Development of a rearing technique for the free-swimming zoea larvae of the freshwater shrimp *Macrobrachium yui* from Northern Laos

In Laos, many freshwater prawns (*Macrobrachium* spp.) have been found in a variety of freshwater environments including rivers, ponds, and caves. They have high market value and thus are economically important for the local farmers. *Macrobrachium yui* (Holthuis 1950, Fig. 1), which mainly inhabits the northern part of Laos, fetches the highest price at the local market. The females of *M. yui* have been reported to migrate toward the inner part of the cave stream to spawn and hatch their eggs. After the zoea larvae hatch out (Fig. 1A), they stay inside the cave until development into postlarvae (Fig. 1B). Then, they change their habitat from the cave stream to the aboveground river and develop into juveniles. Thus, this species inhabits two different water environments in its life cycle. In Laos, *M. yui* catch has decreased dramatically, and the genetic diversity in some local populations has already been greatly reduced by environmental deterioration and overfishing. In order to aid in conserving and recovering local populations of *M. yui*, production of *M. yui* larvae may be one promising solution. In this study, we aimed to develop a technique for rearing *M. yui* larvae without using cave stream water.

According to the relationship between egg size and salinity tolerance of larvae of the *Macrobrachium* species, it was hypothesized that (1) the larvae of *M. yui* can develop at a certain water salinity during zoea larvae stage and (2) they can adapt to freshwater after development into postlarvae. We compared the survival rate of the zoea larvae when reared in 4 different salinities (0-10.5 ppt). Among the tested waters, the zoea larvae showed the highest survival rate, at 91.7 % on average, in 3.5 ppt (Fig. 2). Next, we tested acclimation to freshwater during the postlarval stage using three experimental treatments: rearing at 0 ppt salinity (freshwater) for both the first and second weeks (treatment I), rearing at 1.7 ppt for the first week and 0 ppt for the second week (treatment II), and rearing at 3.5 ppt salinity for both the first and second weeks (treatment III). The postlarvae survived better in treatments II (78%) and III (73%) than in treatment I (51%) (Fig. 3). Finally, the water from the Xuang river in Luang Prabang Province, Laos, where *M. yui* inhabits, was analyzed using ion chromatography to know ion concentrations. The concentrations of SO_4^{2-}, Mg^{2+}, and Ca^{2+} of 3.5 ppt artificial seawater were similar to those in cave water (Table 1).

This study succeeded in rearing zoea larvae of *M. yui* using 3.5 ppt artificial seawater instead of cave water. The postlarvae showed high survival rates when rearing salinities were gradually decreased. The technique developed in this study will contribute to artificial seed production of *M. yui* in aquaculture facilities without cave water, and help in recovery efforts for the endangered local populations of *M. yui*.

(T. Okutsu, S. Morioka, S. Ito [Japan Fisheries Research and Education Agency], K. Hamada [Institute for Rural Engineering, NARO], P. Chanthasone, A. Kounthongbang, P. Phommachan, O. Lasassima [Living Aquatic Resources Research Center])

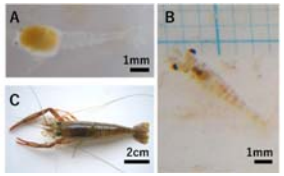

Fig. 1. The developmental stages of *M. yui*.
A: Hatched larva
B: Postlarva
C: Female broodstock

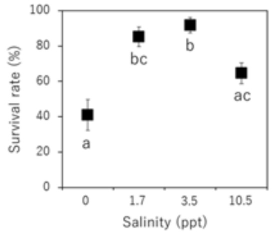

Fig. 2. Survival rates of larvae during the free-swimming zoea larval stages when reared at 4 different (0-10.5 ppt) salinities. The results are expressed as the mean ± SE of 23 replicates. Different letters indicate significant differences ($P < 0.05$).

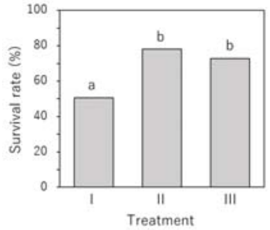

Fig. 3. Survival rates of postlarvae during the 2 weeks after settling to the bottom, in three treatment groups. Treatment I: n = 93, 100, and 107 in Treatment I, II, and III, respectively. Different letters indicate significant differences ($P < 0.01$).

Table 1. The concentration (mg/l) of major ions in 3.5 ppt artificial seawater, cave stream water, and aboveground water. The U and P values indicate statistical results of the comparison of seven ions between cave stream water and aboveground water by the Mann-Whitney U test.

Ions	Artificial seawater at 3.5ppt*	Cave stream water (n=4) (mean (SE))	Aboveground water (n=12) (mean (SE))	*U* value	*P* value
Cl^-	1767.9	1.04 (0.14)	0.34 (0.12)	53	0.025
NO_3^-	N.D.**	2.06 (0.63)	0.19 (0.06)	57	0.006
SO_4^{2-}	270.4	67.48 (46.88)	9.52 (3.96)	52	0.034
Na^+	1053.9	6.34 (0.46)	8.85 (1.33)	28	0.505
K^+	41.5	0.68 (0.06)	1.07 (0.09)	12	0.009
Mg^{2+}	134.9	16.61 (3.60)	8.49 (1.48)	53	0.025
Ca^{2+}	62.5	108.28 (4.80)	41.18 (5.12)	58	0.004

*Kester et al., (1967) Limnol. Oceanogr., 12: 176-179.
**N.D., no data