PAYAO: TUNA AGGREGATING DEVICE IN THE PHILIPPINES

BY

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1. INTRODUCTION

Fish aggregating devices (FADS) are old accessory fishing gears in the Philippines. There is a wide variety of types and design using brushpile, twigs, bamboo and more recently scrap tyres, concrete and steel. Two popular types have emerged as apparently the most economical and effective in terms of resource management and income enhancement for fishermen. These are: 1) the floating and anchored bamboo raft called payao used mainly for attracting free schooling tunas and small pelagics (sardines, round scads, chub mackerel, etc.) and 2) the benthic artificial reefs (ARs) commonly made of bamboo, concrete or scrap tyres and which are sunk and anchored in barren nearshore areas usually adjacent to coral reefs to attract and provide habitat and forage to reef fishes. This report will focus on the tuna payao only.

Tuna fishing in the Philippines is unique in that payaos are used intensively to attract and aggregate pelagic and deep sea fishes for easier capture with a variety of fishing gears including enclosing nets (purse seine, ring net) and handline. The introduction of the payao in tuna fishing in 1975 increased tuna production tremendously. The Philippines thereafter, has become self-sufficient in food fish[2] and ranks as the largest producer of tuna in Southeast Asia and a major exporter of canned tuna in the worldwide international tuna market.

The fast and unregulated development of the tuna fisheries since 1975 and the reported high incidence of small juvenile tunas caught in payao areas has caused apprehension among the industry and science community as well as local and international fisheries agencies who drew the attention of the government to the need to monitor the resource and industry for the proper assessment and rational management of the tuna fishery.[3]

The use of FADs in tuna fishing has spread to other tuna fisheries in Southeast Asia, Japan, Hawaii and the East and South Pacific. To date, however, no regional management arrangement for the shared payao-aggregated tuna fishery exists.

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[2] The Philippines used to import up to 30% of its food fish requirement in the form of canned sardines, mackerel, and squid (Fisheries Statistics of the Philippines. 1960–1975).

[3] In response to the urgent need to monitor tuna catches especially those aggregated in payaos, FAO, in 1980 initiated and coordinated the Joint Indonesian/Philippine Working Group under the South China Sea Fisheries Coordinating and Development Programme (SCSP) and a Biological Data Collection System for Tuna and Related Species in Mindanao and Eastern Indonesia. This research team produced a number of publications on the tuna resources in the study areas. Initially funded by the Government of Japan in 1980–82, the project has been continued by a small group of tuna researchers in the Bureau of Fisheries and Aquatic Resources (BFAR) in the Philippines and the Institute of Marine Fisheries in Indonesia.

2. THE PAYAO

2.1 Structure

The early payao used before World War II was a small bundle of bamboo tied together with rattan or abaca rope (Fig. 1). It was provided on the underside with a hanging line of coconut fronds. At night the raft was illuminated with a kerosene lamp to enhance its attraction effectiveness. Floated across known migratory paths of fishes. payaos were fished with simple hook and line or enclosing nets to harvest concetrated free swimming fishes. These simple payaos were used by fishermen in northern Philippines in coastal Cavite, Batangas and Mindoro. With the introduction of purse seining, larger and strongly built payaos evolved (Fig. 2). In tuna and small pelagic fishing today, the payao is a standard accessory/fish aggregating device. The raft consists of one or two layers of up to 15 bamboos 10 to 15 meters long and 2 to 4 meters wide in each layer. The bamboos are tied to each other with nylon twine. The tips are lashed together to a scrap automobile tyre. Empty oil drums filled with rock and concrete are used to anchor the payao. The side of a scrap automobile tyre is embedded about halfway on the top of the drum for attachment to the anchor line. The anchor line is shackled at the wide end of the raft. Each weight is about 500 kg. The number of weights needed to anchor a payao is dependent on the depth of the water. Three to 4 weights are needed for depths between 1500 and 2200 m and 5 to 6 weights are needed for depths up to 5000 m.

The raft and weight are relatively cheap and cost no more than US$15. The nylon rope anchor line, depending on depth costs about US$1000.

In most payaos, the upper length of the anchor line up to 40 m is made of wire to prevent vandals from cutting the line. A buoy is attached to the anchor line as a marker. On the rear underside of the payao is an attractor or lure, a hanging line 25 to 35 m long with coconut fronds tied to it at 2-metre intervals and weighted with a 10-kg weight. The weight prevents the attractor from getting entangled with the anchor line. Braced coconut palm fronds on top of the payao serve as a marker for easy spotting of the payao at sea.

Bamboo payaos last for six months, usually less, depending on the weather conditions and barring loss due to typhoons or theft. The incidence of payao burning by vandals has prompted more affluent fishing companies to invest in the more expensive but longer lasting steel pontoon type of payao (Fig. 3).

2.2 Payao Ownership and Areas

Payaos are either owned by fishing companies or leased by concessionaires to fishing companies for 20% of the price of the haul. Artisanal/handline fishermen are allowed by payao owners to fish the payao when catcher boats are not fishing in the area. Commonly, this is an arrangement between payao owners and the handline fishermen in return for the latter's efforts in monitoring fish concentrations and warding off poachers and vandals.

Payaos are anchored in many fishing grounds in the Philippines. However, there is no reliable enumeration of the total number of payaos. It has been estimated however, that there are about 3000 payaos in Moro Gulf in southern Philippines alone. The other tuna payao fishing grounds are West Sulu Sea, East Sulu Sea, Visayan Sea, Bohol Sea, waters off Batangas, and northwestern Luzon and other parts of the archipelagic waters* where established viable tuna and small pelagic fisheries exist (Fig. 4).

Payaos are anchored in waters up to 3000 m deep and up to 60 m from the shore. Thirty payaos are anchored for each catcher boat. Generally, there is a crowding of payaos in nearshore fishing grounds.

* Archipelagic waters are enclosed by imaginary straight baselines connecting the outermost points of the outermost islands.

2.3 Fishing Operation

Large concentrations of tunas aggregate underneath the payaos after the rafts have been in place for three weeks. In clear water, tunas may be seen swimming around the payao at dusk and dawn. Small scout boats with fish finders monitor the bamboo rafts to determine the concentration of fish. When the fish concentration is large enough for "harvest" a scout boat contacts the catcher vessel (purse seiner or ring netter) and gives it the position of the "harvestable" rafts. The catcher vessel proceeds to the payao area in time for a sufficient night-lighting period starting before midnight to increase the fish concentration before the net is set. During purse seining or ring netting operations, which usually start at about 0400 hours the attractor line is transferred to a light boat and allowed to drift away with it. Fish attracted by the payao follow the light boat with the attractor line. The attractor line is returned to the payao after the completion of the set.

Bamboo rafts are harvested every 5 to 6 days. Depending on the season, up to 100 MT of young yellowfin and skipjack tunas, a mixture of "little tunas" and small pelagics are hauled in each setting. Non-tuna species may consist of from 5% to 40% of a haul.

When catcher boats are not in the fishing ground, artisanal boats are tied to the payao and lines are lowered to depths ranging from 60 to 300 metres or where the highest concentration of fish is found. One hook is used per line, but an average of six lines may be operated per boat. Handlining is conducted during daytime for security reasons, since piracy is a serious problem among handline fishermen.

In southern Philippines which lies outside the typhoon belt, fishing operations take place year round. In general, monsoons limit the fishing season.

3. BIOLOGICAL IMPACT

Some adverse effects of the effectiveness of payao have been observed on the stock structure.

3.1 Major Species

Payaos attract a variety of species. However, the catches consist largely of juvenile tunas and small pelagics. Ninety per cent of the tuna production in Philippine waters are payao-associated. Six species form the basis of tuna fishing industry. Only four are listed in the national fisheries catch statistics namely, the yellowfin *(Thunnus albacares)*, skipjack *(Katsuwonus pelamis)*, eastern little tuna or kawa kawa *(Euthynnus affinis)*, and frigate tuna *(Auxis thazard)* because of poor indentification.*

3.2 Stock Structure

Skipjack and yellowfin spawn throughout the year probably in all Philippine waters but especially in Moro Gulf and Celebes Sea. The juveniles enter the fishery at 16 cm. About 90% of the skipjack landed by the inshore ringnet and purse seine gears operating around payaos are between this size and 32 cm with a mode between 24 and 38 cm. Together with small pelagics they are landed during all

* Big eye *(Thunnus obesus)* are often caught but are not differentiated from the yellowfin at less than 40 cm and recorded as juvenile yellowfin in the catch data. Attempts to differentiate between these two species suggest that 10% of the smaller "yellowfin" caught by handline maybe big eye tuna. Similar difficulties in differentiating between the early juveniles of frigate tuna *(A. thazard)* and bullet tuna *(A. rochei)* exist. Although only frigate tuna are listed in the Philippine catch statistics there are indications that about 50% of the fish is actually bullet tuna *(A. rochei)*. It is also not uncommon that field enumerators often identify early juveniles of frigate, bullet and eastern little tunas as juvenile yellowfin or skipjack. In coastal areas in Panay Island where early and late juveniles of all tuna species mentioned are caught year round, the early juveniles up to 30 cm are collectively called "aloy".

months around payaos and in free schools in this size. Larger purse seiners (250 GT) operating further offshore capture the larger skipjack in the 40–50 cm range (Table 1).

There are two distinct sectors exploiting two distinct age groups in the yellowfin fishery. The surface fishery is analogous to the skipjack since yellowfin tuna enter the fishery at 12 to 15 cm, the size at which they begin to move offshore. At the 16–30 cm range, juvenile yellowfin tend to concentrate off the coast in 20–39 nm interval where the majority of payaos are set (Table 1). Here, they aggregate under payaos and are captured by purse seines, ring net and handline. The juveniles begin to migrate at about 30 cm and practically all have left Philippine waters at 60 cm. Yellowfin in the 60–110 cm range are not found in significant numbers in Philippine waters. Adult yellowfin apparently return to Philippine waters between 110–150 cm and older and converge in the North Celebes Sea (Mindanao Sea) to spawn. Here they are caught by handline fishermen.

On the basis of growth studies, it was calculated that more than 90% of all skipjack and yellowfin landed in the Philippines are less than one year old. The modal age skipjack was 7.5 months and for yellowfin 5.5 months. The ages of first entry were 3.5 and 1.5 months respectively. The surface fishery is definitely based on early juvenile fish.

3.2 Rapid Exploitation of Juveniles

It has been claimed that payaos tend to selectively attract early juveniles and are therefore detrimental to the fishery. Tuna studies in Mindanao indicated, however, that the size of tunas captured in free schools and payao-associated fishing techniques are similar. Payaos may increase the total catch of tunas, but this may be due to the effectiveness of payaos to attract and concentrate pelagic fish. Since majority of tunas in Philippine waters are apparently juvenile, the use of payaos will increase the catch of small tunas, but not selectively (White, 1982).

3.3 Enhanced Cannibalism

Stomach content studies on yellowfin in Philippine waters prior to the development of payaos did not indicate yellowfin juveniles (Ronquillo, 1953, 1964). The payaos may have altered the food and feeding habits of tunas.

Prey organisms, including yellowfin juveniles, are attracted to and concentrate under payaos, subsequently establishing an artificial situation of an almost unlimited supply of food for large predators especially adult yellowfin. The juvenile tunas and small pelagics are distributed under the payaos in the upper layer of the water column and the larger predators in the deeper water. Stomach content analysis of adult yellowfin in payao areas revealed continuous feeding. It has been calculated that an adult yellowfin (116–150 cm FL) consumes 783 kg of food per year, 30% of which is prey organism (Barut, 1987). Of this 77% consisted of juvenile skipjack and yellowfin. Yesaki (1983) assessed the impact of predation and calculated that the weight of juvenile yellowfin cannibalized in payao areas in Moro Gulf probably equaled the total weight of yellowfin landed annually by the ring net and purse seine fishery. Such cannibalism, however, has been considered as fishing and not natural mortality as it is a consequence of the use of payaos.

4. ECONOMIC IMPACT

The innovation of payaos in catching tunas has had a dramatic impact on the tuna fishing industry as well as on the individual fishermen and the economy in general.

4.1 Tuna Production

Tuna production increased from less than 10,000 mt in 1972 to 125,000 mt when the payao was introduced into tuna fishing. Peak production was 279,641 mt in 1988 comprising over 20% of the

national marine fish catch of 1.35 mt that year (Table 2). The annual average landings of tunas over this period was 236,454 mt, the highest in Southeast Asia.

4.2 Increased Exports of Tuna Products

The foreign market for tuna and tuna products is growing rapidly and local production is not enough to meet the country's utilizaiton requirements, particularly those of the cannery sector whose products are largely exported. The 10 local tuna canneries alone require 120,000 mt annually of raw materials, particularly yellowfin and skipjack, as inputs to their plants. Although local production has the capability to supply the requirement of the canneries, only 75,000 mt or 60% (1983–1987) were actually supplied to them. The rest went to the raw material export market and to domestic consumption. Frozen and sashimi-grade exports were 1,000 mt and 5,000 mt respectively. The Philippines exports tuna to 22 countries but the major markets are the United States, West Germany, Canada and United Kingdom (Table 3). The Philippines share of the market is 17% of the total requirements of Japan, the United States, and Western Europe, the top importing countries, whose imports have manifested an increasing trend (FAO, 1986).

4.3 Better Quality of Life of Small Fishermen

Artisanal handline fishermen used to be the poorest among the poor. Today, artisanal tuna fishermen in their small pump boats are no longer a disadvantaged sector. The average catch per boat is 290 kg for a 5-day fishing trip or 1,450 kg for a 25-day operation per month. At current prices, the average income per month per fisherman is at least US$200. This is comparable to the salary of a fishery scientist.

4.4 Elimination of Conflict Among Tuna Fishermen Groups

The joint use of payaos by commercial and artisanal fishermen demonstrates that conflict between groups of big and small scale fishermen exploiting a common fishery, which in the Philippines is often violent, maybe eliminated and a peaceful and productive sharing can take its place. This is possible because distinct stocks of the same species are exploited by different groups as in the case of the yellowfin fishery. The large scale purse seiners and ring netters (250–300 GT) fish the surface aggregating juvenile yellowfin while the handliners catch the deepwater adults in depths up to 300 m beyond the reach of the former.

4.5 Ease in Monitoring Fishing Grounds

In the fishing business, specific locations of fishing grounds are generally closely guarded trade secrets. The advent of the payao has eliminated the secrecy. Payao areas are indicators of tuna fishing grounds enabling government agencies to monitor the development of the fishery with less difficulty.

4.6 Increased Consumption of Tunas

Earlier, tunas were shunned in urban areas due to the poor condition in which the fish reached the markets, usually a consequence of bad postharvest handling. The increase in tuna production made possible by payaos has lowered the cost, improved fish handling methods, and popularized the consumption of tuna. Today, 87% of tuna landings are marketed locally, contributing significantly to the protein intake, 70% of which comes from fish.

4.7 Ancillary Industries

Unemployment is a serious problem the Philippines. However, as a spin off from increased tuna production, a number of support businesses have come into being. These include ice plants, canneries, tuna fish restaurants, small boatyards, etc. providing a livelihood for otherwise unemployed people

including fish vendors, ice plant and fish processing workers, boat builders, truck drivers, fish cleaners, laborers, etc.

5. ASPECTS OF MANAGEMENT

5.1 Territorial Use Rights in Fisheries (TURFs)

Tuna fish aggregating devices are a form of TURFs because fishing activities around payaos are limited to the fishermen in the employ of the FAD owner or those who have agreed to pay the sharing fee set by the concessionaire. As mentioned above, handline fishermen are generally allowed to fish around payaos when purse seiners are not operating in the area. Moreover, there is another existing arrangement whereby fishing companies provide boats, gear and operational expenses to handline fishermen provided the latter sell their catch to the former. There has been no ownership problems between industrial and artisanal fishermen in the tuna payao fishery.

5.2 Tuna, An Unregulated Fishery

In various dialogues with the government, the local tuna fishing industry leaders have expressed their alarm about the significant quantities of undersized juvenile tunas captured and the apparent decline of catches in traditional tuna fishing grounds. They have proposed mesh size regulation of purse seines and ring nets and limiting the distance between payaos to 7 miles. Mesh size regulation, however, would seem academic because tunas caught under payaos and in free schools are of similar size, thus indicating a juvenile stock and the same mesh size is used to land small pelagics as well. In the off season for tuna the small pelagic species are the mainstay of the ring net and purse seine fisheries. The 7-mile limit between payao is a gentlemen's agreement among fishermen groups and payao concessionaires.

Due apparently to inadequate information on the resource and the industry, and possible resultant political and socio-economic implications, the government has not initiated any regulation of the tuna fishery.

5.3 Tuna Fishing in International Waters

The intensive increase of fishing effort in traditional fishing grounds, starting in 1982 saw the beginning of operations by larger vessels outside Philippine territorial waters. Today, there is a fleet of 17 catcher and carrier vessels from 139 to 995 GT owned by three companies fishing under licence in Papua New Guinea and Micronesia (MFRDF, 1988). The licences obtained by the fishing companies cost about US$20,000 per catcher boat annually. It is not certain whether the tuna catches in extraterritorial waters are included in the national tuna production statistics. In spite of these additional catches however, the production of local canneries fall short of their rated capacities.

5.4 Regional Management Arrangement

The increasing use of tuna aggregating devices should be an area of concern for both the Philippines and other countries that have adopted the payao technology. The widespread capture of juvenile yellowfin and skipjack has thus far remained a dormant issue in Southeast Asia. The Philippines and Indonesia have a thriving tuna payao fishery while Malaysia may have plans of developing its own payao fisheries for tuna.

In many tuna fora it has been recognized that international cooperation for effective utilization of highly migratory species is needed. However, not all nations have agreed to participate in the existing international agencies (IOTC, IPTC, IATTC, SPC, ICCAT) and even fishermen are not regulated in their own countries. A reassessment of the movements of skipjack and yellowfin has shown that long

distance movements are the exception rather than the rule and if Exclusive Economic Zones (EEZ) are extensive, stocks may be considered resident and individual countries can effectively regulate their own fisheries (Hilborn and Sibert, 1988). That being the situation, international cooperation in regulating harvests perhaps not necessary. While this may be true in the Pacific Island Nations (Micronesia, Kiribati, and French Polynesia, ect.) where EEZs are extensive, in Southeast Asian countries, and in the Philippines, Indonesia, Malaysia and Taiwan in particular, there are overlapping EEZ boundaries which have upto date not been mutually agreed upon and have been a source of fisheries conflict*.

While the use of payaos is causing the rapid removal of young juveniles of yellowfin and skipjack from the stocks, it should be mentioned that it was the effectiveness of payaos in concentrating tunas for capture, that spurred the development of the tuna fishing industry of the Philippines and enabled this country to share competitively in the fishery and market of a resource which hitherto had been the monopoly of affluent countries operating long distance fishing fleets. Fishermen groups have urged the Philippine government to regulate the tuna fishery and to study the effects of the unabated capture of early juveniles, in order to ensure the productivity of the tuna fishery resources and industry.

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* In April 1988, three Philippine tuna purse seiners were seized by the Malaysian Navy. Their 49 fishermen and crew were imprisoned. It was alleged that the Philippine boats were intruding into Malaysian territorial waters.

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Table 1. Catch and catch rates of skipjack tuna in different ranges of the north Celebes Sea (Source: White, 1982)

Distance from coast (nm)	0–19	20–39	40 and more	Total
Number of sets	26	55	23	104
Total Catch (kg)	218,100	464,700	201,800	884,600
Catch per set (kg)	8,388	8,449	8,773	8,506
No. Sets with fish less than 35 cm	15	33	10	58
% sets with fish less than 35 cm	58	60	43	56

Table 2. Catch and catch rates of yellowfin tuna in different ranges of the north Celebes Sea (Source: White, 1982)

Distance from coast (nm)	0–19	20–39	40 and more	Total
Number of sets	21	49	22	92
Total catch (kg)	40,100	166,500	50,400	257,000
Catch per set (kg)	1,910	3,398	2,291	2,793
No. sets with fish less than 40 cm	14	27	7	48
% sets with fish less than 40 cm	67	55	32	52

Table 3. Annual total landings (mt) of tunas in the Philippines from 1976–1988.

SPECIES	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	TOTAL
FRIGATE TUNA/BULLET TUNA	28,328	43,007	50,899	79,909	96,874	78,248	67,363	74,219	80,305	95,718	87,225	98,032	107,498	987,625
YELLOWFIN/BIG EYE TUNA	44,478	63,059	47,029	49,224	48,023	56,176	51,922	62,036	58,924	64,293	59,510	51,810	57,650	714,134
SKIPJACK TUNA	29,174	55,090	49,730	45,084	31,178	38,439	50,795	57,151	44,671	60,536	77,031	73,751	58,156	670,786
EASTERN LITTLE TUNA	23,004	54,744	36,341	23,094	24,730	30,891	48,524	48,880	41,899	41,060	42,445	46,934	56,337	516,883
TOTAL	124,984	215,900	183,999	197,311	200,805	203,754	216,604	242,286	225,799	261,607	266,211	270,527	279,641	2,889,428

Source: Bureau of Fisheries and Aquatic Resources.

Table 4. Tuna Exports 1987.

CANNED:

Country	Volume (kg.)	Value (₱)
Canada	1,278,201	62,735,703
U.S.A.	9,186,763	336,151,596
Puerto Rico	29,164	1,042,062
Sweden	317,296	12,795,461
Finland	165,419	6,642,406
Denmark	167,886	7,912,890
United Kingdom	2,146,369	92,265,653
Netherlands	1,045,216	43,222,923
Belguim	73,103	3,489,843
France	78,763	3,322,085
West Germany	7,141,504	289,517,620
Austria	112,210	4,868,112
Switzerland	197,005	8,949,558
Malta and Gozo	88,967	3,755,634
Italy	67,868	2,872,110
Greece	62,554	2,504,471
Israel	471,480	21,912,383
Singapore	12,732	584,964
Mozambique	3,083,029	138,329,480
Barbados	13,506	627,596
Ireland	45,757	2,115,530
Cyprus	14,228	612,560
Lebanon	42,864	2,054,577
Saudi Arabia	42,864	1,831,178
Bahrain	765	52,430
Thailand	72,669	1,192,962
Australia	87,912	3,517,755
New Zealand	15,081	658,660
Subtotal	26,061,235	1,055,538,202

FROZEN: (except fillets)

Country	Volume (kg.)	Value (₱)
Canada	1,411	48,184
U.S.A.	370,282	12,720,578
Denmark	20,000	449,812
Italy	833,758	20,091,207
Israel	831,350	17,985,906
Thailand	1,783,848	25,667,175
Singapore	1,546	69,171
Hongkong	3,231	291,539
Japan	7,081,512	272,790,159
Okinawa	407	46,483
Guam	1,790	70,867
Hawaii	319,392	21,425,066
Trust Territory of the Pac. Is.	1,000	22,417
Subtotal	11,249,527	371,678,564
Total	37,310,762	1,427,216,766

Source: Bureau of Fisheries and Aquatic Resources.

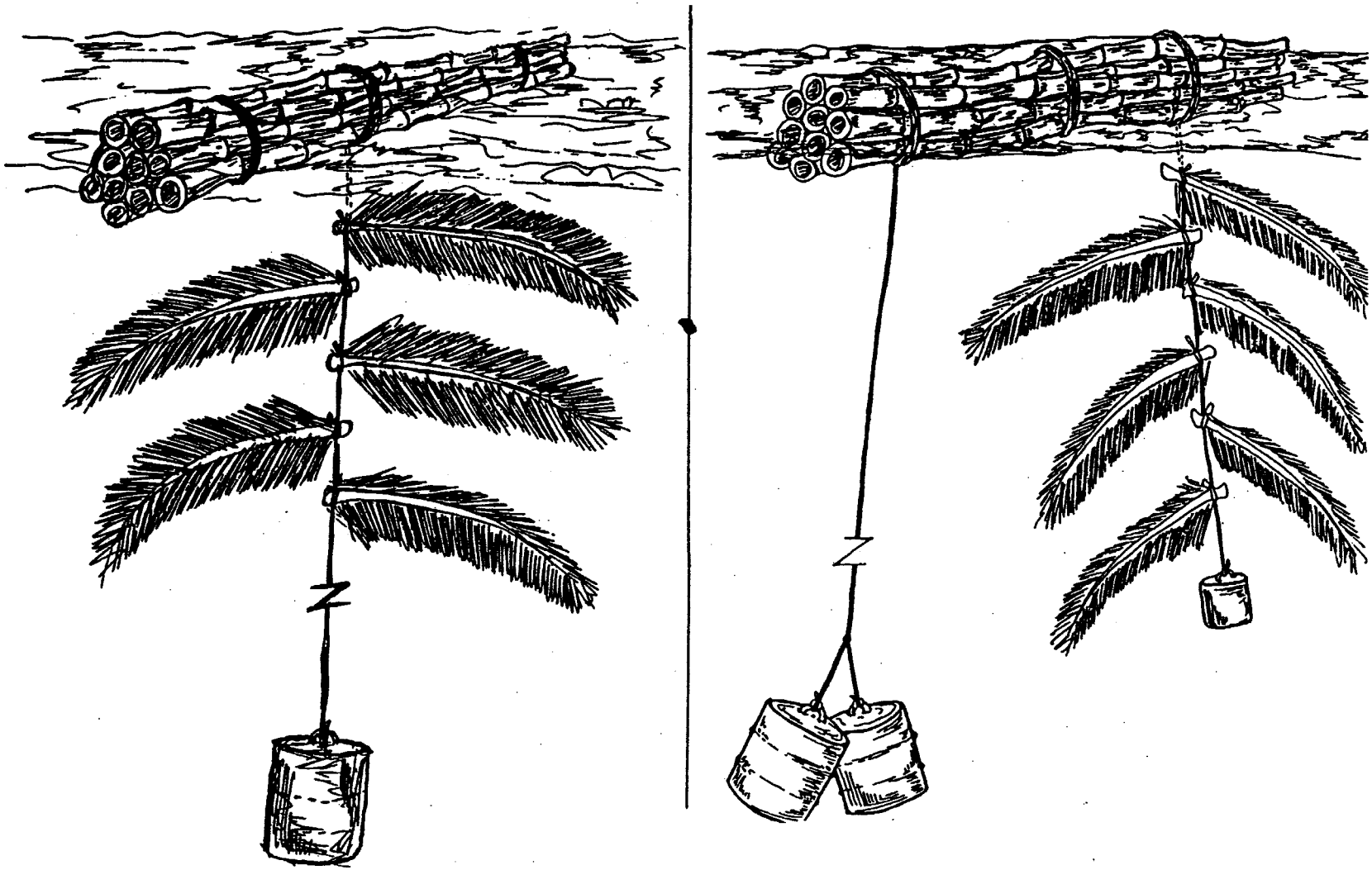

Fig. 1. Early payao designs (After de Jesus, 1982).

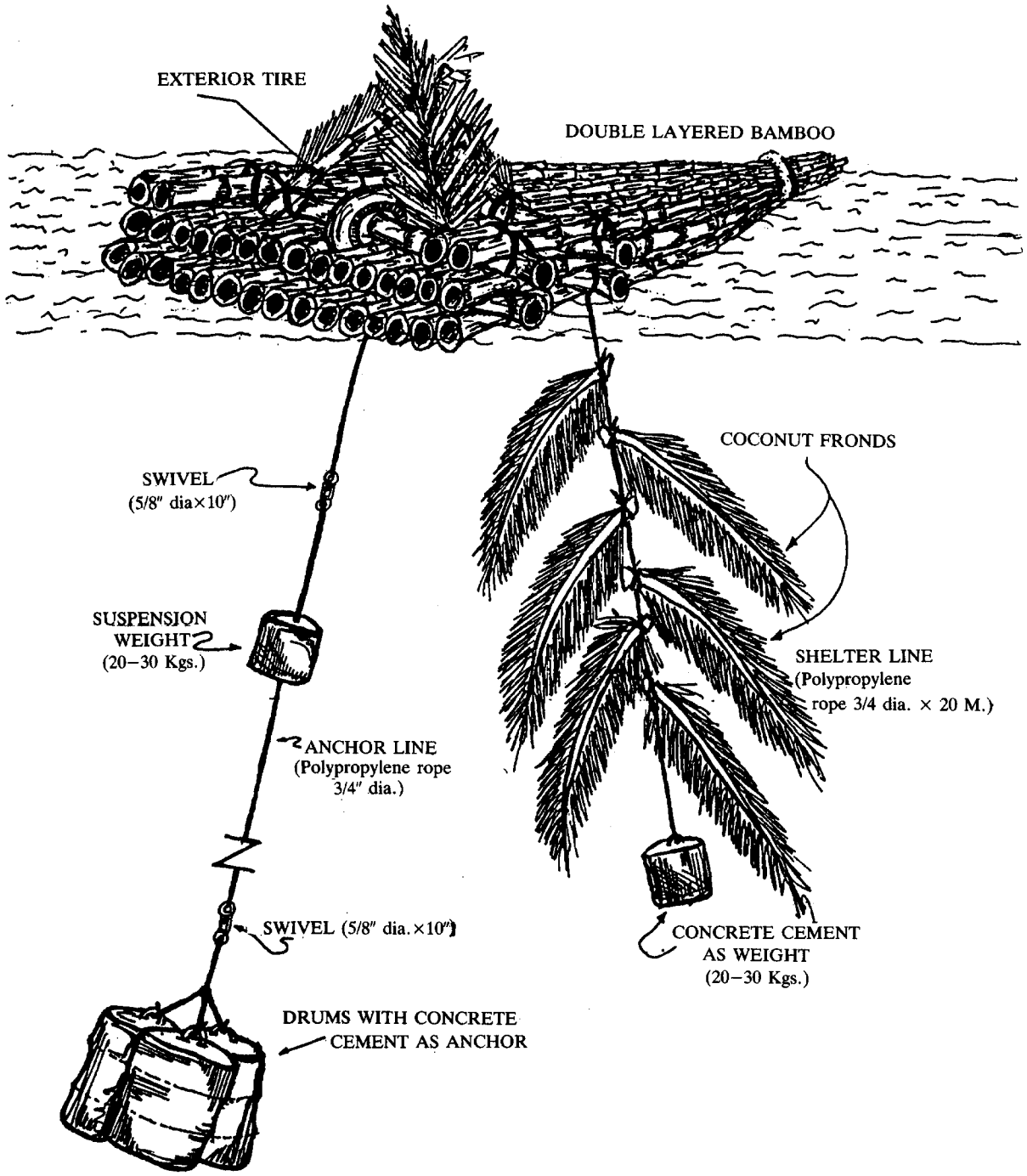

Fig. 2. Tuna payao.

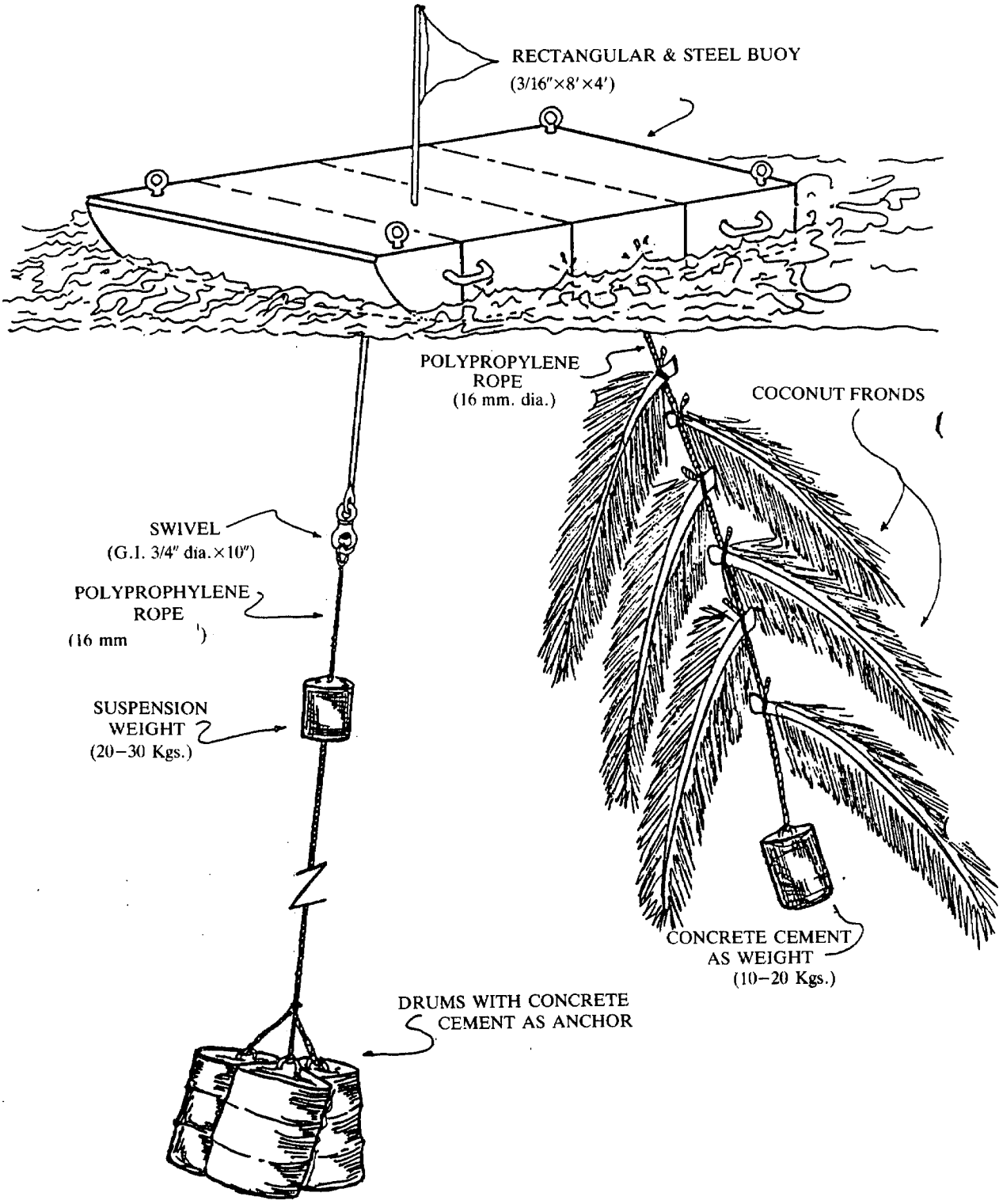

Fig. 3. Steel pontoon type of payao.

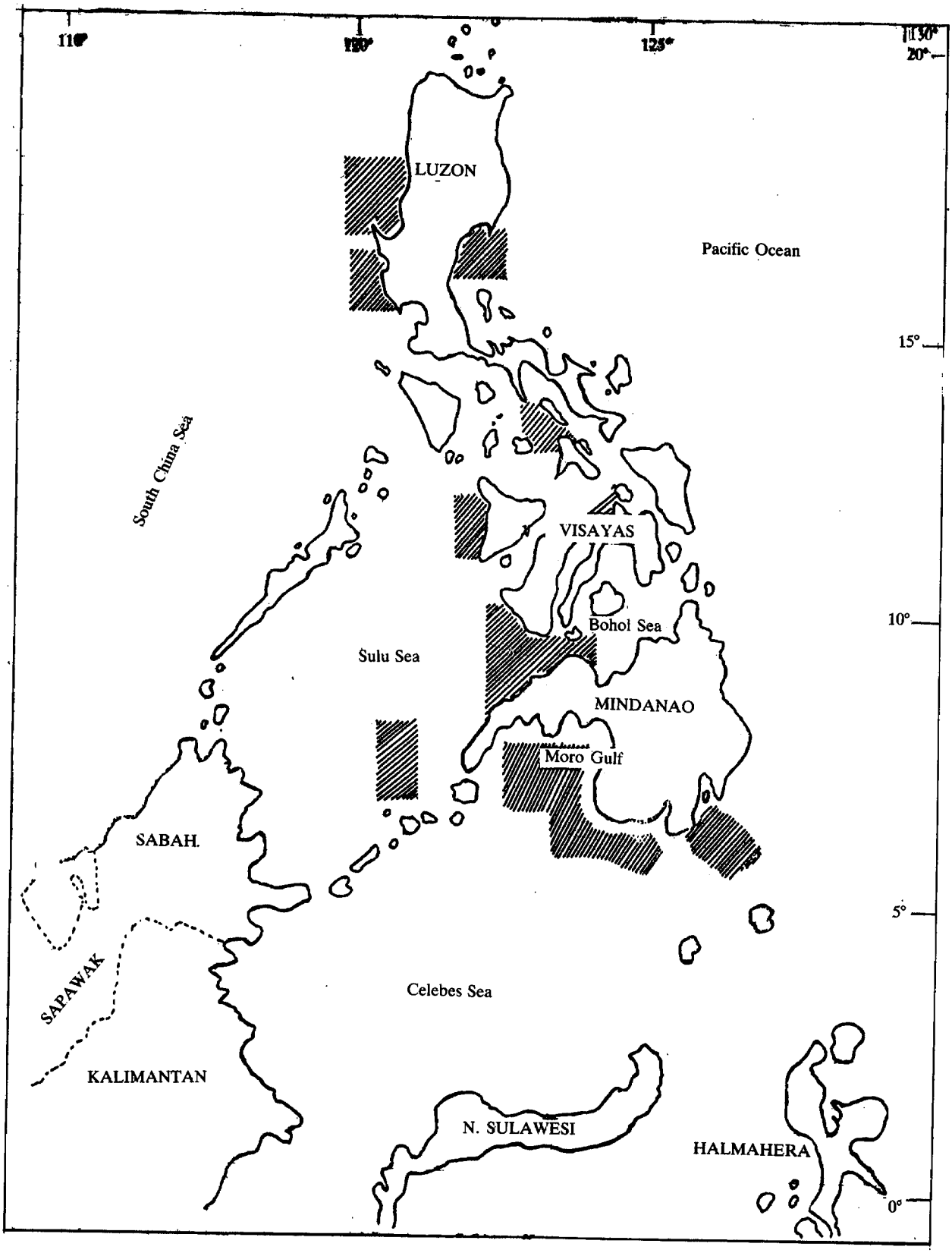

Fig. 4. Payao areas in Philippine fishing grounds.