

FISHERY AND POPULATION DYNAMICS OF *PANULIRUS HOMARUS* (LINNAEUS) FROM MUTWAL, SRI LANKA.

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Abstract: The spiny lobsters are caught at Mutwal by bottom set gillnets operated by 17'-22' mechanised fibre reinforced plastic (FRP) boats and non-mechanised canoes and wooden crafts (theppam). The mesh sizes of these nets vary from 90 mm to 180 mm. The mean catch per unit effort (CPUE) of mechanised boats was found to be higher than those of non-mechanised crafts. The mean CPUE of FRP boats, canoes and wooden crafts showed a ratio of 4:2:1. Production was found to be higher during the inter-monsoon period than during the monsoon period. The sex ratio appears to be approximately 1:1. The percentage of ovigerous females is higher just before and after the monsoon period. The calculated natural and total mortality coefficients were 1.04 and 1.08 respectively giving an exploitation rate of 0.04.

1. Introduction

Spiny lobsters (Family - Palinuridae) are widely distributed in the Indian Ocean. These are the most valuable of the crustaceans in waters around Sri Lanka, India, Malaysia, South Africa and many other regions. This fishery is very important to Sri Lanka as it is a very good export earner. Spiny lobsters are exported mainly to Japan, France and the U.S.A.

Six species of spiny lobsters have been recorded from Sri Lankan waters.⁴ Out of these *Panulirus homarus* (Linnaeus), *P. ornatus* (Fabricius), *P. versicolor* (Latrielle) and *P. penicillatus* (Olivier) are caught off the waters at Mutwal. *P. homarus* forms the major constituent.

The biology and the fishery of spiny lobsters have been described from many parts of the world as for example from Thailand,¹¹ Britain,¹⁴ USA,⁷ Australia,¹³ Yemen¹² and Sri Lanka.^{3,4,5,6,8} De Bruin studied the capture methods, ecology and distribution while Jayakody & Kensler described the fishery in the Southern coast of Sri Lanka.

The present study deals with the fishery and some biological aspects such as sex ratio and population parameters such as asymptotic length (L_{α}), growth constant (K), total mortality (Z), natural mortality (M) and the exploitation rate (E) of *P. homarus* population from Mutwal, with the aim of understanding the status of the fishery of this stock of *P. homarus*.

2. Experimental

The spiny lobsters are caught at Mutwal (Figure 1) by bottom set gillnets with mesh sizes ranging from 90 mm to 180 mm stretched mesh. These are operated in the same area by 17'-22' FRP boats powered by 6-25 HP out-board engines and non-mechanised canoes and wooden crafts made out of logs which are tied together (theppam). Most of the crafts take an average of 10 net pieces, each piece with a length of 1000-1500 meshes. The net is set in the evening and collected on the following morning.

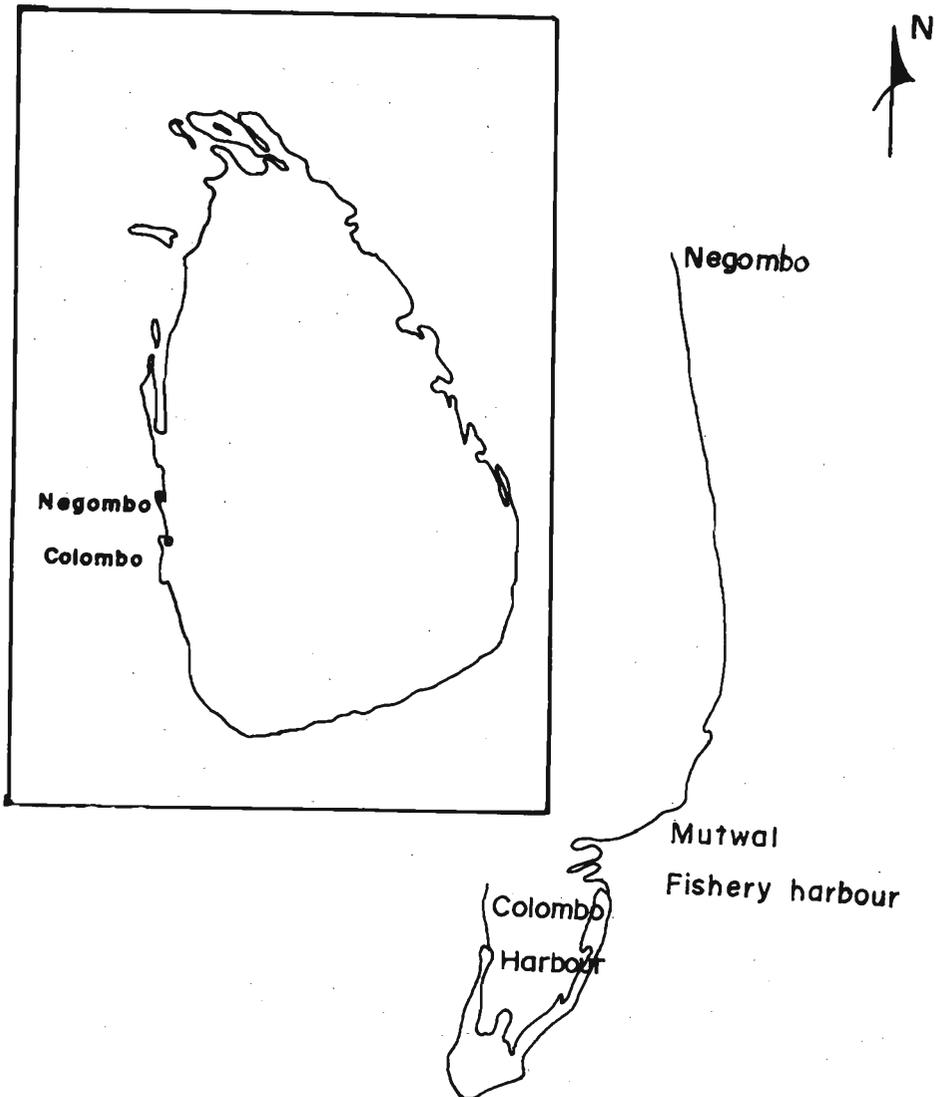


Figure 1: Map of Sri Lanka showing the Mutwal fishery harbour.

This study is based on the data collected between January to December 1985. The landing site at Mutwal was visited once a week and the catch by weight of each species from different crafts was recorded. The total length to the nearest millimeter, sex and the maturity stage were recorded for all the available spiny lobsters. Monthly length frequency distribution was prepared by pooling length data for each month and grouping them into 1 cm length classes.

The null hypothesis, that the sexes are equally distributed, was tested by the log-likelihood ratio test.¹⁵

The breeding cycle of female *P. homarus* was studied by calculating the percentage of ovigerous females among total number of females, for different months.

The length frequency data were analysed using ELEFAN 0, 1 and 2 programs² performed in an Apple II e micro-computer, to estimate the asymptotic length (L_{α}), growth constant (K), total mortality (Z) and the selectivity pattern. The theoretical age of fish when length is zero (t_0) was estimated using the formula⁹ :

$$\log_{10} (-t_0) = -0.3922 - 0.2752 \log_{10} L_{\alpha} - 1.038 \log_{10} K \quad (1)$$

The natural mortality (M) was calculated using the formula (2) given below, taking the mean annual environmental temperature (T) as 28.5°C.

$$\log_{10} M = -0.0066 - 0.279 \log_{10} L_{\alpha} + 0.6543 \log_{10} K + 0.4634 \log_{10} T \quad (2)$$

The fishing mortality (F) was calculated from the relationship $Z = F + M$ and the exploitation rate (E) was then determined.

Where,

$$E = \frac{F}{Z}$$

3. Results

3.1 Fishery

Of the four species of spiny lobsters caught at Mutwal *P. homarus* contributed to 92% of the total lobster landings during the study period (Table 1).

Table 1 : Weight of different species of spiny lobsters caught at Mutwal during 1985.

Species	Total weight (kg)	% by weight
<i>P. homarus</i>	11928	92
<i>P. ornatus</i>	530	4
<i>P. versicolor</i>	398	3
<i>P. penicillatus</i>	133	1

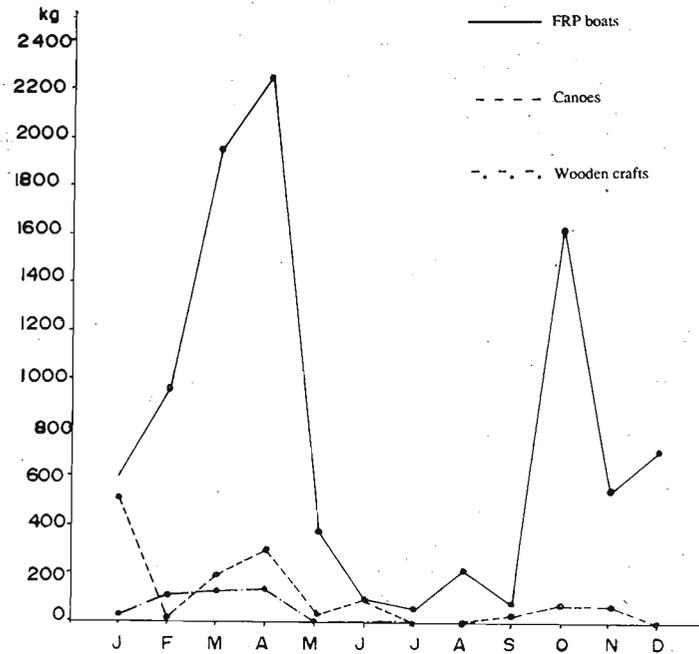


Figure 2: Variation of estimated total monthly production (kg) of *P. homarus* by different crafts for 1985.

The estimated total monthly production shows a peak in April (Figure 2) for FRP boats and canoes. For wooden crafts (theppams) the peak is in the month of January which is associated with an increase in the number of craft. In this case too, the estimated total monthly production was very high in April. But as a whole the catches decreased rapidly during the period of South-west monsoon.

The mean CPUE for mechanised FRP boats, canoes and wooden crafts for the months fished are 1.72 kg, 0.81 kg, and 0.44 kg respectively showing a ratio of 4:2:1 (Table 2).

3.2 Sex Ratio

The results of the log-likelihood ratio test are given in Table 3. It can be concluded that both sexes are equally distributed.

3.3 Breeding Cycle

The percentage of ovigerous females is higher just before and after the monsoon period which is from April to August (Table 4).

Table 2 : The monthly variation of estimated production and effort for *P. homarus* from Mutwal by different gear types.

Month	FRP boats		Canoes		Wooden crafts	
	Production (kg)	Effort (boat days)	Production (kg)	Effort (boat days)	Production (kg)	Effort (boat days)
January	610.7	189	27.0	9	510.8	153
February	1760.0	112	102.4	32	17.6	64
March	1950.0	147	130.0	9	182.0	26
April	2249.0	137	130.0	13	295.8	46
May	374.6	81	-	-	30.0	20
June	95.9	46	-	-	95.9	46
July	51.3	20	-	-	-	-
August	201.5	26	-	-	-	-
September	75.4	69	-	-	34.7	8
October	1603.1	47	-	-	77.6	34
November	543.8	25	12.5	14	62.5	13
December	704.0	26	-	-	-	-

3.4 Growth and Mortality Paramaters

The following values for L_{α} and K were obtained from the ELEFAN 1B program for the length frequency data of *P. homarus*.

$$L_{\alpha} = 28.7 \text{ cm (Total length)}$$

$$K = 0.43/\text{Year}$$

$$\frac{ESP}{ASP} = 0.315$$

The best growth curve points based on these L_{α} and K values were plotted on a sequentially arranged length frequency distribution (Figure 3).

The t_0 value was found to be 0.38 yrs.

The length converted catch curve (Figure 4) gave a value of 1.08 for total mortality. The natural mortality was found to be 1.04 and hence a fishing mortality of 0.04. Therefore the exploitation rate was calculated as 0.04. The results of the selectivity pattern obtained based on the catch curve are as follows :

$$L_{\min} = 11.5 \text{ cm.}, L_c = 14.7 \text{ cm.}, L' = 16.5 \text{ cm.}$$

Where,

$$L_{\min} = \text{Length at first capture}$$

$$L_c = \text{Length at 50\% probability of capture}$$

$$L' = \text{Length at complete recruitment to the fishery}$$

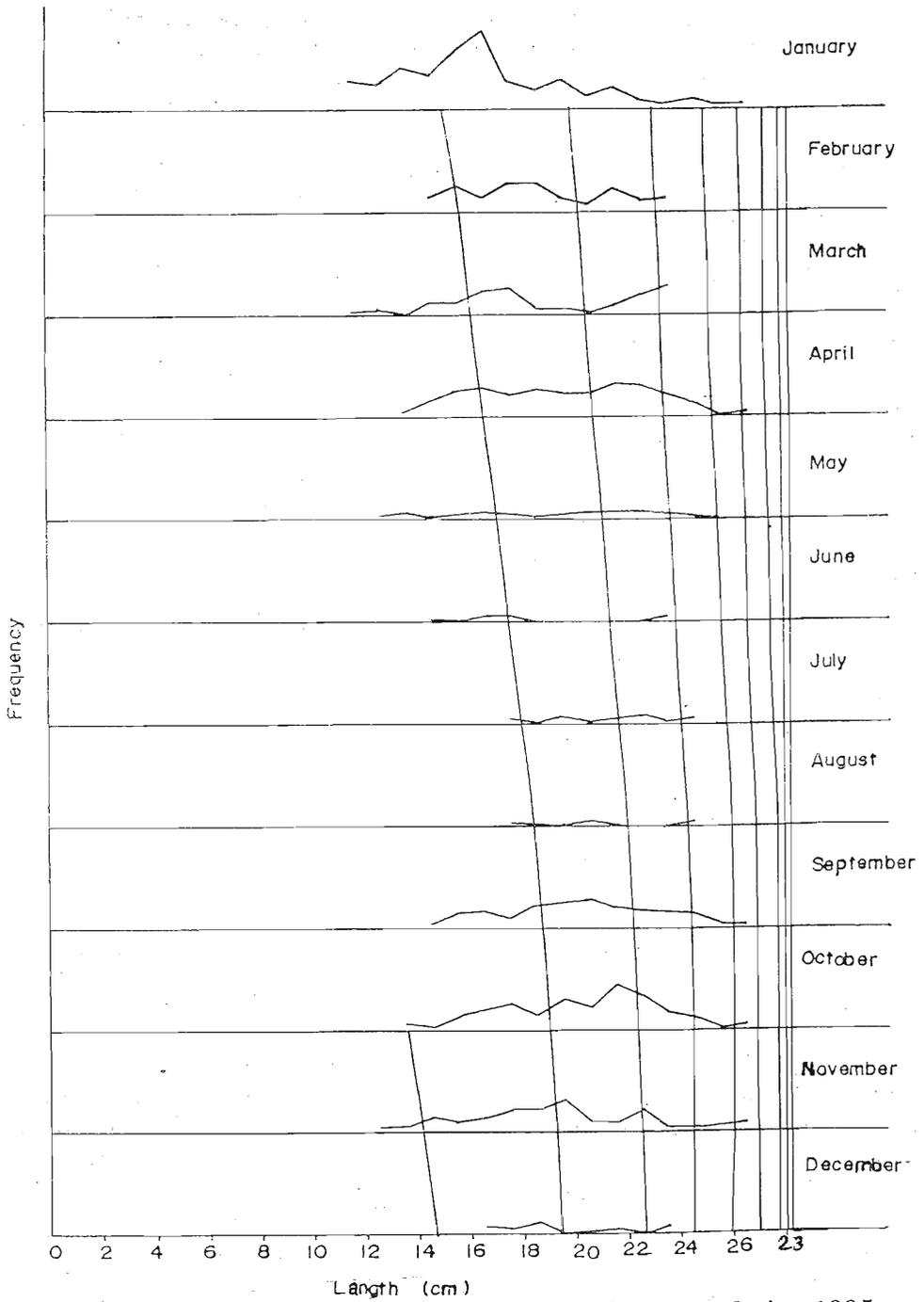


Figure 3: Length frequency distribution of *P. homarus* during 1985. with growth curves fitted by ELEFAN1B.

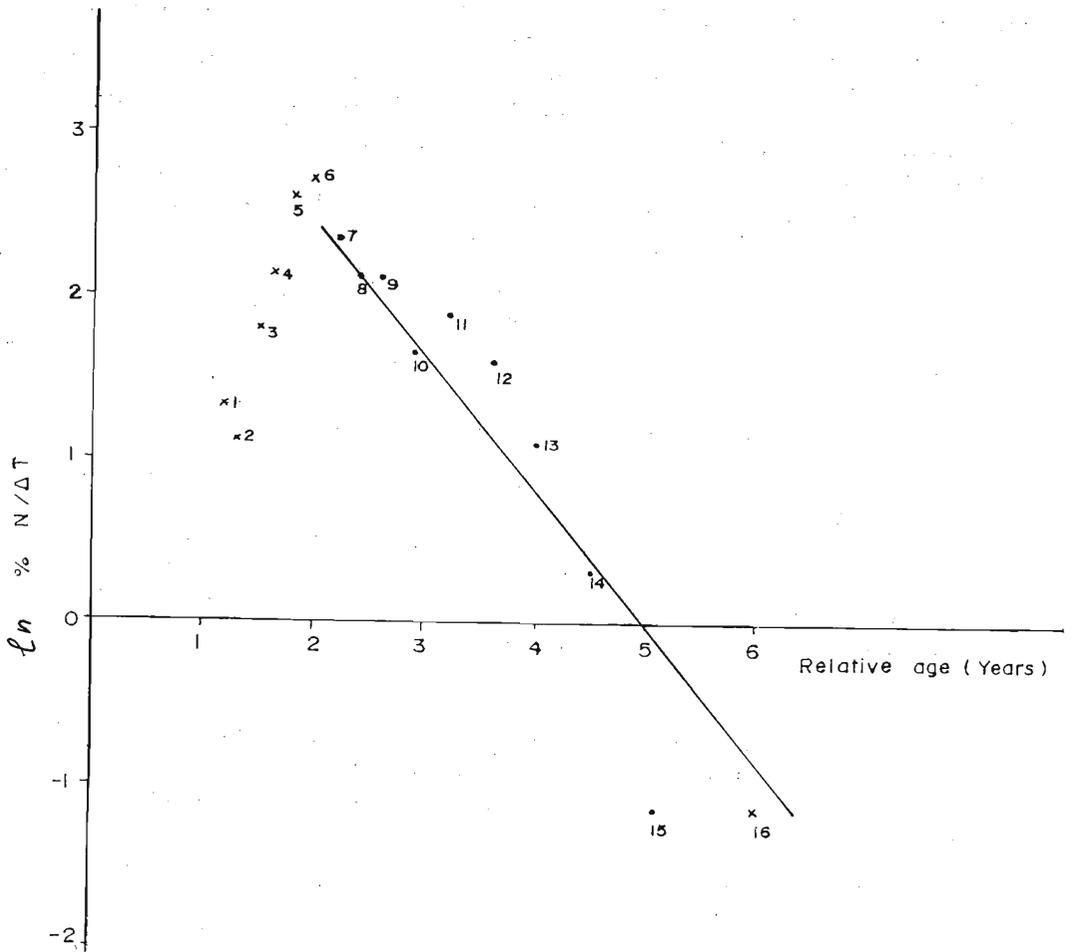


Figure 4: Length converted catch curve for *P. homarus* based on growth parameters estimated by ELEFAN 2 A.

4. Discussion

Of the four species of spiny lobsters caught at Mutwal, *P. homarus* is the major constituent, contributing to 92% by weight. Although the monsoon period is the peak season for the lobster fishery in the western part of Thailand,¹¹ the monsoon period seems to be the lean period for the lobster fishery at Mutwal. A similar pattern had been reported earlier by de Bruin⁶ and Jayakody & Kensler⁸ for the Sri Lankan lobster fishery. This variation in catch is possibly due either to the fact that crafts cannot be operated successfully in the rough seas during the monsoon period or because only few crafts operate during this time.

The results indicate that the sex ratio of *P. homarus* is approximately 1:1. This agrees with the results of other authors.^{4,8,11}

The maximum percentage of ovigerous females was observed in September. According to de Bruin⁴ the number of egg bearers are very low during the monsoon period which is confirmed by the present study.

Published information on growth parameters of *P. homarus* stocks of Sri Lankan waters is not available. But a value 22.5 cm (tail length) has been recorded for *P. homarus* as asymptotic size from Yemen.¹² The asymptotic size recorded in the present study is 28.7 cm (total length). When a regression of tail length and total length was carried out to find out the relationship between these two for comparison, a tail length of 22.7 cm corresponded to 36.8 cm. in total length ($r = 0.98$). Therefore the asymptotic size recorded in the present study seems to be very low. The largest specimen recorded from Mutwal was 28.5 cm (Total length). Jayakody and Kensler⁸ reported a maximum total length of 28.7 cm. As specimens having a total length as high as 36 cm have not been reported in Sri Lanka, the asymptotic size of 28.7 cm (total length) seems acceptable for Sri Lankan waters.

Sanders and Bouhlel¹² reported an annual growth constant of 0.45 for *P. homarus* from Yemen which is little higher than the present value.

The natural mortality coefficient is higher than the value reported for *P. homarus* from Yemen.¹² This may be attributed to the fact that the mean annual environmental temperature of Sri Lankan waters (28.5°C) is higher than that in Yemen, which has been taken as between 20°C-25°C. According to the empirical formula of Pauly,¹⁰ which was used to calculate the natural mortality, a lower value of L_{∞} results in a higher value of M . Beverton and Holt² suggest that the M/K should lie in the range of 1.5-2.5. In this study a M/K value of 2.42 has been recorded which agrees with the suggestion of Beverton and Holt.

The total mortality value and hence the exploitation rate seems to be very low at Mutwal. This low exploitation rate is to be expected for this lobster fishery because lobsters do not form the Main constituent of the bottom set gillnet fishery at Mutwal. The lobster exports however, bring a high amount of foreign exchange to the country. Since the exploitation rate is very low, the lobster fishery can be further expanded in Mutwal. However, necessary steps should be taken to monitor and manage the fishery so as to prevent the fishing

of under sized individuals and berried females. With proper management measures a further expansion of this fishery, within sustainable limits, can be recommended.

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Table 3 : Results of the log-likelihood ratio test for *P. homarus* from Mutwal in 1985.

(d.f. = 1, critical value = 3.841 (P = 0.05)
= 6.635 (P = 0.01)

Month	Value	Probability
January	0	P > 0.05
February	0.008	P > 0.05
March	0	P > 0.05
April	4.89	0.05 > P > 0.01
May	0.017	P > 0.05
June	9.7	P > 0.01
July	0.25	P > 0.05
August	1.33	P > 0.05
September	8.49	P < 0.01
October	1.73	P > 0.05
November	6.25	0.05 > P > 0.01
December	0.58	P > 0.05
TOTAL	5.47	0.05 > P > 0.01

Table 4 : Percentage of ovigerous females found among the female *P. homarus* from Mutwal during 1985.

Month	No. of females	% of ovigerous females
January	76	14.5
February	35	25.7
March	31	45.2
April	43	41.9
May	15	40
June	-	-
July	7	14.3
August	2	-
September	20	55
October	58	51.7
November	29	34.5
December	16	25

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