Marine Resources and Fisheries in the Exclusive Economic Zones of Thailand

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Abstract

Geographically and migratorily, there are four marine fishery resource groups in Thai waters: i) Local fish stocks, ii) Shared transboundary fish stocks, iii) Shared transboundary migratory fish stocks, these 3 fishery resource groups are found as common resources in the Gulf of Thailand where it borders the South China Seas and iv) Highly migratory fish stocks which is the one of the four groups that appear off the Andaman Sea coast of Thailand bordering the high seas of the Indian Ocean. Recommendations for management and conservation of those fish stocks are reported as follows:

1) Development of a legal framework for better promulgation and enforcement of fishery conservation measures;
2) Harmonising study of migratory paths and patterns of highly migratory species by tagging, fish population dynamics, development of fishery statistical systems and exchange of information and experience;
3) Adjust and modify fishing patterns in a way to ensure sustainability and
4) Rehabilitation of the desirable fishery resources and specialised ecosystems and introduction of new hi-tech and other methodologies such as early warning systems on oil spill contingencies and red tide phenomena, including electronic information exchange and continuous automatic monitoring of pollution levels in the EEZs and the high seas

1. Introduction

This analysis and review of marine resources and the status of fisheries in the Exclusive Economic Zones (EEZs) of Thailand, is the consequence of the United Nations Convention on the Law of the Sea (UNCLOS) agreement. It relates to the conservation and management for sustainable use of straddling fish stocks and highly migratory fish stocks. These stocks may migrate between EEZs in some stages of their life cycles based on the biological characteristics of each species such as reproduction, spawning, feeding, etc. After becoming mature, they will migrate to other areas. In the Gulf of Thailand, migration takes place between the EEZs of Thailand, neighbouring countries and the South China Seas. In Andaman Sea, some species will migrate to high seas to become mature and parent stock.

Marine fisheries in the Gulf of Thailand are in an area which can be divided into two zones. One is the EEZ, having approximately 73,471.44 square nautical miles of fishing ground (Phasuk, 1987). Another is the overlapping zone between Thailand, Cambodia, Thailand-Cambodia-Vietnam, and Thailand, Malaysia these have approximately 9,922.746, 4,090.056 and 2,107.17 square nautical miles of fishing grounds, respectively (Nakthon, 1992) (Fig. 1). Marine fisheries in the Indian Ocean has approximately 36,735.72 square nautical miles of fishing grounds (Phasuk, 1987). The fishing grounds are divided into EEZ and high sea areas. There is no overlapping zone between EEZs of Thailand and neighbouring countries (Fig. 2).

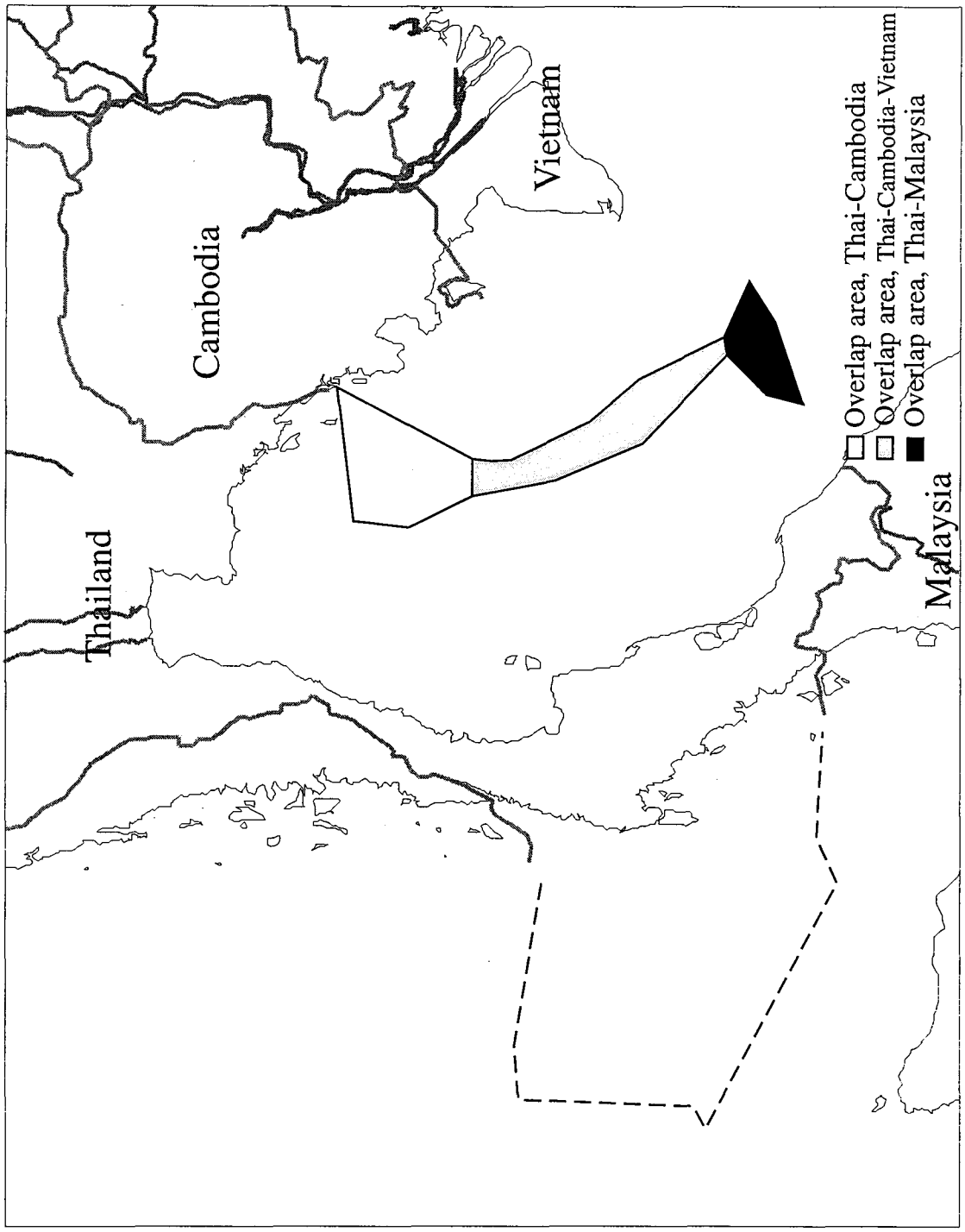


Fig. 1. The EEZs of Thailand and the overlapping areas of EEZs between Thailand and neighbouring countries (Nakthon, 1992)

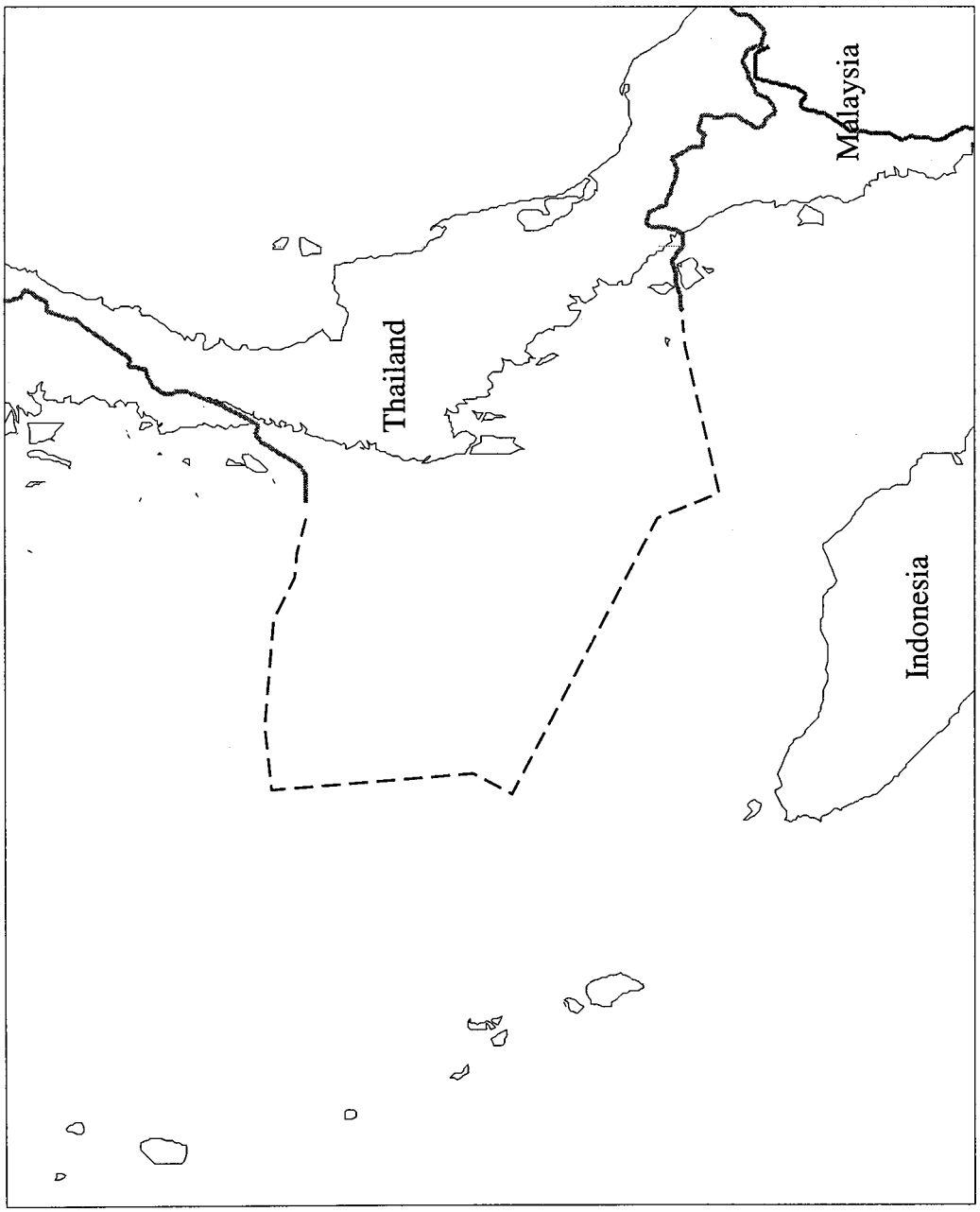


Fig. 2. The Thai EEZ in the Andaman Sea (Charoenlap, 1985)

Based on these circumstances, marine resources are harvested by Thai fishermen, in the EEZ of Thailand and in neighbouring countries under joint ventures. The resources may be transboundary shared stocks, straddling fish stocks and highly migratory fish stocks, which can only be used under the 1995 agreement of the United Nations convention on the Law of the Sea.

The objectives of this paper are to analyse and review technical studies pertaining to marine resources in EEZs of Thailand which have been continuously produced from several aspects; species, biological distribution, fishing grounds, fishing gear, catch size, spawning areas and seasons, biological parameters, marine resources, fisheries and migration. The objectives also seek to establish a way to manage the joint use of straddling and highly migratory fish stocks together with neighbouring countries.

This paper is intended to be a resource for "**the technical Workshop on Straddling Fish Stocks and Highly Migratory Fish Stocks**", and to be used in studies on biology of stock and marine fisheries. It also seeks to guide the management of marine resources in Thai waters, Thai contiguous waters, and Thai-contiguous waters-high seas, for responsible fisheries and sustainable use of marine resources.

2. Marine Species

Marine species in the EEZs of Thailand can be divided into 3 groups as follows:

2.1 Pelagic species

Pelagic species are those that dwell and feed near the sea surface. They consume phytoplankton and zooplankton and gather in schools. Usually they are fusiform of body and fast swimming. Several of the pelagic species that are economically important, are photophile and migrate between the Thai EEZ and contiguous waters. The pelagic species are mainly caught in Thailand are Indo-Pacific mackerel (*Rastrelliger brachysoma*), Indian mackerel (*R. kanagurta*), Faughni's (*R. faughni*), Barred Spanish mackerel (*Scomberomorus commerson*), Indo-Pacific Spanish mackerel (*S. guttatus*), Lined Spanish mackerel (*S. lineolatus*), Longtail tuna (*Thunnus tonggol*), Kawa Kawa (*Euthynnus affinis*), Frigate tuna (*Auxis thazard*), Round Scad (*Decapterus* spp.), Sardine (*Sardinella gibbosa*), Anchovy (*Encrasicholina heteroloba*), Hardtail Scad (*Megalaspis cordyla*), Black pomfret (*Parastromateus niger*), Silver pomfret (*Pampas argenteus*), Banded crevalle (*Atule mate*), yellow stripe trevally (*Selaroides leptolepis*), and Bigeye Scad (*Selar cruminopthalmus*), etc.

2.2 Demersal species

Demersal species have their habitat near the sea bottom. They are carnivorous having strong and sharp teeth. Their major food is fish, shrimp, squid, etc. The demersal species which are economically important and mainly caught are Lizard fish (*Saurida elongata, S. undosquamis*, and *S. tumbil*), Threadfin bream (*Nemipterus mesoprion, N. nematophorus, and N. marginatus*), Bigeye (*Piracanthus tayenus*), barracuda (*Sphyraena obstusata* and *S. langsar*), red snapper (*Lutjanus lineolatus* and *L. malabaricus*) and yellow goatfish (*Upenus sulphureus*), etc. These species move slowly, some are in the EEZs of each country and some straddle between the Thai EEZs and contiguous waters.

2.3 Others species

These species are invertebrate such as squid (*Loligo chinensis, L. duvauceli, L. edulis, L. singhalensis*, and *Sepioteuthis lessoniana*), cuttle fish (*Sepia pharaonis, S. lycidas, S. aculeata, S. esculenta* and *S. brevimana*), octopus (*Octopus* spp.), and marine shrimp (*Penaeus semisulcatus*, and *P. monodon*). Squid and cuttle fish are fast-moving species which may straddle between the EEZs of Thailand and neighbouring countries. Octopus and marine shrimp are slow-moving, living in coastal areas and EEZs. These two species may straddle between the EEZs of Thailand and neighbouring countries or migrate between an EEZ and high seas for reproduction, spawning, etc.

Indo-Pacific Mackerel (*Rastrelliger brachysoma*) (Fig. 3)

SYNONYMS STILL USE: NONE

Rastrelliger brachysoma (Bleeker, 1851)

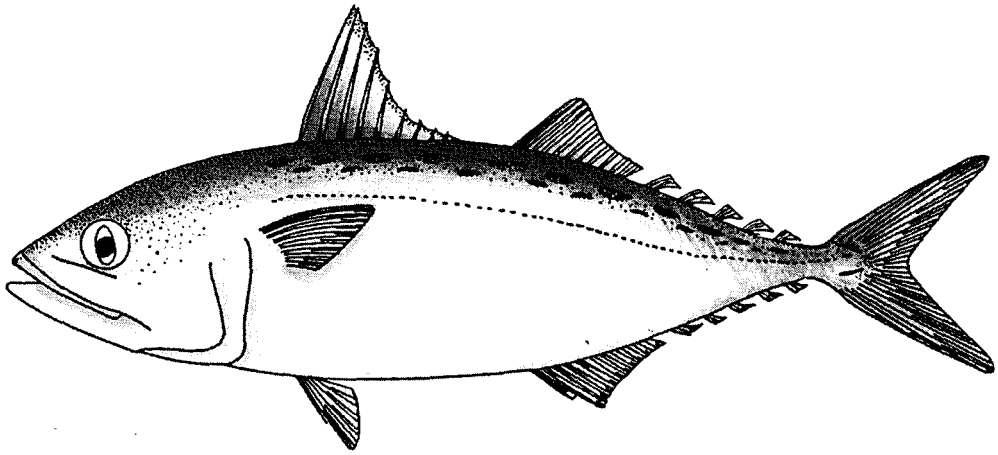


Fig. 3. The Indo-Pacific mackerel found in Thai waters (FAO, 1984)

Indo-Pacific mackerel in the Gulf of Thailand is scattered along coastal areas; at a depth of 50 m., or less. It spawns throughout the year. However, the peak spawning season is around January-March and June-August (Fig. 4). The biggest spawning area is off the coasts of Prachuab Kirikhan, Chumporn, Suratthani provinces. A female spawns about 20,000 eggs at a time, 7 times a year. After the egg has been fertilised and spawned, the egg becomes larvae and juvenile within 20-27 and 72 hours respectively.

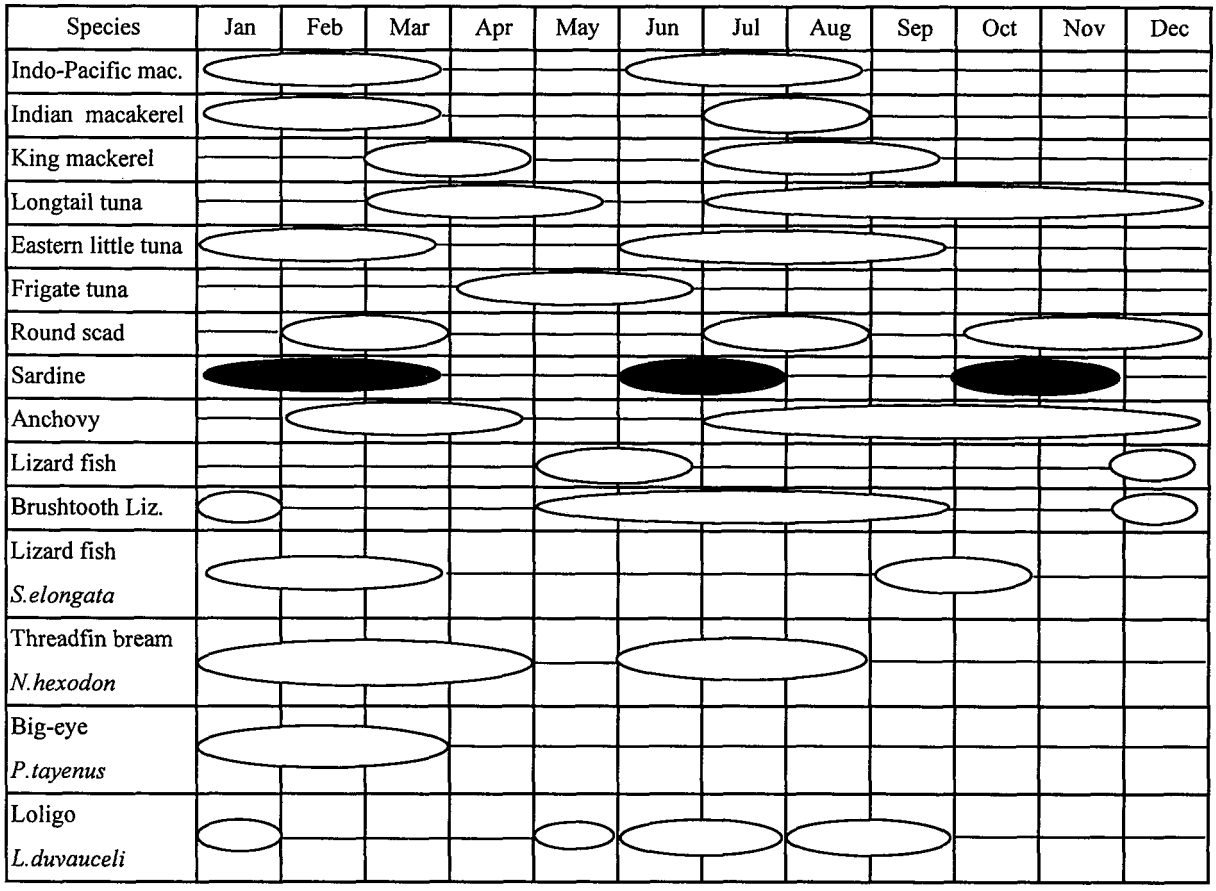


Fig. 4 Spawning seasons of economically important marine species in the Gulf of Thailand

When it reaches 10.0 cm, it will migrate from the spawning area along the western side of the Gulf of Thailand to the northern part, in order to seek food and grow up. This area is the most productive area, rich in phytoplankton. It remains in this area until it grows to the biological minimum size, or 13.4 cm., average. The mature length (L_m) is approximately 17.5 cm. (Boonprakob, 1965, quoted by Sriruengchiep, 1997). It will then migrate to the western side of the Gulf of Thailand. The life cycle of Indo-Pacific mackerel is shown in Fig. 5.

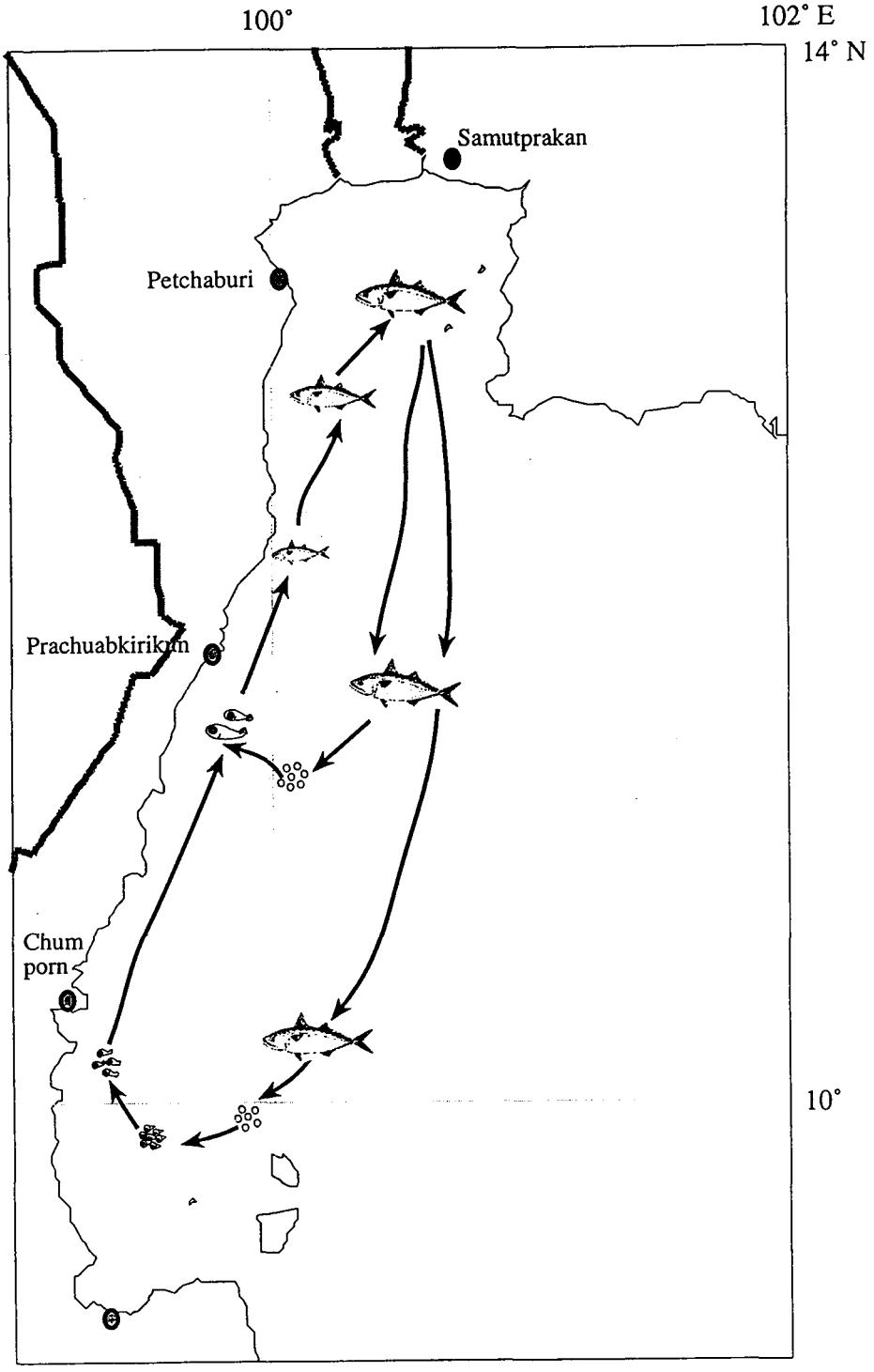


Fig. 5. Life cycle of the Indo-Pacific mackerel in the Gulf of Thailand (Menasveta, 1980)

Biological analyses of the Indo-Pacific mackerel in the Gulf of Thailand shows several parameters. These are the calculated maximum length (L¥); 22.0 cm. natural mortality rate (M); 4.2/year, growth rate (K); 3.2-3.7/year (FAO, 1996). Hongskul (1974) reports the age at a length equal to zero (t_0) of Indo-Pacific mackerel as -0.003. And the coefficient values of the equation of length & weight relationship are a = 0.00614, b = 3.213.

The major fishing gear used to catch this type of mackerel (average catch from 1972-1991), are 85% purse seine (Thai purse seine ; 47.2%, green purse seine ; 37.8%); 7.4% of paired trawls and 7.7% of other fishing gear. (DOF, 1973-1984, 1985-1990, 1991-1993). The quantity of Indo-Pacific mackerel catch before 1971, was 100,000 tons. Between 1971 and 1977 it was approximately 30,000-40,000 tons, except in 1975 and 1976 when it was 60,000 and 50,000 tons, respectively. Since then, the catch of this mackerel has been potentially increased. The peak of the increment was in 1984 when the catch was 100,000 tons. Subsequently, the catch was stable at about 58,000-100,000 tons. After 1989, the catch decreased. In 1991, the catch was only 55,000 tons. The catch record of the Indo-Pacific mackerel in the Gulf of Thailand is shown in Table 1.

Table 1. Catch of marine species from major fishing gear* in the Gulf of Thailand during 1971-1992

Years	Indo-Pacific mac.	Indian mac.	Spanish mac.	Small tuna	Round Scad	Sardines	Anchovies	Lizard fish	Threadfin bream	Bigeye
1971	38.3	5.4	0.0	3.3	0.5	2.1	7.2	10.2	12.1	10.1
1972	33.4	9.3	1.6	4.1	0.7	8.0	12.8	14.9	18.6	13.8
1973	41.4	12.7	3.6	5.9	14.7	21.7	22.3	11.4	16.1	10.8
1974	34.7	14.0	2.3	6.9	33.3	46.3	19.5	9.8	15.4	11.4
1975	58.9	16.3	5.5	8.0	25.0	49.0	14.7	10.0	17.1	13.3
1976	49.6	19.0	6.2	7.4	82.5	91.8	15.3	9.6	14.5	10.9
1977	26.1	30.3	8.9	11.2	129.8	203.4	9.9	11.3	17.0	16.9
1978	42.3	33.7	6.2	7.1	106.3	133.6	8.5	11.8	20.3	12.8
1979	82.6	24.8	7.4	13.3	27.0	136.3	14.1	9.8	17.0	10.8
1980	47.3	24.9	7.8	12.5	30.2	96.4	16.7	9.5	14.9	15.2
1981	66.1	17.1	9.7	20.0	34.4	129.2	12.1	7.6	16.0	14.0
1982	71.2	18.3	6.9	39.4	32.1	87.9	23.1	7.7	14.4	8.8
1983	60.2	50.6	7.2	82.0	24.5	97.7	38.1	8.5	12.8	10.3
1984	99.6	29.8	8.0	69.4	27.5	83.8	88.8	8.7	12.1	9.3
1985	97.9	32.9	8.4	81.2	25.7	68.4	103.1	8.5	14.8	10.9
1986	88.8	38.8	11.0	90.2	23.9	92.5	58.0	13.3	22.6	17.3
1987	92.2	36.3	11.9	96.1	41.8	83.6	55.5	16.5	29.5	24.1
1988	88.8	18.7	12.1	141.3	14.0	89.1	66.7	16.2	26.5	21.9
1989	92.7	26.5	9.2	124.9	17.3	114.3	94.3	17.2	29.7	21.7
1990	68.2	20.8	9.2	156.3	10.7	90.8	118.7	13.2	26.0	21.2
1991	55.2	16.3	6.1	137.9	22.7	114.2	110.0	19.8	33.8	25.3
1992	88.3	29.3	6.7	157.2	42.5	141.4	120.2	31.8	51.3	36.2

Source : Department of Fisheries, 1973-1974; 1985-1990; 1991-1993 and 1994-1996

* Purse seine, trawls, push nets, gill nets, and stake traps

According to the 1992 surveys in the overlapping areas between the EEZs of Thailand and Malaysia or so-called "**Joint Development Area: JDA**" (Fig. 6), these reveal no Indo-Pacific mackerel were found either from trawls or gill nets.

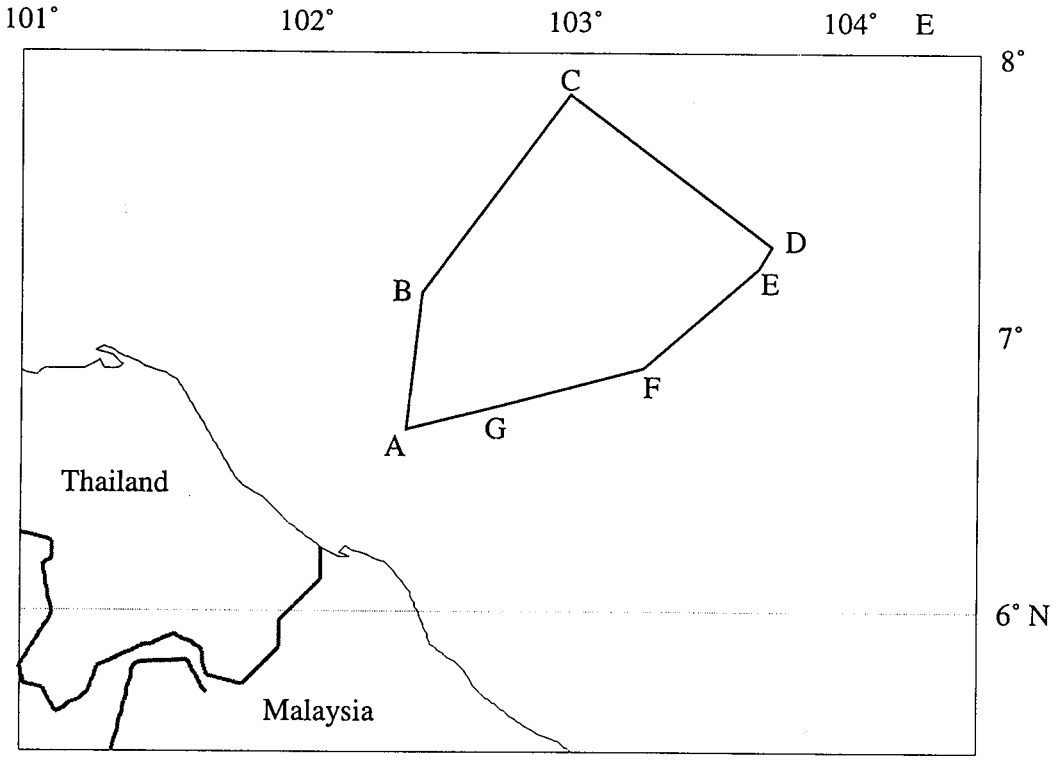


Fig. 6. The Joint Development Area : JDA between Thailand and Malaysia (Anonymous, 1992)

From the stock assessment of the Indo-Pacific mackerel (FAO, 1996), this shows that the maximum sustainable yield (MSY) is 73,000 tons and optimum number of fishing days are 95,327 using the green purse seine. Several tagging studies conclude that there are two stocks of Indo-Pacific mackerel in the Gulf of Thailand. One is the straddling stock between the eastern Thai Gulf and Cambodian waters. The other is the migratory stock between the Inner Thai Gulf and the upper western Thai Gulf (Somjaiwong and Chullasorn, 1974).

In the Andaman Sea, Suthakorn (1986) reported Indo-Pacific and Indian mackerel larvae surveys (the larvae of the two mackerel types can not be technically distinguished), in the southern Phang-Nga Bay and Trang provincial waters, the larvae was abundant in February to April. In March, the abundance was at a peak in the Trang provincial area. The quantity of larvae was more than 50,000 larva/litre. The life study of Indo-Pacific and Indian mackerel, shows the parent stocks of Indo-Pacific mackerel are 13.1 cm. long and above, and the parent stocks are 17.8 cm. long. The peak of the spawning season is in January-February and September-October (Fig. 7).

Boonrak and Chanasit (1995) reported the juveniles of the Indo-Pacific mackerel (sizes 4.0-5.0 cm.) which recruit in the fishing grounds are mostly found in March and November. The normal size of this mackerel is between 14.0-21.0 cm. The biological analysis of the Indo-Pacific mackerel in the Andaman Sea shows several parameters such as the calculated maximum length as being 23.0 cm., the growth rate is 1.15-2.88 a year, the natural mortality rate is 2.13-3.12 a year and the length of the mackerel is 14.5 cm.

The Indo-Pacific mackerel catch by major fishing gear in the Andaman Sea between 1971-1973, has been quite varied and shows a decreasing trend since 1973, until 1980, when the catch was the lowest; at 1,800 tons. Since then the catch gradually increased, until in 1983 it was more than 18,000 tons. In 1985-1988, the catch decreased to between 12,000 and 15,000 tons. After that, the catch in the Andaman Sea has rapidly increased until in 1991 it was more than 38,000 tons (see Table 2).

Boonrak and Chanasit (1995) reported on the fishing grounds of the Indo-Pacific mackerel in the Andaman Sea at 10-40 m. depth, found substantially in Phang-Nga Bay to Satun provincial water which is next to the Malaysian waters and Thai-Myanmar border in the Ranong provincial area (Fig. 8). The important fishing ports for the Indo-Pacific mackerel are in Ranong, Phang-Nga, Phuket, Krabi, Trang, and Satun provinces.

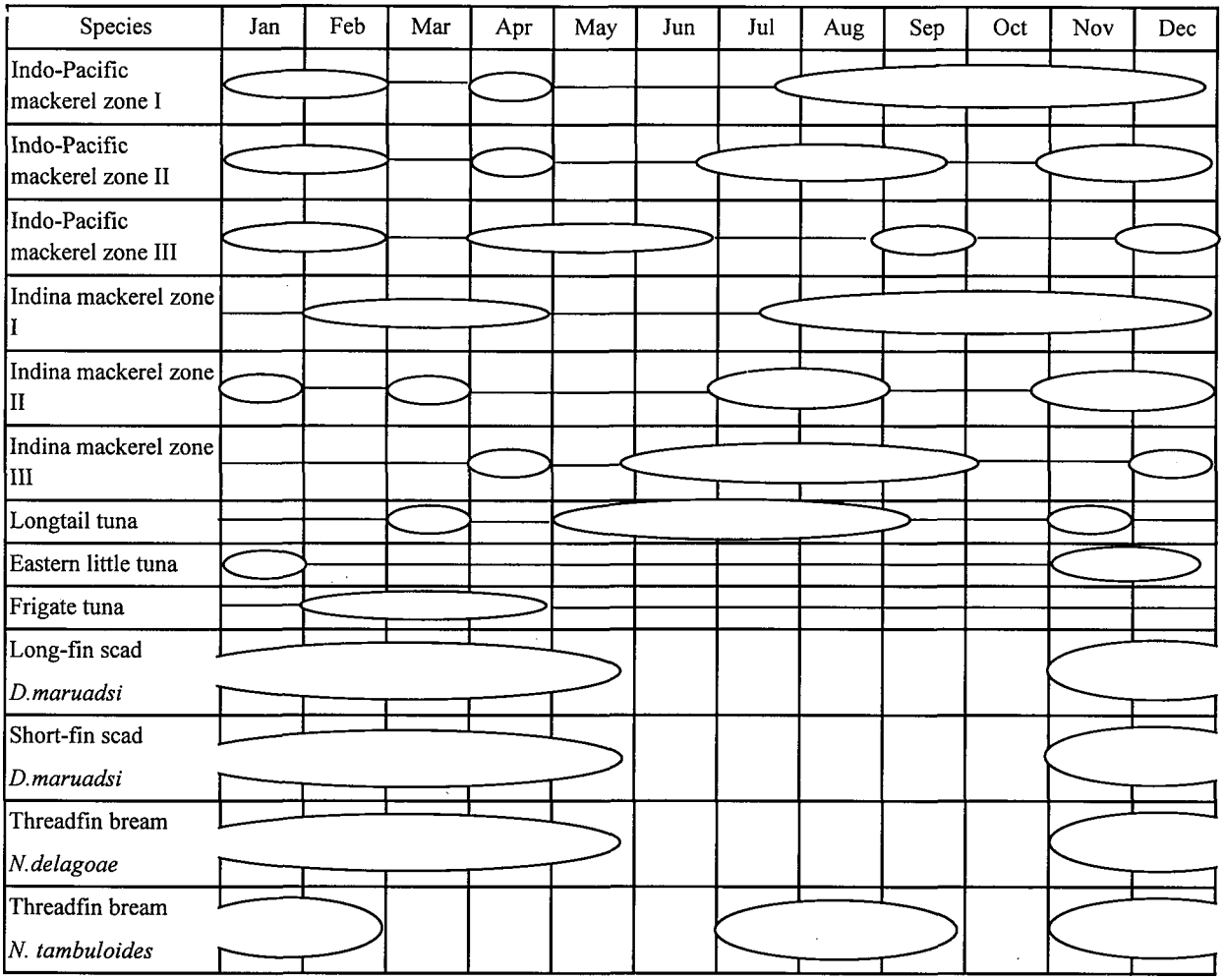


Fig. 7 Spawning seasons of economic important marine species in the Andaman Sea

Spawning seasons

Table 2. Catch of marine species from major fishing gear* in the Andaman Sea during 1971-1992

Years	Indo-Pacific mac.	Indian mac.	Spanish mac.	Small tuna	Round Scad	Sardines	Anchovies	Lizard fish	Threadfin bream	Bigeye fish
1971	12.3	3.9	0.2	1.9	1.8	0.0	0.0	0.9	2.0	0.5
1972	5.7	4.0	0.3	1.7	1.5	0.7	6.1	0.6	2.1	0.7
1973	13.8	10.5	0.2	1.7	0.8	2.1	4.6	1.9	2.2	0.8
1974	5.1	6.1	0.2	1.2	1.4	2.1	7.5	2.2	3.0	1.0
1975	8.0	5.7	0.2	2.9	1.5	2.7	3.7	1.2	1.9	0.5
1976	3.1	5.3	0.5	1.8	1.0	5.5	0.9	0.8	1.7	0.6
1977	4.5	2.5	0.9	1.5	1.5	2.9	0.0	3.1	2.5	1.6
1978	2.3	2.4	0.7	2.1	0.9	3.0	0.8	0.6	1.8	0.7
1979	4.5	2.9	1.2	2.1	1.0	11.0	1.1	0.7	2.2	0.9
1980	1.8	1.0	0.8	0.8	0.9	2.4	0.7	0.4	2.5	1.1
1981	2.2	0.9	1.1	2.1	1.2	2.0	0.4	1.1	3.2	1.2
1982	10.1	1.2	1.4	9.6	3.8	27.0	0.1	0.9	2.2	0.7
1983	13.1	1.9	0.9	3.8	9.6	24.6	0.3	0.9	2.5	0.6
1984	18.7	2.2	0.7	7.4	16.8	30.6	0.4	1.0	1.9	0.7
1985	13.8	1.2	1.4	5.6	8.0	27.5	0.4	1.6	1.7	1.7
1986	13.8	1.0	1.9	3.4	2.5	26.6	0.1	1.6	4.1	0.9
1987	15.0	2.3	1.9	6.3	14.3	41.6	1.4	1.1	4.3	0.9
1988	12.0	5.6	1.8	4.8	17.7	32.6	0.2	1.1	3.0	0.7
1989	17.5	7.1	2.2	4.7	22.3	29.2	0.5	1.7	3.9	0.6
1990	25.1	10.1	2.7	6.9	22.6	27.4	0.8	3.3	4.9	1.8
1991	38.6	14.7	2.5	14.3	24.0	24.2	11.0	3.9	12.9	8.6
1992	32.9	8.5	3.5	11.9	8.4	19.9	36.6	6.5	13.7	8.4

Source : Department of Fisheries, 1973-1974; 1985-1990; 1991-1993 and 1994-1996

* Purse seine, trawls, push nets, gill nets, and bamboo stake traps

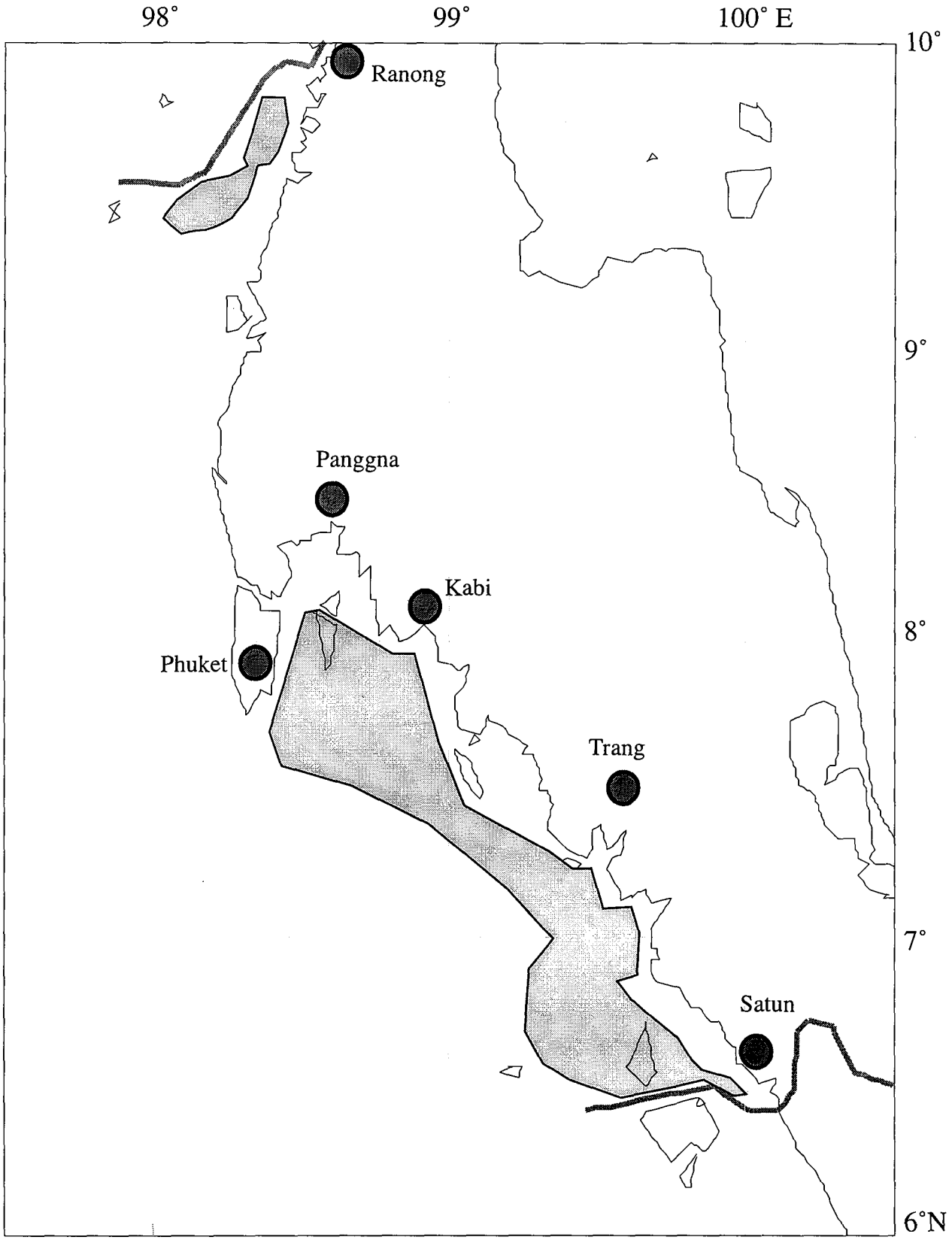


Fig. 8. The important fishing grounds of the Indo-Pacific mackerel in the Andaman Sea (Boonrak and Chanasit, 1995).

Somchaiwong et al. (1984) reporting the migratory studies of the Indo-Pacific mackerel in the Andaman Sea by tagging, found that the Indo-Pacific mackerel in this area can be categorized into 3 groups. The first group is distributed in the Ranong provincial area and Myanmar border. The second group is distributed around Phuket island and Krabi provincial waters, and the third group is distributed in Satun provincial water and the Thai-Malaysian border. In other words, the first group is a shared fish stock between Thailand and Mynmar and the third group is a shared fish stock between Thailand and Malaysia (Fig. 9)

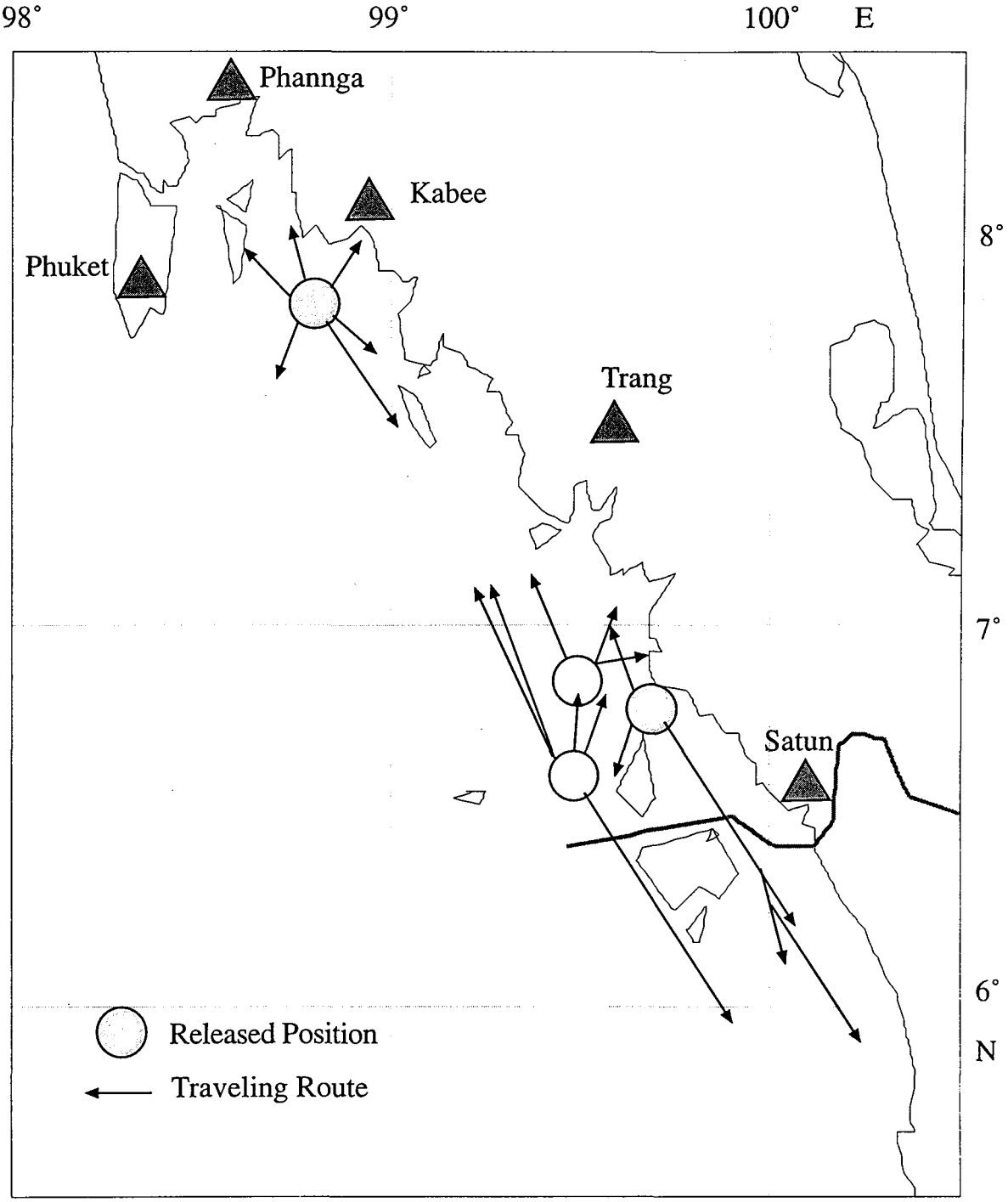


Fig. 9. Distribution and migration of the Indo-Pacific mackerel (*R. brachysoma*) by tagging in the Andaman Sea (Somjaiwong et al., 1984)

BOBP (1987) reporting the distribution and migration of Indo-Pacific mackerel in the Supongphancca Straits found that there are three groups of this mackerel. The first group is distributed in the eastern areas of Sumatra, Indonesia, and the western area of Malaysia (south Penang island). The second group is distributed in the southern area of Myanmar and Thailand (Ranong province), while the third group is distributed in the area between Phang-Nga Bay and Krabi provincial waters up to the north of Penang island, Malaysia (Fig. 10).

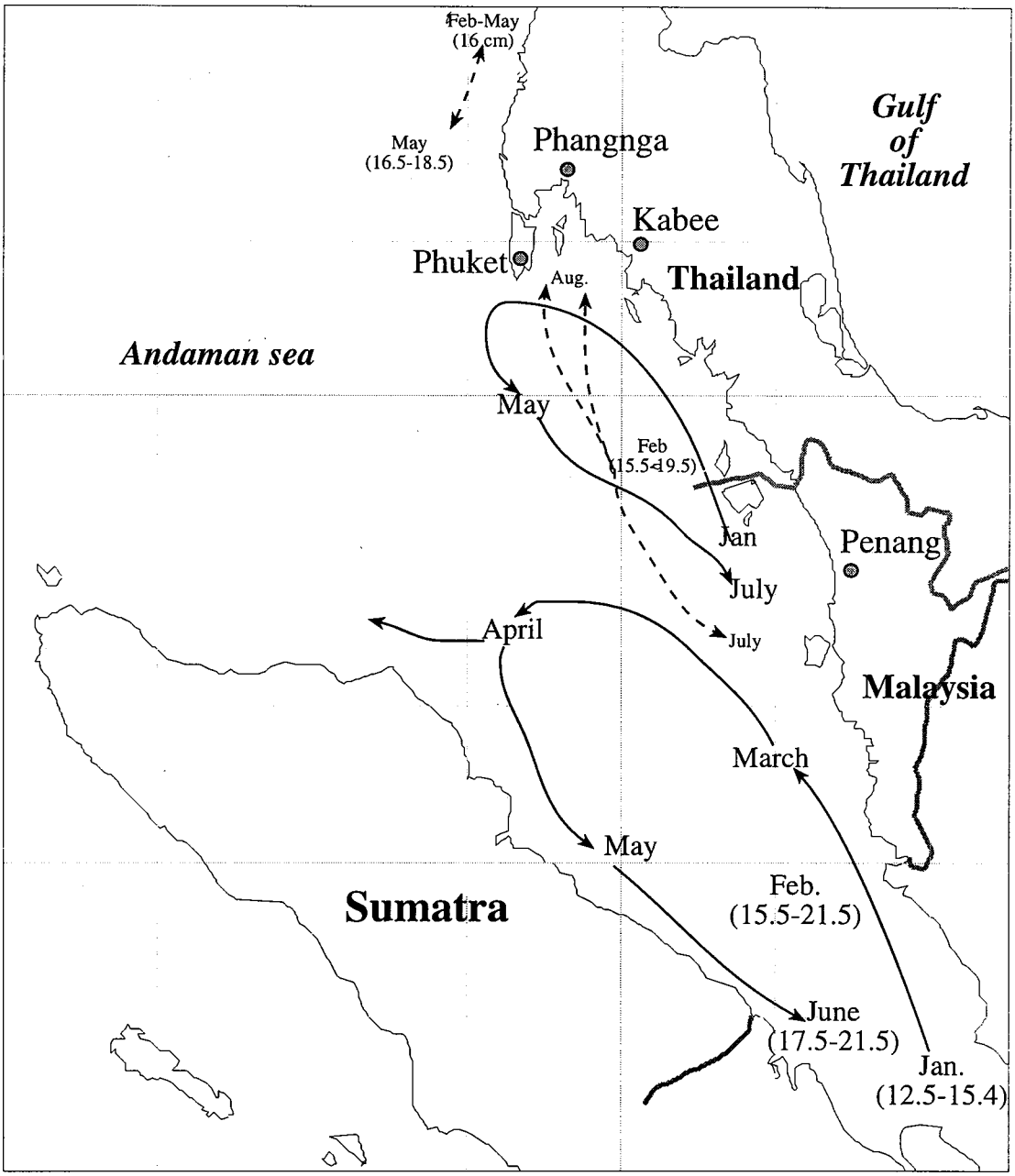


Fig. 10 Length frequency distribution and migration of Indo-Pacific mackerel stocks in the Andaman Sea (Boonrak and Chanasit, 1995)

Marine Fisheries Statistics (1993) shows the catch of Indo-Pacific mackerel in the areas between the EEZs of Thailand and neighbouring countries. Trad province which shares a border with Cambodia, has 484 tons of catch. Ranong province which shares a border with Myanmar, has a catch of 17,627 tons. Satun province which shares a border with western Malaysian waters, has 5,606 tons. Songkhla and Pattani which share a border with Malaysia have catches of 3,852 and 16,336 tons, respectively. From the survey carried out by the Marine Fisheries Division (DOF) found that a number of Thai purse seiners unloaded their catch in these two provinces. But the record is in line with the catch from each province. It can be assumed that the catch was in Thai waters, or it might be straddling fish stocks that migrate into Thai waters according to the season (Table 3).

Table 3. The quantity of marine catch in the contingent areas with neighbouring countries in 1993

unit: tons

Species	Provinces				
	Trad	Songkhla	Pattani	Satun	Ranong
Indo-Pacific mackerel	484	3,852	16,336	5,606	17,627
Indian mackerel	0	0	7,669	704	10,750
Spanish mackerel	192	358	1,521	451	497
Small tuna	146	9,470	48,259	173	164
Round Scad	0	241	33,354	325	1,407
Sardines	0	13,113	6,775	2,518	0
Squid	3,440	18,973	14,629	5,825	3,129

Source : Department of Fisheries, 1996

Indian mackerel (*Rastrelliger kanagurta*) (Fig. 11)

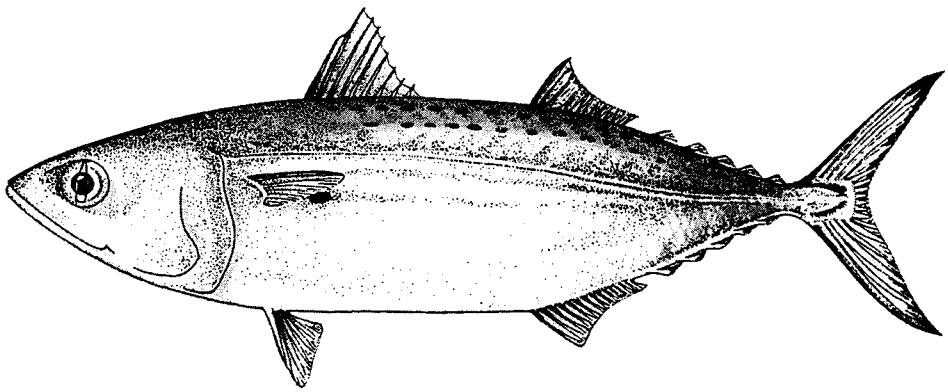


Fig. 11 Indian mackerel found in Thai waters (FAO, 1984)

Indian mackerel is generally distributed in the Gulf of Thailand both in shallow and deep waters. It consumes phytoplankton and zooplankton. Spawning takes place throughout the year. The peak of the spawning season is July-August in the area offshore from Prachuab Khiri Khan Bay, and January-March offshore from Surat Thani Bay (Fig. 4). The first maturity stocks are 19 cm. The maximum size of the Indian mackerel is 28 cm. and the size of normal catch is between 20-25 cm.

In the Gulf of Thailand, the Indian mackerel is caught throughout the year. The peak of the catch is in the central Gulf of Thailand at 30-50 m. depth. The major fishing gear used are purse seines 79.3%, otter board trawls 4.8% and gill nets & others 4.5 and 11.4, respectively. The fishing grounds of the Indian mackerel are shown in Fig. 12

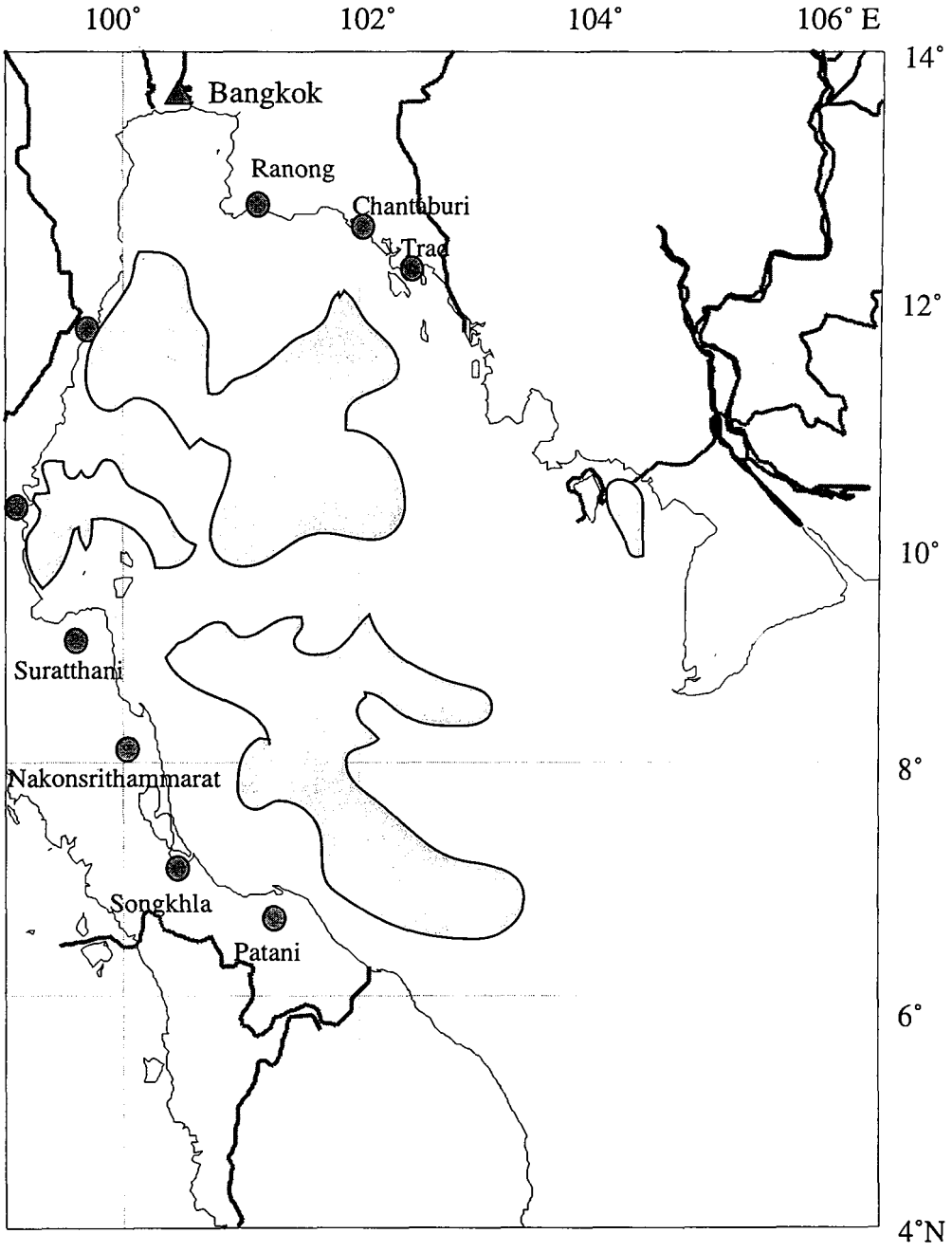


Fig. 12 Fishing grounds of the Indian mackerel in the Gulf of Thailand (SEAFDEC, 1981)

The catch of Indian mackerel from major fishing gear, between 1971-1992 was less than 40,000 tons/year (except in 1983). The catch potentially increased during 1971-1978, but was decreased in the next four years. Since then, the catch has rapidly increased at to a peak in 1983 which was 50,000 tons. Between 1988-1992, the catch was quite stable at 20,000-30,000 tons (Tables 1 and 2).

The survey of Thailand-Malaysia joint development area in 1992, reveals trawls have a fishing effort of 0.1-1.3 kg./hour. Gill nets have a fishing effort of 0.07-4.20 kg./station, and the mackerel caught were 10.5-24.5 cm. with a 20.4 cm. and 113.9 g. average.

The Indian mackerel in the Andaman Sea, spawns throughout the year. The number of spawned eggs at a time is 25,000 eggs. The high spawning season is during December to April (Fig. 7). The first maturity size is 17.0 cm. The maturity stock is 19.0 cm. (Suthakorn, 1986). Boonrak (1984) reports the major fishing gear to catch this kind of mackerel are Thai purse seines, Luring purse seines , Spanish mackerel drift gill nets and trawls. The fishing grounds of the Indian mackerel are along the Andaman Sea coast which has deeper water as compared to that of the fishing grounds of the Indo-Pacific mackerel (Fig. 13).

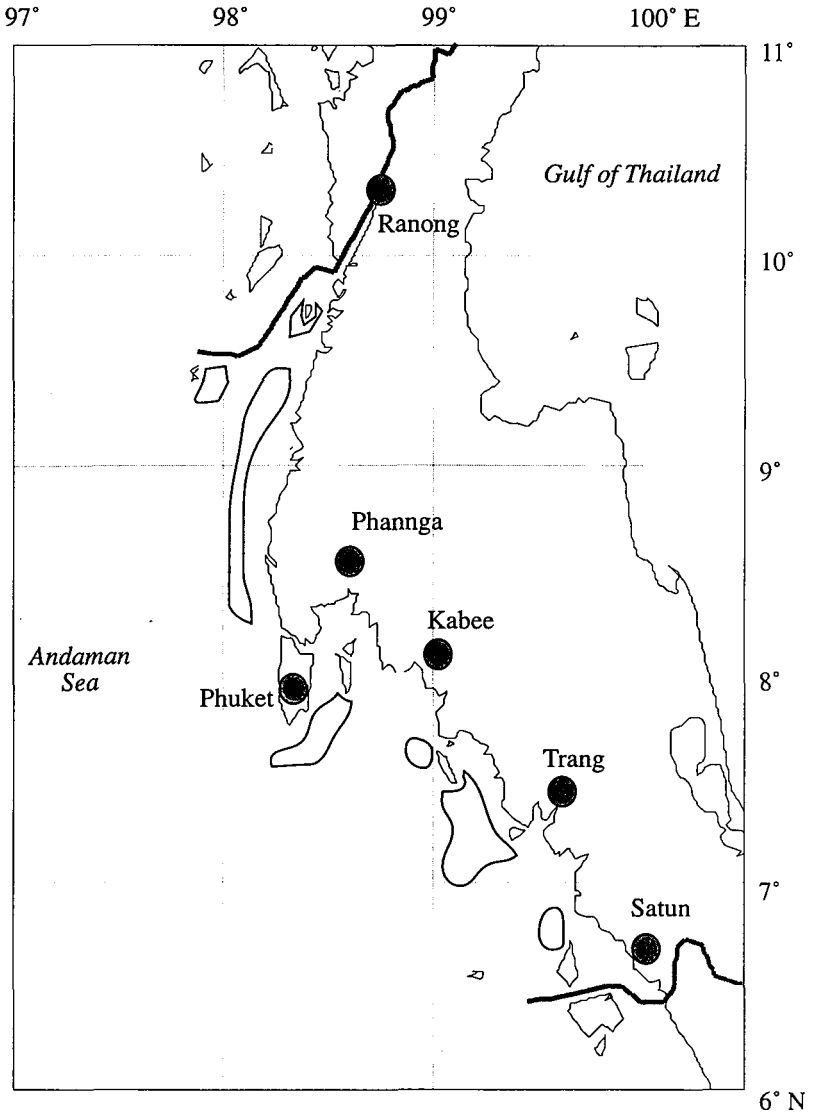


Fig. 13 The important fishing grounds of the Indian mackerel in the Andaman Sea (Boonrak, Suthakorn, and Busravich, 1984)

Spanish mackerel (Fig. 14)

There are 3 species of Spanish mackerel found in the Gulf of Thailand. They are the barred Spanish mackerel (*Scomberomorus commerson*), the Indo-Pacific Spanish mackerel (*S. guttatus*), and the Lined Spanish mackerel (*S. lineolatus*). Barred Spanish mackerel is the most abundant. Second to the Barred Spanish mackerel is the Indo-Pacific Spanish mackerel. The Lined Spanish mackerel is rarely found. The small size Spanish mackerel habitat in the shallow waters near coastal areas, but they will migrate to deeper water when grown up. Based on studies, Spanish mackerel which are 3.0-39.0 cm. long habitat at a depth of 3.0 m. or more. Spanish mackerel spawn throughout the year. The peak of the spawning season is from March-April and July-September (Fig. 4). A parent stock spawns 500,000 to 3,800,000 eggs a time. The first maturity stocks are approximately 58.5 cm., spawning at 20-30 m. deep, 10 miles away from shore. The spawning areas are Prachuab Khiri Khan and Chumporn provincial waters, Chuang island, Kram island, Cholburi province to Chantaburi province and Chang island, Trad province. The survey found a large number of Spanish mackerel juveniles in April in the Sattahip area, in March at Samui and Pa-ngan islands. The food of the Spanish mackerel is shrimps, squids, Anchovies, Sardines and Scad. Spanish mackerel feed throughout the day. They annually recruit 7 generations to its stock. (Supongphan and Chayakul, 1979a and 1979b).

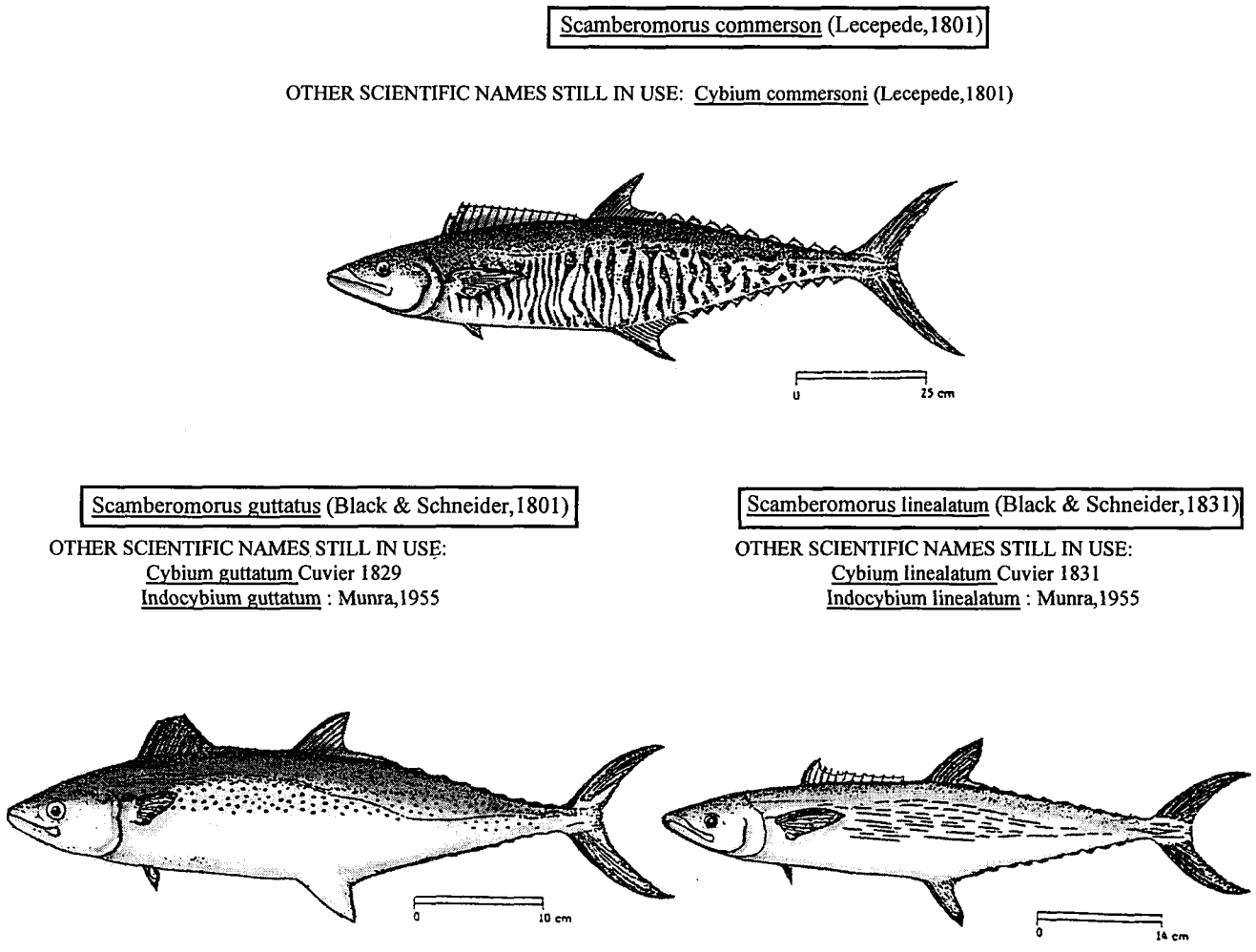


Fig. 14. Spanish mackerel found in Thai waters (FAO, 1984)

Biological analyses of Spanish mackerel caught by stake traps, paired trawls and Spanish mackerel gill nets, show the maximum growth rate and the maximum length in the eastern Thai Gulf as shown in Table 4.

Table 4. Parameters of Spanish mackerel caught by different fishing gear and from different fishing zones.

Fishing zones of the Gulf	Parameters	Fishing gear			
		Bamboo stake traps	Trawls	Gill nets	Paired trawl and gill nets
The eastern area	Lα (cm.)	-	88.7	89.8	-
	K (per year)	1.8-2.04	1.6	1.5	-
The western area	Lα (cm.)	-	87.2	95.0	-
	K (per year)	-	0.4	1.3	-
The upper area	Lα (cm.)	-	-	-	110.0
	K (per year)	-	-	-	1.2

In the upper Thai Gulf, t_o of Spanish mackerel is -1.92/year. The juvenile recruited to trawl fishing grounds are 10.0 cm. long and the gill net fishing ground size is 40.0 cm.

Fishing gear used to catch Spanish mackerel are Spanish mackerel drift gill nets and trawls. In the Gulf of Thailand, the mackerel catch by Spanish mackerel drift gill net is 39.4% and by otter board trawls is 20.5%. From other fishing gear; purse seines, paired trawls, and others are 12.9%, 5.8%, 21.4 %, respectively. In the total catch, there are 77.4% of Barred Spanish mackerel, and 22.6% of Indo-Pacific mackerel. The size of the mackerel caught by bamboo stake traps, trawls, and Spanish mackerel drift gill nets are 3.0-39.0 cm., 11.0-61.0 cm., and 39.0-99.0cm., respectively.

The fishing grounds of Spanish mackerel are found along the coastal areas of the Gulf of Thailand; starting from Trad to Pattani provinces, the fishing gear used depends upon the area. Bamboo stake traps operate in shallow water; 4-12 m.. Trawls operate at a depth of 20 m. Spanish mackerel gill nets operate in deeper than 20 m. Luring purse seines operate in deeper than 30 m. And hooks are used near islands.

Spanish mackerel fishing is carried out throughout the year, day and night. Trawls, purse seines, trolling lines and bamboo stake traps to catch Spanish mackerels, are operated during the day and night time while Spanish mackerel gill nets, and light luring purse seines are operated only at night.

Pramokchutima (1993) reported the species composition of Spanish mackerel caught by Spanish mackerel gill nets, in Surat Thani, Nakhonsri Thammarat, Songkhla, and Pattani provincial areas, there are 99.6% of barred Spanish mackerel and 0.4% of Indo-Pacific Spanish mackerel. Furthermore, at 20 m. deep and deeper than 30 m., barred Spanish mackerel are found, being 22.95% and 25.77%, respectively. The Indo-Pacific Spanish mackerel is found deeper than 20 m. In the area between Samui island and offshore of Surat Thani waters, barred Spanish mackerel and Indo-Pacific mackerel more abundant than in other areas. Spanish mackerel gill nets which are operated deeper than 20 m., and catch barred Spanish mackerel more than Indo-Pacific Spanish mackerel. Uraiwan and Boonvanich (1993) reports two Spanish mackerel in JDA between Thailand-Malaysia. These are barred Spanish mackerel and Indo-Pacific Spanish mackerel. However, the stocks are not dense, being only 0.47-1.2 kg./hour.

The catch of Spanish mackerels in the Gulf of Thailand since 1971 has potentially increased. The peak was in 1988; with 12,000 tons. Since then, the catch has gradually decreased (Table 1). The catch of Spanish mackerel in the Andaman Sea has potentially increased. The catch during 1971-1978 was less than 1,000 tons. But during 1979-1992 the catch increased to 1,000-3,000 tons/year, except in 1980, 1983, and 1984 when the catch was less than 1,000 tons (Table 2).

Fishing gear used to catch Spanish mackerel in the Andaman Sea are Spanish mackerel drift gill nets; 58.7%, otter board trawls; 21.4%, paired trawls; 5.7%, purse seines; 4.7% and others; 9.5%. Chantawong et al. (1994) reports that the catch by Spanish mackerel drift gill nets in the Andaman Sea, was composed of 19% Spanish mackerel of the total. In Phuket 3 kinds of Spanish mackerel are found, namely: Barred Spanish mackerel, Indo-Pacific Spanish mackerel and deep sea Spanish mackerel (*Acanthocybium solandri*). The proportion of barred Spanish mackerel, Indo-Pacific Spanish mackerel and deep sea Spanish mackerel, are 71.2-89.6%, 10.4-28.6% and 0.01-0.2%, respectively. The catch in Phang-Nga provincial waters, indicate only 2 types; the barred Spanish mackerel and the Indo-Pacific Spanish mackerel in the proportion of 50.3-91.8% and 8.2-49.7%, respectively. The size of Barred Spanish mackerel caught by Spanish mackerel gill nets is 26-74 cm. The normal sizes found are 36-50 cm. and 58-60 cm.. The average length of Barred Spanish mackerel in Phang-Nga and Phuket provinces are 47.9 cm. and 48.1 cm. respectively. The Indo-Pacific mackerel is found to be 20-58 cm. long. The normal size is 36-46 cm. with 41.4 cm. and 42.2 cm. average in Phang-Nga and Phuket provinces, respectively.

Small tuna (Fig. 15)

Small tuna found in the Gulf of Thailand are of 3 types, namely: Longtail tuna, Kawa Kawa, and Frigate tuna. The proportion of each small tuna based on fishing gear used is shown in Table 5.

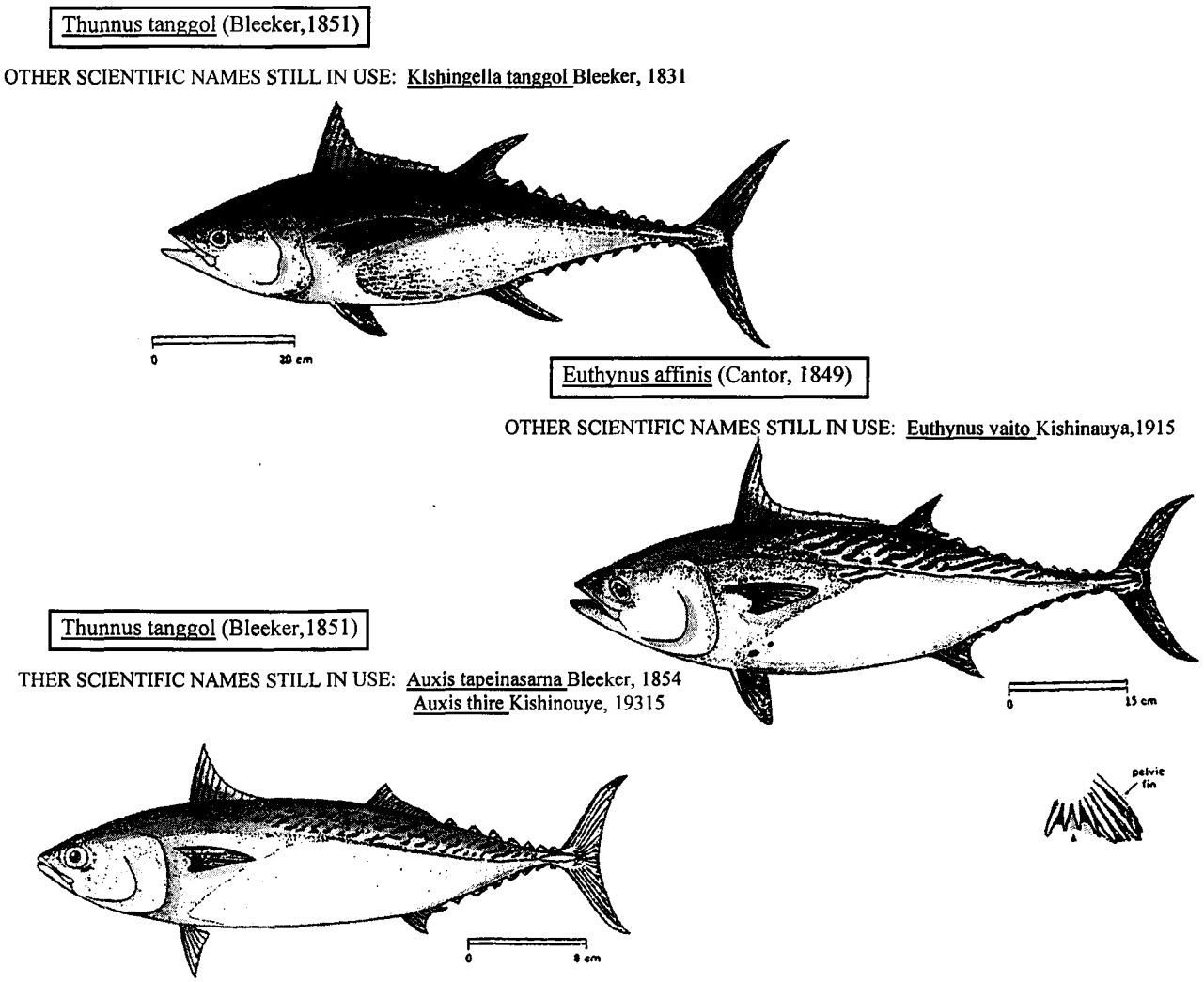


Fig. 15 Small tuna found in Thai waters (FAO, 1984)

Table 5. Proportion of small tuna caught by Spanish mackerel gill nets and purse seines

Fishing gear	Longtail tuna	Kawa Kawa	Frigate tuna
Spanish mackerel gill nets			
% (pieces)	39.9	33.9	26.2
% (weight)	56.6	26.2	17.2
size mostly caught (cm.)	35,47	35,47	35
size caught	24-58	14-56	14-46
size caught in Thai-Malaysia area	24-58	14-64	22-46
Purse seines			
% (weight)	64.5	25.8	9.7
size caught	20-56	18-56	20-46
Spanish mackerel gill nets (in JDA)			
% (weight)	57.4	8.9	33.7
% (pieces)	26	38	36

Source : Klinmuang, 1981. and Anonymous, 1992.

From Table 5, the catch of Longtail tuna is more than that of the others, both in terms of numbers and weight, followed by Kawa Kawa and Frigate tuna. The survey in the JDA between Thailand and Malaysia, shows a different proportion in weight and numbers, to the other tuna.

All small tuna are generally found in the Gulf of Thailand. The fishing grounds for these types of fish, are in the same distributed areas. The fishing season is based upon the monsoon seasons. That is, in the western Thai Gulf, the fishing season is in October-April and in the western Thai Gulf it is April-September. In Thai-Malaysian waters it is in March-December. The catch of small tuna is at a peak in November-February (Supongphan and Saikliang, 1987).

There are several types of fishing gear used to catch tuna such as Spanish mackerel gill nets, purse seines and the gear using luring tools e.g. luring purse seine and Thai purse seine. Among all the mentioned gear, Spanish mackerel gill nets are used throughout the year and regarded as the main fishing gear. Thai purse seine is used in some seasons. The luring purse seine is operated in the central Thai Gulf in deep waters, or at the border of Thai and neighbouring countries (Fig. 16). The number of small tuna caught by the luring purse seine is relatively small and it is rarely found. The length is approximately 9-15 cm.

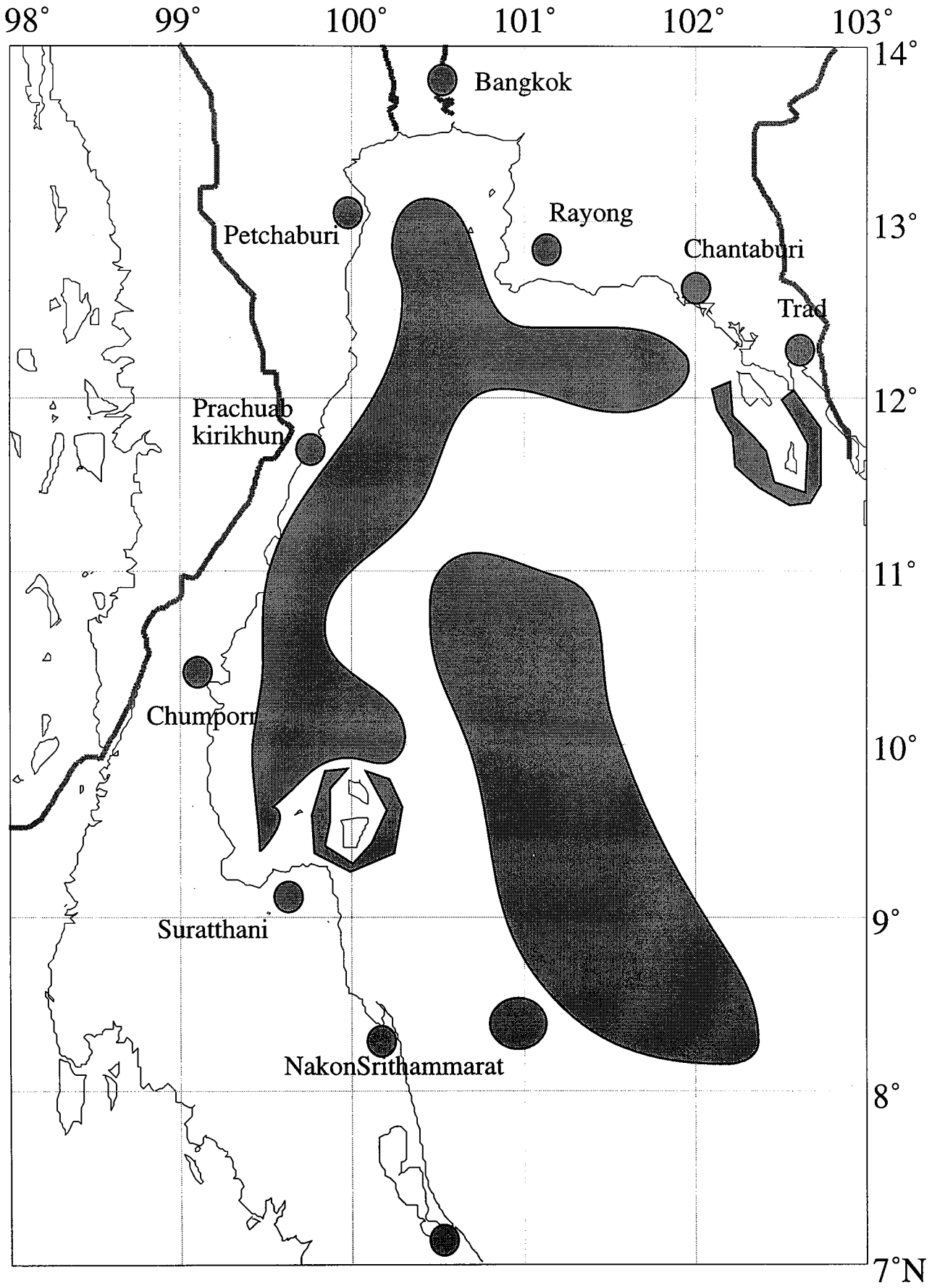


Fig. 16. Fishing grounds of small tuna in the Gulf of Thailand (Klinmuang, 1981)

Small tuna spawn throughout the year. The peak of the spawning season is in March-September. The parent stock of Longtail tuna is 43.8-49.1 cm., spawning 1,400,000 eggs at a time. The parent stock of Kawa Kawa is 39.5-51.0 cm., spawning 1,730,000 eggs at a time (Chuenpan, 1984). The peak of the spawning season is between February-July (Fig. 4). Klinmuang (1981) calculates the equation of the relationship between length and weight of small tuna found in Thai-Malaysian water (between the southern Thai Gulf and Kuala Terranganu, Malaysia) as follows,

Longtail tuna	$W = 0.0195\ L^{2.9824}$
Kawa Kawa	$W = 0.0289\ L^{2.8437}$
Frigate tuna	$W = 0.0049\ L^{3.3651}$

The larvae of Longtail tuna and young tuna which are 31-47 cm. long, straddle between Thai-Malaysian waters. The parent stock of small tuna; longer than 47 cm., are in the border areas. The spawning season is in July. Chamchang and Chayakul (1990) reported larvae of small tuna distributed along the west coast of the Gulf of Thailand up to the Malaysian border (Fig. 17).

According to the fishery biology of small tuna, there are several parameters of the 3 main small tuna. They are: recruitment length (L_r), Length of mature stock (L_m), caught length (L_c), Maximum length ($L\mu$), Growth rate (K), Age at length equal to zero (t_o), Natural mortality rate (M), Fishing mortality (F), Total mortality rate (Z), Exploitation rate (E) as shown in Table 6.

Table 6. Parameters of small tuna in the Gulf of Thailand

Parameters	Longtail tuna	Kawa Kawa	Frigate tuna
Recruitment length (Lr) cm.	22.0-24.0	14.0-23.0	14.0-22.0
Mature length (Lm) cm.	39.6-45.0	37.0-45.0	34.1-37.0
Caught length (Lc) cm.	34.8-47.0	28.6	29
Maximum length (L?) cm.	58.2	55.1-58.2	43.9
Growth rate (K) a years	1.44	2.232	2.4
Hatched age (to)	-0.025	-	-0.024
Natural mortality rate (M)	1.44	2.28	2.45
Fishing mortality (F)	0.2	-	0.25
Total mortality rate (Z)	0.32	-	0.45
Exploitation rate (E)	0.41	-	0.41

Longtail tuna spawn throughout the year. The peaks of the spawning season are between March-May and July-December. The first maturity length is 34.2 cm. and the mature length is more than 39.6 cm..

The Kawa Kawa spawns throughout the year. The peaks of the spawning season are between January-March and June-September (Fig. 7). The first maturity length is 33.4 cm. and the mature length is more then 37.6 cm..

Frigate tuna also spawn throughout the year. The peaks of the spawning season are between April-June and August (Fig. 7). The first maturity length is 31 cm. and the mature length is more than 34.1cm..

Pramokchutima (1993) reporting on a Spanish mackerel gill net survey in Surat Thani, Nakhonsri Thammarat, Songkhla, and Pattani provincial waters states that the proportion of Kawa Kawa, Frigate tuna and Longtail tuna is 59.3%, 30.7% and 10.0%, respectively. The small tuna are found deeper than 20 m. and mostly caught at deeper than 30 m.. Kawa Kawa and Frigate tuna are abundant in the area of Kra island, Nakhonsri Thammarat province. Longtail tuna is mostly found in the areas of Songkhla and Pattani provincial waters.

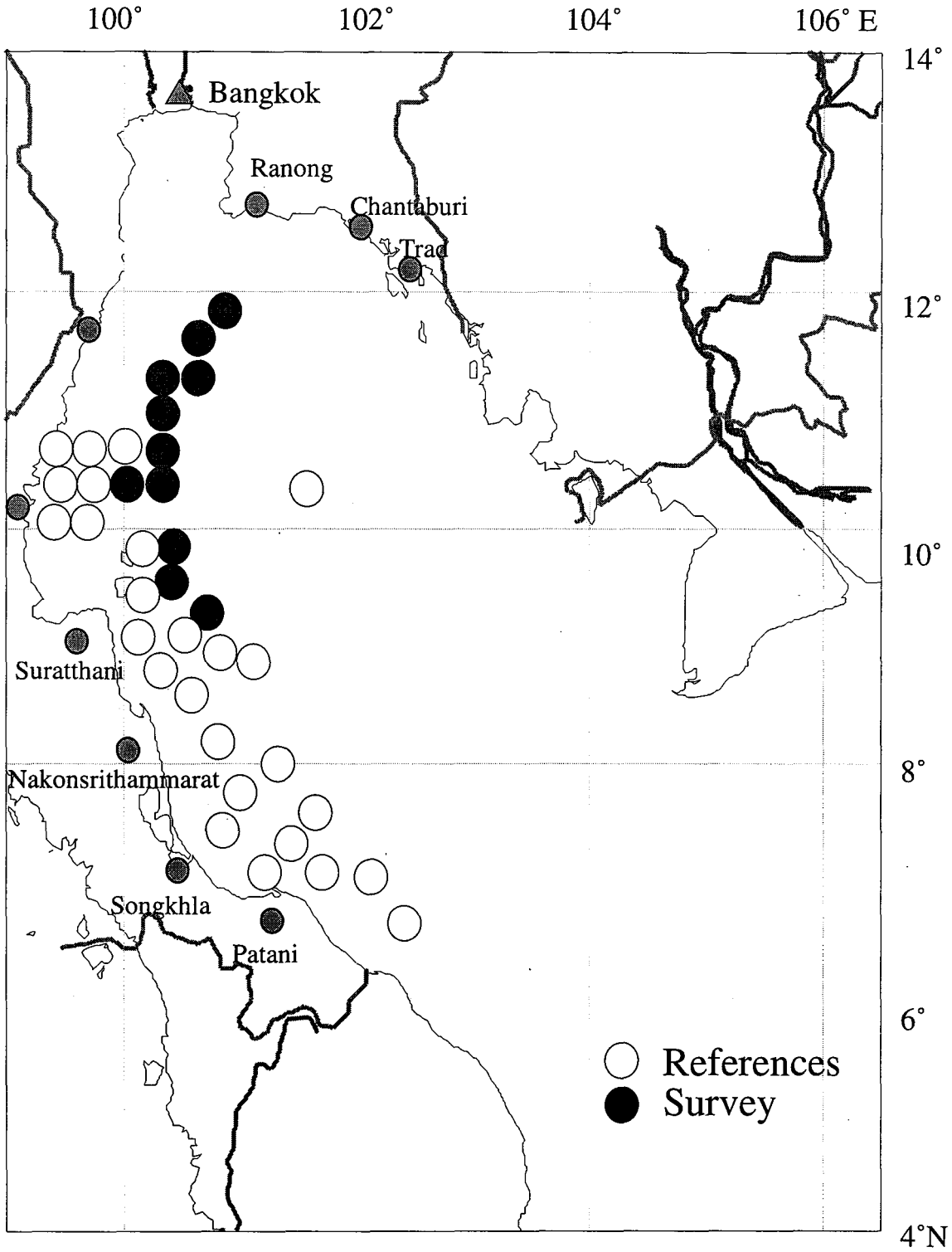


Fig. 17. Distribution of small tuna larvae in the Gulf of Thailand (Chamchang and Chayakul, 1990)

The Spanish mackerel gill net survey in the JDA of Thailand and Malaysia, showed the proportion of each small tuna is different both in terms of weight and numbers. That is, the proportion in term of weight is 57.4% of Longtail tuna, 8.9% of Kawa Kawa and 33.7% of Frigate tuna. The proportion in term of number of pieces is 26.0% of Longtail tuna, 38.0% of Kawa Kawa, and 36.0% of Frigate tuna. In the surface drift gill net and bottom gill net survey, the catch of small tuna, both during the night and at dawn, finds Longtail tuna and Frigate tuna are caught at night. At dawn, there was no catch from the either fishing gear. There was no difference in catch both in term of fishing time and gear. Length and weight of each small tuna are shown in Table 7.

Table 7. Size and weight of small tuna caught by gill nets in JDA

Species	Caught size (cm.)	Average size (cm.)	Average weight (g.)
Longtail tuna	18.0-67.5	40	1,415.40
Kawa Kawa	18.5-30.0	21.5	148.9
Frigate tuna	20.0-38.5	31.3	597.2

Source: Anonymous, 1992

In the Andaman Sea, the fishing grounds are scattered (Fig. 18) Kawa Kawa and Frigate tuna are distributed in the same areas, mostly found around Surin and Similan islands, in Trang provincial waters but rarely found in Satun. Longtail tuna is less dense as compared to the others. Generally, small tuna are abundant between December-May. Kawa Kawa and Frigate tuna recruit to the fishing grounds between March-April and June. The proportion by weight is 47.6% of Frigate tuna, 38.4% of Kawa Kawa, and 14% of Longtail tuna. The minimum caught size is 9.0 cm. The size mostly found and the size caught of each species are shown in Table 8.

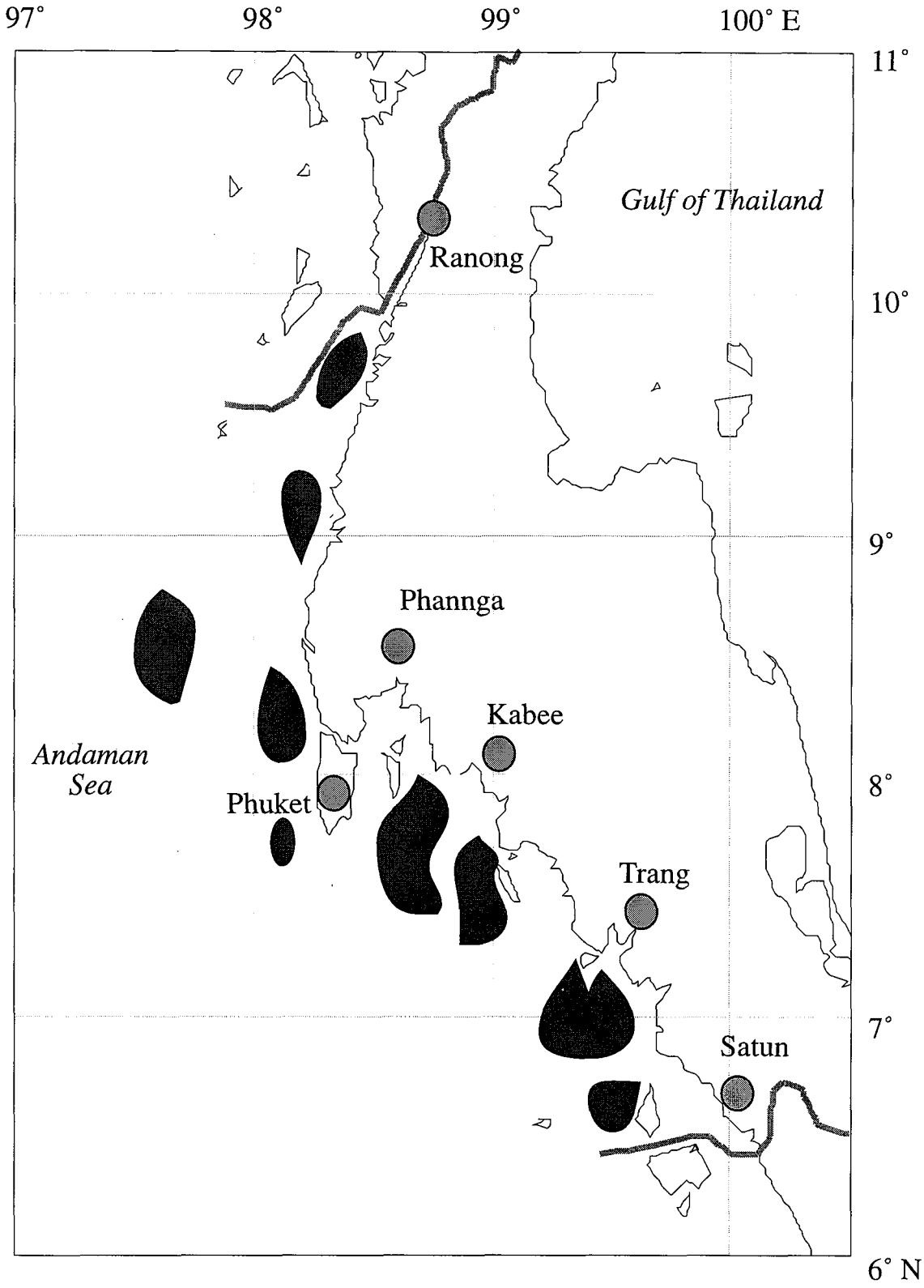


Fig. 18. Fishing grounds of small tuna in the Andaman Sea (Boonrak, Suthakorn and Busravich, 1984)

Table 8. Size of small tuna caught and recruited in fishing grounds in the Andaman Sea

unit: cm.

Species	Recruited size	Size mostly caught	Maximum size	Average length	Month of highest catch
Longtail tuna	11	-	49	-	Feb.-Apr., Dec.
Kawa Kawa	9	25.0-35.0	47	28.8	Feb.-May
Frigate tuna	9	13.0-17.0, 21.0-33.0	41	29.1	

Source: Anonymous, 1992

The fishery biological parameter study of small tuna in the Andaman Sea is concluded in Table 9.

Table 9. Parameters of small tuna caught in the Andaman Sea

Species	Parameters					
	L_c (cm.)	Lα (cm.)	K (a year)	M (a year)	F (a year)	E
Longtail tuna	32.3	51.5	0.75	1.25	0.2	0.14
Kawa Kawa	-	48	0.6	1.12, 1.44	0.9,2.3	0.44, 0.62
Frigate tuna	23.3	44	0.63	1.19	1.2,1.7	0.46, 0.58

The catch of small tuna in the Gulf of Thailand and the Andaman Sea during 1971-1981 was relatively low; 5,000-22,000 tons. The catch of small tuna in the Gulf of Thailand has increased since 1980; the catch in 1982 was twice as much as in 1981. Until in 1992, the catch was at its peak; being more than150,000 tons and almost 12,000 tons in the Gulf of Thailand and the Andaman Sea, respectively. In 1993, the catch slightly decreased; 150,000 tons (Fig. 19). Between 1979-1993, the total catch of Longtail tuna was more than that of the Kawa Kawa and Frigate tuna together. The exception was in 1992 and 1993 when total catch of Kawa Kawa together with Frigate tuna was more than that of Longtail tuna (Fig. 20). The total catches of Longtail tuna from the Gulf of Thailand and the Andaman Sea are approximately 72.4% and 27.6%, respectively (Table 10).

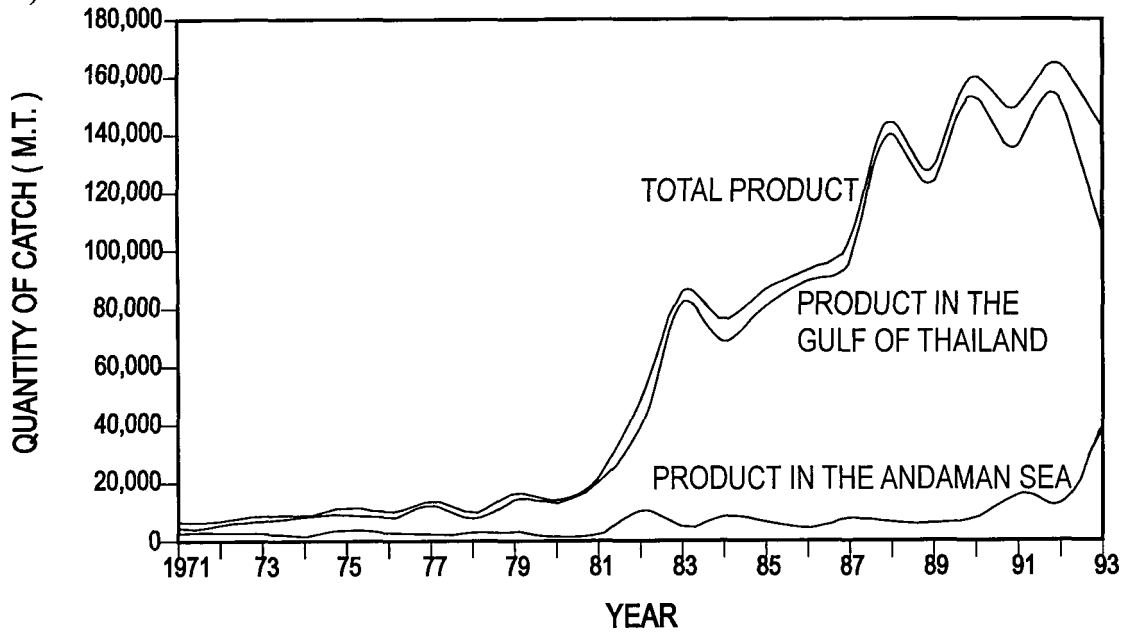


Fig.19. Small tuna caught in the EEZs of Thailand (both in the Gulf of Thailand and the Andaman Sea) (DOF, 1973-1984, 1985-1990, 1991-1993 and 1994-1996)

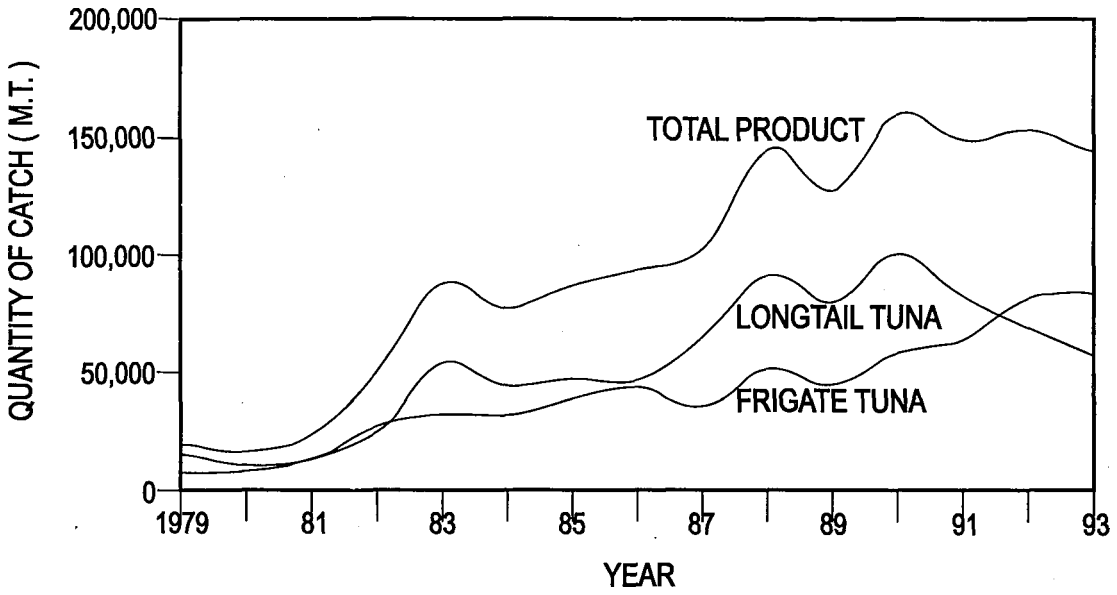


Fig. 20. Catches of Longtail tuna, Kawa Kawa, and Frigate tuna of Thailand (DOF, 1973-1984, 1985-1990, 1991-1993 and 1994-1996)

Table 10. Catch of marine species of Thailand during 1986-1993

unit : 1,000 tons

Species	1986	1987	1988	1989	1990	1991	1992	1993
Indo-Pacific mackerel	113.5	119.2	111.7	121.1	103.5	103.0	129.6	144.0
Indian mackerel	41.9	39.9	25.8	35.1	32.3	32.5	40.1	49.7
Spanish mackerels	14.8	15.5	15.3	12.9	13.0	10.4	12.3	14.6
Total small tuna	93.8	102.6	146.4	129.6	163.2	152.2	169.0	147.6
Longtail tuna	48.3	65.9	92.9	82.1	102.4	84.8	74.4	60.4
Kawa Kawa and Frigate tuna	45.5	36.7	53.5	47.5	60.8	67.4	94.6	87.2
Round Scad	26.4	56.1	31.8	39.6	33.2	46.7	51.0	55.1
Sardines	121.2	127.2	123.7	145.0	120.5	140.9	163.5	152.3
Anchovies	59.0	57.8	69.4	97.1	124.0	127.1	159.4	165.3
Squid	71.3	75.4	67.2	69.8	64.4	69.4	64.8	72.2
Threadfin Bream	26.8	34.1	29.6	33.7	31.2	47.0	65.4	75.3
Bigeye	18.2	25.0	22.6	22.4	23.0	33.9	44.6	59.8

Source : Department of Fisheries, 1985-1990, 1991-1993, and 1994-1996.

Catch of Longtail tuna in Thailand substantially increased between 1988-1993, when the catch was 130,000-170,000 tons. 44% of the catch was used in the tuna canning industry. The tuna canning industry that uses domestic fish is 23% of that of exported canned tuna. 77% of canned tuna uses imported tuna caught in the Indian and Pacific Oceans.

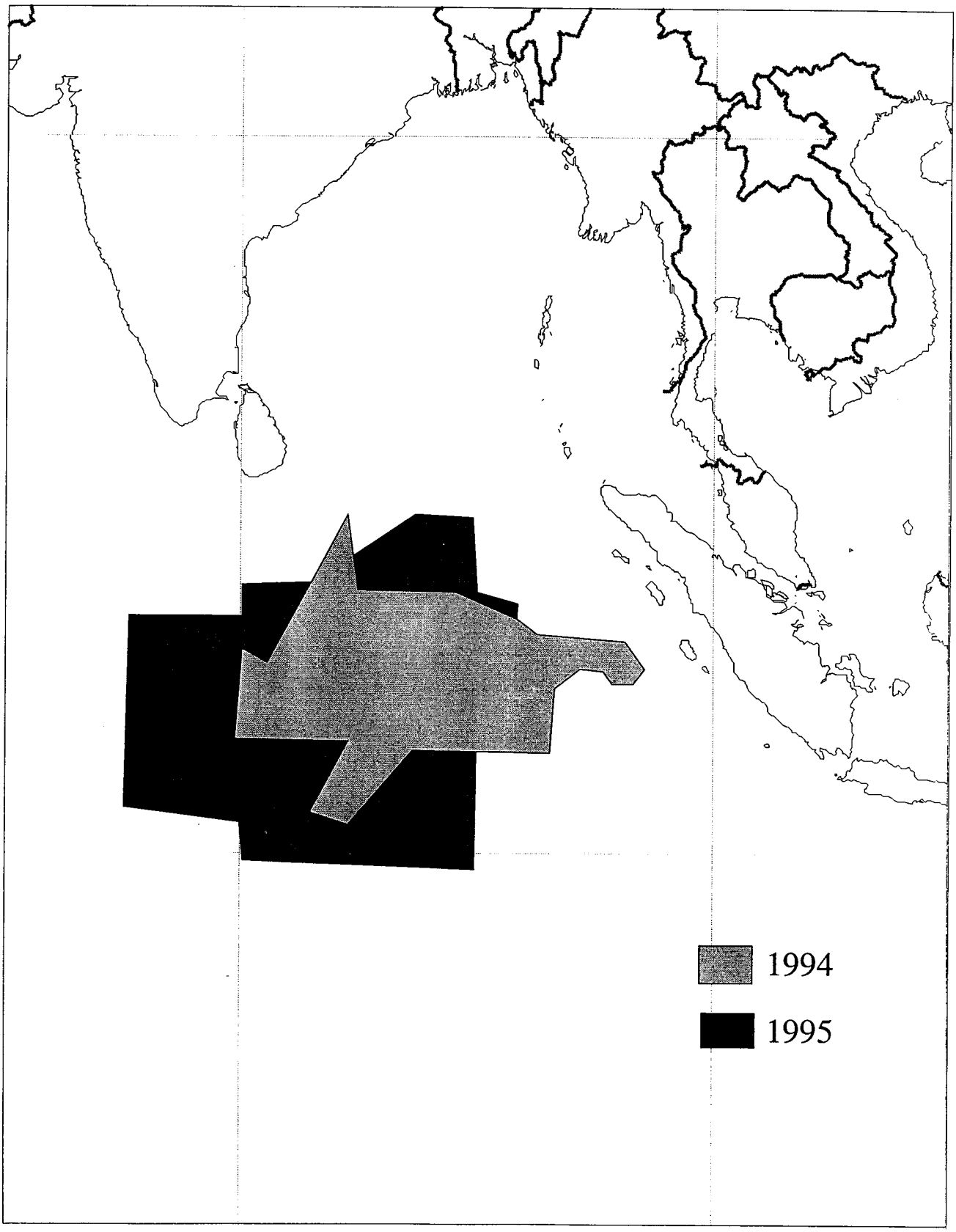


Fig.21. Tuna purse seine fishing grounds in the eastern Indian Ocean in 1994-1995 (Chantawong, Suksawasdi, and Ubonsuwan, 1995)

The deep sea tuna fishing parameters of the eastern Indian Ocean and Pacific Ocean, fishing grounds are shown in Fig. 21. Fishing gear used to catch tuna in the eastern Indian Ocean are purse seines, deep sea longlines and poles & lines. Countries that are active in the fishing ground are France, Russia, Japan, Taiwan and the coastal states of the Indian Ocean. Fishing grounds of purse seines are near ridges; latitude 5°N to 10° S, longitude 75-95° E (Fig. 21). Fishing operation is usually at dawn (05.00-07.00 hr.). A fishing trip is 13-34 days with 1-3 operations a day. Tuna fishing in the Indian Ocean can be done throughout the year. The peaks of the fishing season are October-January and March. Fishing effort is between 34.2-174.4 tons/day/boat, or fishing effort per trip is 410-875 tons (591.5 tons average). Tuna caught are Skipjack tuna (*Katsuwonus pelamis*), Yellowfin tuna (*Thunnus albacares*) and Bigeye tuna (*Thunnus obesus*) (Fig. 22). Weight composition of catch is Skipjack tuna; 60-71%, Yellowfin tuna; 28-36% and Bigeye tuna; 0.7-3.9%. Tuna caught by purse seines weigh between 1.5-34.0 kg. (10.0 kg. average).

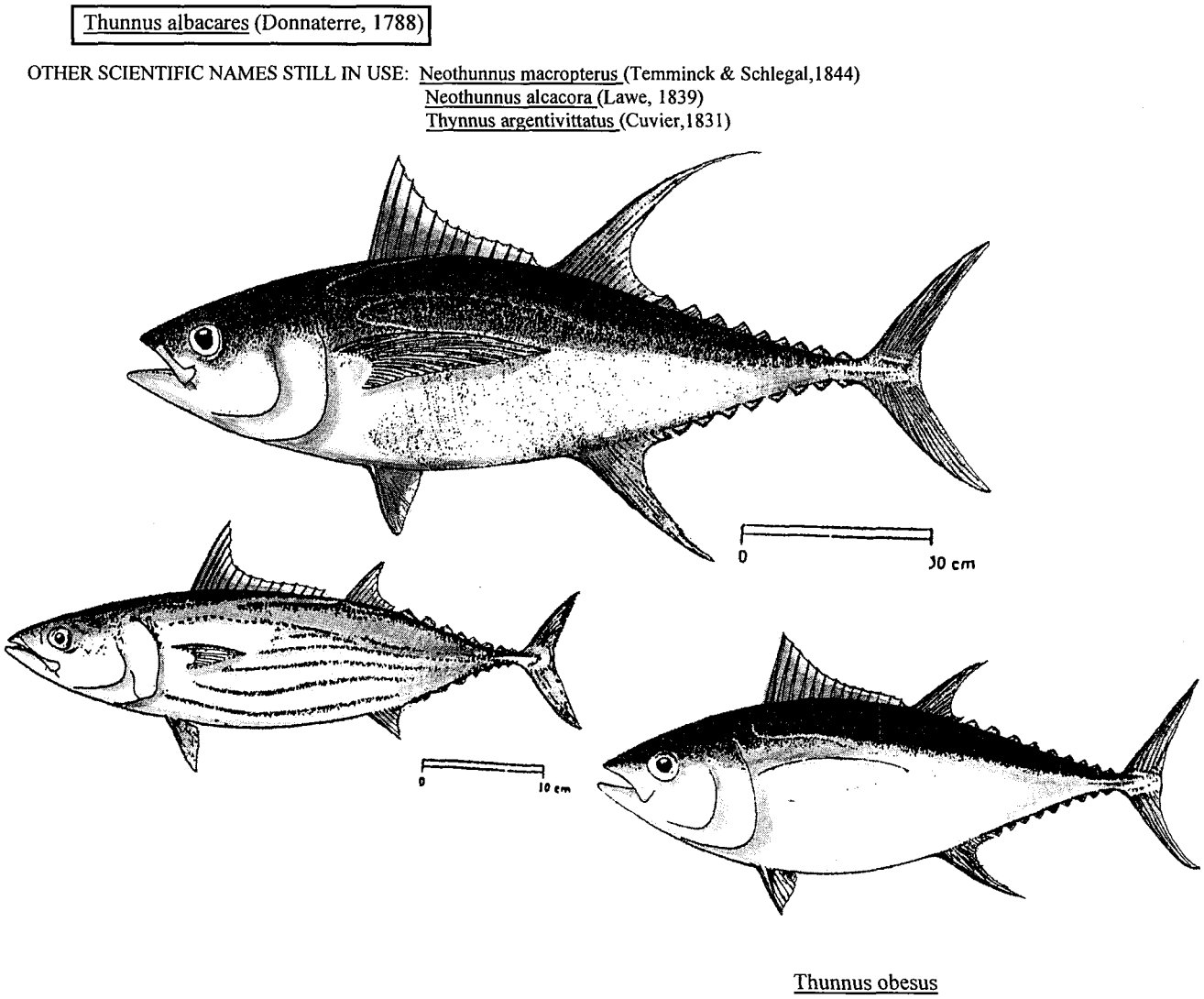


Fig.22. Skipjack tuna (*Katsuwonus pelamis*), Yellowfin tuna (*Thunnus albacares*) and Bigeye tuna (*Thunnus obesus*) (FAO, 1984)

The tuna caught are different in size. Skipjack tuna sizes are 33-68 cm. (46.5 average), its juveniles then recruit in fishing grounds and are 33-38 cm.. The juveniles are generally found between May-November. Big size Skipjack tuna; 51-68 cm., are usually found between March-April and in December. The Yellowfin tuna is 30-120 cm. long (53.9 cm. average). Its juveniles are found throughout the year but mostly found between September-December and January-March. The Bigeye tuna is 35-90 cm. (54.6 cm. average). Its juveniles are 35-50 cm. recruiting in fishing grounds between October-January. Big size Bigeye tuna; 70-90 cm., are mostly found between January-March.

Deep sea longlines can be operated throughout the year. Fishing grounds in the Indian and Pacific Oceans are shown in Fig. 23 these are the same as those for purse seines. The fishing season is between April-October, operating to the north of New Guinea island and then moving to the Indian Ocean between September-April. The high fishing season is between November-February with the peak in December with total catches of 413.6 tons, fishing effort of 2.5-10.3 tons/trip and weight of 19-100 kg. (40 kg. average).

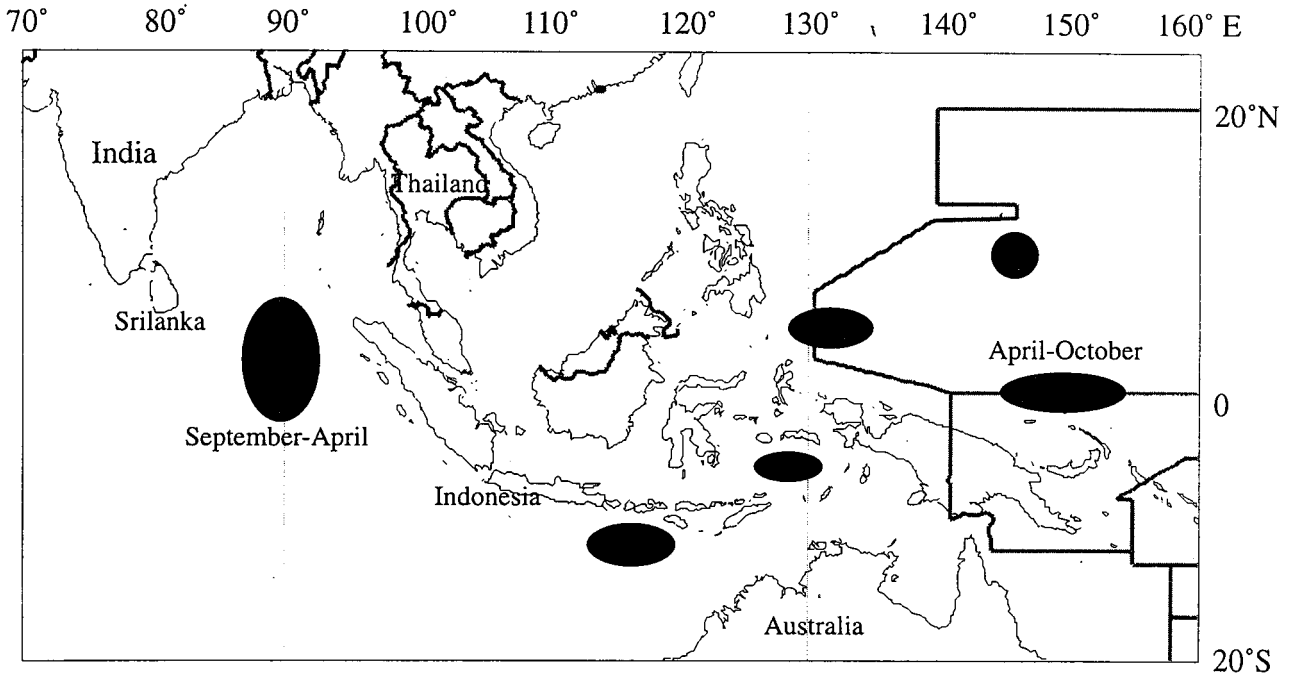
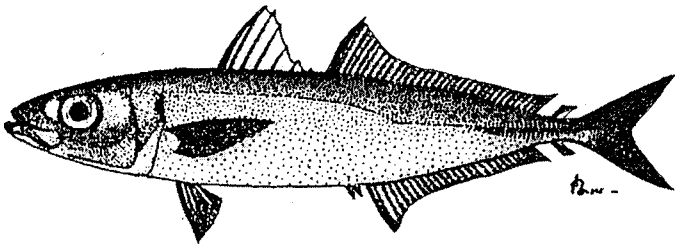
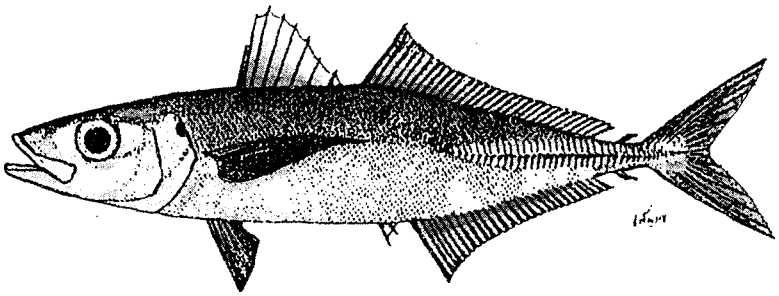


Fig. 23. Tuna longline fishing grounds in the Indian and Pacific Oceans (Poreeyanond and Tantiwala, 1995)

The Marine Fisheries Division, Department of Fisheries, has complied records of the total number of tax exempted tuna between March 1995-June 1996. The record shows the total imported tuna is 80,784 tons. Countries which import the most are Taiwan; 28% of total number, Singapore; 19%, Japan; 18.9%, and others(France, Indonesia, Korea, Panama, Solomon, Hong Kong, Malaysia, Spain, Guana and others); 34% . The peak of importation is between November-January; being 7,000-11,000 tons/month. The lowest importation period is between April-July; 3,000 tons/month. In considering the fishing grounds of tuna, it is found that the eastern Indian Ocean is the most important fishing ground which contributes 59% of total catch. The western Pacific Ocean and other fishing grounds; Atlantic Oceans and Solomon islands have 39% and 2%, respectively. The major fishing gear are purse seines; 68%, deep sea longlines; 31%, and poles & lines; 1%. Fishing days are approximately 30-45 days/trip. These fishing boats land their catch at Thai fishing ports i.e. the Phuket fishing port; 50.0%, the Bangkok fishing port; 39.0%, the Songkhla fishing port; 8.5%, the Maha Chai fishing port; 1.5%, and the Laem Cha-bang fishing port; 1.0%. Tuna caught by deep sea longlines are sent to markets for direct consumption and tuna caught by purse seines are sent to tuna canning factories.



Decapterus macrosoma Bleeker
Decapterus lajang Bleeker



Decapterus marusdsi
(Temminck & Schlegel)

Fig. 24. Round Scad found in Thai waters (Sukavisit and Chuenjitphong, 1982)

Round Scad found in the Gulf of Thailand are long fin Round Scad (*Decapterus maruadsi* Temminck & Schlegel, 1842) which is found to be 96.6% and short fin Round Scad (*D. macrosoma* Bleeker) which is found to be 3.4%. Distribution of Round Scad is generally found at 20-70 m. deep (Fig. 25 and 26).

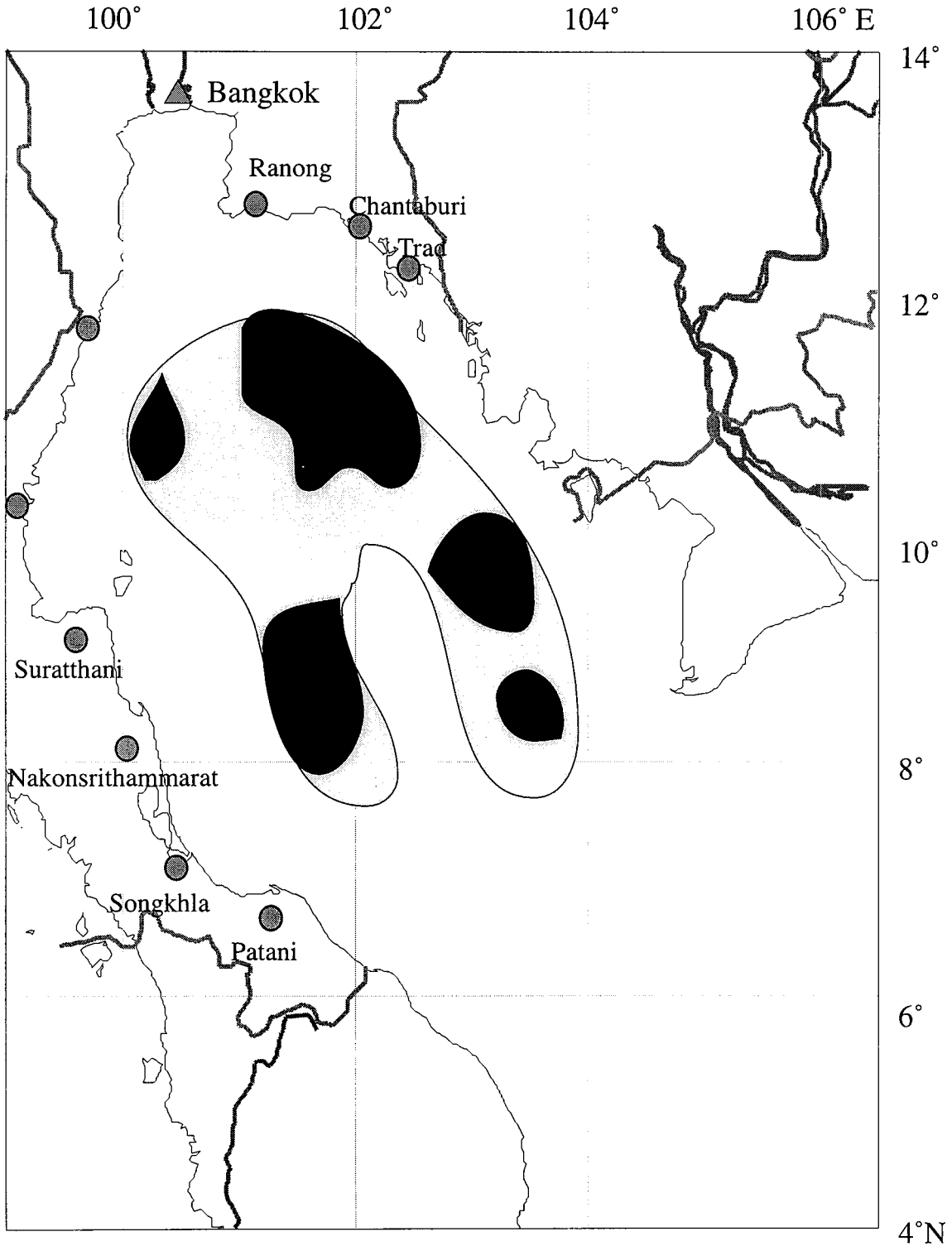


Fig. 25. Fishing grounds of Round Scad in the Gulf of Thailand (Chullasorn and Yusukswad, 1987)

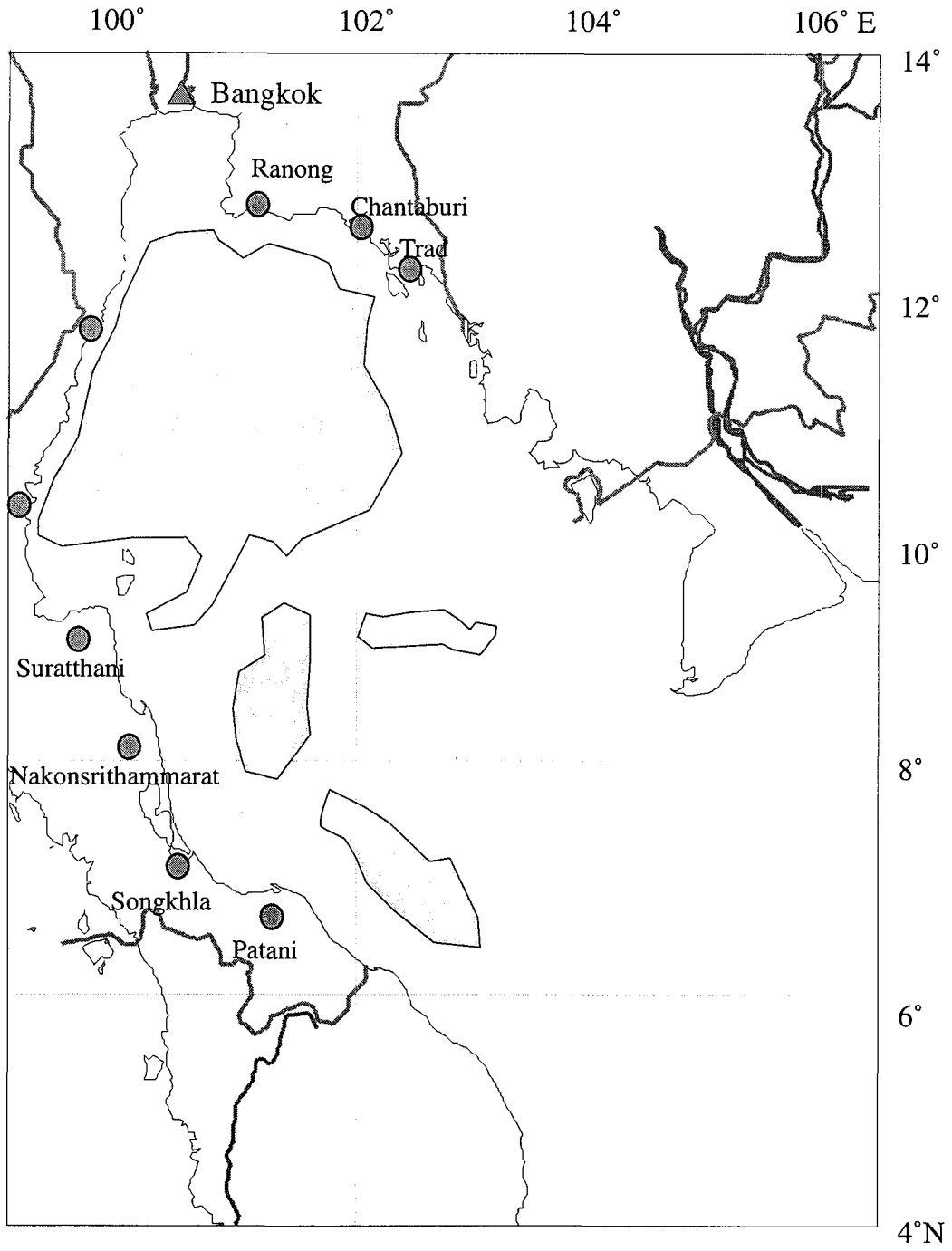


Fig. 26. Fishing grounds of long fin Round Scad (SEAFDEC, 1981)

Round Scad spawn throughout the year with two peaks; February-March and July-August as shown in Fig. 4 (Chullasorn and Yusukswad, 1978). The parent stock of Round Scad spawn 6 times a year. Female stock of long fin Round Scad which are 17.3 cm. long, and are 52 g. in weight, 38,000 eggs are spawned at a time. And the ones which are 20.4 cm., weigh 168 g., 515,000 eggs are spawned at a time (Chuenpan, 1981). Maturity stocks are between 16.2-27.6 cm. The spawning area is 60 Nautical miles out of Chang island and 100 Nautical miles out of Chumporn province. Round Scad size 5.5-6.5 cm., age 4 months, will recruit in fishing grounds between December-February and June-August. Fishing gear used to catch Round Scad in the Gulf of Thailand are luring purse seine, Thai purse seine, and trawls. The major fishing ground is at the Central Thai Gulf and in front of Rayong and Trad provinces in particular. Fishing season is between October-February (Chansri, 1980).

Based on biological analysis of longfin Round Scad, its parameters are growth rate; 0.856/year, calculated maximum length; 23.7 cm., t_0 ; 0.007/year (Nuchmon, 1989)

Trawl surveys in the JDA between Thailand-Malaysia, finds Round Scad in 5 stations out of 12. Fishing rate is between 0.08-1.06 kg./hr.. And gill net surveys; finds them only in 3 stations out of 8. The total catch is between 0.1-0.18 kg.

There are two kinds of Round Scad in the Andaman Sea as in the Gulf of Thailand. And at times, big Round Scad (*D. macarellus*) is also found. The first two kinds are scattered along coastal areas from Ranong to Satun provinces. The spawning season is between December-May (Fig. 7). Minimum mature length is 15.5-16.5 cm. Fishing grounds are scattered as shown in Fig. 27. Catch composition of Round Scad is 58% of long-fin Round Scad sizes 7-24 cm. With greatest numbers 9-19 cm. 42% of short-fin Round Scad have sizes 9-25 cm. with the greatest number being14-22 cm.

The total catch of Round Scad between 1986-1993 fluctuated, the catches were between 26,000-56,000 tons (Table 10). However, the total catch of Round Scad after 1990 increased to 55,000 tons in 1992. Within these amounts, 83.7% are Round Scad caught in the Gulf of Thailand and 16.3% from the Andaman Sea.

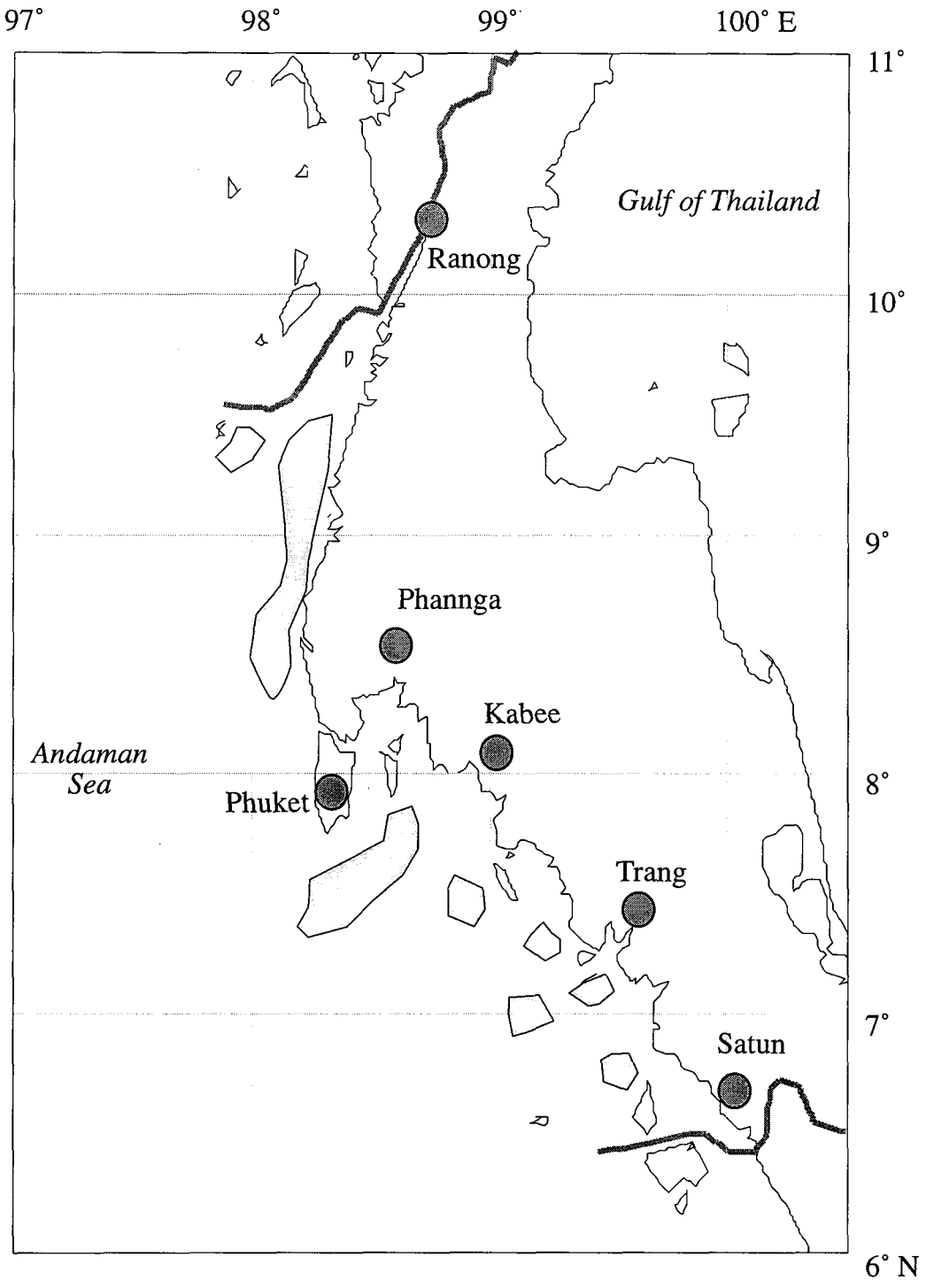


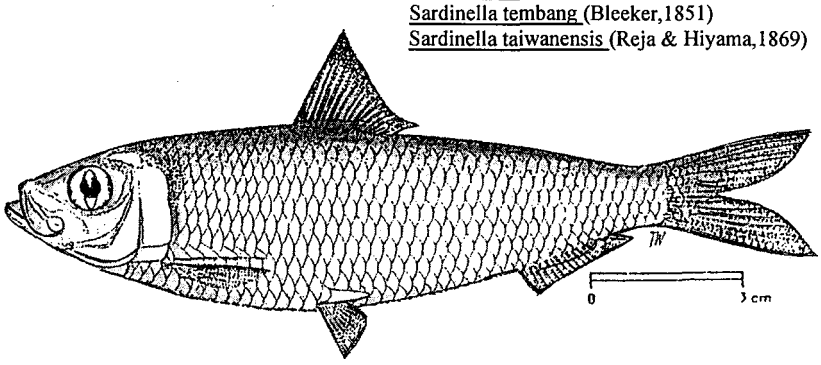
Fig. 27. Fishing grounds of Round Scad in the Andaman Sea (Boonrak, Suthakorn and Busaravich, 1984)

Sardines (Fig. 28)

Sardines are a pelagic school fish, feeding on phytoplankton and zooplankton. There are 6 species of Sardines found in the Gulf of Thailand. However, the 3 most common species are: *Sardinella gibbosa*, *S. frimbriata* and *S. albella*. Catch composition of the three main species form 95% of the total Sardines caught. Small Sardines habitat near the shore up to 20 m. deep while big Sardines inhabit in deeper waters from 20 m. up to 50 m.. Sardines spawn throughout the year. Mature size is 13.30-18.5 cm. long. Juveniles are mostly found between October-November, January-March and June-July (Fig. 4). Recruited size is 7.0 cm. long. There are 3-4 generations a year recruited in the fishing grounds.

Sardinella gibbosa (Bleeker, 1849)

OTHER SCIENTIFIC NAMES STILL IN USE: Sardinella jusslau (Lacepede,1803)
Sardinella tembang (Bleeker,1851)
Sardinella taiwanensis (Reja & Hiyama,1869)



Sardinella albella (Valanelennes,1847)

OTHER SCIENTIFIC NAMES STILL IN USE: Sardinella bulan (Bleeker,1849)
Sardinella perforata (Cantor,1850)
Sardinella dolifosi (Chabanaud,1933)

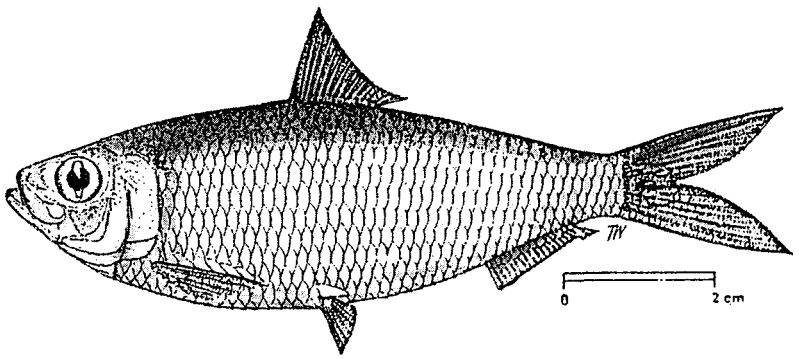


Fig. 28. Sardines found in Thai waters (FAO, 1984)

The major fishing gear catching Sardines are purse seines (luring purse seine, light-luring purse seines and Thai purse seine). The purse seine catch is 72%-92% of the total catch. And 8-28% of the total is from Anchovy purse seine, gill nets, etc..

Fishing grounds for Sardines are in the eastern Gulf of Thailand around Chang-Kood islands to Rayong waters. In the upper Gulf they are found around Samutprakan and Petchaburi waters. In the western Gulf in the Bay of Prachuab Khiri Khan, Chumporn, Surat Thani provinces and Sichol Bay, Nakhon Sri Thammarat Province to Pattani province and in the central Gulf they are found in Prachuab Khiri Khan and Chumporn waters, at depths greater than 45 M. (Fig. 29). Fishing grounds of Sardines in the Andaman Sea are shown in Fig. 30.

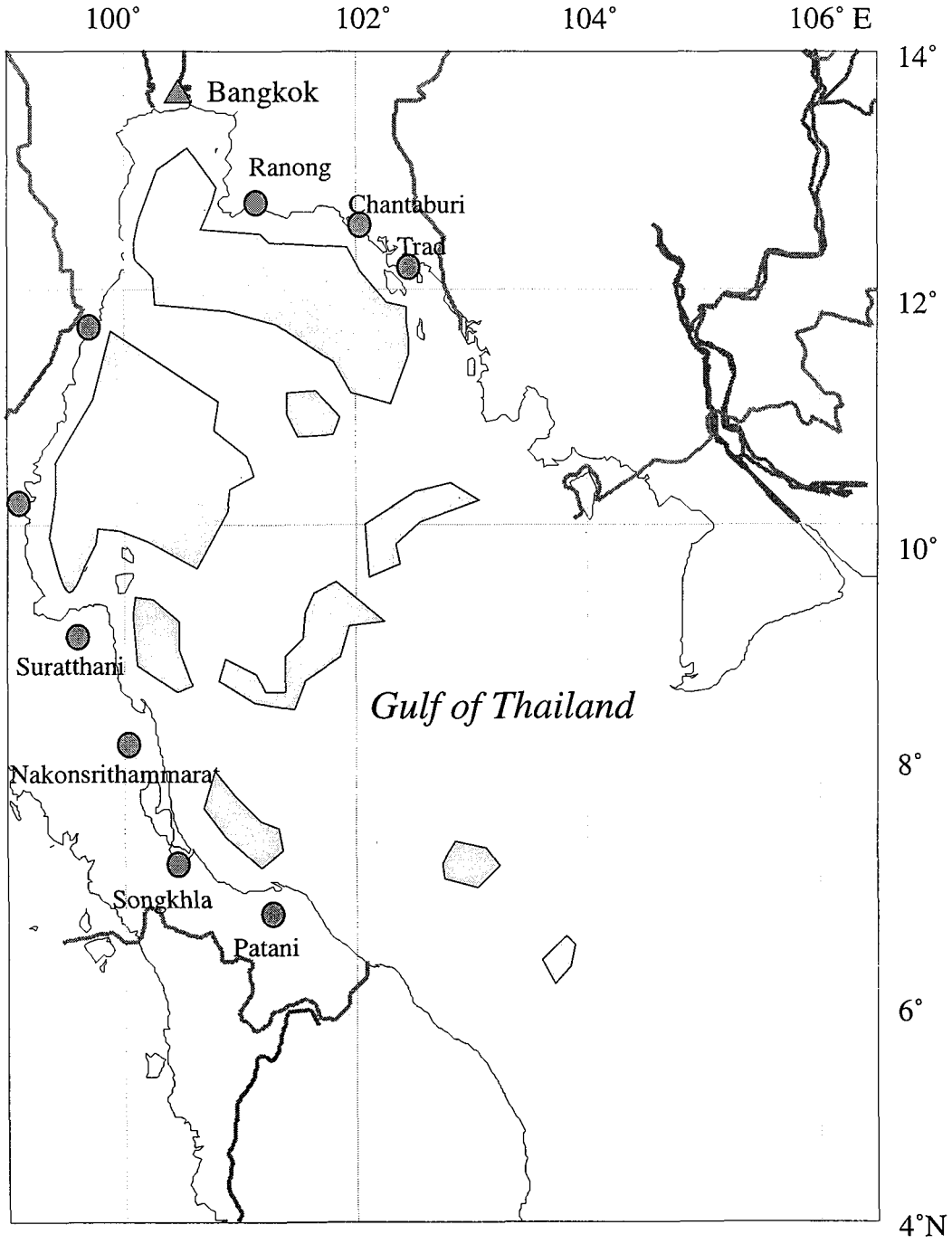


Fig. 29. Fishing grounds of Sardines in the Gulf of Thailand (SEAFDEC, 1981)

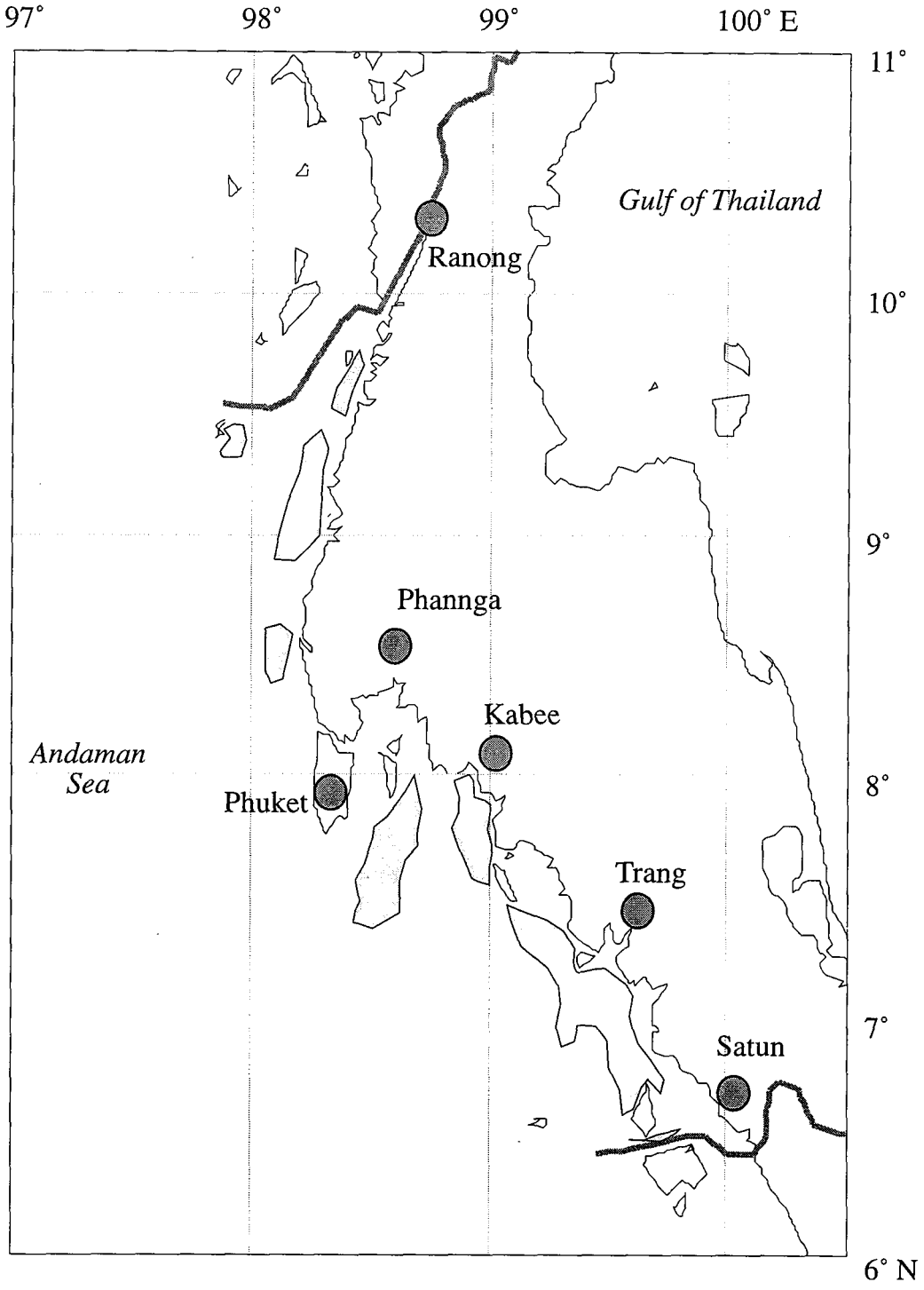


Fig. 30. Fishing grounds of Sardines in the Andaman Sea (Boonrak, Suthakorn, and Busaravich, 1984)

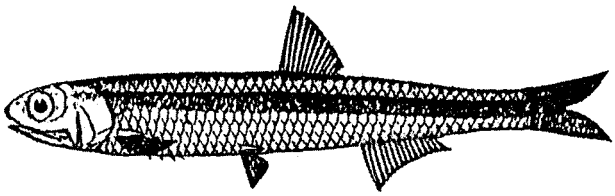
The biological analyses of *Sardinella gibbosa* shows the growth rate to be 3.36/year, maximum calculated length is 18.7 cm., t_o is 0.004/year, minimum caught size is 10.8 cm., length coefficient value (cm.) and weight (g.) relation is a=0.00786 and b=3.0985, natural mortality rate (M) is 4.15/year, fishing mortality rate (F) is 5.98/year (Somjaiwong, 1991 and Piyateeratiworkul, 1983)

Anchovies (Fig. 31)

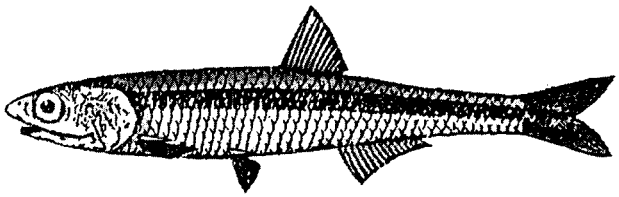
Anchovies are small pelagic fish. They are generally found in schools and are scattered, both in the Gulf of Thailand and the Andaman Sea. In the eastern Gulf of Thailand, they are distributed along the coastal areas to Cambodian waters, and are especially abundant around Chang and Kood islands, Trad province, Makham Pom Bay, Rayong province, Samae Sarn Strait; Cholburi province. In the western Gulf of Thailand, the distribution starts from Prachuab Khiri Khan-Chumporn-Surat Thani waters in the area around Tao, Samui and Pangan islands extending to Malaysian waters (Saikliang, 1995). The size of Anchovies found in the eastern Thai Gulf are greater than those in the inner Gulf. Anchovies feed on zooplankton. Predators of Anchovies are Spanish mackerel, Bonitos, Dorab wolf-herring, Carranges, Sea Bream, Hairtail, Squid, Cuttle fish, etc. There are 10 species of Anchovies in the Gulf of Thailand. The most common species is *Encrasicholina heteroloba* (*Stolephorus heterolobus*), which comprises 86.8% of the total Anchovies in the Gulf. Whereas, in the Andaman Sea 78.9% of this species are found. Percentages of the total Anchovy catch are 83% from the Gulf of Thailand and 17% from the Andaman Sea.

Anchovies spawn throughout the year. The peaks of the spawning season are between February-April and July-December (Fig. 4). The spawning depth is 15 m. 10-30 nautical miles from shore where the eggs and larvae of Anchovies are generally found. The areas of most abundance are around Chang and Kood islands, Trad province, and the southern Sattahip area, Cholburi province. In the western Thai Gulf and is abundantly found in the areas of Prachuab Khiri Khan, Chumporn and Surat Thani provinces, at 5-40 m. deep., between February-April and July-August (Fig. 32). The parent stock spawns 1,600 eggs at a time (Sidthichokpan, 1970 quoted by Saikliang, 1995).

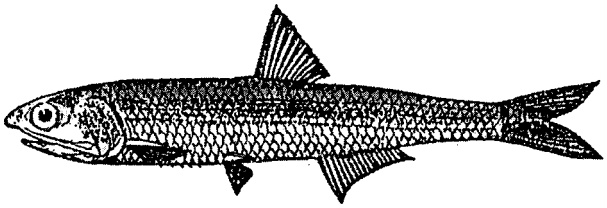
Anchovies are generally 2-8.5 cm. long. Anchovies caught at night by light luring purse seines, are bigger than those caught in day time. In other words, day fishing is done in shallow water, and the average caught size is 5.4 cm. Night fishing is done in deeper water, and the average caught size is 7.3 cm. Mature stocks are 6-8 cm. This means that Anchovies caught by light luring purse seines are of mature size. The caught size (L_c) is 5.6 cm. Maximum calculated size ($L\mu$) is 10.5 cm. Age at length equal to zero (t_0) is -.00004/year (Sidthichokpan, 1970 quoted by Saikliang, 1995). Recruitment size is 2-4 cm. Anchovies recruit to fishing grounds throughout the year (Theptranond, 1972).



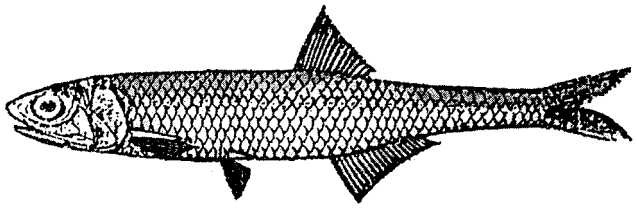
Encrasicholina puncifer (Fowler, 1938)



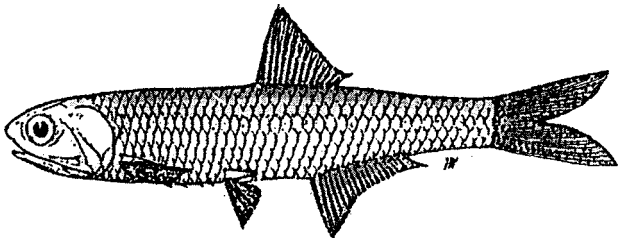
Encrasicholina heterolobus (Ruppell,1837)



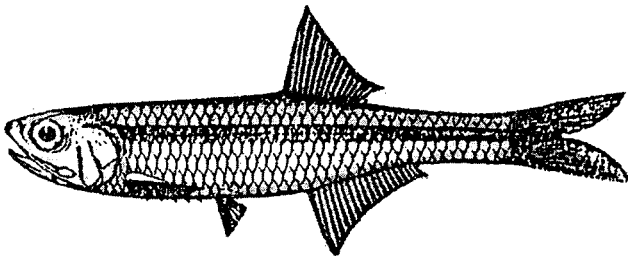
Encrasicholina devisi (Whitley, 1940)



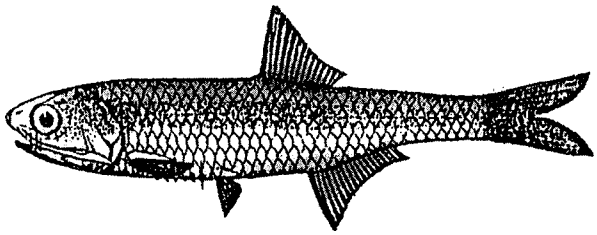
Stolephorus indicus (van Hasselt, 1823)



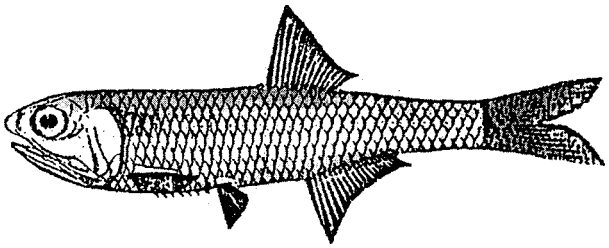
Stolephorus commersonii (Lacepede, 1803)



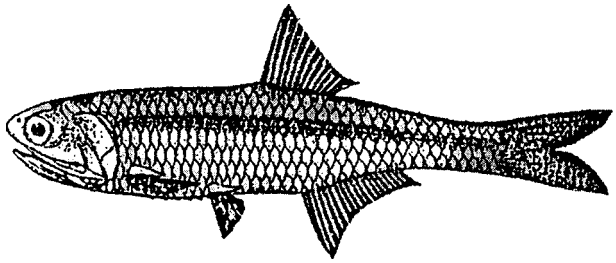
Stolephorus chinensis (Gunther, 1823)



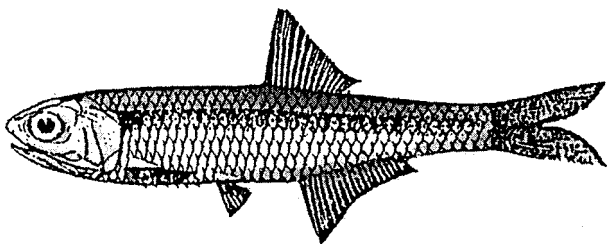
Stolephorus waiteii (Jordan & Seale, 1926)



Stolephorus insularis (Hardenberg , 1933)



Stolephorus dubiosusi (Wongratana, 1980)



Stolephorus tri (Bleeker, 1852)

Fig. 31. Anchovies found in Thai waters (FAO, 1984)

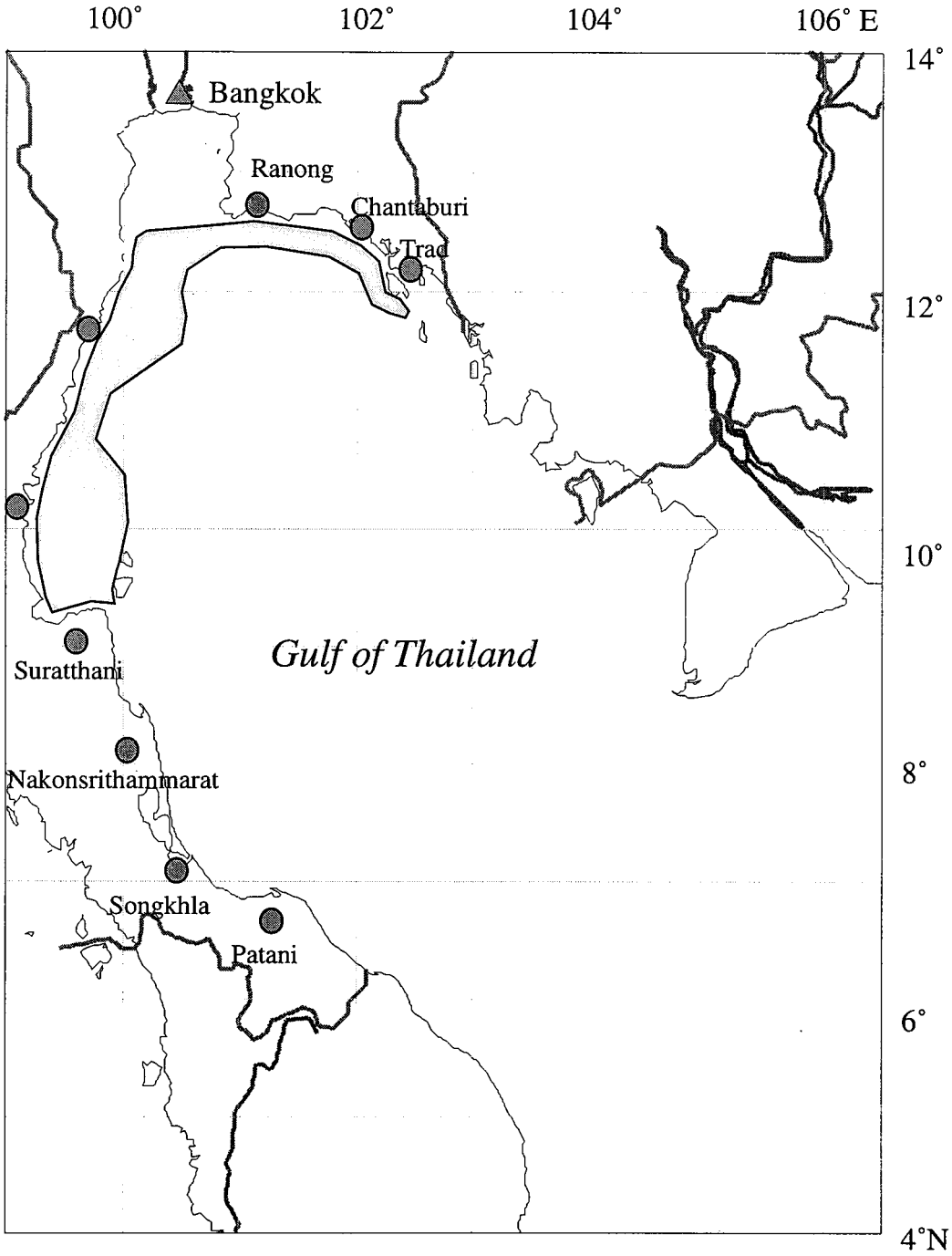


Fig.32. Spawning grounds of Anchovies in the Gulf of Thailand (Chayakul, 1990, Chantarakusol, 1988; Vathanachai, 1978, quoted by Saikliang, 1995)

Anchovy fishing can be operated throughout the year. Fishing seasons depend on monsoon seasons and types of fishing gear such as light luring purse seines which are mainly used between December-February, near the eastern Thai Gulf (Trad and Chantaburi provinces), and then moved to the western Gulf (Prachuab Khiri Khan-Chumporn-Surat Thani provinces) between May-September, beach seine fishing is most commonly done in the Rayong area between April-June, stick-held dip nets are mainly used near the Prasae river mouth in Rayong province between September-May, lift nets are used in the Samae Sarn Strait, Bang Sarae and Cholburi province in March and October, Anchovy surround nets are used throughout the year and are mostly found around Chang, Kood and Klum islands, Trad province.

Saikliang (1995) reported several fishing grounds of Anchovies in the Gulf of Thailand. In the eastern Thai Gulf, these are Trad province (Chang, Kood, Rang and Klum islands), Chantaburi province (Laem Singh and Kung Kra Baen areas), Rayong province (Man islands, Makam Pom bay, Laem Mae Pim, Hin Pleung, Wang Kaew, Suan Son, Samed island, Mae Rampueng beach, Tapong, and Rayong bay). In the inner Thai Gulf they are at Cholburi province (Samae Sarn Strait, Kram, Rin, Kred Keaw, Rang Kwean, Pai, Lan, Luem islands, Bang Sarae, and Sri Chang island), Samut Prakan (stake trap area in Bang Pa Kong and Klong Dan), Samutsakorn and Petchburi. In the western Thai Gulf the grounds are Prachuab Khiri Khan (Hua Hin, Pranburi, Ao Noi, Klong Wan and Boh Thonglang), Chumporn province (Chumporn bay, Pathiew, Tago), Surat Thani (Ang Thong islands, Pa-ngan and Samui islands), Nakhon Sri Thammarat (Khanom bay, Sichol, Thasala, Pak Paying and Pak Nakhon), Songkhla (Ban Sakom andPaknam Thepa), Pattani (Ban Rusamirae, Pattani bay, Laem Tachee, Laem Pho and Saiburi), and Narathiwas (in front of Ban Thon airport, Kuboo village, Praiwan subdistrict and Takbai).

Fishing gear catching Anchovies are classified into 4 main types. These are purse seines; with and without a purse line, and are used both in day and at night. Dip and lift nets, towing gear; pair trawls, push nets, beach seines and bamboo stake traps are also used. Among the fishing gear, purse seines are the most effective and popular as compared to other gear.

Catch composition of Anchovies depends upon the type of fishing gear, fishing methods, and fishing grounds as shown in Table 11.

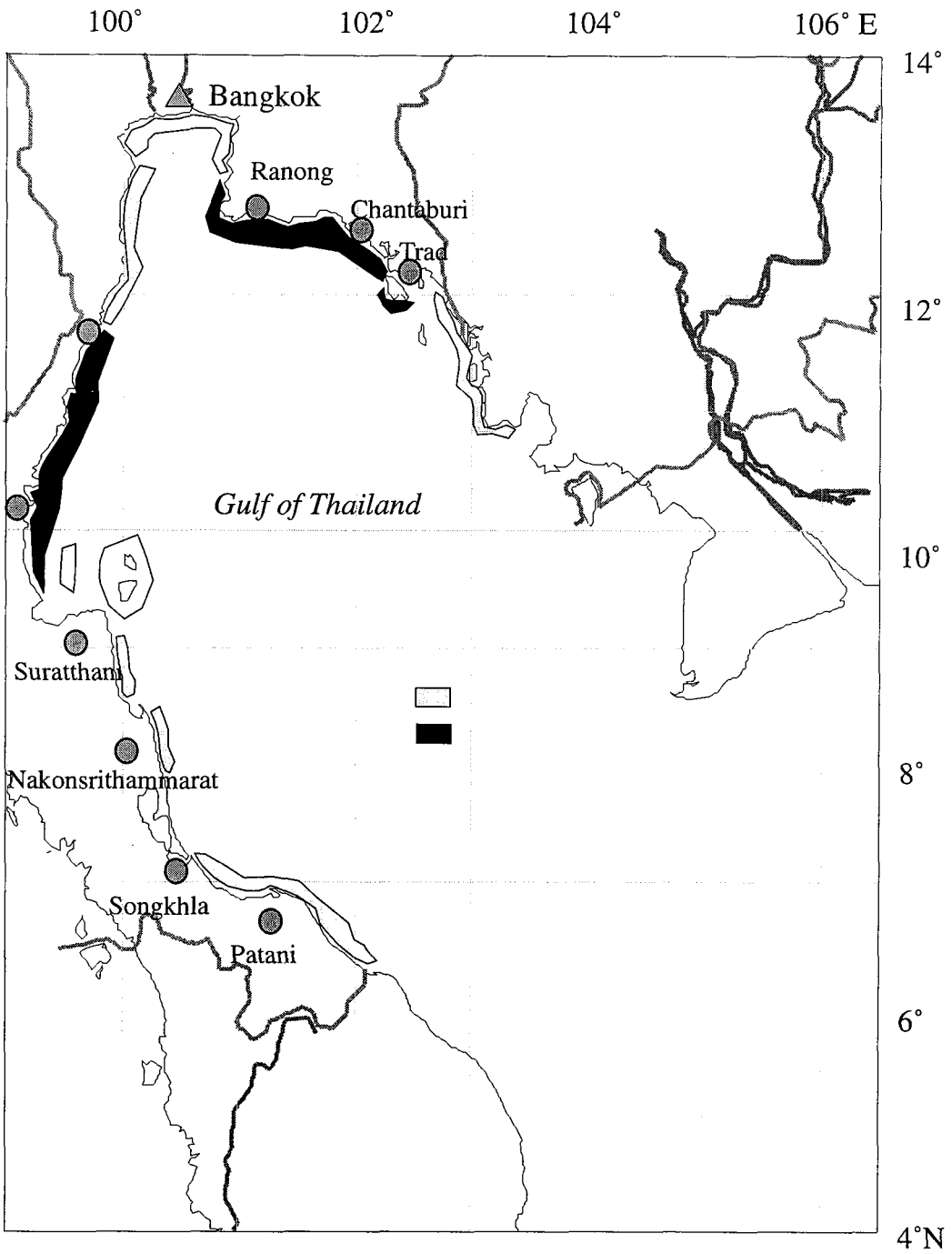


Fig. 33. Fishing grounds of Anchovies in the Gulf of Thailand (Saikliang, 1990 quoted by Saikliang, 1995)

Table 11. Proportion (%) of Anchovies caught by different fishing gear and from different fishing grounds

Fishing gear	Achovies	Other pelagic fish	Fishing grounds	Year of survey
Anchovy purse seine (day operation)	>90	<10	Chumporn-Surat Thani	1985
	93	7	Chumporn-Surat Thani	1990
	93.8	6.2	Prachuab-Surat Thani	1990
	86.6	13.4	Rayong	1978-1991
	94	6	Chumporn	1992
Anchovy purse seine (night opeation and light luring)	59.6	40.5	Chumporn-Surat Thani	1985
	45.9-52.3	47.7-54.1	Chumporn-Surat Thani	1987
	73.5	26.5	the Gulf of Thailand	1991
	70.9	29.1	Trad	1985-1991
	74.8-91.8	8.2-25.2	Rayong-Trad	1992-1993
	74.8-83.5	16.5-25.2	Prachuab Khirikhan	1992-1993
	68.9	31.1	Chumporn	1992
	56.6-80.5	19.5-43.4	Phuket	1990-1991
Lift nets with luring light	84.8	15.2	Rayong	1988-1991

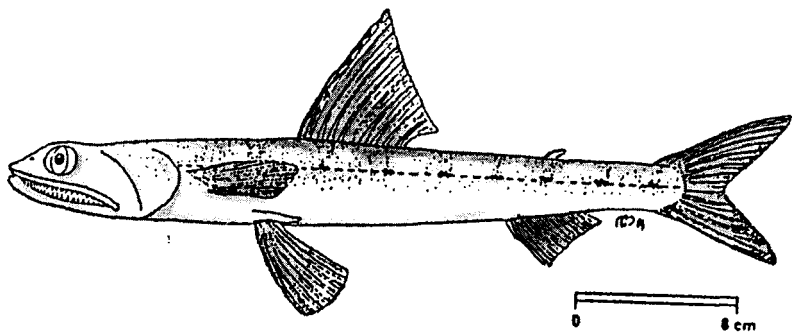
Source : Department of Fisheries, 1993

Lizardfish (Fig. 34)

Lizardfish is a demersal species distributed, both in the Gulf of Thailand and the Andaman Sea. Based on trawl surveys shows that there are 7 species of Lizard fish. The two most commonly found species are; Brushtooth Lizard fish (*Saurida undosquamis*) and Lizard fish (*S. elongata*). Major fishing gear used for catching this kind of fish are trawls

Saurida undosquamis (Richardson,1848))

OTHER SCIENTIFIC NAMES STILL IN USE: Saurida grandisquamis(Gunther, 1864)



Saurida tumbil (Bloch, 1795))

OTHER SCIENTIFIC NAMES STILL IN USE: Saurida ergyrophanes(Richardson, 1846)

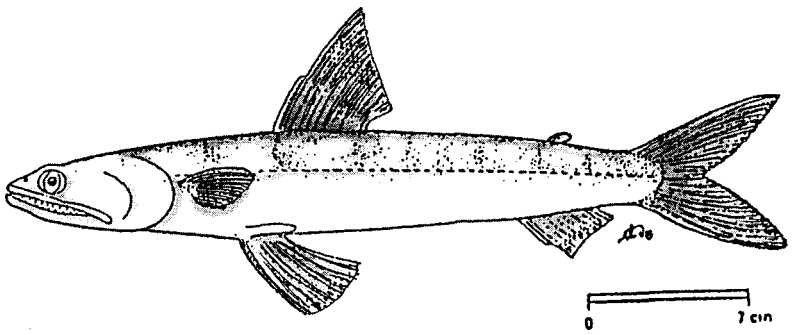


Fig. 34. Lizard fish found in Thai waters (FAO, 1984)

Sirapakavanich (1990) reported, Brushtoothed Lizard fish as being found between July-October and February-March in the eastern Gulf of Thailand (Trad, Chantaburi, and Rayong provinces), between August-September and October-December in the south-western Gulf of Thailand (Nakhon Sri Thammarat and Songkhla), and in the upper western Gulf (Prachuab Khiri Khan, Chumporn, and Surat Thani) they are found throughout the year. Further, the report shows the length frequency distribution is varies with depth. In other words, small fish are caught in shallower water as compared to the bigger fish i.e. at 10-30 m. deep, fish sizes are 6-15 cm., at 30-40 m. fish both large and small are found but at 40-60 m. the fish sizes are 10-34 cm. The average size found is 10-20 cm. Mature stocks are 28.5 cm. Larvae of Lizard fish are found throughout the year. However, the peak is between January-March and July-November.

In the upper western Gulf of Thailand (Prachuab Khiri Khan and Surat Thani), Brushtooth Lizard fish is abundant at 40-50 m. deep and especially so in the rainy season. The Lizard fish is carnivorous, its food being small fish and Pony fish in particular. Juveniles recruit to the fishing grounds between March-April and November-December. Sizes are between 6-34 cm. Maximum length of the male fish is 28.0 cm. while that of the female is 30.0 cm. Maximum length of male and female Brushtooth Lizard fish are 30.2 and 34.8 cm. Growth rate throughout the life span is 2.37 and 2.2 per year, and hatching ages are -0.024 and 0.042 per year, respectively.

The Brushtooth Lizard fish spawns throughout the year. However, there are two peaks; December-January and May-September. The size recruited into the fishing grounds is 12.0-14.0 cm. between June-December and February.

Saurida elongata is abundant at 10-20 m. deep. Maximum size found is 37.7 cm. Maximum size of male and *female S. elongata* is 41.6 cm. It spawns throughout the year. The peaks of the spawning season are January-March and September-October. Juveniles recruit to the fishing grounds between May-July and November.

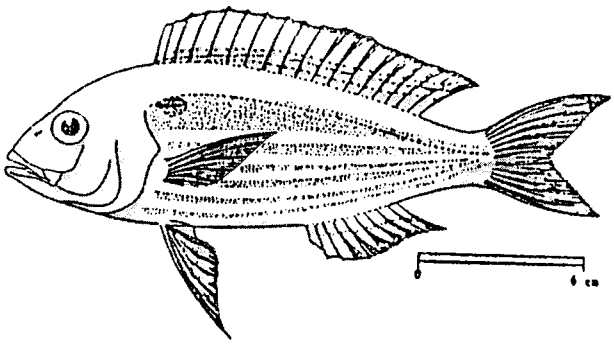
Saurida tumbil has a peak spawning season between January-March. Maximum sizes of the male and female Lizard fish are 34.0 cm. and 40.0 cm., respectively. Juveniles recruit to the fishing grounds between May-July and December. In the Andaman Sea, this kind of Lizard fish is found at 20-60 m.. The average size being 29.5 cm. with a 38.0 cm. maximum. The peak of the spawning season is between February-August.

In the Gulf of Thailand, the Lizard fish is mainly caught by trawls. The catch between 1971-1992 was between 7,500-32,000 tons. Between 1986-1990, catch was between 13,000-17,000 tons. And in 1991 and 1992 the maximum catch at 19,750 and 31,840 tons, respectively was recorded (Table 1). In the Andaman Sea, the catch of Lizard fish is between 0.5-6.5 tons. In 1984-1989, catch was relatively constant at 1,000-1,700 tons. But for the last three years; 1990-1992, the catch increased to 3,300, 3,900 and 6,500 tons, respectively (Table 2).

Threadfin Bream (Fig. 35)

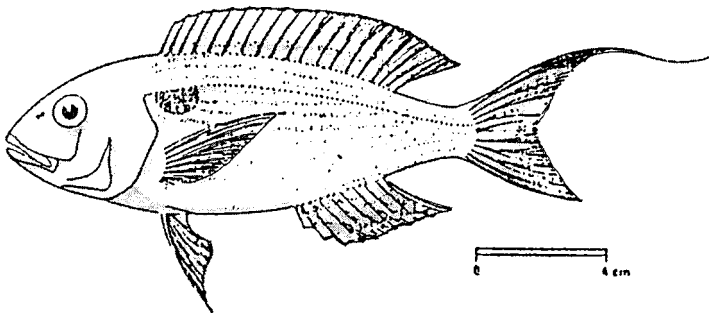
Nemipterus hexodon (Quay &Gaimard 1824)

OTHER SCIENTIFIC NAMES STILL IN USE: *Syanaris hexodon* (Gunther, 1859)



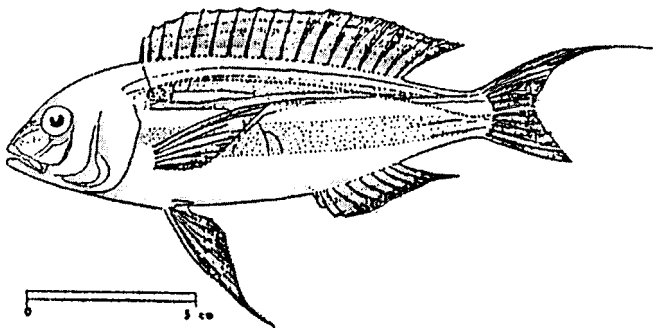
Nemipterus laponicus (Bloch,1791)

OTHER SCIENTIFIC NAMES STILL IN USE: *None*



Nemipterus mesoprion (Bleeker, 1853)

OTHER SCIENTIFIC NAMES STILL IN USE: *Syanaris mesoprion* (Mechan, 1930)



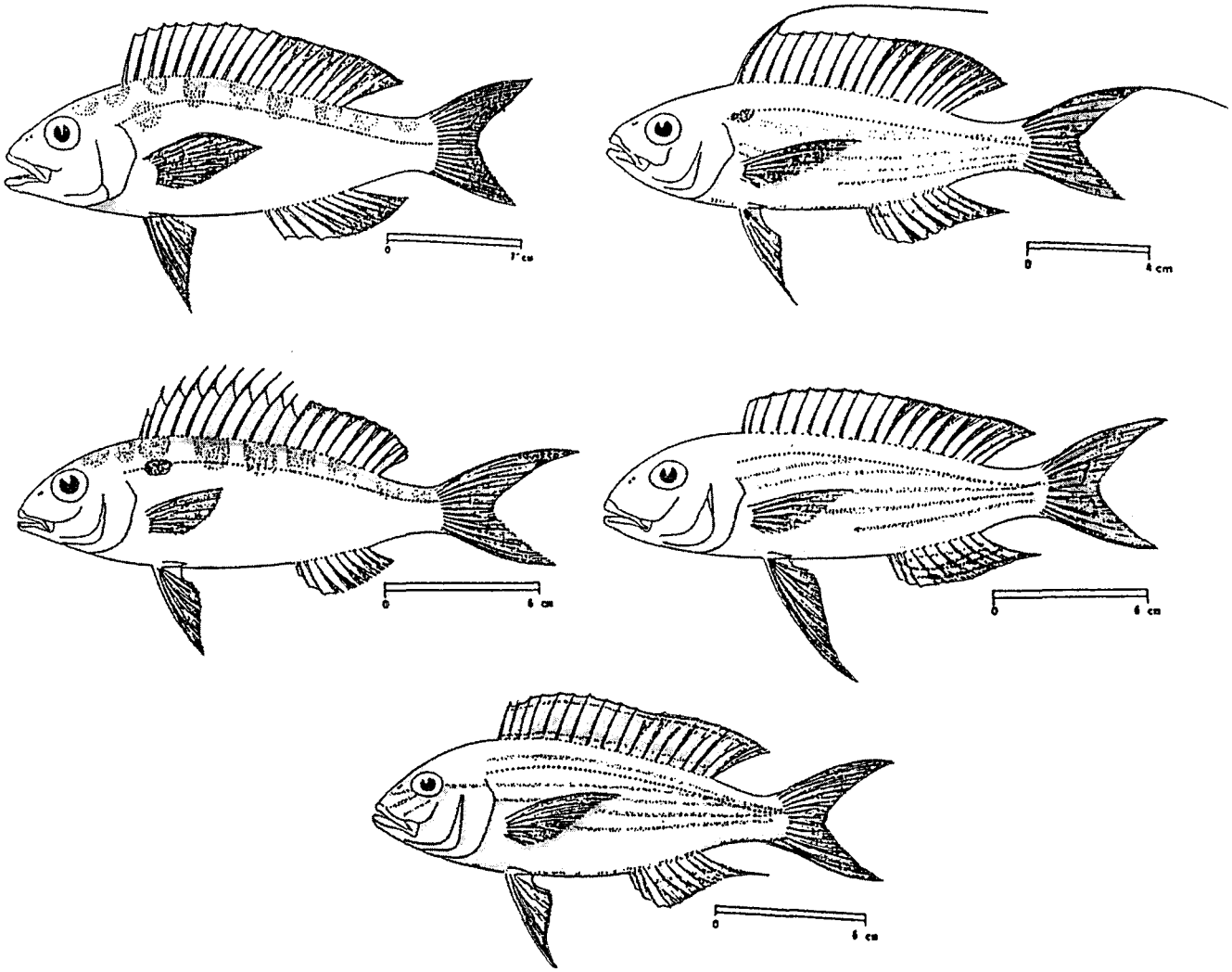


Fig. 35. Sea Bream found in Thai waters (FAO, 1984)

Threadfin Bream are demersal fish distributed along the coastal area to 60 m. deep waters. The small fish inhabit nearer to the shore. Threadfin Bream are carnivorous. The food of the Threadfin Bream is polycheat, shrimps, cephalopod, molluscs and juvenile fish. Juveniles of the Threadfin Bream feed on copepod and ostracod. The male fish grows faster than the female.

In the Gulf of Thailand, there are several species of Threadfin Bream. The most found are *Nemipterus hexodon, N. mesoprion, N. japonicus, N. nematophorus, and N. peronii.*

Rakvichai (1977) reports that *N. hexodon* spawns throughout the year. The peaks of spawning season are between January-April and June-August. The juvenile is 11-12 cm. long recruiting to the fishing grounds between June-August, September-November and May. The minimum size caught is 5.2 cm., and the maximum is 27.3 cm. The average size of the male is bigger than that of the female, these are 16.5 cm. and 15.1 cm., respectively. This kind of Threadfin Bream is distributed at 10-40 m. deep.

N. mesoprion distributes at 30-60 m. deep. Maximum sizes of male and female are 19.5 cm. and 15.5 cm., respectively. It spawns throughout the year. The peak of spawning season is between February-April. Juveniles recruit to the fishing grounds in March, May, and June, sizes being 6.5-7.0 cm. The growth rate is 1.08 per year.

N. nematophorus distributes at 15-50 m. deep. Maximum sizes of male and female are 25.8 cm. and 17.8 cm., respectively. They spawn throughout the year. The peaks of the spawning season are between January-April, August and November. The mature size is 11.7 cm. The growth rate of male and female are 1.72 and 2.73 per year respectively.

N. japonicus distributes at 20-50 m. deep. Maximum sizes of male and female are 25.6 and 23.3 cm., respectively. Juveniles recruiting to the fishing grounds are 10.0 cm. long. The growth rate of male and female are 1.92 and 1.45 per year.

N. peronii distributes at 30-60 m. deep, the maximum sizes of male and female are 27.5 and 27.0 cm., respectively. It spawns throughout the year. The peak of the spawning season is between February-April. Juveniles recruiting into the fishing grounds are 15.2-15.7 cm. long, and recruit in March, July, August and December.

In the Andaman Sea, there are 4 kinds of Threadfin Bream; *Nemipterus delagoae, N. tambuloides, N. japonicus and N. tolu.* Based on the survey of Sarnakomkul (1990) this finds that *N. delagoae* spawns throughout the year. The peak of the spawning season being between December-May. Mature size is 16.4 cm.

N. tambuloides spawns throughout the year. The peaks of the spawning season are July-September and December-February. Mature size is 15.9 cm. long.

In the Joint Development Area (JDA) between Thailand and Malaysia surveyed by trawls at 40-70 m. deep more than 8 species are found. They are *N. mesoprion, N. hexodon, N. marginatus, N. nematophorus, N. nemurus, N. peronii, N. tolu, and Nemipterus spp.* The most common Threadfin Bream is *N. mesoprion*, followed by *N. nematophorus, and N. marginatus. N. mesoprion* is abundant at 40-60 m. deep. *N. nematophorus* and *N. marginatus* are abundant at 50-70 m. deep. And *N. peronii, and N. hexodon* are abundant at 40-50 m. deep (Uraiwan and Boonvanich, 1993).

Between 1971-1985, the catch of Threadfin Bream in the Gulf of Thailand was between 12,000-20,000 tons. In 1986-1992, catch fluctuated between 23,000-51,000 tons, when the maximum catch was in 1992 at 51,259 tons (Table 1). In the Andaman Sea, the catch between 1971-1990 was between 17,000-50,000 tons and the maximum, was in 1992 at 13,722 tons (Table 2).

Bigeye (Fig. 36)

Priacanthus tayenus (Richardson, 1846)

OTHER SCIENTIFIC NAMES STILL IN USE: None

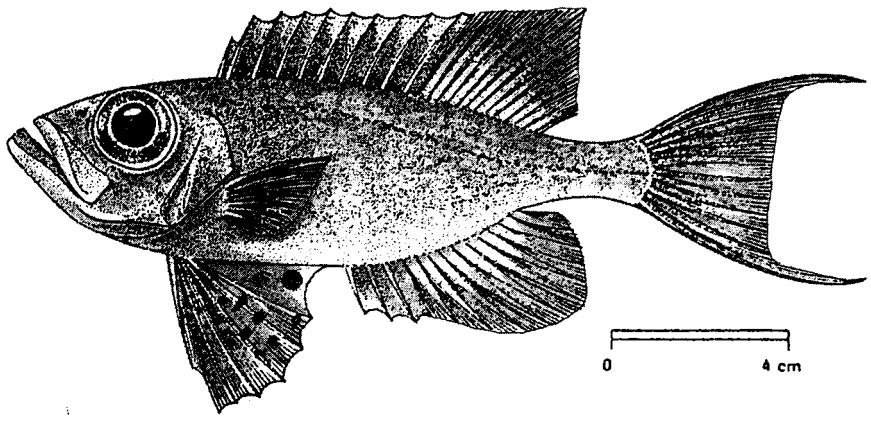


Fig. 36. Bigeye fish found in Thai waters (FAO, 1984)

Bigeye (*Priacanthus tayenus*) is a demersal fish generally distributed in the Gulf of Thailand (Prachuab Khiri Khan and Chumporn provinces) at depths greater than 40 m.. It is carnivorous, its food being fish, shrimps and Squid (Jiraphanpiphat, 1987).

According to surveys by the Marine Fisheries Division in Prachuab Khiri Khan, Chumporn and Surat Thani provinces, it shows a growth rate of 2.11 per year and a maximum length of 27.7 cm. Bigeye is normally found 4.0-30.0 cm. long (Boonvanich, 1987).

In Chumporn and Surat Thani provincial waters, Amornchairojkul (1987) reports that Bigeye found is 3.5-27.0 cm. with 12.1 cm. average. Sex of the Bigeye can be distinguished when it is longer than 6.5 cm.. Male fish are bigger than females and the male is normally 6.5-27.0 cm. (12.9 cm. average) and female is 6.5-23.0 cm. (12.6 cm. average). Juveniles recruiting into the fishing grounds are 8.5-10.5 cm. long, usually between January-February, May, and August-September. The growth rate and maximum length of male and female are 2.06 and 2.23 per year and 28.1 and 25.4 cm., respectively. Mortality rate and minimum caught size of both male and female are 9.2 per year and 5.8 cm..

In Surat Thani to Narathiwas provincial waters, Bigeye size is 3.0-27.5 cm.. Juvenile size is 8-10 cm., recruiting into the fishing grounds between March-June (with the peak in April), July and September. The normal size of the male is 8.5-18.7 cm. and that of the female is 10.2-17.3 cm.. The growth rate and maximum length of male and female are 2.11 and 1.96 per year, and 28.7 cm., 25.0 cm., respectively. The total mortality rate is 6.3 per year and natural mortality rate is 3.1 per year (Boonvanich, 1987). Bigeye spawns throughout the year. The peak of the spawning season is between January-March. A female spawns 56,000-152,000 eggs at a time.

The catch of Bigeye in the Gulf of Thailand between 1971-1992 was between 8,700-36,000 tons (Table 1), while the catch in the Andaman Sea was relatively low (Table 2).

Fishing grounds of demersal fish are generally along coastal areas of the Gulf of Thailand. Otter trawls are an effective fishing gear to catch demersal fish. Small otter trawls (boat length less than 14 m.) mainly catch shrimps and demersal fish in shallow waters. Medium and large sized trawlers catch both shrimp and fish. During night operation, the trawlers use shrimp trawl nets to catch shrimps and use fish trawl nets to catch fish during day time operation. Pair trawls normally catch pelagic fish but also demersal fish, Squid, cuttle fish, Octopus, Blue swimming crab, crabs, including shrimps which are caught in small numbers.

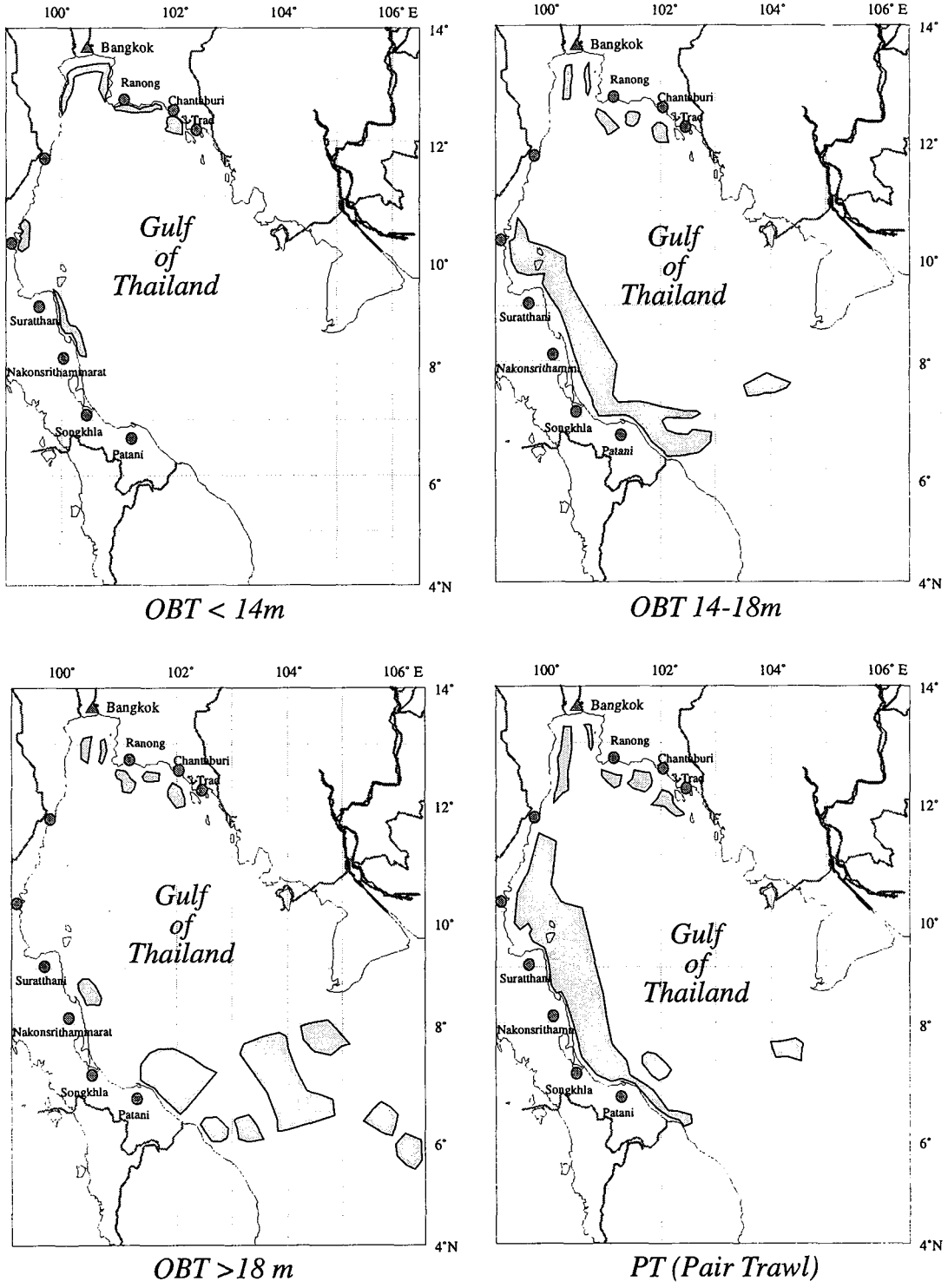


Fig. 37. Fishing grounds of shrimps and demersal fish from otter-board trawls (OBT) and paired trawls (PT) in the Gulf of Thailand (FAO, 1996)

Squid (Fig. 38)

Supongpan (1988a) reports 10 species of Squid found in Thai waters. The economically important and most found species are *Loligo duvauceli, L. chinensis, L. edulis, Loliolus sumatrensis, L. singhalensis* and soft Cuttle fish (*Sepioteuthis lessoniana*) which is classified as a squid. *L. edulis* and *L. singhalensis* are only found in the Andaman Sea.

In the Gulf of Thailand, Squid are distributed from the coastal areas to 50 m. deep. *L. duvauceli* is abundant at 20-40 m. *L. chinensis* is abundant at 40-50 m. deep. *L. sumatrensis* is abundant at 10-20 m. deep. And soft Cuttle fish is abundant at 10-30 m. Major food of the Squid are fish, molluscs. and shrimp.

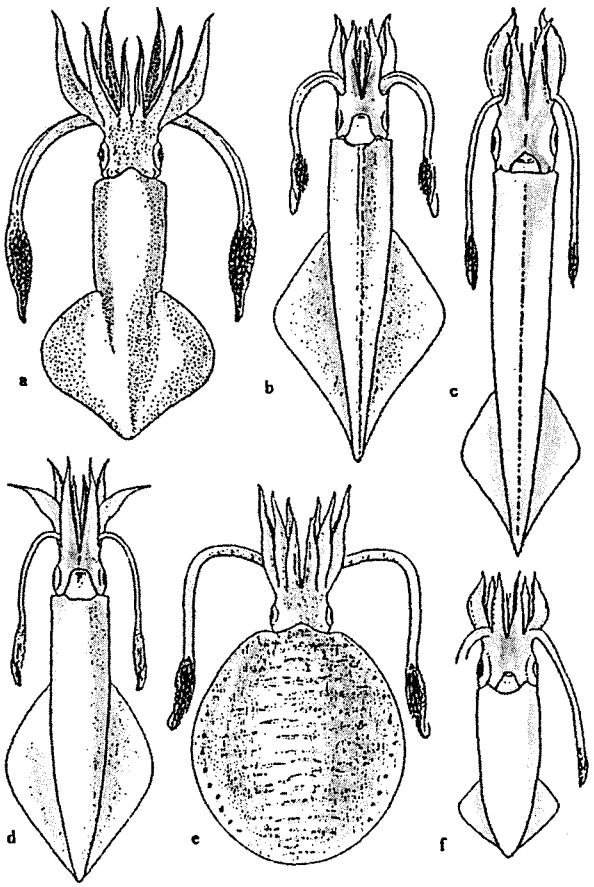


Fig. 38. Squid found in Thai waters (a. *Loligo duvauceli* Orbigny, 1848; b. *L. edulis* Hoyle, 1885; c. *L. singhalensis* Ortmann, 1891; d. *L. chinensis* Gray, 1849; e. *Sepioteuthis lessoniana* Lesson, 1830; f. *Loliolus sumatrensis* (Orbigny, 1835). a, b, d, e from Roper et. Al., 1984; c,f, from Chotiyaputta, 1995

Fishing gear used to catch Squid are otter trawls, pair trawls, squid lift nets with luring lights, squid traps and hooks & lines. The Squid catch from otter trawls is 7.2-8.8% of the total caught, from pair trawls it is 10.4-11.9%, from squid lift net with luring light it is 20-50%. Fishing grounds are around coastal areas in the eastern, upper, and western Gulf of Thailand. The main fishing grounds are in the area of Trad, Chantaburi, Rayong, Cholburi, Prachuab Khiri Khan, Chumporn, Surat Thani, Songkhla, Pattani and Narathiwas provinces, including around islands.

89.7% of the total catch is from the Gulf of Thailand and 10.3% is from the Andaman Sea (average figures between 1971-1993), the Squid catch in the Gulf of Thailand, between 1971-1981, this slightly increased to between 20,00-50,000 tons. After 1981, the squid catch rapidly increased to between 50,000-70,000 tons. And in 1987 the catch was at a maximum of 68,326 tons. In the Andaman Sea, the squid catch between 1971-1990, was between 2,000-7,000 tons. And 1991-1993, the catch was quite high at 13,000-16,00 tons (Table

Table 12. Total Squid catch in Thailand between 1971-1993

unit : tons

Years	Total catch	Catch in Thai Gulf	Catch in the Andaman Sea
1971	23,528	21,240	2,288
1972	44,691	42,521	2,170
1973	37,470	33,003	4,467
1974	42,055	39,264	2,791
1975	37,191	35,198	1,993
1976	36,163	33,960	2,203
1977	52,255	47,210	5,045
1978	52,067	47,235	4,832
1979	42,287	37,340	4,940
1980	39,827	36,158	3,669
1981	48,021	47,389	632
1982	70,583	66,208	4,735
1983	76,489	71,662	4,827
1984	66,368	59,721	6,647
1985	63,926	59,007	4,919
1986	71,344	65,292	6,052
1987	75,420	68,326	7,094
1988	67,176	60,934	6,242
1989	69,840	62,732	7,108
1990	64,370	57,608	6,762
1991	69,367	56,551	12,816
1992	64,774	51,209	13,565
1993	72,162	55,867	16,295

Source : Department of Fisheries, 1973-1974; 1985-1990; 1991-1993 and 1994-1996.

L. duvauceli is generally 3.0-32.0 cm. long. The minimum mature size of male and female are between 8.5-12.00 cm. and 8.5-14.0 cm., respectively. A female spawns throughout the year with 1,000-4,000 eggs a time. The peaks of the spawning season are between June-July and January (Fig. 4). Small size squid are found between May, and August-September (Supongpan, 1988b).

Biological studies of *L. duvauceli* both in male and female, shows that growth rate and maximum length are 1.14 and 0.996 per year and 37.6 and 23.0 cm.,
respectively. The natural mortality rate of male and female are 4.67 and 2.80 per year. Hatched age (t_0) is 0.003 per year. Squid caught from squid lift nets with luring lights are 4.0-23.0 cm. long. The most caught size is 10-14 cm. with 8.0 cm. As the minimum caught size. Coefficient value of catch ability (q) from squid lift net with luring light is 0.55 (Supongpan, 1988b).

L. chinensis has a length between 4.5-40.9 cm., spawning throughout the year. The peak of spawning season is between February-May. A female spawns 800-7,000 eggs at a time.

Based on the report of Suponpan (1988a), the fishing grounds of Squid, Cuttle fish and Octopus are along the coastal areas of the Gulf of Thailand at not deeper than 50 m.. The numbers caught by otter trawls and pair trawls (Fig. 37) are the same as squid lift nets with luring lights. But the advantage of the lift net is that they can be operated in rocky bottom areas and near islands (Fig. 39).

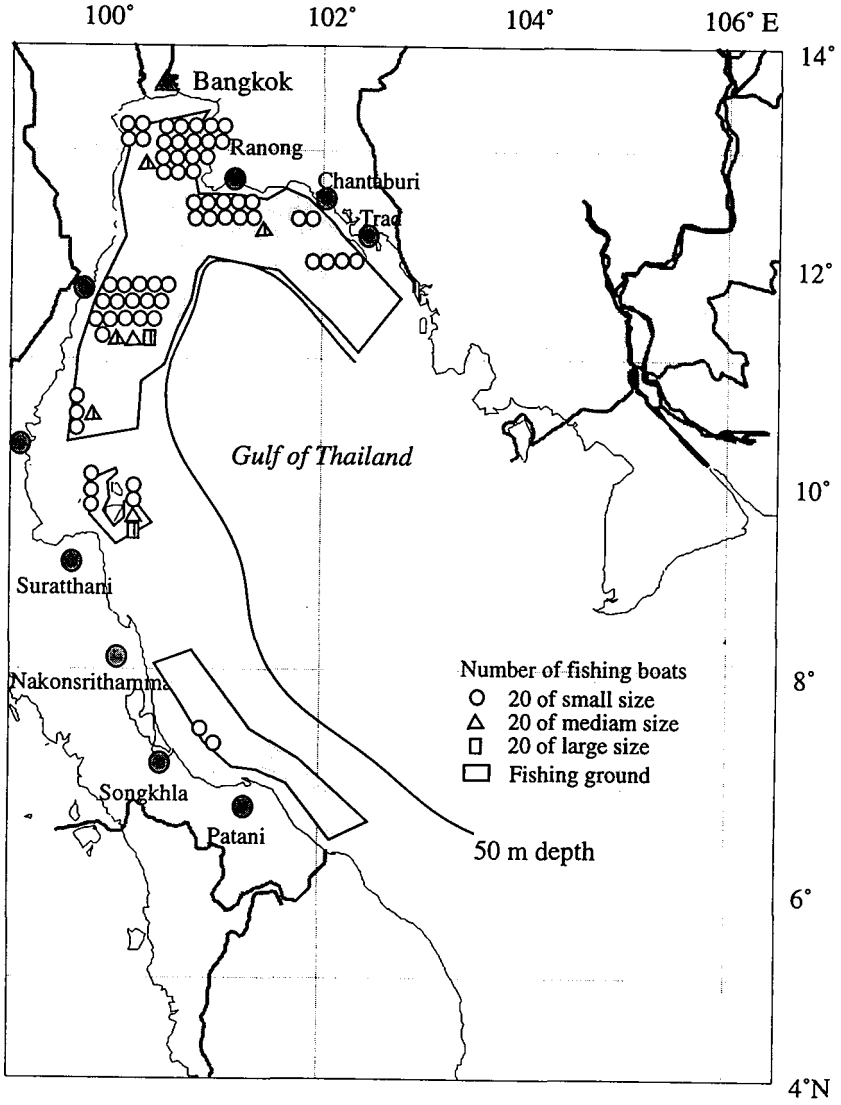


Fig. 39. Lift net fishing grounds of Squid in the Gulf of Thailand (Supongphan, and Kongmuak, 1987)

3. Conclusion

Several studies and researches on species, quantity and size of marine species, spawning grounds and seasons, fishing grounds, migratory routes, stock assessment of the marine species which straddle between 2 or more EEZs of coastal states as well as highly migratory between EEZs and the high seas, is vitally important in term of marine resource management and conservation among coastal states to achieve sustainable long term benefit.

Geographically, the Gulf of Thailand only shares borders with EEZs of neighbouring countries. Unlike the Andaman Sea, which only shares borders with EEZs of neighbouring countries but also connects with the high seas.

The marine species in the Gulf of Thailand are shared stocks which are divided into shared, regularly migratory fish stock, and shared straddling fish stock. In the Andaman Sea, stocks are divided into shared regularly migratory fish stock, shared straddling fish stock and highly migratory fish stock.

Based on several technical studies of the Marine Fisheries Division, Department of Fisheries, marine species which are caught in large amounts and are economically important, both in the Gulf of Thailand and the Andaman Sea, can be divided into 4 categories.

1. **The local fish stocks which inhabit within the EEZ of Thailand.** These stocks are more of than 1,000 species of pelagic, demersal and other marine fish.

2. **Shared transboundary fish stocks.** These stocks slowly migrate and straddle between the EEZs of Thailand and Cambodia, Vietnam, Malaysia and Myanmar. The stocks are demersal fish; Lizard fish, Threadfin Bream, Bigeye, Octopus and others.

3. **Shared transboundary migratory fish stocks.** These stocks rapidly migrate and straddle between the EEZs of Thailand and Cambodia, Vietnam, Malaysia, Myanmar and the overlapping areas between the countries. The stocks are pelagic species; Indo-Pacific and Indian mackerels, Spanish mackerel, Bonito, Round Scad, Sardines, Anchovies, Squid, and others.

4. **Highly migratory fish stocks.** These stocks rapidly migrate between the EEZs and the high seas; some parts of the life cycle are in an EEZ with migration to the high sea when fully grown. They are pelagic species; deep sea Spanish Mackerel, Longtail Tuna, Kawa Kawa, Frigate Tuna, Yellowfin Tuna, Bigeye Tuna, Longfin Round Scad, Shortfin Round Scad, Squid, etc.

The management of fish stocks in the EEZs of Thailand, shared straddling fish stocks, shared migratory fish stocks, and highly migratory fish stocks, can only be achieved through co-operation among coastal states. In other words, each coastal state has to properly maintain the resources within its territory. As a matter of fact that, regardless of type of stocks, marine species inhabit near coastal area in the early stages of their life cycle, and migrate to deeper water in the later stages. Therefore, conservation of coastal marine resources and environment is of such importance that coastal states should strictly carry out and also jointly co-operate with other coastal states to manage resources in the high seas. Responsible fisheries and the Code of Conduct is an approach which is being convened by several international organisations in order to sustain the use of natural resources. The international organisations are, for example, The Food and Agriculture Organization (FAO) of the United Nations, The Indian Ocean Tuna Commission (IOTC), The Asia-Pacific Fisheries Commission (APFIC), etc.. Even within the Southeast Asian region, appropriate approaches to manage marine resources should be used in the future, such as a quota system of numbers of fishing boats and a catch quota system. This is to eliminate conflicts which might be increasingly violent as have occurred in other regions.

Approaches to managed shared stocks are

1. To improve the management system or conservation measurement of marine resources and the environment in each country to be more effective.

2. To co-operate in exchanging information on resource surveys of each coastal state and in conducting surveys between waters, to develop fishery statistical systems, to develop stock assessment & fisheries as well as population dynamics in order to constantly monitor changes of the resource and fisheries situation.

3. To develop fishing gear and methods in a more selective way to minimize the loss of non-target species or small sized fish.

4. To Improve or develop a controlling system against environment destruction together with the rehabilitation of depleted resources. This can be done by taking into account modern technology such as a Geographical Information System or Remote Sensing System, etc..

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