



## A new *Notacanthurus* Tshernova, 1974 and a new *Rhithrogena* Eaton, 1881 (subgenus *Tumungula* Zhou & Peters, 2004) from Thailand (Heptageniidae, Ephemeroptera)

DIETRICH BRAASCH<sup>1,3</sup> & BOONSATIEN BOONSOONG<sup>2</sup>

<sup>1</sup>Kantstraße 5, D-14471 Potsdam, Germany. E-mail: d.braasch@t-online.de

<sup>2</sup>Department of Zoology, Faculty of Science, Kasetsart University, Bangkok 10900, Thailand. E-mail: fscibt@ku.ac.th

<sup>3</sup>Corresponding author

### Abstract

*Notacanthurus baei* sp. n. (larva) and *Rhithrogena* (*Tumungula*) *siamensis* sp. n. (male, female and assumed larva) are described from northern Thailand. Diagnoses and line drawings of key characters are provided. Larvae of Southeast Asian *Notacanthurus* n.sp. resemble those of Palearctic *Notacanthurus* spp. in having a median ridge of spines directed posteriorly on terga, a similar patterning of terga with oblique stripes sloping inward, femoral cross bands and caudal filaments with whorls of small spines. Contrastingly, larvae of the new species bear claws with denticles, while the mature male larva exhibits prospective penis with distally paired portions of rounded lobes like those in most *Electrogena* Zurwerra and Tomka, 1984. Imagines of *R. (T.) siamensis* represent a second species of subgen. *Tumungula* Zhou and Peters, 2004. Males have balloon-shaped hypertrophied foreclaws, with first tarsal segment about 1.4x the length of the second, and divergent penis lobes without titillators. In contrast to *R. (T.) unica* the male styliger plate shows two sharp, inside directed projections, submedian lobes of the penis have circular gonopores lacking subapical spines.

**Key words:** *Notacanthurus*, *Rhithrogena*, Heptageniidae, taxonomy, biology, distribution

### Introduction

Recently, the generic situation in Heptageniidae of Thailand has been discussed by Braasch (2006b), Sangpradub *et al.* (2002) and Sites *et al.* (2001). The updated list of Heptageniidae from Thailand now comprises 12 species: *Afronurus cervina* (Braasch & Soldán, 1984); *A. dama* (Braasch & Soldán, 1984); *A. gilliesiana* (Braasch, 1990); *A. rainulfiana* (Braasch, 1990); *Asionurus* ? *primus* Braasch & Soldán, 1986a; *Compsoeuria* (*Compsoeuria*) *thienemanni* (Ulmer, 1939); *Compsoeuria* (*Siamoneuria*) *kovaci* (Braasch, 2006b); *Epeorus aculeatus* (Braasch, 1990); *E. unicornutus* (Braasch, 2006a); *Rhithrogeniella tonkinensis* Soldán & Braasch, 1986 (probably identical with '*Afronurus*' *sangangensis* You *et al.*, 1983); *Thalerosphyrus sinuosus* (Navás, 1933); and *Trichogenia maxillaris* Braasch & Soldán, 1988. The recently described *C. (S.) kovaci* was found at Nam Lang River in the Mae Hong Son Province of North Thailand (Braasch 2006b). In a continuation of this study, two new species are described that were captured at light (*Rhithrogena*) and by bottom sampling (*Notacanthurus*, *Rhithrogena*) from Nam Lang River and elsewhere.

The collections have shown that several species could be found only once (*Asionurus*? *primus*, *Trichogenia maxillaris*) or a few times (*Epeorus unicornutus*, *Notacanthurus*) over the course of several years. Further, one not-yet-described species of *Dacnogenia* Kluge, 1988 (larva) was reported by Wang and McCafferty (2004) in their world-wide cladistic study of Heptageniidae. In view of a country such as Thailand with its considerable latitudinal and altitudinal diversity, the investigation of the Thai Heptageniidae fauna is

probably incomplete, and Thailand still harbours more species of this family than have been recorded so far. The description of the new species of the genus *Notacanthurus* is preceded by a brief characterization, because we are of the opinion that the here-treated larval morphospecies has several traits deviating from expected normal generic characters in *Notacanthurus*.

Abbreviations used in the text are as follows: DB (leg. Dietrich Braasch); DBP (collection Dietrich Braasch, Potsdam, Germany); DK (leg. Damir Kovac, Frankfurt am Main, Germany); HI (head index = width : length); MNHU (collection of Museum für Naturkunde der Humboldt-Universität Berlin); SMF Eph (collection of Senckenberg Museum Frankfurt am Main, Ephemeroptera); ZMKU (collection of Zoological Museum, Kasetsart University, Bangkok).

## Systematic account

### Genus *Notacanthurus* Tshernova, 1974

(Type species: *Notacanthurus zhiltzovae* [*Ecdyonurus*] Tshernova, 1972)

The outlines of genus *Notacanthurus* described herein are comprehended in the sense of Braasch (1986) and Kluge (2004). The main characters of the males are: anterior part of head strongly extended; ventrally with infolded lapels (Braasch 1986: p. 120, Figs. 1, 2); eyes contiguous; forewings with shaded crossveins between C, Sc and R1. Penis lobes fused and bulging to somewhat bilobed, with exclusion of apex being incised (Braasch 1986: p. 120, Figs. 4, 8, 7); dorsal penis with small triangular or subquadrangular apico-lateral sclerites, ventrally incompletely sclerotized.

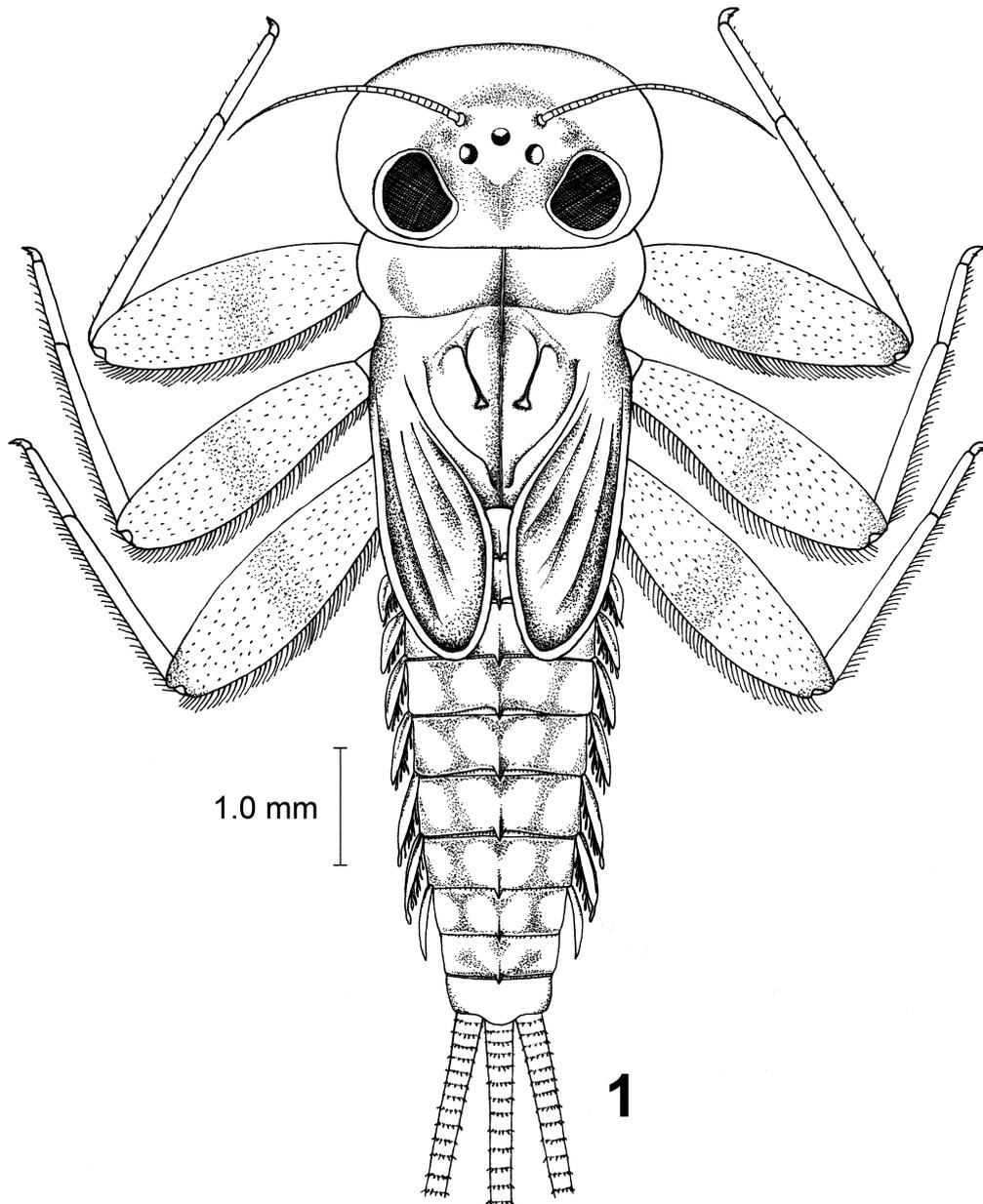
Larvae of *Notacanthurus* are characterized by head broadened laterally (HI = 1.3–1.4); abdominal terga I–IX with longitudinal dorsal ridge, (in most species having shape of spines posteriorly; except *N. edentatus* Braasch, 1986 which has a median dorsal ridge only) (Braasch 1986). Pattern of terga mainly consists of pairs of conspicuous oblique stripes directed inwards distally; posterior margin of terga with densely positioned tiny bristles producing look of chagrination; on femur of mature larvae a striking middle cross band as in imagines of many *Electrogena* Zurwerra & Tomka, 1985, for instance in mature larva of *E. affinis* (Eaton, 1885), a femur band is visible but not consistent in alcohol); claws of legs presumably in all known northern hemisphere *Notacanthurus* species without denticulation; gill I banana-like, gills II–VI ellipsoid-elongated to rounded-triangular plate, gill VII obliquely lanceolate, tufts of filaments moderately evolved; hypopharynx with compact supralinguae shortly reversed, lingua widened at its base; mandibles (Braasch 1986: p. 121, Figs. 18.1–18.4) with long shafts and slender incisors, inner margin completely covered by numerous, apically rounded toothlets; labium with stocky, short-stalked glossae, apically rounded; maxillae with scattered bristles on dorsal surface, crown of maxillae with 21–24 comb-like bristles. Caudal filaments with whorls of small spines. *Notacanthurus* was placed together with *Electrogena* in tribus Notacanthurini (Wang and McCafferty 2004). Kluge (2004) stated the autapomorphy of larvae of *Notacanthurus* as having terga median longitudinal ridge with ‘spines posteriorly.’ Recently, Webb and McCafferty (2007) have made evident such a median dorsal ridge in larva of the new genus *Darthus* (*D. vadorus* Webb & McCafferty, 2007) from Borneo, too.

### *Notacanthurus baei* sp.n.

**Description. Mature larva, male:** Body length 7.95 mm, length of caudal filaments 8.97 mm (female larva: body length 7.47 mm, length of caudal filaments 12.4 mm).

**Head:** Head subquadrate, brown, with irregular pale yellow (Fig. 1). markings; anterior and lateral margins round; posterior margin nearly straight; head width 2.4 mm, head length 1.7 mm, HI (1.4); eyes

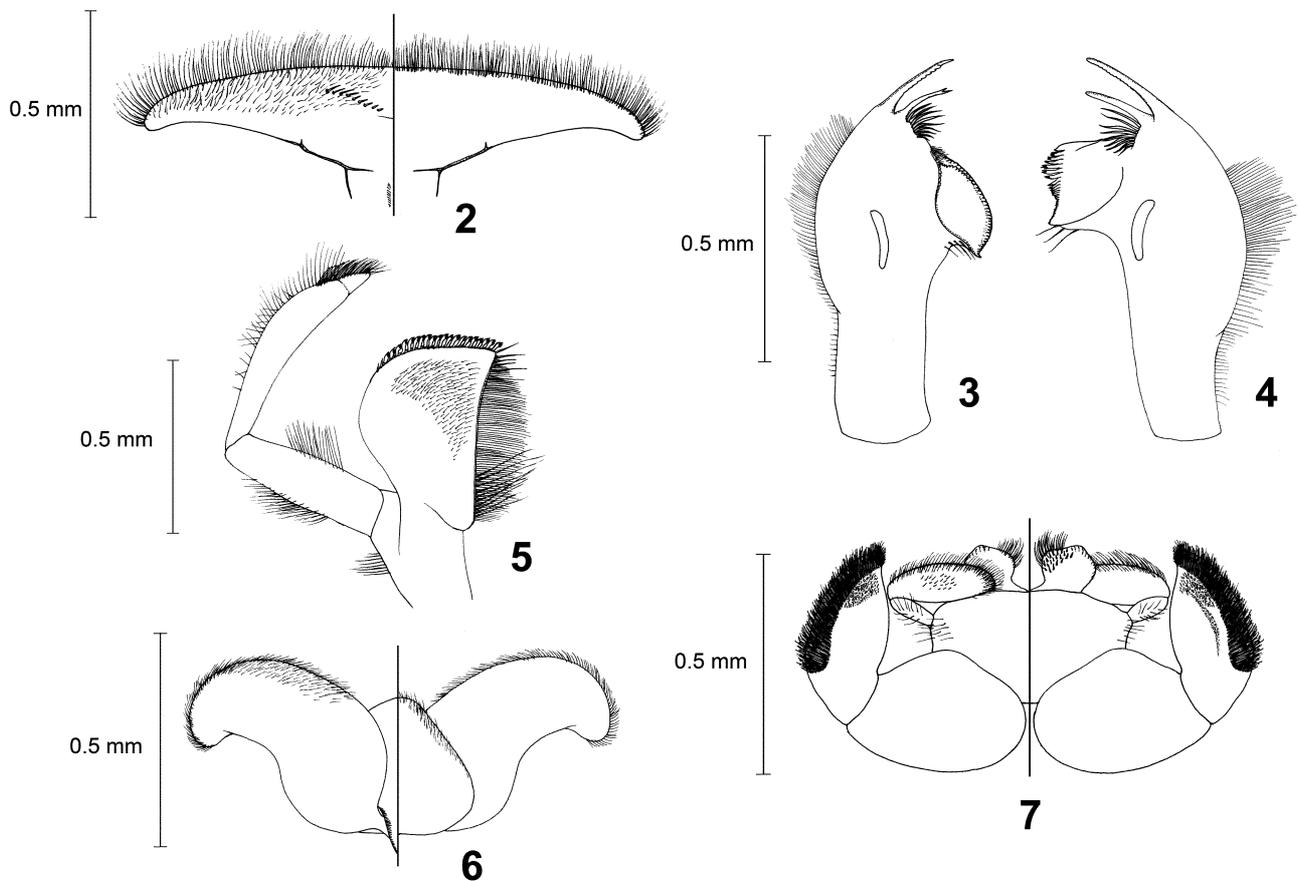
black, antennae brown. Labrum (Fig. 2) ca. 0.5x width of head, dorsally with dense hairlike setae, anteriorly convex and laterally tapering and slightly curved. Mandibles (Figs. 3–4) each with scattered setae along molar area; incisor moderately developed; dense hairlike setae on anterolateral margin. Maxillae (Fig. 5) with 19–21 comb-like setae on crown, with scattered hairlike setae on ventral surface; outer margin of maxillary palp segment 2 and 3 with long hairlike setal field; terminal segment of maxillary palp with dense hairlike setae. Hypopharynx (Fig. 6) with lingua convex at apex; superlinguae each with lateral arm developed, laterally with row of dense hairlike setae. Labium (Fig. 7) with U-shaped separation of glossae; glossae subquadrangular; paraglossae slightly expanded laterally; apical segment of each palp acutely pointed, dorsal surface with dense row of setae.



**PLATE I. FIGURE 1. 1,** Dorsal habitus of *Notacanthurus baei* sp. n.

Thorax: Thorax brown with scattered dark brown markings around basal wingpads; pronotum slightly smaller than head (Fig. 1), pronotum width 2.3 mm, smaller than head width. Legs: Forefemora (Fig. 8) light yellow, with median dark brown spots, scattered short simple stout setae on dorsal surfaces (Fig. 9), with row of long hair-like setae along posterior margins; claws (0.15 mm length) with basal tooth and 3 (rarely 2)

subapical denticles (Fig. 10). Mid legs and hind legs similar to forelegs in colour and setation; foretibiae with weakly developed hair-like setae; mid tibiae and hind tibiae with dense hairlike setal field along outer margin.



**PLATE II. FIGURE 2–7.** Larva of *Notacanthurus baei* sp. n. **2**, Labrum, dorsal view (left) and ventral view (right). **3**, Left mandible, dorsal view. **4**, Right mandible, dorsal view. **5**, Left maxilla, ventral view. **6**, Hypopharynx, dorsal view (left) and ventral view (right). **7**, Labium, dorsal view (left) and ventral view (right).

**Abdomen:** Terga brown, with distinct oblique markings; terga I–IX each with single prominent median spine (Figs. 1, 11, 12), with row of short spiny bristles on posterior margin (Fig. 12). Sterna pale yellow; posterior end of sternum 10 with notch (Fig. 13), in mature specimens sometimes with prospective median dark stripe. Gills with both lamellae and fibrilliform portion on abdominal segments I–VI (Figs. 15–16); gill VII (Fig. 17) with only lamellae; lamellae of gills I knife-shaped (Fig. 15); lamellae of gills II–VI each oval anteriorly; gills V–VI each with arrowlike accessory lobe (Fig. 16); lamellae of gill VII narrower lanceolate, with fine hair-like marginal setae (Fig. 17). **Genitals:** Prospective penis (Fig. 14) from last segment has an *Electrogena*-like shape with narrow, apically rounded lobes and median pair of titillators. Cerci about 1.3x length of body, each

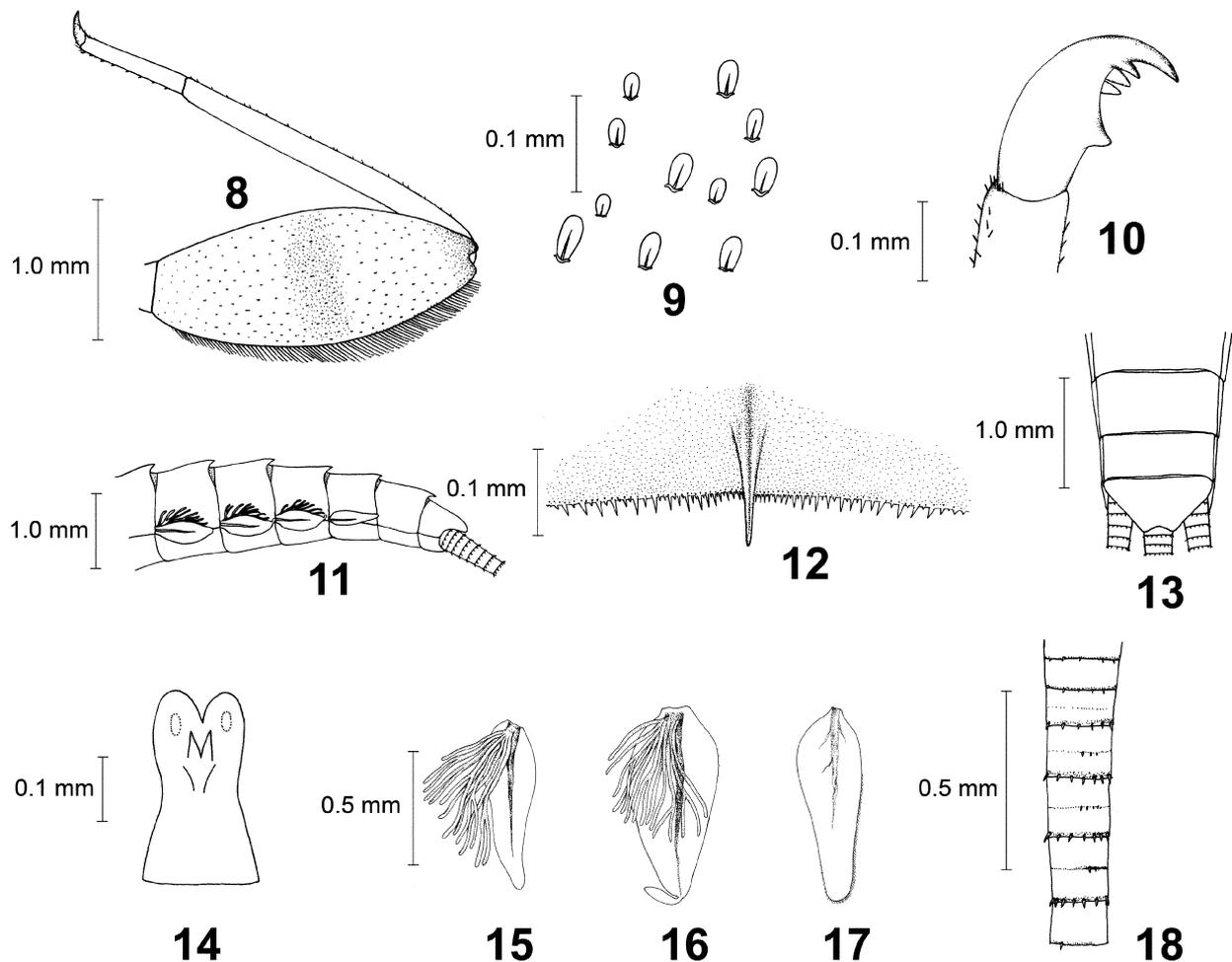
segment with whorls of minute bristles and without interfacing setae (Fig. 18).

Imagines and subimagines: Unknown.

**Etymology:** Species name is given in honour of Prof. Yeon Jae Bae, Korea.

**Diagnosis:** Differing from genuine *Notacanthurus*, the new male larva matches that of *Electrogena* in having a simple, apical penis bulb (Fig. 14) with distally paired portions as wide as proximal integral portion provided with titillators medially. In contrast to *Notacanthurus*, it bears denticles on the claws; the hind margin of the head is nearly straight. With *Notacanthurus* it shares the head proportions, the longitudinal median ridge with posterior spines on terga I–IX as well as the colouration pattern of terga, the crossbar on the dorsal surface of the femur medially and the microstructure as chagration of terga surface. Gill set differs

from that of *Notacanthurus* by having the first gill knife-shaped, gills II–VI moderately lanceolate and gill VII narrower lanceolate (Fig. 17). Mouthparts differ from *Notacanthurus* in having the labrum more tapered and with longer decurved wings and mandibles with shorter stocky shafts.



**PLATE III. FIGURE 8–18.** Larva of *Notacanthurus baei* sp. n. **8**, Foreleg, right, dorsal view. **9**, Foreleg, setae on middle section of anterior face, dorsal view. **10**, Foreleg, tarsal claw, dorsal view (right). **11**, Abdomen, posterior segments, left lateral view. **12**, Abdominal tergum VI, posterior margin. **13**, Abdominal sterna, posterior end, ventral view. **14**, Penis of mature male nymph, ventral. **15**, Gill I, ventral view (right). **16**, Gill V, ventral view (right). **17**, Gill VII, ventral view (right). **18**, Setae on cercus.

**Discussion:** The new species conspicuously resembles those in the genus *Notacanthurus* in having sharp spinal tubercles on most median terga, chagration of terga, similar abdominal colour pattern, HI of 1.4, and a broad middle-femur cross band. In contrast to *Notacanthurus* that has a bilobate head of the penis lobes, the penis of the new species exhibits an *Electrogena*-like shape with apically rounded lobes. Deviating from Palearctic *Notacanthurus* of which claws have only a single subapical tooth, the new species bears also subapical denticles (Fig. 10). Considering all these respects, the new species points out affinities to genera *Electrogena* as well as to *Notacanthurus*. A further species apparently of the same generic origin and identified as *Notacanthurus* has been collected recently by Zhou (personal communication, 2004) in southern China and is being prepared by him for publication. Comparatively, the specimens of Southeast Asian new species are of smaller size, 8.0–9.0 mm, than most genuine *Notacanthurus* from Middle Asia (12.5–14.0 mm), Himalaya (10.0–14.0 mm), Korea (Bae 1997: 9.4 mm, not full-grown). Counting all collection sites of species in northern Thailand, it seems that *N. baei* n. sp. inhabits smaller streams and spring brooks. Unfortunately,

rearing of species was not possible because local people are very active in collecting and hunting for food at the river, even in the night, so that undisturbed working with appropriate devices was impossible. In the near future, recognition of larval stages by use of circumstantial evidence should be attempted based on longer experiences with fauna composition of the area by rearing at suitable habitats.

**Material examined.** HOLOTYPE: **mature larva, male**, THAILAND, North, Mae Hong Son Province, Soppong/Pangmapa, mouth of small tributary into Nam Lang river, 19°34.447' N, 98°18.727' E, altitude 605 m, 21-V-05, DB, in 70% alcohol; PARATYPES: 2 larvae, same locality and same date as holotype. 3 larvae, North Thailand, Mae Hong Son Province, Nam Rhin, small stream below waterfall, 19°28'N, 98°17'E, altitude 829 m, 11-IV-03, DB; 2 mature larvae, Thailand, Mae Hong Son Province, Pai river catchment, small brook, 19°16'N, 98°29', altitude 835 m, DB; 2 larvae, North Thailand, Mae Hong Son Province, Soppong, River Nam Lang, 19°32'N, 98°14'E, 03-25.IV-03, DB; 4 larvae, North Thailand, Mae Hong Son Province, tributary system of Nam Lang River, upper reaches, near village Nam Rhin, 15 km NE Soppong, below a waterfall, 19°28'N, 98°17', altitude 829 m, 11-IV-03, DB; 12 larvae, North Thailand, Mae Hong Son Province, Mae Hong near border to Myanmar, small stream, upper course, 19°41', 98°10'E, altitude 764 m, 23-II-04, DB; 1 larva, North Thailand, Chiang Mai Province, Doi Inthanon National Park, small stream near Headquarters, 18°31'33.35''N, 98°29'57.20''E, altitude 1690 m, 20-V-05, DB; 1 larva, North Thailand, Chiang Mai Province, Doi Suthep National Park, tributary of Ping River; 18°48'20.05''N, 98°55'17.01''E, altitude 844 m, 19-IV-03, DB; 6 larvae, North Thailand, Chiangmai Province, right affluent of large Mae Nam Ping river, coming from Doi Suthep National Park, 18°49'N, 98°55', 19-IV-03, DB.

**Types deposition:** HOLOTYPE: **mature larva, male** PARATYPES: 2 mature larvae, in ZMKU; some larvae in DBP, SMF Eph and MNHU.

### *Rhithrogena (Tumungula) siamensis* sp. n.

**Description. Male:** Body length 7.4 mm; length of forewing 7.4 mm, length of caudal filaments 12.7 mm.

**Head** (Fig. 19): Compound eyes nearly contiguous, grey blue, at base darker blue. **Prothorax:** Dorsally beige, flanked by tan stripes on both sides. Legs: Forefemur reddish brown with longish jet-black spot, tibia tan, proximally and distally darkened, last segment of tarsus darkened; middle and hind legs light with longish jet-black femur spot (Figs. 22–24). Proportions of forefemur : tibia : tarsus (tarsal segments) in mm are 1.76 : 2.3 : 3.2 (1.1 : 0.77 : 0.62 : 0.48 : 0.22); hind legs 1.98 : 1.5 : 0.47 (0.13 : 0.06 : 0.04 : 0.04 : 0.20). Anterotarsal claw with blunt portion remarkably enlarged to a brown sclerotized, somewhat heart-shaped capsula that includes a balloon-shaped pulvillus (Fig. 25) protruding from the apical margin of the capsula; pointed portion of claw broad-based, shorter, with curved tapering tip; at middle and hind legs blunt portion of claw more elongated, pad-like, apically obliquely rounded (Figs. 26–27). Wings: Wings transparent, longitudinal veins weakly yellowish, pterostigma whitish (Fig. 20). Venation of hind wing as shown in Fig. 21.

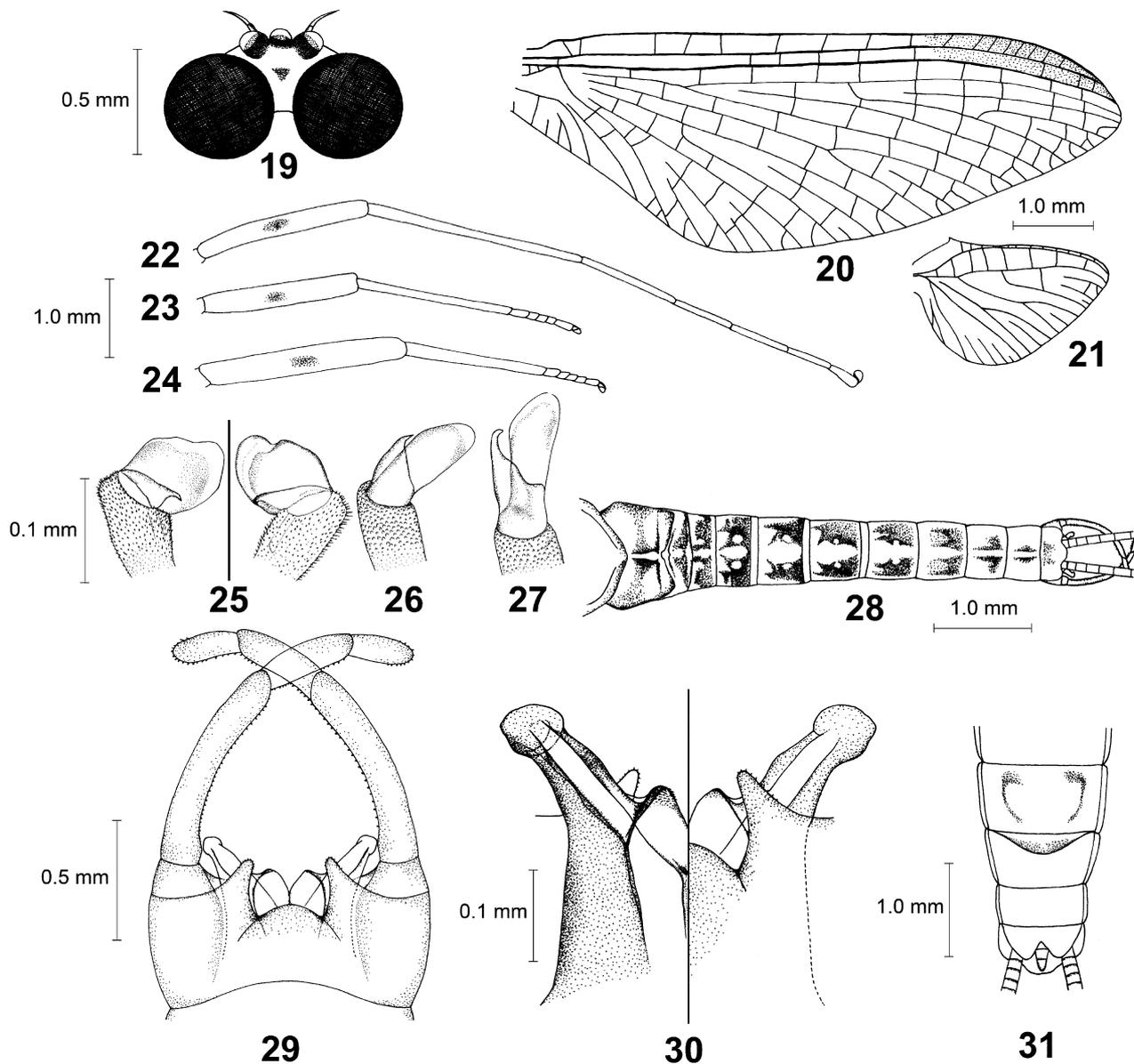
**Abdomen:** Terga with blackish pattern (Fig. 28); sterna whitish. **Genitals.** Genital segment (Fig. 29) of male with long forcipis, styliger plate convex, medially pointed, its flanks with strongly elevated and tapered projections, slightly bent inwards; penis (Fig. 30) widely opened with divergent lobes without apical hooks around gonopore and lacking titillators. Cerci: In proximal third brownish, distally lightened, faintly darkened at joints.

**Description Female:** Size: Body length 6.9 mm, length of forewing 7.0 mm, length of caudal filaments 9.9 mm.

**Head:** Compound eyes blue grey, separated by a distance of 4.2x width of median ocellus; vertex between eyes and ocelli tan with pattern of brownish spots.

**Prothorax:** Upper parts of prothorax principally very similar to that of male. Legs: Legs of same colour as in male; proportions of femur : tibia : tarsus (tarsal segments) of foreleg in mm 1.65 : 2.2 : 1.25 (0.22 : 0.22 : 0.13 : 0.11 : 0.26) and hind leg with 1.65 : 1.65 : 0.53 (0.08 : 0.09 : 0.07 : 0.12 : 0.17). Wings transparent with weakly expressed longitudinal veins and whitish pterostigma.

**Abdomen:** Dorsal segments very similar to that of male, but with slight reddish tinge; sterna of light colour except sternum VI having two parallel, elongated smudges. Subanal plate by half of sternum length acutely cleft (Fig. 31). Cerci: Cerci marked as in male.

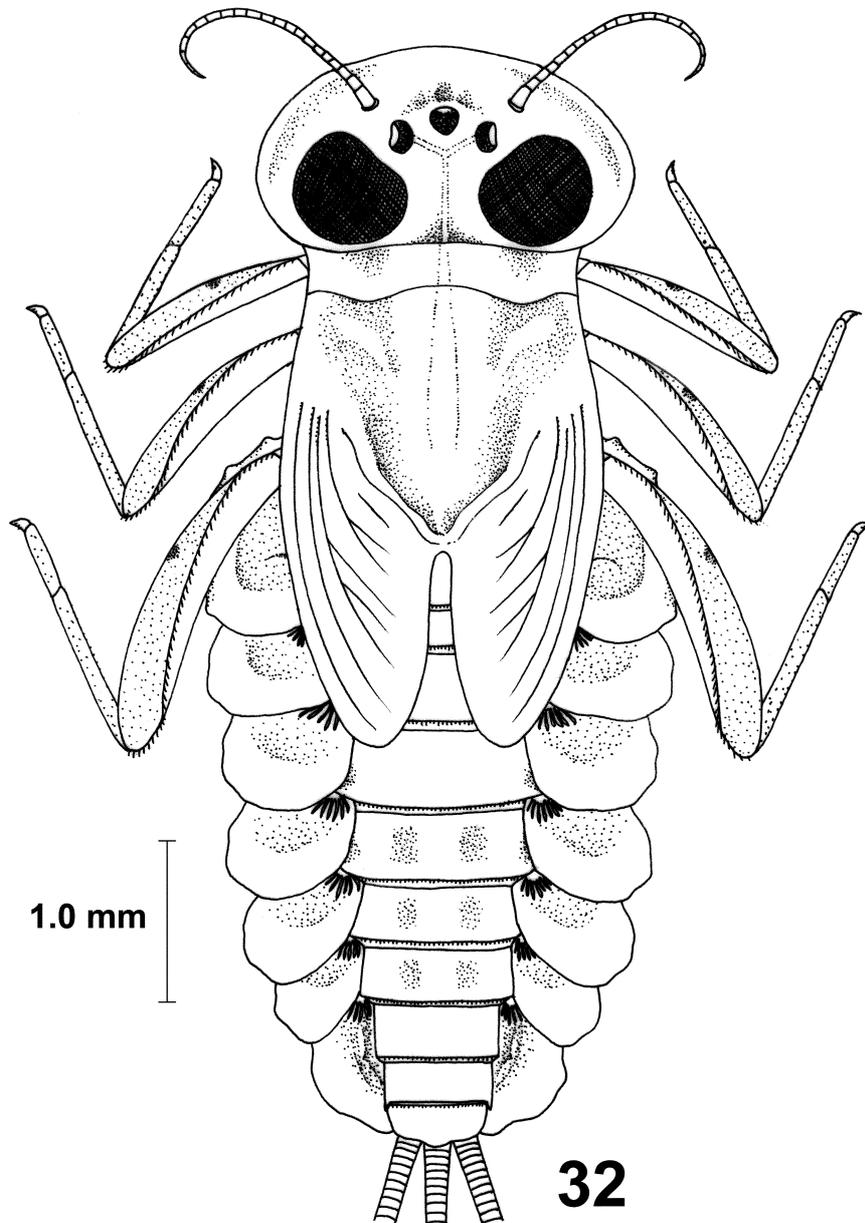


**PLATE IV. FIGURE 19–31.** Imagines of *Rhithrogena (Tumungula) siamensis* sp. n. **19**, Male head, dorsal view. **20**, Male forewing, dorsal view (right). **21**, Male hindwing, dorsal view (right). **22**, Male foreleg, posterior view (right). **23**, Male middle leg, posterior view (right). **24**, Male hindleg, posterior view (right). **25**, Male foreclaw, dorsal view (right) and ventral view (left). **26**, Male, claw of middle leg, dorsal view (right). **27**, Male, claw of hindleg, dorsal view (right). **28**, Male, abdominal tergum, color pattern. **29**, Male genitalia, ventral view. **30**, Penis, dorsal view (left) and ventral view (right). **31**, Female, terminal sterna, ventral view.

**Description: ? Larva, male (unreared):** Body length 6.0 mm; length of cerci 7.0 mm.

**Head:** Head (Fig. 32) brown, sides darkened, medially with conspicuous dark spot above median ocellus and dark spot at median suture base above hind margin; anterior margin evenly rounded; antennae  $\frac{3}{4}$  x width of head. Labrum (Fig. 33) 0.3 x width of head capsule, with shallow median notch, short hairs scattered on anterior margin. Mandibles (Figs. 34–36): outer incisor longer than inner incisor, margin serrated (Fig. 35); prosthema represented by approximately 8 finely branched setae (Fig. 36). Maxillae (Fig. 37): galea-lacinia

consisting of nine stout, pectinate, comb-like setae, basal segment expanded basally, apical segment pointed, covered ventrally with small, pectinate setae (Fig. 38). Hypopharynx with lingua truncate at apex (Fig. 39). Labium with broad V-shaped separation between glossae, paraglossae moderately expanded laterally (Fig. 40).

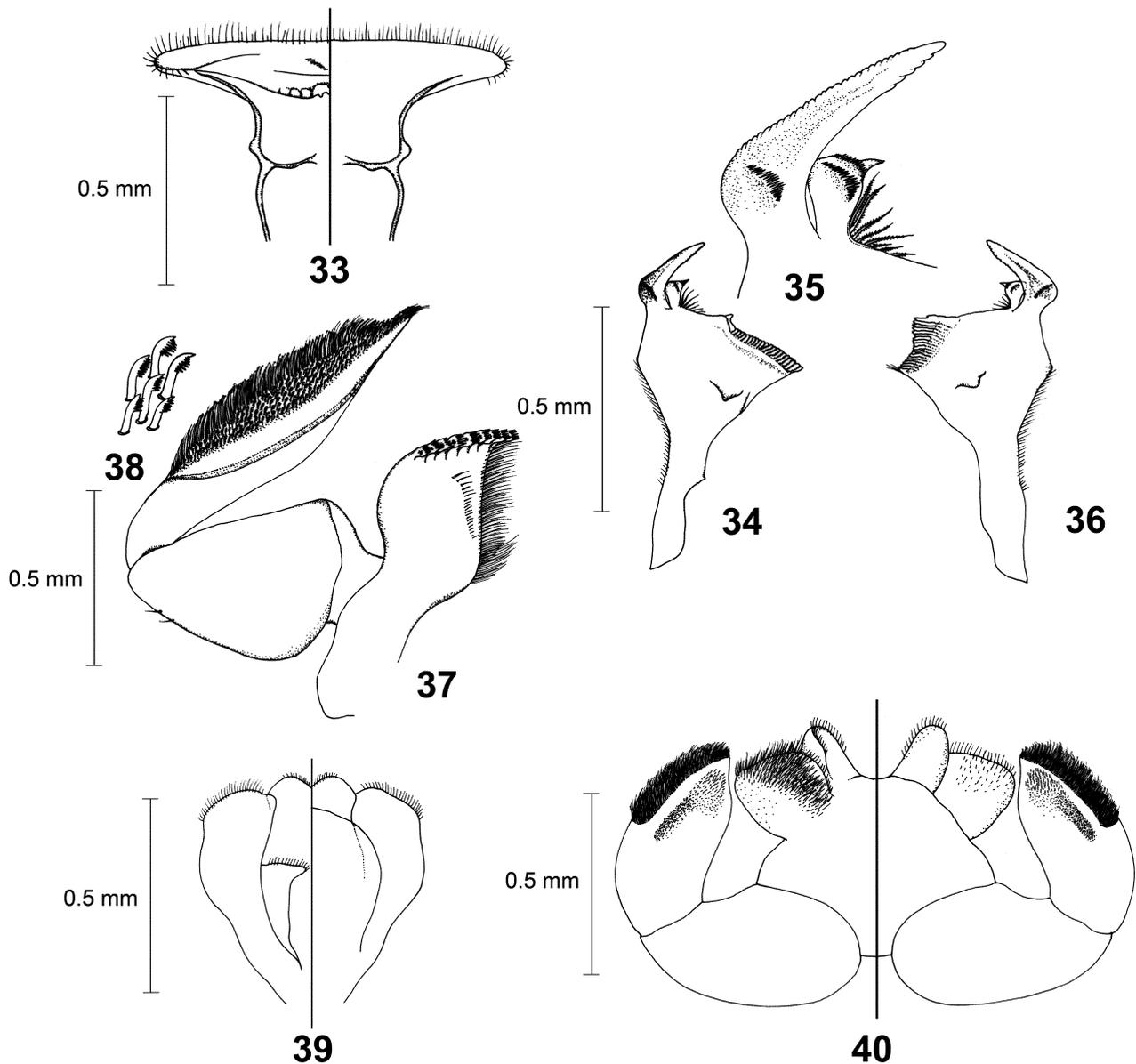


**PLATE V. FIGURE 32.** Larva of *Rhithrogena (Tumungula) siamensis* sp. 32, Dorsal habitus

**Thorax:** Colour brown. Legs: Femora of all legs pale and with median dark marking (Fig. 41), regular row of setae on outer margin; dorsal surface with spatulate setae (Fig. 42). Claws of legs with 4 subapical denticles (Fig. 43).

**Abdomen:** Abdominal segments brown, terga V-VII with pair of submedian smudges, last three paler (Fig. 32). Sterna pale, sternum IX notched (Fig. 44). Gills on abdominal segments I-VII; gill I large, with smooth margins and few pointed crenulations, plica long, narrowly rounded (Fig. 45); gills II-VI with oval lamellae (Fig. 46); gill VII with smooth margins (Fig. 47); all gills with well-developed tufted tracheal tubes. Three caudal filaments with whorls of minute spines at articulations.

**Subimagines.** Unknown.



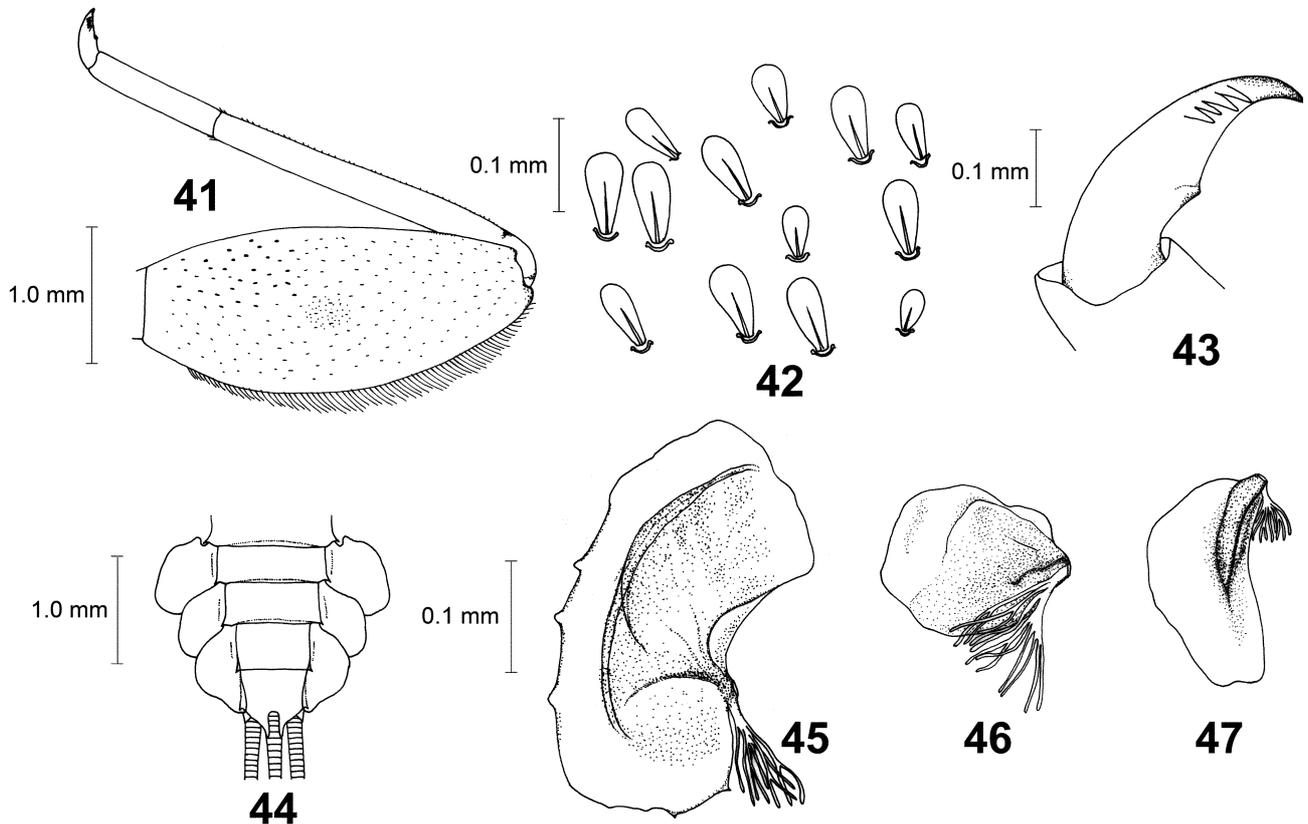
**PLATE VI. FIGURE 33–40.** Larva of *Rhithrogena (Tumungula) siamensis* sp. n. **33**, Labrum, dorsal view (left) and ventral view (right). **34**, Right mandible, ventral view. **35**, Right mandible, dorsal detail of incisors. **36**, Left mandible, ventral view. **37**, Left maxilla, ventral view. **38**, Maxillary palp, detail of setae. **39**, Hypopharynx, dorsal view (left) and ventral view (right). **40**, Labium, dorsal view (left) and ventral view (right).

**Larvae.** Unreared, not known for sure.

**Etymology:** Species name refers to region of first discovery: Siam, former Kingdom of Thailand.

**Diagnosis:** The male of the new species resembles that of *R. (Tumungula) unica* Zhou & Peters, 2004 with hypertrophied foretarsal claw, basal tarsal segment roughly 1.4x longer than second, deeply excavated genital segment, styliger exhibiting remarkable projections and penis without titillators. In contrast to *R. (T.) unica*, the blunt part in the middle and hind claw is conspicuously longer than that in *R. (T.) unica*; the extended styliger projections of *R. (T.) siamensis* are not straight, but directed inwards, while the penis lobes are more elongated, being apically without reversed hook but having round gonopores. In presumed larva, differences are seen in mouthparts: labrum at outer rim without distinct medial emargination and dentate corners as in *R. (T.) unica* (Zhou & Peters 2004, p. 900, fig. 16); glossae are placed more distantly, leaning in laterad position; mandibles with outer incisor somewhat longer and narrower than in *R. (T.) unica*, inner

incisor apically pointed; gill I differs in being pointed-crenulate and having longer plica more flatly rounded, whereas that of *R. (T.) unica* has a few unpointed crenulations and a shorter, more strongly rounded plica. The Sumatran species *R. diehliana* Braasch & Soldán, 1986b, a male subimago, very much resembles that of *R. (T.) unica* by Zhou and Peters (2004: M: p. 899, fig. 3) in having exorbitant extensions of styliger, but gonopores each having somewhat bean-shaped outlines with concave sides directed inwards. Unfortunately, the legs are lost and so there is no certainty in comparison. However, its penis lobes differ from those of *R. (T.) unica* by the gonopores having a much wider opening and lacking a reversed hook.



**PLATE VII. FIGURE 41–47.** Larva of *Rhithrogena (Tumungula) siamensis* sp. n. **41**, Right foreleg, dorsal view. **42**, Foreleg, setae on middle section of anterior face, dorsal view. **43**, Foreleg, tarsal claw. **44**, Abdominal sterna, posterior end. **45**, Gill I, ventral view (right). **46**, Gill IV, ventral view (right). **47**, Gill VII, ventral view (right).

Discussion: The genus *Rhithrogena* seems to be underrepresented in Southeast Asia: *Rhithrogena* spp. was not present in the samples of the Gombak study in Malaysia by Braasch and Soldán (1986a) nor in the collections of I. Sivec (Slovenija) at Belum River, Hulu Perak in Malaysia in the early 1990s. No *Rhithrogena* specimens were obtained in collections from Vietnamese rivers by T. Soldán in the 1980s. In field collections by Sites *et al.* (2001) in the 10 southern provinces of the Thai peninsula, no species of the genus was recorded. However, one unnamed species was found in the extensive benthos inventory in northeastern Thailand by Sangpradub *et al.* (2002), possibly the same as in the western part of North Thailand. Thus, the apparently disjunctive existence of the genus on Java, Sumatra and the Lesser Sunda Islands (Braasch 2005; Braasch & Soldán 1986; Edmunds & Polhemus 1990; Ulmer 1939) is surprising from a zoogeographic point of view and still demands further explanation. For example, *R. diehliana* (Braasch & Soldán 1986: subimago male, p. 92: Fig. 1–2) from Sumatra could belong to subgenus *Tumungula* as evidenced by the long styliger projections in its species. Further, it might be suggested that *R. parva* (Ulmer 1912: larva, p. 374: Fig. 8–10) from Java could be closely related to above-mentioned *R. diehliana*.

**Biology:** In northern Thailand, flight of *R. siamensis* was very intensive in the morning and after dusk, giving the impression of considerable movement of *Rhithrogena* along river banks. So far, subimagines have not been found at places with abundant imaginal presence, merely one larva could be recorded. Otherwise, collections over most of the year revealed that the flight season at altitudes of >600 m was mainly in March/April, just before the beginning of monsoon rains in May. Only a few dates are out of this time, possibly due to different altitude (Mae Kaem) or low temperature conditions (small affluent). More speculative would be the assumption that in October, at the beginning of the dry season, a first, smaller generation could fly. However, there are few mayfly collections in the months between October and January.

**Material examined:** HOLOTYPE: **Male**, THAILAND, North, Mae Hong Son Province, Soppong/Pangmapa, Nam Lang River, 19°34.447'N, 98°18.727 E, altitude 605 m, 03-27.IV-03, at light, DB, in 70% alcohol. PARATYPES: 52 males, 15 females, North Thailand, Mae Hong Son Province, Soppong/Pangmapa, Nam Lang River 19°34.447'N, 98°18.727 E, altitude 605 m, 03-27.IV-03, at light, DB, in 70% alcohol; 1 male, 2 females, same locality, 03-II-05-III-04, at light, DB; 2 females, same locality, 28-X-04, at light, DK; 4 males, same locality, 12-III-07, DK; 23 males, same locality, 30-III-07, at light, DK; all samples in 70% alcohol; 2 males, 1 female, North Thailand, Mae Hong Son Province, Soppong/Pangmapa, small affluent stream, 19°31'01.72"N, 98°14'53.79"E, altitude 605 m, 12-VI-05, at light, DK.

Further material: 2 females, North Thailand, Chiang Mai Province, Mae Chaem River, 10 km above Hot, 18°12'07.54"N, 98°36'32.85"E, altitude 268 m, 01-III-04; at light, DB; 1 female, North Thailand, Mae Kae Waterfall, near Pai, 19°15'01.42"N, 98°38'19.17"E, altitude 1690 m, 23-II-07, at vegetation, DB.

Larval material of *Rhithrogena* sp.? from 4 geographically different localities in North Thailand, apparently of one species; however, affiliation to *R. (Tumungula) siamensis* needs confirmation by rearing.

1 larva, North Thailand, Chiangmai Province, Soppong/Pangmapa, Nam Lang River, 19°31'01.72"N, 98°14'53.79"E, altitude 605 m, 10-III-08; 2 larvae, North Thailand, Chiang Mai Province, Doi Inthanon National Park, river below Headquarters, 18°31'33.35"N, 98°29'57.20"E, altitude 1690 m, 20-II-04; 1 larva, North Thailand, Chiang Mai Province, Mae Chaem River, above Hot Resort, 18°07'N, 98°32'E, altitude 200 m, 01-III-04, DB; 3 larvae, North Thailand, Chiang Rai Province, above Thaton, Kok River, 20°03'39.10"N, 99°21'43.94"E, altitude 844 m, 01-III-04; all bottom samples, DB.

**Types deposition:** HOLOTYPE: **male** [MNHU], PARATYPES: males, females for a time in **DBP**; 2 males, 2 females in **SMF Eph**; 2 males, 1 female in **ZMKU**.

## Acknowledgements

The devices for light trapping were made available by Dr. Damir Kovac, Senckenberganlage Frankfurt/am Main and several times he has taken samples at nightfall in Soppong and in the environment of Nam Rhin at smaller streams. For his ways of helping, we thank him very much. Furthermore, we thank Mrs. Wamphen Bidasak, directrice of the Guesthouse and Resort 'Little Eden' in Soppong/Pangmapa for kind permission to install a light trap on a river-side platform. The junior author is grateful to Prof. Dr. Yeon Jae Bae for his kind advice in the study of Heptageniidae. We would especially like to thank Prof. Dr. John C. Morse (Clemson University, USA.) for critically reading and editing the manuscript.

## References

- Bae, Y.-J. (1997) *Ecdyonurus baekdu* n. sp., an Ecdyonurid mayfly (Ephemeroptera: Heptageniidae) from Korea. *The Korean Journal of Systematic Zoology*, 13(3), 253–258.
- Braasch, D. (1986) Zur Kenntnis der Gattung *Notacanthurus* Tshernova, 1974 aus dem Himalaya (Ephemeroptera, Heptageniidae), *Reichenbachia*, 23(21), 117–25.
- Braasch, D. (1990) Neue Eintagsfliegen aus Thailand, nebst einigen Bemerkungen zu deren generischem Status (Insecta, Ephemeroptera: Heptageniidae). *Reichenbachia*, 28(2), 7–14.

- Braasch, D. (2005) Neue Arten der Gattungen *Atopopus* und *Afronurus* aus Südostasien sowie einige Bemerkungen zur Gattung *Asionurus* von Malaysia (Insecta: Ephemeroptera: Heptageniidae). *Entomologische Abhandlungen Museum Tierkunde Dresden*, 62 (2), 165–174.
- Braasch, D. (2006a) Neue Eintagsfliegen der Gattungen *Epeorus* und *Iron* aus dem Himalaya (Ephemeroptera, Heptageniidae). *Entomologische Nachrichten und Berichte*, 50 (1–2), 79–88.
- Braasch, D. (2006b) *Componeuria* (*Siamoneuria*) *kovaci* subg. n., sp. n., a new mayfly from northern Thailand (Insecta, Ephemeroptera, Heptageniidae). *Senckenbergiana Biologica*, 86(1), 47–53.
- Braasch, D. & Soldán, T. (1984) Zwei neue Arten der Gattung *Cinygmina* Kimmins, 1937 aus Vietnam (Ephemeroptera, Heptageniidae). *Reichenbachia*, 22(26), 195–200.
- Braasch, D. & Soldán, T. (1986a) Die Heptageniidae des River Gombak in Malaysia (Ephemeroptera). *Reichenbachia*, 24(3), 41–52.
- Braasch, D. & Soldán, T. (1986b) *Rhithrogena diehliana* n. sp. von Sumatra (Ephemeroptera, Heptageniidae). *Reichenbachia*, 24(10), 91–92.
- Braasch, D. & Soldán, T. (1988) *Trichogenia* gen. n., eine neue Gattung der Eintagsfliegen aus Vietnam (Insecta, Ephemeroptera, Heptageniidae). *Reichenbachia*, 25(25), 119–124.
- Eaton, A.E. (1883-1888) A revisional monograph of Recent Ephemeridae or mayflies. *Transactions of the Linnean Society of London, Zoology* (2)3, 1–352.
- Edmunds, Jr. G.E. & Polhemus, D.A. (1990) Zoogeographical patterns among mayflies (Ephemeroptera) in the Malay Archipelago, with special reference to Celebes. In W.J. Knight & Holloway, J.D. (Ed.) *Insects and the rain forests of South East Asia (Wallacea)*. Royal Entomological Society of London, London, 49–56.
- Kluge, N.J. (1988) Revizija rodov sem. Heptageniidae (Ephemeroptera). 1. Diagnozy trib, rodov i podrodov podsem. Heptageniinae. *Entomologičeskoje Obozrenije*, 67, 291–313.
- Kluge, N.J. (2004) *The Phylogenetic System of Ephemeroptera*. Kluwer Academic Publishers, Dordrecht-Boston-London, 442 pp.
- Navás, L. (1933) Notes d'Entomologie Chinoise. *Neuroptères et insectes voisins. China et pays environnants. Musée Heude*, 9, 1–22.
- Sangpradub, N., Hanjavanit, C. & Boonsoong, B. (2002) New records of heptageniid mayflies *Asionurus* and *Thalerosphyrus* (Ephemeroptera: Heptageniidae) from northeastern Thailand. *ScienceAsia*, 28, 411–416.
- Sites R.W., Wang, T., Permkam S. & Hubbard M.D. (2001) The mayfly genera (Ephemeroptera) of southern Thailand. *Natural History Bulletin of the Siam Society*, 49, 243–268.
- Soldán, T. & Braasch, D. (1986) *Rhithrogeniella tonkinensis* sp.n. (Ephemeroptera, Heptageniidae) from Vietnam, with descriptions of nymphal stages and biology of the genus. *Acta Entomologica Bohemoslovaca*, 83, 202–212.
- Tshernova, O.A. (1972) Nekotoryje novyje asiatskije vidy podjenok (Ephemeroptera), Heptageniidae, Ephemerellidae). *Entomologičeskoje Obozrenije*, 51, 604–614.
- Tshernova, O.A. (1974) Rodovoj sostav podjenok sem. Heptageniidae (Ephemeroptera) v Golarktike i Orientalnoj oblasti. *Entomologičeskoje Obozrenije*, 53, 801–813.
- Ulmer, G. (1939) Eintagsfliegen (Ephemeroptera) von den Sunda-Inseln. *Archiv für Hydrobiologie, Supplement XVI*, 443–692.
- Wang, T.-Q. & McCafferty, W.P. (2004) Heptageniidae (Ephemeroptera) of the World. Part I: Phylogenetic Higher Classification. *Transactions of the American Entomological Society*, 130, 11–45.
- You, D-S., Su, C-R. & Hsu, Y-C. (1983) A new species of the genus *Afronurus* from Fujian Province (Ephemeroptera; Heptageniidae). *Journal of Nanjing Normal College (Nature Science)*, 5, 61–65.
- Zhou, Ch.-F & Peters, J.G. (2004) A new subgenus of *Rhithrogena* from China, with description of a new species (Ephemeroptera: Heptageniidae). *Annals of the Entomological Society of America*, 97(5), 898–902.
- Zurwerra, A. & Tomka, I (1985) *Electrogena* gen. nov., eine neue Gattung der Heptageniidae (Ephemeroptera). *Entomologische Berichte Luzern*, 13, 99–104.