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Process of *Micrasema uenoi* colonization in stream bryophyte clumps (Trichoptera: Brachycentridae)

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Introduction

Larvae of the genus *Micrasema* Martynov are well known to inhabit preferentially stream bryophyte clumps and to feed on the bryophytes [1, 2, 3, 4, 5, 6]. In Japan, *Micrasema* larvae appear frequently in clumps of stream bryophytes over a wide range of elevations, river systems and geological locations [6]. *Micrasema uenoi* Martynov is the predominant species in bryophyte clumps in the Toyamazawa River, Nikko National Park, central Japan [6, 7]. It has a semivoltine life cycle in the head stream, hatching in fall and emerging in summer. The densities in terms of substrate surface are higher in bryophyte clumps than on cobble beds during the first and second instars while they are similar in the two habitats during the third to fifth instars [6].

In the present study, the process of *M. uenoi* colonization on bryophyte clumps was examined experimentally in the head stream of the R. Toyamazawa to elucidate the relationship between bryophyte clumps and the larvae.

Study site

A field experiment was carried out in the head stream of the R. Toyamazawa, Nikko National Park (elevation, 1440 m; 36° 47'N 139° 25'E). The stream, which runs through mountain forest from Mt. Maeshirane to Lake Chuzenji, is short (6.6 km) and small, two orders at the lake inlet. The stream bed contains cobbles at the study site. These cobbles are covered mostly with the aquatic bryophytes *Rhynchostegium riparioides*. Bare cobbles are chiefly distributed in the center of the water current.

Methods

Glass wool, which mimicks the natural bryophyte clumps, and bryophytes, on which animals and organic matters were washed out, were used as substrates in this experiment. A series of 12 to 20 sets of glass wool (approximately 4×4×2 cm) and bryophytes (approximately 4×2×0.5 cm) were placed in the middle of the stream in September 1992, and in June and September 1993. Two or three of these sets were removed from the stream bottom at intervals of 15 to 30 days. Natural populations of *M. uenoi* were also collected at the same time as a control. Each experiment was performed for two to four months.

Larvae of *M. uenoi* were sorted out from each sample in the laboratory. They were then counted and their head widths measured. The larval densities in each sample were calculated in terms of substrate surface area. Surface areas of bryophytes and glass wool were estimated by the method of Kato (1992,[6]) from dry weights by multiplying by the surface area; dry weight ratios, 0.07856 g^{-1} for bryophytes and 0.00843 g^{-1} for glass wool. Also, some of the third to fifth instar larvae colonizing both substrates, and some of the natural population, were analyzed for their gut contents using a microscope.

Results

The larvae of *M. uenoi* colonized both glass wool and bryophytes. The larval densities on each substrate increased immediately after placement, and reached a level similar to that of natural populations 15 to 30 days after placement: 1000 to 1500 individuals m^{-2} in fall 1992 and 1993, 400 to 500 individuals m^{-2} in summer 1993.

Colonization by *M. uenoi* larvae showed two patterns depending on the developmental stage. Early (first and second) instar larvae colonized well on both bryophytes and glass wool in fall (Fig. 1). The density of early instar larvae was higher on glass wool than on bryophytes. The changes in the larval densities on bryophytes were similar to those of the natural populations. The densities on glass wool, however, decreased after immediate increases. Maximum densities on glass wool were 10061 individuals m^{-1} in 1992 and 3906 individuals m^{-1} in 1993, being two to three times higher than that on bryophytes and that of the natural population. Also the proportion of larval density on glass wool to that on bryophytes, approximately 0.19 (glass wool / bryophytes), was identical to the proportion of fabric density of glass wool to that of bryophytes, approximately 0.2 (glass wool / bryophytes).

Third to fifth instar larvae colonized both on glass wool and bryophytes (Fig. 2). The densities of colonized larvae were similar among glass wool, bryophytes and the natural population.

The gut contents of the third to fifth larvae were classified into bryophytes, leaf litter, algae and detritus (Table 1). Their proportions differed between glass wool and bryophytes. On the bryophyte substrate, the gut contents of the larvae were composed mostly of bryophyte fragments, accounting for 80.2% of the total.The larvae that colonized glass wool fed mainly on leaf litter, which accounting for 72.8% of the total.

Discussion

In the present study, colonization by *M. uenoi* larvae showed two patterns. Early instar larvae showed different colonization patterns between glass wool and bryophytes. They colonized glass wool more actively than bryophytes. However, the colonization densities of late instar larvae were similar on both substrates.

The late instar larvae of *M. uenoi* move actively between bryophyte clumps and bare cobble beds. They feed on bryophytes even on bare cobbles (Kato, unpublished data). Thus it appears that *M. uenoi* larvae might utilize bryophytes as food. In the present study, however, third to fifth instar larvae showed good colonization on glass wool, which is not edible, as well as on bryophytes. Seasonal changes in larval density were similar among glass wool, bryophytes and the natural population. Also, the larvae that colonized glass wool fed mainly on leaf litter and detritus. This means that the larvae do not depend on bryophytes as food, and that they might perceive glass wool as a substrate similar to a bryophyte, since in the laboratory *M. uenoi* larvae were observed to move on substrate with their legs grasping bryophyte stems or small humps on cobbles. These findings suggest that larval colonization is affected by the area of bryophyte surface available as a grasping material.

In the present study, the densities of early instar larvae of *M. uenoi* in terms of substrate surface area were higher in bryophyte clumps than on bare cobbles [6,7]. Similarly, it has been reported that early instar larvae of many taxa of aquatic insects inhabit stream bryophyte clumps (Suren, 1991,[8]). Gerson (1982,[9]) and Suren (1991,[8]) suggested that juvenile larvae increased in number in

bryophyte clumps, because the adults selectively deposited their eggs those.

In the present study, however, early instar larvae colonized both glass wool and bryophytes, where no egg masses had been observed. The density of early instar larvae was higher on glass wool than on bryophytes due presumably to the higher fabric density of the glass wool. Many egg masses of *M. uenoi* were found on the sides of bare cobbles in the head stream of the R. Toyamazawa (Kato, unpublished data). Laboratory observations have suggested that first instar larvae might not be able to migrate (Kato, unpublished data). Also *M. uenoi* hatches mainly from September to December at the study site (Kato, unpublished data). The period during which early instars increased agreed with the period of hatching. Therefore the early instar larvae that hatched on bare cobbles were affected by current velocity. Accordingly, the increase in number of early instar larvae on glass wool and bryophytes was due to the trapping of drifting larvae by the clumps and not to oviposition by adults.

On glass wool, the larval densities in terms of substrate surface area decreased after an immediate increase, and the approached that on bryophytes and the natural population. This indicates that early instar larvae colonizing glass wool are affected by the area of the substrates after colonization.

It is concluded that colonization of bryophytes by *M. uenoi* larvae is affected by the density of bryophytes as a trapping substrate for early larval instars, and thereafter by the total length of stem available as a grasping material.

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Table 1 Gut contents of *Micrasema uenoi* larvae colonized on glass wools and bryohytes.

	Number of samples		bryophyte fragments	litter	algae (daitom)	detritus
glass wools	23	occurence	30.4	87.0	13.0	34.8
		proportion	17.2	72.8	0.9	9.1
bryophytes	25	occurence	92.0	0.0	36.0	72.0
		proportion	80.6	0.0	2.0	17.4

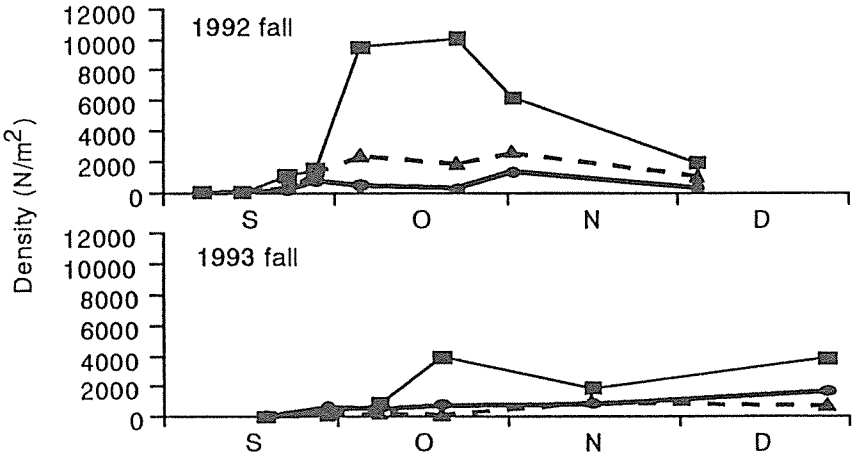

Fig.1 Change in density of first and second instar larvae of *Micrasema uenoi* on glass wool and bryophytes. Circles show densities of natural population, quadrates larval densities on glass wool and triangles those on bryophytes.

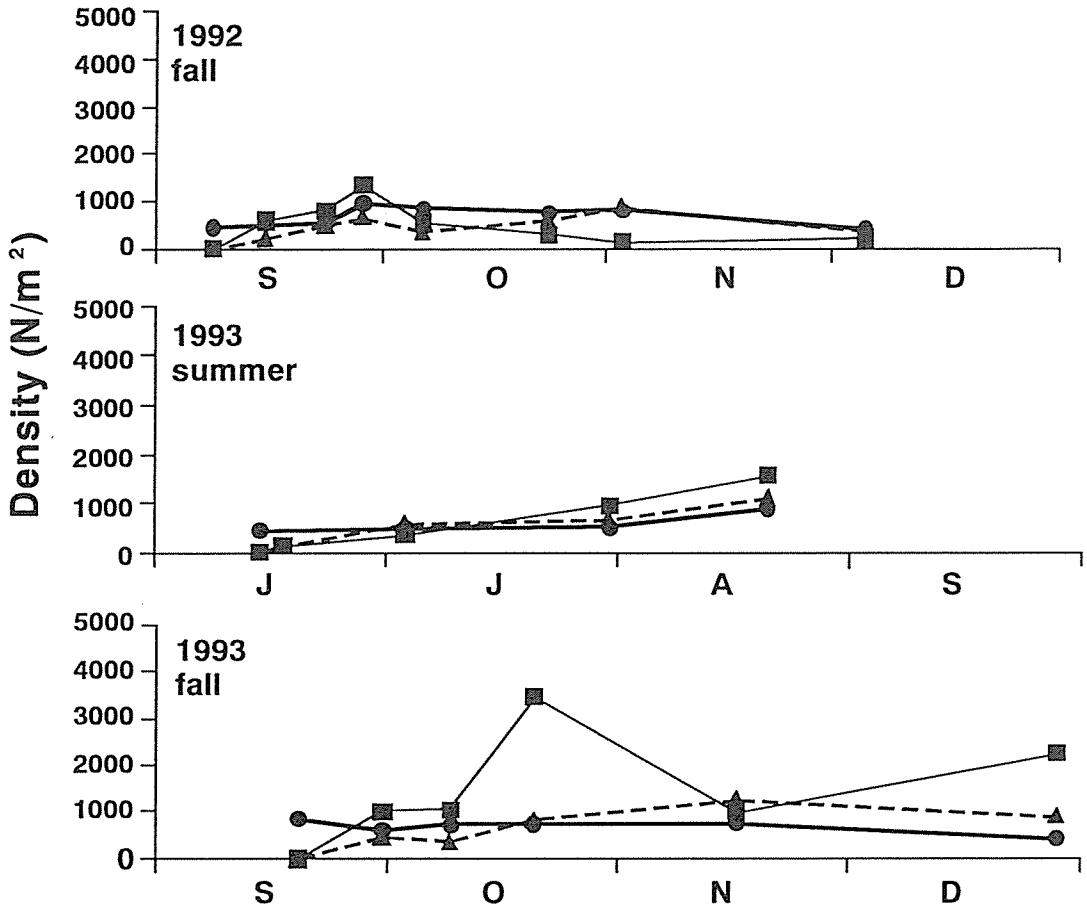

Fig.2 Change in density of third to fifth instar larvae *Micrasema uenoi* on glass wool and bryophytes. Circles show densities of natural population, quadrates larval densities on glass wool and triangles those on bryophytes.