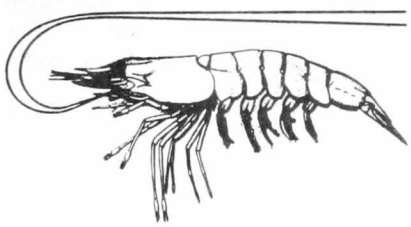
SHRIMP FARMING[1]



by Donald M. Allen

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INTRODUCTION

The idea of shrimp farming, or cultivation of shrimp under controlled conditions in salt- or brackish-water ponds, has aroused much interest in the United States in recent years. Shrimp appear particularly desirable for artificial cultivation because of their rapid growth and high market value. The ex-vessel value of shrimp to United States fishermen in 1962 was $73 million for the 191 million pounds landed. In addition to their worth as human food, shrimp are in great demand seasonally as live bait for sport fishing.

Methods used in shrimp farming take advantage of the ability of certain shrimp to survive and grow rapidly in shallow estuarine waters. By constructing ponds, the shrimp farmer alters the natural environment so that the poundage of shrimp normally harvested from the estuarine areas is greatly increased. It is anticipated that by proper timing, a shrimp farmer may control the development of his stocks, so that abundant live bait shrimp of appropriate size can be harvested at the peak of demand.

The culture of shrimp and other marine animals is an important industry in certain maritime countries of Southeast Asia. Shrimp farming in the United States is still in its infancy, however, and extensive research is required to determine its biological and economic feasibility.

This leaflet gives an account of shrimp culture as it is practiced in Southeast Asia and suggests possible application of techniques developed there to shrimp farming in the United States.

[1] Contribution No. 166, Bureau of Commercial Fisheries Biological Laboratory, Galveston, Tex.

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GENERAL LIFE HISTORY OF SHRIMP

The majority of shrimp cultivated in salt-water ponds in the Far East are marine shrimp which inhabit shallow, brackish estuaries during a large portion of their lives. They are well adapted to this environment and can tolerate considerable change in salinity and temperature. A generalized account of their life history will suffice for most of the species with which we are concerned here.

Female shrimp spawn their eggs freely in the ocean, each releasing several hundred thousand eggs. After hatching and while passing through several larval stages, the tiny shrimp move toward the coast. Upon entering the shallow and brackish inshore waters, the young shrimp settle to the bottom and grow rapidly. As maturation approaches, they gradually move offshore toward the spawning grounds in the ocean and the life cycle is repeated. Depending upon the species, the life span may range from about 1 to 3 years and the maximum size in terms of length, from about 4 to 12 inches.

Along the Gulf and South Atlantic coasts of the United States, there occur four species of marine shrimp which may be suitable for pond culture. These are the white *(Penaeus setiferus)*, pink *(P. duorarum)*, brown *(P. aztecus)*, and Caribbean brown *(P. brasiliensis)* shrimps, all similar in appearance and habits to their relatives, the cultured shrimp of Southeast Asia. These North American shrimp live 1 to 2 years and reach a size of about 9 inches.

In addition to marine shrimp, the southern United States has several species of large river shrimp *(Macrobrachium* spp.) that should be considered for pond culture. These shrimp are generally found in fresh or brackish water. The eggs are not released directly into the water but remain attached to the underside of the "tail" of the female until they hatch into young shrimp.

CULTURE METHODS

Pond Site and Construction

In Southeast Asia, shrimp farms are constructed in shallow, brackish, estuarine areas where shrimp occur naturally. The ponds are situated in such a way that tidal action provides the needed water exchange. Areas where salinity is only slightly less than that of sea water are preferred. The soil is usually clay with a mixture of sand and organic detritus. Experience has demonstrated that ponds constructed in regions of excessive fresh water or with sandy substrate are poor producers.

Salt marshes, shallow lagoons, and mangrove swamps are converted into shrimp ponds by excavation and diking. In Japan, abandoned solar-salt beds have been converted to modern shrimp rearing ponds. A pond system used in the Philippines (fig. 1) consists of five main sections, separated by dikes--two nursery ponds, two rearing ponds, and a catch pond. The tops of the dikes are about 20 inches above the maximum expected tide heights. Sluice gates connect the catch pond to a tidal stream and also to the rearing ponds and nurseries, so that water may be exchanged. Water level and movement are controlled by tidal flow and adjustable drawboards in the sluice gates. The entire pond unit slopes toward the main sluice gate so that all sections can, if necessary, be drained at low tide. Drainage is facilitated by a system of ditches in the pond bottom which lead to the main sluice gate. This particular pond system covers about 25 acres.

Extensive estuaries along the Gulf and South Atlantic coasts of the United States may also be suitable for farming shrimp, although the cost of gaining control over such property will be prohibitive in certain areas. Excluding the cost of leasing or purchasing suitable property, the cost of pond construction in the United States may range from $35 to $600 per acre,[1] depending upon the size of the project and local conditions.

Preparation for Stocking

Before a nursery pond in the Philippines is stocked with shrimp fry, it is drained, cleaned, thoroughly sun dried, and then refilled with 1 to 3 inches of tide water that has been screened to prevent entry of undesirable organisms. Besides eliminating most predators, this entire process serves to encourage the growth of "lab-lab," a Philippine term for a complex mass of small bottom-dwelling plant and animal

[1] Information concerning pond construction costs may be found in an addendum to Lunz, 1958.

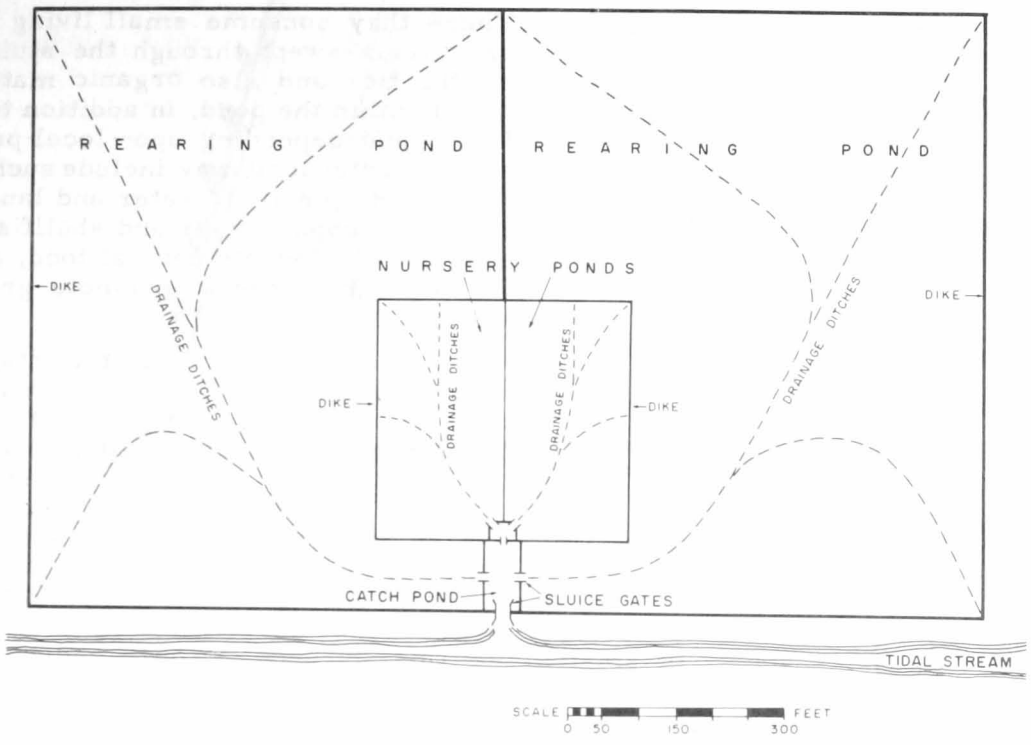

Figure 1.--Layout of Philippine shrimp pond. (After Delmendo and Rabanal, 1956).

life which is a prime source of food for young shrimp. After a good growth of "lab-lab" is established, the water depth is increased to about 12 inches, and the seed shrimp are introduced.

The shrimp grow from juvenile to adult stage in a large rearing pond. Prior to being stocked with juvenile shrimp from the nursery pond, the rearing pond is drained, cleaned, and dried before refilling to a depth of 3 to 4 feet with screened tidewater.

Acquisition of Seed Shrimp

To obtain a successful harvest of shrimp, it is necessary that the pond be adequately stocked. Consequently, much effort is directed toward the critical problem of obtaining a supply of seed shrimp (fry).

In the Philippines and Formosa, clusters of marine plants are strung across tidal creeks and shallow bays. The young shrimp entering the estuaries from the sea gather on the plants, from which they are netted at intervals. These fry are transported to nurseries in earthenware containers.

Nurseries are not used where seed shrimp are obtained by entrapment from incoming sea water. The sluice gate (fig. 2) is opened on a rising tide so that the swarms of young shrimp entering the estuary from the sea will be swept into the pond. When the tide turns, the sluice gate is screened, thus retaining the young shrimp in the pond. This process may be repeated on each tide. Of course, many other marine organisms, some objectionable, are introduced into the pond with the shrimp when this method is used.

Neither method described above supplies a consistently adequate supply of seed shrimp. The most highly developed methods of shrimp culture are those now practiced in Japan, where kuruma shrimp *(P. japonicus)* are reared from egg to adult stage under closely controlled conditions. Although details are lacking, the process may be described generally. Eggs obtained from captive spawning shrimp hatch and develop into larvae in a hatching tank. Since special food is required by certain larval stages of the shrimp, minute marine organisms, including diatoms, are artificially cultured and fed to the tiny shrimp at this time. Upon completion of the last larval stage, the young shrimp are transferred to a nursery tank. Thus, in Japan, the problem of obtaining a reliable supply of seed shrimp has apparently been solved.

In the United States, captive white shrimp have spawned successfully in large tanks

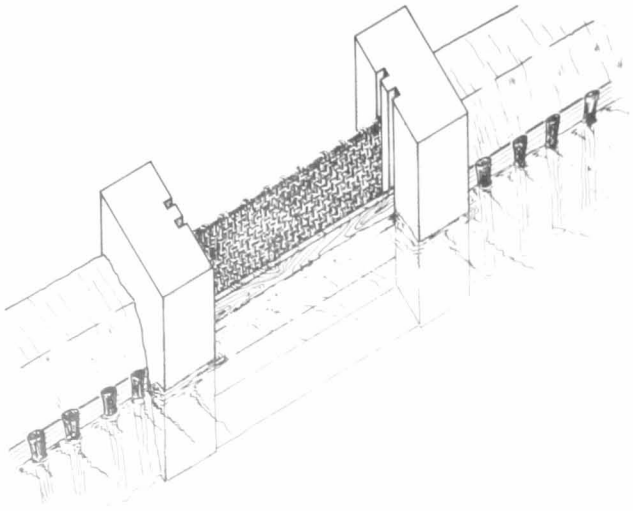

Figure 2.--Diagram of a sluice gate, showing drawboards and screen.

containing shallow salt water. By adding nutrients to the water, a supply of small marine plankton organisms was maintained as food for the larval shrimp, which were successfully reared through the juvenile stage. Elsewhere in this country, captive pink shrimp have spawned their eggs in glass aquaria, after which the resultant larvae were confined in small containers. Here, separately cultured microscopic marine algae were provided as food until the beginning of the juvenile stage. In neither case, however, has the method been sufficiently developed to provide seed shrimp on a commercial scale. Present techniques for obtaining seed shrimp rely either upon their tide-associated movements into ponds, or upon capture by trawl and plankton net. The limited production of a few domestic shrimp farms can be at least partially attributed to inadequate stocks of young shrimp.

Management of the Shrimp Crop

In Southeast Asia, pond water is periodically renewed with screened tide water during the period shrimp are confined. Since losses of shrimp occurring through holes in dikes and screens are particularly common during periods of waterflow, continued maintenance of the pond unit is required.

While confined in the nurseries, seed shrimp feed upon bottom plant and animal life that is occasionally supplemented with rice bran. After several weeks, the young shrimp are transferred to the rearing ponds. There they consume small living and dead organisms swept through the sluice gates by the tide and also organic matter produced within the pond. In addition to natural foods, and depending upon local practices, supplemental food may include such diverse organic material as water and land plants, silkworm pupae, fish, and shellfish. In the absence of adequate natural food, artificial feeding may serve to promote growth and survival.

Even in the ponds where the intake water is screened, the yield of shrimp may be reduced by predators or competitors. These pests may include fish, birds, reptiles, and mammals. Some may be removed by trapping. In Formosa, saponin, a compound extracted from tea seeds, has been used to kill fish, apparently without affecting shrimp contained in the same pond. Rotenone in suitable concentrations may also be useful for this purpose. Growth and survival of cultured shrimp can also be affected by diseases and parasites, for which no methods of control are yet practiced.

Harvest

The length of time that shrimp are held before harvesting depends upon local practices and rate of shrimp growth. Shrimp may be held from a few months to a year. Three methods of harvest used in Southeast Asia merit description:

1. Bamboo screen trap (fig. 3) - this trap consists of a fence or leader extending at right angles from the dike and leading into a heart-shaped catch chamber. Moving shrimp meet the fence while circling the borders of the pond and follow the fence into the catch chamber. Lights are sometimes used to attract shrimp to the trap.

2. Bag net - this net is fastened over the downstream side of the sluice gate. At low tide the water which has been confined in the pond is allowed to flow out, flushing the shrimp into the net.

3. Draining - the pond is drained on outgoing tide and the shrimp are collected by hand.

None of these methods is completely efficient because some shrimp avoid the screen traps and others bury in the mud when the pond is drained.

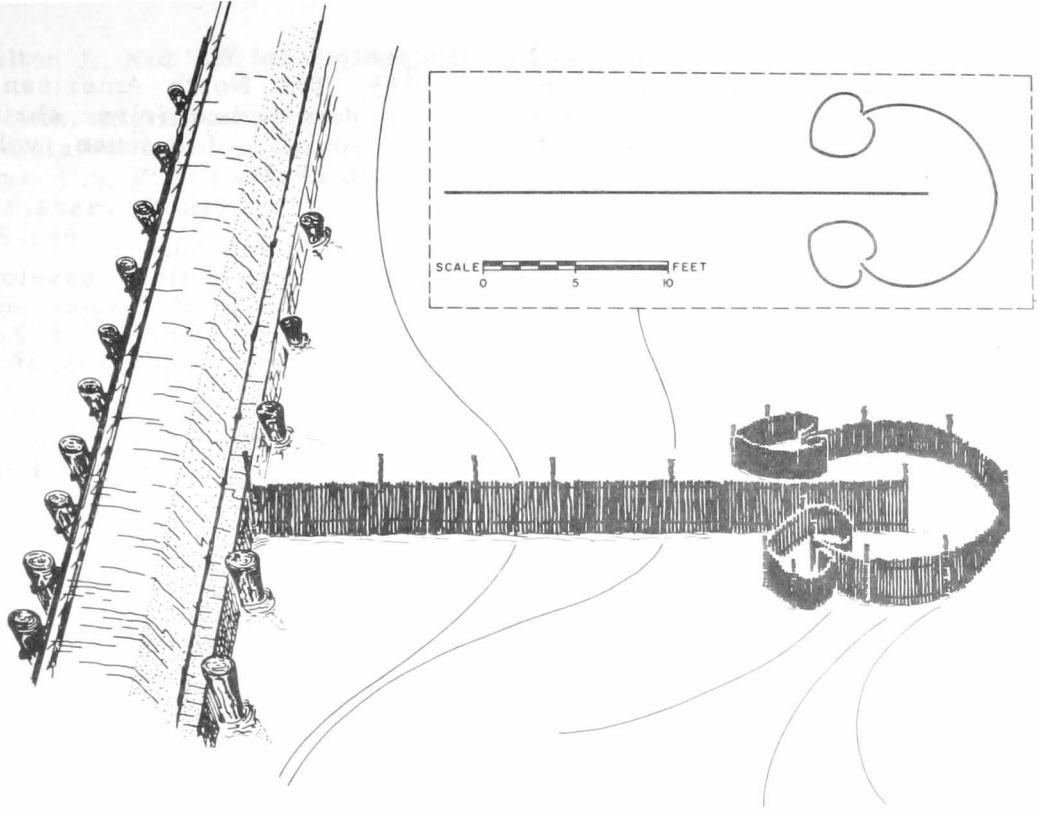

Figure 3.--Diagram of bamboo screen shrimp trap, showing leader and catch chambers. (After Delmendo and Rabanal, 1956.)

The rate of production in shrimp ponds varies markedly, being dependent upon local practices and biological conditions. Annual yields of more than 600 pounds of heads-off shrimp per acre have been reported in Southeast Asia.

RECOMMENDATIONS

Information derived from shrimp cultural practices in the Far East, particularly in Japan, could be useful to prospective shrimp farmers in the United States. The following basic problems, however, should be resolved before commercial shrimp farming is undertaken in this country.

1. The current method of obtaining seed shrimp is unsatisfactory. If, in captivity, the local marine shrimp will not regularly spawn and the young cannot be reared through their larval stages by the use of Japanese culture techniques, then other shrimp species should be considered. Following preliminary experimentation and observing necessary precautions, it may be feasible to transplant kuruma shrimp, which are successfully cultivated in Japan, or the Australian greentail prawn *(Metapenaeus mastersii)*, which spawns naturally in estuarine waters. Finally, the possibility that river shrimp may be suitable for pond culture should not be overlooked.

2. The maximum production of cultured shrimp can be obtained only when optimum conditions are established in shrimp ponds. An understanding of the physical, chemical, and biological factors that control shrimp growth and survival are necessary for successful pond management. The need for research must be emphasized.

3. The present methods of harvesting shrimp from ponds by trapping and drainage are not satisfactory. It may be more efficient to drag the ponds with frame trawls.[3] Possibly, the use of artificial light as a shrimp attractant can be more fully developed. In addition, chemical and electrical shrimp collecting techniques should be investigated.

4. The expected yield of shrimp per acre per year in the United States cannot

[3] Small drag nets with rigid, metal-frame opening and roller.

even be conjectured, but it would be of prime importance to the prospective shrimp farmer. Prior to investment in a large-scale shrimp farming operation, realistic production rates should be determined from pilot experiments.

CONCLUSIONS

In the United States, natural populations of shrimp occur in estuaries along the Gulf and South Atlantic coasts. This region appears well suited for shrimp farming, but commercial ventures in this field have been unsuccessful. If shrimp culture problems relating to seed supply, growth, survival, and harvesting can be resolved, and proven methods followed closely, Gulf and South Atlantic coastal marshes may support a new industry.

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