Some Aspects of the Culture of Red Snapper

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ABSTRACT

Information is scarce on the optimal rearing conditions for red snapper (*Lutjanus campechanus*). Rearing and large scale production of red snapper have been hampered because it is difficult to produce enough prey of appropriate size to ensure survival of larvae to a size at which they can consume *Brachionus plicatilis* and artemia nauplii. Secondly, it has not been possible to rear snapper larvae in small containers for short term experiments; all successful rearing to date has been in containers $\geq$ 200 L. We evaluated the relationship between copepod nauplii available per fish on the day of first feeding and survival of red snapper. Additionally, we assessed the suitability of various types/sizes of containers, from 10 L black plastic containers through 20 L polycarbonate containers to 200 L black plastic containers filled with 100 L of seawater, for rearing snapper larvae. There was a significant positive correlation between prey number per fish on the day of first feeding and survival of snapper (Spearman's rank correlation, $r_s = 0.83$, $n = 10$, $P = 0.013$). Similarly, larval survival was positively correlated with number of copepod nauplii/mL ($r_s = 0.73$, $n = 10$, $P = 0.029$).

Rearing studies using 10 L and 20 L black plastic containers resulted in 100% mortality of larvae by day 7 post-hatch. Experiments carried out using polycarbonate containers and 200 L black tubs containing 50 L or 100 L of brown seawater resulted in 0 to 34% larval survival. Number of larvae that survived was significantly higher in polycarbonate containers (mean = 46.7$\pm$ 21.9 S.E.) than in black tubs with 50 or 100 L of water (mean=5 $\pm$ 4.67 S.E.) [Unpaired t-test value = 2.622, df = 5, P = 0.047]. Differences in larval survival in the culture containers probably resulted from interactions between the amount of light present in the containers and container color that, presumably, affected prey visibility to, and therefore consumption by larval snapper.

KEY WORDS: Larval survival, copepod nauplii density, culture tanks.

INTRODUCTION

Red snapper (*Lutjanus campechanus*) are offshore reef fish of economic importance (Goodyear 1995). They are long-lived, seem to have limited movement, and aggregate around structures as adults (Szedlmayer 1997, Szedlmayer and Shipp 1994) which makes them susceptible to overfishing. The juveniles are captured mainly in areas where water temperature is 24 – 26°C, salinity is around 35 ‰ and dissolved oxygen level is at least, 5 mg/L (Gallaway et al. 1999). Additionally, larval snapper settle out to the bottom of the ocean after about one month of pelagic existence and subsequently live in areas of the northern Gulf of Mexico where shrimp trawling intensity is high (Workman and Foster 1994). As a result, they suffer high by-catch mortality that substantially affects their population abundance and has necessitated the implementation of measures to reduce shrimp by-catch. Recently, much interest has grown in the culture and release of red snapper to assess the feasibility of enhancing the wild stock. However, there is very little information in the literature on the optimal rearing methods and conditions for lutjanids, in general, and red snapper in particular, even though attempts have been made to culture them (Rabalais et al. 1980, Minton et al. 1983, Turano et al. 2000).

Rearing and large scale production of red snapper have been hampered because it is difficult to produce adequate numbers of prey of appropriate size to ensure survival of a large number of larvae to a size at which they can consume *Brachionus plicatilis* and artemia nauplii, the prey commonly used for rearing larval fish. It has also not been possible to rear snapper larvae in small containers for short-term experiments. Thus, adequately replicated experiments to evaluate the effects of environmental conditions on survival of larval snapper have not been undertaken without running the risk of depleting available prey resource and number of larvae required for juvenile fish production. The objectives of this study were:

i) To determine whether survival of red snapper larvae is related to copepod nauplii available per fish on the day of first feeding, and

ii) To assess the suitability of various types/sizes of containers, from 10 L black plastic containers through 20 L polycarbonate containers to 200 L black plastic containers filled with 100 L of 30 ‰ seawater, for rearing snapper larvae.

MATERIALS AND METHODS

Larval red snapper produced in the spring and summer of 1999 and 2000 were stocked into 200 L or 1000 L culture containers a day after hatching. Culture containers were placed outside under a shed covered with a screen that eliminated about 25% of the solar radiation. Larvae were fed copepod nauplii harvested from copepod culture ponds. Larval density in the culture containers was 5 - 10 /L, and prey density was maintained between 1.0 and 6.0/ml. Water samples were collected in the morning prior to feeding fish, and in the afternoon after daily feeding to assess the density of nauplii in the culture tanks. Temperature varied from 25°C to 30°C, and salinity was maintained at about 35 ‰.

In another set of experiments, we assessed the survival of snapper larvae in two types of containers, polycarbonate and black plastic containers. First, we set up 10 L and 20 L black plastic containers in replicates, filled them with 30 ‰ seawater, and stocked them with snapper larvae. The larvae were then fed copepod nauplii at a density of about 2/ml for about seven days after which we compared survival of larvae in the two containers. In another experiment, we compared larval survival in 20 L polycarbonate containers and 200 L black plastic tubs containing 50 or 100 L of 30 ‰ seawater. Each container had 250 larvae in all experiments. The experiment lasted one week after which the number of larvae remaining in each container was counted after passing the culture water through a 65 μ mesh net. Data for 1999 and 2000 were pooled and subjected to a Spearman's rank correlation analysis to assess if there is a relationship between prey number and larval fish survival. We used a t-test following, log (1 + x) transformation of the data, to determine whether snapper larvae survived better in polycarbonate containers than in black plastic tubs.

RESULTS

There was a significant positive correlation between prey number per fish on the day of first feeding and survival of larval snapper (Spearman's rank correlation, $r_s = 0.83$, $n = 10$, $P = 0.013$). Similarly, larval survival was positively correlated with prey density, copepod nauplii/mL ($r_s = 0.73$, $n = 10$, $P = 0.029$). Survival of larval snapper ranged from < 1% to about 18% at prey densities of < 2 to about 3.5/mL, respectively (Figure1).

Rearing studies carried out using 10 L and 20 L black plastic containers resulted in 100% mortality of larvae by day 7 post-hatching. Experiments carried out using polycarbonate containers resulted in 3.6 to 34% larval survival, whereas survival in 200 L black tubs containing 50 L or 100 L of brown water were 0% and 0 to 7.6% respectively. Number of larvae that survived was significantly higher in polycarbonate containers (mean = 46.7 $\pm$ 21.9S.E.) than in black tubs with 50 or 100 L of water (mean = 5 $\pm$ 4.7SE) [Unpaired t-test value = 2.622, df = 5, P = 0.047] (Figure 2).

DISCUSSION

Survival of larval snapper after about 23 days of rearing in 200 L, 500 L, or 1,000 L of seawater ranged from about 0.3 to 18 %, and was affected by prey availability. Survival of larvae of other species of snapper were reported to vary from 0.9 % to about 16% (Doi and Singhagraiwan 1993, Duray et al. 1996a, Watanabe et al. 1998). Density of prey of appropriate size during early larval development is critical for larval survival. Below an optimum density, survival may be poor due to starvation; above a certain level survival may also decrease because of overfeeding or fouling of the culture water (van der Wal and Nell 1986). Prey density used for rearing marine fish larvae depends on the type of prey and fish. It

is usually 0.5 – 6 *Artemia* nauplii/ml, 1 - 10 copepod nauplii/ml, 5 – 20 rotifers/ml, and 100 dinoflagellates/ml (see review by Tucker 1998). Red snapper rearing practice, at present, at the University of Southern Mississippi Gulf Coast Research Laboratory consists of harvesting zooplankton (mainly copepod nauplii) from outdoor culture ponds and feeding them to fish during the first week of exogenous feeding before switching to enriched *Artemia* nauplii. The density of copepod nauplii during larval fish rearing in this study ranged from about 1.5 to 4.5 /ml (mean = 2.4) which falls in the lower end of the range usually used for rearing larval fishes (see Tucker 1998). In general, an increase in prey density up to a limit results in higher food consumption and therefore, larval survival (van der Wal and Nell 1986, Duray et al. 1996b, Duray et al. 1997), although it is also influenced by larval density (Hagen 1993). Our results suggest that increasing prey density and therefore, prey/larval ratio may increase red snapper survival. However, more adequately replicated experiments with larvae from the same batch of eggs needs to be conducted to establish optimum prey and larval densities required for maximum survival of snapper.

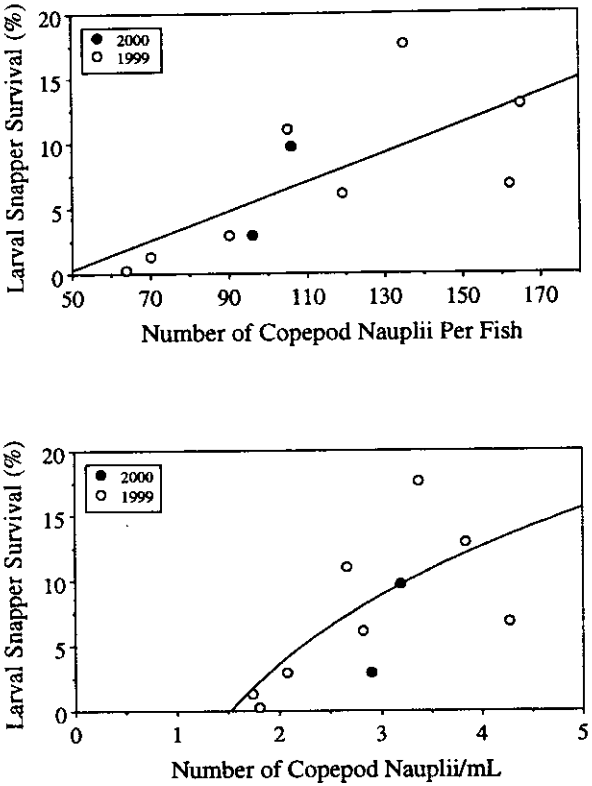

Figure 1. Relationship between larval red snapper survival (%) and copepod nauplii density.

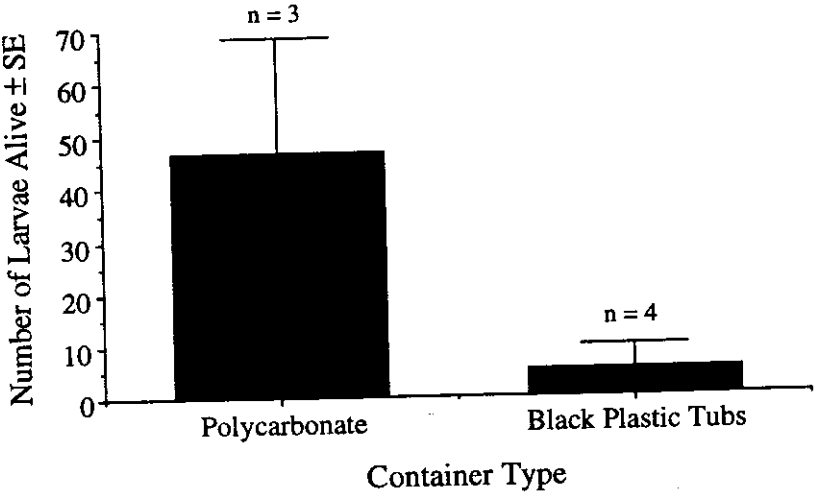

Figure 2. Effect of container type on larval red snapper survival.

Culture tanks used for rearing snapper larvae range in size from 300 L to more than 100,000 L (Doi & Singhagraiwan 1993, Riley et al. 1995, Duray et al. 1996a, Clarke et al. 1997, Watanabe et al. 1998). Not much success has been made in rearing snapper larvae in smaller containers for short-term experiments. We observed significantly higher larval survival in 20 L polycarbonate containers than in black plastic containers with 100 L or less water. All fish reared in 20 L black plastic containers and 200 L black tubs with 50 L of water died within five days. Differences in larval survival in the culture containers probably resulted from interactions between the amount of light present in the containers and container color that, presumably, affected prey visibility and feeding success. Culture tanks with dark colored walls are considered best for rearing marine fish larvae, perhaps because dark colors increase the visibility of prey to fish, reduce reflected light which might distract the larvae, and therefore increase larval food consumption and survival (Browman and Marcotte 1987, Tucker 1998). For example, survival of dolphin larvae was two times greater in black fiberglass tanks than in tan 30 L tanks (Ostrowski 1989). Nevertheless, for short-term experiments we do not recommend the use of black plastic containers with < 100 L of seawater, because of high mortality of red snapper observed in this study, but rather the use of 20 L polycarbonate culture tanks.

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LITERATURE CITED

Browman, H.I. and B.M. Marcotte 1987. Effects of prey color and background on feeding by Atlantic salmon alevins. *Progressive Fish Culturist* **49**:140-143.

Clarke, M.E., M.L. Domeier and W.A. Laroche. 1997. Development of larvae and juveniles of the mutton snapper (*Lutjanus analis*), lane snapper (*Lutjanus synagris*) and yellowtail snapper (*Lutjanus chrysurus*). *Bulletin of Marine Science* **61**:511-537

Doi, M. and T. Singhagraiwan. 1993. *Biology and Culture of the Red Snapper, Lutjanus argentimaculatus*. Res. Proj. Fishery Resource Dev. Kingdom of Thailand. 51 pp.

Duray, M.N., L.G. Alpasan, and C.B. Estudillo 1996a. Improved hatchery rearing of mangrove red snapper, *Lutjanus argentimaculatus*, in large tanks with small rotifer (*Brachionus plicatilis*) and *Artemia*. *Bamidgeh* **48**:123-132.

Duray, M.N., C.B. Estudillo and L.G. Alpasan 1996b. The effect of background color and rotifer density on rotifer intake, growth and survival of the grouper (*Epinephelus suillus*) larvae. *Aquaculture* **146**:217-224.

Duray, M.N., C.B. Estudillo and L.G. Alpasan. 1997. Larval rearing of the grouper *Epinephelus suillus* under laboratory conditions. *Aquaculture* **150**:63-76.

Gallaway, B.J., J.G. Cole, R. Meyer, and P. Roscigno. 1999. Delineation of essential habitat for juvenile red snapper in the northwestern Gulf of Mexico. *Transactions of the American Fisheries Society* **128**:713-726.

Goodyear, C.P. 1995. *Red snapper in U.S. waters of the Gulf of Mexico*. National Marine Fisheries Service, Southeast Fisheries Science Center, Contribution MIA-95/96-05, Miami, Florida USA.

Hagen, N. 1993. Effect of different prey- and larval densities on the gut content of plaice (*Pleuronectes platessa* L.) at initial feeding. Pages 180-182 in: B.T. Walther and H.J. Fyhn (eds.) *Physiological and Biochemical Aspects of Fish Development*. University of Bergen, Norway.

Minton, R.V., J.P. Hawke, and W.M. Tatum. 1983. Hormone-induced spawning of red snapper, *Lutjanus campechanus*. *Aquaculture* **30**:363-368.

Ostrowski, A.C. 1989. Effect of rearing tank background color on early survival of dolphin larvae. *Progressive Fish Culturist* **51**:161-163.

Rabalais, N.N., S.C. Rabalais and C.R. Arnold. 1980. Description of eggs and larvae of laboratory reared red snapper (*Lutjanus campechanus*). *Copeia* **1980**:704-708.

Riley, C.M., G.J. Holt, and C.R. Arnold. 1995. Growth and morphology of larval and juvenile captive bred yellowtail snapper *Ocyurus chrysurus*.*U.S. Fisheries Bull.etin* **93**:179-185.

Szedlmayer, S.T. and R.L. Shipp 1994. Movement and growth of red snapper, *Lutjanus campechanus*, from an artificial reef area in the northeastern Gulf of Mexico. *Bulletin of Marine Science* **55**: 887-896.

Szedlmayer, S.T. 1997. Ultrasonic telemetry of red snapper, *Lutjanus campechanus*, at artificial reef sites in the northeast Gulf of Mexico. *Copeia* **1997**:846-850.

Tucker, J.W. Jr. 1998. *Marine Fish Culture*. Kluwer Academic Publishers, Boston, Massachusetts USA. 750 pp.

Turano, M.J., D.A. Davis and C.R. Arnold. 2000. Observations and technique for maturation, spawning, and larval rearing of the yellowtail snapper, *Ocyurus chrysurus*. *Journal of the World Aquaculture Society* **31**:59-68.

Van der Wal, E.J. and J.A. Nell. 1986. Effect of food concentration on the survival and growth of Australian bass (*Macquaria novemaculata*) larvae.*Progressive Fish Culturist* **48**:202-204.

Watanabe, W.O., E.P. Ellis, S.C. Ellis, J. Chaves, C. Manfredi, R.W. Hagood, M. Sparsis and S. Arneson. 1998. Artificial propagation of mutton snapper *Lutjanus analis*, a new candidate marine fish species for aquaculture.*Journal of the World Aquaculture Society* **29**:176-187.

Workman, I.K. and D.G. Foster. 1994. Occurrence and behavior of juvenile red snapper, *Lutjanus campechanus*, on the commercial shrimp fishing rounds in the northeastern Gulf of Mexico. *Marine Fisheries Review* **56(2)**:9-11.