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Descriptions of Immature and Adult Stages of *Hydropsyche orientalis* Martynov (Trichoptera, Hydropsychidae) with Ecological Notes

동양줄날도래(날도래목, 줄날도래과)의 미성숙 단계와 성충 단계의 기재 및 생태 기록

Jun Mi Hur, Doo Hee Won[1], Tae Ho Ro[2] and Yeon Jae Bae
허준미 · 원두희[1] · 노태호[2] · 배연재

Abstract - Immature and adult stages of *Hydropsyche orientalis* Martynov, previously known as *Hydropsyche* KUe in Korea, were associated based on field observations and rearing experiments. Its larval instars, larval retreat, pupa, pupal case, and male and female adults were described and its ecological notes were provided.

Key Words - *Hydropsyche orientalis*, Trichoptera, Description, Ecology, Immature stage, Korea

초 록 - 야외관찰과 사육실험을 통하여 과거에 한국에서 *Hydropsyche* KUe로 알려져 온 동양줄날도래의 미성숙단계와 성충의 관계를 밝혔다. 각 영의 유충, 유충은신처, 번데기, 번데기집, 수컷과 암컷성충을 기재하였으며, 간략한 생태에 대하여 기록하였다.

검색어 - 동양줄날도래, 날도래목, 기재, 생태, 미성숙 단계, 한국

The net-spinning hydropsychid caddisfly is one of the most abundant and ecologically important aquatic insect groups in northern temperate streams which tolerates wide range of organic pollution (Wiggins, 1998).

As results of previous taxonomic studies of Trichoptera (Tsuda, 1940, 1942; Botosaneanu, 1970; Yoon and Kim, 1988, 1989; Kumanski, 1992; Yoon, 1995; Hwang and Yoon, 1996), six species of *Hydropsyche* have been reported form Korea, but those were all known in the adult stages.

Kim (1974) and Yoon and Kim (1988) provided arbitrary larval identification types on Korean *Hydropsyche*, using informal epithet as in *Hydropsyche* KA~KF and *Hydropsyche* KUa~KUe, respectively, based on the external morphology, but the larval types have not been associated with adult stages.

The purposes of this study were to make clear the larval-adult association of *Hydropsyche* KUe, which is abundant in Korean streams, to describe its immature and adult stages, and to provide its ecological data.

Materials and Methods

Field study

A local population of the larvae of *Hydropsyche* KUe from the Kapyong creek in Kyonggi-do was studied.

Department of Biology, Seoul Women's University, Seoul 139-774, Korea (서울여자대학교 생물학과)
[1] Natural Science Institute, Seoul Women's University, Seoul 139-774, Korea (서울여자대학교 자연과학연구소)
[2] Department of Biology, Korea University, Seoul 136-701, Korea (고려대학교 생물학과)

Field observations and samplings were taken at the site of Sonbawi bridge in the mid-section of the stream (see Yoon *et al.*, 1990 for the site description) from March to November in 1998 (March 26, April 9 and 30, May 7 and 14, June 4, 11, and 21, July 29, August 20, September 4 and 19, October 20, and November 3).

A rearing experiment was carried out to associate the larval and adult stages during the emergence period. To get the adults, last instar larvae of *Hydropsyche* KUe were collected and identified alive under dissect microscope in the field. Each of them was placed in a cylindrical rearing cage (diameter 7 cm, height 14 cm) with substrate materials. The rearing cages were placed in the riffle area of the stream and checked everyday. When they became pupae, the cages were moved to swallow area in order to provide enough space for the emerging adults. Additional adults were collected by a light trap (175 W, white light) as well as by a sweeping net. Collected immature and adult specimens were preserved in 80% ethanol and deposited at Seoul Women's University.

Lab study

Numerous individuals of immature and adult stages of *Hydropsyche* from the study site, including reared specimens (1 male and 6 female adults, emerged during June 17~20, 1998), were used for examining morphological characteristics.

External morphology of the immature and adult stages of *Hydropsyche* KUe were examined and measured under a dissect microscope (40×). Larval head width was used to distinguish instars of *Hydropsyche* KUe as in other holometabolous insects (Mackay 1978). To measure the larvae, 100 individuals of each instar larvae were randomly selected, but only 27 individuals of the 2nd instar larvae were used because they were limited in number. First instar larvae were not sampled in the field.

A line drawing of larval head, SEM photographs of larval ultrastructure and macro-photographs of larval retreat and pupal case were provided. Larval identifications were referred to Kim (1974), Yoon and Kim (1988), Yoon (1995), and Tanida (1986). Adult identifications were referred to Tanida (1986), Hwang and Yoon (1996), and Ivanov (1997).

Results

Hydropsyche orientalis Martynov

Hydropsyche orientalis Martynov, 1934: 276; Botosaneanu, 1970: 296; Tanida, 1986: 468; Kobayashi, 1989: 3; Kumanski, 1992: 66; Hwang and Yoon, 1996: 8.

Hydropsyche ulmeri Tsuda, 1940: 26-27 (Junior homonymy: see Tanida, 1986).

Hydropsyche KE: Kim, 1974: 13.

Hydropsyche tsudai Tanida, 1977 (Renamed for *H. ulmeri* Tsuda, but synonymized with *H. orientalis* Martynov: see Tanida, 1986).

Hydropsyche KUe: Yoon and Kim, 1988: 468; Yoon, 1995: 199.

1st instar larva: Unknown.

2nd instar larva: Head width ranged 0.300~0.325 mm (mean 0.322 mm, SD 0.02). General body color pale light brown. Secondary setae on dorsal head (Fig. 2) and pronotum very sparsely appearing. Foretrochantins poorly developed and not distinctly forked. Branched abdominal gills appearing, but their apices blunt. Paired prosternites on the 1st abdominal segment appearing, but tiny. Paired sternal sclerites on abdominal segments VIII and IX appearing. Few setae appearing at basodorsal area of anal legs.

3rd instar larva: Head width ranged 0.400~0.525 mm (mean 0.470 mm, SD 0.02). General body color light

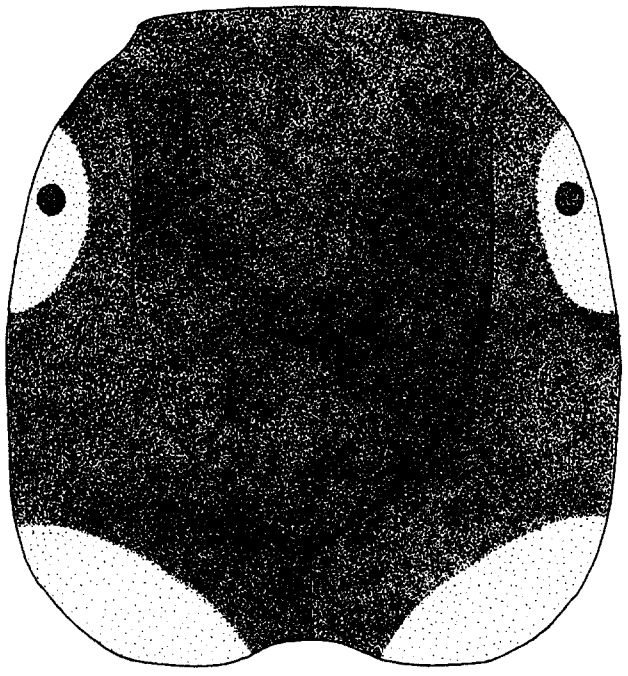
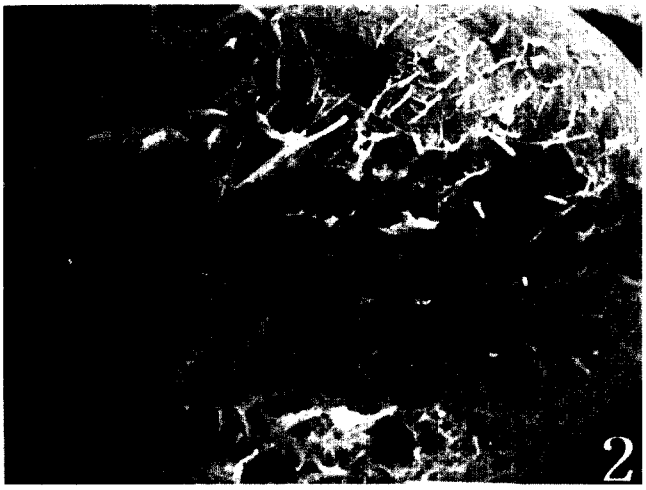
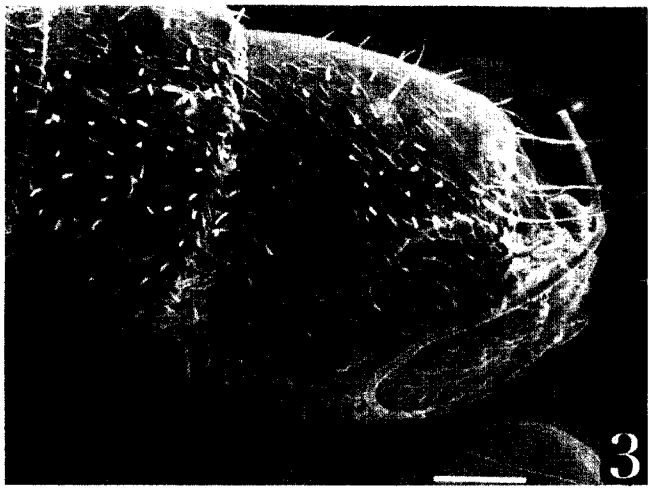
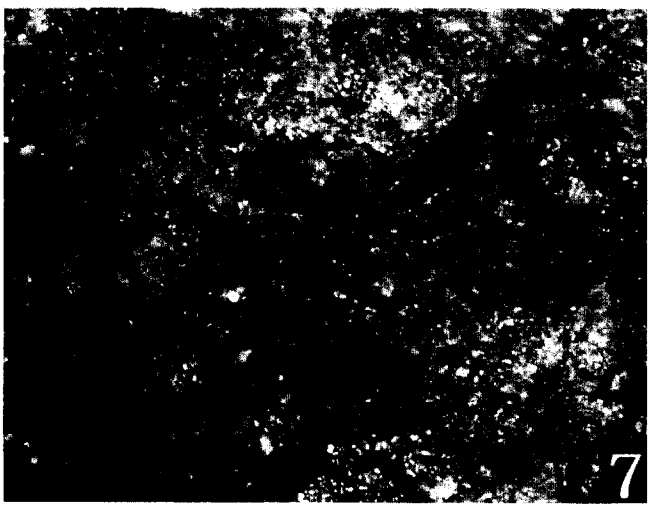


Fig. 1. *H. orientalis*, dorsal head of last instar larva.







Figs. 2-5. SEMs of *H. orientalis* larval parts. (2) dorsal head of 2nd instar larva, (3) dorsal head and thorax of 3rd instar larva, (4) dorsal head of last instar larva, and (5) ventral head of last instar larva.
Figs. 6-7. Macro-photographs of *H. orientalis*. (6) larval retreat and (7) pupal case.

brown. Secondary setae on dorsal head and pronotum (Fig. 3) sparsely appearing. Foretrochantins distinctly forked and darkened. Branched abdominal gills moderately developed. Paired sternal sclerites on abdominal segments VIII and IX moderately developed. Hairlike setae sparsely appearing at basodorsal area of anal legs.

4th instar larva: Head width ranged 0.620~0.750 mm (mean 0.700 mm, SD 0.03). General body color brown. Secondary setae on dorsal head and pronotum moderately developed. Foretrochantins fully developed and distinctly forked. Branched abdominal gills well developed. Paired sternal sclerites on abdominal segments VIII and IX well developed. Hairlike setae densely developed at basodorsal area of anal legs.

Last instar larva: Head width ranged 0.950~1.175 mm (mean 1.050 mm, SD 0.06). General body color dark brown and external morphology fully developed. Ground color of dorsal head dark brown with light round markings around compound eyes (Fig. 1). Stout setae and hairlike setae mixed and densely covered on dorsolateral head (Fig. 4) and nota. Mentum shaped as in Fig. 5. Foretrochantins fully developed and distinctly forked. Paired prosternites on abdominal segment I fully developed. Branched abdominal gills fully developed. Paired sternal sclerites on abdominal segment VIII and IX fully developed. Hairlike setae densely developed and arranged fan-shaped at basodorsal area of anal legs. One to three finger-shaped anal gills present in some individuals (ca. 1/3 in examined population).

Larval retreat: Larval retreat (Fig. 6) basically conical and widely opened at entrance, but often irregular in shape, constructed on a large irregularly shaped stone or within crevices of stone; materials of retreat sandy substrate mixed with leaf, stem, or woody debris attached by silken net. Silken capture net (Fig. 6) constructed at entrance of retreat. Larval retreats of early instar larvae often incomplete in shape.

Pupa: General body color pale yellow, and covered with short setae on head, nota, legs, and abdomen. Antennae visible. Abdomen with ventral gills. Each abdominal segment III and IV with two pairs of hook plates.

Pupal case: Pupal case (Fig. 7) constructed with sand and gravel substrates (diameter ca. 2~16 mm) and attached on silken cocoon. Remnant of larval head capsule and other sclerites found at posterior inside of pupal case.

Male adult: Apical extensions of abdominal tergite X slender and widely departed each other, forming mesal rhombic structure. Dorsolateral membranous appendages of phallus branched, and with a black spine terminally; apicomesal membranous appendage of phallus present.

Female adult: Abdominal tergite IX protruding and without lateral lobes.

Ecological note: Larvae of *H. orientalis* (=*Hydropsyche* KUe) were found in the riffle areas throughout the stream water course except the headwater area, but were most abundant in the mid-section where the stream was 10~20 m wide and 0.2~0.4 m deep, the current was relatively swift, and the substrate was consist of pebbles, cobble, and boulders. The larvae were relatively abundant in unpolluted streams, but were scarce in more or less polluted urbanized streams. Most larval retreats were found under the stones, if enough interstitial space was provided. In case the stones were embedded on the substrate, they were sometimes found in the marginal area of the stones near substrate surface. Approximately 10 larval retreats were found on a boulder stone.

Discussion

Based on our field samples, two distinct cohorts of *H. orientalis* were recognized. Adults were collected during late May to late June and during mid-July to late September, but most abundant in mid-June and late August.

At the study site of the Kapyong creek, *Hydropsyche* KUa and *Hydropsyche* KUc were also collected when the larvae of *H. orientalis*, distinguished by the mentum of mouthpart (Fig. 5) as well as head markings, were sampled. The former two larval types, however, occurred only a minor portion (less than 10%) among the *Hydropsyche* populations throughout the year.

Most of the 3rd and 4th instar larvae of *H. orientalis* were able to be separated from the other larval types by the external morphology, but the 2nd instar larvae were not virtually determinable. First instar larvae were not collected by traditional sampling method using Surber net or hand net (mesh size 0.5 mm). Those were also possibly failed to catch by naked eye during the sorting procedure. Pupae of *H. orientalis* were able to be asso-

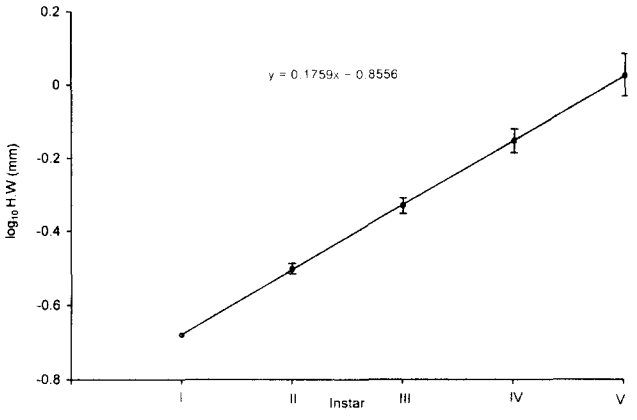


Fig. 8. Larval head width development (mean and SD) of *H. orientalis*. Mean of 1st instar larva is presumed from the regression line.

ciated with the larvae by the remnant of larval sclerites which were found in the pupal cases.

As in other caddisfly larvae, development of the head width of *H. orientalis* showed a regular geometric progression which is known as Dyar's rule (see Mackay, 1978). It thus may be best applicable to separate larval instars of *H. orientalis*, although other morphological characters such as development of secondary setae (Figs. 2~4), foretrochantins, branched abdominal gills, abdominal sclerites, etc. are also useful to identify the instars. In our data, the factor of increase of head width was almost regular ($r^2 = 0.9998$) and the ranges and standard deviations were relatively clear to separate the instars (Fig. 8). The mean head width (W) at an instar number (n) will be predictable as $W_{n+1} = 1.5\ W_n$ (Fig. 8). The mean head width of the 1st instar larvae, therefore, can be estimated 0.215 mm.

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