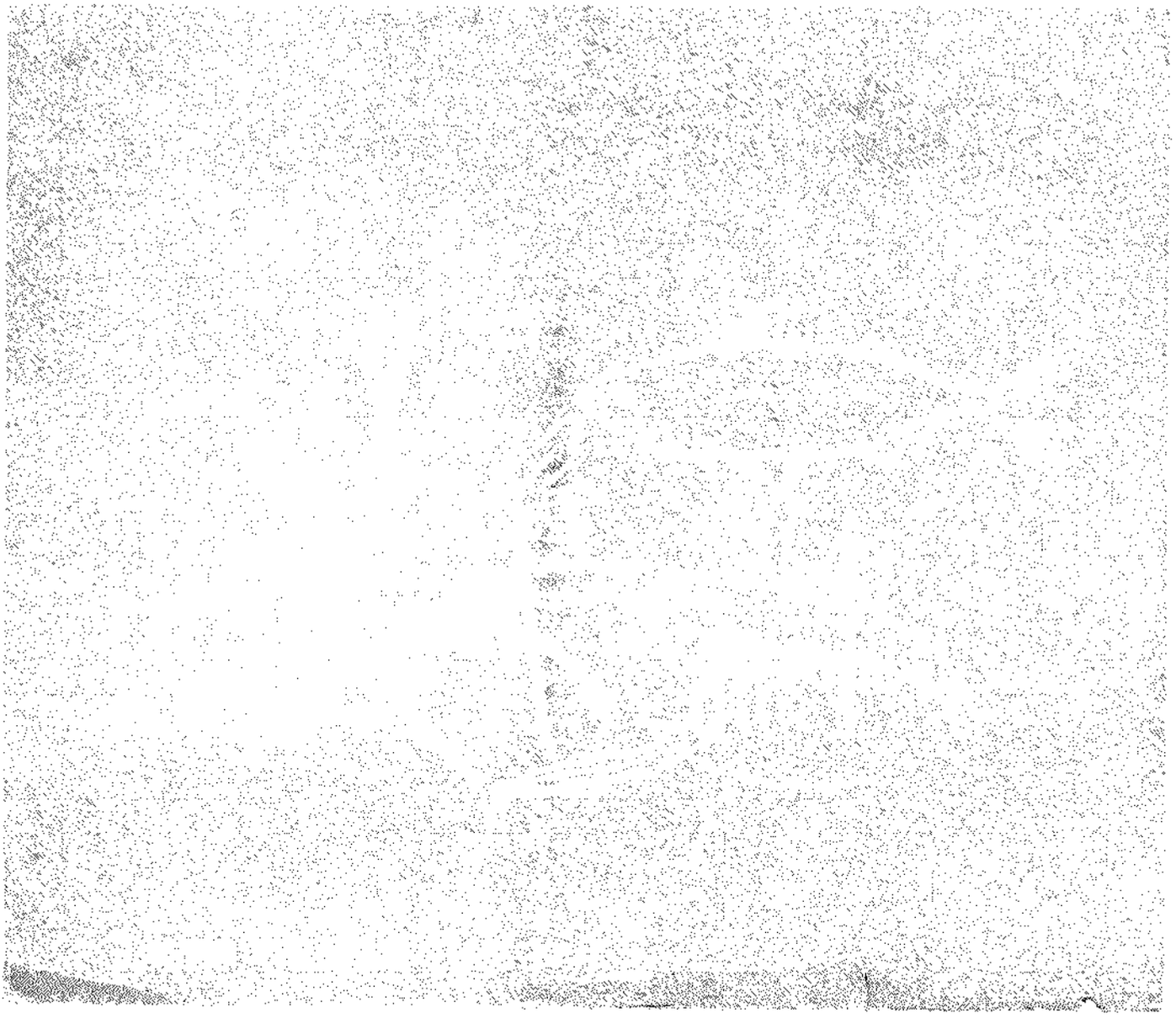
PROCEEDINGS OF THE SYMPOSIUM

ON

LIVING RESOURCES *of* THE SEAS AROUND INDIA

ICAR



PROCEEDINGS OF THE SYMPOSIUM
ON
LIVING RESOURCES OF THE SEAS AROUND INDIA

ICAR

SPECIAL PUBLICATION
CENTRAL MARINE FISHERIES RESEARCH INSTITUTE
COCHIN-11
1973

THE LOBSTER FISHERY RESOURCES OF INDIA

M. J. GEORGE *

Central Marine Fisheries Research Institute, Mandapam Camp

ABSTRACT

The increasing demand for frozen lobster tails from world markets has brought the Indian spiny lobster to the lime light. An assessment of the total lobster resources of the country is made. Among half a dozen species of spiny lobsters reported from the different coastal areas and which are enumerated, *Panulirus homarus* is the most important from the commercial point of view. Details of the distribution of the different species along the coastline are given. Kanyakumari District on the south-west coast is the area with the maximum production. An estimate of the population of this and nearby areas is made both by the fishing success method as well as the Petersen method of tag recovery. The two population estimates are quite in agreement. Based on the population estimates the present rate of exploitation is also calculated. Species of potential commercial importance obtained in recent exploratory cruises in deeper waters off Kerala are mentioned.

INTRODUCTION

DEVELOPMENTS in the frozen sea food industry of the country during the past decade have brought to lime light the Indian spiny lobster as an export commodity due to its great demand in world markets. Exploitation of the spiny lobster resources which remained as a subsistence fishery at some centres along the Indian coasts till recently, has now developed into a very profitable venture. The importance of this resource as a foreign exchange earner for the country may be realised from the fact that the value of the 1,28,300 kg of frozen lobster tails exported chiefly to the U.S.A. in 1967 was around rupees 2·36 millions. The demand for the same is ever on the increase and the industry is on the look out for additional resources. As such an evaluation of the existing resources of the country is quite essential and the same is attempted in the following pages.

SPECIES COMPOSITION

Eleven species of the genus *Panulirus*, belonging to the family Palinuridae, are recognised from the Indo-west Pacific region. Out of these, six species are found to occur in the rocky patches of the coastline of India, contributing to the localised fisheries in different regions. One species each of the genus *Puerulus* and *Palinustus* has been recorded from the deeper waters.

Panulirus homarus (Linnaeus)

The species enjoys a very wide distribution in the Indo-Pacific, extending from South Africa through Red Sea, south coast of Arabia and Indian Seas to East Indies and Japan. The record of this species in India was till recently in the name of two species, namely, *P. dasypus* and *P. burgeri*. According to the latest nomenclature these two have been synonymised with *P. homarus* as suggested

* Present Address : N. I. O., P.B. 1913, Ernakulam, Cochin-18.

by Holthuis (1946) and Gordon (1953). It is found to occur along the west coast and southern region of the east coast of India. The maximum size attained is about 32 cm in length.

Panulirus penicillatus (Olivier)

This species is known to occur throughout the Indian and southern Pacific Oceans, records extending from South Africa through Red Sea and Indian Seas to North Australia, New Guinea and Hawaiin Islands. From the Indian coast it has been recorded by obtaining a single specimen from catches at Quilon (Satyanarayana, 1961). It has been recorded from the islands in the Arabian Sea. The species is known to grow upto about 45 cm in length.

Panulirus longipes (A. Milne Edwards)

In the Indo-west Pacific this species has a very wide distribution, extending from East Africa through Indian Seas and Malaysia to Japan and Polynesia. It is one of the species included in the *japonicus* group and has got the widest distribution among the species of that group. From India it has recently been recorded from the south-west coast by George and Rao (1965). The Indian form appears to belong to the subspecies *Panulirus longipes longipes* created by George and Holthuis (1965). Males of the species attain a maximum length of about 35 cm.

Panulirus polyphagus (Herbst)

General distribution of this species is throughout the Indo-Pacific region from Natal and Mauritius through Indian Seas to Java, Borneo and Great Barrier Reef. In Indian waters it occurs more on the west coast than on the east, especially in the northern region. It contributes to a fishery in Bombay as well as Bengal coast. A maximum size of about 45 cm is reached by males.

Panulirus ornatus (Fabricus)

This has a distribution in the Indo-Pacific from East Africa and Mauritius through the Indian Seas and Malaysia to northern Australia. Along the Indian coast it is found both on the west and east coasts, contributing to a fishery in some places. It also grows to a maximum size of about 46 cm in length.

Panulirus versicolor (Latreille)

This is also a common species known throughout the Indo-Pacific region. The distribution extends from East Africa through Persian Gulf and Indian Seas to Malaysia and Australia. In Indian waters although not contributing to a good fishery anywhere, it is found to occur in small numbers in several localities both on the west and east coasts. It is also found to occur in the Islands of the Arabian Sea. The maximum size is more or less the same as the previous species.

Puerulus sewelli Ramadan

The species has been reported from Gulf of Aden, Arabian Sea off south-west coast of India, Gulf of Mannar and Ceylon. After the initial record of the species off Travancore coast by Alcock (1901) the recent exploratory trawling operations off Kerala coast have revealed the occurrence of the species in fairly good numbers as to support a potential commercial fishery in depths ranging from 200–300 metres. The maximum size attained is about 20 cm.

Palinustus mossambicus Barnard

Till recently the species was considered to be very rare, being known only from five male and one female specimens from Portuguese East Africa and Sulu Sea. George and George (1965) reported about one female specimen obtained from the stomach of a fish caught off Calicut. Since then in the recent exploratory trawling operations off Kerala coast this species was caught

in fairly good number from certain localities. However, the size of the species is not very attractive as in the case of other spiny lobsters, maximum size noticed being about 13 cm in total length.

Distribution of Species and Fishery

The fishery for these spiny lobsters are restricted to the various narrow stretches of rocky areas of the inshore region of the coastline. The catches of spiny lobsters in different areas in the years 1965–66 are shown in Table I.

Table I

Lobster catches of different regions during 1965 *and* 1966

Locality	Catch in kg		Peak season
	1965	1966	
Bombay area ..	..	10,000	October–December
Mysore coast ..	..	..	..
Kerala (north of Cochin) ..	6,000	9,000	July–August
Kerala (south of Cochin) ..	12,200	1,000	January–February
Madras (south-west coast) ..	2,12,600	3,01,400	November–March
Madras (south-east coast) ..	53,900	1,26,000	January–March and July–September
Andhra coast ..	..	..	..
West Bengal and Orissa coast ..	..	..	..

From table it is clear that the south-west coast of India is the most important area of production of these lobsters. The dominant species contributing to the fishery in the southern part of this region south of Trivandrum is *Panulirus homarus*. *P. ornatus* and *P. versicolor* are also fished here to a certain extent. *P. penicillatus* and *P. longipes longipes* have been recorded from this area very rarely. The fishing season here commences by November–December and lasts for about 4 months, ending in March–April (George, 1967). The chief gears employed in the fishery are traps, anchor hooks, scoop nets and gill nets. Details regarding the fishing methods and fishery of this area have been given by Miyamoto and Shariff (1961). Certain biological factors such as breeding season, growth rate, age composition and population characteristics concerning the important species in the fishery have been investigated by George (1967). The movement and growth of the species have been studied by Mohamed and George (1967) by conducting mark recovery experiments.

In the northern region of the south-west coast, in the rocky patches north of Calicut, although *P. homarus* is the dominant species in the fishery, *P. polyphagus* is also equally abundant. *P. ornatus* is also fished in small numbers. Mainly two types of gear are in use in this area, the most important being a type of cast net and the other a bottom set gill net. The fishing season here lasts only for a couple of months in the July–October period.

Nearly 99% of the fishery in Bombay area is contributed by the species *P. polyphagus* as reported by Chhapgar and Deshmukh (1964). *P. versicolor*, *P. homarus* and *P. ornatus* are the other species recorded from this region. Bully nets locally called, 'gadas', wall seine nets and lobster pots are the chief gears used in the fishery here. The main fishing season is during a few months in the October–March period.

On the south-east coast, *P. ornatus* and *P. homarus* are equally abundant in the fishery. Bottom set gill nets and traps are the gears chiefly employed in this area. The peak seasons are January to March and July to September. *P. versicolor* is also caught occasionally in this region.

In the northern section of the east coast, especially along the Bengal coast, *P. polyphagus* is the dominant species fished according to Chopra (1939). *P. ornatus* is also found to occur in this area.

Estimation of Population

Population estimates were simultaneously made by using the Petersen method as well as the fishing success method in the areas of major fishery for lobsters. There are many difficulties in investigations of this kind and the resulting estimates may include some error. Getting precise measure of the fishing effort, to introduce sufficient number of tagged animals into the population and to obtain a large proportion of these back from the population are some of the difficult problems. However, recoveries upto 33% of the tagged animals in the experiments conducted in the south-west coast fishery (Mohamed and George, 1967) have made it possible to attempt an estimation of the population by the Petersen method.

Fishing Success Estimate

The fishing success method or DeLury (1947) method is applicable when a population is fished heavily enough for the animal removed to reduce significantly the catch per effort, which is found to be the case in the lobsters fished on the south-west coast. The stock present is assumed to be proportional to the catch per effort and hence the relation between the accumulated catch upto any time (k_t) and the catch per effort at the same time (C_t) is a straight line and permits an estimate of the initial population $P_{(o)}$.

Estimated monthly landings of lobsters on the south-west coast of India in the region south of Trivandrum along with the catch per unit of effort for the seasons 1964–65 to 1967–68 are shown in Table II. The season November 1965 to April 1966 has been selected for detailed estimation of population since the data for the same season are used for estimation by the tagging method. Data for the lobster fishing season November 1965 to April 1966 regarding monthly catch, $c_{(t)}$, effort, e_t, catch per unit of effort, C_t, cumulative catch, $K_{(t)}$ and accumulated effort $U_{(t)}$ are tabulated in Table III. Stated briefly the method consists of plotting catch per unit effort, $C_{(t)}$ against accumulated catch, $K_{(t)}$ or accumulated effort $U_{(t)}$ and determining the intercept on the Y-axis which is equivalent to $kP_{(o)}$. Then dividing the intercept value by k, an estimation of the total initial population $P_{(o)\,5}$ is obtained. Instead of fitting a line to the plot of $C_{(t)}$ against $U_{(t)}$, a line was fitted to the logarithmic data as:

$$\log C_{(t)} = \log (kP_{(o)}) - bU_{(t)}$$

The least square estimation of b and $\log kP_{(o)}$ were estimated as:

$$b = 0{\cdot}00001813 \quad \text{and} \quad \log kP_{(o)} = 1{\cdot}8100$$

$$\therefore \quad kP_{(o)} = \text{antilog of } 1{\cdot}8100 = 90{\cdot}85$$

The initial population $P_{(o)}$

$$= \frac{90{\cdot}85}{0{\cdot}00004}$$

$$= 227 \times 10^4 \text{ numbers.}$$

TABLE II

Estimated monthly landings of lobsters during 1964–68

Year	Month	Estimated monthly landings (in numbers)	Number of units	Catch per unit
1964	December	2,36,690	4,510	52·5
1965	January	1,93,430	1,580	122·4
1965	February	93,710	860	108·9
1965	March	56,130	470	119·4
1965	April	14,450	290	49·8
1965	November	3,51,390	4,350	80·8
1965	December	3,36,300	5,180	64·9
1966	January	86,250	1,630	52·9
1966	February	33,640	780	43·1
1966	March	21,380	480	44·5
1966	April	1,900	110	17·3
1966	November	1,27,300	1,750	72·7
1966	December	51,890	980	52·9
1967	January	54,860	810	67·7
1967	February	23,600	360	65·6
1967	March	..	..	..
1967	Aprill	..	..	..
1967	November	59,470	1,270	46·8
1967	December	33,330	810	41·1
1968	January	66,670	810	82·3
1968	February	19,670	720	27·3
1968	March	10,000	1,000	10·0
1968	April	8,670	430	20·2
1968	May	1,270	270	4·7

Petersen Estimates

In the Petersen method tagged individuals are released into a population and data are kept of the total catches made and the numbers of tagged individuals caught. The population size, N

TABLE III

Monthly catch (in numbers)

Period		Catch $c_{(t)}$	Cumulative catch $K_{(t)}$	Efforts	Catch per effort $C_{(t)}$	Cumulative effort $U_{(t)}$
1965						
November	..	3,51,390	0	4,350	80·8	0
December	..	3,36,300	3,51,390	5,180	64·9	4,350
1966						
January		86,250	6,87,690	1,630	52·9	9,530
February	..	33,640	7,73,940	780	43·1	11,160
March	..	21,380	8,07,580	480	44·5	11,940
April	..	1,900	8,28,960	110	17·3	12,420

may be found from the relationship:

$$N = nX/x$$

i.e.,

$$\frac{\text{(sample size taken)} \times \text{(total number tagged)}}{\text{(number of recaptured tags)}}$$

For details regarding recoveries of tagged animals *see* Mohamed and George (1967). In this method it has to be presumed that recruitment during the season by immigration is not very significant and also death from natural causes, *i.e.*, natural mortality is very little. Petersen population estimates were made for the same period for which fishing success estimate was made as well as later periods when tagging experiments were conducted along the south-west coast and some other areas. Due to the fact the number of recoveries were few, the tag recoveries and total catches were grouped into monthly intervals and population estimates were made for each of these intervals. Estimates made for different periods show considerable variations between intervals (Table IV) which probably is due to the small numbers of effective tagged lobsters on the grounds in relation to the large number of untagged ones.

Considering the estimate for November 1965 as the best since most tags were recovered during this period and since it is closer in time to the period of the estimation of population using the fishing success method, a value of 174×10^4 is obtained for the initial population. This is more or less in agreement with the value of 227×10^4 obtained by the previous method. The limits of the population can be found using the following formula,

$$N = \frac{nx}{x \pm 2\sqrt{\times\left(1 - \frac{x}{n}\right)}}$$

$$\therefore \quad N = \frac{79 \times 351390}{16 \pm 2\sqrt{16\left(1 - \frac{16}{351390}\right)}}$$

Hence

$$N_L = \frac{27759810}{23 \cdot 996} = 116 \times 10^4 \text{ numbers}$$

$$N_U = \frac{27759810}{8 \cdot 004} = 347 \times 10^4 \text{ numbers}$$

TABLE IV

Petersen population estimates of lobsters (in numbers) *during the period* 1965–67

Interval	Effective tags recaptured (x)	Untagged lobsters caught (n)	Effective tagged lobsters at large (X)	Population of lobsters in numbers $\times 10^4$ $\left(N = \frac{xX}{x}\right)$
1. *Kanyakumari District*				
Experiment 1				
1965				
March–April ..	9	70,580	88	69
November ..	16	3,51,390	79	174
December 1–15 ..	3	1,12,100	63	235
1966				
January ..	1	28,750	60	172
February ..	..	33,640	59	199
Experiment 2				
1966				
November ..	3	1,27,300	47	199
December ..	..	51,890	44	228
1967				
January ..	..	54,860	44	241
February ..	..	23,600	44	104
November ..	2	59,470	44	131
December ..	..	33,330	42	140
2. *Tikkoti region* (area north of Calicut)				
1966		kg		kg.
October–December ..	4	1,000	131	32,750
1967				
January–February ..	4	1,000	127	31,750
3. *Mandapam area* (south-east coast)				
1965				
March–April ..	1	220	16	3,520
1966				
December–January 1967 ..	1	590	3	1,770

From the population estimates obtained by the two methods the average works out to 200×10^4 numbers in the area south of Trivandrum. In terms of weight this estimated population may be expressed as about 500 tonnes.

An estimation of the lobster population of the Tikkoti region north of Calicut also was attempted by the Petersen method. An estimate of about 32 tonnes is obtained for this region Table (IV). Similarly an estimate for the Mandapam area on the south-east coast where the fishery is very limited gives a figure varying from 1·7 to 3·5 tonnes.

Rate of Exploitation

The present rate of exploitation can be found out from the estimated population. The calculation presumes that the annual catch was derived from the initial population and that recruitment during the season by immigration is not very significant.

1. Kanyakumari District :

   Estimated initial population for November 1965: 200×10^4

   Total catch during the season: 830860

   $$\text{Rate of exploitation} = \frac{830960}{200 \times 10^4} \times 100$$

   $$= 41 \cdot 5\%$$

2. Tikkoti region (north of Calicut):

   Estimated initial population : 32 tonnes

   Total catch during the season: 9 tonnes

   $$\text{Rate of exploitation} = \frac{9}{32} \times 100$$

   $$= 28 \cdot 4\%$$

3. Mandapam area (south-east coast)

   Estimated initial population 2·6 tonnes

   Total catch for the season 0·59 tonnes

   $$\text{Rate of exploitation} = \frac{0 \cdot 59}{2 \cdot 6} \times 100$$

   $$= 22 \cdot 7\%$$

The present exploitation rate in these areas seems to be well within the limit to which exploitation can be raised without detrimental effects to the stock. An exploitation upto about 60% is considered not to be harmful to any fishery. Therefore it is felt that the exploitation of the lobster fishery of these regions could be increased considerably without fear of depleting the stock.

Total Resources

While areas like the lobster grounds of the southwest coast of India are comparatively well exploited some other areas are not subjected to exploitation to this extent. The estimation of population is possible only from areas from where data regarding total landings and effort are available. No reliable statistics exist regarding the lobster landings of Bombay-Veraval area and Bengal coast. But it is expected that catches here amount to only a few tonnes so that from the point of view of total resources of the country these are not of much significance. However, it is felt that in these places also there is scope for considerable increase in exploitation of the spiny lobsters. An approximate estimation of the total resources of the different areas may be attempted as given below:

South-west coast of India— south of Trivandrum	..	500 tonnes
South-west coast of India – north of Trivandrum	..	20 ,,
South-west coast of India— north of Calicut	..	30 ,,
Mysore coast—Malpe, Karwar area	..	20 ,,
Bombay coast including Ratnagiri area	..	100 ,,
Veraval area	..	10 ,,
South-east coast—Cape Comorin to Mandapam area	..	250 ,,
South-east coast—north of Mandapam area	..	20
Bengal Coast	..	50 ,,
TOTAL	..	1,000 tonnes

Exploiting about 60% of this resource the total catch could be about 600 tonnes without causing any detrimental effects to the stock. As the commercial 'lobster tail' is the abdomen which forms nearly $\frac{1}{3}$ the weight of the animal, the finished export product could be estimated as 200 tonnes. The total export of frozen tails from the country in 1967 was only 128 tonnes and it would therefore appear that with proper exploitation the export could be stepped up by 50% of the present production.

DISCUSSION

It is clear that the lobster fishery resources of the country are not exploited fully and there is still scope for increasing the exploitation to a considerable extent. However, Balasubramanyan (1967) expressed apprehensions concerning depletion of this valuable resource. But the apparent fluctuation noticed in the catches in certain years can only be due to natural causes. The extremely fast rate of growth recorded in the species contributing to the fishery (Mohamed and George, 1967) adds strength to the contention that conservatory measures involving regulation of sizes may not be necessary at the moment. Observations made at the fishing centres have revealed that very small sized lobsters which do not fetch any appreciable price to the fishermen are being caught in large number, especially in traps and destroyed unnecessarily. As pointed out by George (1967) regulation of the fishing of these small sizes by fixation of a minimum size limit for lobster catches would be beneficial.

With the increasing demand from all quarters of the world and with better exploitation of the resources of different areas along the coastline of India it is expected that this fishery will play an increasing part in the sea food export industry. It will not be out of place here to mention about

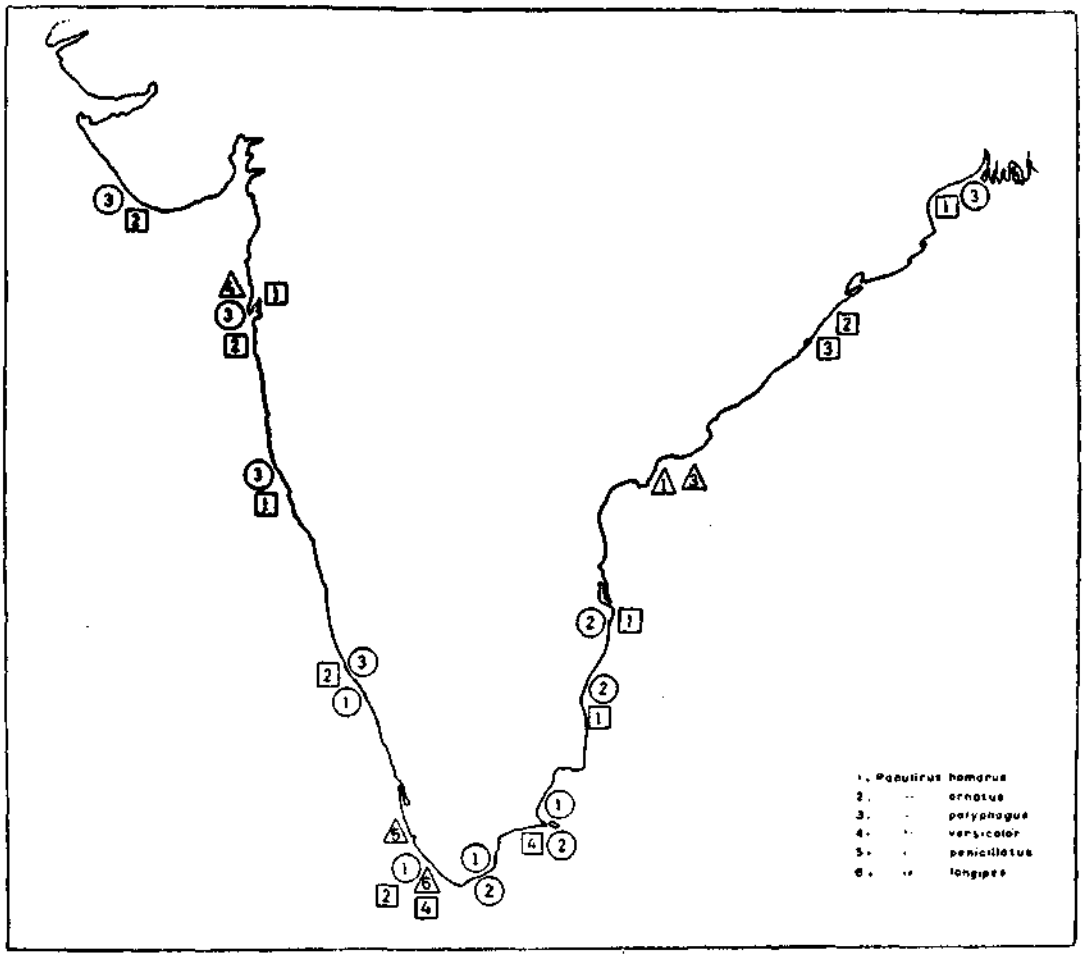


FIG. 1. Distribution of palinurid lobsters along the coast of India; Circle—fairly good fishery; square—occasional and triangle—strayrecord.

the recent findings of the occurrence of the deep water spiny lobster *Puerulus sewelli* and *Palinustus mossambicus* in depths of 200 to 300 metres along the continental slope off the south-west coast (John and Kurien, 1959; George and George, 1965 and Kurien, 1968). It is possible that these species also would be commercially exploited in due course and add to the overall spiny lobster resources.

REFERENCES

ALCOCK, A. 1901. *A Descriptive Catalogue of the Indian Deep-sea Crustacea, Decapoda, Macrura and Anomala in the Indian Museum, being a Revised Account of the Deep-Sea Species Collected by the Royal Marine Survey Ship 'Investigator.'* Calcutta, India, 286 pp.

BALASUBRAMANYAN, R. 1967. Spiny lobsters of India and the present status of their fishery. *Indian Seafood*, 4 (3) 3–7.

CHHAPGAR, B. F. AND S. K. DESHMUKH. 1964. Further records of lobsters from Bombay. *J. Bombay nat. Hist. Soc.*, 61 (1) : 203–207.

CHOPRA, B. N. 1939. Some food prawns and crabs of India and their fisheries. *Ibid.*, 41 (2): 221–234.

DELURY, D. B. 1947. On estimation of biological population. *Biometrics*, 3 (4): 145–167.

GEORGE, M. J. 1967. Observations on the biology and fishery of the spiny lobster *Panulirus homarus* (Linn.). *Proc. 'Symposium on Crustacea' Mar. biol. Ass. India.* Part IV: 1308–1316.

—— AND K. C. GEORGE. 1965. *Palinustus mossambicus* Barnard (Palinuridae: Decapoda), a rare spiny lobster from Indian waters. *J. mar. biol. Ass. India.*, 7(2): 463.

—— AND P. VEDAVYASA RAO. 1965. A new record of *Panulirus longipes* (Milne Edwards) from the south-west coast of India. *Ibid.*, 7 (2): 461.

GEORGE, R. W. AND L. B. HOLTHUIS. 1965. A revision of the Indo-West Pacific spiny lobster of the *Panulirus japonicus* group. *Zoologische Verhandelingen*, 72: 36.

GORDON, I. 1953. On the *Puerulus* stage of some spiny lobsters (Palinuridae). *Bull. Brit. Mus. (Nat. Hist.), Zool.*, 2 (2): 17–42.

HOLTHUIS, L. B. 1946. The decapod macrura of the Snellius Expedition. I. The Stenopodidae, Nephropsidae, Scyllaridae and Palinuridae. *Biol. Res. Sneullius Exped. XIV. Temminckia*, 7: 1–178.

JOHN, C. C. AND C. V. KURIEN. 1959. A preliminary note on the occurrence of deep water prawn and spin, lobster off the Kerala coast. *Bull. Cent. Res. Inst. Trivandrum.*, Ser. C. 7 (1): 155–162.

KURIEN, C. V. 1968. Occurrence of lobster in the offshore waters of Kerala. *Seafood Trade Journal*, 3 (6): 22–26,

MIYAMOTO AND A. T. SHARIFF. 1961. Lobster fishery off the south-west coast of India. Anchor hook and trap fisheries. *Indian J. Fish.*, 8 (1): 252–68.

MOHAMED, K. H. AND M. J. GEORGE. 1967. Results of the tagging experiments on the Indian spiny lobster *Panulirus homarus* (Linn.)—Movement and growth. Australian/New Zealand Meeting on Decapod Crustacea, Sydney, October, 24–28, 1967 & *Indian J. Fish.*, 15: 15-26 (1971).

SATYANARAYANA, A. V. V. 1961. A record of *Panulirus penicillatus* (Olivier) from the inshore waters off Quilon, Kerala. *J. Mar. biol. Ass. India*, 3 (1-2): 269.