

Major fisheries in Thailand and some technical
recommendations for their improvement

by

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CONTENTS

1. Statistics of principal fisheries in Thailand
2. Present major fisheries in Thailand
 - 2.1 Trawl fishery
 - 2.2 Indo-Pacific mackerel purse seine fishery
 - 2.3 Bonito purse seine fishery
 - 2.4 Indo-Pacific mackerel encircling gill net
3. Recommendation for future fisheries in SEAFDEC area
 - 3.1 Skipjack pole and line fishery
 - 3.2 Mechanized squid line fishery
 - 3.3 Vertical long line fishery
 - 3.4 Mid-water trawl fishery
 - 3.5 Philippines lift net fishery
 - 3.6 Jellyfish fishery

1. STATISTICS OF PRINCIPAL FISHERIES
IN THAILAND.

The FAO yearbook of fisheries statistics for 1970, states that the catch of fish in Thailand ranked eighth in the world, and fish production in the same year was 1,595,100 tons, an eightfold increase compared with the catch recorded for 1958, 196,300 tons.

(a) Catch in quantity

Fish species or group of species whose production exceeded 5,000 metric tons.

Name of fish	Metric ton	% to the total
1 Trash fish	438,999	35.2
2 Indo-Pacific mackerel	100,505	8.1
3 Miscellaneous fish	88,109	7.1
4 Sardine	28,803	2.3
5 Anchovy	15,513	1.2
6 Indian mackerel	14,916	1.2
7 Threadfin bream	14,896	1.2
8 Jew fish	13,254	1.1
9 Marine catfish	11,872	1.0
10 Lizard fish	11,066	0.9
11 Big eye snapper	10,627	0.9
12 Spanish mackerel	9,201	0.7
13 Ray	6,869	0.5
14 Bonito	5,631	0.5
15 Shark	5,631	0.5
(Crustaceans)		
Shrimp	68,743	5.5
Crab	18,876	1.5

(Molluscs)		
Squid	23,528	3.0
Cuttlefish	13,253	3.0
Shellfish	292,728	24.5

(b) Catch in value

Ten major commercially important species.

Name of species	1,000 Baht	% to the total	Unit price per Kg (Baht)
1. Exportable shrimps	726,617	23.3	30.00
2. Indo-Pacific mackerel	452,273	14.5	4.50
3. Miscellaneous fish	440,505	14.1	5.00
4. Trash fish	263,399	8.5	0.60
5. Squid and cuttlefish	194,224	6.2	—
6. Other shrimps (for drying)	119,766	3.8	—
7. Sea mussel	85,837	2.8	—
8. Crabs	76,087	2.5	—
9. Spanish mackerel	73,608	2.4	8.00
10. Jew fish	46,389	1.5	3.50

(c) Catch by type of fishing method (1971)

Type of fishing method	catch (Ton)	% to the total
Otter trawl	515,599	41.50
Pair trawl	138,334	11.10
Beam trawl	4,989	0.40
One boat and two boat		
Purse seine	66,520	5.33
Anchovy seine	8,585	0.69
Spanish mackerel gill net	11,578	0.93
Pomfret gill net	938	0.08
Mackerel encircling gill net	53,722	4.31
Shrimp gill net	10,195	0.82
Other gill net	38,118	3.06
Luring lift net	4,454	0.36
Squid cast net	363	0.03
Push net	14,200	1.14
Scoop net	143	0.01
Other net	30,576	2.46
Bamboo stake trap	19,672	1.58
Set bag net	14,914	1.20
Wing set bag net	313	0.03
Ebb tide bamboo stake trap	356	0.03
Shrimp bamboo fence trap	5,152	0.41

Fish trap	733	0.06
Crab trap	2,922	0.24
Other stationary gear	1,624	0.13
Collecting shellfish*	299,832	24.02
Jellyfish fishing	35	0.00
Shrimp culture	954	0.08

2. PRESENT MAJOR FISHERIES IN THAILAND

2.1 Trawl fishery

2.1.1 historical background

The first trial of trawling in Thailand seems to have been made in 1952 by the American owned Gulf Industry Co. Ltd. with the cooperation of an Australian fisheries expert. They operated six trips using two otter trawlers, INSRIGHUM Nos. 1 and 2 (47 ton, 250 horse power), however gave up the operation with unsuccessful results. During 1953 to 1954, Thai Trading Co. Ltd. made shrimp beam trawling and otter trawling with YANAMARGO (5 T., 16 HP.), to which a Japanese expert joined, and their results were successful to some extent. Pair trawl operations were made for two months in 1953 by MUICHIN No.s 1 and 2 (50 T., 100 HP.), Kit Paisal Co. Ltd. Between 1955 and 1961, Thai Trading Co. Ltd. made somewhat large-scale trawl operations using SAMURUAT SATNAM No.s 1 and 2 (20 T., 120 HP.). During January to June 1955, they made otter trawlings in the Gulf of Thailand and surveyed some fishing grounds. From September 1955 to March 1961, the trawlers made operations converting into pair trawling. In 1959, there operated totalling over 300 beam trawlers and over 16 pair trawlers.

In 1960, some German trawl experts were sent into the country, and in the succeeding year the Department of Fisheries demonstrated otter board trawling to the local fishermen. Since that time, otter trawlers increased rapidly in number and a brilliant epoch was introduced in the fisheries in Thailand. Total number of trawlers exceeded 3,000 in 1973. This comprises more than 70 large-size trawlers (100–200 T., 400–1,000 HP.) operating in high sea and the large size trawlers are still increasing in number.

2.1.2 Present situation

The present total number of trawl fishing unit throughout the country is estimated to be 3,608, roughly divided into 2,472 otter trawlers, 522 pair trawlers and 614 beam trawlers. Of the otter trawlers those below 14 m in length share 35 per cent, those between 14 and 8 m are 40 percent and 18 m and above are 25 percent respectively. Pair trawlers classified into the above three categories are 5, 10 and 85 percent respectively. Beam trawlers less than 12 m and 12 m over are 80 and 20 percent respectively.

Most of the trawlers are equipped with diesel engine,

*) Including culture products.

and the over 70 large sized trawlers mentioned above are of 400 to 1,000 horse power. Almost all otter trawlers and pair trawlers are equipped with winches, with the exception of beam trawlers: Small, medium-size and large trawlers use manual, drum type and mechanical winches. The drum type and mechanical trawl winches are of 150 to 250 and 250 to 1,000 horse power respectively.

In Thailand, roughly speaking, three different types of trawl net are in use; German type two seamed (Fig. 1), Mexican type four seamed (Fig. 2), and four seamed trawl net. Two seamed net, introduced in 1960 by German

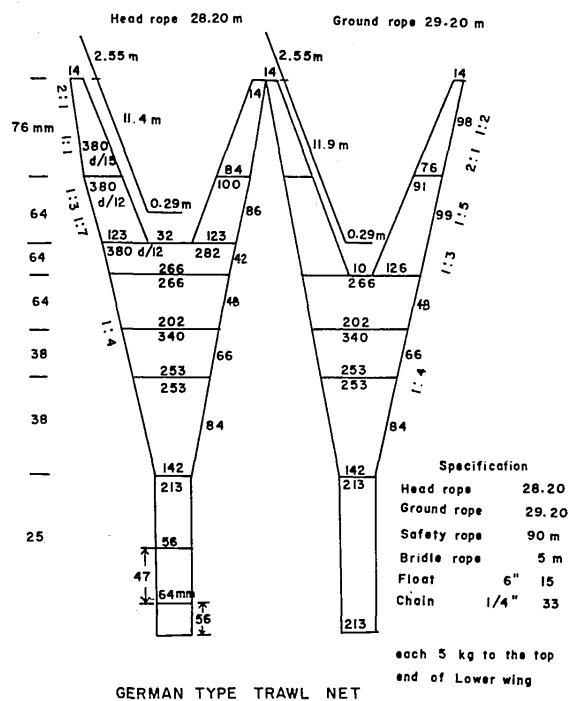


Fig. 1 Design diagram of German type two-seam trawl net.

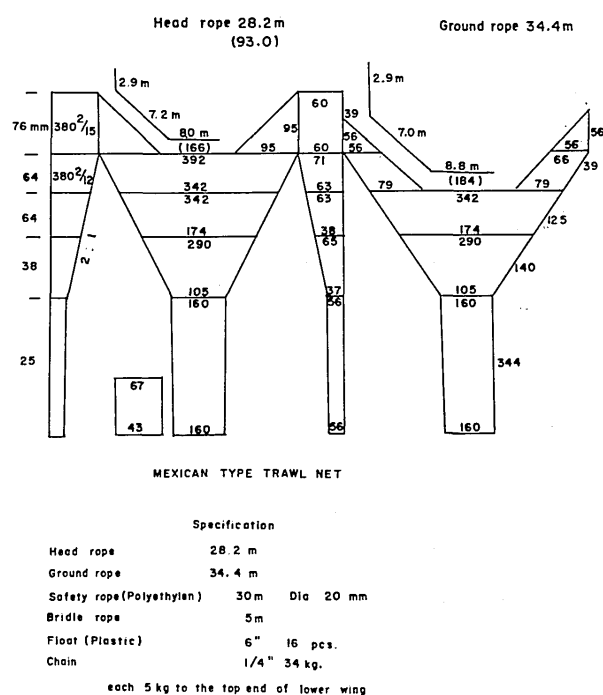


Fig. 2 Design diagram of Mexican type two-seam trawl net.

fisheries experts, are mainly used for catching shrimp. In 1972, comparative studies on catch efficiency were made by the Training Department, SEAFDEC with the cooperation of the Department of Fisheries in Thailand, on the above different types of two-seamed net and four-seamed net, and the Mexican type was found to be superior in catching shrimps. The four-seamed net, popular in Japan, Korea and Taiwan, is used for catching demersal fish. This type of net has a higher opening in action, therefore the net is expected to catch more fish. In Thailand the four seamed nets are mainly used by large trawlers. This type of net was introduced in 1953 by Japanese experts and after modification trials Thai fishermen made up the present type. The mesh of the cod-end part of the trawl nets ranges from 1.5 to 1.6 cm. However, the mesh of the inner netting is between 1 and 2 cm. Trawling duration is usually 3.4 hours on an average, though towing near the border between Thailand and Cambodia sometimes lasts 6 hours. Towing duration of Japanese trawlers is in the range of 0.5 to 2 hours in contrast to that of Thai vessels.

Beam trawlers operate mainly in shallow waters near estuaries. Otter trawlers with shrimp as their main object usually operate from evening to morning, one night each trip. Otter trawlers and pair trawlers, aiming mainly for squid, operate a full day from morning to evening. Larger otter trawlers and pair trawlers, ranging 80 to 150 tons and 250 to 450 horse power, pursue mainly valuable and large-size fish. Their fishing grounds are mostly in the open sea, off the west coast of Vietnam, off-shore waters near the border of Thailand and Malaysia, off the coast of Sarawak, near the river mouth of Irawaddy, and in the Bay of Bengal. They usually make ten to fifteen day trips. Large trawlers which are based in Singapore operate off Sarawak, near the mouth of the Irawaddy, and in the Bay of Bengal and land their catch in Singapore.

Demersal fish resources in the Gulf of Thailand have greatly decreased in recent years. The fishing grounds there are fully exploited and consequently the size of the catch is becoming smaller. On the other hand, however, squid is greatly increasing with the decrease of big fish. The fishing grounds for squid are mostly on the sandy bottom, and the depth ranges from 5 to 30 m. Full exploitation has also reached to the squid resources and as a consequence the catch per boat is increasing and size of catch is becoming smaller. For large trawlers, therefore, good catch cannot be expected in the territorial waters of Thailand but only in high sea fishing grounds.

At present, the large-size trawlers range between 100 and 200 tons, with more than 400 up to 1,000 horse power, and trawlers are still becoming larger in size; some enterprises are planning to build 400–700 ton trawlers. Since the commencement of trawling by Thai vessels in the Bay of Bengal in 1972, Thai trawlers operating there are rapidly increasing in number. Prosperous fishing grounds in the future might be in the Bay of Bengal, the Gulf of Tonkin and off the north coast of Australia.

2.1.3 Recommendations for the future

The otter board trawlers in use at present have mostly been converted from fish carrier, it would be better to

change these into stern trawlers. Since the market price of frozen fish is cheaper than that of chilled fish, it is not necessary to install freezing equipment at present. However, refrigerating systems should be urgently improved to keep ice from melting and to provide chilled sea water. This would help to keep the catch fresh. Four or six-seam trawl nets are recommended for catching large-size fish, these are expected to be more effective than the two seam nets now in common use. On the other hand, mesh size regulations should be made considering the increase of fishing intensity. Most of the larger trawlers operate for twenty four hours; i.e. the towing duration of each haul is 4 hours, therefore it takes 24 hours for six operations. Since, in tropical waters as in the SEAFDEC area, long towing time decreases the freshness of the catch, each towing duration is recommended to be two hours at longest. The shrimp trawlers, towing six hours each haul at present, should reduce their towing time to within one hour. For trawlers below 200 tons, pair trawlers are distinctly more effective than otter trawlers. Considering the present situation of demersal fish resources in the territorial waters some regulations for fishing operation seems to be necessary. In conjunction with the above, fisheries surveys are recommended in the Gulf of Tonkin and the waters off the north coast of Australia as potential fishing grounds where large vessels might operate in the future.

2.1.4 Recommendations for SEAFDEC member countries

The member countries should take precautions not to exhaust their demersal fish resources. The trawlers used at present should be changed to stern trawlers. The Mexican type two seam trawl net is more effective for shrimp otter trawling; for both the otter board and pair trawlers which seek large fish four or six seamed nets are more efficient.

Shrimp trawlers in Thailand are small in size and operate independently without cooperation of other vessels. However, in order to determine the migrating routes of shrimp and catch them effectively, multiple-ship operation is recommended. In American shrimp trawl fisheries, a fleet of more than ten boats usually operates cooperatively exchanging information about fishing grounds and fishing conditions by telecommunication. Therefore, adaptation of multiple-ship shrimp trawling is also recommended in the SEAFDEC area. It seems urgently necessary for fishermen to follow the proper manner of fish processing on board, because the market price of a catch depends mainly upon its freshness.

2.2 Indo-Pacific mackerel purse seine fishery

2.2.1 Historical background

This fishery originated from the traditional *Owan-Dam*, which was a Thai surrounding net operated by man-power using a single row boat. In an early stage of developing one-boat purse seiner, from traditional ones into those of the present day, they were not widely accepted as the two-boat seiners, because of their inferior machinery system.

The present one-boat purse seiners owe much to Japanese fishing gear experts. In 1956, they demonstrated

one boat purse seining with successful results. At the same time, it was recognized that this type of gear did not entangle with the screw propeller during operation. Another merit is that a one-boat purse seiner is increasing in number and it is taking the place of the two-boat type.

The two-boat purse seine came originally from Fukken, China and is hence called Chinese purse seine or *Owan-Tankei*.

This type of purse seiner consists of a engine powered mother boat (15t-30 taons) and two smaller non-powered boats. When locating fish schools, the master fisherman keeps a lookout for them from the top of the mast on board the mother ship. When a fish school is found, the two small boats start to encircle it paying out the seine to surround the fish school within the purse seine. Finally the fish are caught by pursing the seine net. However, with this type of purse seine the gear size is limited by the boat size, and therefore a large catch is not expected in each operation. For the reason mentioned above, the two-boat purse seiners are at present decreasing in numbers.

In 1960, some Japanese type two-boat purse seiners, much bigger than the ordinary Thai seiners, operated in the Gulf of Thailand. However, their results were not successful because the fish schools there were mostly small in size.

2.2.2 Present situation

Most of the purse seiners in Thailand are powered by engine, and operate their gears on the foredeck. For pursing the lines and other uses, drum type winches installed are powered by modified automobile engines. Their chief particulars are as follows:-

	one-boat purse seiners	Two-boat purse seiners
Tonnage	10- 40	20- 40
Horse power	30-150	60-150
Speed (Kt.)	7- 9	7- 9

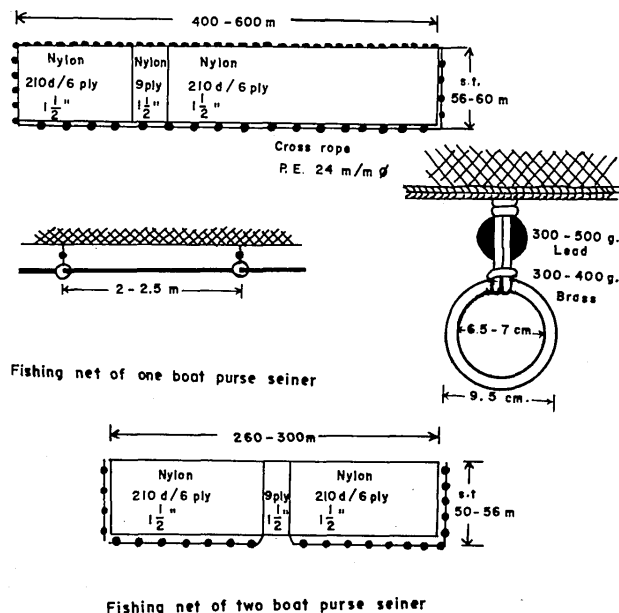


Fig. 3 One-boat and two-boat purse seine nets.

Purse seines now in use are made of synthetic fibers such as nylon or mix-twist of nylon and saran, and are treated by heat setting with resin for the purpose of stiffening the twine. The fishing gears of one-boat and two-boat purse seiners are shown in Fig. 3. Thai fishermen use Polyethylene crossing laid rope as a purse line instead of wire rope, because this crossing laid rope never causes any kinking and is easy to handle during operation. Sinkers are not directly attached to the sinker line but to the ring ropes. This method of construction seems to be effective to prevent entangling the sinkers with the bottom margin of the net. However, a disadvantage is that the sinking speed is much slower as compared with the Japanese or European type.

To detect fish schools, the following methods are adopted by Thai fishermen.

- 1) A watchman observes visually to spot fish schools from the mast during evening and early morning.
- 2) Even during dark nights, fish schools are detected by looking for plankton luminous effects caused by swimming fish.
- 3) Some fishermen are acoustically very sensitive, and can detect fish schools by diving or submerging their ears in the water to listen for the sound of swimming fish.

The technique originally came from Malaysia. Although these methods may appear rather primitive, they are as effective as using a fish finder. Sometimes, the fishermen can recognize the species of fish or shrimp and can predict the direction of movement and a rough estimation of the amount. In the Gulf of Thailand fish schools are rather small in size and occur over a wide area. Consequently, the above methods are popular and widely adopted in place of using fish finders.

The following methods are in use for fish luring:-

- 1) Utilizing the natural inclination of fish to gather in a shady place, coconut leaves are suspended at various depths in water to attract fish.
- 2) At night, three or four lamps are suspended just above the water on one side of the fishing boat to attract fish.
- 3) Though dynamite fishing is illegal, sometimes this method is utilized. Floating fish killed by dynamiting are gathered by the use of the purse seine. It is regretted that some fishermen are still using dynamite.

There are two ways of shooting nets for one-boat purse

- 1) Shooting from the bow, developed from the Thai purse seiner, *Owan-Dam*.
- 2) Shooting from the side, developed from encircling gill netting.

The fishing operations are usually carried out in areas not affected by the monsoon. Therefore the fishing grounds are changed according to the season. Because of this purse seine fishermen know well the migratory routes of fish schools. Fishing operations take place throughout the year except during the spawning season, because fishing in the spawning season is regulated by law. Fishing grounds are usually within 3 nautical miles from shore and at depths below 40 m. Major fishing bases for purse seiners are shown in Fig. 4.

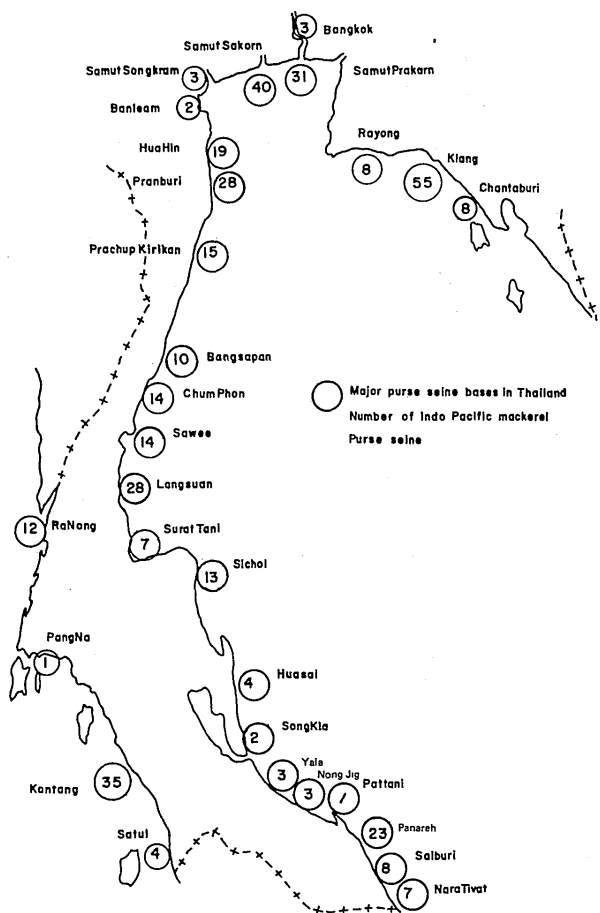


Fig. 4

2.2.3 Recommendations for the future

During operations Thai fishermen haul up the purse seine into the fore deck. As this method is inconvenient and laborious for the crew, it would seem to be better to utilize the stern deck in place of the fore deck. At present many fishermen are needed to carry out the laborious work, such as hauling up the purse seine. However, if a net hauler were installed, it would greatly reduce the laborious work involved and consequently the number of crew could be greatly reduced. Comparatively light weight sinkers are attached to the present purse seine and this has only a moderate effect on the sinking speed of the net. To facilitate the sinking of the net heavier sinkers should be used. With the use of heavier sinkers, the number of escaping fish would be lessened.

As mentioned before, the purse seine fishermen detect fish schools by finding luminous plankton during night time. However, this method is applicable only in calm seas and on dark nights. Therefore, they do not go fishing around full moon nights or under rough sea condition, and this reduces greatly the number of fishing days. It would be beneficial if Thai fishermen had other methods which could be used in place of the present method, as is done in Endau Pahang state, Malaysia. The following are the fish detecting methods used in Malaysia:-

Time	Method	Species of fish
1) Before dawn	By finding luminous plankton	Indo-Pacific mackerel, sardine, small bonito.
2) Early morning	By visual observation near the surface	Sardine, Indo-Pacific mackerel, small bonito
3) Morning	By hearing sound	White shrimp, sardine, thread-fin, goat fish
4) Afternoon	By attracting fish around coconut leaves submerged in water	Sardine, horse mackerel
5) Evening	By visual observation near the surface	Sardine, Indo-Pacific mackerel, small bonito
6) Dark night	By finding luminous plankton, by attracting fish with lamps	Sardine, Indo-Pacific mackerel, squid

Squid are caught by the use of purse seine, after attracting them towards the fish lamps. This method is recommended for study and practice by fishermen in this region in the near future.

2.2.4 Recommendations for SEAFDEC member countries.

The size of fish schools in the Southeast Asian waters is small compared with those in mid-latitude waters. Therefore, the purse seines used in these areas are usually smaller in size than those in U.S.A. or Japan. However, the time necessary to complete one operation with this type of gear is much shorter and consequently more operations are possible in a day.

For purse seine fisheries in the Southeast Asian region, the above mentioned methods which have been adopted along the coast of Malaysia should be improved to install machinery such as a winch and net hauler.

Good refrigeration facilities are not yet installed in most of the purse seiners in the Southeast Asian area. For preservation of fish captured at present, crushed ice is loaded in the fishing boats. However, the fish cannot be kept fresh for a long period by this method. Therefore, the method combining ice and sea water is recommended for the preservation of fish on board.

Nylon twine is widely used at present for making the purse seine instead of cotton or saran as used previously. The material used for purse seine nets should be stiff and should not absorb water. More over it is hoped that the fish caught are not gilled or stuck into the net. For the purpose of minimizing the chance of fish being gilled or stuck into the net, nylon 6 or 7 filament should be used in place of nylon 15 filament or 24 filament.

2.3 Bonito purse seine fishery

2.3.1 Historical background

This fishing method for bonito was developed about eight years ago by Mr. Nakorn, an owner of purse seine boats in Paknam-Pranburi. In those days webbing of saran and nylon mixed twist 210 d/6 ply, 1½" in mesh size was commonly used for all purse seines, and most of the purse seine was less than 450 m in float line length. However, the purse seine constructed by him was 600 m in length and of nylon 210 d/9 ply with the same mesh size. This purse seine was very successful for bonito fishery.

2.3.2 Present situation

At present over 100 bonito seiners are operating in the Gulf of Thailand, and about 60 of them are based in Paknam-Pranburi. Fishing boats used for this fishery are made of wood, and are one-boat purse seiner of foredeck operation type. Main specifications of the boats are as follows:-

Size (Gross tonnage)	35 – 50
Engine (Horse power)	150 – 200
Winch	Drum type

Specifications of the fishing gear used are shown in Fig. 5, and a unit is illustrated in the upper part of the figure.

Name of parts	Twine size	Mesh size	Depth	Length
Selvedge	210d/18ply	1¾ (4.0 cm)	6 meshes	40 m (constructed) 44 m (constructed)
Webbing	210d/9ply (210d/12ply for cod end part)	1½" (3.8 cm)	800 meshes	1,400 meshes

The stretched length of unit webbing 53.3 m (3.8 cm x 1,400 meshes) is hung in to be 40 m and 44 m in constructed length for float line and sinker line, respectively. Weight of unit net in air is 24.8 kg and in water 2.87 kg. These units are laced together to construct the whole net (Fig. 5).

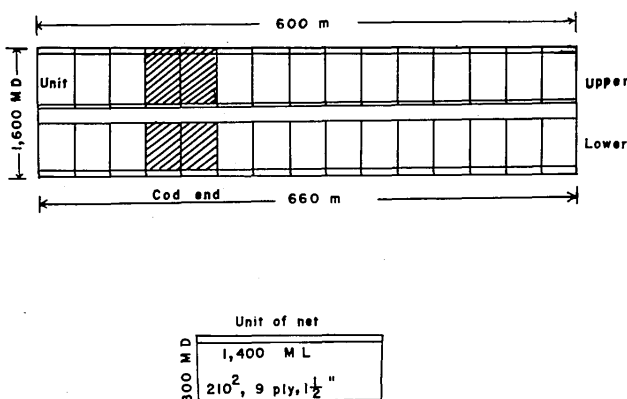


Fig. 5 Bonito purse seine net.

Name of parts	Hang-in	Constructed depth	Constructed length
Upper part	0.25	20 m	600 m
Lower part	0.18	27 m	660 m

Details of ropes used are shown below:-

Name of part	Diameter	Length	Remarks
Float line	6 mm	600 m	S – and Z – twist of ropes are used together
Sinker line	6 mm	660 m	– do –
Purse line	24 mm	600 m	Cross laid rope*

* Breaking strength of the cross laid rope is 4 and 7 tons for Polyethylen and Nylon, respectively.

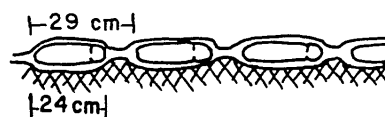
2,000 pieces of synthetic floats (Naigai No. 8) are attached to the float line (Fig. 6). Weight in air, specific gravity, and buoyancy of each one are 70 g, 0.25, 210 g, respectively. Therefore total buoyancy corresponds to 420 kg. A total of 220 pieces of lead sinker, each 500 g. in weight, are attached to the sinker line 660 m in length at regular intervals of 3 m (Fig. 7). The weight of each piece of lead in water is 455 g and therefore the total weight of the sinker in water is 200 kg. The same number of purse rings as the lead sinker are set at the same intervals. The ring is made of bronze (specific gravity is 7.8) and weight in air and size are 500 g. and 10 cm in diameter. The weight of each ring in water is 435 g. and consequently the total weight in water is 95.7 kg. The weight of net in water is 86 kg. Therefore, the extra buoyancy is equal to 138.3 kg. (= 420 – 100 – 95.7 – 86). The fishing boat used is 199 m in length and 40 tons weight with a 60 horse power engine.

Details of each fishing operation are as follows:- 5 min. are necessary for casting net, 75 min. for hauling (hauling from each boat side takes 37 min.). Therefore hauling speed is 17 m per min. (= 600 m/35 min.). The purse seiners in Japan and U.S.A. usually operate in the daytime when skipjack and bonito are active. Contrary to this, Thai bonito purse seiners usually operate at night when skipjack and bonito are not so active, therefore, they can catch them even with a small and low speed boat.

The fishing seasons and changes of fishing grounds are affected by monsoons, and tabulated below.

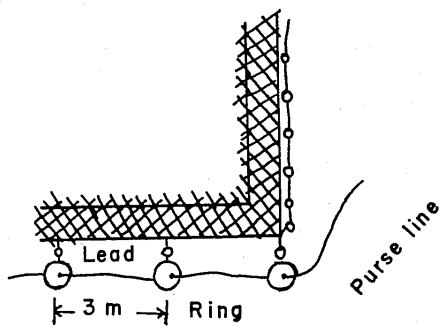
Month	Activity	Fishing ground
January	None	–
February	Moderate	Around Rayong
March	"	"
April	"	"
May	None	–
June	"	–
July	Moderate	Around Pranburi
August	Intensive	"
September	"	"
October	Moderate	"
November	None	–
December	"	–

One complete set of purse seine costs 90,000 Baht. The details are: 6,600 Baht for netting, 2,200 Baht for purse rings, 6,500 Baht for floats, 770 Baht for lead sinkers, and 15,000 Baht for other expenses. On an average, catch landings are estimated to be 10,000 to 35,000 kg per month. Of total landings, 30 percent are bonito and the other 70 percent are Indo-Pacific mackerel, their prices are 2 to 4 Baht per kg respectively. Taking the average price of fish landed to be 3 Baht per kg, the above landings are assessed to be 30,000 to 1,000,000 Baht per month.



FLOAT

Fig. 6 Arrangement of floats for bonito purse seine.



LEAD AND RING

Fig. 7 Arrangement of sinkers and purse rings for bonito purse seine.

Twenty to twenty-two days a month can be used for actual fishing and the number of fishing operations ranges from 3 to 4 times a day. Therefore, the average catch per operation is estimated to be 136 to 470 kg., dividing the catch amount per month (10,000 to 35,000 kg.) by the average number of fishing operations per month (21 x 3.5).

Of the income, 50 to 60 percent goes to the owner and 40 to 50 percent to the crew, though the expenditure for fuel, food and repairs is paid by the owner. Usually 18 to 21 persons are on board and their allocation ratio is shown below.

Staff	Number	Allocation ratio
Captain	1	2
Assistant Captain	1	1.5
Master Fisherman	1	5
Engineer	1	1.5
Quartermaster and Netmakers	3	1.5
Fishermen	11-14	1

2.4 Indo-Pacific mackerel encircling gill net fishery

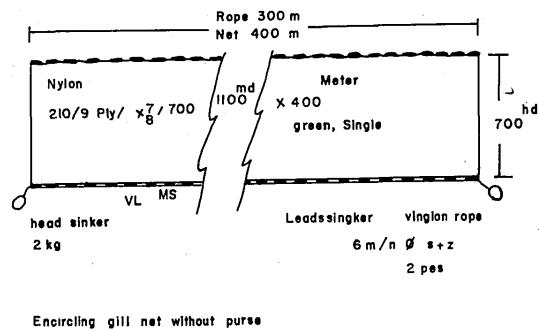
2.4.1 Historical background

This type of net may be roughly divided into two groups:- 1) Encircling gill net without purse line. 2) Encircling gill net with purse line. The encircling gill net without purse line has a long history from before the 2nd World War, and is used in shallow waters, while the latter fishing gear developed around 1965 in Thailand and its use has increased rapidly. At present the number of Indo-Pacific mackerel encircling gill nets with purse line is roughly estimated to be some 2,000 units in the Gulf of Thailand. However, some of the gill netters are converting to one-boat purse seiners.

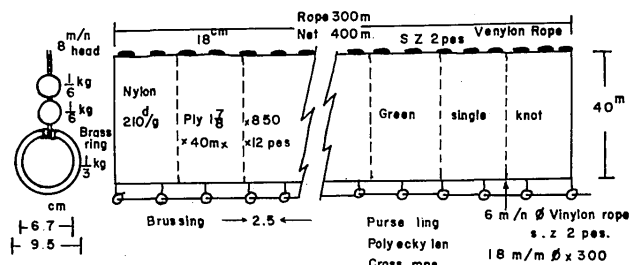
2.4.2 Present situation

The fishing boats used for encircling gill net without purse line are of foredeck operation type, they are in the range of 10 to 20 tons and of 30 to 90 horse power and most are equipped with a drum type winch. The fishing gears used are shown in Fig. 8.

The encircling gill net without purse line is mostly

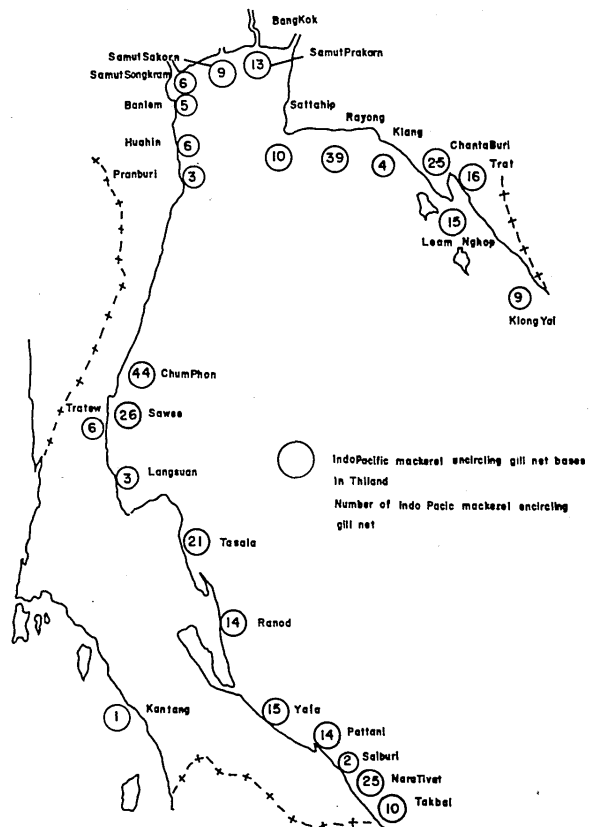


Encircling gill net without purse



Encircling gill net with purse line.

Fig. 8 Encircling gill nets.



Major fishing bases of Indo-Pacific mackerel gill netters in Thailand

Fig. 9 Major fishing bases of Indo-Pacific mackerel gill netters in Thailand.

operated in the daytime. Once the fish school is found near the sea surface, the fishermen start to surround it with the net, beat the sea surface with wood sticks to frighten and chase the fish toward the mid-part of the net, and then haul up the net.

The encircling gill net with purse line is operated on dark nights. A fish school is located by finding luminous plankton which is stimulated by the seimming of fish through the water. From the circumstances of luminous plankton, the master fishermen predicts the species of fish, their swimming direction and speed, and the size of fish school, then the crew lay out the net. The fishing method is similar to that of one-boat purse seiners. In Fig. 9 the fishing bases of Indo-Pacific mackerel encircling gill netters are shown.

The fishing gear and method of encircling gill net with purse line are similar to those of one-boat purse seine. The size of fish caught by ordinary gill net is limited by the mesh size, while a wider size range of fish are caught with the gill net with purse line. However, it is troublesome to remove the fish from the gill net after a good catch.

Encircling gill net is suitable for small scale fishermen, though one-boat purse seine is recommended when enough capital is available for investment.

3. RECOMMENDATIONS FOR FUTURE FISHERIES IN THE SEAFDEC AREA

3.1 Skipjack pole and line fishery

According to calculations, some 2,000,000 tons of skipjack might be caught theoretically in a year, of which 1,200,000 – 1,400,000 tons are from the Pacific Ocean, 300,000 – 400,000 tons from the Indian Ocean and 200,000 – 500,000 tons from other areas. In the SEAFDEC area, the following are considered to be prosperous fishing grounds for skipjack: Indian Ocean, Sulu Sea, Celebes Sea, Jawa Sea, Banda Sea, West Pacific Ocean and South China Sea. The most promising fishery left in those areas seems to be skipjack pole and line fishery. The total catch of skipjack in the world is about 400,000 tons and the total catch of skipjack in Japan is 230,000 tons of which 90 percent is by pole and line and other 10 percent by purse seine and set net.

Japanese boats for skipjack pole and line fishery are specially designed and constructed for this purpose. However, in this area some accessories on the boatside should be modified and changes should be made in the water supply system. In skipjack pole and line fishery, the most troublesome problem is the supply of living bait. However, the supply of anchovy and other fish suitable for live bait of skipjack fishing in this area is no problem, though there still remains the problem of deciding the most suitable fish species for live bait. Live bait may be used not only to supply this fishery in Southeast Asian countries, but also for Japanese skipjack fishing boats.

The technique of handling the pole and line is not difficult. The important thing is to find and lure the fish school. There are several ways of studying the fishing technique; for example (1) sending trainees to Japan, (2) inviting experts from Japan, (3) learning Japanese techniques when supplying live bait to Japanese fishing boats,

and (4) constructing joint enterprises with Japan.

Frozen bonito exported from Thailand to Japan in 1971 amounted to 2,308 tons. During the period January to November 1971, frozen skipjack imported into Japan totalled 15,544 tons valued at 1,686,345,000 Yen. Of which 2,067 tons valued at 202,632,000 yen was from Thailand. During the same period, the total amount of dry bonito imported into Japan was 1,458 tons and that from Thailand being 307 tons (131,288,000 yen). In Thailand two bonito drying factories are operating, one is Eiko Food Co. Ltd. in Pranburi and the other Yun Thai Enterprise in Bangkok; their processing capacities for raw material are 10 and 6 tons per day, respectively.

3.2 Mechanized squid line fishery.

In Japan up to the present time squid fishing has usually been done by hand line from small boats. In recent years, however, larger fishing boats (150 – 500 tons) with mechanical fishing equipment have developed in this fishery, and this type of squid fishery is becoming one of the major deep-sea fisheries. At present, over 300 fishing boats of this type are operating in seas adjacent to Japan. In 1972 ten boats carried out successful fishing operations off California, U.S.A. and in waters off the coast of New Zealand. Some of them are carrying on trial fishing in these areas. In view of the above facts, research and development of the squid fishery is becoming necessary in the SEAFDEC area.

As mentioned above, squid fishery has so far been regarded as inshore or near shore fishery; mostly small boats were used for this fishery and time spent in cruising and fishing was only 2 or 3 hours. Recently, however, the possibility of deep sea squid fishery in the neighbouring waters of Japan has been recognized. Experimental fishing is carried out at depths as deep as 3,000 m in some fishing grounds, and as a result the fishing boats are becoming larger.

The squid resources in the world have been estimated to be approximately 5,000,000 tons while the total annual world catch of squid is only 1,000,000 tons. This means that about 4,000,000 tons of squid are unexploited.

At present squid is caught by hand lining in the south of Thailand near Narativat. The training vessel Paknam of the Training Department, SEAFDEC, has only done a little experimental fishing. However, from our limited experience, the following results were obtained:

- 1) A small size of fishing boat is better
- 2) In selecting artificial bait, yellow was the best for luring. Light blue was also good but red was poor. Bait covered with cotton twine had a better effect than that with a smooth plastic surface.

More detailed research should be done to determine the most effective bait and the most effective attracting lamps.

In 1970, the total catch of squid in Thailand was estimated to be 70,000 tons; this may be compared with the 18,583 tons total amount of frozen squid imported into Japan between January and November 1971.

3.3 Vertical long line fishery

Demersal fish on banks and edges of the continental shelf have not yet been exploited by trawling, gill netting and bottom lining. Vertical long line is thought to be the most effective fishing gear to use on a rocky bottom, coral bottom or steeply sloped bottom. Fish living in those areas include *Prinstipomoides* spp., *Aphareus* spp., *Lutjanus* spp., *Gymnocranius* spp., *Caragidal* spp., *Pseudopriacanthus* spp., *Priacanthus* spp., *Argyropo* spp., *Epinephelus* spp., etc. The following may prove to be promising fishing grounds: the South China Sea, Macclesfield Bank, Philippine waters, the west coast of Malay Peninsula, around the Andaman Islands, the Gulf of Bengal, and around the Nicobar Islands.

Vertical long line is a newly developed gear and is operated by hand, man-powered reel, or motor-powered reel. A main line with a sinker of 0.7 to 1.5 kg attached is lowered vertically to a desired depth. 10 to 12 branches, each of which has a hook, are fastened to the main line at regular intervals of 90 to 100 cm. Squid, sardine and small demersal fish are used as bait. Squid seems to be most effective bait for vertical long lining in deep waters. The fish finder has a most important role in this fishery. Exploitable fish schools are usually found on the brink of the continental shelf. During operation the fishing boat should be kept just above the fish school. For small boats, the spanker and sea anchor are useful to keep the boat in the desired direction.

3.4 Mid-water trawl fishery

Mid-water trawling may be effective for catching squid and white shrimp.

3.5 Philippine lift net fishery

In general surrounding nets such as purse seine, ring net and lampara net are the most effective fishing gear for small size pelagic fish such as anchovy and sardine. However, this type of fishing gear is not always suitable for small scale fishery. In Japan, the stick held lift net is commonly used for catching saury, horse mackerel and anchovy, and the results seem to be successful. However, this type of gear has not yet been proved effective in the SEAFDEC area because of the different environmental factors involved and the different species of fish. Considering the above, the Philippine type lift net is recommended for catching sardine, anchovy and live bait which is always necessary for the skipjack pole and line fishery, because this type of fishing gear which has been developed in Philippine waters seems to be most suitable in this area.

3.6 Jellyfish fishery

In recent years the demand for dry salted jellyfish has increased and jellyfish is another resource not yet fully exploited in the area. The major fishing gear for jellyfish is the scoop net, while the bamboo stake is also in use. The following are suggested as fishing gear which might be used in future.

- 1) Bamboo fence
- 2) Bamboo stake
- 3) Small size two-boat type mid-water trawl.