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Milkfish fry and fingerling industry of the Philippines: methods and practices

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Milkfish fry and fingerling industry of the Philippines: methods and practices

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INTERNATIONAL DEVELOPMENT RESEARCH CENTRE

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PREFACE

The milkfish fry and fingerling industry is a multi-million peso enterprise in the Philippines. This industry has provided livelihood to thousands of families living in many coastal towns. The role of this industry to the social, economic and political life of these communities are undoubtedly far-reaching.

The existing methods and practices in catching, handling, storage, transport, acclimatization and rearing of milkfish fry and fingerlings have been established mostly by trial and error. Very minimal systematic research and experimentation have been done to increase catch and survival of this species. This is probably due to the relative abundance and low price of milkfish fry and fingerlings in the past years. The intensive production of milkfish in brackishwater ponds and freshwater fishpens in recent years led to increasing demand for fry and fingerlings. Reliable baseline information on the current status of milkfish fry resource and technical efficiency of the various phases of activity of the industry, is therefore, needed to determine the problems and prospects of maintaining adequate supply of milkfish seed in the country. The first part of this report is devoted to the biology of the milkfish. Without this fundamental information, it is difficult to relate milkfish conservation, catch and survival to different methods and practices presently being employed. Fishing gears and methods together with the topography of the fry grounds where they are operated are covered in detail. Similarly, storage, handling, transport and acclimatization of fry and fingerlings and subsequent responses of the fish under such circumstances are well elaborated. Included also is nursery pond operation, the most critical in milkfish pond management.

Additional information on the ecology, behavior, physiology and rearing methods of milkfish fry and fingerlings has recently been made available. Consequently, an update of our present knowledge is necessary to further minimize fish mortality and possibly increase supply of milkfish seed. Various papers on milkfish not cited in the text are included in the list of references. It is hoped that these may assist students and general readers in their search for more information and technical details.

The preparation of this report has involved the cooperation of many people to all of whom we are extremely grateful. Dr. Alfredo C. Santiago, Jr., Engr. Rolando Platon and Dr. Jesus Juario provided encouragement and support. Various personnel of the Bureau of Fisheries and Aquatic Resources gave their services willingly in the field and provided data on milkfish fry collection. We are pleased to acknowledge and thank the fishermen, fry concessionaires, fry dealers and pond owners without whose cooperation, this report could not have been written. With regards to the editorial work involved in the preparation of this report, our thanks are due to Ms. M.T. Corpus, Ms. A.B. Dormitorio, Mr. N. Macalinao and the RIS Staff, SEAFDEC AQD, for typing the manuscript.

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ABSTRACT

Milkfish fry catch from Philippine waters can still be increased. Intensified collections in traditional fry grounds and exploitation of new areas may lead to a reduction of adult stock and the possible collapse of the milkfish fry fishery. The implementation of rational conservation and management measures are of immediate concern not only to increase the productivity and number of fry grounds but also to conserve this important aquatic resource.

The present methods of catching milkfish fry involve fry filtration by mobile or stationary devices. The design, construction, area and time of operation of the gears are primarily dictated by the bottom topography of the fry grounds, wind direction, local current patterns and tidal fluctuations.

Catching, handling, storage and transport activities expose the fish to undue stress which contribute to poor survival. The simple method of lowering the salinity of the water medium considerably reduces mortality.

High mortality in nursery ponds has aggravated the seed shortage problem of the milkfish industry. The development of an efficient mass-production technology in rearing milkfish fry to fingerlings and in stunting fingerlings for longer periods could offer the solution not only in meeting the requirements for milkfish seed but also provide part of the fry requirements of other countries in the region.

INTRODUCTION

Milkfish fry is an aquatic resource which can be gathered in great number along particular coasts at certain times of the year. The fry, upon capture, are stored for sometime and transported for considerable distances. The fish are transferred to grow-out ponds or pens when they reach fingerling size. Care and attention are given to the fish to minimize mortality. The stress experienced by the fish during capture and transport affect them even when stocked in a favorable environment. Consequently, mortality may continue for some time after stocking.

The availability of seed stock has become the bottleneck in the culture of milkfish. Decreased fry catch, increased fishing pressure in the fry ground, high mortality, pollution and conversion of coastal wetlands into other uses are some of the difficulties that confront the milkfish fry and fingerling industry of the Philippines. Even when hatchery-bred milkfish fry become commercially available in the forseeable future, the natural fry fishery will remain an important and decisive factor in the culture of milkfish. This report aims to provide a general assessment of the milkfish fry fishery and present methods and practices of the industry as a basis in the formulation of policies for managing our natural milkfish fry resource and conducting research to increase fry survival.

METHODOLOGY

A survey of existing methods and practices of the milkfish fry and fingerling industry in major fry grounds, fry distribution and fingerling production centers of the Philippines were conducted. This was supplemented by examining the milkfish fry catch records of the different regions gathered by the Bureau of Fisheries and Aquatic Resources and personal interviews with fry collectors, concessionaires, fry dealers and pond owners in various parts of the country. Pertinent laboratory findings and field observations on the ecology, physiology, behavior and aquaculture of Chanos were also taken into account to relate these information with the current methods and practices of collecting, handling, storage, acclimatization and rearing of milkfish fry and fingerlings.

BIOLOGY

Spawning of Chanos occurs in the sea and not far from the shore. Initially, the eggs and resultant larvae are dispersed over the coastal and near shore waters. The pelagic larvae are ultimately concentrated and transported by eddies and currents in the general coastal areas from where it originated as spawn (Johannes 1980, Kumagai 1981). The fry (11.5-14.5 mm fork length) migrate to the shore and enter coastal wetlands with the aid of tidal currents. Inside coastal wetlands, the fry seek tidal pools and settle in the area for about one month until it grows to about 50 mm fork length juveniles. The juveniles then migrate to lagoons, lakes, or shallow shore waters and stay in this area until adolescence (25-45 cm fork length). Finally, the milkfish return to the sea for further growth and maturation (Villaluz *et al.* 1982). The life history of the milkfish is illustrated in Figure 1.

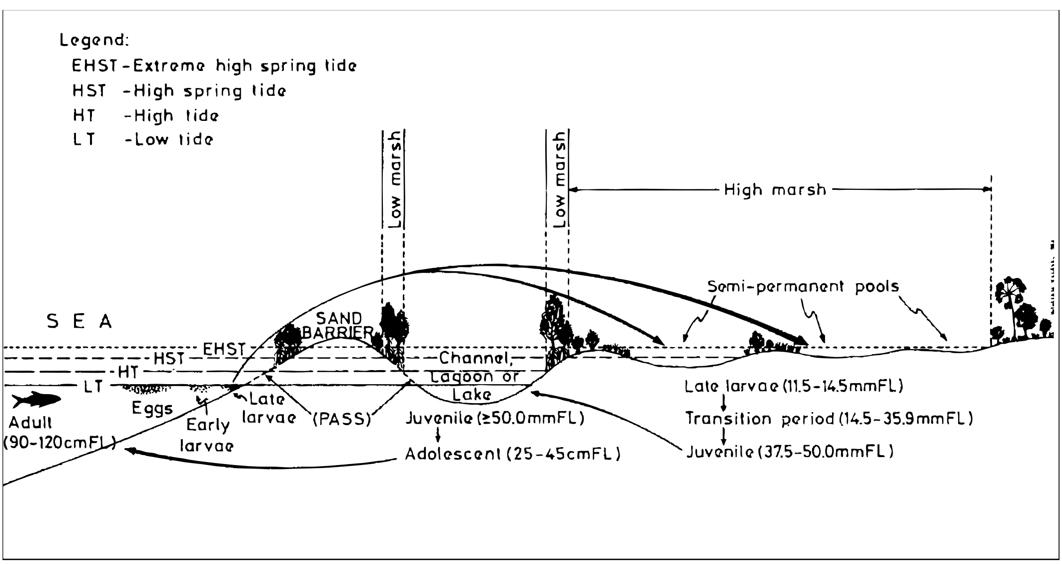

Fig. 1. Life history of the milkfish (*Chanos chanos*).

Large milkfish weighing 11.9 to 17.6 kg have been reported in the coastal waters of Java, Taiwan and the Philippines. Sexually mature Chanos caught along the Antique coast of Panay Island, Philippines, measured 50-120 cm standard length and 5.13 to 7.7 kg in weight, with the males smaller than females (Villaluz 1979). Wild milkfish attain sexual maturity in 5 years (Tiro *et. al.* 1976). This has been found to be also true for domesticated milkfish reared in cages (Lacanilao and Marte 1980). One female can produce 1 to 7 million eggs. It is not known, though, whether this species spawns only once or several times in a year.

Successful spawning of wild milkfish in the laboratory by hormonal induction (Vanstone *et. al.* 1977, Chaudhuri *et. al.* 1978, Liao *et. al.* 1979) and spontaneous spawning of domesticated milkfish in cages (Lacanilao and Marte 1980) have been achieved. Under laboratory conditions, the eggs hatch from 25 to 36 hours after fertilization at 28 to 30°C. The laboratory-bred larvae at 21 days after hatching have similar morphological features to newly-caught shore fry. The early phases of development of milkfish are shown in Figure 2.

The permanent (year round) marine distribution of the species in the Indo-Pacific region is limited to a zone between latitudes 30°N and 30°S. The precise limit of seasonal extensions of range, however, vary yearly depending on prevailing climatic conditions (Fig. 3).

MILKFISH FRY GROUNDS AND SEASONAL OCCURENCES IN THE PHILIPPINES

Milkfish fry can be collected in almost all coastal waters of the Philippines. The fry are more abundant in areas with narrow littoral zones but scarce in places with extensive tidal flats or shallow inland bays with relatively low salinity (5-20‰S).

Traditional milkfish fry grounds in Luzon are located from Cagayan in the north, extending southward along the western side except in the inner portions of Lingayen Gulf and Manila Bay, to the coastal waters of Batangas, Albay in eastern Bicol, and Mindoro Island; in Central Philippines, around Panay Island particularly Iloilo and Antique Provinces, Negros and Cebu; in Mindanao, along the shores of Zamboanga, Cotabato and Davao (Villaluz 1953, Blanco 1972).

The present milkfish fry grounds of the Philippines with the corresponding catching gears being used in each locality and their degree of exploitation are indicated in Figure 4. Fully exploited fry grounds are areas where fry gatherers are engaged in full time collection of fry throughout the season and employ several catching methods to maximize catch in a given locality. Exploited fry grounds are areas where fry collections are generally confined during the peak season or limited to certain days of the season (i.e. during full-moon and new-moon periods

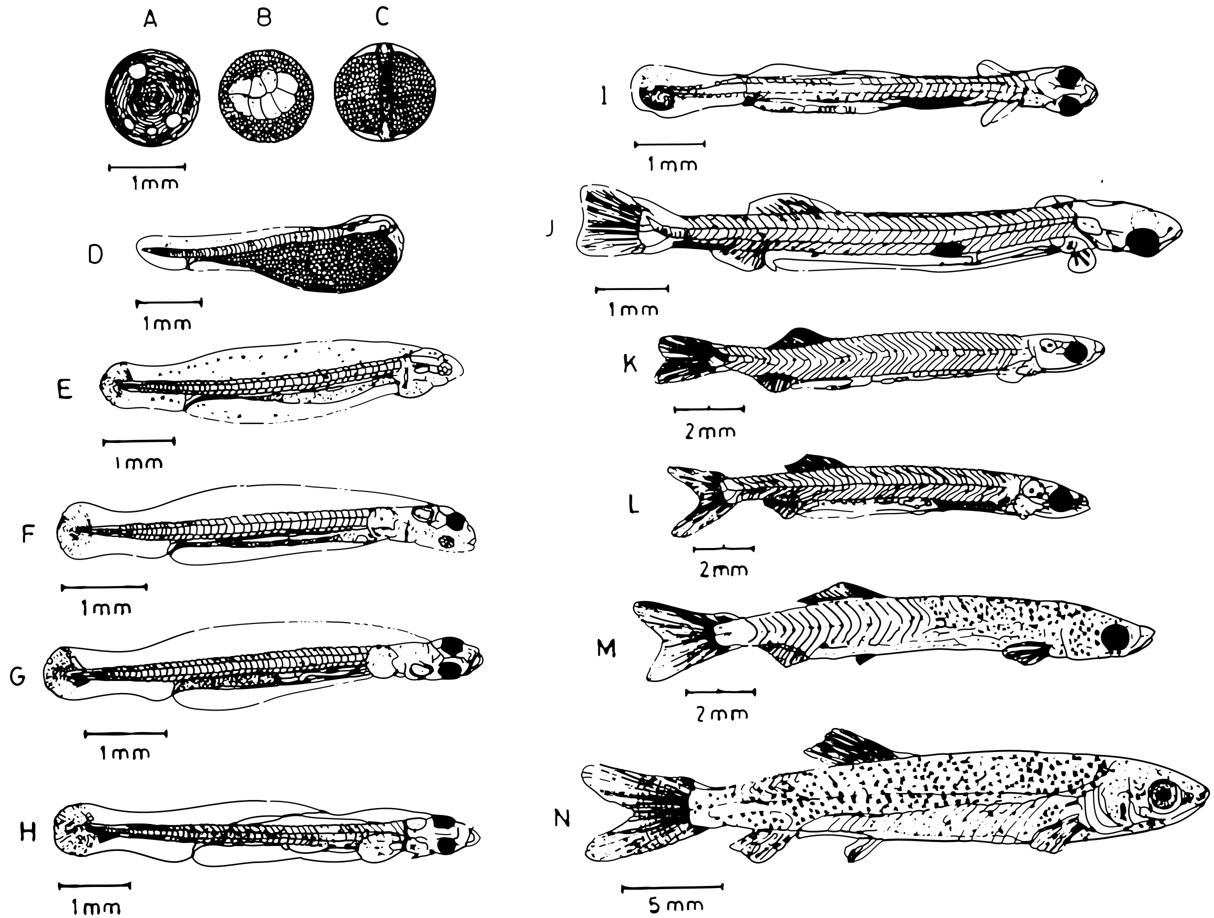

Fig. 2. Early developmental phase of *Chanos chanos*. A) Newly-fertilized egg, B) Cleavage phase, C) Embryonic phase, D) Newly-hatched larva, E) One-day-old larva, F) 2-day-old larva, G) 4-day-old larva, H) 6-day-old larva, I) 9-day-old larva, J) 14-day-old larva, K) Wild caught larva, L) 21-day-old larva, M) 28-day-old transition stage, N) 35-day-old juvenile. (Villaluz 1979).

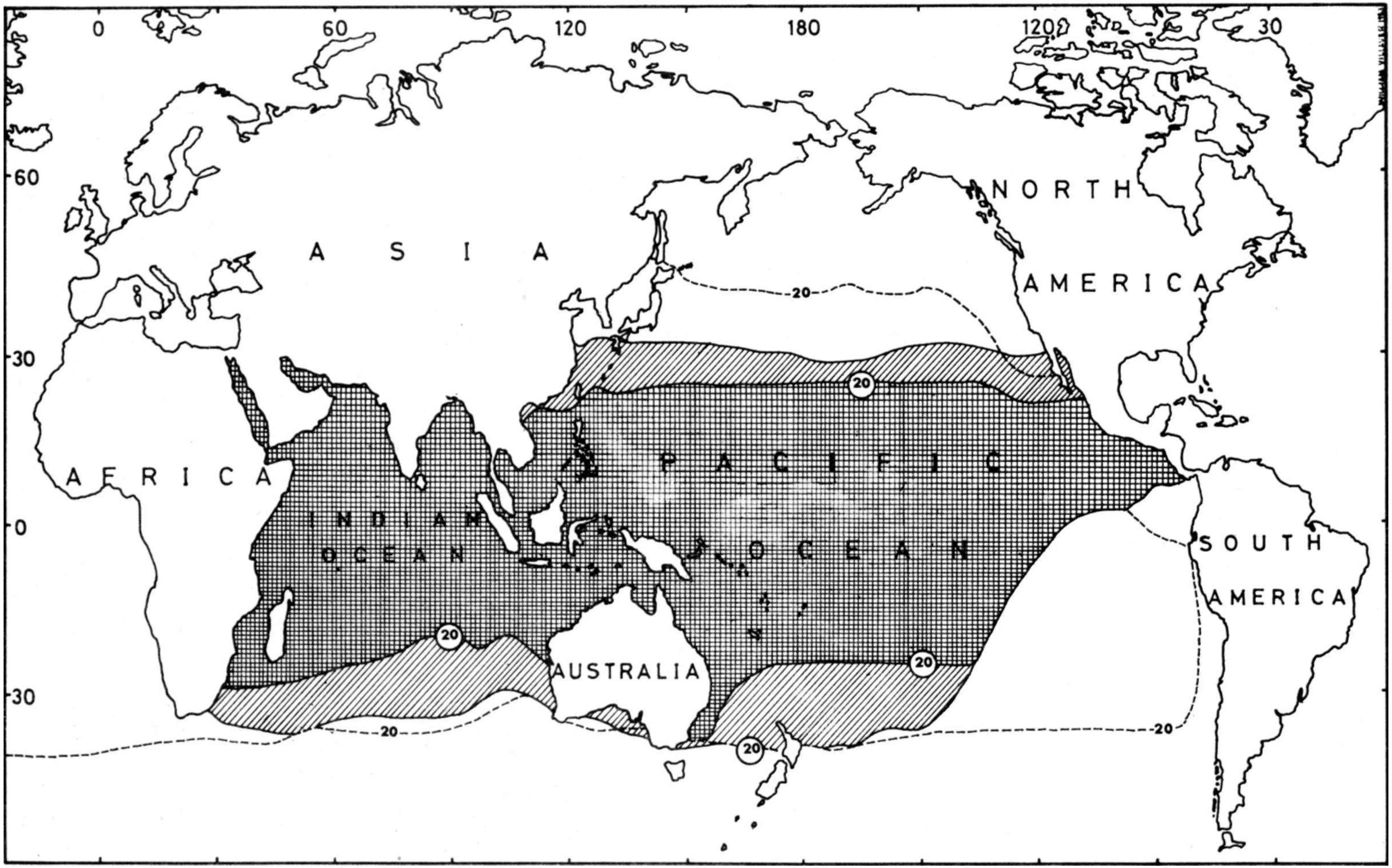

Fig. 3. Geographic distribution of the milkfish. Broken lines represent summer and solid lines winter surface isotherms (after Sverdrup *et al.* 1942). Darker shaded area represent area of general occurrence and lighter shaded portions areas of sporadic occurrence.

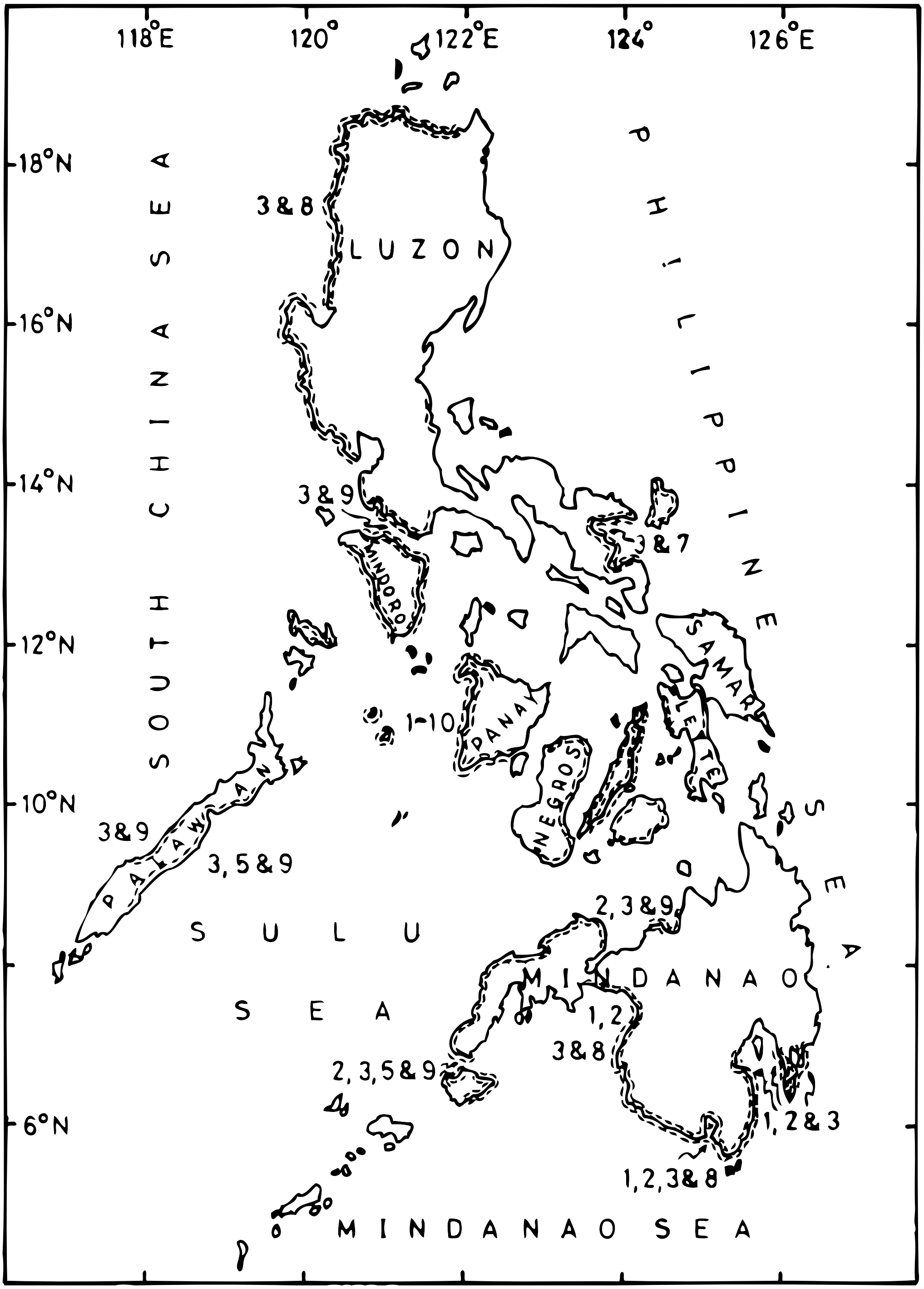

Fig. 4. Milkfish fry grounds of the Philippines with the corresponding gears being used in each locality and their degree of exploitation. Single broken lines indicate exploited fry grounds and double broken lines indicate fully exploited fry grounds. Numbers 1-10 represent the catching gears being used in each locality as follows: 1- fry barrier, 2-skimming net, 3-tidal set net, 4-floating tidal set net, 5-push net, 6-push net with bamboo raft, 7-tow net with bamboo float, 8-tow net, 9-double stick net, 10-fry seine net.

and favorable wind direction when milkfish fry are more abundant) with only one or two catching methods employed.

The time of appearance of milkfish fry in commercial quantity differs in different geographic locations within the Philippines. A single annual peak fry season in each locality is apparent but its occurrence at different latitudes (Fig. 5) and fry abundance may vary from year to year. In Southern Philippines, along the coastal waters of Cotabato, Zamboanga and Basilan, milkfish fry are collected throughout the year with peak season generally occurring from March to May. Milkfish fry are gathered from March to January in Central Philippines (Panay, Negros, Palawan) and most abundant during the months of April to June. In Northern Philippines (Cagayan, Ilocos, Pangasinan), the fry are collected from March to August with peak months from May to July. Milkfish fry occurrence, becomes shorter and peak season later from South to North in Philippine waters.

Milkfish fry fishery is unique among our renewable aquatic resources. Here, it is the larvae that are exploited and therefore, the common methods of stock assessment in predicting the future of the fishery cannot be adopted. It is compounded by the fact that it is illegal to catch adult milkfish (although catching still continues) which precludes acquisition of catch statistics. Further, it has been reported by fry gatherers in the various parts of the country that the appearance of large number of fish predators, particularly anchovy (**Stolephorus** sp.), greatly reduce their catch.

MILKFISH FRY FISHING GEARS AND METHODS

The milkfish fry fishing gears and methods presented herein are arranged under a classification system proposed by Brandt (1972) which is based on the principle of how fish are caught.

A. Trap

1. Fry barrier or fence (Fig. 6)

This is an implement in which fry are either attracted to or concentrated along its sides by favorable wind, current or tidal action. Although used to catch fishes since ancient times, fry barrier (*lambay, saplad, tadtad*) has just been adapted in the Philippines to collect milkfish fry. This gear may consist of fine-meshed nylon nettings (0.3-1.6 mm mesh), split bamboo mattings, coconut palm or combinations thereof, tied to bamboo or mangrove stakes. The barrier walls are either secured in a fixed position or can be adjusted in such a way that the upper portion of the walls are always above the water level when in operation. Fry

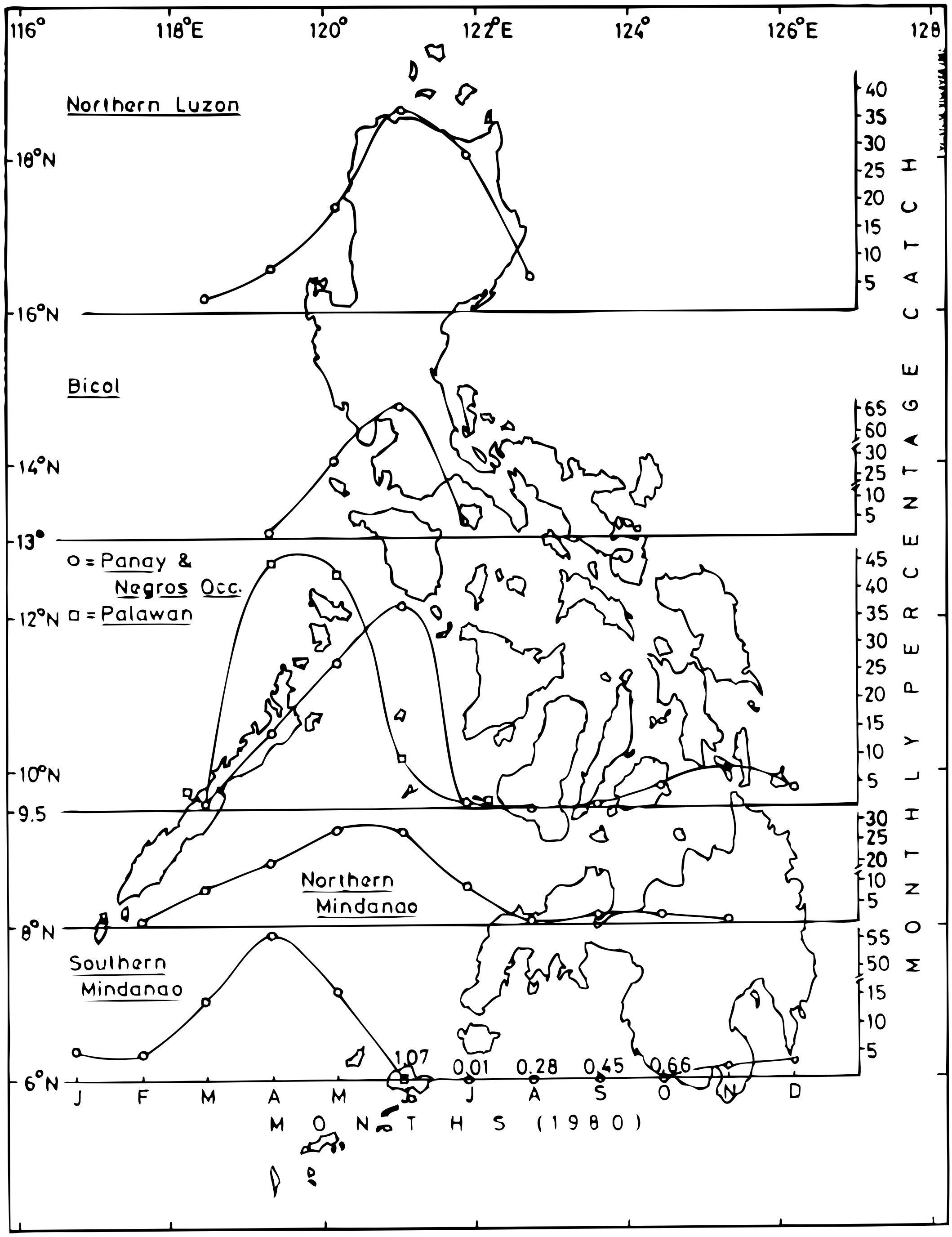

Fig. 5. Monthly percentage catch (1980) of milkfish fry in the different parts of the Philippines.

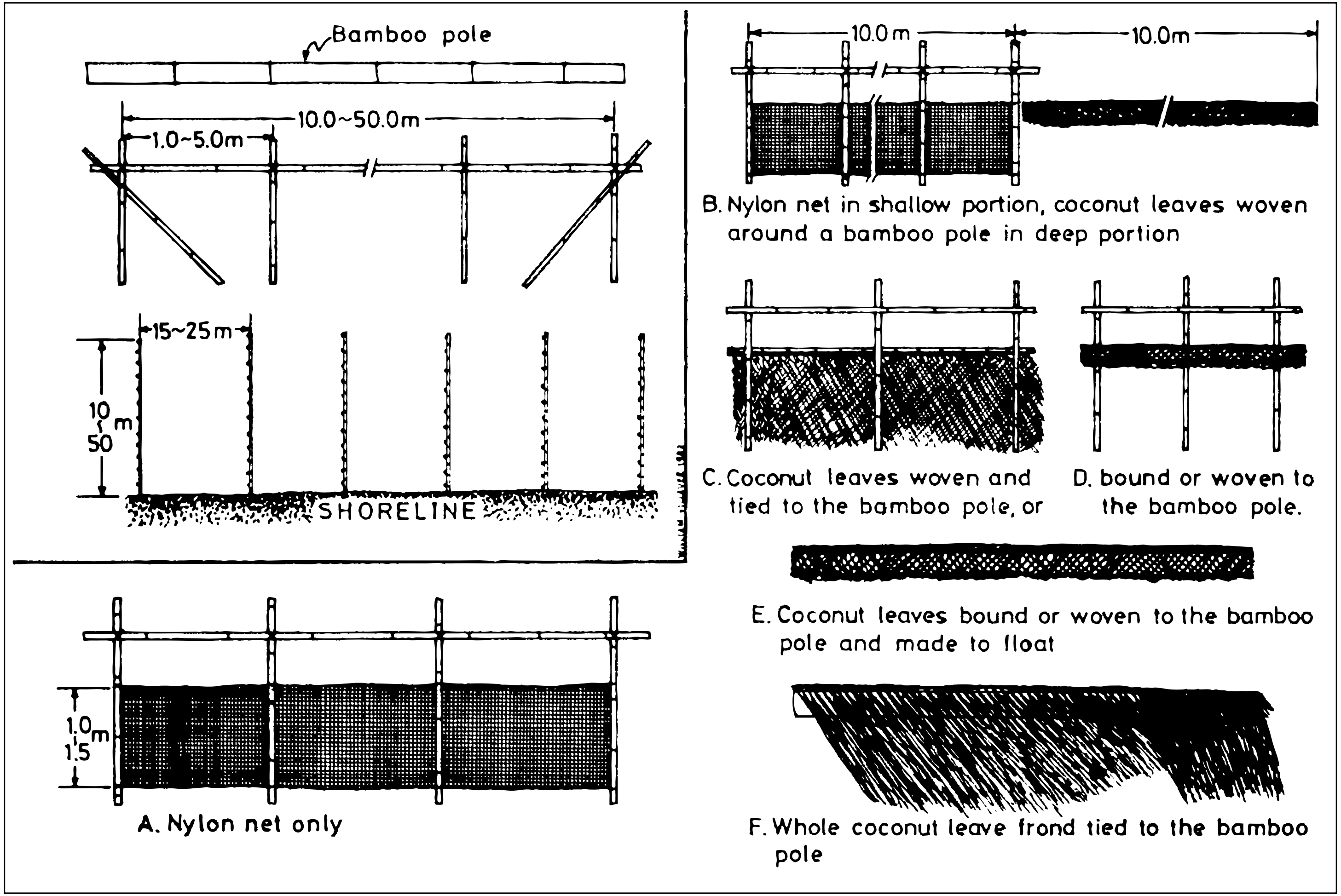

Fig. 6. Milkfish fry barrier or fence, its structure and dimensions (inset) and kinds of materials used (A-F).

barriers are usually set more or less perpendicular to the shore extending to about 10-50 meters from the shoreline. In intensively exploited fry grounds, the gears are located 15-25 meters apart.

Shallow intertidal areas along a narrow pass or straight and tidal flats with muddy or corraline substrate are the most suitable locations for this type of gear. In mangrove areas, fry barriers are set halfway across tidal creeks. Examples of shore profiles and areas of operation for this particular gear are shown in Figures 7 and 8. In fry grounds near fishponds, more fry can be caught along the barrier when pond water is being drained.

Actual catching of fry is done by using skimming net (Fig. 9) or double stick net (Fig. 10). The fry are then transferred from the net to a basin or pail with the aid of a small bowl.

Milkfish fry barriers are simple, easy to construct and operate, extend the area of fry collection and are reusable. However, time of operation and number of catch are highly dependent on favorable wind, current and tidal conditions.

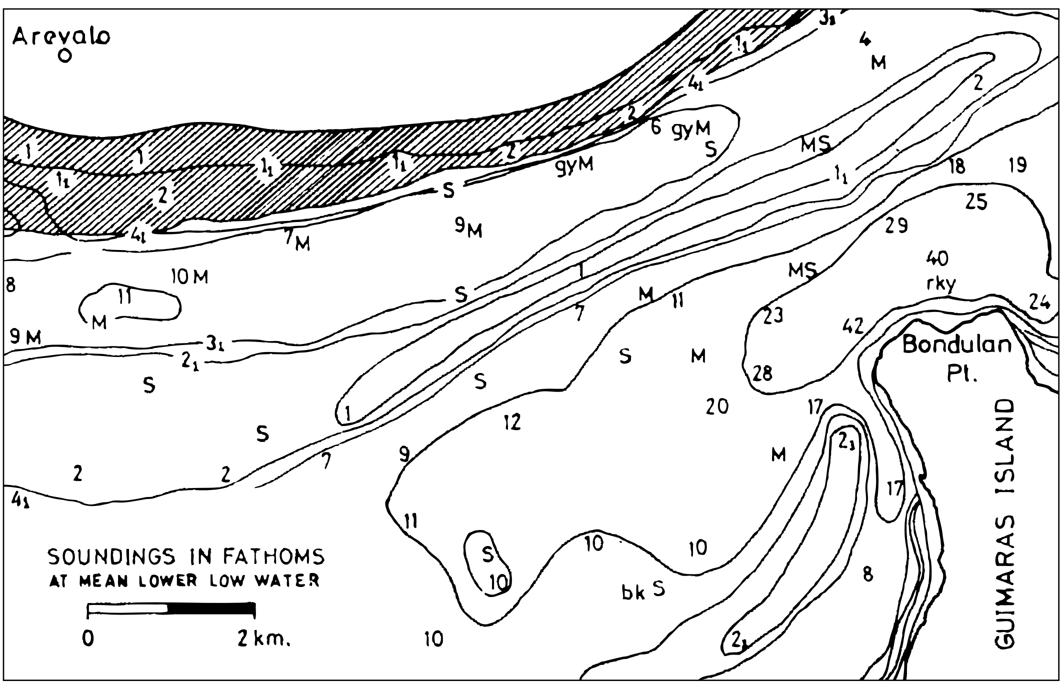

Fig. 7. Typical shore profile and area of operation for fry barrier or fence (Villa Beach, Iloilo City). Shaded portion indicates the extent of operation of fry barrier or fence.

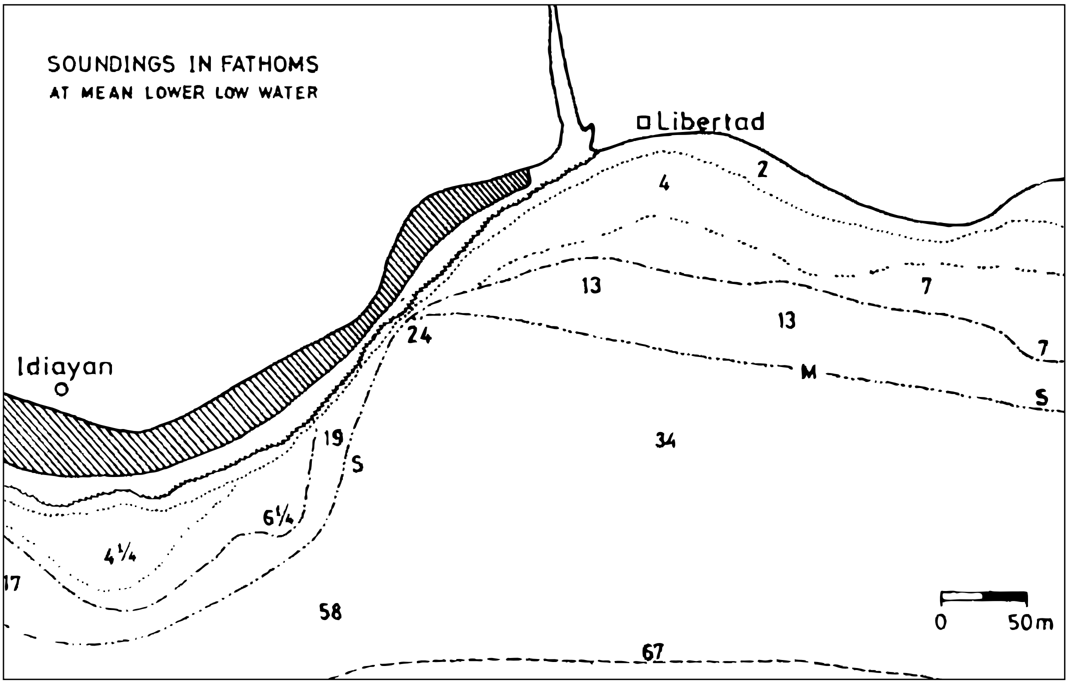

Fig. 8. Another example of shore profile and area of operation for fry barrier or fence (Libertad, Antique).

Fig. 9. Catching of fry concentrated along the fry barrier with the use of skimming net (Villa, Iloilo City).

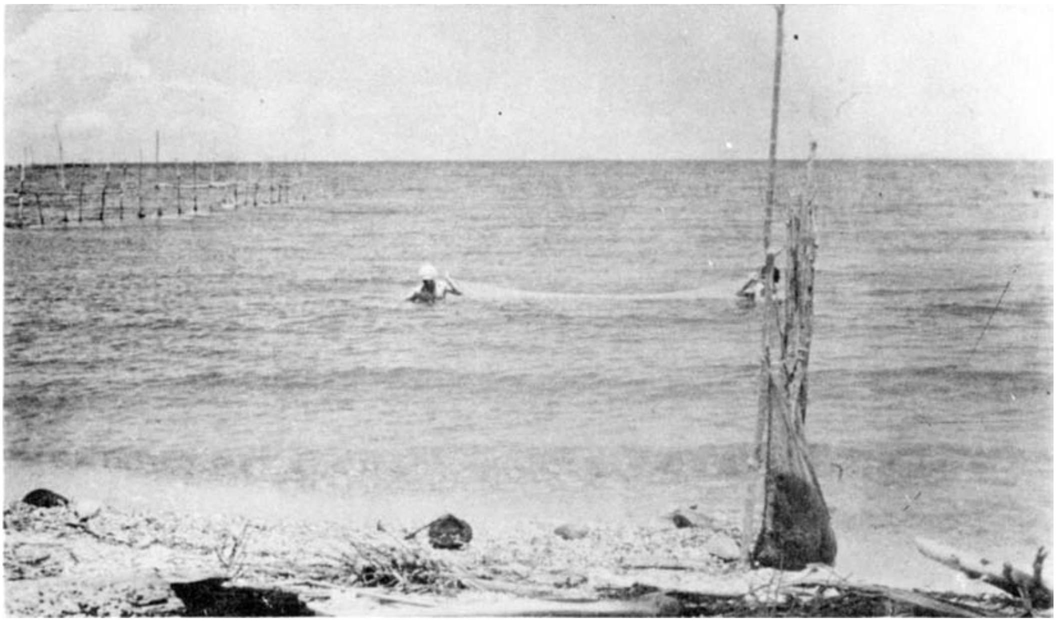

Fig. 10. Catching of fry concentrated along the fry barrier with the use of double stick net (Libertad, Antique).

B. Bag Nets

1. Skimming Nets (Fig. 11)

Skimming nets have fixed triangular or semicircular frame. The nets may be made of abaca nettings (*sinamay;* fiber 0.2-0.4 mm, mesh 0.3-1.3 mm) or fine meshed nylon nettings (0.3-1.6 mm mesh). This gear filters milkfish fry from the water while being pushed forward by the operator. Skimming nets are effective in mangrove areas particularly between roots of trees or nipa stumps; along fishpond dikes and canals (Fig. 12); tidal flats with muddy or corraline (Fig. 13) substrate. It is also utilized to collect milkfish fry concentrated along the sides of fry barriers.

Women and children generally use this type of gear due to its lightness and ease of operation.

2. Filter Bag Nets

2.a. Tidal set net (Fig. 14)

Tidal set nets (*tangab, saplad*) are usually constructed across the mouth of tidal rivers or creeks. The gear consists of a V-shaped barricade with the walls or wings made of matted bamboo (*tadtad*)

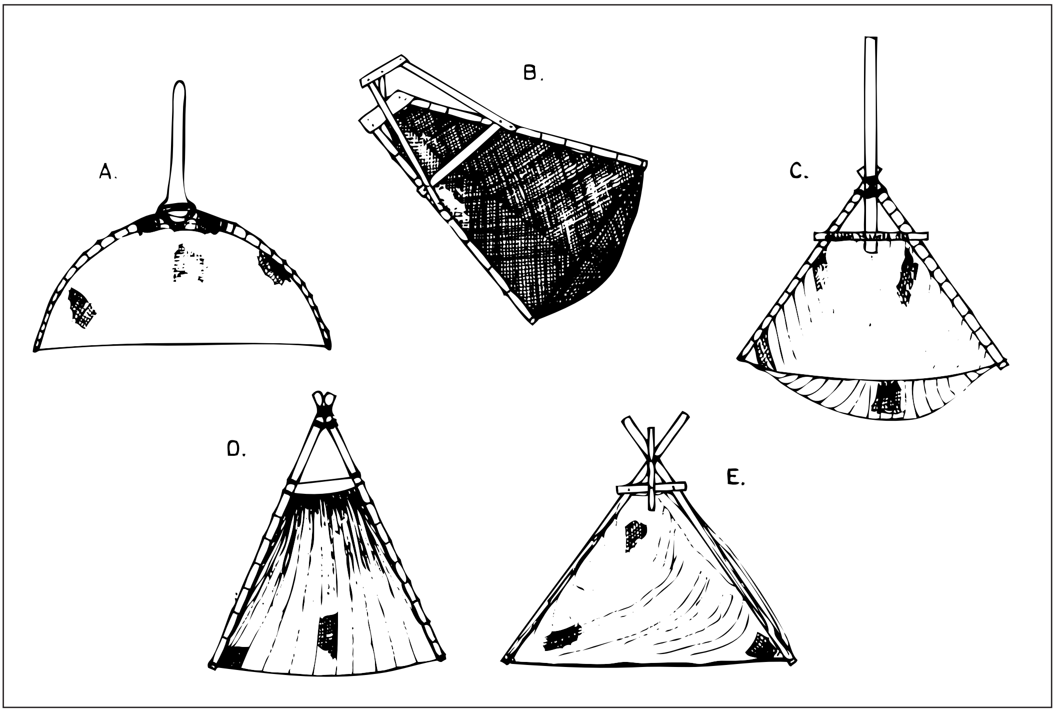

Fig. 11. Different modifications of skimming net.

Fig. 12. Catching of milkfish fry with the use of skimming net along the canal outside the fishpond (Dauan, Davao Oriental).

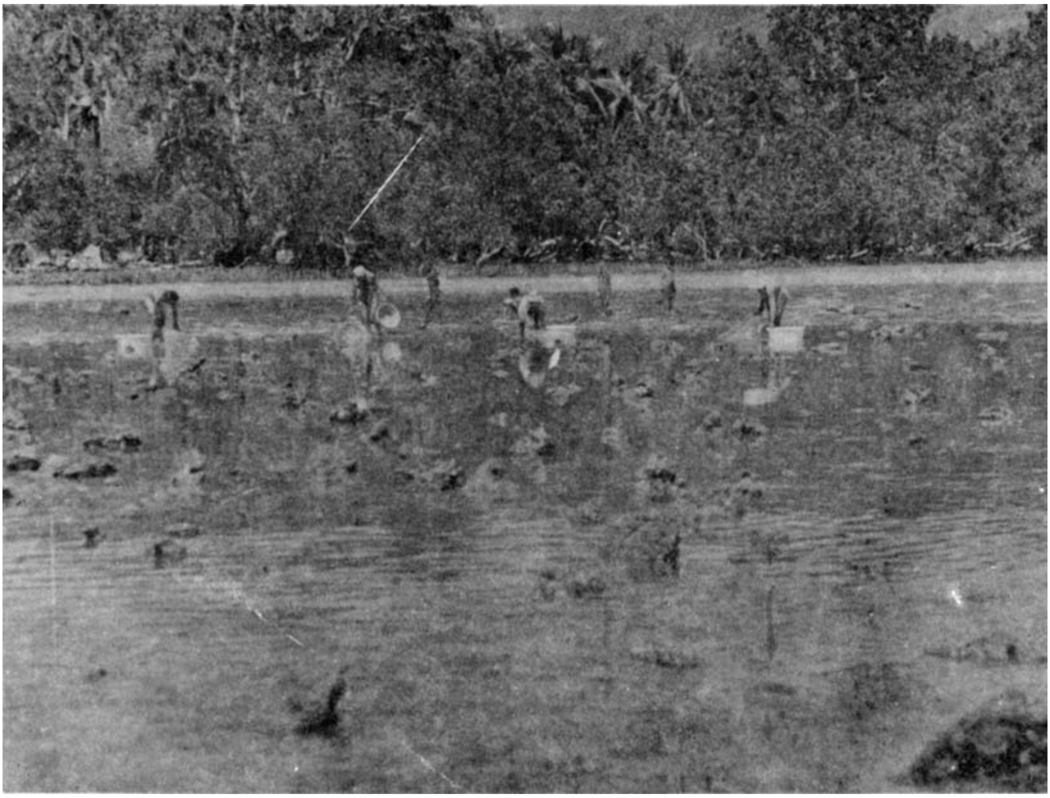

Fig. 13. Catching of milkfish fry with the use of skimming net in tidal flat with corraline substrate (Talisay, Davao Oriental).

or fine-meshed nylon nettings with or without rattan and bamboo slat support. At the end of the wings, a sinamay cloth, rectangular in shape, is placed hammock-like where the fry are concentrated and caught. A modified tidal set net made entirely of fine-meshed nylon nettings is shown in Figure 15.

Mouths of creeks and rivers which were closed by sand deposition are opened manually or by a bulldozer before placement of tidal set nets. There are several ways in which this gear is set. In small creeks (Fig. 16) and rivers (Fig. 17), the gear consists of a single catching chamber with wings extending to both sides of the bank, while in relatively large rivers, a series of *tangab* is set across the river mouth (Fig. 18). In some parts of the Antique province, tidal set nets are constructed along the shoreline facing favorable wind, current and tidal movements (Fig. 19). The tidal set net is generally operated at the start of flood tide until slack water before ebb tide. Operation of this type of gear requires two to five men. One man cleans the catching chamber of debris and scoops the concentrated fry, another sorts and counts the catch while the others adjust the gear to keep the upper edge just above the water level. In some

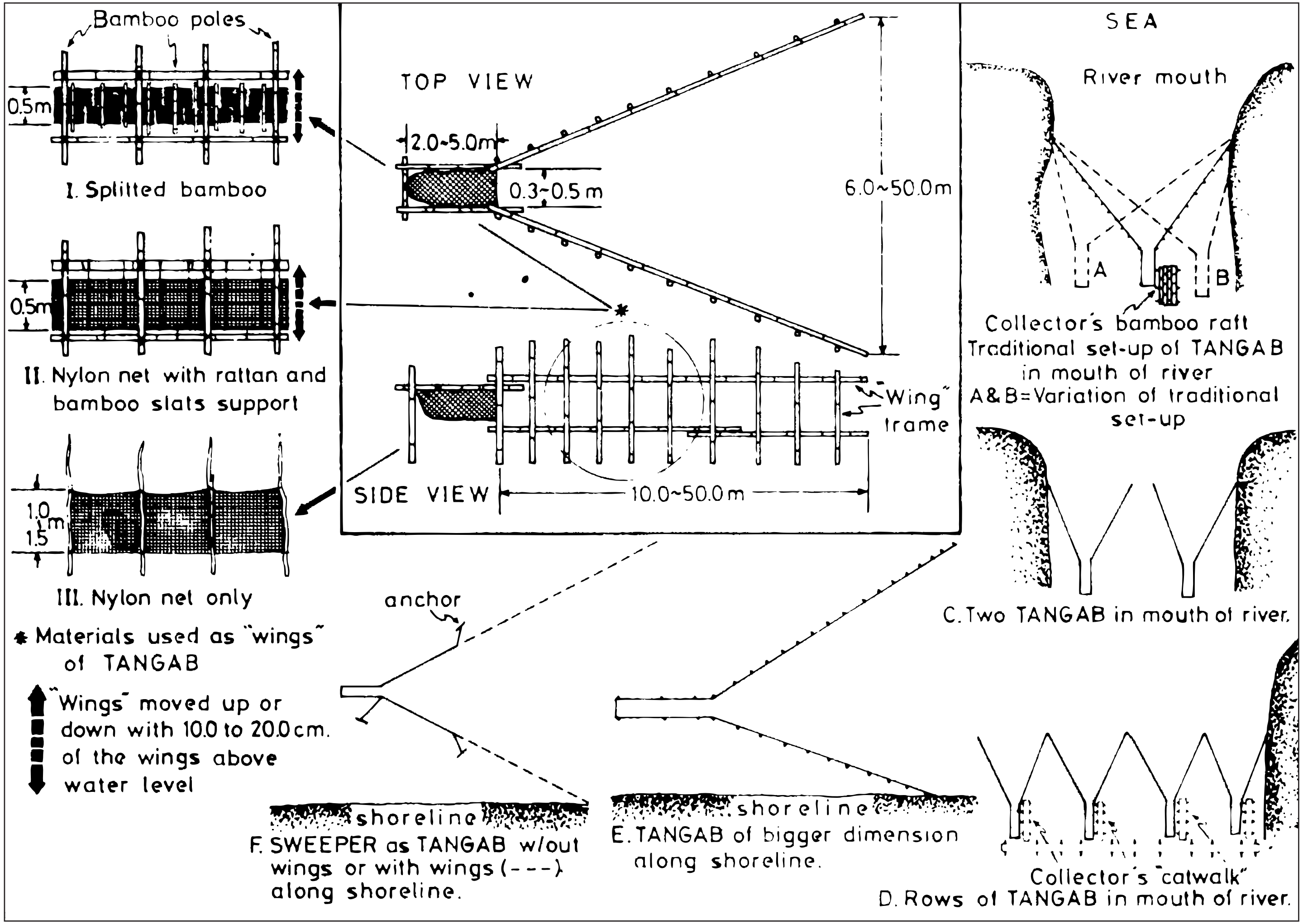

Fig. 14. Tidal set net, its structure and dimensions (inset), wing materials (I-III), and variations in setting (A-F).

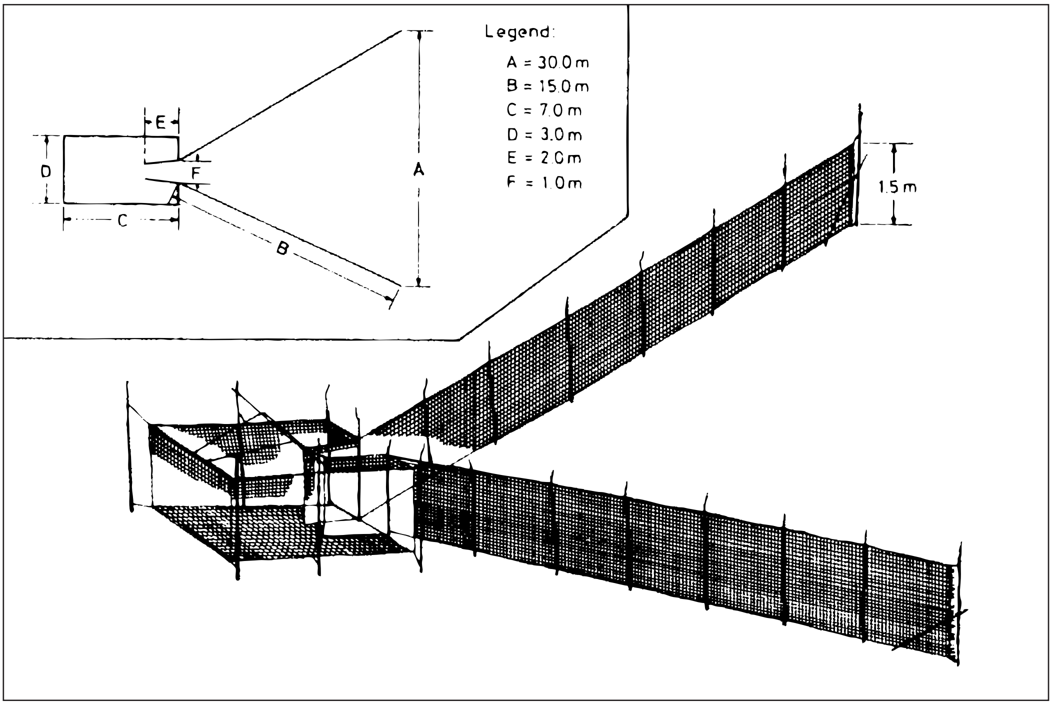

Fig. 15. Modified tidal set net, its structure and dimensions (inset) set along the shoreline.

Fig. 16. Tidal set net with matted bamboo wings set in small tidal creek (Dinaig, Maguindanao).

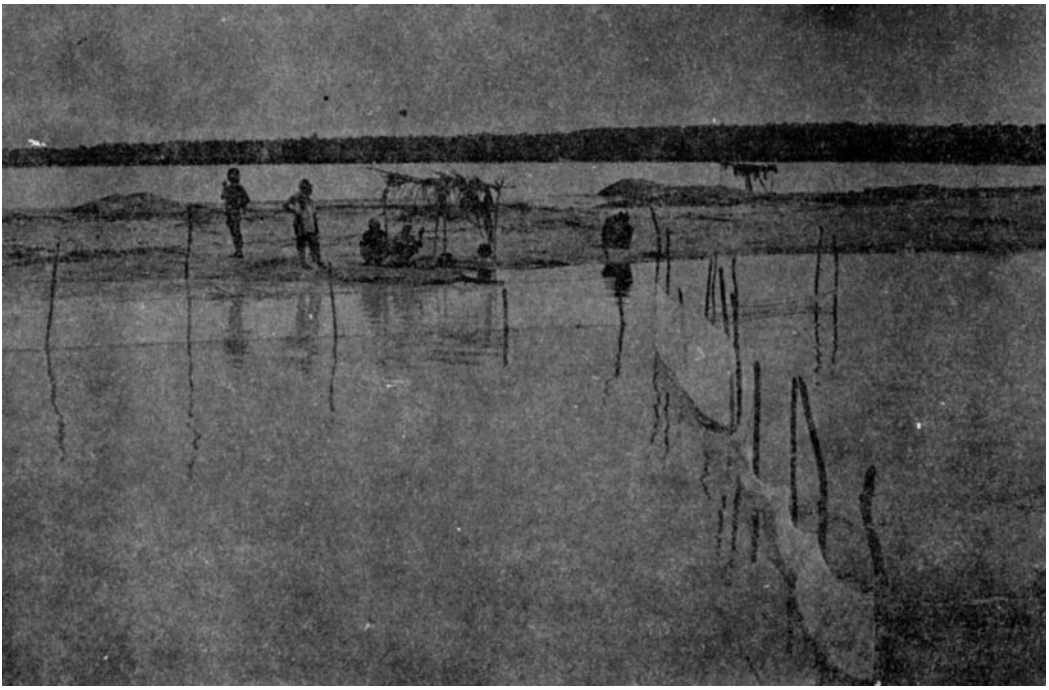

Fig. 17. Tidal set net made of fine-meshed nylon netting set in tidal river (Currimao, Ilocos Norte).

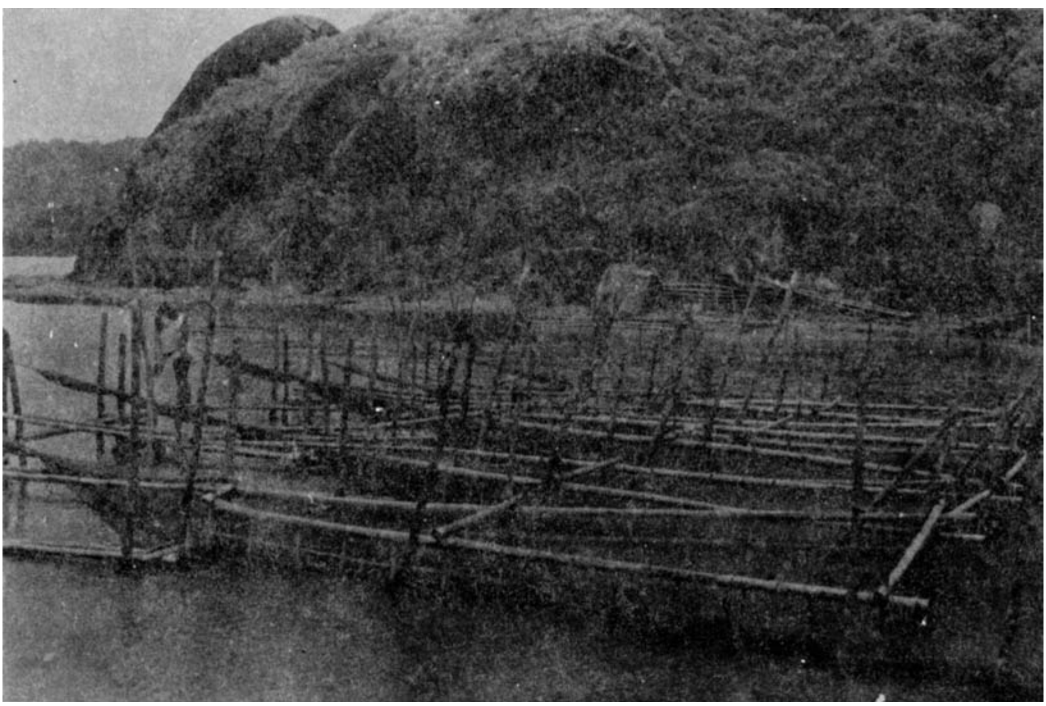

Fig. 18. Series of tidal set net set across the river mouth (Pata Pt., Claveria, Cagayan).

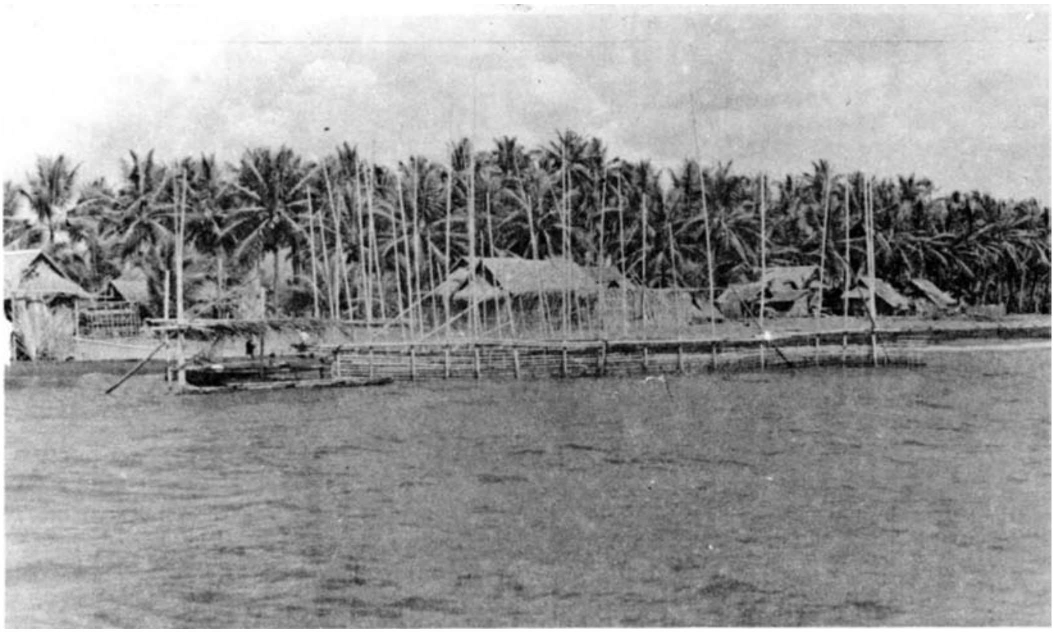

Fig. 19. Large tidal set net constructed along the shoreline facing favorable wind, current and tidal movements (Maybato, San Jose, Antique).

parts of Northern Luzon, *tangab* is still operated even during receding tide. The catch, however, is less during receding tide. Daily total catch ranges from 5,000-20,000 fry.

Though the tidal set net is relatively easy to operate and efficient it is site specific. It can not be operated during the rainy season due to floods or when tidal creeks are closed by sand bars. Operation of this gear is also limited from April to July in tidal creeks which are inundated only during higher high tides.

2.b. Floating tidal set net (Fig. 20)

Floating tidal set net (*tangab-balsa*) is set against longshore currents and is particularly suited to points with relatively shallow corraline platform similar to Lipata Point, Culasi, Antique (Fig. 21). It consists of a V-shaped floating extended wings made of coconut leaves bound to bamboo poles, a bamboo frame with sides provided with fine-meshed nylon netting, and a concentrating and catching chamber which is made of *sinamay* cloth suspended from a bamboo that extends horizontally to the back of the frame. The offshore side of the extended wings is longer (20-30 m) than the nearshore side (6-8 m). The gear opening between the two tips of extended wings is from 20-30 m. *Tangab-balsa* is set about 10-15 m apart, one in front of the other and anchored in place (Fig. 22).

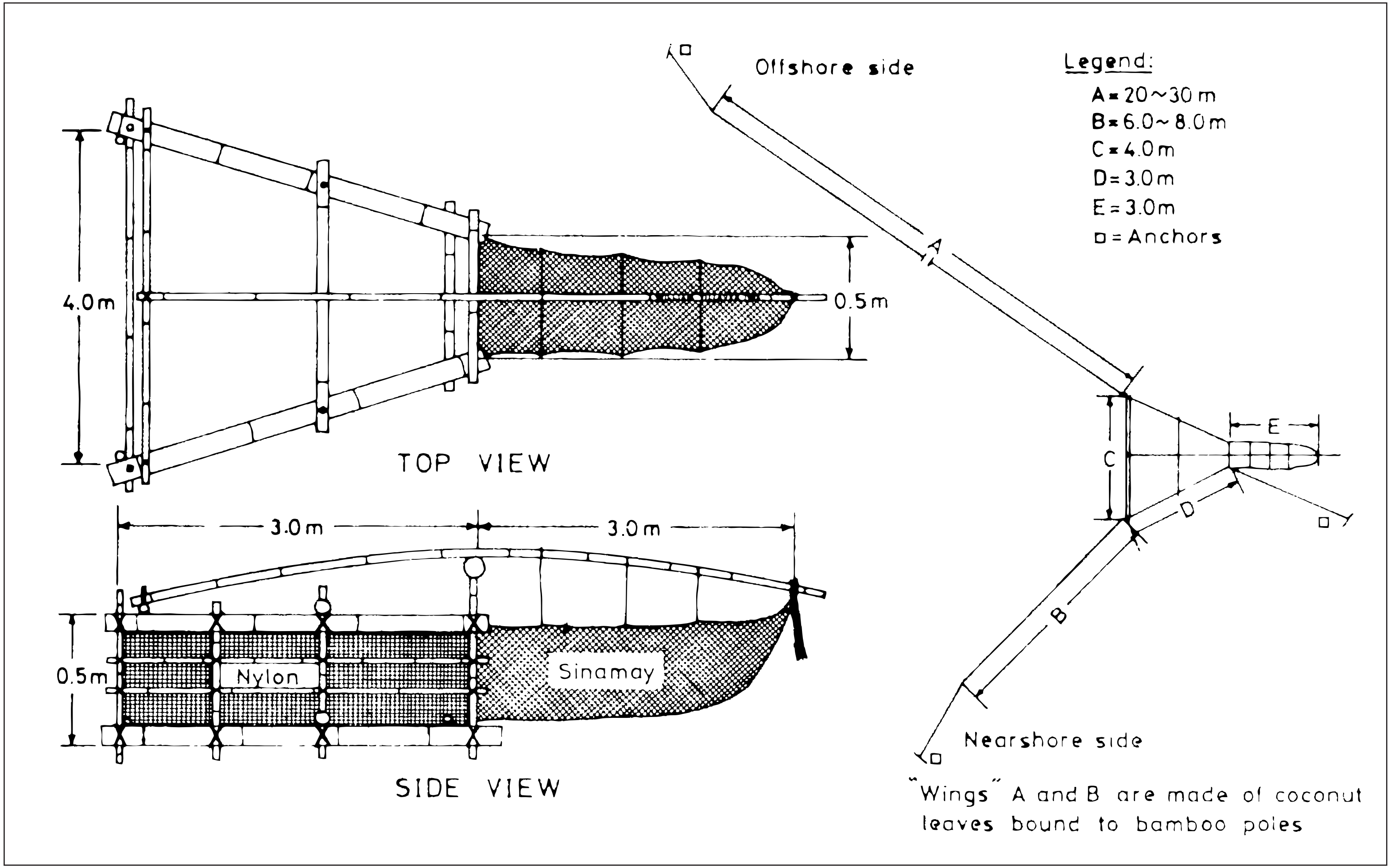

Fig. 20. Floating tidal set net, its structure, dimensions and how to set it up.

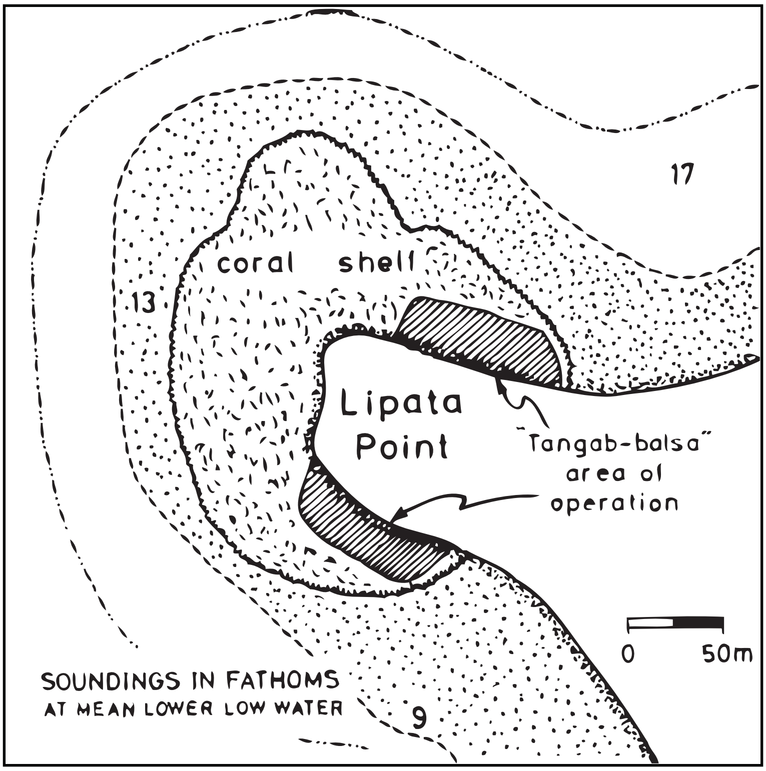

Fig. 21. Typical shore profile for setting up and operation of floating tidal set net (Lipata Pt., Culasi, Antique). Shaded portion indicates area of operation of floating tidal set net operators.

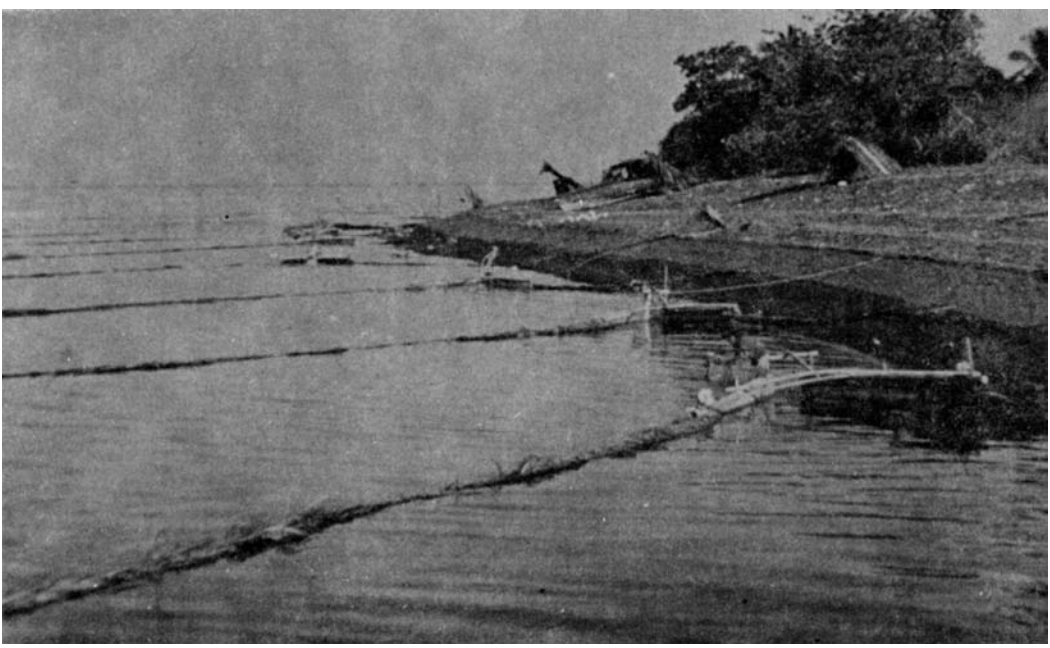

Fig. 22. Floating tidal set net against longshore current (Lipata Pt., Culasi).

The gear is operated by one man. It is usually operated when the tide starts to rise until slack water before ebb tide begins. Operation is continued even during receding tides when wind and current movements are favorable. After operation, the bamboo frame together with the catching chamber is brought to the beach but the wing extensions are left in place. Total daily catch is from 2,000-10,000 fry in Culasi during the peak fry season. The gear is also used to catch prawn fry after the milkfish fry season.

2.c. Push net (Fig. 23)

Push net (fry sweeper) consists of V-shaped bamboo frame with detachable net made of fine-meshed nylon netting. The bagnet is located within the narrow end of the frame. *Sinamay* cloth is usually sewn over the nylon netting at the end portion of the bagnet to prevent the fry from sticking to the nylon netting during the process of concentrating and catching. The wings and bagnet are weighed down with lead sinkers and tied to the frame in such

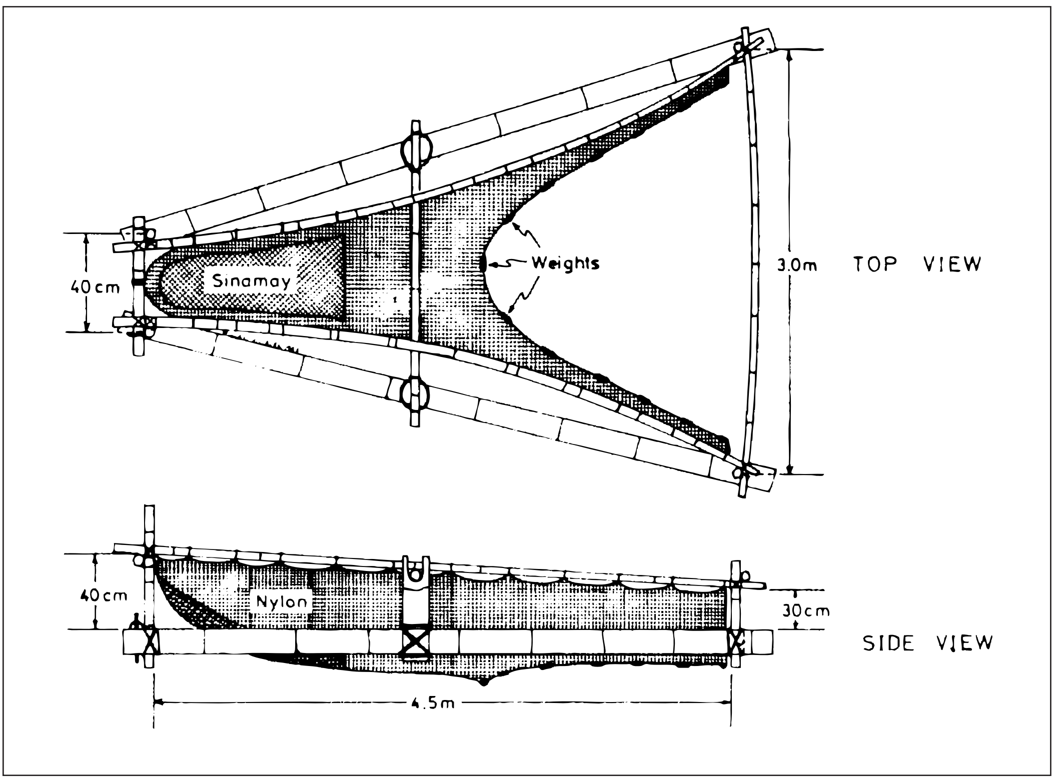

Fig. 23. Push net, basic type, its structure and dimensions.

a way that the top portions are always above the waterline with the lower parts 5-15 cm below the water surface. Adjusting portions of the bagnet and wings in relation to water surface is necessary. Milkfish fry are generally observed to swim very near the surface to about 5 cm deep during fair weather but go down from 6-15 cm below the water surface during the rainy days.

Push net is the most common gear used to catch milkfish fry in Panay Island. Different modifications of the frame in various places in Panay Island are shown in Figure 24. The gear is particularly effective in areas with gently to moderately sloping shore profiles (Fig. 25, 26 and 27). Usually, two people are involved in the operation. One person pushes the gear and scoops the fry from the bagnet. The other person is at the shore and takes charge of bringing the pail or basin whenever the fry are scooped out of the bagnet, and sorts unwanted species. In Culasi Antique, the gear has bigger dimensions and the frame is provided with a platform for basins and pails. Since this modified fry sweeper is too heavy for one person to push, another person in the shore assists by pulling the gear with a rope (Fig. 28). Total daily catch for this type of gear is from 2,000-5,000 fry.

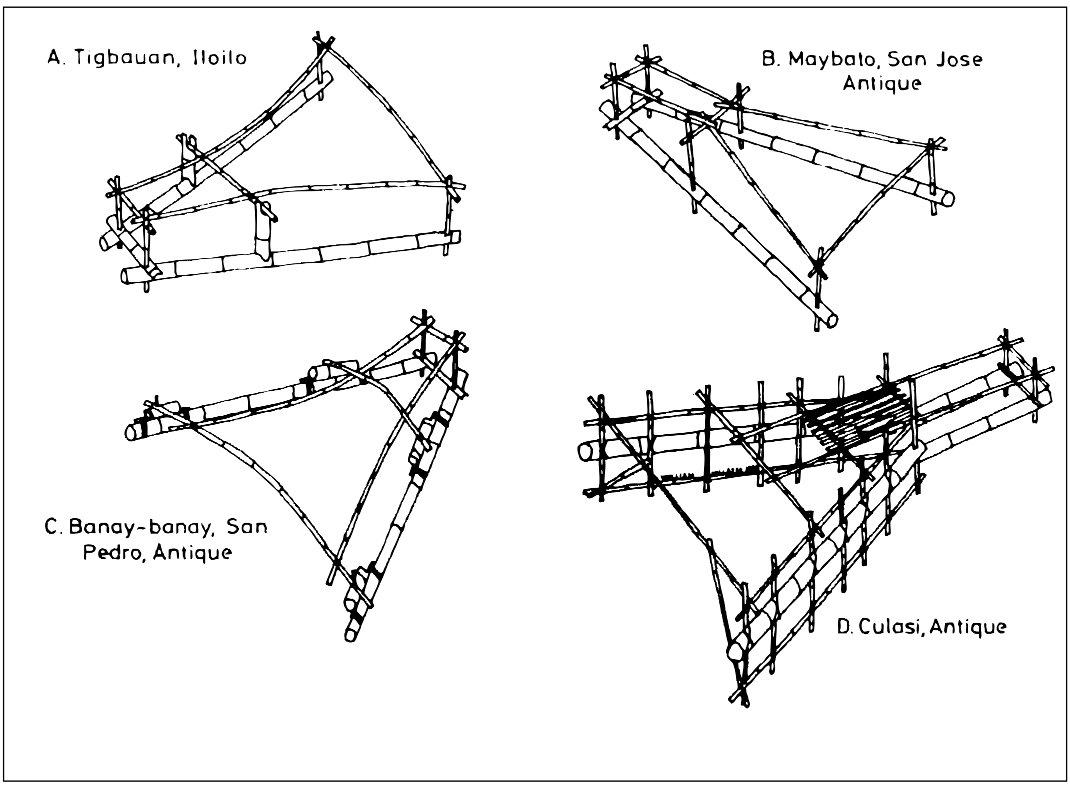

Fig. 24. Variation of the frame of push net in different localities.

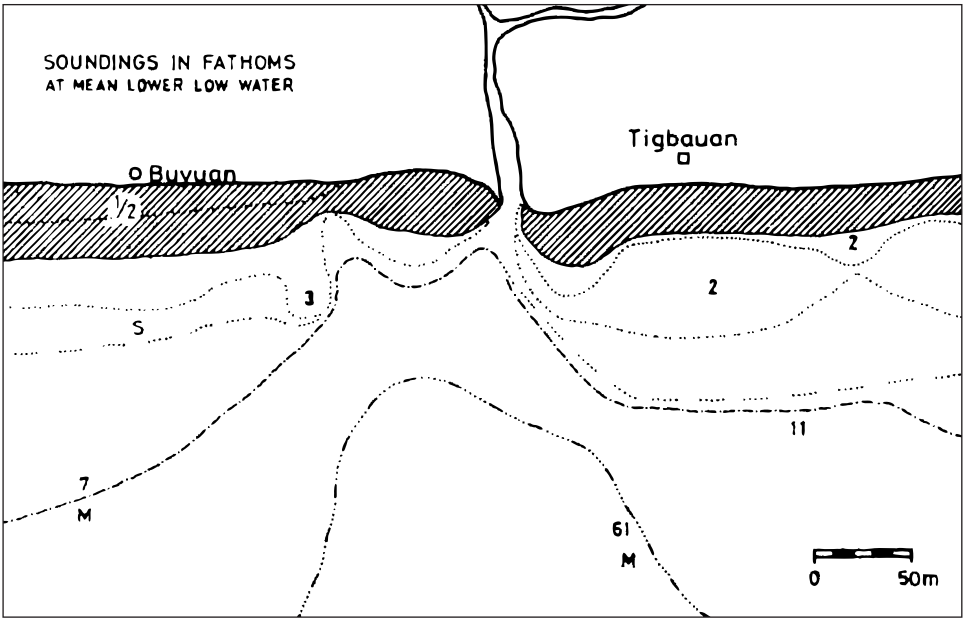

Fig. 25. Typical shore profile for push net operation (Tigbauan, Iloilo). Shaded portion indicates the extent of operation of push net operators.

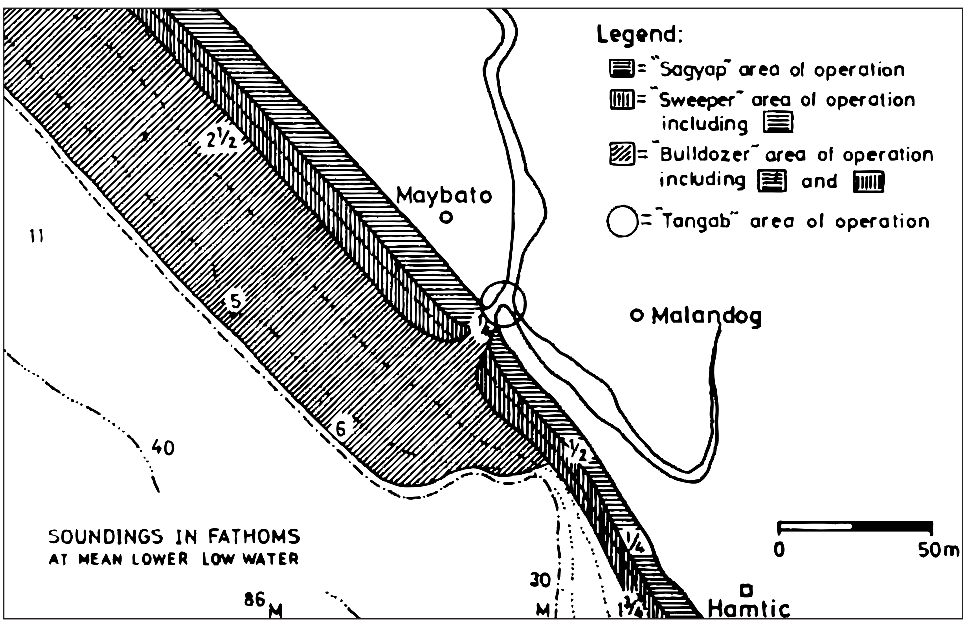

Fig. 26. Example of fry ground with shore profile where double stick net (*sagyap*), push net (sweeper), push net with bamboo raft (bulldozer), and tidal set net (*tangab*) can be operated (Maybato, San Jose, Antique). Shaded portion indicates the extent of operation of four milkfish fry catching gears.

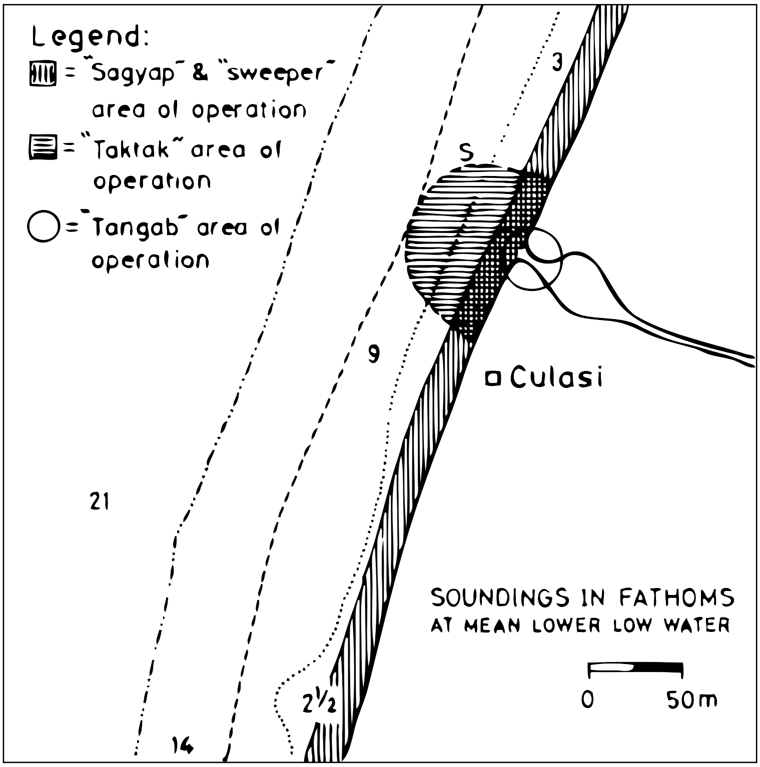

Fig. 27. Example of fry ground with shore profile where double stick net (*sagyap*), push net (sweeper), fry seine net (*taktak*), and tidal set net (t*angab*) can be operated (Culasi, Antique). Shaded portion indicates the extent of operation of three milkfish fry catching gears.

Fig. 28. Fry sweeper in operation (Culasi, Antique).

The gear is sometimes tied to stakes and operated like a tidal set net (Fig. 29). In some places, the gear is also provided with nylon wing extensions. During stormy days when the waves are big for this gear to be operated along the shores, push nets are set against the surf or wave produced current (Fig. 30).

Push net is now being motorized in some fry grounds of Antique. The gear is modified by replacing the wings with bigger mesh size (4 mm mesh) nylon netting. The flooring of the bagnet are extended up to the front end of the gear. One type has an open catching chamber (Fig. 31) while another type is provided with a cylindrical catching chamber made of sail cloth (Fig. 32). The latter type of modification enables fry catching operations to continue even when sea conditions exceed No. 2 on the Beaufort scale. The gear is attached alongside a pumpboat with 10-16 Hp inboard engine (Fig. 33). Gasoline consumption is 4-6 liters per 8-12 hours opera-

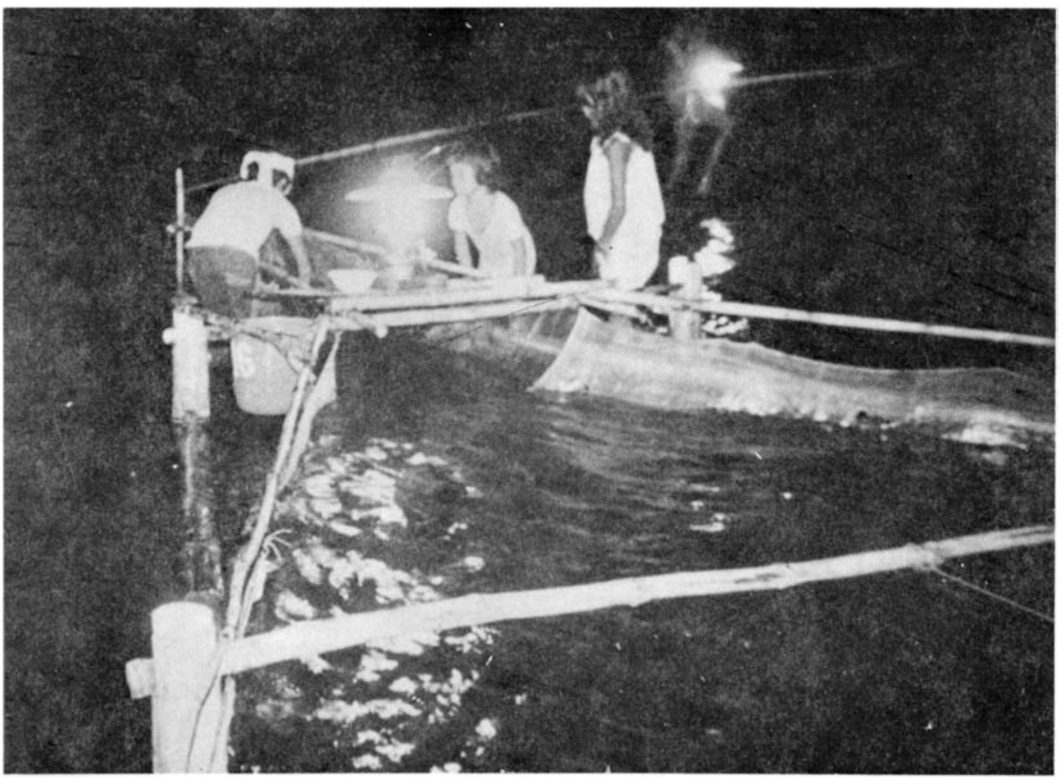

Fig. 29. Fry sweeper operated like a tidal set net along the shore during nighttime (Maybato, San Jose, Antique).

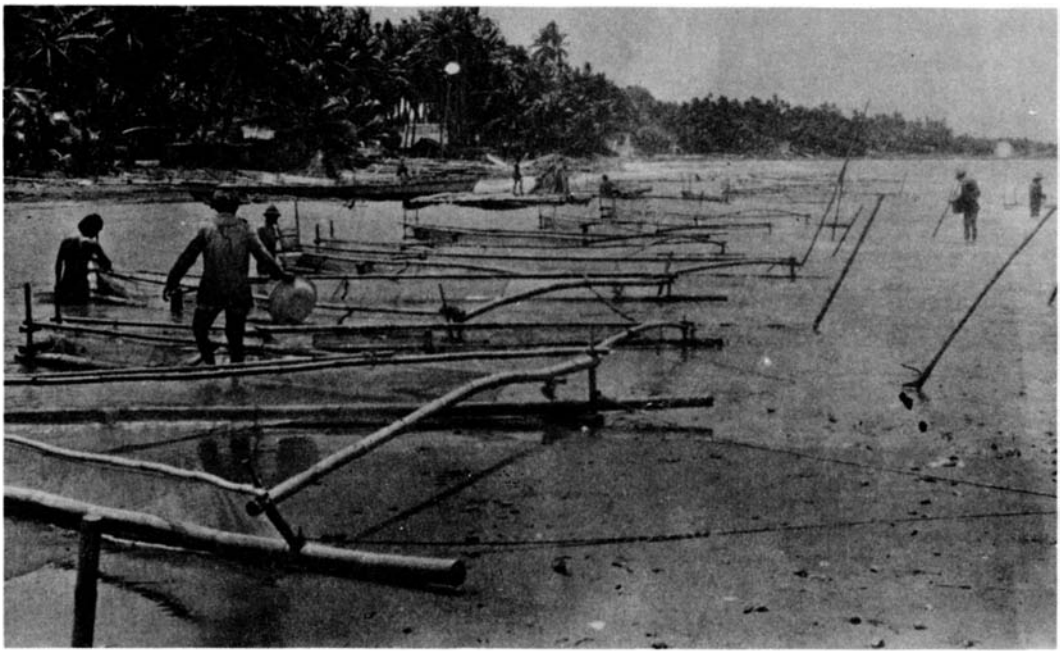

Fig. 30. Operation of fry sweeper during stormy days (Tigbauan, Iloilo).

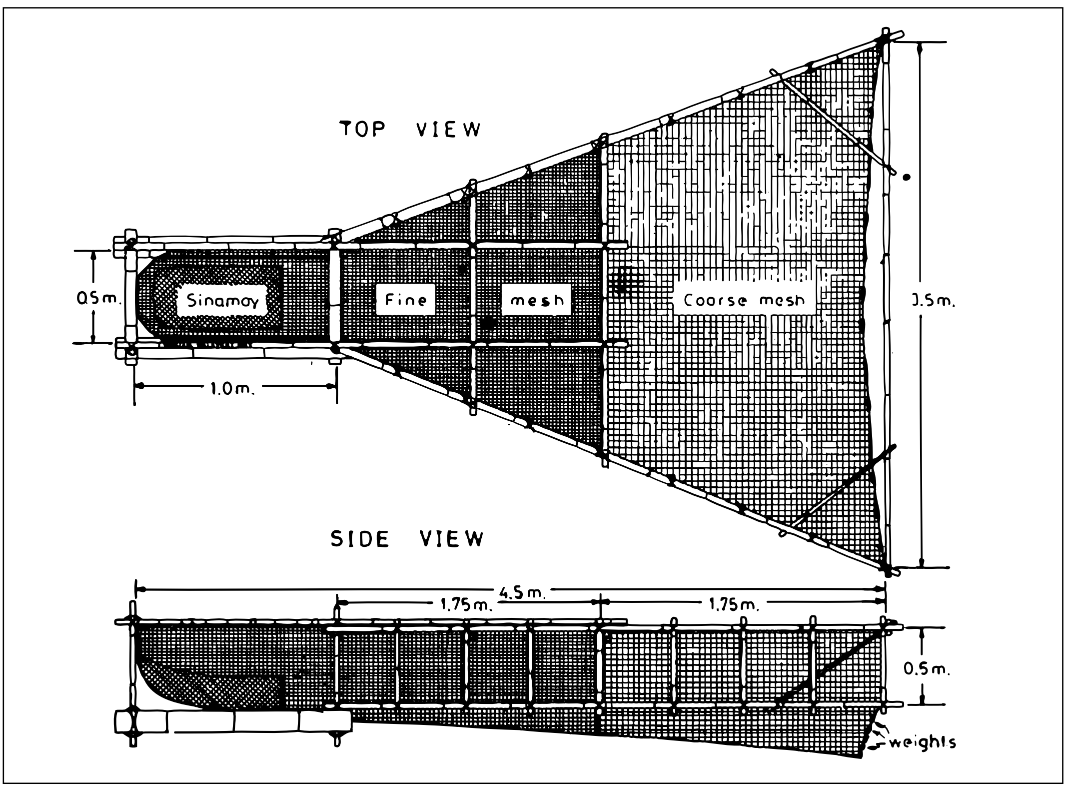

Fig. 31. Modified push net used in motorized boat.

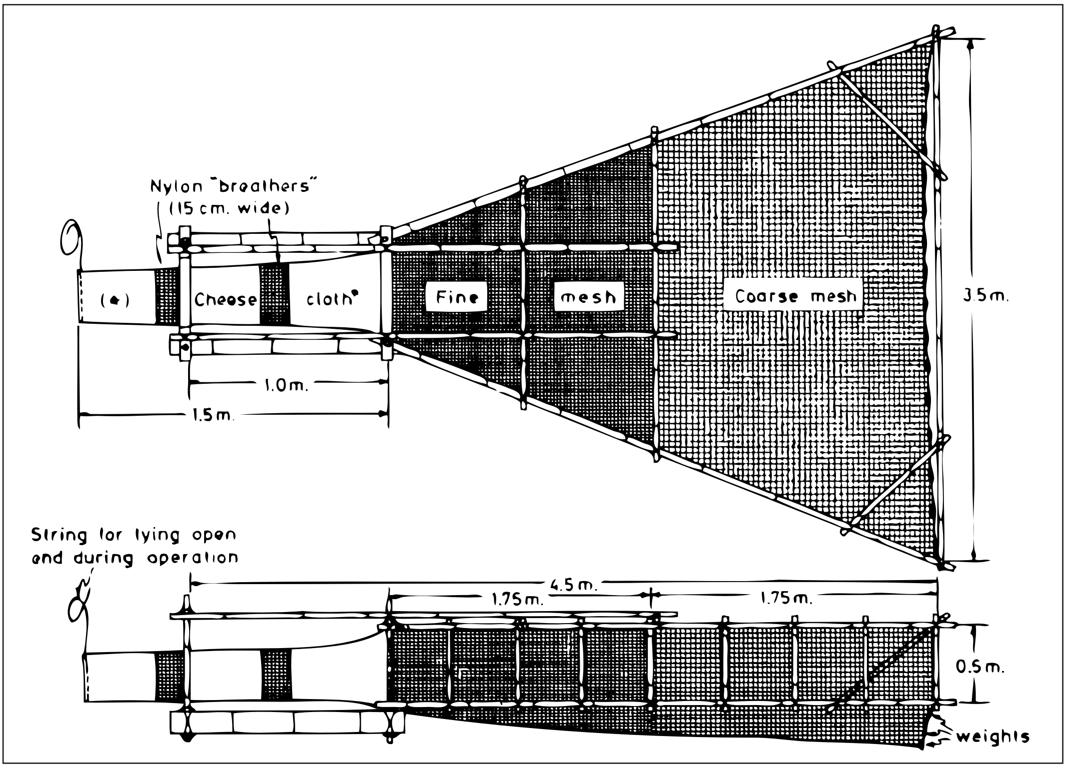

Fig. 32. Modified push net with a cylindrical catching chamber used in motorized boat.

tion. It is usually operated by one man. Night fishing operation is seldom undertaken because of numerous organisms caught with the fry. Total catch per 8-hour operation is 10,000-20,000 fry.

This type of gear can be operated at almost any depth and distance from the shore (especially the motorized fry sweeper), and at any time and tidal conditions but cannot be used in tidal flats at low tide, mangrove areas and in shallow places with rocky or corraline substrate.

2.d. Push net with bamboo raft (Fig. 34)

This gear, also known as fry bulldozer, is similar to the fry sweeper just described. It is provided with a bamboo raft at the back and along the sides of the bagnet. The wings are made of matted bamboos attached to whole bamboos which serve as floats. The catching chamber or bagnet is made of *sinamay*. The raft is used as a place where jars, basins and pails are kept and also as a working area.

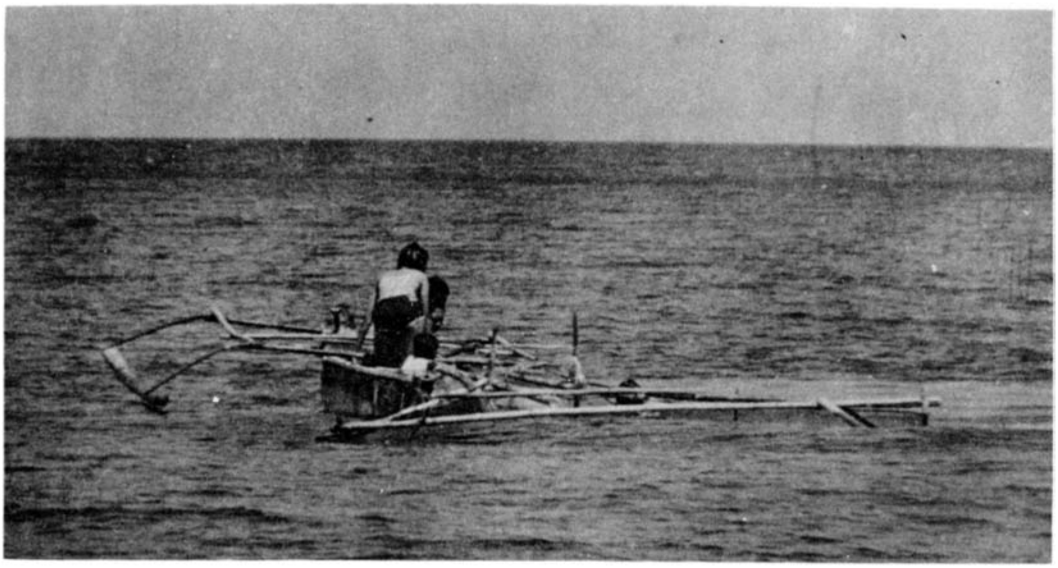

Fig. 33. Motorized fry sweeper in operation (Guia, Bugasong, Antique).

The gear is normally operated in relatively deeper areas of the fry ground. Two persons are required to operate the fry bulldozer (Fig. 35). One scoops and sorts the fry while the other pushes the gear by means of a bamboo pole. This gear is generally operated at night to early morning (21.00 to 4.00h) from March to June when the water in the area is calm and lower high tides occur at night. A kerosene lamp is used to facilitate catching and sorting of fry. Usually, there are more crustacean larvae caught than milkfish fry which makes sorting very tedious and causes high mortality among milkfish fry. At times, this gear is set along river banks and operated like a tidal set net. Average total catch per day is from 1,000-5,000 fry.

Although this gear can be operated near the shoreline and in relatively deeper areas where milkfish fry aggregate during low and lower high tides, use of this gear is generally confined at night time and during calm weather. It is also harder to operate as compared with other types of gear.

2.e. Tow net with bamboo floats (Fig. 36)

The tow net with bamboo floats (*panagap*) is also similar to the fry sweeper. However, instead of a bamboo frame, two bamboo

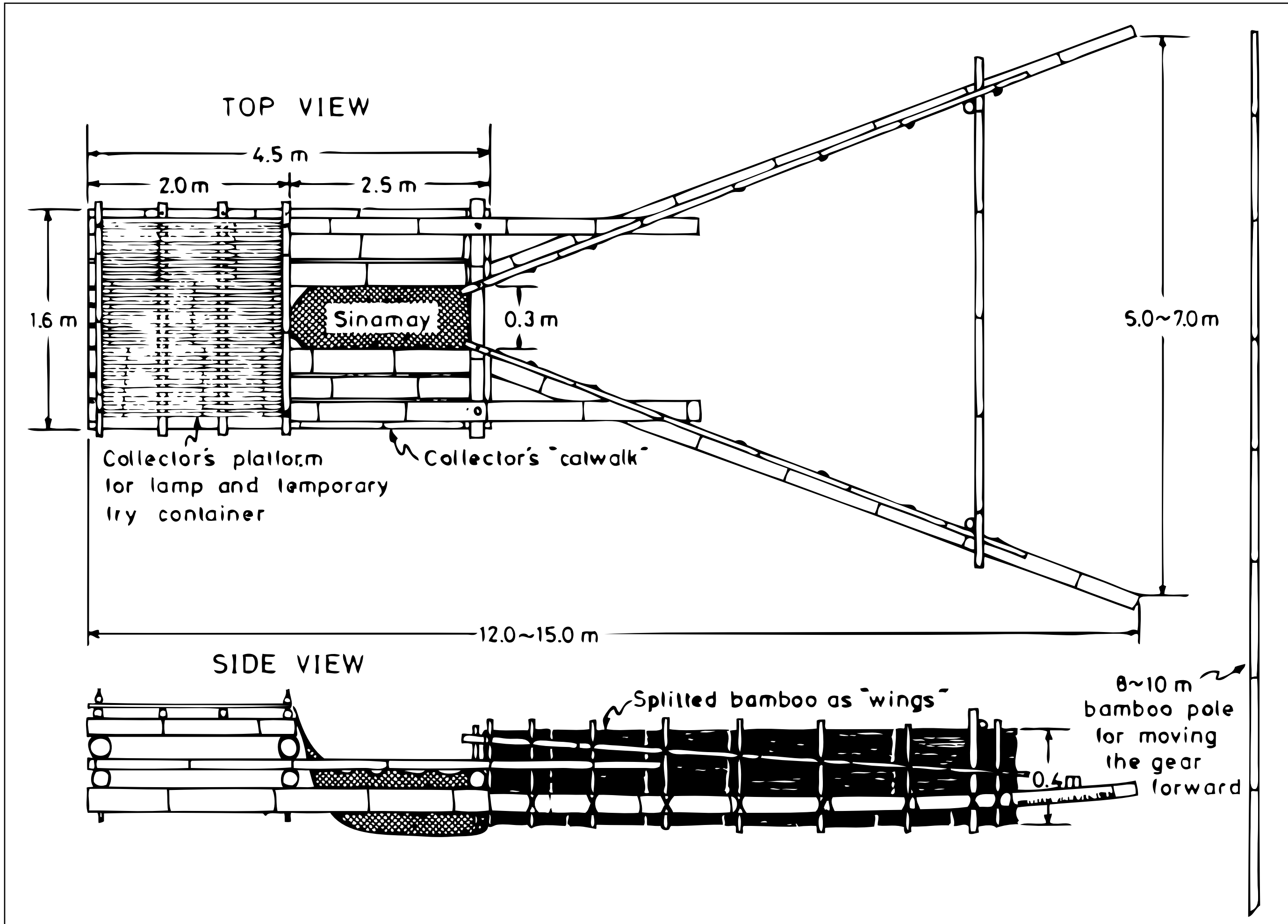

Fig. 34. Push net with bamboo raft, its structure and dimensions.

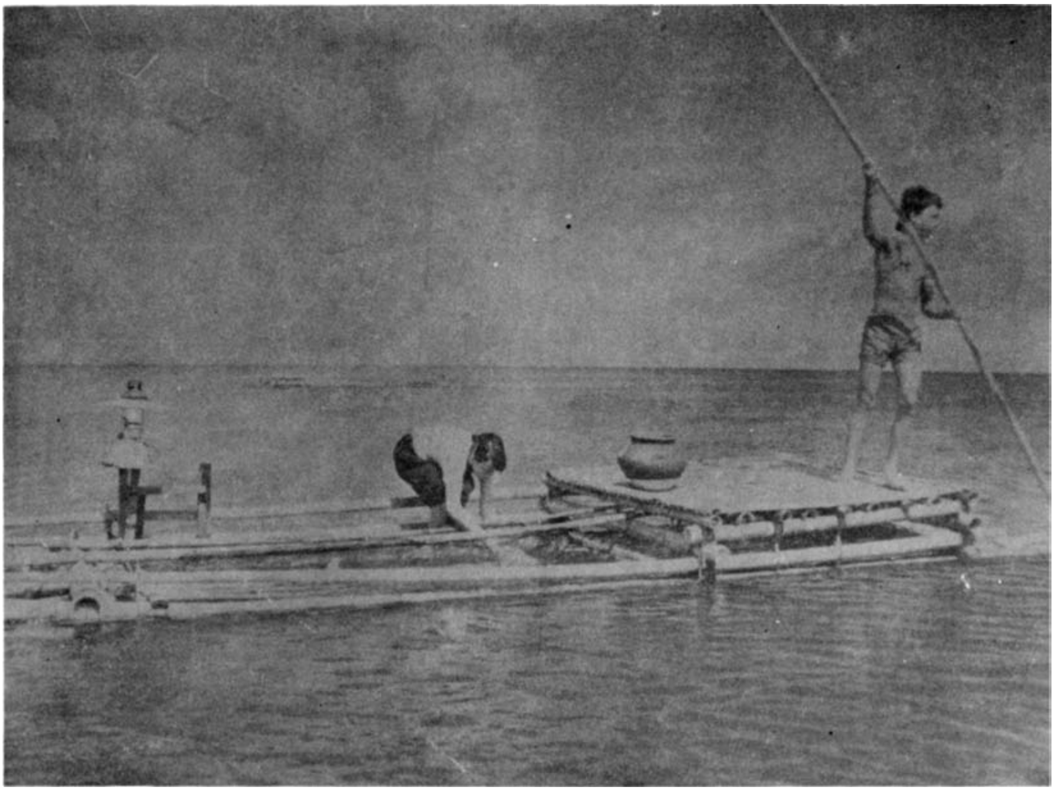

Fig. 35. Push net with bamboo raft in operation (Maybato, San Jose, Antique).

poles are used as floats fixed at about 50 cm apart at the scooping end of the bagnet to keep the bagnet in shape. The wings and bagnet are made of fine-meshed nylon netting. *Sinamay* cloth is sewn over at the scooping end of the bagnet. The mid-front section of the bagnet is provided with a series of lead sinkers. Each wing-end is attached to a bamboo pole to facilitate dragging and to keep the wings in upright position while in operation.

The gear is towed by two persons, one at the end of each wing (Fig. 37). When one of the operators scoops the fry and goes ashore to sort them, the other continues to drag the gear by holding both ends of the wings. This gear is the only active filtering type used in Southeastern Luzon and is particularly suited for fry grounds with moderately sloping shore profile (Fig. 25-27). *Panagap* is also used in rivers either as a mobile gear or operated like a tidal set net. Daily catch ranges from 500-2,000 fry.

Panagap can be used either as stationary or mobile gear, and can be operated in strong winds and in rough seas. However, the radius of operations is limited to wading depth, and cannot be used in mangrove, rocky and corraline areas.

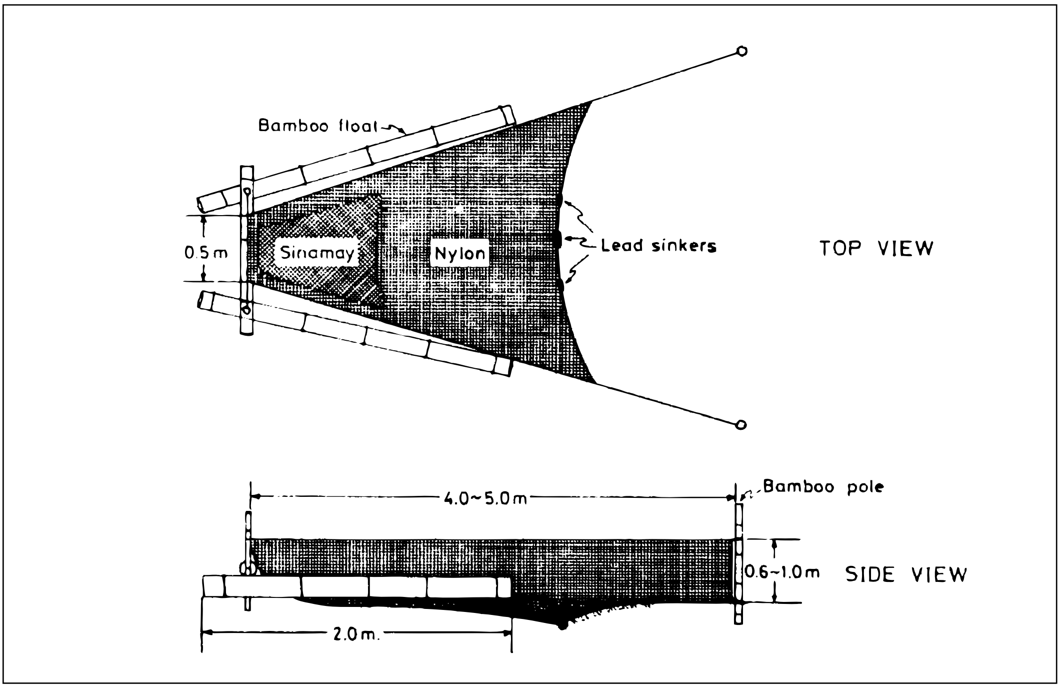

Fig. 36. Tow net with bamboo floats, its structure and dimensions

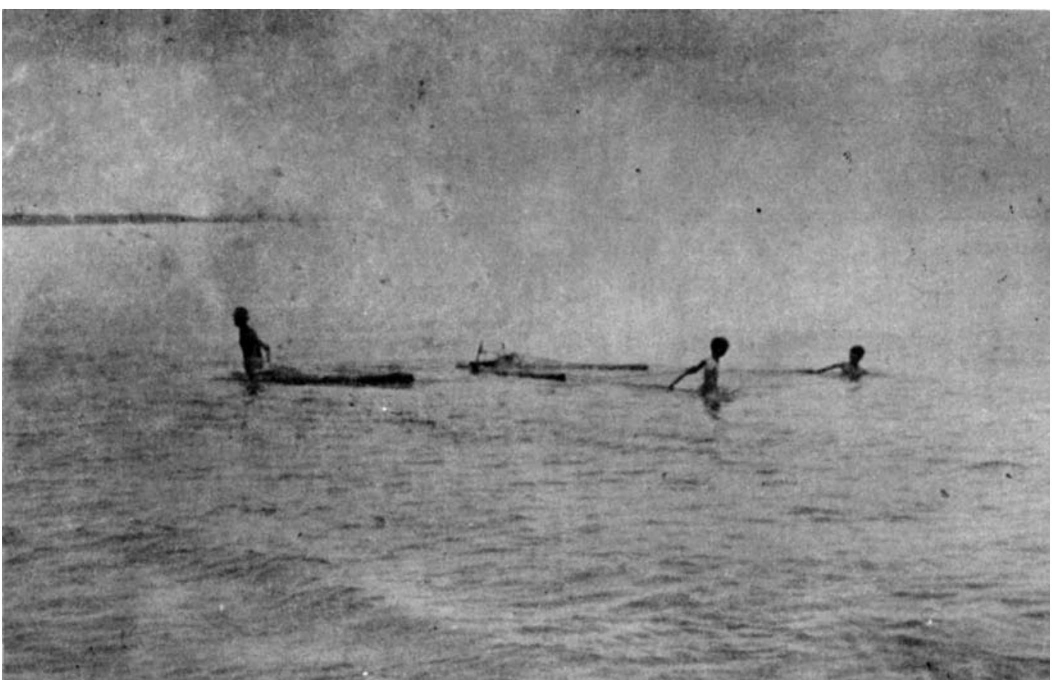

Fig. 37. Tow net with bamboo floats in operation (Tiwi, Albay)

2.f. Tow net (Fig. 38)

Tow net (*sayot*) consists of a cylindrical bagnet made of sail cloth and fine-meshed nylon netting wings. It does not have a frame but a float, usually an empty plastic jar, attached at the upper mid-portion of bagnet's opening. Lead sinkers are placed at the lower edges of the bagnet's mouth. The bagnet is provided with strips of fine-meshed nylon netting (breathers) to minimize water resistance and improve filtration efficiency. For the bagnet to retain its cylindrical shape while in operation, especially when caught in the wave's trough, the use of sail cloth is preferred over *sinamay* or fine meshed nylon netting. This prevents the fry in the bagnet from being crushed. The cod-end of the bagnet is provided with a string to secure the end portion when the gear is in operation. Each wing-end has a bamboo pole, with a 1.0 m nylon rope tied to the lower portion of the pole. These nylon ropes, with a small handle at the free end, keep the wings in vertical position even when the gear is subjected to undercurrent brought about by receding water. The gear is very effective in areas with steep shore profile

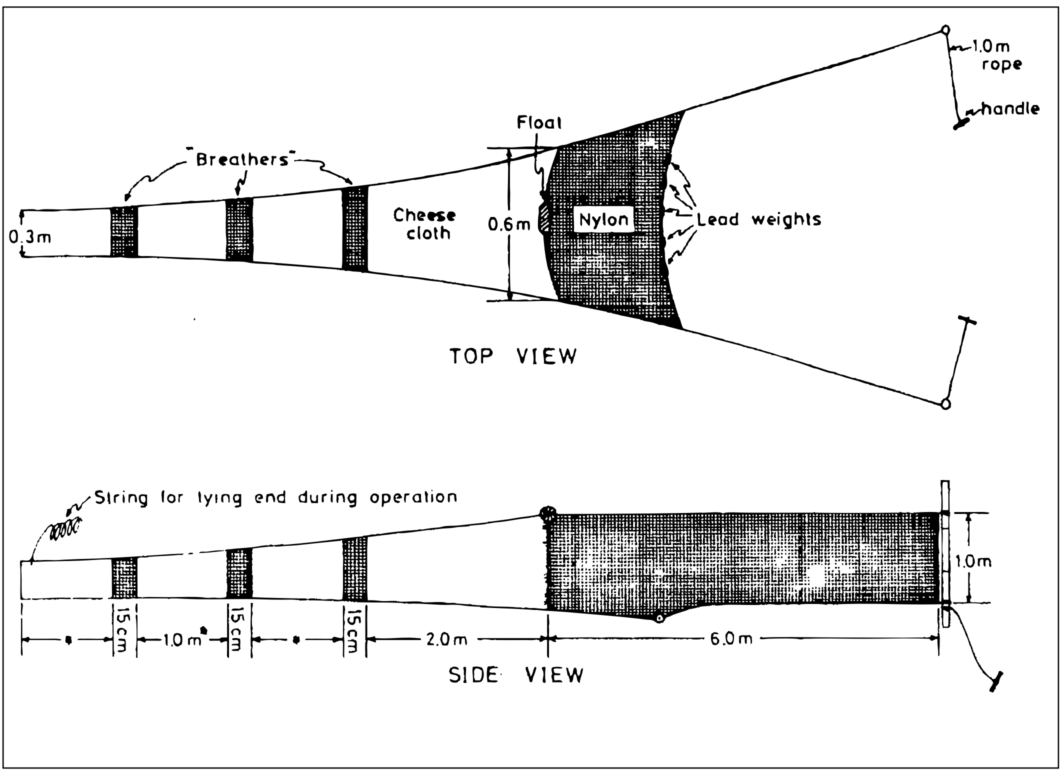

Fig. 38. Tow net, its structure and dimensions.

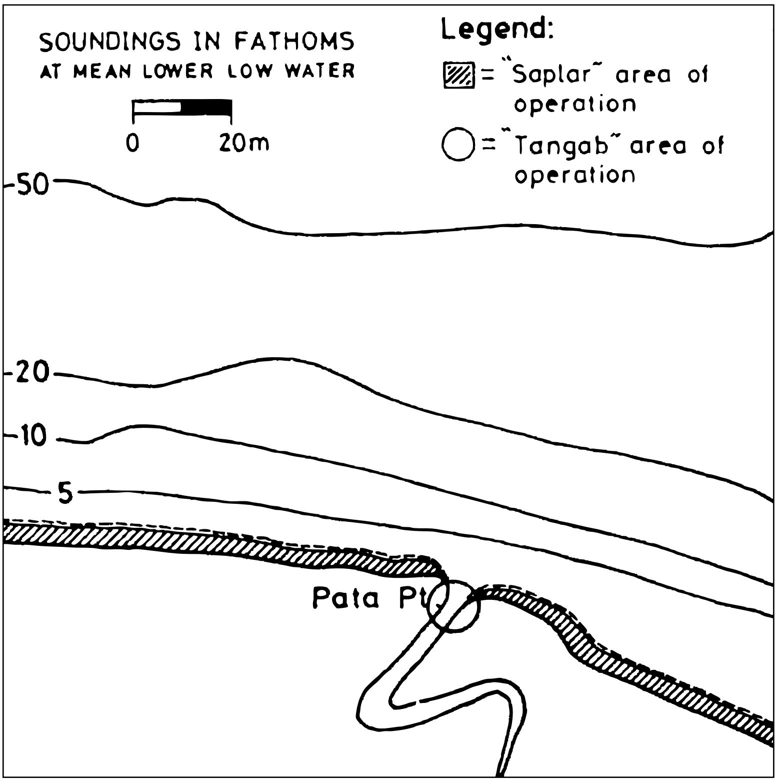

Fig. 39. Typical shore profile and area of operation for tow net (Pata Pt., Claveria, Cagayan).

(Fig. 39) characterized by high waves and strong winds. Two persons operate the gear, each person towing the bamboo pole at each end of the wings (Fig. 40). In towing the gear, the person at the shallower portion of the beach moves forward as a wave comes in. As soon as the wave passes, the person in the deeper portion moves ahead. This positions the gear opening against the undercurrent produced by the receding water. Catching of the filtered fry is done by closing the mouth of the bagnet and slowly concentrating the fry towards the cod-end. The string in the cod-end is then untied and the contents poured into a plastic bag. The plastic bag is brought to shore and the fry are transferred to a plastic basin. The gear is set in places where a sand bar has formed parallel to the shore. In such a situation, the area between the sand bar and shore remains calm but a steady uni-directional current is formed. Average daily catch during the peak season is from 1,000-5,000 fry.

This gear can be operated in strong winds and rough seas and can be used either as mobile or stationary gear. The gear, however,

Fig. 40. Usual operation of tow net (Pata Pt., Claveria, Cagayan).

cannot be used in shallow areas and places with corraline substrate. It is difficult to operate due to greater water resistance, and the area of operation is limited to wading depths of 0.3 to 1.5 m.

C. Seine Nets

1. Double stick nets (Figs. 41 and 42)

Double stick net (*sagyap, sarap*) is operated by two persons towing both ends of the gear over a certain area along the shore (Fig. 43 and 44). It usually consists of a rectangular *sinamay* cloth 1.0 to 1.5 m wide and 4.0 to 6.0 m long with the two sides provided with bamboo poles (Fig. 41A).

This gear has undergone modifications due to cost of materials, mode of operations, and prevailing local conditions. Some modifications involve replacement of wings with fine-meshed nylon netting, while retaining *sinamay* in the central portion where concentration and scooping of fry are done. (Fig. 41B). In other places the lower half (Fig. 41C) or upper and lower portions of the gear (Fig. 42B) are replaced with fine-meshed nylon netting. These modified *sagyap* are easier to operate as it reduces water resistance. Although *sinamay* cloth is relatively expensive and wears easily compared with fine-meshed nylon netting, it is still

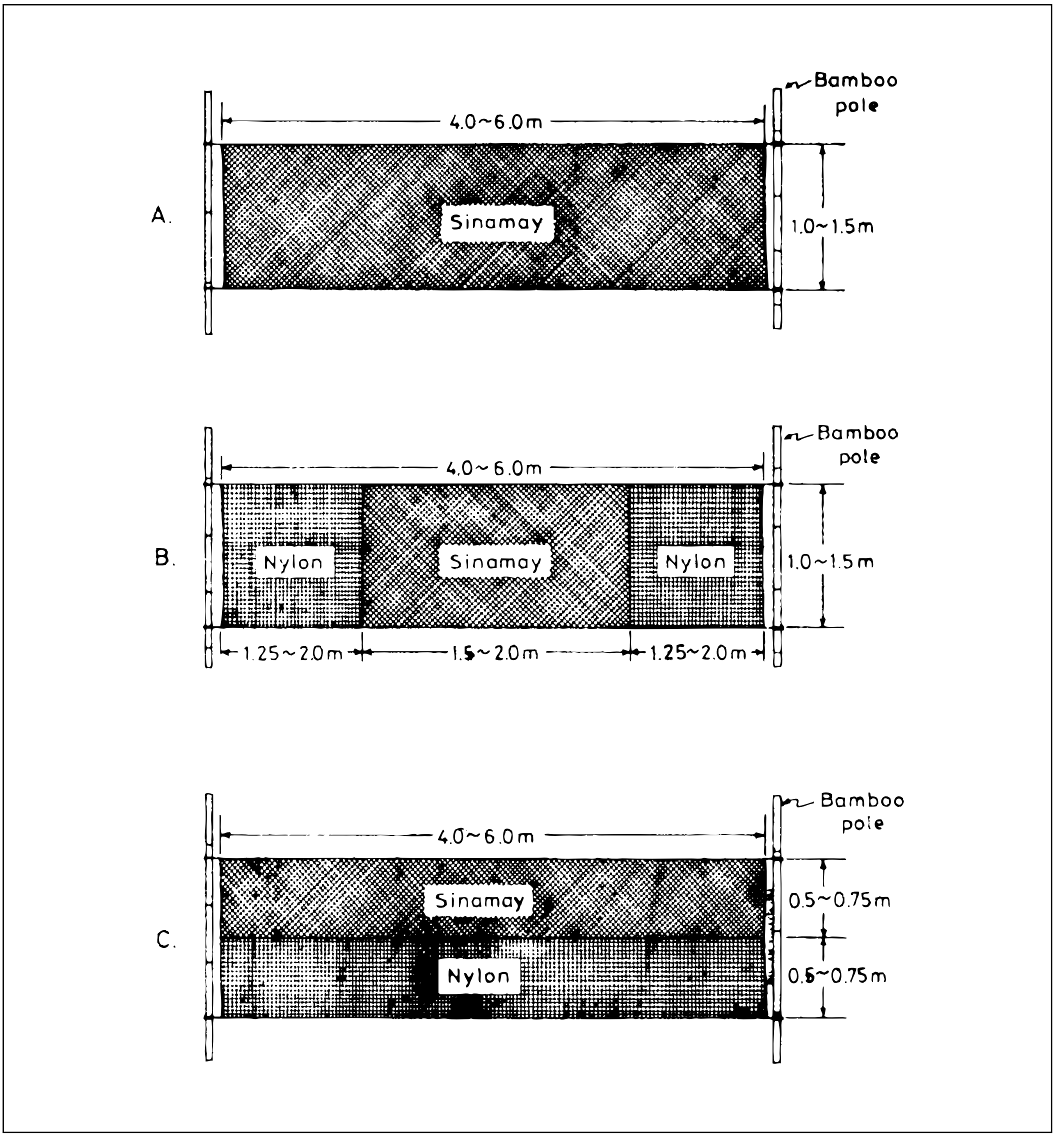

Fig. 41. Modifications of double stick net.

partly used because of its soft and smooth texture when wet which minimizes injury to the fry during scooping.

In places with moderately sloping shore profile, the bamboo poles at both ends or one end of the gear, are replaced with rope loops (Figs. 42A and B). These modifications enable the fry gatherers to operate in deeper waters since the gear can be towed while swimming.

A smaller version of double stick net was observed in San Jose and Hamtik, Antique and in Naawan, Misamis Oriental, mostly used by

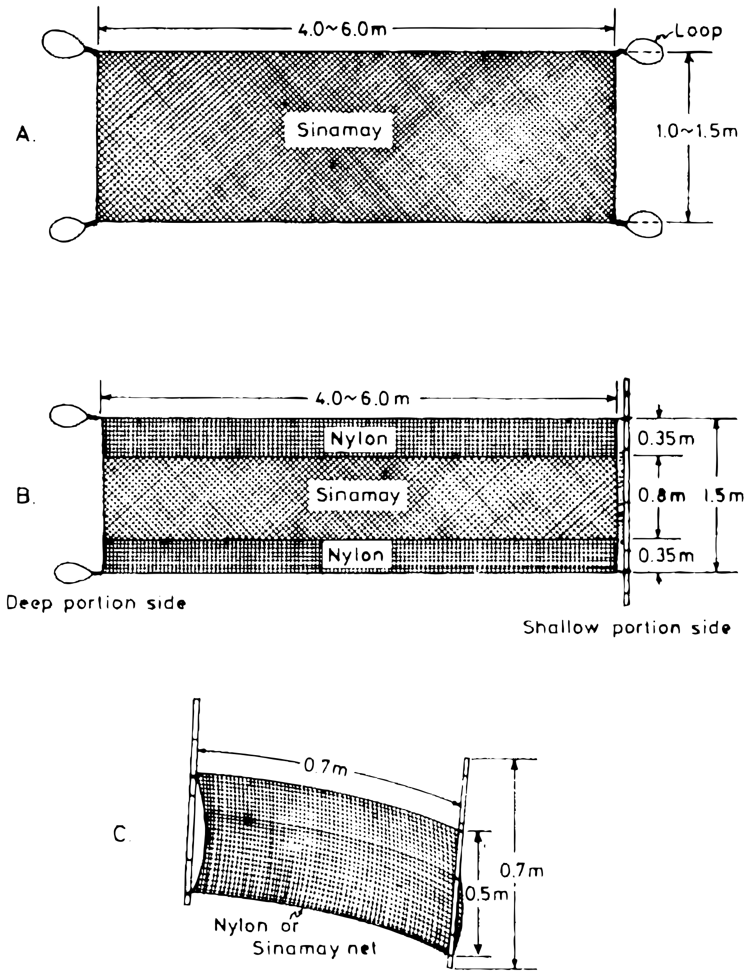

Fig. 42. Modifications of double stick net.

children and operated along shallow river banks or creeks. In Culasi, Antique, *sagyap* is operated on dark nights with the aid of a pressure lantern hanging on a bamboo tripod (*bitay, baka-baka*) which is set along the shore (Fig. 45). *Sagyap* is also used in the actual catching of milkfish fry concentrated by fry barriers.

The double stick net is cheap, easy and simple to construct and can be used in any fry ground in the Philippines. However, this type of gear

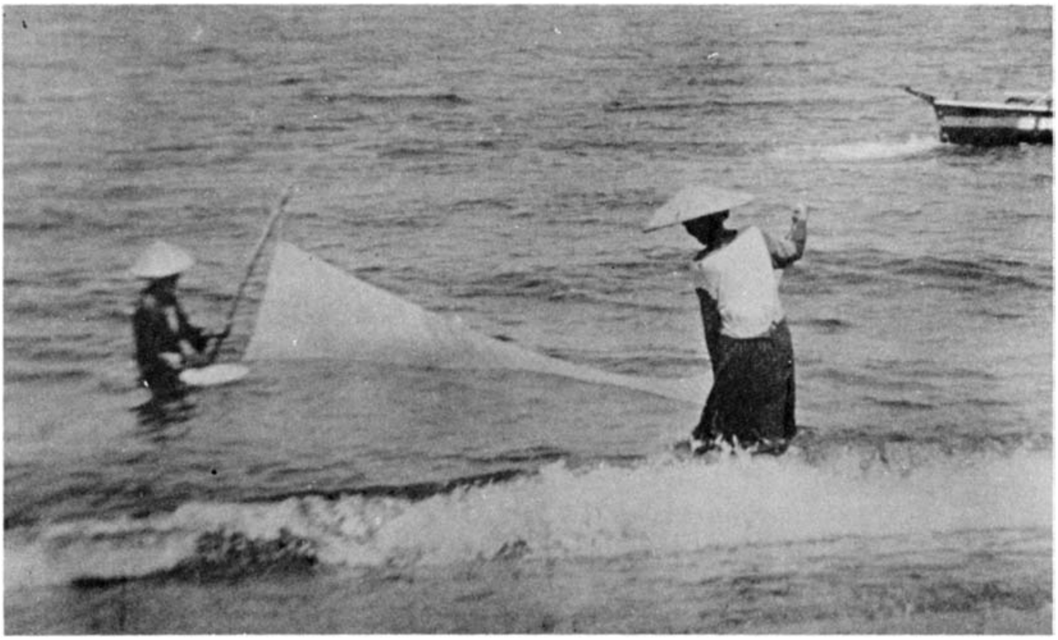

Fig. 43. Operation of double stick net along the shore (Guia, Bugasong, Antique).

Fig. 44. Concentrating of fry in the center of double stick net (Guia, Bugasong, Antique).

can not be operated during strong winds and in rough seas with the area of operation generally limited to wading depth. Average daily catch during the peak fry season ranges from 1,000-5,000 milkfish fry.

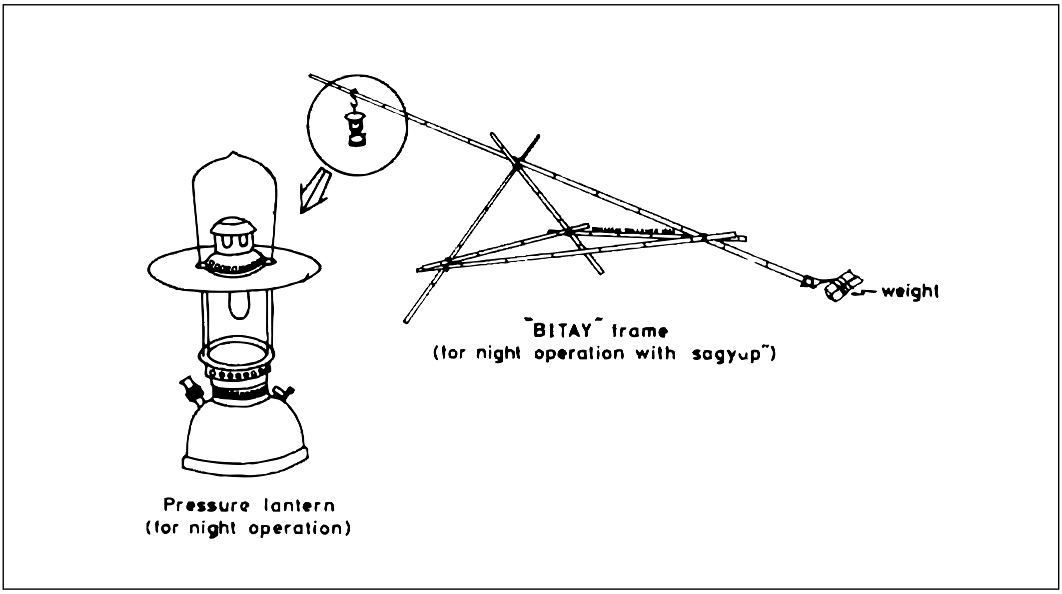

Fig. 45. *Bitay* or *baka-baka* for use during night operation of double stick net.

2. Fry seine net (Fig. 46)

Fry seine net (*taktak*) is similar to beach seine in construction and operation. It consists of equal towing lines at both ends of the gear, coarse-mesh nylon netting (1.6 mm mesh) wings, and a concentrating section made of fine-meshed nylon netting (0.3 mm mesh) with *sinamay* cloth sewn over at the center where the fry are finally concentrated and scooped. The gear is provided with a series of floats at the upper portion and lead sinkers on the lower part.

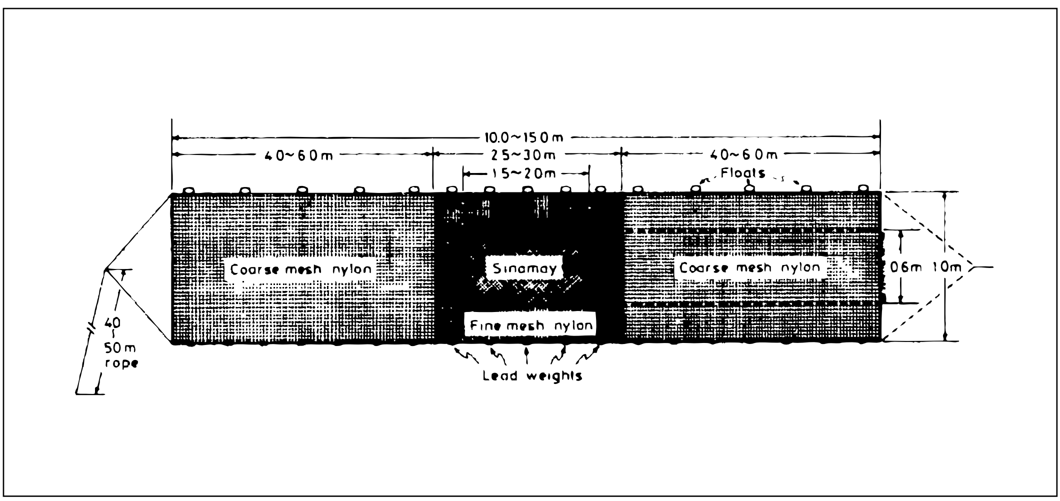

Fig. 46. Fry seine net, its structure, dimensions and materials used in construction.

The gear is used to capture milkfish fry by enclosing a certain area, usually near river mouths, and towing both ends of the gear over this area to fixed points on the shore. Two persons operate the gear. One person casts the gear with the use of a small boat while the other stays on the shore holding the other end of the towline (Fig. 47). Towing of the gear towards the shore starts as soon as the boat reaches the shore. Concentrating and scooping (Fig. 48) of the fry are done in the shallow water near the shore. The whole operation (from setting of the gear to scooping of the fry) lasts about 15 to 20 minutes. Catch per set of *taktak* is from several hundreds to 2,000 fry.

This gear has been modified by adding a bagnet which is similar to *panagap* at the center (Fig. 49). The wings are longer and made entirely of fine-meshed nylon netting. Locally, the gear is called *labay-labay*. Four persons, two to cast the gear while the other two stay on the shore, are required to operate the gear. Operation lasts for 20-30 minutes, with catch ranging from 5,000-10,000 per setting, although in some instances, as much as 30,000 fry are caught.

Taktak is usually operated during low tide, 20-50 m from the shoreline. In most cases, the gear is operated consecutively or is set repeatedly until the catch is minimal.

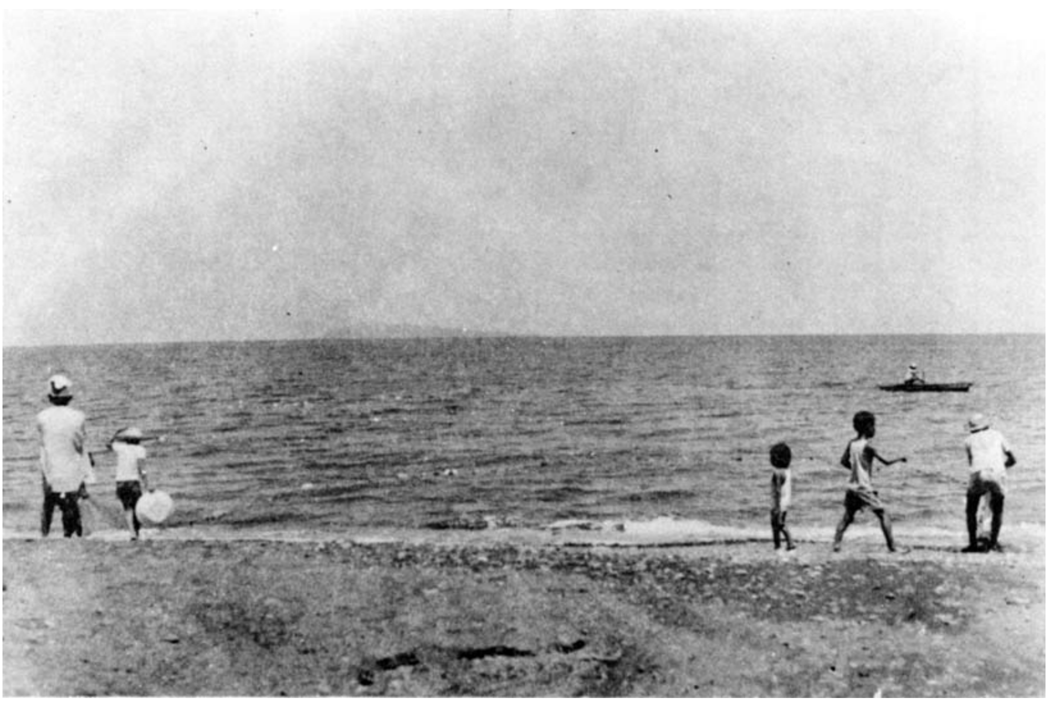

Fig. 47. Casting and towing of fry seine net (Culasi, Antique).

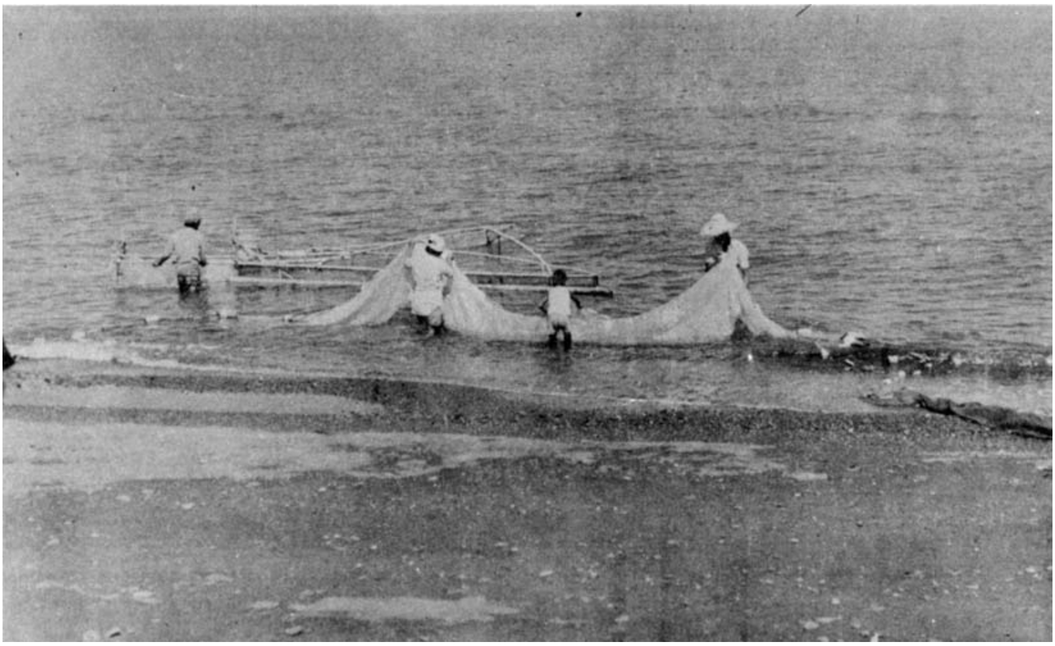

Fig. 48. Concentrating of fry in the center of fry seine net (Culasi, Antique).

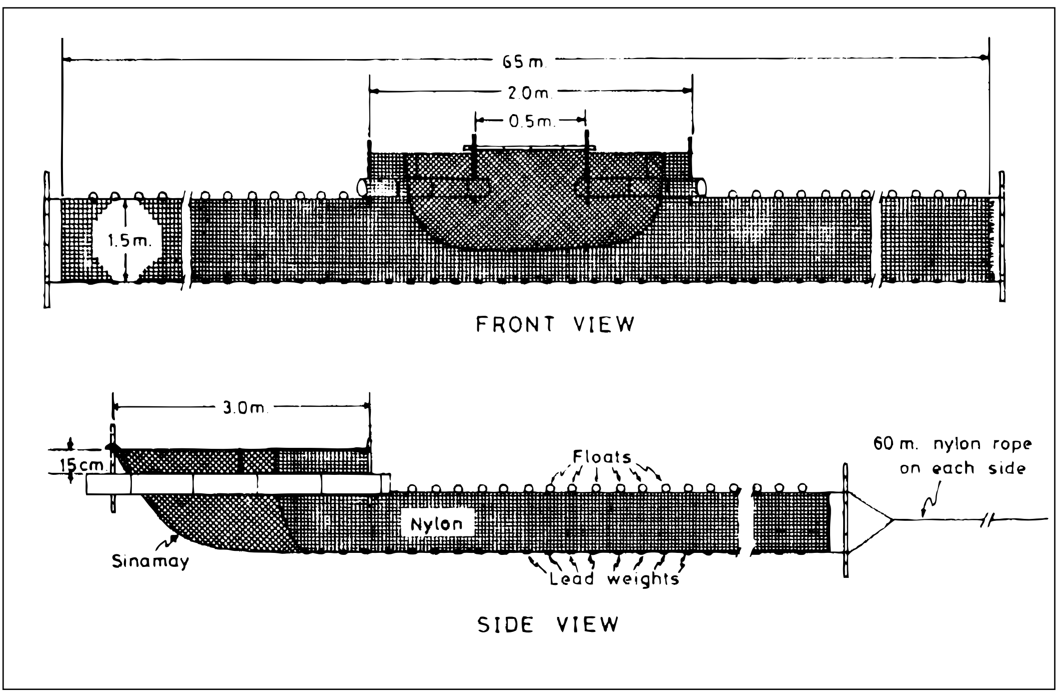

Fig. 49. Modified fry seine net, its structure and dimensions.

REMARKS AND RECOMMENDATIONS ON FISHING GEARS AND METHODS

The apparent increase in milkfish fry catch in the Philippines is due to the exploitation of new fry grounds and more intensified collection in traditional fry grounds. These may lead to reduction of natural stock to such a low level that recruitment of adults almost ceases. The gradual reduction in yearly milkfish fry catch in the Bicol region from 25 million fry (1978) to 12 million fry (1980) may be a consequence of the above event. On the other hand, milkfish fry catch in Western Visayas in recent years seem to be increasing or have at least stabilized to about 100 million fry a year even if the fry grounds are more intensively exploited. The presence of refugia in the form of isolated strings of islands and corral reefs which abound in the Sulu Sea could have easily supplied enough milkfish larvae to maintain the productivity of the fry grounds in Western Visayas. Fishermen have mainly attributed fry abundance with the occurrence of rain. The abnormally low catch of milkfish fry in the 1983 fry season in Antique is attributed to the long drought in the Philippines in 1982-83.

Design, construction and area of operation of traditional milkfish fry catching gears in the Philippines are primarily dictated by the bottom topography of the fry ground, wind direction, current patterns and tidal fluctuations. Modifications of the gears and methods of collection are directed to suit the convenience of fry collectors as well as availability and cost of materials. The different fry fishing gears currently in use in various fry grounds of the Philippines are indicated in Figure 4.

Recently, competition and the realization of the inherent limitations of traditional milkfish fry catching gears in terms of area and time of operation prompted the fry gatherers to adapt and develop new fishing gear designs and catching methods to obtain maximum yield from fry grounds. Using known aspects of milkfish fry behavior as bases for the modifications of fry catching gears and developing methods of collection, areas which have been previously unavailable for milkfish fry gathering could be open for exploitation. Fry collection can be done at any time of the day as long as fry are available even during bad weather.

Milkfish fry generally utilize tidal currents as a passive means of transport but may actively seek coastal wetlands. This is indicated by catching of fry even during receding tide with the use of *tangab* in Northern Luzon. However, most of the fry remain far from the shore after high water spring tides. During this period, fry are inaccessible to most catching gears and methods currently being employed. However, in Culasi, Antique, the use of the fry seine not only catches the fry along its path of operation but attracts them towards the shore. This enables other types of fishing gears to catch fry along the shore during low tide. Mechanization of the fry sweeper also removes the constraint in exploiting deeper portions of the fry ground.

Milkfish fry mainly stay at or near the water surface even when scared (Buri and Kawamura 1983, pers. obs.). The present depths of all types of catching gear, therefore, do not have to be increased to catch more fry.

Kawamura *et. al.* (1980) indicated that filtration of water by fry sweeper is nearly perfect but concluded that the fry are not caught by filtering but driving. They further suggested replacement of wings of fry catching gears with black colored and larger mesh net. However, fry gatherers claimed that although this modification made the operation of the gear easier, their catch were drastically reduced. Hemmings (1966) in his study of visibility of netting in different sea conditions found that illumination and turbidity of the water rather than color are more significant factors in herding fish. The poor catch of modified gears with wings made of larger mesh net is probably due to the relatively turbid water of the fry ground near the shore. It is, therefore, reasonable to state that the present methods of catching milkfish fry basically involve filtration of fry by mobile or stationary devices.

Current developments and modifications of milkfish fry catching gears are directed to areas further from the shore. Encina and Gatus (1977) reported that milkfish fry congregate close to fish shelters located offshore and can be caught in sizable quantities in deeper corraline areas. In such a situation where water is relatively clear, fry catching gears that effectively utilize driving effect and opto-motor response of the fish may be adopted. The use of floating objects and chemical attractants to aggregate the fry in offshore exploitation should be looked into so as to minimize search time as well as maximize the catch per unit of effort.

Mortality due to catching for all types of gear generally increases as the sea becomes rough. *Tangab* has the lowest mean mortality while fry bulldozer has the highest. The high mortality observed in the catch of fry bulldozer might be due to the crowding effect of accompanying crustaceans attracted by light during operation.

Catch efficiency of five milkfish fry catching gears and percentage mortality under different sea conditions are shown in Table 1. This would indicate that both *taktak* and *tangab* are the most efficient catching gears for milkfish fry. However, such comparison is misleading since each type of gear is operated in different areas of the fry ground, times of the day, and sea and tidal conditions. Comparisons of catch of each type of fishing gear at different sea conditions reveal that more fry are caught by all types of fishing gears when sea conditions are from No. 1 to 2 of the Beaufort Scale. Only the fry sweeper, used as stationary gear, can be operated when sea conditions exceed 3 but with exceptionally high mortality.

The following recommendations for exploitation and increasing milkfish seed resource to the maximum without depleting the natural milkfish fishery stock are extracted from research findings and experiences of fry gatherers and concessionaires:

1. Shoals and waters surrounding islets are breeding grounds of milkfish (Kumagai 1981). To protect and conserve our milkfish fry resource, these areas should be declared marine reservations (fish sanctuaries) with a provision that prohibits catching of milkfish of any size in these areas.

Table 1. Catch efficiency of five milkfish fry catching gears and percentage mortality under different sea conditions in Culasi and San Jose, Antique and Tigbauan, Iloilo from April to June 1981.

Type of Gear	Catch per hour *Sea Condition						Percentage Mortality *Sea Condition					
	0	1	2	3	4	Mean	0	1	2	3	4	Mean
Sagyap	159	710	628	214		427.8	4.3	1.4	6.1	5.6		4.3
Sweeper	209.5	509.5	514	580	71	376.8	2.7	2.8	2.5	3.4	19.1	6.1
Bulldozer	425	453	698	310		471.5	3.1	4.9	8.8	13.3		7.5
Taktak	421	2,932	817			1,390.0	0.9	1.3	1.7			1.3
Tangab	789.5	973	1,318	1,302		1,095.6	0.8	0.7	1.3	1.9		1.2

*Beaufort Scale

Beaufort Number	Wind Speed			Nautical Term
	knots	meter per second	km. per hour	
0	Under 1	0.0 — 0.2	Under 1	calm
1	1 — 3	0.3 — 1.5	1 — 5	lighter air
2	4 — 6	1.6 — 3.3	6 — 11	light breeze
3	7 — 10	3.4 — 5.4	12 — 19	gentle breeze
4	11 — 16	5.5 — 7.9	20 — 28	moderate breeze
5	17 — 21	8.0 — 10.7	29 — 38	fresh breeze

2. Coastal wetlands (mangrove, swamps, lagoons, tidal pools) are utilized by the milkfish as nursery and feeding grounds (Villaluz *et al.* 1982). The wetlands should be left undisturbed instead of being converted into fishponds or utilized for other purposes.

3. Natural gonadal maturation and spawning of domesticated milkfish in floating cages have been observed (Lacanilao and Marte 1980). Instead of the conventional practice of collecting the eggs after spawning, the eggs should be left in the sea to hatch and develop into fry. There is evidence that despite initial dispersion of eggs and larvae into off-shore waters, the larvae of milkfish ultimately return to their natal area. The cages containing the adult milkfish therefore can be

placed in areas where oceanographic conditions are favorable (e.g. vicinity of near-shore gyres or favorable current) so that the fry can be caught along nearby shores. Spawning of milkfish reared in floating cages in the Igang Research Station of SEAFDEC AQD resulted to increased fry catch in the vicinity (Marte pers. comm.).

4. Catching of adult milkfish migrating from lakes (e.g. Naujan and Taal Lakes) to the sea should be regulated to replenish the adult milkfish stock. This is an inexpensive alternative to conserve our milkfish fry resource and at the same time increase fry catch.

5. In order to increase catch of a particular fry ground, appropriate types of fishing gears and methods should be utilized at different hours of the day and locations within the fry ground.

6. Suffocation is the main cause of massive mortality of fry in holding containers. Unwanted organisms should be sorted out and the milkfish fry brought to the shore as soon as possible. A 20 liter capacity plastic pail or earthen jar can usually accommodate a maximum of 5,000 newly-caught fry but only 200-500 fry if the water in the holding vessel contains a lot of debris and/or other organisms.

7. Other species caught with milkfish fry should be returned to the sea immediately to conserve our fishery resources.

HANDLING AND STORAGE OF FRY

Milkfish fry, together with fry of other fish and crustacean species, are brought to the shore shortly after capture. The whole catch is then transferred to a white plastic basin to facilitate counting, sorting and removal of debris. Counting and sorting are done with the use of white cup or small bowl (Fig. 50). The counted fry are placed in another basin while dead and unwanted species are discarded. If milkfish fry and accompanying organisms are numerous, a cylindrical device (Fig. 51) made of nylon netting with mesh size sufficient enough to permit milkfish fry to pass through while retaining fry of other species is utilized.

The common fish larvae and juveniles caught with milkfish fry are: Elops machnata, Megalops cyprinoides, Scatophagus argus, several species of Caranx, Leiognatus, Siganus, Atherina, Stolephorus, Therapon, Mugilidae and Gobiidae. Crustacean larvae particularly those belonging to shrimps, prawns and crabs are also collected with milkfish fry.

Fry of tarpon (Megalops cyprinoides) and ten-pounder (Elops machnata) look very similar to milkfish larvae. If not sorted out, they become potential predators of milkfish fry in the nursery pond. Both can be distinguished from the milkfish by their longer and wider bodies, swimming movements and light amber color.

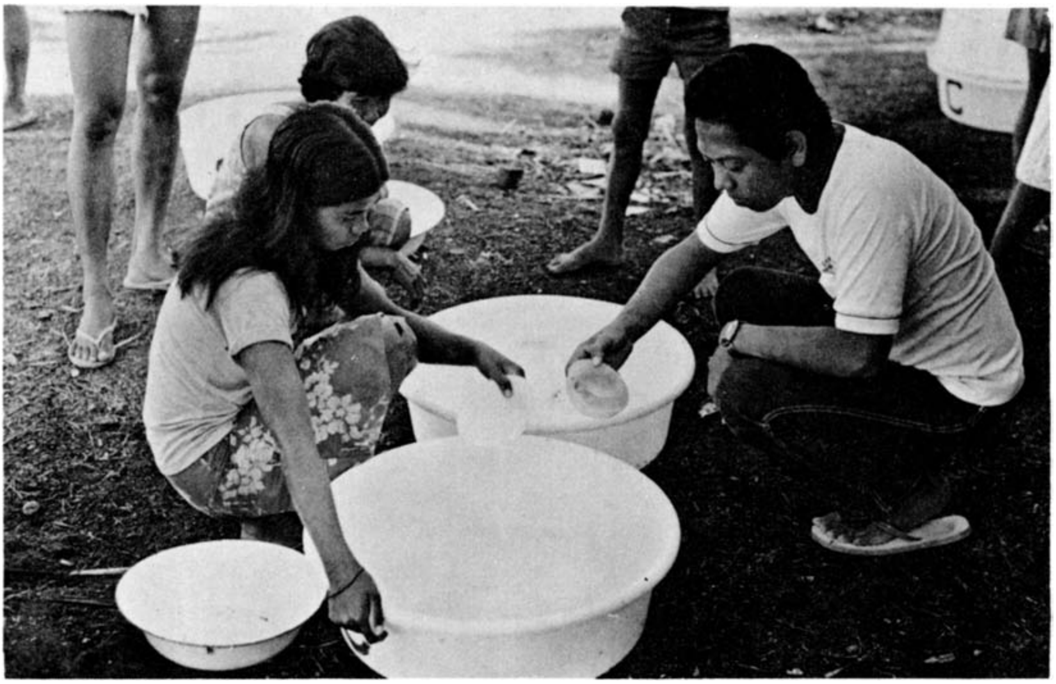

Fig. 50. Counting and sorting of milkfish fry (San Pedro, Antique).

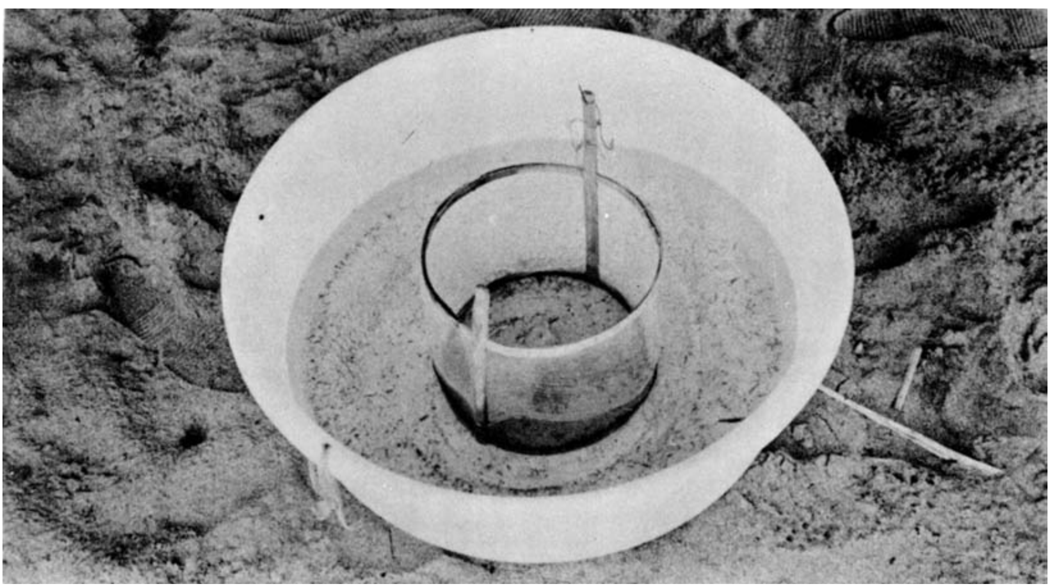

Fig. 51. Device made of nylon netting for sorting undesirable organisms (Pata Pt., Claveria, Cagayan).

Milkfish fry are counted each time the fish are transferred from one container to another and before and after being sold. Fishermen count the fry individually without any counting aid if their catch are few but when their catch runs into several thousands, counting is done with the aid of small pebbles, shells, or any suitable materials and a counting board. One small pebble represents 100 fry while a bigger pebble would represent 1,000 fry. An extra 200 to 500 fry are added to every thousand as allowances for mortalities. Another method of counting fry which is used by fry concessionaires and dealers is visual estimation. The density of fry in one container is compared with the density of fry in another container in which the exact number of fry has been previously determined (Fig. 52).

Fig. 52. Visual estimation of number of fry through density comparison to a container where exact number of fry has been determined (Cotabato City, Maguindanao).

The day's catch are stored overnight in the fishermen's house or storage facility (Fig. 53) provided by the fry concessionaire of the area. Since a certain percentage of the fry are injured in the process of catching, fry concessionaires or dealers avoid buying fry immediately after catching. The water in the basin before storage is generally diluted with freshwater. The fry are not fed at this stage.

Fig. 53. Typical fry storage hut (Maybato, San Jose, Antique).

The fry are again counted and sorted the following morning before acceptance by the concessionaire or dealer. These are then brought to the main warehouse in oxygenated plastic bags which are placed inside *pandan* bags (Fig. 54). The fry are transferred to plastic basins or earthen jars and again the storage water is diluted with freshwater. Stocking rate is from 3,000-8,000 fry/plastic basin, and 2,000-3,000 fry/earthen jar. The containers are provided with covers to minimize activity of fry and prevent dirt from entering.

Yolk of hard boiled egg or fried flour is fed daily or every other day. Very small quantities of food are given to minimize fouling of water. The storage containers are inspected and cleaned of excess food, dead fry and debris every morning and afternoon. Usually the warehouse has a stock of clean water already mixed at the desired salinity level to replace water in the fry container. Water in the container is either completely or just one-half of the total volume replaced with new water everyday or every other day. Before cleaning, the water in the plastic basin is rotated by hand to concentrate excess food, debris, dead fry and feces at the center. A small plastic bowl is then used to scoop out the concentrated unwanted materials.

Fig. 54. Transport of fry to main warehouse in oxygenated plastic bags placed inside *pandan* bag (Culasi, Antique).

Fry which have been stored for more than 15 days are usually weak and very low survival is obtained when stocked in the nursery pond. Fry condition is determined by the following:

1. Strong and healthy larvae move continuously along the wall of the container in the same direction. If the fry display this behavior only intermittently or when swimming is slackened, the fry are already weak.

2. Rotate the water clockwise. Healthy fry swim vigorously against the current.

3. Tap the container or move hand over the container. If the larvae react with quick downward or avoidance movement, they are in good condition.

Some fry dealers can maintain good quality fry in storage for more than 15 days. The fry are stored in earthen jars containing about 20 liters of water with a salinity of 29-33‰. Stocking density is reduced to 500 fry/container.

Mortality of fry while in storage can be due to one or a combination of the following:

1. Physical injuries during catching and handling while counting, sorting and cleaning of container during storage.

2. Overcrowding of fry in container.

3. Water fouling caused by decomposition of excess food, feces, dead fry, debris and high bacterial load. All of these would also greatly reduce oxygen content of the water.

4. Temperature and salinity shock.

5. Starvation of fry.

6. Keeping the fry in storage for longer than 15 days in relatively crowded condition.

7. Predation by other fish species.

The different devices and containers used in sorting, counting and storage of milkfish fry are illustrated in Figure 55.

Milkfish fry storage practices in the different parts of the Philippines are summarized in Table 2.

REMARKS AND RECOMMENDATIONS ON HANDLING AND STORAGE

The comparatively low mortality during storage of milkfish fry in Panay Island and Malabon is not due to sophisticated technical input but may be attributed only to better care and attention. Fry handlers in these two places are relatively more experienced in the care of fry. The inhabitants derive a greater part of their income from this trade. On the other hand, most fry grounds in Cotabato and Davao are located far from fry distribution centers. Fry coming from these areas are more stressed and consequently show higher mortality rates due to longer storage period and travel time under bad road conditions.

It is commonly believed that reduction of salinity during storage enhances survival. Recent laboratory findings confirm this fact. Tissue fluid osmolality of milkfish fry collected from the shore has an osmotic concentration equivalent to 13.67‰S (Almendras 1982). Dilution of storage water with freshwater would, therefore, alleviate osmotic imbalance, thus cancelling out osmotic burden being experienced by the fry. Further, solubility of oxygen in water increases at dec-

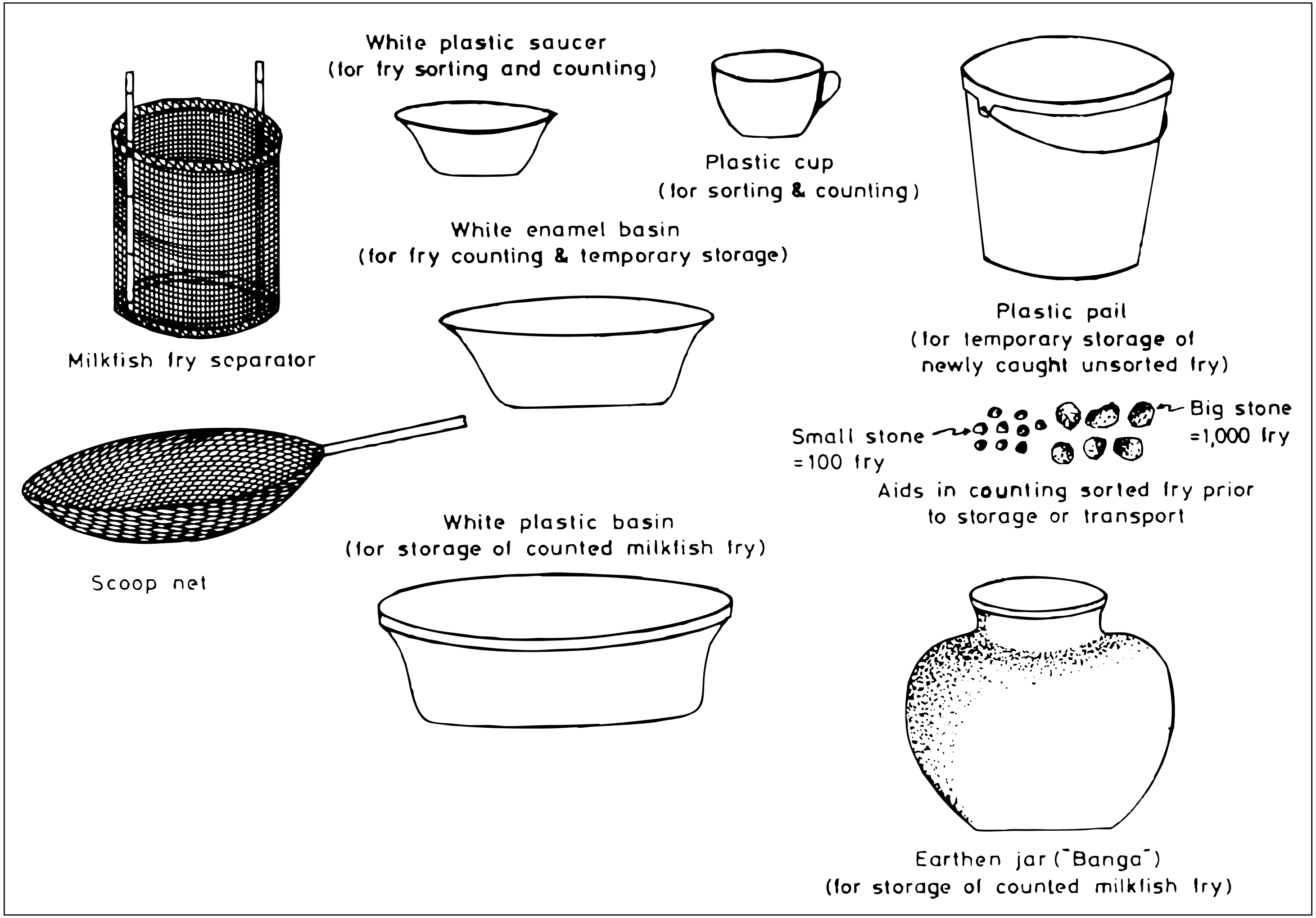

Fig. 55. Different devices and containers in sorting, counting and storage of milkfish fry.

Table 2. Milkfish fry storage practices in the different localities of the Philippines.

Practices / Location	Northern Luzon	Bicol	Panay	Palawan	Northern Mindanao	Southern Mindanao	Malabon*
1. Container	1.a. plastic basin 1.b. earthen jar	1.a. plastic basin 1.b. earthen jar	1. plastic basin	1. plastic basin	1.a. plastic basin 1.b. earthen jar	1. plastic basin	1. plastic basin
2. Water Depth	2.a. 5-6 cm 2.b. ½ filled	2.a. 7-8 cm 2.b. 2/3 filled	2. 5-6 cm	2. 5-6 cm	2.a. 5-6 cm 2.b. 2/3 filled	2. 7-8 cm	2. 5-6 cm
3. Water Volume (liter)	3.a. 15-20 3.b. 10-12	3.a. 20-23 3.b. 18-20	3. 15-20	3. 15-20	3.a. 15-20 3.b. 18-20	3. 20-23	3. 15-20
4. Salinity (‰)	4. 20-30	4.a. 24-29 4.b. 34-36	4. 18-20	4. 20-25	4a. 14-20 4b. 14-20	4. 5-10	4. 12-15
5. Feed and feeding	5. egg yolk or flour every other day	5.a. egg yolk everyday 5.b. no feeding	5. egg yolk everyday	5. egg yolk everyday	5. flour or egg yolk daily	5. flour or egg yolk daily	5. egg yolk everyday
6. Water management	6.a. complete change of water every other day 6.b. ½ of volume change daily	6. a. complete change of water daily 6.b. ½ of volume change daily	6. ½ of volume change daily	6. ½ of volume change daily	6a. ½ of volume change daily 6b. ½ of volume change daily	6. ½ of volume change daily	6. about 3 liters change daily
7. Stocking rate (fry/container)	7.a. 6,000-8,000 7.b. 2,000-3,000	7.a. 5,000-5,500 7.b. 2,000-2,200	7. 3,000-6,000	7. 5,000-6,000	7.a. 3,000-6,000 7.b. 2,000-2,200	7. 4,000-6,000	7. 4,000-6,000
8. Stocking density (fry/liter)	8.a. 300-500 8.b. 167-300	8.a. 217-275 8.b. 100-122	8. 150-400	8. 250-400	8.a. 150-400 8.b. 100-122	8. 174-300	8. 267400
9. Number of days in storage	9. 1-5 days 3 days average	9. 3-7 days 5 days average	9. 2-5 days 4 days average	9. 3-7 days 5 days average	9. 2-7 days 4 days average	9. 3-7 days 5 days average	9. 1-7 days 5 days average
10. Mortality during storage - %	10.a. 5-10 10.b. 5-8	10a. 7-9 10.b. 3-5	10. 2-3	10. 4-5	10.a. 5-10 10-b. 5-8	10. 8-10	10. 2-3

*After transport from different places in the Philippines reasing salinity and temperature. Addition of freshwater, therefore, would not only minimize stress but also increase oxygen availability from the medium.

The increase in activity of the fry during addition of freshwater is a behavioral response from sudden change of salinity and does not in any way contribute to the state of well being of the fry. This flight response may ultimately be harmful to the fry if dilution of storage water is often repeated, especially over a short period.

The apparently contradictory results showing high survival rates (95-98%) among milkfish fry held at different salinity (0, 8, 16, 30 and 32‰) with temperature ranging from 26-28°C for 14 days (Quinitio and Juario 1980, pers. obs.) only further indicates the efficacy of lowering of salinity in minimizing stress. The fry utilized in the said experiments were initially stored in low salinity water (20-25‰) after capture and were not disturbed for at least one day before subjecting to different treatments. Milkfish fry not exposed to lower salinities (≤ 25‰ S) prior to storage show higher mortality rates (pers. obs.). This suggests that prior acclimation history of milkfish fry has significant effect upon subsequent survival and adaptation. In addition, water and mineral balance has been found to stabilize after 24 hours of transfer to different salinity levels (Almendras 1982). This is an indication that the fry recover from osmotic stress after one day. Adequate time, therefore, is required for the fry to recover from the first stress before imposing another kind of stress.

The Na^+ and Cl^- concentrations of the blood plasma of several marine fishes are significantly decreased if the fish are transferred to freshwater and low temperature (Schreck 1981). The disturbance in the Na^+ and Cl^- concentrations if chronic may lead to osmoregulatory failure. Such effect probably cause decrease in survival time of milkfish fry stored in freshwater with low temperature (20°C) as observed by Villaluz and Acosta (in prep.). On the other hand, the masking effect of high salinity on the depressive effect of low temperature on the Na^+ and Cl^- concentrations may have contributed to longer survival time of fry stocked in high salinity water (30‰) at low temperature (20°C).

More milkfish fry can be stocked in plastic basins (300-500 fry/liter) than in earthen jars (100-200 fry/liter) because of greater surface/volume ratio of water in the former container. The fry become weak, emaciated and transparent if starved for 5 days. Mortality would start on the 8th day of storage if the fry are completely deprived of food. If stored for more than 14 days, 10-30% would exhibit behavioral and physical characteristics similar to starved fry. Mass mortality would eventually follow if the stocking density is not reduced.

For long-term storage of fry, however, earthen jars are better. The cooler and darker environment of the jar decreases activity and consequently the metabolism of the fry. These factors, in combination with low stocking density (25 fry/liter) and high salinity (28-30‰ S), would reduce stress and enable the fry to avoid a shift from anabolism to catabolism, thus conserving its energy reserves while in storage.

The milkfish fry upon capture is subjected to a number of stresses which if not alleviated on time would cause immediate death or have detrimental effect on the fish's subsequent survival. The following recommendations would minimize mortality due to handling and storage stresses.

1. Removal of debris and unwanted species should again be undertaken when the fry are brought to the shore and before transferring to a white basin. White colored basin facilitate fry counting and observation. The water in the basin should be diluted with freshwater (1 part freshwater to 4 parts seawater).

2. While handling the fry, care should be taken so that injury and exposure out of water would be avoided.

3. Handling, sorting, counting and temporary storage should be undertaken under the shade. If the container is exposed directly to the sun, water temperature might rise to critical level ($>35°C$) thereby subjecting the fry to thermal shock.

4. Before overnight storage in the fisherman's place, the water in the container should be diluted again with freshwater at a ratio of 1 part freshwater to 2 parts of water in the container.

5. For overnight storage, stocking rate for plastic basin containing 20 liters of water is 2,000-3,000 fry and 1,000-1,500 fry for earthen jars containing 10-15 liters of water.

6. The container should be covered and stored in cool, dark and quiet place.

7. The fry should be transported to the concessionaire's bodega in plastic bags filled with oxygen placed inside *pandan* bags. The stocking density per bag should be 3,000-5,000 fry.

8. Upon reaching the bodega, let the fry rest for at least 3 hours before any manipulation or handling.

9. Recommended stocking density for storage of fry:

Container	Plastic basin	Earthen jar
Optimum		
fry/liter	150	100
fry/container	3,000	2,000
Maximum		
fry/liter	300	150
fry/container	6,000	3,000

10. Clean water pre-mixed at the desired salinity (20-25‰- approximately 1 part freshwater and 1 part seawater) should be used to replace storage water in order to avoid thermal and salinity shock.

11. Storage container should be cleaned of excess food, dead fry and debris; and 2/3 of water volume changed everyday.

12. Feed fry with hard boiled egg yolk or fried flour (3 g per 5,000 fry) everyday.

13. If fry would be stored for more than 15 days, the stocking density should not be more than 25 fry/liter from the beginning of storage.

TRANSPORT OF FRY

Milkfish fry are not fed before transport. The fish are transferred to smaller basins and the number determined by visual estimation. Freshwater is sometimes added to further reduce the salinity. Excess water in the basin is removed by using a cup or small bowl over a scoop net to exclude the fry and minimize injury. The fry are then introduced inside doubled plastic bags (Fig. 56). The stocking rate

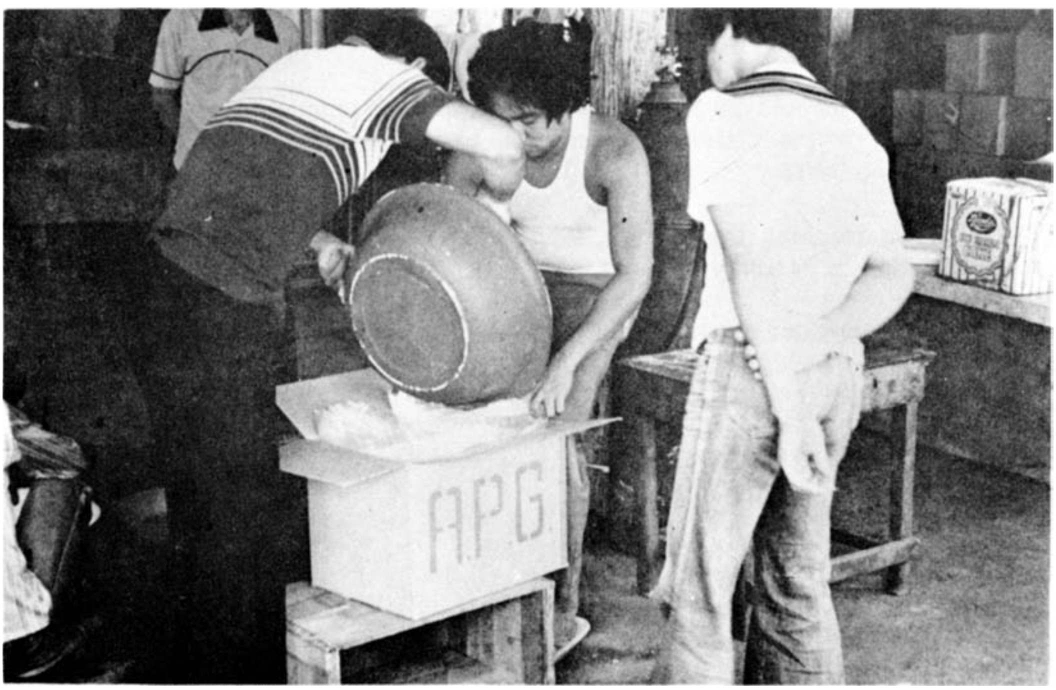

Fig. 56. Counted fry being poured into plastic bags inside styrofoam box in preparation for air transport (Cotabato City, Maguindanao).

(fry/bag) depends on the length of time and mode of transport. In some places, the two bottom end corners of the plastic bag are tied with rubber bands to prevent the bottom of the bag from forming corners. After transferring the fry into the plastic bag, the air in the bag is replaced with oxygen (Fig. 57). As soon as the desired oxygen volume in the bag (usually of equal volume with water) is obtained, the open end of the bag is twisted, bent and tied with rubber bands. The plastic bags are either placed inside *pandan* bags if transport is by land or inside styrofoam boxes if transport is by air. The process in packing milkfish fry for transport is illustrated in Figure 58.

Ice is sometimes used to lower water temperature to about 20°C when plastic bags are placed in styrofoam containers. Care is taken to avoid the melted ice coming into contact with transport water as this would result to an abrupt decrease in transport water temperature. The ice is put in a separate plastic bag and placed on top of the plastic bag containing the fry.

Milkfish fry transported by boat are held in open plastic bags placed inside *pandan* bags. Stocking rate is 3,000-5,000 fry/bag. Transport water is changed every 12 hours. This method is risky.

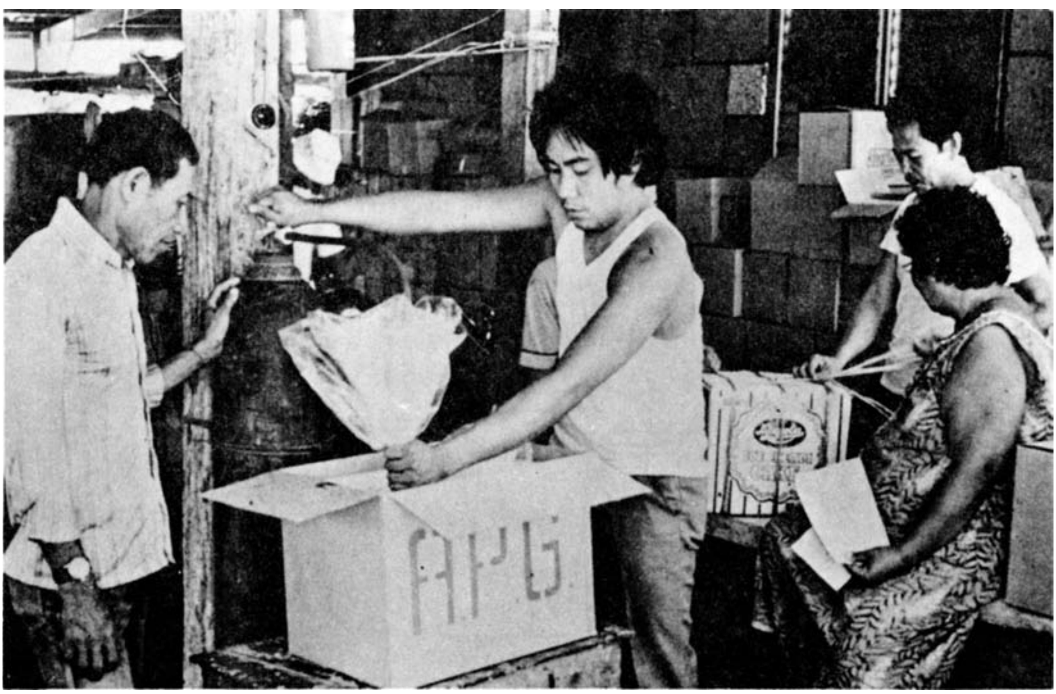

Fig. 57. Introduction of oxygen into the plastic bag (Cotabato City, Maguindanao).

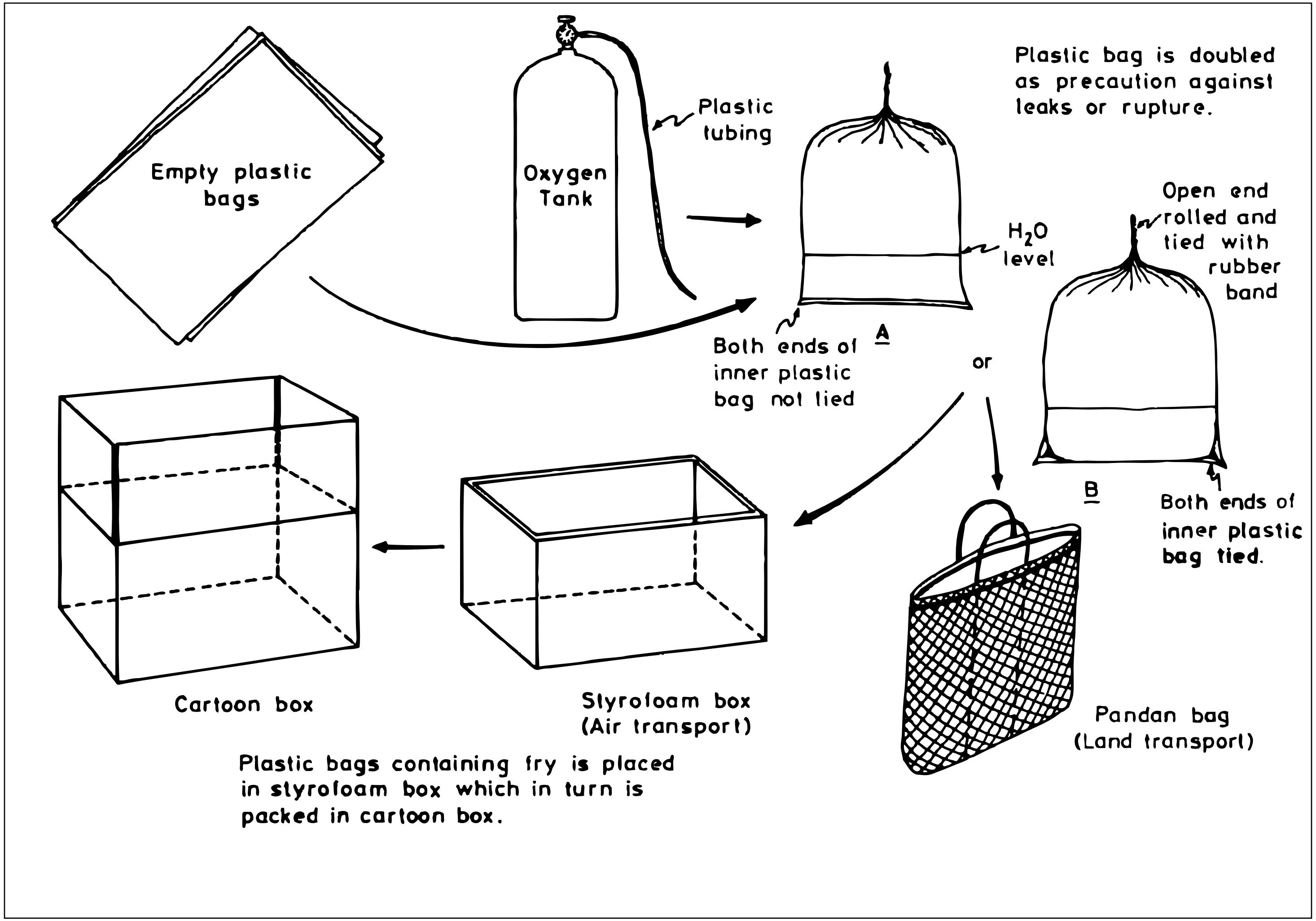

Fig. 58. Process in milkfish fry transport.

Causes of mortality during transport:

1. Physical injuries.

2. Oxygen depletion due to leakage from plastic bag, delays in transport, overcrowding, decomposition of dead fry and other organic matter and high bacterial load of transport water.

3. Accumulation of toxic waste products like ammonia and other metabolites in water.

Methods of transporting milkfish fry, including estimated mortality during transport in the different localities of the Philippines, are summarized in Table 3.

REMARKS AND RECOMMENDATIONS ON FRY TRANSPORT

Temperature is the most critical factor to consider in milkfish fry transport because of its effect on metabolic rate. Oxygen consumption of milkfish fry (5-8 mg body weight) increases from about .011 mg O_2/hr/fry at 20°C to 0.056 mg O_2/hr/fry when temperature is elevated to 32°C (Millamena and Villaluz unpublished). If the number and or size of fish are small, the oxygen content of the water will not become a limiting factor but in a crowded situation, an increase in temperature can result to severe stress if not mass mortality. The stocking density and maximum time of travel are, therefore, primarily dependent on water temperature. Both high temperature and salinity expose the fish to reduced oxygen tension, since solubility of oxygen drops sharply as temperature and salinity rises. Lowering of temperature and salinity of transport water to optimal levels would inhibit the fish to accumulate considerable oxygen debt and minimize stress while in transport.

Physical injuries also cause mortality during transport. These may result from rough handling and bad road conditions from the fry collection areas to fry distribution centers. It has been observed that milkfish fry have the tendency to concentrate at the two bottom corners of the plastic bag which became death traps during transport.

The following recommendations would minimize stress and mortality of fry during transport:

1. Transport fry only after they were allowed to rest for at least one day in plastic basin or earthen jar. This would increase the resistance of the fry to subsequent environmental stresses during transport and upon reaching their place of destination.

2. Optimum salinity for transport is from 15-25‰.

3. The stocking density of fry in one plastic bag should not exceed 6,000. Unnecessary handling and transfer of fry from one container to another could be

Table 3. Milkfish fry transport methods in the different localities of the Philippines.

Methods / Location	Northern Luzon	Bicol	Panay	Palawan	Northern Mindanao	Southern Mindanao
1. Destination	1. Bulacan and Metro Manila	1. Bulacan and Metro Manila	I.a. Iloilo 1.b. Manila	1. Metro Manila	I.a. Agusan 1.b. Metro Manila	1. Metro Manila
2. Mode of transport	2. Land	2. Land	2.a. Land 2.b. Land and air	2. Land and air	2.a. Land 2.b. Land and air	2. Land and air
3. Transport time (Hours)	3. 8-14	3. 8-12	3.a. 2-4 3.b. 4-8	3. 3-4	3.a. 5-6 3.b. 3-5	3. 5-10
4. Container of plastic bag	4. Pandan bag	4. Pandan bag	4.a. Pandan bag 4.b. Styrofoam (40 x 40 x 40 cm)	4. Styrofoam boxes (30 x 45 x 30 cm)	4.a. Pandan bag 4.b. Styrofoam boxes (30 x 30 x 30 cm)	4. Styrofoam boxes (30 x 45 x 30 cm)
5. Size of plastic bag (cm)	5. 50 x 83	5. 55 x 76	5.a. 55 x 76 5.b. 30 x 60	5. 55 x 76	5.a. 55 x 76 5.b. 30 x 60	5. 51 x 75
6. Water volume (liter)	6. 8-10	6. 8-10	6.a. 8-10 6.b. 3-4	6. 4-5	6.a. 8-10 6.b. 3-4	6. 3-4
7. Salinity (‰)	7. 14-18	7. 12-22	7. 14-20	7. 12-16	7. 10-18	7. 2-4
8. Stocking rate (fry/bag)	8. 4,000-6,000	8. 4,000-5,000	8.a. 5,000-6,000 8.b. 6,000-8,000	8. 4,000-5,000	8.a. 5,000-6,000 8.b. 6,000-8,000	8. 4,000-5,000
9. Stocking density (fry/liter)	9. 400-750	9. 400-625	9.a. 500-750 9.b. 1,500-2,000	9. 800-1,250	9.a. 500-750 9.b. 1,500-2,000	9. 1,250-1,333
10. Mortality-%	10. 4-5	10. 3-5	10.a. 2-3 10.b. 3-5	10. 4-6	10.a. 5-8 10.b. 2-4	10. 4-6

avoided since the said stocking density is the maximum number that can be safely accommodated in one plastic basin during storage.

4. Transport of weak or sick fry should be avoided.

5. Tie both bottom ends of plastic bag to be used for fry transport to eliminate corners. This would prevent the fry from being crushed at the corners during handling and transport.

6. If lowering of temperature is to be done during transport, temperature should be lowered gradually (approximately 5°C/hr) and not to exceed below 20°C. Also, high salinity (at least 25‰) should be utilized in transporting the fry to neutralize the ill effect of low temperature on the osmotic adaptation of milkfish fry.

NURSERY POND OPERATION

Nursery ponds are typically shallow compartments measuring from 100 to 5,000m^2. The ponds are provided with gates and/or pipes for effective water management. In the past, the nurseries are provided with catching basins near the water inlet but in newly constructed ponds, water supply canals are used. The water supply canal also serves as water reservoir in case additional water is needed in the nursery pond, particularly during harvest to prevent suffocation of the fish from mud particles clogging their gills.

There are several factors which affect growth and survival of milkfish in nursery ponds: 1) natural food (lab-lab); 2) stocking density; 3) predation; and 4) sudden changes in environmental conditions. Since raising of milkfish fry to fingerlings is an intensive fish culture activity where very high rates of stocking and mortality are encouraged, much care and preparation are necessary to attain good results.

Nursery Preparation

A month or two before stocking, the nursery pond bottom is levelled and exposed to the sun for about 1-2 weeks until the soil cracks with dryness. Prolonged dryness of pond bottom is avoided such that the surface soil of about 10 cm deep should contain at least 16-20% moisture to prevent the soil from hardening or becoming powdery. Sluice gates, leaks and seepages are checked and repaired for effective water control during the drying and fertilization periods. The screens of sluice gates are provided with fine-meshed nylon nettings to restrain the entrance of undesirable organisms.

Fertilizers are applied depending on soil quality to promote growth of food organisms. It is a common practice to initially apply 1-3 tons of chicken manure or 0.5-1 ton of rice bran per hectare. New tidal water is then admitted to a depth of about 5-10 cm. Inorganic fertilizers are applied after 2-3 days. Usually, 1-5 bags (1 bag = 50 kgs) of 16-20-0 or 1-2 bags of 18-46-0 are applied for every hectare.

Some fishfarmers also add 15 kg/ha of Urea to speed up the breakdown of organic fertilizers. Subsequent applications of inorganic fertilizers at 20-30 kg/ha are made at 1-2 weeks interval to bolster lab-lab production.

The remaining undesirable organisms are eradicated either before or after fertilization with the use of the following pesticides:

Endrin	— 200 ml/ha
Gusathion	— 250 ml/ha
Aquatin	— 350 ml/ha
Tobacco dust	— 125-200 kg/ha

Water depth in the nursery is increased gradually 3-5 cm from time to time, depending on growth of lab-lab, until the water level reaches a depth of 25-30 cm. In 20-30 days, when lab-lab has grown luxuriantly, the pond is carefully flushed 2-3 times to get rid of highly saline water and/or toxic substances.

Some progressive fishfarmers in Panay Island are now using artificial net substrates to increase the supply of natural food. The procedure is as follows: Nylon netting (0.5 mm mesh) is cut into strips measuring 30 cm wide with length depending on the size of the nursery pond. The net strips are seed with natural food organisms by dipping in lab-lab, mud and water mixture and air dried for 5 days. The net substrates are then installed parallel to one another, like tennis nets, in the nursery pond using bamboo stakes. The lower edges of the net substrates are set about 5 cm from the pond bottom to allow free movement of the fish. Net substrate surface area equivalent to 30% of surface area of the nursery pond will give optimum production.

Acclimatization, Stocking and Rearing of Fry

Milkfish fry are usually placed in white plastic basins (50 cm in diameter and 16.5 cm in height) upon delivery to the fishpond for conditioning, final counting and sorting out of predatory organisms. Acclimatization of fry to pond salinity is done by gradual replacement or addition of transport water with pond water.

The fry are stocked in the nursery pond either early in the morning or late in the afternoon. Before releasing the fry, the basins containing the fry are left to float for a time in the nursery pond to reduce any temperature difference.

Some fishfarmers stock the fry directly to the nursery pond upon arrival. As in the above method, the plastic bags or earthen jars containing the fry are made to float in the nursery pond while at the same time transport water is gradually replaced with pond water before the fry are released.

An acclimation compartment is sometimes utilized to further condition the fry and reduce mortality in poorly maintained or prepared nursery pond. It is a small compartment measuring about 4 m wide and 5 m long with low earthen dikes and is constructed within the nursery pond. A temporary shade made of palm leaves is provided to keep the water cool even during the hottest part of the day. The dikes of this compartment are sometimes fenced in by fine-meshed nylon nettings to prevent crabs, snakes and lizards from getting in. Stocking density ranges from 4,000-5,000 fry/m^2. In about a week, the fry are allowed to the nursery pond proper by breaking some sections of the dikes.

Another method of fry conditioning used is stocking the fish in fine-meshed hapa net which are set inside the nursery pond. A hapa net measuring 1m x 1m x 1m is stocked with 1,000-2,000 fry. The fish are kept for about one week inside this enclosure before releasing to the nursery pond proper.

Stocking rate in the nursery pond is ordinarily from 30-50 fry/m^2 but commercial nursery operators stock as high as 100 fry/m^2. When natural food (lab-lab) is lacking or has been depleted, supplementary feeding is resorted to. The most common artificial feeds are rice bran, corn bran, stale bread and chicken manure, given either singly or in combination. Pond water is replaced twice a month during spring tides. In about 4-6 weeks of rearing, the fish grow to 5-8 cm in total length (fingerling size) which is the ideal size for releasing in grow-out ponds or pens.

Fingerlings could be stunted without impairing their health and with negligible mortality by transferring them to bigger ponds at the rate of 5-15 fingerlings/m^2. Since most fishfarmers usually buy fry only once a year, stunted fingerlings provide a continuous source of stock for year-round operation.

Generally, only 30-50% of the fry stocked reach fingerling size, although commercial nursery operators claim a survival rate of 60-80%. There is a general consensus among fishfarmers that survival of milkfish fry is better during the dry season (March-May) than during the rainy season (June-August). It is also observed that there are more predators mixed with milkfish fry caught late in the season (June-August) than those caught earlier (March-May).

The common predators and pests in the nursery ponds are: Elops machnata, Megalops cyprinoides, Ophicephalus striatus, Sarotherodon mossambica, Lates calcarifer, Therapon spp., several species of Gobiidae, water snakes (Disteira ornata Lapeneis sp., Chersydrus granulatus), lizard (Varanus sp.) and snails of the Family Lymnaeidae.

Causes of high mortality in the nursery pond are:

1. Improper acclimatization of fry especially when already weak from transport or storage stress.

2. Presence of predators.

3. Insufficient natural food (lab-lab).

4. Overstocking and/or fingerling retained in the nursery pond for more than 45 days.

5. Unfavorable environmental conditions (i.e. oxygen deficiency, sudden changes of temperature and/or salinity, accumulation of metabolic by-products, water pollution).

6. Carelessness of caretakers.

7. Occurrence of typhoons.

Harvesting and Counting Practices

Harvesting of milkfish fingerlings is usually done in the morning. According to fishpond caretakers, mass mortality occurs if fingerlings are harvested before sunrise or late in the day when the water is already warm.

Freshening the nursery pond water with new water is the most popular practice of harvesting. This is done by initially decreasing the pond water level in the morning or at noon time and admitting new water to the nursery pond the following day. This induces the milkfish to go against the current and congregate to the catching pond or canal. The gate is then closed when the required number of fingerlings have been confined.

Another way of harvesting is by seining. This is done by spreading the net on the far end of the pond and dragging it towards the catching basin or canal (Fig. 59).

The fingerlings concentrated in the catching pond or canal are caught with a fine-meshed seine and transferred to a dip net using stainless pail (Fig. 60). Counting is done with the aid of a small perforated plastic bucket (Fig. 61) with a capacity from 500-2,000 fish depending on size of fish and bucket. Three buckets full of fish are scooped and the contents counted. The average number of fingerlings per scoop is multiplied by the number of scoops to provide the total estimated number of fish.

Rearing of Milkfish Fry in Freshwater

High mortality rate (20-30%) in the first week of stocking in Laguna de Bay of brackishwater nursery pond-reared fingerlings motivated fishpen owners to look for alternative methods of rearing milkfish fry to fingerlings. One method involves acclimatization of fry to freshwater in plastic basins. Each plastic basin filled with 20-30 liters of water is stocked with 20,000 fry. The fry are gradually acclimated to the water quality of the lake by providing a continuous flow of lake water at 1 liter/hr into the plastic basins for 5 days. The fish are then transferred to hapa nets (2 x 6 x 2 m) set in the lake. Stocking density is 12,000 fry/net or about 650 fry/m^3. The fry, while still being conditioned in plastic basins are fed with

Fig. 59. Harvesting of milkfish fingerlings with the use of seine net (Malabon, Metro Manila).

Fig. 60. Concentrated fingerlings being transferred to a dipnet (Malabon, Metro Manila).

Fig. 61. Counting of fingerlings with the use of plastic bucket (Malabon, Metro Manila).

mashed egg yolk. Stale bread is given when the fry are transferred to the hapa nets. The fish grow to 34 cm in total length in 3-4 weeks. A survival of 70-80% is claimed. This rearing procedure is feasible only during the summer months (March-May) when the lake water is relatively calm, clear with salinity level of 1.5-3.0 ‰.

Another method of rearing fry to fingerlings in freshwater is the use of marine plywood tanks (1.2 x 5 x 0.6 m) as nurseries. The fry are initially stocked in plastic basins at a density of 3,000-6,000 fry/10-20 liters of water. The fish are acclimated to freshwater by replacing one-half of the water volume of the plastic container every 4 hours. Transfer of fry to the plywood nursery tank is done on the third day. Stocking is from 5,000-10,000 fry/m^3. Aeration is provided and 2/3 of the water volume is changed daily. Artificial diet composed of rice bran, fish meal, wheat flour and vitamin supplements together with Brachionus sp or lab-lab is given twice daily. The fish are grown until they reach 2.5-3 cm in total length which usually takes from 4-6 weeks of rearing. Survival rate is from 80-85%.

REMARKS AND RECOMMENDATIONS ON NURSERY POND OPERATIONS

Survival in the nursery pond can be improved by preparing the fish for new conditions to be encountered in the new environment. Improper acclimation to pond water has been claimed by most fishfarmers to result to as much as 80% mortality upon stocking of fry in the nursery. Such mortality can be attributed to acute or chronic stresses experienced by the fish from the time of capture up to stocking in the nursery pond. Stressed fry are also more vulnerable to predation.

Based on ecological evidence, the nursery pond initially provide more than enough Of the habitat requirements of young milkfish. However, changes affecting food availability and fish biomass in the pond could impose low-level chronic stress on segments of the population, thereby, affecting their performance in resisting diseases, and other unfavorable conditions. Mortality in a crowded population may be beneficial to the fish population as a whole if space and/or food resources are limited (Elloitt 1981). These partly explain the recurrent but partial mortality of young milkfish if reared for more than 30 days in earthen nursery ponds or land-based nursery tanks.

Young milkfish can tolerate transient exposure to high temperature up to 42°C (Panikkar *et al.* 1953) but daily exposure to increasing temperature from 25°C to 34°C at 1°C per hour might be lethal in the first week of rearing (Villaluz and Unggui 1983). This means that the time of exposure to thermal stress is more critical to survival than the magnitude of the temperature change. However, the fry have a high recovery potential from thermal stress and apparently need a fluctuating thermal environment for faster growth (Lin 1969). Shelters such as shades and trenches or canals should be provided in the nursery pond to satisfy the fish's thermal requirement at each moment.

Holding of fry in acclimation compartment for about 1 week would give enough time for the fish to recover their normal movements, form a school and familiarize with the new habitat. It would also be advantageous to initially provide familiar food to hasten the adjustments to new feeding regime. All of these would minimize the hazard of predation and promote faster growth once the fry are released in the nursery pond proper.

Rearing of milkfish fry in land-based nurseries apparently minimize mortalities but no data on their growth and survival to marketable size in grow-out ponds or fish pens have been reported. Moreover, good survival in the present land-based fingerling production systems generally can only be attained up to the 3rd or 4th week of rearing. Uniformity in size and health condition of the fish are severely affected with longer rearing period. Although a survival of higher than 95% and maintenance of good health condition of fingerlings at high stocking density (7 fish/liter) for a 3 month period have been achieved in the laboratory (Villaluz and Unggui 1983), continuous propagation of large quantities of suitable food organisms would be a constraint in the success of such a land-based nursery system. Formulation of nutritionally balanced and efficient artificial diet would, therefore, be of much value in the development of a commercial land-based milkfish fingerling production system.

Milkfish fry can be reared in lake-based cages but survival is very much lower compared with land-based freshwater facilities. (Santiago *et al.* 1983). Rearing of milkfish fry in land-based nurseries for 2-3 weeks before transferring to lake-based cages might result to better growth and survival. Juveniles of milkfish are more resistant to occasional unfavorable conditions and Lernaea infestation (ectoparasitic copepod) in lake environment as implied by highly successful milkfish pen industry in Laguna Lake.

The following recommendations aim to reduce stress and improve survival of young milkfish at various stages of nursery pond operation.

1. Use of synthetic organic pesticides or other non-biodegradable substances in the nursery pond should be limited due to unknown cumulative effects on the pond, fish and man. An alternative method to eradicate undesirable species in the ponds is the application of 1-2 tons of lime per hectare and 10 g/m^2 of commercial ammonium sulfate fertilizer immediately after liming (Norfolk *et al.* 1981).

2. The fry should be placed in plastic basins upon arrival to enable the fish to recover from transport stress. After 6 hours, the water in the basin should either be replaced or diluted with pond water where the fry would be eventually stocked at the rate of 25% of the water volume of the container at a time. This is to be repeated every 4 hours until the salinity more or less equals the pond salinity. The fry should be stocked in the nursery pond the following morning.

3. Acclimatization of milkfish fry to freshwater is best done by providing a gradual but continuous inflow of freshwater and outflow of transport water from the basin over a 12-hr period. A stocking rate of 500 fry/liter during acclimatization is recommended (Santiago *et al.* 1982).

4. For direct stocking in poorly prepared nursery, stock the fry in the morning rather than late in the afternoon to provide the fish sufficient time to adjust to the new habitat. Nightfall decreases activity and responsiveness of milkfish (Buri 1980, Villaluz and Unggui 1983) which would lead to greater exposure to predation.

5. Use artificial net substrate in the nursery pond to increase food supply of young milkfish. This will not only increase the period of time the young milkfish can be held in the nursery pond without impairing their health but also will promote faster growth.

6. The stocking density in the nursery pond should be thinned out to 15-25 fingerlings/m^2 after the 4th week of rearing to prevent diseases and/or mortality.

7. Freshening method of harvesting should be utilized as harvest by seining would cause more stress and physical injury to the fish. Although the effect of stress and injuries during seining might not be immediate, heavy mortality may occur after stocking in grow-out ponds or pens.

8. If seining of fingerlings cannot be avoided, harvesting operation should be undertaken between 6:00 to 8:00 in the morning to avoid mass mortality. Oxygen content of pond water is at its lowest before sunrise while water temperature increases considerably after 8:00 in the morning.

9. When counting and holding fingerlings for transport, continuous flow of water should be provided to reduce stress and avoid suffocation of fingerlings.

TRANSPORT OF FINGERLINGS

One method of transporting milkfish fingerlings is by means of "live boat" locally known as *petuya* (Fig. 62). The boat has a flat bottom and the fingerling compartment provided with holes at the bottom for free entrance of water. A diesel or gasoline-powered water pump (Fig. 63) is used to continuously change the water in this compartment. However, when passing muddy or polluted water, the holes are closed and the water pump outlet is directed towards the fingerling compartment to recirculate and aerate the water inside. Upon reaching the destination, the fingerlings are caught with fine-meshed seine (Fig. 64) and transferred directly to fishponds or pens with the use of stainless pail. The boat can accommodate 80,000-120,000 fingerlings 3-5 cm in total length or 50,000-60,000 fingerlings

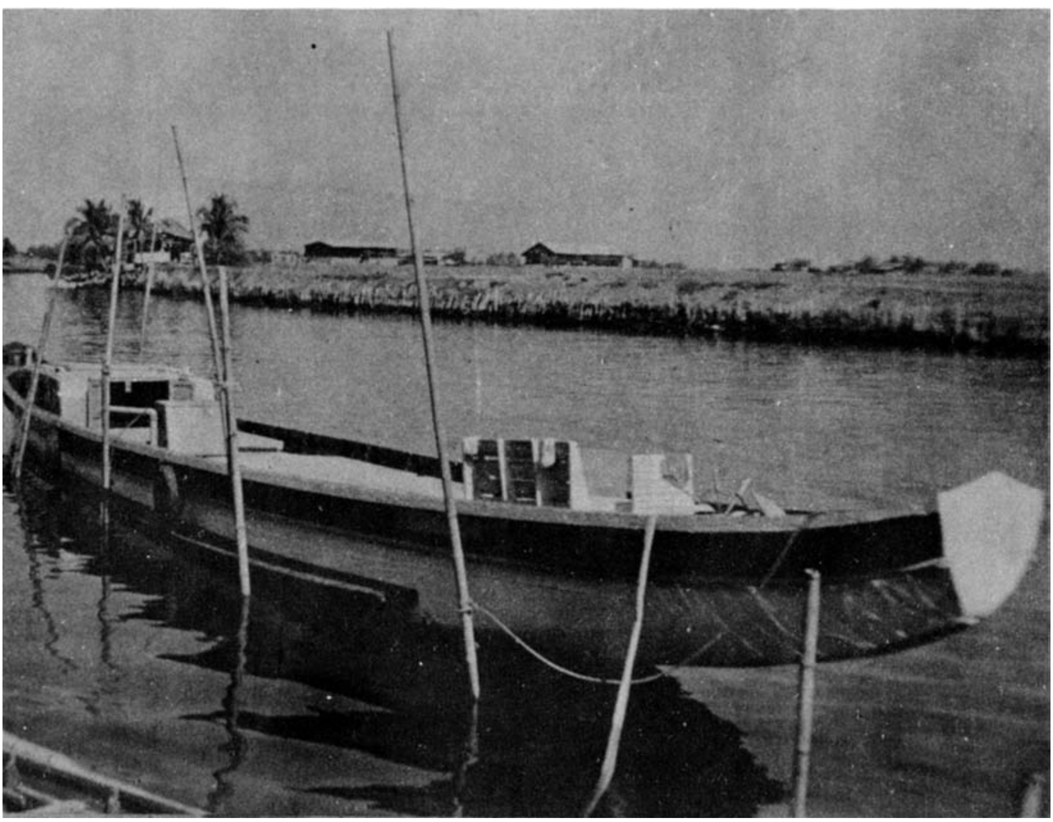

Fig. 62. *Petuya* (live boat) used in transporting milkfish fingerlings (Bulacan).

measuring 6-10 cm. Transport is usually 4-5 hours and mortality rate from 0.05 to 2%. Bad weather, use of polluted or muddy water, overstocking and sick and weak fish are avoided to prevent mass mortality during or shortly after transport.

Milkfish fingerlings are also transported to various places using plastic bags filled with oxygen. A plastic bag containing 5-15 liters of water is stocked with 400-500 fingerlings measuring 3-4 cm in total length but only 200-300 fingerlings if the size is from 5-10 cm. The plastic bag containing the fingerlings are either placed inside a buri bag or cartoon box.

REMARKS ON TRANSPORT OF FINGERLINGS

Harvesting, handling, transport and stocking to a new environment expose the milkfish fingerling to a series of stresses. The initial response of the fish is increased activity to escape from stress. Prolonged activity, however, will cause lactic acid to accumulate in the muscle tissue of the fish and may lead to severe oxygen debt (Black *et al.* 1962). Water and mineral balance (Eddy 1981) and

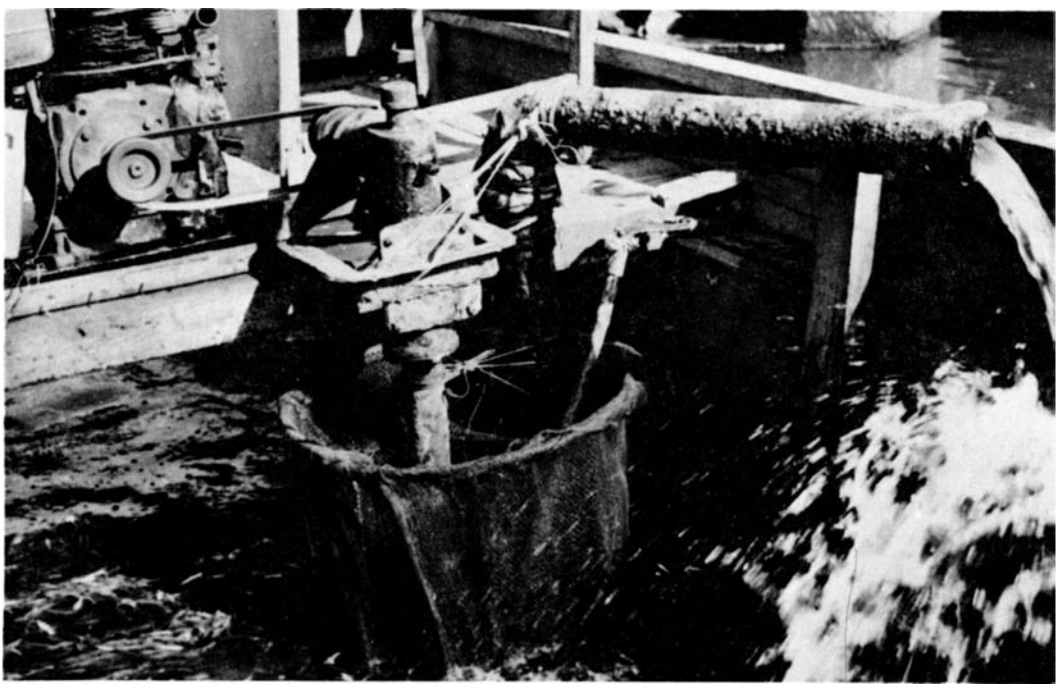

Fig. 63. Diesel powered pump inside fingerling compartment of live boat to continuously change or circulate water.

Fig. 64. Concentrating of fingerlings with seine net inside fingerling compartment of live boat prior to stocking in fishpens with the use of stainless pail (Laguna de Bay).

resistance to diseases (Wedemeyer and Mc Leady 1981) may also be impaired. Such may be the reasons why fungal infestation and mass mortality occur after the next few hours or days of stocking even in environments with optimal conditions.

Newly-caught wild or pond-reared milkfish fingerlings (water salinity 58-2 8 ‰) could be transferred directly to freshwater and vice versa without any ill effect (Villaluz *et al.* 1982, pers. obs.). However, if these fingerlings have undergone transport before direct transfer to freshwater, mass mortality may occur. Water and mineral balance of milkfish fingerlings generally stabilize after 60 hours of transfer to different salinity levels and after 24 hours for milkfish fry (Almendras 1982). This explains the susceptibility of milkfish fingerlings and tolerance of milkfish fry to subsequent stress after a short period of time.

Recommendations in transporting milkfish fingerlings are as follows:

1. Milkfish fingerlings should be acclimated to pond water temperature and salinity before stocking if the plastic bag method described above is used. Upon arrival, the plastic bag should be opened and made to float in the pond where the fish are to be stocked. Transport water is then gradually diluted with pond water. The fish should be released to the pond after 5-10 minutes. This method should not be adopted for stocking in freshwater areas because survival would be less than 30%.

2. If, however, the plastic bag method is to be used to transport fish to freshwater areas, the following procedure should be followed:

A. Acclimatization

a. Stock newly caught fingerlings in concrete or marine plywood tanks preferably measuring 1.2 x 5 x 0.6 m filled with water having a salinity of 5‰.

b. Stocking rate in tanks:

fingerling 3-5 cm total length: 5,000 fish/m^3
fingerlings 6-8 cm total length: 3,000 fish/m^3

c. Feed fingerlings with lab-lab in the morning, daily until the 3rd day.

d. Clean the tank and change the rearing water daily; maintain 5‰ salinity.

e. Transport on the 4th day. The fingerlings should be transported not later than the 5th day of conditioning to minimize the effect of crowding stress.

B. Transport

a. Place 10 liters of freshwater in plastic bag measuring 0.5 x 1 m and stock the fish directly into the bag.

b. Stocking rate in the bag:

fingerlings 3-5 cm total length: 1,500 fish/bag
fingerlings 6-8 cm total length: 700 fish/bag

c. Inflate plastic bag (approximately ½ of its capacity) with oxygen.

d. Place the plastic bag containing the fingerlings inside styrofoam box and put about ½ kg of ice (contained in plastic bag) on top of plastic bag containing the fish. Care should be taken so that transport water temperature would not fall below 25°C.

e. The fish should be stocked directly from the plastic bag to the fish pen or pond immediately upon arrival. Acclimatization to pen or pond water conditions is unnecessary.

3. Gradual acclimatization of milkfish fingerlings to freshwater along the way should be undertaken if "live boat" method would be utilized to transport the fish to fish pens in Laguna de Bay. The fingerlings, being already exposed to transport stress, will have lower performance to resist sudden change of salinity.

CONCLUSION

The yield of milkfish fry from the wild in Philippine waters can still be increased. However, rational management measures based on sound and tested biological principles should be implemented to maintain and optimize the productivity of the fry grounds and conserve this important aquatic resource.

Socio-economic and ecological balances which would optimize energy and labor while not depleting the natural supply of milkfish fry, should be examined and considered in the development of new catching methods and improvement of existing ones not only to increase supply and lower the cost of fry but also to give satisfying and renumerative employment to many.

The different methods and practices used expose the fish to a number of stress which may lower future survival rates. Research is needed to minimize and/or alleviate such stresses encountered by the fish in artificial environments and man's manipulations.

The flow chart of activities of the milkfish fry and fingerling industry of the Philippines together with the duration and mortality at each stage of activity is shown in Figure 65. Although the estimated annual catch of about 1.15 billion fry appears enough for the industry's requirements, mean survival of only 38.8% from catching to fingerling size accounts for the fry shortage being experienced by the milkfish industry as a whole. This condition can be mainly attributed to high mortality in the nursery pond. Development of efficient mass-production technology in rearing milkfish fry and stunting of resultant fingerlings for longer periods of time could furnish the solution in meeting the required and continuous supply of milkfish seed and provide surplus fry for export to other countries.

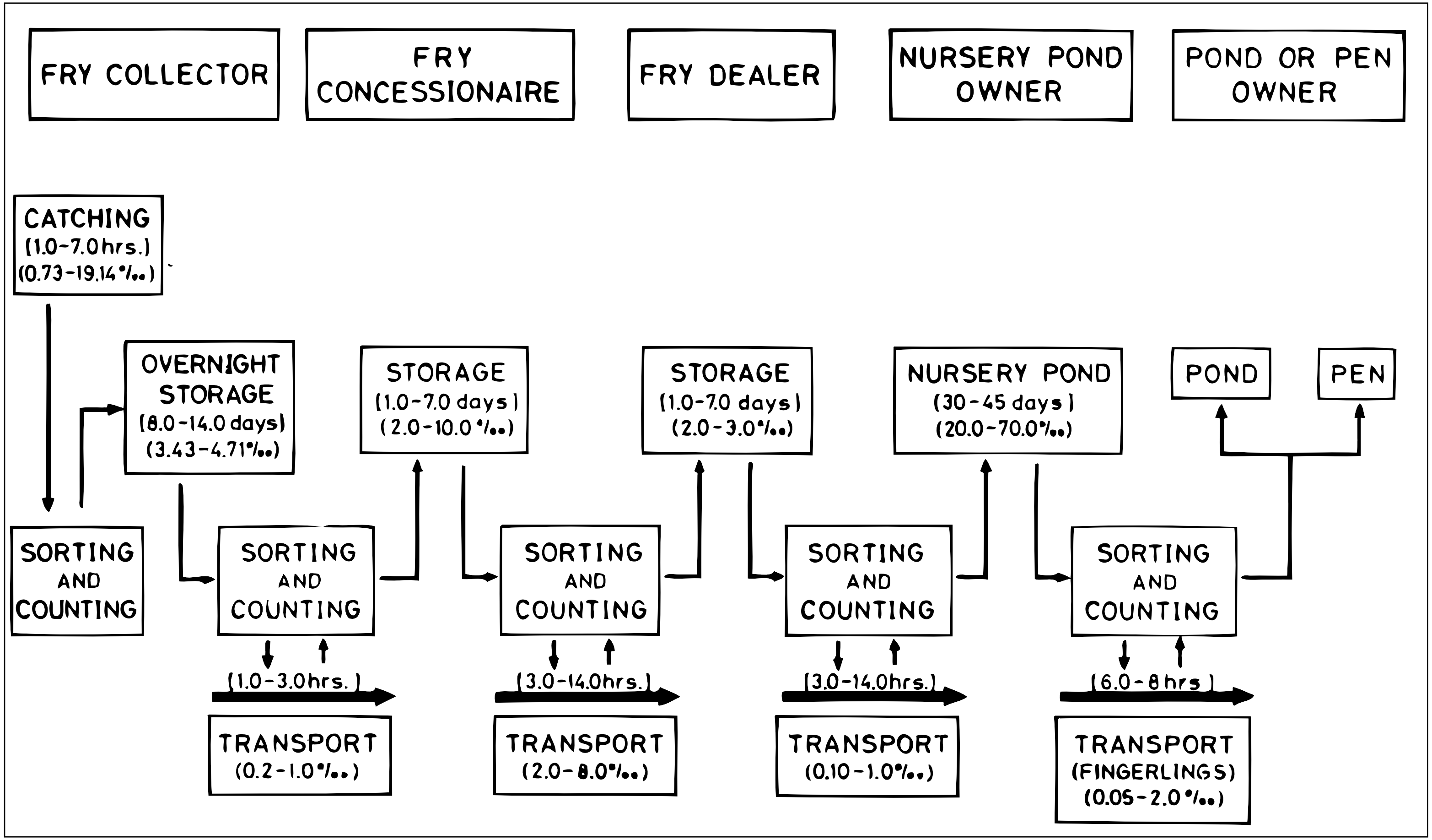

Fig. 65. Flow chart of the milkfish fry and fingerling industry of the Philippines with the duration [ ] and mortality ( ) at each stage of activity.

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