EXPERIMENTAL REARING OF POSTLARVAL BROWN SHRIMP TO MARKETABLE SIZE IN PONDS

By Ray S. Wheeler*

The commercial fishery for several species of penaeid shrimp along the south Atlantic and Gulf of Mexico coasts is the most valuable fishery in the United States. In 1965, fishermen were paid about $82 million--a value exceeding that of Pacific salmon, the shrimp's nearest rival, by 22 percent.

Landings in the United States consist almost entirely of shrimp taken in nets towed by trawlers on the near-shore fishing grounds. Although similar techniques are used by foreign fishermen, their production is not limited to this method. In India, for instance, culturing of shrimp in ponds has developed to a point where production of whole shrimp amounts to more than 1,000 pounds per acre (Menon, 1954[1/]).

In the United States, efforts to rear shrimp in ponds to marketable size have been primarily experimental and attempted by only a few organizations. The BCF Biological Laboratory, Galveston, Tex., began studies in 1964 to determine the feasibility of culturing shrimp under seminatural conditions.

In March and May 1965, postlarval brown shrimp (Penaeus aztecus Ives) were collected at the entrance of Galveston Bay with fine-mesh nets and stocked in each of 2 shallow $\frac{1}{8}$-acre, brackish-water ponds built in December 1964.

Two rearing methods were used. In one pond, shrimp were fed a prepared diet, and filtered sea water was pumped through the pond at a rate of 60 gallons per minute. During a 95-day period, shrimp showed continuous growth and attained an average length of 97.4 mm. (about 106 tails per pound); the projected production was 234 pounds per acre.

In the second pond, commercial fertilizer was applied to stimulate plankton growth, and the water was maintained in a static condition. During a 4-month period, shrimp attained an average length of 80.0 mm. (about 200 tails per pound) and had a projected production of 45 pounds per acre.

Coefficients of condition showed that shrimp held in the circulating-water pond maintained, in general, a good state of relative well-being; those held in the static-water pond could not.

METHODS AND MATERIALS

Each pond is 100 feet by 50 feet by 4.5 feet and positioned so that the long axis is aligned with the prevailing east-west wind to improve water circulation and aeration (fig. 1). In addition, each pond is connected to a lagoon by a 10-inch, concrete-asbestos composition pipeline fitted with a standpipe in the pond to control water level.

Water was supplied to each pond from the adjacent laboratory building with a 2-inch polyethylene pipe. Before entering the pond, however, all water was filtered through crushed oyster shell (fig. 2) to prevent the introduction of predators. Clogging of these shell filters (one for each pond) necessitated frequent changing.

Shrimp were reared by a different method in each pond. In the static-water pond, only small amounts of water were added to compensate for loss through evaporation and seepage. Food was provided by adding fertilizer to promote the growth of plankton. In the circulating-water pond, there was a constant exchange of water, and shrimp were fed a prepared diet.

Young or postlarval brown shrimp (Penaeus aztecus), averaging 14 mm. ($\frac{1}{2}$ inch) in total length (tip of the head spine or rostrum to the tip of the tail or telson), were stocked in both ponds. Before stocking, they had been separated by hand from accompanying organisms, counted, and acclimatized to the pond by introducing water slowly (over a 10-minute period) from the respective ponds into the containers holding them. On the basis of an arbitrary

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1/Menon, M.K.: On the paddy field prawn fishery of Travancore-Cochin and an experiment in prawn culture. 1954. Proc. Inco-Pac. Fish. Council, 5th sess., sec. II: 1-5.

Note: This article is Contribution No. 228, BCF Biological Laboratory, Galveston, Tex.

U. S. DEPARTMENT OF THE INTERIOR
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Sep. No. 785

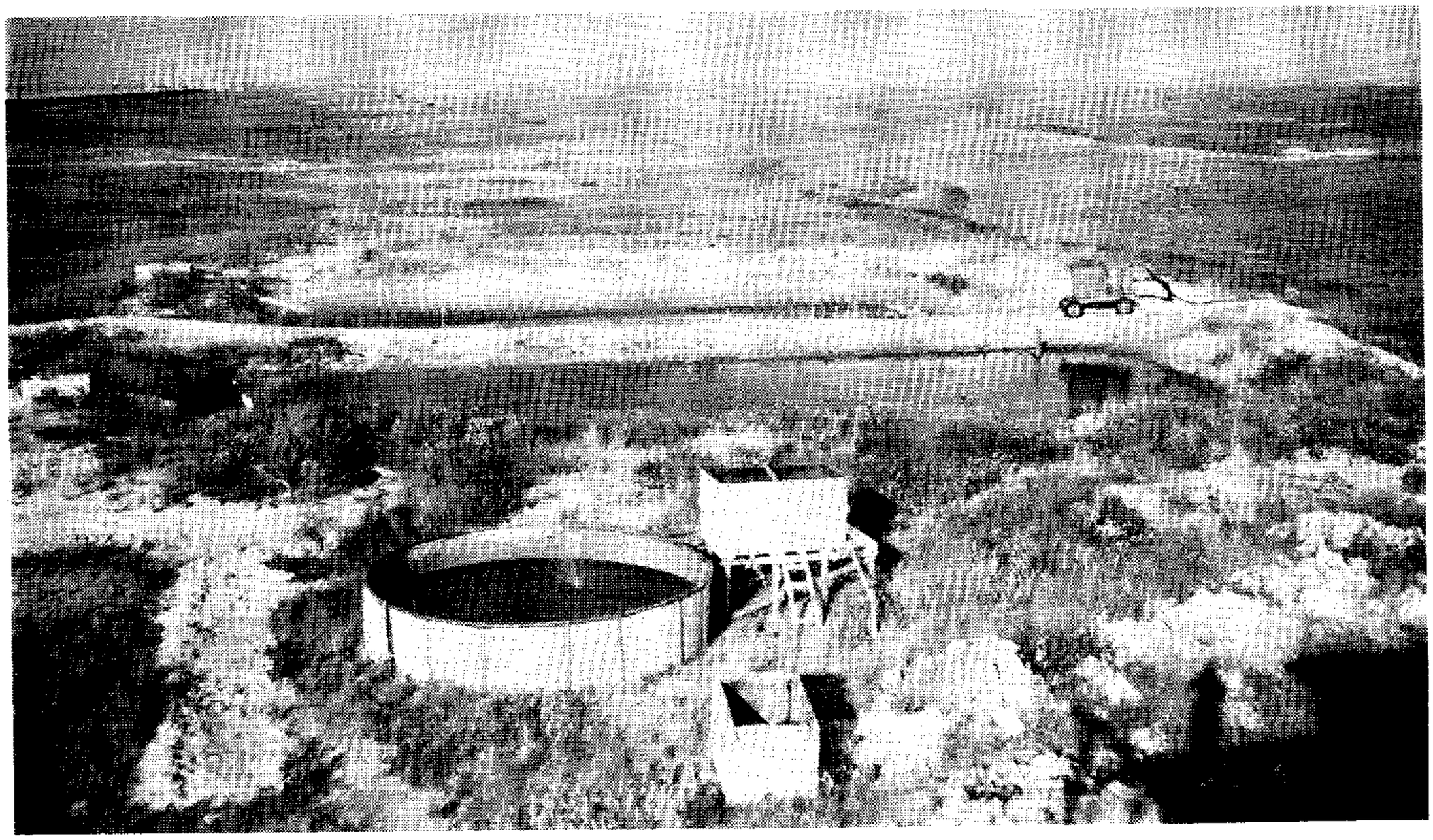

Fig. 1 - $\frac{1}{8}$-acre ponds used for rearing shrimp.

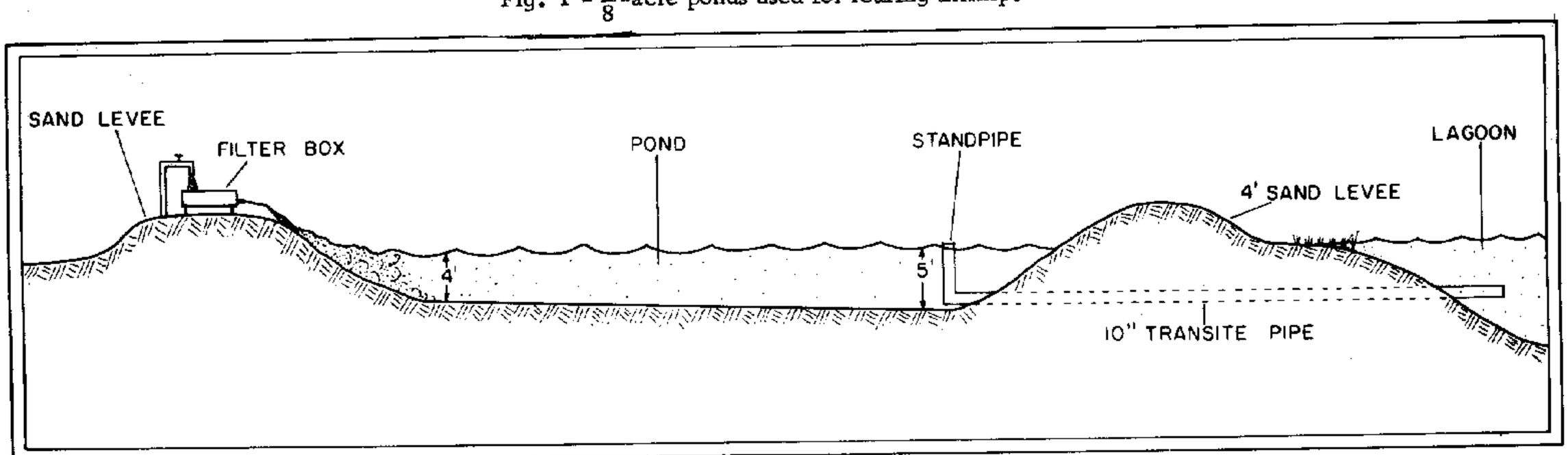

Fig. 2 - Cross section of pond showing location of filter box and standpipe.

estimate of 25-percentage survival, and a production goal of 1,000 pounds of whole shrimp per acre, we stocked 9,000 shrimp in each pond. Three weeks after stocking and, weekly thereafter, 40 shrimp from each pond were weighed, measured, and returned to the pond. In the static-water pond, chlorophyll a measurements were made periodically from surface-water samples to check the effect of fertilizer on the growth of phytoplankton.

GROWTH AND PRODUCTION

1. The Static-Water Pond

On March 26, 12 days before stocking the postlarvae, the researchers made an initial application of 160 pounds of soluble inorganic fertilizer with an NPK (nitrogen, phosphorus, potassium) ratio of 3:2:1. An additional 25 pounds of fertilizer (NPK ratio of 4:2:1) were applied on April 9, 2 days after stocking.

Two days after the initial application, a plankton bloom characterized by a slight green coloration was evident. On April 19, the chlorophyll a density was 73.0 mg./l. (milligrams per liter), a value 35 times greater than that in the adjacent lagoon. The water was pea green and a mat of algae had formed on the bottom along the pond's edge.

By April 21, the green color of the water began to fade. Fertilizer was added to restimulate plankton growth--but failed. The bloom disappeared by April 23, leaving the water clear and the bottom lined with a heavy deposit of black organic matter that had the distinctive odor of hydrogen sulfide. All postlarval shrimp had died. However, later tests in which shrimp were held in aquaria with similar concentrations of fertilizer indicated that the fertilizer had not caused the shrimp mortality.

On May 3, the pond was emptied, flushed, and refilled. Residual fertilizer[2/] in the bottom sediments was sufficient to produce an algal bloom in which the chlorophyll a content ranged from 2.3 to 6.4 mg./l.--values about twice that in the adjacent lagoon.

About 6,500 postlarval shrimp were stocked in this pond on May 6 and held 4 months. Shrimp growth during this period is shown in figure 3.

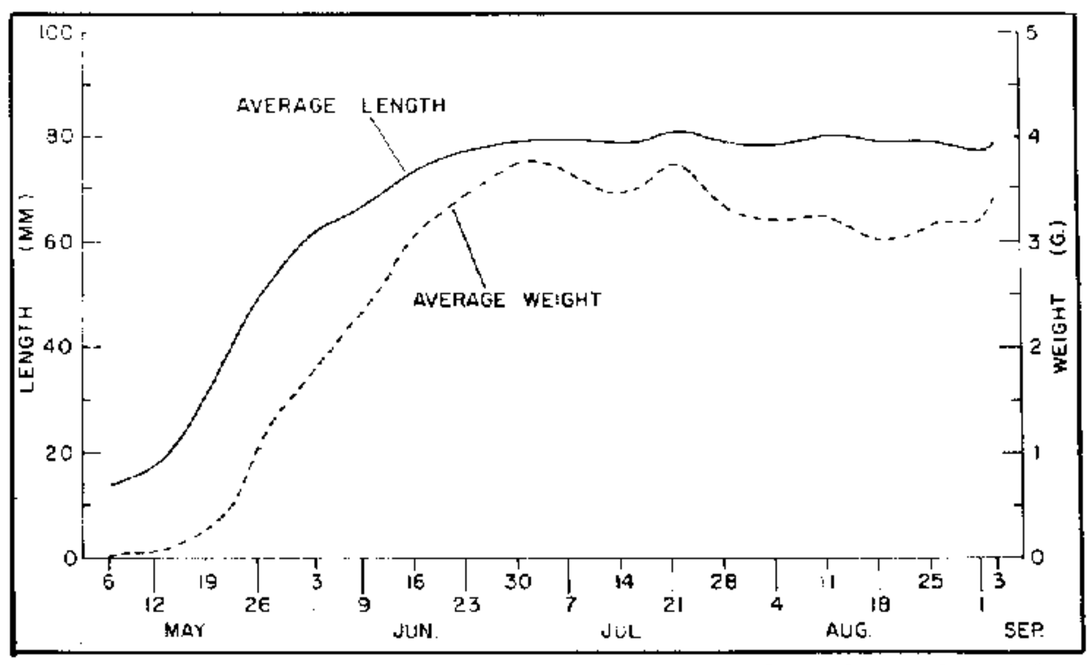

Fig. 3 - Shrimp growth, expressed as average lengths and weights, in the static-water pond over a 4-month period.

In 55 days, shrimp attained an average length of 79.7 mm. (3.1 inches) and average weight of 3.7 grams (0.130 ounce), or about 120 whole shrimp per pound. Average growth rates per day were 1.2 mm. (0.05 inch) in length and 0.7 gram (0.002 ounce) in weight. However, from the beginning of the 3rd month, and for 7 weeks, shrimp exhibited no appreciable increase in length, and showed a statistically significant loss in weight.

When the study was terminated in September, 5.6 pounds of whole shrimp having a tail count of about 200 per pound were removed from the pond. Projection of this value gives an estimated yield of about 45 pounds per acre.

2. The Circulating-Water Pond

Water was circulated at a rate of 60 gallons per minute (an amount equal to about one complete exchange of water every 48 hours); the shrimp were fed daily a prepared diet of ground fish and shellfish (64 percent by weight) mixed with commercially produced livestock food (36 percent by weight). Results are shown in figure 4.

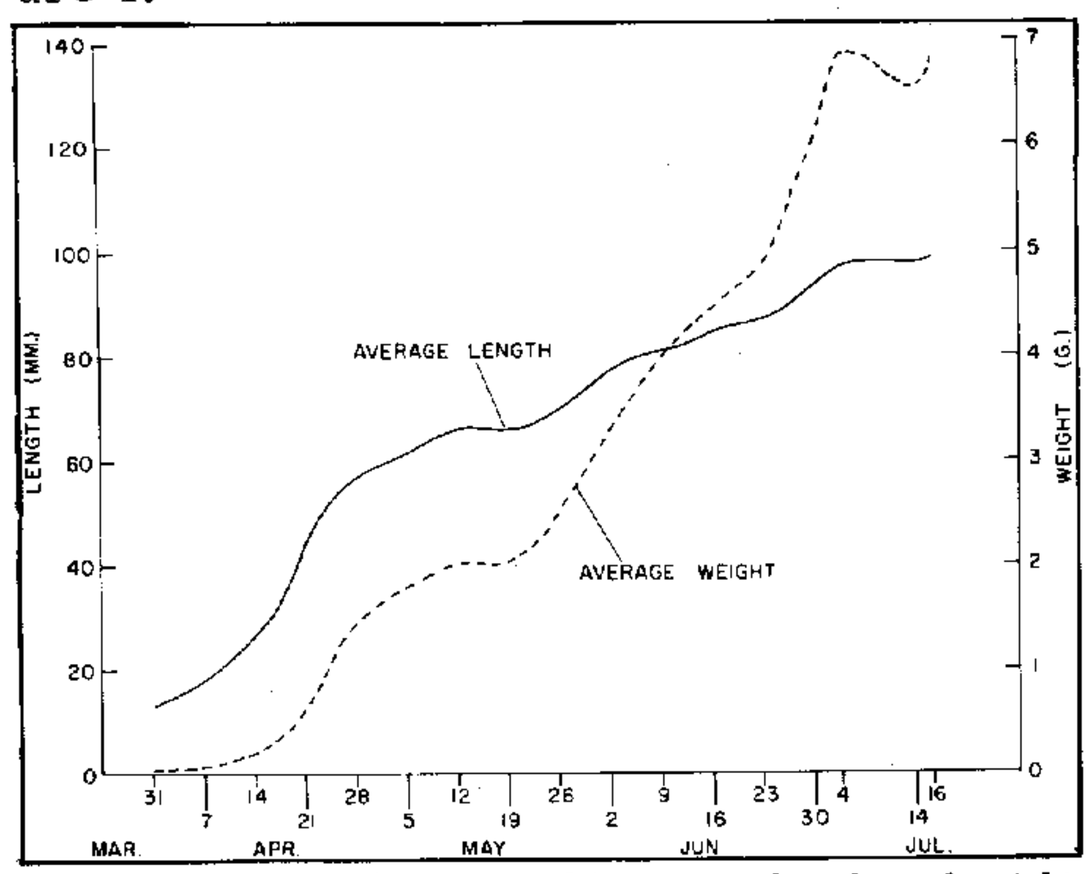

Fig. 4 - Shrimp growth, expressed in average lengths and weights, in the circulating-water pond over a 3-month period.

In 3 months, shrimp grew to an average length of 97.4 mm. (3.8 inches) and weight of 6.9 grams (0.243 ounce), or about 66 whole shrimp per pound. Although weekly growth rates varied, daily increases during this time averaged 0.9 mm. (0.04 inch) in length and 0.073 grams (<0.003 ounce) in weight.

This study was unexpectedly terminated 95 days from the date of stocking. On July 4, shrimp were observed concentrating near the source of inflowing water and crawling out on the banks of the pond. Suspecting low dissolved oxygen, attempts were made to increase water circulation (and thus oxygen) by pumping in more water with a 4-inch pump and agitating the pond water with an outboard motor. The attempts proved only partially successful, however, for when the pond was drained on July 16, only 231 shrimp remained.

After the July 4 kill, 25.7 pounds of dead shrimp (1,696 shrimp averaging 97.4 mm. in length and having a tail count of about 106 per pound) were removed from the pond banks and

2/Four days after refilling, a chemical analysis of water samples from the pond and the lagoon showed the total phosphate content to be 8.20 and 2.85 µg. at./l. (microgram atoms per liter), respectively.

water's edge. All dead shrimp were not recovered, however, because the pond was not immediately drained. Projection of the combined weights of dead and surviving shrimp showed a yield of 234 pounds of whole shrimp per acre in a 95-day growing period.

CONDITION OF SHRIMP IN THE TWO PONDS

Although the initial attempts to rear shrimp under semi-natural conditions were not fully successful, sufficient length-weight data were obtained at weekly intervals to compare the coefficient of condition (K) of the shrimp in the two ponds (fig. 5). This factor (K) expresses relative well-being and robustness of shrimp; it is derived by the formula:

$$K = \frac{1{,}000{,}000\ W}{L^3}$$

where W = weight in grams and L = length in millimeters.

The difference in condition of the shrimp reared in the two ponds is readily apparent.

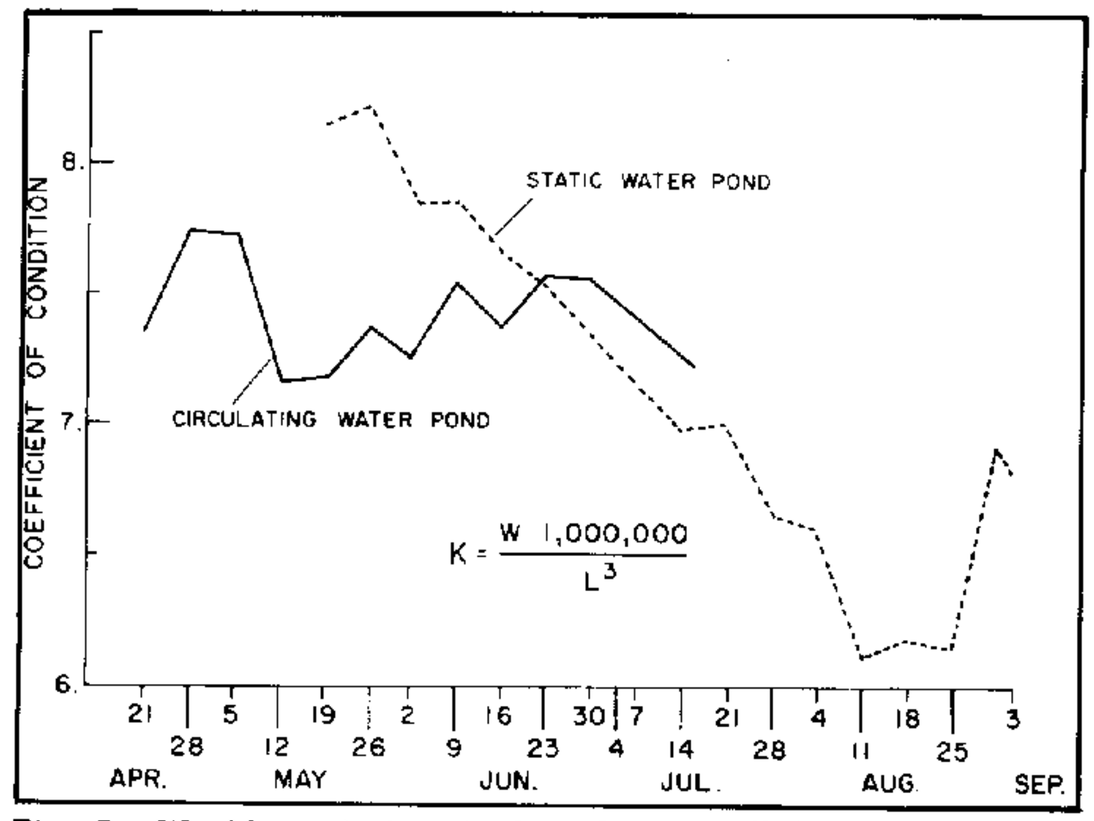

Fig. 5 - Weekly variations in the relative well-being and robustness of shrimp reared in the static- and circulating-water ponds.

Shrimp held in the circulating pond maintained, in general, a good state of relative well-being, whereas those held in the static-water pond did not.

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