

# Shrimp

## At the G

AS THE INITIAL overoptimism concerning the profitability of shrimp farming has faded into a realization that penaeid shrimp may be difficult to culture, research organizations working in the field have had to take a serious look at the usefulness of their work. Although several groups have experimented with pond culture of shrimp, much of their work has been limited to trials of feeds and rearing procedures to determine whether or not rates of growth and survival could be improved. Even though the use of the trial and error approach has led to workable pond culture procedures, it has provided little information concerning the nutrition of shrimp or the factors affecting survival of shrimp in ponds.

Several problems have become apparent during the early experimental work with penaeid shrimp native to the Gulf of Mexico. Some intensive research will be required on at least three of these problems before farming of penaeid shrimp for food will be economically feasible in the United States.

### Problem Areas

The first and probably the most critical need is for work on the causes

A SHRIMP raised in artificial sea-water at the Galveston laboratory is shown at the left. Abnormalities in the carapace of this animal indicate the apparent lack of components essential for normal development.

# Shrimp Culture Research at the Galveston Biological Lab

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and means of controlling mortality of shrimp in captivity. In almost every pilot study, survival rates of shrimp in ponds have been low. The possible exception is to be found in experiments where unusually low stocking rates were used. While most research conducted to date has been directed toward finding methods for increasing growth rates, the major problem facing prospective shrimp farmers is the low survival rate of shrimp in ponds.

A second problem is that of shrimp nutrition. This problem may be closely related to the first problem, but will require a particular type of research. Because the nutritional requirements of shrimp are not known, artificial foods that will support normal growth rates for any of the stages in the life history are not available. A variety of artificial foods have been used with moderate success to supplement the diets of shrimp feeding on natural foods; however, the nutritional value of these supplements has not been ascertained.

A third problem which causes larval culture costs to be high is the failure of female shrimp to mature in captivity. Even though it may not prohibit economical cultivation of shrimp, the high cost of the collection of gravid female shrimp from wild populations constitutes a significant portion of the hatchery operation costs. In addition, no selective breeding can be done until captive shrimp can be maintained through their entire life cycle.

Personnel at the National Marine

Fisheries Service Biological Laboratory in Galveston, Texas, are planning work on the first of these problems, and are presently working on the second and third as well as other minor problems related to larval shrimp culture.

#### Mortality

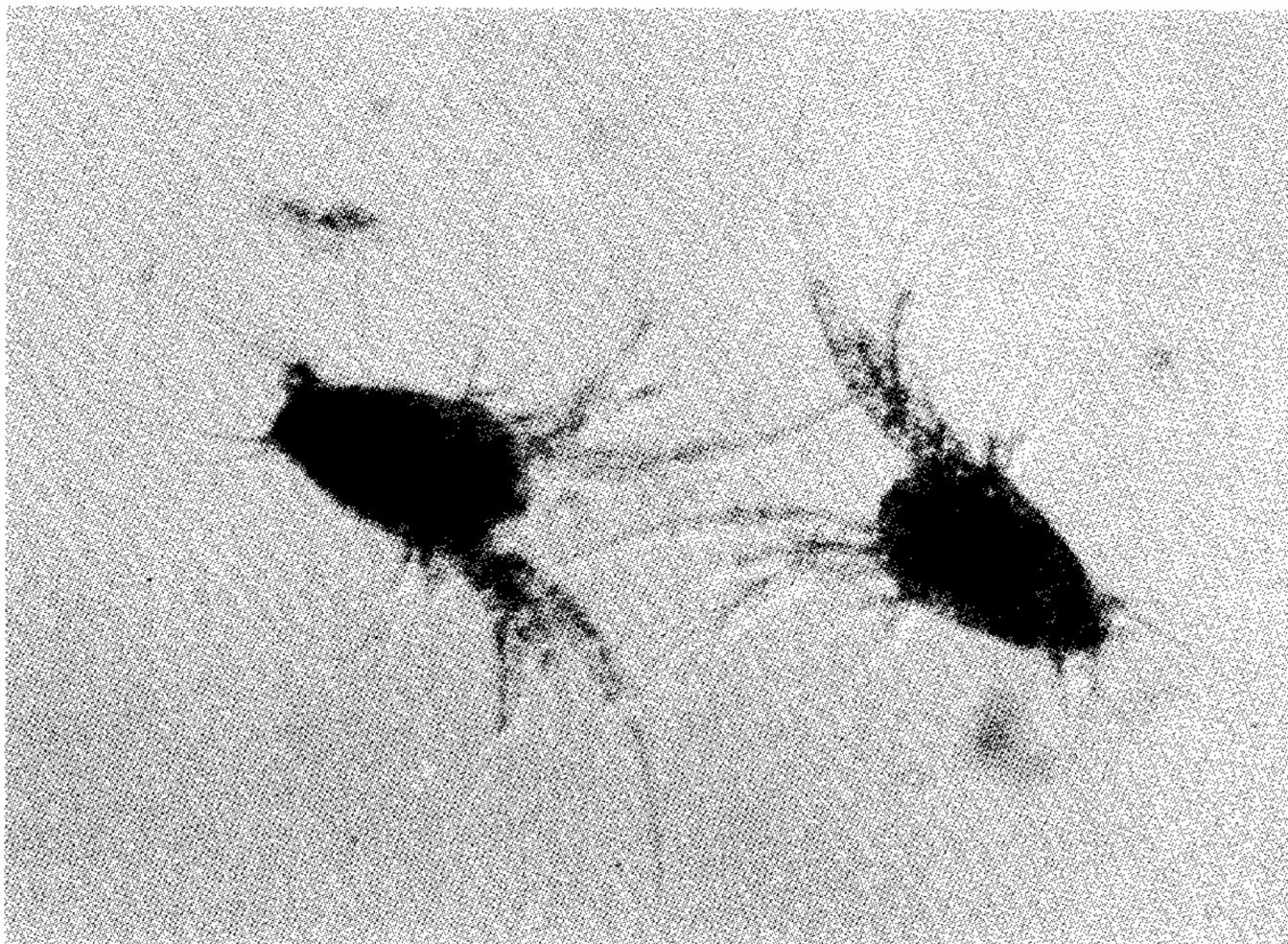
To determine causes and develop means of controlling the mortality of shrimp in captivity, we have established a project to study shrimp diseases. In addition to searching for

causes, we will look for methods of prevention and control of nutritional diseases, environmentally induced injuries or malfunctions, and infectious diseases.

Although we know practically nothing about the diseases of captive shrimp, experience with other domestic animals and preliminary reports of infectious diseases in captive shrimp lead us to believe that disease will be of major concern to shrimp

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THE TWO SHRIMP SHOWN BELOW (greatly magnified) are specimens of the fifth naupliar stage of the species *Xiphoeneus kroyeri*. These shrimp are being studied to determine the techniques which will make successful commercial culture possible.



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farmers in the future. Unfortunately, so little work has been done with shrimp that we are not able to distinguish normal tissues from diseased tissues. Neither can we distinguish between the normal tissue changes and invasions of foreign organisms which follow death from those tissue changes and invasions which cause illness or death.

Obviously much basic descriptive work on the histology and histopathology is needed before the recognition and control of shrimp diseases will be possible. Personnel in our shrimp disease project will be involved in both the basic background work and research with the diseases observed in penaeid shrimp.

A broad program, presently in its early stages, has been initiated to evaluate the potential of stocking shrimp in natural environments, semi-controlled environments, and in controlled ponds or impoundments. This study will encompass many aspects of shrimp ecology, but a major portion of the work will be directed toward

measuring mortality under a variety of environmental conditions.

## Nutrition Studies

Studies on shrimp nutrition have been underway at the Galveston Biological Laboratory for some time. Our approach has been through laboratory experimentation because of the difficulty in determining what shrimp eat in ponds. Shrimp will frequently separate and eat selected portions of prepared foods even when the foods are pelletized. In addition, portions of many foods go into solution in the water before the food is eaten.

The possibility that organic compounds are taken up by larval shrimp directly from the water is a further complication in nutritional studies. If nutrients are being taken from both the water medium and the food, we must either know what shrimp take from the medium or define nutritional requirements for shrimp held in a standard medium.

A considerable amount of our present work is aimed toward defining a medium which is suitable for holding larval shrimp during studies of shrimp nutrition. Since our research to date has shown that commercially available artificial salts plus distilled water do not constitute a suitable medium, other substances are being added experimentally to formulate a satisfactory, completely defined water environment.

Work is continuing on methods of rearing diatoms in mass culture as food for the larval shrimp. Although some quite successful techniques have been developed for rearing *Skeletonema* sp., several other species or combinations of species are apparently better food than *Skeletonema* alone. We are working with methods of preserving algal cells, for example, using refrigeration, freezing and freeze-drying techniques which may make it possible to store these cells for use as food when they are needed. This process would help eliminate one of our major problems, that of providing sufficient living algal cells at precisely the time they are needed for feeding the larvae.

## Growth Rates

With the artificial foods we have tested, growth rates of postlarval shrimp have not exceeded 0.3-0.4 mm. per day while those of shrimp fed freshly hatched brine shrimp eggs may average 1.3 mm. per day. Since we have no satisfactory artificial food that will serve as a control or standard, it is extremely difficult to evaluate individual components of our prepared foods at this time. Generally speaking, high protein foods are required (meaning relatively high costs), and animal sources of protein such as fish meal are utilized more efficiently than proteins from plants. Either grain meals or sugars may be used as sources of carbohydrates, but

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NUTRITION EXPERIMENTS are an important part of the work that is being done in shrimp culture. These flasks contain freeze-dried *Skeletonema*, a diatom which provides important nutritional elements to larval shrimp.

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sugars are readily soluble and encourage growth of undesirable microorganisms in the water.

Other ingredients being tested can be classified as vitamins, minerals, oils, attractants and binders. These encompass the "dark area" of our knowledge of shrimp nutrition. The lack of a good binder is particularly perplexing because we cannot be sure all the components of a food are eaten by shrimp until we have developed a satisfactory binder.

A number of prepared feeds and diets formulated for fish have been tested with juvenile and subadult shrimp. None of the feeds tested have been adequate nutritionally even though supplements of several types have been added experimentally. Nearly all of the high protein feeds tested were apparently utilized by the shrimp, but none supported growth similar to that observed in wild shrimp.

## Spawning

Factors that inhibit sexual maturation

of female shrimp in captivity may be either nutritional or environmental. Although the Japanese shrimp culturists have successfully spawned hatchery-reared shrimp, the fecundity decreases with successive generations. None of the commercially important species native to the Gulf of Mexico have been reared from eggs and spawned successfully in captivity. Personnel at the Galveston Laboratory are involved in studies of the nutritional and environmental requirements for the sexual maturation of females. It is clear much more work is needed in this area so that selective breeding can become a part of the research effort.

## Additional Research

An additional area of research is our experimentation with shrimp hatchery techniques and design. Emphasis is placed on designing an inexpensive facility that will require as little labor as possible to operate. Because of our research needs for shrimp reared using consistent, reproducible methods, we have developed hatchery techniques based on feeding carefully controlled amounts of particular species of cultured algae. Whether or not this approach is more

satisfactory for commercial operation than the Japanese method of rearing mixed algal cultures with the larvae remains to be seen. It does permit the culture of shrimp on a very intensive basis with the use of small tanks. We have reared them at concentrations of up to 2,000 per gallon through the protozoal stages and up to 1,000 per gallon to the first postlarval stage.

A question frequently asked by prospective shrimp farmers is, "Is this the proper time to invest in shrimp culture?" Our answer is, "Not unless you can afford to do it on an experimental basis." We foresee a number of years of research before shrimp farming will be a dependable, profitable business in the United States. ■

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