Zooplankton are the minute animals that graze on phytoplankton, the microscopic plants of the sea. Zooplankton can be considered the foundation of fish larviculture, because they have long been the essential feed for larval fishes that require live prey since they cannot survive on formulated feeds. Although protozoa such as ciliates and trochophore larvae of bivalves have occasionally been used on a small scale, *Artemia* (brine shrimp), rotifers, and copepods are by far the most commonly-used zooplankton live feeds.
**Artemia**

*Artemia* are in wide use because they are a “convenience food.” *Artemia* cysts (resting eggs) are harvested in bulk from the wild and preserved by canning. They therefore have a very long shelf-life, so they may be stored at the hatchery and the cysts are hatched as needed. *Artemia* can also be cultured on a wide variety of feeds. However, *Artemia* have several shortcomings. Before hatching, the cysts should first be “decapsulated” using bleach and sodium hydroxide, both to kill pathogens that may contaminate their surfaces (although endogenous pathogens will not be affected), and to remove the hard shells of the cysts, which can kill larvae if ingested. Even first-stage nauplii are significantly larger than rotifers and so are too large to serve as the first feed for most fish species. Because *Artemia* are wild-harvested from habitats that are dominated by algae with limited nutritional value, the cysts and newly-hatched nauplii have an inferior fatty-acid profile compared to rotifers produced on enrichment feeds. Furthermore, first-stage *Artemia* nauplii are incapable of feeding, so their limited nutritional value rapidly diminishes and they cannot be nutritionally enriched until they molt to the second stage. Another concern is that *Artemia* are harvested from habitats (such as the Great Salt Lake in Utah, USA) that receive runoff and fallout of airborne particulates from nearby urban areas, highways, and farmland, and so may be contaminated with industrial and agricultural chemicals.

**Rotifers**

The rotifers used in aquaculture are almost invariably saltwater strains of the genus *Brachionus*, most often called *B. plicatilis* (the larger, “L-type”) or *B. rotundiformis* (the smaller, “S-type”). They are a suitable size for many fish larvae to consume, and they swim slowly and so are easy for naïve early larvae to capture. Because they tolerate a wide range of conditions (temperature, pH, salinity, oxygen concentration—they even grow in sewage treatment plants!), *Brachionus* cultures are robust, and with due care are not subject to unexplained crashes. They have very high reproductive rates that allow them to more than double in numbers each day, and can achieve very high culture densities (as high as 5-10 million/liter). Such high
culture densities are only possible because rotifers can be grown using commercially-available feeds, which have much higher biomass concentrations than can be achieved in algae cultures. These feeds also free the hatchery from the need to culture microalgae, and the nutritional content of the rotifers can be optimized by choosing appropriate feeds.

**Optimized rotifer production protocols**

Effective and economical rotifer production is now routine practice thanks to the development of protocols that provide optimal growth conditions for rotifers while making hatchery operations simpler, easier, and more economical. Fluctuations in culture conditions (temperature, pH, feed dosing, harvest rate, etc.) are minimized by employing “continuous” cultures rather than traditional “batch” cultures. Some of the benefits are:

1) The consistent feeding and harvest regimes that prevail in continuous culture promote rotifer health, supporting high productivity and nutritional quality.

2) The rotifers have a younger age distribution due to the high daily harvest rate; younger rotifers feed more actively, are more fecund, and are more vigorous swimmers.

3) Once daily harvesting begins, the culture requires the same feeding and harvest every day, simplifying the management of culture operations and so minimizing the opportunities for costly mistakes.

4) There is no interruption of production while a new culture grows to harvest density.

5) Labor inputs are reduced because culture tanks do not require frequent sanitizing and re-inoculation.

Reed Mariculture maintains mass-cultures of L- and S-type *Brachionus* rotifers and routinely supplies the aquaculture industry with orders of 1 million to 1 billion or more. These rotifers are produced using Reed Mariculture’s RotiGrow® liquid algae concentrate feeds, which support high-density cultures of rotifers with nutritional profiles that are optimized for larval fishes.

**Copepods**

Several species of copepods are used in fish larviculture because their first-stage nauplii are smaller than rotifers, and they are nutritionally superior. But they are much more difficult to culture because they have a much longer life cycle (2-3 weeks, in contrast to 2-3 days for rotifers), maximum culture densities are only a few thousand per liter, and the nauplii must be separated from the rest of the culture for feeding to larvae. Unlike rotifers, which can be produced entirely on commercial feeds, many copepod species require live algae cultured in the hatchery as feed. Because of these difficulties, larvae are often started on copepod nauplii, and as they grow they are transitioned to rotifers, which are much easier to mass-produce.

**A new copepod for aquaculture**

Reed Mariculture is the only significant commercial supplier of rotifers for aquaculture in North America, and will soon offer cultures of *Apocylops panamensis*, a Cyclopoid copepod that offers important advantages for aquaculture use compared to many other copepods. *A. panamensis* nauplii have
been shown to be an excellent first feed for the larvae of Red Snapper (*Lutjanus campechanus*), and can be produced entirely on Reed Mariculture’s microalgae concentrate RotiGrow® enrichment/grow-out feeds, while it effectively suppresses any contamination by ciliates. A copepod with these characteristics has the potential to become a widely-used, mass-produced larval feed, perhaps the “New Rotifer” that aquaculture has been waiting for.

Reed Mariculture has supplied microalgal concentrates to the aquaculture industry for over 20 years, and is likewise dedicated to being the dependable supplier of zooplankton. Hatcheries benefit economically by obtaining zooplankton from the zooplankton specialists at Reed Mariculture as the need arises, rather than having to maintain cultures even when they are not needed. This allows them to devote their resources to the culture of fish, rather than fish feeds, and reduces the need for staffing with algae and zooplankton culture expertise. Hatchery operators also enjoy increased peace-of-mind by knowing that microalgae and zooplankton are readily available in case of culture failures.

More information

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