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BIOLOGICAL STUDIES ON BAÑGOS, (*Chanos chanos*)

By

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INTRODUCTION

The milkfish or bañgos, scientifically known as *Chanos chanos* (Forsskal), is a unique fish which has a great impact on the economy of the Philippines and Indonesia wherein about 300 million pesos are invested in its fishery. The countries of India, Malaya, North Borneo, Thailand and Vietnam have recently considered making use of this valuable marine resource.

This fish, the only member of the family *Chanidae,* is found in the Red Sea, east Coast of Africa; all over the Indian and Pacific Oceans to Hawaii, and even in the coast of Mexico. The Philippines appears to be at the center of the range where more fry is taken than elsewhere.

This fish was first described by a Dane, Forsskal, in 1775 from the Red Sea and the Type Specimen (dry skin) is now preserved at the Zoological Museum in the University of Copenhagen, Denmark.

Of the approximately 200 species competing for food in the littoral and estuarine zones of the Indo-Pacific waters, only this fish and the mullets of the *Clupeiformes* depend almost exclusively on the benthic biota of the sea bottom.

To this day bañgos is known to school in the Red Sea during its breeding season, when quantities of the huge fish move near the shore. It is not in any way esteemed in Egypt due to its bony condition. Whether the breeding population of bañgos is homogeneous or not along its range is unknown.

In India, Ceylon, Thailand, and Taiwan, the annual catches of adult bañgos vary from a few stray specimens to some hundreds of fish. These are caught along the coast approximately one month before the beginning of the fry season. Even the commercial and subsistence fisheries of the many islands of Indonesia do not produce more than approximately 1,000 to 2,000 fish a year.

In the Philippines, in spite of conservation measures prohibiting the catching of breeding bañgos (sabalo), in a few localities, thousands could be caught by fish corrals as in Morong, Bataan where 3,418 were caught in 1952 (Bunag MS).

History of the Bañgos Industry

In Indonesian history, between 1200 to 1400 A.D. during the Hindu influence, convicts known as "untouchables" were sent to East Java. They were prohibited to wear clothes, to farm, or to work on ships. These people apparently were the ones who discovered the making of *tambak.* East Java, therefore, became the seat of the bañgos fishpond industry.

In the island of Madura, East Java, where salt making was first discovered, bañgos fry are plentiful and most hardy even to this day. It all points to the fact that in this island the bañgos industry was started about 900 years ago. Salt making was practiced later in Surabaya, East Java near Madura, yet the earliest *tambaks* were recorded from this town and the practice spread to the western part of Java, the Philippines and elsewhere. It is known that all along its range, estuarine waters of virtually every shape and type serve as a temporary habitat to bañgos which come from the sea during juvenile stages. "Primitive" bañgos ponds are in operation in many countries in the Pacific. These are found in the Hawaiian Islands, along the coast of North and South Vietnam, in the Rewa Delta of India, in Fiji, in Gilbert Islands and in certain islands of the Lau group.

Bañgos culture has been developed over many years in the Philippines, Indonesia and Taiwan. Rapid development of the pond areas is reported from all these countries. Experiments on bañgos culture in estuarine waters are also in progress in India, Thailand, Fiji and Samoa (Schuster 1952).

Raising fingerlings is either a part of the process of raising fish to marketable size, i.e., from 500-600 g. individual weight, or it is carried out as a specific operation by people specializing in the work as in Dampalit, Malabon. The basic feature in raising fingerlings is the great care given to the physical, chemical and biological components of the pond environment; the aim is to assure that the rate of survival exceeds the minimum of 50%.

Development of Bañgos Culture

In Indonesia, management of bañgos culture was initiated in 1864 by Superintendent of Culture, P.W.A. van Spall. This was accomplished by excellent instructions to the Javanese supervisors of ponds based on his treatise. Between 1928 and 1942, a scientific basis was laid for effective management of bañgos culture, resulting in the development of artificial irrigation of large pond systems, improvement of fry-rearing methods, and application of organic fertilizers. Furthermore, the marketing of the fishpond products was reorganized and modernized.

In the Philippines, Dr. Albert Herre, Chief of the Division of Fishes of the Bureau of Science from 1920 to 1928, started better management of the fishpond industry. At present, the Philippine Bureau of Fisheries handles scientific as well as managerial aspects of bañgos culture.

In India, Thailand, and Taiwan, investigations on the biology and physiology of bañgos, pond cultivation, and improvement of fish cultural methods are respectively being undertaken.

The FAO of the United Nations appreciating the great potentialities which the Indo-Pacific region has for the culture of bañgos, has sponsored several training courses as a means to help overcome the shortage of trained personnel.

In the Philippines, the coastal municipalities lease the shore areas where fry can be caught to the highest bidder, without establishing any limit for the catches. In the Philippines, as in Indonesia and Taiwan, bañgos ponds are taxed by the government.

Rearing fish to an individual weight of about 500 g. takes six to eight months, the rate of growth and total production depending on the natural productivity of the pond, the density of stocking, the rate of fertilization, and the amount of artificial food given.

The average production per hectare per annum is 300 kg. in Indonesia, 350 kg. in the Philippines, and about 2,000 kg. in Taiwan, where heavy fertilization and artificial feeding is applied.

Juvenile bañgos, varying from 15 to 25 mm. in size, are used in the state of Madras, India, to stock freshwater ponds, tanks and irrigation reservoirs. More than 100,000 fry are collected every year for transportation into the interior of that country.

In Indonesia, rearing bañgos in ponds into which sewage water is admitted at a rate of one part sewage to two parts pond water, comes as a new development.

Distribution of Bañgos Fry

Data collected by the Bureau of Fisheries during the 1962 bañgos fry season, indicated that certain localities in Cebu, Antique, Cotabato, Occidental Mindoro are the most important bañgos fry grounds with a total production of 135 million fry forming 3/4 of the whole fry production during the year. During the 1963 season, Antique, Cebu, Ilocos Norte, and Oriental Mindoro formed 55% of the total production for the year. (Fig. 1). The production from year to year may vary greatly.

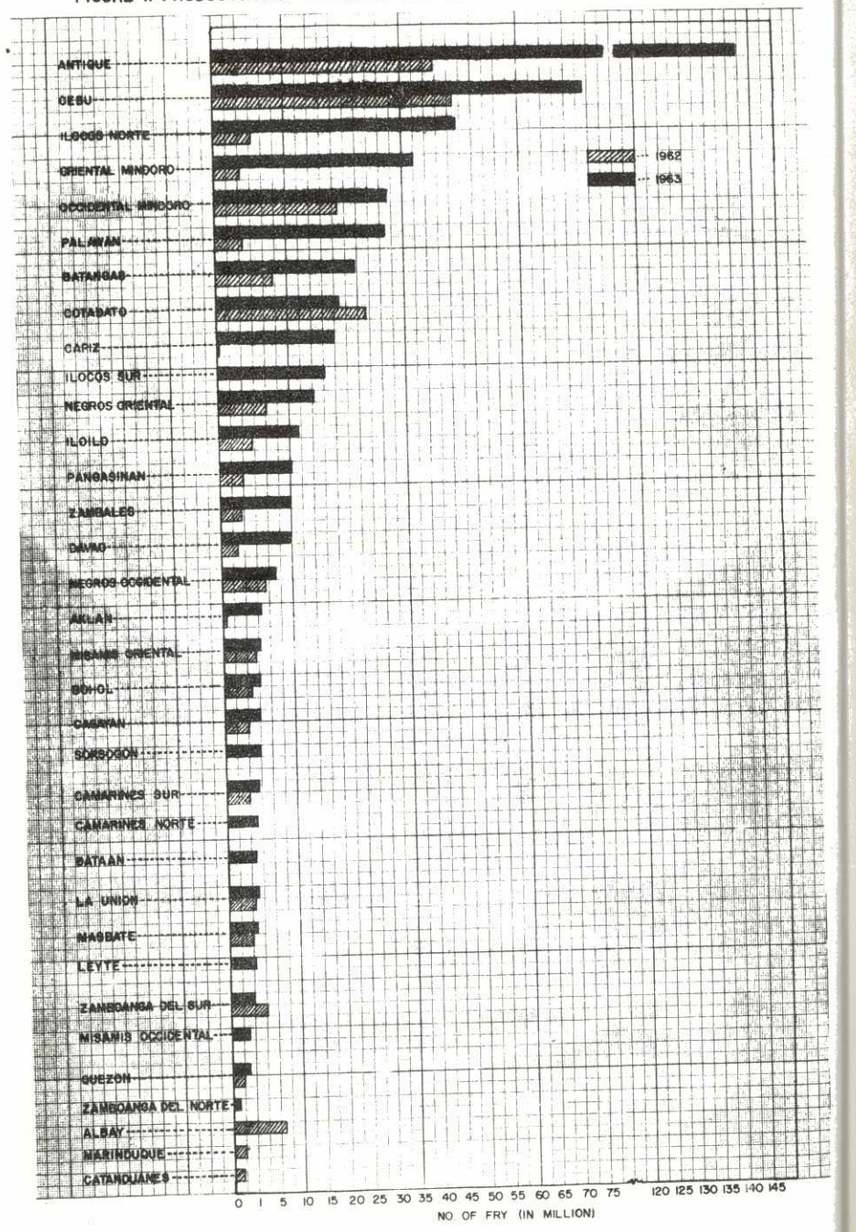
Perusal of the data on the production of bañgos fry shows that the areas with the greatest concentration of bañgos fry have the following common characteristics:

1) They are on the west coast of the island with sandy soil, gently sloping beaches and clear water.
2) They are not far from shoals, or coralline growth, about 30 kms. from the shore.

The prevailing winds blowing toward the shore together with water current parallel to the seashore help accumulate the fry. They appear to be plentiful particularly in sandy areas during the period of high tidal levels at full and new moons and are least found in areas of clay shores. Furthermore, the number of fry gathered in many fry grounds are related to certain amount of rainfall during the months of March, April and May, inasmuch as, the fry accumulate in greater concentration where there are freshets.

Study of the months of occurrences shows that except for a few areas, the fry season in the Philippines starts from March and extends up to June. In a few most productive places such as Antique (Culasi and Tibiao), fry are found throughout the year. In Cotabato, they are found from February to July. In Cebu (Madridejos), they are taken from April to August. These biotopes should be studied in detail. Conditions found in Indonesia and a few localities in the Philippines leading to catching of bañgos fry during the September-December season will be most beneficial to the industry. The Bureau of Fisheries has plans for a more systematic study of bañgos fry distribution which would be the basis of any study

FIGURE I. PRODUCTION OF PRINCIPAL BANGOS FRY GROUNDS IN THE PHILIPPINES



on this important marine fish and has submitted plans to the NRCP, the NSDB and ASA for research activities along this line.

Biology: Eggs and Larvae

Much of the biology and distribution of the mature bañgos is still unknown in spite of the great importance the fish plays as protein source in the Indo-Australian regions.

It is known that the eggs are planktonic. Sunier (1922) in Indonesia examined a mature bañgos of 1.1 meters long weighing 11.9 kilograms. A gram of its ovary proved to contain 4,320 eggs. The whole roe, therefore, according to Delsman, would contain about 5,700,000 eggs. Therefore, the bañgos has, among the highest number of eggs found in fishes and that it is a fish with pelagic eggs inasmuch as fish with demersal eggs have much less number. The size of a mature ovarial egg is 0.7 mm. in diameter and is similar to eggs of other clupeoids and tuna.

Delsman and Hardenberg looked for bañgos eggs for a long period while studying the eggs of marine fishes in Indonesia. In their study only 5 eggs were identified as those of bañgos. Delsman (*op. cit.*) reports the capture of bañgos eggs in plankton hauls in the Java Sea. Bromhall (1954) reports finding bañgos eggs in the plankton of the Ennore backwater in Madras, India.

Saanin (1954) indicates that the bañgos spawns close to the coast in clear water of 20 to 30 fathoms depth. Delsman's observation shows that the early larvae remain in the vicinity where the eggs hatch unless carried away by the water current, inasmuch as individual locomotion then is practically negligible.

Chacko (1950) lists as indicator of bañgos eggs a yellowish frothy yolk with a diameter of 1.1 to 1.2 mm. He encountered bañgos eggs in an annual period from March to August, from 1940 to 1943. He also found miscellaneous fish ova in the stomach content of several inshore fish species. These species are abundant in all areas where the occurrence of bañgos eggs has been recorded and their population density is considerably higher.

Delsman (*op. cit*) describes the development of a single egg of bañgos. He states that spawning takes place in the evening and the eggs develop within 24 hours and that after 12 hours (second morning) the yolk starts to resolve; the head now projects beyond it. Twenty-four hours later, only a small portion of the yolk remains and the underjaw is growing out; at this stage the pectoral fins ap-

pear. On the third morning after hatching, the yolk has been resolved and the eyes became black. The number of myotomes in this larva is 33-34. The length of the fish is 5 mm. A single larva, similar in characteristics to those observed after hatching in the laboratory was caught by Delsman in a plankton catch.

Buñag in his final report (1962) states that he was able to catch young bañgos fry with a total length of 11-12 mm. which were almost colorless except for the black pair of eyes which were quite hard to discern in the water. These were caught in front of the sandy Panibatuhan Station in Morong, Bataan.

I was able to collect 23 very young larvae from the Zamboanga City fry grounds on May 4, 1961, measuring from 4.5 to 9.5 mm. The majority of the fry were from 10 to 14 mm. (Fig. 2). Likewise, larger fry of from 22 to 25 mm. were taken from the catch.

The last size group appears to be an entirely older fish, which may indicate a particular spawning period of a few weeks interval. Panikkar (1952) believes that separate schools of mature bañgos spawn independently of one another.

Villadolid (1932) enumerates the different kinds of fish larvae (mostly carnivorous) which were caught with the bañgos fry. The destruction of these fry based on existing practices of fry gathering were noted.

Fish Behavior

The larvae migrate from the place of hatching to the coast partly aided by water current and prevailing wind, one to two weeks after hatching.

The young fish leave the shore waters about four weeks later, probably to look for benthic and planktonic food. Juvenile bañgos, after having entered estuarine and inland waters may remain there for an uninterrupted period of three to four years before returning to the sea.

In February and March every year, mature breeding fish in the entire range of distribution migrates landward to inshore waters in definite regions for spawning. They leave the coastal zone again immediately after the brief mating period.

All local movements of the fry are tide-controlled. During hours of high tidal levels, fry come into the zone extending from the water's edge to the seaward limit of the tide lands; during ebb they return to deeper water.

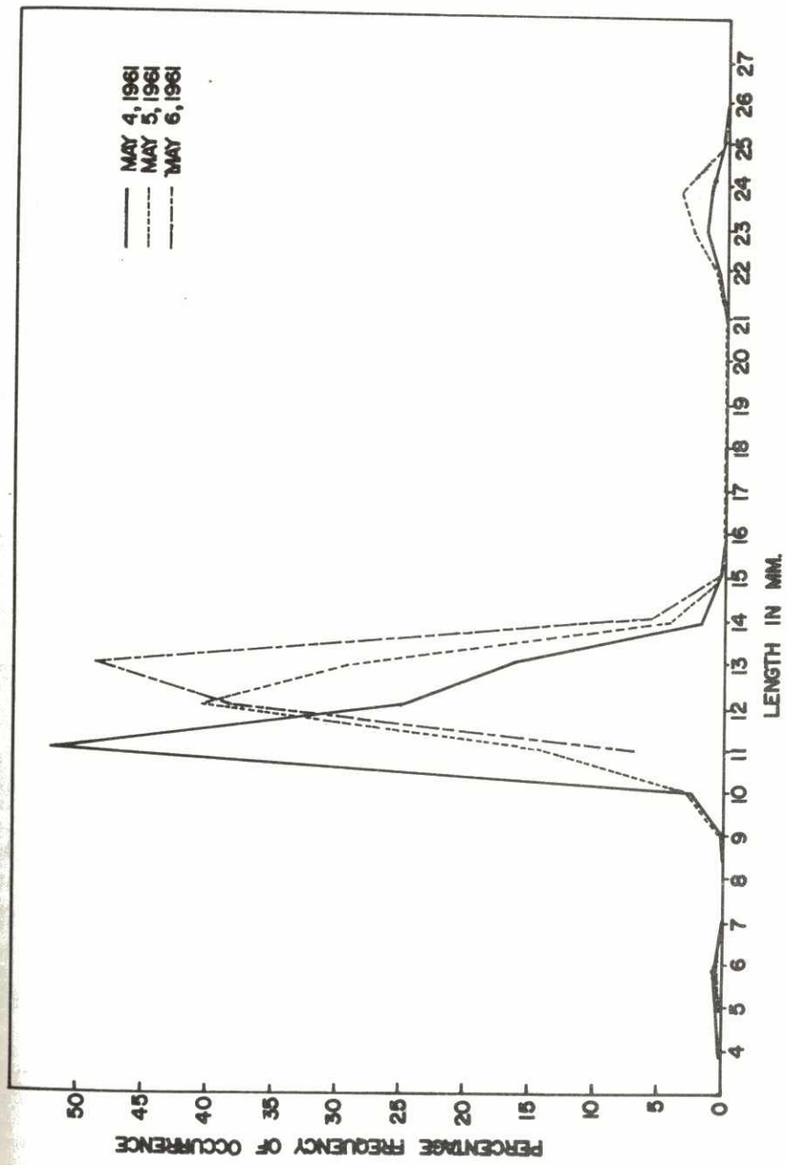


Fig. 2. Size distribution of bañgos fry caught in commercial fry ground, Zamboanga City, May 4-6, 1961

In all phases of its life the bañgos shows that the typical schooling instinct of clupeoids is very strong. Very disciplined schooling is demonstrated in larval stages; swimming in a clockwise direction. Schooling discontinues only when the fish are sick or weak. This fact is made use of by buyers of fry to determine the viability of the stock.

Nutrition After Hatching

Studies on the gestric contents of bañgos fry show that a majority of the fry examined have empty stomachs at the time of capture indicating that the earlier larvae seem to consume very little food, it any at all.

Previous studies on clupeoids by Nair (1952) on white sardine, *Kowala coval* (Cuv.), showed that four-day old larvae became emaciated and died and could not be made to feed on carefully selected fresh plankton for food, and in all cases the larvae died during the critical transition period of their life history. Similar studies on breeding marine fish gives similar results.

Morris (1955) has put forth an old idea (Putter's theory), established since 1909 and supported by Krogh (1931), Bond (1933) and Moore (1912), indicating that the early marine fish larvae especially clupeoids, subsist upon the dissolved organic solutes (leptopel) in sea water. It would be most interesting to put Putter's theory conceived 50 years ago to a test for there are sufficient and increasing evidences found in many marine laboratories that the early larvae of fishes do not depend on the *feast and famine* type of existence; instead there are sufficient quantities of dissolved organic matter in water to constitute an important factor in nutrition of some aquatic animals, especially clupeoid larvae.

Marr (1956), reviewing the critical period in marine fishes, states that "as yet not categorical answer may be made on whether a critical period exists in the early life history of marine fishes. Although catastrophic mortalities, restricted in time, always remain a possibility, the weight of what little evidence there is points toward survival, at a constantly increasing rate, rather than toward the existence of a critical period."

This conclusion, coupled with the idea of the non-particulate feeding of bañgos fry during its early larval stage until the time of its migration toward the shore (leading to its capture), might mean

that the mortality in this fish spreads over a longer period and that fry production in specific localities may be considered a reflection of the size of the breeding populations of bañgos in the area.

Whether there is a continuous migration of one breeding population or whether there are several distinct breeding populations in the different parts of the Philippines moving on a definite pattern of yearly migration is not known. Hence, studies on this subject should be considered.

Mortality of Bañgos Fry in Captivity

At the moment, in view of the dependence of the bañgos industry on the fry collected annually, more attention should be given to reduce mortality of the fry once these are collected. The distribution system of the fry is very defective and gives a mortality as high as 50% before reaching the fingerling stage.

Studies of the bañgos fry fishery of the Philippines show that normally it takes from 5 to 20 days before captured fry are released in fishpond nurseries. During this period, the fry are kept in earthen jar containers and mortality may vary from 5 to 20%. Studies made on the mortality of the fry on its transfer from freshwater to water of varying salinity shows that mortality is negligible up to salinity of 40°/oo (Shuster 1952) (Fig. 3).

In the Philippines, salinity may vary from 10°/oo to 35°/oo during the transport of bañgos fry therefore, variation in salinity *per se* does not form a limiting factor. Studies of mortality on changes in salinity during the first 5 days of the fry after capture, do not exceed 6°/oo as shown by Antonio and Manacop (1956) (Fig. 4). This paper also showes that the mortality of bañgos fry in storage depends upon several factors; i.e., (1) the volume of water in the earthen jar containers which should not exceed 2/3 full. The volume of the water needed appears to be a ratio between overcrowding and surface area of water (Fig. 5). (2) The maximum number of fry that can be economically kept in a standard earthen jar of approximately 20-liters capacity is about 3,000, taking into consideration the cost of fry, storage space and transportation expenses. (Fig. 6). (3) The best water medium for storage seems to be fresh well water which normally contain some dissolved salts. In any medium, the first two days of storage may be considered the period of fry adjustment since a high percentage of mortality was noted.

FIGURE 3

MORTALITY OF CHANOS FRY WITHIN FIVE DAYS AFTER TRANSFER FROM FRESHWATER INTO POND WATER WITH VARYING SALINITIES. Schuster (1952)

Salinity ‰	0	10	20	30	40	50	60	70	80
Mortality %	8	5	5	5	6	100	100	100	100

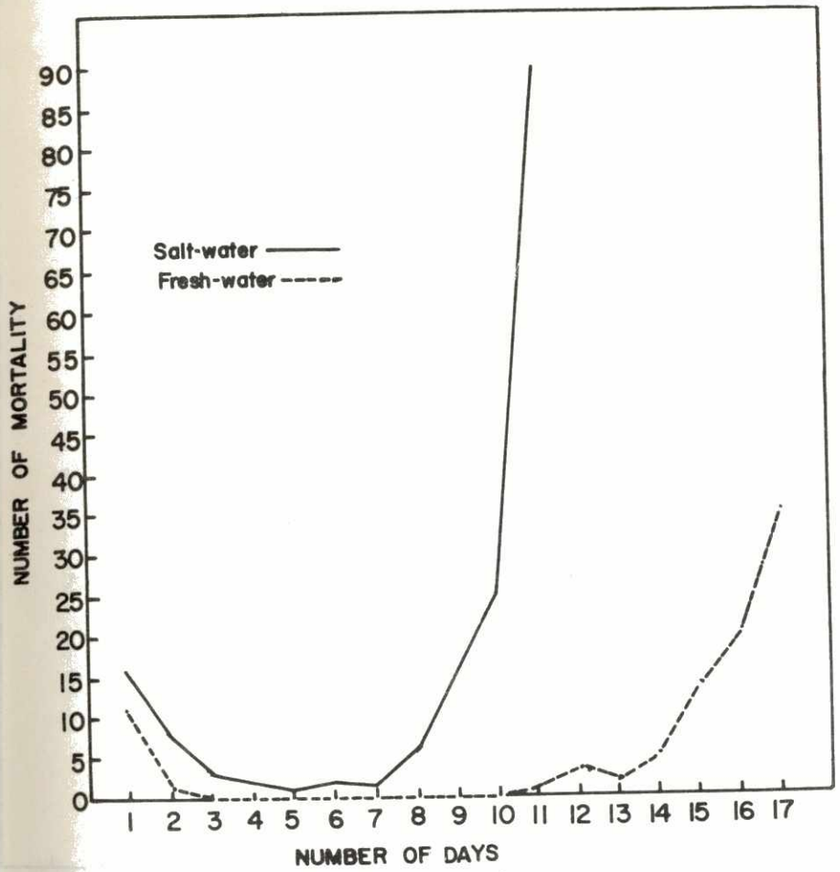


Figure 4

Mortality rate of bañgos fry in fresh-water and salt water media while in storage. (After Antonio and Manacop)

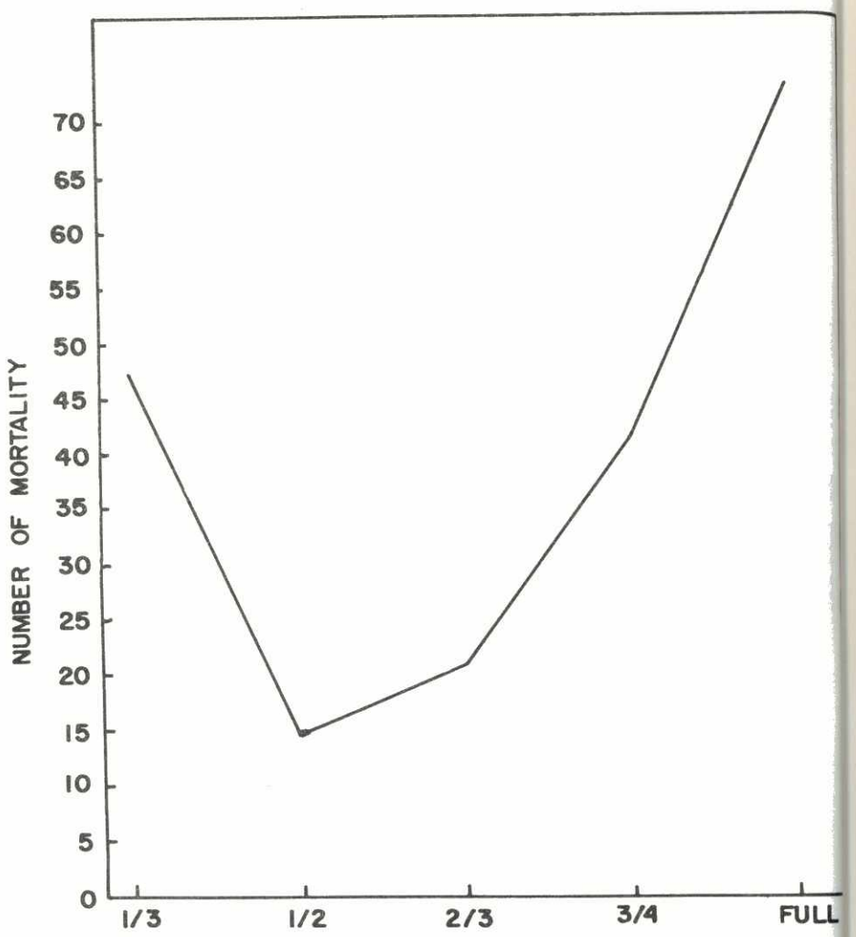


Figure 5
Mortality rate of bangos fry in relation to the volume of water in the storage container. (After Antonio and Manacop)

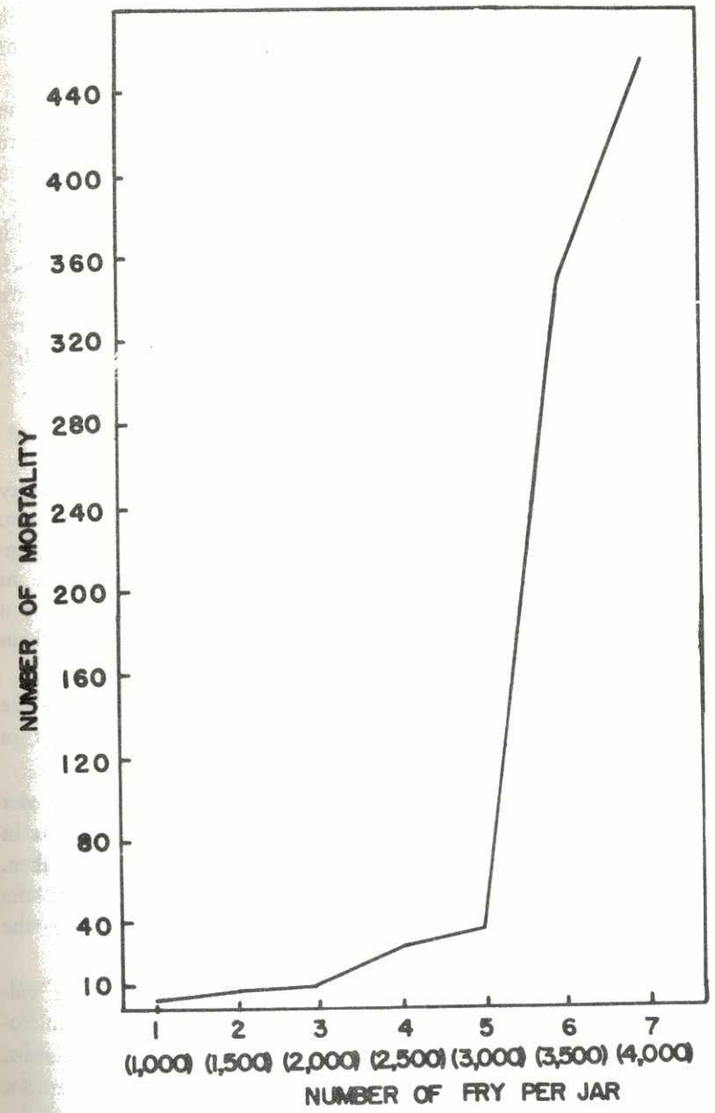


Figure 6
Optimum number of bangos fry for storage
(After Antonio and Manacop)

The average survival of bañgos fry in the *tambaks* in Indonesia is not more than 30 percent, whereas some expert Chinese fish growers in Taiwan obtained a survival of 60-80 per cent by adopting special methods of rearing (Schuster *op. cit.*).

In the cultivation of bañgos in the Philippines, however, an estimated total mortality of 50 to 70 per cent from the fry stage to marketable size has been reported by Adams, Montalban and Martin (1932) and Carbine (1948).

Studies at the Dagatdagatan Fisheries Research Station have also shown that tiny gobies are very destructive to the bañgos fry as each can consume up to 70 fry a day. Considering that the gobies are present in great quantities in nursery ponds, the destruction of fry caused by predators is worth studying. (Ronquillo and Villamater, 1957).

Feeding Habits in Captivity

In captivity, apparently in the second phase of their life history while they stay in the littoral waters, the larvae of 13 to 18 mm. long feed on benthic, epiphytic and planktonic organisms. The principal share of food organisms is diatomaceous. When reared in aquaria, the larvae feed eagerly on benthic diatoms covering bottom and walls. Chacko (1942) reared larvae in captivity by feeding them with netted plankton.

Preliminary studies showed that bañgos fry start feeding by the time they arrive at the fishponds and would even feed at night in the presence of light. (Ronquillo and de Jesus, MS).

Chacko (1949) of India classifies bañgos as a plankton feeder while Hiatt, (1944) of Hawaii classifies the fish as herbivorous in estuarine water which shows no seasonal variations in food taken. The controversial results may be explained by the ability of the bañgos to resort easily to facultative feeding, depending upon the presence of food items.

In ponds, the natural food of fry and fingerlings under cultivation are the brownish, greenish or yellowish crust of microbenthic fauna (protozoa, copepods, ostracods, free-living flatworms, molluscan larvae, etc.) and flora (bacteria, unicellular and filamentous green algae, diatoms and fragments of filamentous green algae of the pond floor. This is known as the *lab-lab*.

The growing of *lab-lab* in sufficient quantity to supply the fry and fingerlings at a high stocking rate or to last until the fish reach a length of 5 to 8 centimeters, when they are ready to eat filamentous algae, is one of the most important problems in nursery ponds. Rabanal (1949) shows the best ways of culturing *lab-lab* in nursery ponds. Ronquillo and de Jesus (1957) show that this difficulty could be solved by the use of organic fertilizers like rice bran or *darak* which boosted the abundant growth of *lab-lab* within thirty days in the fertilized nursery ponds. The use of horse manure and chicken droppings for the same purpose has also been recommended. After the fingerling stage, bañgos continues to consume benthic food until it reaches the adult stage. When benthic food becomes rare, the fish resorts to feeding on filamentous green algae fragmented and softened by decay.

Observations made from the experiments on artificial feeding of bañgos fry showed that the addition of highly nutritive food as dry skim milk and fine corn meal, for 2 to 3 weeks, to fry in confinement before releasing the fry in the nursery ponds was found beneficial and increased the survival rate of bañgos fry up to 90%. (Ronquillo and Villamater, *op. cit.*).

The rate of growth during cultivation in ponds is directly affected by the amount of food available to the individual fish. Although several claims had been reported on the beneficial use of antibiotics particularly Terramycin as supplementary food for young bañgos up to marketable size in commercial fishponds, Ronquillo, Villamater and Angeles (1957) showed that a well-controlled study is needed to determine the efficacy and economics of antibiotics and other growth factors after the fingerling period. Preliminary experiments however, show that the use of Terramycin and Vigofac for more than three weeks up to fingerling stage only reduces mortality but does not increase the growth rate of the fish more than those fed with natural food (*lab-lab*).

Based on these experiments, recommendations were made on the use of suspended rectangular nets made of abaca or nylon where the fry may be kept and artificially fed during the first few weeks of its life, in the nursery pond which appears to be a critical stage in the life history of the fish. Besides supplementary feeding, another practice that can help increase bañgos production per unit area, is thru pond fertilization especially during the dry season. This practice requires the use of chemical fertilizers. The main objective is to

supply the pond with the necessary nutrients to promote and maintain the growth of fish food for increase production. Under normal condition of Philippine soil in brackishwater pond areas, the suitable and economical fertilizer to use is ammonium phosphate which proved to increase the growth of *lab-lab* and algae. The fertilizer is added at a rate of 10 grams per square meter (100 kilograms per hectare) per application for about 3 to 5 times during the growing period of the algae. (Ronquillo, de Jesus and Padlan, MS).

In areas with a tropical climate, bañgos feeds with equal vigor at all seasons of the year. In subtropical areas (Taiwan), feeding is interrupted during the winter season while the fish are kept in small hibernation ponds. The fish are fed with rice bran on warmer days but in cold weather the fish do not take any food. In Luzon area it has been observed that the bañgos grow slowly during the cold months (December to February) thus, posing a problem to fishpond owners who would like to have normal growth of fish during the period.

The 10th Pacific Science Congress held in Honolulu, Hawaii, in August, 1961, recognizing the importance of the bañgos in the economy of the people of the Indo-Australian region, endorsed in one of its resolutions, the establishment of a bañgos research group to undertake concerted efforts on the study of the biology of the fish in its marine environment to locate their exact migration route and spawning grounds.

The Bureau of Fisheries is doing its best to implement this resolution. A ₱100,000 research laboratory is being established at the sea shore of Naujan, Mindoro, on one side of the Butas River, coming from Naujan Lake where bañgos goes for a 3 to 4 year sojourn before returning to the sea to breed. In adjacent areas, bañgos breeders (sabalo) and bangos fry are found in quantities which make the site ideal for this study.

The National Science Development Board (NSDB) recognizing the importance of getting all information leading to the understanding of the breeding habits of the fish, has, since 1961, financed a project on increasing the production of bañgos fry by hatchery methods. It is still continuing and would probably be under the supervision of the Bureau of Fisheries in the future.

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