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THE PREPARATION AND MANAGEMENT OF BAÑGOS [1] FISHPOND NURSERY IN THE PHILIPPINES [2]

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TEN PLATES AND EIGHT TEXT FIGURES

INTRODUCTION

The pond fisheries of the Philippines are concerned primarily with the cultivation of bañgos, or milkfish, *Chanos chanos* (Forskål). At present about 70,000 hectares of bañgos fishponds are scattered throughout the Philippine Archipelago, representing an investment of almost three hundred million pesos. These ponds annually produce approximately 24,500,000 kilograms of fish valued at nearly forty million pesos.

Just when the first fishponds were built in this country cannot be definitely ascertained, but this industry is old, presumed to have been started along the shores of Manila Bay. Although it has not developed along the scientific process of investigation, the industry has attained a high state of development. This has been the result of long years of experience of our fishpond caretakers as evidenced by the fact that certain phases of this fishery have become highly specialized and attained the importance of industries in themselves such as (*a*) the bañgos fry industry; (*b*) the management of the bañgos fishpond nurseries; (*c*) the management of the rearing pond system; and (*d*) the commercial handling of marketable bañgos.

[1] Bañgos is the local name for milkfish, *Chanos chanos* (Forskål).

[2] This paper was presented by the Philippine Delegation before the second meeting of the Indo-Pacific Fisheries Council held at Cronulla, N.S.W., Australia, April 17–28, 1950.

The bañgos fishpond nursery as a unit consists of a series of neatly arranged, relatively small, shallow ponds devoted exclusively to the rearing of milkfish fry and fingerlings. In actual practice, fishpond owners or caretakers may manage their nursery ponds exclusively as a unit, or they may operate them as a subunit of a fishpond system devoted to the cultivation of the bañgos from the fry stage to the marketable size. Because of the great profit derived, a number of caretakers devote their lifetime to the operation of nursery ponds to grow fingerlings exclusively as a unit. These nurseries, centrally located in Barrio Dampalit, Malabon, Rizal Province, Luzon, provide a steady supply of fingerlings for extensive areas of rearing ponds but without nursery ponds in Rizal, Bulacan, Pampanga, Bataan, and Cavite Provinces. The nursery as a subunit of a complete system is present in newly developed areas located far from Dampalit, especially in northern Luzon, the Visayas, and Mindanao. In any kind of unit system mentioned above the nursery ponds are operated with special care and management necessary for their maintenance.

SELECTION AND LOCATION OF A NURSERY SITE

Water supply.—A good site for nursery ponds should be accessible to water supply of tidal origin that is adequate throughout the year and free from pollution. Salt water coming directly from the sea may serve, but brackish water from tidal streams is preferable.

Drainage.—It is essential that the nursery pond site is capable of drainage as often as desired, even under ordinary tide conditions. This factor is important, because during certain periods of the year the ponds are drained and dried to eradicate all fish enemies and also to provide ease in working the pond bottom. Such preparations promote the luxuriant growth of the plankton food of fish once water is allowed in the ponds after the drying process.

Soil.—Before nurseries are constructed it is essential that the soil be closely examined to determine whether or not it is favorable. Clay loam, sandy clay, or clay with rich deposits of organic matter is the best soil for the nursery ponds. Hard mud of the above types are preferable to the soft and very loose kind. Sandy, rocky, or stony soil should be avoided as this would not retain water in the ponds and thereby retard the growth of the natural food. Areas with very thick deposits of organic debris are also to be avoided.

Topography.—Level marshes, swamp lands, or tidal flats are the best sites for nursery ponds. If the topography is too undulating, a great deal of leveling has to be done entailing great expense. Besides, excavation work removes the surface layers of the soil which are usually the most fertile portions of the pond bottom. Digging also often inhibits the growth of the natural food.

Vegetation.—Sites that are thickly wooded or forested are too costly to clear and prepare for ponds. Instead, clear areas or those with scanty vegetation should be selected.

Freedom from floods.—Sites that are periodically flooded are to be avoided as the fish under cultivation may be washed away. Flooding and its bad effects can be minimized if dikes are so constructed as not to obstruct the path of rivers. Fishpond caretakers have experienced that areas nearer the sea are safer from the hazards of floods than those further inland.

Availability of bañgos fry and rearing ponds to be stocked.—Nursery pond units devoted to raising bañgos fingerlings need a sufficient supply of bañgos fry from a nearby fishing ground during the year. A good return from one's investment is assured whenever the nurseries are located in the neighborhood of extensive rearing pond areas to be supplied with fingerlings.

LAYOUT AND CONSTRUCTION

Size of ponds.—In the foregoing account the nursery ponds are referred to as relatively smaller in area than the other ponds in the system. The variation in size of nursery ponds ranges from as small as 500 square meters to as big as 5,000 square meters. The ideal ones range from 1,000 to 4,000 square meters. The next series of ponds, the transition, or stunting, ponds, locally called the "impitan," or "bansutan," usually averages 10,000 square meters or one hectare in area. The rearing ponds, locally called "kaluangan," are large ponds for growing bañgos to marketable size. They vary in size from 10,000 to 150,000 square meters, or from 1 to 15 hectares.

Many advantages are derived from the small-sized nursery ponds. Water control which is essential will be effective in these ponds; leveling and cultivation of the pond bottom and the eradication of fish enemies will be easy. Artificial feeding, when resorted to after the natural food in the ponds has been consumed, can be done easily. Likewise, the fingerlings can be confined and caught easily.

Too small ponds or those less than 500 square meters are also disadvantageous, for their maintenance requires too much expense, besides much space which can be made available for the fish is covered by unnecessary dikes. Small ponds also make the fish an easy prey for predators, whereas larger ones provide bigger space for them to escape from their enemies. Furthermore, the smaller ponds lead to an early stunting of the fish in the process of cultivation, whereas the larger ones are conducive to further growth.

Types of layout.—The first type is a model bañgos fishpond nursery project for the exclusive cultivation of fry and fingerlings (text fig. 1 and Plate 1, fig. 2). This type consists of the following parts: (1) the nursery pond proper, locally called "pabiayan," or "palakihan," or "semillahan," including its pipes and gates; (2) the catching pond called "kulungan"; (3) a few transition ponds called "impitan", or "bansutan"; and (4) an elaborate system of water supply canals or "sangka." In practice the area adjacent to the tidal stream is devoted to the transition ponds. This arrangement prevents the fry from escaping through leaks on the main dikes and also utilizes these deeper areas to advantage. Late in the season these ponds may also serve as rearing ponds, or "kaluangan," for growing some of the left-over fingerlings to marketable size.

A large and firm main dike is constructed along the tidal stream together with the main water control gates which are often made of concrete. This type of gate is so placed that it opens directly on the path of the water supply canal that extends between the series of nurseries. This canal can supply water to a series of ponds on both sides or only along one side of it.

The size of the nursery ponds of this type usually is uniform. Every two of these ponds are often provided with a common catching pond, or "kulungan" (Plate 5, fig. 1). The catching pond varies in area from 20 to 50 square meters. To prevent the fry and fingerlings from escaping, the nursery ponds are provided with a number of small nursery wooden gates and pipes. Usually only a pipe links the nursery water supply canal with the catching pond. Gates connect the catching pond with the nursery pond proper, but pipes are usually installed near them (Plate 5, fig. 2) to minimize the escape of fry or fingerlings during the early stage of cultivation.

The second type is the commercial nursery pond project (text fig. 2). In this type the area and topography of the site

available must be suitable to the layout of the ponds to be constructed. The ponds adjacent to the tidal stream are usually used as the transition, or stunting, ponds. Sometimes, instead of a water supply canal provided for the nursery ponds, a head pond is used. The head pond is the deepest portion in the system. It serves as a water reservoir and as

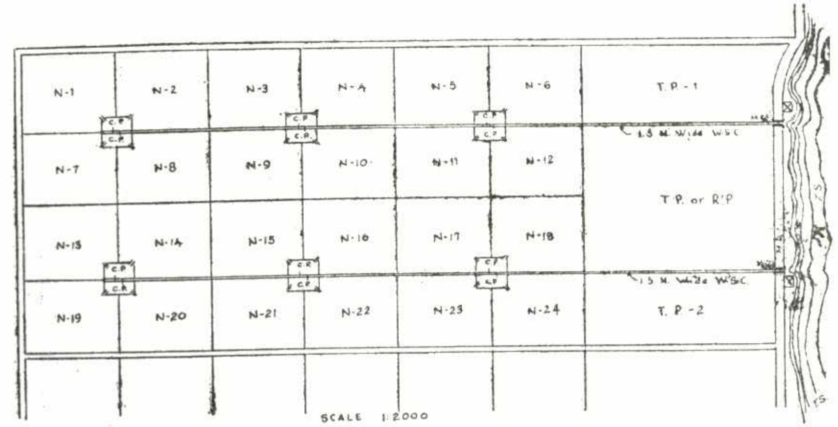

FIG. 1. Model layout of a 6½-hectare Bañgos Nursery Pond System

LEGEND:

N—Nursery pond (*palakihan, pabiayan, semillahan*)
T.P.—Transition or stunting pond (*impitan, bansutan*)
R.P.—Rearing pond (*kaluañgan*)
C.P.—Catching pond (*kuluñgan*)
M.G.—Main gate
M.D.—Main dike
T.S.—Tidal stream
W.S.C.—Water supply canal
—Nursery gate
—Water pipe from W.S.C.
—Caretaker's hut

catching pond for the big bañgos. In this type of layout every two nursery ponds are provided with a catching pond. Nursery gates and pipes are used in similar manner as in the first type described above.

The third type is a combination or a complete self-sustaining bañgos fishpond project (text fig. 3) consisting of three units of ponds, namely, the nurseries, the transition ponds, and the rearing ponds. When such a project is desired the area for the nurseries might be set aside such that the fingerlings it could supply would be just enough for the whole year required stock of the two other pond units. To do this it is estimated that the size of the nurseries should be 1 per cent; the transition ponds, 9 per cent; and the rearing pond, 90 per cent of the total area of fishpond site. Often many of these complete systems have nurseries that raise more than what the other units of the project can use. This is practiced in places where there are extensive rearing pond areas to which the rest of the fingerlings produced can be sold.

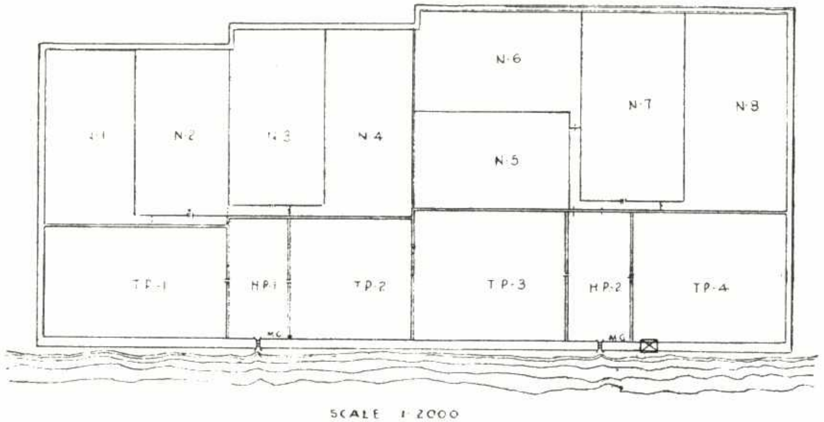

FIG. 2. Commercial fishpond layout for a 5½-hectare Nursery Pond System. H.P.—Head Pond

Dikes.—The main dikes which enclose the project are constructed higher than the highest tide ever experienced in the locality. Typical of fishpond dikes, they consist of a wide base that forms a slope upwards to the top known as the crown. The usual slope of these dikes is about 1.5:1 to 1:1 (base: height). Steeper slopes are subject to erosion while extremely gradual slopes cost a great deal to construct and result in unnecessary waste of space. The main dike along the tidal stream should be the firmest in the system and should be given special care. A generous allowance along the bank of the stream of at least five meters from the base of the main dike should be allotted. This will minimize erosion which is often the cause of undue losses of fish under cultivation.

The secondary dikes form the partition for the different ponds and the system of water supply canals. In a nursery pond project these dikes are smaller than the main dikes and usually steeper in slope. These dikes may have a base

of 2 to 3 meters rising to about one meter in height with a crown of one meter or even a little less. These are well tended and cleaned, and leaks and seepage in them are checked from time to time. They undergo repair at least once a year.

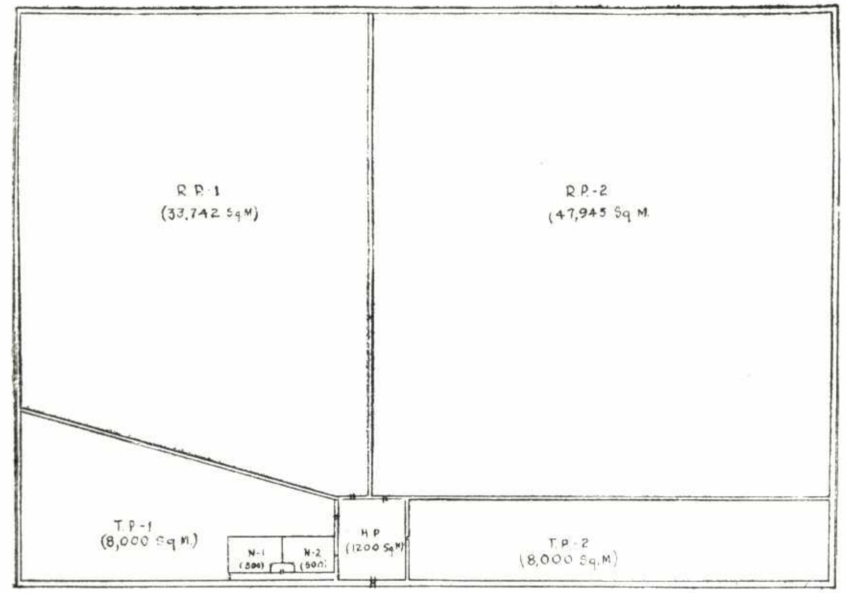

FIG. 3. Model layout of a combination fishpond system showing the relative areas for a 10-hectare project.

Gates and pipes.—The main water control gate is made of concrete or of adobe bricks reënforced with concrete (text fig. 4 and Plate 2). It is located along the main dike, usually in the deepest portion of the pond system. In order to safeguard subsidence of its foundation and future destruction, pilings of bamboo trunks or wood posts are driven in the place where such gate is to be installed. The flooring of the gate is made of stones and concrete and often reenforced with steel bars placed over the pilings. The sides which are about one meter apart rise vertically all the way across the main dike with their outer edges curving outward to form the wings of the gate. This gate is provided with three grooves. A center groove, which is made of first-class wood inlaid into the concrete side of the gate, is used for the wooden sluice gate slabs. The two other grooves, shaped on the concrete sides on both extremities of the gates, are for the screens which are made of bamboo splits attached to a wooden frame.

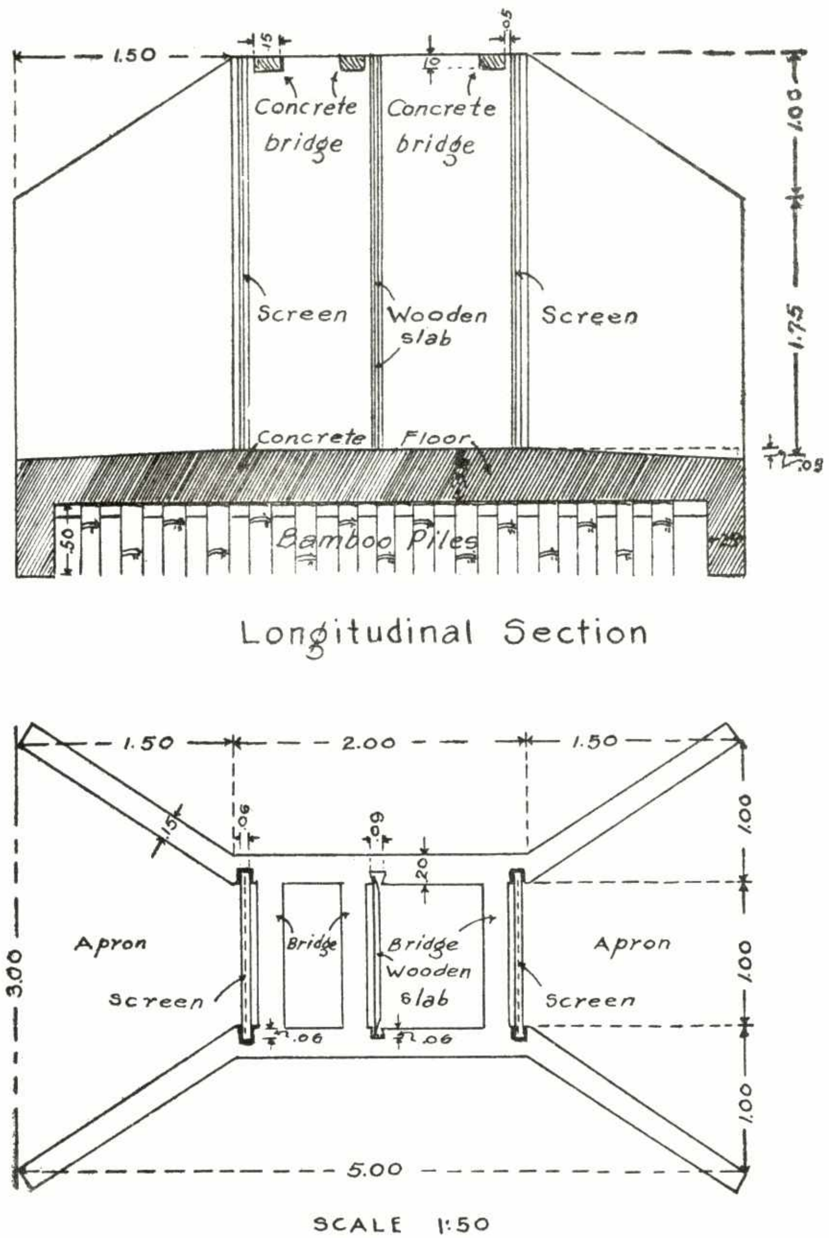

FIG. 4. Details of a main water control gate.

The gates leading to the rearing, transition, and nursery ponds are made of wood (text fig. 5 and Plate 3). These are designated as secondary gates. They are similar in pattern to the main gate except that they are made of wooden pieces nailed together. Three grooves are likewise provided for these gates, a center one for the wooden slabs and two on the edges for the screens.

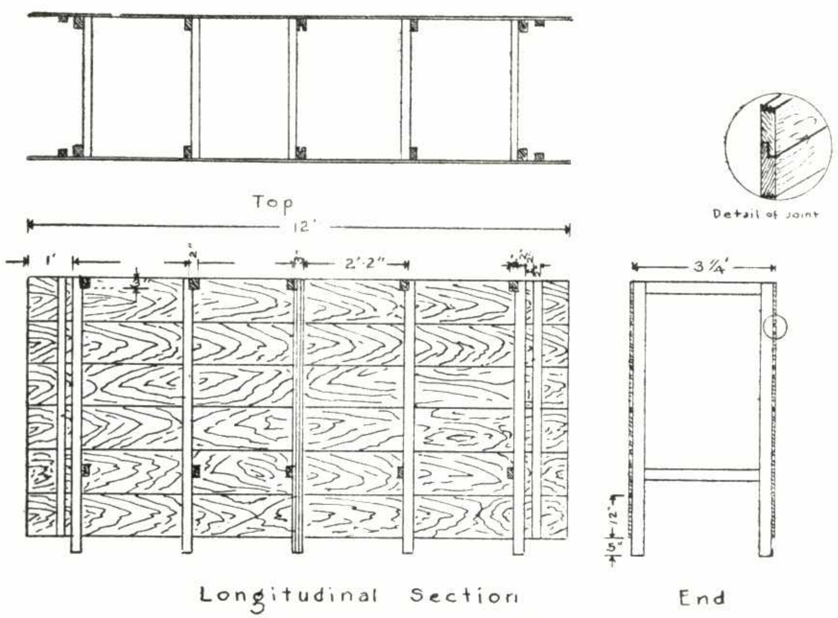

FIG. 5. Details of secondary wooden gate.

Pipes are sparingly used in the nursery ponds because with them the control of the entrance or the exit of fish is better provided. Usually a pipe instead of a gate is used to connect the nursery water supply canal with the nursery catching pond. One or two pipes may also be installed alongside the wooden gate connecting the catching pond with the nursery pond proper.

Pipes used are either quadrangular or cylindrical. Quadrangular pipes (Plate 6, fig. 2), are made by nailing together four pieces of boards. This pipe should be long enough to traverse the base of the dike and protrude about 1/2 meter on both ends. On these exposed ends two grooves are provided near each other. The outer grooves are used for the screens which may be made either of bamboo splits or of fine wire screen attached to a wooden frame. The inner grooves are for the single-piece wood slabs.

Cylindrical pipes are made of wood or of concrete. Those made of wood are trunks of certain palm trees such as the "anahao," *Livistonia* sp. (Plate 10, fig. 2). In making these pipes the trunks of these palms are cut into desired lengths usually varying from 3 to 6 meters. First a hole is bored through the trunk by means of a long-handled drill. Then this hole is enlarged to the desired bore by a gouge which is attached to a long handle. The opening of the pipes varies from 15 to 30 centimeters in diameter and the thickness of the edges left after making the pipe hole usually averages about 3 centimeters. This type of pipe is closed by a solid piece of wooden plug especially made for the purpose. This pipe plug has a cylindrical portion fitting into the pipe to be closed, an enlarged middle portion serving as the knob and an outer flattened structure with a hole bored perpendicularly to the longer axis of the entire piece. Through this hole is inserted a pole or stake stuck to the substratum in order to keep the plug in place when closing the pipe.

Recently concrete cylindrical pipes (Plate 10, fig. 3) have been introduced. These are closed by concrete plugs which fit into the exposed ends of the pipes. While these are more lasting than other kinds of pipes, their weight makes them difficult to install and to handle.

Both of these types of cylindrical pipes are provided with an elongated trap-shaped screen made of bamboo splits, the "galao." When the pipes are to be used their plugs are removed and the "galao" are fitted instead over the protruding ends of the pipes (text fig. 6 and Plate 5, fig. 2).

Provision for better water renewal and circulation.—Proximity to the water supply is essential in a nursery pond project for it provides ease in the renewal and circulation of pond water. This should be considered during the construction of the nursery ponds which should be located as near as possible to the main gate. In instances when the nursery is quite far from the water source a water supply canal is generally constructed leading to the main dike along the tidal stream. This in turn receives new supply of water from the outside by a pipe through the main dike. The use of one catching pond for every two nursery ponds is a good provision for better water circulation. The practice is to put temporary cut through the middle partition dike at its farther extremity so that if water is admitted through one gate and let out

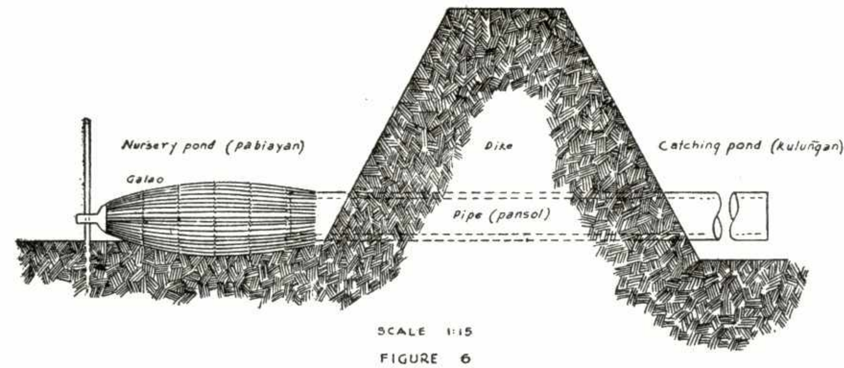

FIG. 6. A cyclindrical pipe with the "galao."

through the other a complete renewal of the pond water is amply provided (text fig. 7).

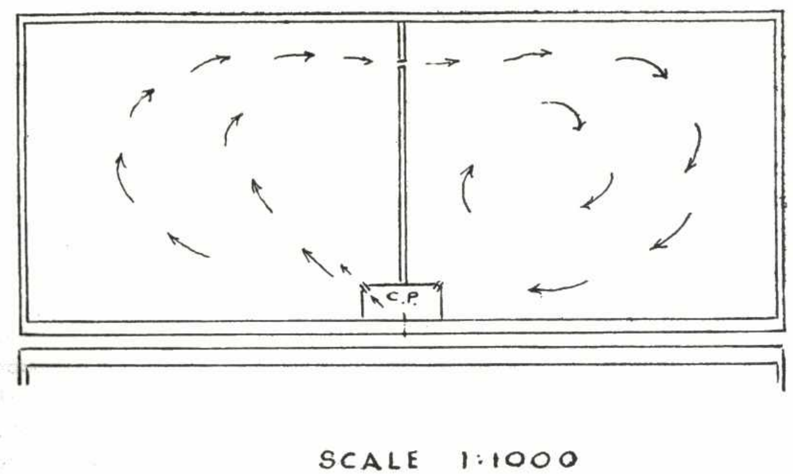

FIG. 7. Provision for effective water circulation in the nursery ponds.

The idea of having a head pond especially if this is deep and large is another provision for insuring a good supply of new tidal water for the ponds. Water stored in the head pond during the spring tides are used to renew the nursery pond water during the neap tides when the water in the stream especially in small and winding creeks is often turbid or contaminated. Sometimes the adjoining transition ponds if devoid of fish are also used as water reservoirs.

PREPARATION OF THE NURSERY PONDS BEFORE STOCKING

Cultivation and leveling of the pond bottom.—Within two months or so, before the arrival of the new supply of bañgos fry for the year, the nursery ponds are cleaned of its old stock of fish. This provides ample time for the preparation of these ponds before stocking. As soon as the caretaker is ready to work on these ponds he drains them during the low tide. The bottom of each pond is immediately worked before it gets dried up and hardened. This is accomplished by stirring or cultivating the pond bottom with a shovel or a rake. By tilling the soil and turning it over the nutrients in the subsurface layers are made available at the surface. The eradication of fish enemies and the destruction of undesirable pond weeds are also achieved during this process.

The cultivation of the substratum makes the mud loose and soft for the leveling that follows. Every season the nursery ponds are meticulously leveled. This is done with the use of especially made wooden rakes (text. fig. 8 and Plate 4, fig. 2)

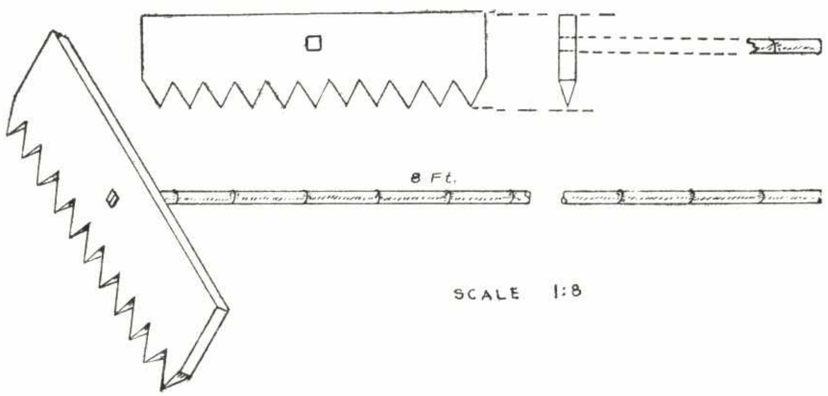

FIG. 8.—A wooden mud rake.

attached to bamboo or wooden pole handles. The purpose of leveling is to make the topography of the pond bottom slope very gradually from its farther extremities down towards the gate which is the deepest portion of the pond. All elevations, holes, and depressions on the pond bottom are leveled off.

Many nursery fishpond caretakers make a canal within the nursery pond that runs from the gate diagonally towards the opposite corner. Such a canal also slopes and gradually deepens towards the gate. This canal system serves as refuge for the fingerlings during hot days and also renders space for confining of fish when it becomes necessary to catch them prior to their transfer. On the other hand, if the pond is gradually sloping on all sides, oftentimes due to the carelessness of the caretaker, it may become completely dried thus causing wholesale death of fish. Whereas if there is a canal present, this serves as refuge for the fish. One disadvantage, however, of this specially made canal is that many fish enemies live in them which later on do harm to the young bañgos once the nurseries are stocked.

Draining and drying the ponds.—The next step in the preparation of the nurseries is to drain and dry the ponds. Nursery ponds that have been properly leveled and cleaned when drained of its water appear like a well-tended tennis court. The nursery ponds are exposed to dryness for a period of two or three days at the beginning before water is let in. This procedure may be repeated two, three, or more times, to induce the burrowing fish enemies like the mudfish or "dalag," *Ophicephalus striatus*, and certain eels to come up to the surface to die. Later the ponds are finally drained and allowed to dry for a longer period until the bottom soil cracks with dryness (Plate 4, fig. 3).

Thorough drying of the pond bottom has several advantages. The fish enemies and competitors are eradicated completely. Snails and other bottom living organisms which may hinder the luxuriant growth of the natural food of young bañgos are killed. Exposing the pond bottom to dryness may hasten the chemical decomposition of the deposits of organic matter, making them available as nutrients for the growth of the fish food. Soil fertility is, therefore, renewed by this process.

Checking dike leaks and seepage.—Before the beginning of the culture period, that is, before the arrival of the bañgos fry the dikes are cleaned and repaired. All the grasses and other vegetation growing on the fringes of the dikes are cleaned. Eroded portions of the dikes are patched (Plate 4, fig. 1). If there are leaks and excessive seepage through these dikes, complete repair may be necessary. Leaks and seepage can be detected by causing an inequality of the water level within the pond and outside of it. First the ponds are drained at low tide and the gates are then closed. During the next incoming high tide, water is introduced through the main water control gate so that the canals and ponds around the nursery system are flooded with water to slightly below the crown of the nursery dikes. This process could be done the other way, that is the nursery ponds are filled with water as high as possible during high tide. The gates are closed and when low tide sets in, the water outside the nurseries are reduced to the minimum. By means of the two methods described, leakage through the dikes or excessive seepage at certain portions can be easily detected.

The remedy for leaks and excessive seepage of the dikes is to make a puddle trench or "mecha" at the segment of the dikes that are defective. The puddle trench may be an excavation about 30 centimeters wide and 50 centimeters or more deep running along the dike. It may be made at the center of the dike, towards one side, or two puddle trenches dug on both sides of the dike under repair. The puddle trench is long enough to cover the entire seepage area and sufficiently deep that it may go beyond the general level of the pond floor or the adjacent water supply canal. This trench is filled with new mud or soil which should be well settled and not in big blocks of mud in order to give a firm line of earth in this renewed dike. Sometimes if the nursery dikes are badly worn out the entire nursery dikes are repaired throughout their whole length. In this process all holes and leaks are filled with new soil and burrowing organisms such as crabs are caught and eliminated.

Screening and closing the gates and water pipes.—After thorough drying of the ponds, water is let in to allow the growth of the natural food. Utmost precaution is exercised so that the gates and pipes are properly screened and closed with the necessary materials. Screens are of fine bamboo splits and they are further covered with abaca fiber cloth or "sinamay." This is done before stocking the ponds and during the early part of the cultivation period.

The pipes are also properly closed and screened as soon as water is allowed into the ponds. The cylindrical pipes are very effectively screened by the "galao" which fits over the protruding end of the pipe (text fig. 6 and Plate 5, fig. 2). Before stocking the ponds and during the early part of cultivation this "galao" is further coated with abaca fiber cloth. So effective is the screening of these pipes that they are almost exclusively used during the early part of cultivation. The gates which were diked at the start of the operation are opened later when the fry have grown to the fingerling stage.

Water management in the nursery ponds before stocking.—There are certain important features in the water management of the nursery ponds during the period when the natural fish food is being grown until the fry are ready for stocking. As soon as water is allowed into the nurseries after the drying period, the depth of the water should be maintained to a level just enough to cover the entire floor of the pond bottom or an average depth of from 3 to 5 centimeters. Within three days to a week under this condition the development of the fish food at the bottom floor becomes evident. As the growth of the natural fish food continues to become thick it becomes necessary to provide a corresponding and gradual increase in the average depth of the pond water in order to obtain maximum productivity.

During this period renewal of the pond water with new tidal river water should be done once or twice a week when possible or at least once in two weeks. Renewal of the pond water is made in such a manner that the current of the incoming or outgoing water would not cause too much stirring of the pond bottom. This can be attained by not causing a big range of difference in the water level inside and outside the pond and also by having the gates and pipes properly screened.

A process known as washing the nurseries is undertaken before the fry are stocked. It consists of the renewal of the pond water at repeated and frequent intervals as the tides permit, the purpose of which is to have a complete change of the very saline nursery pond water with new tidal water. High salinity is sometimes indicated by actual crystallization of salt along the shoreline of the ponds. The repeated water renewal washes out this salt and provides new water that is brackish, clear, and well oxygenated which is very essential for the proper growth of bañgos fry.

The growing of lab-lab.—"Lab-lab" is a vernacular term for the brownish, greenish, or yellowish crust of microbenthic fauna and flora of the pond floor. It is the natural food of the fry and fingerlings under cultivation.

Lab-lab is really a "microbenthic biological complex" instead of what it used to be called a "plant complex." The plant components are exemplied by various forms of bacteria, unicellular and filamentous blue-green algae (Myxophyceae) especially those belonging to the family Oscillatoriaceae, numerous diatoms, and fragments of various filamentous green algae. The animal components of lab-lab which may be as equally important consist of different forms of Protozoa, entomostracan crustaceans like the copepods and ostracods, free-living flatworms, round worms, and larval forms of various kinds of molluscs and larger crustaceans.

It is essential that a luxuriant growth of lab-lab is present in the nurseries before stocking them with fry. All efforts should be exerted to maintain such growth once the fish have been stocked. Lab-lab grows best under the following conditions:

Soil.—The soil must be fertile. Clay, clay loam and sandy clay give better results than sandy or rocky soils. Soils rich with decayed organic matter are also very productive.

Depth of pond water.—Lab-lab grows best when the water is maintained low. At the beginning, water just enough to cover the entire pond bottom should be allowed. For best results, the depth of water is gradually increased as the lab-lab grows thicker up to about 10 to 20 centimeters. The water should not be allowed to go beyond this depth or else filamentous green algae, or "lumut," which is not needed at this stage of cultivation, may develop.

It has been observed that exposure to heat and intense light of the pond bottom filled with shallow water seems to stimulate the growth of lab-lab.

Salinity.—Lab-lab can tolerate big ranges in salinity. Salinities from brackish water conditions to those equivalent to sea water conditions and even little beyond this give good growth (ranges of salinity from 10 to 40 parts per mille). Extremely high salinities, evidenced by actual salt crystallization, cause poor growth of lab-lab. Fresh-water conditions in ponds is found to be definitely detrimental to growth of this fish food.

Water mobility and turbidity.—Stirring of the water due to winds, waves and water currents causes turbidity which is unfavorable for the normal growth and propagation of lab-lab. This can be avoided by planting mangrove trees and other kinds of vegetation around the pond system to serve as wind and wave breaks. Water currents can also be regulated through the gates and pipes.

Freshening the ponds.—Freshening is the process of changing the old, stagnant very saline and stale water in the ponds with clear and well-oxygenated water of lower salinity brought in by the incoming tide. This kind of water favors the good growth of lab-lab so that freshening of ponds should be done as often as practicable. Precaution should, however, be taken that excessive stirring of the pond bottom must be avoided. Water due to rains or that brought in by floods although fresh is usually turbid and should not be used in freshening the nursery ponds.

Presence or absence of browsing organisms which compete with the bañgos fry and fingerlings.—Browsing organisms of various kinds are hindrances to better growth of lab-lab because they feed upon it and also they stir the bottom causing turbidity and disturbance in the proper growth of this fish food. These organisms include snails mostly of the family Cerithiidae, shrimps, crabs and some species of bottom feeding fishes like mullets and "kitang" (Scatophagidæ) which may have secured entrance into the ponds during their earlier stages of growth. These types of organisms should be eliminated from the nursery ponds as much as possible.

There are instances where there is an overgrowth of lab-lab especially in very fertile ponds. Under this condition some of the lab-lab that float may be gathered and dried. Later on, this can be broadcasted in the ponds as artificial feed of the fingerlings. Overstocking the ponds may help control overgrowth of lab-lab.

Lab-lab has the tendency to float when it has poor growth and also during its later stages of development even if it grows luxuriantly. Floating is further stimulated by excessive heating during the afternoons. This condition is not good because after the ponds are stocked with fish fry most of these jump over floating patches of lab-lab and get entangled in them. To remedy a situation like this the ponds are drained so that the floating patches may again secure foothold on the bottom. Another practice is to break them into pieces by any sort of mechanical device to minimize harm to the fry. Some of these patches if thick and coherent may be gathered and dried for future use.

Some nurseries which are easily reached by fresh water may develop a thick growth of certain aquatic submerged plants collectively known locally as "digman." These plants may comprise of the species of *Ruppia*, *Halophila*, *Nejas*, and *Thalassia*. Fishpond caretakers collect these plants and place them in mounds to decay. Fingerlings relish the partly decayed "digman" as food. The growth of these plants in the nurseries should be controlled because they outgrow and overcrowd the lab-lab.

STOCKING THE NURSERY PONDS

The bañgos, as a cultivated species, does not breed under pond conditions. The open sea is its natural habitat and although it has been known to breed almost throughout the year, the height of its spawning occurs in May and June. During spawning season millions of fry are gathered from certain sandy shores and tidal creeks throughout the islands, and these are transported to the fishpond centers.

Upon delivery in the fishponds the fry, which are placed in porous unglazed earthen jars during the transit, are carefully examined. The dead fry are removed and the average number in each container is estimated so that the total number may be computed. Sometimes these fry are sorted before actual stocking into ponds. The procedure consists of the removal of all other kinds of fish fry that may have been caught with them. The fry of predatory species such as those of the Megalopidae, Elopidae, Theraponidae, Gobiidae, and many others are eliminated.

Time and method of stocking.—The best time for stocking the fry is during the colder parts of the day, in the evenings and early mornings. Before the fry are released, it is advisable that the temperature and salinity of the water in the jars and the ponds where they are to be stocked be almost the same. If the difference in these conditions is too great, efforts should be made to have them approximate each other as much as possible, otherwise the stocking may be delayed to avoid undue mortality.

During the stocking the jars of fry are brought to the nurseries preferably near the gates which are supposed to be the deepest parts of the ponds. Each jar is brought down to the pond and tilted toward one side to allow the pond water to flow gently into the jar. This process may be prolonged depending upon the range of difference of conditions of the jar and the pond water. When the jar is almost filled with water it is slowly raised and at the same time further tilted but leaving an air exit at its mouth. In this manner the water with the fry is left in the ponds almost unnoticed and without any agitation. This process is repeated until the desired stock for the pond is filled.

In extensive nursery pond projects the sorting of each jar of fry becomes cumbersome and impracticable. Sorting of the fry in such projects is accomplished during the time the fry are actually being stocked. This is done by making use of a rectangular box of fine screen made of wire or of abaca hemp fiber cloth attached to a wooden frame. This box may measure 30 x 40 x 12 centimeters and open on the top. During the stocking it is immersed in water with the edges exposed so that the fry from each jar could be temporarily retained in this box. An experienced nursery caretaker rapidly goes over the fry being stocked and eliminates any other fry that may have been mixed with the bañgos. The fry are released

from this box after each sorting and the process is repeated until the desired number of fry has been stocked. Sometimes instead of the sorting box above described a big porcelain white basin is used. The advantage in its use is that the white background facilitates recognition of the bañgos fry from the young of other species.

The rate of stocking in the nursery ponds.—Stocking rates in the nurseries depend on the amount of food and space available for the fish. One hectare of nursery ponds with good growth of lab-lab may be capable of supporting around 300,000 to 500,000 bañgos fry, or a rate of 30 to 50 fry per square meter. Most nursery ponds are overstocked, but this is advantageous only up to certain limits because in this way the growth of the fingerlings intended as reserve stock for the rearing ponds through the year round is inhibited and controlled. Under this condition the most ideal stock for a given area of nursery pond is the maximum number that it can hold and keep the fish stunted but healthy without causing wholesale death. If the ponds on the other hand are too much understocked, this would require the same amount of care and maintenance but with less income than when the optimum number is stocked. Understocked ponds, therefore, waste space and also result in wide variation in the growth rates of the stock, a condition which is unwanted for species under cultivation.

REARING THE FRY AND FINGERLINGS IN THE NURSERY PONDS

Water management.—After the fry have been stocked close supervision of the nursery ponds is necessary. Proper management of the water may prevent much unnecessary losses at this time. In the first place the level of the water should be maintained low enough (about 10 centimeters on the average) in order to enhance the growth of lab-lab and avoid the possible growth of filamentous green algae which are not needed at this time.

Freshening of the nurseries with water brought in by the incoming tide should be done as often as practicable. The clear tidal water brought in by the spring tides is preferable to the semiturbid and partly contaminated water brought in by neap tides. A daily and almost round-the-clock examination of the pond water should be made so that immediate remedies can be instituted if anything unusual occurs. It is best to keep a reserve of good water in the head pond or in the nearby transition ponds.

During adverse weather conditions, as heavy rains and floods, it is preferable to maintain the pond water high. This would regulate the possibility of sudden change in salinity and temperature caused by rain and freshets which often cause fish mortality.

Constant vigil against dike leaks and seepage should be undertaken. The pond water should never be reduced unwatched as the possibility of drying the entire nursery ponds is very great. Likewise, the screens of the gates and pipes are frequently checked so that any defect can be repaired at once to prevent escape of the stock.

How to detect starvation and diseases in the nursery ponds.—Experienced pond caretakers can easily detect the advent of starvation and other abnormalities of the fish under cultivation. Healthy fingerlings are usually active and they swim in groups. The normal activity is largely confined to active swimming and feeding. Starvation is indicated by the disproportioned body of the fish with the head overly large while the trunk and tail regions appear to be much compressed. It is also under this condition that the fish is more susceptible to diseases. The fingerlings that are starved can further be identified by the appearance of extra shiny luster at the bases of the fins. This may be caused by slight protrusion of the supporting bones of these regions. Starved or sick fish also show weakness in motion. One very good criterion is the appearance of some specimens that exhibit deep hue of blackish color on their backs. These may swim singly and not in groups and also they may not be so receptive to an effort to scare them. Some caretakers believe this to be a condition of blindness.

Managing overstocked ponds.—During the earlier stages of cultivation the intensity of cultivation may far exceed 30 to 50 fry per square meter without harm to the stock. As the fish grow, however, overstocking becomes evident and unless remedies are made wholesale death of fingerlings may result. The usual practice under this circumstance is to reserve the adjacent nursery for the distribution of fish contained in the overstocked area by simply making a break through the partition dike and allowing the stock to spread. If after the food in the two adjacent nurseries are consumed and they are still overstocked, some of the larger fingerlings can be transferred to the transition ponds, or they can be disposed off to other fishpond owners. Partial thinning of the stock is accomplished in this manner.

Artificial feeding.—As the fish stock in the nurseries continues to grow, the ponds may no longer be able to replenish the growth of natural food. The fish can be maintained stunted in these ponds but they should be healthy in order to keep them from diseases and death. This can be accomplished by artificial feeding. If available, dried "lumut" or filamentous green algae can be used.

Very fine rice bran, or "darak," has been found to be the cheapest and most easily available artificial feed for the fingerlings. This is applied by broadcasting darak to the ponds twice a day once in the morning and another in the afternoon (Plate 7, fig. 1). The amount of rice bran to be given depends on the number of fish in each pond. One hectare of nursery ponds with a stock of about 300,000 fingerlings will need about 5 to 12 kilograms of rice bran per day. Fingerlings after the first few days of feeding easily learn to feed on the rice bran. They learn to nibble continuously on the bran particles on the water surface. Later they even learn their regular feeding times and the place in the ponds where they are fed. In this way the nursery pond projects are able to maintain the continuous stock of stunted fingerlings for the large rearing pond areas throughout the year or at least until a new stock of fry becomes available.

CAUSES OF MORTALITY IN THE NURSERY PONDS

Mortality due to unfavorable conditions of the environment.—Overstocking is a very common mistake in nursery fishpond systems. It has been commonly observed in the overstock ponds that wholesale death of fish occurs in the early mornings. This may be due to oxygen deficiency in the water caused by the excessive use of oxygen by pond organisms during the night and the lack of a compensating supply of oxygen due to photosynthesis.

Lack of food resulting in starvation may not be a direct cause of mortality but if this condition persists, the fish become weak, stunted, and susceptible to diseases. The fish may remain stunted but their health must be maintained by supplying the necessary nutrients for body sustenance.

Pollution of the pond water is another very common cause of wholesale death of pond fishes. This may be caused by excessive decomposition of organic matter in the pond or by polluted water brought in by the water supply. Supplying the ponds with artificial feed much in excess of what the fish can utilize often results in their death due to pollution.

Part of the mortality of pond fishes may be ascribed to extreme changes in water characters such as temperature, salinity, turbidity, and excessive precipitation often accompanied by floods. These unfavorable conditions may be remedied by maintaining a large supply of residual water in the pond to minimize the effect of sudden changes of these environmental factors.

Predators, parasites, and diseases.—The animals that prey upon bañgos fry and fingerlings include fishes, amphibians, snakes and other reptiles, and birds. The predatory species of fish that are commonly encountered in the nursery ponds include the following:

1. Elopidæ. *Elops hawiiensis*, the ten pounder, "bid-bid."
2. Megalopidæ. *Megalops cyprinoides*, the tarpon, "buan-buan."
3. Ophicephalidæ. *Ophicephalus striatus*, the murrel or mudfish, "dalag."
4. Theraponidæ. *Therapon* spp., the grunts, "bagaong" and "ayungin."
5. Anabantidæ. *Anabas testudineus*, the climbing perch, "liwalo" or "martiniko."
6. Latidæ. *Lates calcarifer*, the sea bass, "apahap."
7. Serranidæ. *Ephinephilus* spp., the groupers, "lapu-lapu" or "loba."
8. Carangidae. *Caranx* spp., the cavallas and crevalles, "talakitok," "pampano," "muslo," and "salay-salay."
9. Lutjanidæ. *Lutjanus* spp., the snappers, "also" and "maya-maya."
10. Gobiidæ, Eleotridae, and Periophthalmidae, the gobies, "bia" and "talimusak."
11. Synbranchidae, Anguillidae, Muraenesocidae and Muraenidae. The eels, "palos" and "igat."
12. Ariidæ. *Arius* spp., the sea catfishes, "kandule."

These fish predators gain access into the ponds either with the bañgos fry or through the gates with the incoming water especially during their larval stages. The fry of ten pounders and tarpons are strikingly similar to bañgos fry that it is very hard to sort them out during stocking. The murrels and the climbing perch occur only in nurseries where the water is fresh. The above carnivorous species, when present in the nursery ponds with the bañgos, grow very rapidly and within a short period cause a tremendous reduction in the stock of fish. During the early stages of cultivation these predators may confine themselves around the vicinity of the nursery gate. To reduce their number, the caretaker usually repeatedly dips a fine-meshed scoop net near the gate screens to catch some of the predators lurking around. Sometimes their presence could be detected by a scramble of bañgos fingerlings trying to keep clear of the path of these predatory species.

The amphibian predator is the common frog, *Rana vittigera*, a member of the family Ranidæ. It usually lays its eggs along the edges of the nursery pond before the fry are stocked. These hatch and develop and when the fry are stocked, the parents as well as the young frogs prey upon them. In order to get rid of frogs their eggs should be removed and they should be hunted out at night by using lights especially in newly stocked ponds.

Predatory snakes in bañgos nurseries include *Disteira ornata* and *Lapemis* sp., or "kalabukab," and *Chersydrus granulatus*, or "malabasahan." These are very pugnacious feeders on the bañgos fingerlings and all means should be made to eradicate them. They are usually hunted out with lights. To minimize their presence and to provide ease in killing them the nursery dikes should be cleaned of all sorts of vegetation and debris which may serve as hiding places for these snakes.

Nurseries further inland where the water supply is fresher are occasionally visited by predatory lizard, *Varanus* sp., of the family Varanidæ. This should be closely watched as it is a big and voracious predator and may cause disaster to the fish stock.

Bird predators are very rampant in nursery pond areas. These include the kingfishers, *Alcedo athis bengalensis* and *Halcyon chloris collaris*, or "kasay-kasay"; the common tern, *Sterna hirundo longipennis*, or "kalangay"; the purple heron, *Ardea purpurea manillensis*, or "kandang-ahô"; the eagles, *Butastur indicus*, or "lawin"; the bittern, *Butiroides striatus carcinophilus* and *Ixobrychus* spp., or "bakaw"; and the cattle egret, *Bubulcus ibis coromandus*, or "tagak." These birds may come singly or in big flocks and cause considerable losses to the nursery stock if control measures are not provided for. Nursery caretakers are usually provided with shotguns to kill these birds. There are also varied types of contraptions devised. Scarecrows and noise scares are often installed amidst the ponds. Another innovation is to place bamboo poles at regular intervals along the fishpond dikes. To these poles lines of cotton twine are tied so that the ponds are traversed by these lines of strings. The birds which usually have the habit of diving for their prey are scared by these lines.

Parasite infestation on bañgos fry and fingerlings in the nurseries is rare and the possibility of death due to this cause may be remote. External infestation of flat-worm and crustacean parasites has been reported.

The diseases of bañgos fingerlings have not been well studied. An epidemic disease due to fin rot has been recorded but this is of rare occurrence. Whether this was caused by diet deficiencies or by fungous parasites was not ascertained but strict disinfection and isolation of the case involved was recommended and the recurrence of the disease has not been reported.

Pests, nuisances, competitors and other causes.—There are certain periods when bulblike egg cases of some marine annelids develop in great numbers in the ponds. These are made of a transparent jelly or mucilaginous mass attached by a stalklike anchorage on the pond bottom. The tiny eggs of an annelid belonging to Eunicidæ are lodged in these masses. The active swimming fry and young fingerlings often swim into them and get entagled thus causing their death.

The development of the filamentous algæ in the nurseries is a nuisance because the fry and young fingerlings cannot yet utilize them for food. It is not uncommon that some of these fingerlings get wrapped up in the algæ filaments and die.

Higher aquatic plants that occasionally invade the pond bottom are also a nuisance. Their growth lessens the space for the fish and prevents the growth of the natural food. They are often gathered and placed in mounds to decay so that they can be made available as food for the young bañgos.

Crustaceans which may have come with the bañgos fry or entered through the gates are enemies of the bañgos especially during the earlier stages of the cultivation. These include representatives of the shrimps and crabs. It has been observed that the larval *Penaeus* spp. often cause death of the fry when their sharp rostrum pierces the delicate fry. In later stages of cultivation the stirring caused by these crabs and shrimps on the pond bottom causes turbidity which is not favorable for the growth of fish and the food of fish under cultivation.

There are several types of small and prolific fishes which may secure entrance into the nurseries and are in one way or another unfavorable for pond-fish cultivation. These types include representatives of the Ambassidæ, Poecillidæ Phallostethidæ, Hemiramphidæ, and Leiognathidæ. These fishes either utilize the same food on which the fingerlings feed or compete with them for space.

Some fishes of similar food habits as the bañgos may also grow in the nurseries and in many instances give additional income to the fishpond owners. These, however, are competitors for the food and space and should be eliminated from the

nursery ponds. Species of the families Scatophagidæ, Mugilidæ, Siganidæ, and Dorosomidæ are among the most common examples under this group.

The accidental drying of the nursery ponds sometimes causes wholesale death of bañgos fingerlings. This may be due to very porous soil, poor pond construction, or negligence of the caretaker. The nursery pond is dependent on the tide for its water supply. Proper water management often demands round-the-clock supervision. Only long experience and fine technique will reduce possible mortality due to these causes.

A great number of fingerlings are often lost because of rough handling. This is common especially when fishes are to be transferred from pond to pond or during the transportation to the rearing ponds. Giving the fish enough space and the proper kind of water is essential. Handling should be minimized to avoid removal of scales and mutilation of the fins, two very common causes of the susceptibility to diseases.

COMMERCIAL HANDLING AND MANAGEMENT OF BAÑGOS FINGERLINGS

The rate of growth of the bañgos fry and fingerlings in nursery ponds is quite rapid. The small transparent and almost needlelike fry measure from 1.0 to 1.5 centimeters long and weigh from 0.002 to 0.006 gram when stocked in the nursery ponds. With enough food they grow very rapidly during the first four to six weeks when the fry attain fingerling size, or "hatirin" stage. This stage of growth can be maintained in the nursery ponds for several weeks or even months with only slight increase in length and weight. The fingerlings vary in size from 5.0 to 10.0 centimeters in length and 1.2 to 5.0 grams in weight. It is at this stage that the young bañgos may be transferred to the transition ponds, then to the rearing ponds of the same fishpond project, or they may be disposed of to owners of extensive rearing pond areas. In the transition ponds the rate of stocking per unit area is less and the fish feed for the first time principally on filamentous green algæ, or "lumut." While in these ponds, the young bañgos grow very fast and hardy enough to withstand conditions obtaining in rearing ponds where they are grown to marketable size.

The ability to keep the fish stunted without causing mortality in the nursery ponds is utilized to advantage in the storage of a continuous fish stock. Stunting the fish in the nurseries is accomplished by overstocking the ponds and at the same time supplying them enough food. In this way the sizes of the fish are maintained and they remain as uniform as possible. As stated previously extremely overstocked ponds are not good because these result in the recurrence of wholesale death of fish. On the other hand, understocked ponds produce large variation in the sizes which are not the right stock for planting in the ponds. By proper technique nursery caretakers are able to maintain their stock for a year or even longer in order to supply the wide areas of rearing ponds during the entire year even if bañgos fry come only during a single season.

Confinement and catching of fingerlings.—The minimum period of time for the rearing of the fry to fingerlings in the nursery ponds is from 1½ to 2 months. From this time on, the fingerlings may be disposed of to rearing pond owners for stocking their transition and rearing ponds. To do this the fingerlings are first confined (Plate 7, fig. 2) after which they are caught and counted before actual transfer is made.

Fingerlings are confined in two ways. The first method utilizes the tendency of the fish of swimming against the current while the second method is by making the fish go with the current.

To accomplish the confinement of fingerlings by allowing them to go against the current, the nursery pond concerned is first partially emptied of its water during the preceding low tides to keep the fingerlings in a small space and expose them to intense heat during the day. During the next incoming high tide, new tidal water is allowed in and a gentle flow directed to the nursery pond. The fingerlings will struggle to swim towards the new water passing through the gate up to the catching pond where they congregate. After a sufficient number have been confined, the nursery gate is closed.

To confine the fish by making them go with the current, the nursery pond is drained until most of the pond floor is exposed leaving water only in the canals and in the catching pond where the fish congregate. As soon as the desired number has been confined, the nursery gate is closed and water from some source previously reserved is then allowed to flow into the ponds to avoid mortality of the confined fish. This method is usually used when catching of the entire stock is desired. The first method is often used when only a part of the stock is needed.

The fingerlings thus confined in either case are thereafter caught. The catching is done with a fine-meshed seine called "panagap," especially made for the purpose (Plate 8, fig. 1). From this net the fingerlings are placed in pails and transferred

to a suspension net or "bitinan" (Plate 8, figs. 2 and 4). The bitinan is a fine-meshed rectangular net of variable size depending on the capacity desired. It is set by tying the corners firmly to four bamboo poles stuck to the bottom. By doing this, the middle portion is immersed while the edges are left above the water. The suspension net is usually set in a pond with sufficient amount of water, or along the water supply canal.

Counting the fingerlings.—The fingerlings caught from the nursery catching pond are placed in the bitinan for convenience in counting (Plate 8, fig. 3). In counting the fingerlings a very unique method has been evolved. First a bamboo pole is taken and placed horizontally at one end under the suspension net. This pole is raised and gradually worked toward the opposite end so as to drive the fingerlings to about ⅓ or ¼ of the entire net surface. Another pole is placed horizontally and at right angles with the pole first placed in such a manner that the entire number of fingerlings is about equally divided into two parts. By this time, these operations are being done by representatives of both the dealer and the buyer. The foreman on the dealer's side usually does the dividing while the foreman on the buyer's side feels and tries to determine which part contains more fingerlings. The part selected is discarded to the other side of the net. Then the dealer's side again divides as before the part that was not selected and the buyer's side makes the selection as before. This process is repeated until a convenient number is left to be counted out. In the operation the dealer always attempts to make the division as equal as possible while the buyer attempts to have the least number counted out so that when summed up the number actually counted will be less than the actual composition of the stock. Counting is accomplished by scooping with a bowl or cup a few fingerlings from the portion to be counted. As this is done the number is called out and recorded by one who tallies with the use of shells or pebbles of known quantity that are placed in a tray. The number of times these tally shells or pebbles went around and any fraction thereof represents the number in the counted portion. To get the total of the fingerlings in the entire batch this number is multiplied by 2 if the stock is halved: by 4 if ¼ is counted; by 8 if ⅛ is counted; by 16 if 1/16 is counted and by 32 if 1/32 is counted. The purpose of reducing the amount of fingerlings to be counted to a convenient number is to effect speed in counting and to minimize handling of the fingerlings.

Transportation of live fish.—Bañgos fingerlings are distributed from the nursery pond centers to the various rearing pond areas by means of live-fish boats locally called "pamandawan," or "hatiran" (Plate 9, fig. 1). A hatiran may be a wooden-dugout or a flat-bottomed wooden boat. A wooden dugout ordinarily measures from 10 to 20 meters long propelled by an outboard motor. The bottom of this boat is provided with two or more well-screened holes for the free entrance of the water. A flat-bottomed bargelike boat is usually a larger vessel with much greater capacity than the former. Depending upon the size, each of these live-fish boats may carry from 15,000 to 50,000 fingerlings. If more fish is to be transported, two or more of these carrier boats are usually towed by another powered vessel (Plate 10, fig. 1).

The live-fish boats are thoroughly cleaned a day before they are to be used. The pipes for the water holes are checked and properly screened. As soon as these boats are about to be used for fish transportation they are filled with about 1/3 to 1/5 full with river water. After the fingerlings have been counted in the suspension net, they are scooped by means of pails and transferred to the live-fish boats (Plate 9, figs. 2 and 3).

The fingerlings can be transported even under crowded condition in these live-fish boats. It is essential, however, that water circulation and aeration be maintained. This is done by opening the water holes as soon as the fingerlings are placed in the boats. These boats are prevented from sinking by bailing out the incoming water. This is continuously done by one or more of the personnel of the boat during transit. To avoid having the fingerlings dipped out during the process, water is bailed out from a especially made enclosure with the bottom made of boards and the walls of bamboo screens. The meshes of the screens are fine enough to exclude the fingerlings.

There are certain precautions that should be taken into consideration during the transportation of fish. First of all, fingerlings should not be transported during inclement weather such as typhoons and floods. Turbid waters and shallow areas where the boats may run aground should be avoided. The entrance of mud and other sources of turbidity may cause fish mortality. High tide is the best time for transporting and it is preferable if transport can be accomplished during the colder parts of the day, from late afternoon through the night to the early morning. Maintenance of water circulation should be done continuously

during the trip by constant checking of the water entrance and bailing out of the water (Plate 9, fig. 4).

The holes through the bottom of the live-fish boats are often provided with a short tube made of bamboo. This tube is cut flat and screened at the inner end but the exposed end is transversely cut. This is done so that if it is desired to vary the rate of flow of water into the live-fish boat this tube could be manipulated. If the hole of such tube is adjusted to face the direction of the boat, more inward flow of water is effected. If this opening is sidewise, the water is slightly regulated, but if turned backwards the inward flow of water would be least. Because of the function of this tube it has been named the "panasa" literally meaning, regulator, of the flow of the water.

Upon arrival in the rearing pond areas, the fingerlings are again scooped by means of pails and transferred to a transition pond, or "impitan," which has previously been prepared. This pond can be stocked with 1 to 15 fingerlings per square meter. It should have newly freshened water and abundant food. In many instances, it may have a very luxuriant growth of filamentous algæ in which case the caretaker should attempt to make pathways for the swimming space and grazing areas of the fingerlings.

SUMMARY

1. The cultivation of bañgos, or milkfish, is a very lucrative and highly developed industry in the Philippines. One of the specialized phases of this industry which involve experience and technique is the preparation and management of the bañgos fishpond nursery.

2. In the selection of the nursery site, the following factors should be taken into consideration: clean and adequate water supply, proper drainage, fertile and clayey soil, more or less flat country, freedom from floods, absence of very thick vegetation, and availability of bañgos fry and rearing ponds to be supplied.

3. The layout of the nurseries is characterized by regularity in arrangement and relative smallness and shallowness of the ponds. The construction should provide for good water circulation and freedom from leaks and seepage.

4. The preparation before stocking consists in the cultivation and leveling of the pond bottom followed by drainage and thorough drying. Then with the gates and pipes properly screened,

a limited amount of water is allowed into the ponds for the growth of "lab-lab," the natural food of the fry and fingerlings under cultivation.

5. The bañgos fry are sorted and carefully stocked into the ponds during the colder hours of the day. The stocking rate is about 30 to 50 fry per square meter of nursery pond.

6. Close supervision is necessary during the rearing of the fry and fingerlings. When the natural food gets exhausted, the fingerlings are artificially fed with fine rice bran.

7. The causes of mortality include unfavorable conditions of the environment, predators and diseases, various pests and nuisances, and competitors.

8. The rate of growth of the fish is very rapid during the first few weeks but later the growth becomes stunted. This condition could be maintained for a considerable period thus making these nurseries serve as storage for reserve stock of fingerlings. The maintenance of the stock and its distribution are handled under the usual commercial procedure.

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ILLUSTRATIONS

PLATE 1

FIG. 1. General view of a bañgos fishpond project.
2. The nursery fishpond system showing typical arrangement of ponds.

PLATE 2

FIG. 1. The main water control gate. This is made of concrete.
2. Close view of the main water control gate. Note slabs, screens and bridges.

PLATE 3

FIG. 1. Digging the site for a secondary wooden gate.
2. A newly set secondary wooden gate. Note screens and slabs.

PLATE 4

FIG. 1. Preparation of the nursery ponds begins with repairs of the nursery dikes.
2. The nursery ponds are cultivated and leveled by rakes.
3. View showing a nursery pond drained and exposed until the bottom cracks with dryness.

PLATE 5

FIG. 1. Two nursery ponds have a common catching pond.
2. A nursery gate with a cylindrical pipe alongside it. Note the pipe is screened by a bamboo screen trap, the "galao."

PLATE 6

FIG. 1. One end of the quandrangular pipe partly exposed showing screen and slab.
2. Close view showing details of a catching pond.

PLATE 7

FIG. 1. When the natural food in the nurseries are exhausted the fingerlings are artificially fed with rice bran.
2. Fingerlings are confined in the catching pond so they could be caught and transferred.

PLATE 8

FIG. 1. The confined fingerlings are caught by a fine-meshed seine, the "panagap."
2. Men ready to transfer the fingerlings. Pails are used to scope the fish.
3. Estimation of the fingerlings and actual counting are done while in the suspension net.
4. The caught fingerlings are transferred to the suspension net, the "bitinan."

PLATE 9

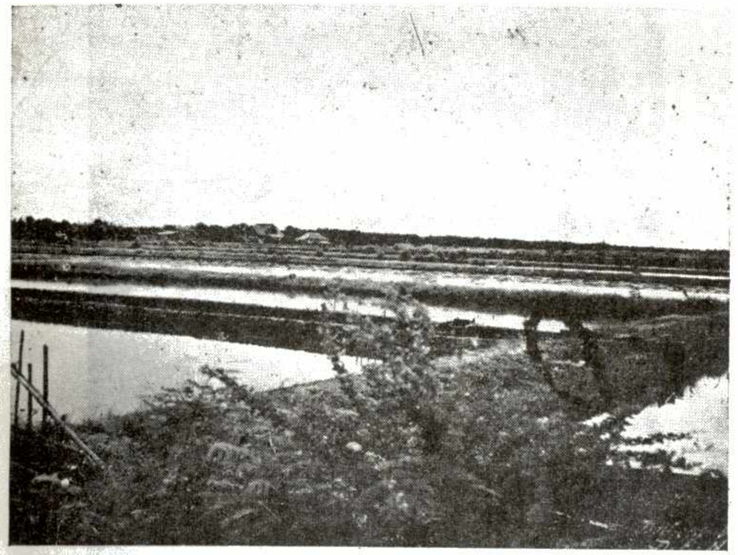
FIG. 1. A group of live-fish boats, the "pamandawan" at anchor.
2. From the suspension net the fingerlings are transferred to the live-fish boats.
3. Pails are used to transfer the fish from the suspension net to the live-fish boats which had previously been partially filled with water.
4. Water circulation and aeration in live-fish boats are maintained by constant entrance of water through holes at the bottom of the boats and by constant bailing out of the water.

PLATE 10

FIG. 1. The live-fish boats are towed by a small-powered vessel during transportation.
2. Making cylindrical wooden pipes for nursery ponds.
3. Concrete cylindrical pipes for nursery ponds.

TEXT FIGURES

FIG. 1. Model layout for a 6½ hectares bañgos nursery pond system.
2. Commercial fishpond layout for a 5½ hectares nursery pond system.
3. Model layout for a combination fishpond system showing the relative areas of the ponds for a 10-hectare project.
4. Details of a main water control gate.
5. Details of a secondary wooden gate.
6. A cylindrical pipe with the "galao."
7. Provision for effective water circulation in the nursery ponds.
8. A wooden mud rake.



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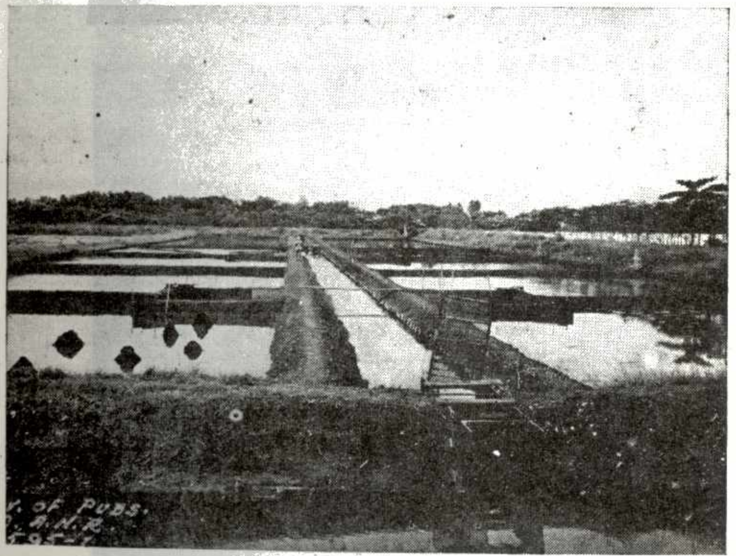

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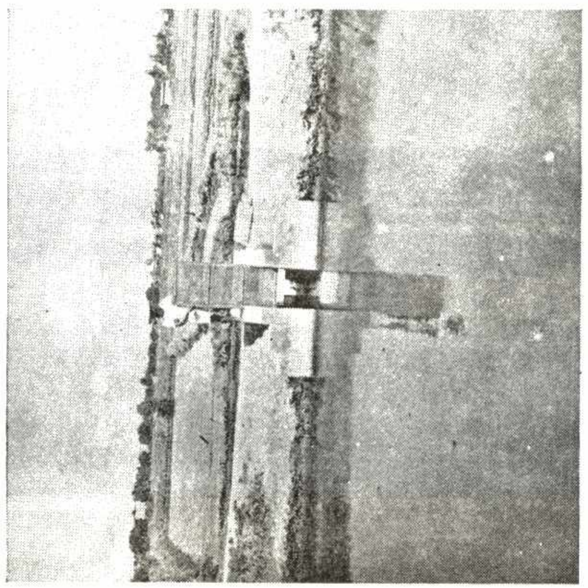
PLATE 1



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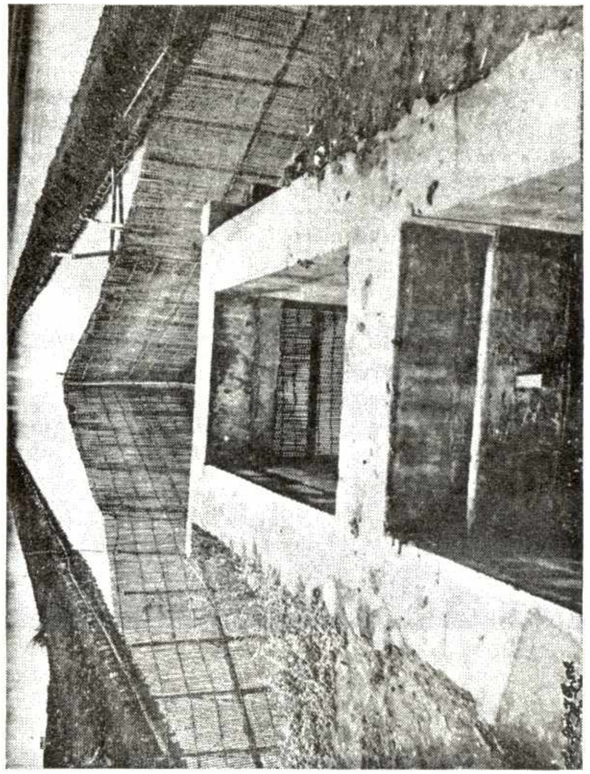

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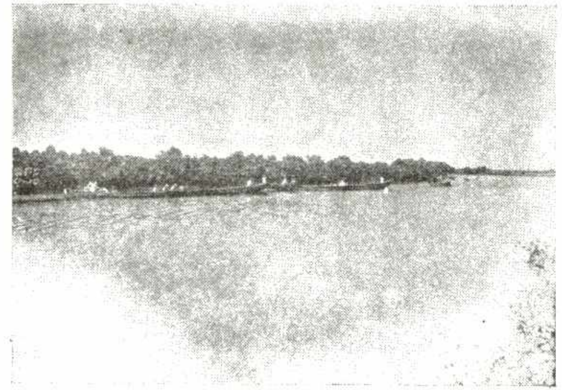

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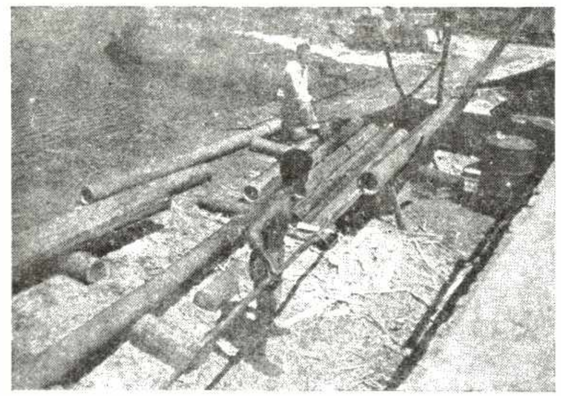

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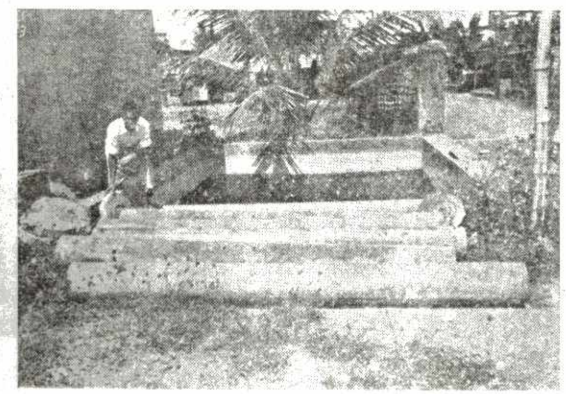

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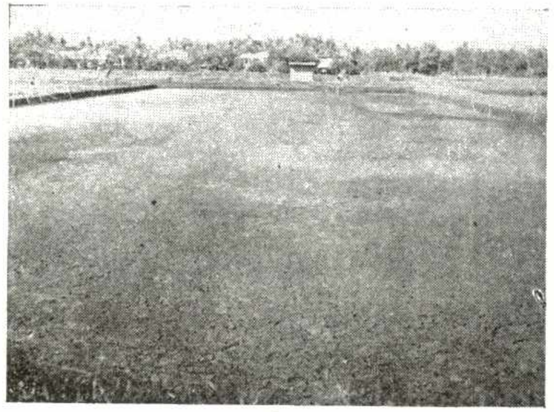

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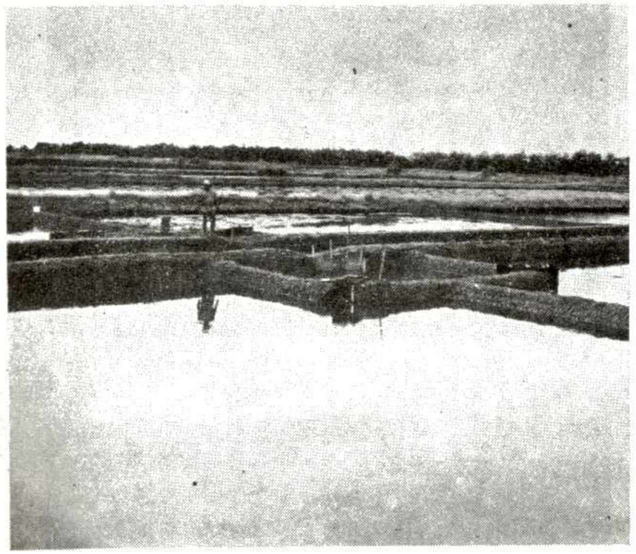

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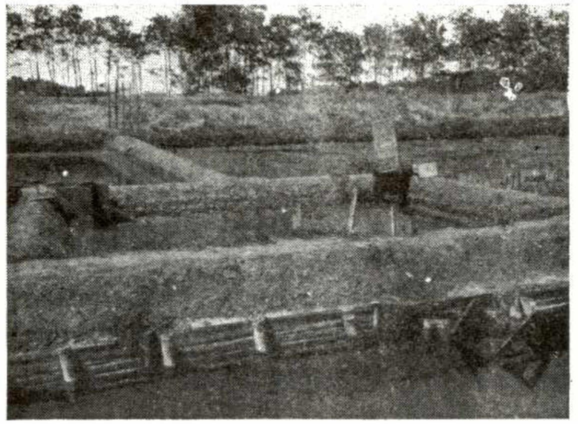

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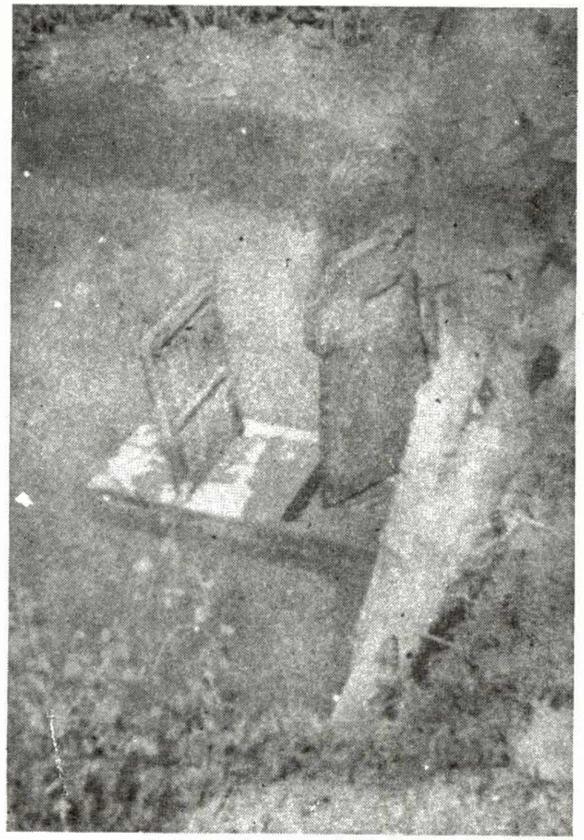

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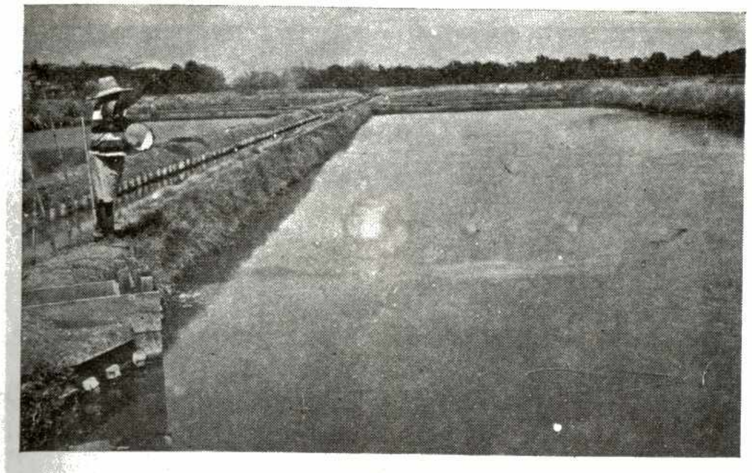

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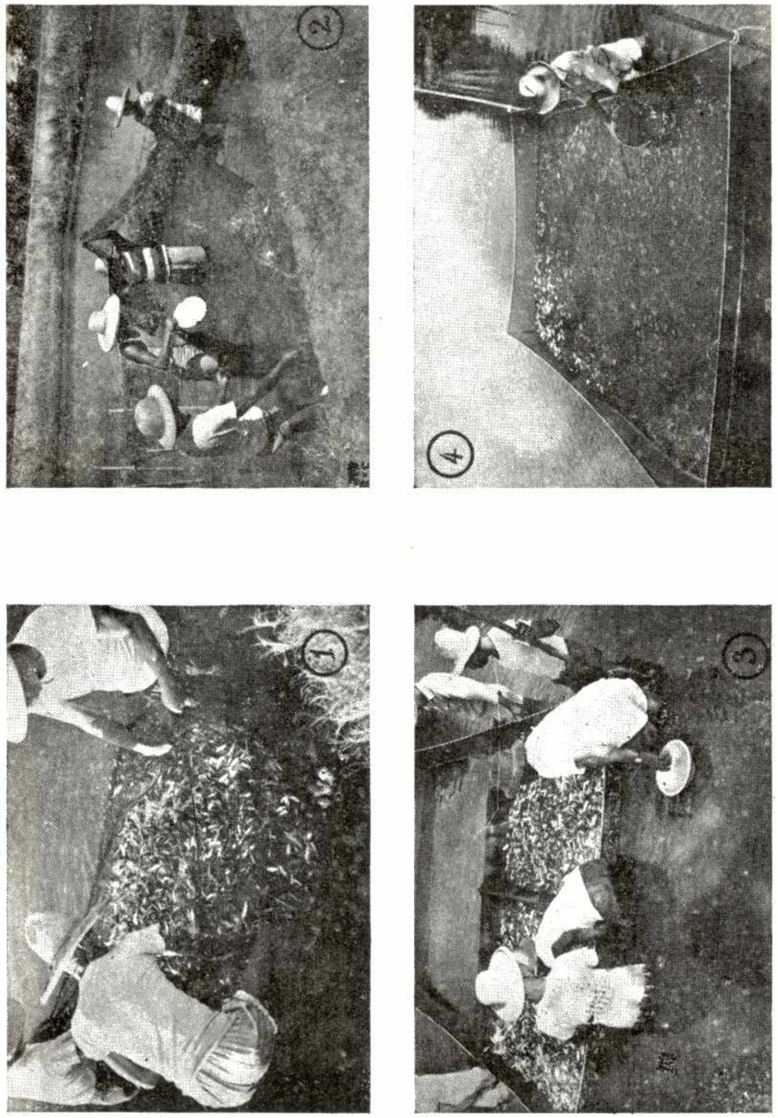

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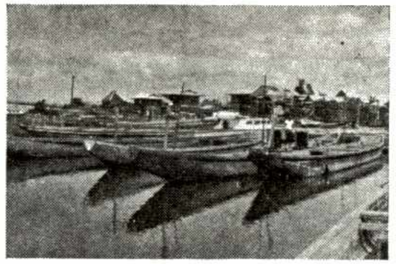

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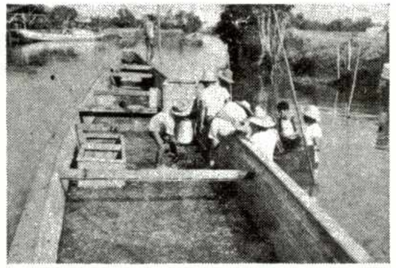

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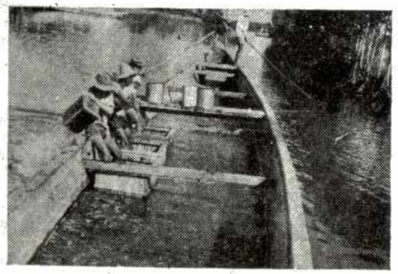

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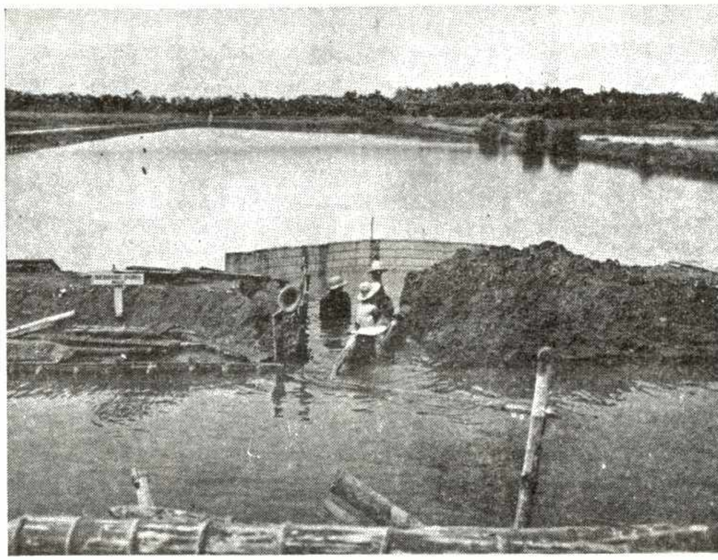

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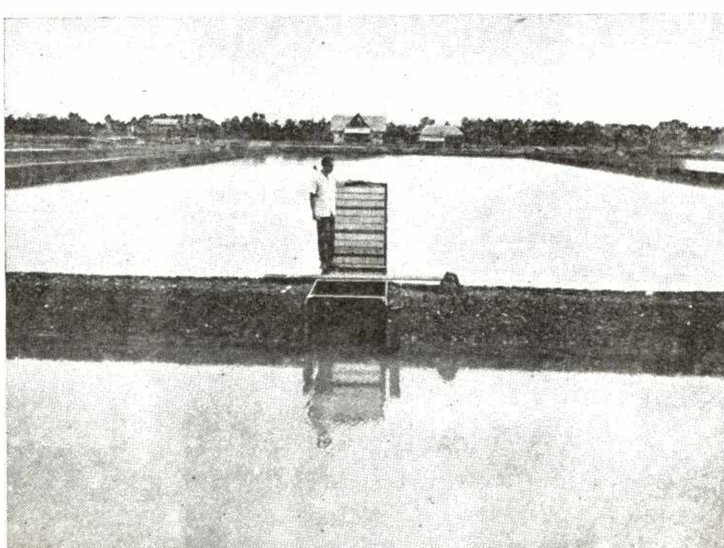

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PLATE 3.