Broodstock and Larval Nutrition of Marine Ornamental Shrimp

Junda Lin, Dong Zhang and Andrew L. Rhyne

Florida Institute of Technology
150 W. University Blvd., Melbourne, FL 32901, USA
Tel.: 321-674-7587, Fax: 321-674-7238
E-mail: jlin@fit.edu

ABSTRACT

In recent years, efforts have been made to develop aquaculture protocols for the marine ornamental shrimp, especially species of *Lysmata* (cleaner shrimp) and *Stenopus* (banded coral shrimp). The largest bottleneck for commercial production is the long and variable larval durations, largely due to mark-time molting. Identifying appropriate broodstock and larval diets is a key in reducing the larval durations and increasing the aquaculture potential for these species. Several broodstock diets (enriched and regular fresh and frozen *Artemia* nauplii and adults, squid, mussels, clams, and polychaetes) have been tested in different shrimp species, the nutritional suitability of the diet seems to be species dependent. Several larval diets have also been tested (microalgae; rotifers; decapsulated cysts, newly hatched nauplii, and enriched metanauplii of *Artemia*; and pellet food). Combination of *Artemia* (meta) nauplii and pellet food (ArteMac) or *Artemia* (meta) nauplii alone produced the best results in larval survivorship and development.

Key Words: Broodstock diet, larval nutrition, marine ornamental shrimp

INTRODUCTION

In contrast to freshwater ornamental species, most marine organisms marketed in the aquarium trade industry are collected from the wild, particularly from coral reef ecosystems. The prevalence of destructive low-cost, low-technology harvesting techniques, such as use of cyanide and explosives, has dramatic and drastic impacts on the health and biodiversity of coral reef ecosystems. Developing aquaculture technology for marine ornamental species is urgently needed to guarantee a sustainable supply for the industry while minimizing the negative impacts on the natural environment. Marine shrimp are among the most popular invertebrates in marine aquarium trade. Although life cycle has been completed for several species, the long and variable larval durations (Table 1) still impair the commercial rearing. Identifying appropriate broodstock and larval diets is a key to improve larval quality and shorten larval durations.

Lin, J., Zhang, D., Rhyne, A., 2002. Broodstock and larval nutrition of marine ornamental shrimp. In: Cruz-Suárez, L. E., Ricque-Marie, D., Tapia-Salazar, M., Gaxiola-Cortés, M. G., Simoes, N. (Eds.). Avances en Nutrición Acuícola VI. Memorias del VI Simposium Internacional de Nutrición Acuícola. 3 al 6 de Septiembre del 2002. Cancún, Quintana Roo, México.

Table 1. Larval duration of marine ornamental shrimp

Species	Larval duration	Reference
Hymenocera picta	28-56 Days	Kraul 1999
Lysmata amboinensis	58-140 Days	Fletcher et al., 1995; TMC, 1999
Lysmata debelius	63-158 Days	Fletcher et al., 1995; TMC, 1999 Palmtag and Holt, 2001
"*Lysmata wurdemanni*"*	22-110 Days	Zhang et al., 1998, Rhyne 2002 G. J. Holt, personal comm.
Lysmata sedicudata	27 days	Calado et al., 2001b
Stenopus hispidus	120-210 days	Fletcher et al., 1995
Stenopus scutellatus	43-77 days	Zhang et al., 1997

***:** the species status within the peppermint shrimp complex (*Lysmata wurdemanni* and *L. rathbunae*) is in dispute (Rhyne *et al*., in preparation).

BROODSTOCK DIET

Although several broodstock diets (enriched and regular fresh and frozen *Artemia* nauplii and adults, squid, mussels, clams, and polychaetes) have been tested in different shrimp species, the nutritional suitability of the diet seems to be species dependent. In *Lysmata debelius*, changing broodstock diet from fresh mussel and polychaete to live *Artemia* nauplii induced an increase on the average (±s.d.) number of larvae produced, from 486±254 to 1766±391 (Simões *et al*., 1998). However, on *Lysmata amboinensis* and *L. wurdemanni* different broodstock diets seemed to have no effect on their reproductive performance (Simoes *et al*., 1998, Lin & Zhang, 2001). Broodstock *Stenopus scutellatus* fed with enriched frozen adult *Artemia* or mixture of regular frozen adult *Artemia* produced more eggs than those fed with regular frozen adult *Artemia* or frozen hard clam (*Mercenaria mercenaria*) (Lin & Shi, 2002).

The issue of egg quality has only recently begun to be investigated on ornamental shrimp species. Lipids represent the most important energy source during embryonic development of most crustaceans (Wehrtmann & Graeve, 1998). Preliminary studies on *Lysmata seticaudata* revealed that the embryos of smaller females presented a higher consumption rate of essential fatty acids (namely docosahaexaenoic acid - DHA and eicosapentaenoic - EPA) (Calado *et al*., 2001a). Through the comparison of the biochemical composition of wild-collected versus laboratory-spawned eggs, the suitability of broodstock diets can be assessed and improved.

LARVAL NUTRITION

The long and variable larval durations are largely due to mark-time molting, a sequence of molts without development (Gore, 1985). The development of suitable larval diets certainly is one of the keys to shorten larval durations. Several larval diets have been tested (microalgae; rotifers; decapsulated cysts, newly hatched nauplii, and enriched metanauplii of *Artemia*; and pellet food).

For *Stenopus scutellatus* larvae (Zhang *et al*., 1997), those fed with algae (*Chaetoceros* or *Isochrysis*) died before completing the larval cycle. The larvae fed with *Artemia* nauplii had higher survivorship than those fed with rotifers. However, the development rate was similar between the two treatments.

For "*Lysmata wurdemanni*" (Zhang *et al*., 1998), again the larvae fed with algae (*Chaetoceros* or *Isochrysis*) died before completing the larval cycle. The larvae fed with *Artemia* nauplii (66.7%) and rotifer (68.9%) had similar survivorship, but the larvae fed with *Artemia* reached postlarvae in 29-32 days, compared with 32-36 days in the rotifer treatment.

In another set of experiment (Rhyne, 2002), "*L. wurdemanni*" larvae were fed with *Artemia* metanauplii (2-day old), a commercial pellet diet (ArteMac), and mixture of the two. Larval survivorship was higher and development was faster (fewer mark-time moltings) in those fed with mixture diet than those fed with *Artemia* alone or commercial diet alone.

The recent use of high-speed video recording in the study of larval shrimp feeding kinematics (Rhyne, 2002) allowed researchers to evaluate the influence of prey size in capture and manipulation effort on different larval stages. The same study documented the strong feeding response of early shrimp larval stages to inert pellet diets, when live preys (*Artemia* metanauplii) were present. These findings will surely enable researchers to test and eventually fulfill several larval nutritional requirements through the use of prepared pellet diets.

REFERENCES

Calado, R., Morais, S., Narciso, L., 2001a. Fatty acid profile of Mediterranean cleaner shrimp (*L. seticaudata*) eggs during embryonic development. *Book of Abstacts, Marine Ornamentals 2001, Orlando, USA* 95-97.

Calado, R., Martins, C., Santos, O., Narciso, L., 2001b. Larval development of the Mediterranean cleaner shrimp *Lysmata seticaudata* (Risso, 1816) (Caridea; Hippolytidae) fed on different diets: costs and benefits of mark-time molting. *Larvi'01 Fish and Crustacean Larviculture Symposium, European Aquaculture Society, Special Publication* 30:96-99.

Fletcher, D.J., Kotter, I., Wunsch, M., Yasir, I., 1995. Preliminary observations on the reproductive biology of ornamental cleaner prawns. *International Zoo Yearbook* 34:73-77.

Gore, R., 1985. Molting and growth in decapod larvae. In *Crustacean Issues – Larval growth*. Vol. 2, edited by A. Wenner, pp 1-65. AA Balkema Publishers, Rotherdam, Netherlands.

Kraul, S., 1999. Commercial culture of the harlequin shrimp *Hymenocera picta* and other ornamental marine shrimp. *Book of Abstacts, Marine Ornamentals 1999, Hawaii, USA* 50.

Lin, J., Shi, P., 2002. Effects of broodstock diet on reproductive performance of the golden banded shrimp, *Stenopus scutellatus*. J. World Aquaculture Society, 33(3), in press.

Lin, J., Zhang, D., 2001. Effect of broodstock diet on reproductive performance of the peppermint shrimp, *Lysmata wurdemanni*. *Journal of Shellfish Research* 20(1):361-363.

Palmtag, M. R., Holt, G. J., 2001. Captive rearing of fire shrimp (*Lysmata debelius*). *Texas Sea Grant College Program Research Report.*

Rhyne, A. L., 2002. Improvements in marine ornamental shrimp culture. M.S. thesis, Florida Institute of Technology, Melbourne, Florida, USA.

Ribeiro, F., Jones, D. A., 1998. The effect of diet on the reproductive performance of marine cleaner shrimps *Lysmata debelius* (Bruce, 1983) and *L. amboinensis* (de Man, 1888) (Caridea, Hippolytidae) in captivity. *Aquaculture 98 Book of Abstracts, Las Vegas, Nevada, USA* 497.

TMC (Tropical Marine Centre), 1999 (December 6). Shrimp breeding successes at Tropical Marine Centre. http://www.tmc-ltd.co.uk/Hatchery/latest.asp.

Whertmann, I., Graeve, M., 1998. Lipid composition and utilization in developing Eggs of two tropical marine caridean shrimps (Decapoda, Caridea, Alpheidae, Palaemonidae). *Comparative Biochemistry and Physiology Part B* 121: 457-463.

Zhang, D., Lin, J., Creswell, R., 1997. Larviculture and effect of food on larval survival and development in golden coral shrimp *Stenopus spimosus*. *Journal of Shellfish Research* 16(2):367-369.

Zhang, D., Lin, J., Creswell, R., 1998. Effects of food and temperature on survival and development in the peppermint shrimp *Lysmata wurdemanni*. *Journal of the World Aquaculture Society* 29(4):471-476.