

THE TRICORYTHIDAE OF THE ORIENTAL REGION

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Abstract

Based on detailed taxonomic revision of predominantly larval material of the family Tricorythidae (Ephemeroptera) so far available from the Oriental Region, a new genus, *Sparsorythus* gen. n., is established to include six new species: *S. bifurcatus* sp. n. (larva, imago male and female), *S. dongnai* sp. n. (larva, imago male and female), *S. gracilis* sp. n. (larva), *S. grandis* sp. n. (larva), and *S. ceylonicus* sp. n. (larva), and *S. multilabeculatus* sp. n. (imago male), respective differential diagnoses are presented. *S. jacobsoni* (Ulmer 1913) comb. n. is transferred from the genus *Tricorythus*, now supposed to cover only a part of Afrotropic species of this family. Further five species are described but left unnamed since the larval stage is still unknown. The egg stage (a single polar cap and usually hexagonal exochorionic structures) is described for the first time, relationships of *Sparsorythus* gen. n. to all other genera of the family and their composition are discussed with regard to classical extent of knowledge and rather confusing data in the past. Available data on biology of this new genus are summarized and its distribution with regard to historical biogeography is briefly discussed.

Key words: Tricorythidae; Oriental region; *Sparsorythus* gen. n.; new species; taxonomy; biogeography.

Introduction

Eaton (1868) established the genus *Tricorythus* on the basis of *Caenis varicauda* Pictet, 1843–1845 described in adult stage from the Upper Egypt. The same author (Eaton 1884) mentioned adults of two species, *T. varicauda* and *T. discolor* ranging the genus to his Section 7 of Third Series of Group II. of the Genera. Moreover, Eaton (1884: Table 15, Fig. 25) figured the wing of a species called *Tricorythus* (Malay sp.), but he did not describe or mention this material in his text. Ulmer (1913) noted the venation figured by Eaton (1884) corresponds to his new species (*T. jacobsoni*), described after adult material from Java. Later, he revised the adult description (Ulmer 1925) and published a description of larval stage assigned just to this species (Ulmer 1940).

The genus has been classified in the Caenidae and Ephemerellidae and, finally, in the separate family with apparently polyphyletic components by Lestage (1942) to include also the present families Leptohephidae, Ephemerithidae and Machadorythidae

defined later (Edmunds and Traver 1954, Edmunds et al. 1963, Landa and Soldán 1985, McCafferty and Wang 2000).

Three additional genera, namely *Dicercomyzon*, *Tricorythurus* and *Neurocaenis*, had been established from the continental Afrotropic region.

The genus *Dicercomyzon* Demoulin, 1954 constitutes the monotypic subfamily Dicercomyzinae Edmunds and Traver, 1954.

The genus *Tricorythurus* Lestage, 1942 (type species *Tricorythus latus* Ulmer, 1916, by monotypy, type locality the Congo River, Zaire, Kingshasa, other locality, Bahr-el-Djebel) seems to be disputable. According to Kimmins (1960), the genus *Tricorythurus* was erected on the basis of possibly 3-segmented forceps (Ulmer 1916, Lestage 1942), female and larvae were unknown. Type species was reexamined by Demoulin (1954). He found the forceps to be actually 2-segmented and also other characters are congeneric with the genus *Tricorythus*. Consequently, he synonymized *Tricorythurus* Lestage 1942 with *Tricorythus* Eaton, 1868 (cf. also Demoulin 1970). But some authors, e.g., Hubbard (1990) maintain the opinion on *Tricorythurus* to be a valid taxon, the subgenus of the genus *Tricorythus* in this case.

The genus *Neurocaenis* Navás, 1936 (type species *N. fuscata* Navás, 1936: by original designation, type locality Zaire, Beni, male and larva unknown) was originally defined mainly on the basis of minor differences in the arrangement of cross veins (Navás 1936; Demoulin 1954, 1970) to include, besides type species, 5 species originally described in the genus *Tricorythus*. The only Oriental species known so far, *T. jacobsoni* Ulmer (1913) was also transferred to the genus *Neurocaenis* (Demoulin 1954). Later Demoulin (1970) admitted subgeneric status of this genus. Demoulin (1970) also summarized all Afrotropic taxa of the Tricorythidae: There are 11 species (6 in *Tricorythus* and 5 in *Neurocaenis*) described mostly according to adult stage with the exception of *T. reticulatus* Barnard, 1932 and *T. discolor* (Burmeister 1938), the larval characters of which are mentioned by Barnard (1932) and Crass (1947).

Generic status of *Neurocaenis* was followed by Edmunds and Traver (1954), Edmunds et al. (1963), Hubbard and Peters (1978), Hubbard and Pescador (1978), Hubbard (1990), the latter author also mentioned the occurrence of this genus in Madagascar most probably on the basis of Demoulin's (1958) record on unidentified species of *Neurocaenis* from Madagascar. Although the synonymy of *Tricorythus-Neurocaenis* has been intuitively supposed for a long time (cf., e.g., Soldán 1983, 1991, Sivaramakrishnan and Venkataraman 1987), the respective formal taxonomic act was conducted by Oliarinomy et al. (1998). These authors, besides discussing the problems of cross veins character value, also described nine new species of *Tricorythus* from Madagascar.

Recently, new genera *Madecassorythus*, *Spinirythus* and *Ranorythus* were established by Elouard and Oliarinomy (1997), Oliarinomy and Elouard (1998a), and Oliarinomy and Elouard (1998b).

After description of *Tricorythus jacobsoni* (Ulmer 1913) only sparse literature data exist about occurrence of Tricorythids in the Oriental region. Hubbard and Peters (1978) and Hubbard and Pescador (1978) mentioned the genus *Neurocaenis* (not identified species) from Sri Lanka. Under the generic name *Tricorythus*, the Oriental Tricorythidae were mentioned by Soldán (1983, 1991) from southern part of Vietnam, Sivaramakrishnan and Venkataraman (1987) from southern India (Madras State), and McCafferty and Wang (2000) from Indonesia.

Based on a relatively extensive material from the Oriental region, the principal objectives of this study are, as follows: (i) to determine the proper generic identity of *Tricorythus jacobsoni* Ulmer; (ii) to compare all the other specimens available from the Oriental region with this species and find possible differences in both adult and larval arrangement of morphological characters and (iii) to discuss in detail the relationships of the Oriental species to other Tricorythidae genera (and subfamilies).

Systematic Part

Sparsorythus gen. n.

Mature larva (in alcohol):

Head – Apparently wider than long. Antennae longer than head length. Scape and pedicel well differentiated, pedicel about twice longer than scape.

Labrum – Oval, about twice as wide as long. A single row of medially diminishing bristles at the anterior margin. Uniformly scattered bristles on dorsal surface. Two submarginal groups of shorter dense tiny bristles on the ventral side of labrum.

Hypopharynx – Lingua rounded, ellipsoidal, with medial incurvation. Lingua longer than superlinguae. Superlinguae triangular, rounded or bluntly pointed at apex, with a row of bristles in distal half of outer margin, diminishing apically.

Mandibles – Outer incisors triangular, with numerous bristles on the ventral side. Apex simple or apically with a pair of short rounded projections. Inner incisors approximately on the same shape and length, with bristles on the ventral side and tiny branched setae on the dorsal side. Right prosthema shorter by 1/3 than left one, expanded apically, bifurcated or with several pointed teeth. A group of branched setae longer than prosthema inserted at its base. Left prosthema as long as or slightly shorter than the inner incisor, rod-like, with simple bluntly pointed apex or apex bearing several bluntly pointed projections. A group of branched setae as long as or shorter than prosthema inserted at its base. Outer margin of mandibles with a row of long filtering setae. Short transversal row of setae on the ventral side near mandible base.

Maxillae – Suture of stipes and galeolacinia apparent. Maxillae roughly oblong-shaped or ellipsoidal. Apical part of maxilla nearly truncate, the outer apical (galeal) lobe well apparent, produced. Maxilla about by 1/3 longer than wide. Outer margin of maxilla convex without any setation. Anterolateral part of maxilla with a group of long setae. Similar, but smaller setae also on the anterior and medial margin of the

galeolacinia. A regular oblique ventral transversal row of stout setae situated at distal third of galeolacinia. Maxillary palps completely missing. No sclerotised structure at the place of insertion of maxillary palp recognizable.

Labium – Glossae and paraglossae fused into rounded triangular plate with two groups of lateral submarginal setae. The whole plate surrounded with a regular row of setae diminishing apically. Labial palps three-segmented. First segment oblong-shaped, about by 1/3 shorter than the second one, without any setation. Second segment curved, apically bluntly pointed, with a row of stout marginal setae at its outer margin and tiny submarginal setae at its inner margin. Third segment very small, bluntly pointed at apex, without any setation.

Pronotum – Oblong-shaped, as wide as head, about twice longer than wide and about by 1/4 shorter than mesonotum.

Legs – Femora flat, shorter than tibiae. Fore femora with a conspicuous transversal row of flat rounded articulated spines and concave posteromedial margin. Foretibiae with a longitudinal row of spines or bristles near their inner margin. Claws strongly hooked, with two teeth approximately in the middle and one or two subapical spines. Surface of the middle and hind femora covered by spines of various sizes. Posterior margins of the middle and hind femora with spines and setae.

Abdomen – Abdominal segments bearing gills only moderately compressed. Segments VIII, IX and X only slightly longer than segments I–VII. Posterolateral spines of abdominal segments well apparent, as long as 1/3 or 1/4 of segment length. Anlagen of male external genitalia (penis and forceps) well apparent in larvae of the last instar.

Gills – Six or five pairs of gills on abdominal segments II – VII or II – VI. Gills on segments II – VI alike, with rounded or elipsoidal plates and two branched ventral membranous parts with rich filaments. Plates simple, thin, not enforced, with only several tiny and short marginal bristles. Gills on abdominal segment VII strongly reduced (if present). Dorsal plate always missing, ventral membranous part reduced to a single or bifurcated filament.

Caudal filaments – Paracercus always apparently longer than cerci. Sexual dimorphism in arrangement of caudal filaments well visible, cerci and paracercus of males much wider and compressed at base than those in females. Segment of cerci and paracercus without hairs and bristles. Spines of different length and shape only round the posterior margin of individual segments.

Imago male (in alcohol): Body smaller and slimmer than female. Head apparently wider than long. Compound eyes large. Antennal pedicle much longer than scape. Pronotum approximately as long as head. Fore wings translucent, colourless or coloured mainly in basal half with dark grey smudges. Costal field with maximally 15 crossveins (if present, mostly badly visible), pterostigma not developed. Posterior margin covered with fine hairs, diminishing distally. Otherwise the venation follows the general tricorythid plan, including the typical “tricorythid fork”.

Posterior margin covered with fine hairs, diminishing distally. Hindwings absent. Fore legs with two rounded claws, other pairs with claws dissimilar, one hooked and one rounded. Subgenital plate entire, not divided. Forceps evidently two-segmented. Basal segment of forceps always shorter than distal one. Last segment of forceps provided with numerous attached structures. Penis lobes completely fused, usually forming a rod-like structure, moderately extending basal segment of forceps. The apex of penis rounded, often with apparent medial nick indicating the original separation of mesomeres. Caudal filaments longer than body, without hairs. Paracercus longer than cerci.

Imago female (in alcohol): Body large and robust. Head apparently wider than long. Compound eyes smaller than those in males. Antennal pedicle much longer than scape. Pronotum approximately as long as head. Fore wings translucent, colourless or coloured mainly in basal half with dark grey smudges. Costal field with maximally 15 crossveins (if present, mostly badly visible), pterostigma not developed. Posterior margin covered with fine hairs, diminishing distally. Hindwings absent. Legs slender, long. All pairs with claws dissimilar, one hooked and one rounded. Caudal filaments shorter than body, covered with fine hairs. Paracercus longer than cerci.

Subimago (in alcohol): Similar to imago, with darker wing coloration.

Egg (dissected from mature female, critical point dried, gold-coated, and electronmicrograms taken by scanning microscope Jeol JSM 6300 at 10–15 kV): Generally oval-shaped, always apparently longer than wide, about 150–200 μ m in length and 70–130 μ m in width. A single polar cap (type I - noncoiled, single unit cap according to Koss and Edmunds 1974) of about from 1/4 to 1/2 of the egg length always present. Egg pole opposite to the polar cap rounded or bluntly pointed like. Polar cap itself always rounded at apex. Egg surface regularly covered with numerous polygonal (usually hexagonal) exochorionic structures of about 25–30 μ m in diameter. Micropyle unknown.

Etymology: *Sparsorythus* (m.), from Latin *sparsus* meaning spotted or blotched and *Tricorythus*, related genus. Named after common presence of dark spots or smudges on wings.

Type species: *Sparsorythus bifurcatus* sp. n.

Species included: *Sparsorythus bifurcatus* sp. n., *S. jacobsoni* (Ulmer 1913) comb. n., *S. dongnai* sp. n., *S. gracilis* sp. n., *S. grandis* sp. n., *S. ceylonicus* sp. n., *S. multilabeculatus* sp. n.

Biology and distribution: Eggs adapted to be attached to substrate (polar caps well developed). Larvae highly rheophilous, at the localities always at places with the highest or very high current velocities preferring stony bottom, passive filtrators, life cycle unknown. Generally known from the Oriental region (Indian subcontinent, South East Asia, Sunda Islands and Philippines).

***Sparsorythus bifurcatus* sp. n.**

(Figs. 1–6, 9–14, 35–40, 52, 67)

Tricorythus sp.1 (partim): Soldán, 1991: 8.

Tricorythus sp. 2 (partim): Soldán, 1991: 8.

Mature larva (in alcohol): General coloration of body pale yellowish with black markings on dorsal side. Uniformly pale yellowish without any markings on ventral side. Body length 4–5 mm. Cerci approximately 1.1 x longer than body, paracercus approximately 1.3 x longer than body. Head apparently wider than long (ratio length : width 1 : 1.4). Eyes black, ocelli grayish. Composed eyes of males considerably larger than those in females (Figs. 5, 6). Distance between composed eyes in males as long as or slightly larger than the eye width. The ratio of distance between composed eyes in females to the eye width 2.2: 1. Hypopharyngeal lingua approximately as wide as long, divided by a short rill in the middle (Fig. 13). Right prostheca (Fig. 14b) notched, triangular, with concave margins and several short pointed teeth, bearing several setae on the inner side. Length of right prostheca about by 1/3 shorter than that of the inner incisor. Left prostheca (Fig. 14a) rod-like, pointed at apex, as long as the inner incisor. Two stout long setae, subequal to prostheca, inserted on its base. Labial plate without a small nick at the middle of anterior margin. Posterior margin of mesonotum overlapping at most the first abdominal segment. Rudimental gill on abdominal segment VII bifurcated, Y-shaped (Fig. 9f). Legs (Fig. 10) relatively robust. Length ratio femur : tibia : tarsus - 1.9 : 2.2 : 1 (fore legs); 2 : 2 : 1 (middle legs); 2.4 : 2.5 : 1 (hind legs). Ratio of femur length : width 1.8 : 1 in all leg pairs. Posterior margin of the middle and hind femora convex with rounded or bluntly pointed setae, irregularly alternating with tiny hairs. Transversal row of setae on fore femora slightly S-shaped. Fore femoral setae rounded at apex and about 4–5 times longer than wide (Fig. 11a). Foretibiae with conspicuous inner submarginal oblique row of setae, narrower and longer than femoral ones (Fig. 11b). Surface of the middle and hind femora sparsely covered by very small spines. Caudal filaments (Fig. 12) with a circles of sparse and small setae on the rounded posterior margins of individual segments. Setae are smaller than one-tenth of the length of segments.

Imago male (in alcohol): Body length 3.5–5.5 mm. Cerci approximately 1.9 times longer than body, paracercus approximately 2.6 times longer than body. Head dark blackish-brown. Prothorax yellowish-brown with black markings. Mesothorax and metathorax brown. Abdomen pale, brownish, with pale black markings. Legs pale brown-yellowish. Cerci pale, yellowish, posterior margins of segments darker, grey. Compound eyes much larger than those in females (Fig. 35). Distance between compound eyes in males slightly shorter than the eye width. Pedicel longer than scape (ratio length of scape : length of pedicel is 1 : 1.8). Penis lobes apparently constricted subapically (Fig. 52). Penis extending the basal segment of forceps and reaching approximately the 1/4 of the second forceps segment. Penis with apparent medial nick indicating the original separation of mesomeres. Venation of the forewing (Fig. 39) relatively variable in number and pattern of cross veins. Forewing basal half dark coloured and distal half translucent. Femora narrower than those in females (Fig. 36). Length ratio femur : tibia : tarsus – 2.5 : 2.5 : 1 (fore legs); 2.9 : 3 : 1 (middle legs); 3.7 : 3.8 : 1 (hind legs).

Imago female (in alcohol): Body length 5–6 mm. Length of cerci approximately 0.92 x body length, length of paracercus approximately 0.96 x body length. Head dark blackish-grey. Prothorax brownish-grey. Mesothorax and metathorax brown. Abdomen and legs brownish-grey. Compound eyes much smaller than those in males (Fig. 35). The ratio of distance between compound eyes to the eye width 2.8 : 1. Scape very small (ratio length of scape : length of pedicel is 1 : 2.3). Venation of the forewing (Fig. 40) relatively variable, similar to male. Forewing dark coloured in their basal half, distal half of wing translucent. Femora wider than those in males (Fig. 36). Length ratio femur : tibia : tarsus - 3 : 3 : 1 (fore legs); 2.9 : 3.2 : 1 (middle legs); 3.5 : 3.4 : 1 (hind legs).

Subimago: Unknown.

Egg (Fig. 67): 175 μ m long, 74 μ m wide. Surface with apparent polygonal (mainly hexagonal) structures. Polar cap covers approximately 1/5 of the surface. Egg pole opposite to the polar cap rounded.

Material examined: Holotype: mature larva, Vietnam, Kinh-Dinh River, Nha-Ho, 16. IV. – 4. V. 1982, T. Soldán leg.; paratypes (parts on slides): 7 mature larvae, 12 immature larvae, 132 male imagines and 283 female imagines, same data as holotype, 1 mature larva, Vietnam, Tuan Hai prov., Kinh-Dinh R., Nha-Ho, 2. XI. 1984, T. Soldán leg, 4 mature larvae and 2 female imagines, Vietnam, Dong-Nai prov., Dong-Nai R., Nam Cat Tien res., 6. – 18. XI. 1989, T. Soldán leg.

Holotype and paratypes deposited in the Institute of Entomology, České Budějovice, Czech Republic.

Etymology: Species is named according to a characteristic bifurcation of the last tracheal gill in larvae.

Biology: The Kinh Dinh river at Nha-Ho, about 10 km W of Phan Rang is a large permanent lowland river (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 of about 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 50–70 years ago (Rejmánek, *pers. comm.*). Water is very turbid (transparency at most 15–20 cm), slightly alkaline (pH = 7.2–8.0) and relatively warm (maximal temperatures 24.6–29.8°C by night and day, respectively, in dry season).

Larvae of *S. bifurcatus* sp. n. were collected in various habitats by kicking technique, or occasionally by Surber sampler in April and May 1982 (dry season) and October–November 1984 (wet season).

They evidently prefer gravel bottom riffles or stones from small to medium size (up to 10–15, or 30–40 cm in diameter, respectively). They were never found on pure coarse sand bottom, at mixed sandy and clayey habitats and organic debris or in plat roots or submerged vegetation of *Elodea* sp. and *Polygonum tomentosum*. They were collected only at places with fast to very fast current velocities being never found at habitats with the current lower than 30–40 cm s⁻¹. Most larvae were collected at gravel bottom riffle with more than 60 cm s⁻¹, however some specimens occurred also at places with about 40–50 cm s⁻¹ current velocity. They can easily survive fluctuation of current velocity up to more than 100 cm s⁻¹ as well as fluctuation of water level (fluctuation observed by 1.5 m during dry season). On the other hand, their survival is apparently limited by gradual drying up of respective habitats. They were never found in temporary backwaters or pools isolated temporarily for more than one day. Larvae are always solitary to rare at habitats in question, their standing crop never reached more than about 5%, contrary to, e.g., *Rhoenanthus distafurcus* Bae et McCafferty, 1991 (up to 10%), *Potamanthus (Potamanthodes) formosus* Eaton, 1892 (up to 10%), Baetidae (mostly *Baetis* spp. and *Pseudocloeon*, up to 25%), Leptophlebiidae (mostly *Choroterpes [Euthraulius]* and *Choroterpides* sp., up to 15%), Heptageniidae (mostly *Cinignina* spp. up to 10%), and Ephemerellidae and Caenidae (mostly *Ephemerella*, *Torleya* and *Drunella*, and *Caenis* and *Clypeocaenis*, respectively, up to 20%). Life cycle is generally unknown. During dry season, first subimagines emerged about half an hour before sunset, submarine molting occurred shortly after the emergence. Mating flight followed immediately and was finished shortly after the sunset.

Differential diagnosis: Combination of larval characters distinguishing *S. bifurcatus* sp. n. from other species of *Sparsorythus* gen. n. is apparent from Table 1 in Appendix A. Unique characters no. 9, 11 (reach of mesonotum and shape of the last

tracheal gill) distinguish it from all other species of the genus. The species has united characters 10, 21, 22 (number of tracheal gills, shape of middle and hind femoral margins) with *S. jacobsoni* comb. n. and 7, 26 (shape of right prostheca, setation on caudal filaments) with *S. dongnai* sp. n. Adults can be compared only with *S. dongnai* sp. n., *S. jacobsoni* comb. n. and *S. multilabeculatus* sp. n. From these, males can be generally distinguished by wing coloration, penis shape and eye size.

Eggs can be distinguished by shape and arrangement of hexagonal structures and relative size of the polar cap.

***Sparsorythus jacobsoni* comb. n.**

Tricorythus jacobsoni Ulmer, 1913: 105, fig. 5, 6.

Tricorythus jacobsoni: Ulmer, 1924: 50, fig. 23, 24.

Tricorythus jacobsoni: Ulmer, 1939: 521, 638, figs. 336–344.

Mature larva (in alcohol): General coloration of body brownish-yellow. Body length 5–6 mm. Cerci approximately 1.5 x longer than body, paracercus approximately 1.6 x longer than body. Head apparently wider than long. Hypopharyngeal lingua approximately as wide as long, without a rill in the middle, with large U-shaped medial incurvation. Superlinguae pointed at apex. Right prostheca notched, with one long curved projection at distal part, bearing several setae on the inner side. Right prostheca about by 1/3 shorter than the inner incisor. Distal part of the left prostheca extended, with several short pointed teeth. Left prostheca about by 1/3 shorter than the inner incisor. Some stout long setae, subequal to prostheca, inserted on its base. Labial plate with a small nick at the middle of anterior margin. Rudimental gill on abdominal segment VII filamentous. Legs relatively robust. Length ratio femur : tibia : tarsus - 2 : 2.7 : 1 (fore legs); 2.6 : 2.8 : 1 (middle legs); 2.2 : 2.6 : 1. (hind legs). Ratio of femur length : width 2 : 1 in all leg pairs. Posterior margins of the middle and hind femora convex with rounded or bluntly pointed setae, irregularly alternating with tiny hairs. Arrangement of setae on the fore femoral dorsal surface irregular. Foretibiae with conspicuous inner submarginal row of setae (shape of this setation unknown). Surface of the middle and hind femora sparsely covered by very small spines. Caudal filaments with circles of sparse setae rounded the posterior margins of individual segments. Setae are smaller than 1/5 of the length of segments.

Imago male (in alcohol): Body length 5–5.5 mm. Cerci approximately 2.5 times longer than body, paracercus approximately 2.6 times longer than body. Head and prothorax dark blackish. Mesothorax yellowish-brown. Metathorax yellowish-brown. Abdomen pale, greyish. Legs pale greyish, femora darker. Cerci pale, greyish, with darker blackish stripes. Penis lobes apparently only slightly constricted

subapically. Penis extending the basal segment of forceps and reaching approximately the 1/4 of the second forceps segment. Penis without apparent medial nick indicating the original separation of mesomeres. Venation of the forewing relatively variable in cross veins number and pattern. Cross veins in costal field present, badly visible. Forewing dull, coloured dark grey, with blackish-grey veins.

Imago female (in alcohol): Body length 6 mm. Length of cerci is approximately 0.8 x body length, length of paracercus is approximately 0.9 x body length. General coloration of body dark greyish-yellow with black markings. Prothorax lighter. Ventral side of body greyish-yellow. Venation of the forewing is relatively variable, similar to male. Forewing dull, coloured dark grey, with blackish-grey veins.

Subimago female (in alcohol): Similar to imago, with darker wing coloration.

Egg: Unknown.

Type locality: Wonosobo, Java.

Distribution: Java, Sri Lanka, Sumatra, Philippines.

The more detailed description of this species in:

Ulmer G. (1913) Note V. Ephemeriden aus Java, gesammelt von Edw. Jacobson. Notes Leyden mus. 35:102–120. [male described, figured; type: male, Wonosobo, Java].

Ulmer, G. (1924) Ephemeropteren von den Sunda-Inseln und den Philippinen. Treubia 6:28–91. [male, female described, figured].

Ulmer G. (1939–1940) Eintagsfliegen (Ephemeroptera) von den Sunda Inseln. Arch. Hydrobiol., Suppl. 16:443–692. [larva described, figured].

Differential diagnosis: Combination of larval characters distinguishing *S. jacobsoni* comb. n. from other species of *Sparsorythus* gen. n. is apparent from Tab.1. Unique characters no. 8, 11, 19 (presence of nick on labium, shape of the last tracheal gill and irregular arrangement of fore femoral setae) distinguish it from all other species of the genus. The species has united characters mainly with *S. grandis* sp. n. (5, 6 – absence of rill on hypopharynx, shape of apex of the left protheca), and with *S. bifurcatus* sp. n. (10, 21, 22 – number of tracheal gills, shape of middle and hind femoral margins). Adults can be compared only with *S. bifurcatus* sp. n., *S. dongnai* sp. n. and *S. multilaberculatus* sp. n. From these, males can be distinguished by coloration of wings and penis shape.

Sparsorythus dongnai sp. n.

(Figs. 7, 8, 15–19, 41, 42, 51, 53–55, 68)

Mature larva (in alcohol): General coloration of body pale yellowish-brown with black markings on dorsal side similar to *S. bifurcatus* sp. n. Uniformly pale yellowish without any markings on ventral side. Body length 4–5 mm. Cerci are approximately 1.2 times longer than body, paracercus is approximately 1.3 times longer than body. Head apparently wider than long (ratio length : width is 1 : 1.6). Eyes black, ocelli greyish. Composed eyes of males considerably larger than those in females (Figs. 7, 8). Distance between composed eyes in males shorter than the eye width. The ratio of distance between composed eyes in females to the eye width 2.6 : 1. Hypopharyngeal lingua rounded, approximately as wide as long, divided by a short rill in the middle (Fig. 18). Right prosthema (Fig. 19b) notched, triangular, with several long pointed teeth, bearing several setae on the inner side. Length of right prosthema is about 2/3 of the length of inner incisor. Left prosthema (Fig. 19a) rod-like, pointed at apex, slightly shorter than the inner incisor. Several stout long setae, subequal to prosthema, inserted on its base. Labial plate without a small nick at the middle of anterior margin. Posterior margin of mesonotum overlapping at most the fourth abdominal segment in females and the fifth one in males. Rudimental gill on abdominal segment VII absent. Legs (Fig. 15) relatively robust. Length ratio femur : tibia : tarsus – 2.1 : 2.6 : 1 (fore legs); 2.2 : 2.2 : 1 (middle legs); 2.8 : 3 : 1 (hind legs). Ratio of femur length : width 1.9 : 1 (fore legs); 2.1 : 1 (middle and hind legs). Fore femoral setae about 2.5–4 times longer than wide, with blunt apex (Fig. 16a). Fore tibial setae narrower and longer (Fig. 16b). Dorsal surface of the middle and hind femora sparsely covered by very small spines. Middle femoral posterior margins slightly concave, hind femoral ones convex. Individual segments of caudal filaments sparsely rounded at its posterior margins with very small setae. Setae are always smaller than 1/10 of the length of segments (Fig. 17).

Imago male (in alcohol): Body length 5–5.5 mm. Length of cerci approximately 2 x body length, length of paracercus approximately 2.4 x body length. Head pale brown. Prothorax pale yellowish with dark brown markings. Meso- and metathorax pale brown. Abdomen, legs and cerci whitish. Composed eyes are much larger than those in females. Distance between composed eyes in males slightly shorter than the eye width. Pedicle longer than scape (ratio length of scape : length of pedicle is 1 : 2). Penis (Fig. 51) extending to the basal segment of forceps and extending to approximately 1/4 of the second forceps segment. Penis with apparent medial nick indicating the original separation of mesomeres. Wings (Fig. 41) translucent, very slightly coloured in proximal part. Venation of the forewing relatively variable in cross veins number and pattern. Legs see Fig. 53. Length ratio femur : tibia : tarsus – 2.7 : 3 : 1 (fore legs); 2.6 : 2.7 : 1 (middle legs); 3.4 : 3.4 : 1 (hind legs).

Imago female (in alcohol): Body length 5–6 mm. Head, prothorax, legs and abdomen brownish-yellow. Mesothorax and metathorax brown. Cerci whitish. Length of cerci is approximately 0.5 x body length, length of paracercus is approximately 0.6 x body length. Composed eyes much smaller than those in males. The ratio of distance between composed eyes to the eye width 2.7 : 1. Venation of the forewing (Fig. 42) relatively variable, similar to male. Forewings dark coloured in their basal half, distal half of wing translucent. Coloration of basal wing part is much darker than in males of this species. Legs see Fig. 54. Length ratio femur : tibia : tarsus – 2.6 : 3 : 1 (fore legs); 3 : 3 : 1 (middle legs); 3 : 2.8 : 1 (hind legs).

Egg (Fig.68): 175 µm long, 73 µm wide. Surface with exserted polygonal (mainly hexagonal) structures. Polar cap covers approximately 1/3 of the surface. Egg pole opposite to the polar cap rounded.

Subimago: Unknown.

Material examined: Holotype: mature larva, Vietnam, Dong-Nai R., Nam Cat Tien res., 6. – 18. xii. 1989, T. Soldán leg.; paratypes (parts on slides): 8 mature larvae, 5 immature larvae, 6 male imagines and 4 female imagines, same data as holotype.

Holotype and paratypes deposited in the Institute of Entomology, České Budějovice, Czech Republic.

Etymology: Species is named after its type locality – the Dong-Nai River.

Differential diagnosis: Combination of larval characters distinguishing *S. dongnai* sp. n. from other species of *Sparsorythus* gen. n. is apparent from Tab.1. Unique character no. 9 (reach of mesonotum) distinguish it from all species of the genus. The species has united characters 7, 26 (shape of right prostheca, setation on caudal filaments) with *S. bifurcatus* sp. n. Adults can be compared only with *S. bifurcatus* sp. n., *S. jacobsoni* comb. n. and *S. multilabeculatus* sp. n. From these, males can be generally distinguished by wing coloration, penis shape and eye size. Eggs can be distinguished by shape and arrangement of hexagonal structures and relative size of the polar cap.

***Sparsorythus gracilis* sp. n.**

(Figs. 20–24)

Mature female larva (in alcohol): Body length 4.9 mm. Length of cerci is approximately 0.8 x body length, length of paracercus is approximately 0.9 x body length. General coloration of body surface brownish-yellow. Gills very pale yellowish. Ventral side of body pale yellowish. Head apparently wider than long

(ratio length : width is 1 : 1.4). Eyes black, ocelli grayish. The ratio of distance between composed eyes to the eye width 2.6 : 1. Hypopharyngeal lingua approximately as wide as long, divided by a long rill in the middle. Small nick at the anterior margin of the lingua (Fig. 23). Right prostheca (Fig. 24b) notched, with several pointed teeth, bearing several setae on the inner side. Length of right prostheca is about 2/3 of the length of the inner incisor. Left prostheca (Fig. 24a) rod-like, bluntly pointed at apex, as long as the inner incisor. Two stout long setae, subequal to prostheca, inserted on its base. Labial plate without a small nick at the middle of anterior margin. Posterior margin of mesonotum overlapping at most the third abdominal segment. Rudimental gill on abdominal segment VII absent. Legs (Fig. 20) with regard to other species of this genus very slim. Length ratio femur : tibia : tarsus – 1.9 : 2.3 : 1 (fore legs); 2 : 2.3 : 1 (middle legs); 2.5 : 2.9 : 1 (hind legs). Ratio of femur length : width 2.5 : 1 (fore legs); 2.6 : 1 (middle legs), 2.9 : 1 (hind legs). Posterior margin of the middle and hind femora slightly concave at its basal half, with rounded or bluntly pointed setae, irregularly alternating with tiny hairs. Transversal row of setae on the fore femora bow-shaped, with a group of chaotically inserted setae near fore femoral posterior margin. Fore femoral setae about 5–6 times longer than wide, rounded apically (Fig. 21a). Setae on the fore tibiae very thin, spiky (Fig. 21b). Dorsal surface of the middle and hind femora sparsely covered by spines of the small and medium size. Individual segments of caudal filaments rounded at its posterior margin with setae approximately as long as 1/3 of the length of segments. Lateral margins with spiky setae as long as 2/3 of the length of segments. These long spiky setae on both sides of paracercus and only on the inner sides of cerci (Fig. 22).

Male larvae, imagines and subimagines unknown.

Material examined: Holotype: 1 mature larva, India, Madras state, Poona R., Poona, ix. 1962, V. Landa leg.; paratypes (parts on slides): 2 mature larvae, same data as holotype.

Holotype and paratypes deposited in the Institute of Entomology, České Budějovice, Czech Republic.

Etymology: From Latin *gracilis* meaning slim, the species is named after tenuous body structures (legs, fore tibial setae).

Differential diagnosis: Combination of larval characters distinguishing *S. gracilis* sp. n. from other species of *Sparsorythus* gen. n. is apparent from Tab.1. Unique characters no. 7 (shape of right prostheca), 15, 16, 17 (shape of legs), 20 (bristle like setae on fore tibiae), and 24, 25, 26 (specific setation on caudal filaments) distinguish it from all species of the genus. The species seems to be well separated from all other species of *Sparsorythus* gen. n. Most united characters to *S. gracilis* sp. n. can be found in *S. ceylonicus* sp. n. (4, 19, 23 – presence of nick on hypopharynx,

arrangement of fore femoral setae, shape of setae on middle and hind femoral surface).

***Sparsorythus grandis* sp. n.**

(Figs. 25–29)

Mature female larva (in alcohol): Body length 8 mm. Length of cerci is approximately 0.9 x body length, length of paracercus is approximately 1.1 x body length. Body coloration dark, brownish-black. Gills blackish with lighter margins. Ventral surface brownish. Head apparently wider than long (ratio length : width is 1 : 1.5). Eyes black, ocelli grayish. The ratio of distance between composed eyes in females to the eye width 3 : 1. Hypopharyngeal lingua apparently wider than long, without a rill in the middle (Fig. 28). Right prosthema (Fig. 29b) notched, triangular, with concave margins and many pointed teeth and extremities, bearing several setae on the inner side. Length of right prosthema is about 2/3 of the length of the inner incisor. Distal part of left prosthema (Fig. 29a) extended, with several pointed teeth. Left prosthema approximately as long as the inner incisor. Some stout long setae, subequal to prosthema, inserted on its base. Labial plate without a small nick at the middle of anterior margin. Posterior margin of mesonotum overlapping at most the third abdominal segment. Rudimental gill on abdominal segment VII absent. Legs (Fig. 25) relatively robust. Length ratio femur : tibia : tarsus – 2.4 : 3 : 1 (fore legs); 2.8 : 2.9 : 1 (middle legs); 3.2 : 3.7 : 1 (hind legs). Ratio of femur length : width 2 : 1 (all leg pairs). Medium femora slightly concave at its basal half, hind femora at basal half approximately straight. Middle and hind femoral margins with rounded or bluntly pointed setae, irregularly alternating with tiny hairs. Transversal row of setae on the fore femoral dorsal surface S-shaped. Fore femoral setae about 4 to 5.5 times longer than wide, rounded apically, with apical part extended (Fig. 26a). Setae on the fore tibiae narrower, long, not extended at its apical part (Fig. 26b). Surface of the middle and hind femora sparsely covered by small setae. Individual segments of caudal filaments thickly rounded at its posterior margins by setae. Setae approximately as long as 1/5 of the length of segments (Fig. 27).

Male larvae, imagines and subimagines unknown.

Material examined: Holotype (parts on slides): mature larva, Indonesia, West Java, Ciwalen riv., NR Puncak (Gudung Gede), ca 1360 m a. s. l., 8. iv. – 3. ix. 1983, P. Sporrer leg.; paratype: 1 mature larva, same data as holotype.

Holotype deposited in the collection of Agriculture and Mechanical University, Tallahassee, Florida, paratype in the Institute of Entomology, České Budějovice, Czech Republic.

Etymology: From Latin *grandis* meaning large, the species is named after its relatively robust body.

Differential diagnosis: Combination of larval characters distinguishing *S. grandis* sp. n. from other species of *Sparsorythus* gen. n. is apparent from Tab.1. Unique characters no. 3, 7 (shape of hypopharyngeal lingua, shape of right prostheca) distinguish it from all species of the genus. Most united characters to *S. grandis* sp. n. can be found in *S. jacobsoni* comb. n.(5, 6 – absence of hypopharyngeal rill, shape of apex of the right prostheca).

***Sparsorythus ceylonicus* sp. n.**

(Figs. 30–34)

Mature male larva (in alcohol): Body length 4–5 mm. Length of cerci is approximately 0.9 x body length, length of paracercus is approximately 1.1 x body length. General coloration of body yellowish-brown. Uniformly pale yellowish on ventral side. Head apparently wider than long (ratio length : width is 1 : 1.4). Eyes black, ocelli grayish. The ratio of distance between composed eyes to the eye width 2.8 : 1. Size of composed eyes comparable with female larvae of other species of the genus. Hypopharyngeal lingua rounded, approximately as long as wide, divided by a short rill in the middle (Fig. 33). Right prostheca (Fig. 34b) bifurcated, with a small number of projections, bearing several setae on the inner side. Length of right prostheca is about 2/3 of the length of the inner incisor. Left prostheca (Fig. 34a) rod-like, pointed apically, subequal to the inner incisor. Some stout long setae, as long as prostheca, inserted on its base. Labial plate without a small nick at the middle of anterior margin. Posterior margin of mesonotum overlapping at most the second abdominal segment. Rudimental gill on abdominal segment VII absent. Legs (Fig. 30) relatively robust. Length ratio femur : tibia : tarsus – 1.7 : 2.2 : 1 (fore legs); 2 : 2 : 1 (middle legs); 2.6 : 1.9 : 1 (hind legs). Ratio of femur length : width 1.6 : 1 (fore legs); 2 : 1 (middle and hind legs). Posterior margins of the middle and hind femora slightly concave at its basal half, with sparse rounded or bluntly pointed setae, irregularly alternating with tiny hairs. Transversal row of setae on the fore femoral dorsal surface bow-shaped. Setae on the fore femora (Fig. 31a) relatively wide near its base, narrowing apically. Apex blunt. Fore femoral setae about 3 to 4.5 times longer than wide. Fore tibial setae (Fig. 31b) narrower and longer. Dorsal surface of the middle and hind femora very sparsely covered by some setae of various sizes, including relatively big ones. Individual segments of caudal filaments sparsely rounded at its posterior margins by small setae. Setae are smaller than 1/3 of the length of segments (Fig. 32).

Female larvae, imagines and subimagines unknown.

Material examined: Holotype (parts on slides): mature larva, Sri Lanka, Ratnapura dist., Kukula Ganga, Waddagala, 17. iv. 1973, Dawis and Rowe leg.

Holotype deposited in the collection of Agriculture and Mechanical University, Tallahassee, Florida.

Etymology: The species is named after the type locality (Sri Lanka, formerly Ceylon).

Differential diagnosis: Combination of larval characters distinguishing *S. ceylonicus* sp. n. from other species of *Sparsorythus* gen. n. is apparent from Tab. 1. United characters to *S. ceylonicus* sp. n. can be found mainly in *S. gracilis* sp. n. (4, 19, 21, 22, 23 – presence of nick on hypopharynx, arrangement of fore femoral setae, shape of middle and hind femoral posterior margins, shape of setation on the middle and hind femoral dorsal surface).

***Sparsorythus multilaberculatus* sp. n.**

(Figs. 43, 49, 50, 56)

Imago male (in alcohol): Body length 3 mm. Cerci approximately 3.3 x longer than body, paracercus approximately 5 x longer than body. Head, prothorax, abdomen, legs and cerci pale greyish-brown. Meso and metathorax brown. Composed eyes (Fig. 49) moderately enlarged (the ratio of distance between composed eyes to the eye width 2.4 : 1.). Pedicle much longer than scape (ratio length of scape : length of pedicle is 1 : 2.6) Penis extending the basal segment of forceps and reach to approximately 1/3 of the second forceps segment. Some small thorn-like structures on the subgenital plate near penis base. Penis (Fig. 50) with apparent medial nick indicating the original separation of mesomeres. Wing (Fig. 43) with typically organised smudges of various intensity. Most dark smudges in fields C, Sc, A, and near MA1 – MA2 fork. Lighter blotches in fields R1 and MP1. Legs see Fig. 56. Length ratio femur : tibia : tarsus – 2.5 : 2.6 : 1 (fore legs); 2.9 : 2.7 : 1 (middle legs); 3.5 : 3.3 : 1 (hind legs).

Larvae, female imagines and subimagines unknown.

Material examined: Holotype: imago male, Vietnam, Dong-Nai Prov., Dong-Nai R., Nam Cat Tien res., 6. – 18. xi. 1989, T. Soldán lgt.; paratypes (parts on slides): 27 male imagines, same data as holotype.

Holotype and paratypes deposited in the Institute of Entomology, České Budějovice, Czech Republic.

Etymology: The species is named after the presence of more dark spots on its wings.

Differential diagnosis: Adults of this species can be compared only with *S. bifurcatus* sp. n., *S. dongnai* sp. n. and *S. jacobsoni* comb. n. From these, males can be distinguished by coloration of wings, penis shape and eye size.

***Sparsorythus* sp. 1**

(Figs. 44, 57, 58, 69)

Imago female (in alcohol): Body length 3.5–4 mm. Head, prothorax and abdomen greyish-brown. Mesothorax, metathorax and legs brownish-yellow. Dorsal side of body and cerci whitish. Forewing (Fig. 44) dark coloured in their basal half, distal half of wing translucent. Legs see Fig. 57. Length ratio femur : tibia : tarsus – 2.8 : 3.1 : 1 (fore legs); 2.5 : 2.6 : 1 (middle legs); 3.3 : 3.7 : 1 (hind legs).

Egg (Fig. 69): 160 μ m long, 100 μ m wide. Surface with exserted polygonal (mainly hexagonal) structures. Polar cap covers approximately 1/4 of the surface. Egg pole opposite to the polar cap bluntly pointed like.

Larvae, male imagines and subimagines unknown.

Material examined: Female imagines (parts on slides), Vietnam, Dong-Nai prov., Dong-Nai riv., Nam Cat Tien res., 6. – 18. xii. 1989, T. Soldán leg.

Ca 100 ex. deposited in the Institute of Entomology, České Budějovice, Czech Republic.

***Sparsorythus* sp. 2**

(Figs. 45, 59, 60, 70)

Imago female (in alcohol): Body length 4 mm. General coloration of body brownish-black. The ratio of distance between composed eyes to the eye width 1 : 2.5. Cerci pale yellowish with darker grey stripes. Wings (Fig. 45) very lightly brownish, mainly in fields C, Sc. Legs see Fig. 59. Length ratio femur : tibia : tarsus – 2.3 : 2.7 : 1 (fore legs); 2.4 : 2.4 : 1 (middle legs); 2.8 : 2.9 : 1 (hind legs).

Egg (Fig. 70): 190 μ m long, 115 μ m wide. Surface with slightly exserted polygonal (mainly hexagonal) structures. Polar cap covers approximately 1/2 of the surface. Egg pole opposite to the polar cap bluntly pointed like.

Larvae, male imagines and subimagines unknown.

Material examined: Female imagines (parts on slides), Thailand, Chiangmai prov., Chiangmai, Mae Ping, 9. iv. 1964, W.L. & J.G. Peters leg.

Two ex. deposited in the Institute of Entomology, České Budějovice, Czech Republic.

***Sparsorythus* sp. 3**

(Figs. 46, 61, 62, 71)

Imago female (in alcohol): Body length 5–6 mm. Length of cerci is approximately 0.9 x body length, length of paracercus is approximately 1.1 x body length. Head, prothorax and legs yellowish-grey. Meso and metathorax brownish, abdomen yellowish-brown. Dorsal side of body very pale yellowish. Cerci whitish. Wings (Fig. 46) translucent, whitish. The ratio of distance between composed eyes to the eye width 2.8 : 1. Legs see Fig. 61. Length ratio femur : tibia : tarsus – 2.5 : 2.9 : 1 (fore legs); 2.7 : 2.9 : 1 (middle legs); 3.3 : 3.3 : 1 (hind legs).

Egg (Fig. 71): 190 μ m long, 125 μ m wide. Surface with slightly exerted polygonal (mainly hexagonal) structures. Polar cap covers approximately 1/3 of the surface. Egg pole opposite to the polar cap bluntly pointed like.

Larvae, male imagines and subimagines unknown.

Material examined: Female imagines (parts on slides), Sri Lanka, Kandy dist., Kandy peak, Vievo motel, 17. iv. 1973, Dawis & Rowe leg.

8 ex. deposited in the Institute of Entomology, České Budějovice, Czech Republic.

***Sparsorythus* sp. 4**

(Figs. 47, 63, 64, 72)

Imago female (in alcohol): Body length 4–4.6 mm. Length of cerci is approximately 0.8 x body length, length of paracercus is approximately 0.9 x body length. General coloration of body brownish-yellow. Cerci whitish. Wings (Fig. 47) translucent, with very pale brown smudges in proximal part. The ratio of distance between composed eyes to the eye width 3.2 : 1. Legs see Fig. 63. Length ratio femur : tibia : tarsus – 3 : 3.2 : 1 (fore legs); 3.2 : 3 : 1 (middle legs); 4.8 : 4.2 : 1 (hind legs).

Egg (Fig. 72): 185 μ m long, 115 μ m wide. Surface almost smooth, with polygonal (mainly hexagonal) structures only very slightly exerted. Polar cap covers approximately 1/4 of the surface. Egg pole opposite to the polar cap rounded.

Larvae, male imagines and subimagines unknown.

Material examined: Female imagines (parts on slides), Philippines, Mindanao, Mt. Apo School, 15 km SW Davao, ca 500 m a. s. l., 22. – 31. x. 1965, D. Davis leg.

Fifteen ex. deposited in the Institute of Entomology, České Budějovice, Czech Republic.

***Sparsorythus* sp. 5**

(Figs. 48, 65, 66, 73)

Imago female (in alcohol): Body length 4–4.5 mm. Length of cerci approximately 0.5 x body length, length of paracercus approximately 0.6 x body length. General coloration of body black. Cerci greyish with darker grey stripes. Wings (Fig. 48) black. The ratio of distance between composed eyes to the eye width 3.3 : 1. Legs see Fig. 65. Length ratio femur : tibia : tarsus – 3.2 : 4 : 1 (fore legs); 3.9 : 4 : 1 (middle legs); 4.5 : 5 : 1 (hind legs).

Egg (Fig. 73): 190 μ m long, 120 μ m wide. Surface with only slightly exerted areas between polygonal structures. Polar cap covers approximately 1/4 of the surface. Egg pole opposite to the polar cap rounded.

Larvae, male imagines and subimagines unknown.

Material examined: Female imagines (parts on slides), Indonesia, Sulawesi – Utara, Dumoga-Bone, NP Sungai Tupah, 5. viii. 1985, D. Dudgeon leg.

26 ex. deposited in the Institute of Entomology, České Budějovice, Czech Republic.

Discussion

Systematics. Altogether, six genera of the family Tricorythidae have been described from the Afrotropic (Ethiopian) Region (including Madagascar) so far.

The genus *Dicercomyzon* Demoulin, 1954 (separate subfamily Dicercomyzinae) is undoubtedly well characterized by its prominent apomorphies mainly in the larval stage: highly expanded femora, dorsoventrally flattened body, pro- and mesosternum with a disc of friction hairs, superlinguae of hypopharynx highly developed laterally (Demoulin 1954, 1970, Kimmins 1957, Edmunds and Traver 1954, Edmunds et al. 1963, Landa and Soldán 1985, McCafferty and Wang 2000). In adults, penes are slightly to deeply divided, associated with auxilliary processes (McCafferty and Wang 2000).

Genera *Madecassorythus*, *Spinirythus* and *Ranorythus* represent either the most plesiomorphic lineage within the Tricorythidae (*Madecassorythus* and *Spinirythus*), or intermediary lineage to that represented by afrotropical tricorythids (*Ranorythus*). Genera *Madecassorythus* and *Spinirythus* were separated into the subfamily Madecassorythinae by Oliarinomy and Elouard (1997). The same authors placed genus *Ranorythus* into the separate subfamily Ranorythinae (Oliarinomy and Elouard 1998). This subfamilial classification was discussed by McCafferty and Wang (2000) who point out, e.g., lack of some synapomorphies in *Tricorythus* and *Ranorythus*, even suggesting by default that *Ranorythus* even belongs to the Tricorythinae lineage.

The genus *Spinirythus* differs from *Sparsorythus* gen. n. in imaginal stage (larvae of *Spinirythus* remain unknown) by penis shape and degree of paracercus reduction. *Spinirythus* has entirely separated penial lobes associated with lamellar auxilliary processes. Penis and auxilliary processes are approximately of the same size and shape, paracercus reduced.

Second genus of the subfamily Madecassorythinae, *Madecassorythus*, is characterized also by separated penial lobes with auxilliary processes (penis and auxilliary processes differently formed, penis lobes much longer than gonostyles), paracercus well developed. Both genera of the subfamily Madecassorythinae have big sexual dimorphism in eye size (composed eyes in males much larger than in females).

On the other hand, *Sparsorythus* gen. n. has completely fused penial lobes without auxilliary processes, paracercus well developed. Sexual dimorphism in eye size often pronounced but probably do not represent a truly consistent character (see below). Larvae of *Madecassorythus* have following characters, which separate them from the *Sparsorythus* gen. n.: presence of maxillar palp, absence of regular row of setae on the fore tibiae. In *Madecassorythus* larvae, tracheal gill on the abdominal segment VII always missing. (But in some *Sparsorythus* gen. n. species also present only five pairs of tracheal gills like in *Madecassorythus*).

The genus *Ranorythus* is characterized in imaginal stage (larvae remain unknown) by partly (in proximal part) fused penial lobes, distally separated. Auxilliary processes are absent. Sexual dimorphism in eye size well apparent. Paracercus reduced in males only, in females paracercus normally developed.

Difference between *Sparsorythus* gen. n. and *Tricorythus* is mainly completely reduced maxillar palp in the larval stage of *Sparsorythus* gen. n. Other characters are not consistent throughout all species of this genus. Sexual dimorphism in eye size in *Tricorythus* always absent, in *Sparsorythus* gen. n. present, but probably in a variable degree. In some species, difference in eye size between sexes is really big (*S. bifurcatus* sp. n., *S. dongnai* sp. n.). On the other hand, some species have relatively small eyes of males (*S. ceylonicus* sp. n., *S. multilabeculatus* sp. n.). Unfortunately, there we have not any comparison with females of these species. Tracheal gill on

abdominal segment VII in *Tricorythus* absent, in *Sparsorythus* gen. n. sometimes present, but not in all species.

As noted above, *Sparsorythus jacobsoni* comb. n. was originally described by Ulmer (1913) after male adult stages as *Tricorythus jacobsoni*. Later, the more detailed description of male adults was given by the same author (Ulmer, 1925). In this study, female adults from the same type locality as males were also described. Fifteen years later, Ulmer described a larva, which in his opinion belongs to *T. jacobsoni*. Larvae were collected in a different localities than imagines and there is not any evidence, which associates larvae described by Ulmer in 1940 with imagines described by him before. It is a question if this larva really belongs to *S. jacobsoni* comb. n. The nymph figured by Edmunds et al. (1963), collected in the Philippines, and called “*Neurocaenis jacobsoni* Ulmer ?“ is evidently a different species than Ulmer’s larva, described in 1940 and declared to be a larva of *T. jacobsoni*. In larva, figured by Edmunds et al. (1963), the tracheal gill on abdominal segment VII is absent and also the shape of its legs is different from Ulmer’s larva, similar to *S. gracilis* sp. n.

Establishing *Sparsorythus bifurcatus* sp. n. as a type species of *Sparsorythus* gen. n. (instead of *S. jacobsoni* comb. n.) rests upon our better knowledge of *S. bifurcatus* sp. n. In this species, that the described larva really belongs to imago (the same type locality of these with the only tricorythid species founded) is a greater probability. Another occasion is nonavailability of any comparative material of *S. jacobsoni* comb. n.

However, within the “true” African *Tricorythus* are still open questions. Quite recently, Barber-Jones (2004) indicates there are only two species, namely *T. reticulatus* Barnard, 1932 and *T. discolor* (Burmeister, 1938) among the representatives of the genus *Tricorythus* in South Africa, which really can be classified within this genus. The others might represent an undescribed genus, possibly related to the genus *Ranorythus*.

Oriental Tricorythidae significantly differ from African ones. The most explicit difference is completely reduced maxillar palp in all oriental species. All African Tricorythidae have big, well-developed maxillar palp. Total reducing of maxillar palp is a big morphological change and it was very probably unique event, which happened to one collective ancestor of all present oriental Tricorythidae. Within the genus *Sparsorythus* gen. n. can be found a big variability (in some species present six pairs of tracheal gills, in some only five; in some species is difference in eye size between sexes big and in some species is small). But absence of maxillar palp shows their collective origin.

Genus *Sparsorythus* gen. n. is an advanced group from the Tricorythidae family with many apomorphies (reduced hind wings, completely fused penial lobes without auxilliary processes, missing maxillar palp, reduced or missing gill on abdominal segment VII, big sexual dimorphism in eye size in some species). Diversity of the family Tricorythidae in Asia is very probably much bigger than species described in

this study. Establishing of the genus *Sparsorythus* gen. n. like a taxon involving all Asian Tricorythidae is not certainly the final status.

Distribution and Biogeography

The family Tricorythidae appear to have evolved primarily in Gondwanaland. All the subfamilies occur in Africa or Madagascar. Only the genus *Sparsorythus* is found in Sri Lanka and Southeast Asia. These oriental Tricorythidae are geographically isolated from African species for more than 100 mil. years. After seceding of Indian subcontinent and Africa, Indian species developed separately. After connecting of Indian subcontinent and Asia (about 45 mil. years ago), mayflies from India expanded into the rest of the South-east Asia (Edmunds 1979), Jacob (2003).

The genus *Sparsorythus* was found in almost all regions of the South-East Asia (Sri Lanka, India, Thailand, Vietnam, Indonesia and Philippines).

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Appendix A

Table 1. Critical characters distinguishing larvae of the genus *Sparsorythus* gen. n.

Character/Species	<i>S. bifurcatus</i> sp. n.	<i>S. jacobsoni</i> (Ulmer, 1913)	<i>S. dongnai</i> sp. n.	<i>S. gracilis</i> sp. n.	<i>S. grandis</i> sp. n.	<i>S. ceylonicus</i> sp. n.
1. Distance between composed eyes in males	as long as or slightly larger than the eye width	unknown	shorter than the eye width	unknown	unknown	much larger than the eye width
2. Ratio of distance between composed eyes in females to eye width	2.2 : 1	unknown	2.6 : 1	2.6 : 1	3 : 1	unknown
3. Shape of hypopharyngeal lingua	as wide as long	as wide as long	as wide as long	as wide as long	wider than long	as wide as long
4. Presence of medial nick on hypopharynx	absent	absent	absent	present	absent	present
5. Presence of medial rill on hypopharynx	present	absent	present	present	absent	present
6. Apex of the left prostheda	pointed	extended, with several teeth	pointed	bluntly pointed	extended, with several teeth	bluntly pointed
7. Ratio right prostheda length : width	2 : 1	2.4 : 1	2 : 1	3.3 : 1	1.8 : 1	2.4 : 1
8. Medial nick on labium	absent	present	absent	absent	absent	absent

Table 1. (continued)

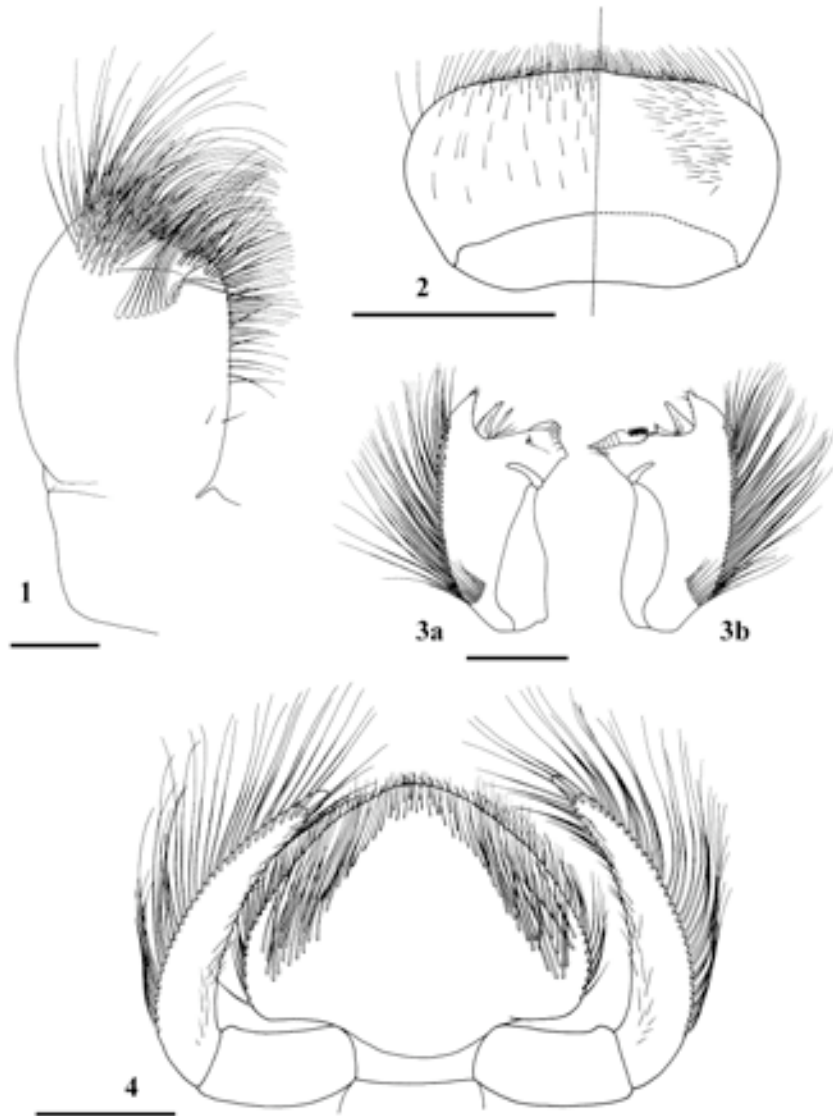
Character/Species	<i>S. bifurcatus</i> sp. n.	<i>S. jacobsoni</i> (Ulmer, 1913)	<i>S. dongnai</i> sp. n.	<i>S. gracilis</i> sp. n.	<i>S. grandis</i> sp. n.	<i>S. ceylonicus</i> sp. n.
9. Wing pads reaching to the abdominal segment	I	unknown	IV (females); V (males)	III	III	II
10. Rudimental gill on abdominal segment VII	present	present	absent	absent	absent	absent
11. Shape of rudimental gill on abdominal segment VII	bifurcated	filamentous	-	-	-	-
12. Ratio femur : tibia : tarsus (fore leg)	1.9 : 2.2 : 1	2 : 2.7 : 1	2.1 : 2.6 : 1	1.9 : 2.3 : 1	2.4 : 3 : 1	1.7 : 2.2 : 1
13. Ratio femur : tibia : tarsus (middle leg)	2 : 2 : 1	2.6 : 2.8 : 1	2.2 : 2.2 : 1	2 : 2.3 : 1	2.8 : 2.9 : 1	2 : 2 : 1
14. Ratio femur : tibia : tarsus (hind leg)	2.4 : 2.5 : 1	2.2 : 2.6 : 1	2.8 : 3 : 1	2.5 : 2.9 : 1	3.2 : 3.7 : 1	2.6 : 1.9 : 1
15. Ratio fore femur length : width	1.8 : 1	2 : 1	1.9 : 1	2.5 : 1	2 : 1	1.6 : 1
16. Ratio middle femur length : width	1.8 : 1	2 : 1	2.1 : 1	2.6 : 1	2 : 1	2 : 1
17. Ratio hind femur length : width	1.8 : 1	2 : 1	2.1 : 1	2.9 : 1	2 : 1	2 : 1

Continued on next page

Table 1. (continued)

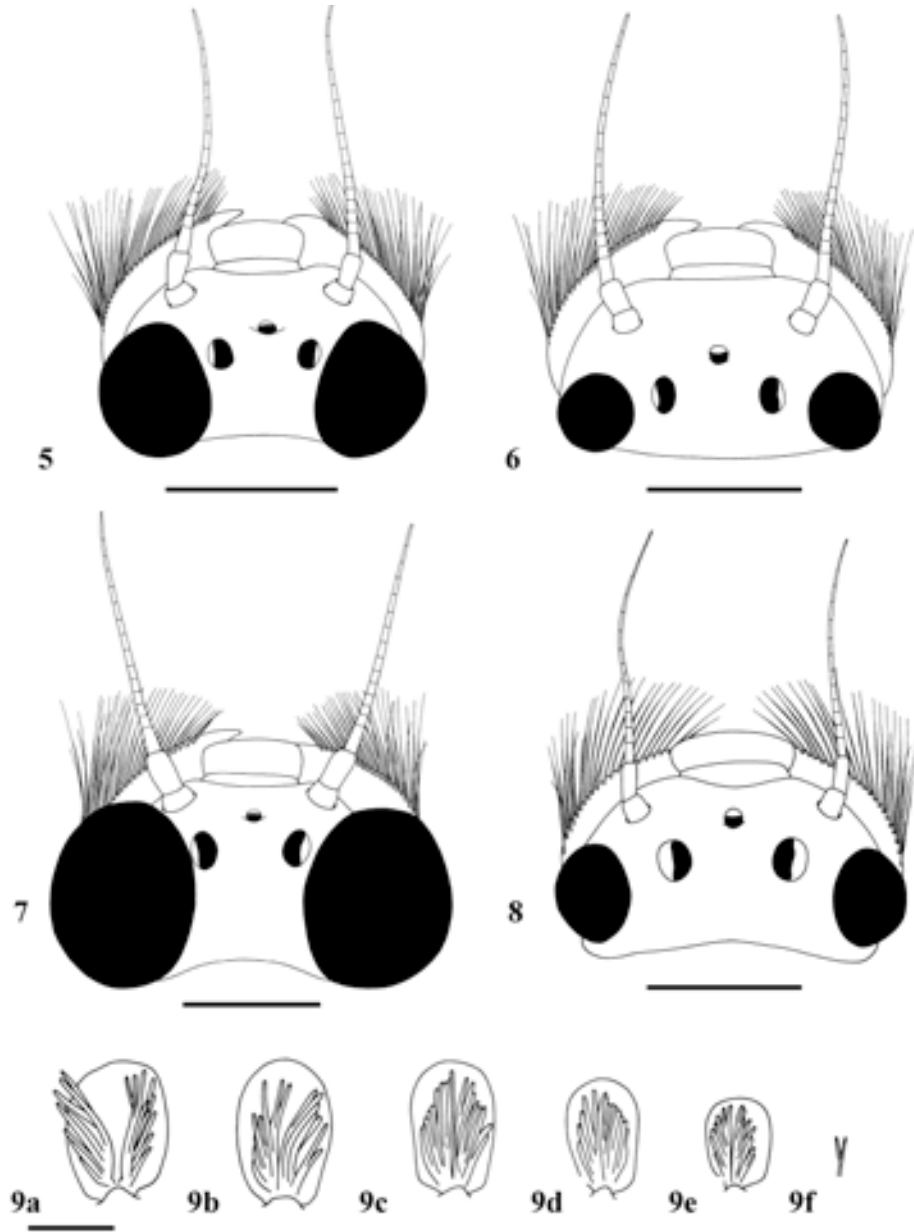
Character/Species	<i>S. bifurcatus</i> sp. n.	<i>S. jacobsoni</i> (Ulmer, 1913)	<i>S. dongnai</i> sp. n.	<i>S. gracilis</i> sp. n.	<i>S. grandis</i> sp. n.	<i>S. ceylonicus</i> sp. n.
18. Ratio fore femoral setae length : width	4 - 5 : 1	unknown	2.5 - 4 : 1	4 - 5.5 : 1	3 - 4.5 : 1	5 - 6 : 1
19. Transversal row of setae on the fore femora	S - shaped	irregular	S - shaped	bow-shaped	S - shaped	bow-shaped
20. Shape of fore tibial setae	spatulated	unknown	spatulated	bristle like	spatulated	spatulated
21. Posterior margin of hind femora (basal half)	convex	convex	convex	concave	straight	concave
22. Posterior margin of middle femora (basal half)	convex	convex	concave	concave	concave	concave
23. Length of setae on surface of middle and hind femora	same	same	same	different	same	different
24. Arrangement of cerci and paracercus setae	same	same	same	different	same	same
25. Length of cerci and paracercus setae	same	same	same	different	same	same
26. Maximal length of setae on caudal filaments	1/10 of the segment length	1/5 of the segment length	1/10 of the segment length	2/3 of the segment length	1/5 of the segment length	1/3 of the segment length

Figures

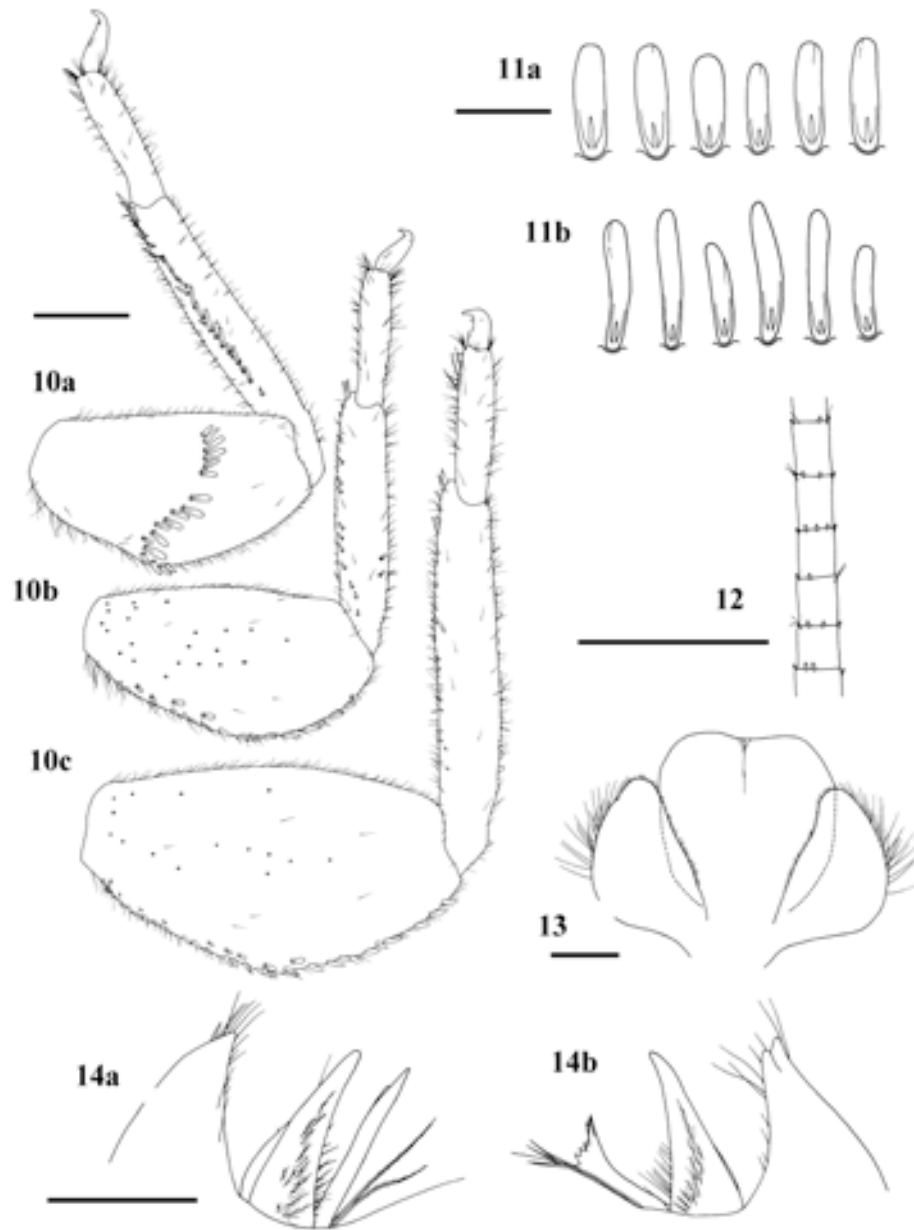


Figures 1–4. *Sparsorythus bifurcatus* sp. n. 1: maxilla (ventral view); 2: labrum (left part dorsal view, right part ventral view); 3a: left mandible (dorsal view); 3b: right mandible (dorsal view); 4: labium (ventral view).

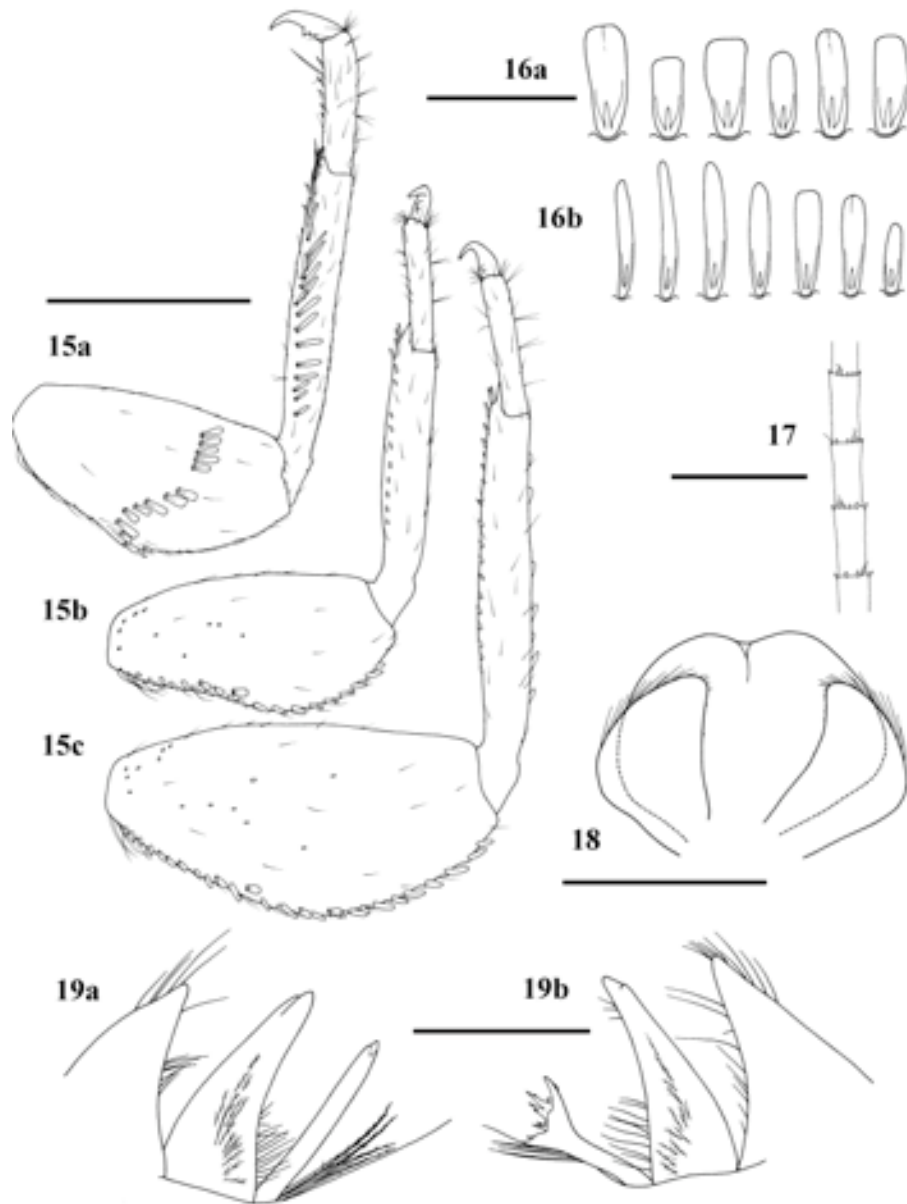
Scale Fig. 1 = 0.1 mm; scale Fig. 2 (= scale Fig. 3–4) = 0.25 mm.



Figures 5–9. *Sparsorythus* spp. 5, 6, 9: *S. bifurcatus* sp. n.; 7, 8: *S. dongnai* sp. n.; 5: head of male larva; 6: head of female larva; 7: head of male larva; 8: head of female larva; 9a–9f: gills on abdominal segments II–VII. Scale Figs. 5–8 = 0.5 mm; scale Fig. 9 = 0.25 mm.

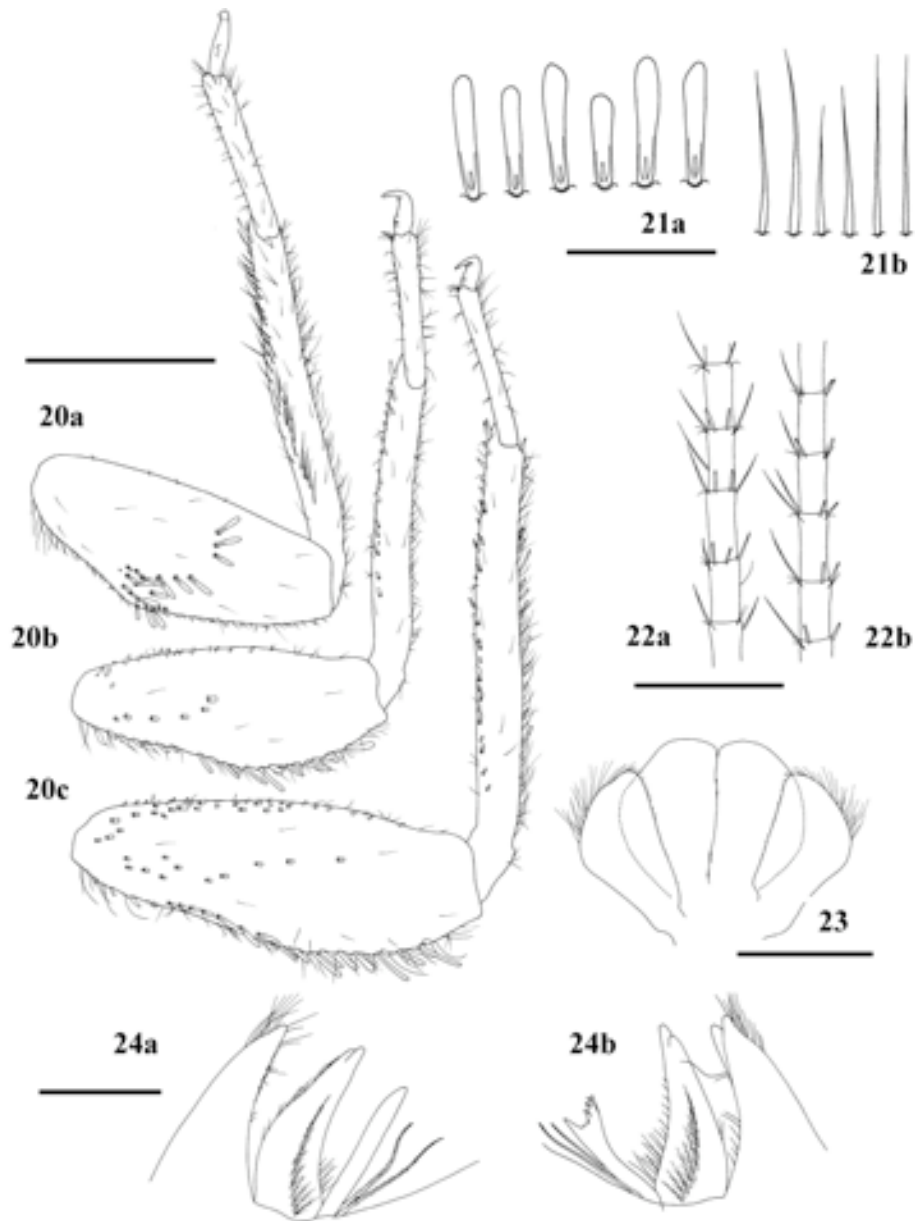


Figures 10–14. *Sparsorythus bifurcatus* sp. n. 10a: fore leg; 10b: middle leg; 10c: hind leg; 11a: fore femoral setae; 11b: fore tibial setae; 12: caudal filament; 13: hypopharynx; 14a: left prosthema; 14b: right prosthema.
Scale Fig. 10 (= scale Fig. 12) = 0.25 mm; scale Fig. 11 (= scale Fig. 13–14) = 0.1 mm.

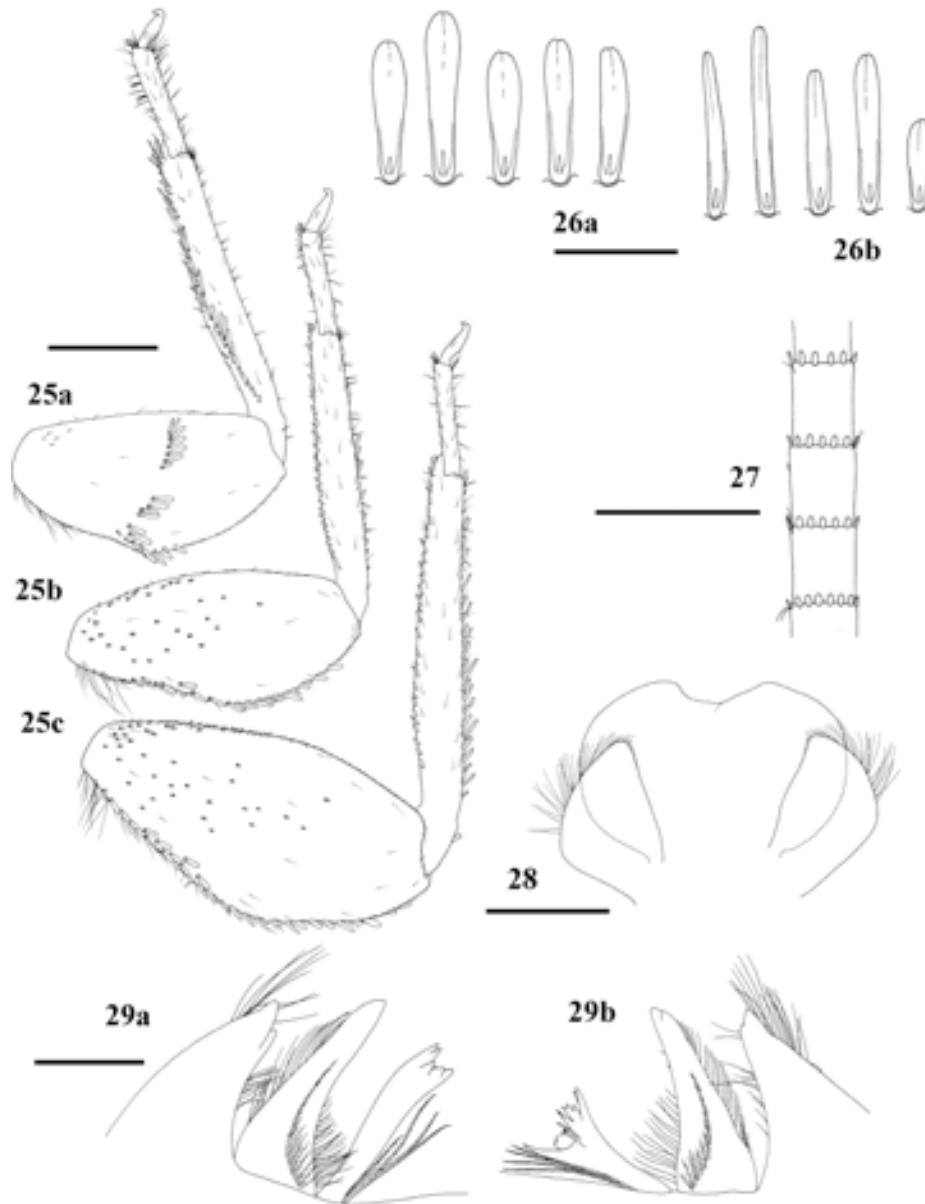


Figures 15–19. *Sparsorythus dongnai* sp. n. 15a: fore leg; 15b: middle leg; 15c: hind leg; 16a: fore femoral setae; 16b: fore tibial setae; 17: caudal filament; 18: hypopharynx; 19a: left prostheca; 19b: right prostheca.

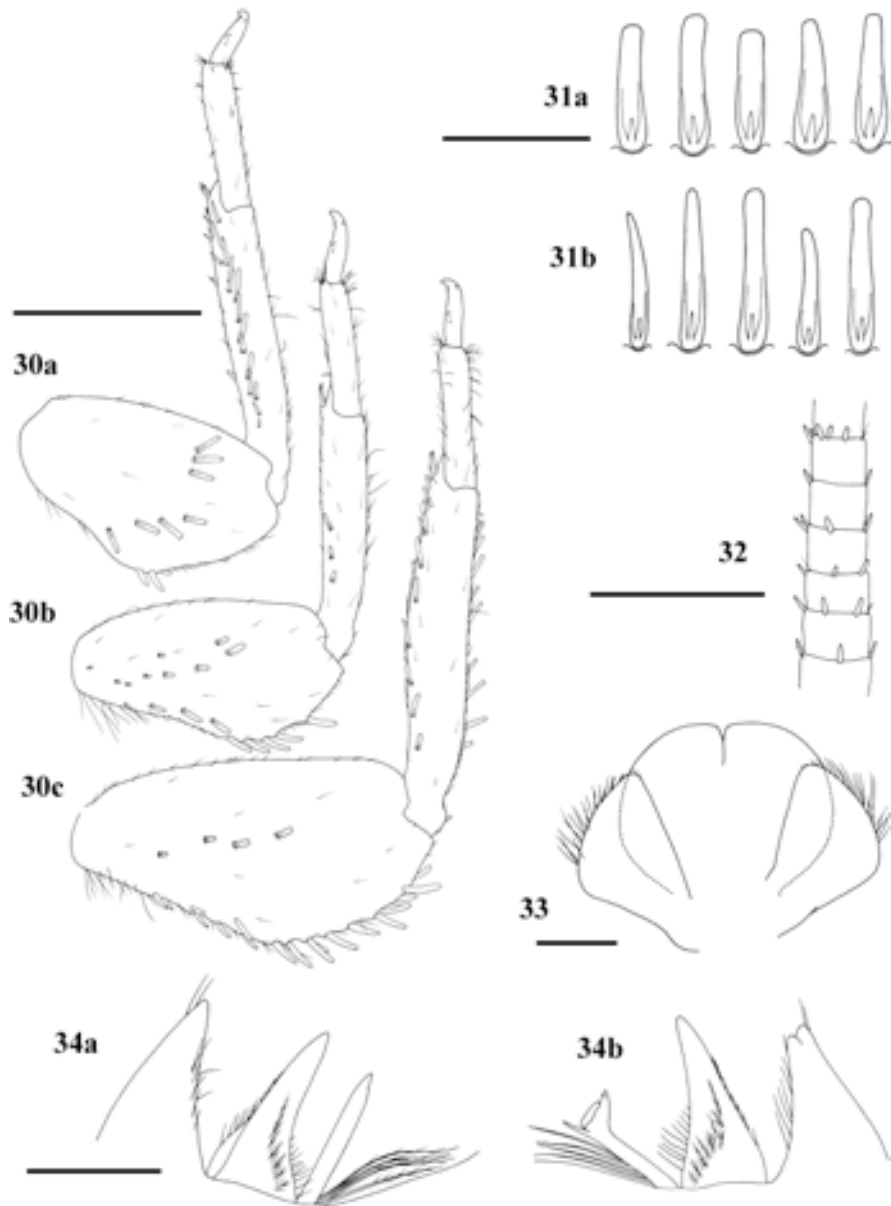
Scale Fig. 15 = 0.5 mm; scale Fig. 16 (= scale Fig. 19) = 0.1 mm; scale Fig. 17 (= scale Fig. 18) = 0.25 mm.



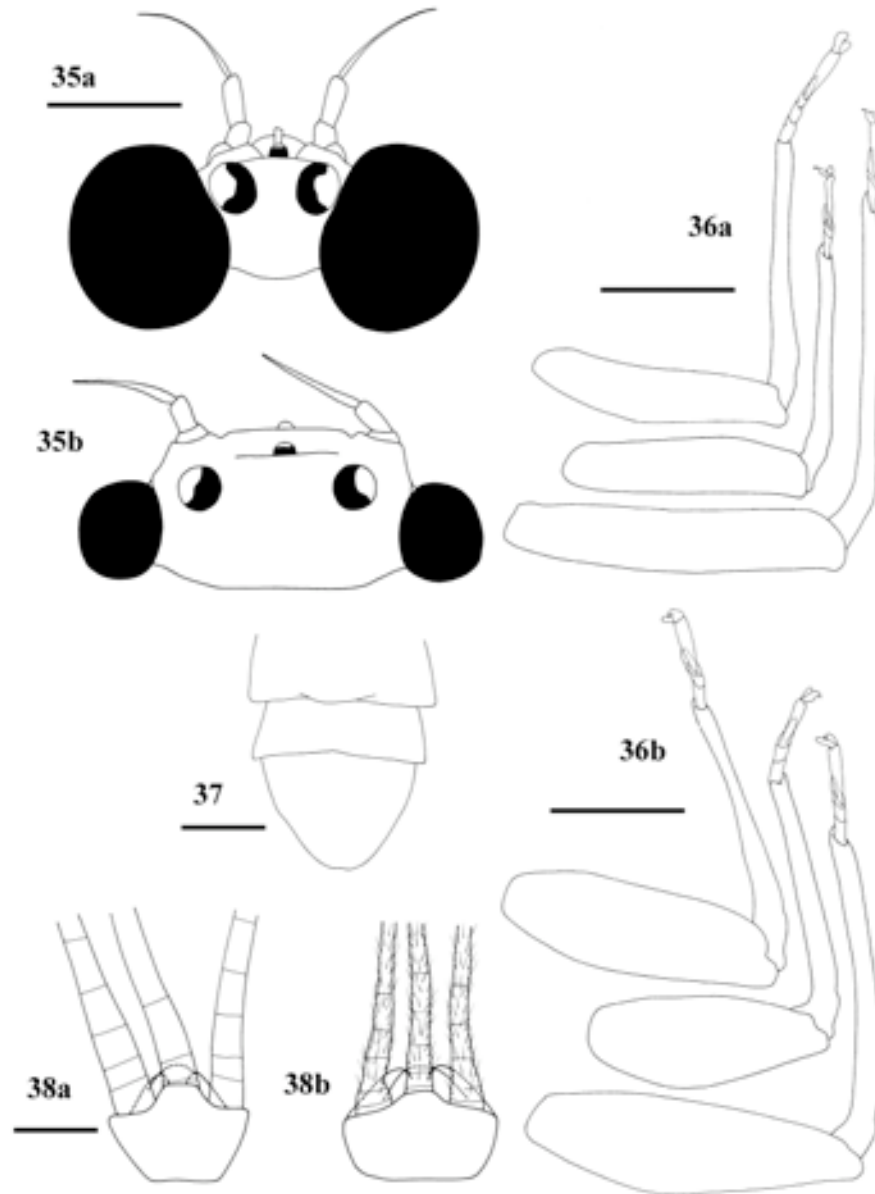
Figures 20–24. *Sparsorythus gracilis* sp. n. 20a: fore leg; 20b: middle leg; 20c: hind leg; 21a: fore femoral setae; 21b: fore tibial setae; 22a: paracercus; 22b: left cercus; 23: hypopharynx; 24a: left prosthema; 24b: right prosthema. Scale Fig. 20 = 0.5 mm; scale Fig. 21 (= scale Fig. 24) = 0.1 mm; scale Fig. 22 (scale Fig. 23) = 0.25 mm.



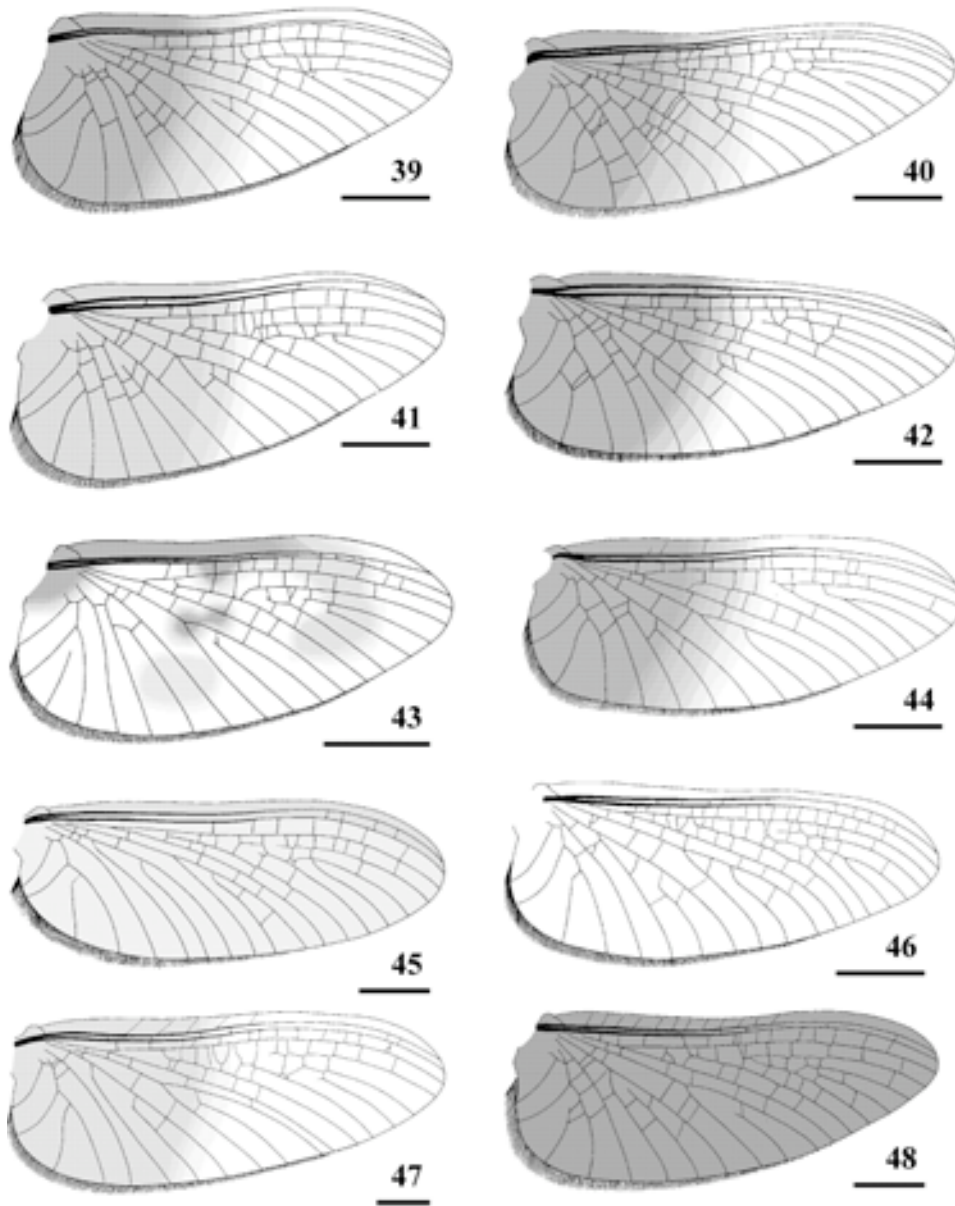
Figures 25–29. *Sparsorythus grandis* sp. n. 25a: fore leg; 25b: middle leg; 25c: hind leg; 26a: fore femoral setae; 26b: fore tibial setae; 27: caudal filament; 28: hypopharynx; 29a: left prosthema; 29b: right prosthema. Scale Fig. 25 = 0.5 mm; scale Fig. 26 (=scale Fig. 29) = 0.1 mm; scale Fig. 27 (=scale Fig. 28) = 0.25 mm.



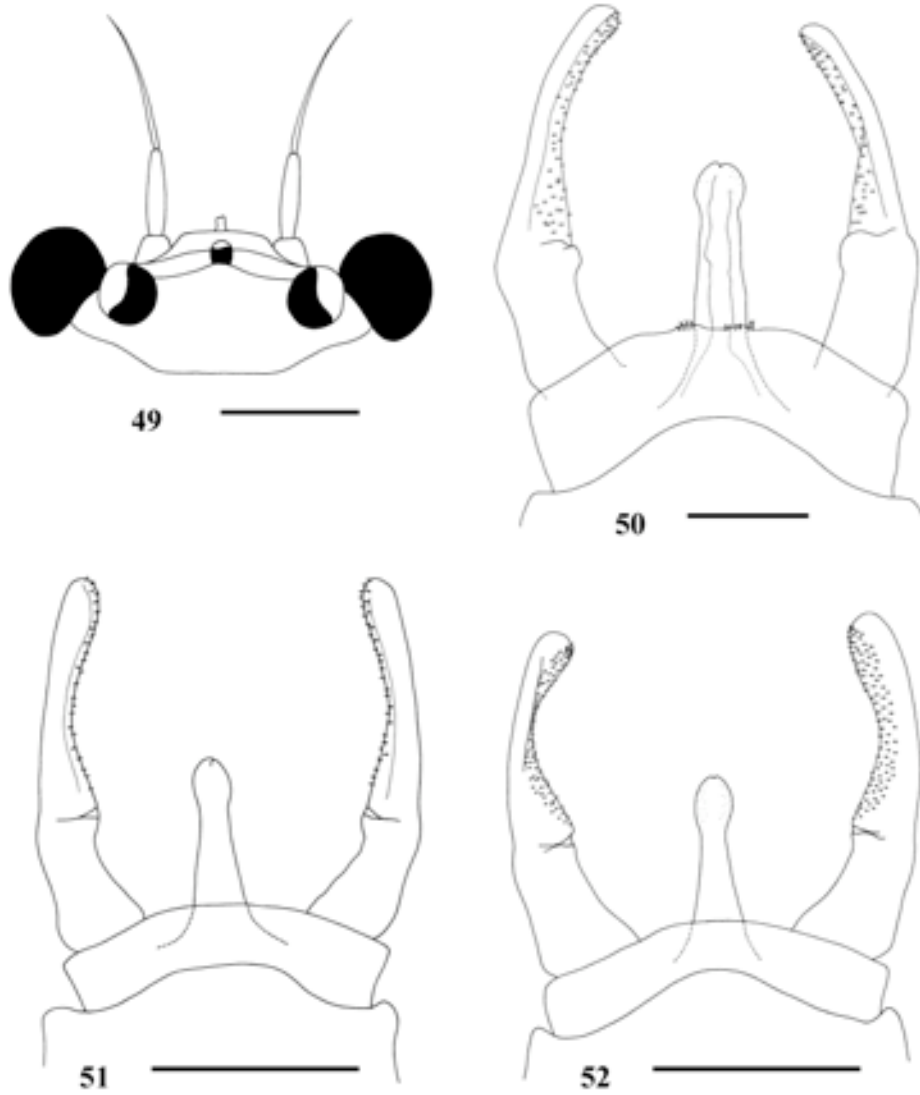
Figures 30–34. *Sparsorythus ceylonicus* sp.n. 30a: fore leg; 30b: middle leg; 30c: hind leg; 31a: fore femoral setae; 31b: fore tibial setae; 32: caudal filament; 33: hypopharynx; 34a: left prosthema; 34b: right prosthema. Scale Fig. 30 = 0.5 mm; scale Fig. 31 (= scale Fig. 33–34) = 0.1 mm; scale Fig. 32 = 0.25 mm.



Figures 35–38: *Sparsorythus bifurcatus* sp. n. 35a: head of male imago; 35b: head of female imago; 36a: legs of male imago; 36b: legs of female imago; 37: female subgenital plate; 38a: male caudal filaments; 38b: female caudal filaments. Scale Fig. 35 = 0.5 mm; scale Fig. 36 (= scale Fig. 37) = 0.5 mm; scale Fig. 38 = 0.25 mm.

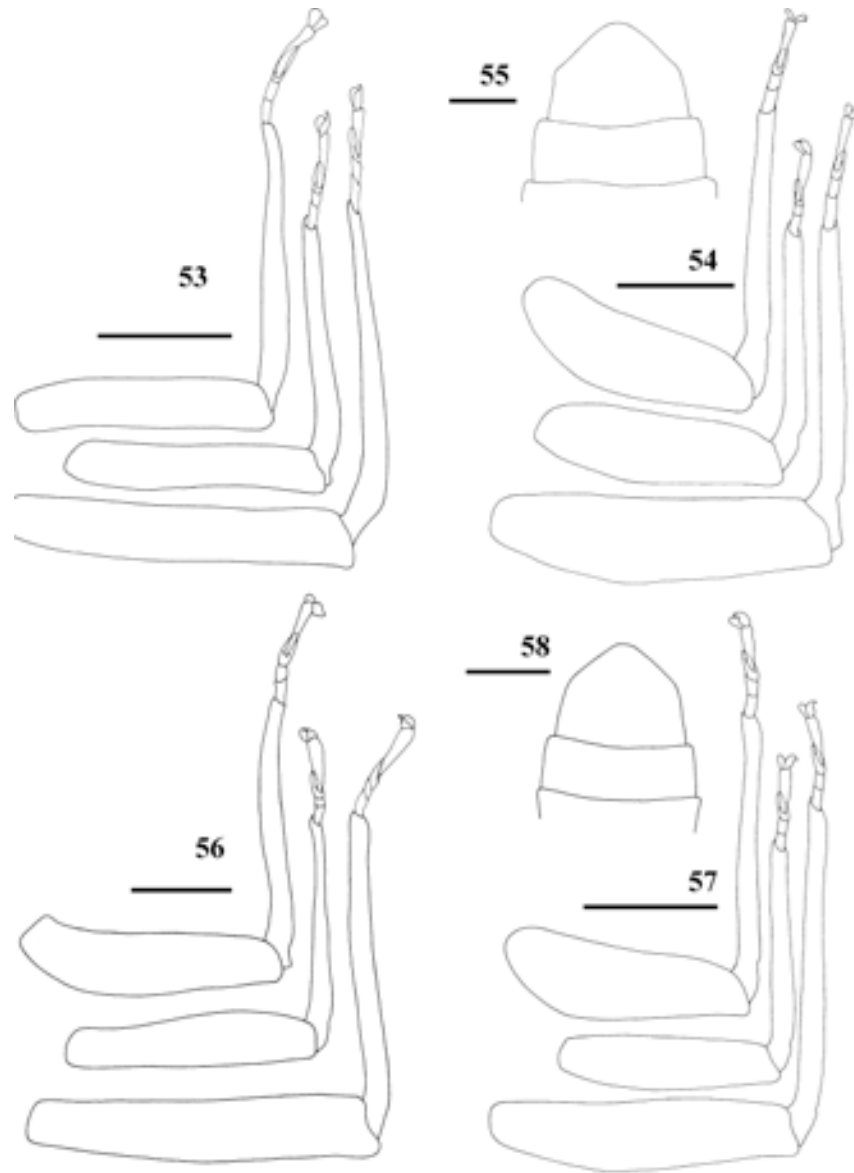


Figures 39–48. *Sparsorythus* spp. 39: *S. bifurcatus* sp. n. (male); 40: *S. bifurcatus* sp. n. (female); 41: *S. dongnai* sp. n. (male); 42: *S. dongnai* sp. n. (female); 43: *S. multilabeculatus* sp.n.; 44: *S. sp. 1* (female); 45: *S. sp. 2* (female); 46: *S. sp. 3* (female); 47: *S. sp. 4* (female); 48: *S. sp. 5* (female).
Scale = 1 mm.



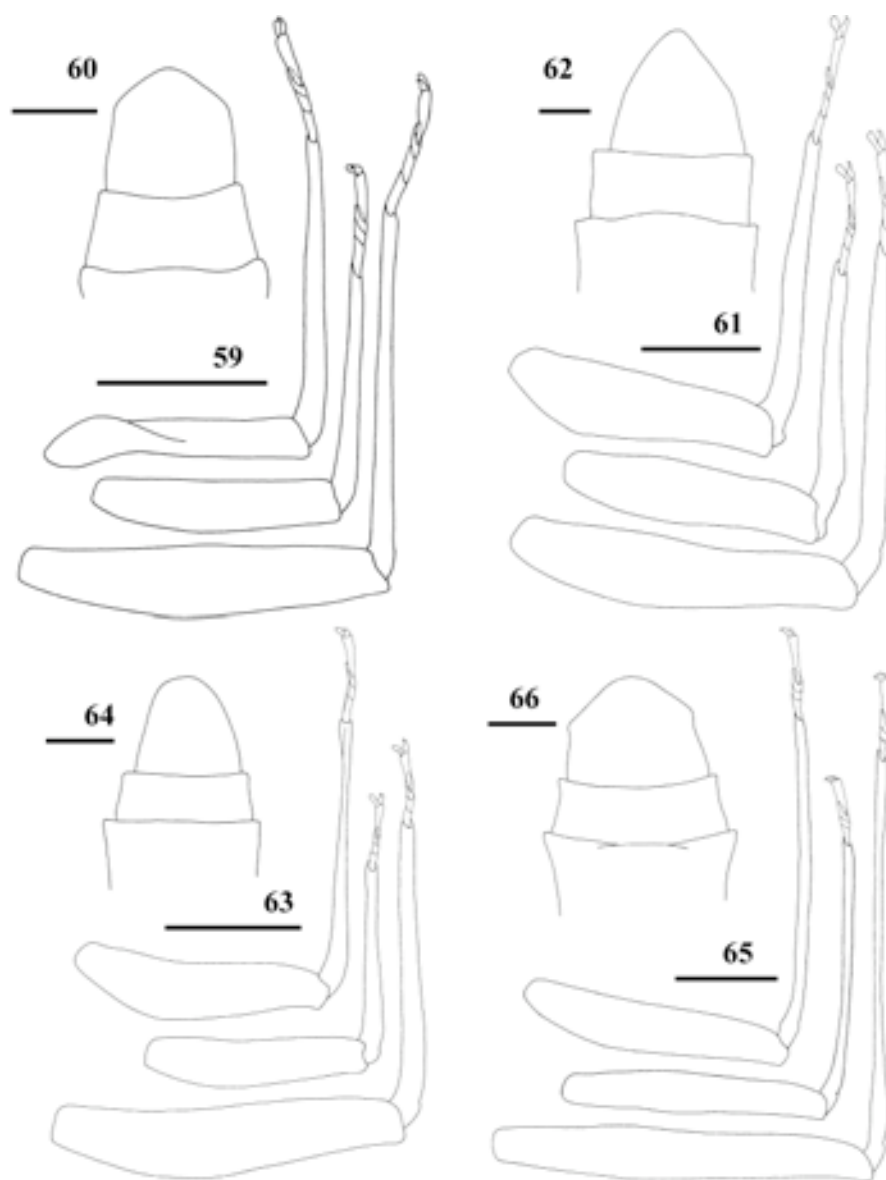
Figures 49–52. *Sparsorythus* spp. 49: *S. multilabeculatus* sp. n., head of male; 50: *S. multilabeculatus* sp. n., penis; 51: *S. dongnai* sp. n., penis; 52: *S. bifurcatus* sp. n., penis.

Scale Fig. 49 (= scale Figs. 51, 52) = 0.25 mm; scale Fig. 50 = 0.1 mm.

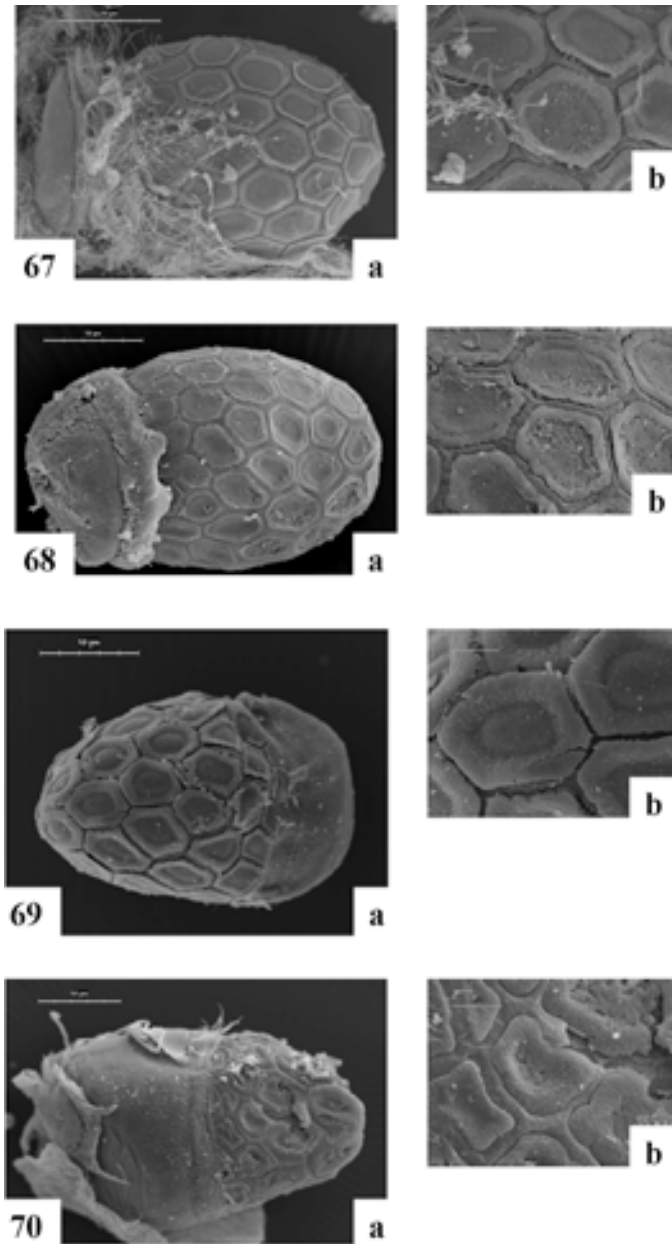


Figures 53–58. *Sparsorythus* spp. 53: *S. dongnai* sp. n., legs of male; 54: *S. dongnai* sp. n., legs of female; 55: *S. dongnai* sp. n., shape of last female sternites; 56: *S. multilabeculatus* sp. n., legs of male; 57: *S. sp. 1*, legs of female; 58: *S. sp. 1*, shape of last female sternites.

Scale Fig. 53 (= scale Fig. 54, 57) = 0.5 mm; scale Fig. 55 (= scale Fig. 56, 58) = 0.25 mm

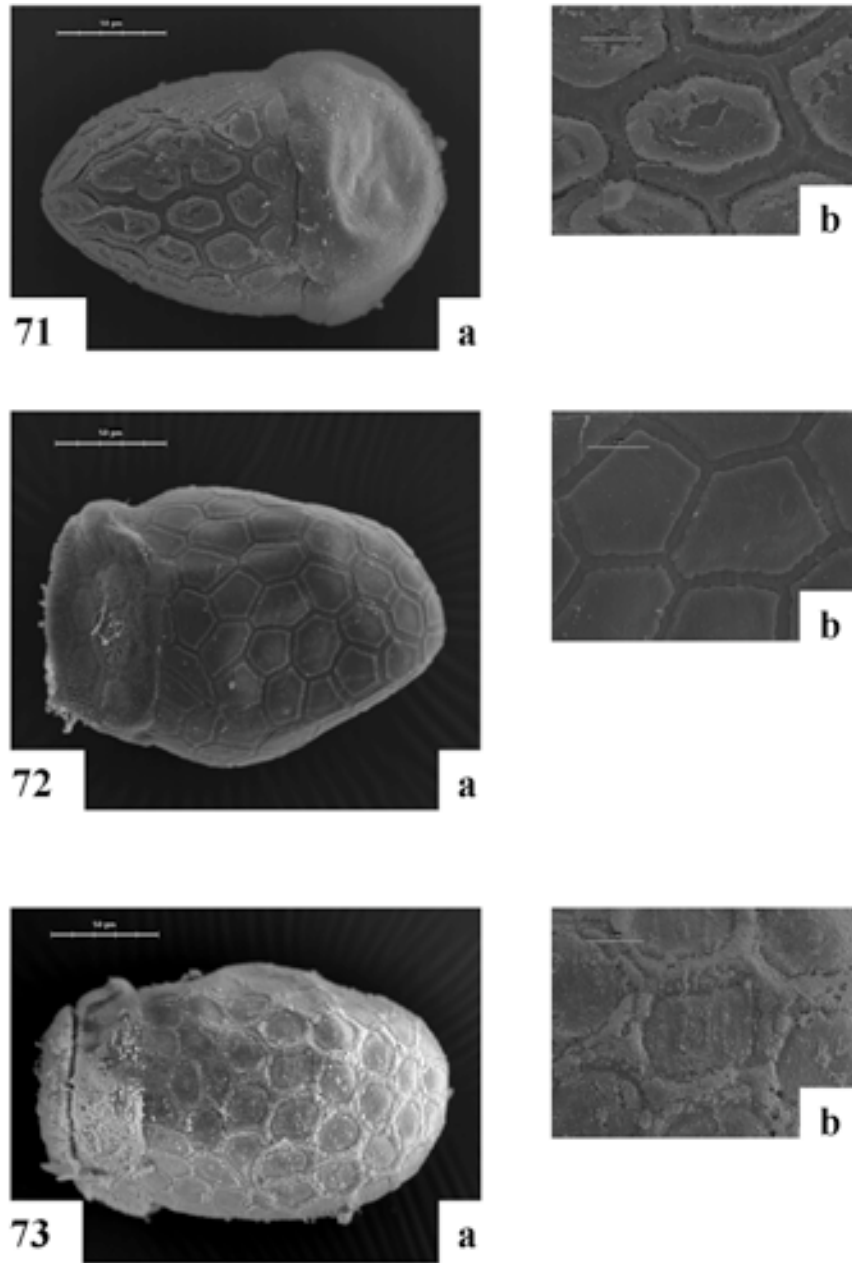


Figures 59–66. *Sparsorythus* spp. 59: *S. sp. 2*, legs of female; 60: *S. sp. 2*, shape of last female sternites; 61: *S. sp. 3*, legs of female; 62: *S. sp. 3*, shape of last female sternites; 63: *S. sp. 4*, legs of female; 64: *S. sp. 4*, shape of last female sternites; 65: *S. sp. 5*, legs of female; 66: *S. sp. 5*, shape of last female sternites. Scale Fig. 59 (= scale Figs. 61, 63, 65) = 0.5 mm; scale Fig. 60 (= scale Figs. 62, 64, 66) = 0.25 mm.



Figures 67–70. *Sparsorythus* spp., eggs (a: entirely egg; b: chorionic surface in detail). 67: *S. bifurcatus* sp. n.; 68: *Sparsorythus dongnai* sp. n.; 69: *Sparsorythus* sp.1; 70: *Sparsorythus* sp. 2.

Scale Figs. 50–53a = 50 μ m; scale Figs. 50–53b = 10 μ m.



Figures 71–73. *Sparsorythus* spp., eggs (a: entirely egg; b: chorionic surface in detail). 71: *Sparsorythus* sp. 3; 72: *Sparsorythus* sp. 4; 73: *Sparsorythus* sp. 5. Scale Figs. 54–56a = 50 µm; scale Figs. 54–56b = 10 µm.