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The Larva of *Rhoenanthus distafurcus* Bae et McCafferty (Ephemeroptera: Potamanthidae) with Notes on Distribution and Biology

Tomáš Soldán[1] and Milan Putz[2]

[1]Academy of Sciences, České Budějovice, Czech Republic
[2]University of South Bohemia, České Budějovice, Czech Republic

ABSTRACT

The larva of *Rhoenanthus* (*Rhoenanthus*) *distafurcus* Bae et McCafferty, 1991 is described for the first time from specimens taken in southern Vietnam. Critical characters distinguishing it from other species of the family Potamanthidae are keyed and figured. Distribution of *R. distafurcus* is summarized, including a list of 14 new occurrence records from Vietnam. Some aspects of its biology (habitat, larval habits, emergence and life cycle) are discussed.

KEYWORDS: Ephemeroptera, Potamanthidae, distribution, biology, Vietnam.

INTRODUCTION

The genus *Rhoenanthus* Eaton, 1881 consists of six species distributed in India, China and Indochina, South East Asia and Far East Asia. Two of them, namely *R. speciosus* Eaton, 1881 (larvae described by Ulmer, 1939) and *R. distafurcus* Bae et McCafferty, 1991 are comprised in the subgenus *Rhoenanthus* s. str. established by Bae & McCafferty (1991) in their extensive monograph on recent Potamanthidae. Since *R. distafurcus* was originally described from several adults only, larval characters and biology remained unknown. This paper is intended to complete the original description and to discuss some aspects of larval biology and distribution of this species on the basis of material collected in southern Vietnam.

DESCRIPTION OF MATURE LARVA

Dimensions (mm): Length of body 17.0–19.0 (female larvae), 15.0–16.0 (male larvae); antennae 5.2–7.1; mandibles 3.3–4.5; caudal filaments 10.5–12.0; dorsal diameter of male compound eyes 0.8–1.0; female compound eyes 0.7–0.8.

Address correspondence to: T. Soldán, Institute of Entomology, Academy of Sciences of the Czech Republic, 31 Branišovská, CZ-370 05 České Budějovice, Czech Republic

Head: Ratio width: length 1.5–1.8:1. Vertex pale yellowish brown with diffuse light spots, frons slightly darker, a pair of low rounded protuberances situated laterally near the base of clypeus. Antennae 2.6-2.8x length of head, unicolorous, yellowish; scape and pedicle slightly darker. Compound eyes broadly oval or nearly circular, black; male compound eyes full sized with ES=1.3–1.4 (ES defined as ratio of a compound eye size and shortest distance between compound eyes, for details see Bae & McCafferty, 1991: 6–7).

Labrum (Fig. 4) oblong-shaped with regularly rounded anterolateral lobes. Ratio width: length 2:1. Stout, spine-like setae on fore margin; simple, long, hair-like setae on dorsal surface; a group of short pointed spines in the posterolateral area of labrum.

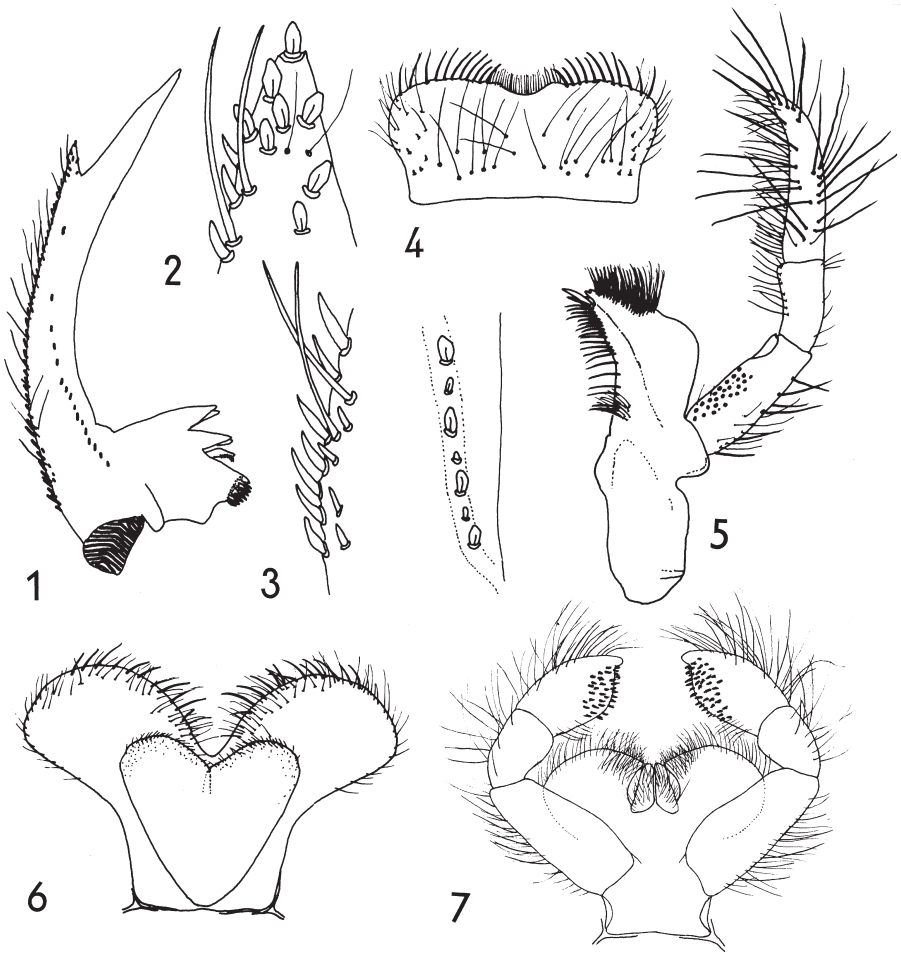
Mandibles yellowish brown, 1.7–1.9× length of head with tusks, moderately arched inward (15) and with large, lateral subapical spine (Fig. 1). Lateral spine triangular, reaching about 1/3–1/4 of medial spine length, densely covered with short stout setae; long, simple setae and hairs present as well (Fig. 2). Medial spine broader by about 1/3 at base, smooth (Fig. 1) and slightly darker than mandibular base. Body of mandibles with 40–55 marginal short stout setae (numerous setae of the same shape but smaller are situated submarginally, Fig. 3) and about 15 hair-like setae laterally. A row of medial simple stout rounded setae well developed; 15–18 setae arranged irregularly, 2/3 of them at basal half of mandible; proximally, small setae regularly alternate with larger ones (Fig. 3). Tusks bare and relatively slender (2.2–3.1× length and 0.5–0.6× width of body of mandibles, Fig. 1).

Maxillae (Fig. 5) with pectinate hair-like setae on apical 3/4 of galeolacinial crown. Segment 3 of maxillary palps slightly bent medially and bluntly pointed, with concave inner margin; 5 times longer than wide and 2.2–2.4 times longer than segment 2 (Fig. 5). Basal segment subcylindrical, hairy only at outer margin with well developed anteromedial cavity harbouring base of segment 2 (Fig. 5).

Hypopharynx (Fig. 6) nearly colour-less, membraneous; lingua heart-shaped with very fine setae and hairs. Superlinguae lobate, slightly asymmetrical, with straight inner margins and stout elongated setae and long fine hair situated medially.

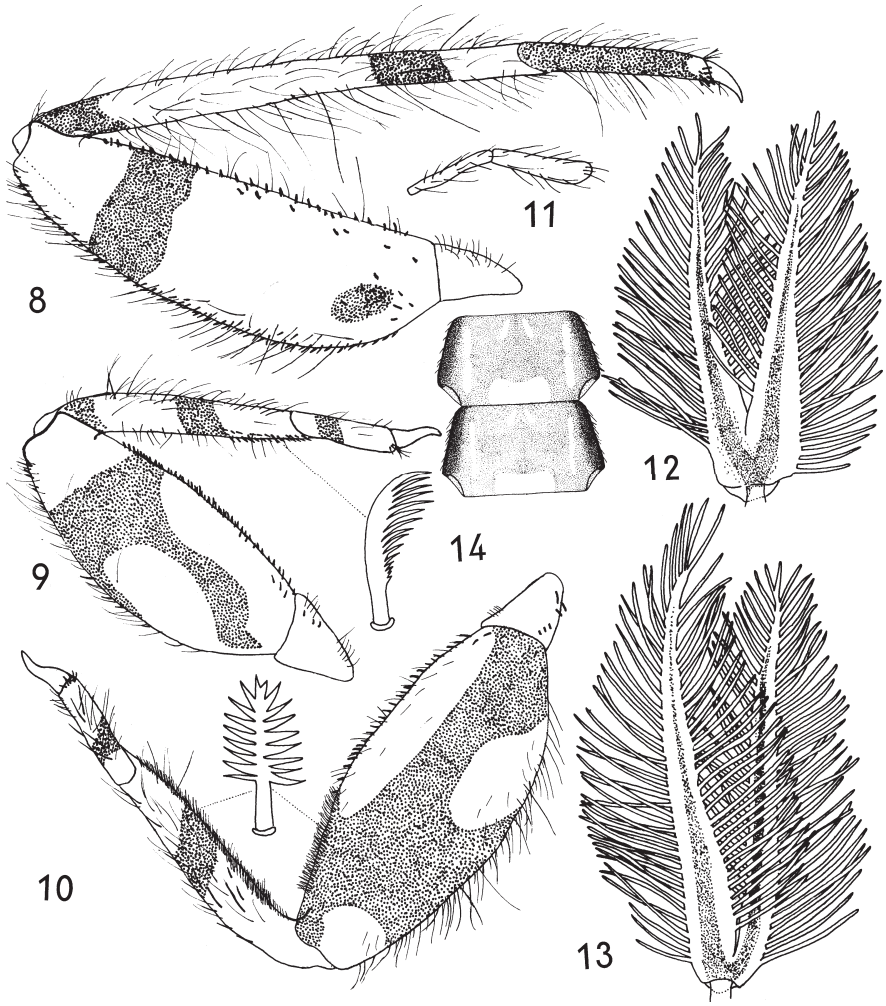
Labium (Fig. 7) with rounded symmetrical paraglossae and elongated glossae bearing numerous setae. Segment 3 of labial palps bluntly pointed, asymmetrical, 1.3–1.4× length of segment 2, with numerous short stout setae situated anteromedially and marginal long pectinate setae.

Thorax: Pronotum 1.9–2.1 times broader than long, apparently broader anteriorly, yellowish brown with diffuse paler spots and colourless lateral areas; lateral



Figs. 1–7. *Rhoenanthus distafurcus* Bae et McCafferty, larva: (1) right mandible; (2) detail of the outer distal projection of right mandible; (3) detail of the basal part of mandibular tusk; (4) labrum, dorsal view; (5) maxilla, dorsal view; (6) hypopharynx, dorsal view; (7) labium, ventral view.

margins divergent, convex in anterior half and straight or slightly concave in the posterior one. Anterior margin of pronotum with a pair of conspicuous teeth situated laterally beside eyes. Ground colour of meso- and metanotum yellowish brown with irregular light markings, two pairs of diffuse dark brown spots at the anterolateral area of mesonotum. Wing pads yellowish brown in younger larvae; wing pads with well visible subimaginal venation with dark brown or purplish



Figs. 8–14. *Rhoenathus distafurcus* Bae et McCafferty, larva: (8) fore leg; (9) middle leg; (10) hind leg; (11) gill 1; (12) gill 3; (13) gill 7; (14) terga 3 and 4, colour patterns.

colour patterns in older larvae. Legs yellowish brown with conspicuous colour markings: fore legs with dark or olive brown stripe in posterior half of femora and usually also with basal rounded spot of the same colour; stripes present also at base and in posterior half of tibiae; tarsi dark (Fig. 8). Colour pattern of middle and hind femora as in Figures 9 and 10, tarsi and tibiae similar to fore legs in colour pattern. In some specimens all spots and stripes diffused and hardly distin-

guishable. Fore tibiae 1.19–1.25× length of fore femora, 2.5–2.8× length of fore tarsi. Middle and hind tibiae 0.8x and 0.7–0.8× length of femora and 1.9–2.0× and 1.9–2.1× length of tarsi. Femora with short stout setae at anterior margins and simple hair-like setae on posterior margins. A group of pectinate setae near the apex of middle tibiae (Fig. 9); numerous bipectinate setae near the apex of hind femora and on inner margin of hind tibiae (Fig. 10)

Abdomen: Ground colour yellowish brown with markings of terga often diffuse, not clearly defined; most individuals with terga 2-10 darker at base with 1–2 pairs of oval lighter spots near lateral margins and a pair of divergent elongated spots in the middle; posterior margin of terga with large, oblong-shaped and pale diffuse spot (Fig. 14). Ventral side of abdomen unicolorous, pale, without any markings. Gill 1 colourless, as long as about 1/2 of gill 2; without tracheal fringe, hairy (Fig. 11). Gills 2–7 whitish to yellowish brown with darker main (longitudinal) tracheae often pink tinged (Figs. 12, 13). Gill 3 each with 37–47 (mostly 42–45) marginal fibrillae along each lateral margin of dorsal lamellae and 32–40 on ventral lamellae. Caudal filaments yellowish, unicolorous, without whorls of simple stout setae. Paracercus usually 1/4–1/5 longer than cerci.

DIAGNOSIS

Larvae of *R. distafurcus* were associated with adults by rearing to subimagines in the field (riv. Nhim, Duc Trong, Vietnam) and by collecting adults at the same locality (riv. Kinh Dinh, Vietnam). They can be associated also by subimaginal colour patterns and double forking of A_1 in fore wing pads of some older larvae.

Larvae of *R. distafurcus* can be distinguished from all other known larvae of Potamanthidae by the following combination of characters: (1) fore tibiae 2.5–2.8 times longer than fore tarsi; (2) fore tibiae densely covered with hair-like setae also on outer margins and dorsal surface; (3) mandibles (including mandibular tusks) 1.7–1.9 times longer than head; (4) lateral subapical spines of mandibular tusk well developed, densely covered with simple short spines; (5) segment 3 of maxillary palps 5 times longer than wide; (6) legs with bright and conspicuous colour markings in most specimens; (7) 40–55 marginal short stout setae on mandibles; (8) no bipectinate setae on lateral margin of mandibles, only about 15 simple setae present, and (9) medial row of 16–20 spines on mandibular tusks well developed.

R. distafurcus larvae can be distinguished from all other genera of Potamanthidae by the arrangement of the first three characters presented above. The colour pattern of legs of *R. distafurcus* is also quite different, although it resembles the colour pattern of, e.g., *Anthopotamus distinctus* (Traver, 1937) from North America (cf. Traver, 1937; Bae & McCafferty, 1991). The characters No. 4–6 clearly distinguish *Rhoenanthus* (*R.*) *distafurcus* from all remaining species of the subgenus *Potamanthindus* Lestage, 1931, those listed under No. 6–9 from *Rhoenanthus*

(R.) speciosus Eaton. Consequently, we propose to modify the existing key to larvae of the genus *Rhoenanthus* by Bae & McCafferty (1991: 72), i.e. to replace the original couplet 3a by two couplets (3aa and 3ab), as follows:

3 aa Legs unicolorous, at most with diffuse smudges; 28–46 simple stout setae and 4–5 bipectinate hair-like setae laterally on mandibles; no medial row of spines developed; Indonesia, Malaysia ..... *R. speciosus*

3 ab Legs with conspicuous dark marking (bands and stripes); 40–55 simple stout setae and about 15 simple hair-like long setae laterally on mandibles; bipectinate setae absent; medial row of 15–20 spines well developed; Vietnam, Thailand, India ..... *R. distafurcus*

DISTRIBUTION

In Vietnam, *R. distafurcus* was collected from the following localities:

Ha Son Bin Prov., riv. Da, Hot Bin, Nov. 18, 1984 (3 larvae); Vin Phu Prov., riv. Chu Xuoi, Thanh Thui, Nov. 20, 1984 (1 larva); Lam Dong Prov., riv. Nhim, Duc Trong, Oct. 29, 1984 (15 larvae, 2 subimagines, reared); Thuan Hai Prov., riv. Kinh Dinh, Nha-Ho near Phan Rang (108 52 19 E., 11 37 58 N.), April 16 – May 5, 1982 (numerous larvae, 4 subimagines, 5 , 2 imagines); riv. Kinh Dinh, Dap Hha Trinh, April 20, 1982 (16 larvae); riv. Anh Lam, Bin Lam, April 14, 1982 (1 larva); Dong Nai Prov., riv. Dong Nai, Nam Cat Tien National Park, Nov. 6-18, 1989 (2 larvae); riv. La Nga, Bao Loc, Nov. 29, 1989 (6 larvae); Tai Nhin Prov., riv. Vam Co Dong, Chan Thanh, Nov. 29, 1989 (1 larva); Ho Chi Minh Prov., Dong Nai River delta, Nha Be, Nov. 24, 1989 (1 male subimago at light). All material was collected by T. Soldán and is deposited in the Institute of Entomology, České Budějovice.

We had a possibility to study the collection of mayflies of the University of Hanoi in Hanoi. *R. distafurcus* was collected at the following localities: Son La Prov., riv. Da, Ban Than, April 1969 (2 larvae); Than Hot Prov., riv. Ma, Than Hot, May 1962 (1 larva); Ga Lawi-con Tum Prov., riv. Da Rang, Try Hot, Sept. 1973 (2 larvae); N.E. Tanh Prov., riv. Ca, Con Cong, October 1970 (3 larvae). All this material was collected by Dang Ngoc Than and is deposited in Hanoi.

R. distafurcus seems to be generally distributed in the larger rivers of Vietnam. However, with the exception of the river Kinh Dinh (very common occurrence of larvae) it is solitary or very rare at all the localities studied. Larvae were collected mostly at lowland localities situated not higher than 250 m a.s.l., with the exception of the locality Dap Nha Trinh of the Kinh Dinh river (450 m). On the other hand, the type locality in Thailand lies at an altitude of 750 m (Bae & McCafferty, 1991).

Taking into account its distribution in Vietnam *R. distafurcus* is probably widely distributed all over Indochina. The northern limits of its area probably lie in the Yunan Prov. mountain ranges in China and in the basin of the Hong (Red) River in Vietnam. No larvae were found at numerous localities in northernmost Vietnam. The southern limits of its area are probably situated in the region of the Isthmus of Cra in Thailand/Malaysia. Only *R. speciosus* was found in West Malaysia and we believe that the two *Rhoenanthus* species are allopatric (*R. speciosus* is reported also from the Great Sunda Islands – see, e.g., Ulmer, 1939). The western limits of the area of *R. distafurcus* are poorly known. Bae & McCafferty (1991) studied one female collected in southern India. This finding suggests *Rhoenanthus distafurcus* has a broad Oriental or disjunctive Oriental distributional pattern, similar to *Ephemera* or *Afromera* of the Ephemeridae (cf. McCafferty &

Edmunds, 1973; McCafferty & Gillies, 1979). *R. distafurcus* is most probably not present in Sri Lanka (cf. Hubbard & Peters, 1978).

BIOLOGY

The biology of *R. distafurcus* was studied at the locality of the river Kinh Dinh at Nha-Ho, about 10 km W of Phan Rang. The Kinh Dinh is a large permanent lowland river (about 150–200 m across), 20–150 cm in mean depth during dry season and about 4-5 m water level fluctuation in the wet season (daily fluctuation ± 10 cm during dry season). The river is regulated in order to supply a system of artificial irrigation and forms a large number of rapids and backwaters. Judging from the primary plant succession on the river bed this regulation originates from at least 50 years ago (Rejmánek, pers. comm.). Water is very turbid (transparency 15–20 cm), slightly alkaline (pH = 7.2-8.0) and relatively warm (26.4–29.8°C by night and day, respectively, in dry season).

Nymphs of *R. distafurcus* were collected in various habitats by kicking techniques, or occasionally by Surber sampler in April and May 1992 (dry season) and October-November 1984 (wet season). They evidently prefer gravel bottom riffles or small stones (up to 10–15 cm in diameter). They constitute up to 65% of the total mayfly standing crop at these habitats, followed by *Ephemera* species (28-35%) and *Potamanthus* (*Potamanthodes*) *formosus* Eaton, 1892 (15–26%). They are also present at mixed sandy and clayey habitats (10–20% of standing crop) but they are never found on pure coarse sand bottom. Larvae of *R. distafurcus* also live in plant root habitats of *Homonoia riparia* (a very common riparian species here) and among submerged vegetation of *Elodea* and *Polygonum tomentosum* but they are very rare there, never reaching more than 5% of the standing crop. These habitats are dominated by Baetidae such as *Baetis* spp. and *Cloeon marginale* (Hagen, 1858), Ephemerellidae, Caenidae and *Compsoneuriella* spp. (Heptageniidae). Larvae of *R. distafurcus* seem to prefer habitats covered with organic debris but they were not found among coarse organic debris sediments without stones. Their densities at different current velocities differ and in the preferred habitats (gravel bottom riffles) were 100–150, 30–50 and less than 10 ind.m^{-2} for current velocities of 10–25, 30–50 and more than 60 cm.s^{-1}, respectively. Larvae apparently avoid places with faster current where larvae of *Baetis* spp., *Cynigmina, Pseudocleon* and *Choroterpides* dominate. However, they can tolerate dramatic changes of current velocity. For instance, current velocity increased from 0.2–1.0 m.s^{-1} for a period of 12 hours during the wet season and the density of *R. speciosus* decreased only by 20% by downstream drift. At the same time larvae easily tolerate a decrease of flow in backwaters. During the dry season, they evidently survived in quite isolated, very shallow pools for at least a month even under water temperatures reaching 31.2°C at noon.

Nearly nothing is known about larval habits. Larvae live in substrates under stones being probably typical sprawlers/interstitial dwellers. However, they rare-

ly invade soft or fine substrates. Larvae probably burrow to some extent but not deeper than 2-3 mm under the surface, never making special tubes or constructions (cf. Bae & McCafferty, 1995). Orientation of larvae to current direction is evidently variable. Smaller larvae, i.e., those smaller than 1/2 definitive body length seemed to prevail at lower depths (1–5 cm), older ones were more abundant in deeper water. They rarely occur deeper than 1 m, never deeper than 1.5 m. Although they normally never swim, they are very good swimmers if forced. They can easily follow fluctuating water levels and nearly none die in drying river bed during dramatic changes of flow, contrary to, i.e., baetid or heptageniid larvae.

Our knowledge of the life cycle of *R. distafurcus* is also scarce. Although larvae ready to emerge were abundant at the locality studied, we failed to observe the emergence. Adults collected were attracted to light after sunset, in full darkness. This type of activity seems to be usual in the tropics (Edmunds & Edmunds, 1980). On the contrary, reared subimagines emerged in the early afternoon. As to season, emergence (and larval growth) seems to be continuous. We found approximately the same percentage of older nymphs ready to emerge in both dry (about 20 %) and wet (about 15 %) seasons. The relative quantitative presence of larval length categories was approximately the same. The whole larval development lasts probably for 1 year, embryonic development lasts for 21± 3 day at 25±1°C (determined by rearing in Petri dishes at the laboratory).

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