

Forget Worms:

Producers May Put Fish on Insect Diet

There is no difference in the appearance of conventional fish feed, left, and insect-based feed.



Kit Lawrence

Frank Davis during the 2007 Insect Rearing Workshop.



Bob Ratliff

Davis, left, and Ernest Papadoyianis in the Insect-Rearing Center.



Kit Lawrence

Linda DeFoliart of Fairbanks, Alaska, gets hands-on experience during the 2007 workshop.

By Bob Ratliff

Bugs are just pests for most people, but a group of Mississippi State University scientists is working to make insects an important crop.

"In early 2007, I was called by Ernest Papadoyianis, president of Neptune Industries in Boca Raton, Florida, about visiting MSU to talk about the mass rearing of insects," said MSU entomologist Frank Davis. "His interest was in mass producing insects as a sustainable protein source to replace fish meal in fish and livestock feeds."

The call brought together a company with diversified interests in seafood and aquaculture technologies, including the integration of fish farming, hydroponics and waste-to-energy production, with perhaps the only university in the world with the ability to researching all aspects of rearing insects as a source of food for fish and other livestock.

"Growing insects for use in research began at MSU when the Department of Entomology established a facility called 'The Worm Shed' and U.S. Department of Agriculture entomologist R.T. Gast and I started growing several insect species on artificial diets in the 1960s at the Boll Weevil Research Laboratory," Davis said. "During these years, rearing systems were developed for the boll weevil and other insects, including fall armyworms, corn earworms, southwestern corn borers and tobacco budworms, with the purpose of finding ways to rid crops of these costly pests."

As a USDA entomologist for 35 years, Davis led a team that developed a major insect-rearing facility at the federal laboratory for rearing pest moth species for corn and cotton research. When he retired from USDA in 1999, Davis accepted a position as an emeritus adjunct professor in the Department of Entomology and Plant

Pathology at MSU. In that capacity, he organized the university's first Insect Rearing Workshop in the fall of 2000. During the past seven years, the workshop has brought hundreds of scientists from throughout the United States and overseas to campus to learn about raising insects for use in research, for educational purposes and for commercial uses, including natural control of insect pests. The workshop has also led to the construction of the state-of-the-art Insect-Rearing Center on campus.

It was the workshop's reputation as one of the few places in the world to learn about insect rearing that caught the attention of Neptune Industries.

"We were brainstorming about ways to eliminate one of the major bottlenecks in the aquaculture industry—reliance on fish meal for protein in fish diets—when someone mentioned insects. The light bulb immediately went off. We immediately began searching for the top entomology programs in the country to assist us in this research. Serendipitously, we saw a pet industry newspaper article on Dr. Davis and the insect rearing workshop at Mississippi State," said Ernest Papadoyianis, president of Neptune. "We had just talked about how many freshwater fish species derive most of their nutrition from various stages of small insects, some just the size of the head of a pin."

Aquaculture, the commercial production of seafood in managed ponds or tanks, currently supplies about 46 percent of all seafood consumed in the world today. The United Nations' Food and Agriculture Organization predicts that commercially grown supplies will rise to 75 percent of consumption in the next 20 years.

"The supply of wild-caught fish has really been flat since the late 1980s, and those stocks have little chance of regaining their past levels because of pollution, overfishing and other factors affecting commercial fishing," Papadoyianis said. "Aquaculture is left to bridge the widening gap, and we have to be sustainable in all aspects of our industry."

More than 25 percent of all fish harvested today are used for fish meal, and the majority of fish meal is used to produce other fish, he said. These baitfish stocks such as anchovies, menhaden and herring are exploited and growing scarcer as time goes on. The result is an ever-tightening supply situation, which has caused sharp price increases over the last year. This trend is expected to worsen.

"In order for our industry to grow and become independent of protein from wild-caught fish, we have to come up with sources that are sustainable," Papadoyianis said. "Having a source of high-quality protein that can be mass produced essentially from processing by-products from fruits, grains, and vegetables, and even fish and animal waste, would be an ideal situation for the aquaculture industry."

Just days after the initial telephone call, Papadoyianis and Sal Cherk, Neptune's chief operating officer, visited the MSU campus. The result of the visit with Davis, entomologist John Schneider, and entomology and plant pathology department head Clarence Collison was an agreement with the university to research the use of feed made from commercially grown insects for fish production.

"The first phase of the research was the selection of insect species with high amounts of protein that can be economically produced by the millions," Davis said. "That part of the research was completed during the summer, and feeding trials with hybrid striped bass supplied by Neptune began during the early fall."

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ERNEST PAPADOYIANIS

The feeding trials are being conducted by Mississippi Agricultural and Forestry Experiment Station scientist Lou D'Abramo, who is comparing feed pellets made with fish meal to pellets produced from insects. Both were commercially produced and look identical.

"The early trial results indicate the fish have no real preference for one over the other," D'Abramo said. "In the wild, fish do come to the surface to feed on dragonflies and other insects, so it makes sense that they will eat pellets made from insects."

D'Abramo is also studying weight gain and other factors that will determine whether the insect-based diet is acceptable for commercial fish production.

The next phase of the research was conducted at MSU's Garrison Sensory Evaluation Laboratory to determine whether an insect diet affects the taste, texture or other qualities of the fish.

"Our evaluation of the samples of hybrid striped bass from the feeding trial indicated no difference in appearance, flavor or texture of the fish grown on the insect-based diet and those grown on the fish meal diet," said Patti Coggins, director of the sensory evaluation lab. "The only difference we found was that the fillets from the fish raised on the insect diet did not have a strong 'fishy' smell."

With research pointing to the potential success of insect-based diets in fish production, Papadoyianis is looking ahead to the next step in the process—construction of a pilot insect-rearing facility to test growing, harvesting and processing methods.

"We've already had inquiries from all over the world about this," Papadoyianis said. "Our vision is to have insect production facilities in all of the geographical regions with major commercial aquaculture industries in order to reduce freight costs. That will require researching the use of local insect species, nutrition and production methods, so we envision a long-term relationship with Mississippi State University."