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The effect of water temperature on the early-life development, growth and survival of the freshwater mussel *Hyriopsis bialata*

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ABSTRACT

The effect of water temperature on early-life development, growth and survival of the freshwater mussel, *Hyriopsis bialata*, was studied under controlled conditions. Gravid female mussels carrying gastrula embryos or early glochidia larvae were reared at 4 temperatures (25, 28, 31 and 34 °C) until they released mature glochidia; glochidia were then allowed to develop into juveniles. The highest survival rate of glochidia released from mussels carrying gastrula embryos was at 25 °C (91.4%), while survival for glochidia released from mussels carrying early glochidia larvae ranged from 83.2–91.3%. Average larval development time for gravid females carrying gastrula embryos or early glochidia larvae was between 5.0 and 9.2 days and 2.6–3.6 days, respectively. The survival of glochidia cultured to early juveniles in artificial medium was high in gravid mussels with gastrula embryos originally reared at 25 °C (93.9%) or 28 °C (93.6%), but was markedly decreased when originally reared at 31 °C (49.6%), while survival rates of those in gravid mussels with early glochidia larvae originally reared at 25, 28 or 31 °C were 92.3, 90.2 and 87.7%, respectively. The average transformation period from glochidia to early juvenile was 8–11 days, regardless of the temperature. Juveniles were reared for 1 month, and survival and length were measured. For glochidia released from gravid females with gastrula embryos, survival (85.7%) and length (0.49 ± 0.05 mm) were highest when originally reared at 25 °C, and both measures were significantly decreased at 28 and 31 °C. For glochidia released from gravid females carrying early glochidia larvae, survival (82.2%) and length (0.45 ± 0.06 mm) were highest when originally reared at 28 °C and lower when reared at 25 or 31 °C. Our results indicate that the optimal water temperature for culturing gravid female mussels carrying gastrula embryos or early glochidia larvae was 25 and 28 °C, respectively. These temperatures allowed high juvenile survival and growth.

1. Introduction

Freshwater mussels (*Hyriopsis bialata*), of the family Unionidae, are dioecious and have a complex mode of reproduction. *Hyriopsis bialata* spawning occurs year-round (Jindamongkol et al., 2003) and is widely distributed across large areas of Thailand, including the Mekong, Mun and Chi Rivers (Brandt, 1974; Kovitvadhi and Kovitvadhi, 2002).

Temperature is an important environmental factor that influences the duration of embryo development, transformation of the glochidium to the juvenile mussel and the duration of the parasitic phase (Kovitvadhi and Kovitvadhi, 2010). The factors that promote glochidial release are poorly understood for most species but are assumed to relate to water temperature (Hastie and Young, 2003; Watters and O'dee, 1998). Altered river water temperatures are typically due to climatic effects (Langan et al., 2001). While *H. bialata* zygotes developed into mature glochidia in 6–9 days when water temperature was 24–25 °C, this duration decreased to 5–6 days when the water temperature increased (Jindamongkol et al., 2003). In another species, the freshwater pearl mussel *Margaritifera margaritifera*, increasing water temperature induced gravid females to release their glochidia (Wellmann, 1943; Young and Williams, 1984), and mussels in the warmest rivers (> 10 °C) tend to release glochidia earlier than in colder rivers (Hastie and Young, 2003). In *Anodonta cygnea*, the development of incubating glochidia was severely delayed at low water temperatures (< 10 °C; Wood, 1974).

Previously, freshwater mussel cultures were initiated by aspirating mature glochidia from gravid females and transferring them to artificial culture medium (Uthaiwan et al., 2001, 2002; Kovitvadhi et al., 2006, 2008; Kovitvadhi and Kovitvadhi, 2013; Supannapong et al., 2008). Presently, climate change is leading to glochidia release before they

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