Fresh shrimp for tempura can command upward of $10 a pound in Japan. An NMFS scientist reports on the culturing of this specialty.

Shrimp Culture in Japan

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One of the most valuable marine species in Japan is the "Kuruma-Ebi" *(Penaeus japonicus)* shrimp fishery, which commanded a price of 7 to 30 U.S. dollars per kilogram in 1971 at the Tokyo Central Fish Market. Although this price is high compared with U.S. prices, it is due to the fact that the Japanese people demand live shrimp for the preparation of a delicacy known as tempura.[1]

Over the years much time has been spent developing methods of holding this species in ponds and rearing it to market size. Even though the Japanese have successfully reared shrimp through several generations, they explained that it was not economical to rear shrimp to sexual maturity because it was time-consuming and because the fecundity of the females was reduced. Therefore, gravid females are purchased directly from the commercial fishing fleets and then spawned.

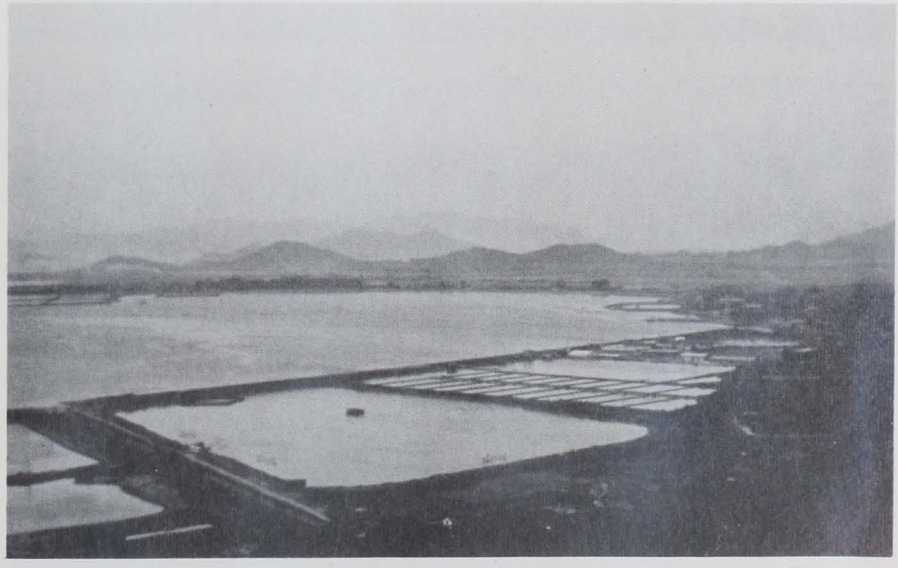
Once the eggs have hatched, the water is fertilized to stimulate the growth of diatoms. Predetermined amounts of fertilizer and seawater are added each day to the tank until the larval shrimp have reached the last mysis stage. Brine shrimp nauplii *(Artemia* spp.) are fed from the last mysis stage through the fourth postlarval stage. The shrimp are then fed fresh meats of clams *(Venerupis philippinarum)* and mussels *(Mytilus edulis)*, which are crushed and distributed throughout the ponds. Because it is too costly and time-consuming to separate the crushed shell from the meats, the shell eventually covers the pond bottom, resulting in a substrate that hampers the burrowing of the shrimps. Thus, ponds must be drained or dredged periodically to remove the shell debris.

Although larval rearing techniques are primarily the same today as they were 10 years ago, research in shrimp culture has been expanded because of three important factors: (1) the rising demand and costs for fresh food items to be fed to the shrimp; (2) the rising wages of employees; and (3) disease problems encountered.

Of particular interest is the use of a by-product of soy sauce production, a cake which is ground into powder to fertilize the water. Not only does it stimulate the growth of diatoms, but the larval shrimp also eat it. As the shrimp grow in size, this powder is either extruded or pressed into a size suitable for

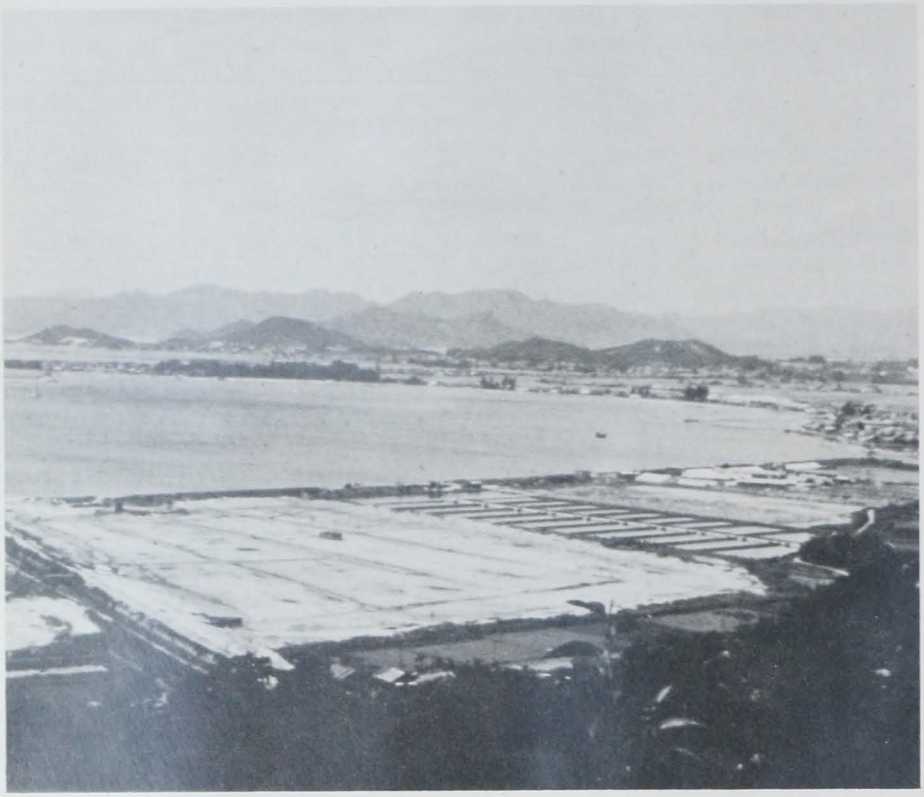
Metric tons of *Penaeus japonicus*.

YEAR	SOURCE		
	Cultured	Natural Catch	Imported
1964	154	3,184	17,087
1965	95	3,010	21,011
1966	211	2,479	36,156
1967	307	2,338	44,466
1968	311	1,884	32,204
1969	295	1,585	48,886

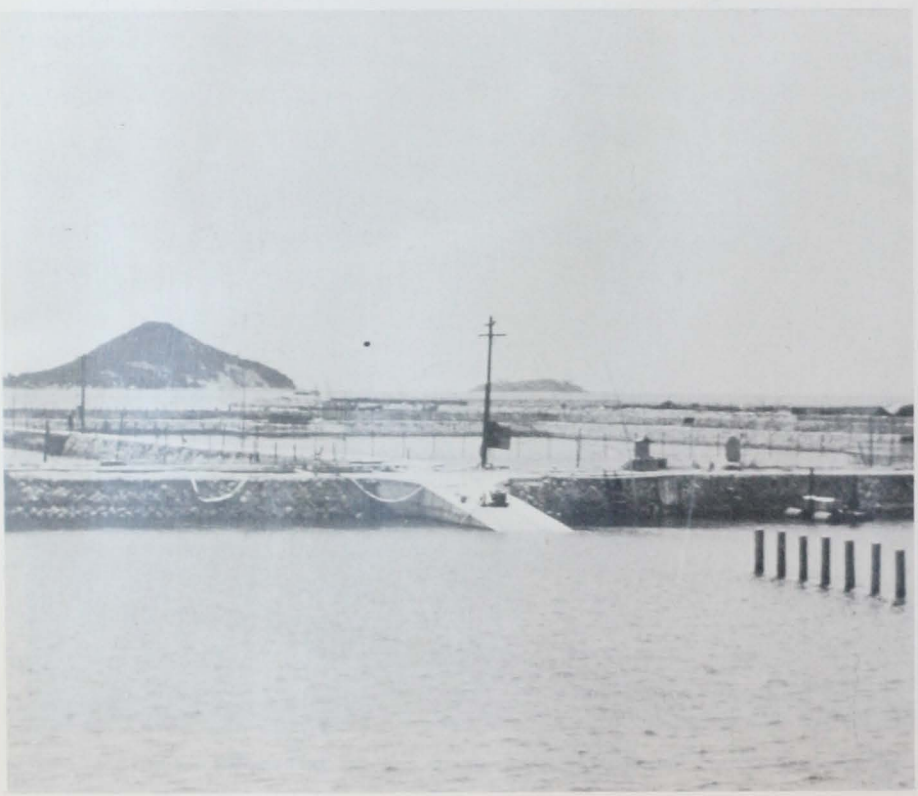


Shrimp farming ponds in Yamaguchi Prefecture, at the southern tip of Honshu, the principal island of Japan.

[1] Editor's note: Tempura is a method of cooking. Shrimp, other seafoods, chicken, fresh vegetables are dipped in batter and deep-fried. Recipes for the batter vary and are often a closely-guarded professional secret. Usually, foods cooked this way are served with a special sauce. It is popularly held that the technique was introduced into Japan by the Portuguese centuries ago. Tempura restaurants are a frequent and delightful feature of the Japanese scene.



Above and below.—Further views of shrimp farming ponds in Yamaguchi Prefecture.



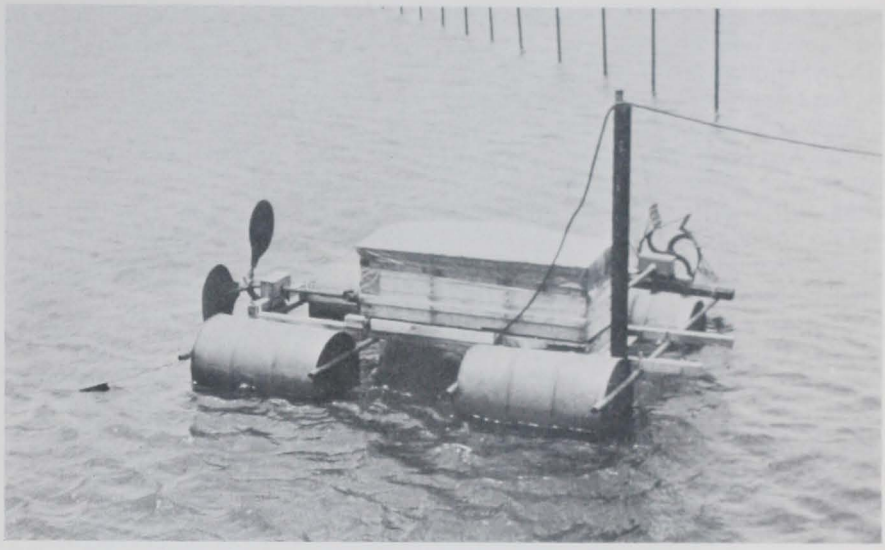
eating. At the Kagoshima Prefecture Fisheries Experimental Station, the Director, Dr. K. Shigeno, remarked that although the shrimp ate this artificial food and grew to market size, the consumer was not satisfied with the quality or color of the prawns. He felt that the problem was primarily a vitamin deficiency. Artificial foods with a variety of additives are being tested at Dr. Shigeno's laboratory.

Research is also being directed toward rearing prawns to market size in a closed system. A 1,000-cubic meter cement tank (23 m in diameter and 3 m deep) has been built at the Tarumizu Kagoshima Prefecture Fish Experiment Station. The water temperature can be controlled, and a false bottom with airlift pipes has been installed as an in-bottom filter. Twenty-day-old postlarval shrimp have been stocked in this tank and reared to market size with good results. However, during two recent experiments a number of problems occurred, resulting in poor production.

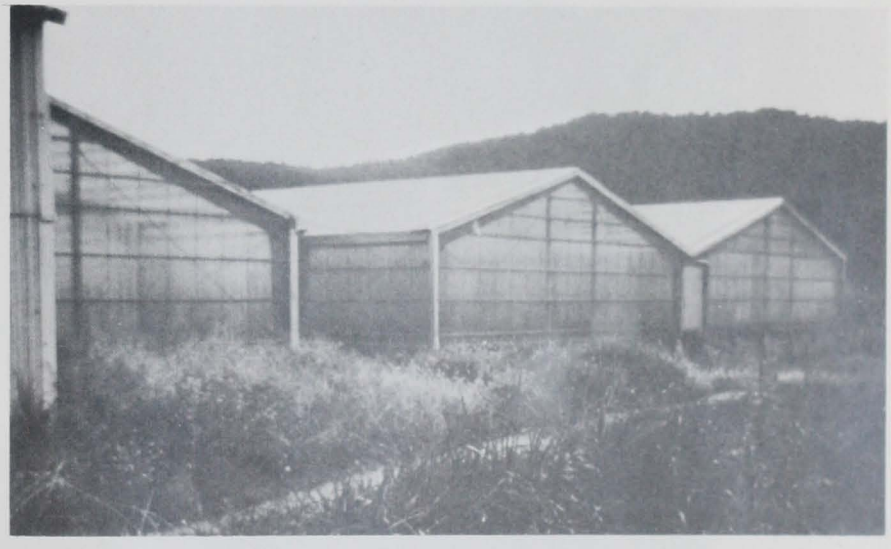
Circulation of the water mass within a rearing system was emphasized for either fish or shrimp culture. At Tarumizu Kagoshima Prefecture Fish Experimental Station the flow was maintained with water jets, while a large mechanical stirrer was being tested at Setonaikai Saibai Gyogyo Center, Tamano Jigyojo.

At the Nansei Regional Fisheries Research Laboratory, Dr. H. Kurata spoke about the natural waves of *Penaeus japonicus* postlarvae that enter the estuaries. Monitoring of these waves now indicates that recruitment is presently less than in previous years. The total tonnage landed by the commercial shrimp fleet is also down. Therefore, the concept of seeding the system with 1.2×10^8 20-day-old postlarval shrimp is being tested to see if the system is still a suitable environment, if production of shrimp can be stimulated, and if new areas can be used. Some shrimp are released directly into the nursery grounds, while others are placed in a pen (30 x 10 x 10 m) for 2 to 4 weeks to acclimate them to estuarine waters.

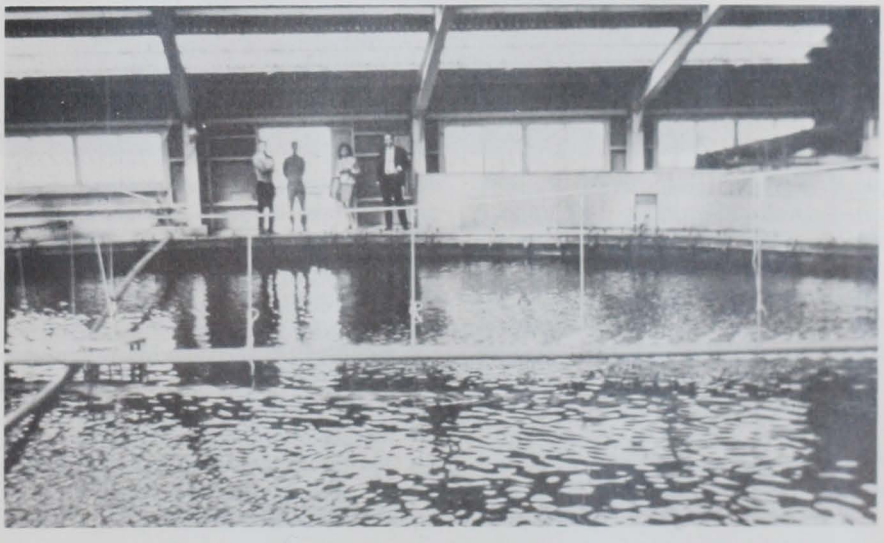
Dr. M. Fujiya, also of the Nansei Laboratory, began physiological studies to measure the "quality" of shrimp larvae reared in different ways, by observing their reaction to anesthetics. His approach is to insert electrodes into the



Floating raft with electrical agitator used to maintain circulation and desired oxygen levels in ponds.



Greenhouse used to house fish hatchery.



New experimental 1,000-ton tank (23 meters in diameter) for intensive culture of shrimp to market size.

brain of the shrimp and record their brain waves on an oscilloscope.

Dr. H. Hirata, at Kagoshima University, has begun work on the production of single-species mass cultures of diatoms and their preservation. At present, diatoms are concentrated and later frozen at 0°C. They can be held successfully for periods of 30 days or less. Various other techniques are now being tested.

At the University of Tokyo, School of Fisheries, Dr. Ogoaowara and Dr. T. Sano discussed the culture of freshwater shrimp of the species *Macrobrachium*. Eleven different species were being studied. To rear the larval stages, they indicated that a medium of 50 percent fresh water and 50 percent seawater was necessary. A diet of *Artemia*, reared on a freshwater culture of *Chlorella*, is fed during the larval stages along with ground clam (*Tapes* sp.) meat. When the shrimp are older, pieces of chicken egg shells are added to supplement the calcium in their diets.

Juveniles of *Macrobrachium rosenbergi* have been reared on commercial trout pellets to market size in 6 months at the Izu Branch Laboratory. Although results have been satisfactory, production costs were not made available.

Packing live shrimp for the market.

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Hauls in the southern U.S. shrimp fleet consist of shrimp, fishes, and other creatures. Here the shrimp are being sorted from a mixed catch taken off Florida.

Chitin Bibliography

An unexpected spinoff produced by the new water pollution laws is a bibliography on chitin and chitin derivatives. E.R. Pariser and S. Bock used a Massachusetts Institute of Technology Sea Grant Program seed grant to support preparation of an annotated bibliography of selected publications from 1965 to 1971 on the polymer chitin and its derivatives.

Information included in the compilation includes investigation into chitin's distribution, properties and uses.

Impetus for the bibliography came from the Federal government's pressures on the fishing industry to stop dumping lobster, shrimp and crab carcasses, which are primarily chitin, into the ocean—the industry's traditional disposal method. Chitin resists biodegradation and is thus a source of visual and biological pollution.

The rulings meant that unless the industry could find new ways for chitin disposal—or better, new uses for the "wastes"—many of the smaller processors would be forced out of business because they could not afford expensive disposal alternatives.

Despite its abundance, chitin has aroused minimal scientific and no real commercial interest. The polymer is difficult to harvest, isolate and purify. Almost no economic incentive existed prior to the pollution legislation to prompt a systematic, in-depth study.

Chitin derivatives have many potential uses, including: in pharmaceuticals; in paper and on it, to increase its wet strength and to improve its printing surface, respectively; in water purification processes as a coagulant; in agriculture, mixed with insecticide (since it resists biodegradation, it would provide long-term time release effectiveness on the insecticide).

Several billion tons of chitin are produced each year by marine copepods, and these are only one of the many animal groups that synthesize the polymer as an important exoskeleton component. Insects, crustacea, some of the annelids, the molluscs, other of the invertebrates, and even some cephalochordates synthesize chitin. Many fungi, possibly even some bacteria, have chitin in their cell walls, where it appears to replace cellulose.

Source: Sea Grant 70's, Vol. 3, No. 5, Jan. 1973

Shrimp Yield of 4 Tons Per Acre Claimed

Intensive culture methods at the Kanda Fish Farm in Japan have resulted in yields as high as 10 tons per hectare per year (in English units, more than 4 tons per acre), according to a scientific paper published in Taiwan, Republic of China.

The paper, in Chinese with an English abstract, is written by Ting-Lang Huang, Tainan Fish Culture Station, Taiwan Fisheries Research Institute, and Shumei Kanda, Kanda Shrimp Farm. It appeared in the publication *Aquiculture*, Vol. 2, No. 1, June, 1972. The publication is issued by the Tungkan Marine Laboratory, Taiwan Fisheries Research Institute, Taiwan, Republic of China.

The shrimp in question is *Penaeus japonicus*, commonly used for culture in Japan.