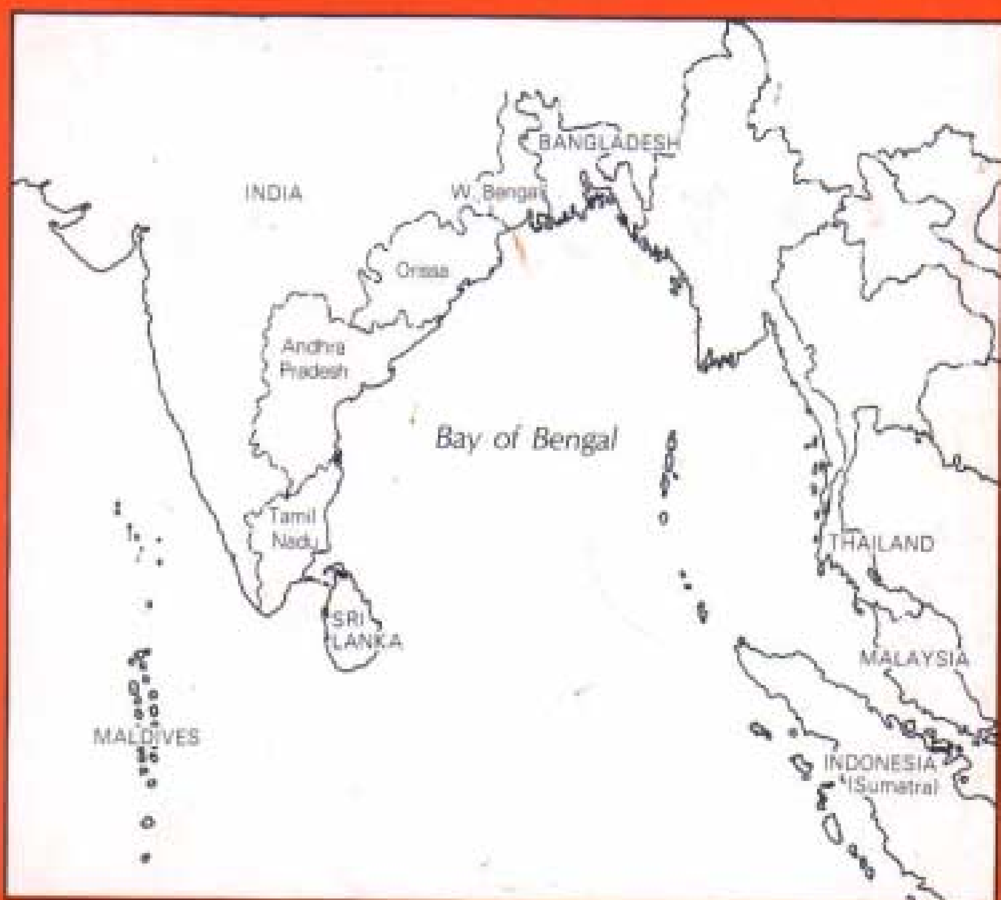
BAY OF BENGAL PROGRAMME

Marine Fishery Resources Management

BOBP/REP/40
RAS/81/051

Tuna in the Andaman Sea



UNITED NATIONS DEVELOPMENT PROGRAMME

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BAY OF BENGAL PROGRAMME BOBP/REP/40
Marine Fishery Resources Management RAS/81/051

TUNA IN THE ANDAMAN SEA

Executing Agency:

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This report summarizes available knowledge on tuna resources in the Andaman Sea area. It is based on cooperative investigations by Thailand and Indonesia, and on decisions and discussions at two meetings of a working group established for the purpose, all under the auspices of the Bay of Bengal Programme (BOBP). The meetings were held in Colombo, Sri Lanka (October 1985) and Phuker, Thailand (August 1986).

Technical and financial support for the tuna resource investigations and the two working group meetings were provided by the project "Marine Fishery Resources Management in the Bay of Bengal" (RAS/81/051), which was a component of the BOBP. The project commenced January 1983 and terminated in December 1986. It was funded by the UNDP (United Nations Development Programme) and executed by the FAO (Food and Agriculture Organization of the United Nations). Its immediate objectives were to improve the practice of fishery resources assessment among member countries (Bangladesh, Sri Lanka, Maldives Thailand, Malaysia, Indonesia) and to stimulate and assist joint management activities between countries sharing fish stocks.

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SUMMARY

One of the activities of the project "Marine Fishery Resources Management in the Bay of Bengal" was to assist in the assessment of exploited tuna resources in the Andaman Sea area. Indonesia and Thailand participated in this activity, and Malaysia provided information about her tuna fishery on the west coast of Peninsular Malaysia. One component of the work was a tuna sampling programme. This was conducted in conjunction with the study on mackerels (BOBP/REP/39) in view of limitations of personnel and funds.

On the west coast of Thailand, tuna is captured mainly by 180 mackerel-cum-tuna purse seiners and 30 gillnetters. There are no fisheries aimed solely at tuna, but tuna are an important constituent of mixed-target fisheries. Estimating the tuna landings is somewhat problematic, as the burgeoning tuna canning industry, which consumes a substantial proportion of the catches, does not readily provide facts and figures on the sources of its supply. A few of the purse seiners seem to concentrate on catching tuna.

In Indonesia, the tuna fishery around Sumatra is mainly the troll fishery with about 170 boats on the west coast and some 200 boats purse seining in the north. Production in the west coast of South Sumatra Province is greater than in Banda Aceh and the west coast of North Sumatra Province.

In Malaysia, 300 to 400 purse seiners for small pelagics account for the bulk of tuna landed as incidental catches. The landings are primarily in Perlis, Kedah, Penang and Pangkor.

Despite the proximity among of the EEZs of the three countries, there are substantial differences in catch composition, largely due to the limited exploitation of the EEZs and the ecological differences between them. Catch compositions in the west coast of Peninsular Malaysia and the west coast of Thailand are however somewhat similar. The north and west coasts of Sumatra, which have an oceanic frontage, have access to skipjack and yellowfin tuna while the other two countries catch mainly insular species such as eastern little tuna, frigate tuna and longtail tuna.

Purse seine catch rates for tuna off Banda Aceh. though tuna catches are incidental, were higher than troll catch rates off the west Sumatra coast. The troll catch rates, however, were surprisingly higher than rates achieved elsewhere in the Indian Ocean. The catch rate at Banda Aceh was also higher than that for Thai and luring purse seines in Thailand.

In general, production fluctuated during 1980-1985, in the areas studied, without any noticeable trend, probably due to the absence of a specific fishery for tunas except on the west coast of Sumatra. Off Banda Aceh, the production of skipjack and small tuna showed a steady increase from 1977 to 1985. In Malaysia, the highest annual tuna production appears to have been in 1980, and in Thailand, production of small tuna seems to have increased from 1979 to 1985.

Seasons of good tuna catches are : Thailand — November to April ; Sumatra — June to August for most species; west coast of Peninsular Malaysia -April, May and August.

Only limited length frequency data are available in the study area and modal progressions are not very clearly evident in purse seine and troll catches and growth parameters estimated using the length frequency data available are not very satisfactory.

Peak maturity seasons for various tuna species are: longtail — January-April and August-September; eastern little tuna -January-April and August-December; frigate tuna — March (?) and September (?). Data available on peak seasons of occurrence of each species and their sizes in the areas studied were not sufficient to postulate any migration pattern.

Further, it is difficult to estimate the maximum sustainable yield of various tuna species with the data base available.

There is very little evidence that Thailand and Indonesia share stocks of *Auxis* and Euthynnus species; these are, in any case, insular species. Sharing of skipjack, longtail and yellowfin tuna stocks is likely to occur when the fishery expands towards the common EEZ boundaries.

1. INTRODUCTION

One of the activities of the FAO/UNDP project for "Marine Fishery Resources Management in the Bay of Bengal" was to assist in the assessment of exploited tuna resources in the Andaman Sea area. Initially it was anticipated that India would participate with Thailand and Indonesia in this programme; Malaysia was not interested because of the limited tuna potential off the west coast of Peninsular Malaysia. India's participation, however, did not materialise. There were delays in starting the work because of the limited number of biologists available in the countries that could be assigned to the investigations. Eventually, some of the biologists involved in the project's mackerel study in the Malacca Straits (BOBP/REP/39) had to participate in the tuna investigation programme also, and the tuna sampling programme was combined with that for mackerels*.

A meeting of a working group with biologists from Indonesia and Thailand was convened in Colombo (Sri Lanka) in October 1985, to discuss the information collected and improvements required. The second meeting of the working group was held in Phuket (Thailand) in August 1986. Malaysia participated actively in the second meeting and presented a working paper. The findings of the field investigations and the discussions at the two meetings are incorporated in this report. The materials from the participating countries used during the two meetings figure as annexures to this report.

The list of participants in the two meetings is given in the Appendix.

2. SAMPLING PROGRAMME

For reasons mentioned above, the tuna sampling programme was combined with the mackerel sampling programme in both Indonesia and Thailand. The sampling centres on the west coast of Thailand were the landing ports of Ranong, Takuopa, Tarmuong, Phuket, Krabi, Trang and Satul. In Sumatra, samplings were done at Banda Aceh, Padang and Lhok Sumawe, which are the primary tuna landing places. Samplings at landing places in Thailand were done twice a month while in Sumatra, they were undertaken daily. Samples were taken for catch, effort, species composition and length frequencies, during 1985/86.

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*The areas covered by the sampling programme were the west coast of Thailand and West and North Sumatra provinces of Indonesia. Malaysian data cover the west coast of Peninsular Malaysia.

3. THE FISHERIES

The tuna production on the west coast of Thailand is accounted for primarily by purse seines and gillnets, which have several mixed target species such as mackerels, scads, hardtails, tuna and king mackerels. Hence the effort is not specific and may be considered to be equally directed on all these species. This being the case, fishing is done generally in areas where most of these fish occur and not specifically in areas where only tuna are abundant. Thus the fishery does not extend up to its outer EEZ boundary. The landings are higher in the southern part.

Purse seining for tuna showed an increase in 1985/86. Some mackerel purse seiners operate with tuna as the target species; some larger vessels operate larger purse seine nets, aimed at catching tuna, with a larger mesh size than in the mackerel nets. Because of the demand for tuna from canneries, catches are sometimes transferred directly to the cannery, either by trucks or by fishing vessels. As a result, estimation of the landing has become problematic: the tuna canneries do not readily provide facts and figures on the sources of their supplies. Since tuna are the target species in some instances but incidental catches in others, estimation of realistic effort values is also causing some anxiety.

The luring purse seiners are more popular than the Chinese purse seiners. The former belong to three different classes — < 14 m, 14-l 8 m and >18 m. The larger class is the most numerous among the estimated 183 mackerel-cum-tuna purse seiners. Some 30 gillnetters belonging to similar size ranges also contribute to the tuna landings.

The fishing area has expanded from the northern to the southern coast. Production figures show that Takuopa and Taimuang areas north of Phuket contributed a little less to the total landings than areas south of Phuket in 1985.

The Indonesian fishery around Sumatra is primarily a troll fishery off South Sumatra province (Padang) and a purse seine fishery in Banda Aceh and Lhok Sumawe. The production is higher on the west coast of South Sumatra province than in Aceh and the west coast of North Sumatra province ; sometime ago, the highest was in Aceh but the production seems to have declined slightly over the years, while it has increased in West Sumatra. Production in Indonesia is higher than in Thailand.

On the west coast of Sumatra, trolling boats range from 7 to 18 m in length (16-55 hp). Of about 170 boats, 60 are small in size (20 hp). Some 200 (mainly 15 m LOA) mackerel and tuna purse seiners contribute to the tuna production from other areas such as Banda Aceh and Lhok Sumawe. In addition, about 800 units of gillnetters make a relatively small contribution to tuna catches. The number of small boats (smaller than 20 hp) involved in the troll fishery for tuna has increased by 30% between 1980 and 1985 but there is no increase in the number of larger boats (larger than 20 hp). No significant differences in the catch rates of these two classes of boats were observed, as they appear to be operating in the same fishing grounds and with a similar number of trolling lines.

No significant or noteworthy changes were observed in the tuna catches on the west coast of Peninsular Malaysia. About 300-400 mackerel purse seiners (15-25 m) continue to be the main contributors to the production; hence landings are primarily in Perlis, Kedah, Penang and Pangkor and catch rates do not appear to have changed since 1980 or even earlier.

The mackerel-cum-tuna catching purse seine nets have the following dimensions.

		Thailand	Malaysia	Sumatra
Length	(m) .	400-1200	400-800	400-1200
Depth	(m) .	50-120	80-120	20-60
Mesh Size	(mm).	20-90	25	25-90

4. SPECIES COMPOSITION AND DISTRIBUTION

Skipjack *(Katsuwonus pelamis)* and yellowfin tuna *(Thunnus albacares)* are the dominant species in the troll fishery off the west coast of Sumatra. Eastern little tuna *(Euthynnus affinis),* frigate tuna *(Auxis thazard)* and bigeye tuna (Thunnus obesus) are other species that make noticeable contributions to the production in that area. Frigate tuna, skipjack and longtail tuna appear to be dominant in the Banda Aceh area. Frigate tuna, eastern little tuna and the longtail tuna (Thunnus tonggol), are the dominant species in Thailand. Yellowfin and bigeye tuna are completely absent in the Thai production. In spite of the proximity of the two EEZs, there are significant differences in catch composition that are due to the limited exploitation of the EEZs and the ecological differences in the two EEZs. The composition in Malaysia is similar. to that of Thailand.

Composition of the tuna species caught by Thailand, Malaysia and Indonesia in the Andaman Sea area (percentage).

	FT	ELT	SKJ	LOT	YFT	Remarks
Thailand	54	28	0	18	N	Purse seine catch
Malaysia	10	30	0	60(?)	N	Purse seine catch
Indonesia						
W. coast of Sumatra	5	4	78	x	13	Troll catch
N. coast of Sumatra	53	NA	27	20	x	Banda Aceh (only 5 monthsdata P. seine)
E. coast of Sumatra	x	x	N	x	N	P. seine

FT = Frigate tuna

ELT = Eastern little tuna

SKJ = Skipjack tuna

LOT = Longtail tuna

YFT = Yellowfin tuna

X = Species present but no estimate available

N = No landings

NA = No information available

The north and west coasts of Sumatra, which have oceanic frontage, have access to the skipjack and yellowfin tuna. The other areas show similarities in the species caught. However, the occurrence of longtail and yellowfin tuna in the surface fishery off Banda Aceh has to be verified, as also perhaps the very high percentage of longtail tuna in Malaysia.

Frigate tuna and eastern little tuna are distributed widely in the Andaman Sea and Malacca Straits, except in the extreme southern part. The longtail has a similar distribution but is evidently *more* concentrated in the north, along the coast of Thailand. Longtail tuna does not appear to be a common species on the west coast of Sumatra, though it may be caught close to Banda Aceh. The catch rate (in number of fish caught) of larger tuna declines from north to south, in the area studied, much more rapidly than that of smaller tuna. Skipjack and yellowfin are found off the west coast of Sumatra and further north around and beyond the Andaman islands, but a suitable fishery for these species does not exist in the area at present.

5. CATCH RATES

Catch/boat/day in the troll fishery off the west coast of South Sumatra (small craft 84.6 kg/day and large craft 133 kg/day) is not higher than the catch/boat/day in the purse seine fishery in Banda Aceh (345 kg/day) despite the fact that tuna are incidental catches of purse seiners. However, the troll catch rates are considered very good in comparison with levels in other areas of the Indian Ocean. Surprisingly, the proportion of frigate and eastern little tuna in the troll catches is very low, compared with the pattern elsewhere, such as in Sri Lanka or Seychelles. This may be due to the use of single hook type troll lines as against the multiple hook types which are extremely effective on these smaller species.

The annual catch rate of tuna in the purse seine fishery of Thailand, for the years 1978 to 1985, appears to show heavy fluctuation, without any steady trends (83 — 222 kg/day; 95 kg/day, in 1985), because tuna is not the only target species in this fishery.

The purse seine catch rate in Banda Aceh (1984/85) appears to be higher than that of the Thai and luring purse seines in Thailand.

Experimental tuna purse seining by the Japanese Marine Fisheries Resources Research Centre, between 1979 and 1983, off the west coast of Sumatra showed the catch composition to be similar to that of traditional fisheries (Watanabe, Y. 1985) *. The catch rates in the offshore range exhibited the presence of reasonably large sized schools in the area, The catch per set during different seasons were as follows.

March — May 1979	9.3 t
May — July 1979	6.9 t
January — February 1980	12.1 t
March — April 1980	7.7 t
May — June 1980	15.0 t
July — August 1980	Very poor results, few sets outside EEZ
October — December 1981	13.1 t (one set with 50t)
November 1982 — March 1983	12.9 t

* Watanabe,Y., 1985. Review of experimental purse seine operation in the Indian Ocean by Japan Marine Fisheries Resources Research Centre. Expert consultation on stock assessment of tuna in the Indian Ocean. 28 Nov. — 2 Dec. 1985 Colombo, Sri Lanka. Compilation of working documents, TWS/85/24 ; pages 141-149.

6. PRODUCTION TRENDS

The annual tuna production in the three areas has been fluctuating largely because the fishing effort has not been systematically directed on the tuna except in Sumatra. In Thailand, the production of longtail tuna fluctuated between 745 metric tons and 3,188 m. tons in the period 1979-1985. The range of production was between 1,002 mt and 4,701 mt in Malaysia between 1972 and 1983 while it was between 10,857 mt and 17,938 mt during 1976-l 984 in Indonesia.

However, off Banda Aceh, the production of small tuna and skipjack shows a steady increase from 1977 to 1985. Banda Aceh had higher production than the west and east coasts of Sumatra. In Malaysia the production appears to have peaked in 1980, with Perak recording the highest monthly production. In Thailand, no clear trends were observed in overall production and in the production of longtail tuna, but the production of small tuna has increased steadily from 1979 to 1985.

7 . SEASONALITY

The seasons of good tuna catches or high catch rates in Thailand, Malaysia and Indonesia are summarised below :

Area	Peak Season	
Thailand	November to April	
Indonesia	June to August for most species; also November to April for some species	
Banda Aceh	Yellowfin -August and November	
	Skipjack -August, September and January, February.	
	Auxis spp. -August and January-February	
Padang	Yellowfin	— May
	Skipjack	— August
	Frigate tuna	-August
Malaysia	April, May and August	

Seasonality not well defined in Thailand probably because the effort was not specifically focused on tuna alone.

8. SIZE COMPOSITION

Length frequency distributions are available for four species occurring in the study area but they do not cover the entire Malacca Straits and the Andaman Sea area. They do not represent the wide size ranges commonly observed for the same specie= elsewhere. Very small sizes of small tuna that are known to occur are not well represented in the length-frequency samples and very large sizes are not evident, probably because they are found further offshore and outside the Malacca Straits waters. Larger sizes have been recorded for small tuna and skipjack on the west coast of Sumatra. Longtail tuna of over 50 cm is rarely caught in the area, and it is conjectured that it emigrates from the area on reaching that size. Modal progressions are also not clearly evident in the samples from purse seines and troll lines. It is probable that small-sized small tuna aggregating with larger-sized mackerels constitute the major component of their catch. The use of mackerel purse seines with small mesh size permits the capture of juveniles which are observed frequently as incidental catches.

Japanese purse seine trials between 1979 and 1983, off west Sumatra, indicated that the skipjack caught were of the medium size range (46-52 cm) and small size range (32-36 cm), with occasional large size (60 cm) fish. The proportion of small size fish increased from February to March. In June, medium size fish disappeared and only small ones remained.

9. GROWTH PARAMETERS

Some length-frequency data, collected during the BOBP-assisted sampling programme, were available for frigate tuna, eastern little tuna, skipjack, longtail tuna and yellowfin tuna from certain locations within the study area and were analysed using the ELEFAN I program. The results obtained from the 1985 and 1986 data are presented below.

Growth parameters for frigate tuna (FT), skipjack (SKJ) and yellowfin tuna (YET) off the west coast of Sumatra and for frigate tuna, (FT), eastern little tuna (ELT) and longtail tuna (LOT) on the west coast of Thailand

	West coast of Sumatra			Thailand				
	FT	SKJ	YFT	FT		ELT		LOT
	1985	1986	1986	1985	1986	1985	1986	1986
Growth constant value K/annum	0.85	0.62	0.50	0.84	0.63	0.84	0.60	0.45
Asymptotic length L_∞ cm	62	86	170	41	44	43	48	95

The Indonesian data gave relatively high asymptotic length (L,) values, while Thailand data showed relatively low values, influenced mainly by the small maximum sizes observed in the samples. This has influenced the K values obtained.

Application of the Bhattacharya method (for the separation of modal groups) and the Ford-Walford plot gave the following results for Thailand :

Growth parameters of longtail tuna, eastern little tuna and frigate tuna in Thailand

	LOT	ELT	FT
Asymptotic length (L, cm)	61.7	54.8	46.6
Growth constant (K)	0.59	0.51	0.56

it was observed that the L_∞ values derived by this method also were rather low, especially for longtail and frigate tuna. This may be due to the small sample sizes and their narrow size ranges. No longtail tuna were measured above 50 cm, and the longest frigate tuna in the samples was 40 cm. Not more than 2 or 3 modes, representing year-classes, were identified while using the Bhattacharya method ; this led to very few data points for the Ford-Walford plot. In one eastern little tuna length-frequency distribution three modal groups were recognised, resulting in the estimation of growth parameters, although L_∞ values still seemed low.

Although the results in this study were not very satisfactory due to inadequacy of the length-frequency sampling, the ELEFAN methods have proved their applicability to length-frequency data with wider-size ranges in other countries.

In the case of longtail tuna in Thailand, if we assume that the first modal group in the spawning season represents one-year-old fish from the previous spawn of the same cohort, then the modal groups identified are as follows:

Cohorts of spawning season	Group I	Group II	Group III
February-March	19.5-24.4 cm	31.4-31.9 cm	44.4 cm
September- December	23.5 cm	37 cm	40.6-45.1 cm

However, if the first group observed in one spawning season is from the cohort of the preceding spawning season, it will be less than a year old (about 6 months) and the second group, would be about one year old.

Yesaki (unpublished), using the length-frequency of longtail tuna caught during the pole and line survey on the west coast of Thailand, estimated the growth parameters as K-0.38 and L_∞ =95 cm. He also infers that fish of 30 cm and 47 cm length are one and two year-old fish respectively and that the age at maturity is two years,

10. MATURITY AND SPAWNING

Fish egg and larval surveys conducted between February 1980 and July 1981 off the west coast of Thailand showed the presence of relatively higher concentrations of longtail tuna larvae during February than during March and April, and their absence in other months, Gonad maturity stages studies in the same area during the UNDP/FAO pole and line fishery survey* showed the following peak seasons of maturity :

Longtail tuna : January-April and August-September

Eastern little tuna : January-April and August-December

Frigate tuna : March ? September?

* Anonymous, 1985 : Tuna resources and fisheries in Thailand, Department of Fisheries, Bangkok, Thailand.

It is felt that the main spawning season for longtail is around January according to the number of ripe and spent fish in the catches, and this is supported by the larval abundance in February. Eastern little tuna also records a major spawning in February-April.

These results are also supported by the occurrence of juveniles of eastern little tuna and frigate tuna (1 O-l 5 cm) in the purse seine catches in Thailand, Malaysia and North Sumatra in April/May.

11. SEASONAL MOVEMENTS

The peak seasons of occurrence of each species and their sizes in the various areas covered by this study were investigated by tabulating the production, the catch rates and the size compositions during the peak seasons by area. The data available were not enough to bring out any pattern of distribution. However, since larvae of longtail tuna have been observed within the area, the presence of longtail tuna juveniles close to all thiee countries is possible. The larger size group, about 50 cm in fork length, has been observed off Thailand. It is believed that fish of this size may be migrating out of the area, northward, or moving into a deeper-swimming layer in the Bay of Bengal. L *ongline* surveys conducted by Thailand in 1985 in the Andaman Sea area failed to show evidence of their occurrence in the deep swimming layers. Even the frigate tuna and eastern little tuna appears to spawn within the Andaman Sea and Malacca Straits areas, and juveniles of these species were a!so observed off the coasts of all three countries at the same time of the year.

From these observations, it is indirectly inferred that these three species are distributed widely in the Malacca Straits and the Andaman Sea, that they move freely within the area and inter-mingle to form one entity. In Banda Aceh, one notices phenomena observed in both Malacca Straits and the west coast of Sumatra. On the west coast of Sumatra, the ecology and species distribution are regarded as typical of an open sea environment. Pole and line (live bait) surveys done by FAO during 1979-1981 and tuna longline surveys carried out by Thailand in 1985 beyond the shelf area of the west coast of Thailand have also shown occurrence of skipjack and yellowfin tuna respectively.

The longtail tuna and the eastern little tuna may be regarded as the two primary contributors to the tuna resource on the continental shelf araa off Thailand, Malaysia and the east coast of Sumatra. Beyond the continental shelf, skipjack and yellowfin tuna may be available for exploitation in the north and west coasts of Sumatra, opposite the west coast of Thailand.

12. MAXIMUM SUSTAINABLE YIELD AND EXPLOITATION RATE

Attempts have been made to estimate the maximum sustainable yield and the exploitation rate by applying production models and the ELEFAN II program respectively, at a national level. It was noted that the validity of these methods for resources such as tuna that are highly migratory and found beyond the EEZs of most countries, depends on the coverage of the area of distribution for the data required. For example, stocks of eastern little tuna and frigate tuna are found distributed along the entire Malacca Straits ; the MSY analysis for these species should be based on data from the whole area. In the case of longtail tuna, the area of distribution is expected to be much wider, and extends outside the Malacca Straits. But effective application of these methodologies is difficult because the extent of the distribution is unknown, and information on the catches of this species from adjacent areas is absent. For the yellowfin and skipjack tuna on the west coast of Sumatra, the distribution of stocks may be even wider, while the extent of the exploitation outside this coast is unknown.

Difficulties also exist in estimating the tuna fishing effort of purse seiners which fish for many other species and thus form a mixed species fishery. There is a need for direct estimation cf fishing effort based on criteria to be identified for classifying the effort on the various species and for standardizing the effort for each group of fish.

There are strong possibilities of expanding the tuna fisheries on the west coasts of Sumatra and Thailand, but perhaps this cannot be said about Malaysia because of the shallowness of the EEZ.

13. TUNA LONGLINE CATCH TRENDS IN THE ADJACENT AREA

The hooking rates of yellowfin and bigeye tuna in and around the Andaman Sea area were extracted from the computer printout provided by the Indo-Pacific Tuna Programme (Tables 1 and 2). The monthly hooking rates indicated that the first half of the year is better than the second half for both bigeye and yellowfin tuna in this area.

The annual hooking rates for both species fluctuated widely without a clear trend. The hooking rate for yellowfin tends to decline towards the equator, whereas that of bigeye tuna appears to increase. Korea achieved equally good hooking rates for bigeye tuna, even in the higher latitudesof the Bay of Bengal, unlike Japan and Taiwan. The Korean longline fishery does not exhibit a consistently higher hooking rate for bigeye tuna than the Japanese or Taiwanese fisheries in all the five grids within the area.

Mean weights of bigeye tuna recorded by the Taiwanese longline fishery tend to show an increase towards higher latitudes; this may influence the performance of the gear fishing at different depth ranges.

Thailand is conducting experimental tuna longline operations in its EEZ on the west coast. Indonesia has closed down its longline base on Sabang Island, north of Sumatra.

14. SHARED STOCKS

There is very little evidence of sharing of tuna stocks by Thailand and Indonesia at present, as the production is primarily of *Auxis* and *Euthynnos* species. These being more insular, the stock may be independent. However, expansion of their fishery towards the common EEZ boundary would lead to exploitation of skipjack, longtail and perhaps yellowfin tuna, and these are very likely to belong to common stocks.

15. RECOMMENDATIONS

1. Tuna production estimates are at present made largely by statisticians. Scientists too need to be involved in arriving at independent production estimates.
2. Fish egg and larval surveys should be continued and expanded to cover other areas and seasons.
3. The quality of the statistics collected should be improved and sampling programmes should be intensified and the coverage made broader. Expansion of data collection calls for removing personnel and financial constraints that now exist. It is also necessary for biologists to participate in sampling programmes to improve the quality of sampling.
4. A newsletter or similar material may have to be used to enlighten field officers and fishermen on activities relating to research data collection and the benefits that arise therefrom. This should help secure the cooperation of fishermen in data and information collection.

5. In view of the tuna production level in Malaysia, the attention of the Malaysian Fisheries Research Institute may be drawn to the need to establish a tuna sampling programme.

6. In Thailand, tuna investigation on the west coast is one of the priority areas in fisheries; it is suggested that activities such as intensive survey of spawning areas, estimation of biological parameters and tagging will be carried out.

Table 1

Catch rates of yellowfin tuna (Number/l000 hooks) in the Japanese, Korean and Taiwanese tuna longline fishery in the area — 90-100°E and 0°-15°N

5" x5" Grid		1976	1977	1978	1979	1980	1981	1982	Number/ 1000 hooks (Average)
95°-100°, 10°-15°	J	2.7	—	—	—	—	—	—	2.7
	K								
	T								
95°-1 00°, 5°-10°	J	0	0	0	1.3	—	—	—	1.3
	K	3.9	—	13.7	6.6	2.3	—	—	8.0
	T								
95°-1 00°, 0°-5°	J								
	K	3.8	3.7	4.0	3.2	1.8	—	—	3.5
	T	—	—	—	—	2.3	—	1.8	2.1
90°-95°, 10°-15°	J								
	K	—	—	2.1	—	9.6	—	—	8.8
	T	—	—	—	5.6	—	0.5	6.4	3.8
90°-95°, 5°-10°	J	1.9	—	0	3.8	—	—	—	1.4
	K	3.8	9.6	2.3	2.4	3.3	—	—	3.9
	T	—	—	1.9	1.2	1.9	3.3	1.6	2.6
90°-95°, 0°-5°	J	0	—	6.1	7.7	3.7	—	—	6.1
	K	5.6	5.6	4.1	2.9	1.5	—	—	3.5
	T	—	—	4.3	2.8	3.1	2.4	2.4	2.8

J -Japan K–Korea T -Taiwan

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Table 2

Catch rates of bigeye tuna (Number/1000 hooks) in the Japanese, Korean and Taiwanese tuna longline fishery in the area — 90°-100°E, 0°-15°N

5° Grid		1976	1977	1978	1979	1980	1981	1982	Number/ 1000 hooks (Average)
95°-100°, 15°-10°	J	2.3	—	—	—	—	—	—	2.3
	K	—	—	—	—	—	—	—	—
	T	—	—	—	—	—	—	—	—
95°-100°, 5°-10°	J	—	—	—	1.3	—	—	—	1.3
	K	4.5	—	18.7	3.2	4.0	—	—	9.7
	T	—	—	—	—	—	—	—	—
95°-100°, 0°-5°	J	—	—	—	—	—	—	—	—
	K	4.4	8.4	13.7	5.9	15.0	—	—	12.0
	T	—	—	—	—	2.7	—	2.2	2.5
90°-95°, 15°-10°	J	—	—	—	—	—	—	—	—
	K	—	—	7.5	—	0.5	—	—	1.3
	T	—	—	—	10.1	—	1.0	1.0	3.2
90°-95°, 5°-10°	J	7.7	—	0.8	2.1	—	—	—	5.0
	K	4.9	9.2	6.0	3.3	4.4	—	—	5.3
	T	—	—	2.8	7.3	2.6	4.0	5.2	4.4
90°-95°, 0°-5°	J	4.9	—	8.4	12.8	12.6	—	—	11.1
	K	7.4	9.9	11.6	7.2	7.5	—	—	8.6
	T	—	—	8.6	7.6	8.4	6.4	7.3	7.5

J—Japan K—Korea T—Taiwan

Appendix

LIST OF PARTICIPANTS

First and Second Working Group Meetings[1] on Tuna in the Andaman Sea

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1 First Working Group Meeting
— Colombo, Sri Lanka, October 10-11, 1985

Second Working Group Meeting
— Phuket, Thailand, August 25-26,1986

2 Attended only the Second Working Group Meeting.

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Annexure 1

TUNA RESOURCES IN THE THAI WATERS OF THE ANDAMAN SEA

by Veera Boonragsa

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This paper was presented at the second meeting of the Working Group on tuna in the Andaman Sea area, 1986.

1. Introduction

Prior to 1970, tuna were caught incidentally by purse seiners and gillnetters that were targeting more lucrative species such as mackerels, sardines and carangids. The development of the pelagic fishery together with the development of a fish canning industry during the 1970s has considerably expanded the market for mackerel, sardine and tuna. The development of this industry in recent years has resulted in a rapid increase in the production and export of canned tuna. The total catch of tuna on this coast increased from 1,721 t in 1980 to 3,321 t in 1984.

The rapid development of the canned tuna industry is making Thailand a significant contributor to world trade in canned tuna. This industry has grown ninefold between 1979 and 1983, and with the rapid increase in production, export rose from 340,000 cases in 1979 to 3,000,000 cases in 1983.

2. Fisheries

There are 10 types of fishing gear engaged in coastal tuna capture on the west coast of Thailand. These include four types of purse seines (Thai, luring, Chinese and anchovy purse seines), three types of gillnets (king mackerel drift gillnet, mackerel encircling gillnets, and other gillnets), beach seine. bamboo stake trap, and king mackerel troll line.

The principal fishing craft used for capturing coastal tunas are purse seiners and gillnetters. Purse seining has developed a unique style of seining appropriate to the conditions in Thai waters. This development was based on the catch of small pelagic species other than tunas, and only recently have tunas been considered as a target species because of the development of the tuna canning industry in Thailand.

The Thai purse seine was considered to be the most important gear, accounting for 65 per cent of the annual tuna landings from 1971 to 1978. The luring purse seine has played an important role in recent years, its catch ranging from 1,296 to 667 t between 1979 and 1983. Gillnets are less important for capturing tunas. Among them the king mackerel drift gillnet is considered the most important type of gillnet and its catch ranged from 20 t to 897 t between 1972 and 1981.

The size classes of purse seiners are divided into three categories : less than 14 m, 14 m-18 m and 19 m-25 m in length (LOA). The dominant type of boat is the one ranging from 14 m to 18 m (Table 1). The purse seine net ranges from 800 m to 1600 m in length and from 60 m to 120 m in depth with the stretched mesh sizes ranging from 2.5 cm to 9.69 cm. However, there was no correlation between size of vessel and size of seine net used along this coast (correlation coefficient r^2=0.2). Generally the purse seiners make only one-day cruises, sailing out from port in the afternoon, searching schools or operating purse seines around lures and landing their catches from early morning to noon on the following day. Sophisticated electronic equipment such as depth recorders, sonars, transceivers and satellite navigation instruments are used on board. However, purse seiners still rely on manpower with as many as 40 crew members on a 25 m vessel. The traditional Thai purse seine is operated in coastal waters not deeper than 80 m so that the lead line is allowed to reach the bottom before the net is pursed. A thick braided polyethylene rope is used as purse line and is hauled over the bow by two capstan head winches. The use of this method, however, results in a slow sinking net which allows tunas to escape before the net reaches the bottom. Presently, some purse seiners in the Gulf of Thailand are deviating from the traditional purse seining method to more modern techniques.

Previously, the gillnetters targeted on king mackerel *(Scomberomorus* spp.) by using vessels smaller than 14m, with gillnets ranging from 3,000m to 5,000m in length and 30m to 50m in depth. Incidental big catches of tunas are also obtained but are often of low quality, as graded by the canneries. The trolling lines are also used as minor gear catching tuna at the lower part of the coast in some areas of Trang and Satul provinces.

There are about 10 purse seiners that have recently been modified into tuna purse seiners. Among them, seven seiners between 14 m and 18 m in length are operating purse seine nets of 600 xl00 m and 7.6 cm mesh size, about 30 km or further offshore. The rest are 24 m in length and use nets of 1400 x 120 m and 9.4 cm mesh size, to operate around 30 km cr further offshore.

The landings of tuna are higher in the southern part, but the tuna landings in the Taimuang port in the north have formed a high percentage of total tuna landings since 1983. Takuapa landing port, located near Taimuang and sharing the fishing ground, had high landings in 1985, as shown in Table 2.

Targeting on tunas is influenced largely by prevailing prices paid by tuna canners. There has been a marked increase in the price of tunas, from approximately baht 3/kg in 1977 to over baht 20/kg in late 1980. In the last few years the prices for tunas were graded by species and they have been about baht 35/kg for yellowfin, baht 28/kg for skipjack, baht 24/kg for longtail and baht 14-1 8/kg for different sizes of smaller species. The increase in price in recent years has encouraged fishermen to fish actively for tunas.

3. Species composition

Although tuna fishing along the west coast of Thailand is not recognised as a major fishery due to its seasonal character, Thai fishermen have classed tuna caught in Thai waters as “bonito” with no breakdown of species. The sampling survey conducted by the Phuket Marine Fisheries Station showed that tuna resources comprised three main species: eastern little tuna (Euthynnus *affinis),* frigate tuna (Auxis *thazard).* and longtail tuna (Thunnus tonggol). Other species which were less occasionally landed are bigeye tuna (Thunnus *obesus),* skipjack tuna (Katsuwonus *pelamis),* dogtooth tuna *(Gymnosarda unicolor),* bullet tuna (Auxis *rochei),* yellowfin tuna (Thunnus *albacares)* and oriental bonito *(Sarda orientalis).* The Fisheries Department has recorded that the proportion of longtail tuna in the landings is the highest, with smaller amounts of eastern little tuna and frigate tuna (see Table 3), but the Phuket Marine Fisheries Station survey shows that few longtail tuna have formed part of the various samples. This might be due to the virtual absence of this species in the commercial catches at the time this sampling programme was conducted.

4. Catch rate

The catch rate of longtail tuna in kg per boat per day in the purse seine fishery along the west coast of Thailand, has shown a fluctuating trend since 1982. The catch rate dropped from 125 kg/day in 1982 to 28.8 kg/day in 1983, increased to 180.4 kg/day in 1984 and decreased to 19.73 kg/day in 1985, as shown in Table 4A. This fluctuation may have been caused by the uncertainty in estimating the fishing effort of the purse seiner fleet. Generally the Thai, Chinese and luring purse seiners make only one-day cruises while the tuna purse seiners carry out cruises lasting 3-14 days. The effort of the non-tuna purse seiners is not specific and may be considered to be equally directed on almost all pelagic species, while the tuna purse seiners operate mainly in areas where tunas are abundant.

The catch rate for coastal tuna, which consists of the eastern little tuna and frigate tuna, has been decreasing since 1982. However, it showed an upward trend in 1985, as shown in Table 4B.

5. Seasonality

Tunas in the Thai waters of the Andaman Sea have been caught incidentally all year round and seasonality is not well defined, probably because effort is not specifically directed OR tunas throughout the year. Nevertheless as shown in Table 5, the monthly catches of tunas between 1982 and 1985 were considered to be higher during the north-east monsoon (November to April) than during the south-west monsoon.

A report of the exploratory fishing conducted by the "Pole and Line Tuna fishing in Southern Thailand" project, from May 1979 through September 1980, determined the relative abundance of large pelagic fish by school sightings, and concluded that fish schools were sighted much more frequently during the north-east monsoon (1.33 schools/h) than during the south-west monsoon (0.87 schools/h). The lower rate for the south-west monsoon was generally due to bad sea conditions which decreased the effectiveness of visual search. However, another approximation of the seasonal species composition of fish schools off the west coast was made by visual identification, trolling and pole and line operations. It was found that longtail tuna was the dominant species, accounting for 60-70% of the fish schools in the outer neritic zone throughout the year. The eastern little tuna was the second most abundant species, representing 17-19% of all fish schools, and the catches obtained from pole and line showed its abundance in the south-west monsoon. Skipjack tuna is a common species, representing 4-5% of fish schools in the outer neritic zone during the north-east monsoon. Frigate tuna is a common species during the same season.

6. Fishing grounds

Since the beginning of the development of the pelagic fishery on the west coast of Thailand in 1963, pelagic species have been caught mainly by Chinese and Thai purse seiners in the coastal area at a depth of 30 m, which is about 10-15 km offshore. The luring purse seine was introduced to this coast in 1973 and, as a result, the main fishing grounds have been expanded further offshore. Presently, the purse seine fisheries are conducted mainly in waters of the depth range 30-80 m, which is about 45 km wide in the north and 30 km opposite Phuket island, and widens to about 80 km in the south. Geographically, the major fishing grounds for tunas are off Surin Islands due south of Similan Islands and off Raja Islands. The new fishing grounds for tunas in the lower part of the coast are located about 40 km west of

Adang Islands of the Satul Province. The king mackerel drift gillnets are mainly operated in the depth range of 20-50 m not more than 20 km from the shore. The map of fishing grounds for tunas in the west coast of Thailand is shown in Figure 1. This information was obtained from interviews with master fishermen during the sampling survey along the coast.

There have been some surveys for large pelagic fish along the west coast of Thailand. A survey by the modern purse seiner Southward Ho, chartered by the South China Sea Programme, was conducted from late November 1975 to mid-January 1976. The survey was coordinated with an aerial fish spotting survey in both the neritic and oceanic areas. Eight flights were conducted during an eight day period, but the large pelagic fish schools were not detected during these flights and some surface swimming tuna schools were observed during the surveys by the vessel.

Resurvey of the surface and sub-surface waters and searches for fish schools during day and night were conducted by the purse seiner *Royal Venture,* which was chartered by the South China Sea Programme, during the first week of August 1976. Few fish schools were observed in the oceanic area and many coastal tuna schools were found in the neritic regime.

Exploratory and simulated commercial fishing operations were carried out by *R. V. Pramong 10*, of the Phuket Marine Fisheries Station, in cooperation with the FAO/UNDP “Pole and Line Tuna Fishing in Southern Thailand” project from October 1978 through September 1981. The results of this project have shown that tuna resources exist in this area with potential total catches estimated to lie in the range 9,400 to 15,200 t annually. Concerning the species composition of the tuna resources it was reported that longtail tuna was the first dominant species, while eastern little tuna frigate tuna and skipjack tuna were the seriate dominant species respectively.

7. Size composition

The mean size of eastern little tuna and frigate tuna have declined over the years since 1976 as shown in Figures 2 and 3, except in 1982 for eastern little tuna. This may be due to shifting to the new fishing grounds west of Satul Province as evident from the area-wise production presented in Table 2.

The entry of small eastern little tuna (9-16 cm) occurs from January to April and in June, while fish of maximum size (45-47 cm) are caught in December. From February to June small frigate tuna (9-18 cm) enter the fishery and fish of a larger size range (39-41 cm) are caught in February, August and December. Small sized longtail tuna (11-18 cm) appeared to enter the fishery from January to July and the maximum sizes (4749 cm) appeared in the catches in February, April and September. The size compositions for these three species are shown in Figures 4, 5 and 6.

The FAO/UNDP project concluded that eastern little tuna of the 20-40 cm size range from the inner neritic zone had moved out to the outer neritic zone after attaining a length of 40 cm, remained in this regime until they touched 53 cm, and then probably migrated out from this coast. Frigate tuna of the 20-35 cm size range were distributed in the inner neritic area and moved offshore at about 30 cm. Longtail tuna with a mean length 37.6 cm were caught in the inner neritic area south-west of Phuket Island during the south-west monsoon and distributed principally in the outer neritic zone after entering the 40-49 cm length range. Larger fish of more than 50 cm are believed to migrate out from the coast. On the basis of these findings, it is postulated that the inner neritic zone south-east of Phuket island is the nursery ground of longtail tuna.

8. Spawning season

The gonad index study based on data collected from commercial tuna catches in this coast shows that eastern little tuna has a major spawning during February and March and a minor spawning from August to October. The monthly changes in mean gonad index of frigate tuna show that there are two spawning periods for this species, which extend from February to April and from September to November, as shown in Figures 7a and 7b.

The spawning seasons of each species had been separately studied by the FAO/UNDP project. It was reported that longtail tuna had a major spawning peak during the north-east monsoon from January through April, the principal spawners being about two years old. A minor peak of spawning during the south-west monsoon seemed to occur in August and September.

The monthly distribution of maturity stages of eastern little tuna indicated that the principal spawning period extended from February to April and that the second occurred in September. As for frigate tuna, it was similar to longtail and eastern little tuna in having its spawning period during the north-east monsoon.

However, length frequency data of longtail tuna, eastern little tuna and frigate tuna obtained from a sampling survey were analyzed using the ELEFAN programs, and only one annual peak of recruitment was obtained for both species as shown in Figures 4, 5 and 6.

9. Spawning grounds

On the basis of a study of maturity stages and the proportions of mature females of eastern little tuna and frigate tuna occurring in different areas, it is expected that their spawning grounds may be in the areas of Surin Island, Similan Island and south of Pipi Island. Additionally, an egg and larval survey conducted by the M.S. *Fishery Research Vessel No.* 2 between February and April 1986 showed that Thunnidae (T. tonggol) larvae are abundant south-west of Phuket Island. More larvae were collected during February than in March and April. Small quantities of larvae were found west of Similan Island. The occurrence of the Thunnidae larvae per 1,000 cubic metres, from horizontal hauls at the surface during the oceanographic survey along this coast in February, is shown in Figures 8a-8e.

10. Growth parameters

The results of the estimation of growth parameters of eastern little tuna, frigate tuna and longtail tuna obtained through the ELEFAN program, are as follows:

	K	L_∞
Eastern little tuna	*0.6*	*48.0* cm
Frigate tuna	*0.63*	*44.0* cm
Longtail tuna	*0.75*	*51.5* cm

The modal progressions in eastern little tuna and frigate tuna length frequencies are very clear, and hence good growth curves were realized for both species. This was not the case for longtail tuna data, probably because of insufficient length frequency data. The growth curves for these three species are shown in Figures 4, 5 and 6.

11. Status of stocks

The ELEFAN II program analyses yield, mortality rates and the selection patterns as follows:

	Z	M	F	E	L_c
Eastern little tuna	2.24	1.12	1.12	0.50	27.9
Frigate tuna	2.42	1.19	1.23	0.51	26.06
Longtail tuna	1.47	1.27	0.20	0.14	32.3

Z: Total mortality. M: Natural mortality. F: Fishing mortality E: Exploitation rate.
Lc: Mean length at first capture.

The exploitation rate for longtail tuna is rather low, perhaps because its distribution is mostly in peripheral areas where only large seiners are able to operate.

The maximum sustainable yields for longtail tuna, eastern little tuna and frigate tuna were estimated from yield curves established using available catch and fishing effort data. The data obtained from the landing place survey of the Fisheries Statistics Subdivision, Department of Fisheries, were used for these estimates (see Tables 4 A and 4 B). Though the results obtained from this survey probably differ from statistics presented in earlier reports (data used from the sampling survey), the correlation coefficient (r^2) derived was much higher with the present set of data. As mentioned earlier, tunas are mainly caught by purse seiners; therefore, the purse seine was considered as the standard gear for the assessment.

The estimated maximum sustainable yield is 2,550 t for longtail tuna and 1,994 t for eastern little tuna and frigate tuna, as shown in Figures 9 and 10 respectively. The maximum sustainable yield for longtail tuna was exceeded in 1981 and that for coastal tunas in 1985. The fishing effort for longtail tuna has exceeded the optimum effort level for the past several years and that for coastal tunas was exceeded from 1983 to 1985. This impression may have been created by the fact that the fishing effort estimated was not specifically on tunas only and not specifically in areas where only tunas are abundant, as discussed earlier. Hence, the results must be regarded with great caution.

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Table 1

The pelagic fishing fleet registered by type of gear and by size of boats along the west coast of Thailand, 1975-1983.

Fishing gears	Size of boat (metres)	Year 1975	1976	1977	1978	1979	1980	1981	1982	1983
Thai purse seine	< 14	13	6	12	16	1	7	5	1	—
	14-18	35	41	10	31	3	4	9	-	-
	> 18	37	42	—	—	—	1	3	-	-
	Total	85	89	22	47	4	12	17	1	—
Chinese purse seine	<14	—	—	—	1	—	—	—	—	—
	14-18	10	7	9	6	7	9	7	9	10
	> 18	7	8	13	8	8	3	7	4	8
	Total	17	15	22	15	15	12	14	13	18
Luring purse seine	<14	—	—	—	1	3	9	13	16	7
	14-18		—	56	37	38	54	46	42	41
	> 18	—	—	39	30	28	51	68	81	87
	Total	—	—	95	68	69	114	127	139	135
King mackerel gillnet	<14	23	7	17	14	9	7	7	14	19
	14-18	15	15	21	22	15	17	19	17	11
	> 18	5	—	—	—	—	—	—	—	–
	Total	43	22	38	36	24	24	26	31	30

Source: Thai fisheries vessels statistics, Department of Fisheries, Thailand.

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Table 2

Landings of small tunas by major fishing port on the west coast of Thailand, 1979-1985

Landing port	1979		1980		1981		1982		1983		1984		1985	
	Catch t	%	Catch t	%	Catch t	%	Catch t	%	Catch t	%	Catch t	%	Catch t	%
Ranong	12	0.7	22	1.3	209	5.1	6	0.2	235	8.2	84	2.5	194	4.7
Takuopa	138	7.6	84	4.9	264	6.4	113	3.1	80	2.8	112	3.4	858	20.8
Taimuang	34	1.9	69	4.0	475	15.5	309	8.6	949	32.9	655	19.7	780	18.9
Phuket	8	0.4	6	0.3	30	0.7	17	0.5	524	18.2	666	20.1	825	20.0
Krabi	324	18.0	129	7.5	555	13.5	480	11.9	19	0.7	1,525	45.9	317	7.7
Trang	569	31.5	463	26.9	589	14.3	478	13.3	548	19.0	279	8.4	33	0.8
Satul	718	39.8	948	55.1	1,997	48.5	2,251	62.4	525	18.2	—	—	1,118	27.1
Total catch	1,803		1,721		4,119		3,604		2,880		3,321		4,125	

Sources: For 1979-I 984, the Landing Place Survey, Department of Fisheries, Thailand. For 1985, the sampling survey conducted by Phuket Marine Fisheries Station.

Table 3

Annual catch and catch by types of gear of tuna species in the west coast of Thailand, 1979-1985

Year	Total	Species	Sub-total	RPS		LPS		Others	
				Catch	%	Catch	%	Catch	%
	t		t	t		t		t	
1979	1,803	LOT	1,624	527	29.2	990	54.9	107	5.9
		TUN	179	37	2.1	106	5.9	36	2.0
1980	**1,721**	LOT	1,548	—	—	—	—	—	—
		TUN	173	—	—	—	—	—	—
1981	4,119	LOT	3,188	—	—	—	—	—	—
		TUN	931	—	—	—	—	—	—
1982	3,604	LOT	2,007	918	25.5	1,006	27.9	83	2.3
		TUN	1,597	31	0.9	1,499	41.9	67.	1.8
1983	2,880	LOT	1,397	1,303	45.2	88	3.1	6	0.2
		TUN	1,488	22	0.8	1,430	49.6	31	1.1
1984	3,321	LOT	2,014	—	—	—	—	—	—
		TUN	1,307	—	—	—	—	—	—
1985	4,125	LOT	848	785	19.0	43	1.0	20	0.5
		TUN	3,277	1,604	38.9	1,597	38.7	76	1.8

LOT Longtail tuna TUN — Other tunas

Sources: For 1979-l 984, Marine Fisheries Statistics based on Landing Place Survey, Department of Fisheries, Thailand. For 1985, the sampling survey conducted by Phuket Marine Fisheries Station.

Table 4

Catch, effort and catch per unit of effort data (purse seine as standard gear) of tuna in the west coast of Thailand, 1979-1985.

A. Longtail tuna

Year	1979	1980	1981	1982	1983	1984	1985
Total catch (tons)	1,624	1,548	3,188	2,007	1,397	2,014	745
Total effort (days)	27,377	42,692	37,916	16,056	48,507	11 ,1 65	37,760
CPU E (kg/day)	59.32	36.26	84.08	125	28.8	180.38	19.73

B. Coastal tuna

Year	1979	1980	1981	1982	1983	1984	1985
Total catch (tons)	179	173	931	1,597	1,483	1,307	3,380
Total effort (days)	9,521	12,098	2,804	10,541	26,964	29,298	44,200
CPUE (kg/day)	18.8	14.3	332.0	151.5	55.0	44.61	76.47

Sources: For 1979-l 984, total catch from the Landing Place Survey, Department of Fisheries, Thailand. For 1985, total catch from the sampling survey conducted by Phuket Marine Fisheries Station. For 1979-1985, CPUE from the sampling survey conducted by Phuket Marine Fisheries Station.

Table 5

Monthly catch of small tuna by various types of gear in the west coast of Thailand, 1982-1985

(tonne)

	Longtail tuna				Coastal tuna			
Month/Year	1982	1983	1984	1985	1982	1983	1984	1985
January	293	199	25	—	259	207	50	36
February	162	280	43	6	102	138	91	613
March	416	189	260	15	232	272	100	306
April	217	391	219	121	135	189	118	785
May	109	249	9	—	168	233	235	574
June	45	35	54	—	105	70	289	17
July	76	7	287	273	54	78	44	242
August	186	13	233	1	294	37	34	362
September	184	20	216	8	78	84	59	36
October	60	—	287	144	88	1	60	86
November	144	8	242	280	22	6	95	135
December	115	6	139	—	60	168	132	85
Total	2,007	1,397	2,014	848	1,597	1,483	1,307	3,277

Sources: For 1979-1984, the Landing Place Survey, Department of Fisheries, Thailand. For 1985, the sampling survey conducted by Phuket Marine Fisheries Station.

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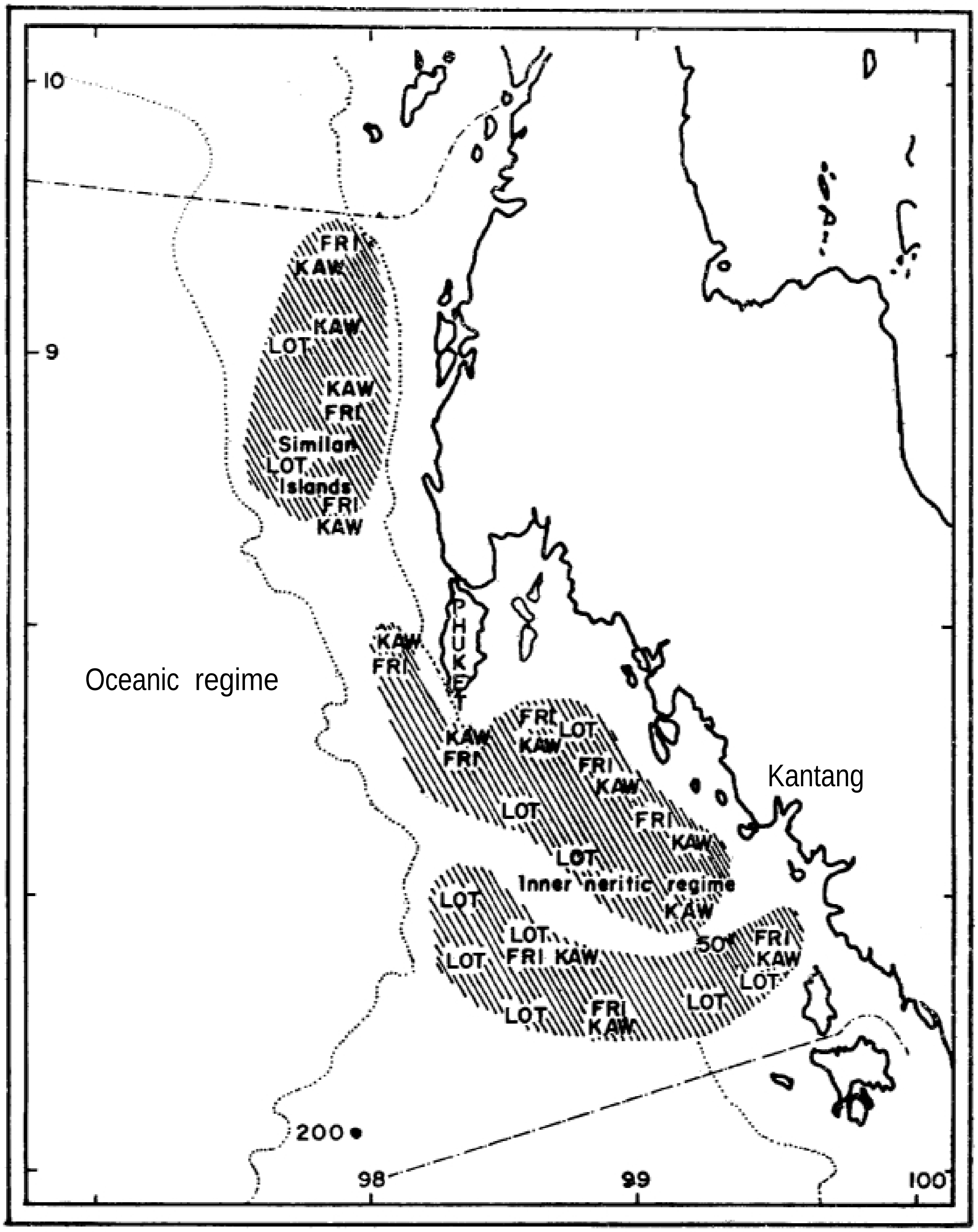

Fig. 1 Major fishing grounds for tuna on the west coast of Thailand.
FRI-Frigate Tuna, KAW-Kawakawa, LOT-Longtail Tuna.

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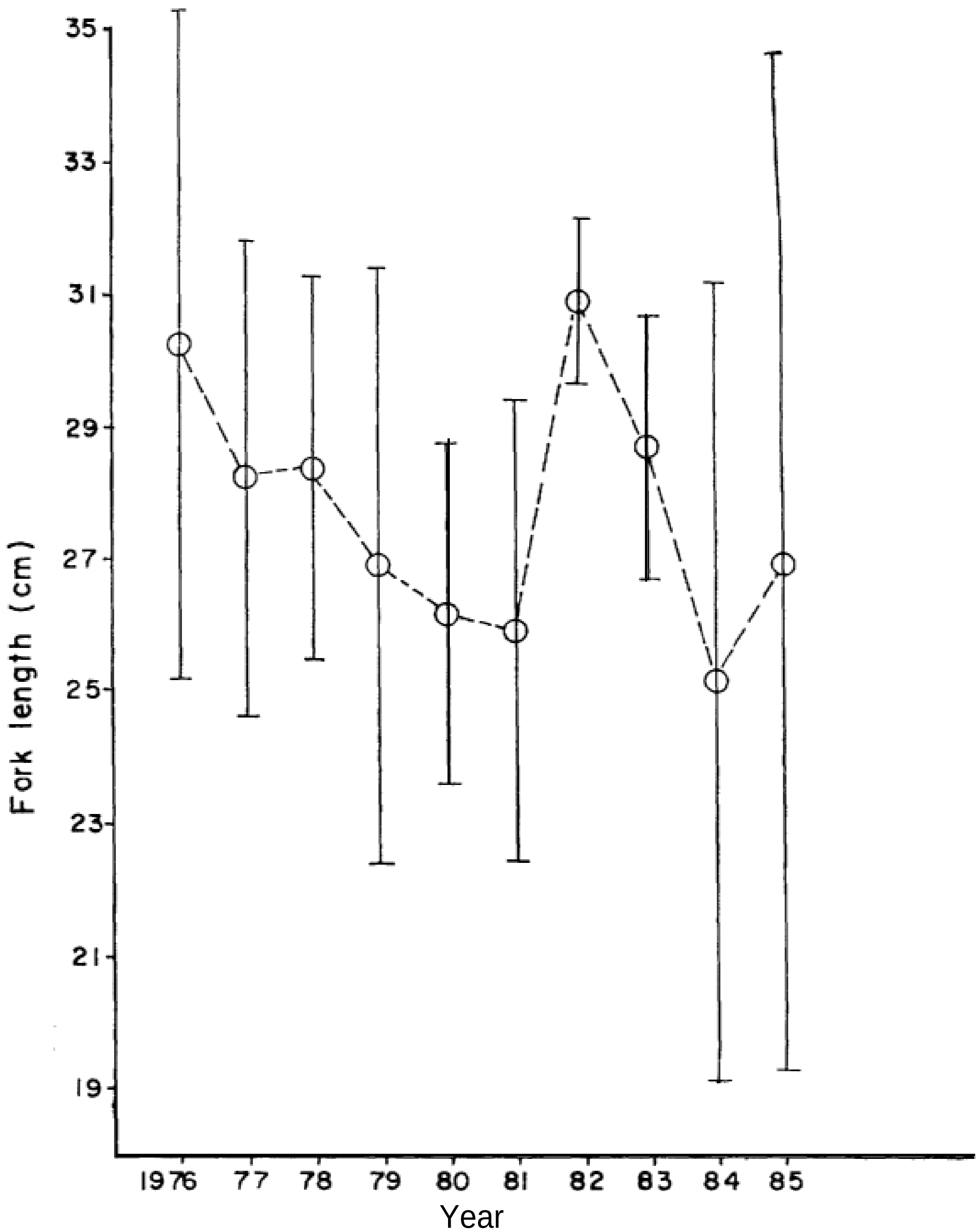

Fig. 2 Annual mean length and size ranges of *E. affinis* on the west coast of Thailand, 1976—1985.

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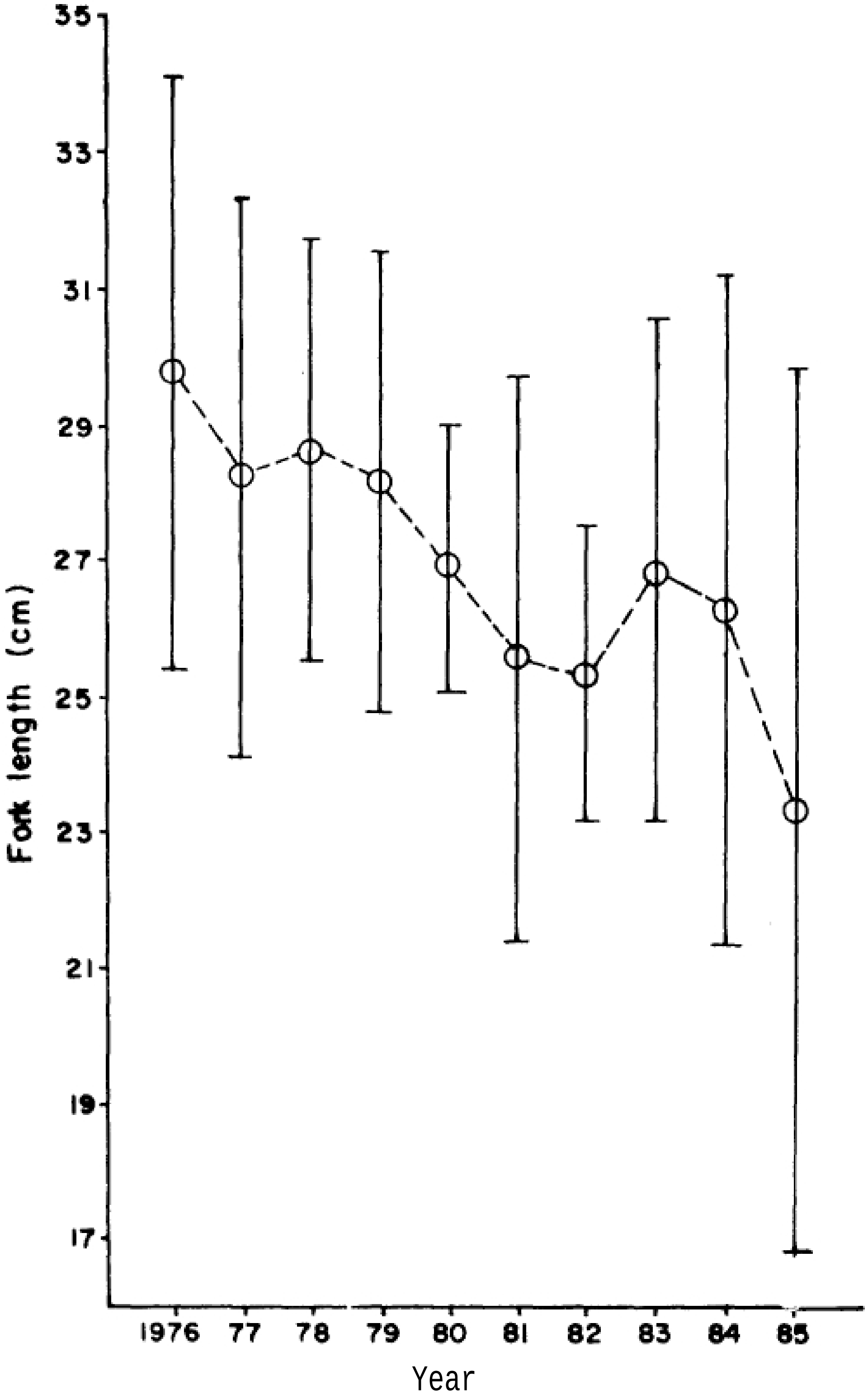

Fig. 3 Annual mean length and size range of
A. thazard on the west coast of Thailand, 1976–1 985.

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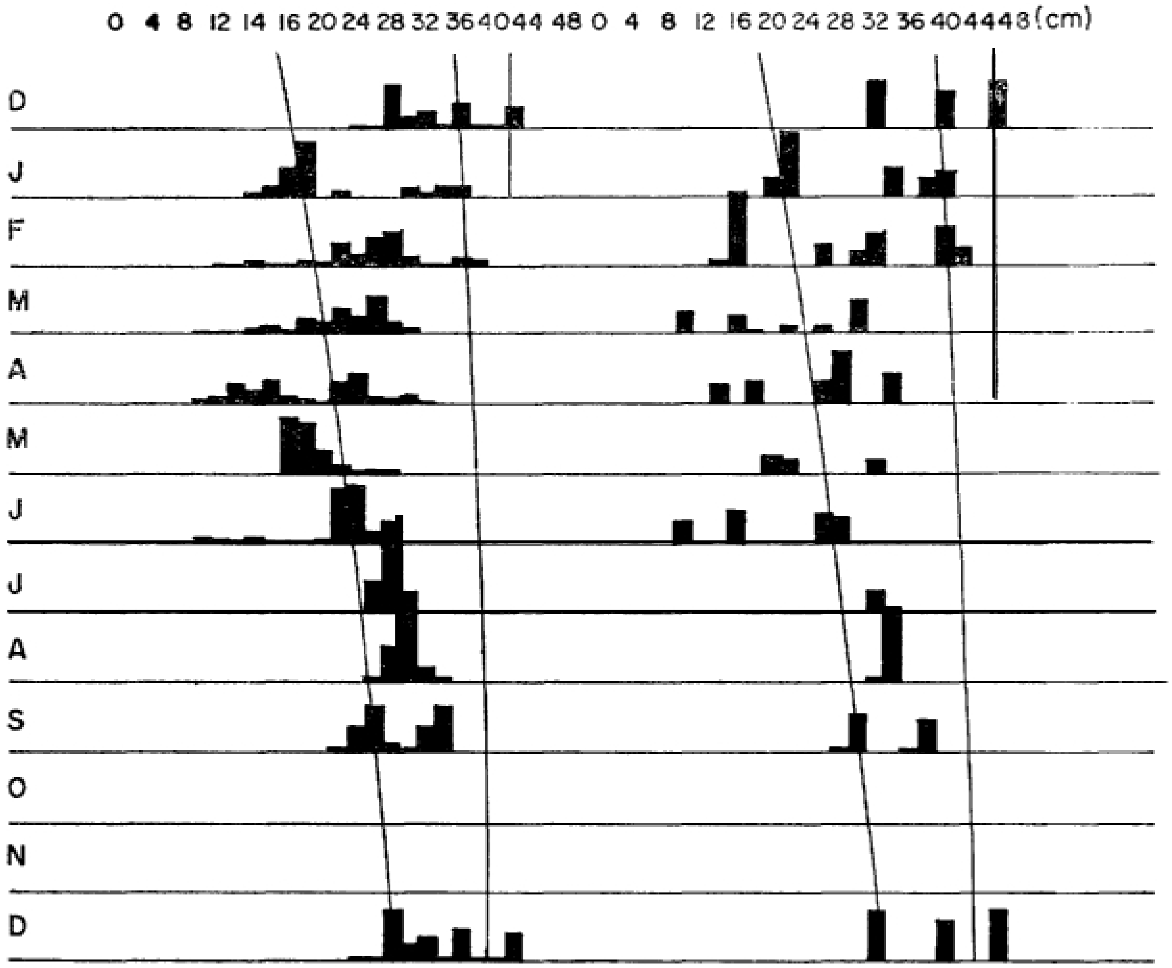

Fig. 4 Monthly length frequency distributions, restructured frequencies and growth curve of *E. affinis* from the west coast of Thailand (1985).

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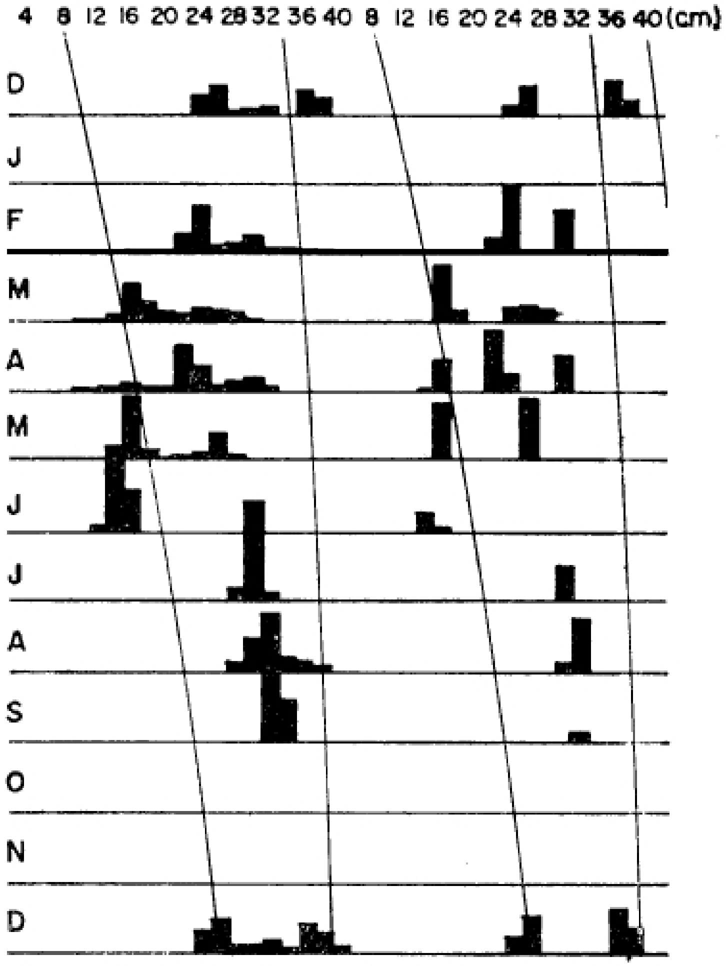

Fig. 5 Monthly length frequency distributions, restructured frequencies and growth curve of *A. thazard* from the west coast of Thailand (1985).

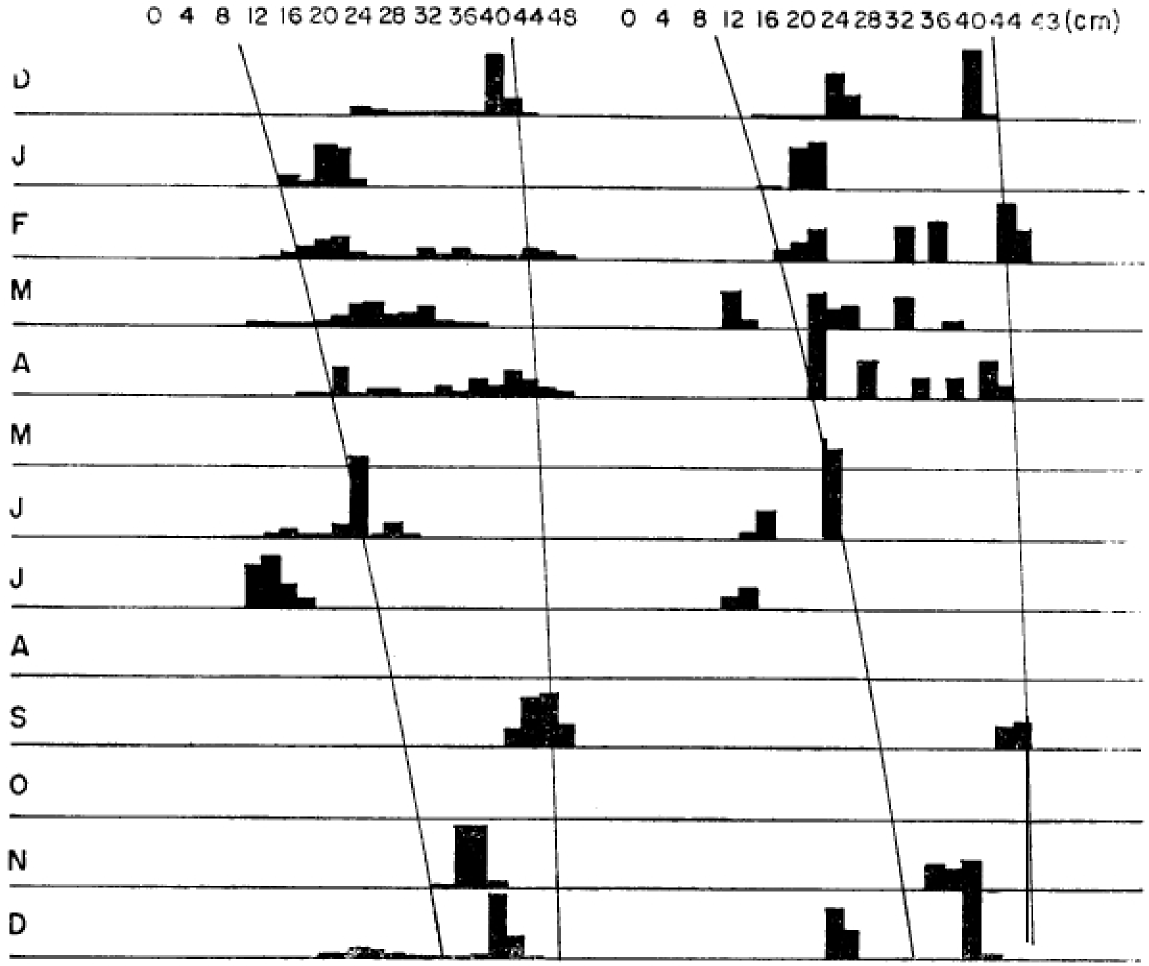

Fig. 6 Monthly length frequency distributions, restructured frequencies and growth curve of *T. tonggol* from the west coast of Thailand (1985).

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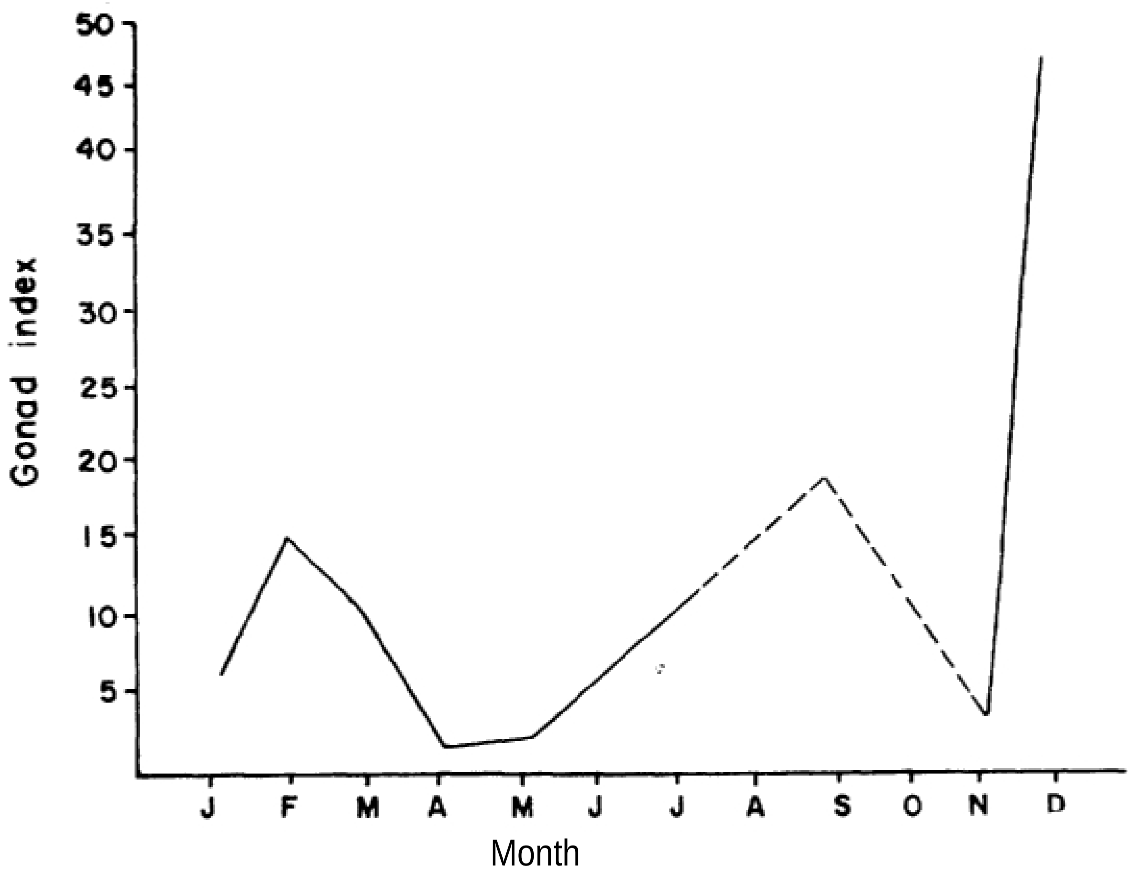

Fig. 7a Monthly changes in mean gonad index of *A. thazard* from west coast of Thailand (1979—1981)

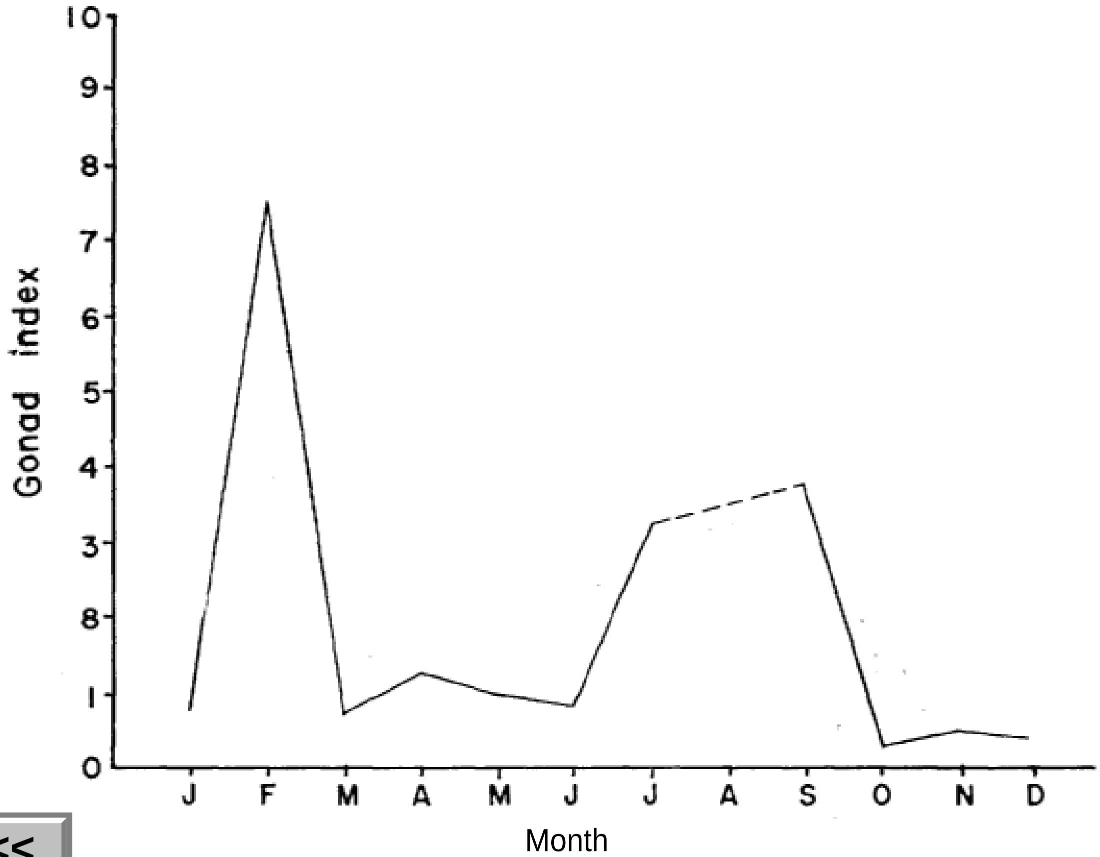

Fig. Ib Monthly changes in mean gonad index of *E. affinis* from west coast of Thailand (1979—1981)

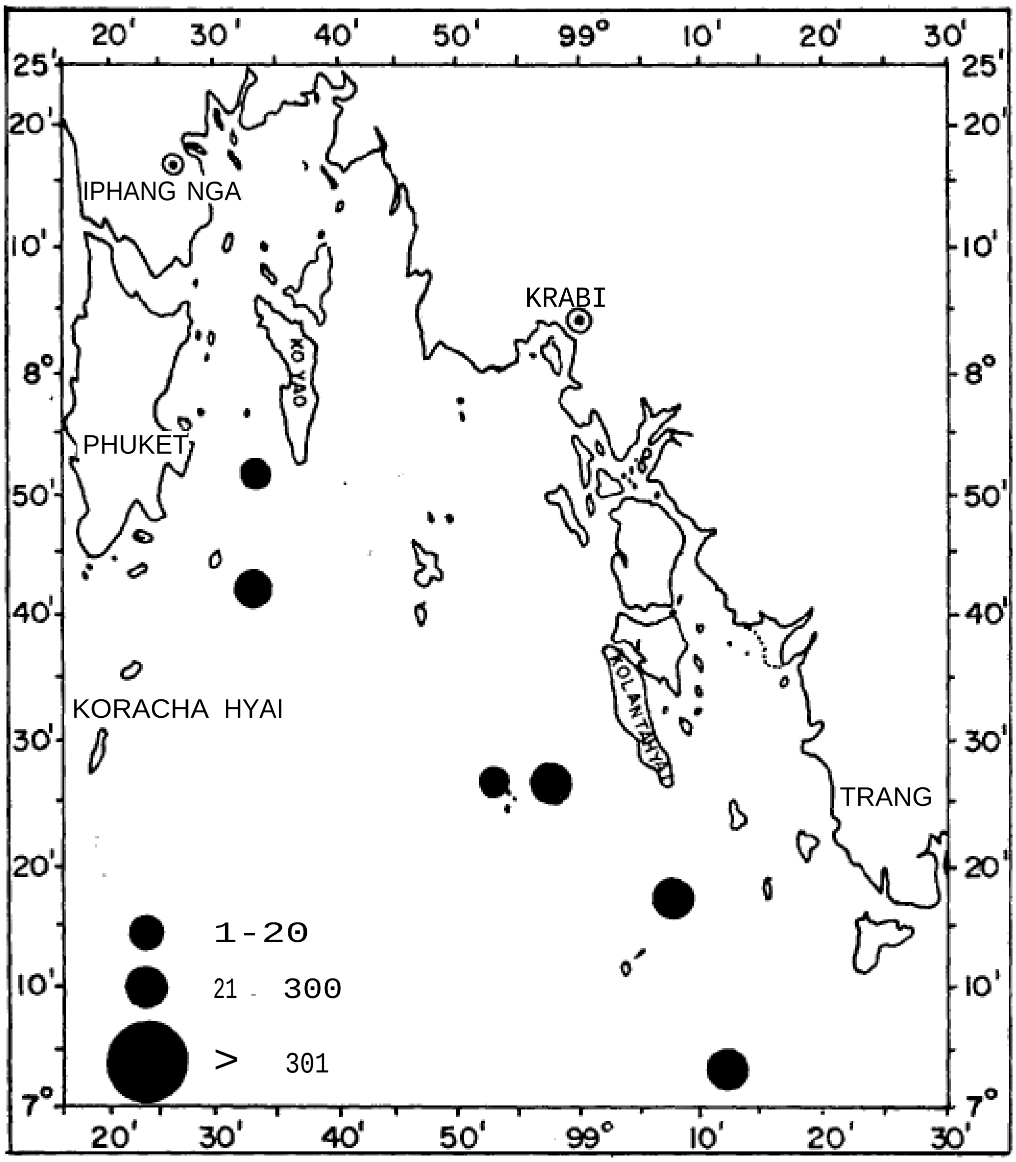

Fig. 8a Occurrence of *T. tonggol* larvae per 1000 m3 as estimated from oblique hauls on the west coast of Thailand during February, 1986.

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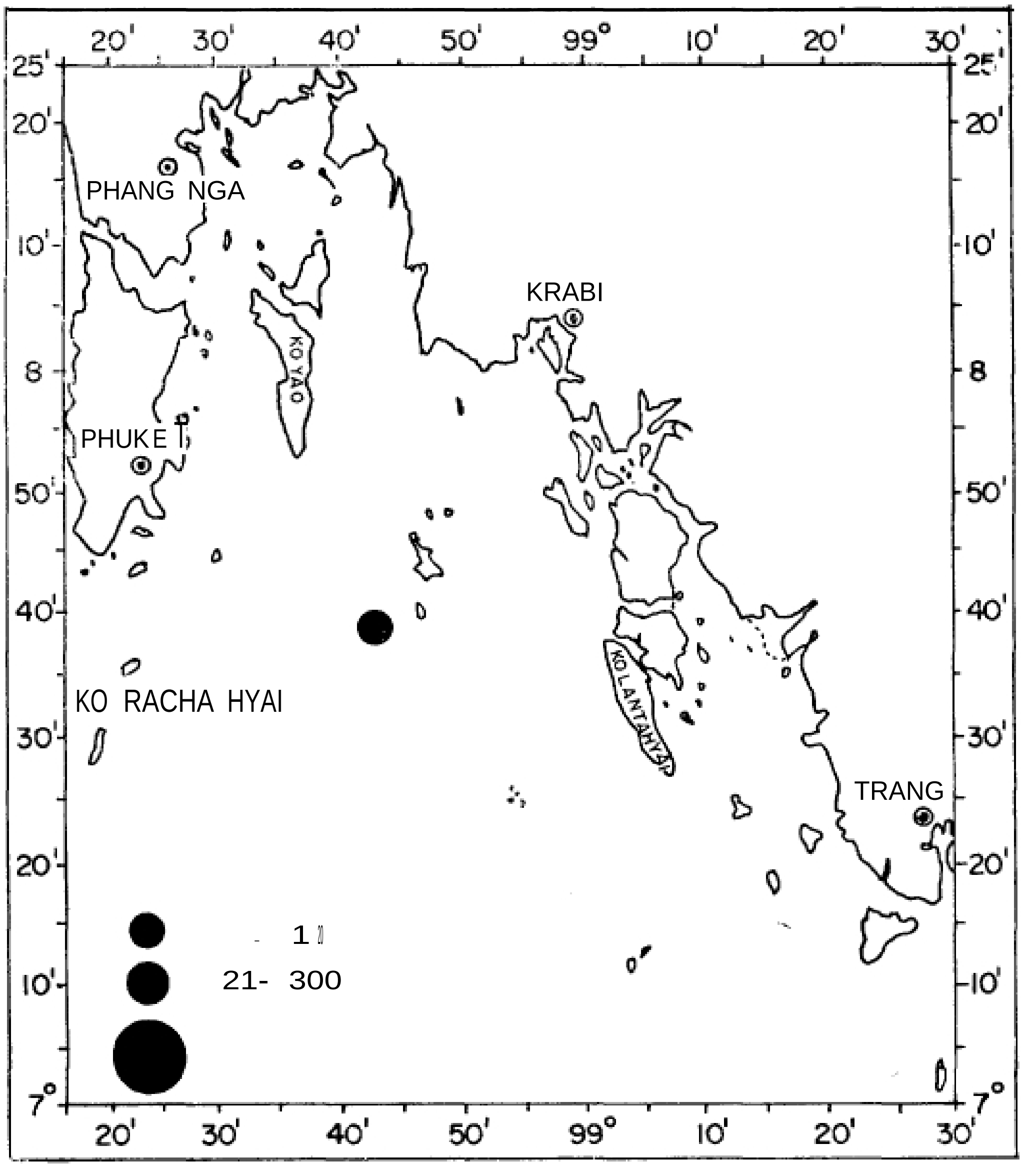

Fig. 8b Occurrence of *T. tonggol* larvae per 1000m3 as estimated from oblique hauls on the west coast of Thailand during March, 1986.

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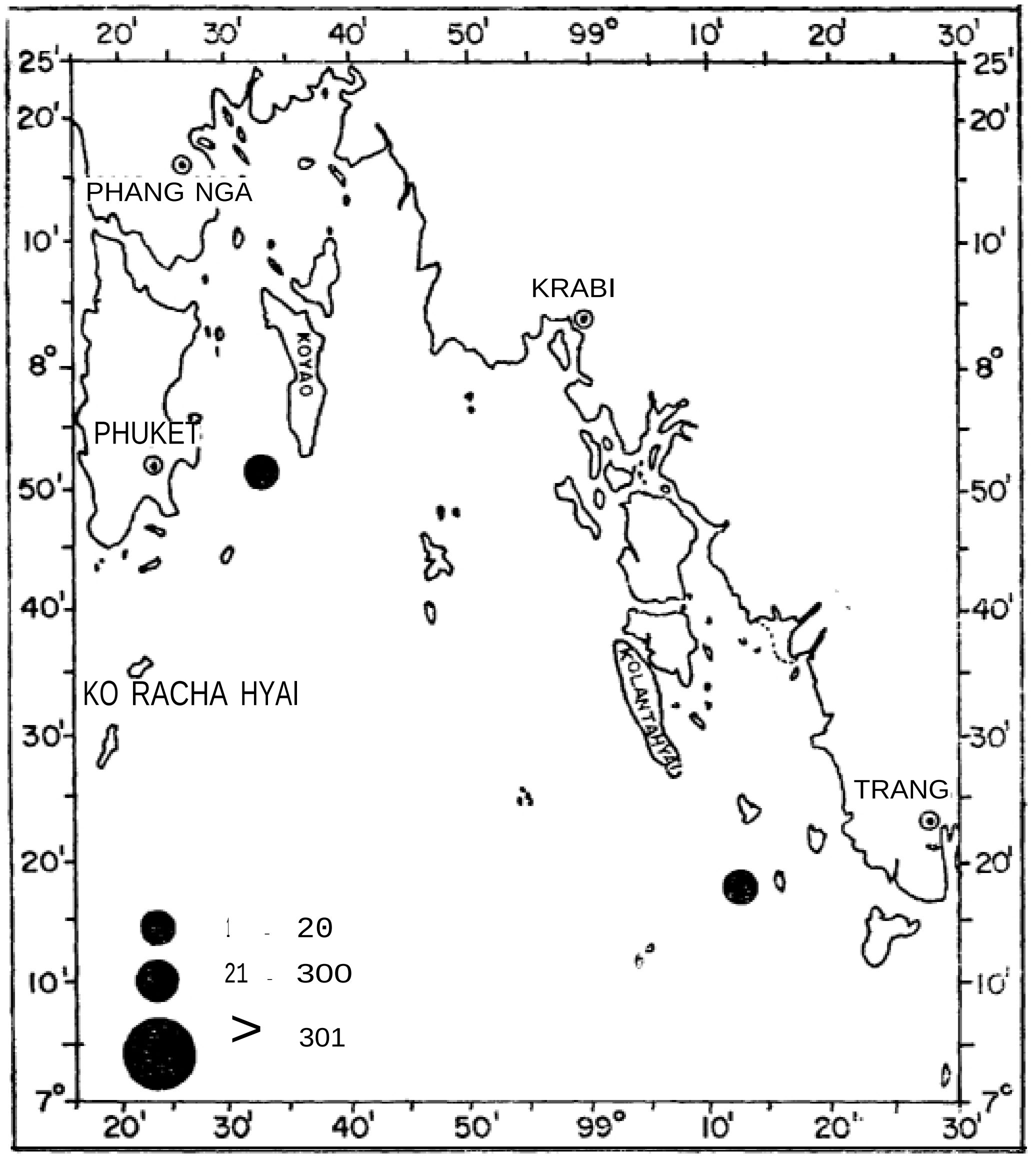

Fig. 8c Occurrence of *T. tonggol* larvae per 1000m3 as estimated from oblique hauls on the west coast of Thailand during April 1986.

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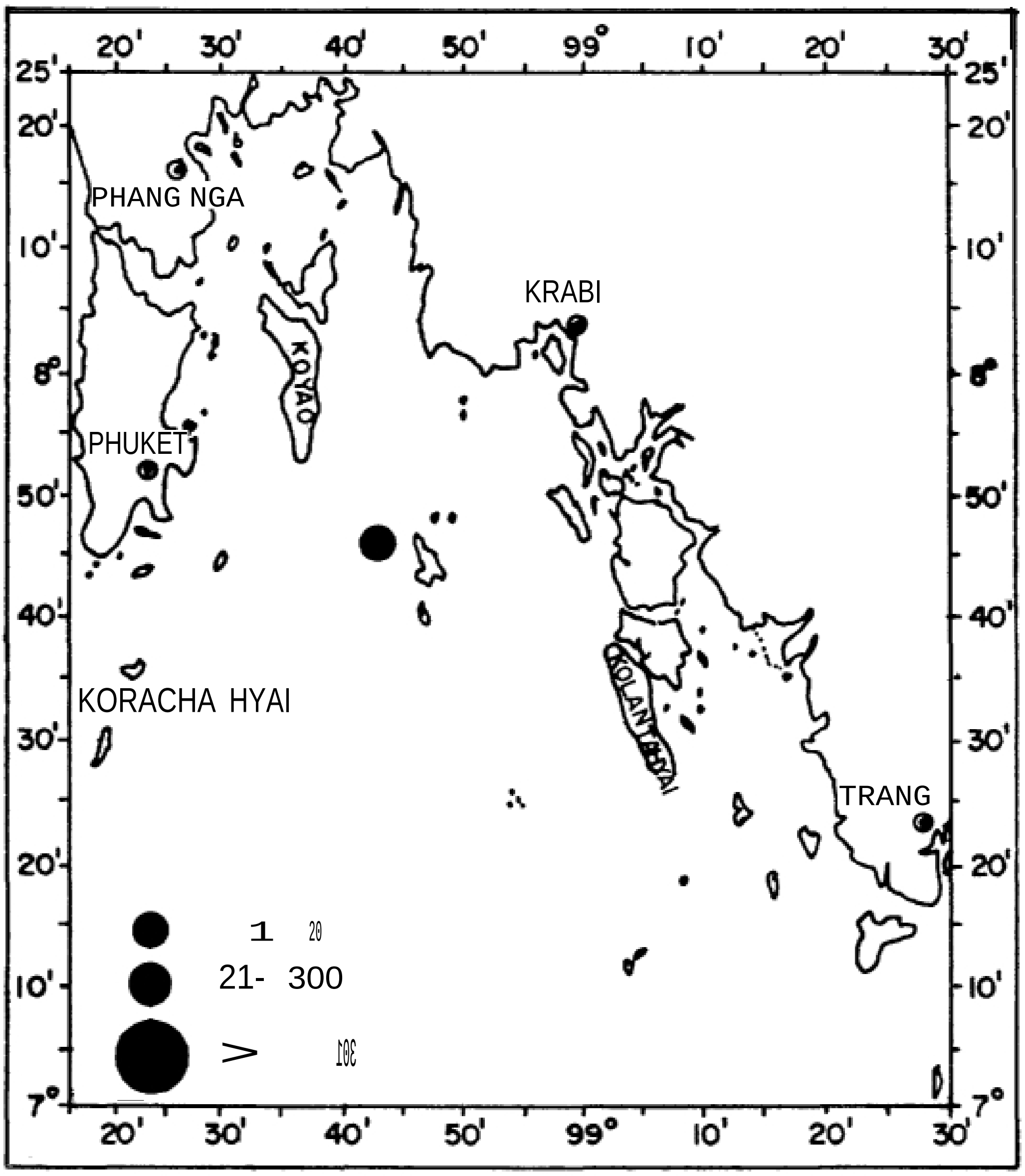

Fig. 8d Occurrence of *E. affinis* larvae per 1000 m3 from oblique hauls on the west coast of Thailand, February 1986 (larva-net)

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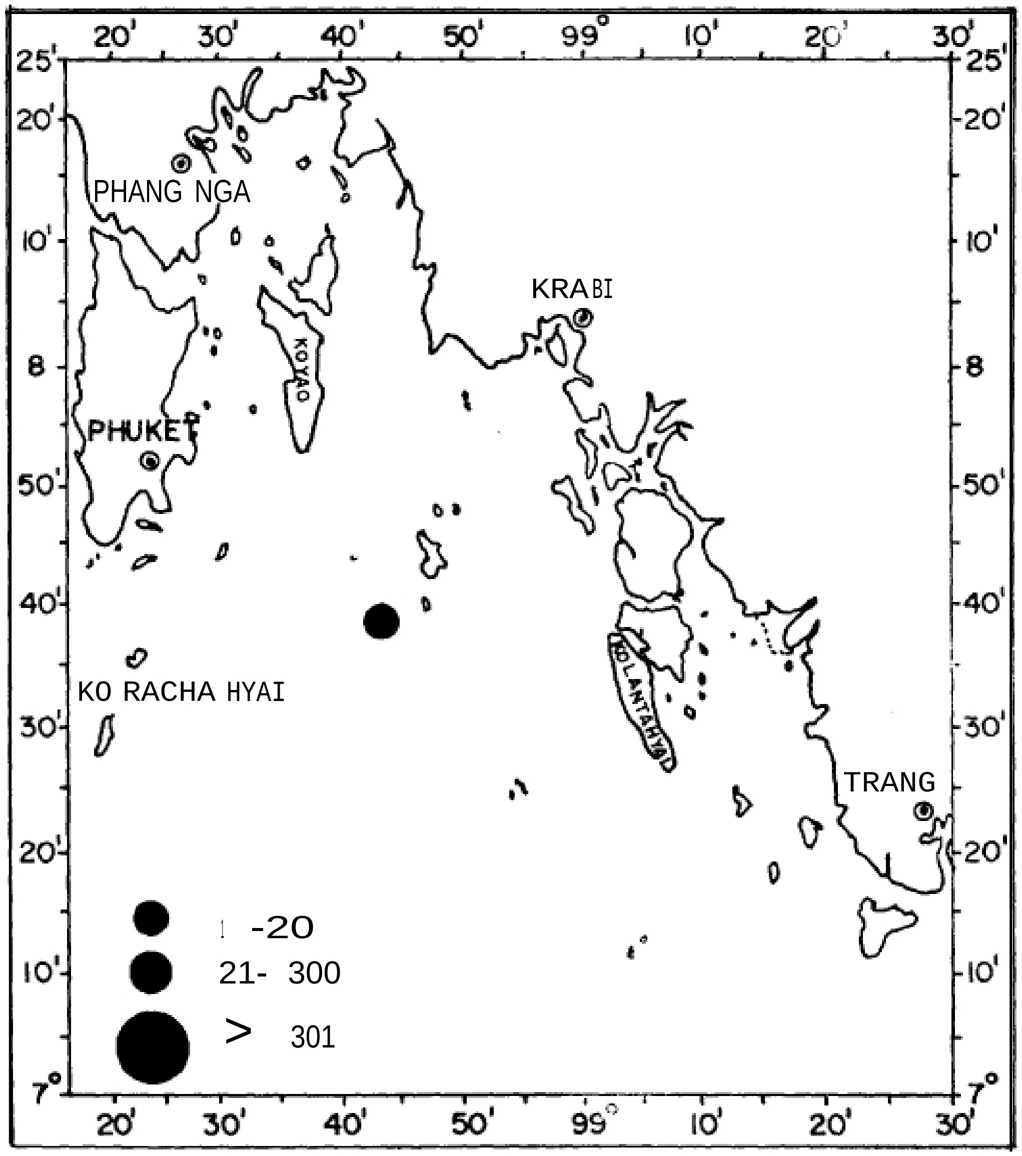

Fig. 8e Occurrence of *A. thazard* larvae per 1000 m3 from oblique hauls on the west coast of Thailand, March 1986 (larva-net)

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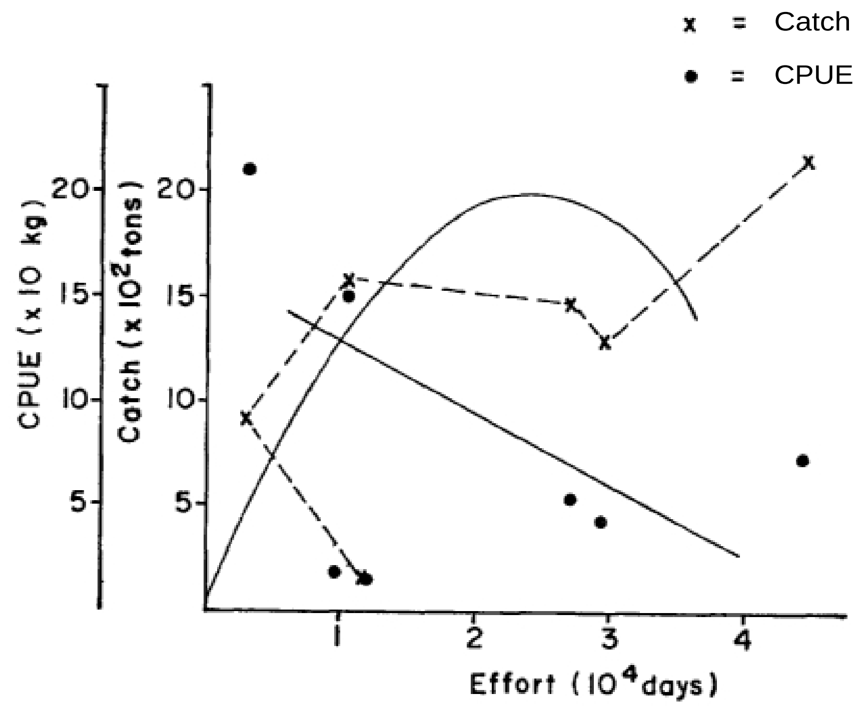

Fig. 9 Catch and catch per cent of effort related to total standardised effort (purse seine units), for *T. tonggol* on the west coast of Thailand (1979 —1985).

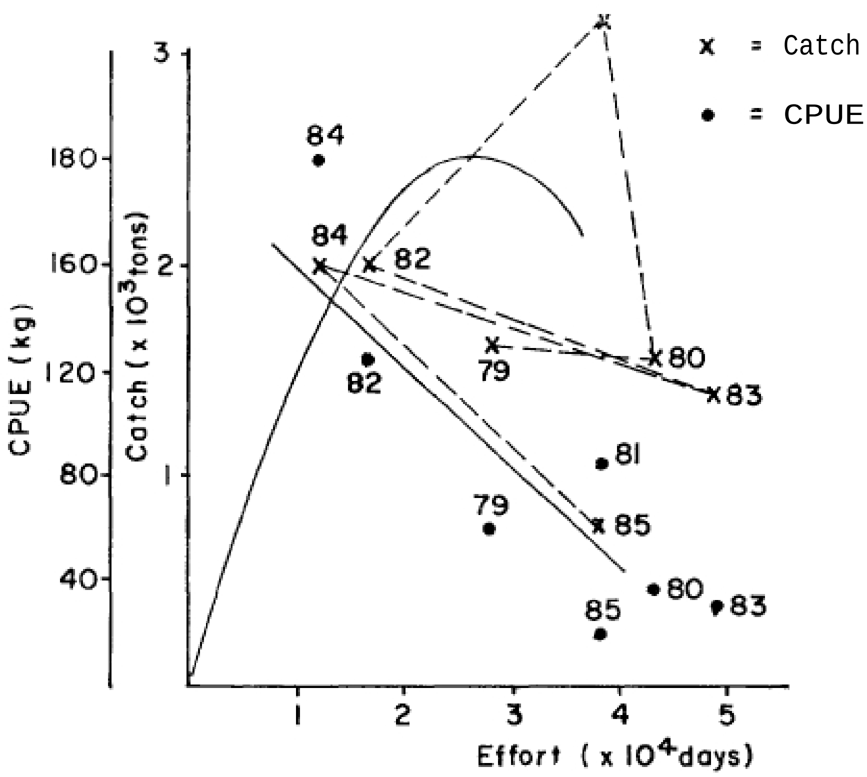

Fig. 10 Catch and catch per cent of effort related to total standardised effort (purse seine units), for coastal tuna on the west coast of Thailand (1979—1985).

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Annexure 2

TUNA FISHERY IN THE WEST COAST OF PENINSULAR MALAYSIA

by **Abdul Hamid Yasin**
Fisheries Research Institute, Jerengganu, Malaysia.

This paper was presented at the second meeting of the working group on tunas in the Andaman Sea area, 25-26 August 1986. Phuket, Thailand.

1. Introduction

The tuna fishery on the west coast of Peninsular Malaysia is not as important as that on the east coast. Tuna landed on the west coast made up only 2% of the total pelagic fish landed in 1983. The tuna landings on the west coast were of the order of 2,600 t in 1983 and the landings on the east coast were 16,157 t. The annual tuna landings have been fairly constant, varying between 1,000 t and 2,600 t from 1970 to 1983, except for the peak landing of 4,700 t in 1980, as shown in Figure 1.

2. Fishing gear

The principal gear for catching tuna on the west coast of Peninsular Malaysia is the purse seine. The other gears that catch tuna are gillnets and lines. The purse seine accounted for more than 80% of the tuna landings, although tuna is not the target species of the purse seine fishery — tuna is not as lucrative as other pelagic species. Gillnets landed less than 15% of the tuna, lines landed 5%, and trawlers landed a negligible portion. Table 1 shows the landings of tunas on the west coast by gear type.

Tuna species are caught with other pelagic species such as *Rastrelligerkanagurta. R. brachysoma, Decapterus maruadsilrusselli* and *D. macrosoma,* which constitute the bulk of the catch. Purse seining includes both luring purse seine and the hunting type purse seine. The mesh size of the net is 25 mm, length 600 m and depth 90 m.

3. Tuna species

There are three main tuna species landed on the west coast: longtail tuna *(Jhunnus tonggol)* which forms the major species landed (about 60%); eastern little tuna *(Euthynnus affinis),* 30%; and friqate tuna *(Auxis thazard),* 10%. Some species that were landed occasionally were skipjack tuna *(Katsuwonus pelamis)* and bullet tuna *(Auxis rochei).*

4. Fishing grounds

Figure 2 shows the main fishing ground of the purse seine fishery. The purse seiners operate in waters 20 km from shore, at a depth of 30 m. In the northern oart of Peninsular Malaysia, the main purse seine fishing ground is in the waters south of l-angkawi island and areas near Penang Island. Another major fishing ground for these purse seiners is in the northern part of Pangkor Island and around Jarak Island. The number of purse seiners operating in waters off the southern part of the west coast of Peninsular Malaysia is negligible, and this may be due to limited fishing grounds in the international shipping lane. The fishing ground of the gillnetters is along the coast, in an area less than 20 km from the shore, off Perak, Selangor and Johor states.

5. Monthly catch

As shown in Figure 3, tuna species were caught all the year round. This figure shows the monthly catches of tuna from the landing place statistical survey for purse seines, in 1983. These data were collected from the receipts of fish transactions. It may be observed that there are two peaks in the landings, one peak from February to May and another peak from July to September.

6. Landing by station

There are five major landing sites on the west coast of Peninsular Malaysia. The State of Perlis in the north landed 435 t of tunas in 1983 and the main landing site is Kuala Perlis. In Kedah State, 334 t of tuna species were landed in 1983 and the main landing site is Kuala Kedah The landing of tunas in Penang island in 1983 was 76 t and the landing site is Teluk Bahang In the south, below the State of Penang, is Pulau Pangkor in the State of Perak; the tuna landing was the highest in 1983, when 1,733 t were landed. Further south, in the State of Selangor the tuna landing is insignificant. Figure 2 shows the major landing sites for tuna.

7. Stock assessment

The data available for the assessment of the tuna stocks is obtained mainly from annual catch statistics. The assessment is also based on the purse seine as a standard gear. Figure 4 shows the results of applying Schaeffer's production model and Table 2 shows the catch and effort data used. It may be observed that the maximum sustainable yield was estimated at 2,706t and the optimum effort at 381 units of purse seiners.

8. Conclusion

The collection of data on small tunas is far from satisfactory on the west coast of Peninsular Malaysia. The general lack of detailed information on small tuna landings by species make it impossible to estimate potential yield by species. Biological studies are important for stock assessment of tuna species. Due to insufficient stress on tuna studies on the west coast, little useful information regarding these species can be gathered for management purposes.

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Table 1

Landings of tuna on the west coast of Peninsular Malaysia by gear

(tonne)

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
Purse seine	1012.58	978.83	1524.99	920.14	1500.66	2500.30	1655.29	1494.97	2784.39	1737.45	4090.37	1683.26	1403.40	2477.91
Trawl	-	-	18.87	67.03	7.56	29.22	26.80	17.85	57.29	26.01	1.45	11.56	2.14	4.30
Gillnet	105.44	72.84	38.23	15.00	81.55	60.00	26.56	831.04	347.25	250.04	600.66	850.99	292.44	183.42
Lines	1,373.50	688.63	409.80	-	0.06	-	3.51	0.18	-	-	-	14.51	13.70	14.03
Lift net	-	-	-	-	-	4.53	-	-	-	-	8.35	13.56	1.00	-
Others	-	-	-	-	-	-	-	-	1.27	10.47	-	58.08	-	-
Total	2,491.52	1,740.30	1,991.89	1,002.17	1,589.83	2,594.05	1,712.16	2,344.04	3,190.20	2,023.97	4,700.83	2,631.96	1,712.68	2,679.66

Table 2

Catch, effort and catch per unit effort data (purse seine) of tunas on the west coast of Peninsular Malaysia

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
Total catch (tons)	1992	1002	1590	2594	1712	2344	3190	2024	4701	2632	1713	2679
Effort (boats)	233	202	198	215	178	222	223	274	276	432	438	351
CPU E (kg/boat)	8.55	4.96	8.03	12.07	9.62	10.56	14.30	7.39	17.03	6.09	3.91	7.63

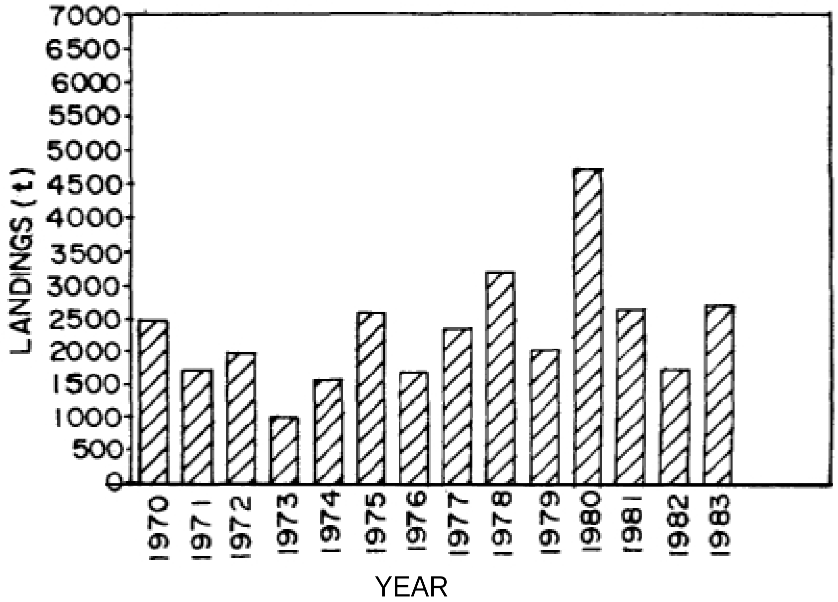

Fig. 1 Annual tuna landings in the west coast of Peninsular Malaysia 1970—1983.

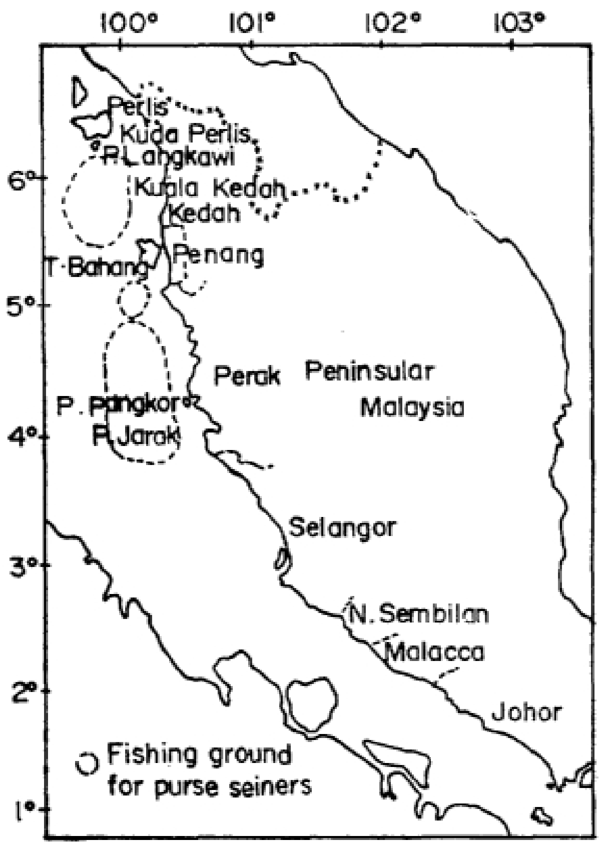

Fig. 2 Purse seine fishing grounds for tuna and major landing sites.

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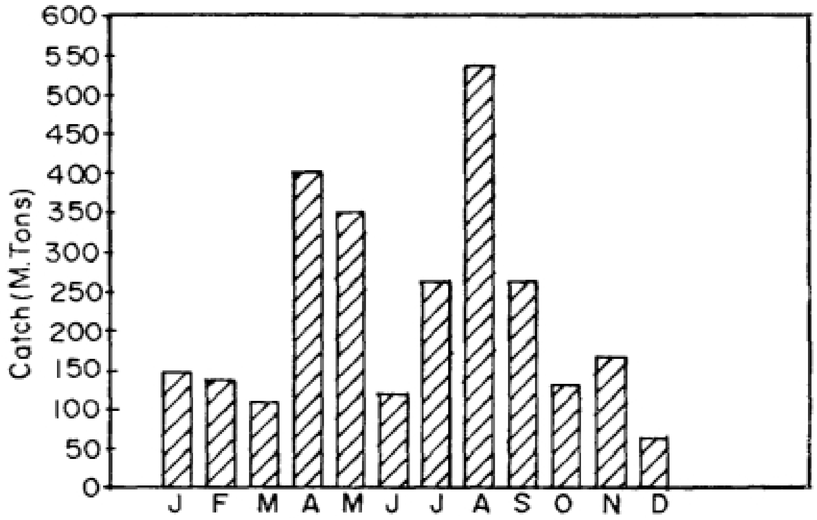

Fig. 3 Monthly purse seine landings of tuna on the west coast of Peninsular Malaysia.

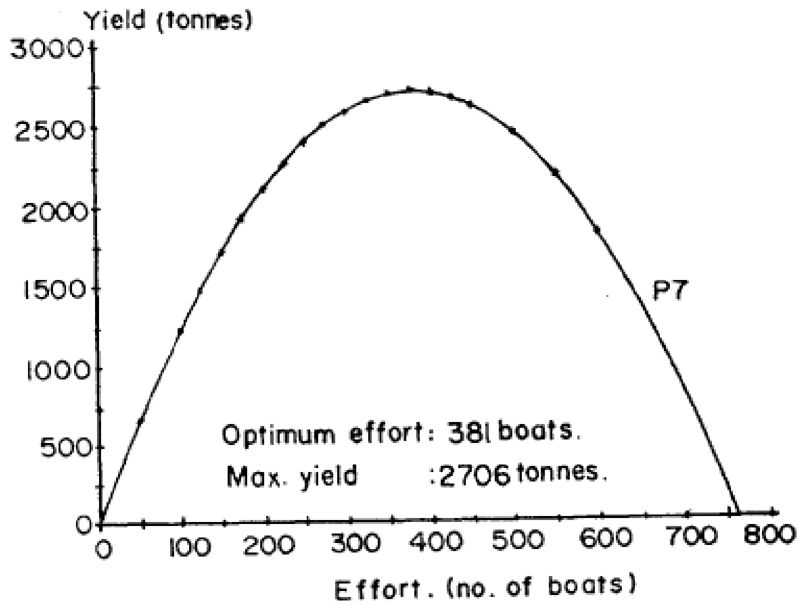

Fig. 4 Schaeffer's production model for tuna on the west coast of Peninsular Malaysia.

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Annexure 3

TROLL AND PURSE SEINE FISHERIES IN WEST AND NORTHERN SUMATRA

by I Gede Sedana Merta
Research Institute for Marine Fisheries, Jakarta, Indonesia

This paper was presented at the second meeting of the working group on tunas in the Andaman Sea area, held 25-26 August 1986 in Phoket, Thailand.

1. Introduction

The tuna fisheries in West and North Sumatra are concentrated mainly in Padang and Banda Aceh. The production is only for local consumption, though it is occasionally marketed in Medan and other large cities in Sumatra. From Banda Aceh, tuna and tuna-like fish are transported in trucks and stored in boxes with ice. From Padang, they are transported in refrigerated trucks to other cities such as Medan, Pekan Baru and Bengkulu. Refrigerated trucks are owned by the marketing project of the Directorate General of Fisheries.

During the peak season, when there is a glut of tuna, a part of it is processed in Banda Aceh into ***katsuboshi*** which is locally called ***ikan kayu.*** The katsuboshi is also for local consumption.

The areas covered by this paper are : West Sumatra province, North Sumatra province (west side), and Aceh province (west side). (See Figure 1).

2. Gears used

Unlike in eastern Indonesian waters, where the main gear used for exploiting tuna and skipjack is pole and line, the main gears in western Indonesian waters are troll line, gillnet, seine net and purse seine. There is no pole and line operation in this area. A trial operation was done in West/Sumatra waters in the 1970s. but there was no follow up.

Tuna fisheries in western Indonesian waters are mainly small-scale operations. Troll lines are used mainly in Bali and West Sumatra, gillnets in Muncar and Prigi (East Java) and Pelabuhan Ratu (West Java). Seine nets are used in Pelabuhan Ratu. Purse seines for small pelagic fish in Muncar and Prigi, and purse seines for skipjack in Bande Aceh. Purse seines for pelagic fish have been developed recently in West Sumatra, where there are 15 purse seiners operating now. Trolling boats that are operating in West Sumatra waters have engines varying from 16 to 55 hp and capacities between 4.43 and 28.89 GT. More than 80% of the boats use 33 hp engines About 4 to 5 fishermen work on each boat, using 8 to 12 trolling lines. The fishing ground is mainly in the western part of Mentawai Islands (see Figure 2). Each trip ranges from 4 to 15 days with an average of 8 days, and boats carry 2.5 to 3 tonnes of ice per trip (Marcille ***et al.,*** 1984). During the past year, fishermen have started using smaller boats, locally known as “kapal unyil”, with engines of 8 to 12 hp (most of them 12 hp), and three fisher-men, using 8 lines and operating 3 to 7 days per trip with an average of 6 days. The fishing grounds are the same as those of the larger boats.

A small purse seine net fishery has also developed recently in Padang, but mainly for catching small pelagics and small tunas. The Sumatra Fisheries Development Project (SFDP) in Padang has started operating a small purse seiner and a multipurpose boat.

There is no commercial scale fishery in this area. The number of small trolling boats (kapal unyil) operating in this area has increased from 51 in 1984 to 67 in 1985. There was no increase in the number of larger boats (mostly of 33 hp) which is about 109, used for troll fishing in Padang.

In North Sumatra Province (west coast), the gear mainly used for small pelagics and small tunas are the purse seine, gillnets and encircling gillnets. In 1984, as many as 31, 68 and 853 units respectively of these gear types were registered.

In Banda Aceh, Pidie and Lhok Sumawe, the main gear used for catching small pelagics, skipjack tuna and other small tunas is the purse seine. The boats in Banda Aceh are 19 to 26 GT, with engines of 33 to 105 hp, and operate nets of about 700 to 1,200 m in length and 20 to 40 m in depth, with a crew of 20 to 23. They operate as day boats because the fishing grounds are not far, about 3 to 4 hours steaming from Banda Aceh, Pidie and Lhok Sumawe (see Figure 3). The number of boats registered in Banda Aceh, Pidie and Lhok Sumawe is presented in Table 1. The 7m boats used in Lhok Sumawe have engines ranging from 33 to 37 hp and use purse seine nets of 800 to 1,000 m length and about 55 m depth. They operate with a crew of 15 to 25. The main target species of purse seiners in the three centres is skipjack tuna and small tunas, but they also catch other pelagic fish during the night by using lights (in Banda Aceh), and during the day by using fish aggregating devices, which are locally called "unjam" or "tuasan" (in Lhok Sumawe).

3. Species composition

The tuna species caught in West Sumatra and Banda Aceh differ. In Banda Aceh, the species observed in the catches are:

- Yellowfin (Thunnus *albacares)*
- Skipjack (Katsuwonus pelamis)
- Eastern little tuna (Euthynnus affinis)
- Frigate tuna (Auxis *thazard)*
- Bullet tuna (Auxis *rochei)*

In West Sumatra (Bungus and Pariaman landing centres), the following species are caught, in addition to the above.

- Bigeye (Thunnus obesus)
- Longtail tuna (Thunnus tonggol)
- Dogtooth tuna *(Gymnosarda unicolor)*
- Double-lined tuna *(Grammatorcynus bilineatus)*

Juvenile bigeye tuna, usually 20 to 70 cm long, are caught during March, April and May. Only a few longtail, dogtooth and double-lined tuna are caught and they do not appear in the records. Although many tuna species are caught, they are reported in the statistics under three groups, i.e. :

Tuna group.	Yellowfin, bigeye and other large tunas caught by tuna longline and handline around deep sea fish aggregating devices.
Cakalang group:	Skipjack.
Tongkol group:	Small tunas, such as eastern little tuna, frigate tuna and bullet tuna, dogtooth, double-lined mackerel and bonitos *(Sarda orientalis).*

4. Production

The production of tuna in West Sumatra, North Sumatra (west coast) and Aceh (north coast) provinces is presented in Table 2. From 1976 to 1984, the production of tuna in the three provinces increased by about 11.3%, 8.6% and 5.1% respectively.

The monthly catch rates of the troll fishery in Padang (West Sumatra) in 1985 are presented in Table 3. The catch rates of larger boats appear to be higher than those of smaller boats during the entire period except in July 1985. The distribution of catch rates in West Sumatra in April 1986 is presented in Figure 2.

Monthly catch rates of the purse seine fishery in Banda Aceh are presented in Table 4. These catch rates fluctuated and revealed no trend.

5. Research activities

Fisheries research lags far behind agricultural research; the manpower, money and materials needed to probe the marine waters of Indonesia are lacking. Research into tuna fisheries was started towards the end of 1979 at some designated sampling sites that are mainly in the eastern Indonesian waters. Sampling activities in Banda Aceh were started in 1984 as a collaborative effort of the Fishing Technique Development Center, the Directorate General of Fisheries and the Bay of Bengal Programme (BOBP). In Padang, the Research Institute for Marine Fisheries (RIMF), the Sumatra Fisheries Development Project (SFDP), and the Directorate General of Fisheries commenced a collaborative programme in 1986. The sampling programme in Padang aims at collecting data on :

- catch by species by boat
- number of days per trip
- fishing grounds
- number of fishing boats landing.

Another important sampling site chosen in Sumatra is at Lampulo (Eanda Aceh). At any sampling site, the catch and effort data are collected and enumerated every day. The data collected includes :

- catch by species for each boat
- GT/hp of the boat
- number of hooks or pieces of net used
- number of days per trip
- number of fishermen per boat
- fishing grounds.

For biological data, only length and weight are collected for each species. Because of budget limitations, no other biological data are collected at present, The length frequency distributions for yellowfin, skipjack, eastern little tuna and frigate tuna caught by troll lines in West Sumatra are presented in Table 5, 6, 7 and 8. The length frequency distributions for frigate tuna and skipjack caught by purse seine in Eanda Aceh are Presented in Table 9. Length-weight relationships for several tuna species are presented in Table 10.

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Other biological data, such as gonad maturity, fecundity, food habits and morphometric measurements are collected incidentally by the staff of RIMF during their field visits. The preliminary result obtained by RIMF is that the size at first maturity of skipjack can be estimated at 417 mm FL for male and 428 mm FL for female (Merta, 1983). It was observed also that the food of skipjack caught in West Sumatra waters consisted mainly of fish, cephalopods and crustaceans (Merta, 1983).

Length frequency data for skipjack were analyzed using the ELEFAN program (post-Sicily version) provided by BOBP. The best combination of L_∞ and k obtained is 860 mm and 0.62 respectively. The growth, selection curves and recruitment pattern are presented in Figures 5, 6 and 7.

From the length distributions of frigate tuna in the purse seine catches, a reasonable result was obtained (Figure 4). The best values obtained for k and L_∞ are 0.85 and 620 mm respectively. From this combination, the values of M, F and E obtained are 1.31, 3.20 and 0.71 respectively. The length-converted catch curve, the selection curve of frigate tuna and their annual recruitment patterns are presented in Figures 8,9 and 10.

6. Discussion

As stated by Marcille *et al.* (1984), it is likely that the number of purse seiners operating in Banda Aceh has reached the maximum level, and any further increase in the number of boats, because of the restricted fishing grounds, may not increase the catch per boat. This is also supported by the high exploitation rate obtained from the ELEFAN analysis, as mentioned above. In order to increase the catch, two suggestions have been made :

1. Increase the size and power of the boats in order to find new fishing grounds.
2. Use deep sea fish aggregating devices which have successfully been introduced in Tomini Bay (North Sulawesi) and recently in Sorong.

It may be seen from Figure 2 that the fishing grounds for the troll fishery off Padang are very far, west of Mentawai Islands and sometimes furhter north, and can be reached in about 12 hours of steaming. The distant fishing grounds make the trip very long, even longer during the lean season, and consequently reduce the quality of the catch. Since the fuel price is high, the costs of fishing in this area are also very high -about Rp. 500,000 (US$ 450) per trip (see Table 11). This problem may be solved in the near future, because SFDP in Padang is planning to build cold storage and other facilities on Siberut Island. Another way to improve the troll line fishery in West Sumatra, as suggested by Marcille *et a/* (1984) is to use deep sea fish aggregating devices, adapting Hawaiian, Samoan or Fijian designs, which are strong enough to stand the bad weather.

However, the fishermen in West Sumatra have their own solution to the problem, i.e. using the smaller boats. Fifty-one new smaller boats (8 to 12 hp) have been given licences by the West Sumatra Provincial Fisheries Office. By using these smaller boats, fishermen can decrease operating costs to about a fourth of those of the larger vessels. They operate on the same fishing grounds, with shorter trips and the catch rates not very different.

7. Acknowledgements

I wish to thank Mr. P. Rahardjo and Mr. Agus B. Sulistiadkji, Research Institute for Marine Fisheries, Jakarta, for their help in compiling the data. Thanks are also due to Mr. Gomla H. Tampubolon of FTDC, Semarang, for providing the data from Banda Aceh, **and to Mr. Ali** Tarmudji **and** his staff, for their collaboration in collecting the data in the field.

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Table 1

Number of purse seiners registered in Aceh Besar, Pidie and North Aceh, 1977-1984

Regency	1977	1978	1979	1980	1981	1982	1983
Aceh Besar	72	64	64	64	93	100	94
Pidie	12	8	12	12	11	14	28
North Aceh	10	41	72	83	96	98	—

Source: Marcille et *al* (1984) ; Aceh Provincial Fisheries Office.

Table 2

Catch statistics of tuna species in West Sumatra, North Sumatra (west coast) and Aceh (west coast) provinces, 1976-1984

(tonne)

Area	1976	1977	1978	1979	1980	1981	1982	1983	1984
West Sumatra									
Tuna	1,001	911	1,303	1,763	1,598	973	1,196	1,055	1,278
Skipjack	2,394	1,434	2,245	126	2,994	3,166	2,379	3,426	3,601
Tuna-like species	-	913	786	1,481	2,745	3,680	1,713	2,872	3,130
Subtotal	3,395	3,258	4,334	3,370	7,337	7,819	5,288	7,353	8,009
North Sumatra									
Tuna	234	551	626	728	720	746	571	349	566
Skipjack	209	427	350	432	438	644	1,028	587	498
Tuna-like species	870	5,423	1,153	1,453	1,194	3,209	1,894	1,703	1,476
Subtotal	1,313	6,401	2,129	2,613	2,352	4,599	3,493	2,639	2,540
Aceh									
Tuna		694	696	538	513	657	614	319	299
Skipjack	1,986	422	531	2,161	1,892	1,183	1,930	1,826	2,336
Tuna-like species	5,088	1,698	3,167	2,239	2,168	3,680	2,627	2,486	4,369
Subtotal	7,074	2,814	4,394	4,938	4,573	5,520	5,171	4,631	7,004
Total	11,782	12,473	10,857	10,921	14,262	17,938	13,952	14,623	17,553

Source: Directorate General of Fisheries, 1976-1984; Fisheries Statistics of Indonesia 1976-1984.

Table 3

Monthly catch rates of small and large trolling craft in West Sumatra

Month		No. Trips	No. of days at sea	Catch rates (kg/day at sea) YFT	SKJ	KAW	FRI	BUL	Total
1985									
May	- A	201	2,003 (10)	22.9	107.0	0.4	4.3	–	134.6
June	- A	117	1,371 (8)	6.8	174.0	–	6.1	–	186.9
July	- A	200	2178 (11)	1.3	89.8	–	2.6	–	93.8
	-B	11	57 (5)	-	157.8			–	157.8
August	- A	201	838 (4)	37.2	311.9	9.5	17.0	1.0	376.7
	-B	19	80 (4)	4.6	153.0	26.3	37.7	3.8	225.4
September	-A	206	1,062 (5)	5.0	210.3	0.2	0.3	–	215.8
	-B	8	37 (5)	31.4	133.0		0.3	–	164.7
October	-A	195	2,388 (12)	19.5	69.1	12.9	7.5	–	88.7
	-B	25	291 (12)	15.8	53.2			–	69.1
November	-A	201	2,470 (12)	19.4	63.2	27.3	12.5	–	122.4
	- B	36	405 (11)	18.0	41.9	0.4	0.04	–	60.3
December	- A	174	2,015 (12)	23.5	75.9	0.1	0.1		99.5
	- B	25	246 (10)	12.9	61.3	–	–	–	74.2
1986									
January	- A	160	1,902 (12)	23.5	59.8	—		—	83.3
	- B	13	164 (13)	13.4	33.7	5.0	4.1	–	56.1
February	- A	128	1,622 (13)	16.2	60.9	0.03	0.02	--	77.1
	-B	18	195 (11)	14.2	40.2	4.4	3.4	–	62.7
March	-A	128	1,587 (12)	17.7	49.2	1.7	2.1	–	70.6
	- B	44	278 (6)	9.3	26.5	17.2	16.9		69.8
April	- A	112	1,309 (12)	26.2	65.6	0.7	0.05	–	92.6
	- B	14	134 (10)	9.4	42.1	15.3	8.7	–	75.5
	-A	2,023 (169)	20,745 (1 ,729)	(18.3)	(111.4)	(4.4)	(4.4)	(0.1)	(133.5)
	- B	213	1,887	(10.8)	(61.9)	(5.7)	(5.9)	(0.3)	(84.6)

A: >20 GT boats
B : <20 GT boats (locally called "kapal unyil")
Figures in brackets are average trip durations

Table 4

Monthly catch rates of tuna in the purse seine fishery in Banda Aceh (1985)

Month	No. of operat-ing days	Catch rates (kg/day)					
		YFT	SKJ	LTT?	FRI	Others	Total
January	445	1.0	103.8	131.7	13.0	3.1	252.6
February	384		108.6	88.1	96.2	14.3	307.2
March	297	0.3	45.8	28.5	33.7	97.1	205.4
April	269	—	8.8	3.7	124.9	114.8	252.2
May	136	—	7.9	6.5	421.7	58.2	494.3
June	51	—	86.4	—	43.6	29.4	159.4
July	193	—	51.7	—	114.3	26.3	192.3
August	—	—	—	—	—	—	—
September	297	—	79.5	—	158.3	122.3	360.1
October	408	—	96.0	—	257.8	188.4	542.2
November	374	—	101.3	—	121.5	337.6	560.4
December	330	—	79.1	—	147.6	246.8	473.5
Average	289	0.1	69.9	23.5	139.3	111.7	344.5

Keterangan : YFT : Yellowfin tuna
SKJ : Skipjack
LTT? : Long tail tuna (not sure yet)
FRI : Frigate tuna

Source: Fishing Technique Development Center (FTDC), Semarang.

Table 5

Length frequency distributions of yellowfin tuna caught by troll line in West Sumatra

(1985/l 986)

Mid-length (cm)	1985								1986			
	5	6	7	8	9	10	11	12	1	2	3	4
22	2			1								
26	6			1								
30	20	1	1	1	3	7	4			8		7
34	33	14	6	4	6	10	10	4	8	7	2	12
38	39	9	7	6	2	5	14	13	24	19	13	20
42	19	8	-	7	63	199	131	154	107	16	22	24
46	31	2	2	12	94	330	678	787	664	364	244	204
50	58	14	-	55	35	158	178	207	140	609	700	483
54	101	8	8	60	31	123	78	60	42	50	97	132
58	52	9	9	90	10	115	76	29	18	40	4	21
62	37	2	2	65	6	17	55	14	6	3	1	3
66	9	2	1	32		3	8	2	1	4		-
70	9	—	1	4								3
72	8	-	1	3								1
78	5	-		2								
82	2	-		-								
86	5	-		-								
90	3	1		2								
94	1			1								
	440	70	38	346	250	967	1,232	1,270	1,010	1,120	1,083	910

Table 6

Length frequency distributions of skipjack caught by troll line in West Sumatra (1985/86)

Mid-length (cm)	1985									1986		
	5	6	7	8	9	10	11	12	1	2	3	4
18	3	1										
22	10	7	12	5								
26	19	36	50	9								
30	67	89	164	36	8	4	1	11	17	22		4
34	93	91	216	43	3	1	2	3	-	3		18
38	99	98	178	141	21	34	3	6	3	29	3	15
42	104	118	154	160	324	386	434	439	358	142	63	50
46	152	145	148	158	307	522	593	700	636	516	524	447
50	180	129	145	139	237	352	350	232	177	365	508	434
54	130	116	58	142	42	62	44	47	28	67	69	111
58	115	126	66	128	8	4	3	2	1	4	3	11
62	34	40	21	34						2		1
66	18	4	4	27								1
70	7											
74	3											
78	3											
82	1											
86	-											
90	2											
	1,040	1,000	1,216	1,022	950	1,365	1,430	1,440	1,220	1,150	-1,170	1,092

<<

Table 7

Length frequency distributions of eastern little tuna caught by troll line in West Sumatra (1985/86)

Midlength (cm)	1985								1986			
	5	6	7	8	9	10	11	12	1	2	3	4
23	1	4										
25	1	10	13									
27	1	10	19									
29	1	14	25				1					
31	1	7	18		8		—					
33	1	8	10		3	1	3				8	3
35	-	12	15		18	8	21	3		6	47	23
37	1	11	43		2	5	8	3	2	6	14	6
39	-	2	32		2	3	5	1	1	3	35	3
41	1	2	30		-	-	5	-	1	3	3	2
43	-		27		3	8	3	-	1	1	2	1
45	-		32		2	7	6	3	1	10	-	1
47	1		2		-	2	5		1	4	1	1
49	1				2	1	2		3	3		1
51							-					1
53							1					2
55												2
57												1
59												1
	10	80	266		40	35	60	10	10	36	110	48

<<

Table 8

Length frequency distributions of frigate tuna caught by troll line in West Sumatra (1985/86)

Midlength (cm)	1985								1986			
	5	6	7	8	9	10	11	12	1	2	3	4
21			4									
23			5	2								
25			11	12								
27			9	23								
29			1	30			1					
31			4	26	9	5	2					
33			1	14	5	1	4			3	25	13
35			-	34	14	18	3	6		11	22	17
37			1	23	1	3	15	-		7	-	
39			-	23	1	2	6	-		3	15	
41			-	34	2	1	2	-		2	1	
43			1	22	-	-	1	-		2	4	
45			1	15	1	-	2	-		3	-	
47			5	5	-	-	-	1		7	3	
49			5	5		-	1	1		2		
51			-		1							
53			1		1							
			49	268	35	30	37	8		40	70	30

<<

Table 9

Length frequency distributions of skipjack and frigate tuna from Banda Aceh

Katsuwonus pelamis

Mid-length (cm)	1984								1985						
	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7
300											1				
320									3		7	6			
340									0		1	0			
360									3		13	4			
380	1		2					10	6		9	5			
400	2	2	5			1	6	4	15	2	15	6		2	
420	2	3	2			0	0	2	5	7	13	4		3	1
440	5	30	3	7		0	6	32	10	8	5	5	1	5	1
460	7	19	18	8		3	22	6	11	25	17	12	2	5	4
480	11	47	27	7		7	37	16	35	21	15	10	9	2	8
500	15	64	52	72	55	56	47	80	40	29	16	8	5	4	9
520	6	16	32	45	18	20	42	9	27	16	6	5	2	4	4
540	1	3	2	2	1		7	10	6	1	2	1	1		1
560	0	0	1					17	1						
580		1						8	0						
600		2							2						
	50	187	144	141	74	87	167	194	164	109	120	66	20	25	28

Auxis thazard

Mid-length (cm)	1984							1985						
	6	7	8	9	10	11	12	1	2	3	4	5	6	7
300	8					1		1		1				
320	14					12		2	6	14	5	1	3	2
340	4	1				3		3	2	1	0	0	0	0
360	4	1				17	2	13	6	12	10	3	1	3
380	11	2	1			12	8	19	9	15	5	3	4	2
400	30	18	4	2	5	45	13	28	20	18		5	7	12
420	18	1	1	0	1	28	13	14	12	8		2	0	4
440	17	1	17	0	6	5	34	18	5	0		0	0	2
460	24	26	19	3	10	8	16	30	12	8		1	4	8
480	15	32	17	2	6	18	13	33	17	11		1	2	10
500	13	48	90	92	66	27	77	46	23	9		3	3	4
520	18	30	39	32	13	18	5	21	10	2		0	0	0
540	1	6	3			1	3	4	3	3			1	0
560	0		3			0	4	1	0					0
580	0		2			0	5	0	0					0
600	5					11		3	2					1
	182	166	196	131	107	206	193	236	127	102	20	19	25	48

Source: Fishing Technique Development Center, D.G.F.

<<

Table 10

Length-weight relationships of several tuna species from Padang, June and July 1985

	n	a	b	s^2	r	L_1-L_n (cm)
June						
Yellowfin	70	0.663×10^{-1}	2.705237	0.020	0.9785	26-90
Skipjack	980	0.226×10^{-1}	2.981127	0.067	0.9357	24-67
Eastern	80	0.364×10^{-1}	2.789002	0.053	0.8848	21-41
Frigate	–	–	–	–	–	–
July						
Yellowfin	38	0.672×10^{-2}	3.258277	0.049	0.9639	29-75
Skipjack	1252	0.847×10^{-2}	3.238389	0.031	0.9712	21-67
Eastern		–	–	–		–
Frigate	743	0.194×10^{-2}	3.59688	0.033	0.9859	21-53

Yellowfin : ***Thunnus albacares***
Skipjack : ***Katsuwonus pelamis***
Eastern : ***Euthynnus affinis***
Frigate : ***Auxis thazard***

Table 11

The development of tuna export and fuel price, 1976-1984

	1976	1977	1978	1979	1980	1981	1982	1983	1984
Total volume (tons)	62'1	1,898	9,426	9,797	11 ,1 39	14,013	18,788	20,311	14,702
Total value (US $'000)	33	19	6,193	8,003	12,900	15,416	19,863	14,776	10,674
Tuna (US $/ton)		—	—	1,124	1,424	1,533.3	1,293.3	1,259	1,253
Skipjack (US $/ton)	—	—	—	871	1,190	1,210	980	500	550
Fuel (Rp./litre)	—	—	—	35	52.5	52.5	85	145	220

Source: Tambunan (1985) ; Directorate General of Fisheries (1984)

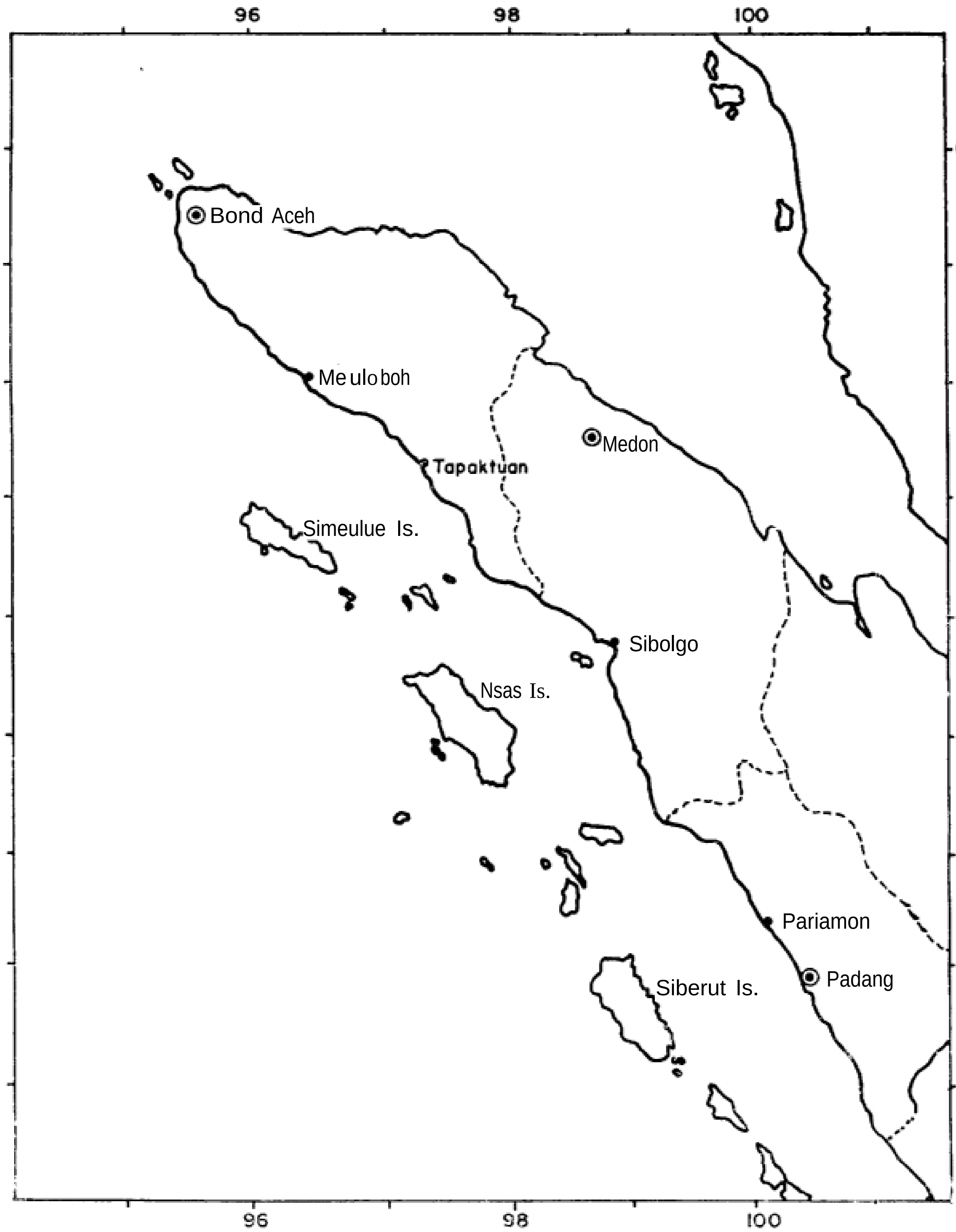

Fig. 1 Map of western and northern Sumatra waters.

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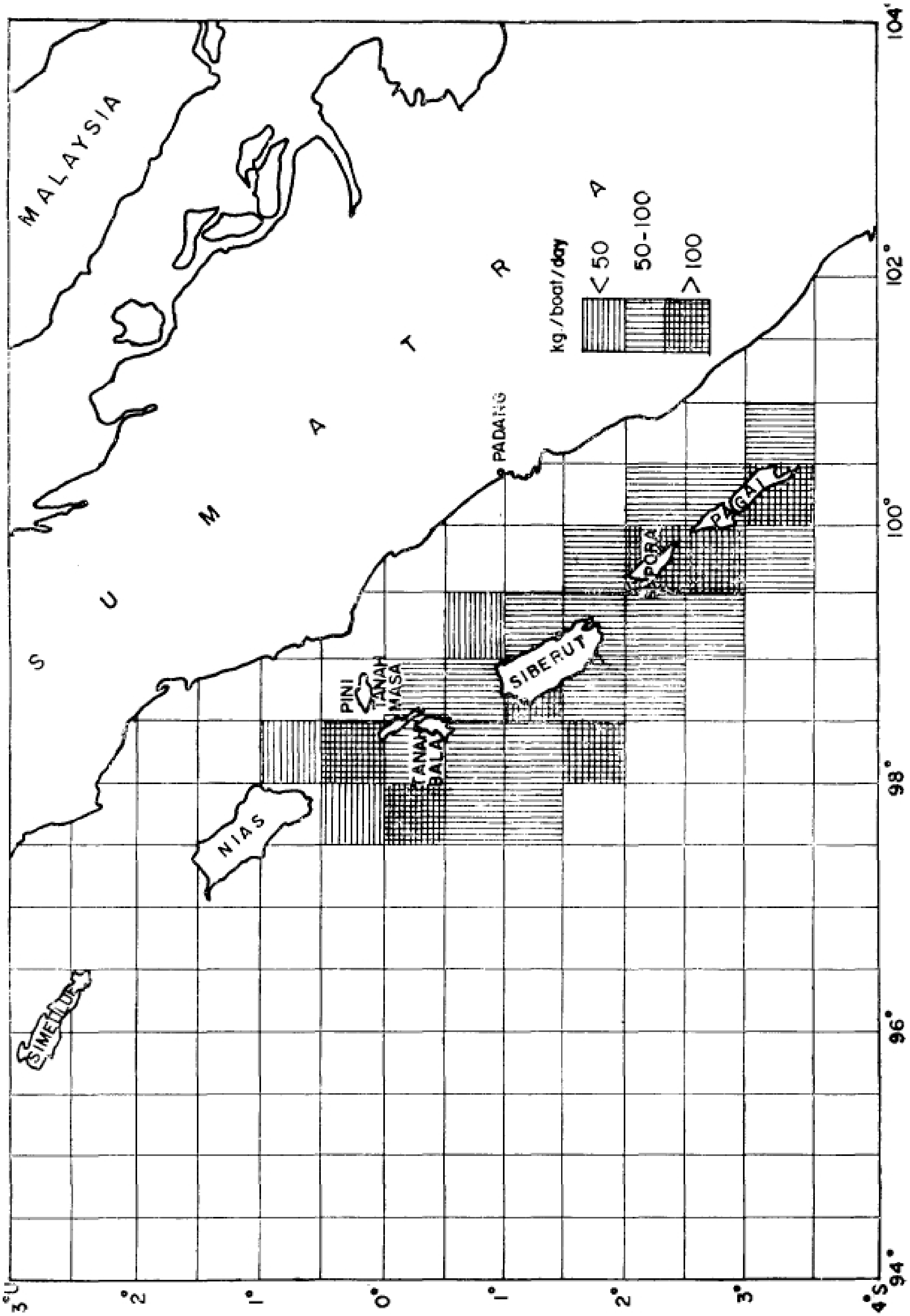

Fig. 2 Catch rate distribution of troll line fishery for tuna in the West Sumatra area (April 1986).

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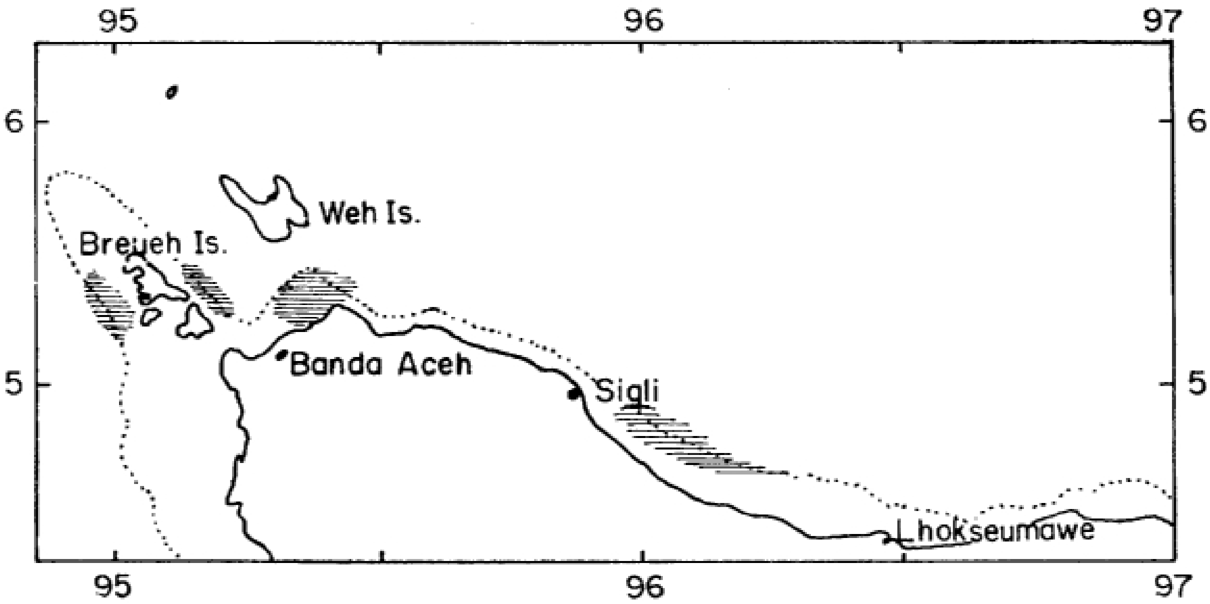

Fig. 3 Major fishing grounds for the artisanal purse seine fishery in the north of Sumatra (Marcitle et al., 1984).

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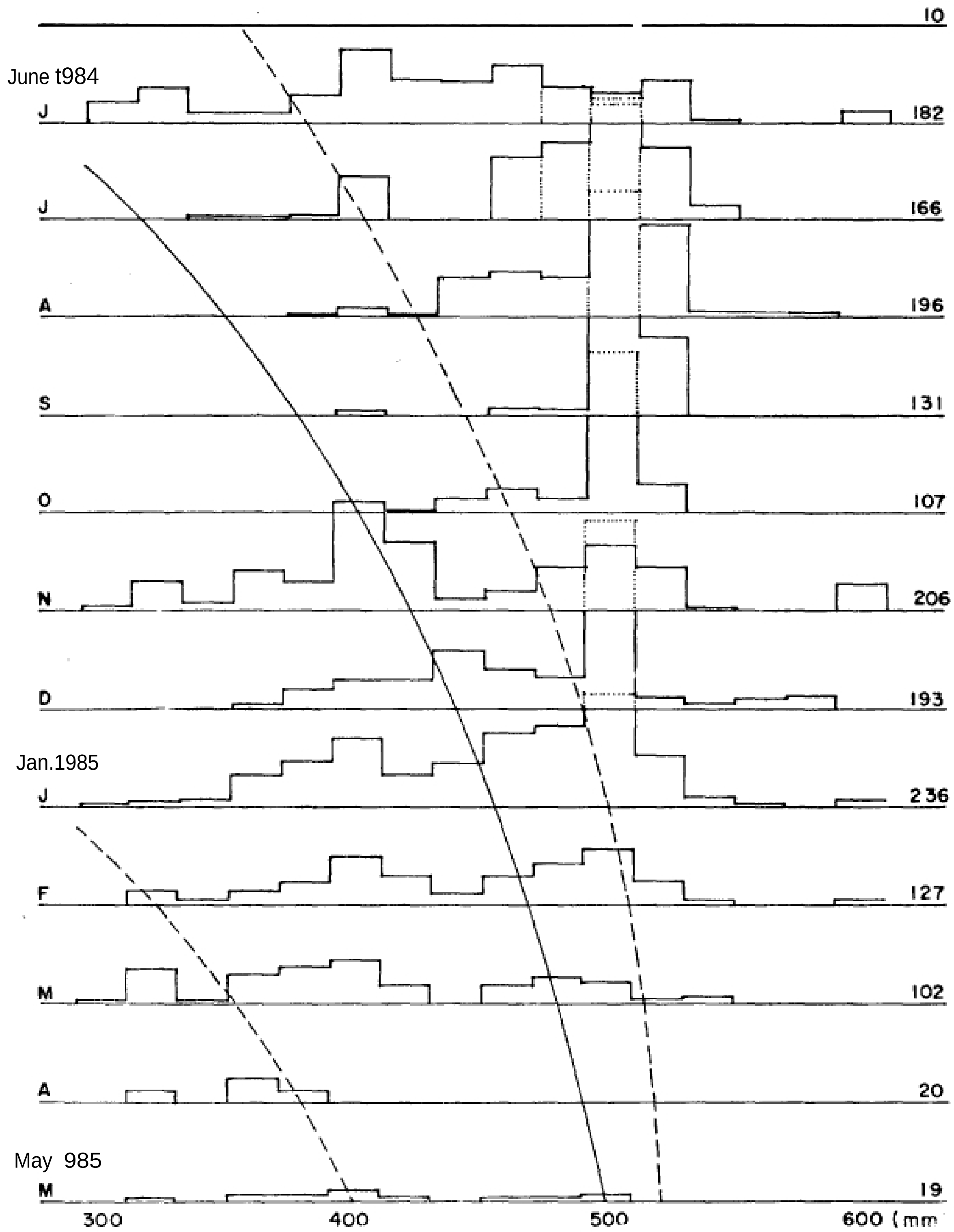
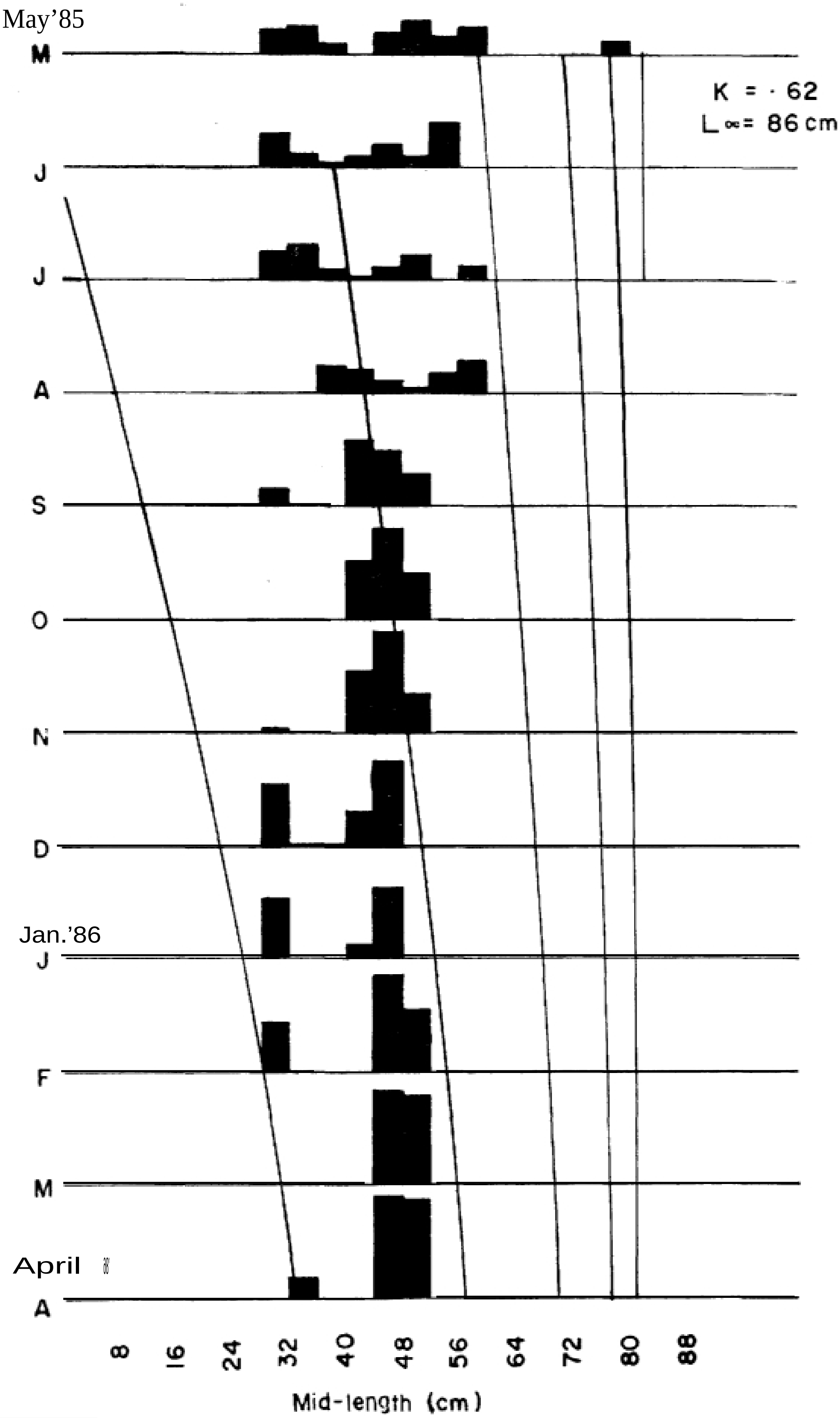


Fig. 4 Monthly length frequency distribution of *A. thazard,* caught by purse seine in Banda Aceh (1984—1985).



<< 5 Monthly length frequency distribution of *K. pelamis* caught by troll lines on the west coast of Sumatra (1985—1986).

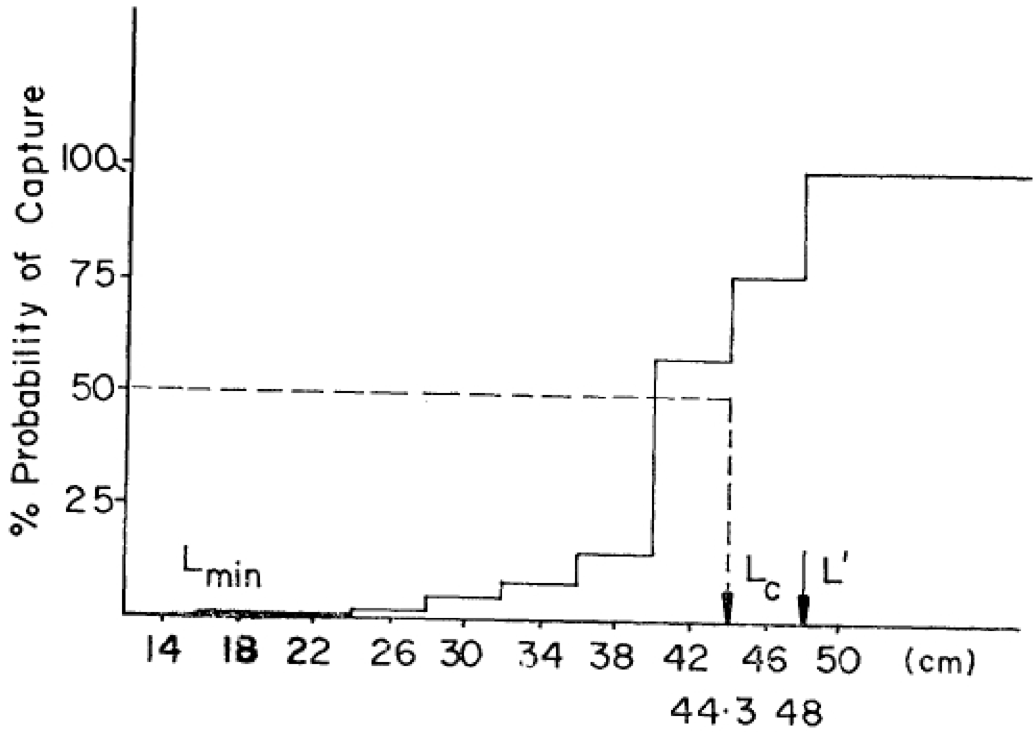


Fig. 6 Selection curve of *K. pelamis* caught by troll lines off West Sumatra (1985 —1986).

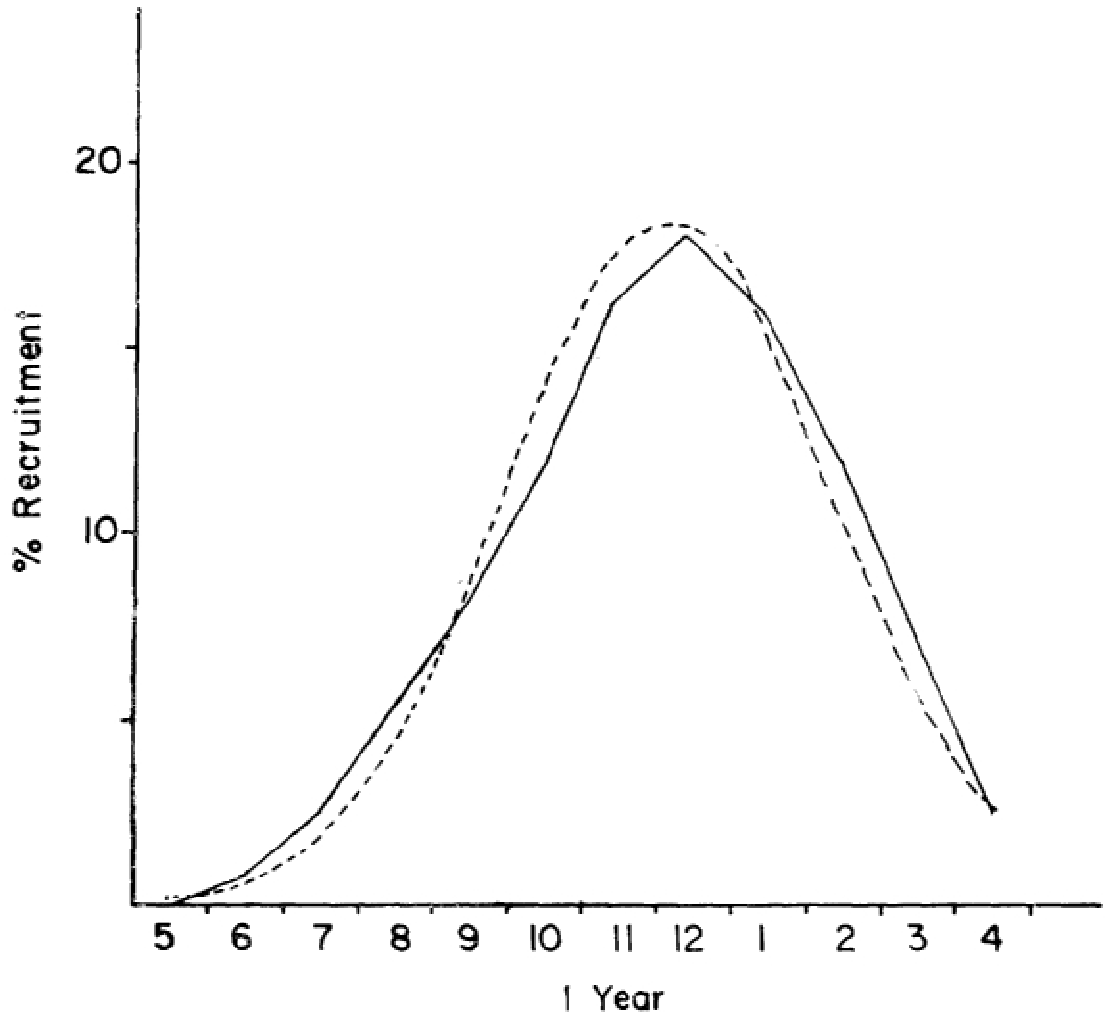


Fig. 7 The annual recruitment pattern of *K. pelamis* from West Sumatra (1985–1986)

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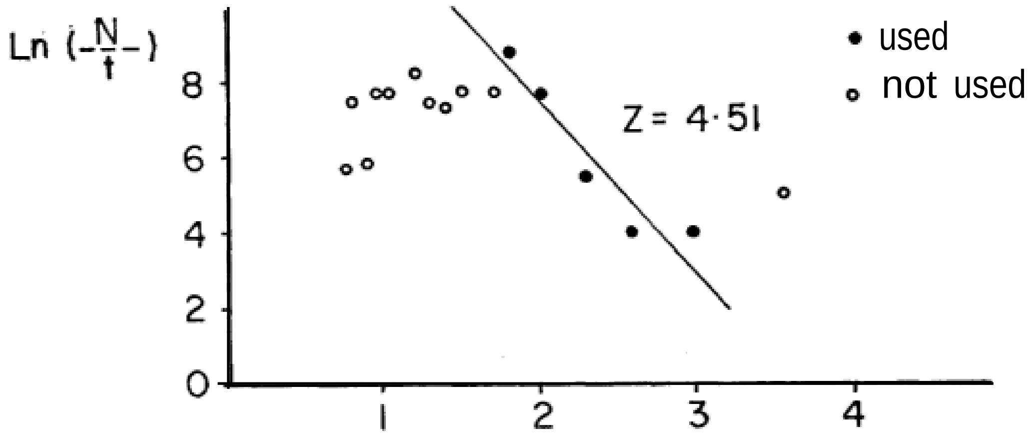
Fig. 8 Length converted catch curve for *A. thazard* from West Sumatra.



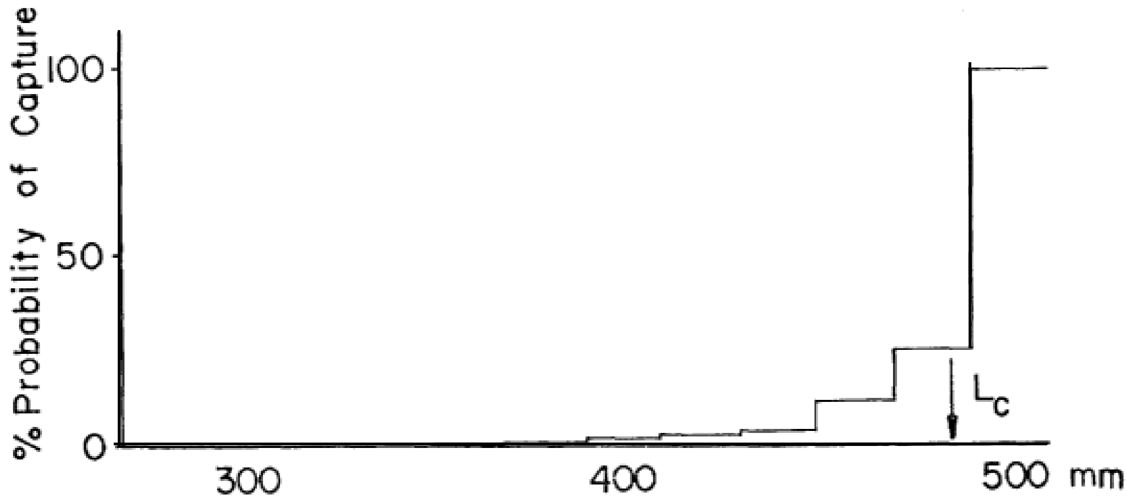


Fig. 9 Selectivity pattern of *A. thazard* troll fishery in West Sumatra.

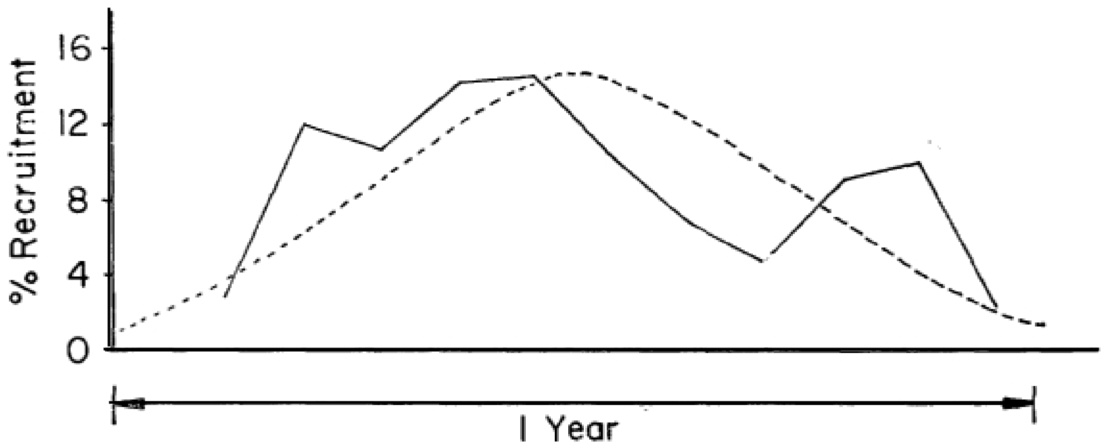


Fig. 10 Annual recruitment pattern of *A. thazard* from west coast of Sumatra.

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Publications of the Bay of Bengal Programme (BOBP)

The BOBP brings out six types of publications.

Reports (BOBP/REP/. . . .) describe and analyze completed activities such as seminars, annual meetings of BOBP's Advisory Committee, and projects in member-countries for which BOBP inputs have ended.

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Manuals and Guides (BOBP/MAG/ . . .) are instructional documents for specific audiences.

Miscellaneous Papers (BOBP/MIS/. . .) concern work not originated by BOBP — but which is relevant to the Programme's objectives.

Information ***Documents*** (BOBP/INF. . .) are bibliographies and descriptive documents on the fisheries of member-countries in the region.

Newsletters (Bay *of* Bengal News), issued quarterly, contain illustrated articles and features in non-technical style on BOBP work and related subjects.

A list of publications follows.

Reports (BOBP/REP/. . .)

1. Report of the First Meeting of the Advisory Committee. Colombo, Sri Lanka, 28-29 October 1976 (Published as Appendix 1 of IOFC/DEV/78/44.1, FAO, Rome, 1978)
2. Report of the Second Meeting of the Advisory Committee. Madras, India, 29-30 June 1977. (Published as Appendix 2 of IOFC/DEV/78/44.1, FAO, Rome, 1978)
3. Report of the Third Meeting of the Advisory Committee. Chittagong, Bangladesh, l-10 November 1978 Colombo, Sri Lanka, 1978. (Reissued Madras, India, September 1980)
4. Role of Women in Small-Scale Fisheries of the Bay of Bengal. Madras, India, October 1980.
5. Report of the Workshop on Social Feasibility in Small-Scale Fisheries Development. Madras, India, 3-8 September 1979. Madras, India, April 1980.
6. Report of the Workshop on Extension Service Requirements in Small-Scale Fisheries. Colombo, Sri Lanka, 8-12 October 1979. Madras, India, June 1980.
7. Report of the Fourth Meeting of the Advisory Committee. Phuket, Thailand, 27-30 November 1979. Madras, India, February 1980.
8. Pre-Feasibility Study of a Floating Fish Receiving and Distribution Unit for Dubla Char, Bangladesh. G. Eddie, M. T. Nathan. Madras, India, April 1980.
9. Report of the Training Course for Fish Marketing Personnel of Tamil Nadu. Madras, India, 3-14 December 1979. Madras, India, September 1980.

10.1 Report of the Consultation on Stock Assessment for Small-Scale Fisheries in the Bay of Bengal. Chittagong, Bangladesh, 16-2 1 June 1980. Volume 1: Proceedings. Madras, India, September 1980.

10.2 Report of the Consultation on Stock Assessment for Small-Scale Fisheries in the Bay of Bengal. Chittagong, Bangladesh, 16-21 June 1980. Volume 2: Papers. Madras, India, October 1980.

11. Report of the Fifth Meeting of the Advisory Committee. Penang, Malaysia, 4-7 November 1980. Madras, India, January 1981.
12. Report of the Training Course for Fish Marketing Personnel of Andhra Pradesh. Hyderabad, India, 1 l-26 November 1980. Madras, India, September 1981.
13. Report of the Sixth Meeting of the Advisory Committee. Colombo, Sri Lanka, l-5 December 1981. Madras, India, February 1982.
14. Report of the First Phase of the "Aquaculture Demonstration for Small-Scale Fisheries Development Project" in Phang Nga Province, Thailand. Madras, India, March 1982.
15. Report of the Consultation-cum-Workshop on Development of Activities for Improvement of Coastal Fishing Families. Dacca, Bangladesh, October 27-November 6, 1981. Madras, India, May 1982.
16. Report of the Seventh Meeting of the Advisory Committee. New Delhi, India, January 17-21, 1983. Madras, India, March 1983.
17. Report of Investigations to Improve the Kattumaram of India's East Coast. Madras, India, July 1984.
18. Motorization of Country Craft, Bangladesh. Madras, India, July 1984.
19. Report of the Eighth Meeting of the Advisory Committee. Dhaka, Bangladesh, January 16-19, 1984. Madras, India, May 1984.

20. Coastal Aquaculture Project for Shrimp and Finfish in Ban Merbok, Kedah, Malaysia. Madras, India, December 1984.
21. Income-Earning Activities for Women from Fishing Communities in Sri Lanka. E. Drewes. Madras, India, September 1985.
22. Report of the Ninth Meeting of the Advisory Committee. Bangkok, Thailand, February 25-26, 1985. Madras, India, May 1985.
23. Summary Report of BOBP Fishing Trials and Dcmersal Resources Studies in Sri Lanka. Madras, India, March 1986.
24. Fisherwomen's Activities in Bangladesh: A Participatory Approach to Development. P. Natpracha. Madras, India, May 1986.
25. Attempts to Stimulate Development Activities in Fishing Communities of Adirampattinam, India. P. Natpracha, V.L.C. Pietersz. Madras, India, May 1986.
26. Report of the Tenth Meeting of the Advisory Committee. Male, Maldives. 17-18 February 1986. Madras, India, April 1986.
27. Activating Fisherwomen for Development through Trained Link Workers in Tamil Nadu, India. E. Drewes. Madras, India, May 1986.
28. Small-Scale Aquaculture Development Project in South Thailand: Results and Impact. E. Drewes. Madras, India, May 1986.
29. Towards Shared Learning: An Approach to Non-formal Adult Education for Marine Fisherfolk of Tami] Nadu, India. L. S. Saraswathi and P. Natpracha. Madras, India, July 1986.
30. Summary Report of Fishing Trials with Large-Mesh Driftnets in Bangladesh. Madras, India, May 1986.
31. In-Service Training Programme for Marine Fisheries Extension Officers of Orissa, India. U. Tietze. Madras, India, August 1986.
32. Bank Credit for Artisanal Marine Fisherfolk of Orissa, India. U. Tietze. Madras, India, May 1987.
33. Non-formal Primary Education for Children of Marine Fisherfolk in Orissa, India. U. Tietze, Namita Ray. Madras, India, December 1987.
34. The Coastal Set Bagnet Fishery of Bangladesh-Fishing Trials and Investigations. SE. Akerman. Madras, India, November 1986.
35. Brackishwater Shrimp Culture Demonstration in Bangladesh. M. Karim. Madras, India, January 1987.
36. Hilsa Invrstigations in Bangladesh. Colombo, Sri Lanka, June 1987.
37. High-opening Bottom Trawling in Tamil Nadu, Gujarat and Orissa, India: A Summary of Effort and Impact. Madras, India, February 1987.
38. Rrport of the Eleventh Meeting of the Advisory Committee. Bangkok, Thailand, March 26-29, 1987. Madras, India, June 1987.
39. Invrstigations on the Mackerel and Scad Rtsourcts of the Malacca Straits. Madras, India, December 1987.
40. Tuna in the Andaman Sea. Colomho, Sri Lanka, December 1987.

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