SPAWNING AND LARVAL REARING OF SIGANUS GUTTATUS (BLOCH) (PISCES: SIGANIDAE)

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The successful spawning and larval rearing of Siganus guttatus (Bloch) up to the post-metamorphosis stage is reported. S. guttatus generally spawns within the first quarter moon, laying an estimated half million eggs. The incubation period lasts for about 24 hours. Newly hatched larvae depend on yolk and oil globules for nourishment. They begin feeding on day two, when the yolk and oil globules have been almost consumed. Complete metamorphosis is observed to occur on day 30. Larval survival depends on (1) adequate and proper food and (2) sub-toxic nitrite concentration in the rearing container.

The earliest work on the reproductive biology rabbitfishes (Family Siganidae) in the Philippines dealt with t artificial fertilization of "danggit," Siganus oramin (Bloch a Schneider) [=Siganus canaliculatus (Park)], by Manacop (1937 Burgan and Zselecsky (1979) reported on induced spawning a larval growth of Siganus argenteus (Quoy and Gaimard) and Alca and Alcazar (1979) reported on the gonad morphology, oocy development and gonad index of Siganus canaliculatus (Park Alcala and Luchavez (1980) described the spawning and ear development of Siganus guttatus (Bloch). Studies on the reari and larval development of some species of rabbitfishes have be made elsewhere (May, 1970; Bryan and Madraisau, 1973; May et a 1974; Popper et al. 1976; Popper and Gunderman, 1976; Soh a Lam, 1973).

The feasibility of culturing rabbitfishes has be entertained for the last ten years (Ben-Tuvia and Kissil, 197 von Westernhagen, 1974; Tsuda et al., 1974; Popper a Gundermann, 1974; Tahil, 1978). Tahil (1978) found that reari S. guttatus in cages did not appear promising; however, suggested that improved techniques and further investigati might lead to successful results. Luchavez (1986) had so success in cultivating S. guttatus in inland ponds.

Observations on spawning and larval rearing of Sigan guttatus reported by Alcala and Luchavez (1980) showed that guttatus can spawn in captivity without hormonal treatment. Ho ever, the larvae survived only for five days due to inadequa and improper food, and nitrite accumulation in the rearing tank

This paper reports on the early development and successful rearing of Siganus guttatus larvae up to post-metamorphosis stages.

MATERIALS AND METHODS

Preparation.

The spawners, consisting of four males and nine females reared in one concrete rearing tank measuring 1 m long x 2 m wide x 1 m deep, were maintained on a mixed diet of the algae Gracilaria and Enteromorpha collected in nature. Food pellets prepared by mixing rice bran, fish meal, bread flour and vitamins were added to the diet to enhance regular spawning (Jesus Juario, pers. comm.). The spawners were fed three times daily.

Phytoplankton (Chlorella and Tetraselmis) and zooplankton Brachionus, copepods and the brine shrimp Artemia) were cultured as food for the Siganus guttatus larvae. Trochophores of two species of oysters, Crassostrea cucullata (Born) and Crassostrea iredalei gathered in nature, were used to feed the fish larvae simultaneously or alternately with the cultured planktonic food. Trochophore cultures were prepared by stripping the male and female gonads of oysters a few hours before feeding, then mixing them in a jar to effect fertilization and to allow development.

Larval feeding was done from the second day after hatching until after metamorphosis, when the larvae were capable of weaning. The metamorphosed larvae were fed with powdered pellets regularly and small amounts of Enteromorpha occasionally.

Spawning and Early Development.

The spawners (130 - 237 mm total length) were sexed by palpation two or three days before the expected date of spawning. A male and female pair was placed in each of the four 1-t glass aquaria. These were about one-third filled with sand-filtered sea water and totally covered with black plastic sheets, to minimize stress due to disturbance. The fish were not fed for three to four days before spawning to prevent fecal accumulation and the resulting fouling of the water in the tank. (Duyet and Lam [1973] observed that some species of siganids do not feed before spawning.) After spawning, the fish were transferred to the large stocking tank and fed. The fertilized eggs were left to develop and hatch in the spawning containers. By using a screen fitted with a 48-um filter, water in the spawning containers was changed often to prevent excessive nitrite accumulation. The number of eggs laid per female spawner was determined by siphoning out all the water and replacing it with 1000 ml of sea water. The number of eggs in an aliquot of 100 ml was counted. The average of three trials multiplied by 10 was

taken to represent the total number of eggs laid by one femal
During the incubation period, a few fertilized eggs w
observed under the microscope and the time needed for them
hatch after fertilization was noted.

Larval rearing.

The newly hatched larvae were transferred to three concr
tanks (2 m long, 1 m wide, 1 m deep) with water of two differ
salinities (25 and 30 ppt). The first tank (oval-shap
contained 30 ppt sea water and the unicellular alga Chlorel
the second (rectangular-shaped), 25 ppt sea water, and the th
(oval-shaped), 25 ppt sea water and zooplankton.
Water temperatures taken morning, noon and afternoon ran
from 27 to 32 C. Nitrite content was determined every other
from day 1 to day 10 and maintained at less than 10 mg/l,
toxic level, by frequent changes of the water. Dissolved oxy
was determined only on the first five days. Water in the t
was changed daily until metamorphosis.
Feeding of the larvae was started on the second day, w
the yolk and oil globules were almost completely absorbed. T
were fed with trochophore larvae of Crassostrea spp. during
first four or five days, Brachionus plicatilis from day 5 to
and Artemia nauplii and copepods from day 15 to metamorphosis.

RESULTS AND DISCUSSION

Siganus guttatus spawned from one to six days after
first quarter moon, based on 10 spawning events from March
December 1981. The exact spawning time is not known, but se
to be late afternoon (1730 - 1800 h) or evening (2200 - 2400
or early morning (0300 - 0430 h). Spawning of this species, l
that of other rabbitfishes, is influenced by the lunar cy
(Alcala and Alcazar, 1979; Burgan and Zselecsky, 1979; Popper
Gundermann, 1976; Popper et al., 1976; Manacop, 1937).
Other siganid species with monthly spawning times similar
S. guttatus are S. vermiculatus, which spawns one or two d
after the first quarter moon (Popper and Gundermann, 1976),
S. lineatus, which spawns three days before the full moon (Br
and Madraisau, 1977). S. canaliculatus spawns from four to se
days after the new moon (Manacop, 1937), while S. argent
spawns from two to five days following the new moon. The ho
of spawning for Siganus are as follows: S. argenteus, betw
0200 and 0400, or before dawn (Burgan and Zselecsky, 1979),
canaliculatus, around midnight (Bryan et al., 1975; Manac
1937); and S. lineatus, around 0600 or 0700 (Popper et a
1976).
Based on six females, the number of eggs per female spaw
was estimated at 400,000 to 500,000. The eggs were sligh

...sive and demersal, with several oil globules. Unfertilized ... were transparent, with the yolk occupying two-thirds of the ... egg. The mean size of the fertilized egg was about 0.59 ... (SD= 0.008; range: 0.57 - 0.60 mm). About an hour after ...ilization, eggs became opaque and oil globules became ...ent.

The two-cell stage was reached after 1.5 hours; the early ...ula stage, after 4 hours; the ring stage, after 5.5 hours. ... embryo, which appeared curved, began to exhibit twisting ...ents the twelfth hour after fertilization. Hatching occurred ...ours after spawning, or 12 hours after fertilization. The ... length of the newly-hatched larva was 2.06 - 2.10 mm (n = ... After hatching, the larva depended on the yolk and oil ...les for nourishment. This stored food lasted for two days.

On day 1, about one day after hatching, pigmentation started ...ppear on the antero-dorsal part of the head and ventrally, ...g the body from the abdominal cavity to the tail region. At ... stage, the lens and optic vesicle appeared bluish, slightly ...sparent and non-functional. The mouth was not yet fully ...ed. The one-day-old larvae had a mean total length of 2.45 ...=0.013; range: 2.43 - 2.47 mm; n = 50).

On day 2 pigmentation thickened and became very dark. The ... and the optic vesicle started to become functional. The ... was fully opened; the yolk and oil globules were still ...ent, but the yolk was almost resorbed. The gut was a single ...ar organ. The mean total length of the larvae at this stage ...52 mm (SD=0.012; range: 2.49 - 2.53 mm; n = 50). Migratory ...or was noted when the larvae showed signs of splashing from ...ottom towards the midwater.

On day 3 the eyes were not yet fully developed, but the lens ...become conspicuous. The gut had started to form two loops ... the brain had begun to develop just behind the eyes. The ...ord was still a straight tube. The yolk at this stage was ...tely resorbed, but oil globules were still present. At ... stage, the larvae began to avoid strong illumination, ...g to stay in the shaded part of the rearing tank container, ... food was also abundant. The mean total length of the three-...d larvae was 2.63 mm (SD=0.007; range: 2.62 - 2.65; n = 5).

On day 4 pigmentation was concentrated in the abdominal ...n. Oil globules had completely disappeared; the brain and ...erve cord were completely formed. The vertebrae were ...g to be distinct. The larvae now were capable of swimming ...ally and vertically from the bottom to the surface to feed, ...ting a snatching behavior. The mean total length of the ... was now 2.79 mm (SD=0.005; range: 2.78 - 2.79; n = 3).

On day 5 somites had formed. The heart and the gills were ...ional, the gut had developed into three loops, and the eyes ... fully developed. The mean total length of the larvae was ...81 mm (SD=0.012; range: 2.80 - 2.81 mm; n = 3).

On days 6 and 7 the head was fully developed but the eyes ... still over-sized in relation to the head. The fins were

also fully developed and enabled the larvae to escape from disturbance in the water. The mean total length of the six-seven-day-old larvae were 2.94 mm and 3.43 mm.

On days 8 and 9 there were no microscopic observations to limited survival (only about seven or eight larvae were see

On day 10 larvae had fully developed muscular and nerv systems and the eyes were now proportionate to the head. operculum and the ventral and dorsal fins were hig functional.

Of the 15,000 larvae stocked in the tank, only six completely metamorphosed on day 32, and only one survived to juvenile stage. That juvenile was maintained on pelletized f and Enteromorpha spp. in the laboratory.

From the second batch of eggs spawned in April 1982, larvae metamorphosed out of 30,000 stocked in a 4000-l tank, 0.03% survival rate. Six fry fed with pellets and Enteromor spp. survived to sexual maturity (ca. 100 - 160 mm total lengt

CONCLUSION

Siganus guttatus can be successfully cultured if (1) a quate and appropriate food is supplied to the larvae and (2) water quality is favorable for development. The fact affecting water quality are temperature, salinity, oxygen cont and nitrite concentration.

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