Zoological Studies

Peculiar Oviposition Behavior of the Endangered Ground Beetle *Pterostichus isumiensis* (Coleoptera: Carabidae) and Implications for Its Conservation

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Pterostichus isumiensis Kasahara and Saito is a ground beetle that is restricted to a hilly area in Chiba Prefecture, eastern Japan and is listed as "vulnerable" on the *Japanese Red List*. Despite the need to preserve this species, many aspects of its ecology are unknown (Chiba Prefecture 2000). In particular, factors that affect its distribution are poorly understood. This study reports peculiar oviposition behavior of this beetle as observed in the laboratory, which was assumed to reflect habitat requirements of ovipositing females in the field.

Laboratory-rearing experiments began on 25 Sept. 2009, with reproductive adults (3 males and 2 females) that were collected on 21-25 Sept. 2009. Females were initially reared individually in plastic boxes (12.0 × 11.0 × 9.0 cm) that were filled to the halfway point in depth with moistened garden soil. During the 1st month, every 7 d, a male was added for 48 h, and females were allowed to mate (Fig. 1A). Both males and females were fed pieces of *Tenebrio* larvae. Experiments were conducted in incubators maintained at 15°C under a light dark 8: 16 h photoperiod.

From 3 to 19 Oct., 1 female laid 11 eggs, and the other female laid 4 eggs, both on the soil surface or on the wall of the plastic box; these eggs became moldy and never hatched, suggesting that the eggs were laid under abnormal conditions. On 19 Oct., a Petri dish (6.0 cm in diameter, 1.5 cm high) filled with mud was newly added to the plastic box. This Petri dish was designed to simulate a wetland, which was reported to be the habitat of the beetle in autumn (Chiba Prefecture 2000). On 20 Oct., several mud cells, each containing 1 egg, were found glued to the wall of the plastic box. Therefore, subsequent rearing was conducted in this "new" type of rearing box (Fig. 1B), each of which held a "wetland" Petri dish and stones on the soil as egg-laying sites. In the new rearing boxes, females began to lay many eggs, always in mud cells glued to the stones or walls of the box (Figs. 1B, C). From 19 Oct. to 6 Nov., 1 female laid 77 eggs, and the other female laid 47 eggs; most eggs (75 and 43 eggs, respectively) hatched (Fig. 1D).

Importantly, when mud was unavailable, females could not oviposit normally. In the field, this beetle frequently occurs at the border between wet grasslands and forests in autumn (Chiba Prefecture 2000). These results suggest that the wetland environment, where mud is consistently available, is essential for the reproduction of *P. isumiensis*, and that the protection of wet grasslands is vital for its conservation.

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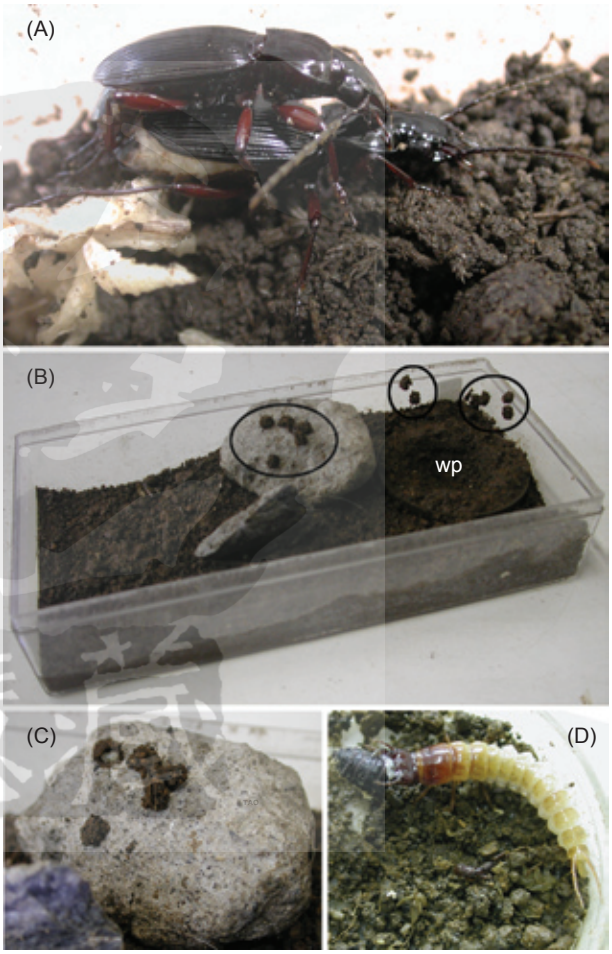

Fig. 1. (A) A copulating pair of *Pterostichus isumiensis*; (B) 2nd type of rearing box used for females in the study, containing a "wetland" Petri dish (wp) and stones as egg-laying sites; (C) mud cells (each enclosing a single egg) laid on a stone; and (D) a 3rd-instar larva feeding on a dipteran pupa. Circles in (B) indicate mud cells glued to a stone or the box walls. The photos vary in magnification.

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