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A study on the milkfish fry fishing gears in Panay Island, Philippines

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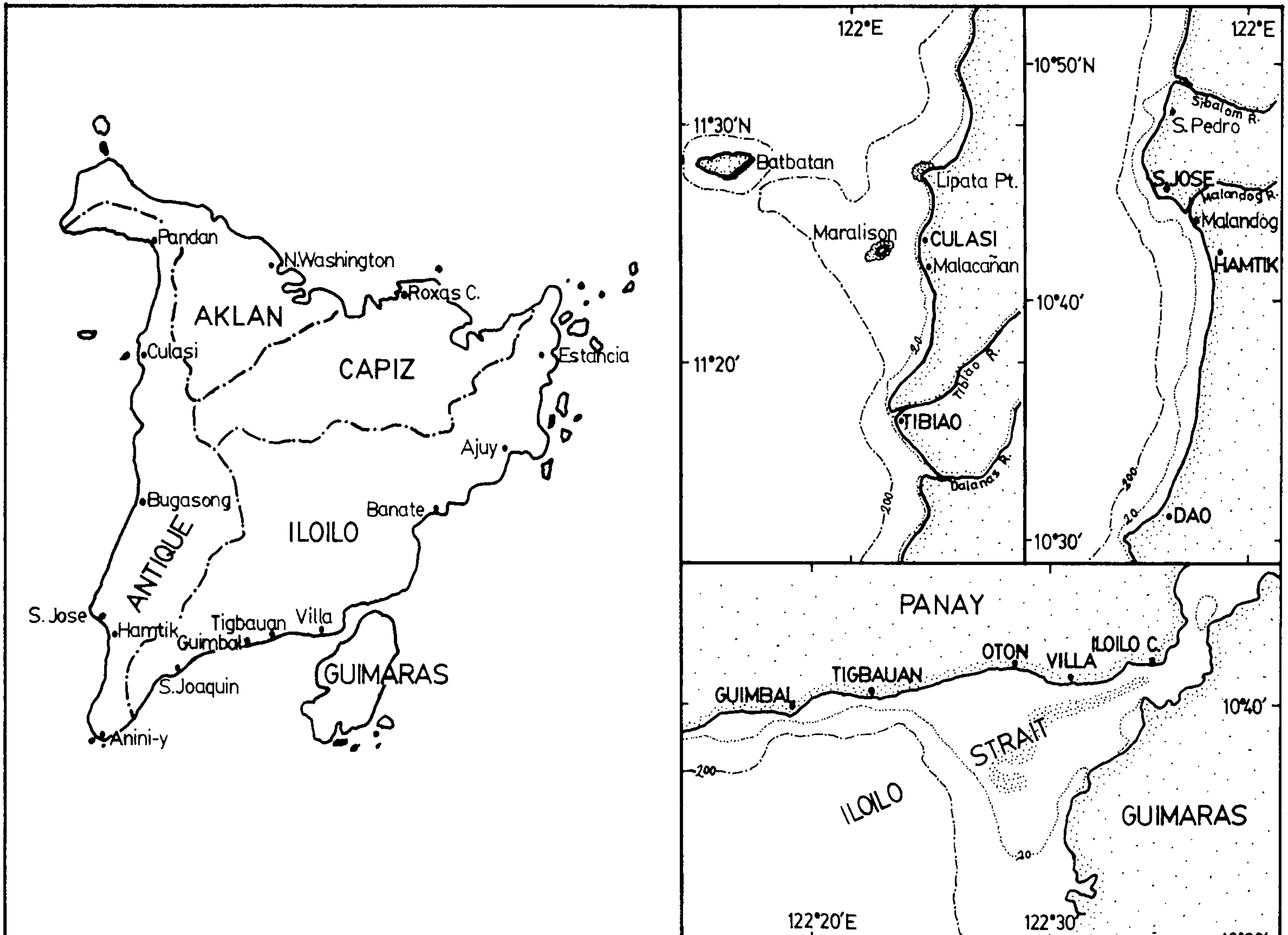

Fig. 1. Map of Panay Island, showing some of the fry grounds mentioned in this report. Depth is in meters.

A study on the milkfish fry fishing gears in Panay Philippines

S. Kumagai, T. U. Bagarinao and A. S. Unggui

The Panay coastline, particularly the western coast, is one of the best milkfish fry fishing grounds in the country. The catch was estimated at 120 million in 1975 (Villaluz, 1975). Despite the success that artificial propagation of milkfish has had in the past few years, the milkfish culture industry will continue to depend on the wild sources in the foreseeable future. The current pressure on the culture industry has brought about the need to increase the fry supply. One approach to this problem is the improvement of the fishing gears – for which purpose an evaluation of the existing ones is necessary.

The fishing practice gives highly valuable insight into the behavior of a fish and is an important source of information for students of fish ecology and behavior. Although the origin of the milkfish fry fishing gears is obscure, it is understood that they have been designed based on, and have over the years been more and better adapted to, the behavior of milkfish fry. This study was conducted to obtain information for evaluating the present fry fishing practice and for understanding the behavior of the fry.

Fishing for milkfish fry is very different from the usual fishing practices. For one, the fish is in the larval stage, tiny and delicate. They also have to be kept alive. These conditions have made the authors hesitate in using the term "fishing" especially because it has been very common practice to refer to fry fishing as "fry collection" and to gears as "collecting" gears. However, the authors have decided to stick to the basic terminology, thus fishing is used throughout this report to mean the capture of milkfish fry without killing them. The fry collectors are simply called "fishermen". Gears are the instruments used in attracting, barring and capturing the fry alive.

The milkfish fry fishing gears have been treated perfunctorily in several reports (Umali, 1950; Lerma, 1975; Villaluz, 1975; Librero et al., 1976; PCARR, 1978; Smith, 1978; Lijauco et al., 1979; Kawamura and Bagarinao, in press). This paper is the first in-depth report on the milkfish fry fishing gears in Panay Island. Here, the gears are classified according to a scheme quite different from those of other workers (Umali, 1950; von Brandt, 1972; Kawamura and Bagarinao, in press). The authors consider most fry fishing gears as operating on the principle of filtration. Some gears do take advantage of the active movement of the fry: phototaxis in the *bulldozer;* driving reaction in the *blabar* (used in Indonesia, Schuster, 1952). But all other gears capture milkfish fry by straining the water. In this report, the gears are classified either as passive filtering or active filtering gears, the latter either dragged or pushed. Restraint was exercised in the use of the various generic names such as "fry seine," "fry filter net," "tidal set net," "fry set trap" because of their unqualified or ambiguous meanings. Instead, descriptions of the gears and their operation are given together with the local names (in Italics). Also presented are the variations and modifications in structure and function of the gears. Unless otherwise indicated, descriptions apply anywhere in Panay. Places mentioned in the text and figures are shown in Fig. 1.

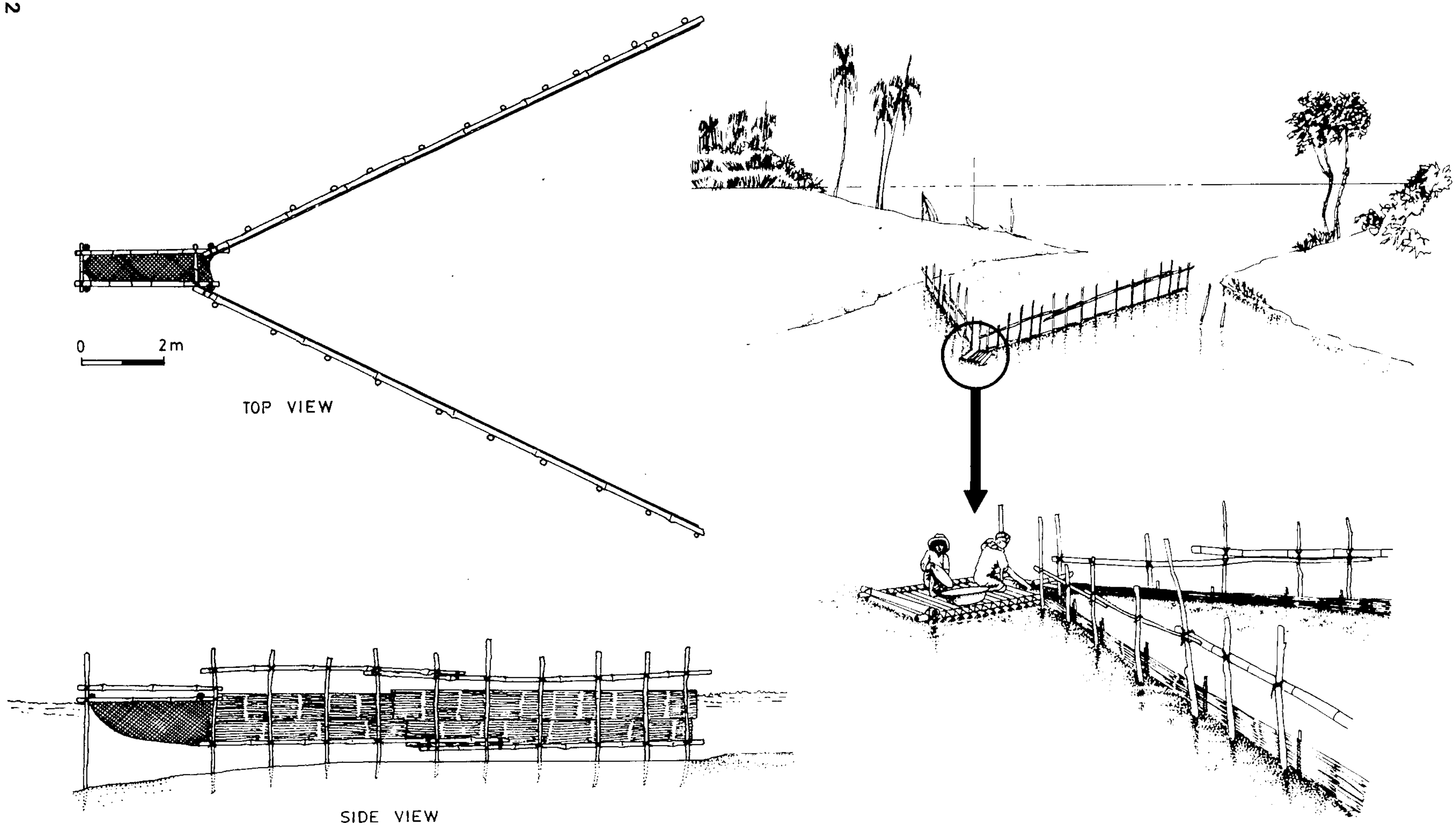

Fig. 2 The most common *tangab* for milkfish fry — its structure and operation.

The milkfish fry fishing gears and their operation — classified and described

I. Passive filtering gears

The fry carried by water movements are filtered by a stationary gear. The different types of stationary gear are:

A. Gear set at and against flood tide in rivers and creeks (*tangab, saplad*)

The gear is a V-shaped barricade with a bagnet behind the narrow end (Fig. 2). It is set spanning the banks of rivers, estuaries and tidal creeks at varying distances near the opening to the sea, in relatively shallow portions where current during flood tide is strong. The wings are 3-15 m long, and made of split bamboo slabs (*tadtad*- bamboo opened up and chopped with heavy knife) with ends tied to poles fixed in the bottom. The depth of the slabs, when fixed in position, is determined by the depth at highest water. The upper edge is kept above the waterline; the lower edge usually off the bottom. The bagnet made of abaca netting (*sinamay, bedang;* fibers 0.2-0.4 mm, mesh 0.3-1.3 mm) measures 2-3 m long, 50-80 cm wide and is held in place by two poles. The parts of the *tangab* are detachable; they are set in position only shortly before flood tide. At flood tide, the fry distributed off the river or creek mouth are carried by the current into the river and guided by the wings into the bagnet where they are filtered. One fisherman keeps watch and scoops the fry with a basin from time to time. Sometimes, a raft is used to get to the bagnet from the banks without the fishermen getting wet. In many areas along Antique, river and creek mouths that had been closed by sand deposition the previous southwest monsoon period are opened by man or machine at the start of the fry season for the purpose of operating the *tangab*. Usually it is the concessionaire (the highest bidder for the fry grounds) who finances the operation of this gear. The *tangab* can get 3-20 thousand fry per day's operation.

In some places, fishermen construct improper makeshift *tangab.* The gear is set at the narrow and excavated river mouth. The wings are short, and made of poles, branches, leaves and netting that extend to the very bottom. The current at flood tide is very swift and brings with it plenty of drift materials. Due to the turbulence, fry mortality runs high. In trying to catch all, the fry gatherers lose many.

B. Gear set against long-shore currents (*tangab-balsa*)

The gear consists of a V-shaped bamboo wing-frame with an extended bagnet behind the narrow end and long wing extensions in front (Fig. 3). The bagnet is of *sinamay,* about 2-4 m long, suspended from a bamboo pole that extends horizontally backwards from the frame. The wing-frame is 3-5 m long, 1 m deep, with whole bamboo for main supports and nylon netting (several kinds, 0.3-1.6 mm mesh) or split bamboo matting at the sides. The wing extensions consist of whole bamboo poles joined on both ends to which are attached coconut palms. The outer wing, 20-30 m long is much longer than the inner one; both are fixed by anchors. The gear has a wing opening of about 20 m. The wing-frame is set in position only when there is the strong long-shore current towards the gear. During this time, the

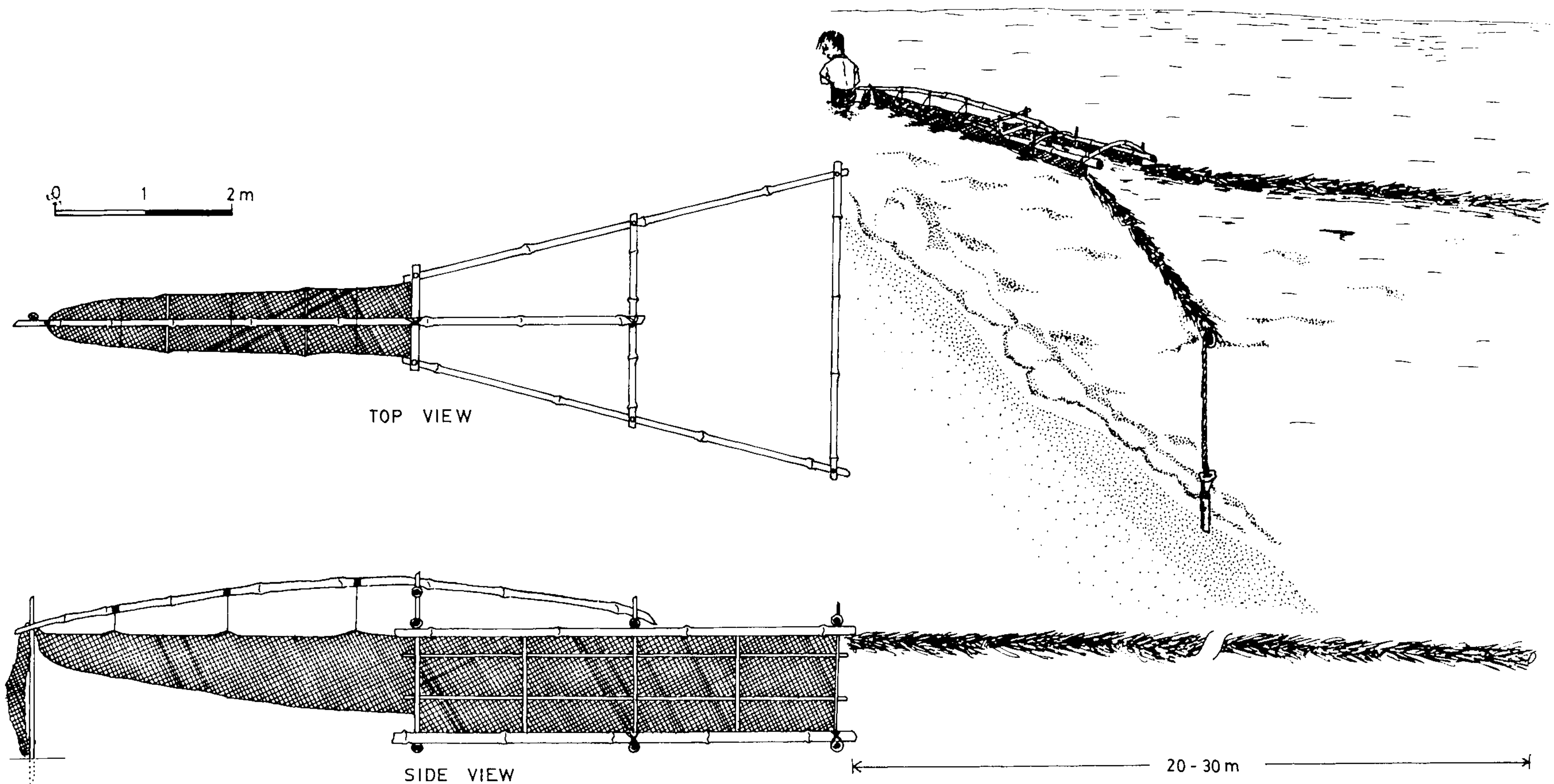

Fig. 3 **The *tangab-balsa* in Lipata Point, showing structure and operation.**

fry in the vicinity are carried along the wings into the bagnet. Only one fisherman is required to operate; he scoops the fry with a basin as often as the fry appear. When not in operation, the wing-frame is hauled up to the beach and the bagnet is detached but the wing extensions are left in place.

This gear was observed only in Lipata Point, Culasi, a shallow coralline area which remains calm even when other shores are very turbulent. Except at the time of highest or lowest tide, there is always the long-shore current that moves either away or towards the gear. Lipata has, so to say, a northern shore and a southern shore. Along the northern shore, the *tangab-balsa* are set facing northeast; along the southern shore, southeast (Fig. 4). The direction of the gear opening is constant throughout the entire period of operation. The gear cannot be reversed with the current because it is bulky and very exhausting to move. Of the *tangab-balsa* set single-file along the shore, one at the back of the other, the first one in line usually has the biggest catch which could be as much as 20 thousand a day. The southern shore has more *tangab-balsa* apparently because it benefits more from the northerly current off Culasi during the better part of the fry season. The gear is operated year-round by many fishermen because it can also get prawn fry.

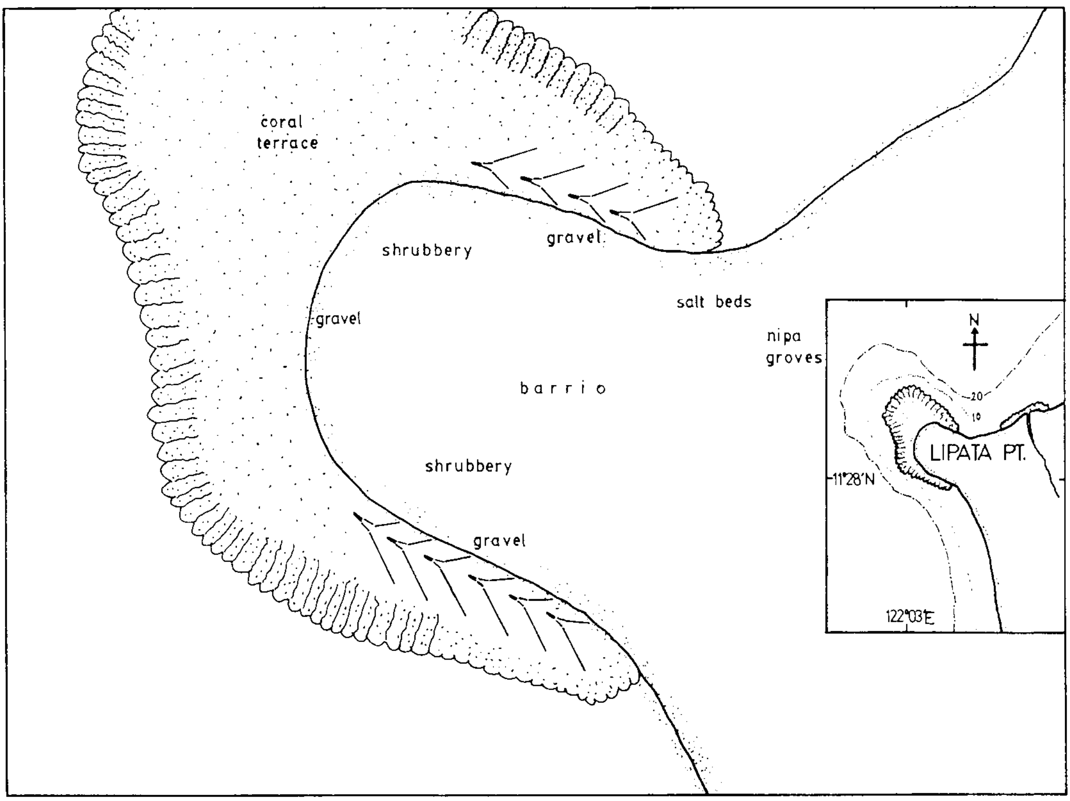

Fig. 4 Diagram showing position of *tangab-balsa* in Lipata Point, Culasi.

C. Gear set against tidal currents in narrow pass or strait (*lambay, saplad, tadtad*)

The gear is simply a barricade or fence of split bamboo slabs or nylon netting (Fig. 5), extending some 20 m from shore, more or less perpendicular to it, in relatively shallow areas along a narrow pass, channel or strait where tidal currents are strong (as in Iloilo Strait, Fig. 1). The fry carried by the tidal currents in both directions are barred by the fence, captured by small triangular skimming nets and scooped with a basin. In many channels or straits, the water currents are strong only at flood tide. The barricade walls are thus set in position just before the flood tide and dismantled at low tide. The bamboo slabs or nylon nettings are so positioned that the top edge is above the surface at high water; they extend usually only about 20-30 cm deep from the surface.

Some *lambay* are so modified that they curve somewhat in the direction of the flood tide and bear a *sinamay* or nylon bagnet at the center (Fig. 5). The fry are scooped with a basin from the bagnet.

The barricade can also be V-shaped, with a sweeper (described on page18) attached behind the narrow end (Fig. 5). The gear opening is about 3-10 m.

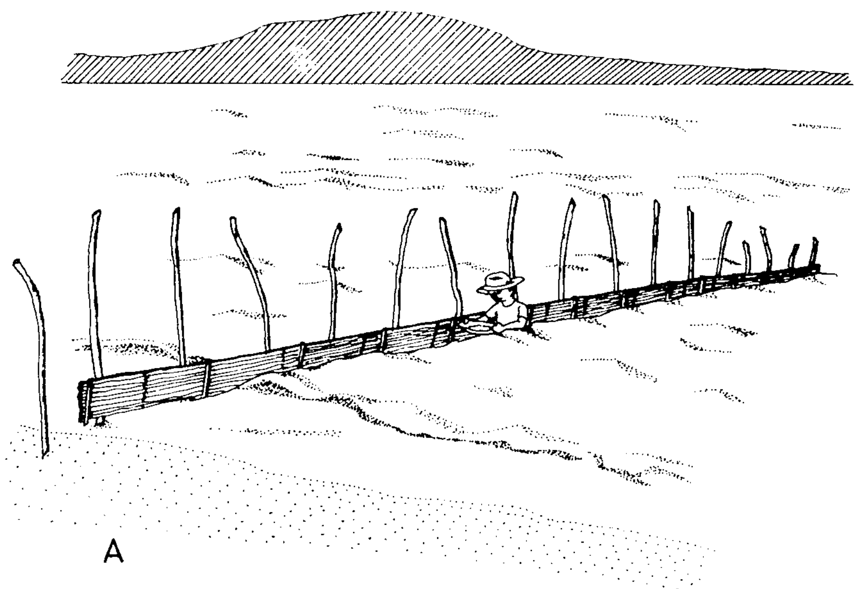

Fig. 5 A. *lambay* structure and operation;

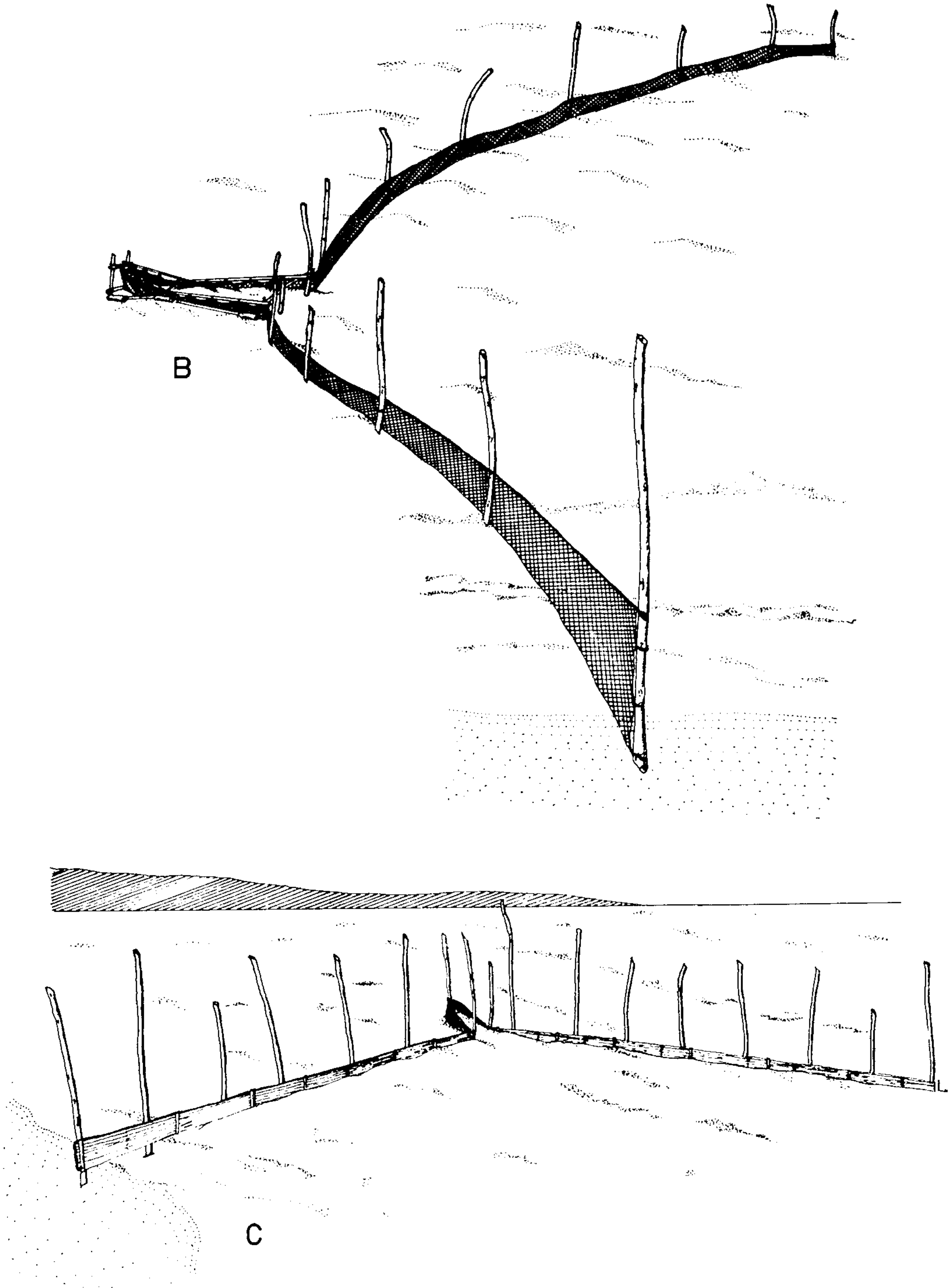

Fig. 5-B. *lambay* used with *sweeper* (Villa, Iloilo); C. *lambay* with bagnet at center.

D. Gear set against the surf

The gear is usually the V-shaped fry-sweeper set at the water's edge open to the surf waves (Fig. 6). The fry carried by the breaking waves are guided by the wings into the bagnet from which they are scooped with a basin. The fry sweeper is held in place by tying it to a fixed pole. This operation is especially evident during rough days when fry are present and the usual method of pushing the gear is tedious and difficult.

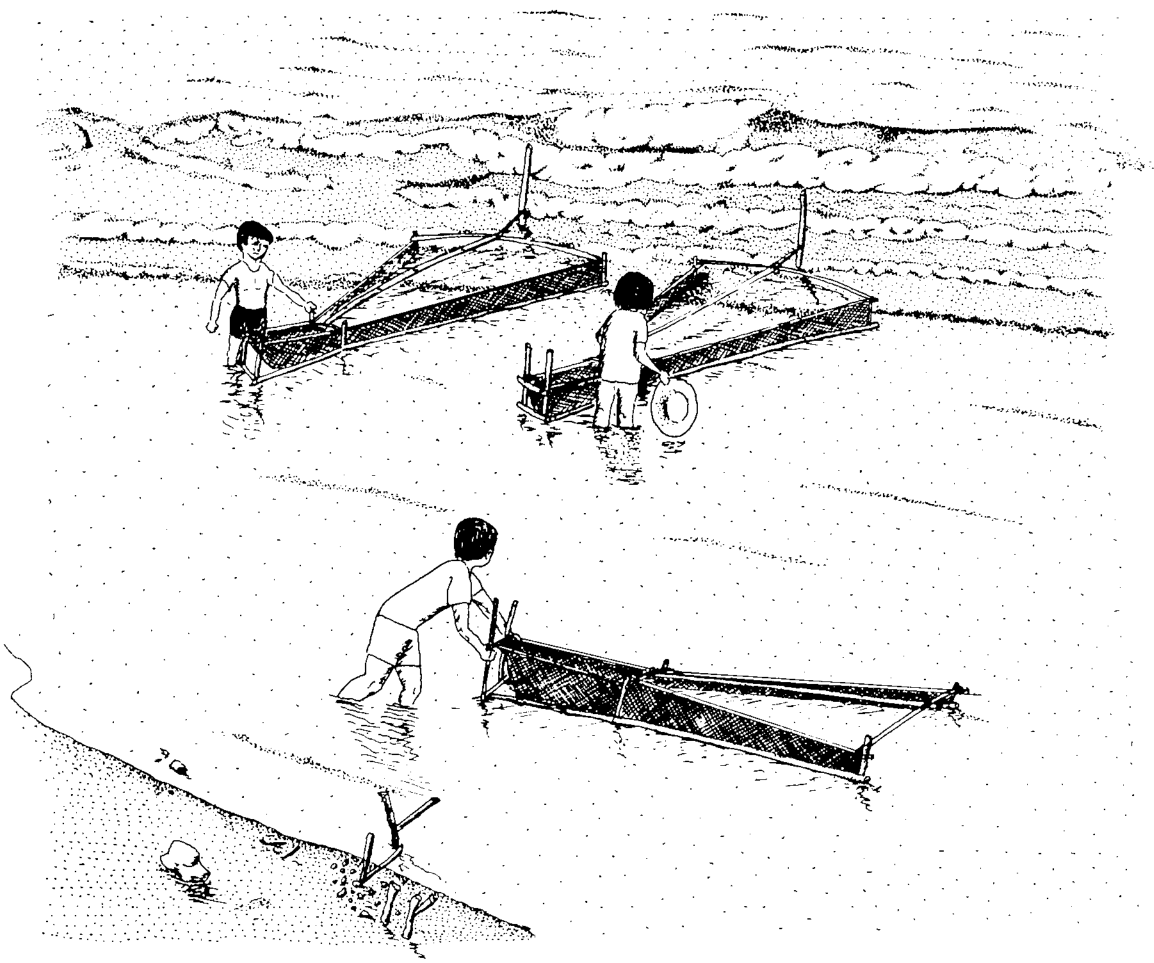

Fig. 6 The *sweeper* used in the surf zone as a passive filtering gear (Tigbauan, Iloilo).

II. Active filtering gears

The fry suspended in the water mass are filtered by a mobile gear. Capture of the fry is effected by pushing or dragging a gear through the water mass. The gears are of two types.

A. Dragged seine type (*sagyap, sarap*)

The gear is a rectangular sheet of netting held between two bamboo poles and dragged by two fishermen along the shore or river bank (Fig. 7). The net is of *sinamay;* its depth (width) is more or less constant (1.5 m) but its length varies (3-7 m). The latter is an adaptation to the shore profile. If the shore is flat and shallow for a considerable distance, the net is made longer to cover a greater area. But if the shore is sharply inclined, the length of the net is limited by how far the fisherman in the deeper side can go neck-deep. During the operation, the net is kept submerged except the top edge so that in shallow waters the entire water column from surface to bottom is filtered.

Figure 7 illustrates the step-by-step operation of the *sagyap.* This apparently simple gear is in fact very complicated in operation, compared with the other fry fishing gears. For one, there is a need for teamwork. The two fishermen have to know and anticipate each other's movements as well as those of their fellows. They have to adjust to the wind and waves. If the wind is strong, operation can only be in one direction — against the wind — otherwise the net flies. The fishermen have to carefully watch the waves: they usually stop momentarily when a wave passes. The critical phase in the *sagyap* operation occurs while concentrating the fry when coordination between the two fishermen is very important. At this time, the net is turned up, with the central part maintained in the water. Each fisherman transfers his grip from his pole to his end of the net and progressively towards the center. The net now assumes the form of a bag. In scooping, the basin is introduced vertically, and then slowly moved to one side. The net is lifted slightly to reduce the water. The basin is then suddenly turned up, with the net held over it to make sure no fry has been left. The catch is checked for fry and brought to some container in the shade.

The *sagyap* is operated anytime between 0500 and 1800 H during the fry season. The duration of operation (1-6 hours) depends upon the abundance of fry. The fishermen stop sooner if the catch is small and continue till dark if fry are plentiful. Catch can range from a few hundreds to ten thousand fry a day.

Sagyap is a very simple and traditional gear. Many fishermen have mastered the art of its operation and their children learn to operate it early. In many fry grounds, majority of the *sagyap* users are 7-17 years old. This gear has undergone various modifications.


A
B
C

Fig. 7 A-F Steps in the operation of the traditional sagyap.

1. *Sagyap* without poles

Instead of the poles, the gear has loops at the four corners of the net. With these loops, the net is dragged with the hands and feet (between toes) (Fig. 8). Without the poles, the *sagyap* could be operated even in deeper water or using a longer net (6 m) since swimming is made possible. Towards the end of the operation, the fisherman in the deeper side brings his end of the net to the shallow side for concentrating and scooping. This modification was observed in Culasi where the shore is relatively sharply inclined. The fishermen using this type claim it is much easier to operate than the traditional one.

2. *Sagyap* with bag

In this *sagyap,* the net has a depression or bag at the center (Fig. 8). The concentrating part of the operation is made relatively easy. This modification is not so popular in Panay, presumably because it is difficult to sew the bag part and the fishermen are experienced enough with the traditional one.

3. *Sagyap* with wings (side parts) of different material

Sinamay is the most preferred material for the nets of fry fishing gears because it is soft, pliant and smooth when wet. Unfortunately, it is not very durable, and with frequent change due to wear and tear, it turns out to be expensive. In many fry grounds, the wings of the *sagyap* are now made of nylon netting (Fig. 8). The *sinamay* net is retained at the central portion where concentrating and scooping are done. With this modification, expenses are minimized and desirable conditions are maintained.

4. *Sagyap* used with lamp (*bitay*)

Recently, fishermen have started night fishing with *sagyap* by using a lamp. A bamboo tripod is set at the water's edge; from this tripod extends a bamboo pole from which hangs a kerosene lamp, directly above the water (Fig. 8). The *sagyap* is dragged towards the light from a short distance away. The fry that have gathered around the light are thus captured. The fishermen allow some 5-15 min interval between *sagyap* operations to allow the fry to gather. The *bitay* is operated mainly on dark nights, during which the catch can be as much as 5 thousand fry. The disadvantage in the use of lamp in fry fishing is that it also attracts many other organisms. Sorting becomes difficult and time consuming; fry injury and mortality are high.

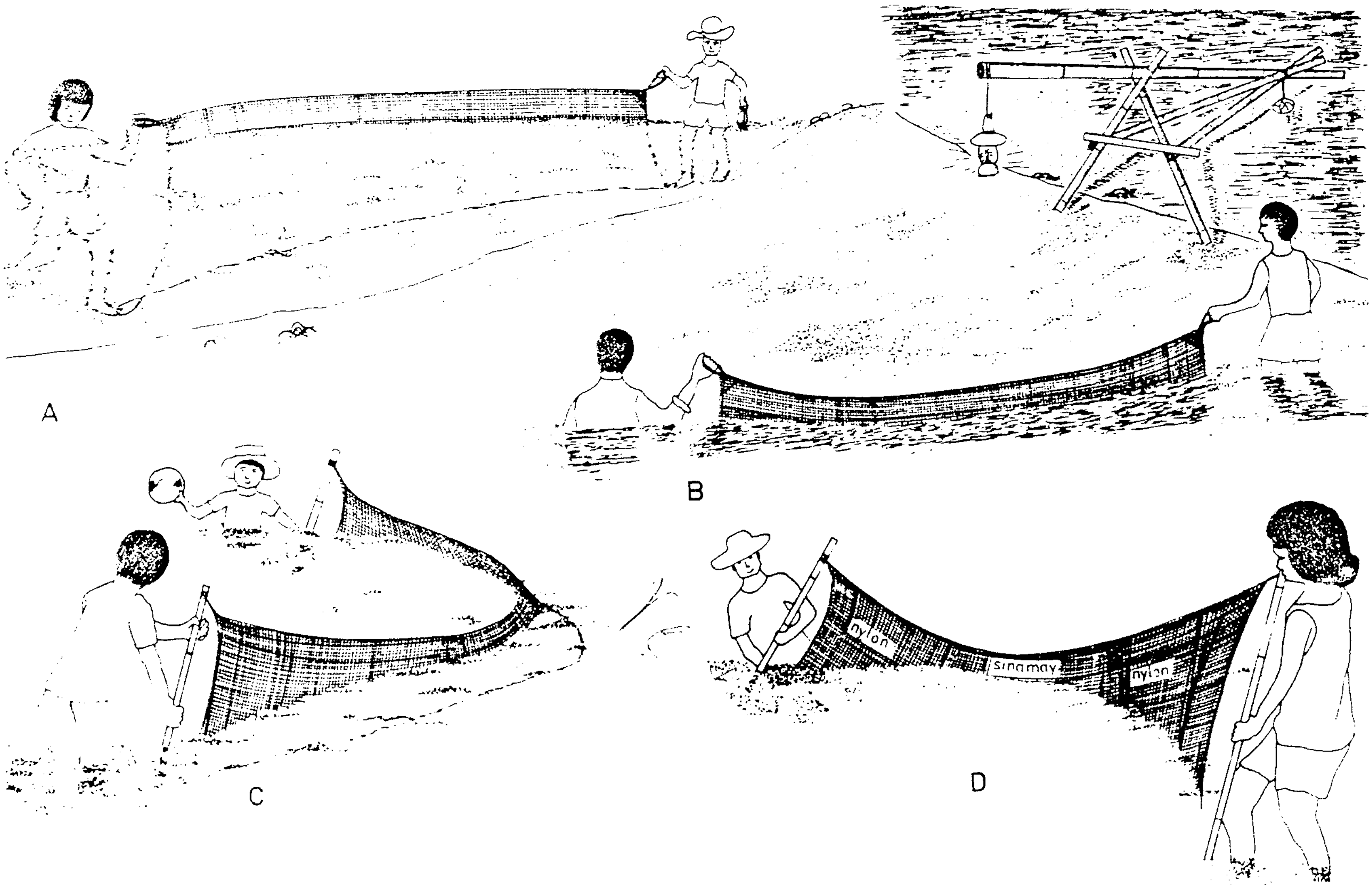

Fig. 8. Modifications of the *sagyap*. A. Without poles, with loops (Culasi, Antique); B. Used with kerosene lamp (*bitay*; Culasi, Antique); C. With bag (San Joaquin, Iloilo); D. With wings of different materials (Anini-y, Antique).

5. *Sagyap* of bigger scale (*taktak*)

This *sagyap* is modified as to be operated like a common beach seine. The net is much longer, about 20 m, with the side parts made of nylon netting and the central part of *sinamay* (Fig. 9-A). The depth of the net (1.5 m) is similar to that of the ordinary *sagyap.* Floats are attached to the top edge; there are no sinkers. The net is loaded on a paddle boat and cast 30-50 m offshore. The 50-m long towing warps are then pulled (Fig. 9-B). The concentrating and scooping are done as in the ordinary *sagyap*. This modification makes possible the coverage of a much wider area including offshore waters. Catch per unit operation of *taktak* is much greater than in the ordinary *sagyap* but the total number of operations is limited by the time and effort spent for one operation. This *taktak* is presently used only in Culasi where the beach seine is very popular. It is probable that the fishermen just latched on to the idea of technique transfer and operated the *sagyap* as beach seine.

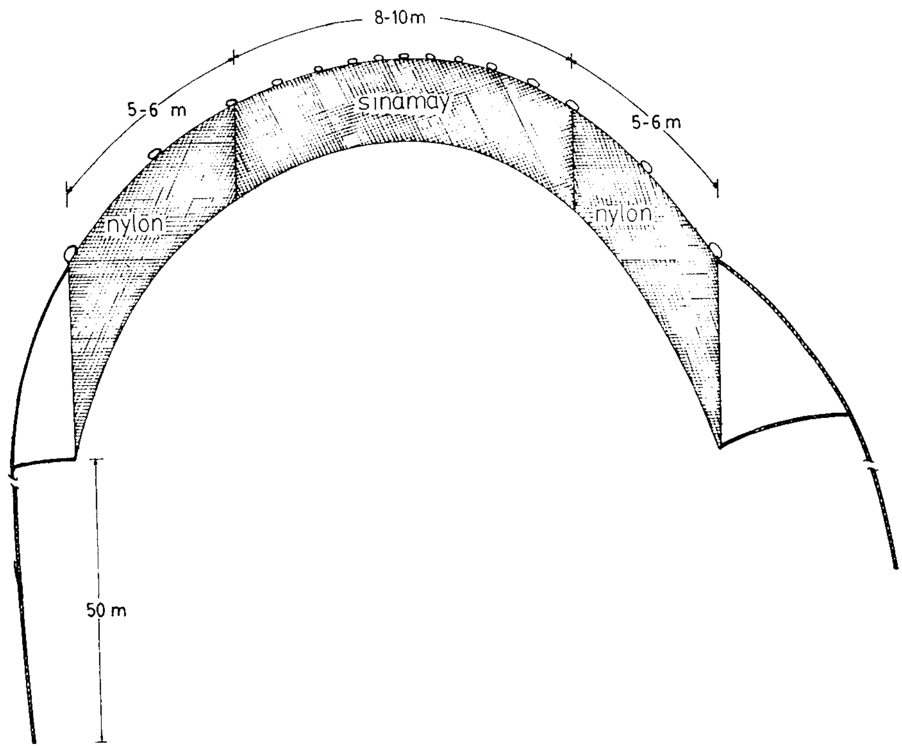

Fig. 9-A. The *taktak* — its structure.

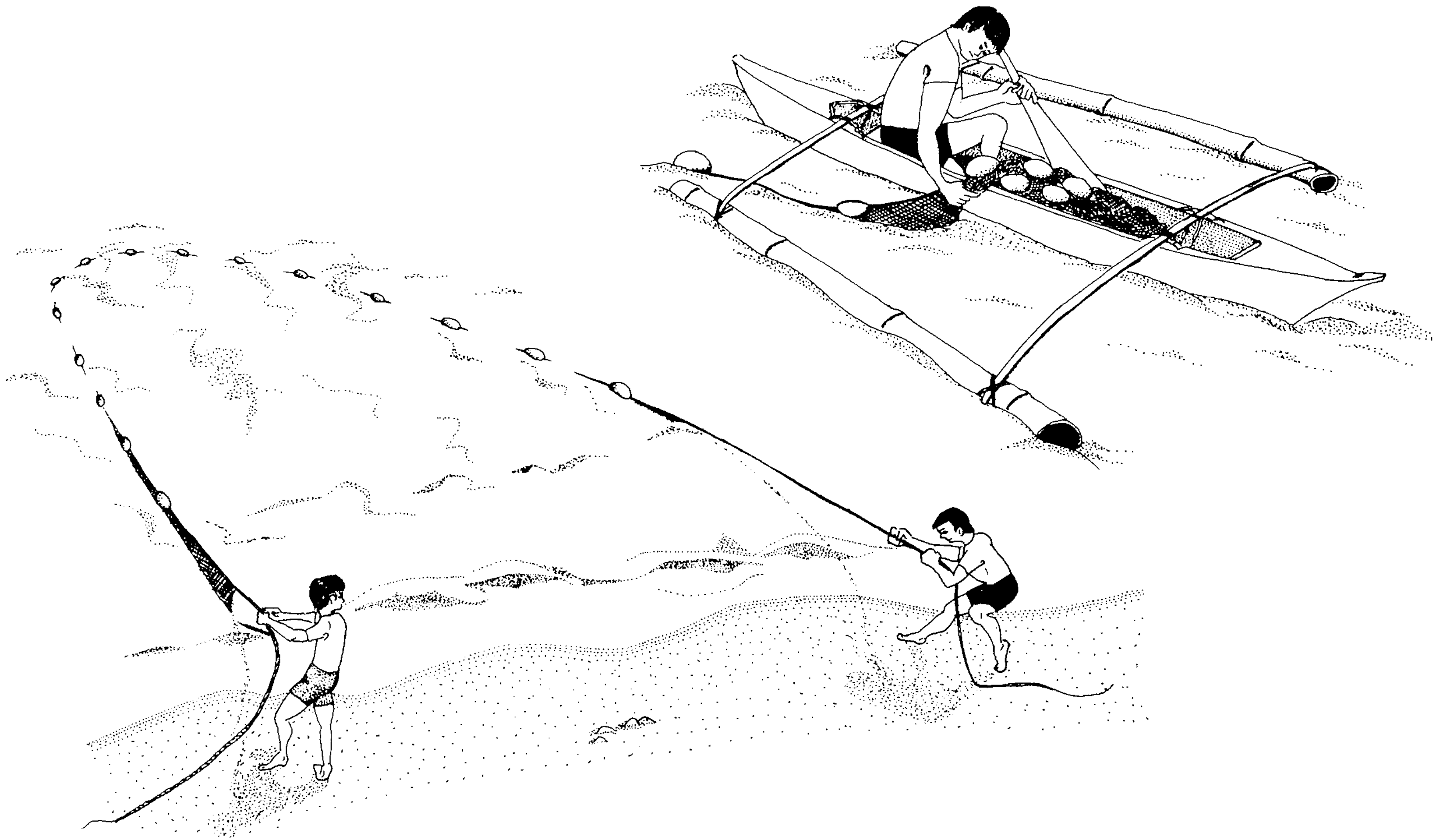

Fig. 9-B. The *taktak* in operation.

B. Skimming or pushed type

Gears under this category are pushed through the water and cover mainly the surface.

1. Simple skimming net (*hudhud, tigyapan*)

This gear consists of two crossed poles, 0.5-2 m long and about 0.5-1 m wide at the opening, and a bagnet of double-sheet *sinamay* or nylon screen (Fig. 10-A). It is used along the shore, river banks and mangrove swamps, in ankle-deep to waist-deep waters (Fig. 10-B). The fry caught in the bagnet are scooped with a bowl or basin. This gear is very primitive and unspecialized (it could be used for shrimps and other small fish); it is also, in a way, ineffective. But it is cheap and easy to make, and it can be operated by one person. In mangrove areas where submerged roots inhibit effective operation of other active gears, the skimming net comes in useful and handy, even for young children.

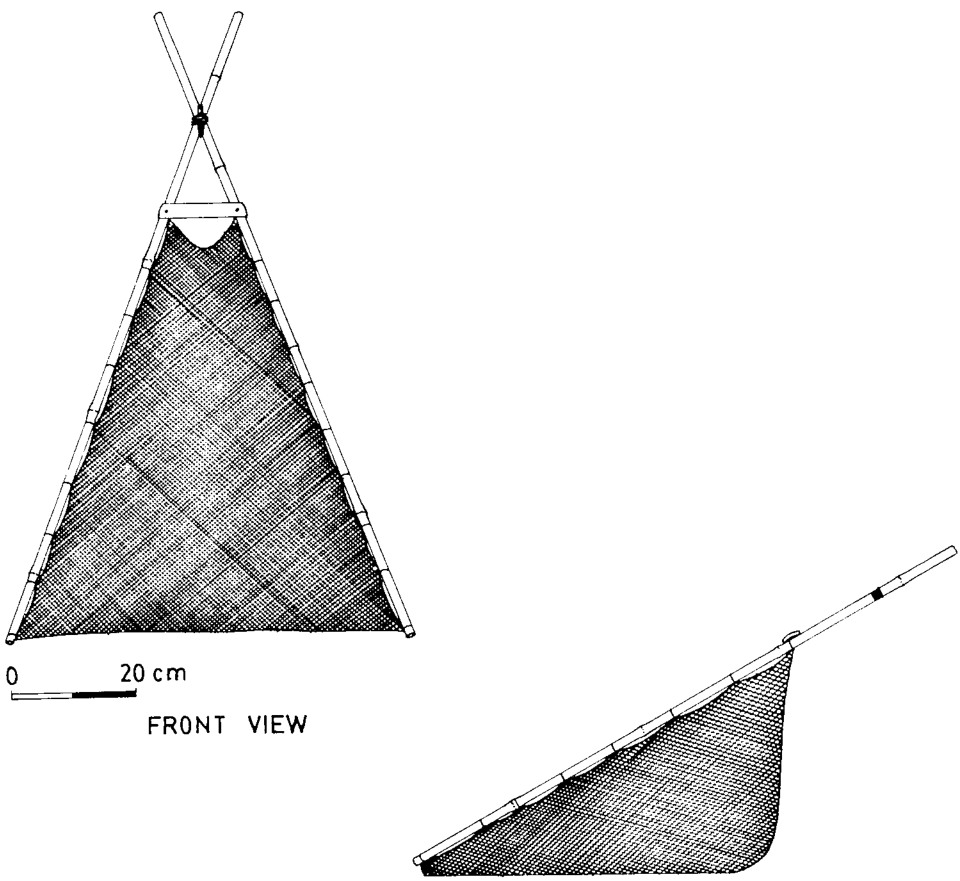

Fig. 10-A. The *hudhud* – its structure.

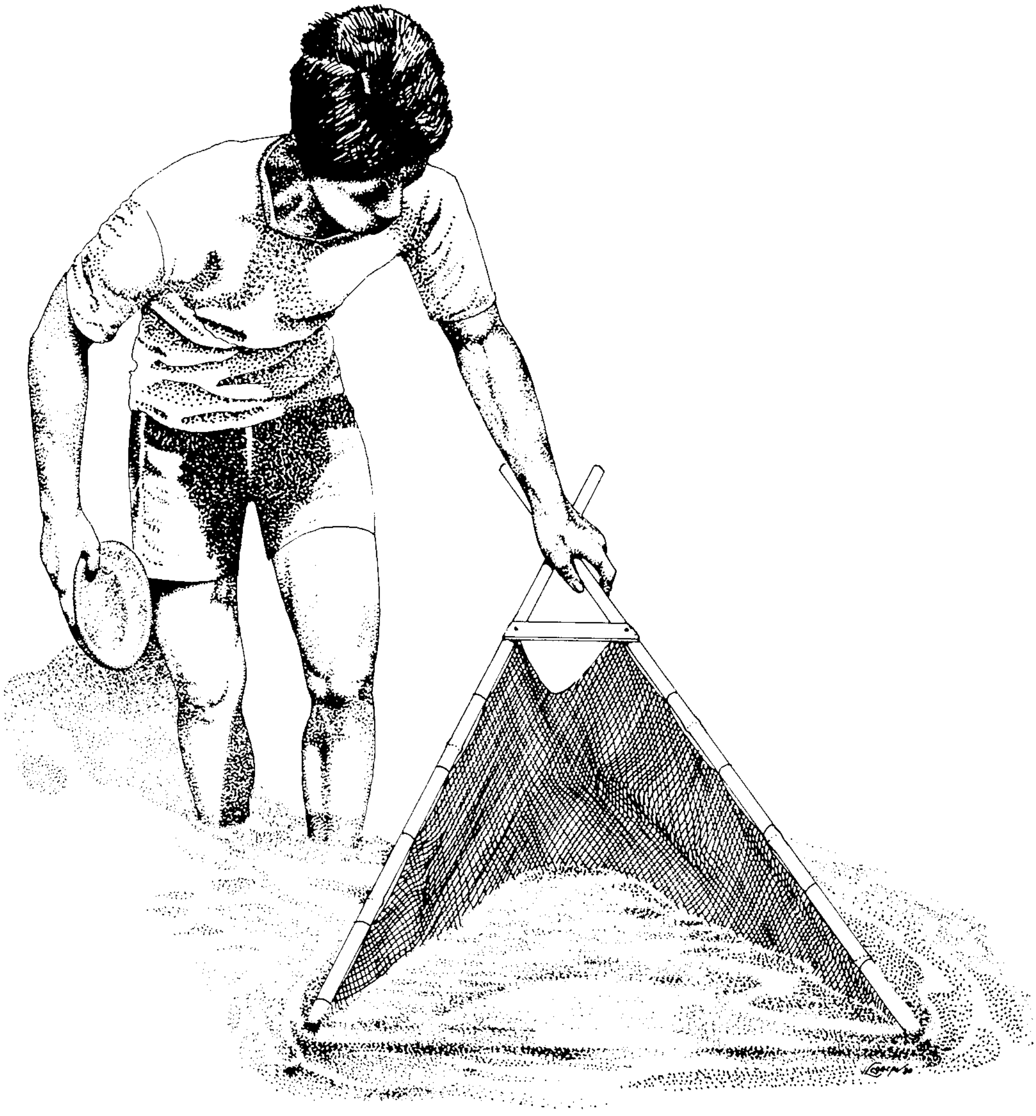

Fig. 10-B. The *hudhud* in operation.

2. Fry-sweeper (*bakabaka, sweeper*)

This gear is of recent development. Designed especially for milkfish fry, its origin is difficult to trace. The authors surmise that the fry-sweeper may have started as a modification of the skimming net. The two crossed poles were probably mounted on whole bamboo so as to float and pushing was confined to the horizontal plane. At the start, netting spanned the entire bottom of the gear and then was gradually reduced to the sides as wings.

Presently, the *sweeper* is constructed of a V-shaped bamboo frame that floats and measures 2-4 m at the sides and 2-3 m at the opening (Fig. 11). The bagnet is usually within the narrow end of the frame; it is made of double sheet *sinamay,* or nylon, or *sinamay* over nylon. Some sweepers still have bottom net up to the very opening; others have the bottom net for only a short distance from the bagnet and have wings of netting instead. The wings and bottom net are weighed down with stones or pieces of iron and hang 10-30 cm below the waterline. The nettings are detachable from the frame.

The *sweeper* is pushed along the shores of fry grounds in waist-deep to chest-deep waters. Except in sharply inclined shores with relatively deep waters, or during rough days, this gear could be operated even by children. Adults can easily operate the *sweeper* alone but children are often asked to help. The older one pushes the net along; the younger brings the basin which the former uses to scoop the fry from the bagnet, and then takes the catch to some container in the shade. Catch can range widely as in the *sagyap.* During the season, the *sweeper* is operated anytime between 0500 and 1800 H; the duration (2-8 hrs) depends on the amount of fry available.

The fry-sweeper has seen several modifications in structure and function. The following account should not be considered as chronological. It is just an arbitrary arrangement based on the presumption that the basic structure is one and the same.

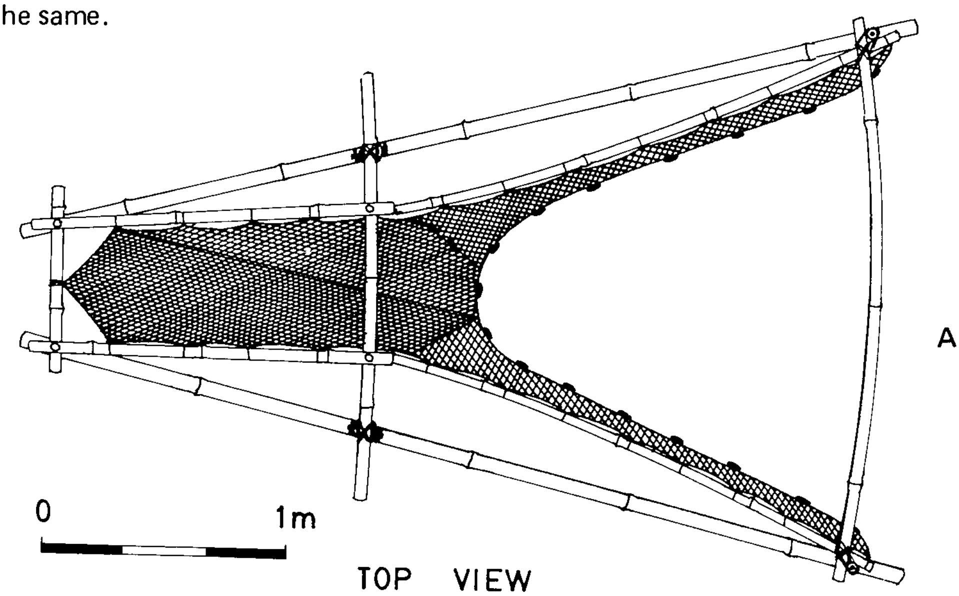

Fig. 11-A Top view of the fry sweeper

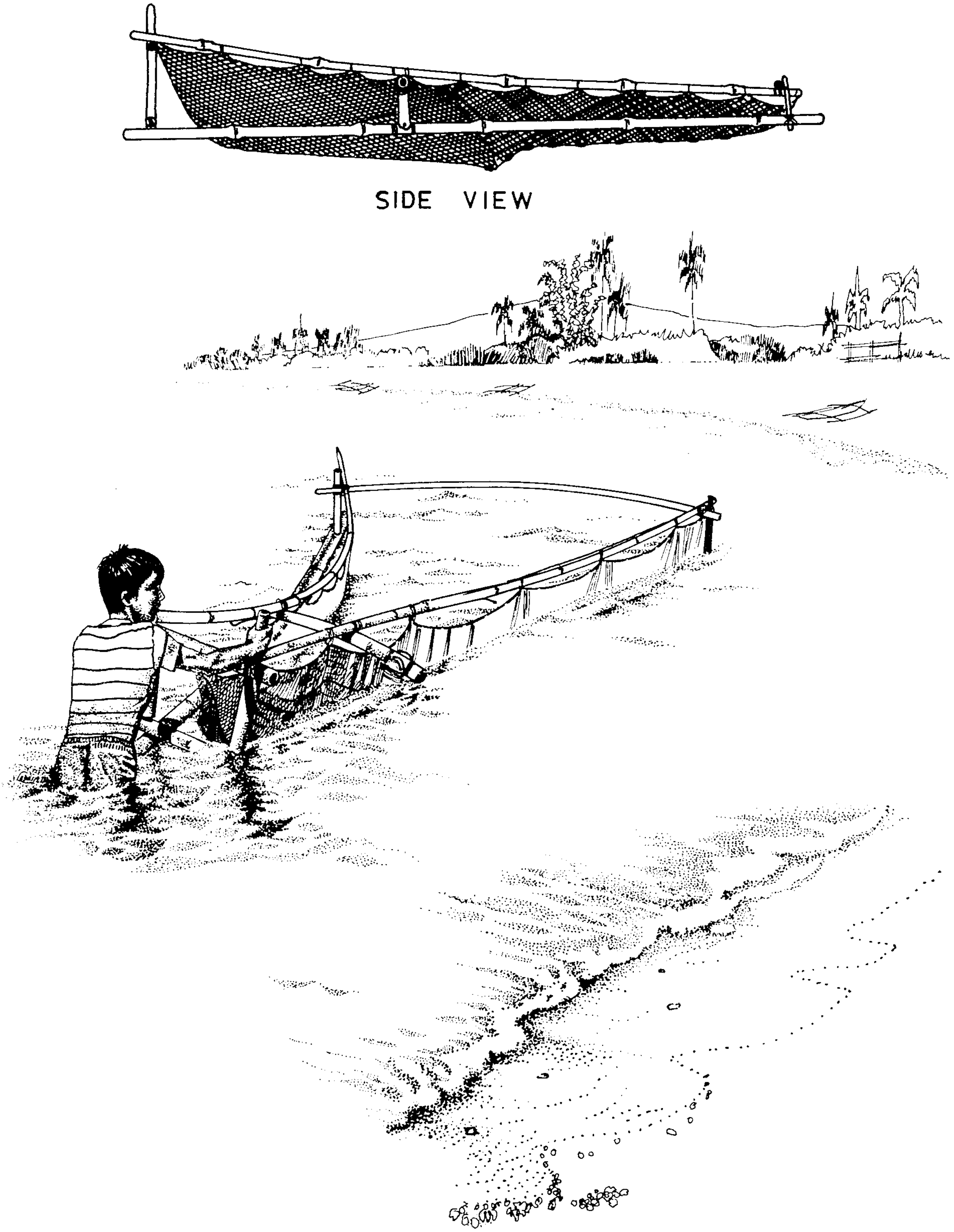

Fig. 11-B The fry-sweeper, basic type, showing structure and operation.

a. Increase in sweeper scale and dimensions

In many places, fry sweepers have become massive. One type is simply the enlarged version of the fry-sweeper as described above, with the frame measuring some 4-6 m at the sides, 3-5 m at the opening. Another type measures similarly; but its main floats of whole bamboo are fixed halfway from the bottom of the frame such that the lower half of the entire structure becomes submerged during the operation (Fig. 12). The wings are covered with netting. The bagnet is located in a rectangular box-like extension behind the narrow end of the frame. In front of the bagnet is a platform for the basin and pails or pots. The bottom net is reduced to only the inner half of the gear, immediately in front of the bagnet. In Culasi where this type is used, the gear (called *bulldoz*) is pushed by one fisherman and pulled by his partner from the beach. A day's operation can bring in as much as 10-15 thousand fry.

The enlarged sweeper has a wider wing opening and can cover a greater area and filter a greater volume of water. But it is rather heavy and becomes difficult to operate when the sea is rough.

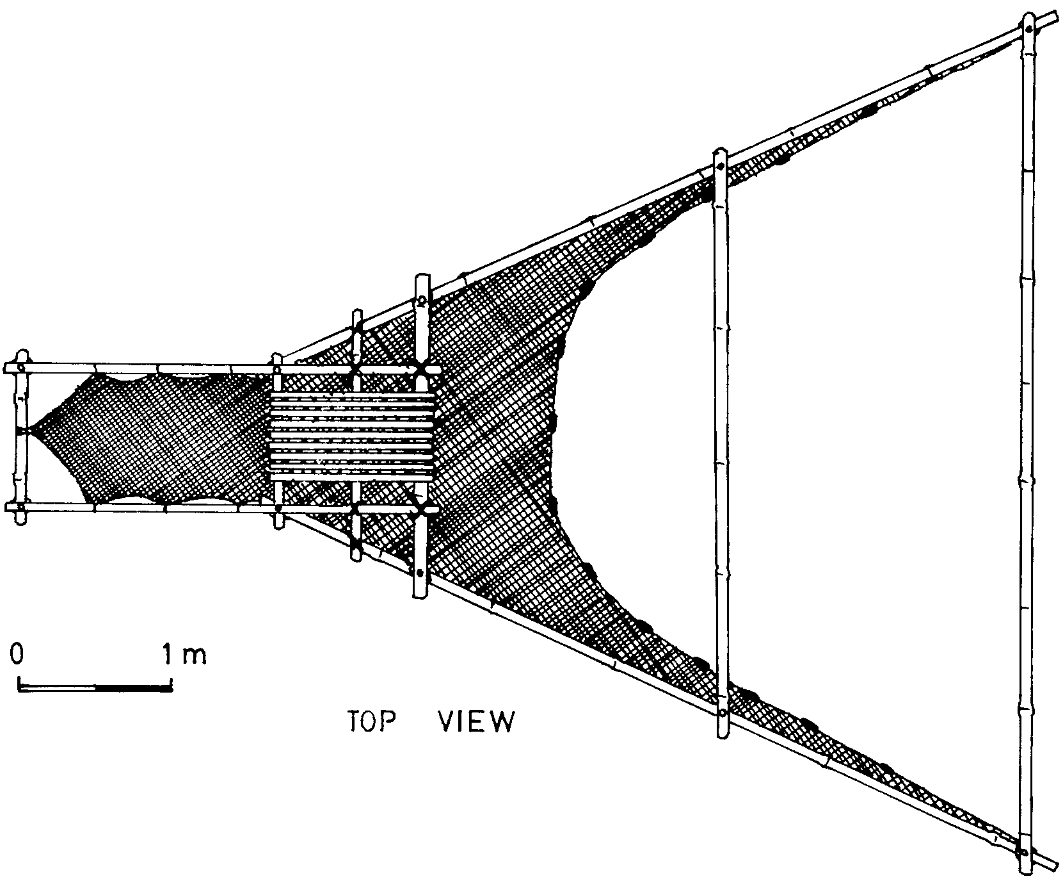

Fig. 12-A Top view of fry sweeper with bigger scale and dimensions

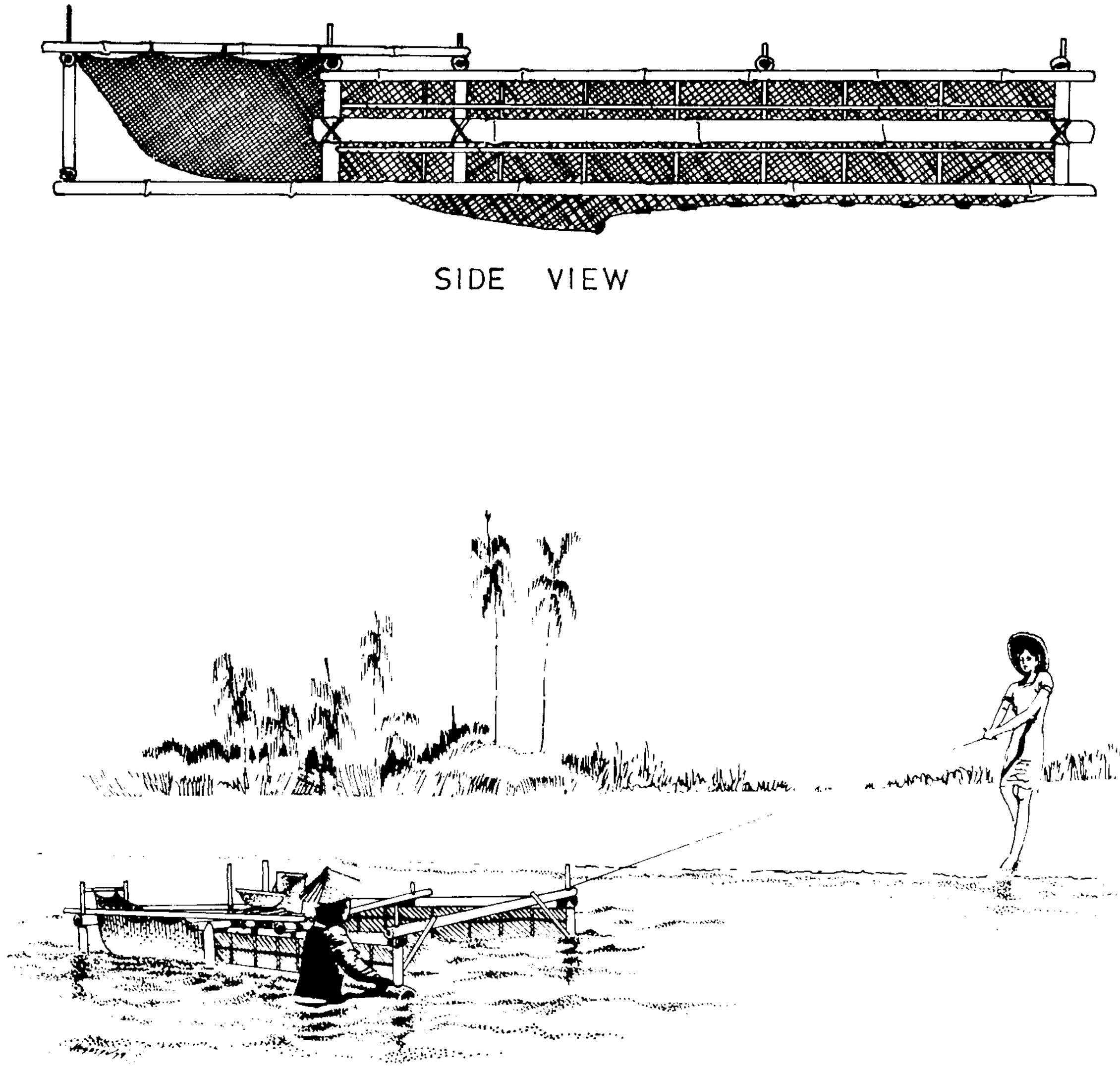

Fig. 12-B Fry-sweeper of bigger scale and dimensions, showing structure and operation as in Culasi, Antique.

b. Use of sweeper with lamp

The ordinary and the modified sweepers described above are, in certain places like Hamtik and Culasi, operated at night with a kerosene lamp (Fig. 13). The lamp is mounted on the platform at the narrow end of the wing in front of the bagnet and the scooping area. The sweeper is operated as usual; the fisherman checks the catch by the lamp. Operation of sweeper with lamp is done anytime between 2000-0600 H on any night during the season that fry are available, although most fishermen prefer dark nights. The gear can get as much as 3-5 thousand fry in one night's operation.

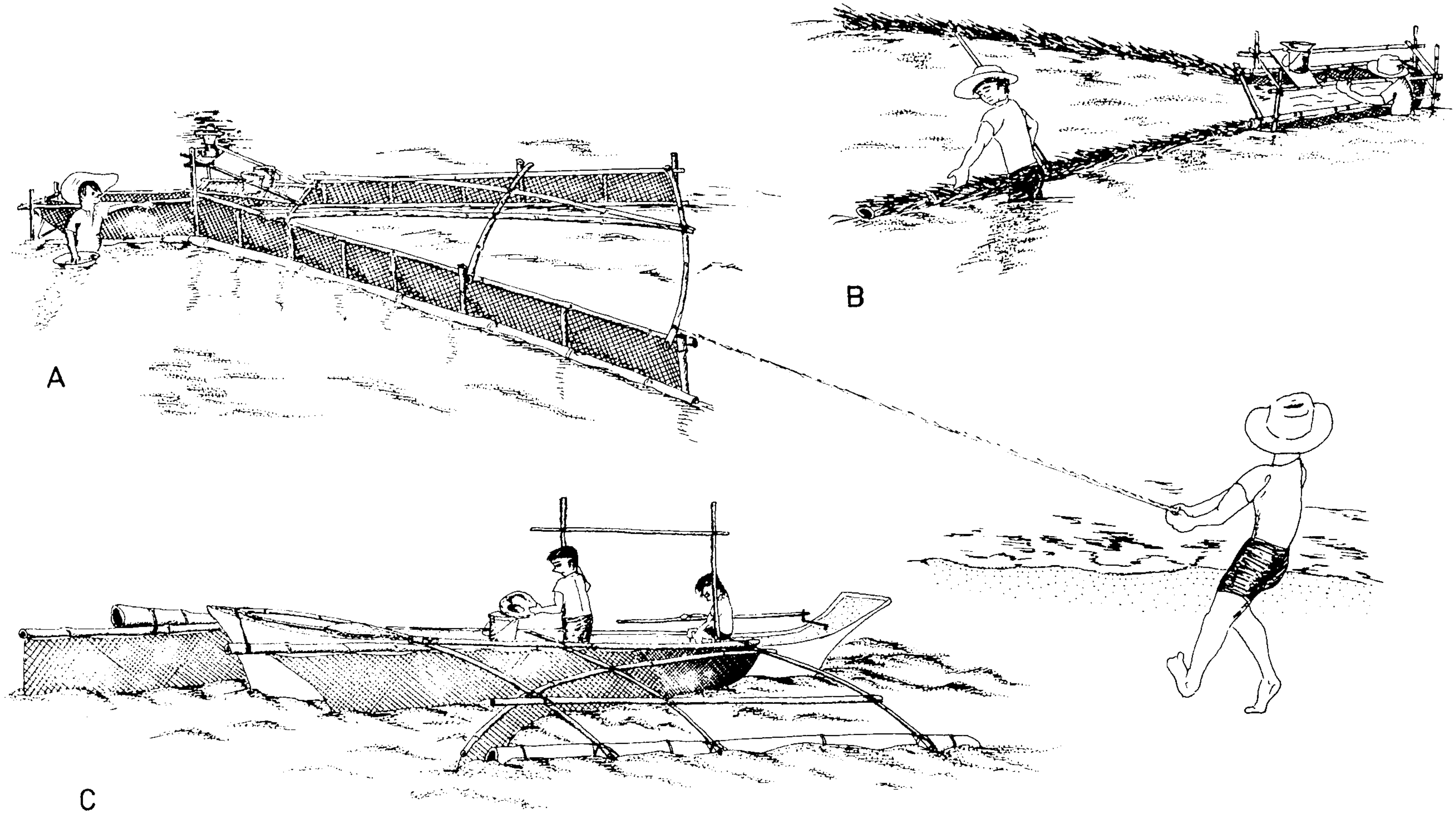

Fig. 13. Modifications of fry sweeper structure and operation. A. Operated with kerosene lamp; B. With wings of frame and coconut leaves (San Joaquin, Iloilo); C. Operated from pumpboat.

c. Reduction of wing of sweeper to frame only

In San Joaquin, the sweeper has been drastically modified. The wings are only bamboo poles 4-6 m long with coconut leaves attached (Fig. 13). The bottom and wing nettings are done away with. Only the *sinamay* bagnet at the scooping end is retained. This modified sweeper covers a greater surface area with less effort and uses less expensive materials.

d. Annexation of bamboo raft to sweeper (*bulldozer*)

In Hamtik, a bamboo raft is annexed to the type of sweeper just described. The resulting gear is operated at night with a kerosene lamp mounted in front of the bagnet (Fig. 14). The bamboo raft measures 2 x 4 m and is constructed around the 3-m long bagnet behind the narrow end of the 8-10 m long V-shaped wings. The wings are 6-7 m wide at the opening, and are made of whole bamboo to which are attached narrow slabs of split bamboo and coconut or nipa leaves. Baffles are provided at the sides of the lamp platform such that the light illumines only the bagnet behind and the wing area in front. The raft serves as the boarding and working area for at least two fishermen who operate the gear. One man pushes the *bulldozer* along or away from the shore with a long bamboo pole, the other scoops every 2-5 minutes the fry which have been filtered in the bagnet. The fry are sorted from among the undesirable species and stored in earthen pots brought aboard the raft. This gear can go as far offshore as the depth limited by the length of the bamboo pole. Operation is anytime between 2000 and 0600 H, with most fishermen going out at midnight and staying about 3 hours. Catch is anything from a few hundred to about 3-5 thousand fry.

e. Motorization of sweeper

The *bulldozer* is sometimes operated with an outboard engine and is then able to cover a much wider area or go much farther offshore. On the other hand, the sweeper is used with the popular pumpboat in many fry grounds in Antique. Two sweepers are attached to one pumpboat, one on each side between the hull and the outrigger (Fig. 13). The sweepers are therefore modified to fit the boat's structure. The frame is lightweight, without the whole bamboo ordinarily required to keep it afloat. The sides toward the outriggers retain the ordinary structure of the sweeper wing; the sides toward the boat fit in snugly with the hull. Bottom net of nylon netting spans the entire area between hull and outrigger. The bagnet of *sinamay* is located at the narrow end near the stern, within easy reach during scooping. The length of the sweeper varies with the length of the boat, specifically, the distance between prow and the posterior bar of the outrigger, but it is usually 3-5 m. The opening is determined by the span of the outrigger, usually 2-3 m. Two fishermen are involved in this operation – one runs the boat, the other scoops the fry filtered in the bagnet. This motorized sweeper is operated anytime during days that fry are available; the duration of operation depends on the catch. This modification makes possible offshore (5-50 m from shore) operation and faster coverage of a greater area. Catch could be as much as 10-20 thousand fry a day but oil crisis has discouraged this method.

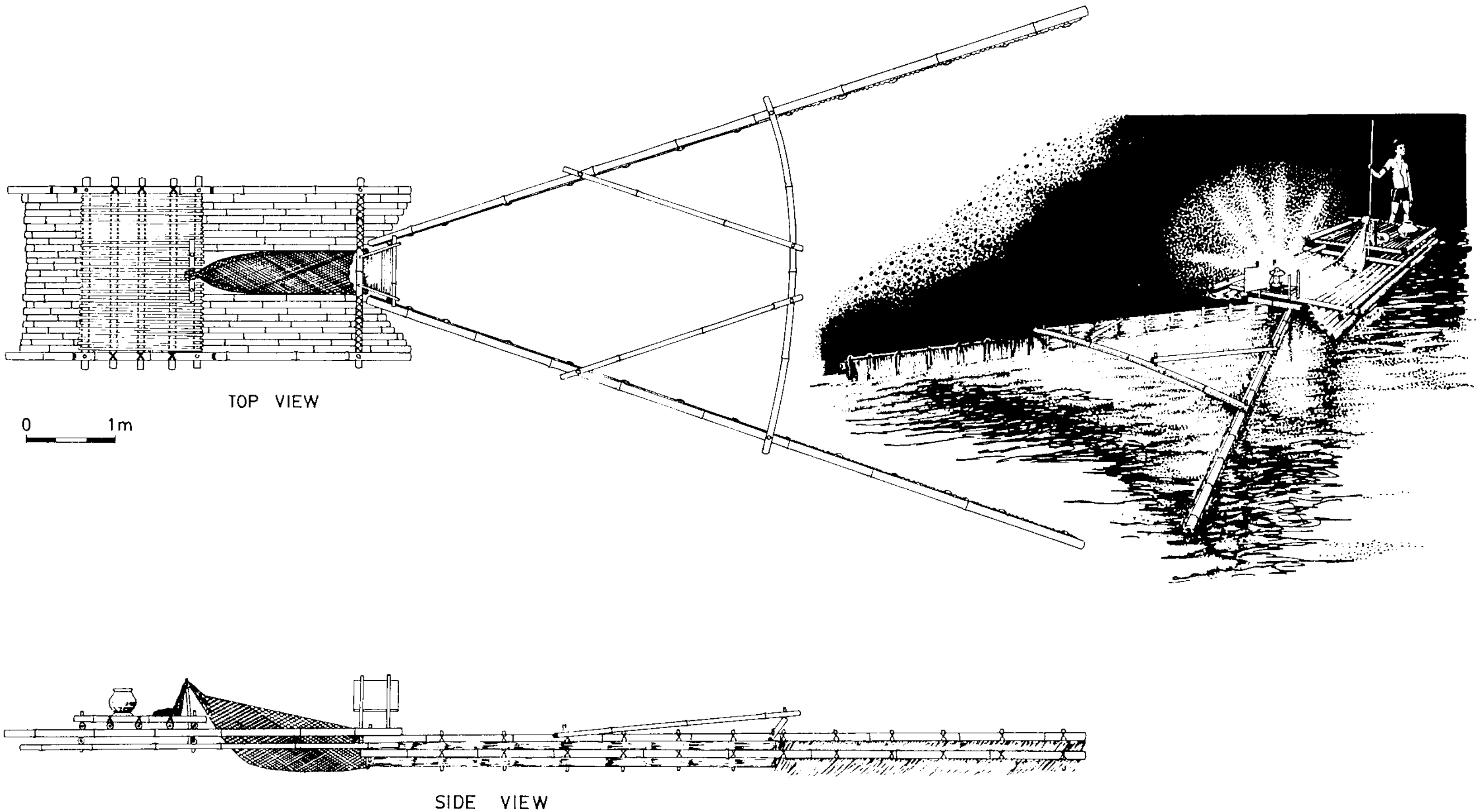

Fig. 14 *Bulldozer* **structure and operation (Hamtik, Antique).**

DISCUSSION AND CONCLUSION

On the fry fishing gears and the fishing practice

Figure 15 summarizes the various fishing gears and their modifications. The figure suggests the following tendencies in the development of the gear:

1. Increase in gear size and wing opening
2. Extension of area of operation to offshore waters
3. Reduction of the bottom net (in the sweeper)

The development of the traditional *sagyap* into the *taktak* exemplifies increase in gear size and operation area. The development of the sweeper into the bulldozer demonstrates increase in gear size, extension of area of operation offshore and loss of the bottom net. Coupling of the kerosene lamp with many of the gears has made night operation possible. All these trends of development reflect most obviously the economics of fry fishing and less clearly the behavior of the fry. First of all, the fishermen want to increase the catch to increase their income, so that the gear structure and operation are made as extensive as possible, the use and cost of materials are seriously considered, and competition is avoided by varying the gears and the area of operation.

It is usually asked: How efficient are the various gears? Which one is the best?

It is very difficult to answer these questions and misleading to compare the catching efficiency of different fry gears. Each type has properties and advantages that cannot be equated with those of another. The different gear types operate under different, and rather specific, conditions as have been described. The physical effort involved in the operation differs from gear to gear, and for one gear, from place to place, from time to time. This is because the shore profiles of the fry grounds differ; so do the weather and sea conditions from day to day. Even if all the gear types were operated in the same fry ground at the same time, a comparison would still be questionable because milkfish fry, it seems, are not homogenously distributed in shore waters. The catch depends heavily on where the gear is and where the fry are at a particular moment. A gear can catch from zero to several thousands. To illustrate this complicated situation, refer to Table 1. It gives some idea of the catch by traditional *sagyap,* ordinary *sweeper* and *bulldozer* in Hamtik, one of the best fry grounds in Panay. For each gear type, 3 or 3 pairs of fishermen were independently asked to record their catch after their usual operating time, daily for one week. No schedules were set but the *sagyap* and *sweepers* were operated mostly in the afternoon; the *bulldozers,* around midnight. The mean hourly catch of the three gear types were compared after it was ascertained that there was no significant difference in the efficiency of the fishermen operating each type. The *sweeper* had the smallest mean hourly catch among the three gears. This difference was found (by t-test) to be significant at the 95% level. Nevertheless, it would not be valid to say that the sweeper is the least efficient of the three. The sweeper in Hamtik (wings 4 m long, 3.5 m wide) requires only one person to operate, quite comfortably (as reflected by the longer duration of operation, average 5.4 hours). The *sagyap* requires two fishermen, and the dragging could be strenuous (average duration of operation, 3.4 hours) considering the 6-7 m long net. The *bulldozer* requires two fishermen, is strenuous to push (average duration of operation, 3.3 hours), is operated at night, can cover a wider area, etc. The point is that evaluation of gear efficiency involves serious consideration of input and output. Comparison of the efficiency of different gears could be complicated.

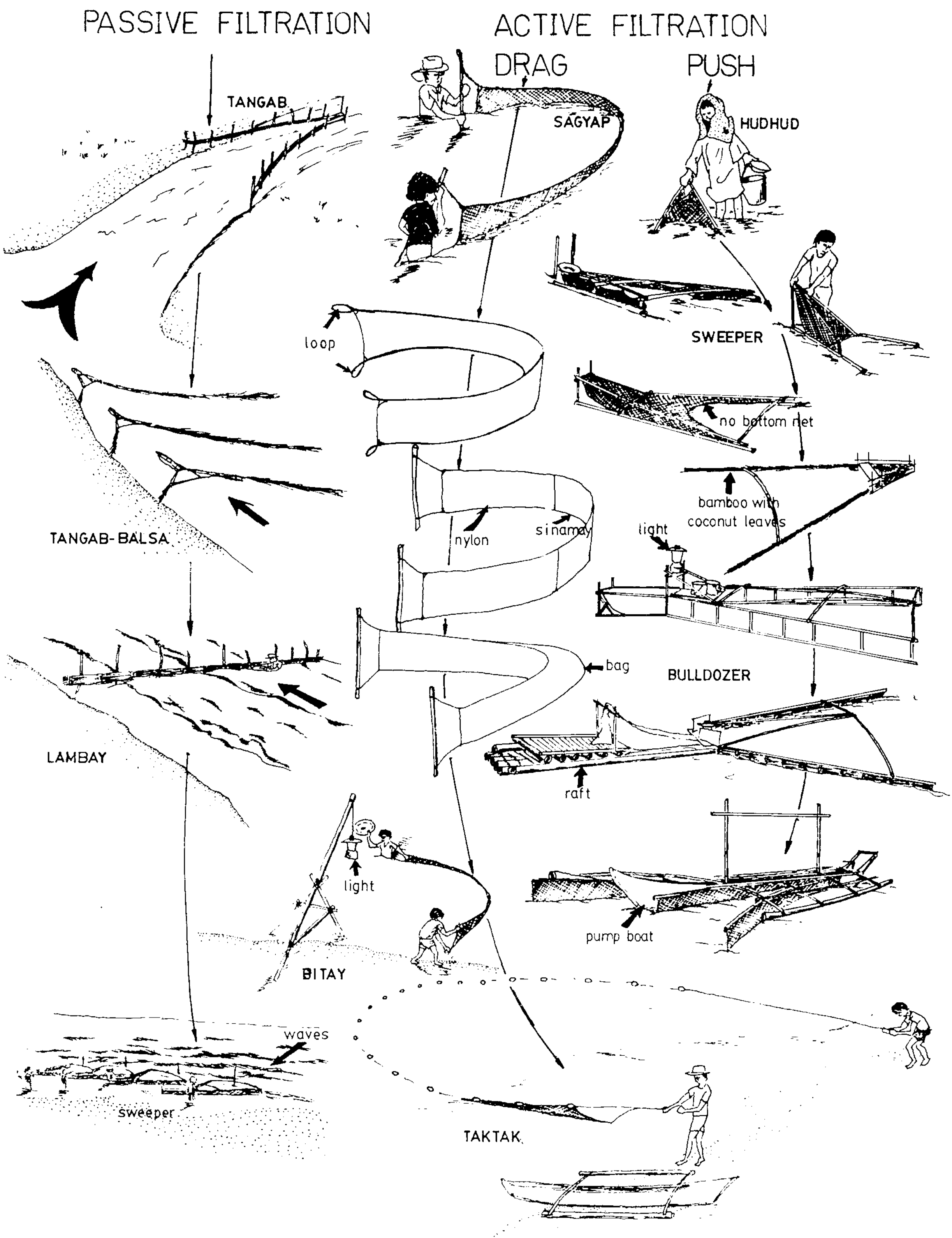

Fig. 15 Summary of the milkfish fry fishing gears. The modifications and apparent trends of development are indicated.

Table 1. The catch of milkfish fry by 3 different gears in Hamtik, Antique.

Date (1977)	*sagyap* (traditional) Duration of operation (hr)		Catch/ hour	*sweeper* (ordinary) Duration of operation (hr)		Catch/ hour	*bulldozer* Duration of operation (hr)		Catch/ hour
30 April	A	4	375	D	6	225	G	4	295
	B	5	425	E	7	280	H	2	425
	C	4	312.5	F	7	300	I	5	291.6
1 May	A	1	300	D	8	187.5	G	3	633.3
	B	4	244.5	E	6	208.3	H	5	292
	C	3	316.7	F	4	223.8	I	3	432.3
2 May	A	4	321.8	D	7	213.4	G	1	1,500
	B	3	292.7	E	5	179.4	H	4	722.5
	C	4	337.5	F	6	197.5	I	5	557.2
3 May	A	4	700	D	7	365.1	G	2	433.5
	B	2	650	E	5	227.4	H	4	392
	C	4	645	F	6	331.2	I	4	418.8
4 May	A	3	633.3	D	5	430	G	4	532.5
	B	4	700	E	6	375	H	3	933.3
	C	4	687.5	F	4	197.3	I	4	650
5 May	A	3	116.7	D	3	166.7	G	3	186.7
	B	4	100	E	4	192	H	4	200
	C	2	150	F	5	160	I	3	166.7
6 May	A	3	150	D	5	151.8	G	3	266.7
	B	4	222.5	E	5	179.4	H	0.5	600
	C	2	150	F	3	192.7	I	2	250
TOTAL		71			114			68.5	
MEAN			372.9			237.3			484.7
± S.E. x $t_{.05}$			± 95.9			± 35.8			± 139.3

NOTE:

A. Duration of operation is the normal operating time period of the fishermen.

B. The letters A-I stand for the fishermen who operated the gears, 3 for sweeper and 3 pairs each sagyap and bulldozer.

C. The differences in the mean hourly catch of the 3 gears are shown by t-test to be significant at the 95% level.

The gears presently used are in themselves practically fully developed as far as actively fishing the fry is concerned. The main problem is in the proper use and operation. Use of a particular gear should be based on its suitability to the shore profile, currents and such conditions as may affect its effective operation. It might be worthwhile to conduct a study considering the effectiveness of various gears in different fry grounds. Then it might be possible to effect some technique transfer, that is, to introduce certain suitable gears to certain fry grounds. It was observed that several effective gears were used only in Culasi. There certainly are fry grounds similar to Culasi in topographical conditions, not only in Panay but all over the archipelago, if only a study could be done along this line.

Moreover, the gears should be properly operated so that the fry are not only caught alive but healthy. Ten days operation of the *sweeper* in April-May 1980 between 0600 and 1800 H, showed that mortality rates during the fishing operation range from 2.6 to 41.2%, with mean of 14.3%. Examination of newly-caught live fry showed a high percentage of injured ones irrespective of gear type, place and sea conditions (Table 2). The injury cases are illustrated in Fig. 16. Smith (1978) estimated that 5.3% of the available fry resources in the Philippines is lost during the gathering process and 8.7% during storage. These figures seem rather small but all point to

Table 2. The degree of injury in live milkfish fry newly captured by different gears under different conditions.

Gear	Place	Date	Sea Condition	Percentage of Fry			
				0*	1*	2*	3*
sagyap	Pandan	17 May '79	Slightly rough	65.4	19.2	15.4	0
	Pandan	18 May '79	calm	64.0	16.0	20.0	0
	Pandan	24 May '79	rough	70.0	20.0	8.0	2.0
	Pandan	26 May '79	calm	35.4	41.7	18.8	4.2
sweeper	Guimbal	15 Oct '78	rough	52.0	20.0	28.0	0
	Tigbauan	15 Oct '78	rough	54.0	32.0	14.0	0
	Tigbauan	18 Oct '78	calm	46.0	30.0	24.0	0
	Hamtik	15 May '79	rough	78.3	12.0	8.4	1.2
	Pandan	20 May '79	calm	50.0	33.3	16.7	0
	Pandan	12 May '79	rough	74.0	10.0	12.0	4.0
	Pandan	27 May '79	calm	60.0	34.0	2.0	4.0
tangab	Pandan	27 May '79	slightly rough	76.5	17.7	2.0	4.0

**Degree of injury: 0 - no injury; 1 - slight or negligible; 2 - disruptive, causes change in behavior; 3 - serious, may cause death. Refer to Fig. 16. Dead fry were not included in the counts; thus, the lower percentage with degree 3 injury.*

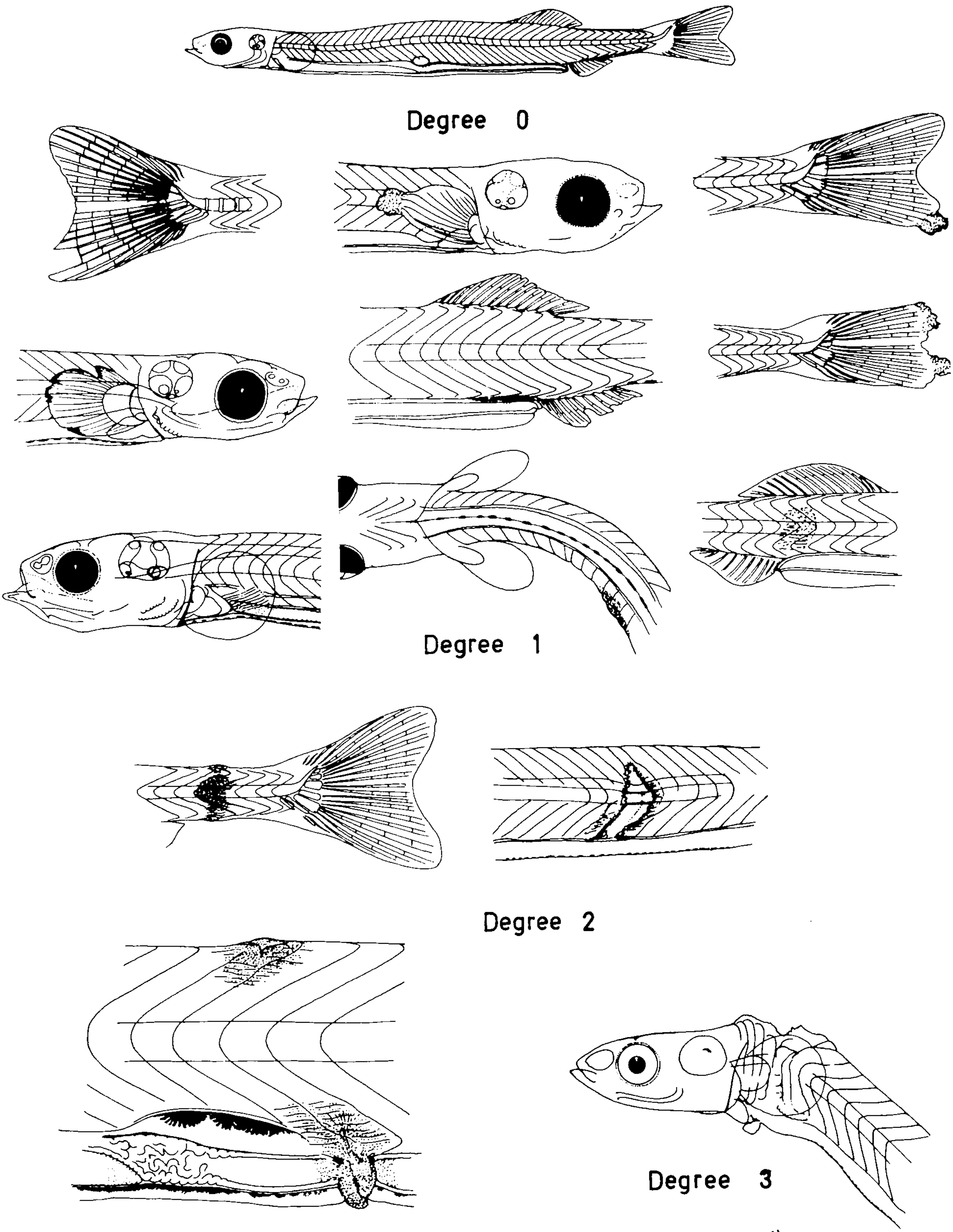

Fig. 16 Injury of newly-caught live milkfish fry (Drawings by P. Buri).

a need for improving the fishing operation. Capture is very stressful to the fry. With improper handling and severe injury at capture, the fry easily succumb to the stress during storage. Ways and means to reduce fry mortality during capture should be studied. A few suggestions are in order in the meantime:

1. The *tangab* should be set where the current is strong, but not where it is too swift that it plasters the fry against the bagnet, causing high mortality. The *tangab* should not completely block the river or creek mouth that turbulence and mortality result. Milkfish fry should be allowed access to these coastal wetlands that serve as natural nurseries.

2. During the operation of any of the gears, drifting and floating debris should be removed as much and as often as possible so that they would not be scooped with the fry. Otherwise, their pressure against the fry can injure or kill the latter. Scooped debris presents sorting problems to the fishermen and more stress to the fry. This problem is especially serious and important in the case of the gear with lamp wherein nocturnal crustaceans overwhelm the fry.

Gear innovations that would make the fry fishing operation less strenuous and more profitable for the fishermen are also necessary. Kawamura (pers. comm.) tested 2 modifications of the *sweeper* — one with wings of frame only and another with wings of coarse mesh (mesh 2 cm) dark-colored netting — and one modification of the *sagyap,* that is, with wings of coarse mesh dark-colored netting. The modifications were based on the premise that milkfish fry could be caught by driving and therefore the fine-mesh netting at the wings of the gears could be done away with, in favor of coarse-mesh ones which would enable the fishermen to move the gear through the water more easily, and to use larger gears for bigger catch. In terms of catch, tests failed to prove this premise but the fishermen who operated the gears agreed that the modifications were easier to handle. More experiments along similar lines would be useful. In any case, all gear improvements and development should consider at least these three factors:

1. Structure and operation of the presently used gears
2. Condition of the fry fishing grounds, i.e. shore profile, currents, etc.
3. Behavior of milkfish fry

On the behavior of milkfish fry

The following aspects of milkfish fry behavior are manifested in the fishing method and gears:

1. Fry appear inshore in great numbers and distribute mainly at the surface.

All the fry fishing gears presently used operate inshore in generally shallow waters. While the *bulldozer* can go as far as 100 m and the *taktak,* motorized sweeper, *lambay* and *tangab-balsa* extend to various distances (20-50 m) from shore, all other gears are limited to the surf zone, within 10 m of the water's edge. The fishermen believe fry are most abundant in the surf zone and most of them find no need to go far offshore except to avoid very stiff competition. Moreover, most fry fishing operations cover mainly the surface waters (the uppermost 10-30 cm), the greatest filtering depth being obtained by the *taktak* (net depth 1.5 m).

The virtual confinement of the fishing operation to inshore waters, particularly the surf zone, is a response to that remarkable characteristic of milkfish fry — their appearance inshore in great numbers. Studies have been made to determine the factors behind this phenomenon (Schmittou, 1977; Kumagai and Bagarinao, 1979; Kumagai *et al.,* 1976; Kumagai *et al.,* in preparation) but the why and how have remained largely unanswered. The main question is whether the transport and movement of fry towards, and in shore waters, is active or passive. Our unpublished data show that there are active components in this behavior, particularly with respect to movement from offshore to inshore. But there are passive aspects too, like being carried by currents, that merit serious consideration.

Judging from fishing practices, fry are distributed mainly at the surface. In the surf zone where most of the gears are operated, there is not much difference between surface and bottom waters, particularly where it is shallow and turbulent, and it is difficult to say with certainty how the fry are distributed. But in the case of the *tangab-balsa* and the motorized sweeper, it is clear that fry are caught from the surface waters. Whereas most gear types show the tendency to increase the wing opening, there is no corresponding increase in the depth of the net. The gears filter the surface waters and successfully get the fry.

2. Fry are carried by water movements

A variety of passive filtering gears have been designed to utilize water movements or currents; they get fry successfully only during times of favorable currents. Active filtering gears that can be operated anytime are usually operated during times and days of strong currents or high water. Indeed, there is a consensus of experience among fishermen, and there is a considerable pool of data (Kumagai *et al.,* in preparation) that show that milkfish fry are relatively more abundant at flood tide, on rough days and during full and new moon periods.

Within one tidal cycle, current is strongest at flood tide; water movement is extensive, shorewards or into straits. If and when there are fry offshore, or in open waters adjacent to straits, flood tides have the effect of concentrating the fry in the surf zone, and carrying them into rivers or creeks, where the gears are operated. But if there are no fry nearby, then no fry appear with flood tides. Milkfish fry may also be extraordinarily abundant on certain rough days characterized by some or all of the following: storm, wind and waves at force 3-4 (wind speed 4-8 m/sec, Beaufort scale), turbulence at the surf zone, dark overcast skies, rain, turbid waters. Here again, the primary factor in the amount of the catch is the presence of fry in, or in the vicinity of shore waters. If fry are present, their visual and active movements such as strong swimming, rheotaxis and escape reactions may be so negated or nullified by the turbulence and turbidity during these rough days that they could easily be carried and concentrated and captured. It is not unusual to find the fishermen very busy during stormy days. Similarly, it is not unusual to find fishermen idle for days on end after a storm because there are no fry.

The relative abundance of fry during the full and new moon periods is an effect of the periodicity in the spawning activity of adult milkfish (Kumagai *et al.,* in preparation). The sure presence of the fry in greater numbers, coupled with the very extensive spring tide movements, results in bigger catch for the fishermen.

3. Fry enter coastal wetlands

Fry gears are set across openings of rivers, creeks, estuaries; more still are operated just outside. Many of the good fry grounds are in the vicinity of nipa and mangrove swamps. In fact, in some areas, fishing is done in these very waters themselves. The fishermen believe that the fry are attracted by the low saline water and/or the smells emanating from the nipa and mangrove slush. Some fishermen even claim that if the closed-off rivers and creeks are not opened, fry do not appear.

It is common knowledge that juvenile milkfish could be caught from estuaries and nipa and mangrove swamps and lagoons. Presumably, they enter as fry and grow there. The question is: do the fry actively seek coastal wetland environments (and if so, how do they locate these), or are they just passively carried in by water movements? Results of preliminary experiments (Juario and Vanstone, 1976; Bagarinao and Kumagai, unpublished) are contrary to fishermen's assumptions. This area is open for more research.

4. Fry are attracted by light

Historically, the use of lamp in fry fishing had a fortuitous beginning. At first, it was not known that fry could be attracted by light. What the fishermen wanted to do was simply to gather fry during flood tide at night (Villaluz, 1975). For this night operation, they had to use a lamp. Very soon, they realized that the lamp also helped in the actual fishing. Thus, the lamp now fulfills two functions: to attract and gather the fry, and to enable the fishermen to work at night.

Milkfish fry had been confirmed to be positively phototactic by experiments (Kumagai, unpublished data; Kawamura, in preparation). Further studies on this aspect of fry behavior may provide some solutions to the most pressing problem of gears with lamp — that of isolating the fry from the other phototactic species.

5. Fry are caught by filtering

The present fry fishing gears operate mainly, if not only by filtration. The gears all have fine mesh bagnets at the terminal end. Most have fine mesh wings and bottom net. The passive gears utilize strong currents (speeds around 50 cm/sec). The active gears are moved fairly fast at fairly constant speeds: *sagyap* around 30 cm/sec, *sweeper* around 40 cm/sec. The swimming speed of the fry (cruising speed 9 cm/sec, burst speed 24 cm/sec, unpublished data) is lower than the speed of gear operation. The fry at the surface layers are summarily filtered whether or not they try to swim away.

In trawling operations at constant speed, fish may not be frightened much to try to escape but may get accustomed to the steady movements of the net, swim with it in the same direction, and finally get caught due to fatigue (Blaxter, 1967). This may also be the case in the active fry gears. The fry may swim with the gear when they are trapped between the wings, for they have been shown to have optomotor reaction (Kawamura and Hara, in press). So, unless they suddenly go down to escape the moving gear, they will be eventually caught in the bagnet.

It appears that in shore waters, the positive rheotaxis, the optomotor reaction and the strong swimming ability of the fry are in abeyance. Thus they are easily filtered. It also appears that the fry do not go deep when frightened. During the concentrating part of the fry fishing operation, the fishermen usually splash water in front of, and in the direction of the bagnet. This action is intended to drive the fry. It seems that fry is indeed driven towards the bagnet but not to go deep, judging from the fishing success. The gears also have the tendency to lose the bottom net despite the increase in the wing opening.

Kawamura *et al* (in press) have shown that milkfish fry react visually to stationary and moving nets and contended that fry could be caught by driving. However, the surf zone where most active gears are operated is usually turbid and the optomotor reaction/driving effect are easily weakened. Fry fishing gears that effectively utilize driving may in the future be developed.

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