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Author(s)	NAGAO, Zen
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Observations on the Breeding Habits in a Fresh-Water Leech, *Herpobdella lineata* O.F. Müller¹⁾

By
Zen Nagao

(Zoological Institute, Hokkaido University)

(With 7 Text-figures)

Although several works have been published concerning the copulatory process and the formation of cocoon in the herpobdellid leeches (Iijima, 1882; Brumpt, 1899, 1900a,b; Brandes, 1899, 1901; etc.), so far as the author is aware, comparatively little has been published regarding the breeding habits of *Herpobdella lineata* since the early work of Iijima (1882). In the present paper, there have been described some observations on the copulation and spawning habits of a common Japanese leech, *Herpobdella lineata*.

It is a great pleasure to be permitted to dedicate this work to Professor Tohru Uchida, under whose direction the observations were carried out, in commemoration of his sixtieth birthday. The author is indebted to Assistant Professor Mayumi Yamada for helpful advice.

Material and methods

The material used in this study is the leech, *Herpobdella lineata* O.F. Müller, which is commonly found in the streams in Sapporo. Observations were made in the field and also in the laboratory, during the breeding seasons of 1955 and 1956. The leeches were kept in aquaria in the laboratory and fed on the fresh-water earthworms, *Tubifex* and *Limnodrilus*. The water temperature varied between 13° and 23°C in the laboratory, and between 10° and 25° C in habitats.

Observations

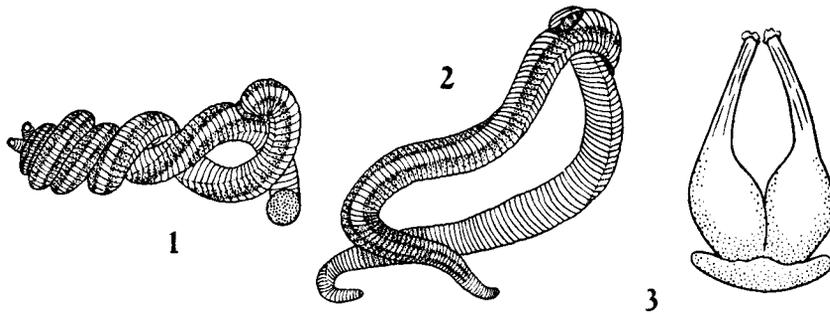
Copulation: The copulation was often observed in Sapporo in May, when water temperature in habitats ranged from 11° to 15°C. Judging from the number of vestiges of spermatophores on the body surface, a leech possibly copulates several times in this season.

When two mature individuals are brought together in an aquarium, copulation occasionally occurs. The copulatory behavior is as follows. If two leeches come across, their bodies are entangled in the anterior portions, being attached by their posterior suckers to a substratum. At this time their male gonopores become everted to a conical form. Meanwhile, they are firmly fastened together.

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Then their posterior suckers often become detached from the substratum, and their bodies are spirally entwined with each other (Fig. 1). Each posterior sucker



Figs. 1-2. Successive behavior in copulatory process. Detailed explanation in text.
Fig. 3. Spermatophore (\times ca. 60).

is generally attached to the body surface of the partner, and simultaneously the oral sucker of the more active leech is firmly fastened to the dorsal surface of the other, so as to press the male gonopore tightly upon the body surface of the partner, usually upon the ventral side of the clitellum. During the copulation

the position of the creatures is continuously changed, hence always the alternation of direction of winding. Meanwhile, the spermatophore is implanted upon the skin of the partner, and the two animals become joined to each other by one (partial case) or two (reciprocal case) spermatophores and by their posterior suckers (Fig. 2). Thereafter, they become enervated, considerably quiescent and keep this position *in situ* about 15 minutes. Meantime, the spermatozoa are injected into the tissue, penetrating the spermatophore. Consequently the portion anterior to the implanted spermatophore again begins to move slowly, and the two leeches become separated by moving or winding reversely, leaving the spermatophore on the body surface of their partner. The whole process takes about 20-30 minutes.

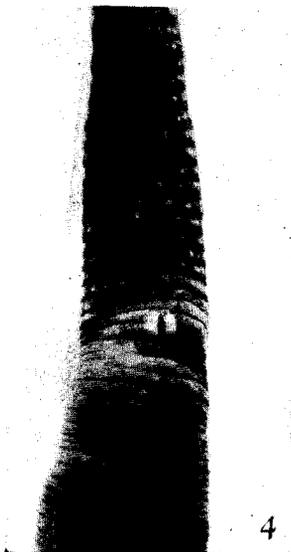


Fig. 4. A leech with implanted spermatophore on the body surface. \times 4.5

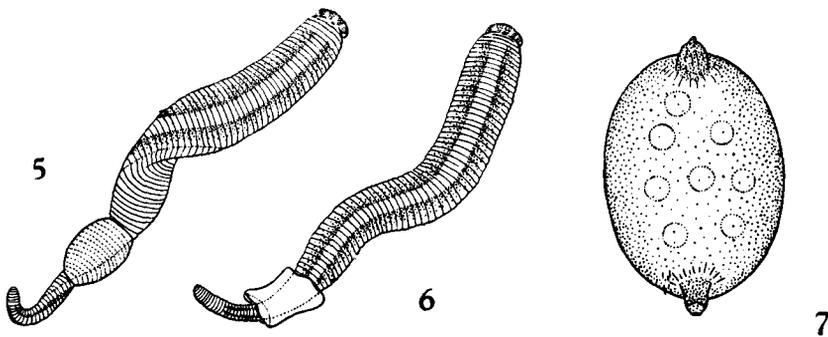
The fecundation of this species is mostly reciprocal, so the respective spermatophore is implanted in the hypodermis of the partner

(Fig. 4). The spermatophores are transferred usually to the ventral surface of the clitellum, but sometimes near the genital band or on the dorsal surface of it, and rarely to a place distant from the genital band. One day afterwards the place where the spermatophore was implanted is easily found as a white spot.

The spermatophore consists of a pair of elastic bottle-shaped tubes, about 0.6 mm in length; the broader ends are closely set to each other and open separately into a small disc-like basal plate which is 0.3–0.4 mm in diameter; its distal half is quite slender and ends in a free opening (Fig. 3).

Deposition of eggs: The spawning was observed from late April to September, especially frequent for about two months from late May to early July in Sapporo. About 20 cocoons can be deposited by a leech in the spawning season. After the last half of August, cocoons gradually decrease in number and young animals newly hatched increase.

When the spawning time approaches, the leech moves actively here and there to find a suitable place for laying cocoon. The animal stops at an appropriate place for laying and laps the place to deposit cocoon for about five minutes. Meanwhile, the body becomes considerably contracted and the undulatory movements are nearly ceased. Then the clitellar portion of the animal is brought to the place lapped about by means of elongation of the whole body. Thereafter, the clitellar glands begin to secrete material for cocoons, and the clitellar portion is constricted at the anterior and the posterior ends, thus becoming nearly ellipsoid in form. Simultaneously, the portion anterior to the clitellum turns remarkably slender. Meanwhile, the genital band is little by little thickly enveloped by products from the clitellar glands, and the leech quietly revolves its clitellar region along its body axis *in situ* (Fig. 5). About 10 minutes after the constriction,



Figs. 5-6. Successive behavior in spawning process. 5. The clitellar portion of the leech is enveloped by the secretion produced from the clitellar glands. 6. The portion anterior to the clitellum is being gradually pulled out through the sac.

Fig. 7. Cocoon ($\times 6.5$).

eggs are rapidly laid in the enveloped sac together with liquid nutritious substance in two or three masses. About 1–2 minutes after this, the sac is pushed forwards by swelling of the constricted posterior end or by the clitellar portion becoming slender. Now the head and the preclitellar region are gradually pulled out backwards through the sac (Fig. 6). By this act the sac which is already attached to the substratum is invaginated at the anterior end, then closed at both ends; thus the eggs and the nutritious substance are enclosed in it. The cocoon newly took off is still soft. It is formed into a flat elliptical shape by pushing, lapping or kneading with the parental oral sucker for about 1–2 minutes. Thereafter the parent goes away, leaving the cocoon. The newly deposited cocoon is very soft, semi-transparent white in color; it becomes hardened and opaque brown in two or three days.

The cocoon is a flat elliptical sac, 3.5–7.0 mm in length, slightly curved on the dorsal surface, composed of a tough brownish membrane; and contains 4–15 (7.5 average) eggs. It is closed at the two ends by a somewhat round anterior end caused by the invagination and a relatively protruded posterior closed tube (Fig. 7). The embryos carry on their development within the cocoon, and the young newly hatched abandon their cocoon about 4 weeks after the spawning by piercing through the two ends.

Remarks

The copulatory process of the present species is generally like that of *Herpobdella octoculata* observed by Brumpt (1899, 1900a). Concerning the copulation of *Herpobdella lineata*, Iijima (1882) described the copulation by means of the spermatophore as "abnormal copulation". Moreover, he observed direct transferences of spermatozoa through the female orifice and reported them as "normal copulation". Nevertheless, it may be reasonable to consider that the process of the "normal copulation" only corresponds to the prebehavior of the indirect copulation as pointed out by Brumpt (1900a). Furthermore, according to Brandes (1901) who recorded practical examples in a species of the Herpobdellidae, a spermatophore seems often to be implanted into the female gonopore by chance. In reference to the portion in which a spermatophore is implanted, similarity as in the present species was recorded by Brumpt (1900a) in *H. octoculata*. The spermatophore of *H. lineata* is of typical form in the Herpobdellidae. A difference of diameter between the slender distal part and the proximal broader part is more distinguishable than corresponding features in *H. octoculata* described by Brumpt (1900a).

The act of spawning of the present species also agrees with that of *H. octoculata* described by Brumpt (1900b). In regard to the number of young in a cocoon and the number of cocoons deposited by a leech in the season, Mann (1953) reported in *Erpobdella octoculata* 4.7 young and 5 cocoons as the average number; however, those of *H. lineata* are rather more.

Summary

The copulation and the spawning habits of a fresh-water leech, *Herpobdella lineata* are described.

1) In copulation, two leeches are actively and spirally twisted each other, then the spermatophore is implanted upon the skin of the partner. The mated leeches are connected with each other by the spermatophore and maintain the position about 15 minutes before liberation.

2) In the spawning, 7.5 (average) eggs are deposited together with the nutritious substance in a sac enveloping the clitellum. Then the anterior part of the body is pulled out from the sac, and the sac is formed into a flat elliptical shape.

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