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Review of the Vietnamese Potamanthidae (Ephemeroptera)

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Abstract Six potamanthid mayflies, *Rhoenanthus* (*Rhoenanthus*) *distafurcus* Bae and McCafferty [L, M, F], *Rhoenanthus* (*Potamanthindus*) *magnificus* Ulmer [L, M, F], *Rhoenanthus* (*Potamanthindus*) *obscurus* Navás [L, M, F], *Rhoenanthus* (*Potamanthindus*) *sapa* Nguyen and Bae [L, F], *Rhoenanthus* (*Potamanthindus*) sp. V1 [L], and *Potamanthus* (*Potamanthodes*) *formosus* Eaton [L, M, F], are comprehensively reviewed based on materials collected throughout Vietnam. Description of newly known species, diagnoses, distributions, habitat and biology data, taxonomic remarks, and larval and adult keys are provided.

Keywords: *Rhoenanthus*, *Potamanthus*, Potamanthidae, taxonomy, Vietnam

Introduction

The burrowing mayfly family Potamanthidae is widely distributed throughout the Holarctic and Oriental regions. The family, comprehensively reviewed by Bae and McCafferty (1991), contains relatively small number of species, 24 species worldwide, and all but four Nearctic species occur in Palaearctic East Asia and Southeast Asia. The larvae of Potamanthidae can be easily distinguished from those of other burrowing mayfly families by the flattened body as well as by the unique mandibular tusks projecting anterior head. The adults and subimagos are characterized by the forewing characters of strongly arched MP2 and CuA and distinctly forked A1 (Bae and McCafferty, 1991).

In Southeast Asia, members of the family have been studied by Eaton (1883-88, 1892), Ulmer (1920, 1924, 1939), Navás (1922, 1930), Lestage (1921, 1930), Bae et al., (1990), Bae and McCafferty (1991), Soldán and Putz (2000), and Nguyen and Bae (2004) and seven

nominal species in two genera and five subgenera have been recognized: *Rhoenanthus* (*Rhoenanthus*) *speciocus* Eaton, *Rhoenanthus* (*Rhoenanthus*) *distafurcus* Bae and McCafferty, *Rhoenanthus* (*Potamanthindus*) *magnificus* Ulmer, *Rhoenanthus* (*Potamanthindus*) *obscurus* Navás, *Rhoenanthus* (*Potamanthindus*) *sapa* Nguyen and Bae, *Potamanthus* (*Potamanthodes*) *formosus* Eaton, and *Potamanthus* (*Stygifloris*) *sabahensis* Bae, McCafferty, and Edmunds. In Vietnam, *R. distafurcus*, *R. magnificus*, *R. obscurus*, *R. sapa*, and *P. formosus* were recorded.

The purpose of this study is to review and additionally describe the Vietnamese species of Potamanthidae. Most larval and adult materials used in this study were collected throughout Vietnam in 2000, 2001, and 2002. Mayfly collections of Hanoi University of Science were also checked. Adults were collected by light traps and sweeping nets. Larvae were collected by various aquatic nets. All the materials are preserved in 80 % ethyl alcohol and are housed in the Aquatic Insect Collection of Seoul Women's University (SWU-AIC).

Accounts of Taxa

Family Potamanthidae

Genus Rhoenanthus

Subgenus Rhoenanthus

***Rhoenanthus distafurcus* Bae and McCafferty**

Rhoenanthus distafurcus Bae and McCafferty, 1991: 18; Soldán and Putz, 2000: 9.

Diagnosis. Larvae of *R. distafurcus* can be distinguished from those of other *Rhoenanthus* by the mandibular tusks and forelegs. The mandibular tusks (see Soldán and Putz, 2000: 11, Fig. 1) are relatively thin, weakly arched (15°), and possess pronounced lateral subapical spine, medial row of simple-stout setae, and lateral field of simple-stout and hairlike setae. (Mandibular tusks of *R. speciosus* Eaton lack medial row of simple-stout setae.) Their foretibiae are relatively short (1.19-1.25 times length of forefemora, 2.5-2.8 times length of foretarsi) and the filtering setae are relatively short and weakly developed. Adults of this species are distinguished by the double forked A1 in the forewings (see Bae and McCafferty, 1991: 131, Fig. 82) and by the unique male genitalia (see Bae and McCafferty, 1991: 140, Fig. 118). Their penes are dorsoventrally flattened, furcated at the level of subgenital plate, and apically rounded. Their forewings are transparent and stained light brown to brown variously at forks of veins; vein MP2 is basally connected to CuA as in other species of the subgenus *Rhoenanthus*. Their abdominal terga 1-10 are light yellow and possess dark brown broad midlongitudinal stripe containing 2 pairs of teardrop-shaped light spots. Cerci of male are relatively long, ca. 3.3 times length of body, and possess purplish brown band at each suture; median terminal filament is rudimentary, 0.02 times length of cerci.

Description. *Larva*: See Soldán and Putz (2000: 9). *Male adult*: See Bae and McCafferty (1991: 18). *Female adult*: See Bae and McCafferty (1991: 19).

Distribution. Vietnam, Thailand, India.

Materials examined. 2 M: Da Nang Prov., Ba Na, Nui Chua, (alt. 250 mm), 31-III-2002.

Habitat and biology. Larvae of *R. distafurcus* are found in the lower reaches of streams and large rivers throughout Vietnam. Detailed distributional records and habitat and biology data are in Sodán and Putz (2000).

Remarks. The male and female adults of *R. distafurcus* were described by Bae and McCafferty (1991) based on materials from Thailand, Vietnam, and India. Later, Soldán and Putz (2000) described mature larva of this species base on materials collected throughout Vietnam. This species is more common in southern Vietnam (Bae and McCafferty, 1991; Soldán and Putz, 2000).

Subgenus *Potamanthindus*
***Rhoenanthus magnificus* Ulmer**

Rhoenanthus magnificus Ulmer, 1920: 11; Lestage, 1921: 219; Bae and McCafferty, 1991:22.
Rhoenanthus vitalisi Navás, 1922: 59. (synonymized by Bae and McCafferty, 1991).
Rhoenanthus ferrugineus Navás, 1930: 15. (synonymized by Bae and McCafferty, 1991).
Rhoenanthopsis magnificus (Ulmer): Ulmer, 1932: 212.
Neopotamanthodes lanchi Hsu, 1937-38: 221. (synonymized by Bae and McCafferty, 1991).

Diagnosis. Larvae of *R. magnificus* can be distinguished from those of other *Rhoenanthus* by the relatively large body size (18.2-21.2 mm) and relatively long and strongly arched (33.4°) mandibular tusks (see Nguyen and Bae, 2004: 11, Fig. 1). Their foretibiae are relatively long (about 1.47 times length of forefemora and about 2.9 times length of foretarsi) and the filtering setae are strongly developed. Male adults of this species are distinguished by the heavily stained forewings (Fig. 1) and hindwings (Fig. 2) and the shape of genitalia (Fig. 3). The penes (Fig. 3) are purplish brown, basally cylindrical, V-shaped, and apically slightly notched. Forewings and hindwings of female adults are almost entirely stained purplish brown. The median terminal filament of male adult is rudimentary (0.04 times length of cerci), while that of female adult is well developed (0.44 times length of cerci).

Description. *Larva*: See Nguyen and Bae (2004). *Male adult*: See Bae and McCafferty (1991: 22). *Female adult*: See Bae and McCafferty (1991: 23).

Distribution. Vietnam, Southern China.

Materials examined. 47 L: Nghe An Prov., Con Cuong, Khe Choang Cr., 12-I-2001; 3 M, 1 F & 3 mature L: Nghe An Prov., Con Cuong, Khe Choang Cr., 6-IV-2002; 36 L: Cao Bang Prov., Pac Po, Lenin Cr., 15-VI-2000, 16-XII-2000; 1 L: Ha Giang Prov., Vi Xuyen, Bac Phat Cr., 11-XII-2000; 4 L: Da Nang Prov., Ba Na, Nui Chua, Tuy Loan, Mo Cr. (alt. 250 m), 31-III-2002.

Habitat and biology. *R. magnificus* is distributed from northern to mid-Vietnam. In our investigations, the larvae are found in the lower reaches of mountain streams (altitude 500-650 m) in limestone areas. The streams are 50-80 m wide, 10-50 cm deep, and contain a large number of rapids and backwaters. The water temperature ranges 22-28°C; and pH ranges 7.2-7.6. The substrates are mostly stony and sandy. The larvae are often found from the interface of a stone and finer substrate such as sand and gravel. Mature and last instar larvae are dominant in the end of January, but the adults occur in January, March, April, May, August, and September.

Remarks. The adult of *R. magnificus* Ulmer (1920) was described for the first time from central Tonkin (northern Vietnam) and male and female adults were redescribed by Bae and McCafferty (1991). Its larval stage was described by Nguyen and Bae (2004). The line-drawings of male genitalia in Ulmer (1920: 12, Fig. 9, b) and in Bae and McCafferty (1991: 140, Fig. 120) were based on dried holotype specimen. So we herein correct the genital figure (Fig. 3) using our fresh adult materials. Base on comparative examinations of type materials and literatures, *R. vitalisi* Navás (1922), *R. ferrugineus* Navás (1930), and *Neopotamanthodes lanchi* Hsu (1937) were synonymized with *R. magnificus* Ulmer by Bae and McCafferty (1991). This species is relatively common in northern and mid-Vietnam.

***Rhoenanthus obscurus* Navás**

Rhoenanthus obscurus Navás 1922: 58; Bae and McCafferty, 1991: 24.
Potamanthindus auratus Lestage, 1930: 123. (synonymized by Bae and McCafferty, 1991).
Potamanthus sp. TPA: Gose, 1969: 125. (associated by Bae and McCafferty, 1991).

Diagnosis. Larvae of *R. obscurus* are distinguished from those of other *Rhoenanthus* by the strongly convergent and abruptly curved (28°) mandibular tusks at midlength (see Bae and McCafferty, 1991: 115, Fig. 12) and highly setaceous mouthparts and truncated galealacinial crown. Their foretibiae are relatively long (1.32-1.47 times length of forefemora, 2.55-2.69 times length of foretarsi) and the filtering setae are relatively long and strongly developed. Larval body is medium (12.5-16.7 mm). Male adults of this species are distinguished by their

wings and genitalia. Their forewings (see Bae and McCafferty, 1991: 132, Fig. 85) possess light brown stripe and infuscated crossveins at approximately midlength; and their hindwings (see Bae and McCafferty, 1991: 137, Fig. 104) are almost entirely stained light brown. In addition, their basal R1 of hindwings is moderately arched; and their costal projection of hindwings is rounded. Their penes (see Bae and McCafferty, 1991: 140, Fig. 121) are light brown, basally cylindrical, Y-shaped, and apically slightly notched. Female adults are distinguished by the combined characters of fully stained forewings (see Bae and McCafferty, 1991: 132, Fig. 86) and hindwings and moderately arched R1 in hindwings (see Bae and McCafferty, 1991: 137, Fig. 105). Cerci of male adult are pale brown and possess white segment alternating with every 3 darker segments; median terminal filament is dark brown and rudimentary (0.04-0.05 times length of cerci). Median terminal filament of female adult is well developed (0.63-0.71 times length of cerci).

Description. *Mature larvae*: See Bae and McCafferty (1991: 24). *Male adult*: See Bae and McCafferty (1991: 24). *Female adult*: See Bae and McCafferty (1991: 22).

Distribution. Vietnam, Thailand.

Remarks. The holotype (male adult) of *R. obscurus* Navás and the holotype (female adult) of *Potamanthindus auratus* Lestage (= *R. obscurus*) were known from Vietnam, but we were unable to collect this species from our investigations in Vietnam.

***Rhoenanthus sapa* Nguyen and Bae**

Rhoenanthus sapa Nguyen and Bae 2004: 13.

Diagnosis. Lavae of *Rhoenanthus sapa* can be distinguished from other species of *Rhoenanthus* by the gradually attenuated and moderately arched (27.7°) mandibular tusks that possess mixed simple-stout and hairlike setae throughout dorsal and lateral surfaces (see Nguyen and Bae, 2004: 11, Fig. 2). Their foretibiae are relatively short (ca. 1.09 times length of forefemora, 1.85 times length of foretarsi) and their filtering setae are relatively short and weakly developed. Forewings of female (see Nguyen and Bae, 2004: 13, Fig. 3) are lightly stained brown in costal and central areas. Basal R1 of hindwings is strongly bent to costal area; and costal projection of hindwings is acute (see Nguyen and Bae, 2004: 13, Fig. 4).

Description. *Mature larva*: See Nguyen and Bae (2004: 13). *Male adult*: Unknown. *Female adult*: See Nguyen and Bae (2004: 14).

Distribution. Northern Vietnam.

Material examined. HOLOTYPE: Female mature larva (SWU-EPH-3403), VIETNAM, Lao Cai Prov., Sa Pa, Cat Cat, alt. 1400 m, 21-IV-2002, Y. J. Bae & V. V. Nguyen, [SWU-AIC]. PARATYPES: 4 female adults (SWU-EPH-3410, 3415, 3417, 3418), 3 mature and 2 mid-grown larvae (SWU-EPH-3404), same data as holotype, [SWU-AIC]. Others materials: 5 mid-grown L: Lao Cai Prov., Sa Pa, Cat Cat, 28-XII-2000; 15 mid-grown L: Lao Cai Prov., Sa Pa, Ta Van, 28-XII-2000; 36 mid-grown L: Lao Cai Prov., Sa Pa, Cau May, 28-XII-2000.

Habitat and biology. Larvae of *R. sapa* are found in high mountain areas ranging 1200-1500 m in altitude where the streams are about 12-15 m wide and 10-70 cm deep during the dry season. The substrates consist of mixed sand and gravel and various sized stones with rich organic matter. The water temperature ranges 17-22°C; and pH ranges 7.6-8.0 in the streams of Sapa in April. The larvae occur in a wide range of microhabitats except for rapids with very fast current, but they clearly prefer relatively slow current areas in the main stream (10-30 cm deep). General kick samplings may yield the larvae, but they can be found attaching on the surface under large stones embedded on sandy and gravel substrates. Mid-grown larvae are predominant in late December, while mature larvae reach up to 80% of the total larvae collected in the latter part of April. Some adults occur around this time. One female adult contains about 500-700 eggs.

Remarks. Possession of phylogenetic characters of *R. sapa* such as less specialized (unarranged) setation in mandibular tusks and weakly developed filtering setae in forelegs suggest that this species itself can be a proximal (plesiotypic) branch in the *Rhoenanthus* lineage (see cladogram in Bae and McCafferty, 1991: 88, Fig. 6).

Rhoenanthus sp. V1

Diagnosis. Larvae of *Rhoenanthus* sp. V1 can be distinguished from those of other species of the genus by the mandibular tusks. Their mandibular tusks are weakly arched (13.5°) and gradually attenuating. The tusks also possess a medial row of simple-stout setae and a lateral field of simple-stout setae mixed with hairlike setae, and often possess pronounced subapical seta as in that of *R. coreanus* (see Bae and McCafferty, 1991: 116, Fig. 13). Their dorsal forefemora possess moderately developed hairlike and simple-stout setae; their foretibiae are relatively short (1.07-1.16 times length of forefemora, 2.05 times length of foretarsi) and the filtering setae are moderately developed.

Mid-grown larva. *Dimensions*: Body length 11.5 mm; caudal filaments 8.2 mm.

Head: Head 1.42 mm in length, and 1.90 mm in width, light brown, with dark brown markings between compound eyes, between ocelli, and along anterior margin. Compound eyes black; female compound eyes 0.41 mm in width, and 1.22 mm in distance

between compound eyes (ES = 2.97). Antennae 3.92 mm in length, anterodorsally located. Clypeus anteriorly convex and brown, posteriorly light brown, with short hairlike setae dorsally. Labrum oblong, with relatively short hairlike setae along anterior margin and relatively long hairlike setae on dorsal surface. Mandibular tusks 0.90 mm in length, weakly arched inward (13.5°) and gradually attenuating; body of mandibles light brown, with 6-8 large simple-stout setae basomedially, and with 22-24 simple-stout setae mixed with 5-7 hairlike setae basolaterally, with pronounced subapical seta as in that of *R. coreanus* (see Bae and McCafferty, 1991: 116, Fig. 13). Maxillae with dense hairlike setae on apical 3/4 of galealacinial crown; maxillary palpi 3-segmented; segment 1, 2, and 3 0.43 mm, 0.20 mm, and 0.42 mm, respectively; segment 3 with scattered hairlike setae on entire surface. Hypopharynx expanded laterally, with hairlike setae along margins. Labium glossae with dense hairlike setae; paraglossae expanded laterally; labial palpi 3-segmented, segment 1, 2, and 3 0.35 mm, 0.15 mm, and 0.27 mm, respectively; segment 3 with hairlike setae on outer margin, with minute simple-stout setae and hairlike setae on inner margin.

Thorax: Pronotum brown, with irregular light markings dorsally; anterolateral processes small and acute; lateral margins white. Mesonotum and metanotum brown, with light markings. Forefemora, foretibiae, foretarsi, and foreclaws 2.10 mm, 2.25 mm, 1.10 mm and 0.25 mm, respectively; forefemora pale yellow, dorsally with brown stripe on 2/3 apically andwith brown spot subbasally, with long hairlike setae and simple-stout setae densely on anterior and posterior margins and relatively sparsely on dorsal surface; foretibiae pale yellow, with dark brown stripes basally and broadly at midlength, with fields of hairlike setae moderately developed on inner margin and weakly developed on outer margin; foretarsi dark brown, with moderately developed hairlike setae dorsally and laterally, and with tuft of short hairlike setae apically; foreclaws brown basally and dark brown apically. Midfemora, midtibiae, midtarsi, and midclaws 1.55 mm, 1.00 mm, 0.55 mm, and 0.25 mm, respectively; hairlike setae relatively weakly developed. Hindfemora, hindtibae, hindtarsi, and hindclaws 1.85 mm, 1.10 mm, 0.65 mm, and 0.3 mm, respectively; hairlike setae relatively weakly developed.

Abdomen: Abdominal tergum 1-10 light brown to brown, with 2 pairs of white submedian spots (anterior spots round, smaller, and closer; posterior spots teardrop-shaped, larger, and apart), and with paired white triangular submedian markings on posterior margin. Gills 1 single, rudimentary, 2-segmented, curved upward, flattened, with hairlike setae on margin of terminal segment; gills 2-7 lateral in position, double, white with slightly dark tracheae, with long marginal fringes; gills 3 with 34-36, and 28-30 marginal fringes in each lateral margin of dorsal and ventral lamellae, respectively. Caudal filaments 0.82 x length of body, with long lateral hairlike setae.

Male adult: Unknown. *Female adult*: Unknown.

Distribution. Vietnam.

Materials examined. 44 early and mid-grown L: Cao Bang Prov., Ha Quang, Soc Ha, Giang Cr., 15-17-XII-2000; 2 mid-grown L: Lam Dong Prov., Bao Loc, Da Mre R. (alt. 350 m), 23-III-2002.

Habitat and biology. Larvae of *Rhoenanthus* sp. V1 are found in the lower reaches of streams in northern Vietnam where the streams are 10-15 m wide and 10-30 cm deep (in pool areas sometimes up to 2 m deep). The larvae prefer slow current and shallow (10-20 cm) areas where the substrates are mainly cobble-sized stones (about 10-20 cm in diameter) embedded on sandy and silty bottom. General samplings such as kicking and disturbing substrate can yield the larvae, but their burrowing behavior may be similar to that in typical *Rhoenanthus* such as *R. coreanus* (Bae and McCafferty, 1991).

Remarks. Mid-grown larvae of this species are similar to those of *R. coreanus* (Yoon and Bae) and *R. youi* (Wu and You) in general body and tusk morphology. However, this species can be determined when the mature larvae and adults are found.

Genus *Potamanthus*
Subgenus *Potamanthodes*
***Potamanthus formosus* Eaton**

Potamanthus formosus Eaton, 1892: 186; Bae and McCafferty, 1991: 61; Tiunova, 1999: 2.
Potamanthodes formosus (Eaton): Ulmer, 1920: 11.
Potamanthus iyonis Matsumura, 1931: 1469. (synonymized by Bae and McCafferty, 1991).
Potamanthus (*Potamanthodes*) *kamonis* Imanishi, 1940: 178. (synonymized by Uéno, 1969).
Potamanthodes kamonis (Imanishi): You et al., 1982: 410.

Diagnosis. Larvae of *P. formosus* (see Bae and McCafferty, 1991: 120, Fig. 17) can be distinguished from other *Potamanthus* by the combination of minute compound eyes (ES = 2.80-3.67 in male; 2.96-3.67 in female), relatively short mandibular tusks (0.10-0.23 times length of head), relatively short foretibiae (0.75-0.87 times length of forefemora), and their relatively small body length (7.5-12.0 mm). Male adults of this species can be distinguished from other *Potamanthus* by the combination of tiny compound eyes (ES = 2.15-2.55) and medium-sized and Y-shaped penes (ca. 0.5 times length of genital forceps) that are furcated at midlength (see Bae and McCafferty, 1991: 141, Fig. 130). Female adults of this species cannot be easily distinguished from other *Potamanthodes* by only morphological characters.

Description. *Mature larva*: See Bae and McCafferty (1991: 62). *Male adult*: See Bae and McCafferty (1991: 62). *Female adult*: See Bae and McCafferty (1991: 63).

Distribution. Southeast Asia (Burma, Thailand, West Malaysia, Vietnam), China, Korea, Russian Far East, Japan.

Material examined. 3 M, 2 F & 5 L: Nghe An Prov., Con Cuong, Khe Choang Cr., 12-I-2001; 2 L: Lao Cai Prov., Sa Pa, Cau May, 28-XII-2000; 13 L: Cao Bang Prov., Ha Quang, Doc Lap, 18-XII-2000; 12 L: Cao Bang Prov., Ha Quang, Soc Ha, Giang Cr., 16-XII-2000; 5 M, 3 F & 3 L: Da Nang Prov., Ba Na- Nui Chua, 1-IV-2002.

Habitat and biology. In Vietnam, larvae of *P. formosus* are collected from mountain streams throughout Vietnam with an altitude range 450-1400 m. The streams are about 20-70 m wide and 10-50 cm deep in the dry season. Water temperature is 18-22 °C in December and January and is 28°C in April; pH is 7.5-7.9. The larvae generally occur in the sandy substrates mixed with gravel and larger stones and additional fallen leaves and wood pieces. Adults are collected from late January to early April.

Remarks. This species is widespread throughout mainland Southeast Asia, China, and Northeast Asia up to Russian Far East. Various morphological variations, e.g. color pattern and markings, length of tusks, ratio in foreleg segments, and setation, are found among the local populations. Bae and McCafferty (1991) reviewed synonyms of this species.

A different type of larvae belonging to the subgenus *Potamanthodes* is recognized in the materials from Nghe An, Cao Bang, and Thua Thien Hue Provinces in Vietnam. They are similar to the larvae of *P. formosus*, above, but are somewhat different from those in possessing relatively distinct color pattern, larger body size (11.8 mm-12.6 mm), minute compound eyes (ES= 2.75) in male larvae, longer mandibular tusks (0.25 times length of head length), and longer foretibiae (foretibiae 0.82 times length of forefemora, 1.45 times length of foretarsi). In Nghe An Province, the larvae were found together with *P. formosus* at a stream habitat in January 2001, but only adults and larvae of *P. formosus* were collected at the same place in April 2001. Since *P. formosus* shows a wide range of character states from a relatively wide distributional range, the character states in these local populations are still within the ranges of *P. formosus*. However, their information on life cycles and reared adults are needed to verify this species.

Key to Genera and Species of Vietnamese Potamanthidae

Known larvae

1. Mandibular tusks longer than 1/2 x length of head (see Nguyen and Bae, 2004: 11, Figs. 1-2). Genus *Rhoenanthus*, 2

   Mandibular tusks shorter than 1/2 x length of head (see Bae and McCafferty, 1991: 120, Fig. 17). Genus *Potamanthus*

Subgenus *Potamanthodes*

Potamanthus formosus

2. Mandibular tusks with large lateral subapical spine (see Soldán and Putz, 2000: 11); maxillary palpi slender, with weakly developed hairlike setae on terminal segment. Subgenus *Rhoenanthus*
Rhoenanthus distafurcus

Mandibular tusks without large lateral subapical spines (see Nguyen and Bae, 2004: 11, Figs.1-2); maxillary palpi thick, with strongly developed hairlike setae on terminal segment. Subgenus *Potamanthindus*, 3

3. Simple-stout setae of mandibular tusks distributed throughout dorsal and lateral areas (see Nguyen and Bae, 2004: 11, Fig. 2). *Rhoenanthus sapa*

Simple-stout setae of mandibular tusks distributed 1/2 basally and marginally. 4

4. Forefemora dorsally with moderately developed hairlike setae mixed with simple-stout setae; mandibular tusks often with pronounced subapical seta as in that of *R. coreanus* (see Bae and McCafferty, 1991: 116, Fig. 13). *Rhoenanthus* sp. V1

Forefemora dorsally with greatly developed hairlike setae; mandibular tusks without pronounced subapical seta. 5

5. Mandibular tusks greatly long (1.4 x length of head), gradually curved inward; body large (18.2-21.2 mm) (see Nguyen and Bae, 2004: 11, Fig. 1). *Rhoenanthus magnificus*

Mandibular tusks moderately long (ca. 0.8 x length of head), abruptly curved inward; body medium (12.5-16.7 mm) (see Bae and McCafferty, 1991: 115, Fig. 12).
Rhoenanthus obscurus

Known adults

1. MP2 of hindwings originating from MP1, forming symmetrical fork with MP1 (see Bae and McCafferty, 1991: 139, Fig. 117); subgenital plate of male concave (see Bae and McCafferty, 1991: 141, Fig. 130). Genus *Potamanthus*
Potamanthus formosus

MP2 of hindwings originating from CuA; MP1 and MP2 never forming symmetrical fork (Fig. 2); subgenital plate of male convex (Fig. 3). Genus *Rhoenanthus*, 2

2. MP2 of forewings basally connected to CuA; costal crossveins of forewing not concentrated near bullae; A1 of forewings forked twice (see Bae and McCafferty, 1991: 131, Fig. 82). Subgenus *Rhoenanthus*
Rhoenanthus distafurcus

MP2 of forewings basally connected to MP1; 3-5 costal crossveins of forewings concentrated near bullae; A1 of forewings single forked (Fig. 1). Subgenus *Potamanthindus*, 3

3. Male. 4

Female 5

4. Forewings with purplish brown stained markings scattered throughout wings (Fig. 1).
Rhoenanthus magnificus

Forewing with purplish brown stained markings concentrated transversely in midregion (see Bae and McCafferty, 1991: 132: Fig. 85). *Rhoenanthus obscurus*

5. Cerci with dark brown band at each suture; terminal filament > 0.9 x length of cerci. *Rhoenanthus sapa*

Cerci with white segment alternating with every 3 darker segments; terminal filament < 0.8 x length of cerci. 6

6. R1 of hindwings slightly arched at base; terminal filament ca.0.4 x length of cerci. *Rhoenanthus magnificus*

R1 of hindwings moderately arched at base (see Bae and McCafferty, 1991: 137, Fig. 105); terminal filament 0.6-0.7 x length of cerci. *Rhoenanthus obscurus*

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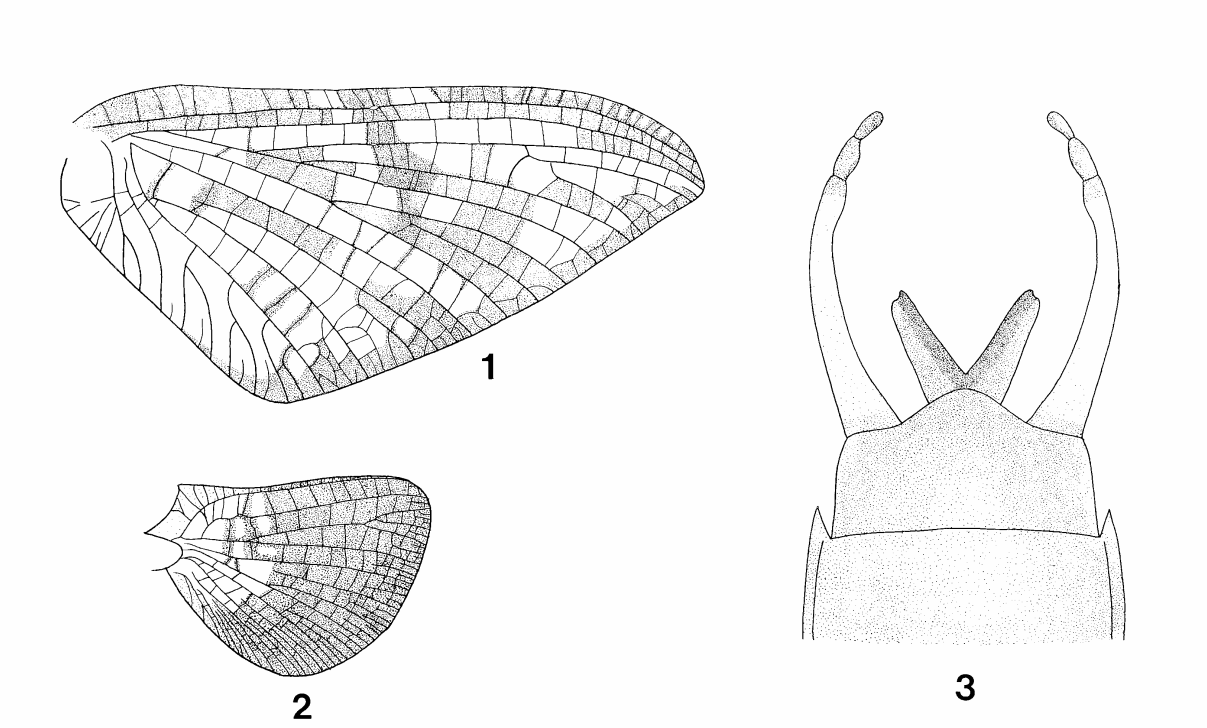

Figs. 1-3. *Rhoenanthus magnificus*, male adult. (1) forewing. (2) hindwing. (3) genitalia.