Micro-Distribution and Head direction of Plecopteran Exuviae in Kuro River, Kiso Region, Japan

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Introduction

Stonefly (order Plecoptera) is a hemimetabolous insect. Its larva is aquatic, and it emerges and turns into a terrestrial imago without pupation. Because of its difficulty, Plecoptera should have its strategy where to hatch out. While it is difficult for us to observe directly the behavior of emergence, we can easily find cast-off skins (exuviae) remained at the hatching site. We can understand where the larva hatched out on and which direction the larva turned toward through exuviae. I attempted to examine hatching site and head direction of plecopteran exuviae, and to find out what tendency of eclosion is observed.

Method

I located plecopteran exuviae along Kuro River (the Kiso River system) on 21st – 22nd August 2012 and measured the following data about each exuvia:

A) length and width of the overwater part of the stone on which the exuvia remains.
B) height of the stone on which the exuvia remains from the surface of the water.
C) height of the position in which the exuvia remains from the surface of the water. I fixed criteria for measuring on the mesothorax of the exuvia.
D) size of the exuvia: length from the frontal edge of the head to the end of the abdomen (i.e. measuring exclusive of the antennae and the cerci)
E) distance of shortest route from the surface of the water to the exuvia.
F) distance of imaginary trait assumed along the head direction from the surface of the water to the exuvia.
G) angle of elevation of the exuvia.
H) angle of the head direction of the exuvia to right or left direction from the right upper direction.
I) angle of the head direction against water current.

I measured angles in units of 15 degrees by eye and length or height with a tape.

Result and Discussion

I collected 104 samples – 22 samples of species-A, 12 samples of species-B and 70 samples of group-C from 49 stones.

species-A *Paragnetina* sp. (Perlidae); largest species of the collected samples
species-B Perlodidae gen. sp. (possibly *Ostrovus* sp.); medium-sized species of the collected samples
group-C not yet identified but includes plural species; small-sized group of the collected samples

Most of plecopteran species tend to emerge from spring to summer in Japan, so only a few species of stonefly exuviae can be discovered in late summer. We have to notice that cast-off skins are very light and fragile and so can regard exuviae as the very latest.

Stone size – (A), (B)

49 stones which I collected exuviae from are within the range of 6.5 – 88 cm (average: 47 cm) in length and 3.0 – 45 cm (average: 17cm) in height. I don't suppose that these stones which stoneflies selected to hatch out on have unbalanced tendency in size.

Hatching height – (C)

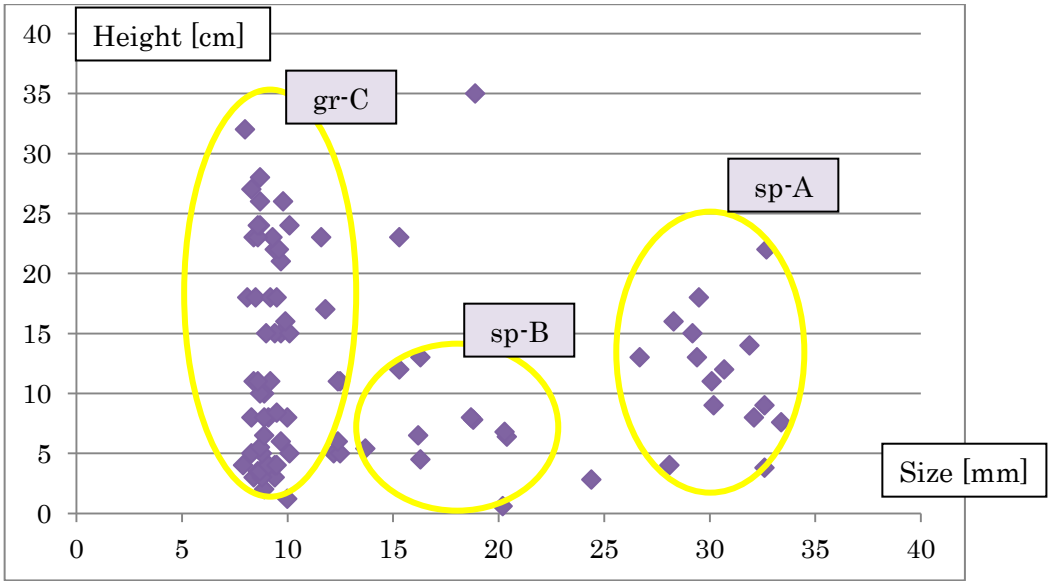

Fig. 1: Hatching height – Exuvia size relationship

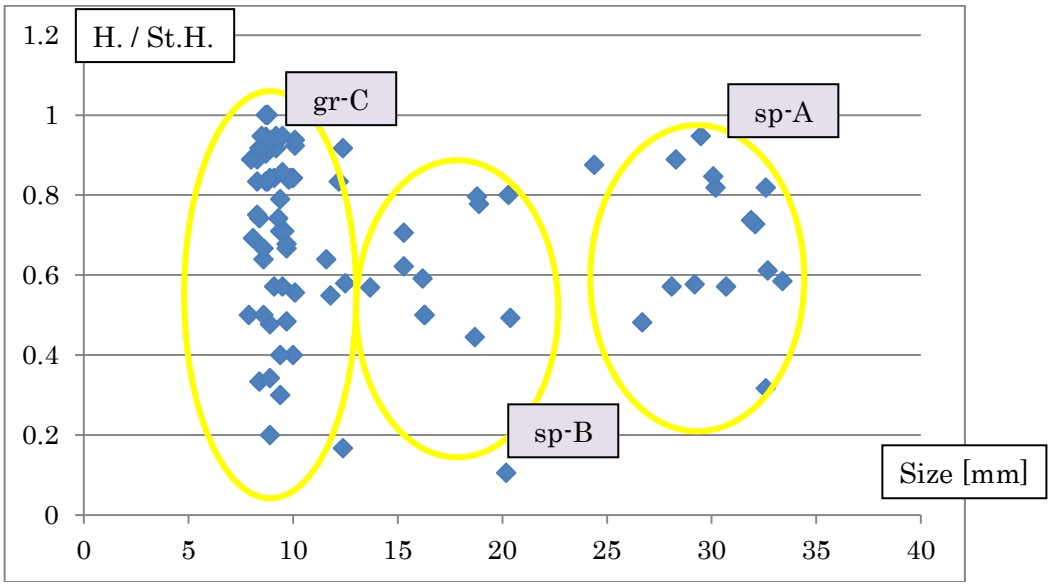

Fig. 2: (Hatching height / Stone height) – Exuvia size relationship

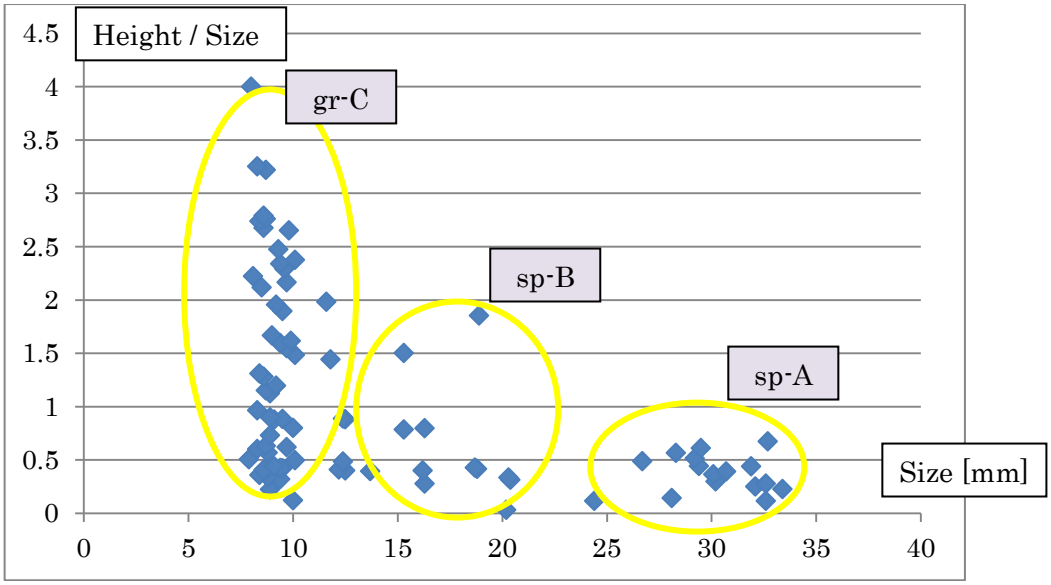

Fig. 3: (Hatching height / Exuvia size) – Exuvia size relationship

These exuviae were found from the height of 0.6 – 35 cm. The exuviae are within the range of 7.9 – 33.4 mm, hence the longest one is about 4 times larger than smaller one. Therefore it is necessary to compare the hatching height with the size of the exuvia.

Fig. 1 shows a relationship between the hatching height and the exuvia size. Because sp-A, sp-B and gr-C can easily be distinguished by its size, dots of each group are respectively circled by yellow line. The value of height should have stronger

meaning for smaller-sized stonefly, so I considered the ratio of hatching height to exuvia and showed in Fig. 3. These show that larger stoneflies are apt to hatch nearer to the surface of the water while smaller-sized stoneflies hatched out however high. However, I cannot deny that each species of gr-C has its own inclination toward a specified height to make emergence at. Hatching height is unlikely to be influenced by the size of the stone which a stonefly climbed up, and that appeared in Fig. 2.

Distance of Shortest route and imaginary route – (E), (F)

The relationship between distance of shortest route and exuvia size is similar to that between hatching height and exuvia size (Fig. 4). I can recognize the same tendency about distance of hypothetical trait supposed through the head direction (imaginary trait; F). It is difficult to decide how the stonefly larva walked to stop; hence I cannot say how reproducible each parameter is as true trait. However the these three parameters – (C), (E) and (F) have similar tendency to each other.

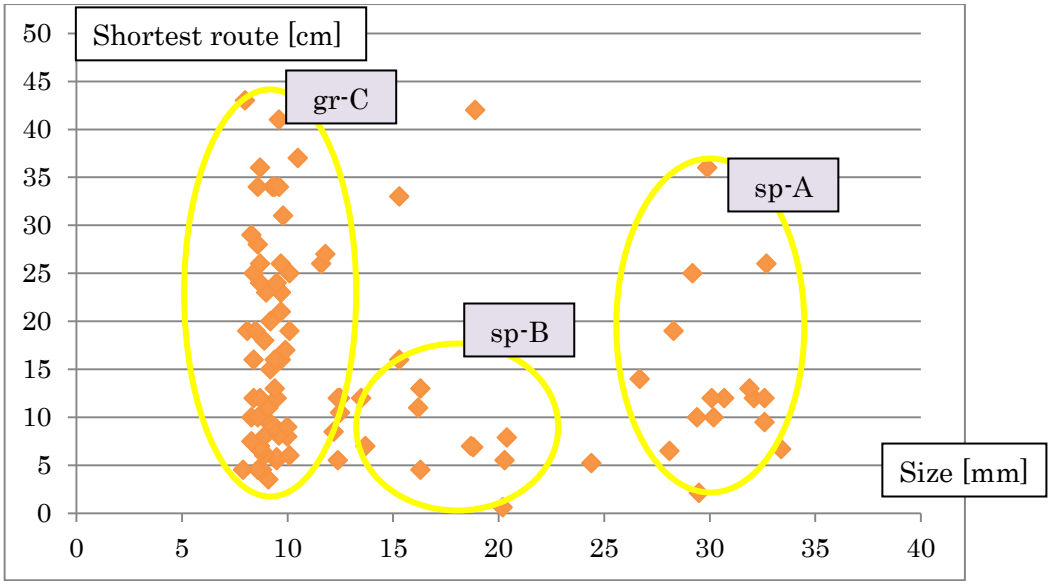

Fig. 4: Distance of shortest route – Exuvia size relationship

Exuvia elevation – (G)

The exuviae elevate to the angle of 135 degrees at most, and decline to the angle of 120 degrees at most. Fig. 5 shows the proportion of how each exuvia elevates. According to the graph, most of the exuviae lean upward and very few exuviae remain upside down (more than 90 degrees or less than -90 degrees). Most common case is that an exuvia inclines upward but not to the extent of vertical level. This style looks easier to fix the body to emerge than upside-down localization.

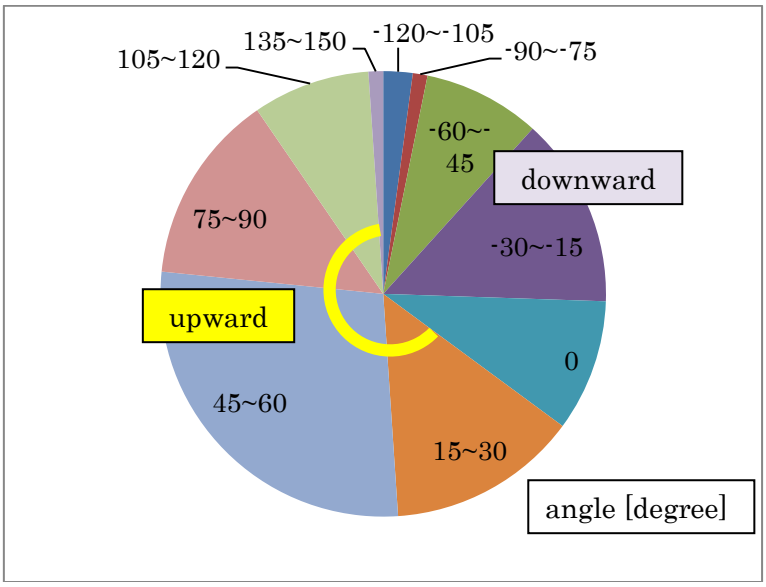

Fig. 5: angle of exuvia elevation

Head direction of (H) and (I)

The value of (H) means how the exuvia inclines toward right or left from the right upper direction along the surface of the stone. Fig. 6 shows that most of the exuviae turn toward almost upper direction. They sometimes turn toward almost downward direction, but scarcely turn sideways.

I also attempted to measure the angle against water current, but I did not decide criteria for measuring whether I should treat current macroscopic or microscopic. Therefore, to my regret, the value of (I) cannot be accurately examined in this time.

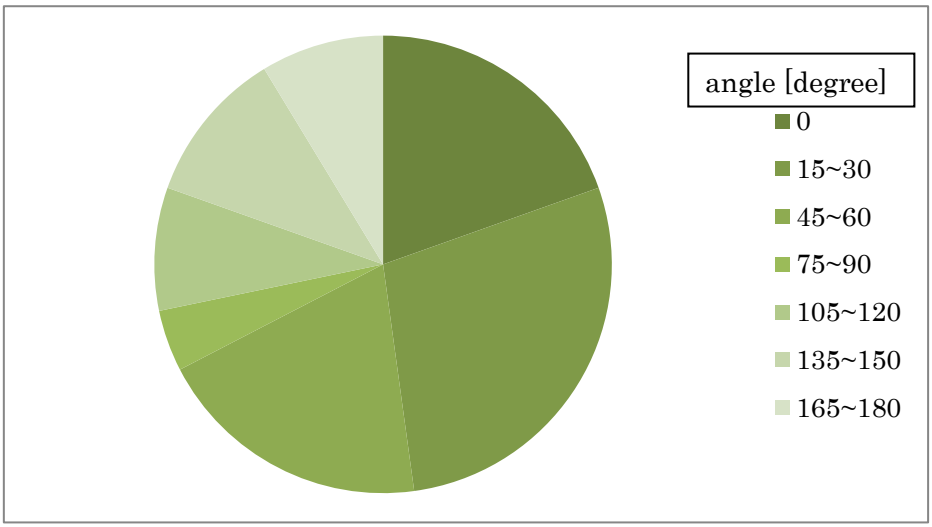

Fig. 6: angle of right or left direction; (H)

Conclusion

I supposed that the route which stoneflies walked around in should be short to emerge safely and the larger individual had more ability to walk in the terrestrial site; on the contrary I cannot see the difference in the size of stoneflies and small-sized stoneflies (group-C) walked to hatch out for relatively long distance. Larger individuals show their tendency to walk not so much to emerge, and their walking distances are more likely to depend on species than on their body lengths. Therefore, I should examine the interspecific relationship of the walking distance among group-C and should check the cause of the random variation in its data of walking distance.

Head direction of emerging stoneflies tends to be natural position after their direct appearance from water. This tendency matches the observational fact in 22nd August 2012 (though only one case): a stonefly (order Perlodidae) came out from water, walked for short distance, fixed its body to the position and hatched out without any change in direction or detour.

Reference

Kawai, T. and Tanida, K., 2005. 日本産水生昆虫: 科・属・種への検索. Tokai University Press: Tokyo.