Biology, Population and Exploitation of the Indian Deep-Sea Spiny Lobster, PUERULUS SEWELLI Ramadan

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The occurrence of the deep-sea spiny lobster or the whip lobster, **Puerulus sewelli** Ramadan (Fig.1) off the Kerala coast and in the Gulf of Mannar was reported as early as the turn of this century. It was however, only after its rediscovery in 1959 by John and Kurian and the subsequent exploratory surveys and experimental fishing carried out for over a period of about two decades from 1960, the availability of the species in commercial concentration at certain areas in the deeper waters of the Indian Coast was brought to light. Nevertheless, the exploration of the resource by the Indian entrepreneurs has started only very recently. This paper provides a synopsis of the available information on the biology, population and exploitation of the species which would be useful to consider a pragmatic strategy for the rational exploitation of the resource.

The salient findings of the various exploratory surveys and fishing operations carried out for deep-sea lobster from 1967 and the published accounts by John and Kurian (1959), Kurian (1965), Tholasilingam **et al.** (1968), Silas (1969), Joseph (1972, 1984, 1986), Pillai and Ramachandran (1972), Chekunova (1973), Rao and George (1973), Oommen (1974, 1985), Oommen and Philip (1976), Somavanshi and Bhar (1984), Ninan **et al.** (1984), Philip **et al.** (1984), Joseph and John (1987) and Kathirvel (1988) form the sources for this review.

DISTRIBUTION

P.sewelli is recorded from off Somalia, Gulf of Aden, Pakistan, West coast of India, Gulf of Mannar, south-east coast of India and the Andaman Sea. (Fig.2 A). The bathymetric distribution of the species extends over depths from 73m to 1309 m, with greater abundance at 180-300m. In the Arabian sea, though the species is recorded from off Pakistan, it has not so far been reported from the upper west coast of India. On the west coast of India, it is distributed in varying concentrations between 7°N and 18°N Latitudes at 150-450 m depth. In the Gulf of Mannar, it occurs between 7°N and 9°N Latitudes at 146-400 m; on the south-east coast it is reported at present from 10°N to 14°N Latitudes at 220-280 m depth. In the Andaman Sea, the species occurs between 8°N and 12°N Latitudes at 150-380 m depth.

Though the general geographical distribution of the species is discontinuous, at present with a gap between the Gulf of Aden and Pakistan and again in the upper west coast of India, further intensive survey may reveal the occurrence of the species continuously along the range of its present geographical distribution in the deeper waters of the shelf edge and slope. The phyllosoma larvae of **P.sewelli** are recorded from the Laccadive Sea (Lakshadweep Sea) and from 35° 31'S 20° 44' E; 20° 52'N 59° 29'E and 16° 45'N 57° 30'E in the Indian Ocean.

BIOLOGY

Reproduction: P.Sewelli is heterosexual and sexually dimorphic. The coxopodite of the last pereoppod in the mature male is extended as a fleshy projection, at the tip of which is located the gonopore. In the female, the genital opening is situated at the base of the coxa of the third pereoppod. Further, the sternal plates between the third and fifth pereopods in female are relatively broader and wider than those in the male.

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As in the other palinurid lobsters, **P.sewelli** oviposites the eggs on the pleopods. Such 'berried' lobsters are encountered in the catch throughout the year. The percentage distribution of berried lobsters in different months has shown two peaks, the major one during January-April, and the other in October, indicating a protracted breeding season. In the peak breeding season (January-April) the percentage of berried females in the catch ranges from 51 to 83, while in the lean period (May-September), it forms only 6 to 31.

Documented studies on the structural aspects of the gonads of **P.sewelli** or on their maturation process are not available. As the ovarian eggs attain a size of about 0.67 - 0.72 mm, they are liberated and get transferred to the pleopods. It is presumed that the fertilisation of the ova takes place during this process. On the basis of the change of colour of the egg mass during its development in the pleopods, four stages are distinguished. In the first stage, which represents the eggs recently oviposited on the pleopods, the egg mass is lemon yellow with majority of eggs measuring 0.75-0.99 mm in diameter. In the second stage, the colour of the egg mass turns to yellowish red or orange and the diameter of the eggs increases to 0.83-1.08 mm. As the development advances, it changes to brick red colour, the egg diameter being 0.80-1.25 mm. In the fourth stage, the egg mass becomes dull white or cream white (0.94-1.33 mm in diameter) and represents the advanced embryonic stage, the black pigmented naupliar eye being visible through the egg membrane.

The size of the smallest female carrying the berry recorded in the catch was 129 mm in total length, measured from the anterior margin of the carapace in between the frontal horns to posterior margin of telson. Similarly, the egg bearing setae on the pleopods were found to develop in specimens measuring above 120 mm. These indicated that the lobster attains maturity at a size of 120-129 mm.

The number of eggs in the berry varied from 10,170 in a specimen measuring 136 mm to 36,400 in that of 196 mm in total length. The relationship between the size of the lobster and the fecundity is expressed by the formula: Log F = 1.9334 + 2.8201 Log X, where 'F' is the fecundity and 'X' is the total length.

Deep sea lobster Puerulus sewelli **Ramadan.**

FOOD AND FEEDING

P.sewelli is a carnivorous feeder. Crustaceans (mostly deep-sea prawns), fishes and molluscs, which co-exist in the ground, constitute the main items of food as revealed from the gut content analysis. The sand particles and foraminiferan shells have also been observed frequently in the stomach contents of the lobster. But these might not represent the primary food, but would have been ingested along with the prawns and molluscs.

SIZE DISTRIBUTION AND GROWTH

The recorded size range of **P.sewelli** population caught off the south-west coast of India was from 36 to 207 mm in total length. The dominant size groups of males and females in the catch measured 151-160 mm and 161-170 mm respectively. Smaller specimens measuring below 100 mm are generally encountered in October and again in April-May. Between the sexes, no appreciable difference in the size is noticed. The relationship between the carapace and total length is expressed by the formula Y = 4.0721 + 0.4647 X for males and Y = 2.6160 + 0.4410 X for females, where 'Y' is the carapace length and 'X' the total length. This relationship indicates that the males have greater carapace length as compared to the females of corresponding size. The length-weight relationship is found to be Log W = -4.9523 + 3.1705 Log L for males

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and Log W + -4.8332 + 3.1130 Log L for females. The data on the count of head-on lobster (whole animal), tail with shell-on and meat alone in one Kilogram in different size groups are depicted in Fig.3.

MIGRATION

P.sewelli appears to perform a migratory movement associated with the breeding activity. In January, when the principal breeding season commences, the lobsters move to 150-200 m depth zone from the deeper waters and linger there till April/May. They return to the deeper waters in June and remain there till December.

Information on biological aspects such as age, longitivity, breeding behaviour, larval development and distribution, larval ecology, hardiness and behaviour of the lobster are not available at present.

POPULATION

Sex-ratio: P.sewelli population caught from the 'Quilon Bank' during January-April and August-December 1969-1970 was dominated by females. Males were generally found to be predominant in the rest of the period.

Seasonal abundance (Fig.4): Although this lobster occurs throughout the year, the abundance and the density of the population vary from month to month. in 1969, the catch rate of **P.sewelli** landed by the vessels belonging to the Integrated Fisheries Project (IFP) and the Central Institute of Fisheries Nautical Engineering Training (CIFNET) operating off the south-west coast of India was 15.1 kg/hr in January. Showing an increasing trend, it reached the maximum rate of 328.9 kg/hr in March. Thereafter, it gradually declined to reach 96.4 kg/hr in July. In August, the catch rate, though showed an improvement, decreased in the subsequent months, the lowest being recorded in November. Thus, the lobster population is found to be abundant in the fishing grounds (150-250 m) during January-April and thereafter the population moves to the deeper waters and is found to be more sparcely distributed as compared to its concentration in the shallower regions. The recent survey by the Fishery Survey of India (FSI) vessels along the south-west coast of India has revealed a protracted seasonal abundance from August to February. From the available data on the occurrence of smaller specimens in the catch, it appears that the main recruitment to the population takes place in October.

Area-wise abundance (Fig.2 B): Within the distributional range off the south-west and south-east coasts, the abundance of the species not only varies from region to region, but also within the same region. The greatest population density with a catch rate of 200-300 kg/hr was recorded off Mandapam (725 sq.km) on the south-east coast. The areas next in the order of abundance are off Quilon and Trivandrum (150-200 kg/hr), followed by off Cape Comorin, Colachel, Alleppey and Cochin (100-150 kg/hr). Within this region, the abundance in certain area was found to vary from 100-150 kg/hr to below 50 kg/hr, depending on the depth regime and characteristics of the ground. Between Latitudes 7°N and 13°N, the overall contribution of **P.sewelli** was found to be 7.8% of the total catch realised from 200-500 m depth zone. In the areas north of Cochin, the species was encountered in lesser abundance (below 50 kg/hr) except off Ponnani and Calicut. The extent of the lobster ground between Ponnani and Quilon is estimated as 5,000 sq.km, the most productive ground in this region being the 'Quilon Bank' covering an area of about 3,300 sq.km.

Depth-wise distribution: The depth-wise distribution of **P.sewelli** caught off the south-west coast of India in different months by the IFP and CIFNET vessels during January 1969 - May 1971 is given in Table 1. During January-May, the lobsters are found in greater abundance (186.5 - 241.0 kg/hr) in the depth zone of 151-250 m. As the season advances, they →

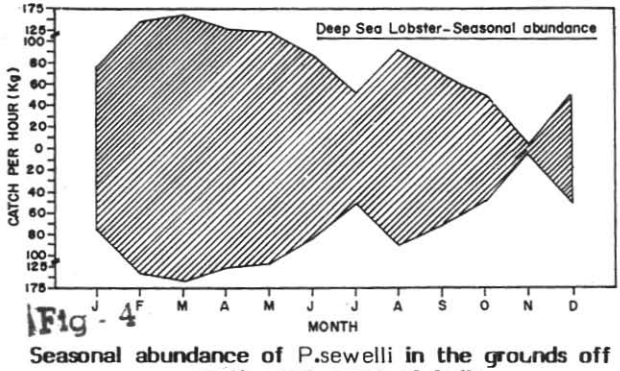

Fig - 4

Seasonal abundance of P.sewelli **in the grounds off the south-west coast of India.**

move to deeper areas beyond 250 m.

EXPLOITATION

Fishing vessel and gear: In the exploratory surveys and experimental fishing, the vessels of 19.8-28.3m overall length belonging to the IFP and CIFNET were employed. The Norwegian deep-sea fish trawl provided with oval or rectangular otter boards, and with cod-end mesh size of either 35 mm or 60 mm was operated by these vessels. As the oval otter board does not get entangled with the underwater obstructions, it does not get very much buried into the ground during the operation of the net, and since it is relatively lighter in weight, it was found to give better performance than the rectangular otter boards.

Table 1. **Depth-wise distribution (catch/hr) of P.sewelli**

MONTH	DEPTH ZONES (m)				
	151-200	201-250	251-300	301-350	351-400
January	265.3	3.3	34.5	3.3	3.0
February	521.5	88.2	56.5	283.0	*
March	196.5	279.6	74.3	Nil	*
April	196.0	235.5	172.9	Nil	*
May	186.5	168.8	34.3	*	*
June	Nil	160.8	*	*	*
July	Nil	84.9	21.8	6.3	*
August	Nil	63.1	Nil	4.0	18.0
September	*	37.8	28.8	3.9	*
October	*	32.3	Nil	Nil	Nil
November	*	39.3	16.6	12.1	*
December	*	Nil	149.6	33.6	44.7

* No operation.

In the recent commercial operations, it is reported that the vessels of size 15.2 to 25 m are employed.

Fishing Ground :

The fishing grounds being located in the continental shelf edge and the upper slope, the distance between the shore and the fishing ground varies from region to region depending on the disposition of the shelf line. Off Mandapam, the ground is located about 25-40 km from the shore. In other regions it is relatively away, being 90-95 km off Cape Comorin, 55-65 km off Trivandrum, 65-76 km off Quilon, 55-60 km off Alleppey, 60-65 km off Cochin, 70-75 km off Ponnani, 75-85 km off Kasargod and 85-95km off Mangalore. While the fishing grounds off Quilon and Ponnani are even areas suitable for trawling, the grounds off Mandapam, Trivandrum and Cape Comorin are narrow with ups and downs, necessitating careful manoeuvring while trawling. Similarly, patches of rocks are found off Cape Comorin, Trivandrum and north of Cochin, Cannanore and Mangalore. Generally, the bottom consists of fine sand mixed with shell fragments and little silt over a hard bottom. In the Andaman Sea, the bottom ground in the area between 9° and 12° N Latitudes is sandy with an admixture of shell fragments like that of the south-west coast. The environmental features of the ground at 180-460m depth off the south-west coast are characterised by a temperature range of 10.8°C - 13.0°C; salinity 34.60 - 35.50% and dissolved oxygen, 0.20 - 1.90 ml/l. In the Andaman Sea, the bottom water temperature at the lobster ground has been recorded at 11.0 - 14.0°C, salinity 34.5 - 35.0%. and dissolved oxygen 1.0 ml/l.

CATCH RATE

West coast : In the earlier period of survey, the catch of **P.sewelli** realised by →

R.V.Kalava operating in the depth range of 274-351m off Alleppey in March 1963 amounted to 599 kg in 13.65 hrs of trawling (43.9 kg/hr). During 1962-1968, R.V.Varuna undertook 88 deep sea hauls in 201-340m depth in the area between 7° and 12° N Lat. resulting in the capture of considerable number of deep-sea lobsters.

Details of deep-sea lobsters landed by the IFP and CIFNET vessels operating off the south-west coast during 1967-1979, fishing efforts expended and the percentage contribution of the lobster in the total catch are given in Table 2. From October 1967 to February 1968, three vessels of IFP caught 1.2 tonnes and the catch rate was low (2.8 to 4.6 kg/hr). Intensifying the survey, the year-round fishing was undertaken by both the IFP and CIFNET vessels during 1969-1971 when relatively heavy landings of **P.sewelli** were registered with the catch rates varying from 157.6 to 199.7 kg/hr. Though the fishing effort was more during 1972, the return declined to 97.8 kg/hr, which further lowered to 28.3 kg/hr in 1976. However, when the fishing for lobsters was confined to February-March period during 1977-1979, the catch rate enhanced from 88.2 to 148.6 kg/hr. Initially, the percentage contribution of **P.sewelli** in the total catch was low and in the subsequent years, lobsters became the major component of the deep-sea catch.

Table 2. **Details of deep sea lobster landings by IFP and CIFNET vessels during 1967-1979**

Year	Fishing efforts (hrs)	Total catch in tonnes	Lobster catch in tonnes	Catch/ hr	% shared by lobster in total catch
1967	62.41	15.7	0.2	4.6	1.8
1968	360.82	78.1	1.0	2.8	1.3
1969	888.36 *	267.4	172.7	194.4	65.3
1970	490.88 *	129.3	77.3	157.6	59.8
1971	491.80 *	128.1	98.2	199.7	76.7
1972	875.92	92.7	85.2	97.8	91.8
1973	255.24	14.8	13.0	51.6	87.8
1974	422.34	35.5	32.3	76.5	91.1
1975	255.41	11.8	10.9	42.7	92.2
1976	146.53	4.7	4.1	28.3	88.3
1977	83.83	14.4	12.5	148.6	86.6
1978	48.42	6.9	5.5	121.2	80.0
1979	63.75	6.6	5.6	88.2	85.0

* by both IFP & CIFNET vessels.

In the recently located grounds (200-300 m) off the Konkan coast (13° N - 15° N Lat.), **P.sewelli** was found to contribute to 5.2% of the catch with an yield rate of 12.4 kg/hr. The northern grounds in the same depth zone extending up to 18° N gave an average rate of 18.0 kg/hr.

Gulf of Mannar: During April 1970, one of the IFP vessels, namely, **Klaus Sunnanna** was deployed to survey the deeper waters off Mandapam-Tuticorin sector. Totally 16.88 tonnes of **P.sewelli** were caught from 146-366 m depth zone in 1·23 hrs of trawling with a catch rate of 137.2 kg/hr.

Coromandal coast: The deep-sea survey undertaken by one of the FSI vessels off Point Calimere - Madras sector during February 1983 indicated the occurrence of deep-sea lobsters in 150-425 m depth zone in the area between 10° N and 14° N Latitudes. Though the areas of abundance (10° N 80' E; 11° N 80' E & 13°N 80' E) were mentioned, no data on the catch rate were given.

Andaman Sea: The Russian Research Vessel 'Academik

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Knipovich' conducted 14 deep water trawling hauls in 150 - 380 m depth zone during February - March 1966, of which, 8 hauls contained **P.sewelli.** The catch rate varied from 7 to 60 kg/hr.

By-catch: Besides **P.sewelli,** the above grounds also sustain a variety of prawns, other lobsters, crabs and fishes. The deep-sea prawn resource in the south-west and lower east coasts is mainly constituted by five species of pandalids, namely, **Heterocarpus woodmasoni, H.gibbosus, Parapandalus spinipes, Plesionika martia** and **P.ensis** and six species of penaeids - **Aristeus semidentatus, Solenocera hextii, Hymenopenaeus aequalis, Parapenaeus investigatoris, Penaeopsis rectacuta** and **Metapenaeopsis andamanensis.** The production of prawn in general was relatively greater between 275 and 375 m depth zone and the average catch rate was to 89.43 kg/hr of trawling in the south-west coast. In the Gulf of Mannar, the prawn catch was relatively less, being about 1 kg/hr of trawling.

Among crabs, the important species encountered in these grounds were the swimming crab, **Charybdis (Goniohellenus) smithii, Pleistocantha mosley** and **Thelxiope megalops.** Of these, the former species was the most abundant between Mangalore and Ponnani.

The important fishes found in the lobster fishing grounds were **Chlorophthalmus agassizi, C.bicornis, Priacanthus hamrur, Emmelichthys nitidens, Epinula orientalis, Cubiceps natalensis, Psenes indicus, Polymixia nobilis** and **Chascenopsetta lugubris.**

Utilisation: Almost the entire catch of lobsters at present is processed and exported to countries such as United States of America and Japan. It is generally processed into a frozen form. Irrespective of proper freezing, the main problem faced in the processing of deep sea lobsters is the rapid decolouration of the meat due to the quick oxidative as well as enzymatic reactions that take place within the body. However, cleaning with Sodium hypochloride solution and hygienic way of handling have been found to reduce the decolouration. While processing, the head, telson, pleopods and lateral spines of the abdomen are removed, deveined, graded and finally treated with sodium hypochloride solution. The graded product is then packed in polythene bags and frozen in contact-freezer at a temperature of -30°C to -35°C. After quick freezing, the products are packed in paper cartons and stored in the freezer. The lobster meat is recovered after beheading and removing the abdominal shell and then graded, washed, packed and frozen as in the case of lobster tail. The recovery of tail and the meat in different size groups is given in Table 3.

Table 3. **The recovery of tail and meat on processing of the deep-sea lobster**

SIZE GROUP		PERCENTAGE RECOVERY	
TL in mm	TW in g	Tail	Meat
101-110	25-30	42	34
111-120	35-39	42	33
121-130	40-49	41	31
131-140	55-63	39	38
141-150	66-80	35	25
151-160	97-101	34	23
161-170	105-112	34	22
171-180	119-135	34	22
181-190	150-170	34	22

Potential resources: On the basis of surveys conducted since 1967, several estimates on the potential resource of **P.sewelli** from different grounds have been made. Based on the early surveys during 1967-68, Rao and George (1973) estimated the potential resource of **P.sewelli** off Quilon at 108 tonnes. Later Joseph (1972) estimated the potential yield at 2,000 tonnes and the standing crop at 6,000 tonnes based on the catch landed during 1969-71. Recently, Oommen (1985) estimated the standing stock at 12,941 tonnes from the south-west coast and 1,869 tonnes from the Gulf of Mannar. The sustainable yield in the former ground at 60% level of exploitation is 7,765 tonnes. James **et al.** (1987) estimated the sustainable potential for deep-sea lobster as 8,000 tonnes for the south-west coast and 1,200 tonnes for the south-east coast.

GENERAL OBSERVATIONS

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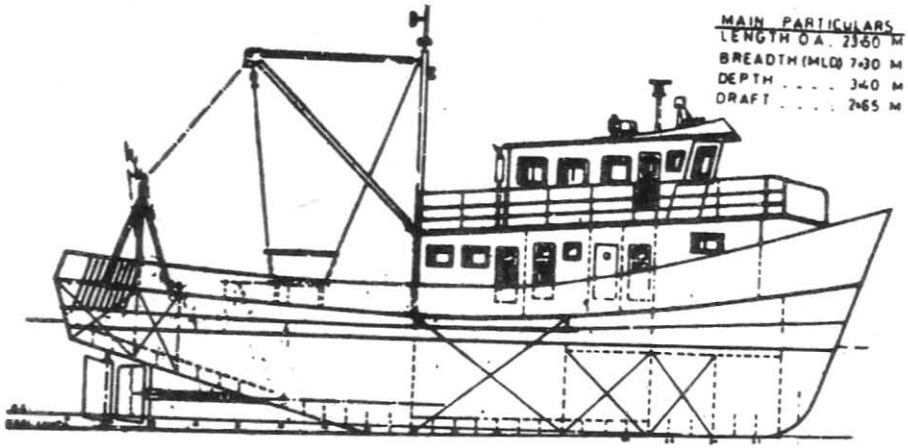

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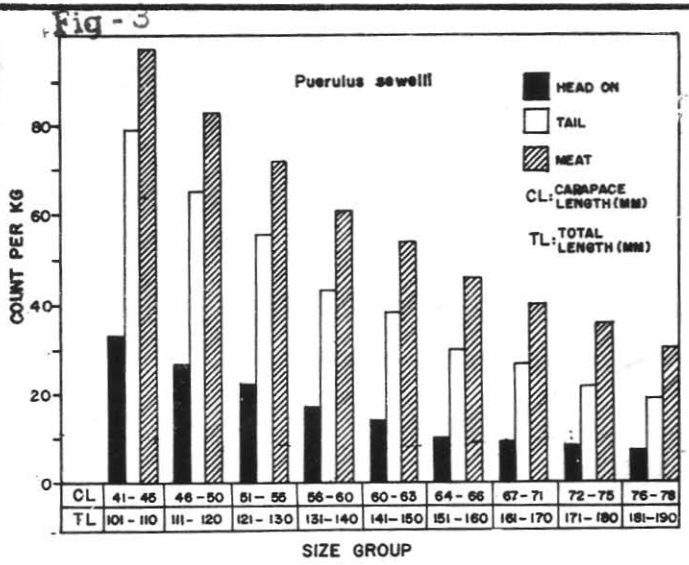
Fig - 3



Grade-wise (whole animal, tail with shell-on and meat alone in one kg) composition of P.sewelli.

P.sewelli is undoubtedly the most important species at present because of its higher unit value and greater demand in the export trade. Following the location of lucrative grounds and information on the catch rate and potential resource, certain private entrepreneurs ventured to exploit the resources during 1979-80. More recently, some more private enterprises have entered into this fishery during 1987-1988, basing the vessels at Cochin (10 vessels), Mandapam (one in 1987 and 3 in 1988) and Tuticorin (one vessel). This is a welcome development and would definetely promote the exploitation of the deep-sea fishery resources of the country.

While endeavouring the development of the sector, it would be prudent to consider some of the points which are relevant for its sustained growth on a long-range programme. It is well known that successful exploitation of deep-sea fish resources, which is capital intensive, largely depends not only on the availability of the resource, but also on the vessel utilisation, technology applied, technology externalities and managerial skill. As presented above, the information available now on the fluctuations of the lobster resource and on the extent of exploitable quantum is rather limited. Similarly, the spread of lobster fishing grounds is also not extensive, except perhaps the ground between Quilon and Ponnani. The fishing season which is amenable to catch that quantity of lobsters which could make economics of operation viable, is also restricted for a short period of 4 to 5 months. In view of these, it is essential to consider in detail, the size and number of vessels which could be deployed for the exploitation of this resource. Taking into consideration primarily the deep-sea prawn and lobster resources (that co-exist in the same ground), the Expert Committee that went into these aspects, indicated that about 35-40 vessels of size 20 m and above could be deployed on a seasonal basis for the exploitation of these resources from 81-450 m depth zone on the south-west coast and three vessels on the lower east coast.

Some regulatory measures are also found necessary for the management/conservation of the deep-sea lobster resource. The relative abundance of the lobsters in the fishing grounds at 150-250 m depth zone coincides with the breeding season of the species. Appreciable quantities of 'berried' lobsters have been taken during this period. It is also observed that large number of small sized lobsters measuring below 100 mm are also caught in April-May and in October. The exploitation of such berried females and sub-adult population would adversely affect the resource. Although no data are available on the duration of larval development, age and longevity of the species, it is expected that the growth rate of lobster may be slower as it inhabits relatively colder and less oxygenated ecosystem unlike the shallow water lobsters which live in a more congenial environment for growth and maturity. It is therefore essential to keep a watch over the level of exploitation and behaviour of the stock in different fishing grounds.

To conclude, the exploitation of deep-sea lobster is an emerging fishery activity. To sustain it and for its further development, an integrated approach taking into consideration the resources characteristics, its harvesting strategy, vessel utilisation, preservation, processing, price structure and marketing, should be planned appropriately for better management and improvement of the sector.

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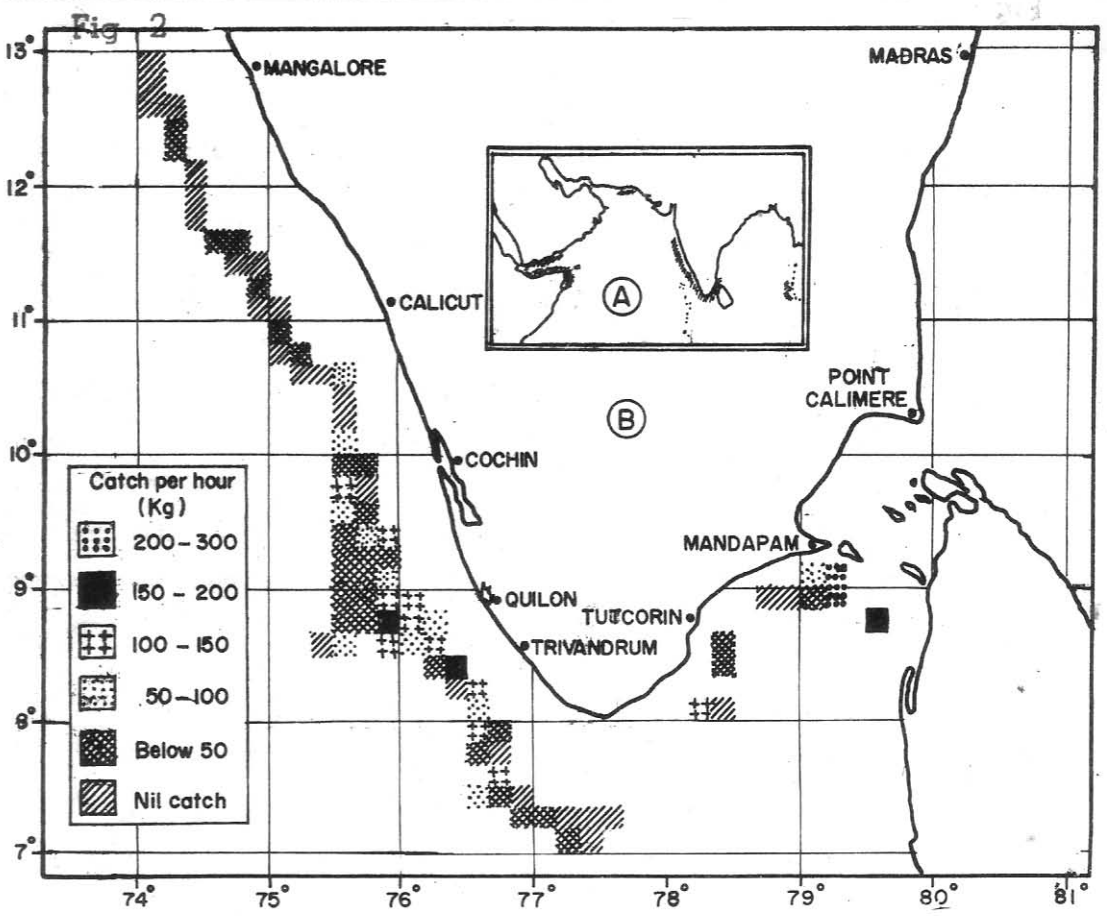

A. General distribution of P.sewelli. B. Productive areas for P.Sewelli as known at present along the Indian coast.

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CANADIAN WHALES' STRUGGLE FOR SURVIVAL

The Beluga whale, found in relative abundance in Arctic waters, has frolicked for decades in a unique southerly habitat at the mouth of the St.Lawrence river. But environmentalists said this refuge, considered an important scientific oddity by biologists, is threatened by the tonnes of garbage dumped into the river every year from Canadian cities and industries.

They claim a government plan to build a marine park to protect the mammals is being delayed unnecessarily, threatening the survival of the rapidly diminishing herd. The whales are struggling to survive in what is ranked one of the most polluted waterways in the world. Each year Canadian industries dump into the river more than 100,000 tonnes of refuse--oil, grease, metal and a smorgasbord to toxins.

The Canadian Government announced this year a five million dollar programme to save the whales that involves establishing a marine park with the Quebec provincial government. While critical of the delays, environmentalists applaud the government's plan as it will lead to cleaner water for the whales and eventually better conditions for all forms of life, including human.

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