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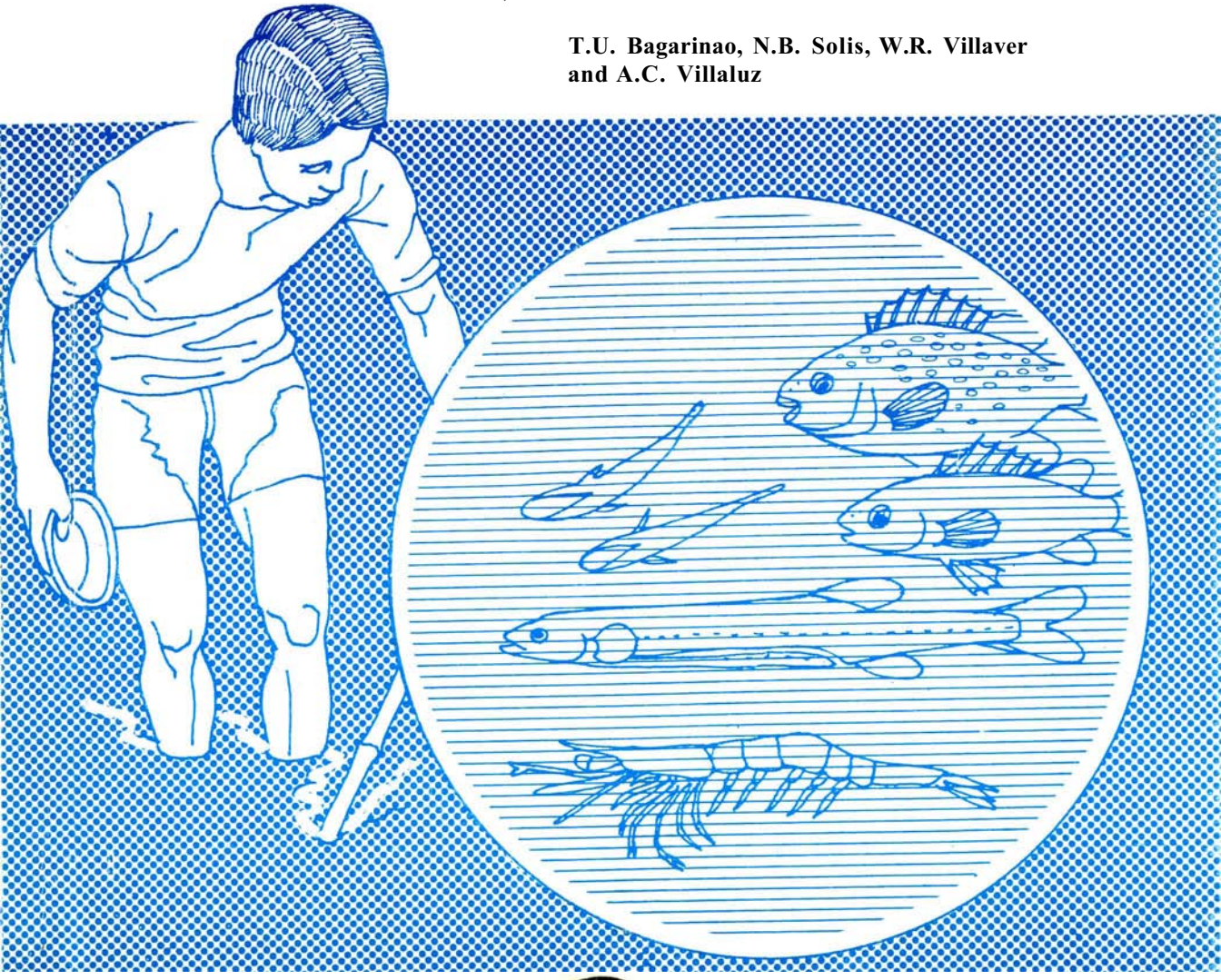

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CONTENTS

IMPORTANT FISH AND SHRIMP FRY IN PHILIPPINE COASTAL WATERS: IDENTIFICATION, COLLECTION AND HANDLING

I. INTRODUCTION

This manual deals with economically important fish and shrimp fry — aspects of their biology and occurrence in natural waters, collection, identification, storage, and transport. Milkfish (*Chanos chanos*), seabass (*Lates calcarifer*) and siganids (*Siganus* spp.) are the fish groups discussed, along with the economically important penaeid shrimps (*Penaeus* spp.).

These species were chosen for their importance in brackishwater aquaculture and because the SEAFDEC Aquaculture Department has itself been successful at producing them from the hatchery. Milkfish has been a traditionally important aquaculture species in Indonesia, Taiwan, and the Philippines. The industry is being supported by the natural fry fishery and recently by pilot-scale hatcheries in these countries. Seabass, siganids, and shrimps have for a long time been incidental crops in milkfish ponds, but have recently become prime culture species themselves. Shrimp culture is now a major industry catering to the export market. Its rapid expansion has been made possible by the development of hatchery techniques to produce fry. Seabass fry are produced in large quantities in hatcheries in Thailand, and since 1984, at the SEAFDEC Aquaculture Department. Net-cage and pond culture of seabass is fast expanding in Southeast Asia. Siganids are of many species, and several of the fast-growing ones lend themselves to culture. Hatchery and grow-out culture trials with siganids are undertaken by many countries in the Indo-Pacific region. Perhaps the most successful has been the work on *S. guttatus* at the SEAFDEC Aquaculture Department where fry have been produced almost monthly since 1984. Aquaculture has become a very profitable business and will remain so in the years to come. Because of this, the need for seed (fry) will correspondingly increase.

Rationale

The natural sources of fry will continue to be important in the future, notwithstanding the development of hatchery techniques for many species. This will be especially true for milkfish fry whose natural fishery is a major source of income for millions of coastal villagers in the Philippines, Indonesia, and Taiwan. Milkfish fry collectors also sort out and sell shrimp fry. In fry grounds where sea-bass and siganid fry also occur, these could be collected for additional income. This manual provides information on the known places and seasons of occurrence of fry of the various species and describes ways to identify them from among the catch. The manual also provides a guide to fry collection, storage, and transport, topics which are treated in greater detail in the reports "A study on the milkfish fry fishing gears in Panay Island, Philippines" (Kumagai et al., 1981), "Milkfish fry and fingerling industry of the Philippines: methods and practices" (Villaluz et al., 1982), and "Studies on the fisheries biology of the giant tiger prawn, *Penaeus monodon* in the Philippines" (Motoh, 1981), all three published by the SEAFDEC Aquaculture Department.

Objectives

This manual should enable readers to:

(1) understand the important aspects of the biology and ecology of milkfish, seabass, siganids, and the penaeid shrimps;

(2) understand aspects of fry occurrence so they know where and when to collect;

(3) recognize the fry (seed) of these species as they occur in natural waters;

(4) know the methods and gear for collecting the fry of these species;

(5) know the methods of storage and transport of fry for maximum survival.

II. GENERAL BIOLOGY AND LIFE HISTORY

A. MILKFISH

Milkfish (Fig. 1) is a large, muscular, silvery-bodied migratory fish that occurs widely in the Indo-Pacific, the Philippines being at the center. It is known

to science as *Chanos chanos* (Forsskal) and is called various names in various countries. In the Philippines, different names apply to different life stages of milkfish:

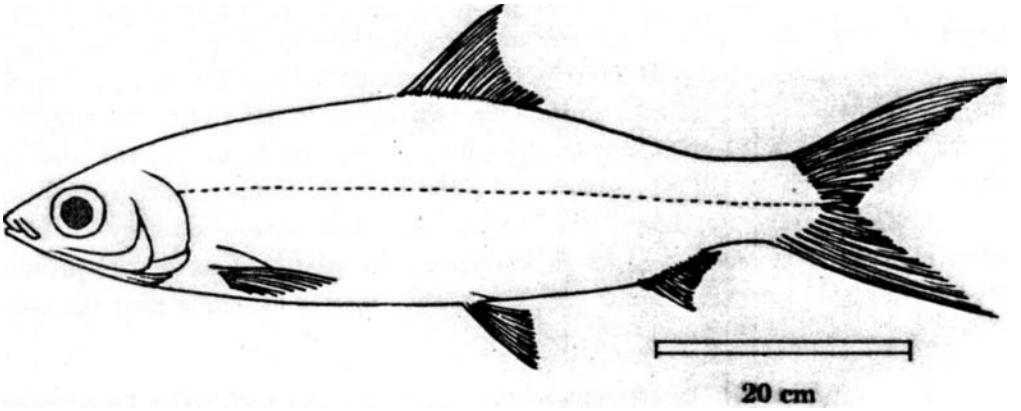

Fig. 1. Milkfish, *Chanos chanos* (Forsskal).

Stage	*Local term*	*Size (cm)*
Adult	sabalo, banglis, awa	50-150
Juvenile (marketable size)	bangus, bangrus, kugaw	20-35
Post-fingerling	garongin	7-15
Fingerling	hatirin	4-10
Pre-fingerling	gadampalit	1.5-5
Fry	kawag-kawag, semilya, gutok	1.0-1.7

Economic Importance. Milkfish is the most important aquaculture species in the Philippines, Indonesia, and Taiwan. It is hardy, herbivorous (mainly plant-eating), and fast-growing. It can be grown very successfully in fresh- and brackish-water pens and ponds. Milkfish fry support a large fishery in these three countries. The Philippines alone collects about 1.35 billion fry (in 1974) and employs thousands of coastal villagers in this activity.

Life History and Habitat. Adult milkfish measure 50-150 cm in length and 5-15 kg in weight. They inhabit warm, clear, saline, relatively shallow waters around islands where reefs are well developed. During the spawning season in March-June, many adults get caught in fish corrals and otoshi-ami's (Japanese nylon set nets) along the coasts, presumably during their spawning migrations.

Spawning takes place in the open sea. The eggs and larvae float and drift in surface waters. At age two to three weeks when they are about 10 mm long, the larvae migrate to shallow waters and appear along the shores as fry.

From shore waters, the fry are either caught and grown in ponds, or enter coastal wetlands like lagoons, estuaries and creeks which serve as nurseries. The fry soon develop dark coloration and, in about a month's time, assume the juvenile and typical milkfish shape and appearance. Juveniles spend from one month to a year in coastal nursery grounds, depending on the food supply, the area and depth of the habitat, and its connection with the sea. Some milkfish find their way into large freshwater lakes, like Naujan Lake, and leave when they are about ready to mature sexually. Little is known of the whereabouts of the juveniles after leaving the nursery grounds and before they appear as adults near the coasts to spawn.

The Aquaculture Department of the Southeast Asian Fisheries Development Center pioneered the successful induced spawning of wild milkfish in the laboratory in 1977. Soon after, one generation cycle was completed with the spawning in 1983 of the captive offspring (2 4 kg body weight, 50-60 cm fork length) of a wild female induced to spawn in 1978. Broodstock kept in floating cages at the SEAFDEC Aquaculture Department Igang Station have repeatedly spawned spontaneously. Pond- and tank-reared milkfish have also matured and spawned in Taiwan, and considerable numbers of fry have been produced.

Food Habits. Milkfish larvae and fry feed on small animals and plants in the water column. Juveniles and adults eat mainly bottom-associated blue-green algae, diatoms and detritus, and, occasionally, small shrimps and fish.

B. SIGANIDS

The siganids (Fig. 2) are a group of generally deep-bodied fish characterized by many pungent, poisonous fin spines, 13 in the dorsal, 7 in the anal and 2 in the pelvic fin, for which they have been called "spinefeet". The mouth is small and the jaws have a row of small cutting teeth. The snout looks like that of a rabbit, hence siganids are often called "rabbitfish".

There are some 25 species of siganids in the tropical Indo-Pacific, from Tanzania to the Pacific islands. Some 15 species occur in the Philippines, the more common of which are: *Siganus guttatus, S. vermiculatus, S. canaliculatus, S. spinus, S. virgatus, S. corallinus, S. javus, S. punctatus, S. argenteus, S. sutor,* and *S. vulpinus.* The fry of these species occur at one time or another in the catch from seagrass beds.

Some of the names applied to one or the other siganid (but usually to *S. canaliculatus* and *S. guttatus*) are: samaral (Tagalog); batawayi, turus (Bicol); malaga, barangen (Ilocano, Ibanag); danggit, mandalaga, kitong, layap, tayug, (Visayan); belong, indangan (Tausug and Samal). As juveniles and adults, the siganids

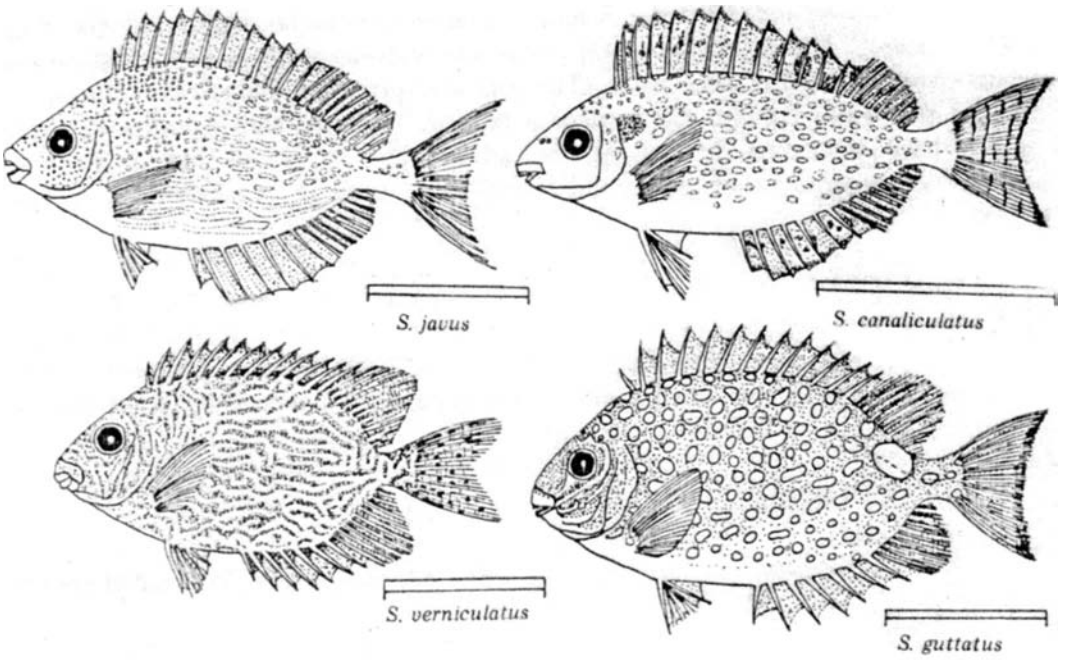

Fig. 2. The more common species of the genus *Siganus* in the Philippines. Scales represent 5 cm.

can readily be differentiated by color patterns and relative body depths, but as fry they pose identification problems.

Siganids are mostly small. Those caught from the wild and sold in markets generally measure 10-20 cm long and weigh 20-100 g. Some species grow large, up to 2.3 kg like *S. guttatus* and *S. vermiculatus*. Most siganids are slow growers, taking a year to reach a size of 150 g. They mature early (within one year) and this slows down further growth. *S. guttatus* spawns every month at the SEAFDEC Aquaculture Department under favorable conditions of clean water and good food. Other siganids also appear to be monthly spawners.

Economic Importance. Siganids are highly esteemed food fish throughout the western Pacific, like Guam, Palau, and the Philippines. Large schools of siganid fry, called padas (Ilocano) or kuyog (Visayan) are caught along certain coasts in the Philippines at predictable times of the year. These are salted whole or fermented into bagoong or guinamos, a delicacy condiment. The juveniles and adults of siganids, predominantly *S. canaliculatus* and *S. spinus*. are also caught in large quantities in the Visayas and sold fresh or cut open and dried.

Life History and Habitat. Siganids generally occur in shallow waters from 5-30 m deep. Adults inhabit coral reefs and adjacent seagrass beds. Spawning occurs over clearings in these areas. The eggs are very small and sticky. The larvae drift in the water column for perhaps a month. The fry and juveniles of some species have the same habitat as the adults, but in others like *S. guttatus* and *S. vermiculatus*, they enter and spend some time in brackishwater coastal wetlands.

Food Habits. The larvae and fry of siganids feed on small plants and animals in the water column. Juveniles and adults are primarily herbivorous, preferring filamentous green algae like *Enteromorpha,* and other species with soft thalli. Many siganids also ingest small animals, and some species accept any food offered (e.g. bread crumbs) at least for some time.

C. SEABASS

Known to science as *Lates calcarifer* (Bloch), seabass (Fig. 3) is called apahap,

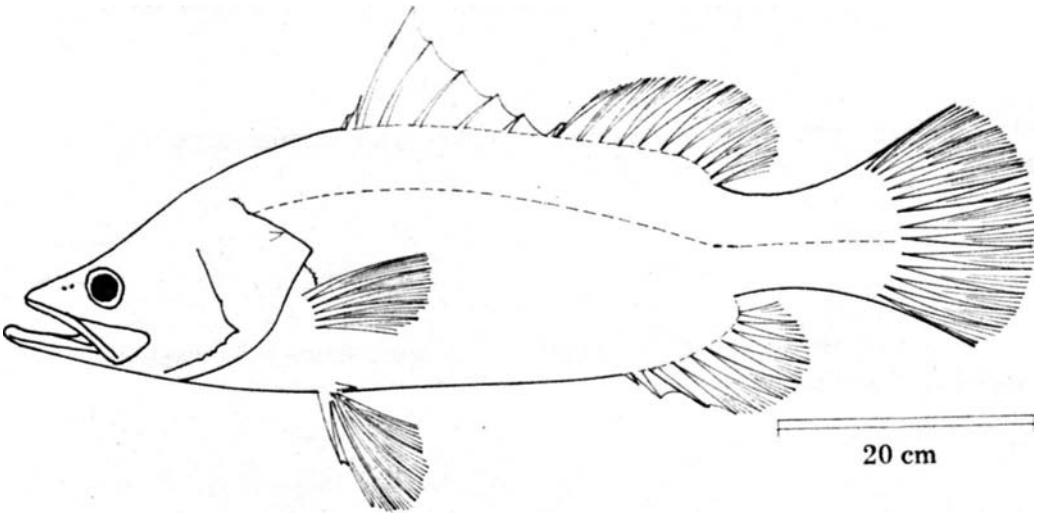

Fig. 3. Seabass, *Lates calcarifer* (Bloch).

bulgan, mangagat, matakuting and salongsong in different areas of the Philippines. Seabass is widely distributed in the tropical and sub-tropical Indo-West Pacific, but does not occur in the Pacific Islands beyond Australia. It is a bulky, slow-moving fish that grows to a maximum length of 2 m (usually 50-100 cm) and a weight of 50 kg. Seabass is leaden gray or greenish gray above and silvery below, with yellowish gray fins. The larvae and fry are dark (black with two to three vertical white stripes), becoming lighter (blue-brown above and silvery below) as they become juveniles. The eyes of seabass are shiny pinkish-red in color and glow in the dark.

Seabass (Family Centropomidae) closely resembles the groupers (Family Serranidae) in body form, but can readily be distinguished by its plain color and by its two dorsal fins (actually one fin that is almost completely separated into two), in contrast to the variegated colors and the single continuous dorsal fin of groupers.

Economic Importance. Seabass is a highly esteemed food fish in southeast Asia and India. Capture fisheries of seabass amounted to 10,192 metric tons in 1978, mostly from Indonesia, Philippines, and Malaysia. In western Papua New Guinea and Australia, there is a small commercial gill net fishery (270 metric tons) and a significant recreational fishery. In Thailand, seabass is cultured commercially in both fresh- and brackishwater ponds and cages.

Life History and Habitat. Little is known of seabass life history in the Philippines but considerable information is available from Thailand and from Australia and Papua New Guinea. Seabass is a migratory fish living in inland waters and spawning at sea. Spawners apparently congregate near the mouths of river systems and lagoons, more abundantly in those with extensive swamps and deltas. The eggs require high salinity (greater than 20 ppt) conditions for proper development. The larvae drift into brackishwater and mangrove areas where they grow to sizes of 10-30 cm. The juveniles also migrate into freshwater bodies where such are available and spend the first 3-4 years growing to weights of 1-5 kg and lengths of 30-70 cm. By the third to the fourth year, seabass migrate back to the sea where gonadal maturation takes place.

Food Habits. Seabass has a large mouth with fine teeth but no canines. It is extremely predaceous, subsisting on live prey, mostly other fish, shrimps, snails, and worms, which it sucks up and swallows whole. It is cannibalistic (the larger ones eat the smaller ones) when food is scarce. In culture operations, seabass are usually given trash fish since they do not readily take to artificial diets.

D. SHRIMPS

There are six important species of the genus *Penaeus* in Philippine waters: *Penaeus monodon, P. semisulcatus, P. merguiensis, P. indicus, P. japonicus,* and *P. latisulcatus.* Among these, *P. monodon* (giant tiger shrimp), *P. indicus,* and *P. merguiensis* (both white or banana shrimp) grow large or fast enough to be selected for pond culture. These three species are widely distributed in the Indo-Pacific. Adult shrimps are fairly easy to identify, but the fry and juveniles are often difficult to distinguish from each other.

It is important to know the external features of shrimps in order to identify them (Fig. 4). They have (1) the head section or cephalothorax, which bears the head spine (rostrum), eyes, antennae, mouthparts, the shell (carapace), and the walking legs (pereiopods); and (2) the abdomen which bears the swimming legs (pleopods), tail fan (uropod), the tail (telson) and most of the meat. Shrimps are often measured in carapace length (CL) since the abdomen is curved; CL is proportionately related to total body length.

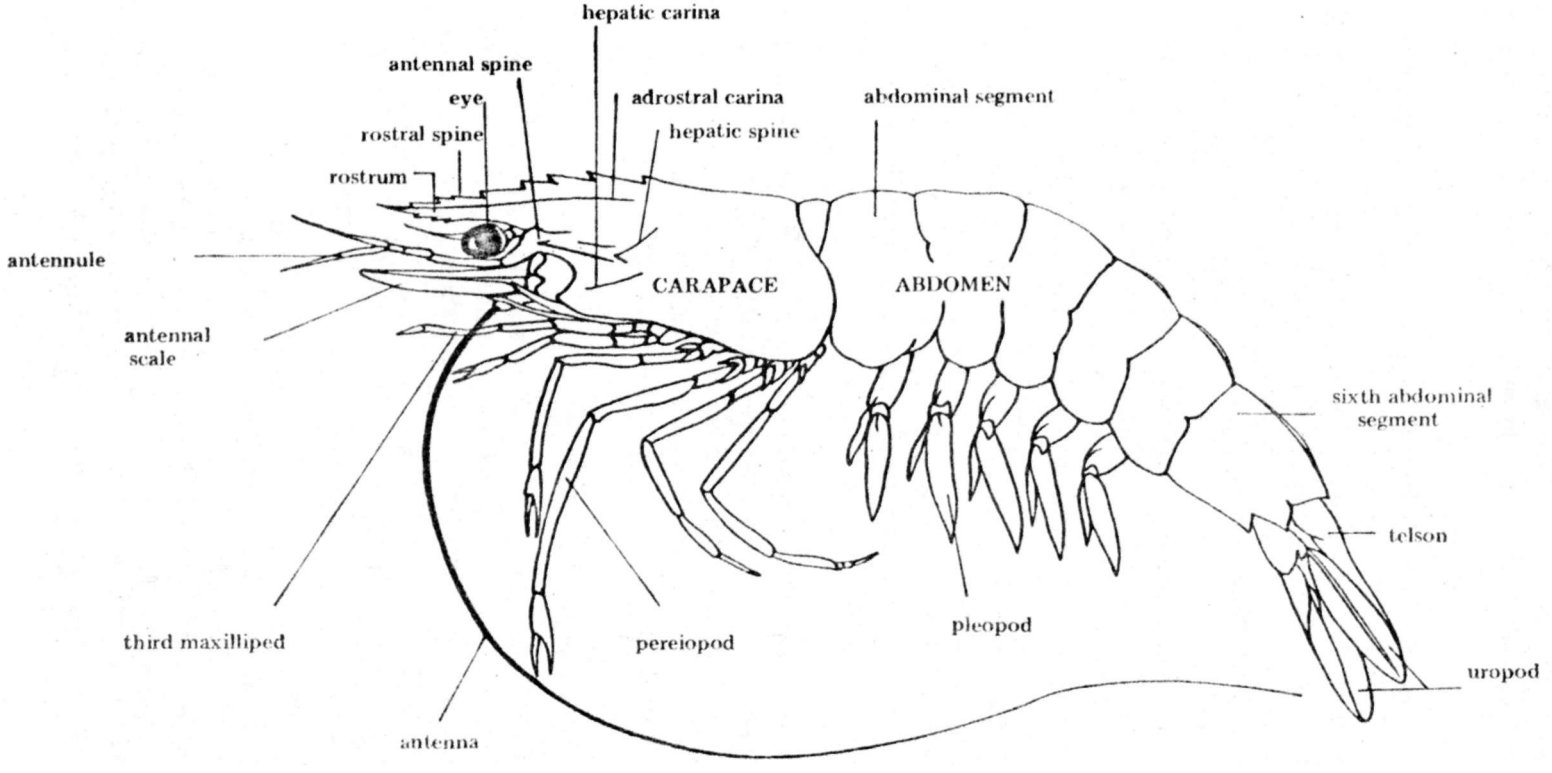

Fig. 4. External features of penaeid shrimps.

1. *Penaeus monodon*

The giant tiger shrimp *P. monodon* (Fig. 5) is the largest and most important commercial species among the penaeids in the Philippines, reaching 270 mm in body length and 260 g in weight. The rostrum is slightly curved with 6-8 spines above and 3 below. The color varies with the habitat and fades with time or when preserved. In natural seawater, *P. monodon* is dark reddish brown with well defined transverse bands in the head and abdomen. The legs are brown to blue with red hairy borders; the antennae are grayish brown. In the mangrove areas and brackish-water ponds, the body is dark brown, bluish-green, or almost black.

While *P. monodon* can easily be distinguished from the white shrimps (*P. indicus* and *P. merguiensis*), it could be mistaken for the green tiger shrimp, *P. semisulcatus,* which has more or less similar coloration. Among the external features used to differentiate these two species are:

Feature	*P. monodon*	*P. semisulcatus*
Rostrum	distinctly curved	more or less straight
Antennae	grayish brown and not banded	banded with red and white

Moreover, in contrast to *P. monodon, P. semisulcatus* does not grow well in ponds but is caught abundantly from the sea by trawlers.

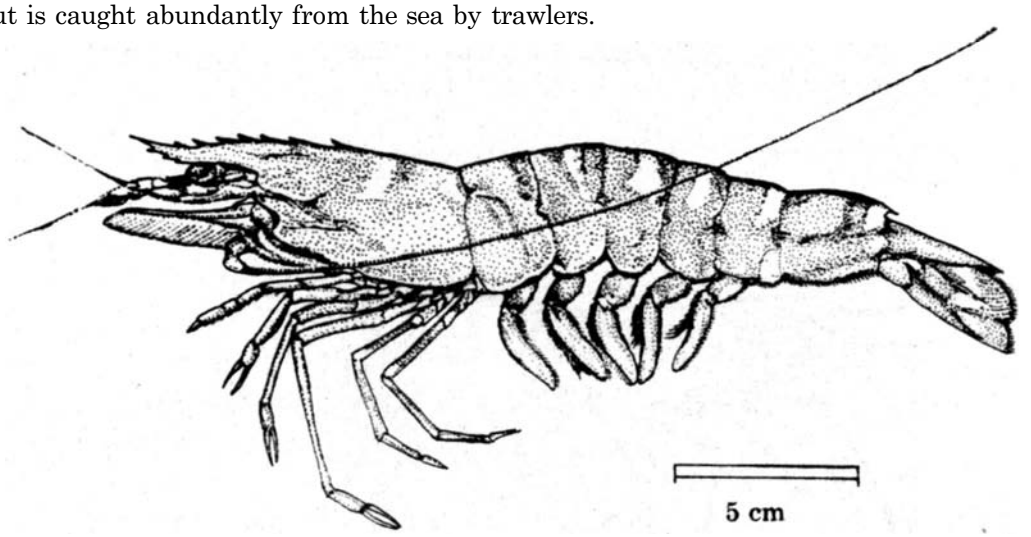

Fig. 5. Giant tiger shrimp, *Penaeus monodon* Fabricius.

2. *Penaeus indicus* and *Penaeus merguiensis*

These two species of white shrimps (Fig. 6) are difficult to tell apart at first glance because their color in life is similar. Among the external features that help to identify them are:

Feature	*P. indicus*	*P. merguiensis*
Body color	grayish or dull green	cream to yellow with spots of brown, olive or light green
Tail fan edge	yellow	yellowish green with brownish tinge
Rostrum	long and gradually curved	short and almost straight

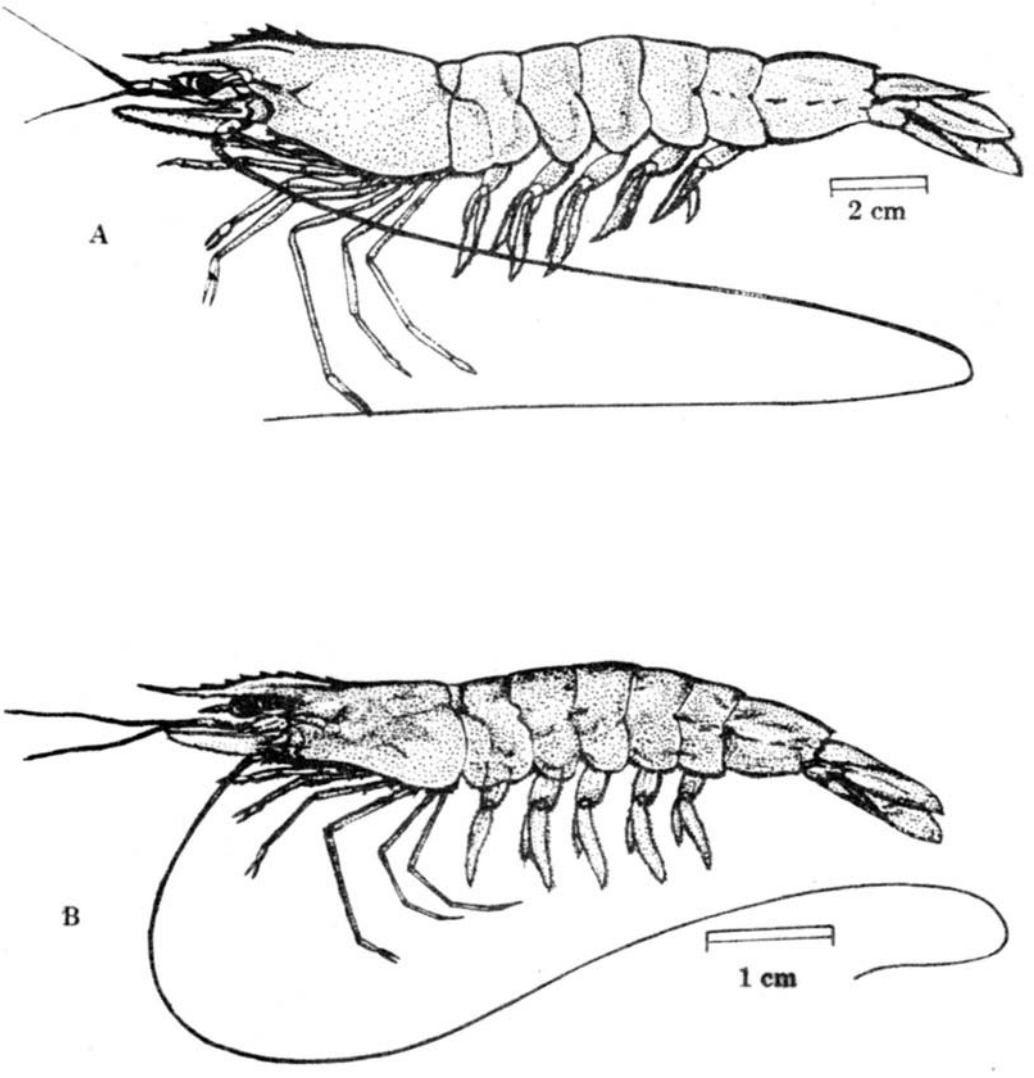

Fig. 6. A, *Penaeus merguiensis* De Man and B, white shrimp, *Penaeus indicus* H.M. Edwards.

Economic Importance. Penaeid shrimps support important fishery industries in many countries. In the Philippines, adult penaeids are caught offshore by trawlers and inshore by fish corrals. Fry are caught from shore and inland waters, and juveniles are cultured in brackishwater ponds. Several tons of penaeid shrimps, mostly *P. monodon* and *P. semisulcatus* are annually exported to Japan and other countries. Shrimps used to be a secondary crop in milkfish ponds, but now they are often the main crop, promising greater profits than milkfish. Shrimp hatcheries have sprung up in many parts of the country and now supply most of the seed for the shrimp ponds.

Life History and Habitat. The life history of these large penaeid species is similar and is outlined as one in Fig. 7. In general, they spawn offshore at depths of 20-70 m in salinities of 30-35 ppt. The semi-buoyant fertilized eggs hatch within 24 hours and the larvae drift with water currents. The larvae successively change shape with every molting (shedding of shell) and go through many stages of development: 6 naupliar, 2 protozoeal, and 3 mysis stages. The nauplii are nourished by their own folk reserves, while the protozoea and mysis feed on microscopic plants and animals. After the mysis stage, the postlarvae acquire the familiar shrimp-like appearance and start to crawl and live on the bottom or on substrates.

The postlarvae find their way to shore waters, mangrove swamps, bays, and estuaries where they are collected as fry. Those that escape the collectors' nets then stay in these coastal nursery grounds to feed and grow through the juvenile, adolescent, and sub-adult stages. These nursery areas are sheltered and protected from waves and winds, are rich in food, but have wide temperature (20-30°C) and salinity fluctuations (5-32 ppt). The three species described above can tolerate such wide variations while the others can not.

After about 24 months in brackishwater, the adolescent and sub-adult shrimps start leaving the nursery grounds to go back to sea. The gonads of sub-adults mature as they reach full saline waters outside of estuaries. *P. monodon* reaches sexual maturity and spawns when it is about 47 mm CL or one year old. *P. indicus* sexually matures at about 35 mm CL, and *P. merguiensis* at 30-40 mm CL.

When shrimps mate, a sperm capsule or spermatophore from the male is inserted into receptacles within the thelycum of the female. This happens when the female is in the soft-shelled condition (newly molted) and the male is hard-shelled. The female carries the sperm as its own shell hardens again. A female *P. monodon* may develop from 100,000 to one million eggs. On average, a *P. merguiensis* female produces about 100,000 eggs, while a *P. indicus* female produces from 40,000 to 70,000 eggs. The eggs are released through the openings at the base of the third pair of walking legs while the sperm is released between the fourth and fifth pairs of walking legs. Fertilization takes place in water. First spawnings may occur near the mouths of estuaries after the shrimps leave the nursery grounds. Subsequent spawnings occur offshore where the adults live.

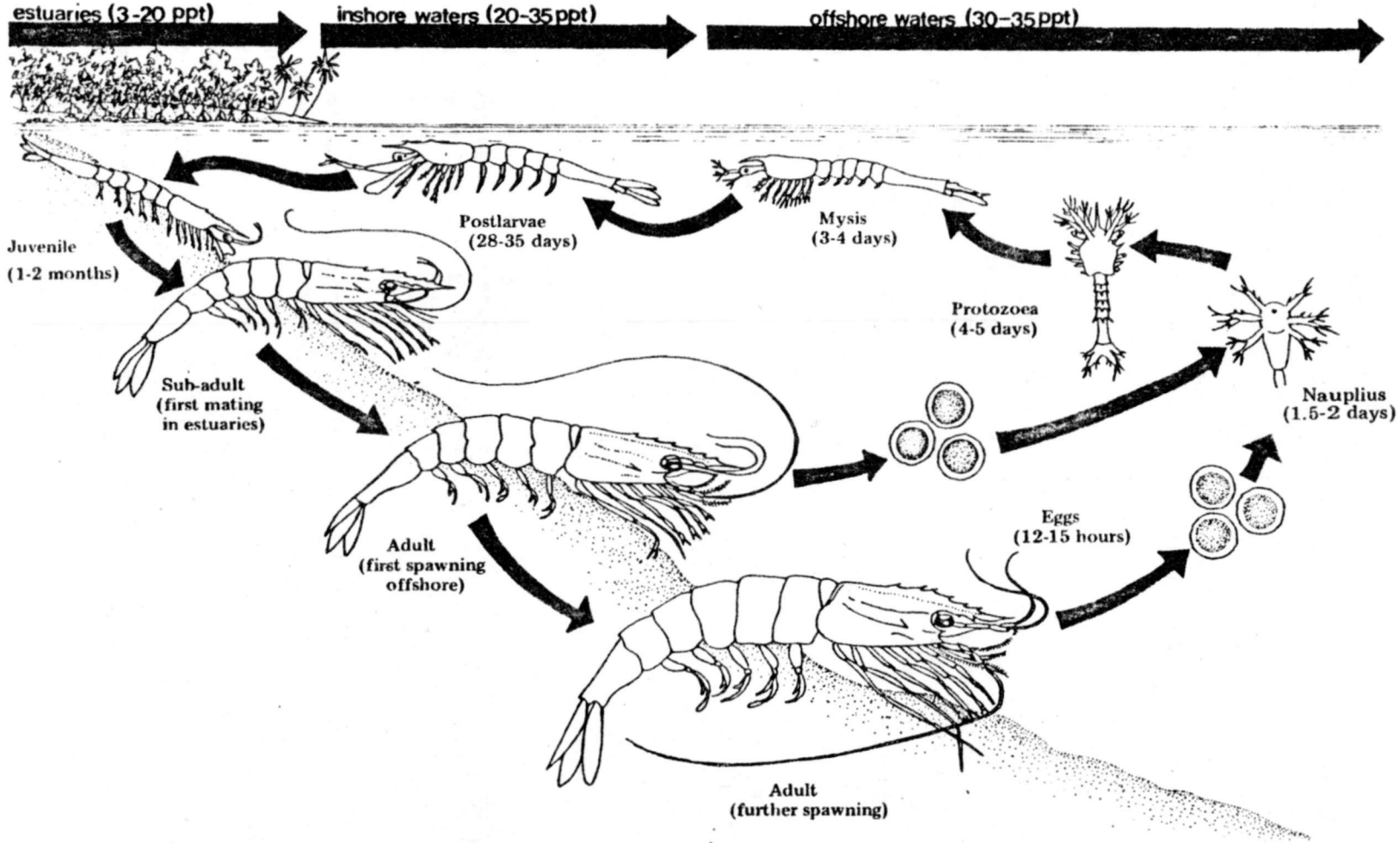

Fig. 7. Generalized life history of penaeid shrimps (After Motoh, 1981).

Food habits. Penaeids feed on a great variety of food. Gut contents of *P. monodon* include slow-moving benthic macro-invertebrates like small shrimps, crabs, molluscs, polychaetes, and some detritus. Shrimps grasp their prey with the pereiopods and nibble on it. Undigested food particles are defecated after about four hours.

III. IDENTIFICATION OF FISH AND SHRIMP FRY IN COASTAL WATERS

The term "fry" is often used loosely to refer to different, often undefined, sizes or stages of young fish and shrimps caught from coastal waters (shore, estuaries, lagoons, swamps) and used to stock culture ponds. "Fry" is synonymous with "seed" in most contexts.

A. MILKFISH FRY

Milkfish fry (Fig. 8) are late postlarvae 10-17 mm in total length (average about 14 mm) which are caught from shore waters when they are about 2-3 weeks old from the time of spawning. Fingerlings are 15-100 mm long, about 1-2 months old, which are occasionally caught in inland waters fronting the fry collection beaches, but are more commonly produced in nursery ponds stocked with fry, as in the Malabon area in the Philippines. In countries like Sri Lanka, Kiribati, and Fiji, both the fry and the fingerlings are collected from natural waters and used as seed for ponds.

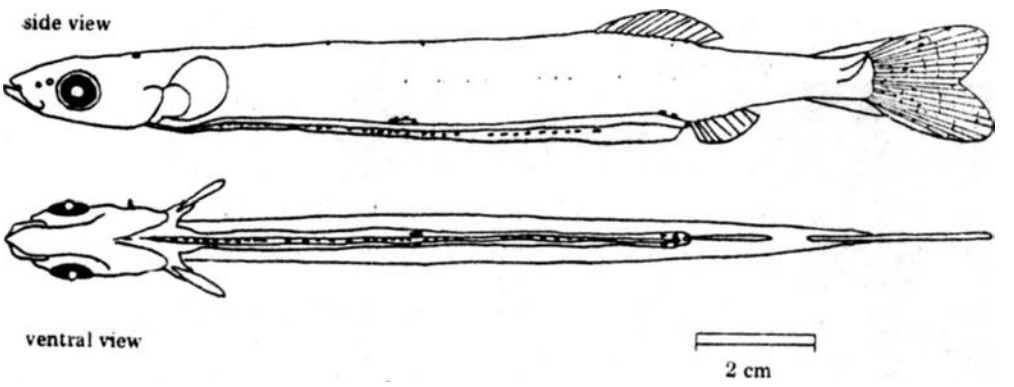

Fig. 8. Milkfish fry from shore waters.

Upon capture from shore waters, milkfish fry have transparent, elongate bodies like those of larval anchovy and sardines and some gobies (Fig. 9). In the collector's basin, milkfish fry can be readily picked out by their energetic movements and their conspicuous eyes. They swim together and circle continuously in the same direction. They are able to stay alive where the fry of most other fish species in the same catch have died. Under the microscope, milkfish fry can be seen to have a straight gut without transverse foldings of the intestine, unlike in anchovy and sardine larvae where the intestines appear striated (Fig. 9). A single line of pigments runs along the lower edge of the abdomen from the throat almost to the anus. The liver is large and sometimes looks like yolk, which is why the fry have been mistaken to be newly hatched when they are in fact 2-3 weeks old.

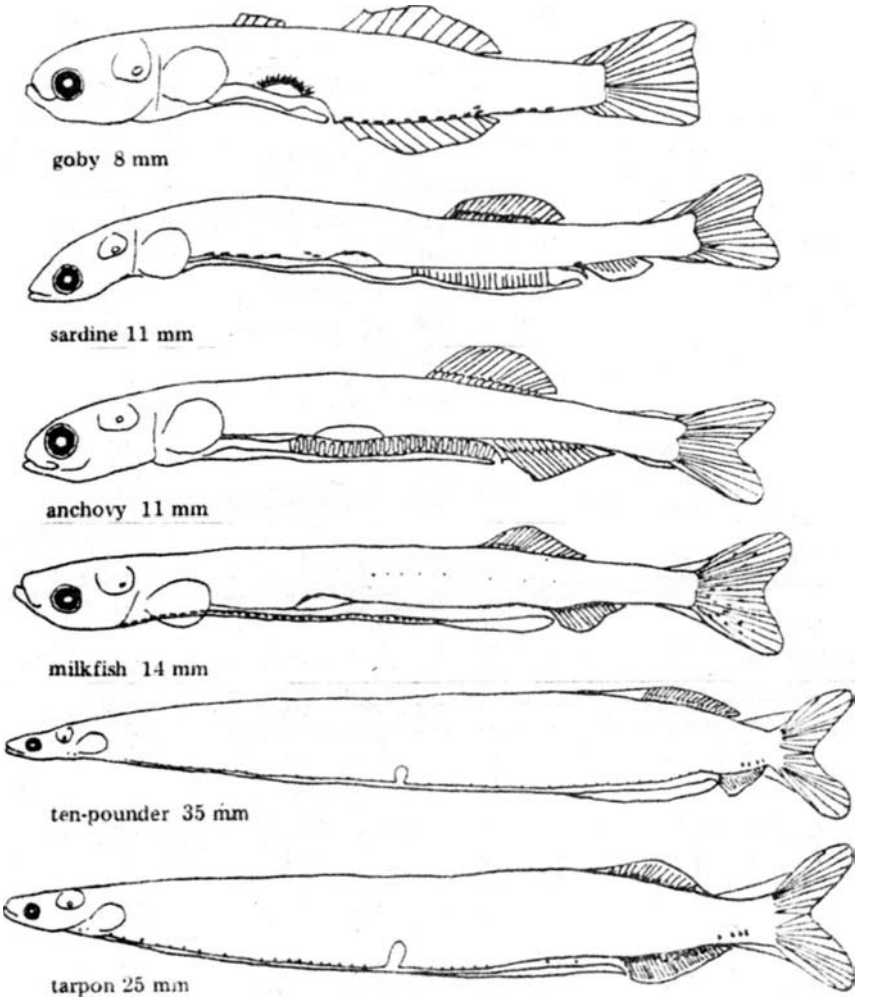

Fig. 9. Larvae of other species of fish that are often confused with milkfish fry.

After one day or more in storage, milkfish fry show a dark spot and a bubble in the middle part of the body — this is the pigmented, inflated swim bladder. With longer storage, the fry gradually develop a dusky coloration over the body and silvery coloration on the abdomen. The pelvic fins on the lower side are absent at capture but develop 5-6 days later. Within one month of capture the scales develop, the body becomes bright silvery, and the fingerlings develop the typical milkfish shape and appearance (Fig. 1). At this time, the fingerlings are ready for stocking in grow-out ponds. Fry and fingerlings produced in the hatchery are heavier at a given length than those from the wild, but there are no significant differences in growth and survival performance in ponds.

Milkfish fry are often confused with the larvae of tarpon (buan-buan, *Megalops cyprinoides*), ten-pounder (bidbid, *Elops machnata*) and some gobies. The larvae of tarpon and ten-pounder are larger (25-35 mm) and have flatter, ribbon-like bodies, relatively smaller eyes, and slightly amber body color (Fig. 9). Goby larvae have shorter guts than milkfish fry, a conspicuous swim bladder, and two dorsal fins. In the collector's basin, goby, anchovy, and sardine larvae do not school or swim together continuously in the same direction: they also die more readily.

B. SIGANID FRY

Siganid fry (Fig. 10) collected from coastal waters are of a wide size range. The padas in Pangasinan are 10-55 mm in length, mostly 20-30 mm, while those of the Visayas are 1040 mm and estimated to be 1-3 months old. Siganid fry collected in Pandan, Panay Island in 1976-1977 with a two-man dragged seine were 10-40 mm in total length. *Siganus vermiculatus* fry in Israel measure 3646 mm in the Red Sea and 45-95 mm in the Mediterranean. At the SEAFDEC Aquaculture Department hatchery. *S. guttatus* fry are defined as early juveniles 20-30 mm in total length and 3545 days old.

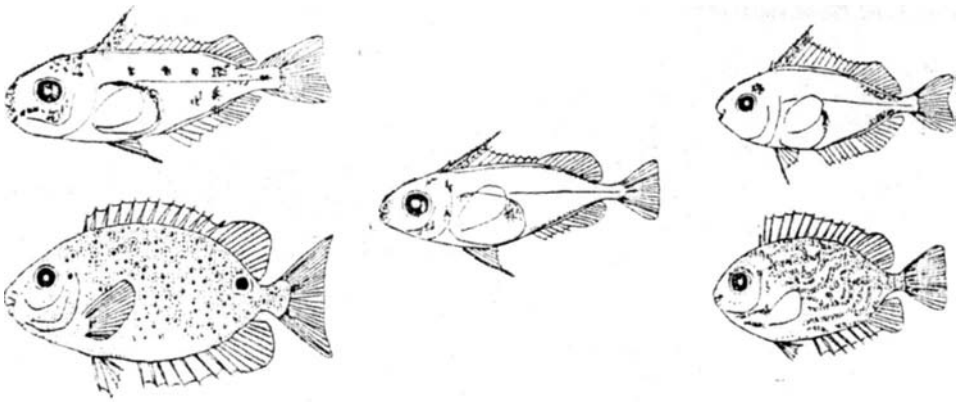

Fig. 10. Siganid fry of different species and stages. Scales represent 2 mm.

Younger siganid fry up to about 10 mm long are pale and transparent, with few pigments on the body. The front part of the head has a series of short spines. The gut is visible through the body wall. Older fry are darker in pigmentation, have silvery abdomens, relatively short, deep bodies, a high number of fin spines, and oftentimes exhibit the color pattern of the adult (Fig. 10).

Siganid fry. being deep-bodied and laterally compressed, may be confused with the larvae and juveniles of surgeonfish (*Acanthurus* spp.), filefish Monacanthidae), snappers (*Lutjanus* spp.), and the slipmouths (Leiognathidae) (Fig. 11). Siganid fry may be distinguished by the high number of stiff fin spines and by the blunt, rabbitlike snout. Surgeonfish juveniles occasionally found in shore waters often have the adult color pattern already, and the scalpel-like spine near the tail. Younger ones have elongate first dorsal and second anal spines. Filefish juveniles have erect first dorsal spine and sandpaper-like skin. Snapper larvae have elongate second dorsal and pelvin spines and a large mouth with canine-like teeth. Slipmouth juveniles in shore waters are silvery bodied, with highly protrusible mouths.

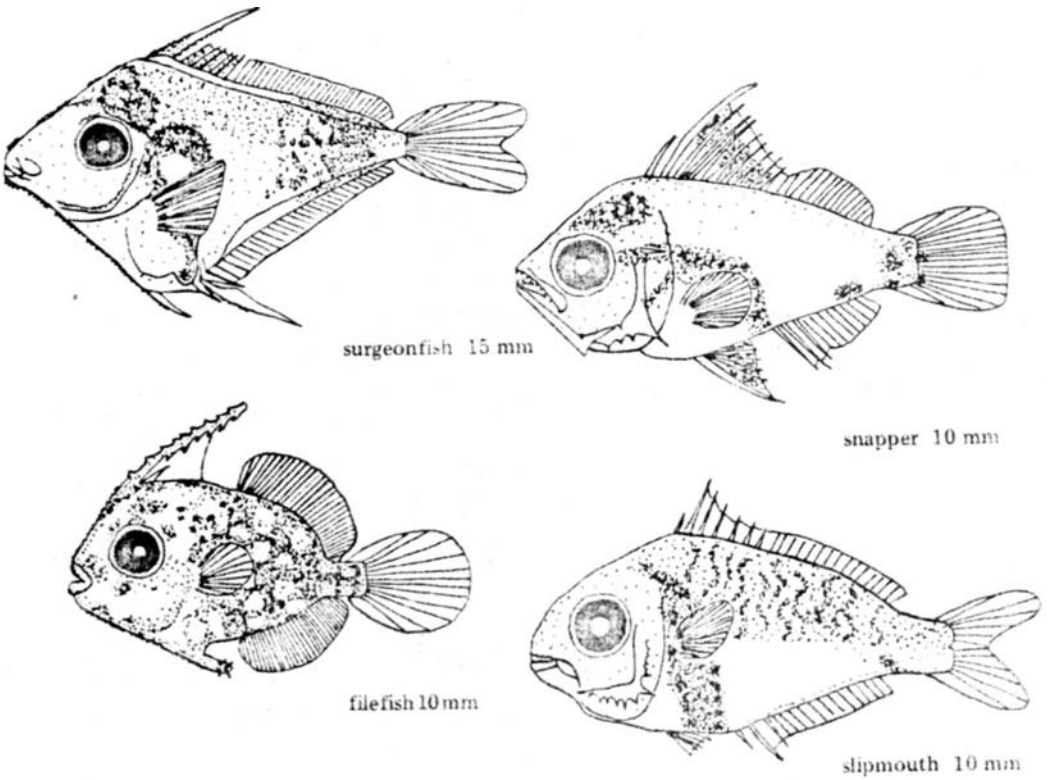

Fig. 11. Fry of other fish species that may be confused with siganid fry.

It is difficult to distinguish among the fry of the many species of siganids. One has to observe which adults occur in a particular area, and in what proportion. Meristic and morphological characteristics are of little help. Studies in this area are badly needed.

C. *SEABASS FRY*

Seabass fry (Fig. 12) are likewise of a wider size range. Wild fry may be as small as 5 mm and as large as 10-20 cm. The seabass fry collected in milkfish fry gear in Iloilo are 5-8 mm in total length, probably 2-3 weeks old from hatching. In Thailand, where seabass is cultured in floating cages and 1 kg fish are harvested for the market, juveniles 10-20 cm long are used for stocking. Wild seabass fry and juveniles are not abundant and most of the present supply comes from hatcheries. Hatcheries in Thailand and at SEAFDEC AQD produce seabass fry that are 1-2 cm long between 1 to 2 months of age.

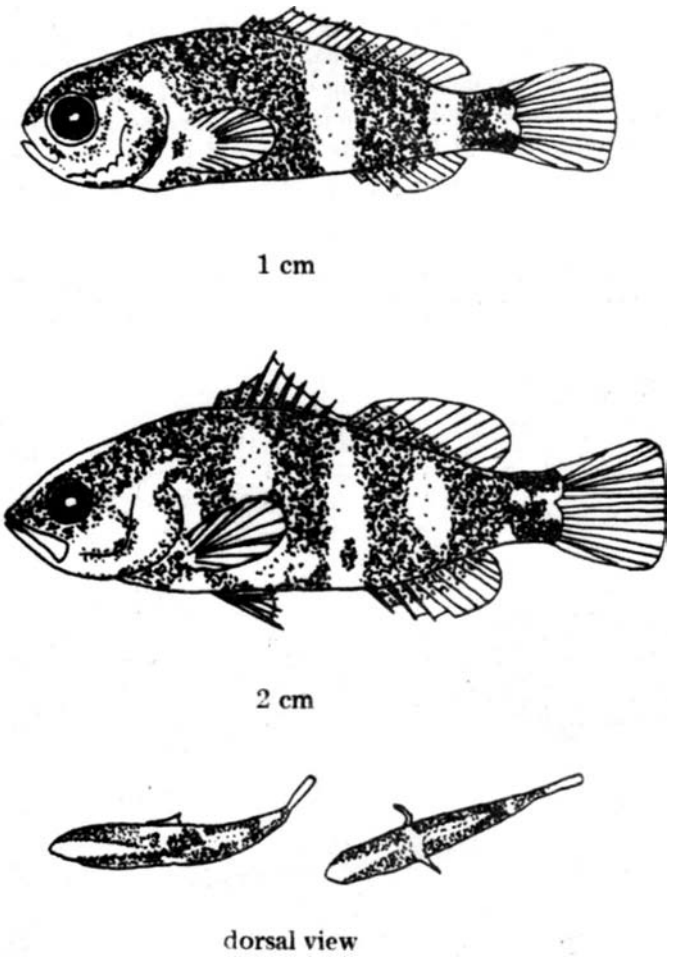

Fig. 12. Seabass fry of different stages, showing dorsal head stripe.

Very young seabass fry less than 1 cm in length appear black. Those about 1 cm and larger are dark brown with three roughly vertical white bands on the body, and a white longitudinal stripe on the head between the mouth and the dorsal fin, the "dorsal head stripe" (Fig. 12). The juveniles larger than 5 cm are light brown or bluish-black with silvery abdomens and a concave head profile, as in the adult fish (Fig. 3).

Seabass fry may be confused with the juveniles of snappers (*Lutjanus* spp., particularly *L. argentimaculatus*), tiger perch (*Therapon* spp.), scat (*Scatophagus argus*), tripletail (*Lobotes surinamensis*) damselfish (*Abudefduf vaigiensis*), mullets, and groupers (Fig. 13). Seabass fry may be distinguished from all these other species by its dorsal head stripe. *L. argentimaculatus* has 5-6 vertical white stripes on the body while seabass has only three when young (up to 2-3 cm) and none later. Tiger perch fry have a black blotch on the first dorsal fin; slightly older ones have black stripes running in a curve from behind the head to the tail. Scat fry are black, almost discoidal in body outline and have a bony head armor; slightly older ones are brown with small black spots. Tripletail and damselfish juveniles also have stripes on the body, but both are deeper bodied than seabass. Mullet fry are dark-colored with a silver sheen, with two short dorsal fins placed far apart. They are abundant in shore waters, occurring in schools of mixed species, mostly small and slow-growing. Grouper fry have rarely been collected from shore waters. They have a single continuous dorsal fin while seabass fry have two dorsal fins placed close together. Younger grouper fry may have elongate second dorsal spine and pelvic spine as in snappers.

These species may occur all together in the same fry ground. Snappers, scats, mullets and groupers are highly valued food fish and have been or should also be collected for culture.

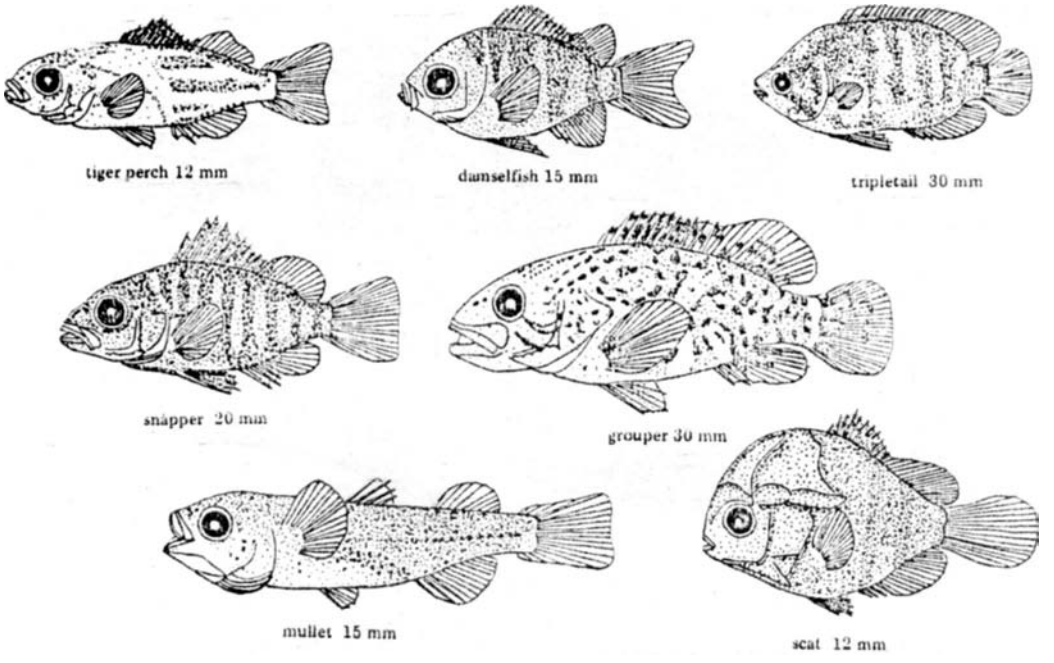

Fig. 13. Fry of other fish species that may be confused with seabass fry.

D. SHRIMP FRY

The fry of penaeid shrimps (Fig. 14) are the postlarval or early juvenile stages of the life cycle. There are four groups of shrimp fry that occur in shore waters in considerable abundance. These may be quickly identified by their general pigmentation patterns (Fig. 14). The number of pigment cells on the sixth abdominal segment (here called PSAS) is an important and easily ascertained character for identification.

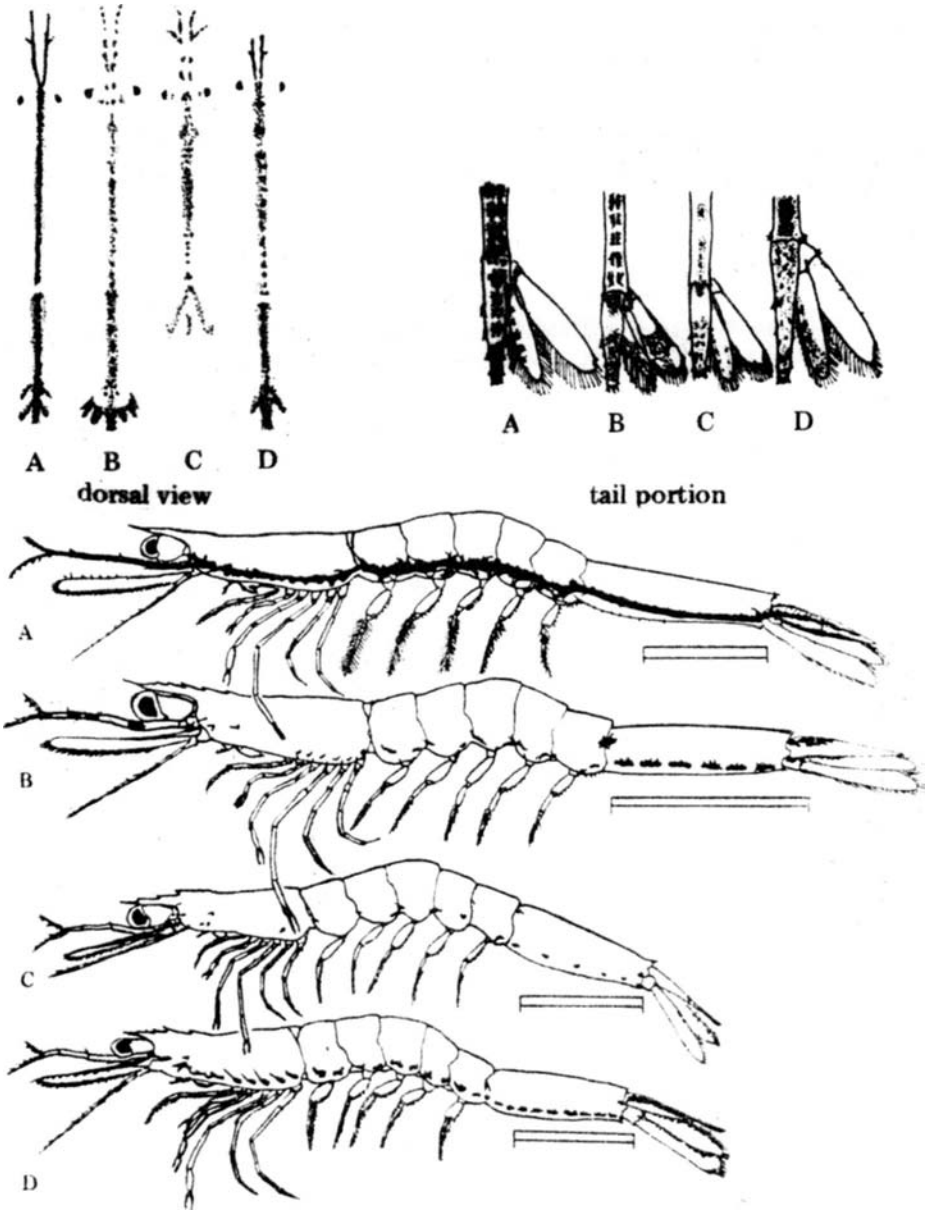

Fig. 14. Fry of different species of penaeid shrimps. A. *P. monodon;* B. *P. semisulcatus;* C. *P. indicus/merguiensis;* D. *P. japonicus* group. Note pigmentation patterns on body and tail. Scales are 2 mm.

Penaeus monodon fry, while not so abundant in natural waters is the most sought-after. They are the largest (1.4-3.1 mm in carapace length CL, average 2.6 mm) among all shrimp fry and can easily be picked out because of their dark brown-red streak along the entire body from the tip of the inner antennular flagellum to the tip of the telson. The rostrum is slender and straight or very slightly curved, 0.4-0.5 x CL in length. PSAS is greater than 13, dense and continuous.

P. semisulcatus fry are relatively smaller (1.2-3.0 mm CL, average 1.8 mm), and closely resemble *P. monodon* fry in general pigmentation, except that there is mid-way break in the pigmentation of the telson and the uropods. The rostrum is uptilted, 0.5-0.8 x CL in length. PSAS is from 6 to 12.

P. indicus/*P. merguiensis* fry measure 1.2-3.0 mm CL (average 1.8 mm), and are translucent and indistinctly pigmented. The rostrum is long and straight, 1.4-1.5 CL. PSAS is less than 7.

P. japonicus/*P. latisulcatus* fry also resemble *P. monodon* fry in having the continuous longitudinal streak of dark-brown or dull-green chromatophores. They are relatively shorter (1.2-3.0 mm CL, average 2.0 mm) but stouter. The rostrum is short, 0.2-0.3 x CL in length, not reaching the tip of the eye.

Relative abundance of these four groups in shore waters may differ in place and time. In Iloilo, Philippines the rank of abundance was found to be: *P. indicus*/ *P. merguiensis* (65%), *P. japonicus*/*P. latisulcatus* (18.5%), *P. semisulcatus* (11%), and *P. monodon* (5.5%).

Catches during fry collection include other crustacean larvae that may be mistaken for penaeid shrimp larvae, such as the metapenaeid shrimps, caridean shrimps, mysids, and the sergestid shrimps (e.g. *Lucifer* and *Acetes*) (fig. 15). Other species are easily distinguished, e.g., crab zoea and megalopa, and mantis shrimp (Fig. 15).

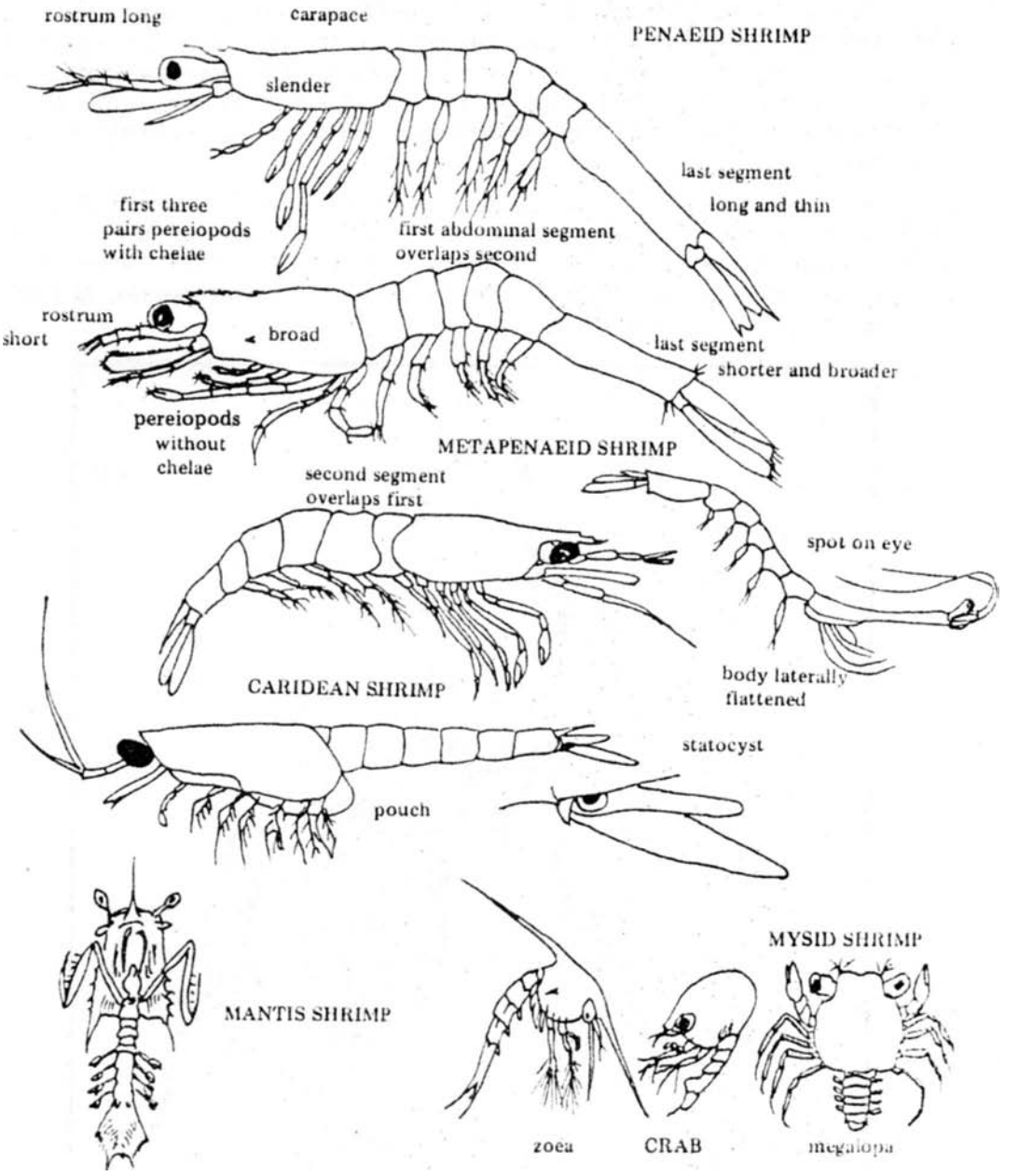

Fig. 15. Larvae of other crustaceans that co-occur and may be mistaken for penaeid shrimp fry.

IV. FRY GROUNDS AND SEASONS

A. MILKFISH FRY

Milkfish fry occur from India to Tahiti and from southern Japan to Malaysia. They have not been reported outside this range, probably due to non-use of the appropriate gear at the right place and time. At present, only the Philippines, Indonesia, and Taiwan collect milkfish fry for commercial culture, while several countries collect fry and fingerlings for experimental culture (e.g. Sri Lanka, Kiribati, Fiji, India).

Milkfish fry grounds in the Philippines have been well surveyed (Fig. 16). Fry grounds are located throughout the country although they are more prevalent on the western and southern coasts of islands than on eastern and northern shores. The milkfish fry grounds are usually flat sandy beaches, river mouths, and tidal creeks and mangrove swamps.

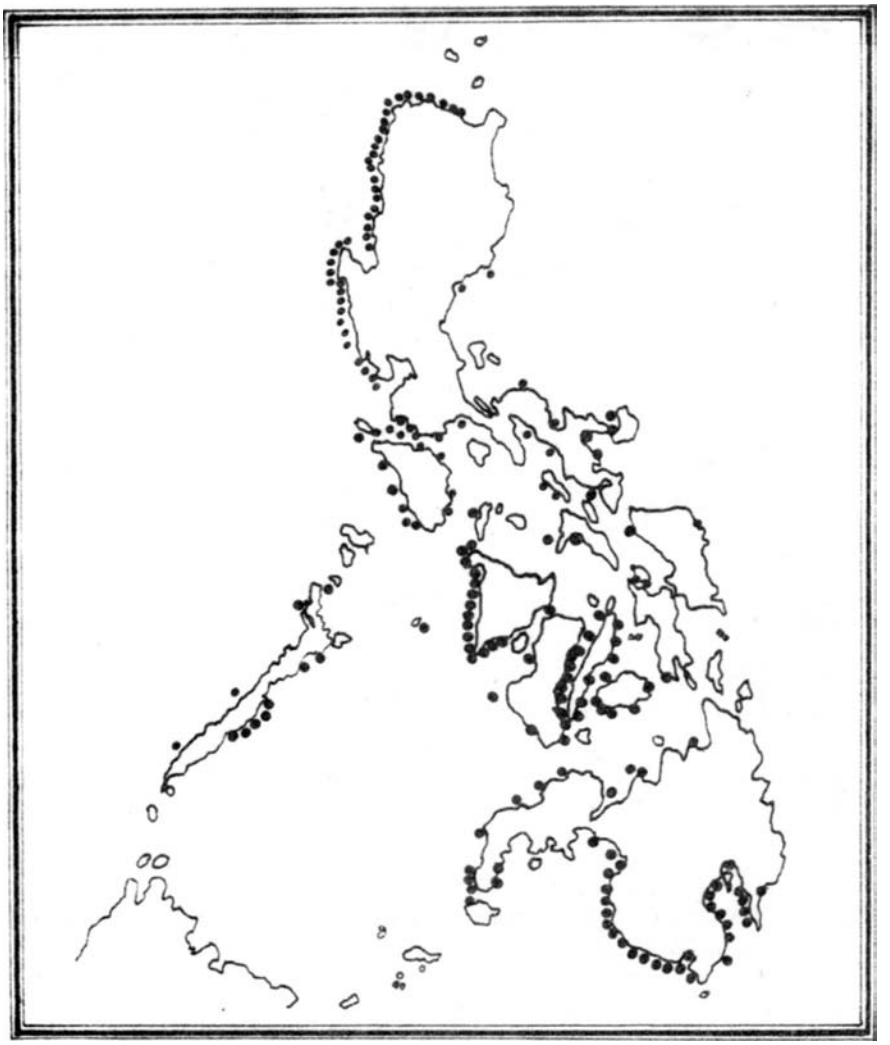

Fig. 16. Milkfish fry collection grounds in the Philippines. (From Ohshima 1973).

Milkfish fry are available throughout the year at one location or another, but individual fry grounds experience marked peaks and slack periods at certain times of the year. The season begins earliest in Mindanao (Cotabato-Zamboanga) where it peaks in May. After a decline in catch through August, a smaller peak occurs in September to November. In the Visayas (Cebu, Panay, Negros), the season begins in March-April, peaking in May, and lasts till November-December, with a second peak in October in some fry grounds and none in others. In northern Luzon (Ilocos, Cagayan, Pangasinan), the season starts in April and lasts till October with a peak in May-June.

The difference in the length of the milkfish fry season seems to be due to the latitudinal position of the fry grounds (Table 1).

Table 1. Milkfish fry collection season at various localities from north to south in the Philippines. After Kumagai 1984).

Latitude N	Localities	Collection season	Peak
	Santa Ana	April to October	June
	Badoc	April to October	(July) August
17.5°			
	San Fernando	April to July	May
	Lingayen	(March) April to July	June
15.0°			
	Batangas	(March) April to July	May
	Naujan	April to August	May
	Tabaco	April to November	May
12.5°			
	Culasi	April to November	June
	Hamtic	March to November	May & October
	Cadiz	March to November	May & October
10.0°			
	Narra	March to December	May & October
	Sipalay	March to December	May & October
	Naawan	(February) March to December	May & November
7.5°			
	Malita	February to December	April & October
	Zamboanga	(January) February to December	(March) April & October (November)
	Glan	Throughout the year	(March) April & November

The Philippines covers from 5 to 21°N latitudes. Fry appear early (January-February) in the south, and later (March-April) in the north. They disappear earlier in the north (August-October) than in the south (December-January). Moreover, in the south at latitudes about 5-11°N, there are two peaks, of which the former is higher; in the north 12-21°N, there is only one peak. In western Panay (Antique Province), the two towns of Pandan and Hamtik, 130 km apart on the same coast have different fry seasons. In Pandan, milkfish fry start to appear at the end of March and disappear early in December, with a peak in May. In Hamtik, fry appear in the middle of March and disappear in the middle of December with peaks in May and October.

B. SIGANID FRY

Large schools of siganid fry (as well as juveniles and adults) appear inshore and become objects of traditional fisheries in the Pacific islands like Palau, Guam, and Fiji. In the Philippines, no systematic survey of siganid fry collection grounds has been conducted, but it is known that large schools or swarms of siganid fry (padas) regularly appear in, and are collected from, the extensive seagrass beds in Pangasinan, the Ilocos provinces, Cagayan, Sorsogon, Camarines Sur, Bohol, Negros, Cebu, Surigao, Siquijor, and the Sulu group, the latter ones being yet largely unexploited. Apparently, the fry feed on seagrass (*Thalassia, Halophila,* etc.) and the associated algae (*Enteromorpha,* etc.). These swarms are often composed of several siganid species, with 2-3 species predominating.

The western Lingayen Gulf is noted for its siganid fishery, for both adults (barangen) and fry (padas). The fishing centers are the towns of Anda, Bolinao, and Alaminos (Fig. 17). The littoral zones of these places have sandy-rocky bottoms with a dense community of seagrass, seaweeds, and the associated fish and other animals. In May 1972, unlimited fishing in Bolinao yielded 40 tons of padas in three days. At Santiago and Tagaporo islands, the catch by beach seine could be as much as 78% siganid by weight. Large-size fry of *S. guttatus, S. vermiculatus* and *S. javus* are collected from brackishwater river mouths and mangrove lagoons around Lingayen Gulf and stocked in ponds around Alaminos and Dagupan.

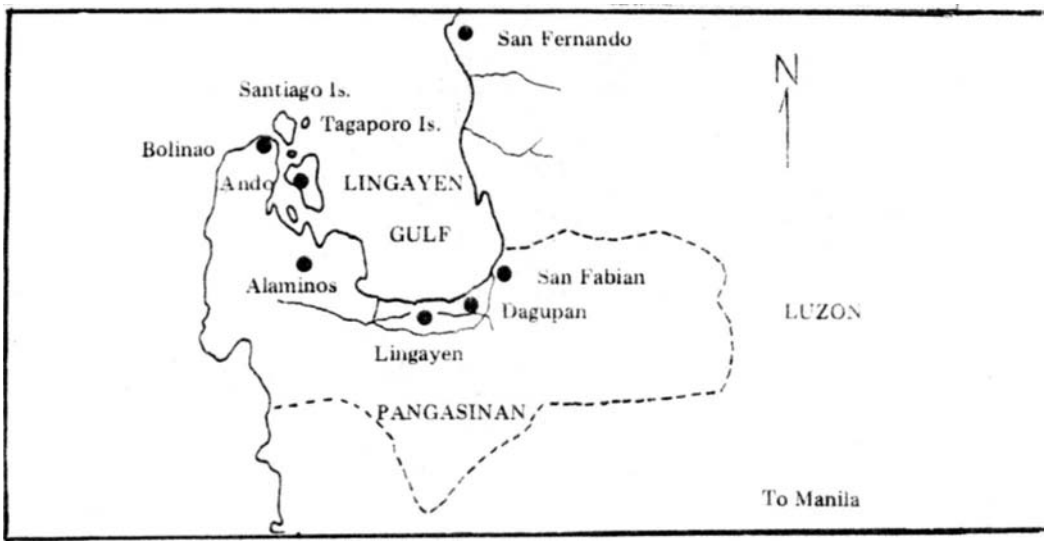

Fig. 17. Lingayen Gulf in Pangasinan. the most productive siganid fry ground in the Philippines. (After Kumagai 1984).

Collection of siganid fry in Pangasinan is from February to October each year, with a peak in April to June. The fry season varies in different places for different species. In Bohol and Negros, the fry season for *S. canaliculatus* extends from January to November; for *S. guttatus*, January to September; for *S. spinus,* February to September. In Pandan, Panay island, siganid fry occur in shore waters from May to October. At the SEAFDEC Aquaculture Department hatchery, *S. guttatus* spawns every month and fry could be produced the whole year round.

C. SEABASS FRY

Seabass fry have only recently come to the attention of fry collectors and pond culturists in the Philippines. In Iloilo (Villa and Oton), seabass fry have been collected along with milkfish fry in gear set across river mouths and tidal creeks. There are reports of fingerlings being collected in mangrove swamps near fishpond areas in Dumangas, Barotac and Banate, and of fry being also available in certain places in Negros. In Iloilo, seabass fry seem to be most abundant in May, although the fry season probably extends from May to November.

In Thailand, seabass fry can be found in mangrove areas with salinity of 1-20 ppt and in rivers, canals, swamps, and even rice fields with connection to the sea. Fry and fingerlings may be collected from the Gulf of Thailand from Songkhla to Samutprakarn and in the Andaman Sea from Ramong to Satun. Fingerlings 10-20 cm may be collected at the beginning of the rainy season. Later, the catch consists of mixed sizes, but 2-5 cm fry come to dominate. The fry season in the Gulf is October-January, while in the Andaman Sea, it is May-August. Most seabass fry in Thailand, however, come from hatcheries.

D. SHRIMP FRY

Shrimp fry are often collected together with milkfish fry from shore waters, as well as from inland waters where the latter can hardly be caught. Shrimp fry are present all year round with two peak seasons a year: June-July and October-November. However, there are differences among species:

Species	Peak of occurrence
P. monodon	July-August; November-December
P. semisulcatus	February-March; November-December
P. merguiensis/ P. indicus	June-July; October-November
P. japonicus	March-April; September-November

Table 2. Local and seasonal occurrences of *P. monodon* fry, based on interviews with fry collectors in the Philippines (Motoh, 1981).

Place	Collection period	Peak season
LUZON		
Dalahican	Southwest monsoon	August
Atimonan	Northwest monsoon	February
Calauag	Year round	Northeast monsoon (February to June except March and April)
VISAYAS		
Batan	Year round	November to February
Barotac Nuevo	June to October	August
Villa, Tigbauan	May to December	October to November
Bolanon, Danao	March to September	May to June
Tabao, Caingin	Northwest (December to February) & Southwest (June to November)	August-October
Aguisan	Year round	November
Bocana, Tabla	July to December	August to September, November
Sipalay	March to June, October to December	June, November
Malabugas	April to December	May to June
Polo	March to June, October-December	June, November
MINDANAO		
Dapitan	Year round	September to October
Dipolog	Year round	September to November
Ozamis	Northeast & Southwest monsoon	July, November to December
Zamboanga	September-November	-
Tagum	Northeast & Southeast monsoon	April to May, October to November
Matina, Aplaya	Northeast monsoon	April to May

Seasonal occurrence seems to depend primarily on the prevailing monsoon and secondarily on the geographic location (Table 2). Shrimp fry seem to be carried by wind-generated currents. In addition, the collecting activity depends on the demand, e.g., shrimp culturists do not buy shrimp fry immediately prior to the dry season because growth of shrimps in ponds is slow at high salinities.

In the past 10 years, several shrimp hatcheries have sprung up in the Philippines to supply the great demand for *P. monodon* and *P. merguiensis-P. indicus* fry. The demand for wild fry nevertheless remains undiminished due to the expansion of shrimp culture operations supplying the export market.

V. FRY COLLECTION METHODS AND GEAR

The present methods of collecting fry and fingerlings involve filtration by mobile or stationary gear. Bottom topography, wind and water current patterns, and tidal fluctuations in the fry grounds are the most important considerations in the design and construction of the gear. The behavior of the fry and fingerlings determines the collection methods to be employed in specific areas. Operation of the appropriate gear at appropriate times and localities results in higher fry catches. The methods and gear described here are presently used for milkfish and shrimp fry, with some exclusively used for the latter. Siganid and seabass fry are collected in some of these gear and may have been collected in others but have not been duly noticed. The siganid fry fishery in Pangasinan employs several specialized gear

A. STATIONARY GEAR

1. *Lures*

These lures ("bonbon", "pagungpong") are devices made of bundles of twigs, grass or coconut leaves that are set in shallow brackishwater mangrove areas (Fig. 18) and used by shrimp fry as substrates for attachment. The fry are shaken off these lures into scoop nets and other collecting gear. Lures have been used to a limited extent for seabass fry in mangrove areas. In Fiji, bundles of grass attached to bamboo floats are used to collect *Siganus vermiculatus* fry from shore waters.

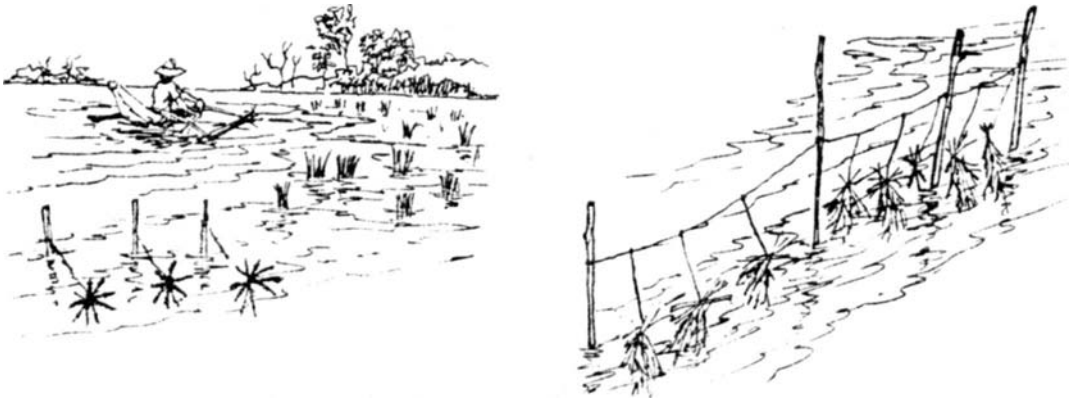

Fig. 18. Fry lures made of bundles of grass and twigs.

2. *Barriers*

Barriers ("saplad", "lambay", "tadtad") are wall-like devices against which fry are concentrated by favorable wind or tidal currents (Fig. 19). Collection of fry is by scoop nets or seine nets.

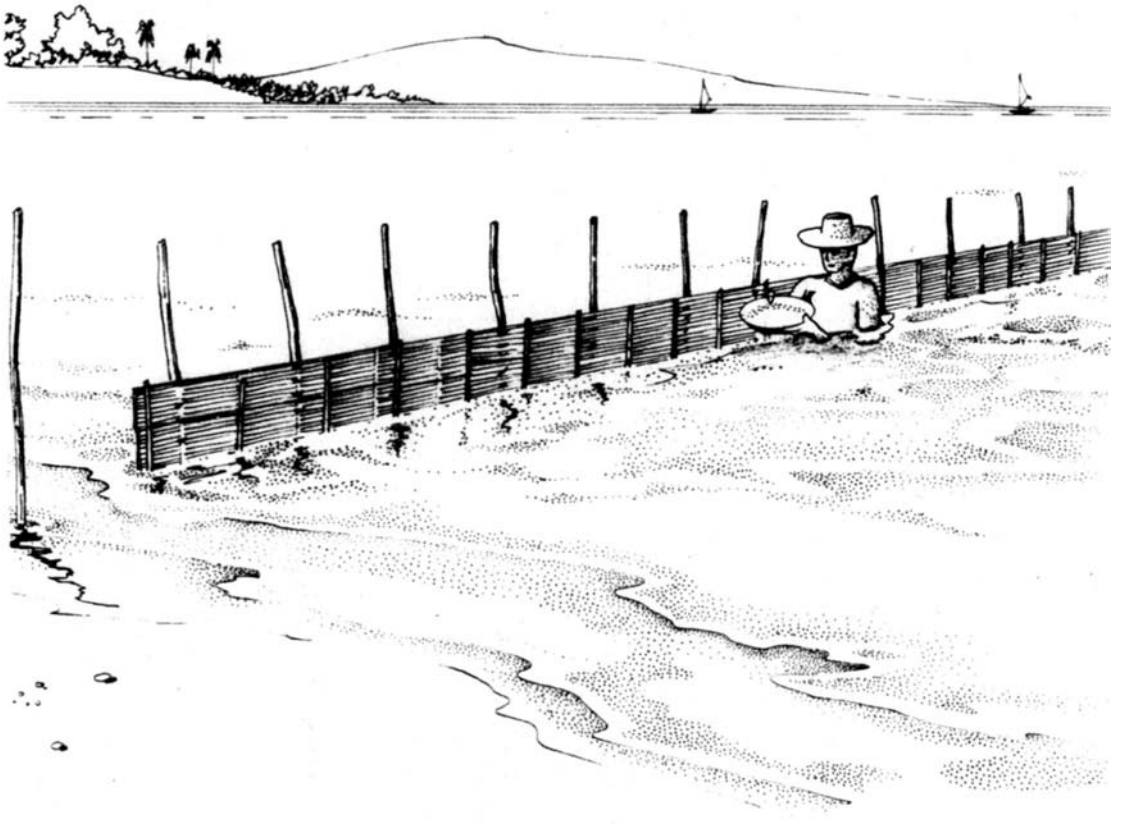

Fig. 19. Barriers set on shore perpendicular to currents.

3. *Tidal set net*

The tidal set net or "tangab" (Fig. 20) consists of a bagnet with fixed wings, usually constructed across river mouths or creeks, and occasionally along the shore facing favorable wind and tidal currents. The gear is usually operated at flood tide and high tide when it is most effective.

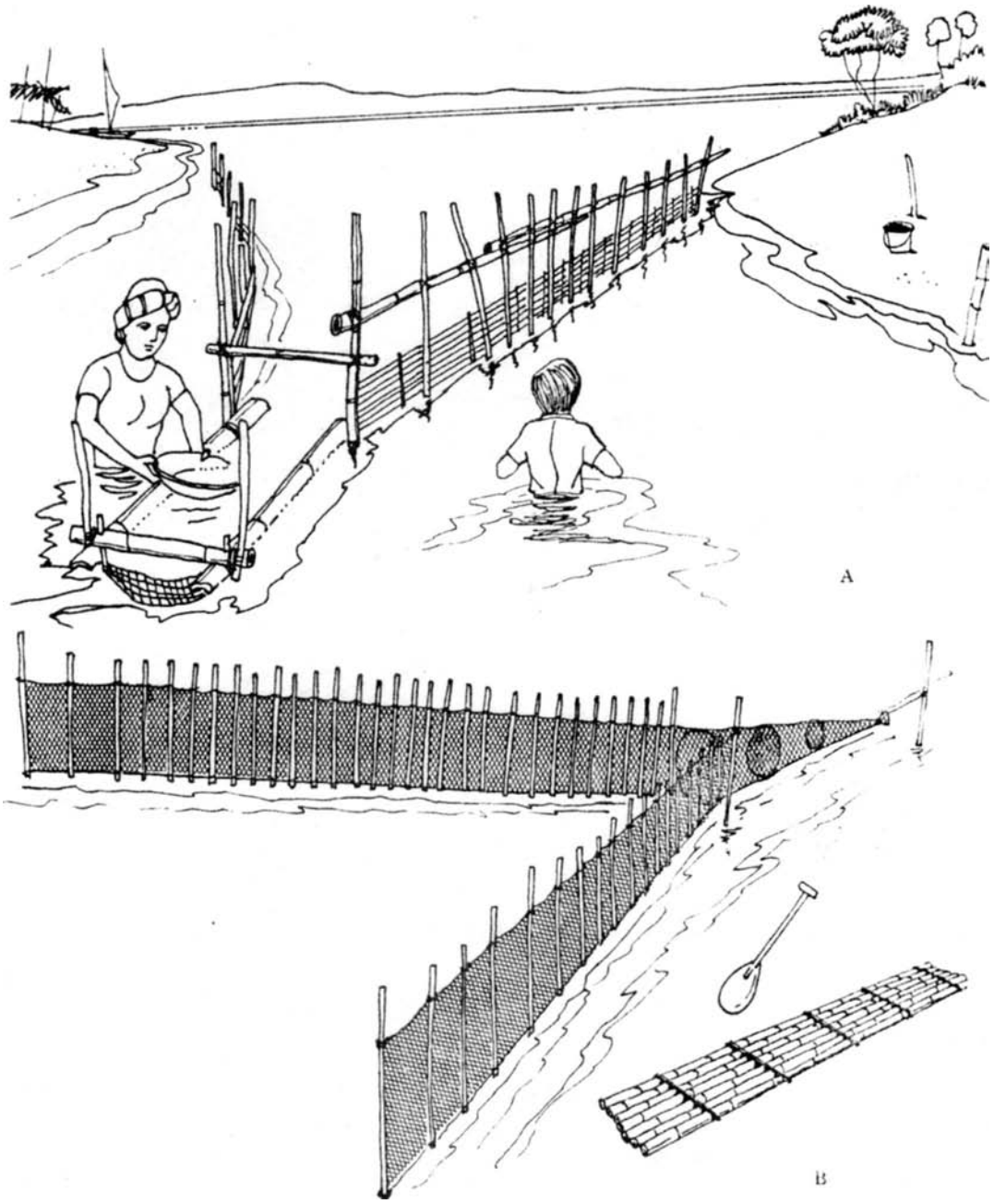

Fig. 20. Tidal set nets. A, commonly used for milkfish and shrimp fry; B, used for siganid fry.

4. *Fry filter net with raft*

Known locally as "saplad", this gear is essentially a tidal set net operated inside estuaries (usually deeper water) and provided with a raft as a working platform (Fig. 21). The raft has a small hut where the collector can rest and wait. This gear is used for shrimp fry and siganid fry.

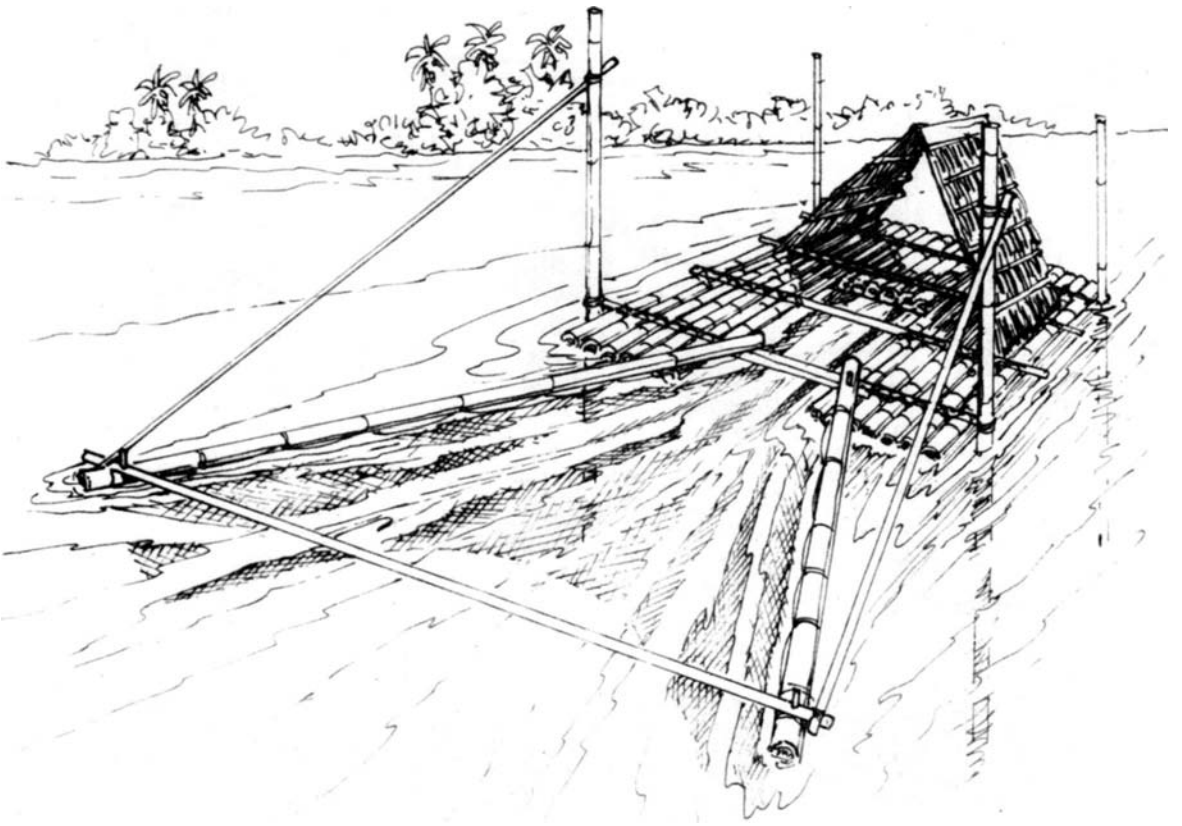

Fig. 21. Fry filter net with raft and small hut.

5. *Floating tidal set net*

This gear, also called "tangab-balsa" is set along coastal promontories with shallow coralline platforms (Fig. 22). It consists of long wings fixed in place and a catching chamber (frame and bagnet) that is set in place during operation at flood and high tides, but removed when not in use. Several units of this gear may be set on the same stretch of beach one in front of the other all facing in the same direction. The gear utilizes mainly longshore currents.

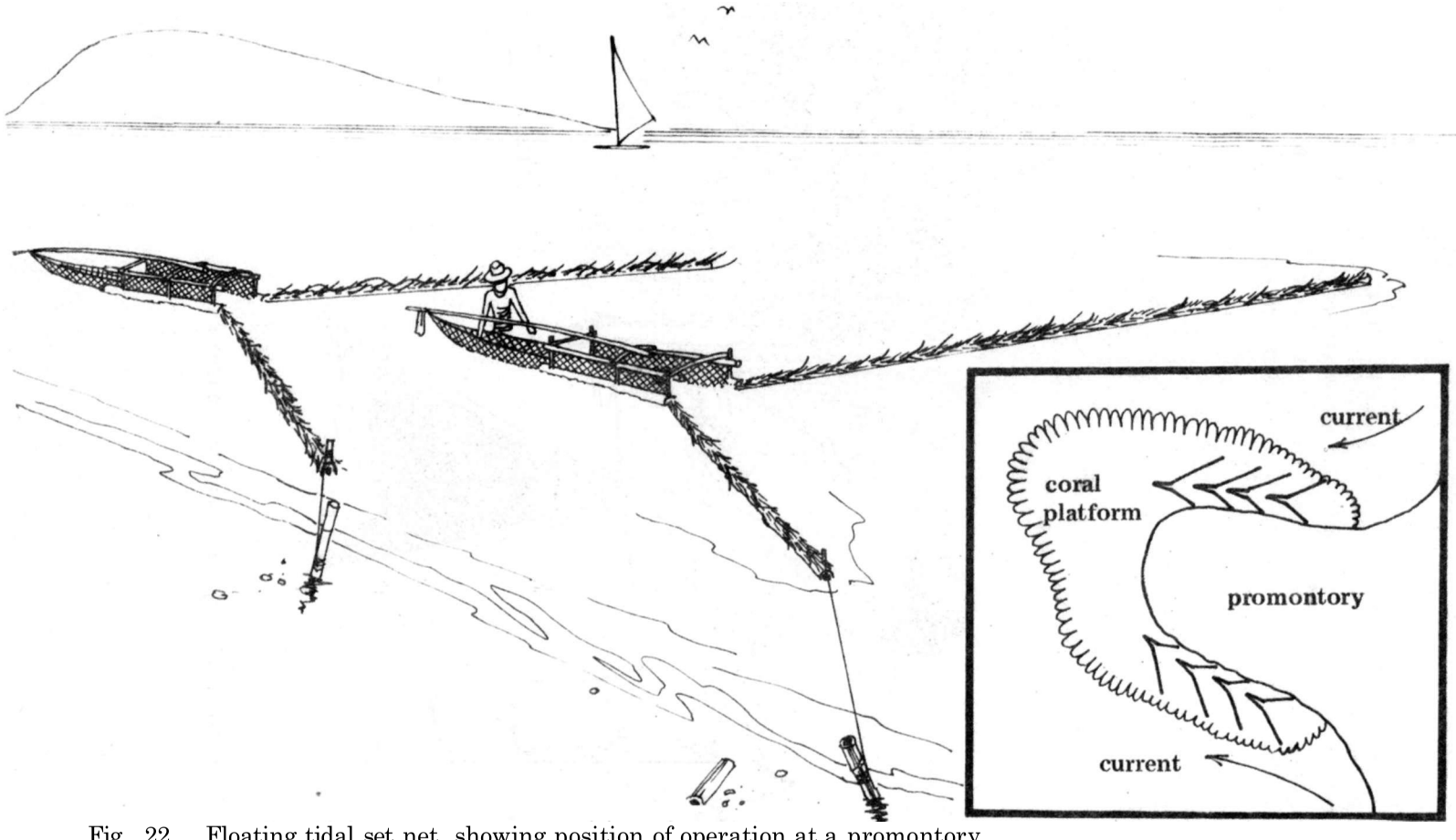

Fig. 22 Floating tidal set net, showing position of operation at a promontory (Lipata Point, Panay Is., Philippines).

B. MOBILE GEAR

1. *Scoop nets*

Scoop nets or "sibut" (Fig. 23) are small nets attached to fixed or movable frames, operated in shallow areas like mangrove swamps, fishpond dikes and canals and tidal flats with rough bottoms, or as accessory to other gear.

Fig. 23. Scoop net operated in shallow mangrove areas.

2. *Scissors net or skimming net*

This gear "hudhud" (Fig. 24) consists of a bagnet attached to a fixed or movable frame, usually quite large and operated by a man in waist-deep waters. Using this gear, shrimp and goby fry are often caught from estuarine areas, while siganid fry are collected from seagrass beds. The latter are kept in a net cage after capture.

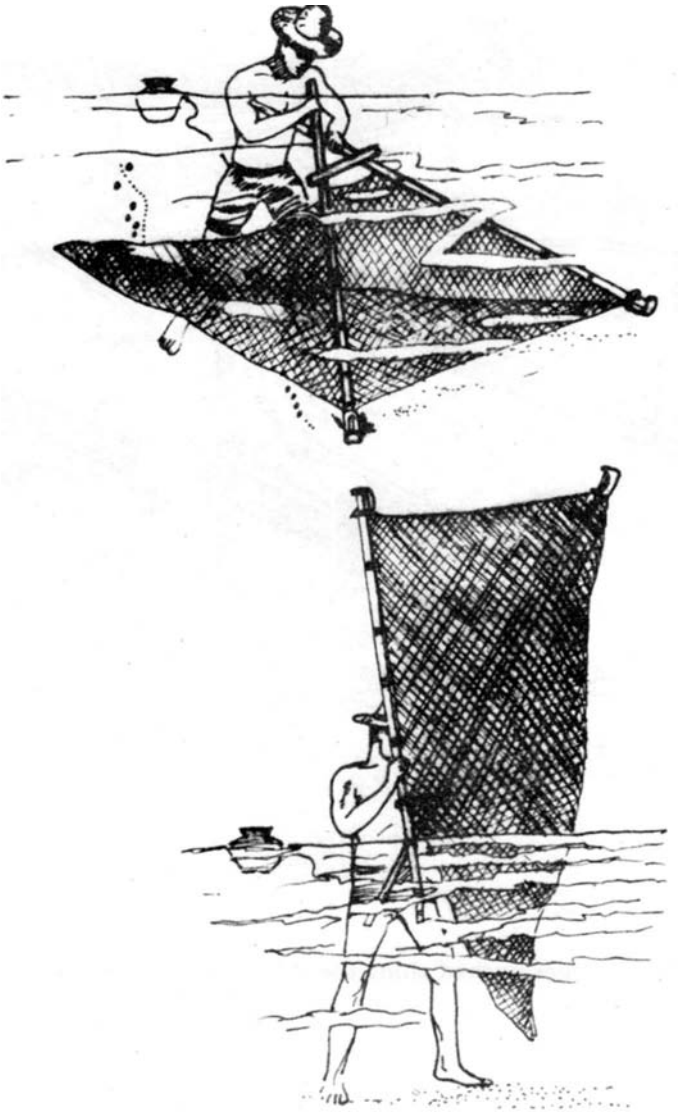

Fig. 24. Scissors net or skimming net used for shrimp fry and siganid fry.

3. *Push net or fry sweeper*

This fry sweeper or "baka-baka" (Fig. 25) is essentially a filter bagnet with a floating frame, operated along the shore or river banks by one or two persons. It is sometimes used as a stationary gear during rough sea, being set open to surf and currents. It has also been variously enlarged and modified to suit different fry grounds (Fig. 26).

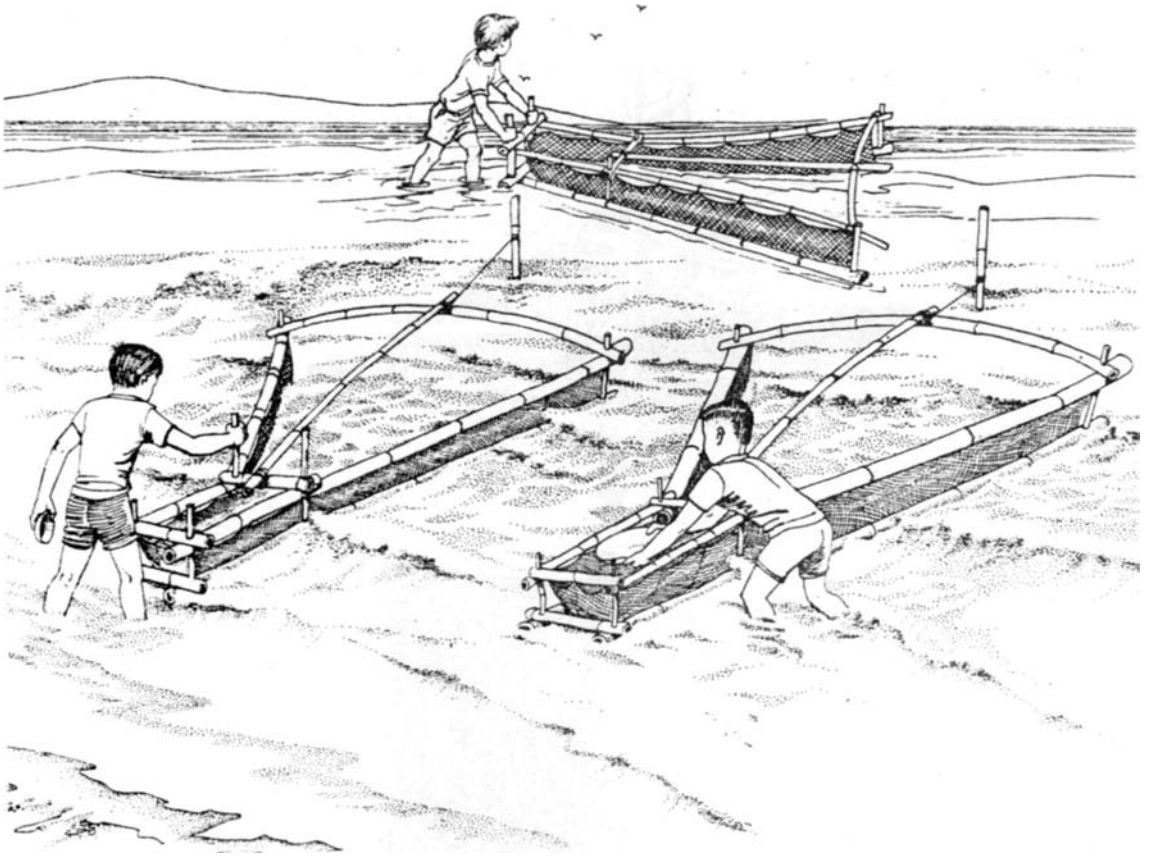

Fig. 25. Push net or sweeper pushed along the shore, or fixed in place.

4. *Motorized fry sweeper*

A lightweight fry sweeper without the rigid frame is attached to one or both sides of a boat and operated some distance offshore (Fig. 26).

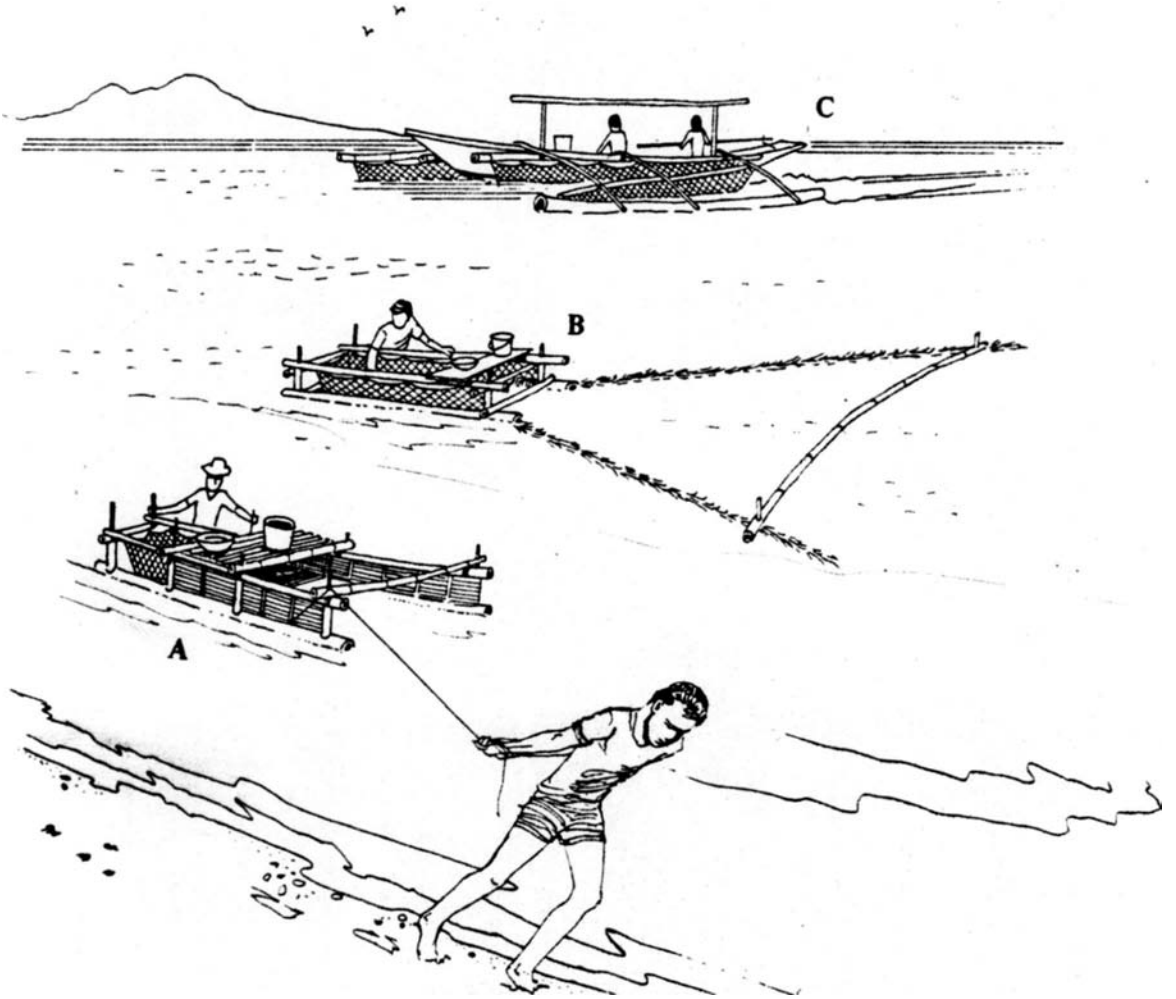

Fig. 26. Modifications of the push net. A, enlarged frame with a person dragging and another pushing it; B, with long wings made of coconut leaves; C, the motorized sweeper operated from a boat offshore.

5. *Fry sweeper with raft*

An enlarged sweeper with longer wings is attached to a raft, and is operated some distance from shore often at night with a lamp (Fig. 27). It is driven by a man with a long bamboo pole, or sometimes with an outboard engine. This gear may also be operated like a tidal set net.

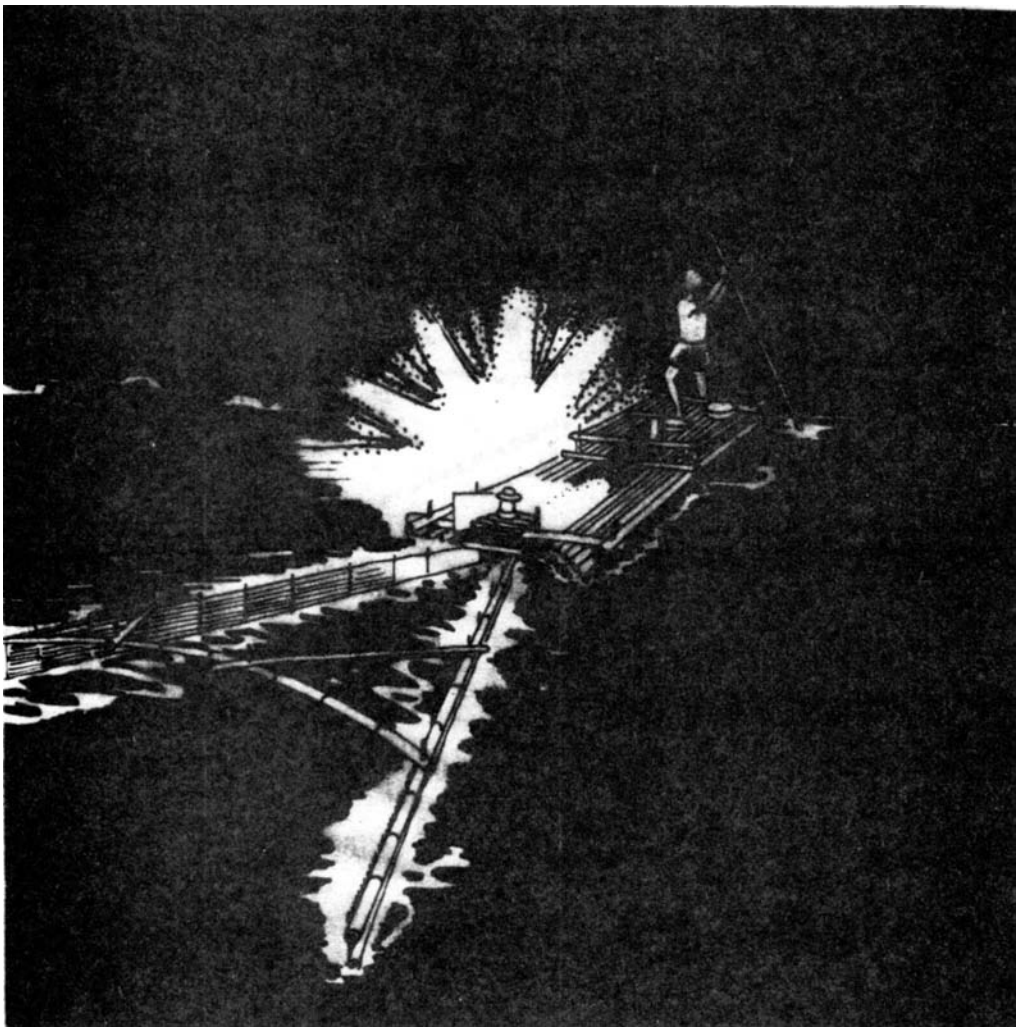

Fig. 27. Fry sweeper with raft operated with a lamp at night.

6. *Towed bagnet*

This is a long conical net called "sayot" attached to bamboo poles and dragged along the shore (Fig. 28). The narrow end is bunched and tied with a string during operation, and later untied to release the collected fry into a plastic bag. Bamboo floats may be attached to the wings to facilitate operation. This gear may be operated like a tidal set net.

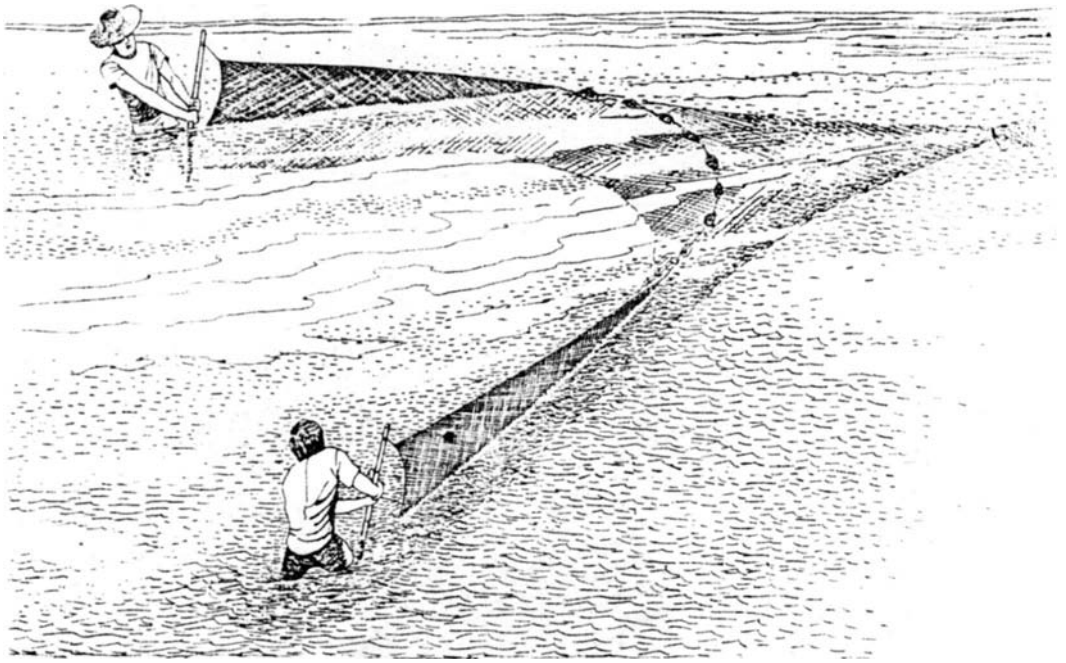

Fig. 28. Towed bagnet with conical end secured with a string.

7. *Double-stick seine*

Locally known as "sagyap", this is the traditional seine, 3-7 m net with bamboo poles at both ends, dragged by two persons along the shore or river banks (Fig. 29). It has been variously modified in response to prevailing topographic, weather, and economic conditions.

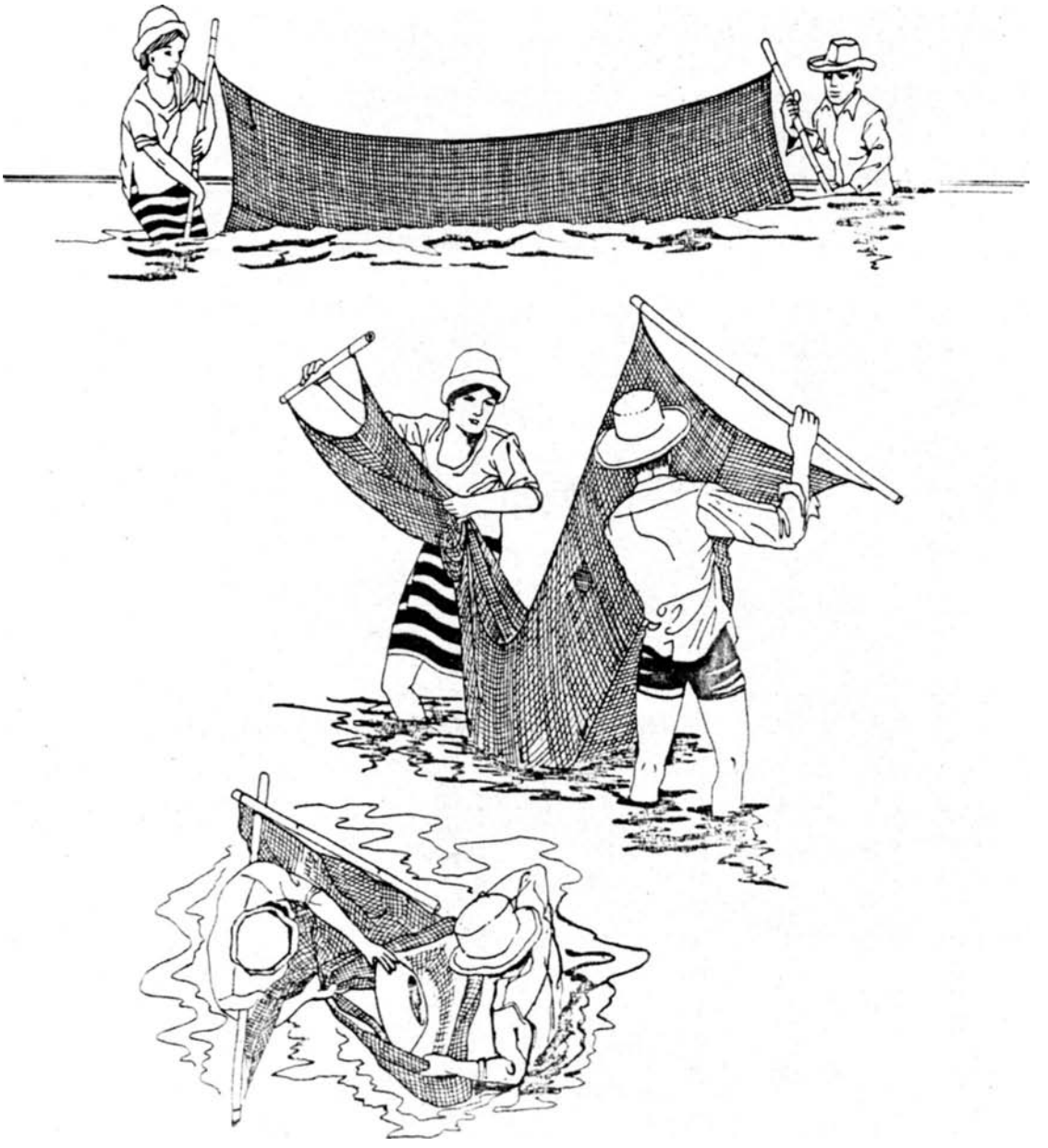

Fig. 29. Double-stick seine and its operation.

8. *Fry beach seine*

This is a much longer (20 m) sagyap, called "taktak" and operated like a beach seine. One person stays on the shore holding one end of the towline, while another takes a boat out and casts the net 50-100 m offshore; the net is then pulled back to shore (Fig. 30).

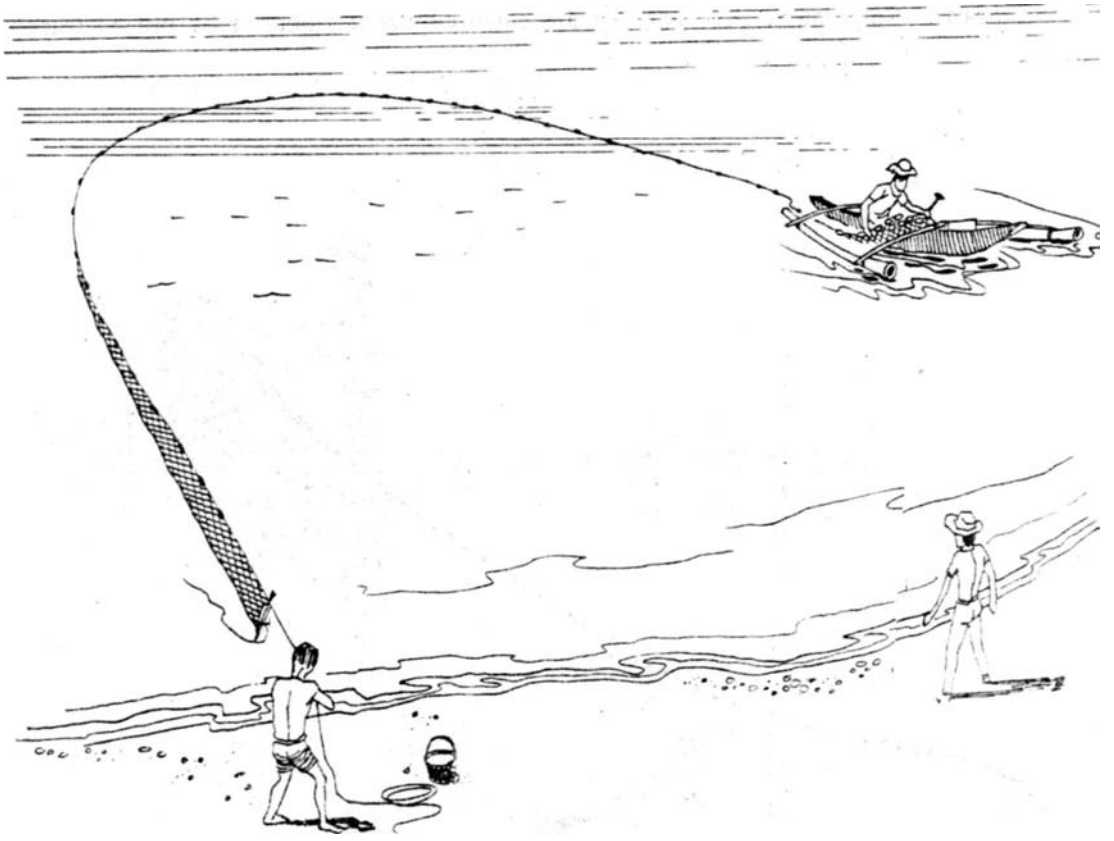

Fig. 30. Fry beach seine cast offshore and pulled back.

A similar beach seine with a conical bagnet (karukod) is operated in seagrass beds in Pangasinan to collect siganid fry.

9. *Encircling scare line and drive-in nets*

The scare line or "kalaskas" is made of coconut leaves, grass or plastic strips attached to a rope, and is used to drive the fry into shallower water or into a trap (Fig. 31). A floating scare line is used to encircle milkfish fry in shallow areas (common method in Indonesia), but lead sinkers are attached to scarelines used for prawn and siganid fry. The fry are caught by scoop nets or by pre-set traps.

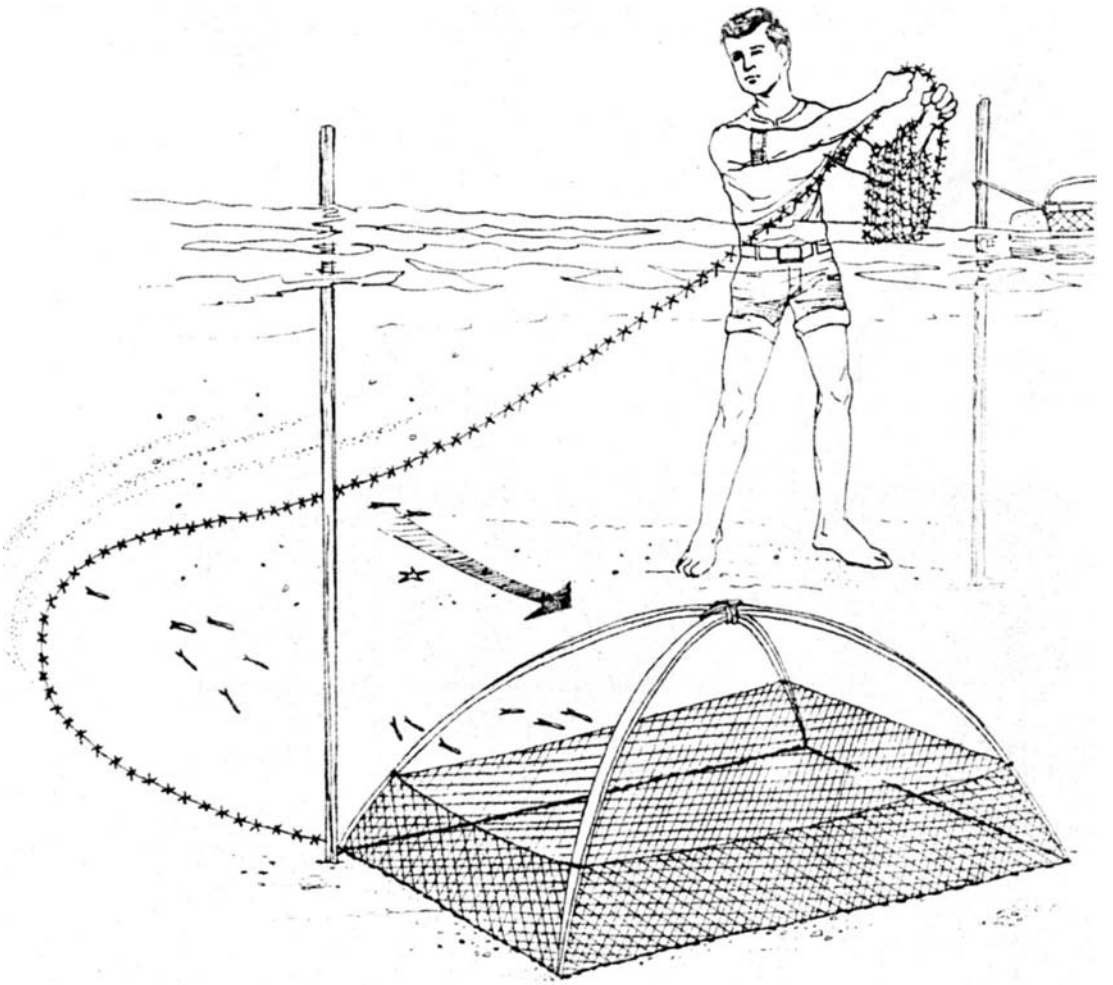

Fig. 31. Encircling scare line and drive-in net used for siganid fry.

VI. STORAGE OF FRY

A. GENERAL HANDLING PRACTICE

The catch from fry collecting gear usually consists of fish and shrimp larvae and juveniles, other animals and debris. The whole catch is brought to shore after capture and transferred to white basins to facilitate sorting and removal of debris (Fig. 32). A small white bowl is used to transfer and count fry from one container to another. Dead fry and unwanted species are discarded with the debris. If the accompanying organisms are too numerous, a cylindrical sorting device made of nylon netting is utilized. The device has mesh large enough to allow the desired fry to pass through and small enough to retain the unwanted species inside.

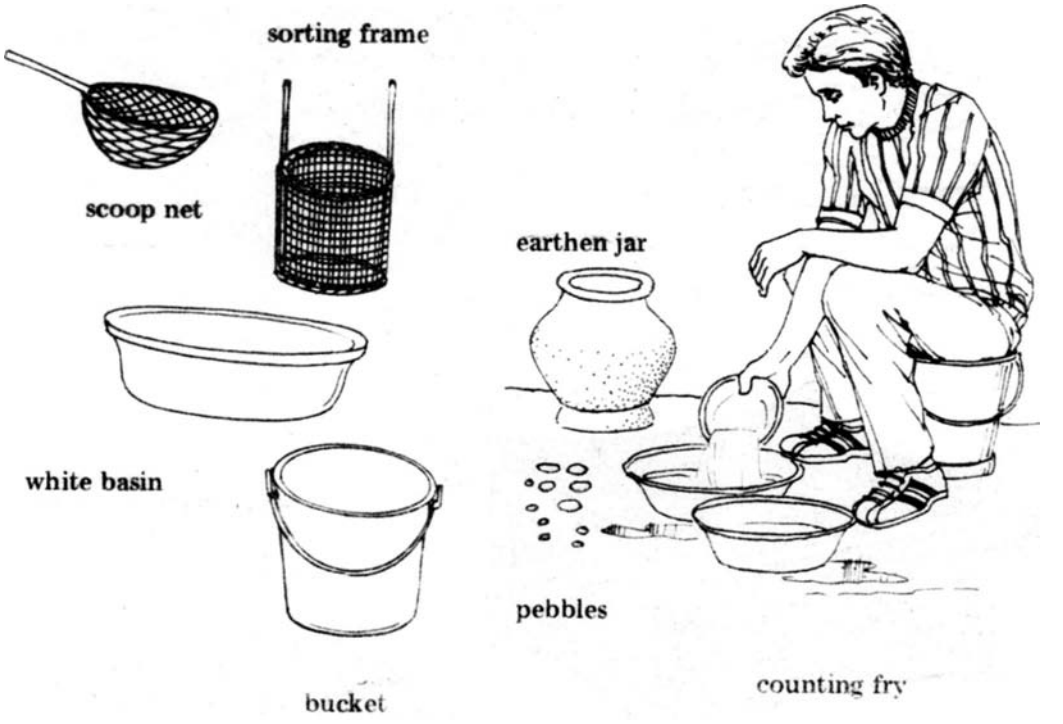

Fig. 32. General handling practice for fish and shrimp fry involves sorting, counting, cleaning, and storage.

The fry are counted each time they are transferred from one container to another and before and after purchase. They may be counted individually, but when numbers run into several thousands, counting is done with the aid of small pebbles, shells, and a counting board. One small pebble represents 100 fry while a large one represents 1000 fry. Another method of counting is by visual estimation. The density of fry in a container is compared with the density of fry of almost exactly known number in another container.

Since different fry have different behavior and environmental requirements, storage practices are slightly different although the materials used are similar (Fig. 33).

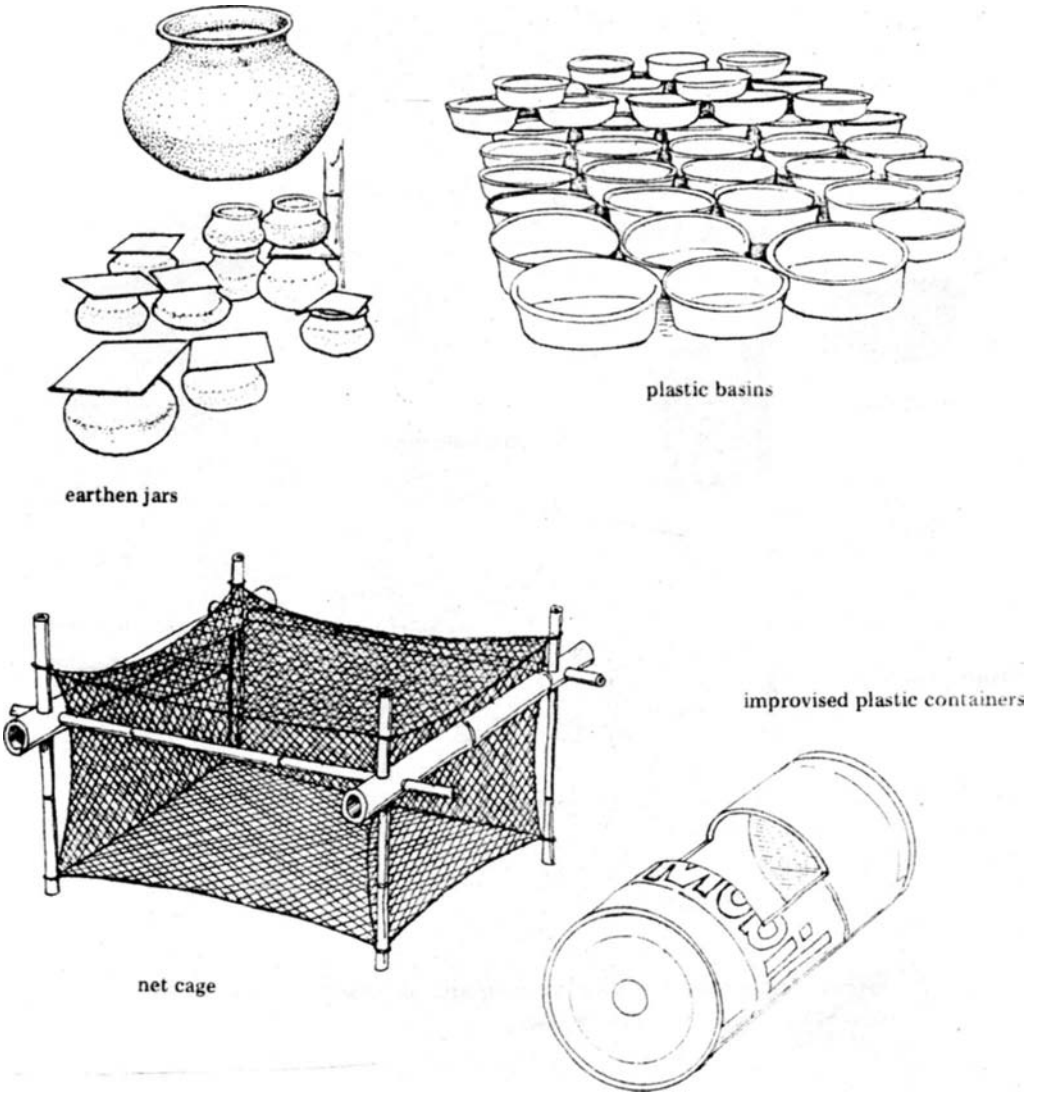

Fig. 33. Fish and shrimp fry are often stored in earthen jars and plastic basins. Net cage is used for siganid, seabass and shrimp fry. Perforated motor oil container is also used for shrimp fry.

B. STORAGE OF MILKFISH FRY

At the collector's house or storage facility, further sorting and removal of debris is done. The seawater containing the fry is diluted with about 4:1 freshwater. Further 4:1 dilution is done before overnight storage. The fry may be sold the next day and transported to the house or bodega of the concessionaire or dealer. The fry are stored in plastic basins or earthen jars at 4,000 to 6,000 fry per basin and from 2,000 to 3,000 fry per earthen jar. Containers are provided with covers to minimize disturbance to the fry and to prevent contamination. Hard-boiled egg yolk or fried flour is given to the fry daily or every other day, at a rate of about 3 g per 5,000 fry.

The storage containers are inspected and cleaned of excess food, dead fry, and debris every morning and afternoon. It is advisable to have a stock of clean water already mixed at the desired salinity level, 20-25 ppt, or approximately, 1 part fresh-to 1 part seawater, to replace water in the containers partially or completely, every day or every other day. When cleaning, the water is swirled to concentrate the debris at the center, and this is then scooped out by a bowl.

Storage practices for fry of different species are summarized in Table 3.

Table 3. Storage practices for the different species of shrimp and fish fry and juveniles.

Conditions	SHRIMP		SEABASS			SIGANIDS
	Fry cm (1.2-2.0 cm)	Juveniles (2.5 cm)	Fry (1.0-1.6 cm)	Fry (0.8-1.5 cm)	Juveniles (2-8 cm)	Juveniles (2.0-5.0 cm)
Type of container	plastic basin, earthen jar	plastic basin, earthen jar, floating net cage, cylindrical floating cage	plastic basin, earthen jar	plastic basin	floating cage	floating net cage
Water volume (1 liter) or size of cage	10-25 l	10-25 l 1x0.5x0.5 m 10 cm diameter by 1.8 m	10-25 l	20-25 l	1x0.5x0.5 m 1x0.5x0.5 m	1x0.5x0.5 m
Salinity (ppt)	26-32	26-32 estuarine (5-33)	10-25	10-25	estuarine (5-33)	estuarine (5-33)
Feeds and feeding	egg yolk everyday chopped fish no feeding	egg yolk everyday	egg yolk or wheat flour daily	egg yolk everyday	chopped fish daily	filamentous algae daily
Water management	complete or 50% volume change daily	complete or 50% volume change daily	complete or 50% volume change daily	complete or 50% volume change daily	flow through	flow through
Stocking rate (number/ container)	500-1,500	300-800 300-800 1,000-5,000 500-600	3,000-6,000 2,000-3,000	500-2,000	500-1,000	500-1,000
Days of Storage	1-7	1-7	1-7	1-5	1-7	1-10
Mortality (%)	5-50	5-50	2-10	2-10	2-10	2-5

Fry stored more than two weeks are, as a rule, weak and will hardly survive when stocked in the nursery ponds. The condition of the fry may be determined by the following method:

1. Observe the fry closely. Strong and healthy fry circle continuously in the same direction. If the fry do not do so, they are weak.

2. Swirl the water. Healthy fry swim against the current.

3. Tap the container or move a hand over it. Fry which react with quick avoidance movements are in good condition.

Some dealers keep milkfish fry alive and in reasonably good condition for one month or longer by storing them in earthen jars at low stocking densities of a few hundred fry per container.

C. STORAGE OF SIGANID FRY

Upon capture, siganid fry are stocked in floating cages (dimensions 1 x 0.5 x 0.5 m and mesh 5 mm). They are later sorted and counted and stored for 5-10 days in these floating net cages set in protected areas. About 500-1000 fry may be stocked in one cage, depending on size. Filamentous green algae like *Enteromorpha* sp. are fed daily to the fish. If not fed, siganid fry resort to cannibalism.

D. STORAGE OF SEABASS FRY

The general storage practice for seabass is similar to that for milkfish fry except that the stocking rate is only 500 to 2,000 fry per basin. Seabass juveniles are stocked in floating net cages similar to that for siganids. Care is taken to sort seabass according to size to minimize cannibalism during storage. Small live or chopped fish and shrimps are given as feed. Stocking density is 500-1000 juveniles per 1 x 0.5 x 0.5 m cage.

E. STORAGE OF SHRIMP FRY

Storage and handling methods for shrimp fry are similar to those used for milkfish fry, except that the storage medium is not diluted with freshwater. About 300 to 2,000 shrimp fry may be stored in plastic basins or earthen jars filled with 15-30 liters of water. Hard-boiled egg yolk is given as feed.

Shrimp fry may also be stored in floating net cages of appropriately small mesh at 1,000 to 5,000 fry per cage. Perforated plastic (motor oil) containers are sometimes used (Fig. 32); these can accommodate from 500 to 600 fry.

Minimize disturbance during storage, because shrimp fry may jump out of the water and get struck dry on container walls. They should be disposed of as early as possible to minimize mortality due to cannibalism.

F. CAUSES OF FRY MORTALITY DURING STORAGE

1. Physical injuries sustained during collection and handling (sorting, counting, cleaning)

2. Overcrowding

3. Water fouling (high bacterial content) due to decomposition of excess food, dead fry, feces, and debris

4. Temperature and salinity shock

5. Starvation

6. Predation and/or cannibalism

7. Too long storage (longer than one week)

G. WAYS TO MINIMIZE MORTALITY DURING STORAGE

1. Remove debris and unwanted species before storage.

2. Fry should not be taken out of the water nor injured.

3. Sort, count, and store fry in the shade.

4. Keep storage containers in a cool, dark, and quiet place to avoid disturbance to the fry.

5. Allow a period of rest of about three hours in between manipulation to enable the fry to recover from stress.

6. Dispose of fry as early as possible.

VII. TRANSPORT OF FRY AND FINGERLINGS

A. GENERAL PRACTICE

The fry or fingerlings are not fed for at least two hours prior to transport. They are placed in containers with clean water of similar salinity and temperature as that in which they had been stored. They are then counted, usually by visual estimation in small lots. Freshwater may be added to reduce the salinity to 12-20 ppt (1-2 parts freshwater to 2 parts storage water) when transporting milkfish and seabass, but not when transporting siganid and prawn. Water temperature is left at ambient (26-30°C) if the number and/or size of fry is small and transport time does not exceed 6 hours. At higher stocking densities, bigger fry sizes, and longer transport times, temperature is reduced to 20-22°C. Lowering of the water temperature is done by placing in the transport medium a small plastic bag of ice (use of bags prevents reduction in salinity). Care should be taken that the temperature does

not drop below 20°C. The desired number of fry are poured into double plastic bags (Fig. 34). Oxygen is introduced at a volume equal to or twice that of the water in the bag. The plastic bags are then placed inside *pandan* bags in case of land transport, or in cardboard and styrofoam boxes for air shipment or long duration transport. Ice wrapped in newspaper may also be placed on top of the plastic bags of fry to maintain low temperature during transport.

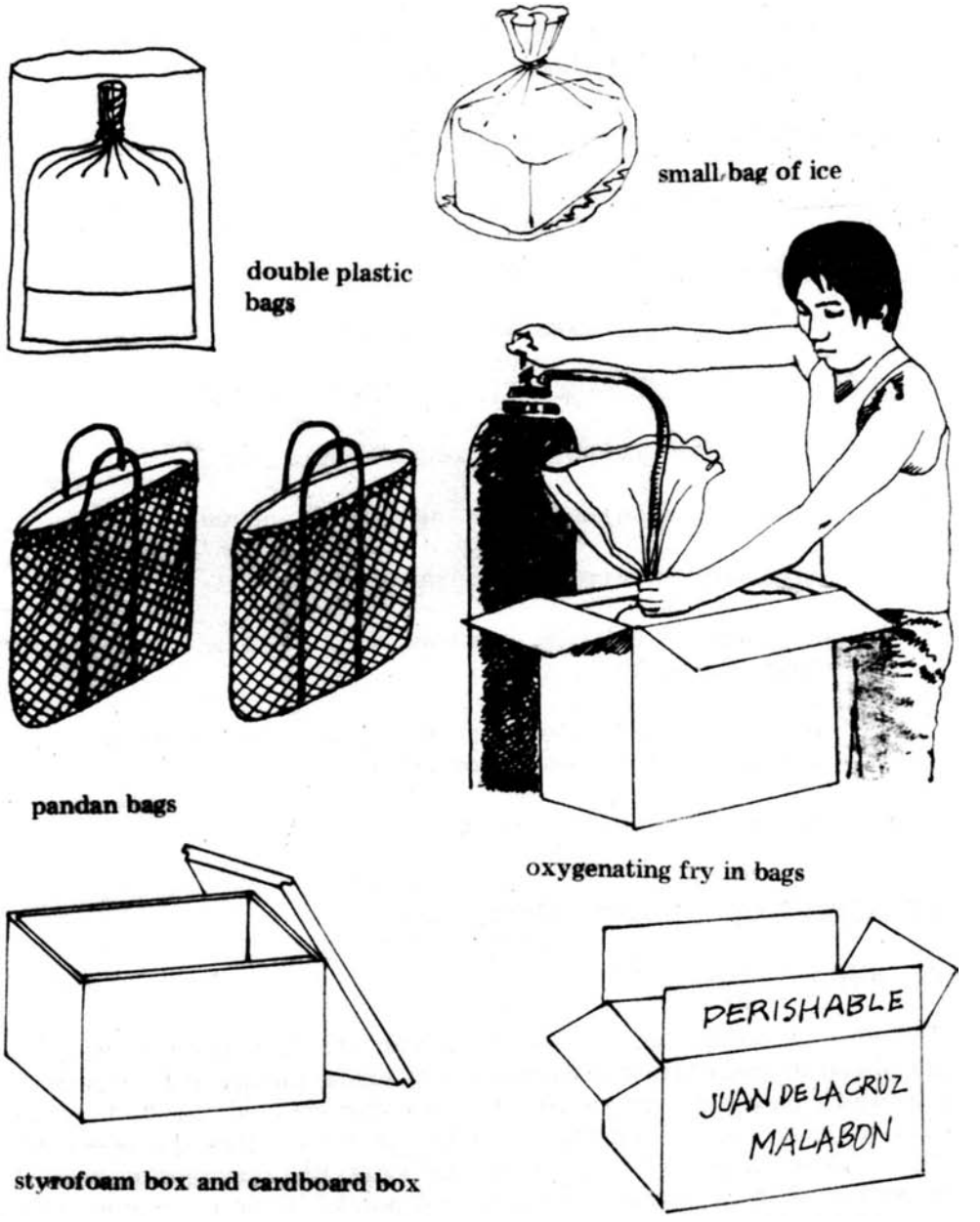

Fig. 34. Fry to be transported are placed in double plastic bags, to which oxygen is added. These bags are placed in pandan bags for short distance transport, or in styrofoam boxes and cardboard boxes for long distance transport. Small bags of ice are placed in transport containers to maintain low temperature.

Another way of transporting milkfish fingerlings is by means of a live-fish boat (petuya). The boat has a flat bottom serving as the fingerling compartment, and 1-3 holes for free entrance of water. A water pump is used to change the water in the compartment. When passing through muddy or polluted waters, the holes are plugged and the pump recirculates the water inside. For juvenile shrimp the cylindrical floating cage used for storage may be utilized for transport over water: it is simply towed to its destination.*

B. CAUSES OF MORTALITY DURING TRANSPORT

1. Physical injuries

2. Overcrowding due to high number or large size of animals transported

3. Oxygen depletion due to leakage of plastic bags, delays in transport, decomposition of debris, high bacterial count of transport water.

4. Thermal stress due to high (30°C) or low (20°C) temperature

5. Accumulation of toxic waste products like ammonia in the water

C. WAYS TO REDUCE MORTALITY DURING TRANSPORT

1. Acclimate the fry to lower salinity before transport. The acclimation salinity should not be more than 5 ppt difference from that of the storage or pond salinity at the destination.

2. Do not feed the fry for at least two hours before transport.

3. Transport only healthy fry.

4. Allow the fry to recover from handling stress for at least 12 hours before transport. This would increase their resistance to subsequent stress.

5. When water temperature has to be lowered, it should be clone gradually, approximately 1°C per minute, and should not go lower than 20°C.

6. Avoid unnecessary handling and transfer of fry. The stocking density in one transport bag should not exceed the stocking capacity of a subsequent container.

*Transport practices are summarized in Table 4.

Table 4. Transport practices for the different species of shrimp and fish fry and juveniles.

Conditions	SHRIMP		MILKFISH		SEABASS		SIGANIDS
	Fry (1.2-2.0 cm)	Juveniles (2.0-5.0 cm)	fry (1.0-1.6 cm)	Juveniles (3.0 5.0 cm)	Fry (0.2-1.5 cm)	Juveniles (2.0-8.0 cm)	Juveniles (2.0-5.0 cm)
Container	plastic bag in pandan bag, plastic bag in styrofoam box (low temperature)	plastic bag in pandan bag, plastic bag in styrofoam box, floating cylin-drical cage	plastic bag in pandan bag, plastic bag in styrofoam box (low temperature)	plastic bag in pandan bag, plastic bag in styrofoam box live-fish boat	plastic hag in pandan bag, plastic bag in styrofoam box	plastic bag in pandan bag, plastic bag in styrofoam box	plastic bag in pandan pandan bag
Water volume (liters)	2.5-10	5-10 depends on size of cage	4-10	10-15 6,000-8,000	5-10	5-10	5-10
Salinity (ppt)	20-32	10-25 depends on river salinity	12-22	10-35 2-10 depends on the salinity along the way	10-30	5-30	5-30
Stocking rate (number/ container)	800-1,000 1,500-5,000	200-600 600-1,500 500-800	4,000-6,000 6,000-8,000	200-500 500-1,500 50,000-120,000	1,000-2,000	200-00	200-500
Transport time (hr)	2-6 6-10	2-6 6-10	2-6 6-12 1-2	3-5 6-8	2-6 6-8 4-5	2-6 6-8	2-6
Mortality (%)	2-5	2-5 negligible	2-6	1-10 0.5-2	1-10	1-10	1-10

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