51 mm at the end of one year and 80 mm at the end of the second year (Unnithan, 1982). The growth pattern of this cuttlefish in Cochin area on the west coast is similar to that on the east coast with sizes of 35 mm, 61 mm and 81 mm reached at the end of six months, one year and one and half years. However, a size of 101 mm

is reached in two years along Cochin coast compared to only 80 mm in Mandapam area.

Distribution of adults

Adults of this species are distributed in the shallow coastal waters of both the east and west coasts of India. They are caught in trawl nets and shore seines and occasionally in boat seines. Adults 35-85 mm are obtained in the trawl catches off Waltair, Kakinada and Portonovo coasts while the size range of adults captured off Madras coasts is 45-75 mm. The size range of adults occurring in trawl catches off Cochin is 55-105 mm.

Maximum size

The maximum sizes recorded for males and females on the east coast are 84 mm (Madras) and 94 mm (Portonovo). On the west coast at Cochin the maximum size noticed in the trawl fishery is 124 mm for both the sexes.

Food

Correlation was not observed between the stages of maturity and intensity of feeding. Penaeid prawns were the main food item of the species along Waltair coast followed by other crustaceans such as *Acetes* sp., fish crab and *Squilla* and. In Mandapam area the intensity of feeding of this species was higher from January to April than in other months and prawns formed the common food item followed by fish, stomatopods and crabs (Unnithan, 1982).

Oommen (1977) who studied the digestive system and food and feeding habits of this species reported that it feeds mostly on fishes, crustaceans and unidentifiable matter along the Cochin coast with squids occurring in a few individuals. Along Madras coast *Alpheus*, *Penaeus* spp., *Metapenaeus* spp. and *Acetes* sp. were noted in the stomach contents with *Alpheus* being dominant in April and *Acetes* in July and August (Jothynayagam, 1981).

Fecundity

The total number of eggs found in mature ovaries of cuttlefish 69-71 mm in mantle length of Mandapam area varied between 470 and 850. In the ripe ovaries the ripe eggs formed 37.5-62.6% (Unnithan, 1982).

Eggs

The diameter of intraovarian eggs of this species in Mandapam area ranges from 2.56 mm to 3.84 mm (Unnithan, 1982).

Distribution of juveniles

Juveniles measuring 10-44 mm have been recorded throughout the year along Kakinada, Madras and Portonovo coasts while along Waltair coast juveniles 20-34 mm were noticed only in four months April-June and August. On the west coast juveniles of the size range 30-54 mm occurred in the trawl catches throughout the year except September and December in Cochin area.

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