OBSERVATIONS ON THE EFFECT OF DIET ON SHELL COLORATION IN THE DONKEY'S EAR ABALONE, *HALIOTIS ASININA* LINNE

Emmanuel C. Capinpin

ABSTRACT. Shell color was determined by the food eaten by the Donkey's ear abalone, *Haliotis asinina*. Shells of abalone juveniles fed with two cultured red seaweed, *Gracilariopsis heteroclada* and *Kappaphycus alvarezii* were dark brown in color as compared to light bluish-green in juveniles fed with an artificial feed. The use of this artificial feed for cultured abalone to produce the light bluish-green color is suggested as a biological tag for field growth and reseeding experiments.

INTRODUCTION

The Donkey's ear abalone, *Haliotis asinina* Linne, is a tropical abalone widely distributed in coastal rocky reef zones of Southeast Asia (Singhagraiwan and Sasaki, 1991) extending up to the subtropical and tropical regions of Japan (Hahn, 1989a). In the Philippines, *H. asinina* (Fig. 1) is common in Tawi-Tawi, Bohol, and Eastern Samar (PCMARD, 1991), Negros Oriental (L. Fabro, personal communication), and Panagatan Cays, Antique and its nearby islands (Capinpin et al. 1994).

Artificial seed production of *H. asinina* was first reported in 1989 at the Eastern Marine Fisheries Development Center in Thailand (Singhagraiwan and Sasaki, 1991). Since then, it has become experimentally possible to spawn and rear this species in hatchery tanks.

This experiment was designed to evaluate growth performance of *H. asinina* juveniles fed with three different food items for 120 days. Since the results of this experiment will be reported in another paper, the present report will only provide observations on the effect of these food items on shell coloration in *H. asinina* juveniles.

Figure 1.
H. asinina collected from the wild.

MATERIALS AND METHODS

Juvenile Production

H. asinina juveniles used in this study were produced from natural spontaneous spawning of abalone broodstock at the mollusc hatchery of SEAFDEC/AQD. Fertilized eggs or trochophore larvae from natural spawns were collected using a special larval trap (80mm mesh size) installed at the drain outlet of the broodstock tank. These were then washed with ultraviolet-irradiated seawater and held in 9l plastic containers until the veliger stage. Upon development of the operculum, eyespot, and fully formed propodium, the veliger larvae were transferred to a 1-ton settlement tank provided with corrugated collector plates. Abalone larvae were initially fed with the diatoms *Navicula* sp. and *Nitzschia* sp. that have grown on the plates. After reaching 1 cm in length, *Gracilariopsis heteroclada* was added to the tank.

Experimental Food Items

Three different food items consisting of two cultured red seaweed, *G. heteroclada* and *Kappaphycus alvarezii*, and an artificial feed (Nosan Awabi No. 3) manufactured by Nihon Nosan Kogyo specifically for the Japanese abalone were used in this experiment. The natural algae were given ad libitum while the artificial feed was given at 2-5% body weight once daily in the afternoon depending on consumption of the animals.

Grow-out Culture

H. asinina juveniles with an average total weight of 0.48 g and shell length of 1.45 cm were randomly chosen from a similarly sized population. Batches of 20 juveniles were held in hanging net cages consisting of a plastic tray (5 X 20 X 24 cm) covered with nylon netting material. Halved PVC pipes were placed inside the cages as additional substrates. The hanging net cages were then installed in a 1-ton oval fiberglass tank provided with running seawater of about 350 l/h and continuous aeration. Juveniles were grown in these cages for 120 days. All the juveniles were fed with *G. heteroclada* after the experiment.

RESULTS

Shells of *H. asinina* juveniles fed with the two cultured red seaweed, *G. heteroclada* and *K. alvarezii* were dark brown in color (Fig. 2a, c). On the other hand, shell color of all juveniles fed with the artificial feed was light bluish-green (Fig. 2b) which was already evident as early as 15 days.

After a shift of diet from the artificial feed to *G. heteroclada*, the juveniles slowly secreted brown colored shells at their anterior margin (Fig. 3).

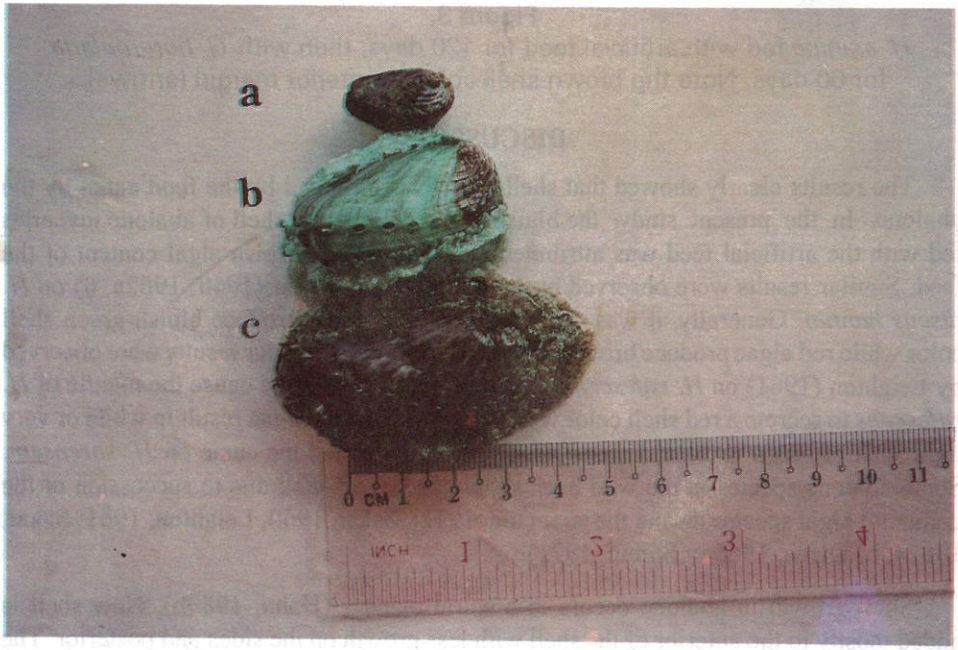

Figure 2.
H. asinina fed with three different food items for 120 days: a, *K. alvarezii*; b, artificial feed; and c, *G. heteroclada*.

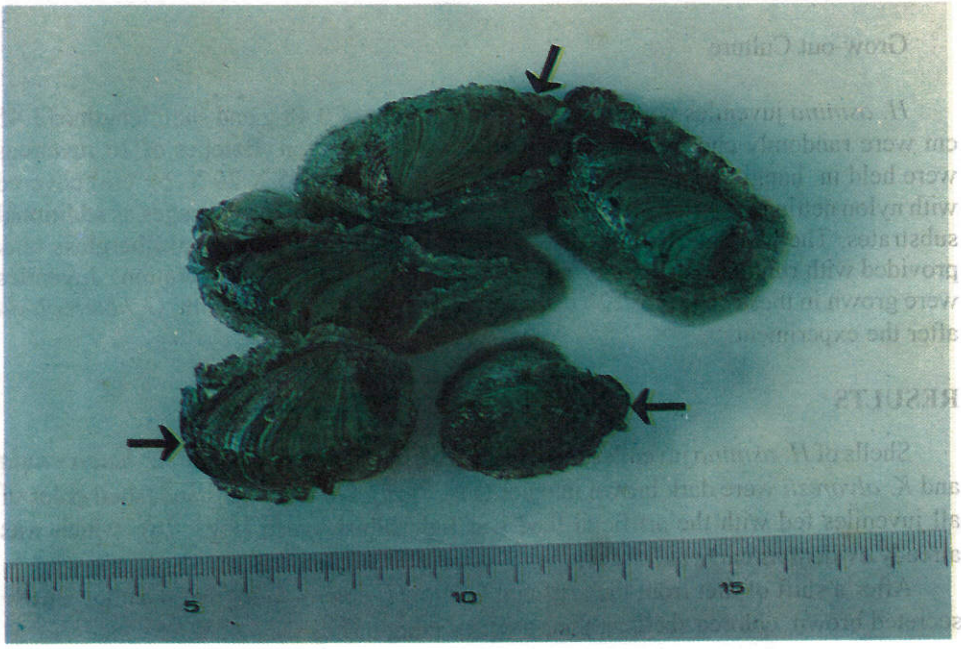

Figure 3.
H. asinina fed with artificial feed for 120 days, then with *G. heteroclada* for 60 days. Note the brown shell color at anterior margin (arrows).

DISCUSSION

The results clearly showed that shell color is determined by the food eaten by the abalone. In the present study, the bluish-green color of the shell of abalone juveniles fed with the artificial feed was attributed to the powdered brown algal content of the feed. Similar results were observed by Ino (1952) and Sakai (1960; 1962a, b) on *H. discus hannai*. Generally, it was shown that brown algae produce bluish-green shell color while red algae produce brown color of shell. Closely similar results were observed by Leighton (1961) on *H. rufescens*. He reported that red algae cause the mantle of *H. rufescens* to secrete a red shell color while brown and green algae result in white or very light tints of green or blue. Later, Olsen (1968b) reported the same on *H. sorenseni*. Some abalone species in the wild even show banding of shell due to succession of the dominant algal species during the year (Ino, 1952; Sakai, 1960; Leighton, 1961; Sakai, 1962a, b; Olsen, 1968a; Shibui, 1971).

Shell growth in abalone occurs in a spiral manner (Hahn, 1989b). New shell is added mostly to the anterior of the shell with less growth on the sides and posterior. The shell anterior shifts to the right as more shell is added to the right side. Figure 3 shows the recent growth of the shell of abalone juveniles previously fed with an artificial feed for 120 days and after shifting to *G. heteroclada* for 60 days.

The shell of wild-caught *H. asinina* is basically brown-colored with light cream triangular patches (Fig. 1). No bluish-green markings were observed in more than 500 wild specimens collected by the author from November 1993 to December 1994 in Panagatan Cays, Antique. This would suggest slight variations in the food preference of *H. asinina* in the wild. Hence, the use of the artificial feed for cultured abalone to produce the bluish-green shell color is suggested as a biological tag for field growth and reseeding experiments.This is in view of the difficulty of tagging small juveniles before they are placed into the ocean.

ACKNOWLEDGEMENTS

I wish to express thanks to Mr. Masahiro Hosoya, Japan International Cooperation Agency (JICA) Fisheries Expert for providing the artificial feed used in this study; Ms. Kaylin G. Corre, Team Leader of Mollusc Research, for her support and encouragement; Mr. Sid Tendencia for the photographs; and Mr. Nestor Bayona for his technical assistance.

References

Capinpin, E.C., W.G. Gallardo, and V.C. Encena. 1994. Abalone fishery in Panagatan Cays, Antique, Philippines. *Out of the Shell, Coastal Resources Research Network Newsletter* 4(2): 7-8.

Hahn, K.O. 1989a. Survey of the commercially important abalone species in the world. In K.O. Hahn (ed.). *Handbook of culture of abalone and other marine gastropods*. Boca Raton, Florida: CRC Press, Inc., pp. 3 - 11.

Hahn, K.O. 1989b. Nutrition and growth of abalone. In K.O. Hahn (ed.). *Handbook of culture of abalone and other marine gastropods*. Boca Raton, Florida: CRC Press, Inc.,. pp. 135 -156.

Ino, T. 1952. Biological studies on the propagation of Japanese abalone (genus *Haliotis*). *Bull. Tokai Reg. Fish Res Lab*. 5: 1-102.

Leighton, D. 1961. Observations on the effect of diet on shell coloration in the red abalone, *Haliotis rufescens* Swainson. *The Veliger* 4(1): 29-32.

Olsen, D.A. 1968a. Banding patterns of *Haliotis rufescens* as indicators of botanical and animal succession. *Biol. Bull.* 134: 139-147.

Olsen, D.A. 1968b. Banding patterns in *Haliotis*. II. Some behavioral considerations and the effect of diet on shell coloration for *Haliotis rufescens*, *Haliotis corrugata*, *Haliotis sorenseni*, and *Haliotis assimilis*. *The Veliger* 11(2): 135-139.

PCMARD-DOST. 1991. *Primer on the abalone: its nature and uses*., Los Banos, Laguna, Philippines: Philippine Council for Aquatic and Marine Research and Development.Department of Science and Technology.

Sakai, S. 1960. On the formation of the annual ring on the shell of the abalone, *Haliotis discus* var. *hannai* Ino. Tohoku. *J. Agric. Res.* 11(3): 239-244.

Sakai, S. 1962a. Ecological studies on the abalone, *Haliotis discus hannai* Ino. I. Experimental studies on the food habit. *Bull. Jpn Soc. Sci. Fish.* 28(8): 766-779.

Sakai, S. 1962b. Ecological studies on the abalone, *Haliotis discus hannai* Ino. II. Mutuality among the colored shell area, growth of the abalone and algal vegetation. *Bull. Jpn. Soc. Sci. Fish.* 28(8):780-783.

Shibui, T. 1971. Studies on the transplantation of red abalone and its growth and development. *Bull. Jpn. Soc. Sci. Fish.* 37(12): 1168-1172.

Singhagraiwan, T. and M. Sasaki. 1991. Breeding and early development of the Donkey's ear abalone, *Haliotis asinina* Linne. *Thai Mar. Fish. Res. Bull.* 2: 83-94.