Vol. 11 JANUARY-DECEMBER 1973 Nos. 1 & 2

THE PHILIPPINE JOURNAL of FISHERIES

Published semi-annually by the
BUREAU OF FISHERIES AND AQUATIC RESOURCES
Intramuros, Manila
1975

The PHILIPPINE JOURNAL OF FISHERIES

Official Publication of the Bureau of Fisheries and Aquatic Resources
Intramuros, Manila 2801, Philippines

Vol. 11 **January-December 1973** **Numbers 1 & 2**

A REVIEW OF THE ROUNDSCAD FISHERY IN THE PHILIPPINES

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ABSTRACT

The roundscads (*Decapterus* spp.) form the most important fishery in the Philippines today. More than 30% of the total fish production of about one million tons reported in 1970 was composed of the two species of roundscads: both species are caught in commercial quantities throughout the Philippine archipelago. The fishery is based on the capture of the immature forms, since adults are not available. The absence of adults may be due to the loss of phototaxic response of adults to the lights used to lure the fish into the gear (the bagnet), or the adults may have moved out of the fishing grounds. The biology of these species is reviewed and a general introduction of the geography and oceanographic background of the Philippine waters provided. A description of the oceanographic conditions of the Sulu Sea, which is one of the most important fishing grounds for roundscads, was made. Through a brief discussion of the zooplankton, egg and larval distribution of tuna and tuna-like fishes, as well as other fish species, an assumption of the probable spawning areas of roundscads was advanced. For the pelagic fish, the bagnet and purse seine fisheries were shown to be the most productive; the landing from these methods exceeded 50% of the total fish production is explained by the increased efficiency attained by the bagnet and purse seine, resulting from the use of brighter lights, better synthetic (kuralon) nets, larger vessels, and more efficient gear.

INTRODUCTION

This is a review of the most important commercial fish in the Philippines which has been responsible for the great expansion of the bagnet and the introduction of the modern purse seine in the country. The use of the purse seine led to a several-fold increase

in commercial fish production and helped greatly to reduce importation of fish and fishery products necessary to fill the protein requirement of the Filipino people.

This phenomenal growth of the roundscad (*Decapterus* spp.) fishery after the Second World War is unparalleled by any fishery in the country.

Roundscad catches were insignificant during the early years after the Second World War; landings were recorded as 18,900 mt in 1956, increasing to 96,000 mt in 1966, and 151,000 mt in 1970.

The important fact on this fishery is that, since the fishery consists largely of one-year class of young to maturing fish before it leaves the fishery for the breeding ground, the problem of overfishing is probably not yet imminent.

It is believed that to have a better understanding of the development of this extraordinary fishery in Southeast Asia, background information should be given.

GEOGRAPHY

The Philippine archipelago, which is in the outer rim of the western Pacific, is spread over a territorial area of about 1,965,700 sq km lying between latitudes 21°25'N and 4°23'N and longitudes 116°00'E and 127°00'E. It is bounded on the east by the Pacific Ocean, on the south by the Celebes Sea and the coastal waters of Borneo, and on the west and north by the China Sea, which separates it from the Asiatic mainland.

The total coastline of the islands is 17,460 km, almost as long as that of the United States, fringed by many navigable bays and gulfs.

A number of seas surround the islands, and these range from deep troughs and trenches to shallow basins and coral reefs. Selga (1971 b) pointed out four deep regions: one off east of Luzon up to the southeast of Taiwan; another in the Sulu Sea; a third in the Celebes Sea; and the fourth, the Philippine Deep, east of Samar and Mindanao.

The Philippine waters are extensive, about five times the land in surface area but the insular shelves, the seat of commercial fisheries, are narrow and steep. Shallow waters with depths of 200 m add up to about 165,000 sq km which are limited around the islands. Large portions of the shelf cannot be trawled due to the growth of coral reefs, and in such areas as northern and southern Palawan, fishing for pelagic fish species takes place with the use of bagnet (*basnigan*) and purse seine. The slopes, however, are gradual around many small islands and in a number of partially land-locked bays.

According to Selga (1931 a), the average temperature of the surface waters in the Philippine seas is 27.3°C, a little higher than that over the land, and the mean sea temperature varies inversely with the latitude. He also showed that the mean daily range over the sea is very small; less than 1°C. The mean annual range is about 7°C in the Bashi and Balintang Channels near Taiwan. about 5°C in the waters east and west of Luzon, and less than 4°C in all seas north of Luzon.

Winds over the Philippine area are normally light to moderate. Three general air streams almost entirely govern the climatic pattern and divide the year into three "seasons"; the southwest monsoon, the northeast monsoon, and the trade wind.

The southwest monsoon brings a very cloudy and rainy season (June to October), especially on the western coasts which are fully exposed to the monsoon. This air stream is generally intermittent in character due to storms which occur mostly during this period. The northeast monsoon is more uniform and steady than the southwest monsoon and prevails from November to March. This current, which starts from the Siberian high pressure areas, brings modified polar continental air and rushes down over the ocean causing heavy rainfall along the eastern coast and cool, dry weather on the western parts of the islands.

The trade wind originates in the great tropical high-pressure area in the eastern North Pacific Ocean and hits the Philippines in a general easterly direction, dominating the air pattern during April and May. It is very moderate in force and is the least moist.

From July to October, the Philippine archipelago is affected annually by about three to 20 tropical storms (typhoons) or cyclones. The majority of these originate from the east of the Philippines near the Caroline and Marianas Islands. This in a way prevents extensive exploitation of the pelagic fish resources in the area east of the archipelago. Occasionally typhoons form in the China Sea and east of the islands. Areas in the southern part of the country below latitude 8°N are almost never affected.

The Philippine archipelago forms a topographic unit separating the South China Sea from the Pacific Ocean. It stands on a roughly triangular platform with its base forming a natural boundary between the Philippine and Indonesian seas, and its apex pointing northward in the direction of Taiwan and the Ryukyu chain of islands with which the Philippines is linked geologically. Within this platform are various depressions or basin seas in which the bottom water is not in free communication with that of the Pacific Ocean to the east nor with that of the South China Sea to the west. The sills between these seas and the Pacific Ocean are shallow barriers situated along the eastern side of the Philippines. The basin seas are themselves separated oceanographically from one another by definite topographical boundaries.

OCEANOGRAPHY

Philippine waters are made up of distinct properties of temperature and salinity. These water masses are disposed in layers — the deep, intermediate, central, and surface.

The surface waters are distinctly tropical in character. They are warm and less saline. In summer, temperatures generally exceed 28°C and in winter, only a degree or so lower. The salinity of the waters in the eastern Philippines varies little from season to season; on the South China Sea side, the surface layers show a marked decrease in salinity during the southwest monsoon.

On the basis of the bathythermograph data collected by the *R/V S.F. Baird* (Megia, 1952), the thermocline is thicker and deeper in the eastern Philippines than elsewhere in the islands. Superimposed upon the thermocline is the isothermal layer of uniformly high temperatures.

The current system that modifies water movement within Philippine territorial waters is the North Pacific Equatorial Current. This divides into two streams upon striking the southern part of the islands. The north-swinging branch touches the eastern side of Luzon and generates the great Kuroshio Current. The other stream turns southward and then eastward across the Pacific Equatorial Counter-Current with a minor branch flowing south of the Philippines toward the Celebes Sea. The direction of currents in the South China Sea west of the Philippines is regulated to a great extent by the prevailing winds.

A giant eddy of great vertical extent appears to dominate the water circulation off eastern Luzon. On the western side of the Philippines a smaller eddy was reported to enclose a patch of warm water which shifts its position with the seasons.

A survey of the distribution and concentration of nutrient salts in Philippine waters on the basis of the Baird data shows that the surface waters are almost everywhere near depletion which seems to extend down to the depth where the thermocline begins.

The Sulu Sea

A brief description of the oceanographic condition of the most important fishing grounds for roundscad follows:

One of the most important aspects of the Philippine Fisheries Programme (1947-51) consisted of surveys of the Sulu Sea and the Celebes Sea. Each of these areas has been investigated during the two monsoon seasons by the occupation of a carefully spaced grid of oceanographic stations. From a scientific viewpoint, both seas were practically unknown. A total of eight cruises of the *Baird* was necessary to cover each of the two seas during each of the two monsoon seasons and 187 stations were occupied.

At each oceanographic station, serial observations were made from the surface up to the 800 or 2000-m depth at 16 different levels. At each level, temperatures were observed and water samples collected for analyses including the determination of salinity, dissolved oxygen, phosphates, silicates, hydrogen ion, alkalinity, nitrite and nitrate. About 24,000 determinations were conducted (Megia, 1952).

Although the waters surrounding the Philippines and in between the islands had been previously investigated by the Philippine Fisheries Programme (1947-51), very little of the data were analysed.

The oceanographic condition of the most important fishing ground of the country, the Sulu Sea, however, was analysed by Graham (1952) who described it as a "basin" sea which is located between latitudes 5°N and 12°N and longitudes 117°E and 123°E and is separated from the South China Sea to the west by the elongated Island of Palawan, with shallow sills on both ends of the island, from the Pacific Ocean to the east by

the southern Visayan Islands, and from the Celebes Sea to the south by the Sulu archipelago (Fig. 1).

The Sulu Sea has a maximum depth of 5,576 m and over a large area is over 4,000 m deep. According to Graham (*op. cit.*), the Sulu Sea is one of the four deep regions in the water areas of the Philippines. It is connected with surrounding seas only by shallow sills or through narrow troughs.

The surface waters are in communication with the South China Sea to the west through Balabac Strait, which lies between Palawan and Borneo, and to the north by way of Mindoro Strait, west of Mindoro. Communication with the open Pacific is by way of various straits between the southern Philippine Islands to the east and by way of the Celebes Sea to the south through the Sulu archipelago.

All these communications with outside waters are restricted to upper water layers. The shallowest of the connections is to the east through the Mindanao Sea, although deep water connects the Sulu Sea with the Mindanao Sea. (The Mindanao Sea is isolated from the Pacific Ocean below a depth of 64 m by the reef fringing on the east side of the Islands.)

The next deeper connection with China Sea is at Balabac Strait over a sill less than 100 m in depth, while the deepest connection is also with the South China Sea to the north by way of Cuyo East Pass, west of Panay, and Mindanao Strait west of Mindoro, with a sill depth of about 459 meters.

The winds in the Sulu Sea are definitely seasonal, although the two monsoons are not so well developed here as in other northern parts of the Philippine waters. This is particularly true of the southern part of the sea.

The surface currents in the Sulu Sea, as shown by studies on dynamic topography, are dominated by two large eddies — the cyclonic eddy to the south, known as the South Central Eddy, and an anticyclonic eddy toward the northeast part of the sea which is called the North Central Eddy. These eddies dominate the pattern during both the northeast monsoon and the southwest monsoon. No strong flow of water to or from the Sulu Sea is indicated during the northeast monsoon. However, a flow of water from the China Sea between Palawan and

Borneo takes place during the southwest monsoon which travels northeasterly along the coast of Palawan.

At the surface, the temparatures during the northeast monsoon were mostly between 29.0°C and 30.0°C, with the highest temperature near the central part of the sea, when the northeast half of Sulu Sea was surveyed in October. These temperatures during the second survey of the southwest half of the sea in December had dropped about 1°C, the values falling within the ranges 28.°C to 29.0°C.

During the southwest monsoon, in June and July, the surface temperatures were not greatly different from those during the northeast monsoon. The values were also mostly within one-half degree of 29.5°C throughout. The temperatures were also somewhat higher in the northeastern portion of the sea than in the southeastern part.

During the northeast monsoon survey the salinity over the entire Sulu Sea was less than 34.0°/oo. During the June-July (southwest monsoon) survey, the salinity throughout the central and eastern part of the sea was between 34.0°/oo and 34.2°/oo.

At the 50-meter level during the northeast monsoon survey, most of the water had a salinity of about 34.0°/oo, with a number of centers with lower values, 33.6°/oo to 33.4°/oo. The salinity was very uniform during the southwest monsoon, all values being close to 34.2°/oo or 34.3°/oo.

Magnusson (1970) found very uniform surface temperature of 28°C — 29°C in the Sulu Sea on several cruises. He reported the greatest plankton abundance in Mindoro Strait, around the Tubbataha Reef and off southwest Palawan.

He also reported the existence of distinct thermoclines which were merely observed in these waters. A thermocline was observed in the northern Sulu Sea in September-October 1968 at 100 — 150 m over great depths but only 75 — 100 m in the shallower waters. He also observed the existence of a thermocline across Mindoro Strait in November 1968 with the upper limit being as high as in 20 m depth with an average drop in temperature of about 1.7°C per 10 meters. A thermocline was also found outside the edge of the continental shelf off Northern Palawan in 50 — 75 m depth with an average drop of temperature of 2.1°C per 10 m.

Spawning Areas of Roundscads.

There are very few studies on the distribution of fish eggs and larvae in the Philippines. One of the most comprehensive was the work of Wade (1951) on the distribution of tuna and tuna-like fish larvae from the collection of the *Baird.*

Wade (1951) found many unidentified eggs and larvae in the collection (showing the importance of the waters around the islands as spawning grounds for pelagic fish); degree of accuracy: namely *Grammatorcynus bicarinatus, Thunnus albacares, Katsuwonus pelamis, Euthynnus yaito,* and *Auxis* sp.

Wade (*op. cit.*) made note of the abundance of materials collected, especially of many small specimens which could not be identified as to species.

Six irregularly timed trips to the Sulu Sea showed that most tuna-like larvae were taken during December and January, and it appears that the greatest number of larvae was taken during the months of lowest water temperature while the least number was taken when the temperature was high. Tows made during darkness were three times more productive than those made at daytime and the larvae were more widely distributed. Wade also noted a downward migration of the larvae at daytime. These observations were verified by the findings of Tiews (1958) and Magnusson (1970) in the case of roundscads.

Figure 2 shows the distribution of tuna spawning areas based on concentration of larval tuna-like fish collected throughout the year from October 1947 to November 1949. The great majority of the larval forms could not be identified accurately. The triangles represent undetermined tuna-like species (modified after Wade, 1951).

Zooplankton and Fish Larval Distribution

In the Philippine Sea

As Philippine contribution in the Co-operative Study of the Kuroshio (CSK), two cruises (a summer cruise from 20 May to 31 July, 1968 and a winter cruise from 25 January to 30 March, 1969) were conducted on board the R/V Researcher of the Philippine Bureau of Fisheries.

The area covered was the eastern side of the Philippine archipelago from the portion north of the tip of Luzon

Island to about 21°25'N, the eastern boundary extending from the east coast of the archipelago to about 32°E, and the southeast extending off the east coast of Karabelong, Indonesia, (which is now known as the Philippine Sea).

Tan *et al.* (in press) described the distribution of zooplankton volume and the density of fish eggs and larvae in the samples using standard Norpac plankton nets. Data from 68 stations from the summer cruise and 94 stations from the winter cruise were analysed. The higher values for zooplankton, fish eggs, and fish larvae were plotted together in Figs. 3 and 4 (modified after Tan, *et al.*).

Figure 3 shows the distinct variation in the distribution of zooplankton volume during the summer cruise with maximum density of values higher than 100 ml/1,000 m^3 occurring in four separate areas; the highest was found in Davao Gulf, followed by patches in northern Luzon, the Bicol Peninsula and southeast of Mindanao.

The occurrence of fish eggs was very variable; a distinct concentration of fish eggs was noted in the southern section of the area under study, the maximum occurring east of northern Mindanao, southeast of Mindanao, and east of Samar Island.

In contrast, fish larvae were present in almost all stations over the area investigated, the highest concentration being in a station of Luzon.

There seem to be three areas of concentration of fish larvae separated by areas of minimum value from north to south, which are those near the coast, those off the shore, and those far from Mindanao Island.

During the winter cruise, a richer crop of zooplankton was recorded. The highest value of 925 ml/1,000 m^3 was recorded north of eastern Luzon and east and southeast of Mindanao.

The density of fish eggs concentration appears to parallel the high total zooplankton volumes in most stations.

Very high counts were observed in the coastal areas off Bicol Peninsula, numbering up to 15,600 eggs/1,000m^3. This is followed by nearby areas west and south of Bicol Peninsula, east of Mindanao, northern Luzon, and in the offshore areas east of northern Luzon. There also appears the presence of a coastal and oceanic maxima.

As for larval fish density, there were concentrations of high counts in areas north and east of Luzon, the highest value from 1,500 to 2,000 larvae per 1,000m^3 being found near the coastal waters off Bicol Peninsula.

There was a more evenly scattered distribution of fish larvae all over the area (Fig. 4).

Around Palawan

Under the above programme, zooplankton distribution was also surveyed around Palawan Island. The first trip of the Researcher was made from September 18 to October 5, 1968 covering the waters off the entrance to Manila Bay through the west coast of Mindoro Island to the northeastern part of Palawan Island southwards to the Sulu Sea. The second trip from November 5 to 20, 1968 was off the western coast of Palawan. The main objectives of the trips were to determine the fishing potentials of the area and to explore possible areas for trawling.

Part of the investigations carried out during those trips was the study of the plankton abundance and distribution in the area. During the first cruise, 67 stations were occupied while 46 stations were covered during the second trip.

The significant concentrations of the major plankton components were plotted in Fig. 5. The volume of plankton ranged from 87 ml to more than 1,000 ml per 1,000 m^3 as found by Tan *et al.* (in press).

The plankton was dominated by the copepods which were most abundant and ranged from 13% to 80% of the animal components in the sample. The most common genera were *Calanus, Eucalanus, Rhincalanus, Oncea, Corryceaus,* and *Temora.* Crustaceans other than copepods ranged from 4% to 68% of the total amount of organisms. Chaetognaths ranged from 1% to 35% while mollusks were observed in almost all the samples examined. It was also observed that the fish larvae were more abundant than the fish eggs although there were more fish eggs near the shore.

The high plankton standing crop almost all over the area studied during the cruise leads us to recognize the high productivity of the area.

In Lamon Bay, eastern Luzon

A hydro-biological survey off the eastern part of Luzon covering the region from the coast of Quezon Province to the Bicol Peninsula, with latitude 15°20'N as the northern boundary and longitude 124°30'E as the eastern boundary, was undertaken from April 12 to 17, 1967 on board the *Researcher*.

Ninety-one plankton stations were occupied, two vertical plankton hauls were made at each station, (one with the Norpac net and the other with the Marutoku net. A comparative analysis of the difference in the filtering capacity of the two kinds of nets was made and it was found that the Norpac net was more efficient than the Marutoku net. No significant difference, however, was found between the plankton volumes of the day and night samples.

Magnusson, *et al.* (1970) reported that zooplankton was abundant in Lamon Bay proper but extremely scarce east of it. It was also observed that the copepods, particularly the calanoids, dominated the zooplankton group. Several crustaceans were found dominantly occurring in most stations while among the chaetognaths, *Sagitta* was the most common. The hydrographic conditions in the area were complicated, indicating interchange of different bodies of water and that the zooplankton distribution was correlated with certain hydrographic features.

The percentage frequency of fish eggs and larvae in the eastern section of the area was somewhat higher than in the western section of the region. Fish larvae were found at almost all stations.

Magnusson (1970) likewise confirmed previous findings that fish spawn in all parts of the Philippine waters although certain areas have greater densities. This is therefore indicative of the presence of more intensive spawning areas, and was found true in southern Palawan waters more than in northern Palawan, in September to November, 1968. Other areas where relatively more intensive spawning took place were off Manila Bay, Mindoro Strait, Visayan Sea, Samar Sea, and within the waters of the Sulu archipelago.

These studies indicate the widespread distribution of fish eggs and fish larvae both in the internal and territorial waters of the Philippines. More studies, however, are needed to determine the true identity of these fish larvae especially those taken in large quantities. It is possible that some of these larvae, if not the majority, are those of roundscads, as these larvae are found in the vicinity of important roundscad fishing grounds.

THE MARINE FISHERIES

Fish is the primary source of protein and supplies 67% of the animal protein in the Philippines. In fact, rice and fish go together in the daily diet of the Filipinos.

The annual production of fish, however, has not met the requirement of the fast growing population. In 1970, the total fish output of some 989,000 mt was only 73.8% of the fish nutritional need of the people. More than 90% of the fish produced by the country come from the marine fisheries.

The general marine fish resources include those of the inshore and offshore areas. The inshore resources consist of many demersal species and migratory pelagic species. Up to the 1960s only the inshore resources were fished extensively, and fishing was comparatively limited in scope. The offshore resources include pelagic and demersal species which are similar to those caught in the inshore areas, except that greater catches were taken offshore by the use of larger and more modern equipment, fishing gear and vessels.

The fisheries of the country have been arbitrarily subdivided into inland fishery, i.e., fishpond culture (mostly of *Chanos chanos*, bangos, in brackish water): municipal fishery, and commercial fishery, (Table 1).

Municipal Fisheries

There are about 500,000 sustenance fishermen using small boats (not more than 3 gross tons) which make up the municipal fishery and produced in 1970 some 511,000 tons of fish. This made up 51.6% of the total production that year. However, this sustenance fishing, which is the main source of fish pro-

The fishing activity for roundscads changes with the prevailing monsoon, and in most islands, the fishery is shifted to the protected coasts, i.e., northeastern section during the southwest monsoon and to the western coast during the northeast monsoon as in Masbate, Palawan, and in southern Luzon.

The bagnet and purse seine vessels operate during the dark nights for at most 20 days a month. Dinglasan (1967) reported on the introduction, development, description, and operation of the modern purse seine in the Philippines, while Mane, *et al.* (1969) described the purse seine and bagnet which were mainly the gear used for roundscads and the possibilities of their being introduced in other regions of Southeast Asia.

Roundscad catches for the past 15 years show the rapid development of the fishery especially with the introduction of the modern purse seine (Table IV). Roundscads were fished to a limited extent before World War II, but they became commercially more important after the war. With the use and development of bagnet and light, the roundscad became the principal catch, especially since 1963 with the introduction of the modern purse seine.

The Fishing Gear for Pelagic Fish

The use of kerosene lamps in commercial pelagic fishery started with the operation of the round haul seine. The use of bagnet and light was first started in the sustenance or "municipal" fishery, *sapiao* in the Visayan Islands and by 1935 it was picked up by commercial fishermen using larger nets and dugout boats. The bagnet quickly outpaced the round haul seine which was not only cumbersome but also expensive to operate (Table V).

The Bagnet (*Basnigan*) Fishery

The bagnet fishery expanded greatly especially after the Second World War (Manacop and Laron, 1953). Most vessels used a large dugout with powerful 220 hp diesel engines. A 10 to 15 KVA electric generator was used to supply electric current for the powerful lamps to lure the fish. These vessels operate daily from home base and do not take ice when going to the fishing ground. Such vessels are found in Rosario, Cavite, (Manila Bay), Tayabas Bay, Mercedes in the Bicol region, and some parts of Palawan.

TABLE IV. Total annual catches of roundscads for 15 years (1956-70).

Year	Quantity (in tons)
1956	18,385
1957	19,322
1958	21,050
1959	21,904
1960	23,783
1961	25,258
1962	39,125
1963	58,527
1964	80,294
1965	99,939
1966	96,089
1967	100,327
1968	87,521
1969	109,729
1970	150,713

TABLE II. Total commercial fish production by gear in 1970.

Gear	Quantity (in tons)	Percentage
Otter Trawl	135,622	35.51
Bag Net	125,520	33.20
Purse Seine	86,718	22.27
Muro-Ami	16,823	4.40
Hook and Line	8,282	2.16
Beach Seine	4,605	1.20
Round Haul Seine	3,214	.86
Long Line	610	.15
Gill Net	382	.20
Total	381,876	99.95

TABLE III. Amount of catch of the three types of gear by species in 1970 (in metric tons).

Kind of Fish	Bagnet	Purse Seine	Round Haul Seine	Total
Anchovy	7,476	1,026	469	8,971
Big-eyed scad	658	4,179	138	4,975
Bonito	2,013	3,861	162	6,036
Chub mackerel	1,380	5,763	509	7,652
Roundscad	88,281	55,482	887	144,650
Herring	882	60	132	1,074
Sardine	17,736	10,643	507	28,886
Other species	7,095	5,702	511	13,308
Total	125,521	86,716	3,315	215,552

TABLE I. Quantity and Percentage of Fish Produced by Source of Production 1960-1970.

Year	Commercial Fishing Vessels		Fishponds		Municipal Fisheries and Sustenance Fishing	
	Quantity (metric tons)	Percentage	Quantity (metric tons)	Percentage	Quantity (metric tons)	Percentage
1960	120,022	26.99	60,119	13.52	264,481	59.48
1961	125,626	27.62	60,825	13.37	268,448	59.01
1962	150,037	31.00	61,436	12.69	272,475	56.30
1963	208,748	38.14	62,044	11.34	276,562	50.53
1964	258,100	42.77	62,680	10.39	282,726	46.85
1965	300,074	44.97	63,198	9.47	303,930	45.55
1966	314,899	44.65	63,654	9.03	326,725	46.33
1967	330,922	44.36	63,912	8.57	351,229	47.08
1968	406,794	43.38	86,711	9.25	444,179	47.37
1969	368,727	39.19	94,573	10.05	477,492	50.75
1970	381,877	38.62	96,461	9.75	510,546	51.63

duction in the country, regrettably is not properly documented because the municipal fishery is not under the control and supervision of the national fishery office, the Philippine. Bureau of Fisheries.

It is estimated that there are probably as many as 200,000 fishing boats in the municipal fishery one-fourth of which are motorized.

Commercial Fisheries

There are about 2,284 licensed commercial fishing vessels (1970). These fishing vessels vary greatly in size, ranging from 31 to 600 gt, mostly averaging about 39 gt and operating from 50 to 800 km from the home port. There are some 900 vessels of over 30 gt which produced 381,877 t of fish (more than 38%) or about 4.25 t of fish per gross ton of fishing vessel. Roundscad forms one of the most important catches of this fishery, totalling some 150,000 t in 1970.

Bagnet and purse seine catches formed more than 55% of the total catch of commercial fishing vessels in 1970 (Table II).

Species Caught by Light Fishing (Bagnet and Purse Seine)

More than 25 species of pelagic fish are caught in commercial quantity by light fishing. Besides the roundscad, *Decapterus,* the species commonly taken with light are sardines, *Sardinella sirm* and *Sardinella fimbriata,* anchovies, *Stolephorus* spp. and *Engraulis,* chub mackerel, *Rastrelliger* spp., Spanish mackerel, *Scomberomorus commersonii,* slipmouth, *Leiognathus* spp., cavallas, *Caranx,* big-eyed scads, *Caranx,* yaito tuna, *Euthynnus yaito,* skipjack, *Katsuwonus pelamis* and frigate mackerel, *Auxis.* Table III shows the production of the three most important gear for pelagic fish.

The Fishing Grounds

The major fishing grounds for pelagic fisheries are usually concentrated in coastal and shallow seas between the islands throughout the country. The principal fishing grounds covered by bagnets and purse seiners are northern Palawan-Mindoro area, southern Sulu Sea, Turtle Island Group, Sibuguey Bay, Ragay Gulf, Tayabas Bay, Davao Gulf, Lamon Bay, and off San Miguel Bay. Fig. 6 shows the comparative production of the principal fishing areas for the past 15 years.

TABLE V. Fish production of three types of gears for the years 1960 to 1970 (Total and per unit vessel in metric tons).

Year	Bagnet		Purse Seine		Round Haul Seine	
	Total	Per Unit	Total	Per Unit	Total	Per unit
1960	56,320	84	590	7	4,040	44
1961	53,590	75	870	11	8,370	65
1962	58,140	78	950	11	7,840	73
1963	88,030	99	3,750	34	12,210	94
1964	102,950	122	9,560	57	10,840	97
1965	119,490	118	28,680	171	8,770	63
1966	119,786	112	25,701	113	12,146	97
1967	111,105	110	40,445	230	10,645	93
1968	150,644	170	63,138	322	7,235	85
1969	115,276	145	80,050	358	4,251	62
1970	125,520	146	86,718	403	3,314	43

Another type of *basnigan* vessel was that developed in Navotas, Rizal, (Manila Bay), using the larger launch-type hull. These wooden vessels of 30-60 tons are provided with large fish holds which are loaded with cracked ice in metal tubs. These vessels fish far from the Manila Bay area especially in Palawan waters, operating for 10 to 15 days before returning to Manila with their catch. These vessels may also be used exclusively as fish carriers. Rasalan and Villadolid (1951) described in detail the development of the different types of *basnigan* as well as their construction, operation, and a prospectus of the gear.

In view of its effectiveness for catching pelagic fish with less manpower needed than the *sapiao,* the bagnet became very popular all over the country. Since 1956 the dugout bagnet fishery of Rosario, Cavite, has reached its apex on boat size as the size of the vessel is limited by the common available marine engine and the largest diameter of the log for the dugout hull. Further, the number of bagnet vessels in Rosario, Cavite, has been more or less stationary since 1956 at about 100 units. One half of these vessels move out of Manila Bay during the height of the fishing season to northern Palawan waters, Tayabas Bay, Batangas Bay, Mercedes, eastern Luzon and nearby fishing grounds.

The bagnet is the second most important commercial gear at the moment in the Philippines, being surpassed only by the otter trawl (Table II).

In 1970, there were 858 *basnigan* units, of which about 50% are from three to 10 gross tons. The improvement made on the gear with the use of brighter lights and synthetic (kuralon) nets helped in the rapid expansion of this fishery.

The Purse Seine Fishery

Non-mechanized small purse seines, the *talacop* and kub-kub, had been used by small commercial fishing vessels for a long time especially in Manila Bay. Yet they were inefficient and were mostly used for catching chub mackerel, a species which commands a much higher price than the roundscads.

TABLE VIII. Roundscad production of ten most important fishing grounds and their corresponding percentages of total production for 1970.

Fishing ground	Quantity in metric tons	Percentage
Sulu Sea	127,004	84.55
Visayan Sea	14,858	9.87
Sibuguey Bay	2,466	1.64
Manila Bay & approaches	1,620	1.08
Sarangani Bay	1,248	0.08
Davao Gulf	1,000	0.07
Tayabas Bay	588	0.04
Batangas Bay	329	0.02
Lamon Bay	319	0.02
Burias Pass	314	0.02

Although Herre (1973), recorded four species of *Decapterus* from Philippine waters, namely, *Decapterus kurroides* Bleeker (1855), *Decapterus lajang* Bleeker (1855), *Decapterus macrosoma* Bleeker (1851), and *Decapterus russelli* Ruppell (1828), only two species could be differentiated in the commercial catches. The first species, *D. kurroides,* is very rare.

Tiews, *et al.* (*op. cit.*) and Magnusson (*op. cit.*) concluded that only two species of roundscads of commercial importance can be distinguished in Philippine waters. These are *Decapterus russelli* (Rüppell) and *D. macrosoma* (Bleeker). Table IX shows the diagnostic characteristics separating the two species. No characteristic differences could be found to distinguish clearly one species from the other in the number of vertebrae, of gill rakers, and of other fin rays. Biological studies indicate that *D. lajang* is probably synonymous to *D. macrosoma.* In any case, the genus is awaiting a revision on a regional basis.

Bionomics and Life History

Reproduction

The dominant age group in the fishery usually matures uniformly and slowly. Tiews, *et al.* (*op. cit.*) observed that the gonads developed from maturity stage I-II to stage IV-V (eight maturity stages were distinguished) from February, 1957 to January, 1958. The stock disappeared from the fishery with the gonads not yet fully ripe for spawning. Thus the exact spawning time could not be determined because fully ripe specimens were not available.

Tiews et al. (*op. cit.*) also reported that the spawning period of both species of roundscads extends from November to March in Palawan waters, while off Manila Bay area there seems to be a delay of one to two months. Magnusson (op. cit.), on the other hand observed that spawning may start from October and extend to April for both species with greatest intensity during the latter half of the period. When the fish leave the fishery, the majority have reached stages IV and V. Magnusson found very few spawning fish (stage VI) in *D. macrosoma* catches in October to February and in *D. russelli* catches from November to March. The spawning period of *D. russelli* might therebe slightly later than that of *D. macrosoma.* Only very

TABLE VI. Annual catch of roundscad and other species principally caught by light fishing (in metric tons) 1962-1970.

Kind of Fish	1962	1963	1964	1965	1966	1967	1968	1969	1970
Roundscad	89,120	58,530	80,290	99,940	96,090	100,330	87,521	109,729	150,713
Other Species	25,720	40,000	48,920	67,120	65,260	76,010	105,003	100,729	86,071
Anchovy	7,430	14,910	15,980	12,600	11,480	14,650	14,463	11,005	9,241
Big-eyed scad	3,790	3,850	8,620	10,560	15,010	12,610	20,052	17,014	14,373
Bonito	230	220	1,760	3,030	5,550	7,240	13,282	12,392	7,247
Chub mackerel	2,170	6,460	2,580	5,500	7,360	16,100	25,391	23,944	21,010
Sardine	9,570	11,360	15,610	32,610	22,400	22,360	27,567	34,347	32,883
Herring	2,530	2,600	3,990	2,820	3,460	3,050	4,248	2,027	1,317

TABLE VII. Roundscad production by month and its percentage to total fish landed by commercial fishing vessels (1970).

Month	Weight (tons)	Percentage
January	9,458	29.57
February	10,779	34.87
March	19,886	49.99
April	13,314	40.97
May	16,018	49.35
June	17,228	46.26
July	16,575	47.74
August	17,867	44.48
September	12,762	39.20
October	7,527	28.11
November	6,016	26.04
December	3,461	17.57
Total	150,713	

The introduction of the modern purse seine may be traced from the success of the bagnet to improve further its efficiency. Previously, the stickheld lift net, the *boki-ami*, was introduced in the late 1950s especially for catching roundscad but without success.

In 1962, a private operator introduced a modern U.S. west coast-type purse seiner equipped with puretic power block while using similar lighting methods as those used by the *basnig* vessels. In fact these vessels may be used as light boats for purse seiners.

The following year, through representations made by the Philippine Fisheries Commission, the FAO sent a purse seine expert to the Philippines to demonstrate and extend technical know-how in purse seine fishing. He successfully convinced fishing boat owners to shift to purse seining. This led to a sudden increase in the production of commercial fishing vessels by 25,000 tons in 1963, which was about 13.1% increase in annual fish landing (Table V). Whereas, a *basnigan* catches up to 100 tubs or about 3.5 tons of fish in a single night's operation, a purse seine vessel catches from 1,000 to 3,000 tubs (35 to 100 t.) of fish a night. The record catch of a modern purse seiner in Palawan waters is about 100 tons (Rasalan, 1968).

The success of these operations led other boat owners to purchase similar fishing gear and vessels, the number of purse seiners increased to five units by the end of 1963 and to 50 units by 1965. Rasalan (*op. cit.*) further stated that the modern purse seiner used in conjunction with light proved to be more productive than any other fishing method for pelagic fish, so much so that fishing boat operators converted their old basnigan and trawlers into purse seiners and at the same time new ones were procured from Japan and Norway.

At the moment there are about 60 units of modern purse seiners with size ranging from 60 to 180 gt operating in the country. Each vessel produces, on the average, 800 t of fish per fishing season of seven months. About one-third of the fleet has been constructed locally. It is estimated that approximately 87,000 mt of fish have been landed from purse seiners in 1970, which is equivalent to

about 22% of the combined production of all commercial fishing vessels of the country.

The joint effort of the Philippine Fisheries Commission and the FAO-UNDP Deep Sea Fishing Development Programme, with the co-operation of the private sector, made possible the rapid expansion of purse seine fishing with light throughout the country.

THE ROUNDSCAD FISHERY

The roundscad is undoubtedly the most important commercial fish in the Philippines (Table VI). In 1970, some 150,713 t of the commercial fishing vessel's catch were roundscad. This is more than one-third (39.5%) of the total fish production of the country. The fish is popular for it is low priced (as the catch is mostly small, 13-20 cm T.L.) and is caught in commercial quantities the year round.

Even before 1956 this fish has been an important commercial species. As early as 1957, Tiews (*op. cit.*), in his report to the government of the Philippines on his researches on the marine fishery resources of the country, noted that the roundscad was one of the very few fishes in Philippine waters which was always caught in large quantities most of the year. This fish, which was mostly caught from Palawan waters, Batangas and Tayabas Bays, Mercedes, Camarines Norte, Ragay Gulf, and northern Zamboanga, made up 17.7% of the total landing of commercial fish in 1958. He concluded then that further development of the roundscad fishery must be pursued since the fish is popular among poor people.

Although the fish is caught throughout the year in all principal fishing grounds and on all coasts of the country, there is a marked season of the fishery in the different fishing grounds. The season starts in March and ends in August with peak production during the dry season of April and May (Table VII). The total catch in a few main fishing grounds is listed in Table VIII.

The roundscads form the basic species of the pelagic fishery, comprising in 1970 about 70.3% of the total of *basnigan* catches and 64% of the purse seine.

Identification

The studies on the biology of roundscad, *galonggong*, in the Philippines come mostly from the papers of Tiews (1958), Tiews, *et al.* (1970), Ronquillo (in press), and Magnusson (1970).

TABLE IX. Diagnostic differences between *D. macrosoma* and *D. russelli*

	D. macrosoma	D. russelli
Scales along lateral line (Region - from head to the first scute)	74 - 93	51 - 66
Pectoral length in standard length	4.9 - 6.3	3.7 - 4.7
No. of scutes	26 - 32	32 - 39
Finrays of 2nd dorsal	34 - 38	30 - 33
Body depth in standard length	4.7 - 6.5	4.0 - 5.1
Head length in standard length	3.4 - 4.3	3.0 - 3.7

few fish, if any, return to the fishing ground once they have left to breed.

The fecundity between the two species varies greatly. The average number of eggs per fish was 67,900 to 106,200 in *D. macrosoma* while it was much less in *D. russelli*, (28,700 to 48,700), according to Tiews, *et al.* (*op. cit.*).

Infestation with Nematode Parasites

Tiews, *et al.* (*op. cit.*) reported on the infestation rates of nematode parasites in the two species. It was found that infestations in both species were higher in fishes from Palawan waters than those from the Manila Bay approach, which may indicate a certain degree of separation of fish stocks in both areas. For example, the females of *D. macrosoma* from Palawan waters were infested on the average by about 3.6 parasites per fish while those in Manila Bay approach by 1.3 per fish. The males of *D. russelli* from Palawan waters were infested by about 5.5 per fish while those from Manila Bay approach only about 1.6 per fish. The parasites have not been determined. However, recently, Velasquez (per. comm.) who has been studying parasites on Philippine fishes, stated that these are larval marine forms of the nematode belonging to the subfamily Anisakinae, and cannot readily be properly identified.

Food and Feeding Habits

Tiews, *et al.* (*op. cit.*) reported that the roundscads were primarily zooplankton and fish feeder.

Examination of stomach contents of *D. macrosoma* from March, 1968 to May, 1969 verified the fact that this species was definitely a particular feeder, feeding on larger plankton components (copepods), mysis stage of crustacean. The fish prey to a larger degree on other fish, as invariably scales, fins, and vertebrae are found in their stomachs.

Population

Tiews, *et al.* (*op. cit.*) reported that the fisheries in Palawan waters exploit chiefly *D. macrosoma* while in the approaches to Manila Bay, it exploits more of *D. russelli*. In Palawan waters, only 0.3 to 4.1% of the roundscad catches from April to November 1957 was *D. russelli*. However, during the north-east monsoon season from December to March/April, the catches were more considerably mixed with *D. russelli* at a rate between 21.8 and 66.8%.

Magnusson (*op. cit.*) also reported that *D. macrosoma* and D. russelli were found mixed in the catches in Palawan waters where most catches originated. Experimental trawling in southeast Palawan waters (50-90 fm depth) caught almost entirely *D. macrosoma* with the exception of a few *D. russelli*. In the offshore areas of northern Palawan (100-125 fm depth), however, the catch consisted exclusively of *D. russelli*. He also noted that there seemed to be a predominant catch of *D. macrosoma* between islands while D. russelli predominated at the outskirts of the archipelago.

Continuous sampling for pelagic fishes at the Navotas Fish Landing has been carried out since 1967. Recent samples for roundscads taken at this landing during the 1971-72 season indicate the scarcity of D. russelli from the commercial catch. The catch from most fishing grounds which supply roundscads to the Manila market consisted almost entirely of *D. macrosoma*. In contrast from September 1968 to February 1969 about one-third of the landed fish was *D. russelli*.

The smallest D. macrosoma that entered the fishery early in 1972 (January to February) was with a mean length of from 7.6 to 12.9 cm in almost all fishing grounds of the country (Table X). When they leave the fishery a year later, by November to March the following year, they have attained a mean length of 19.6 to 20.9 cm. Extra-ordinary large fishes (29.2 cm and 33 cm mean length) were sampled in March and February 1971, respectively, in Palawan waters (Table XI).

Roundscads do not usually enter Manila Bay probably because of the absence of suitable food organisms inside the bay. The main catching places were a little offshore with depths ranging from 20 to 25 fathoms up to 100 fathoms.

Size Composition and Growth Rate

Based on commercial landing samples from 1957 to 1959, Tiews, *et al.* (*op. cit.*) reported that the fish sizes for both species varied on the average between 8 cm to 20 cm; that the size composition of males and females was very uniform; and that variation in the growth differences between the sexes was not likely. By using the Petersoen method the yearly growth

TABLE X. Smallest mean total length of *Decapterus macrosoma* sampled from the commercial catches in Manila Bay, indicating the size distribution by date in the different fishing grounds (1971-1972).

Date	Locality	Gear	Mean Total Length (cm)	No.
January 1972	Palawan	Purse Seine	10.8	176
February "	"	"	11.5	152
February "	"	"	12.87	603
January "	Zamboanga	"	10.6	175
February "	"	"	10.6	134
February "	"	"	11.1	121
February "	Lucena, Quezon	"	7.79	230
February "	"	"	7.6	191
February "	Masbate	"	12.9	603
February "	Off Manila Bay	Trawl	8.3	94

TABLE XI. Highest mean total length of *Decapterus macrosoma* sampled from the commercial catches in Manila Bay, indicating the size distribution by date in the different fishing grounds (1971-1972).

Date	Locality	Gear	Mean Total Length (cm)	No.
January 1971	Palawan	Purse Seine	19.31	325
February "	"	"	33.0	423
March "	"	"	29.2	18
July "	"	"	21.34	1,351
August "	"	"	19.6	92
November "	"	Basnig	27.38	26
December "	"	Purse Seine	19.0	294
January "	Zamboanga	"	20.95	69
February "	"	"	21.7	43
October "	"	"	19.6	125
November "	"	"	20.1	264
December "	Masbate	"	19.5	63
January 1972	Palawan	"	19.24	64

rate was estimated to be about 6 to 7 cm for both species. The roundscads of sizes 15 to 20 cm caught by the bagnet were estimated to be on their third year of life or age.

Magnusson, (*op. cit.*) however, reported the growth rate to be greater, i.e., 7 to 8 cm a year. He found few specimens from Muro-ami catches with modes 26-27 cm, 30 cm, and 33-34 cm which represented age groups II and V, respectively. He added further that these older fish spawned every year.

Tiews, *et al.* (*op. cit.*) reported that juvenile fishes entering the fishery at the start of the year from January through April are in their second year of life (age 1); growing rapidly in length month by month. Between October until April or May they have nearly reached maturity on their third year of life or age and then leave the fishery, to breed in places unknown.

Length-Weight Relationship

Magnusson, (*op. cit.*) computed the length relationship for both sexes of *D. macrosoma* and *D. russelli* based on 5,899 individuals of D. macrosoma with length range from 8 cm to 30 cm and 3,744 individuals of D. russelli with length range from 8.5 cm to 28 cm. The equation $W = aL^b$ and its longarithmic transformation were used to express the relationship between length (in cm) and weight (in g).

For *D. macrosoma* the values were found to be:

a = 0.005639
b = 3.16994
and for *D. russelli*
a = 0.0099771
b = 3.01520

DEVELOPMENT PROSPECTS OF THE PELAGIC (ROUNDSCAD) FISHERIES

The production of the marine fisheries by and large is mainly from the coastal waters of the country. Kvaran (1971) estimated that 90% of the total production of the commercial fishery (382,000 t) and the municipal fishery (511,000 t) may be considered to have been obtained from within the shallow waters (to 200 m deep) of the archipelago.

This would correspond to a total production of 804,000 t, or an average of about 48 t per sq km in the shallow waters with a total area of 163,372 sq km. Very roughly the above production may consist of about 300,000 t of demersal fish and 500,000 t of pelagic fish.

The pelagic fish produced from shallow waters (500,000 t represents just 3.0 t per sq km on the average.

Based on the above estimates, and other related works in the region, Kvaran (*op. cit.*) estimated the potential catch of pelagic fisheries in the Philippines to be just twice or 650,000 t in shallower waters from the deeper continental shelf, which has an area of about 1,500,000 sq km.

This would give a total potential yield of about one million tons of pelagic fish from the Philippine inland and territorial waters.

This estimate is in close agreement with previous estimates by Tiews (1966), Shimura and Gulland (1970).

In view of the position of the roundscad fishery in the pelagic fisheries of the country, and the fact that the fishery is mainly based on immature forms, we may be on the safe side to conclude that, this fishery can be expected to expand further almost twice the present production, or until we find the breeding stock and it becomes available to the fishery.

With the use of the German and big-opening Norwegian trawls in deeper waters, pelagic fish, of which 50% may be chub mackerel and 10% may be roundscads, are now taken in the Visayan Sea (Sarmiento, per communication).

Similar experiences have been reported by our gear technologist in the field. It is possible that the breeding fish may have different habits and do not become attracted to light, become more sedentary, and feed on benthos as reported by Tiews, (*op. cit.*). If this is so, the older and larger fishes may be made more available to the trawl fishery and these may be the missing breeding population. This is one phase of the fishery which is worth looking into.

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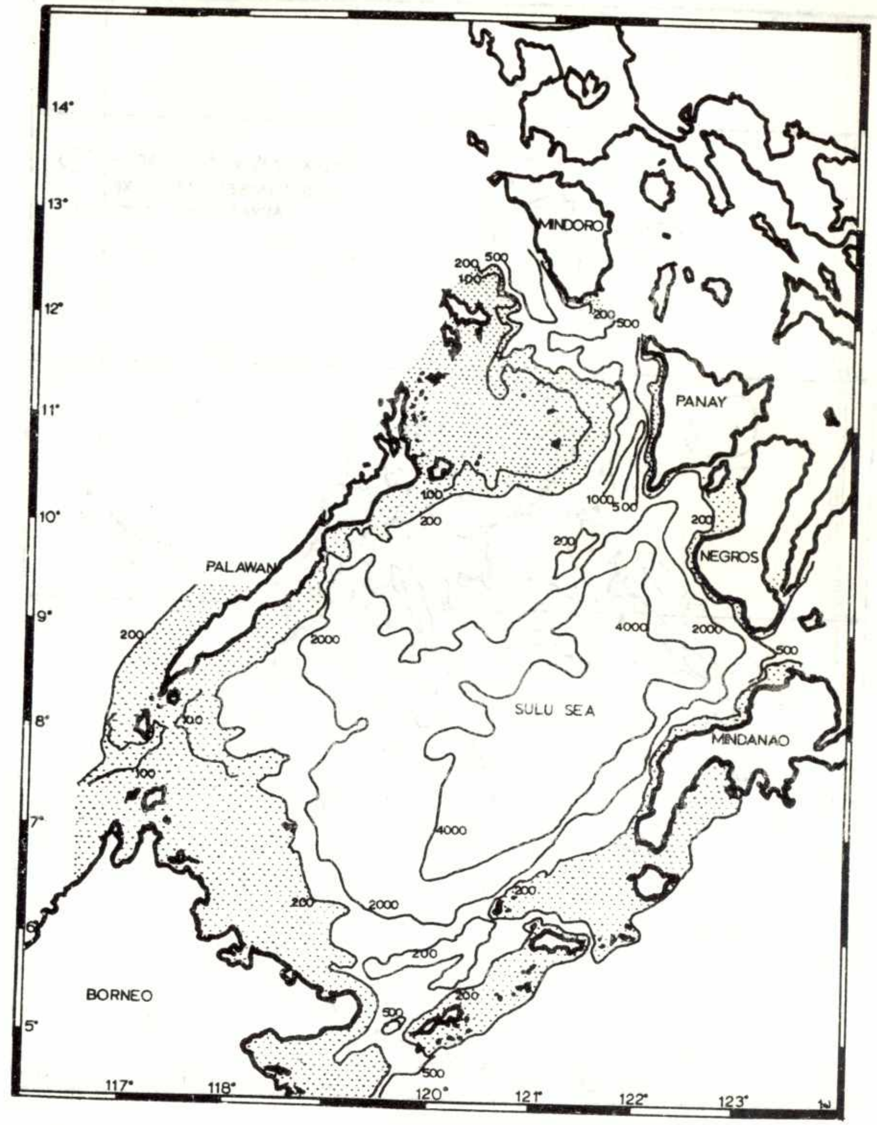

Fig. 1. The Sulu Sea Basin showing the shallow water surrounding the areas which are the most important fishing grounls for roundscads and other pelagic fish.

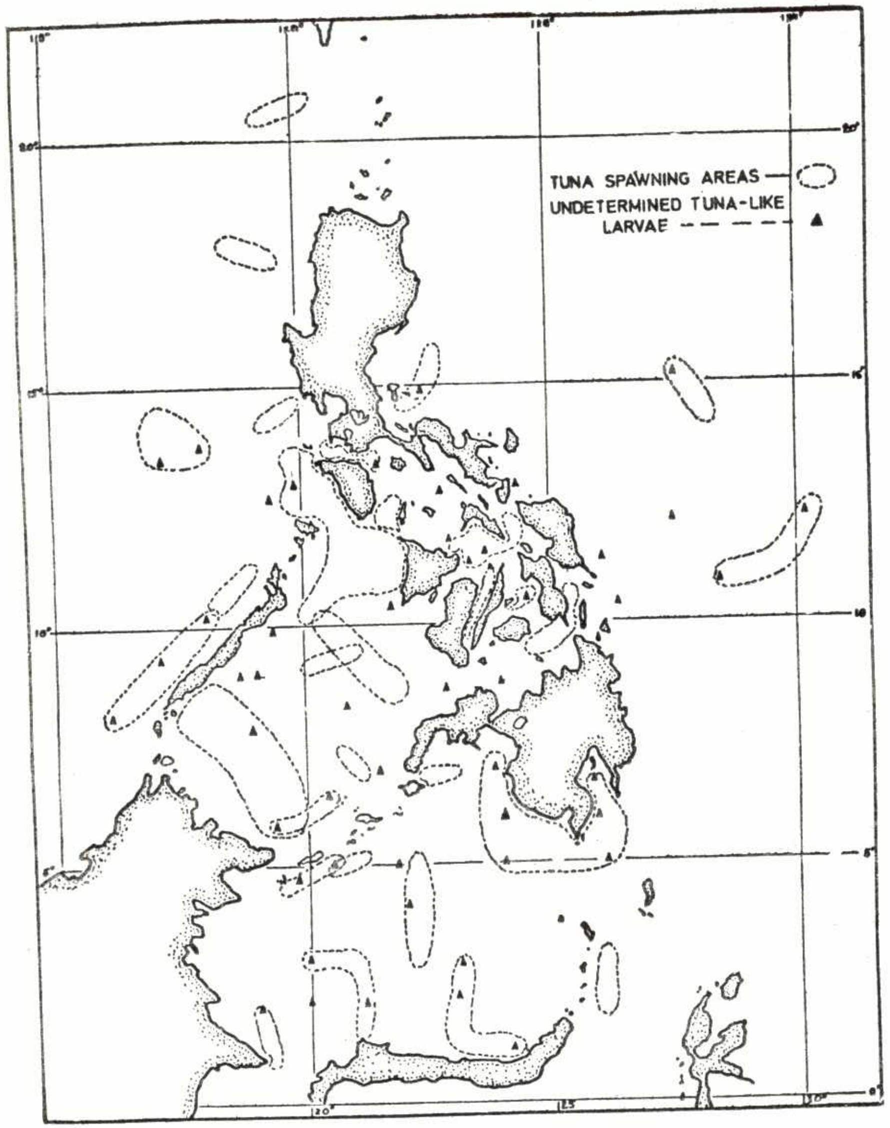

Fig. 2. Spawning areas of tuna and tuna-like larvae (after Wade, 1951, modified)

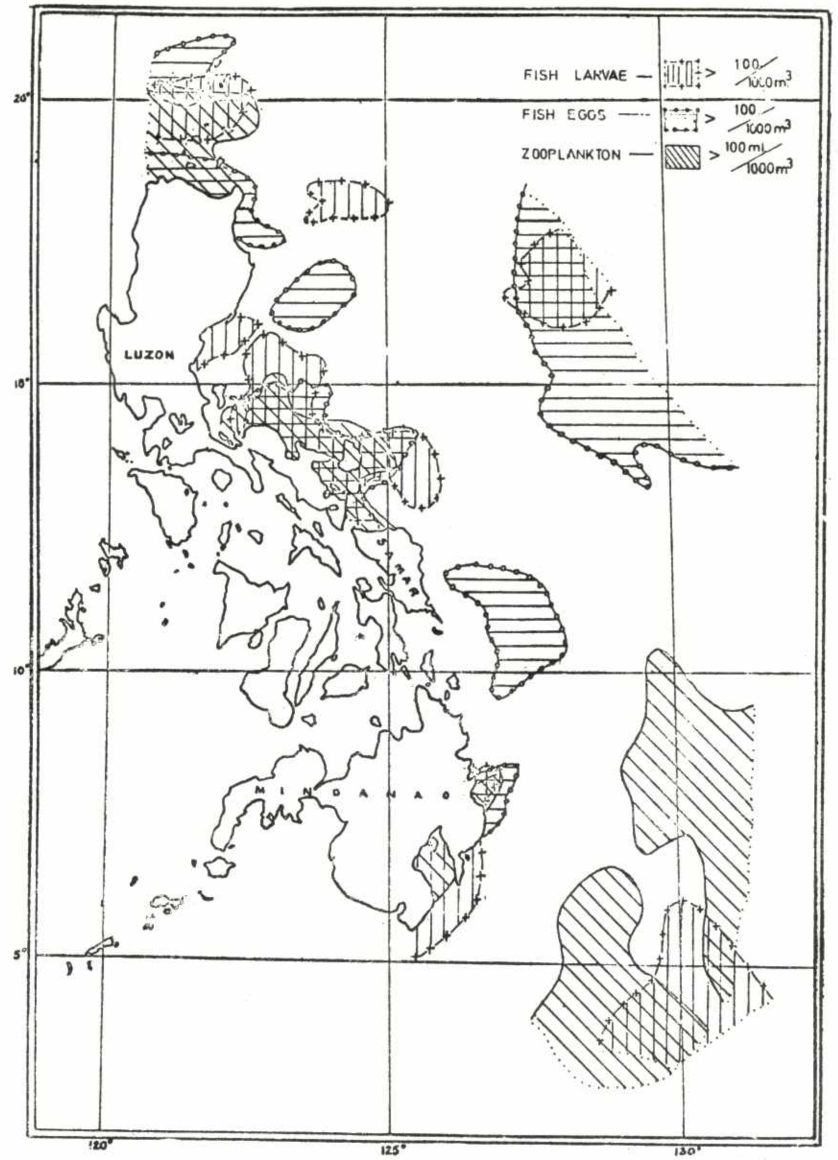

Fig. 3. Concentration of Zooplankton, fish eggs and larvae (100/1000m³ and above) east of the Philippines during the winter months (after Tan *et al.*, modified)

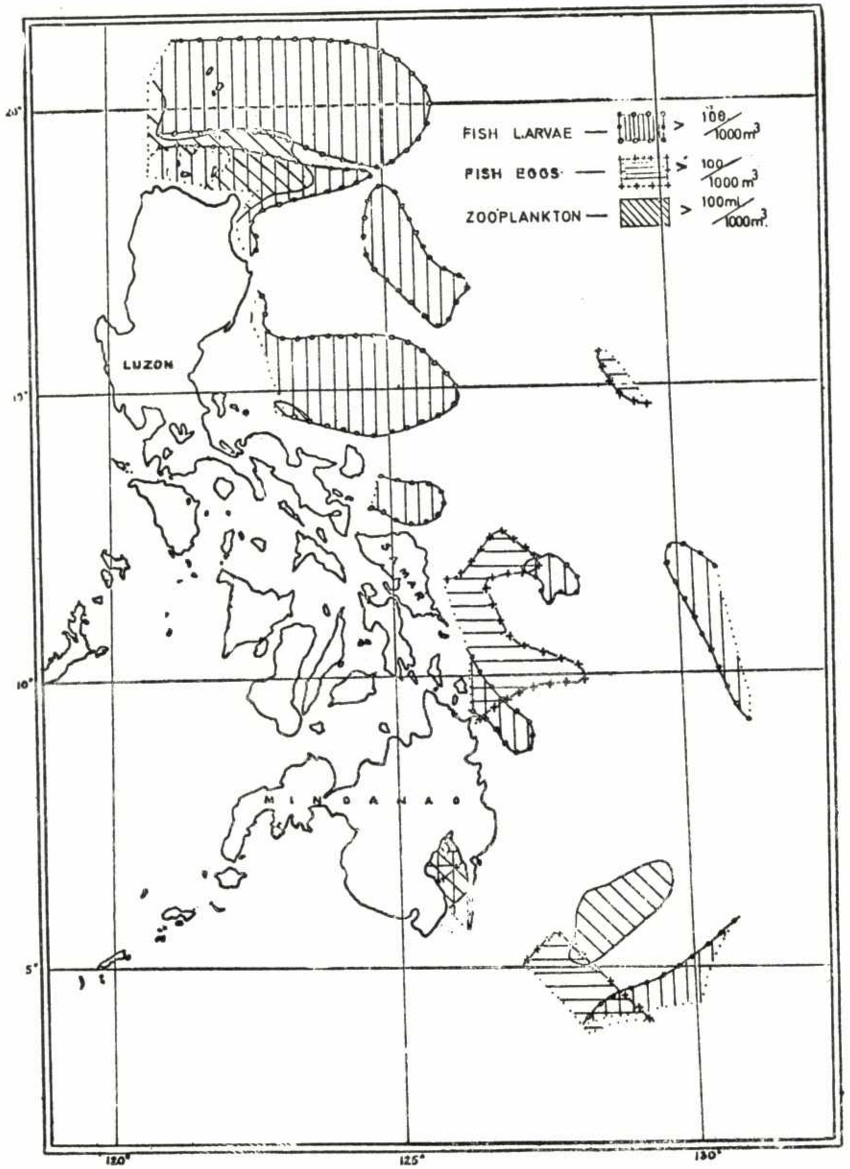

Fig. 4. Concentration of zooplankton, fish eggs and larvae (100/1000m³ and above) east of the Philippines during the summer months (after Tan *et al.*, modified).

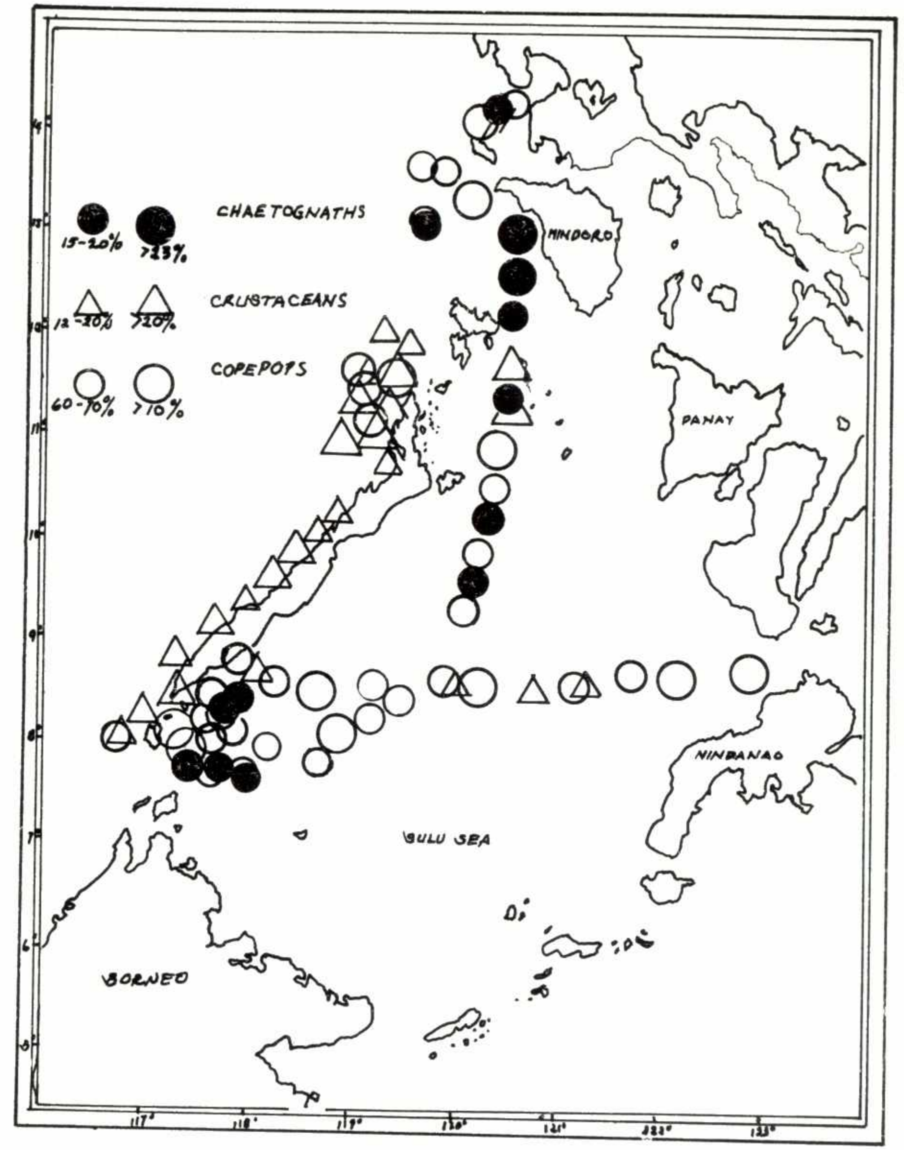

Fig. 5. Zooplankton concentration off Manila Bay, around eastern Mindoro, Palawan and part of Sulu Sea showing abundance of copepods and other crustacean (after Tan *et al.*, modified)

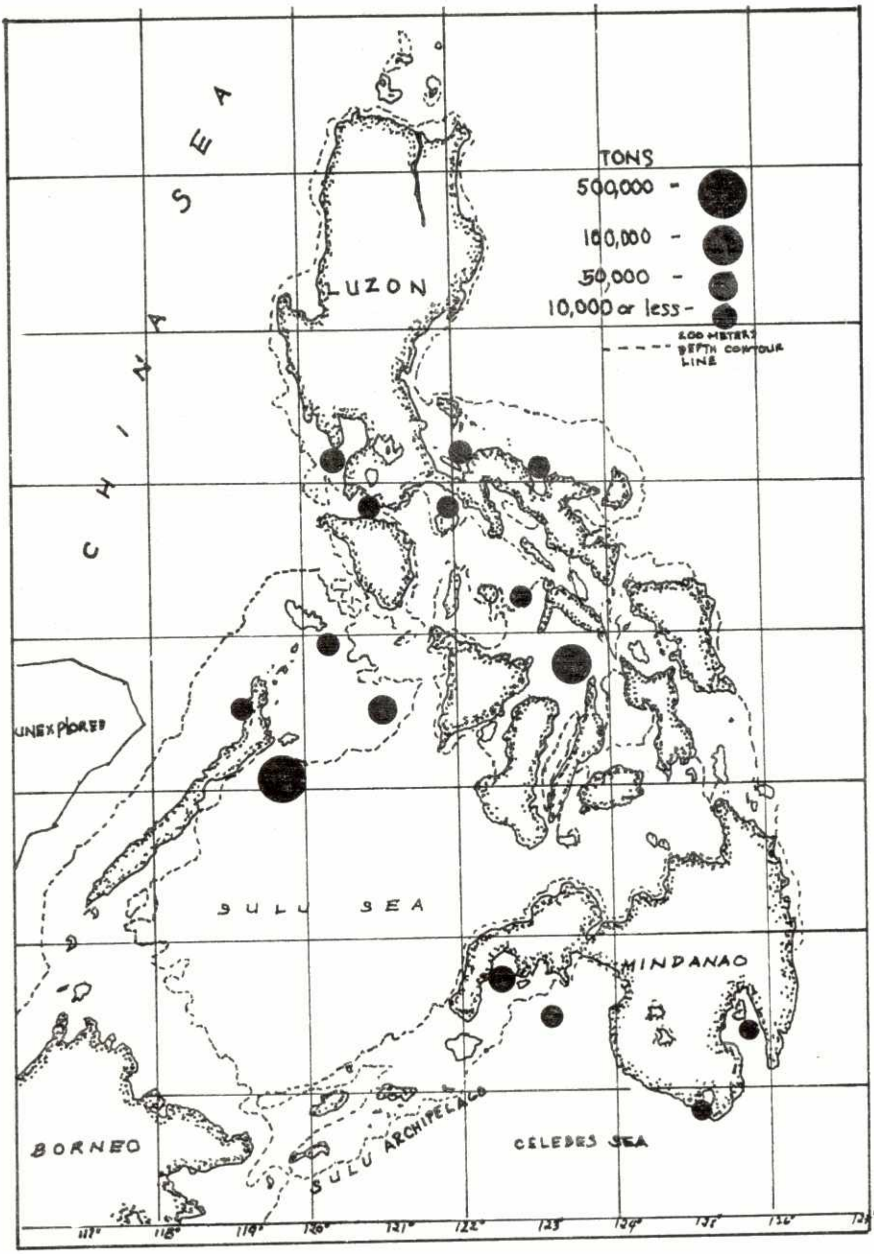

Fig. 6. The most important fishing grounds for roundscads over a period of 15 years (1956-70) in the Philippines.