

**Florida Department of Agriculture and Consumer Services  
Florida Aquaculture Review Council**

**Title: Mass Scale Production of Copepods for Marine Aquaculture**

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**Summary of Accomplishments July 17, 2008 to June 15, 2009.**

We isolated the copepod, *Pseudodiaptomus pelagicus*, from the waters of south Florida and have kept it in continuous culture for five years. *Pseudodiaptomus* spp. are semi-benthic calanoid copepods; the adults are substrate oriented and nauplii and early copepodites are pelagic. The genus is globally distributed from tropical to temperate waters. Predominantly an estuarine genus, they generally tolerate a wide range of environmental parameters. Unlike many other calanoids, *Pseudodiaptomus* spp. appear well suited to culture systems because they can tolerate heavy aeration, tolerate the presence of sediment and suspended solids, grow and reproduce well on readily produced microalgae and can achieve densities of over 5/mL.

Survival, time to maturity, and fecundity were significantly affected by production conditions (temperature, salinity). Time to first maturation and maturation of the entire population was significantly influenced by temperature and salinity. Increased temperature (28-32°C) and decreased salinity (15-20 ppt) affected the mean daily nauplii production by decreasing the brood interval but did not affect the mean brood size. The distribution of developmental stages in the population was also affected by temperature and salinities; at lower temperatures and higher salinities the population consisted of a greater proportion of nauplii. When developing production objectives, aquaculturists must consider temperature and salinity because it has multiple effects on the culture. The optimal temperature range to achieve high survival and the greatest nauplii production is 28-32°C. The optimal salinity was determined to be between 15-20 ppt. To maintain long term stock cultures the best temperature may be 24°C to slow maturation and growth while 28-32°C may be used to maximize nauplii production by decreasing time to maturation and decreasing brood intervals.

We conducted experiments on the effects of dietary algae on the copepod *Pseudodiaptomus pelagicus*. We fed them *Isochrysis* (T-iso), *Thalassasira*, *Rhodomonas*, *Tetraselmus*, and *Chaetoceros*. Each alga affects the copepods differently. Maturation rate was fastest with *Rhodomonas* and *Thalassasira*. Fecundity was the highest with *Thalassasira*. The lifespan of the adults was longest with T-iso. Blends of the various algal species were conducted but the results have not been quantified. Given that this species has been cultured exclusively on T-iso for six years, these results are important to maximize nauplii production so they can be fed to larval marine fish. This data will be prepared for publication in the journal *Aquaculture*.

We cultured *Pseudodiaptomous pelagicus* for over 40 generations during the last year. We have designed and evaluated two airlift systems for collection of newly hatched nauplii. The bucket airlift is capable of collecting 80-85% of the nauplii in a tank without disturbing the adult population which can cause decreases in survival and future nauplii production. We designed and evaluated a mass scale culture system. The standard culture container is a 200 L barrel, the mass scale system is a 1100 L cone bottom tank. The tank is equipped with a sump containing a nauplii collection device and can be equipped with biofilter media. In a barrel we consistently attained production of 200,000 nauplii every two days from the first day of adulthood through day 8 of adulthood. After that, production slows and the adults die by day 14 of adulthood. In the 1100 L tank we were able to harvest an average of >1 million nauplii per day (range = 750,000 to 1.75 million) for over 9 days before production decreased.

We have shown that *Pseudodiaptomous pelagicus* can be cultured in batch and mixed age populations. Mixed age populations should be used to maintain cultures long term but are not as efficient at producing nauplii as batch cultures. It appears that the daily removal of nauplii signals the adults to continue to produce nauplii, whereas in mixed populations the adults decrease their nauplii production to prevent overpopulation from occurring.

We fed *Pseudodiaptomous pelagicus* to larvae of pompano, pinfish, and pigfish. Pigfish required copepod nauplii as a first feed and were able to consume rotifers by day 6 post-hatch. Pigfish which were not provided copepods did not survive. Further research is needed to refine the feeding protocol of pigfish larvae, but the results are clear that copepods are necessary and did allow for the life cycle of this new species to be closed. Pinfish were fed copepods until day 7 post-hatch and were compared to feeding rotifers exclusively. Pinfish larvae fed copepods grew larger than those fed rotifers. Further research is needed to define feeding protocol but there is preliminary evidence of improved growth in larvae fed copepods for 2-4 days versus rotifers only.

Five experiments were conducted to evaluate the efficacy of feeding copepods to larval Florida pompano (*Trachinotus carolinus*). Four experiments were conducted in replicated 13L tanks and one experiment was conducted in 200L tanks.

The Florida pompano (*Trachinotus carolinus*) is a high-value marine fish species which plays an important role in recreational and commercial fisheries of the south Atlantic and gulf coasts of the United States. The culture of Florida pompano (*Trachinotus carolinus*) larvae has recently been refined and there is growing interest in its production.

One of the major bottlenecks to marine fish production, including Florida pompano, has been low survival during the larval phase. Rotifers (*Brachionus* spp.) and *Artemia* spp., the traditional live feeds during this phase, are not nutritionally complete and require use of enrichments to achieve acceptable survival. Recently, the use of copepods as a primary or supplemental live feed has been evaluated with many species and shown to greatly increase growth, survival, and resistance to stress. Copepods are the natural food of larval fish species in the wild, have a high nutritional value without enrichment, and show promise in their ability to be cultured for mass production. By instituting copepod nauplii as a food source during this first feeding phase; the

survival, growth, and subsequent condition of Florida pompano larvae should be improved.

Three 9 day rearing trials were conducted to evaluate feeding regimes in 13L tanks. The feeding of rotifers (*Brachionus* sp.), copepod nauplii, mixed diets of each, and a mesocosm of *Pseudodiaptomus pelagicus* were evaluated. In each trial, six replicate tanks were used for each treatment. Fish larvae were stocked at a rate of 50/L and fed four times daily at a rate of 2.5 individuals / mL / feeding from day 2 to day 9 post hatch. Water quality parameters and culture conditions were monitored daily. Percent survival, growth, and stress resistance were compared for all treatments. Survival was assessed at 9 days post hatch and morphometric data was calculated from samples taken at 0, 3, 6, and 9 days post hatch using image analysis software. The results will be summarized in a thesis by Eric Cassiano and will be submitted for publication to the journal Aquaculture.

#### Peer Reviewed Journal Articles

Ohs, C.L., A.L. Rhyne, and E. Stenn. 2009. Viability of subitaneous eggs of the calanoid copepod, *Acartia tonsa* (Dana), following exposure to various cryoprotectants and hypersaline water. *Aquaculture* 287: 114-119.

Ohs, C.L., A.L. Rhyne, S.W. Grabe, E. Stenn, and M.A. DiMaggio. Culture characteristics of the calanoid copepod *Pseudodiaptomus pelagicus*: Effects of salinity on reproduction and population dynamics. Submitted to *Aquaculture*.

#### Published Abstracts

Rhyne, A.L., E. Stenn, C. Ohs. 2009. Optimizing the culture characteristic of the marine calanoid copepod *Pseudodiaptomus pelagicus*; moving toward mass culture. *World Aquaculture* 2009. Veracruz, Mexico.

Cassiano, E.J., C.L. Ohs, C.R. Weirich, B.D. Petty, and J.E. Hill. 2009. Evaluation of larval Florida pompano *Trachinotus carolinus* fed the calanoid copepod *Pseudodiaptomus pelagicus*. *Aquaculture America* 2009. Seattle, WA.