

Notes on the life history and a description of the immature stages of the water bug, *Aphelocheirus vittatus* (Heteroptera: Aphelocheiridae)

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INTRODUCTION

Aphelocheirid bugs, which generally inhabit streams, have evolved a very efficient physical gill system or plastron, so that they are not necessary to visit a water surface to breathe. As a consequence, this species appears a most adapted bug to lotic habitats [1-3]. The aphelocheirid *Aphelocheirus vittatus* has been found in Honshu, Shikoku and Kyushu of Japan [4]. It lives on and among the stones in streams, and sucks the contents of its prey. At present, the biology and ecology of this species is poorly understood.

This paper presents information on the life history of *A. vittatus*. Species morphology, diel activity, copulation and oviposition are described, mainly from data acquired from a laboratory-rearing experiment. This also gives the first illustration of the immature stages of this species.

METHODS

Sampling site. All samples were collected at an altitude of 175 m within the Yoro River system located in central Japan (35°12'N, 140°12'E). The stream was 4-10 m in width, about 70 cm in depth at the deepest part. Current velocity was 30-100 cm/s at the rapids, and the annual water temperature was 4-24°C.

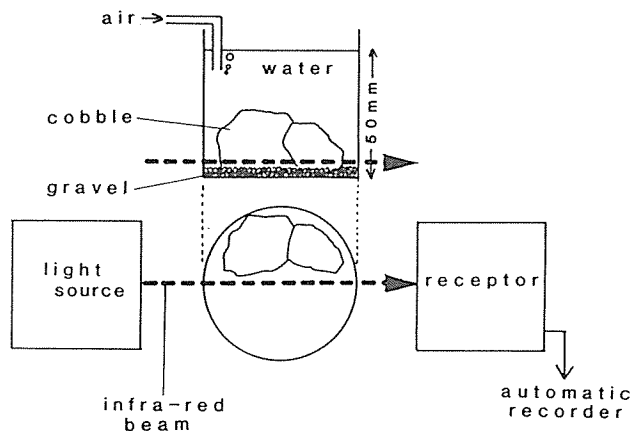


Fig.1. Diagram of the system used for monitoring the activity of *A. vittatus*. When the bug intercepts an infra-red beam (1 mm diameter), a pulse is recorded on a recording chart.

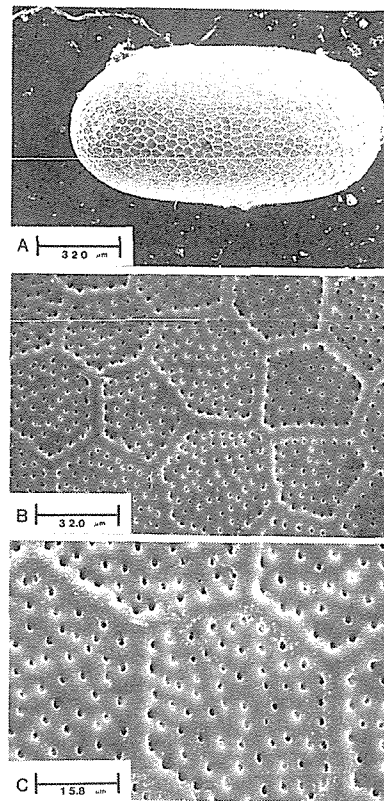


Fig.2. Scanning electron micrographs of an egg of *A. vittatus*. A: a whole egg. B: polygonal reticulation patterns on the egg surface. C: small holes on a chorion.

Sampling and rearing. At the sampling site, nymphs and adults were sampled with a hand net (0.5 mm mesh) at monthly intervals during April to November in 1993. Their total body length and width at the widest part were measured with a slide caliper to the nearest 0.1 mm. Following the measurement, they were usually released into the stream at the point of captured. On 8 April 1993, overwintering adults (11 females and 17 males) were collected and brought to the laboratory. They were divided into 11 groups (1 female + 1-2 males per group), and reared separately in a water-filled container (11 cm diameter, 7 cm deep), which was constantly aerated and renewed every 2-3 days. They were reared within temperature and photoperiod parameters similar to that which they experienced in the field, and fed chironomid larvae ad libitum. Cobble stones were placed in the container for the bugs' oviposition and the number of eggs laid were counted every 2-3 days. This experiment continued until all animals died. Egg sizes (length and width) were measured with an ocular micrometer to the nearest 0.025 mm within three days after oviposition.

Diel activity of movement. On 29 July 1993 the fourth- and fifth-instar nymphs and adults were collected in the field. They were kept together in an aquarium tank (25 cm long, 15 cm wide, 16 cm deep), supplied with a bubbler at 25°C (14 h light: 10 h dark photocyclus), and chironomid larvae were fed to the bugs. After the bugs acclimatized to the temperature and to the photocyclus for 2-3 weeks, the experiments were carried out using an individual of each instar or sex under the same conditions in which the bugs were reared. Individual movement in the container (36 mm diameter for nymphs; 60 mm diameter for adults) was automatically monitored using an infra-red fine beam system (Fig.1). Each movement that intercepted the beam was recorded as a pulse on a recording chart. Recording was performed for 5 days after the bugs were acclimated to the system. Water in the container was exchanged every day and the bugs were daily fed chironomid larva (about 15 mm in total body length).

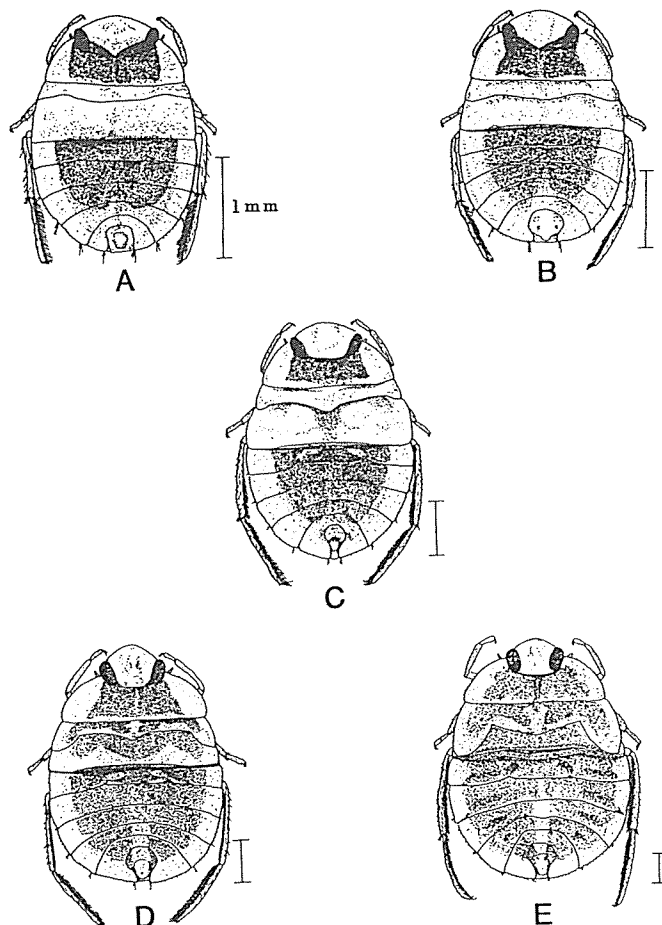


Fig.3. Nymphal instars of *A. vittatus*. A: the first-instar. B: the second-instar. C: the third-instar. D: the fourth-instar. E: the fifth-instar.

RESULTS AND DISCUSSION

Eggs (Fig.2). Eggs were laid singly and adhered to the surface of substrata in the water. Eggs were ellipsoidal, 1.266 mm (SD=0.057 mm, N=645) in mean length and 0.626 mm (SD=0.033 mm, N=645) in mean width. Eggs possessed a polygonal reticulation pattern, generally pentagonal or hexagonal, with many small holes on the chorion. Eggs, when oviposited, were yellow, but turned black during development.

Nymphs (Fig.3). The body width/length ratio tended to increase in the late instar nymphs, and the proportion of head to body decreased with instars. Although swimming hairs were present on the tarsus of hindlegs in all nymphal stages, those on hindleg tibia increased in number at subsequent instars. Bodies were slightly yellowish with some black maculations. The five nymphal instars were clearly distinguished, with no size overlap among the instars. The mean body length was 2.29 mm (SD=0.09 mm, N=206) in the first-instar, 3.13 mm (SD=0.13 mm, N=251) in the second-instar, 4.24 mm (SD=0.15 mm, N=305) in the third-instar, 5.84 mm (SD=0.17 mm, N=331) in the fourth-instar, and 8.02 mm (SD=0.23 mm, N=227) in the fifth-instar. The mean body widths of the first to fifth-instars were 1.46 mm (SD=0.06 mm, N=29), 2.04 mm (SD=0.08 mm, N=33), 2.91 mm (SD=0.08 mm, N=40), 4.11 mm (SD=0.12 mm, N=58), and 5.98 mm (SD=0.13 mm, N=50), respectively. Monitoring of individual movement revealed that the fourth- and fifth-instar nymphs were completely nocturnal (Fig.4, A and B).

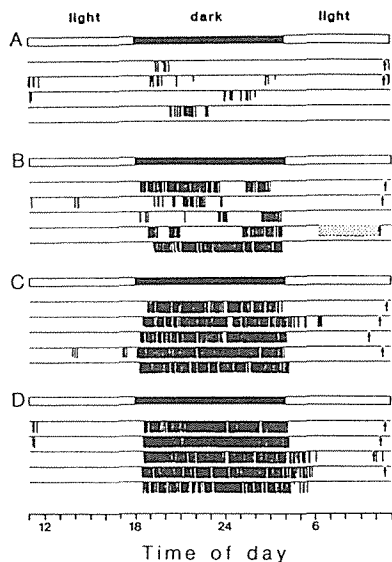


Fig.4. Actograms of nymphs and adults at 25°C (14 h light: 10 h dark photocycle). Arrows show the time at which the water in the container was exchanged and food (chironomid larvae) was added. The dotted area shows the period during which the actograph did not work. A: the fourth-instar. B: the fifth-instar. C: the adult male. D: the adult female.

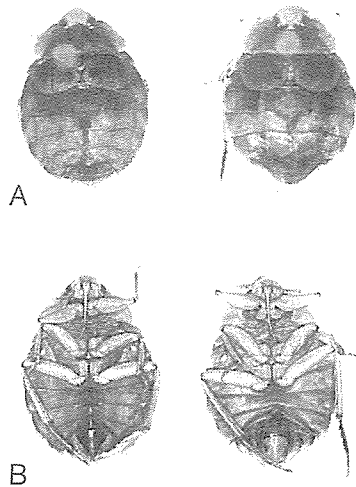


Fig.5. Adult males (right) and females (left) of *A. vittatus*. A: dorsal view. B: ventral view.

Adults (Fig.5). Adult males were 10.27 mm (SD=0.23 mm, N=503) in mean length and 7.12 mm (SD=0.16 mm, N=82) in mean width. Adult females were 10.39 mm (SD=0.24 mm, N=615) in mean length and 7.26 mm (SD=0.17mm, N=93) in mean width. Although macropterous forms have been reported from other areas of Japan [5], a macropterous form was not found at the sampling site. All adult specimens had very short forewings reaching anterior edges of the second abdominal segment. Adult coloration was dark brown with some individuals displaying yellow mottles.

Both adult males and females as well as the nymphs showed a clear nocturnal habit (Fig.5, C and D). In the laboratory copulations were observed during the period when water temperature was over 8°C. The male, when encountering the female, mounted her by grasping the lateral margins of her pronotum with his forelegs. Copulatory duration was about 2 hours. After genitalic coupling, the male continued to grasp the female for several hours (probably post-copulatory mate guarding). Females reared in the laboratory laid eggs for a long period (usually 130 days: from late April to August)(Fig.6). The mean number of eggs deposited per day per female during this period was 1.63 (SD=0.44, N=11). Oviposition was absent during September to March, but some females did again the egg laying after overwintering. The maximum cumulative number of eggs deposited per female was 237. Males also had a long lifespan, and several individuals were able to copulate after overwintering.

Conclusion. Nymphs and adults of *A. vittatus* are nocturnal. Both males and females live for a relatively long period in the laboratory. Female oviposition continues during late April to August, at the rate of one or two eggs per day, resulting in a high lifetime fecundity.

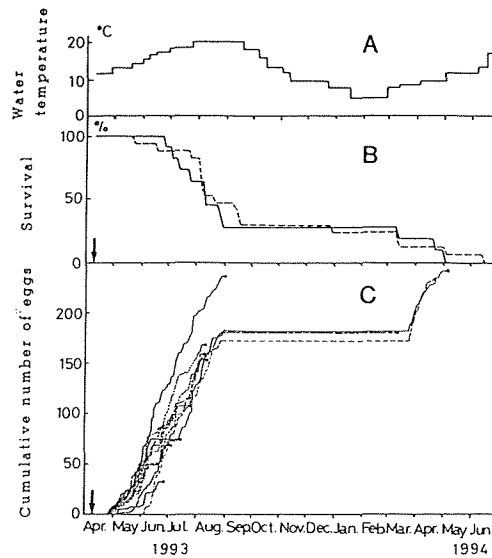


Fig.6. Survival and oviposition profile for adults collected from the field on 8 April 1993 (arrow). A: the rearing temperature regime in the laboratory. B: survival of males (broken line) and females (solid line). C: cumulative number of eggs deposited by each female (lines). The closed circles indicate the female death.

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