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THE STOCK STATUS AND MANAGEMENT SCHEME OF Kerisi *(Nemipterus peronii)* ON THE EAST COAST OF PENINSULAR MALAYSIA

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LIST OF TABLES

LIST OF FIGURES

CONTENTS

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ABSTRACT

The fish, Kerisi, is a group of species of the genus *Nemipterus* which comprises at least 11 species in the South China Sea area and is one of the most important demersal resource in the trawl fisheries of Malaysia. *Nemipterus peronii* is the most abundant Kerisi species found along the east coast of Peninsular Malaysia. However its stock status has not been fully studied and appropriate management has become important in recent years. With this in mind an attempt to assess the Kerisi stock was made for the purpose of management and was discussed in this paper. This study indicated that the present status of *N. peronii* was slightly over exploited by the trawlers. To properly manage this species, it was suggested that the present level of fishing effort should be reduced by about 35% to allow the stock to recover at the MSY level. This study further suggested that decline of the stock would suddenly occur if the age at first capture is lowered.

The stock status and management scheme of Kerisi (*Nemipterus peronii*) on the East Coast of Peninsular Malaysia

- Hideaki Kimoto and Ibrahim Johari -

Introduction

The fish, *Kerisi*, of the genus *Nemipterus* are normally mentioned in the Malaysian Annual Fisheries Statistics as comprising of a number of species. One species found in abundance along the east coast of Peninsular Malaysia is *Nemipterus peronii* (Pathansali *et al.*, 1974). Actual landing ratios of *N. peronii* to all *Kerisi* in the past were not known with precision, but was estimated at about 50 % of the total *Kerisi* landings. Distribution of this species appeared to be, more or less, limited to the shallow waters of 20-40 m in depth (Weber and Jothy, 1977) and is more related to the coastal fisheries. The launching of deep sea trawlers in 1988 led to an increase in the landings of the other species of *Kerisi* causing the ratio of *N. peronii* to drop to around 30 %. This shows *N. peronii* still to be a fairly important group of demersal fish.

Previous studies on *N. peronii* by other workers were confined to length-weight relationship, the spawning season and sex ratio in the Gulf of Thailand (Menasveta, 1980), and estimating growth in the coastal waters of Borneo (Weber and Jothy, 1977). These studies were mostly surveys carried out 20 to 30 years ago. This paper is the first attempt to study the population structure and stock level of *N. peronii* in the waters off the east coast of Peninsular Malaysia in recent years. Studies carried out in this area under a variety of topics were used as references such as the works of Pathansali *et al.* (1974), Aglen *et al.* (1981), Abu Talib and Hayase (1984), Department of Fisheries Malaysia (1989), Ahmad Adnan (1990), Mohsin *et al.* (1992) and Department of Fisheries Malaysia and Department of Fisheries Thailand (1992).

Biological data of *N. peronii* used in this study were gonad index, length frequency distribution and length-weight relationships. For the estimation of total landing, information extracted from the Annual Fisheries Statistics was used. The main fishing gears operating in this water in the 1970's were known to comprise mostly traps and lines fishing. These gears, however, declined when trawlers became more dominant and become the principal gears. Amount of trash fish landed has been observed increasing year after year, due to a change in these principal fishing gears. The aim of this paper is to evaluate the present status and to suggest a proper management scheme to ensure a conservation of this species.

Materials and Methods

Specimens of *N. peronii* were obtained on a monthly basis from commercial landing centres in Endau, Johor, from trawlers of over 40 GRT. Sampling was carried out from February 1993 to November 1994. Fish were caught in the Malaysian EEZ waters between latitudes 01° 30' N and 03° 30' N, at a depth 30-70 m. Landings of *Kerisi* were first recorded before sorting into species. Measurement of total length (in mm, from the tip of snout to the tip of the upper caudal lobe) was made on all samples. We next selected 50-100 individuals at random for gonad study. The selected fish were measured, weighed and dissected individually to determine gonad weight and maturation stage. Gonad stage was directly determined through visual observation. GSI was calculated as the ratio of gonad weight to the theoretical body weight.

Length-weight relationship of *N. peronii* was established using the general equation

$$W = a\,L^{b}$$

where W is body weight (g), L is length (mm), a and b are constants. In this analysis, 976 fish were used.

There was little information regarding growth of this species from this area. As such, we attempted to estimate the growth parameters using length frequency data collected within the sampling period, and assuming this fish, like many others, follow the von Bertalanffy growth equation. More precise estimates would probably be obtained if age-based analysis was used. However, this was difficult to do and the following easier method was adopted. First, we determined the number of age groups in the monthly length frequency distributions by eye, and estimated growth from the detected growth speed through the shift of the mode of respective age group (modal progression analysis). From these results, age-length at a proper month were selected. We then used biological parameter of other species to verify the absolute age. This led to the estimation on growth equation of the spawning months of *N. peronii*. Some previous reports commented on a different growth between sexes in *Nemipterus mesoprion* and *Nemipterus nematophorus* but, so far, none on *N. peronii*. Moreover, as the mentioned data had not been segregated into sexes, these analyses were carried out without any sex distinction.

Rate of maturity was determined from analysis of the maturation stage and GSI. Longevity and the natural mortality coefficient (M) were calculated using the technique of Biomass Analysis shown by Doi (1982). Calculation of the age composition of the catch was carried out as follows. First, the monthly length distributions were pooled into quarters and broken down into normal distributions. These distributions were next converted into weight composition, and then the ratio of each group was calculated. Using these ratios, the monthly catches obtained from annual catch statistics of 1991 and 1992 were separated into age groups in each quarter. Finally, weight of each age group was converted into number of individuals by dividing with the average body weight of each age group. Age composition of the annual catch was decided by totaling the number of age groups. The fully available age can now be estimated from the age composition.

The stock-recruit relationship was presumed from the relationship between recruitment stock and adult stock estimated from the past and present status (Kimoto *et al.*, 1990). The present (1992) and past status (early 1970's) of the stock in this area were estimated from trawl surveys and measured in weight per hour (kg/hr). The models of stock analyses used in this paper are the steady analysis model and the production models (Nose *et al.*, 1988; Kimoto *et al.*, 1988). The fishery of this area initially was mostly comprised small boats up to 1986. A change in the licensing policy in 1987 encouraged local fishermen to venture into the deep sea (up to 200 nautical miles) and greatly increased the number of large fishing vessels (> 70 GRT). This resulted in increase of *Kerisi* catch that appeared to stabilise after 1989 (Figure 1). After due consideration, the landings of *Kerisi* from 1987 to 1992 were used in the analyses using the production models (Schaefer's and Fox's). Related equations are given below. The steady analysis model was carried out using biological information and the average annual catch (in weight) from 1989.

Schaefer's model

$$Y = a - bX$$

Fox's model

$$ln(Y) = ln(a) - cX$$

where *a,b,c* are constants, *X* is the catch effort (number of boats) and *Y* is the CPUE.

Results and Discussion

1. Growth

The results of the breakdown of the monthly polymodal distributions into monomodal normal components are shown in Figure 2. These results were arranged in a chronological order (Figure 3). Arrangement of modes by month created some difficulty in reading the probable growth curve. However, pooling these data into quarters made it easier to detect the growth. An age group of between 15-16 cm in length in April-June was shown to grow up to 17-18 cm in October-December, 18-19 cm in January-March (of the next year) and continued up to 21-22 cm in October-December (of that year). It is possible that a second age group may exist. This group of the fish in length between 12-13 cm grew up to 17-18 cm in April-June of the next year but then appeared to gradually merge into the first age group. On the other hand, growth of the age group of 24 cm in January-March appeared to grow to 25-26 cm in October-December. From these hypothetical growth curves, we defined the mode of October-December to be the length of each age group. The age in November (the central month) was not known, but we hypothesized that the modes at 17.5 cm, 22 cm and 25.5 cm in length were respective age groups of one year interval. The congener *Nemipterus mesoprion* grows to about 14-17 cm in length at age one (Boonwanich, 1980). We thus calculated the following growth formula at age one at 17.5 cm in length.

$$L_t = 376.8\ [\ 1 - exp\{-0.252(t+0.810)\}]$$

where L_t is length (cm) at age *t*. Weber and Jothy (1977) have reported the average total length at age one to be 10.2 cm. They further stated that length at age one for *N. mesoprion* is 5-6 cm. Unfortunately, they did not explain the basis of these estimates. There is a big difference between estimates given by Weber and Jothy (1977) and Boonwanich (1980) on *N. mesoprion*. As Boonwanich stated the growth from the earlier stage, we thus interpret his estimate as being the more reasonable of the two. The histograms of Figure 2 were decomposed into normal components using the above growth formula. Figure 4 shows plots of the lengths of age groups by month and quarter. This result seems to show the spring-born group and winter-born group merge at the age of two. The spring-born group is the main spawning group. Accordingly, the above formula was improved to include the month of March as the main spawning month, resulting in

$$L_t = 377.5\ [\ 1 - exp\{-0.2513(t+1.4782)\}]$$

The length (*L*)-weight (*W*) relationship equation derived is

$$W = 1.107 \times 10^{-5}\ L^{3.022}$$

2. Maturity rate and sex ratio

Gonad indexes of *N. peronii* of over one year old clearly indicated maturation (Figure 5) and followed the derived growth equation. It is known that individuals reaching gonad stage 3 may be considered as matured. We classified the samples into individuals having stage 3 and higher, and those under stage 3, according to length. The median length between each age was used as a bufferline and the derived growth equation was adopted to convert to age length. From these results it was clear the maturity rates of 1, 2, 3 and 4 years were 20%, 34%, 60% and 100%, respectively. As these included data obtained from the lower spawning season, we rechecked the rates within two years and found a lot of mature individuals included in the March sampling. This being the main spawning month (with the maturity rate of about 85 %) had probably caused the above results to be underestimated. Estimating the maturation ratio of other ages using this ratio, age 1 and over age 3 were found as 50% and 100%, respectively. We therefore used the ratios for age 1, 2 and over 3 years as 50%, 85% and 100%, respectively in this model.

The ratio of males and females were 60% and 40%, and this was also used in this model.

3. Longevity and natural mortality coefficient

As actual age of *N. peronii* is not exactly known, there is no information on the actual longevity. But results obtained from this length frequency analysis suggested that fish would grow to about 30 cm after 5 or 6 years (Table 1), and we thus regarded 6 years as the first guess on the fish's longevity. It is natural to be about 10 % in biomass to remain at six year old. On checking the change in biomass (Table 1) with the mentioned longevity, the biomass of 10% survives at 0.4 of survival rate (S) . We therefore hypothesized the survival rate was 0.4 and longevity at about 5 years. Namely, we considered that the spawning at 5 years would be the last and be disappear before 6 years.

Weber and Jothy (1977) estimated the natural mortality coefficient (M) of *N. peronii* at 1.16 (S=0.3). This value was based on their analysis of age composition, but there was a problem in the process of this analysis. They carried out the normal distribution analysis using Cassie's method. But since they hypothesized that the number of age groups was 2 on the length range 8-20 cm in the original data, it seems that they underestimated the number of age groups. We therefore tried to reanalyze this data (Figure 6) eliminating those under 12 cm in length (the yearlings) because very few in number. When we calculated the total mortality coefficient (Z), we obtained the value 0.95 (S=0.39). This value is almost equivalent to the above M (S=0.4). Weber and Jothy (1977) mentioned that fishing pressure in the early 1970's may be regarded as having a negligible effect on the stock. The average annual catch of *Kerisi* from 1970 to 1973 shown in the Annual Fisheries Statistics was about 170 tonnes at its lowest estimate. Compared to the estimated annual catch of 4000 tonnes at present, it is correct to say the fishing mortality (F) in the past was very low. We therefore found that their M value might have been overestimated.

4. Age composition of catch and the fully available age

The results of breakdown of monthly size frequency distributions (Table 2) were pooled in quarters, into normal distribution by using the improved growth formula. Some age groups were not found in the result e.g. age groups 1 and 4 year-olds in the January-March (1993) sample, age groups 2 and 3 year-olds in the January-March (1994) sample and age group 3 in the April-June. (1994) sample. The apparent absence of these age groups does not always mean the actual absence of these age groups but rather we were not able to break the available data into these respective components for one reason or another. We have to consider that there were the catch from age groups 0-4 year-olds in January-March and 1-4 year-olds in April-June. We therefore summed up the number by age in both years in order to make up for the absent periods (Table 3). The reason is to correct the number of the younger age groups already over emphasized and which may give bias to others age groups (the relation between 1126 and 189, between 163 and 135 in Table 3). On the other hand, as there was not the common age group in January-March, the age composition was summed up simply one, two, and four years using the data from January to March, 1994 (Table 4). Calculated age composition between January to March (Table 5) was determined according to Table 3 of April-June by using the above result of 1994 (Table 4) and the data of January-March, 1993 (Table 2).

The age composition (%) by quarter is presented in Table 6. *N. peronii* accounted for about 30% of *Kerisi* while Table 7 shows the recent monthly and quarterly catch of *Kerisi* in tonnes. Finally, the quarterly catch in weight in Table 7 was converted into numbers. The percentage composition of each age group in Table 6 was converted into weights and then the ratio of each age group was calculated. Using these ratios, the quarterly weight in Table 7 were divided into respective age groups. Moreover, the weight of each age group was divided by the mean body weight in order to obtain age composition in numbers. The result indicated that the mostly available age was 2 years (Table 8). The mentioned individual body weight (W) by age was derived using the length-weight relationship. Calculation of length was based on the growth formula.

5. Stock-recruitment relations

Several surveys have been conducted in this area since the early 70's: once in 1970, 1980 and 1981; and twice in 1972. Reports from these surveys were used as references to assess the status of the stock in the past. As all these reports (with the exception of two reports in 1972 and 1981) used the same vessel and fishing gear and covered the same area, the results obtained can be used for mutual comparison. However, it is difficult to compare these early reports to the recent 1992 report. The catch rates in the early 1970's surveys (1970, 151 hauls; 1972, 144 hauls) were between 24-30 kg/hr while those in 1981 (78 hauls) was about 11 kg/hr (Pathansali *et al.*, 1974; Chang *et al.*, 1975; Ahmad Adnan, 1990). This shows the stock density in the early 70's is probably two to three times higher than that of 1981.

According to other trawl reports from this area, the average catch rate in 1972 of the genus *Nemipterus* was around 8.5 kg/hr (Abu Talib and Hayase, 1984) and in other year was around 8.4-11.2 kg/hr (Aglen *et al.*,1981) and 13.7 kg/hr (Department of Fisheries, 1987). While a recent report from the joint research between Malaysia and Thailand in the northern waters of the east coast of Peninsular Malaysia in 1992 gave the catch rate at only 4.5 kg/hr (Department of Fisheries Malaysia and Department of Fisheries Thailand, 1992). The trawl net used by Abu Talib and Hayase was four-seam trawl with head-rope about 36 m in length and were operated at a towing speed of 2.5-4 knots. While the trawl net of the joint research was horizontally opened about 20.5 m at a towing speed of 3.5 knots with the cod-end mesh of about 38 mm. Hence, to make simple comparisons between these two would not be suitable, but if the joint research net opening was about half of the head-rope (36 m) in previous report, it seems that the modes of operation were comparable. Therefore using the CPUE rate for all, the density in the past was about nearly twice as that in the present.

The increase in the catch between 1987 and 1988 suggest that the status between 1988 and 1992 might be different (Figure 1). Taken into account this phenomenon, the difference in density between the past (1970's) and the present (1992) is at least two to three times. Using the results, the recruitment stock in the past was about 460 millions and 690 millions in number respectively. And the adult stock was 501 millions and 752 millions in number respectively. As F in the past was very small, we can hypothesize that the recruitment and adult stock was at a saturation point in the stock-recruitment relation. We, then used the above values and made the following stock-recruitment relation:

Two times (case A) : $R = 1.13335 A \exp(-0.00000296288 A)$

Three times (case B) : $R = 1.12256 A \exp(-0.00000257505 A)$:

6. Analysis by production models

Analysis using the production models (Schaefer's and Fox's) gave very low values of r (0.44 and 0.43, respectively). While the residual values obtained from the two models were 0.43 and 0.19, respectively. The constant of fishing effort for both models were nearly equal and showed very low values (Table 9). Therefore when we estimated MSY and the fishing effort at the MSY level using these parameters, the result obtained was not significant. The MSY and fishing effort calculated were not much different for the two models- the MSY being about 5000 tonnes and fishing effort at around 3000 units.

The analysis using the production models ending in a weak result due to the data being few and to get data suitable for a model to be quite difficult. Stock parameters in the tropics are generally characterised by a variety of factors: (1) the age-character is not clear, (2) many spawning groups, (3) more than one spawning season annually, and (4) a long spawning period.

7. Analysis by steady analysis model

The present status (Table 10) shows the major available stock comprised two and three years age groups. The two age groups contribute about 70% of the total catch. If the total catch is about 20 % of the available stock, it seems that the exploitation rate is low. But sustainable yield (SY) curve using the mentioned stock recruitment relation support the diagnosis.

The SY curve (Figure 7) based on the mentioned two cases (i.e. A and B) of stock-recruitment relation, the curve formed a "dome-shape" leaning toward the left, while the status of the present fishery is situated on the right hand curve indicating overfishing. The level of overfishing in both cases was similar. The estimated maximum sustainable yield (MSY) of A and B is 5043 tonnes 5299 tonnes respectively. Overfishing is generally brought about from an *increasing* fishing effort while maintaining an increasing catch. Therefore by monitoring a serial changes in catch and fishing effort, we can judge the status of the stock. The increasing catch on the boundary between 1987 and 1988 as mentioned earlier recorded a maximum of about 6500 tonnes in 1988. It seems the main factor of overfishing was this temporary increase in catch. It is difficult to conclude because the possibility of over fishing is obvious both in these cases. But as both cases are similar in the status of overfishing, it seems usefull for further analysis. Accordingly as F at present is 0.37, the stock can recover at the MSY level in both cases (F=0.23-0.24) (Figure 7) when fishing efforts are cut down by about 35-38 % of the present.

On the other hand, if the stock management scheme include changes in the age at first capture, consideration should be made on the optimum scheme such as mesh size regulation. In this case the isopleth contour line of the sustainable yield is usually used as a decision tool (Figure 8). Using this figure, by raising the level of age at first capture slightly upwards in both cases, depletion of stock will hardly occur although some increase in fishing efforts may take place. Moreover, some positive economical effects may be expected due to a general increase in body weight of fish. On the contrary, lowering the level of age at first capture in both cases is dangerous and can bring real disaster on the fish stock. Trawlers on the west coast of Peninsular Malaysia discarded 40-65 % of the total catch as trash in recent years and prawn trawlers discarded *Nemipterus japonicus* under 12 cm in length (Mahyam, 1992). The present study on the east coast of Peninsular Malaysia shows the situation to be similar to that of the west coast. There is a direct relationship between depth of water and body size of fish caught (Weber and Jothy, 1977). For the stock management it is important to determine the actual situation in the fishing operations where the smaller fish are frequently captured.

In fact, the Beverton-Holt type analysis can also be applied on other demersal fishes with short spawning period, and do not migrate widely. It should be noted that an improvement in the biological information is needed for the analysis. We used many hypothesized biological parameters for this study, such as maturity rate, sex ratio and the differences in growth between sexes. However, it is necessary to improve the precision of these parameters. For that purpose, as the accuracy of an analysis is affected by varying level of precision, we need to examine the worst parameter first. The fishery on the east coast of Peninsular Malaysia is still under the developmental stage and we consider the management scheme through a proper diagnosis of their fish stock to be quite an urgent matter.

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Table 1. Results of biomass analysis of *Nemipterus peronii*

AGE (YEAR)	LENGTH (mm)	WEIGHT (g)	S=0.1 N	M=2.303 BIOMASS	S=0.2 N	M=1.609 BIOMASS	S=0.3 N	M=1.204 BIOMASS	S=0.4 N	M=0.916 BIOMASS	S=0.5 N	M=0.693 BIOMASS	S=0.6 N	M=0.511 BIOMASS	S=0.7 N	M=0.357 BIOMASS	S=0.8 N	M=0.223 BIOMASS	S=0.9 N	M=0.105 BIOMASS
1	148.00	40.4	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
2	199.00	98.2	100	243	200	486	300	729	400	972	500	1215	600	1459	700	1702	800	1945	900	2188
3	239.00	170.1	10	42	40	168	90	379	160	674	250	1053	360	1516	490	2063	640	2695	810	3411
4	270.37	246.2	1	6	8	49	27	165	64	390	125	762	216	1317	343	2091	512	3121	729	4444
5	294.97	319.7	0	1	2	13	8	64	26	203	63	495	130	1026	240	1901	410	3243	656	5194
6	314.27	386.7	0	0	0	3	2	23	10	98	31	299	78	745	168	1609	328	3137	590	5654

Table 2: Calculated age groups of *N. peronii* by quarters

Age (Year)	0+	1+	2+	3+	4+
1993 Jan. - Mar.	132		553	166	
Apr. - June			1126	189	
July - Sept		679	530	260	
Oct. - Dec.		683	367	121	
1994 Jan. - Mar.		734			157
Apr. - June		101	163		135

Table 3: Calculated age groups of *N. peronii* between April and June

Age (Year)	1+	2+	3+	4+
1993 Apr. - June		1126	189	
1994 Apr. - June	101	163		135
Total	101	1289	189	135
%	5.9	75.2	11.0	7.9

Table 4: Calculated age groups of *N. peronii* between January and March in 1994.

Age (Year)	1+	2+	3+	4+
1994 Jan.		149		54
Feb.	319			44
Mar.	277			48
Total	596	149		146
%	66.9	16.7		16.4

Table 5: Calculated age groups of *N. peronii* between January and March in 1993 and 1994.

Age (Year)	0+	1+	2+	3+	4+
1993 Jan. - Mar.	132		553	166	
1994 Jan. - Mar.		596	149		146
Total	132	596	702	166	146
%	7.6	34.2	40.3	9.5	8.4

Table 6. Percentage age groups of *N. peronii* by quarters

Age (Year)	0+	1+	2+	3+	4+
Jan. - Mar.	7.6	34.2	40.3	9.5	8.4
Apr. - June		5.9	75.2	11	7.9
Jul. - Sept.		46.2	36.1	17.7	
Oct. - Dec.		58.3	31.3	10.3	

Table 7. Catch in tonnes of Kerisi and *N. peronii* and average by quarter

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1991	688	616	1006	936	1057	999	1230	971	2000	1867	1324	735
1992	843	1150	1370	1141	1347	1006	1276	1476	1921	1755	895	698
Average		2834			3243			4437			3682	
N. peronii		850			973			1331			1105	

Table 8: Calculated age groups in the catch of *N. peronii*

Age (Year)	0+	1+	2+	3+	4+
Jan. - Mar.	465447	2094510	2468100	581809	514442
Apr. - Jun.		497594	6342210	927717	666269
Jul. - Sept.		6115680	4778700	2343020	
Oct.- Dec.		6248310	3354580	1103900	
Total		14956094	16943590	4956446	1180711
%		38.84	44.01	12.87	3.07

Table 9: Result of the production model of *N. peronii*

	Schaerfer's model	Fox's model
Regression line	Y= 3.58 - 0.000658 X	Ln Y= 1.4 - 0.000301 X
Residuals	0.439	0.194
Standard error		
Constant term	1.44	0.636
Fishing effort	0.000673	0.000298

Table 10 . Result of the steady model analysis

(1) Input data for the model

Longevity	Survival rate at present	Total mortality	Survival rate in virgin stock
5	0.27635	1.28607	0.4

Natural mortality	Fishing mortality	Exploitation rate	Full recruited age
0.91629	0.36978	0.2081	2

Age (Year)	Maturity (%)	Sex ratio (Female/total)	Availability
1	50	0.4	0.3183
2	85	0.4	1
3	100	0.4	1
4	100	0.4	1
5	100	0.4	1

(2) Present status

Age (Year)	Total stock		Available stock		Catch		Adult
	Number x 10^4	Weight Tonnes	Number x 10^4	Weight Tonnes	Number x 10^4	Weight Tonnes	number x 10^4
1	22990	7583	7317	2413	1523	809	11495
2	8291	7271	8921	7271	1725	1996	7048
3	2291	3614	2291	3614	477	900	2291
4	633	1472	633	1472	132	347	633
5	175	533	175	533	36	121	175
Total	34380	20473	18707	15303	3893	4173	21642

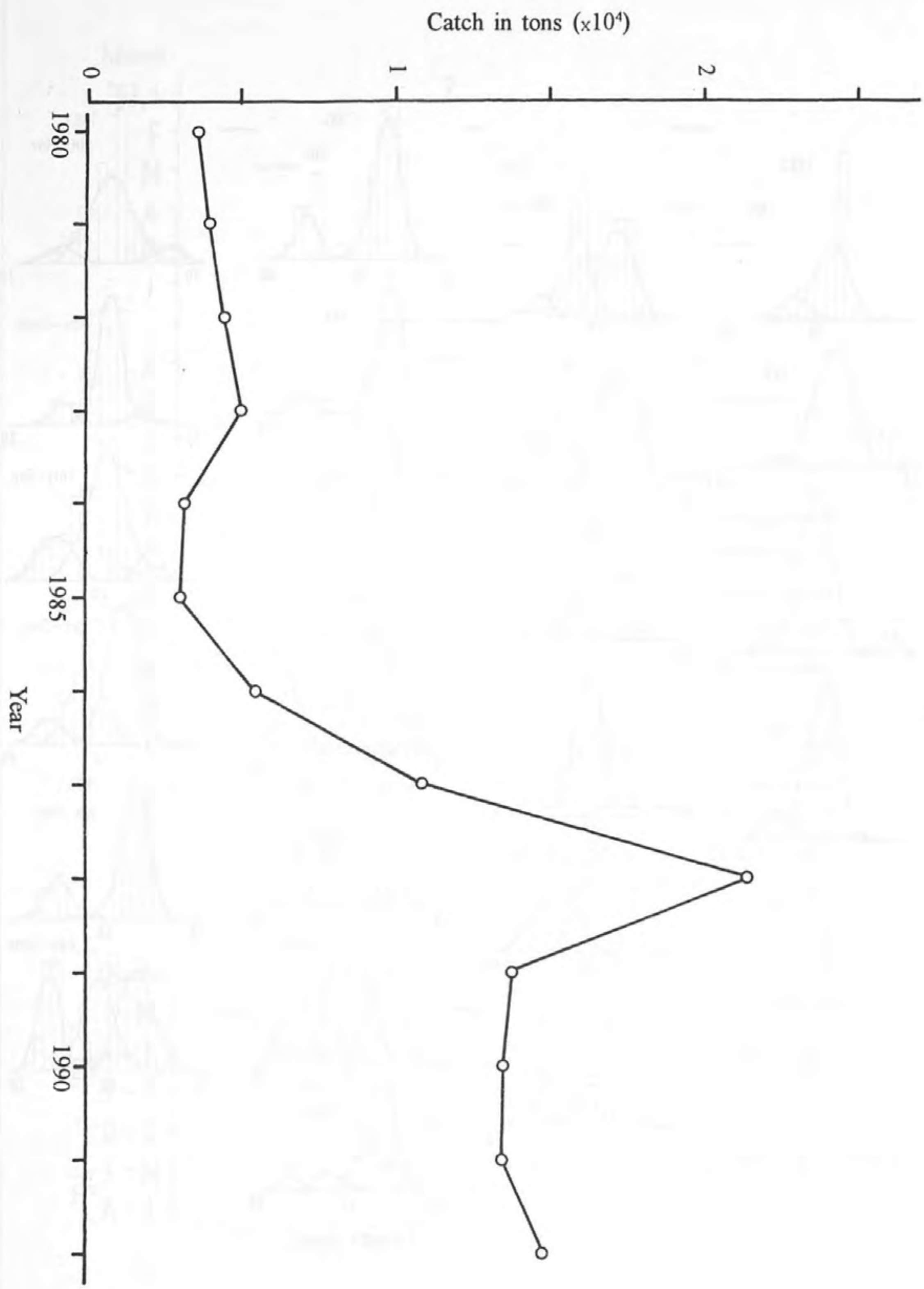

Fig. 1: Changes in the catch of Kerisi on the east coast of Peninsular Malaysia.

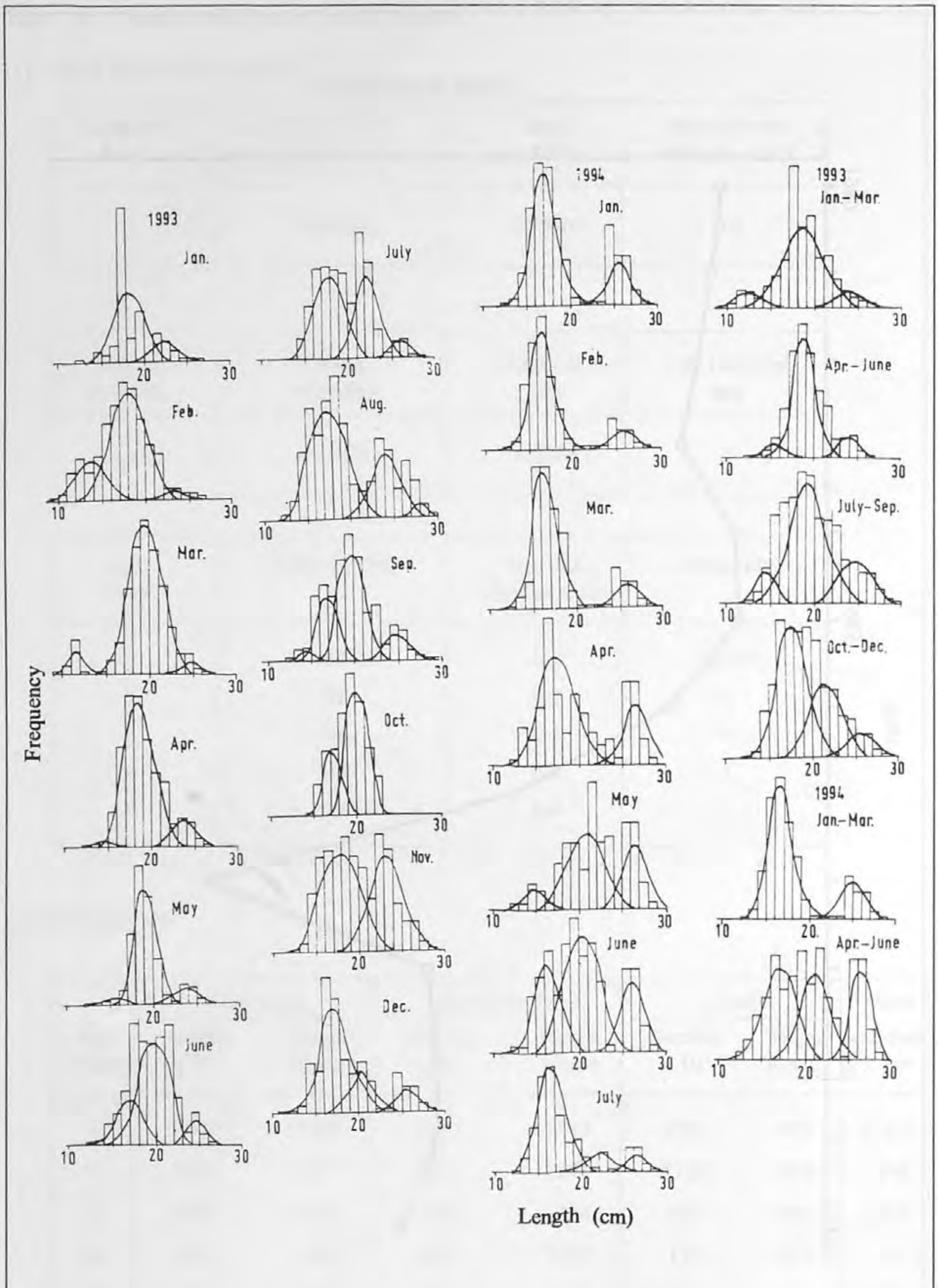

Fig. 2: Length - frequency distributions of *Nemipterus peronii* on the east coast of Peninsular Malaysia.

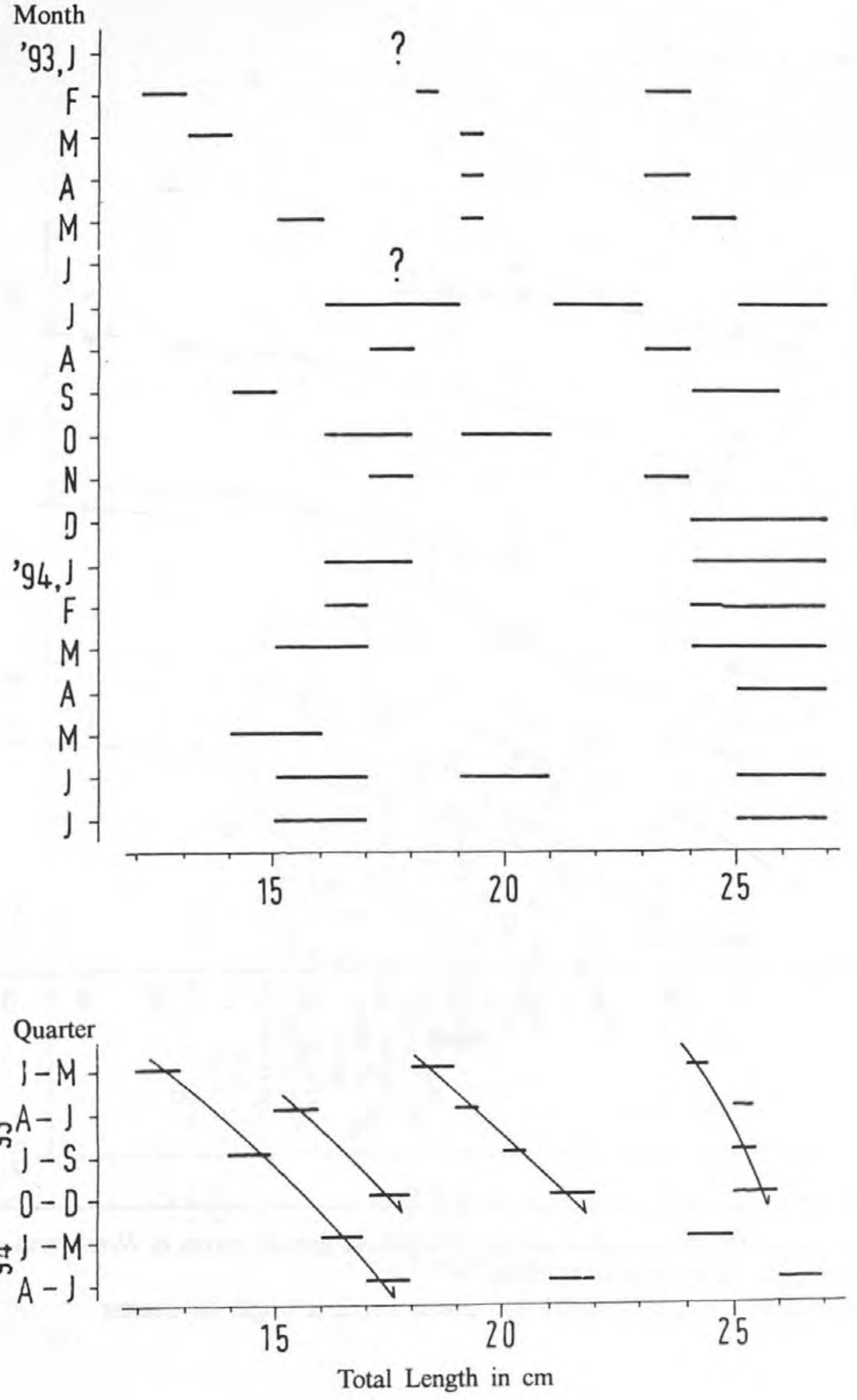

Fig. 3: Time-series trends of modes of length-frequency distributions of *Nemipterus peronii* on the east coast of Peninsular Malaysia.

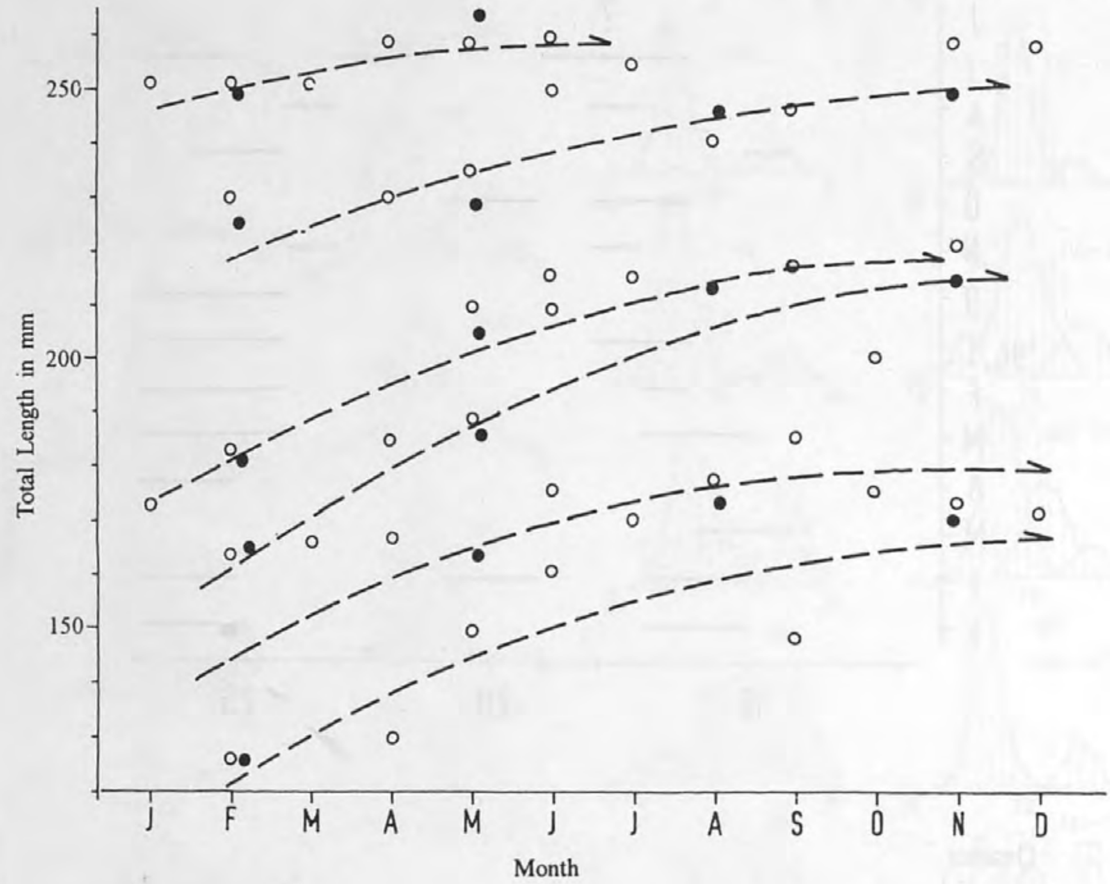

Fig. 4: Modes of normal distributions and the hypothetical growth curves of *Nemipterus peronii* on the east coast of Peninsular Malaysia.
Open - Cirle is length by month and closed - cirle is length by quarter.

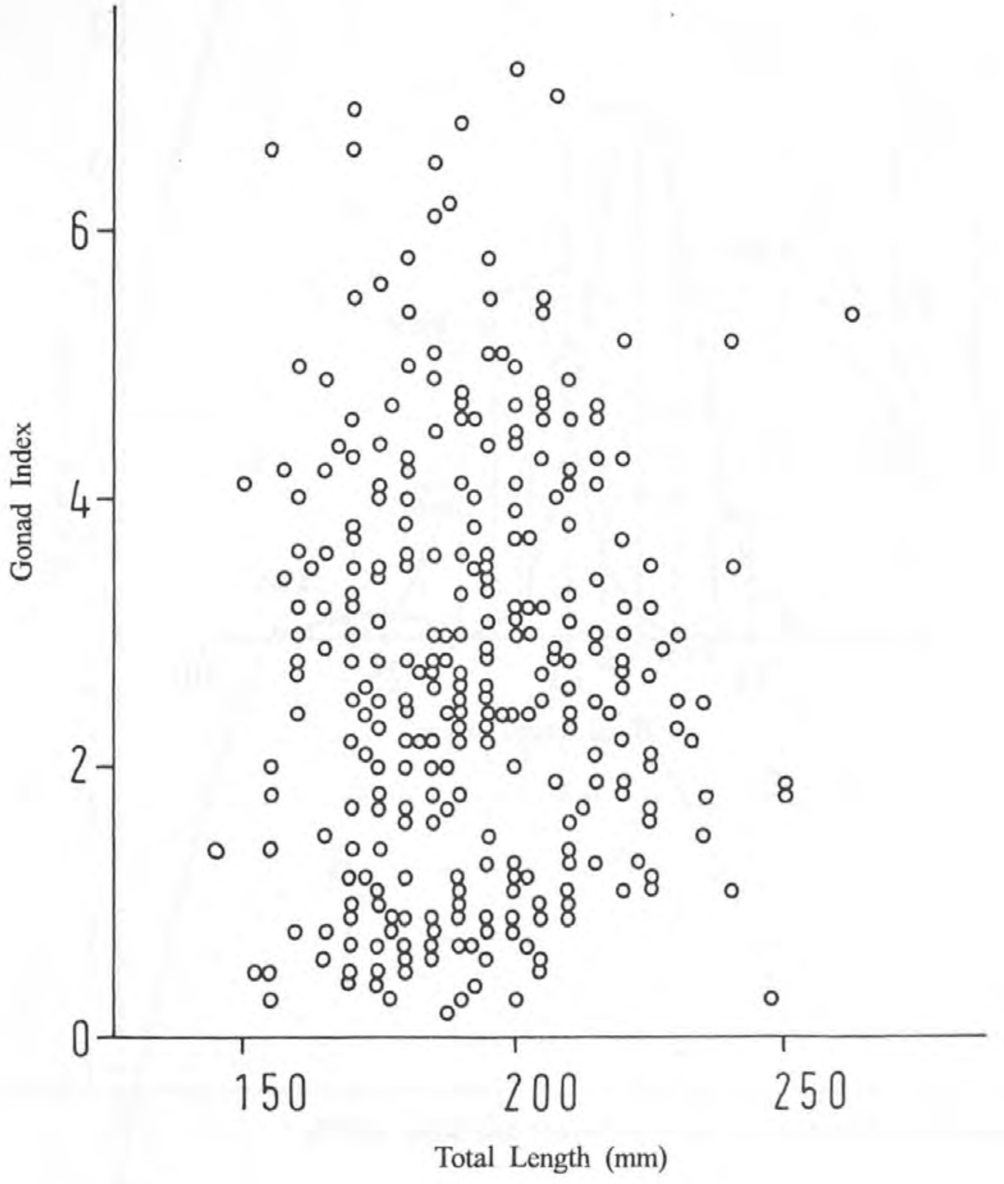

Fig. 5: Gonad indexes of *Nemipterus peronii.*

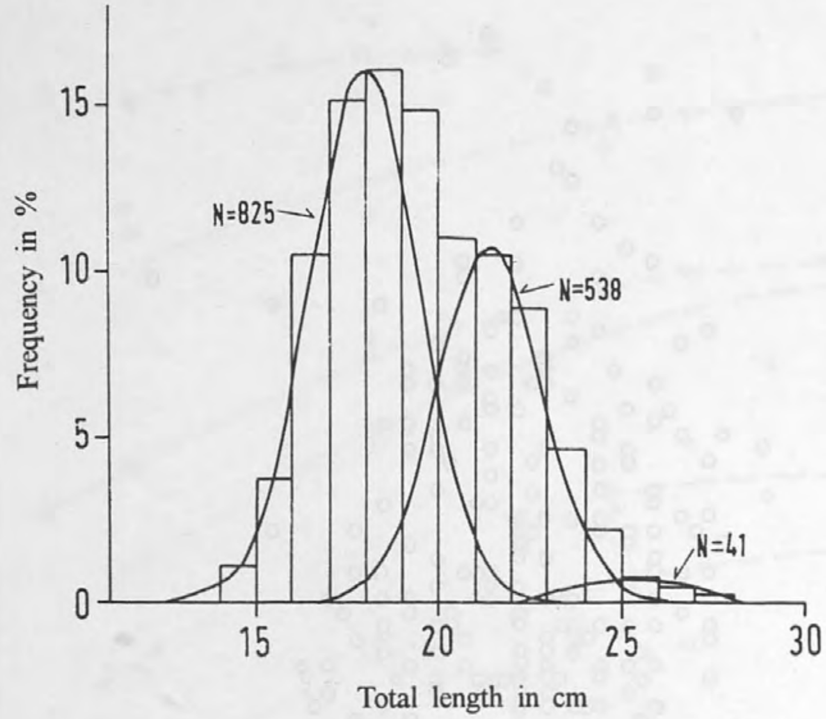

Fig. 6: Re-analysed result of the data from Weber and Jothy (1977).

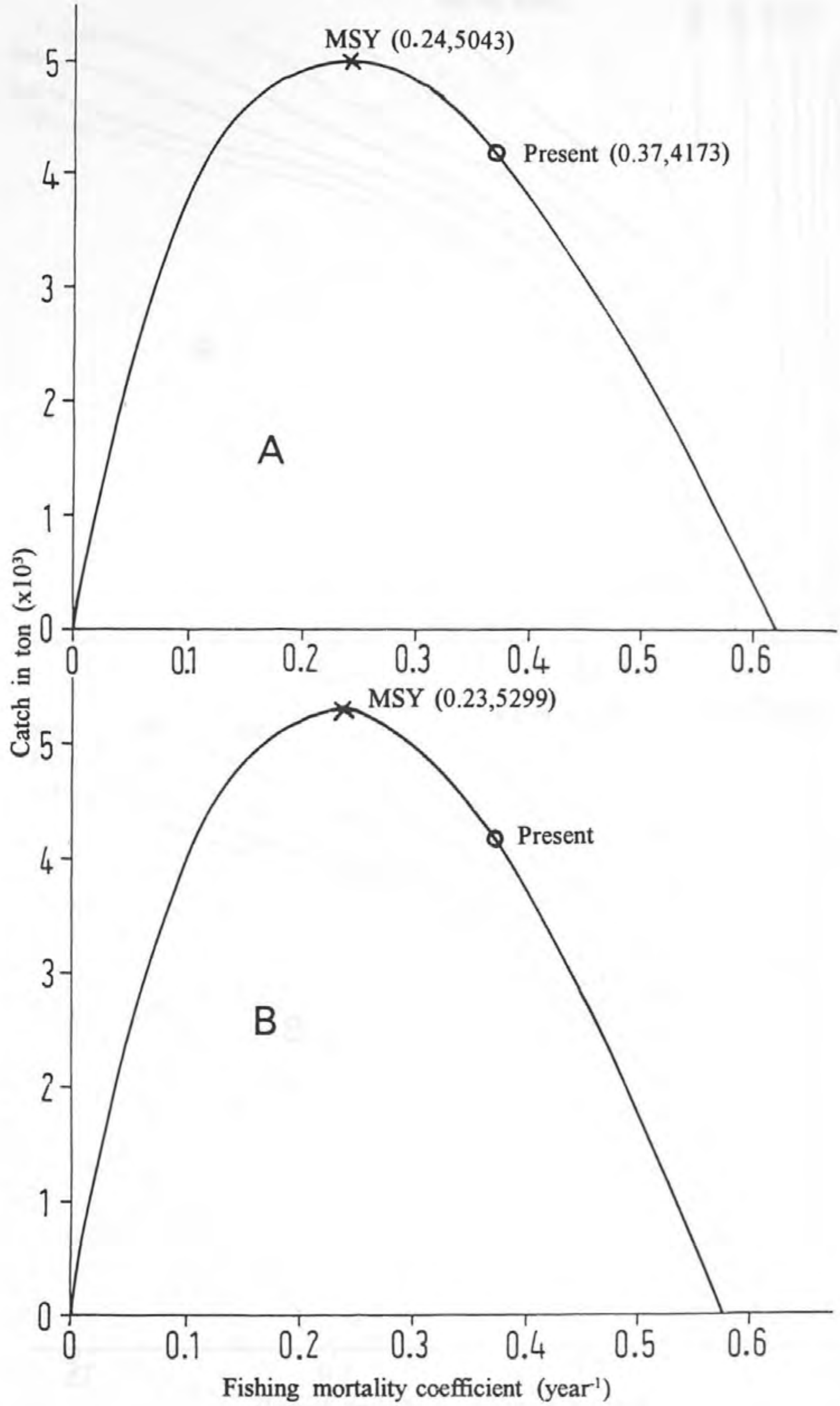

Fig. 7: Sustainable yield curves of two cases of recruitment of *Nemipterus peronii* on the east coast of Peninsular Malaysia.

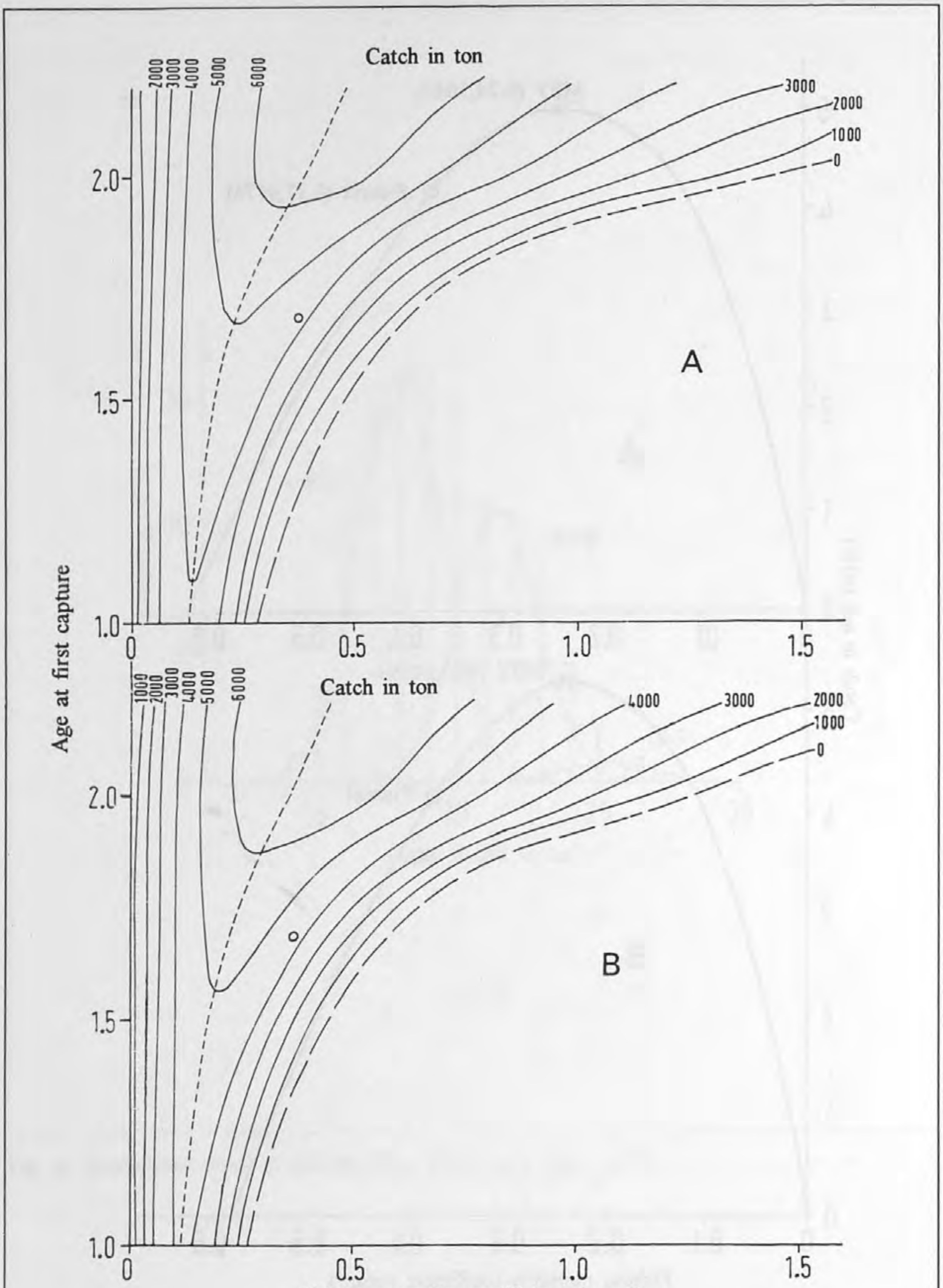

Fig. 8: Isopleth of the sustainable yield of *Nemipterus peronii* on the east coast of Peninsular Malaysia

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