

## Effects of delayed metamorphosis on larval survival, metamorphosis, and juvenile performance of four closely related species of tropical sea urchins (genus *Echinometra*)

### ABSTRACT

We report here, the effects of extended competency on larval survival, metamorphosis, and postlarval juvenile growth of four closely related species of tropical sea urchins, *Echinometra* sp. A (Ea), *E. mathaei* (Em), *Echinometra* sp. C (Ec), and *E. oblonga* (Eo). Planktotrophic larvae of all four species fed on cultured phytoplankton (*Chaetoceros gracilis*) attained metamorphic competence within 22–24 days after fertilization. Competent larvae were forced to delay metamorphosis for up to 5 months by preventing them from settling in culture bottles with continuous stirring on a set of 10 rpm rotating rollers and larval survival per monthly intervals was recorded. Larval survival was highest at 24 days, when competence was attained (0 delayed period), and there were no significant differences among the four species. Larvae that had experienced a prolonged delay had reduced survival rate, metamorphosis success, and juvenile survival, but among older larvae, Em had the highest success followed by Ea, Eo, and Ec. Juveniles from larvae of all four species that metamorphosed soon after becoming competent tended to have higher growth rates (test diameter and length of spines) than juveniles from larvae that metamorphosed after a prolonged period of competence with progressively slower growth the longer the prolonged period. Despite the adverse effects of delaying metamorphosis on growth parameters, competent larvae of all four species were able to survive up to 5 months and after metamorphosis grew into 1-month-old juveniles in lab condition. Overall, delayed larvae of Em showed significantly higher larval survival, metamorphosis, and juvenile survival than Ea and Eo, while Ec showed the lowest values in these performances. Em has the most widespread distribution of these species ranging from Africa to Hawaii, while Ec probably has the most restricted distribution. Consequently, differences in distribution may be related to differences in the ability to delay metamorphosis.

**Keyword:** Delayed metamorphosis; Larval survival; Metamorphosis; Juvenile; Genus *Echinometra*