

POSTLARVAE DENSITY AND PHOTOPERIOD EFFECTS ON THE SETTLEMENT AND METAMORPHOSIS OF THE DONKEY'S EAR ABALONE, *HALIOTIS ASININA* LINNÉ, 1758

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ABSTRACT

The effects of photoperiod and density of postlarvae on settlement and metamorphosis of the native abalone, *Haliotis asinina* were determined in two separate experiments. Abalone larvae were hatched from spontaneously spawned eggs of tank-held broodstock. Experiments were conducted in static water conditions within a 10 day-period. Post-larvae held under at 24 h light regime showed higher settlement rates (mean: 12 %) than did larvae held at different light-and-dark periods (range: 3-9 %). Larvae kept in the dark had the lowest survival (3 %). Postlarvae stocked at lower stocking densities of 100 and 150 l⁻¹ had higher settlement rates (12-12.5 %) than postlarvae stocked between 200 and 600 postlarvae l⁻¹ (1-5 %).

INTRODUCTION

The donkey's ear abalone, *Haliotis asinina* is the major basis of abalone fishery production in the Philippines. *H. asinina* is dubbed as the "cocktail" abalone because of its smaller size that can be harvested within one year of culture at sizes ranging from 55-65 mm SL (McNamara & Johnson 1995; Singhagraiwan & Doi 1993; Capinpin *et al.*, 1999; Fermin & Buen 2000). Like most abalone hatchery, a major setback in the culture of *H. asinina* is the very low survival of young juveniles. However, this species has an advantage over other subtropical and temperate species because of its ability to spawn year-round (Singhagraiwan & Doi 1993; Capinpin *et al.* 1998; Fermin *et al.* 2000). The SEAFDEC Aquaculture Department is currently refining some existing

hatchery rearing techniques with the aim of increasing the survival of the native abalone species in the hatchery. This paper presents the results of some investigations on post-larval settlement and metamorphosis of the donkey's ear abalone, *H. asinina*.

MATERIALS AND METHODS

Source of eggs and larvae

Eggs were obtained by spontaneous spawning of captive broodstock held at 1:4 male to female ratio in perforated plastic baskets in flow-through tanks. Breeders were maintained on fresh *Gracilariopsis bailinae* given to excess at weekly intervals. Tanks were aerated and supplied continuously with sand-filtered seawater. Eggs and trochophore larvae were collected by siphoning into a deep plastic basin, filtered to remove dirt and other materials and then stocked and maintained in 300 litre conical tanks until the veliger or early creeping stage (indicated by loss of velar cilia). Larvae were stocked in the experimental tanks late in the afternoon between 5 and 6 PM of the same day.

Stocking density of postlarvae

Abalone post-larvae were stocked from 100 to 1000 post-larvae l⁻¹ in 60 litre fiberglass tanks with corrugated plastic sheets filmed with epiphytic diatoms as artificial substrates. Tanks were placed under ambient photoperiod (12L:12D) regime. Percent settlement was determined by taking some or all the plate substrates in each tank and gently brushing using a camel hair brush to collect settled post-larvae. Larvae were counted individually under a compound microscope. Percentage settlement was com-

puted by dividing the number of post-larvae counted by the total post-larvae stocked x 100.

Photoperiod

Postlarval settlement and metamorphosis at different photoperiodic regimes i.e. 24L:OD, 12 (diffused)L: 12D, ambient photoperiod, OL:24D were tested. Experiments were conducted either on a small-scale laboratory set-up (3.5 litre vessels or 60 litre tanks) or in large fiberglass tanks (1000 litre capacity). For treatments with continuous lighting during normal dark period, a 32 watt fluorescent lamp that provided approximately 480 lux above water surface was installed at 1 m over the rearing tanks. Treatment tanks held in the dark were covered with a thick black cloth. Settlement rates were determined 10 days after stocking. Surviving larvae were counted under a stereomicroscope. Survival rate was computed by dividing the number of survivors by the original number of postlarvae stocked.

Data on percentage survival of metamorphosed postlarvae were arcsine-transformed prior to statistical analysis using Analysis of Variance (SAS Institute 1988) followed by Duncan's Multiple Range Test to compare significant differences among treatments at 5 % level of significance.

RESULTS

Stocking density

A stocking density of 100 larvae l^{-1} gave the highest settlement rate of 11.7-12.5 % from two trials (Fig. 1). Lower percentages (1.25-4.7 %) of larval settlement were obtained at higher stocking densities ranging from 200-600 l^{-1} .

Photoperiod

Results of two trials showed that postlarvae held at 24-h photoperiod had the highest settlement rates of 12.1% however this was not significantly different from larvae held under ambient photoperiod (7.8%) or diffused daylight-normal dark period (8.9%) (Fig. 2). Postlarvae kept in the dark for 24 h had the lowest settlement rate at 3.1 % among all treatments.

DISCUSSION

Settlement is a change in behavior and habitat while metamorphosis is a non-reversible phenomenon involving morphological and physiological changes in the larvae (Chia 1978). According to Crisp (1974), several important factors affecting the choice of site by settling organisms include texture, contour and permanence of surface, exposure to water flow, light, temperature and salin-

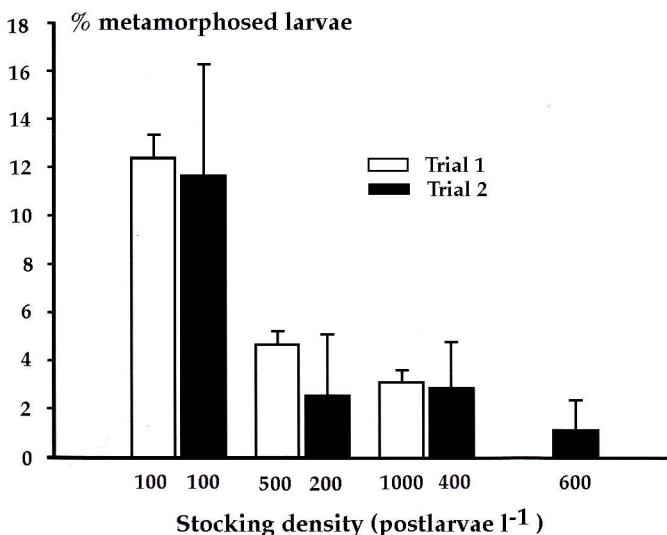


Fig. 1.

Effects of different stocking densities on settlement of abalone *H. asinina* postlarvae. Postlarvae were held under static water and 24-h light conditions for 10 days. Settlement plates were filmed with diatoms immediately after stocking. Water temperature ranged 27-29 °C during trial 1 and 26-29 °C during trial 2.

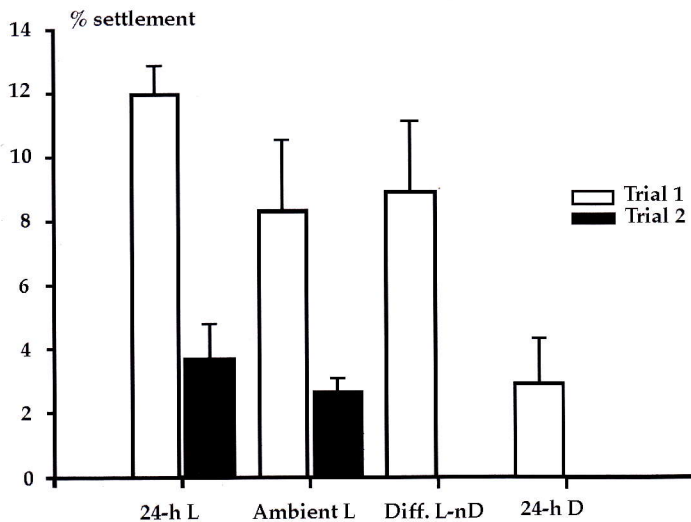


Fig. 2. Percent larval settlement at different photoperiodic regimes i.e 24-L= continuous 24 h lighting, Amb.L= ambient light (24L/24D), Diff.-L/ND= diffused daylight-normal dark period; 24-h D= 24 h dark period, with 5 replicates per treatment.

ity, availability of food, presence of predators and competitors and the chances of success in reproduction. Most studies on larval settlement do not pay much attention to the optimum stocking density of larvae in the settling tanks. Because of the very low survival rates of metamorphosed larvae there is a tendency to stock at higher densities with the idea of achieving higher recovery. For red abalone, *H. rufescens*, Ebert & Houk (1989) stocked from 25000-35000 larvae in 260 litre tanks that offered a total wetted surface area of 17,000 cm². The Japanese method of using corrugated polyvinylchloride (PVC) racks as settlement substrates was aimed at increasing surface area for larval settlement, thus allowing the stocking of larvae at higher densities (Hahn 1989). An 1800 litre tank containing 300 corrugated plates can be stocked with 0.6 million larvae or an average of 2,000 larvae plate⁻¹. In the present study *H. asinina* larvae had higher settlement and metamorphosis at lower stocking density of 100-200 l⁻¹ even with the use of settlement plates. These results do not conform to the suggestion of Singhagraiwan & Doi (1993) that stocking densities ranging from 300-1000 larvae l⁻¹ maybe used. We suspect that survival of larvae was affected by oxygen depletion due to micro-algal respiration during the normal dark periods (Searcy-Bernal *et al.* 1992) and deteriorating water quality caused by de-

composition of dead larvae.

So far there is a lack of study on the effect of light regimes on larval settlement and metamorphosis in abalone. However, species-specific phototaxis during the larval stage is used mainly to separate different batches of larvae during culture (Hahn 1989). In the present experiments, a higher settlement was obtained in larvae held under a 24-h illumination as compared to larvae held under different combinations of light and dark periods. The significantly lower settlement rate obtained in larvae held in 24-h dark regime suggested some probable cues on the sensitivity of abalone larvae to different light gradients. Searcy-Bernal *et al.* (1992) suggested that during darkness or low light intensity, micro-algal community respiration might deplete oxygen levels below tolerable limits to abalone larvae. However, the possibility of larval exposure to toxic oxygen supersaturation produced by benthic microflora during illumination was not discounted. In the oyster *Crassostrea gigas* the production of settled postlarvae was 65% higher on a light compared with a dark bottom (Beiras & Widdows 1995). Chen (1989) suggested that settlement tanks should be kept under 100 lux illumination level to ensure an even settlement of larvae. In Japan, settling tanks are continuously illuminated by fluorescent lamps (40W) immediately after stocking to

ensure diatom growth and prevent diatom respiration that produce anoxic conditions on plate surfaces, thus causing asphyxiation of the larvae (Hahn, 1989). During harvest of 60-day old juveniles, about 81% (total juveniles counted = 734) were found at the upper part of the corrugated settlement plates (n=33) as compared to 17 % and 2 % found at the middle and bottom sections respectively (Fermin, unpublished data).

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