"Golden Fish" Culture in India

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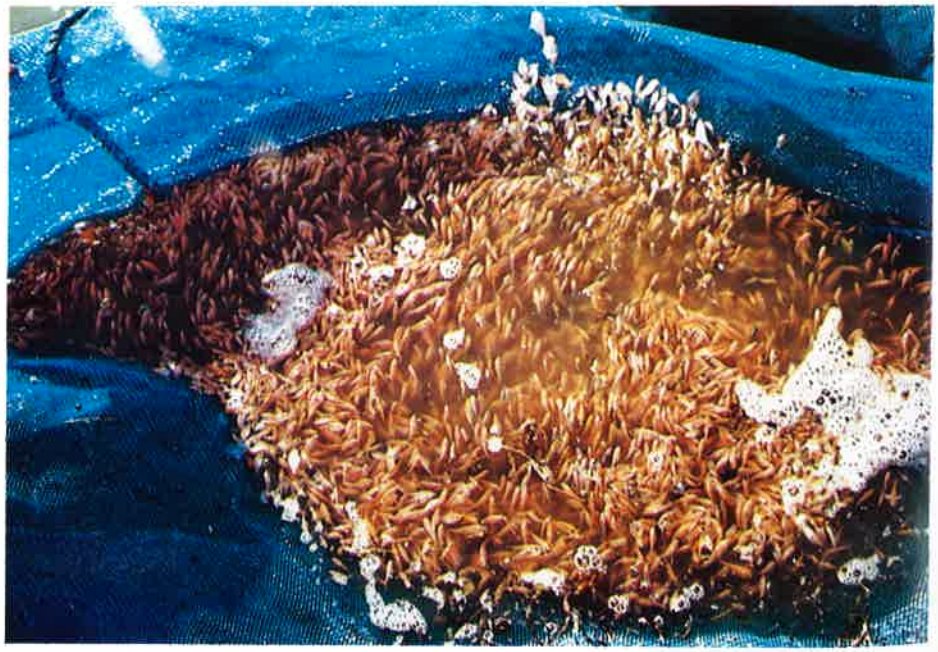
In India, in recent years, more and more importance has been given to fish culture, particularly freshwater fish culture. The country's total fish production at present is 2.85 million t and the target for 1989-1990 is 4 million t. This is to be achieved by increasing fish landings from marine sources and intensifying inland fish culture. Several programs are being implemented under the sponsorship of the Government of India and the State Governments to achieve the above targets. Since intensive fish culture in inland waters requires heavy investment, only a limited area can be covered under government-sponsored programs. Several industrial enterprises have been interested in intensive fish culture, but not many have succeeded for want of technological and financial inputs. Vorion Chemicals and Distilleries Ltd. (VCDL), Madras has become a path-setter in India by being able to implement successfully a fish culture project.

Biotechnology for Fish Culture

The project involves the application of two major breakthroughs in biotechnology. First, industrial effluent water is used for fish culture after proper processing. Second, a suitable strain or species of fish has been developed for intensive culture in the treated effluent water. Relevant technology is continuously being developed. The financial inputs are also high. Over a period of 3 years, VCDL has developed the biotechnology, which is now available for adoption by other similar enterprises.

Top: "Golden Fish" ready for harvest. *Below:* Sex-reversed male fingerlings ready for transfer to fingerling ponds.



Treatment of Distillery Effluent

In India, as in many other parts of the world, distillery effluent is considered to be the worst, since the biological oxygen demand (BOD) is very high. The raw material used in the distillery is molasses and the process is microbial fermentation. Water requirement is also very high, about 5-8 l per liter of alcohol produced. In some respects distillery effluent should be very valuable for it contains large quantities of organic matter and there are no metallic elements to damage the environment. However, highly concentrated organic matter in the effluent is harmful when the effluent is directly disposed into stagnant or stream water. An anaerobic microbial process breaks down the organic matter and converts it into biomass, producing methane gas in the process.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(1) The floating aerator at work. (2) An overview of the fish farm. Note the "bioreéf" in the middle of each pond. (3) The VCDL alcohol plant, with the fish farm in the background.

Traces of sulfur in the effluent are converted into hydrogen sulfide by sulfur bacteria. The methane gas could be used as a source of energy for the boiler in the distillery or converted into electrical energy in a gas-turbine. These processes require relatively heavy investment, but the value of the biogas can partially, if not fully, compensate for this high cost. There are about 150 molasses-based distilleries in the country and each has problems with efficient disposal of effluent. Through proper adoption of the technology described above, these industries can effectively solve their pollution problems.

The digested effluent containing about 2,500 ppm of BOD is further treated aerobically to bring down the BOD to 500-1,000 ppm, which is tolerable for fish culture. This is done by letting the effluent pass through an aerated bioconversion tank. The various microflora and microfauna, including protein-rich blue-green algae, are encouraged to multiply faster in the medium, reducing the BOD further to 500 ppm. Large volumes of valuable biomass accumulate in the medium. These microflora and microfauna in the substratum are the starting points for fish culture. They become the primary feed for the fish. Thus, the organic matter in the distillery effluent is converted into fish feed, both anaerobically and aerobically. The resulting digested water containing various groups of organisms is led into fish ponds as feed.

"Golden Fish"

VCDL has developed a technology for continuous hybridization of different strains of *Oreochromis* and has obtained different shades of a golden colored hybrid. The hybrid is named "Golden Fish" for marketing purposes. The parents are exotic and the pure lines are maintained separately. First, a pure line male from one strain is used against a genetically pure female to exploit hybrid vigor. The golden color being dominant, the resultant F-1 offspring are mostly golden. The hybrid fry are transferred to sex-reversal tanks. In the sex-reversal process, the fry are fed with methyltestosterone; about 95-97% of the population is converted into male over a period of 3 weeks. The males grow at least 30% faster than the females, there being no diversion of energy into reproductive activities. The males, when about 3 weeks old, are taken to fingerling ponds and cultured there for about 4-6 weeks and then transferred to growout ponds.

Growout Ponds

The growout ponds are of the optimum size of about 0.20 ha. They are especially designed with a central "bioreef" divider and electrically operated paddlewheel aerators. This design promotes rapid growth of the fish. The aeration provides the fish with more oxygen and accelerates the multiplication of microflora and microfauna. While the main feed for the fish comes from the digested effluent which carries the biomass, additional, especially formulated feed is also supplied to maintain high growth rate. In about 6 months the fish reach the optimum size of 450-500 g. In one 0.20 ha fish tank, 10,000 to 12,000 fingerlings are seeded, giving a harvest of 5 t by the end of the sixth month. In a year, two crops can be harvested with a total yield of 50 t/ha -- about 20-30 times higher per unit area than the normal yield in India.

The construction cost of one pond is approximately US$4,000, including earth work, construction of the bioreef, end-walls, fixing of the paddlewheel aerator, etc. The cost of fingerlings is approximately $1,000 and the cost of feeding and energy input, $1,000 per crop. Adding the costs of labor and supervision, the annual expenditure would be approximately $4,000 per pond per harvest. Even when the fish is sold at a very reasonable price of $1.50/kg, one could get a large margin of profit.

The fish farm which has been set up at Vedanarayanapuram, near Chingleput in Tamil Nadu, India, covers 30.35 ha. There are 95 growout ponds. The total daily evaporation of water from the ponds is 500,000 l. The quantity of digested effluent available for replenishing the pond is also 500,000 l/day. Thus, no extra effluent water is flushed out of the system to cause pollution. All the materials contained in the effluent are properly taken care of by the microbes and eventually by the fish. The residues in the growout ponds are degraded by the microbes and recycled in the system. The system has been in operation for over 2 years without any technical difficulty. The fish are sold live as "Golden Fish" in the Madras city market.

Shallow sex-reversal tanks with subdued aeration.

Further Project Plans

VCDL has also developed extensive facilities for research and development, and large-scale production of eggs and fingerlings and for sex-reversal. The total cost of the project is US$1.5 million. In the next 12 months, 2-3 t of fish per day are expected to be harvested and marketed in Madras, Chingleput, Kancheepuram and other nearby cities. VCDL also has plans to sell the technology and to supply the fingerlings of the hybrid fish at a nominal cost to those who are interested in going into intensive fish culture, using VCDL technology. ●