Odonatologica 13 (2): 301-307 *June 1, 1984*

ON THE OVIPOSITION HABITAT OF *EPIOPHLEBIA SUPERSTES* (SELYS) (ANISOZYGOPTERA: EPIOPHLEBIIDAE)

Y. TAMIYA[1] and K. MIYAKAWA[2]

[1] Negoro 911-5, Iwade-cho, Naga-gun, Wakayama 649-62, Japan
[2] Imafuku 1024, Kawagoe, Saitama 356, Japan

Received and Accepted March 7, 1984

Oviposition site selection in *E. superstes* was investigated at a mountain stream in Japan. The dragonfly selected, at the stream, nearly always the liverwort *Conocephalum conicum* as the host plant for oviposition, which grew close to the stream in shaded environment. The trace of oviposition was detected only in healthy thalli, and a high egg density was observed in thalli of a rather small-sized colony of the liverwort. The significance of these observations is discussed in relation to larval development.

INTRODUCTION

Evidence of oviposition by the relic dragonfly *Epiophlebia superstes* into Mesozoic-borne bryophytes was recently documented by ASAHINA & SUGIMURA (1981) and ASAHINA & EDA (1982). This fact prompted the question as to how frequently bryophytes are selected by this species as the oviposition target as compared to spermatophytes. On the other hand, no information has so far become available on oviposition habitat selection of *E. superstes* from the ecological point of view, though some points were touched by early workers (ASAHINA, 1934, TOKUNAGA & ODAGAKI, 1939).

We commenced an ecological research on the larval stage of the species from April 1983 at some mountain streams, Saitama Pref., Japan and obtained some data, including the trace of oviposition.

This paper deals with oviposition habitat selection in relation to the prospective environment of the eggs and newly hatched larvae at one of the mountain streams.

METHODS

Observations were made on June 19, 1983, in a small valley near Higashiagano, Saitama Prefecture, ca 45 km W of Tokyo. Through the valley bottom, a small branch stream of the Koma River flows straight under Japanese cedar forest which is 10-20 meters high. This stream is on average 900 m long and 1 m wide. It runs parallel to a path of 3 m wide, and most of the stream was exposed to direct sunshine for 1-2 hrs a day. In both upper and middle parts of the valley, the cedar trees were all cut, therefore, the stream near these parts is exposed to sunshine for 1-2 more hrs.

We inspected all the plants along the stream expected to be used by the dragonfly for oviposition. When eggs were found, the plant species, its part containing the eggs, height, and distance from the stream, were recorded. In liverwort, the surface area of the colony was also recorded. Then, the plant parts containing the eggs were sampled. The surface area of each egg-batch was examined and the number of eggs was counted under a stereo-microscope. After the measurement, the samples were put into covered plastic cups and brought back to their sampled sites. Several small holes (3 mm in diameter) were drilled in the bottom of each cup. This hole-size was large enough for hatched prolarvae to go out safely and small enough for the liverwort not to dry out.

OBSERVATIONS

The *Epiophlebia superstes* eggs were ascertained to have been laid at 25 sites, in the thalli of the colonizing liverwort *Conocephalum conicum* (24 sites) and in a stalk of *Ligularia Schmidti* (1 site) (Figs 1-2). The latter plant has not been known earlier as being used for the oviposition by *Epiophlebia*. It stood on a rock (50 x 50 cm, 30 cm above the water level), in running water shaded by the cedar forest, which was estimated to be 20-30 years old.

The oviposition was limited to the liverwort, growing on the streamside, shaded completely from the direct sunshine. Figure 3 shows the height and distance of the colonies from the water. All the oviposition sites were found to be within a range of 0-100 cm above the waterlevel and at 0-130 cm from the stream. Many liverwort colonies were found elsewhere, but oviposition could not be ascertained in them. Of the 24 colonies, 18 were sited on the streamside of the upper stream cedar forest, which shaded the forest ground completely from the sunshine. The other 6 colonies were found on the sunny streamside along the path shaded less completely by the cedar leaves, the liverwort growing under shrubs like *Rubus* sp. The eggs laid in the thalli, therefore, were always completely shaded. The liverworts used for oviposition had a space of more than 50 cm high and 1 m wide above them, which might be necessary for the flying female dragonfly to reach the thalli for oviposition.

No trace of oviposition by *Epiophlebia* was found in the liverworts growing (1) under the forest downstream near the junction to the main trunk of the Koma River, (2) under the upstream forest with further shade by shrubs, (3) on the sunny streamside without shade, and (4) on the sunny streamside with shading vegetation but without space enough above it.

Eggs were arranged in the thalli at regular intervals (Fig. 4, $r=0.907$). These were the same as reported by ASAHINA & EDA (1982). Average egg density

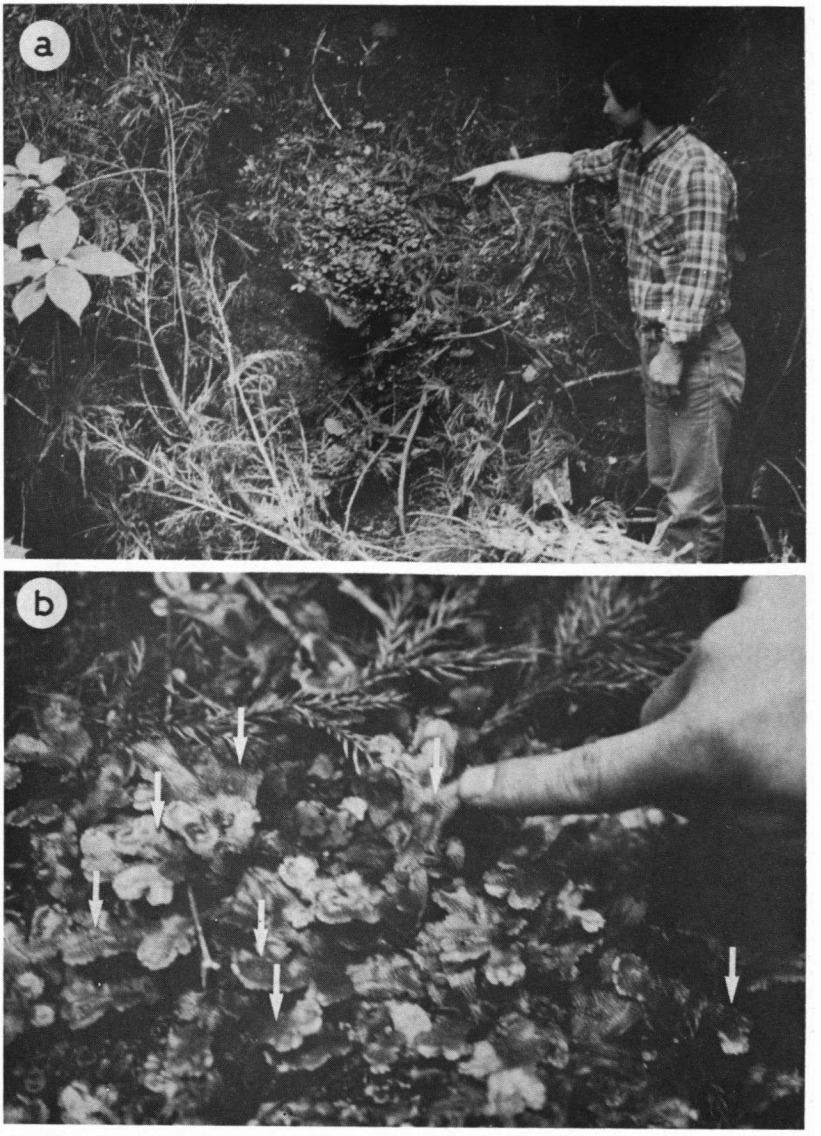

Fig. 1. A colony of the liverwort, *Conocephallum conicum* on the streamside (a); — and thalli in which the *Epiophlebia* eggs were found (b, arrows).

was 0.62/mm². In most cases, oviposition was avoided at or near the border of the thalli. Table I shows the liverwort colony size and the number of eggs laid. The latter was not proportional to the colony size of liverwort; the ratio being often

greater in smaller colonies. Oviposition was ascertained only in thalli which grew well and were fixed firmly to the ground or rocks. Smaller and ill-fed thalli were not selected.

DISCUSSION

In order to ensure the favorable development of embryos, the endophytic species are thought to select their oviposition site restrictedly. The host-plant species must satisfy the following conditions: (1) abundant occurrence in the habitat, (2) firm attachment on substrate, to prevent the plant from being carried away by wind or rainfall, (3) resistance against the damage caused by the oviposition, and (4) the temperature of the habitat should not exceed the range tolerated by embryos.

The host-plants, reported to be used for oviposition by *Epiophlebia,* are shown in Table II. All species grow on wetty ground along the stream, and have stalks, leaves or thalli with soft tissues. Only such plants may satisfy the above conditions. ASAHINA (1934) reported that female *Epiophlebia* flew away without ovipositing when the plants were too hard. In our observation area, *Epiophlebia* laid eggs only in the liverwort *Conocephalum conicum,* except in one case, but we cannot say anything about the preference of *Epiophlebia,* since the liverwort colonies were quite abundant around the stream whereas the other plants were scanty.

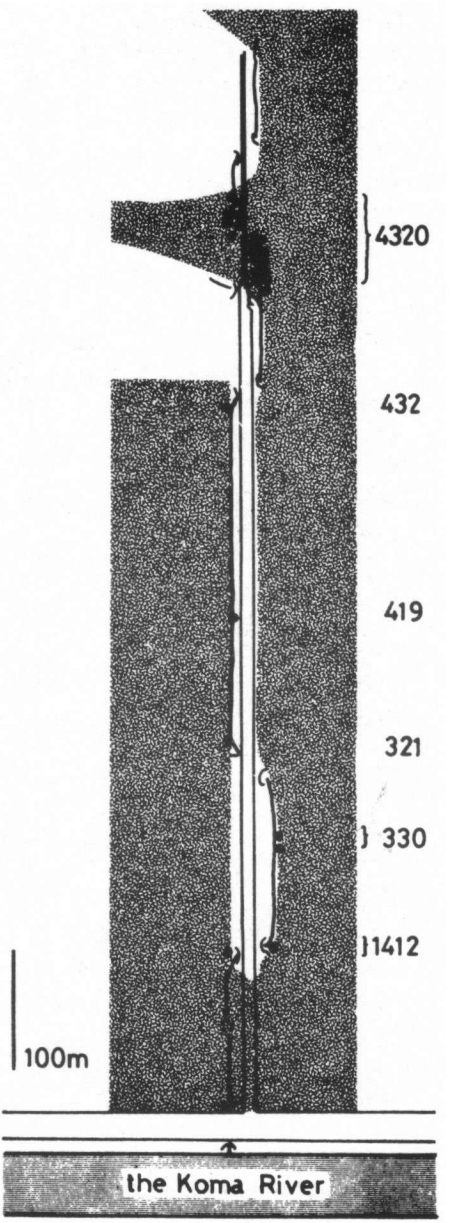

Fig. 2. Oviposition sites along the stream and numbers of eggs found at each site. (Shaded area: cedar forest; — circles: oviposition sites).

The liverwort colonies in which eggs were found grew in quite restricted spots, near the shaded stream. It was already known that the *Epiophlebia* prolarvae can jump (10-15 cm) until they reach the water (TOKUNAGA & ODAGAKI, 1939). The oviposition ranges seemed to be small enough for prolarvae to jump into water surely and safely. The shade over the liverwort colonies may be meaningful as protection against temperature. Additionally, evaporation from the surface of flowing water also cools the air temperature. This habitat, furthermore, may keep the humidity near the saturation level, which ensures

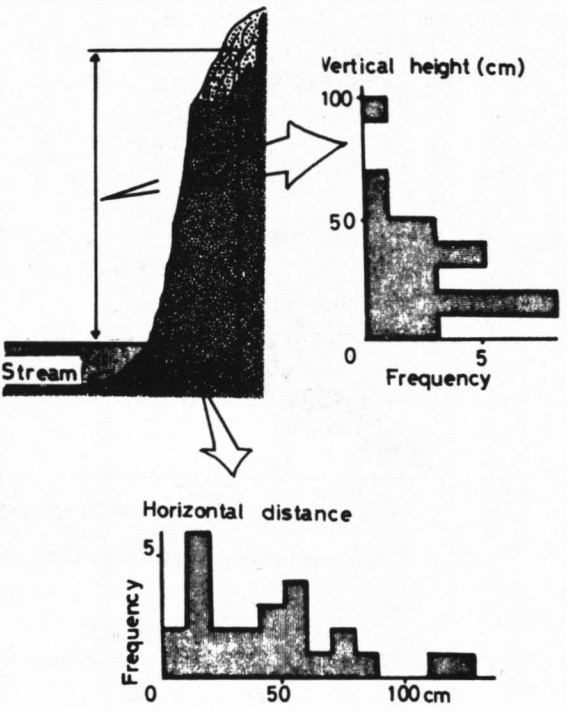

Fig. 3. Height and distance of the liverwort from the water surface in which *Epiophlebia* eggs were deposited.

Table I
Frequency distribution of colony size of the liverwort and the number of *Epiophlebia* eggs

Range (cm^2)		Total area (cm^2)	Total eggs	Density (eggs/cm^2)
0 - 200	6	617	732	1.19
201 - 400	5	2000	1294	0.65
401 - 600	6	3300	3643	1.12
601 - 800	1	750	124	0.17
801 - 1000	2	1900	331	0.17
1001 <	4	8300	1240	0.16

survival of the thalli damaged by oviposition. Drying up or decay of the damaged thalli may cause egg mortality. No egg was found in withered thalli. Only the oviposition in healthy thalli may guarantee successful egg development. Besides, firm attachment of the thalli to the substrate may be essential, since the latter half of egg development coincides with the rainy season. All of the spermatophyte species shown in Table II are supported by developed roots.

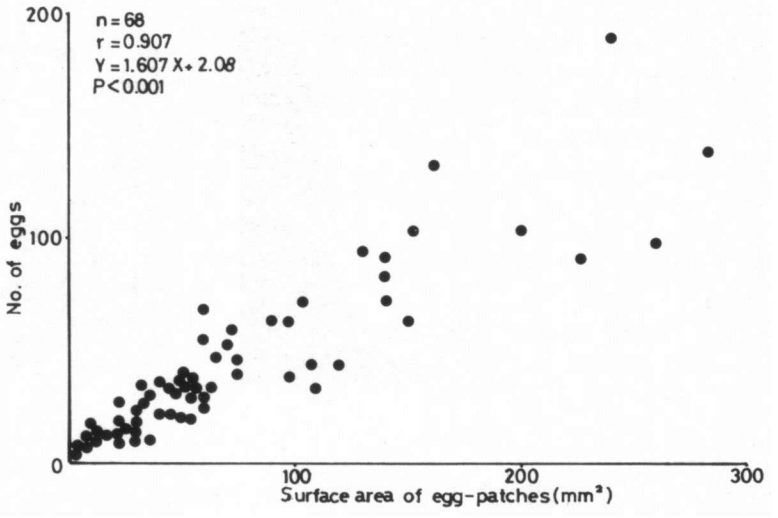

Fig. 4. Relationship between the area of egg-batch and the number of eggs in it.

Table II
Host-plants of *Epiophlebia superstes*

Plant species	References
SPERMATOPHYTA	
Houttuynia cordata	ASAHINA & EDA, 1982
Elatostema involucratum	TOKUNAGA & ODAGAKI, 1939
Trautvetteria carolinensis	ASAHINA, 1934
Eutrema wasabi	ASAHINA, 1934
Cardamine flexuosa	ASAHINA & EDA, 1982
Saxifraga stolonifera	ASAHINA & EDA, 1982
Cacalia adenostyloides	ASAHINA & EDA, 1982
Petasites japonicus	ASAHINA , 1934
Ligularia Fisheri	TOKUNAGA & ODAGAKI, 1939
L. stenocephala	TOKUNAGA & ODAGAKI, 1939
L. Schmidti	this report
Lilium cordatum	ASAHINA & EDA, 1982
BRYOPHYTA	
Dumortiera hirsuta	ASAHINA & SUGIMURA, 1981
Conocephalum conicum	ASAHINA & SUGIMURA, 1981; this report
Pellia endiviaefolia	ASAHINA & EDA, 1982

Since no details on *Epiophlebia* larval development are known, we cannot judge whether the egg-density (total 7234 eggs in the stream section of 600 m) is adequate or not. The results of our other researches point towards the possibility

that *Epiophlebia* larvae of different size segregate into different shallows in the stream; the bigger ones select shallows of bigger-sized stones and the smaller ones, smaller stones. The density of oviposition sites (12.05 eggs per 1 m distance along the stream) might be approximately in accordance with sampling data (unpublished) of the larvae.

ACKNOWLEDGEMENTS

We are grateful to Dr SYOZIRO ASAHINA for having suggested this research. Thanks are also due to Mr KOJIRO SHIRAISHI for his information about the distribution of the species in Saitama Prefecture.

REFERENCES

ASAHINA, S., 1934. Ecological observations on Epiophlebia superstes. *Konyû* 8 (2): 103-106. (Jap.).

ASAHINA, S. & M. SUGIMURA, 1981. Oviposition of Epiophlebia superstes into bryophytes. *Tombo* 24: 22-23.

ASAHINA, S. & S. EDA, 1982. Further observations on bryophyte oviposition by Epiophlebia superstes. *Tombo* 25: 2-6.

TOKUNAGA, M & S. ODAGAKI, 1939. Ecological and morphological studies on a dragonfly Epiophlebia superstes Selys. *Vol. jubil. Prof. Sadao Yoshida,* pp. 472-496. (Jap.).