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Improved shrimp larviculture using diatoms

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Implementation aids operating efficiency, postlarval quality

Progressive hatchery operators have long recognized the benefits of adding benthic pennate diatoms of the genera *Amphora* and *Navicula* to their larviculture tanks. The practice began when wild plankton filtrates of 500-µ fraction were added to the culture tanks to stimulate a bloom of naturally occurring flora and fauna.

Frequently, these filtrates produced a luxuriant growth of surface-adhering benthic diatoms. Improved survivals from these tanks prompted the isolation and propagation of the species involved. One operator referred to the practice of adding benthic diatom cultures to culture tanks as “sliming.”

An *Amphora* diatom.

Benthic diatoms and periphyton

Microscopic examination reveals that benthic diatoms provide the basic matrix for a complex of microorganisms commonly referred to as periphyton. Periphyton include benthic diatoms and associated microfauna (bacteria, rotifers, protozoans, etc.). Nutritional analyses have shown benthic diatoms and the associated periphyton to be rich in highly unsaturated fatty acids and polyunsaturated fatty acids, making periphyton a valuable feed resource for postlarvae.

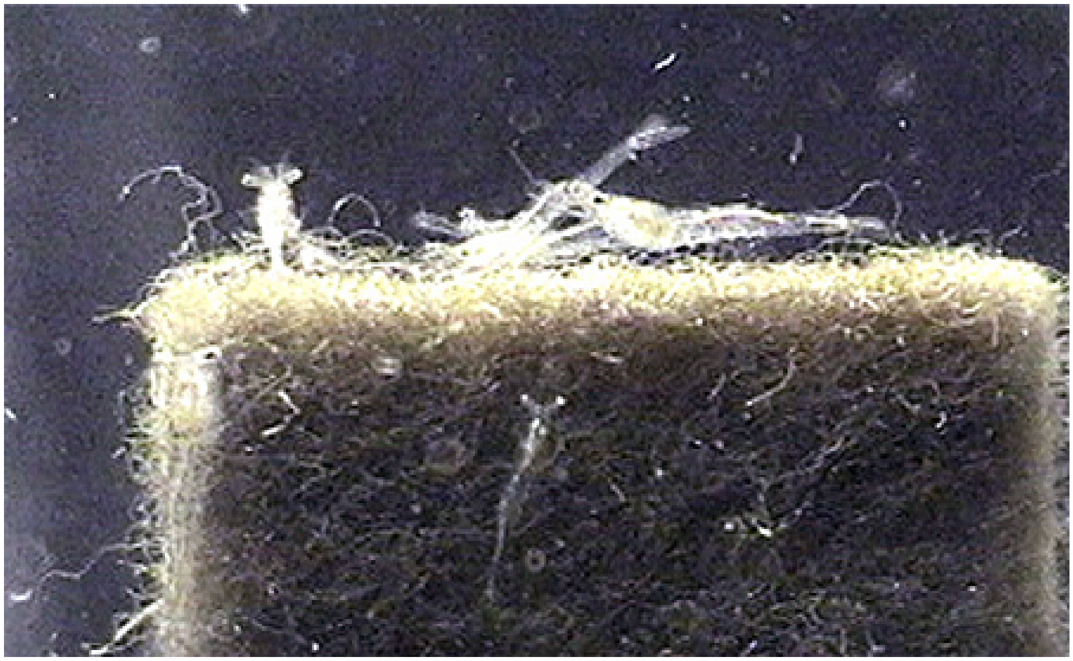
Concentrated diatoms

The arrival of Taura Syndrome Virus, White Spot Syndrome Virus, and other pathogens, and the resultant strict biosecurity protocols eliminated the practice of using plankton filtrates. Also, the hatchery industry trend to intensify production and lower costs has imposed the need for greater control over the culture environment.

Recognizing the benefits of benthic diatoms, Meridian Aquatic Technology, LLC has been closely involved with several commercial hatcheries and their efforts to test and isolate strains of benthic diatoms. The goal was to select a strain that combines the benefits of a high nutritional profile and ease of use in commercial hatchery environments. This research led to the commercial production of a concentrated product containing pure, live, disease-free *Amphora* diatoms.

Artificial substrates

Upon metamorphosis, *P. vannamei* postlarvae begin to exhibit a strong preference for surface grazing, as opposed to the more pelagic behavior associated with larval stages. Often the area provided by culture tank surfaces is not sufficient to support the benthic algae biomass required by the shrimp, and can be completely grazed within three days following metamorphosis.



After metamorphosis, shrimp postlarvae show a preference for surface grazing.

The use of artificial substrates like AquaMats® provides additional algae growth area of approximately 140 square meters per unit. Also, substrate units can provide about 410 square meters for beneficial bacteria growth. Coating these surfaces with diatoms of high nutrient value satisfies both the behavioral and nutritional requirements of postlarvae. Hatcheries using this combination have successfully increased stocking densities, improved survivals, and reduced or eliminated artemia usage.

Implementation

Taking full advantage of this new understanding of postlarval requirements requires some rethinking of the postlarval production process.

Single-stage production

Traditional postlarvae production is carried out in indoor tanks equipped with aeration and water temperature control systems. For *Penaeus vanna-mei*, tanks are typically stocked at densities of 50 to 150 nauplii (omega-5) per liter and grown out through metamorphosis until harvest size is reached.

Two-stage production

Recognizing the change in shrimp feeding behavior from the pelagic to the more benthic mode has prompted some Western Hemisphere hatcheries to physically separate larviculture into two phases (Table 1). Phase I includes traditional larviculture from nauplii to metamorphosis, while phase II includes postlarvae transfer to different tanks shortly after metamorphosis.

Table 1. Two-stage larval production process.

	Phase I	Phase II	Phase II with Artificial Substrate and *Amphora*
Tank Type	Conventional indoor, 5-20 m^3, concave-, V-, or flat-bottom tanks. May be rectangular or circular.	Outdoors or enclosed in translucent greenhouse. Usually long, rectangular 5-50 m^3 tanks with flat bottoms, occasionally pitched to drain.	Outdoors or enclosed in translucent greenhouse. Usually long, rectangular 5-50 m^3 tanks with flat bottoms, occasionally pitched to drain.
Aeration	Usually bottom-mounted airline that supplies vigorous aeration to maintain larvae and feeds in suspension.	Aeration with airstones, perforated plastic pipes, or venturi injectors.	Airstones preferred for gentle aeration that allows postlarvae to feed on surfaces.
Duration	Nauplii to 100% metamorphosis to postlarvae (typically PL_2 to PL_4).	Postlarvae to harvest. Typically PL_{10} to PL_{12}. Can also be extended to early juveniles (approx. 0.5 g/animal).	Postlarvae to harvest. Typically PL_{10} to PL_{12}. Can also be extended to early juveniles (approx. 0.5 g/animal).
Stocking Density	50-200 nauplii/l.	30-60 postlarvae/l.	50-200 postlarvae/l.
Maximum Shrimp Biomass		Typically less than 1 kg/m^3.	1.5-4 kg/m^3.
Feeds	Pelagic (free-floating) microalgae, *Artemia*, prepared dry diets.	Pelagic (free-floating) microalgae, prepared dry diets, including ground shrimp starter.	Benthic diatoms, prepared dry diets, including ground shrimp starter.
Water Exchange	Up to 100%/day.	25-50%/day.	0-10%/day.
Temperature Control	Water temperature maintained at 28-30° C.	Water temperature maintained at 25-28° C. Heating apparatus sometimes used.	Water temperature maintained at 25-28° C. Heating apparatus sometimes used.

Conclusion

Implementation of artificial substrates with *Amphora* diatoms in two-phase larviculture systems has produced improvements in both operating efficiency and postlarval quality. Operations have seen increased stocking densities, improved survivals, faster growth, larger average size, improved stress test results, and increased production.

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