

1447-2554 (On-line)

<https://museumsvictoria.com.au/collections-research/journals/memoirs-of-museum-victoria/>

DOI <https://doi.org/10.24199/j.mmv.2026.85.5>

New genera and species in the Australian Philorheithridae (Insecta: Trichoptera)

<https://zoobank.org/urn:Isid:zoobank.org:pub:8045204E-E413-430C-97C3-24958F024C81>

ROSALIND M. ST CLAIR

Museums Victoria, GPO Box 666, Melbourne, Victoria 3001, Australia [ros.stclair@gmail.com]

<https://orcid.org/0000-0002-4990-5535>

Abstract

St Clair R.M., 2026. New genera and species in the Australian Philorheithridae (Insecta: Trichoptera). *Memoirs of Museum Victoria* 85: 161–182.

Three new species in two new genera of Philorheithridae Hare from Australia are described: *Choristorheithrus camurus* gen. et sp. nov., *C. metadosis* gen. et sp. nov. and *Humorheithrus idiomatus* gen. et sp. nov. Two new species, *Philorheithrus frere* sp. nov. and *P. theischingeri* sp. nov., are described and are the first species of this genus described from Australia, with a further undescribed species known from a single larva from Tasmania. Females, pupae and larvae of some species are also described.

Keywords

Family diagnosis, new species, COI, Australia

Introduction

Philorheithridae Hare, 1910 is a small family of Trichoptera with a Gondwanan distribution. The main diversity is in Australia, with 15 species described in five endemic genera to date. The total Australian fauna is here increased to 20 species in eight genera, seven endemic. *Choristorheithrus camurus* gen. et sp. nov. and *C. metadosis* gen. et sp. nov. (northern New South Wales and southern Queensland) and *Humorheithrus idiomatus* gen. et sp. nov. (northern Queensland) are described. The type genus, *Philorheithrus* Hare, contains six species from New Zealand (Henderson and Ward, 2006) and now two Australian species, *P. frere* sp. nov. from north Queensland and *P. theischingeri* sp. nov. from northern New South Wales and southern Queensland. A third species from Tasmanian World Heritage area is known from a single larva only so cannot be described. These are the first *Philorheithrus* described from outside New Zealand. Larvae, pupae and females of some species are also described.

Males of the genera and species described here were originally recognised and some defined using sketch diagrams by the late Arturs Neboiss, but the work was not completed. All new names were assigned by Neboiss, apart from *Humorheithrus* gen. nov.

Neboiss (1977) noted that Philorheithridae are unusual within the Australian Trichoptera in the variation in the form of the warts on the scutum and scutellum. This variation continues to be very useful for distinguishing genera.

Materials and methods

Almost all specimens examined are housed in the Museums Victoria (NMV) collection. Some type specimens are held by the Queensland Museum (QM) and Australian Museum (AM).

The following abbreviations are used for names of collectors of specimens examined: AC A. Calder; AG Alena Glaister; AN Arturs Neboiss; AS A. Sheldon; AW Alice Wells; C Carter; DC David Cartwright; DB D. Bickel; EFR E.F. Reik; FP F. Perkins; GT Gunter Theischinger; ICY I.C. Yeo; JM Julia Mynott; JD John Dean; JW J. Webb; LB L. Benson; LS L. Sheldon; RP R. Pearson; RS Rosalind St Clair; MS Michael Shackleton; SRM, S. R. Monteith. Other abbreviations in specimens examined sections are SF State Forest, NP National Park, m male, f female, p pupa and l larva.

Terminology follows Holzenthal et al. (2007). Abdomens and genitalia of most specimens figured were cleared in potassium hydroxide solution.

Females were associated with the appropriate species by collection with males, based on their distribution and/or wing patterns. Advanced pupae with developed genitalia and larval sclerites in the case enabled identification to species of the larvae of *H. idiomatus* gen. et sp. nov. and confirmed the identification of the female. Such pupa also confirmed species identifications for female *P. theischingeri* sp. nov. Larval associations for species in *Philorheithrus* and *Choristorheithrus* gen. nov. were confirmed using the cytochrome oxidase sub unit 1 (COI) gene from data on BOLD (Barcode Of Life Database v4 <http://www.boldsystems.org/>, accessed 2020). Data on BOLD is also used for decisions on species differences using adults and larvae.

Family diagnosis for Australian species

Philorheithridae are most readily recognised from other Australian families by the following combination of characteristics.

Adult. Absence of ocelli; an apicomesal expansion on segment 1 of the maxillary palps bearing a tuft of setae; forewings with a sclerotised, usually pronounced basal projection apically and a post-anal vein; unique pilifers (sensory structures) present on the anterior of the head in males of most genera.

Pupae. Anal projections very lightly sclerotised, with a brown band basally.

Larvae. Forelegs and mid-legs raptorial, tibia and tarsus of mid-legs fused to form a tibiatarsus.

Family description for Australian species

Adult. Antennae about as long as wings. Spur formula 2:4:4. A mid-sternal process present on abdominal sternite VI and/or VII in some species. Forewing vein 1A may be atrophied.

Pupa. Dorsal posterior hook plates on abdominal segment V with very short spines covering most of the width of the segment, sometimes with a short gap between two plates. Mid-legs with fringes of setae along the margins, except in *Ramiheithrus*.

Larva. Mid-legs with four weak setae near the region of fusion of tibia and tarsus. Also near this region is a very subtle clear area ventrally, developed as a distinct small spine in a few species. Both the setae and clear area or spine may be the remnants of the setae and spine at the end of the original tibia prior to fusion. Abdomen with a line of bunched filamentous gills along each side of the body. Case usually very strong, made of sand grains, rarely with some detritus and weaker. Case closure membrane variable within the family at genus and species level.

Philorheithrus Hare, 1910

Type species: *Pseudoeconesus* (?) *agilis* Hudson, 1904
Pseudoeconesus agilis Ulmer, 1907
Philorheithrus agilis Hare, 1910

Diagnosis. The following generic diagnosis and description are for all the species in the genus, but information on some character states is not available for the New Zealand species.

The following combination of character states is required to define the genus.

Adults. Male maxillary palps long and thin, usually much longer than the labial palps, 3-, 4- or 5-segmented, membranous in some species. Antennae with first segment long (usually at least twice the diameter of the eye), slightly curved inward, cylindrical in both sexes. Scutum with a row of setal punctures on either side of the midline running most of the length of the segment; punctures may fuse to form elongate setal warts. This arrangement of setal punctures is also found in *Tasmanthrus* Mosely, 1936 and *Choristoreithrus* gen. nov. The post-anal vein in the forewings of males of all Philorheithridae is particularly strongly developed in the Australian *Philorheithrus* males. In

these species, the post-anal vein is a trough containing long golden setae, each seta the length of the vein. Figures for the New Zealand *Philorheithrus* (Henderson and Ward, 2006) suggest these species have the more common philorheithrid arrangement of a fringe of short setae along the post-anal veins (perhaps apart from *P. aliciae* Henderson and Ward). This is supported by the few specimens of the two New Zealand species *P. agilis* (Hudson) and *P. lacustris* Tillyard in the NMV, which lack the very long setae. The superior appendages can arise from segment 9, close together or further apart. Female genitalia are highly variable across the genus with no particularly defining features.

Larvae. Larvae possess a strongly developed abdominal tergite IX and three associated ventral sclerites, comprising two broad lateral sclerites and a narrow median sclerite. An undescribed *Aphilorhithrus* species from the same geographical area as *P. theischingeri* sp. nov. also bear three ventral sclerites on tergite IX, but these are paler and equal-sized.

Description – adult

Head. Males with pilifer shape species specific, ranging from elongate baton-shaped, finger-like, elongate broad or very short and rounded; maxillary palps long and thin; third segment of antennae about half the length of the first segment, following segments little modified apart from being notably longer and thinner than in other genera.

Thorax. Scutellum with no or one pair of small, rounded warts.

Forewings. Long and narrow with long projecting basal lobe, mottled light brown with scattered very small white patches. In both sexes, vein R1 joins R2 just before the wing margin, at the wing margin, or does not join R2. Forewing forks 1, 2, 3 and 5 present in males, fork 4 also present in males of both Australian species, but absent from New Zealand species. Forewing forks 1–5 present in females. Hind wings with forks 1, 2, and 5 present in males, and 1, 2, 4 and 5 in females of most species.

Abdomen. Usually without a small projection on sternite VI or VII, but some specimens of the Australian species have a small projection ventrally on segment VI, so this is variable in the species. The female of New Zealand species, *P. aliciae* Henderson and Ward, is described as having a small projection. Male genitalia with long superior appendages, usually longer than depth of segment IX, widely separated at their bases. Segment X with a distinct dorsomesal ridge. Inferior appendages comparatively short and stout, each with a structural non-articulating branch; harpago absent.

Pupa. Only two species are known in the pupal stage. Those of *P. theischingeri* sp. nov. described below match the description of *P. agilis* in Cowley (1976).

Description – larva

This description is based on the detailed description of *P. agilis* in Cowley (1978), notes on other New Zealand larvae in Henderson and Ward (2006), larvae of one Australian species and a few specimens of *P. agilis*, *P. aliciae* and *P. lacustris* in the NMV. Final instar about 15 mm long.

Head. Usually reddish brown, sometimes almost black or pale brown, may have darker areas from the back of the head following the sutures; elongate with at most a short carina over each eye; frontoclypeal apotome long, about four times length of posterior suture, widest anterior to constriction; antennae minute to very short, close to both anterior and lateral margins; ventral apotome very short, about one tenth the minimum length of the head ventrally.

Thorax. Mesonotal sclerites each with a carina the width of the segment, with a fringe of long setae along it at about posterior third; metanotum with three pairs of sclerites, lateral and posterior pairs much narrower than mesal pair. Mesosternum with two posterior and one anterior sclerite, each with shape somewhat variable. Forelegs with one moderately strong to strong seta on the anterior face of each femur.

Abdomen. Tergite IX strongly developed with a strong serrated margin posteriorly, a fringe of 16–22 strong setae from serrated edge. Anal claws strong, with a small dorsal tooth.

Case. Strong, tubular and slightly tapered with almost no closure membranes until pupation.

Philorheithrus frere sp. nov.

Figures 1–9.

Diagnosis

Adult. Pilifers finger-shaped, about half the diameter of the eye with numerous dorsal, dark setae longer than the pilifer (fig. 1). Each male maxillary palp has two basally sclerotised segments, whereas the rest of the palp is long and membranous, and appears extensible (fig. 1). The membranous section of the maxillary palp makes it difficult to count the number of segments, but there appear to be three. Morphologically similar palps are noted in *P. latensis* Henderson and Ward (2006) from New Zealand but lack the androconia. The male inferior appendages are approximately rectangular and unbranched; other *Philorheithrus* species have two branches (figs 4–6). Female tergite 10 strongly divided medially, to form a pair of triangular apical lobes extending well past the end of the abdomen (figs 7–9). Similar triangular apical lobes are present in *P. agilis* from New Zealand (Henderson and Ward, 2006) and *Kosrheithrus* (Mosely, 1953) from Australia.

Pupa and larva. Although the pupa and larva of *P. frere* are unknown, they are likely to be very similar to those of the other two Australian species and *Philorheithrus* larvae from New Zealand. Furthermore, the pupa and larva of the three Australian species are unlikely to be confused due to their widely separated distributions.

Description

As for family and generic description, with the following amendments.

Head. Antennae with first segment long, about 1.5 times diameter of eye (fig. 1).

Thorax. Scutum with a line of setose punctures running most

of the length of the segment on either side of the midline (fig. 2). Scutellum rounded, without warts (fig. 2). Male forewings 11.2–11.6 mm (n=4), fork 4 footstalk variable in length, about twice as long to half as long as the fork (fig. 3); vein R1 joins R2 in forewing of both sexes (fig. 3); female forewing broader, with post-anal vein shorter and with just a light fringe of setae; hind wings with forks 1, 2, and 5 in both sexes (fig. 3).

Abdomen. Sometimes with a small projection on sternite VI.

Male genitalia. In dorsal view, tergite IX short dorsally; superior appendages widely separated at base narrowing slightly apically; in lateral view, segment X basally very deep, long and, then narrowing at about one quarter length before becoming apically cleft for about one third length to form two narrow arms that curve ventrally; inferior appendages simplest in the genus, stout, somewhat rectangular with a darker extension ventroapically, paler dorsoapically (figs 4–6); in ventral view, segment IX about as long medially as laterally.

Female genitalia. A narrow sclerite on each side extends from the base of the apical lobes almost to the gonopore (figs 7–9).

Pupa and larva. Although the larva of *P. frere* is unknown, it is likely to be very similar to larvae of the other two Australian species and *Philorheithrus* larvae from New Zealand. Furthermore, larvae of the three Australian species are unlikely to be confused due to their widely separated distributions.

Type material

Holotype male. North Queensland. Mt Bartle Frere 0.5 km North of South Peak, 6–8 Nov 1981. 1500 m Earthwatch Qld. Mus. QM T262525.

Paratypes. 2 males NMV TRI39541 and NMV TRI39551 and 1 female TRI39549 collected with holotype.

Derivation of name

The name is derived from the type locality.

Philorheithrus theischingeri sp. nov.

Figures 10–29.

Diagnosis

Male. pilifers very short, about one quarter the diameter of the eye and rounded (fig. 10). Superior appendages pale distally. Inferior appendages longest in the genus, each slender, with a long, very pale, curved branch mesodorsally (figs 12–14). Female lacking long apical lobes (figs 17–19).

Pupa. Mandibles ending in a slender narrowing tip (easily broken), and appear unique within the Australian philorheithrids (fig. 20). Posterior hook plates on segment V divided into two sections, similar to *Kosrheithrus* and *Ramiheithrus*.

Larva. As for generic diagnosis and description.

Description

As for generic and species diagnoses, with the following amendments.

Head. Palps 5-segmented in both sexes, all segments sclerotised, almost three times as long as labial palps (fig 10); maxillary

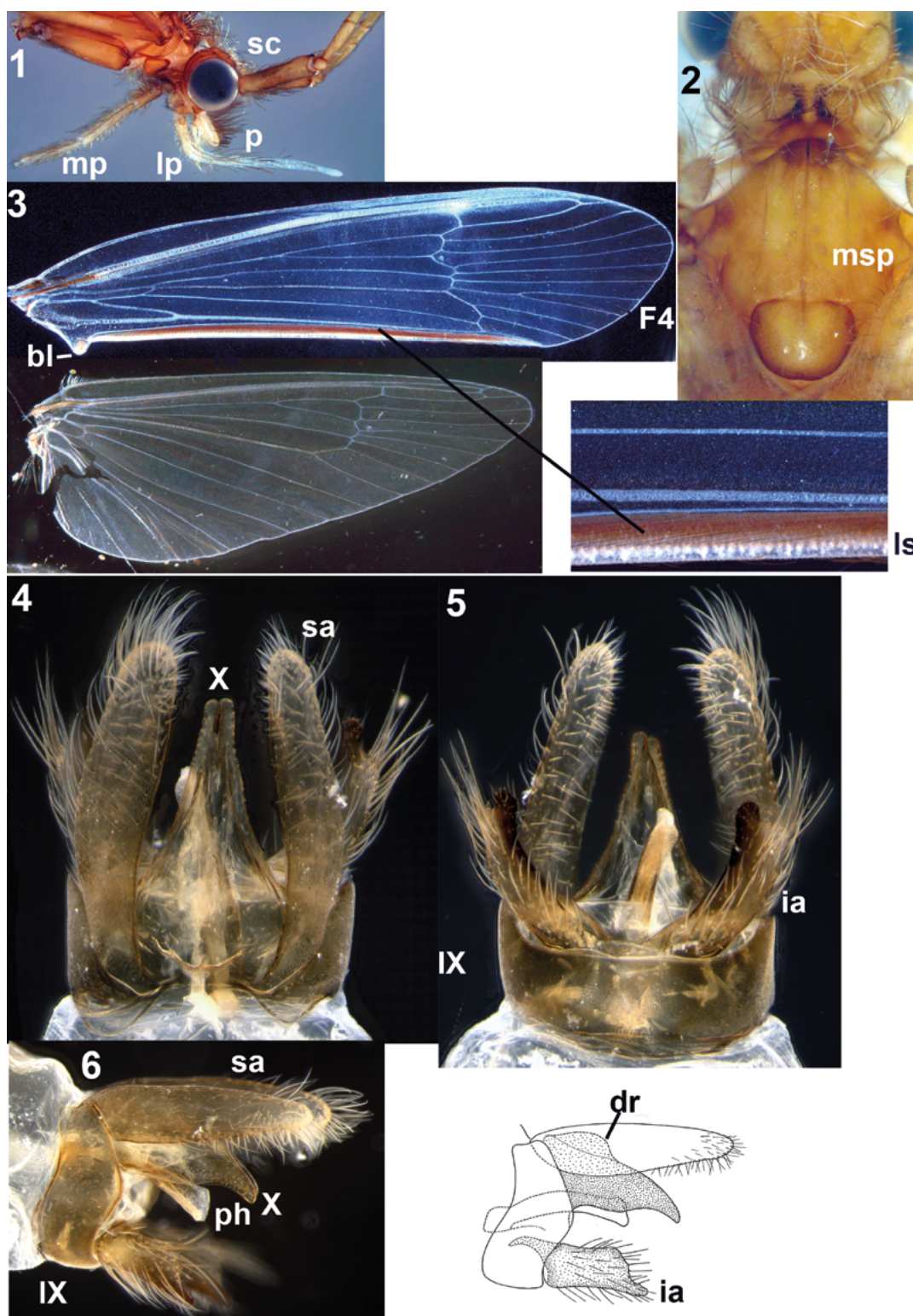


Plate 1. Figures 1–6. *Philorheithrus frere* sp. nov. Male. Paratype TRI 39551: 1. head lateral. Paratype TRI 39541: 2. thorax dorsal; 3. wings. Paratype TRI 39551: 4. genitalia dorsal; 5. genitalia ventral; 6. genitalia lateral, with line drawings.

Abbreviations: bl basal lobe of forewing; dr dorsomesal ridge on segment X; ia inferior appendage; IX segment IX; F4 fork 4; lp labial palp; ls long setae in 'post anal' vein; mp maxillary palp; msp mesoscutellar setal punctures; p pilifer; ph phallus; sa superior appendage; sc scape; X segment X.

palps, first segment on antennae, head, pronotum and midline of mesoscutellum with numerous yellow to brown setae (figs 10, 11).

Thorax. Scutum with setal punctures on both sides of the midline highly variable, sometimes coalescing to small setal warts; some setal punctures may form just two pairs of small warts (fig. 11); scutellum approximately square, with one pair of rounded warts very close to the anterior margin (fig. 11). Male forewings 8.2–9.5 mm long (n=7), female 10.0–12.3 mm (n=5). Forewings very similar to those of *P. frere*, other than the shape and vein 1A being nearly twice as long; vein R1 joins R2 in forewings of both sexes (figs 15, 16). Female forewing broader and post-anal vein shorter and not strongly developed, otherwise very similar to male (fig. 16). Female hind wings similar to male.

Abdomen. Without a projection on sternite VI.

Male genitalia. In dorsal view, tergite IX short, superior appendages widely separated at base, narrowing slightly apically; in lateral view, superior appendages shorter than basal depth of segment X, narrowing strongly apically; in lateral view, segment X long, very deep basally but narrowing at about half length to form two straight arms, deeper than the arms of *P. frere* sp. nov.; inferior appendages each with a curved, very pale non-articulating branch, ventral branches almost as long as superior appendages (figs 12–14), more slender than those of *P. frere* sp. nov.; in ventral view, segment IX much shorter medially than laterally.

Female genitalia. In dorsal view with a broad tergite dorsally, covering most of the segment, slightly divided medially, each side broadly rounded posteriorly not extending past the end of the segment, with long setae posteriorly; in lateral view, a long concavity on the length of most of segment (figs 17–19).

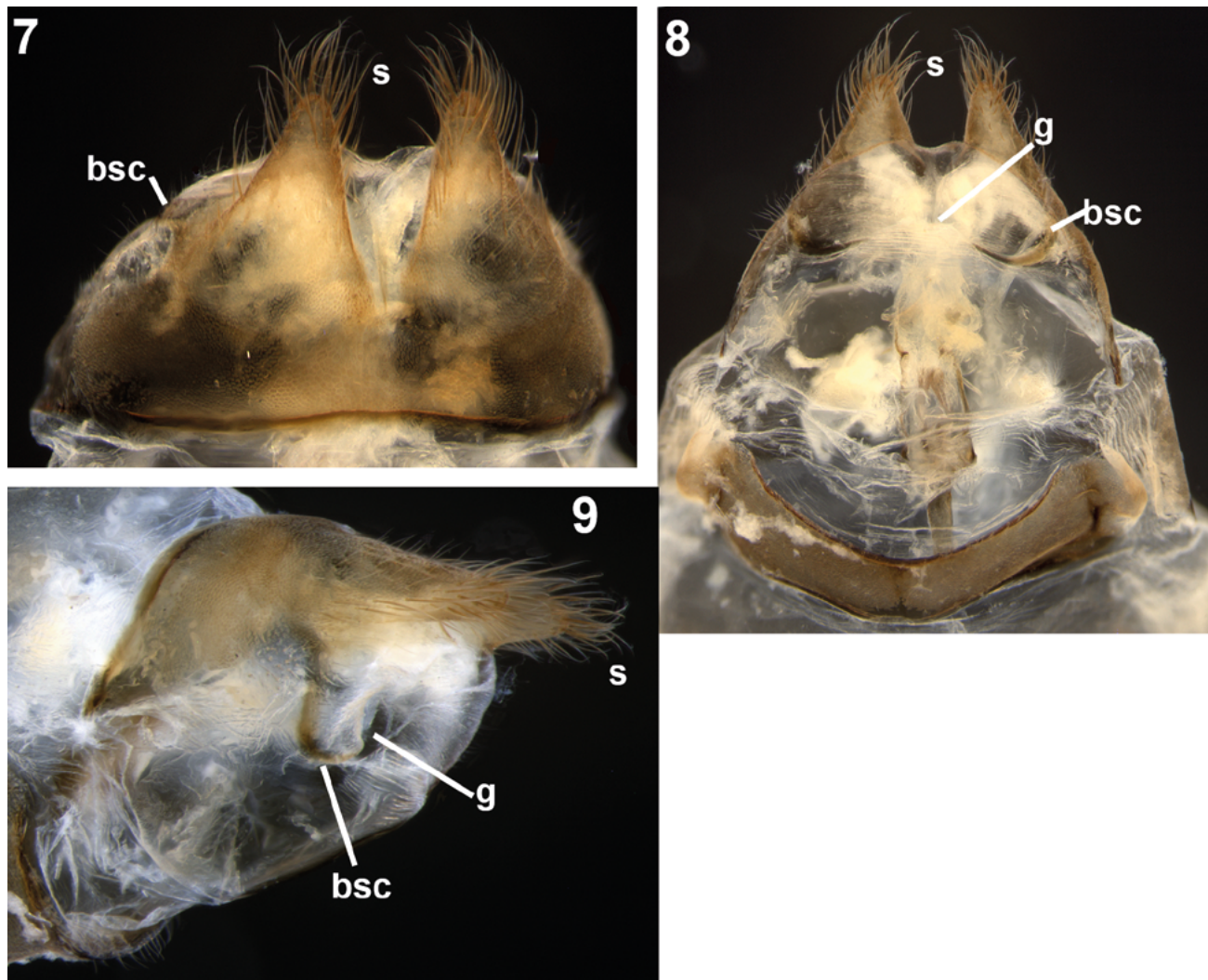


Plate 2. Figures 7–9. *Philorheithrus frere* sp. nov. Female Paratype TRI 39549: 7. genitalia dorsal; 8. genitalia ventral; 9. genitalia lateral. Abbreviations: bsc basal sclerite; g gonopore; s triangular setose dorsal processes.

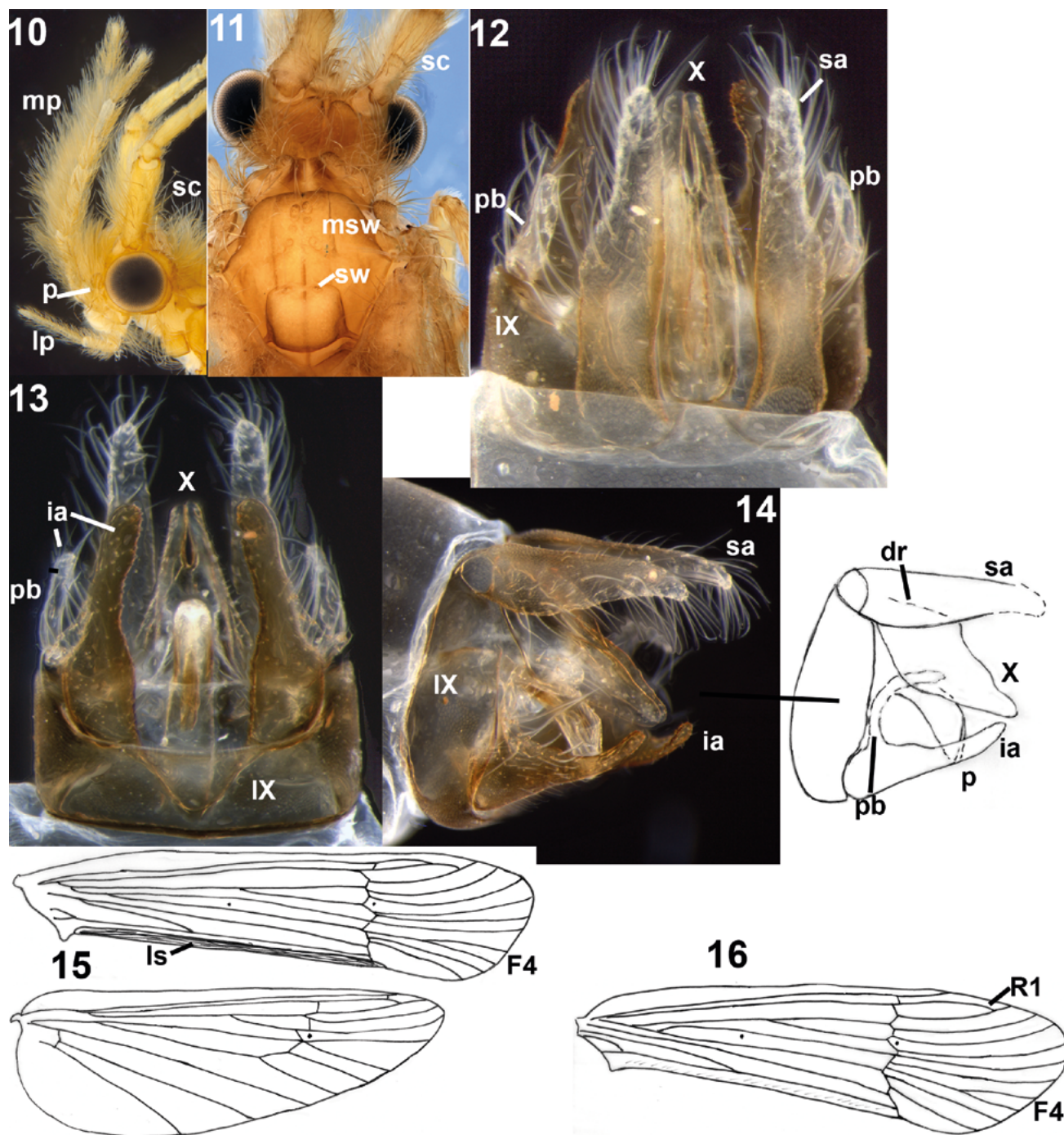


Plate 3. Figures 10–16. *Philorheithrus theischingeri* sp. nov. Male: Paratype TRI 40313: 10. head lateral; 11. head and thorax dorsal. K.677085 Holotype: 12. genitalia dorsal; 13. genitalia ventral; 14. genitalia lateral. TRI 58129: 15. wings. Female: Paratype TRI 40373: 16. forewing. Abbreviations: ia inferior appendage; dr dorsomesal ridge on segment X; IX segment IX; F4 fork 4; lp labial palp; ls long setae in 'post anal' vein; mp maxillary palp; msp mesoscutellar setal punctures; p pilifer; pb pale curved basal branch of inferior appendage; ph phallus; R1 vein R1 joining R2; sa superior appendage; sc scape; sp scutellar setal puncture; X segment X.

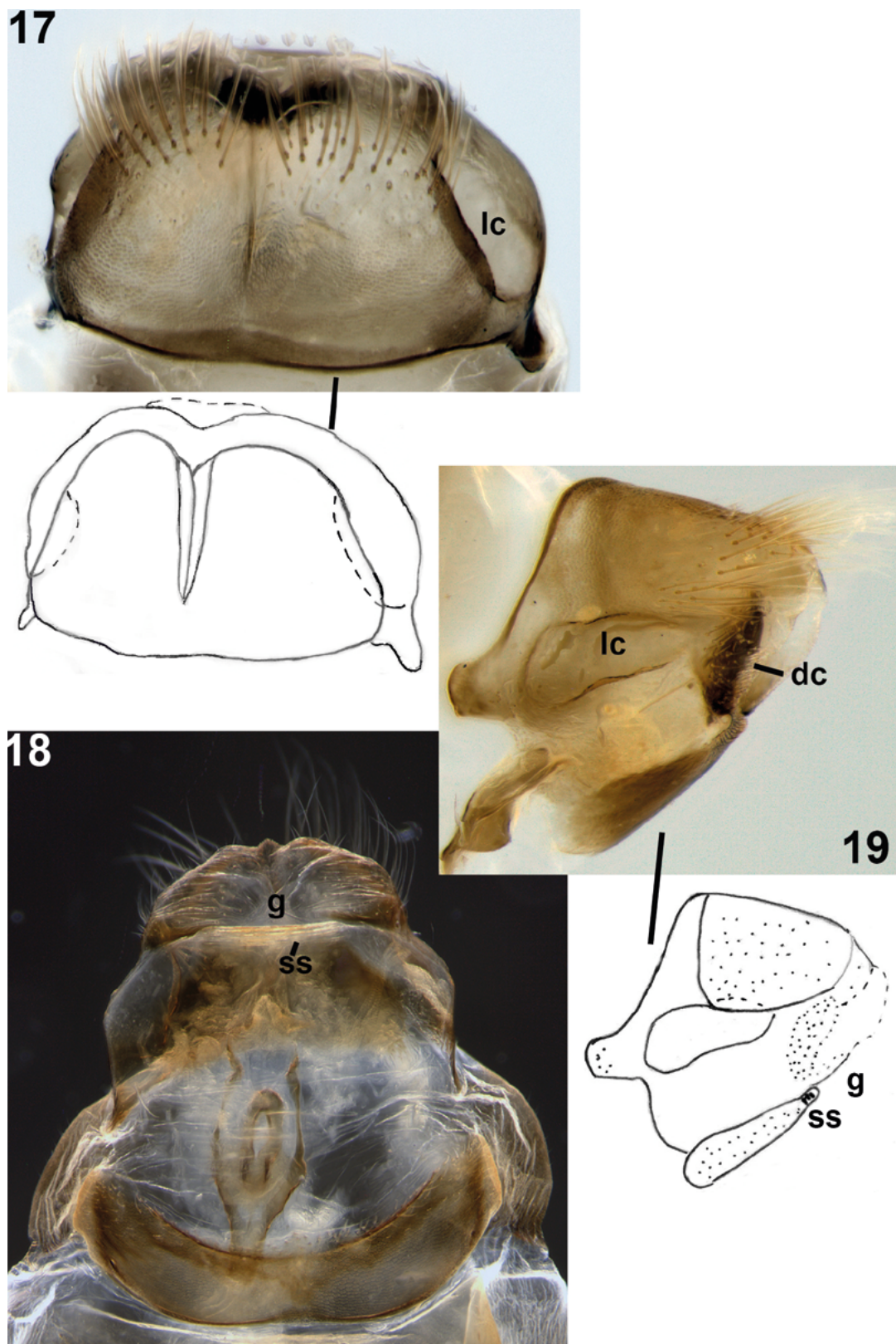


Plate 4. Figures 17–19. *Philorheithrus theischingeri* sp. nov. Female. Paratype TRI 40373: 17. genitalia dorsal; 18. genitalia ventral; 19. genitalia lateral. Abbreviations: g gonopore; l lateral cavity in segment IX; dc dark coloration anterior to gonopore.

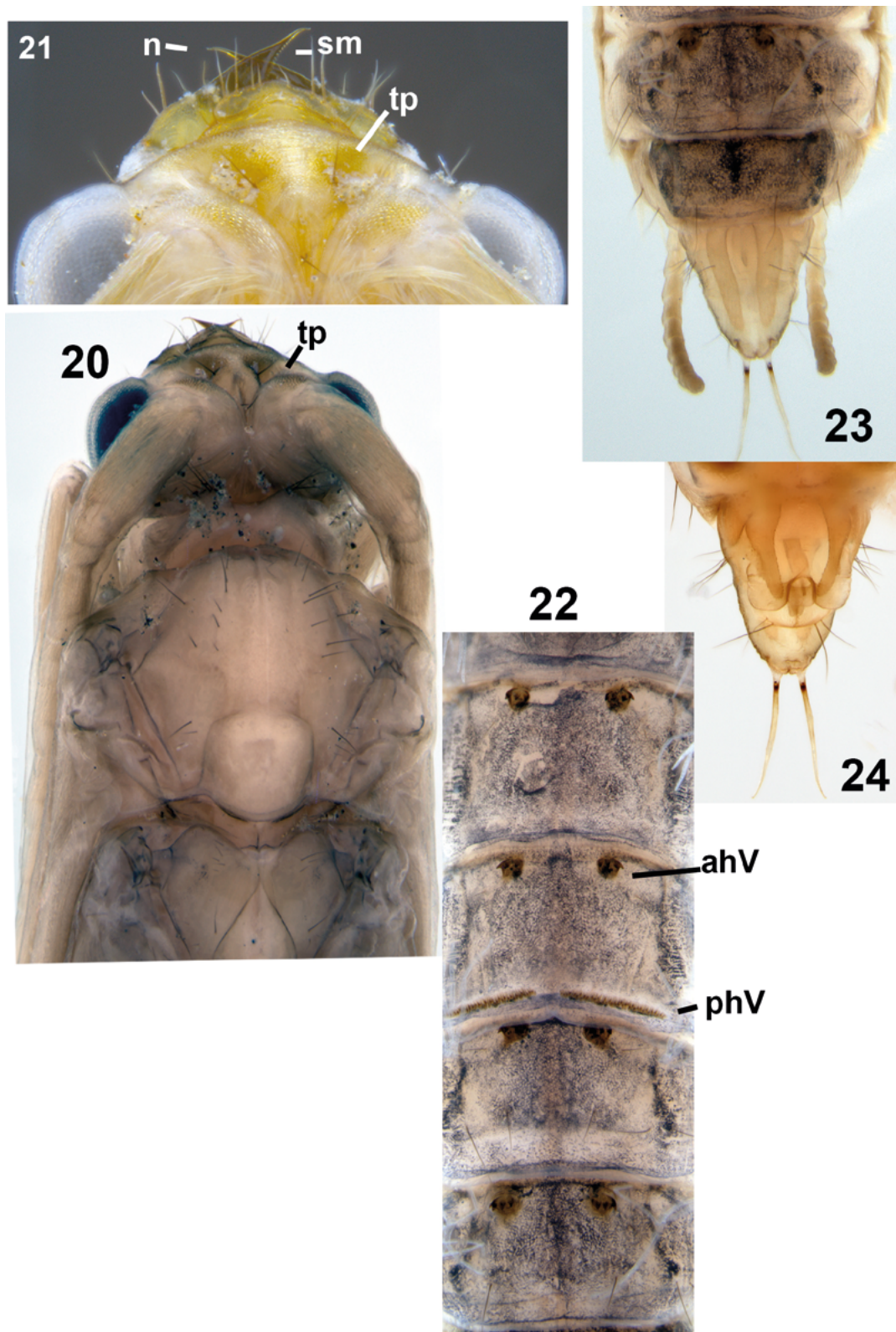


Plate 5. Figures 20–24. *Philorheithrus theischingeri* sp. nov. Pupa. TRI154507: 20. head and thorax dorsal. TRI154513: 21. anterior of head dorsal. TRI154507: 22. abdomen dorsal. 23. segment X dorsal. TRI154513: 24. segment X ventral. Abbreviations: n narrowing tip; sm serrate margin; tp tuberculate patch; ahV anterior hook plate segment V; phV posterior hook plate segment V.

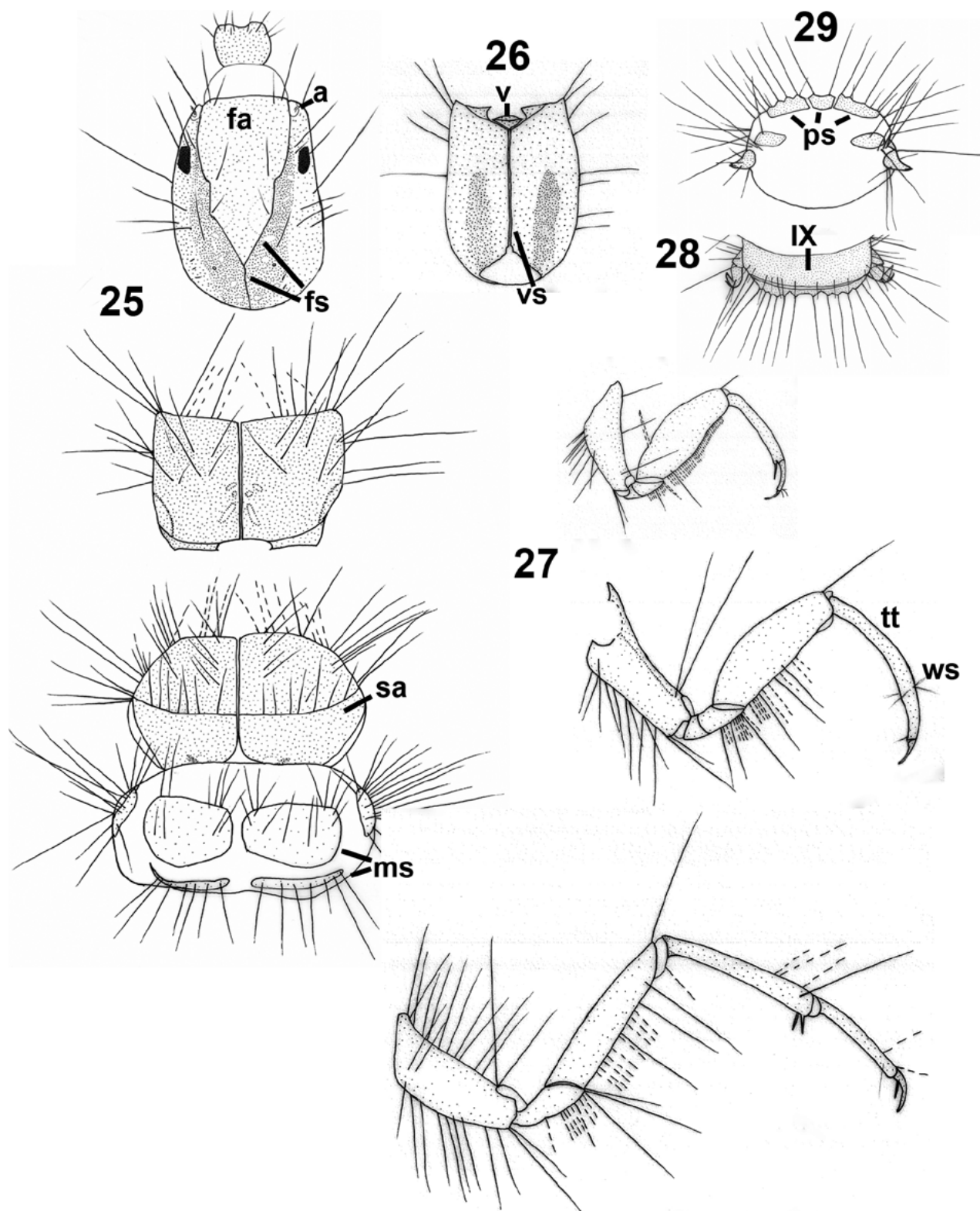


Plate 6. Figures 25–29. *Philorheithrus theischingeri* sp. nov. Larva. TRI 54761: 25. head and thorax dorsal; 26. head ventral; 27. legs posterior face lateral; 28. tergite IX dorsal; 29. tergite IX posterior view.

Abbreviations: a antenna; fa frontoclypeal apotome; fs frontoclypeal suture; IX tergite IX; ms mesonotal sclerites; ps sclerites ventral to tergite IX; sa setal ridge on metanotum; ws weak setae possibly remnant distal setae of original tibia; tt tibiarsus; va ventral apotome; vs ventral suture.

Pupa. Head with a pair of tuberculate patches on the frons and one pair on the antennal bases; one pair of setae between the eyes each adjacent to a deep concavity and just posterior to the tuberculate patches, one pair of short setae between the antennal bases (fig. 20); mandibles very finely serrate on inner margin, with a pair of medium length setae basally (fig. 21); antennae without setae, a clump of about eight setae laterally on the head on each side posterior to the antennae on raised areas (fig. 21). Pronotum with an irregular row of setae extending much of the length of the scutum laterally on each side (fig. 21). Abdomen dorsally with a pair of anterior dorsal hook plates on segments III to VI each with 2–4 teeth, segment VII each with 5–6 teeth; pair of posterior hook plates on segment 5 each composed of a very short row of 25–35 spines covering most of the width of the segment and with a short gap between each plate (fig. 22). Segment IX elongate subtriangular, dorsally with five scattered setae on each side laterally at about mid-length (fig. 23), ventrally two pairs of long setae mesally (fig. 24). The pupa is enclosed within the larval case with a capping stone covering anterior and posterior openings.

Larva. As for the generic diagnosis and description with the following amendments. Head elongate, (fig. 25); ventral apotome very small, less than 1/10th the length of the ventral suture (fig. 26). Case posterior opening with, at most, a very thin lining of silk around the perimeter.

Type material

Holotype male. New South Wales. Coombadjha Creek, Washpool National Park, 29° 16' S, 152° 22' E, 5 Jan 1986, 1 m, AM K.677096.

Paratypes. Wiangaree SF via Kyogle, SRM, 18 Nov 1974, 2 m AM K.677096, AM K.677097; 7 m NMV TRI 40393, 1 m NMV TRI 58129; 1 f NMV TRI 40373, 2 f NMV TRI 39565.

Other material examined

Queensland. SE Queensland: Killarney, Browns Falls, 13 Oct 1973, AN, 1 f; Morans Ck above Morans Falls, Lamington NP 28.2260° S, 153.129° E, 16 Nov 2011, MS & JM, 1 m, DC & RS, 1 f, 1 l; Binna Burra 29 Nov 1955, FP, 1 m; Lamington NP, 14–20 Feb 1958, ICY, 2 m.

New South Wales. Never Never R. at Whitneys Rd 30.33° S, 152.862° E, 10 Nov 2010, JM & MS, 1 m; Styx R 12 km S of Ebor, 17 Oct 1973, AN, 2 f; Dorriggo NP, GT, 1 f; Gloucester Tops, elevation 1280 m, 19 Nov – 4 Dec 1988, malaise trap, DB, 3 m; Wilson River Reserve 15 km NW Bellangry, 7 Dec 1986, GT, 1 m; Dorriggo Nat Park, Nov. 1990, GT, 1 f; New England NP, 21 Feb 1966, EFR, 5 l; Polblue Ck Tubrucca Rd 31° 54' S, 151° 23' E, 1 Oct 2008, JD & DC, 1 l; Polblue Ck Barrington Tops Forest Rd 31° 57' S, 151° 26' E, 2 Dec 2007, AG, JD & RS, 1 m, 4 l, 6 p; Dilgry R, Banksia campground 31° 53' S, 151° 32' E, 2 Dec 2007, AG, JD & RS, 3 l, 7 p; Manning R. at Pheasant Creek Road, 31° 53' S, 151° 29' E, 3 Dec 2007, AG, JD & RS, 13 m, 2 f; Wiangaree SF via Kiogle, 18 Nov 1974, SRM, 2 f.

Derivation of name

This species is named for Gunther Theischinger, the prolific taxonomist and collector of some of the specimens.

Distribution

This genus is known from three widely separated areas, with one species from one site in N Queensland, one moderately common species in S Queensland and northern New South Wales, and a probable third species from SW Tasmania.

Potential third species of *Philorheithrus*

The *Philorheithrus* larva in the NMV collection (*Philorheithrus* sp. AV2 in St Clair, 1997, TRI45207 collected from Lake Tahune, Frenchmans Cap National Park, Tasmania by J. Jackson in 1988) is from an undescribed species. As yet, no other specimens of this genus are known from Tasmania as adults or larvae despite extensive collection of Philorheithridae. This seems unusual but reflects the remote and very difficult to area for collecting. No reliable characters have been found to separate the Tasmanian larva from the NSW species.

Although the larva of *P. frere* is unknown, it is likely to be very similar to larvae of the other two Australian species and *Philorheithrus* larvae from New Zealand. Furthermore, larvae of the three Australian species are unlikely to be confused due to their widely separated distributions.

Choristorheithrus gen. nov.

Type species: *Choristorheithrus camarus* sp. nov.

Figures 30–51.

Diagnosis Male maxillary palps elongate cylindrical and shorter than the labial palps, each maxillary palp with two segments (figs 30, 35), segment 1 short and segment 2 about five times as long (figs 30, 35). Male antennae with segment 1 distinctly longer than segment 3, somewhat flattened dorsoventrally and with androconia dorsally (figs 30, 35). Antennal androconia similar to *Humorheithrus* gen. nov. and longer than *Tasmanthrus*. Scutum of both sexes with a pair of diverging rows of setal punctures down the midline, similar to *Philorheithrus* and *Tasmanthrus*, but in other characters this genus is closest to *Austrheithrus* (figs 30, 35). Discoidal cells in fore- and hind wings in both sexes, short, about 1/4 length of the thyridial cells (figs 34, 39), similar to *Austrheithrus* Mosely, 1953. Male superior appendages are small and segment X is large (figs 30–32, 36–38), a unique arrangement in Australian Philorheithridae. This is most similar to *Austrheithrus*, in which the relative sizes of these structures are similar, and *Humorheithrus*, in which segment X is a little longer than the superior appendages. Male inferior appendages each lack an harpago, are unbranched and curved inward, narrowing to a point distally (figs 31, 32, 35, 36).

Pupa. Unknown.

Larva. Larvae are unique in having a very dorsally flattened head. Their cases have the most elaborate silk posterior closure membrane of any Australian Philorheithridae genus.

Description

Head. Pilifers baton-like, slightly curved apically, a little longer than the diameter of the eye and about as long as the maxillary palps (figs 30, 35). Antennae with first segment about as long as the diameter of the eyes, irregularly cylindrical in shape, broader than the rest of the segments; segment 2 very short and with a forward projecting fringe of setae on the distal margin; segments 4 onwards somewhat elongate with the distal ends broadened, a narrow dark band distally, v-shaped dorsally (figs 30, 35).

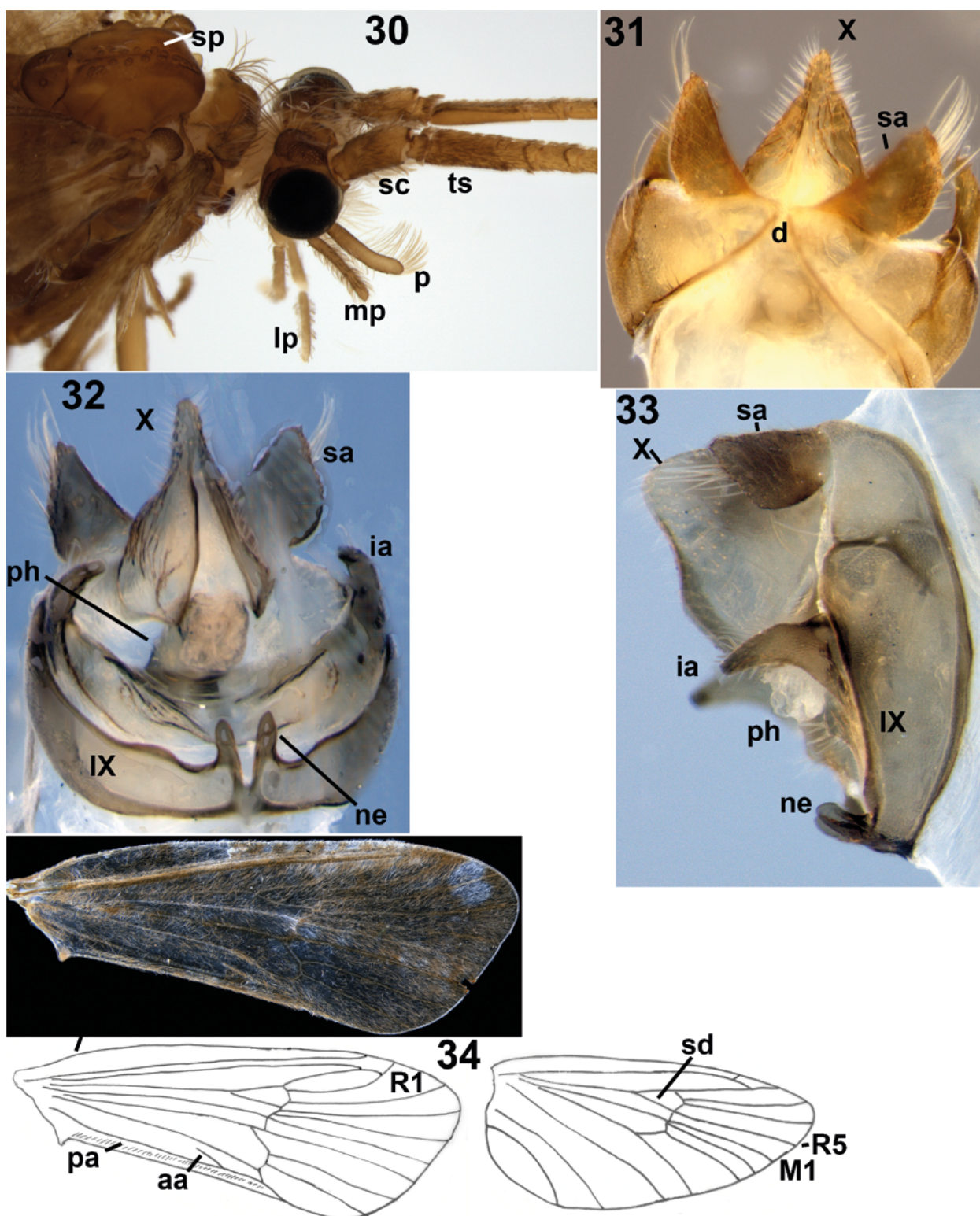


Plate 7. Figures 30–34. *Choristorheithrus camurus* gen. et sp. nov. Male Holotype AM K.677086: 30. head and thorax dorsolateral; 31. genitalia dorsal; 32. genitalia ventral; 33. genitalia lateral; 34. wings.

Abbreviations. aa atrophied anal vein; d strongly divided segment IX; ia inferior appendages; IX segment IX; lp labial palp; pa 'post anal' vein; M1 Vein M1; mp maxillary palp; sp scutal setal punctures; ne narrow extension of sternite IX; p pilifer; pa 'post anal' vein; ph phallus; R1 vein R1 joining R2; R5 Vein R5 confluent with M1; sa superior appendages; sc scape; sd short discoidal cell; ts third antennal segment; X segment X

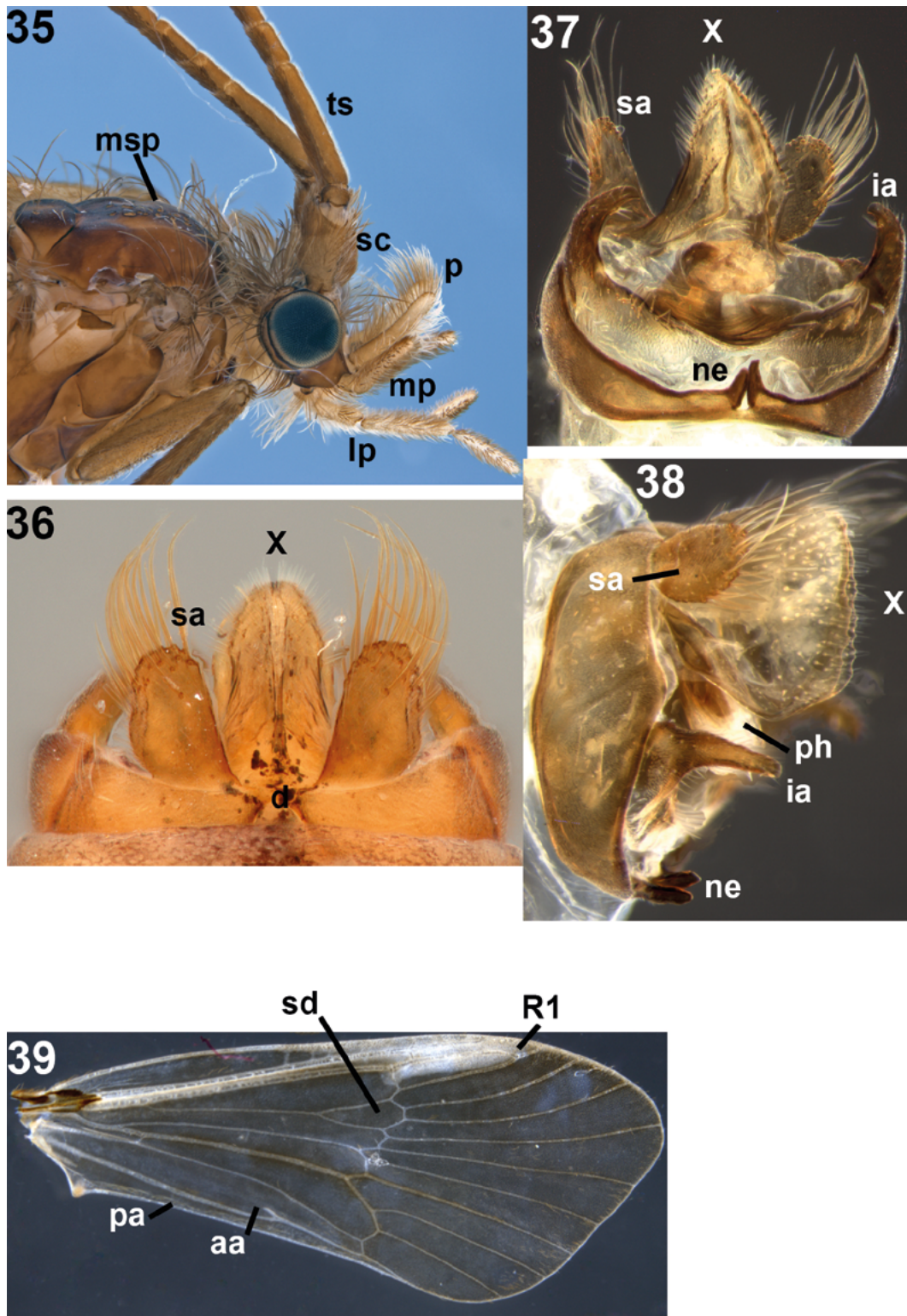


Plate 8. Figures 35–39. *Choristorheithrus metadosus* gen. et sp. nov. Male. Holotype AM K.677087: 35. head and thorax lateral; 36. genitalia dorsal; 37. genitalia ventral; 38. genitalia lateral; 39. Wings.

Abbreviations: aa atrophied anal vein; d strongly divided segment IX; ia inferior appendage; lp labial palp; pa ‘post anal’ vein; mp maxillary palp; msp mesoscutellar setal punctures; ne narrow extension of sternite IX; p pilifer; pa ‘post anal’ vein; ph phallus; sa superior appendage; sc scape; sd short discoidal cell; ts third antennal segment; R1 R1 joining R2; X segment X.

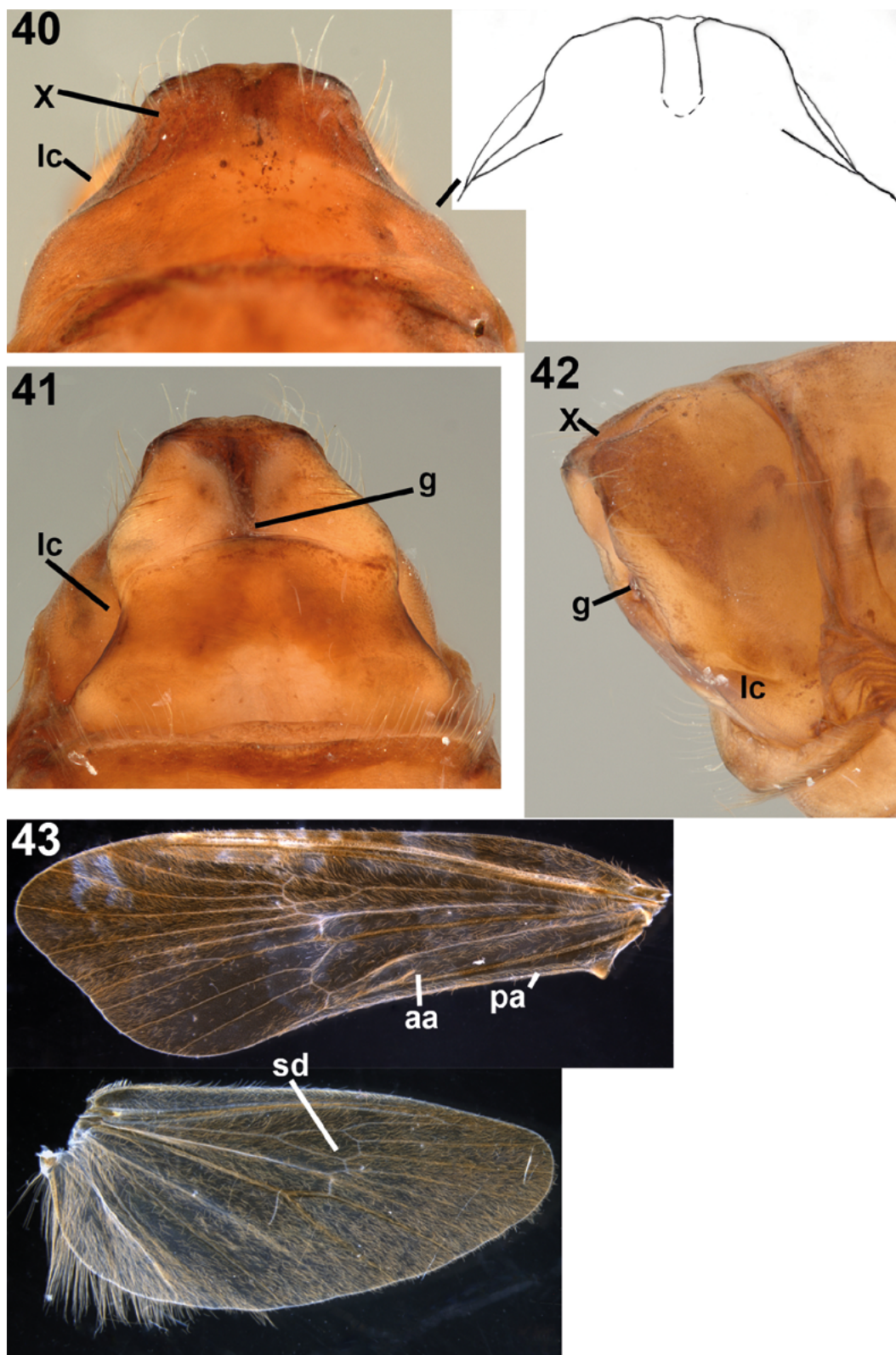


Plate 9. Figures 40–43. *Choristorheithrus* gen. nov. Female. TRI 58127: 40. genitalia dorsal; 41. genitalia ventral, 42. genitalia lateral. TRI 40390: 43. wings.

Abbreviations: aa atrophied anal vein; g gonopore; l lateral cavity; pa 'post anal' vein; sd short discoidal cell.

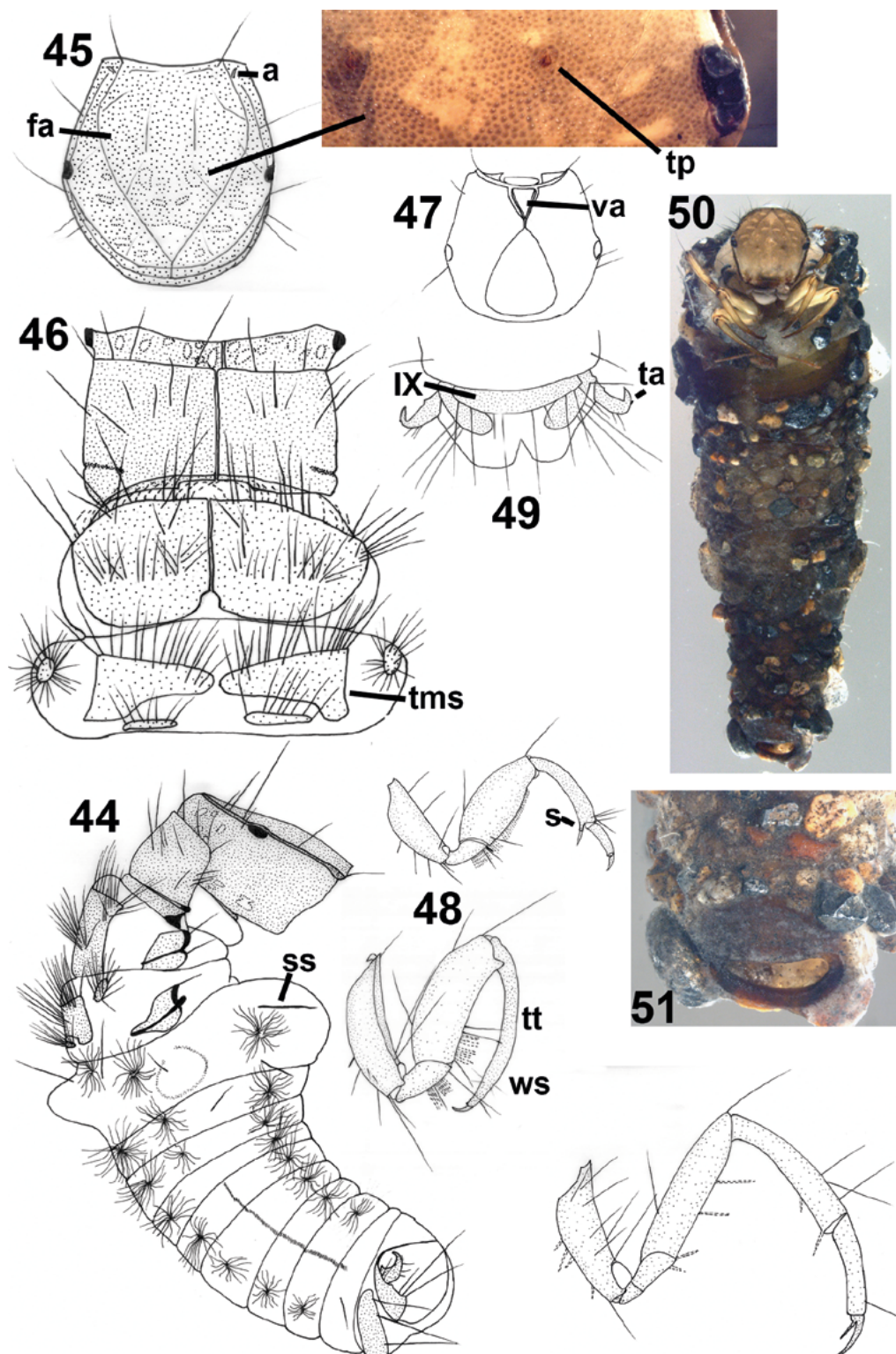


Plate 10. Figures 44–51. *Choristorheithrus* gen. nov. Larva. TRI 54696: 44. body lateral. TRI 54795: 45 head dorsal; 46. head and thorax dorsal view; 47. head ventral; 48. legs posterior face lateral; 49. segment X dorsal. TRI 54696: 50. larva in case; 51. case closure membrane. Abbreviations: fa frontoclypeal apotome; a antenna; c case closure membrane; IX tergite IX; s short extension of tibia; ss stout seta on abdominal sternum I; ta tooth on anal claw; tp tentorial pit; tms triangular metanotal sclerites; tt tibiarsus; va ventral apotome; ws weak setae possibly remnant of distal setae of original tibia.

Thorax. Scutellum variable, with 0–3 rarely more setal punctures of similar size to those on the scutum, medial or posterior on the scutellum or in a line running down parallel to midline. Wings broad. Forewings with a distinct white patch distally from R4 to anterior margin and alternating white and dark along anterior margin distally from level of discoidal cell running from scutellum to anterior margin, other small light patches present (figs 34, 43). A fold in the male forewing, on subcosta or just below, similar to that of *Austrheithrus* but weaker and closer to the front margin. Forewings of both sexes with vein R1 joining R2 before margin consistently, apart from one individual in which it does not meet R2 or the wing edge. Forewing vein 1A atrophied with stump distal in both sexes, basal lobe distinct. Hind wings vein R5 arising separately or confluent with M1 (figs 34, 39). Male forewing with forks 1, 2, 3 and 5. Female forewing forks 1–5 present, forks 1, 2 and 5 in hind wing (fig. 43).

Abdomen. Without a small projection on sternite VI or VII.

Male. In lateral view, tergite IX very narrow at the midline, strongly curved on both anterior margins (figs 31, 36); in ventral view sternite IX narrowly extended posteriorly on either side of the midline (figs 32, 37). In lateral view, segment IX broadest dorsal to the midline, with a distinct to indistinct suture medially. Superior appendages in dorsal view spaced well apart basally (figs 31, 36), in lateral view somewhat oval shaped (figs 33, 38), in ventral view each somewhat cupped (figs 32, 37). In dorsal view segment X is narrow and joined along the entire length, in lateral view is deeper than long and in ventral view is broader and separated medially and basally.

Female. Forewing length 8.5–11 mm (n=4). Genitalia simple, without projections. In dorsal view, tergite X broadest on anterior margin, tapering posteriorly, with a longitudinal medial sulcus from about one fifth the length to the posterior margin, with a truncated end on each side, a row of long setae present on each side just anterior to posterior margin (fig. 40). A concavity laterally on each side (figs 41, 42). Genitalia moderately strongly sclerotised ventrally (fig. 41).

Larva. Short, about 6 mm. Body widest at the prothorax and tapering strongly to the last abdominal segment, curved (fig. 44). The head is very distinctive in this genus being strongly flattened dorsally, with a very strong carina encircling it and with the frontoclypeus covering most of the dorsal surface (figs 45, 46). Tentorial pits visible, the only Australian Philorheithridae genus in which this occurs (fig. 45). They are also visible in the larvae of Antipodoeciidae, which also have a very flat head. The head is very short ventrally and the ventral apotome is almost as long as the head (fig. 47). The anterior pair of setae on abdominal sternum 1 is stouter than the posterior pair (fig. 44), as in *Austrheithrus* and *Kosreithrus*. Forelegs each with a single strong seta on anterior face, tibial spines more than half the length of the tarsi, on short extension of the tibiae similar to *Kosreithrus*. Tergite IX is short, almost as wide as segment, with few long setae and without sclerites below it (fig. 49). The curved case of this genus is similar to that of *Austrheithrus* but the case of *Choristorheithrus* gen. nov. is less strongly curved and incorporates some large sand grains not found in the cases of *Austrheithrus* (fig. 50). It has an elaborate posterior closure membrane made entirely of hardened silk leaving an elongate opening less than a quarter of the area. This is similar to that of *Austrheithrus* larvae but made

of stronger silk, completely encircling the rim of the case and extending less along the ventral margin (fig. 51).

Derivation of name

Choristo is a Greek word meaning separate.

Gender

Masculine.

***Choristorheithrus camurus* gen. et sp. nov.**

Figures 30–34.

Diagnosis

As for family and generic diagnoses, with the following amendments.

Description

Male segment 10 posterior margin curved inward laterally in lateral view. Male forewings 6.3–7.7 mm (n=3).

Type material

Holotype male. New South Wales. Upper Allyn River 12 km East of Eccleston, 21 Feb 1980, AC 1 m AM K.677086.

Paratypes. 4 m, K.677092 to K.677095, 9 m, Upper Allyn River 12 km East of Eccleston, 21 Feb 1980, TRI 40389, TRI 40388.

Other material examined

New South Wales. Never Never R. at Whitneys Rd., 30.3300° S, 152.8622° E, 10 Nov 2010, JM & MS, 1 m; Wilson River Reserve NW of Wauchope, 31° 14' S, 152° 34' E, 30 Oct 1981, AW and C, 1 m; Wilson River Reserve, Wilson R Rd, 31° 12' S, 152° 29' E, 2 Sep 2008, JD and DC, 1 m; 31.2071° S, 152.4795° E, 12 Oct 2010, JM & MS, 1 m; Wilson River Reserve 15 km NW of Bellangry, 7 Dec 1986, 244 m asl, GT, 2 m; Wilson River Reserve near Bellangry, 5 Dec 1988, GT, 2 m; Barrington R, Rocky Crossing, West Barrington Rd 32° 02' S, 150° 52' E, 30 Dec 2008, JD & DC, 1 m; Allyn River Chichester SF 10–11 Nov 1981, T. Weir, 1 m; Gloucester River 9 km SW of Gloucester, 17 Feb 1980, AC, 4 m; Upper Styx River, 21 Feb 1966, EFR, 6 m; Orara SF, Tuckers Knob, 22 Nov 1990, GT, 1 m.

Derivation of name

Camurus is a Latin word meaning turn inward. This was chosen by A. Neboiss, and possibly refers to the distinct inward curve of segment X visible in lateral view in males of this species.

***Choristorheithrus metadosis* gen. et sp. nov.**

Figures 35–39.

Diagnosis

As for family and generic diagnoses, with the following amendments.

Description

Male segment X with a straight lateral margin. Male forewing 8.0–10.1 mm (n=3), narrower than in *C. camurus* sp. nov, vein R1 reaching wing margin except in one specimen, vein 1A shorter than in *C. camurus* sp. nov.

Type material

Holotype. New South Wales: Styx River, 12 km south of Ebor 17 Oct 1973 AN, 1 m. AM K.677087.

Paratypes. Same locality and collector, 2 m TRI42487, 1 m TRI42485.

Other material examined

New South Wales. Type locality and date, Styx River, 12 km south of Ebor, 17 Oct 1973, AN 4 m TRI320295. Orara SF, Tuckers Knob, 22 Nov 1990, GT, 1 m.

Derivation of name

Metadosis is a Greek word meaning exchange; the reason for its use for this species by A. Neboiss is unknown.

Distribution

The genus is found over a comparatively small area of southern Queensland and northern NSW south to the Hunter River area. Both species were collected from the one site. The Queensland records are unpublished data of the Department of Primary Industries for the Monitoring River Health Initiative. Only one Queensland specimen, a larva, was available for this study.

Female specimens examined

New South Wales. Wilson River Reserve 15 km NW of Bellangry, 7 Dec 1986, 244 m asl, GT, 3; Upper Allyn River 12 km East of Eccleston, 21 Feb 1980, AC, 1 PT1882, TRI 40394; Allyn River Chichester SF, 10–11 Nov 1981, T. Weir, 5; Gloucester River 9 km SW of Gloucester, 17 Feb 1980, AC, 9; Styx River, 12 km south of Ebor, 17 Oct 1973, AN, 7; Orara SF, Tuckers Knob, 22 Nov 1990, GT, 2 TRI 40383.

Larval specimens examined

Queensland. Running Ck at Drynans, 4 Oct 1994, Queensland Department of Primary Industries, 1.

New South Wales. Lynchs Ck on Lynchs Ck Rd before Border Ranges NP, 16 Nov 2011, JM & MS, 1; Barwick\Back Ck near Moffit Falls, 10 Nov 2010, JM & MS, 1; Guy Faulkes R. at Ebor, 10 Nov 2010, JM & MS, 1; Watercress Ck, New England NP, 26 May 1983, 1; Upper Allyn River, 16 Feb 1966, EFR, 1 (no X) X. The first specimen listed is included in BOLD, Bin No. ABV 8944. The second two specimens listed are included with adults of *C. camarus* gen. et sp. nov. in BOLD Bin No. ABV 8943.

Discussion

This genus contains two very similar species with males, females and larvae varying little, so species descriptions are very short with most detail given above for the genus as a whole. Females and larvae cannot be identified past genus level at this stage. COI sequences on the BOLD (BIN no. ABV8943) associate two larvae with *C. camarus* gen. et sp. nov, but another species is represented by only a medium instar larva (BIN no. ABV8944). This larva is assumed here to be *C. metadosis* gen. et sp. nov. The genetic distance of 8% seems adequate to confirm two species, but this is not always the case in some genera of Philorheithridae (St Clair, 2021). Arturs Neboiss recognised three species of *Choristorheithrus* gen. nov., based on a single main character of the male genitalia. One species was based on a few poor condition specimens with only very minor variation to the other two species, so only the two are recognised here.

Larvae of *Choristorheithrus* gen. nov. and *Austrheithrus*, while quite distinct from each other, share some character states not found in the other Australian genera. They are comparatively short, with a pair of triangular-shaped metanotal sclerites. In both genera, the dorsal tooth on the anal claw is particularly short and they have the least sclerotisation on the anal segment. Larvae of these two genera have one distal spine on the end of each hind tibia, with all other genera having two. Their cases are curved and have similar elaborate silk posterior closure membranes that may be species specific in these two genera.

The very flat head of the *Choristorheithrus* gen. nov. larva and more enclosed posterior opening of the case may indicate phragmosis (Bishoff et al., 2023).

Humorheithrus gen. nov.

Type species: *Humorheithrus idiomatus* sp. nov.

Figures 52–71.

Diagnosis

As for family diagnosis, with the following amendments.

Adults. Both sexes are readily identifiable from the following character states. The antennae are very dark with a white band of four or five segments in the distal third. The scutum has a pair of setal warts on either side of the midline and a pair of depressions posterior to the setal warts, about four times the area of the warts (fig. 52). Antennae, tibiae and tarsi all have dark androconia.

Male superior appendages, in dorsal view separated basally with an unsclerotised region between, in all views strongly narrowing to a rounded downturned tip apically. Female with a unique small, narrow, heavily sclerotised, rasp-like striated plate present ventrally immediately anterior to the gonopore. In dorsal view, tergite IX is very short medially dorsally with a fleshy area between the two main sections.

Pupa. A pair of setae at the base of each mandible are particularly dark and thick, and long dark setae are present on the labrum. Similar mandibles setae occur on the mandible, but not on labrum, of *Austrheithrus*, but are longer and thinner.

Larvae. Nine sclerites posterior to the well-developed tergite 9. There are three such posterior sclerites in *Philorheithrus* and about 18 (rarely three) in *Aphilorheithrus*, but none in any other Australian genus.

Description

Male pilifers short, curved and finger-like, about as long as the diameter of the eye (fig. 52); male maxillary palps 4-segmented, moderately long, a little longer than labial palps (fig. 52), female maxillary palps 5-segmented. Scutellum with or without a pair of small setal punctures (fig. 52). Male forewing narrower than in most genera; with only a small anal lobe; with strongly developed post-anal vein, almost as strong as in males of Australian species of *Philorheithrus* and *Tasmanthrus* (fig. 57).

Gender

Masculine.

***Humorheithrus idiomatus* gen. et sp. nov.**

Figures 52–71.

Description

As for family and generic descriptions, with the following amendments.

Head. Antennae longer than wings, segment 1 a little longer than the diameter of the eye, about twice as wide as following segments, segment 3 almost as long as segment 1 (fig. 52), following segments shorter, all antennal segments little modified but dark, androconia thick dorsally on segments 3 to about 5, sparser for the rest of the antenna.

Thorax. Forewing veins R1 and R2 consistently join the wing margin separately in both sexes. Male forewings 6–7.1 mm long (n=5), rounded apically. Female forewings 7.4–7.7 mm (n=4). Forewings with forks 1, 2, 3 and 5, 5 with short footstalk in male, very short in female, fork 4 also present in females, with a footstalk about twice as long as fork (figs 57, 61). One female with M2 about half as long as M1 and not reaching the wing margin in either wing. Vein 1A atrophied in most males with a stump apically (fig. 57). Hind wings pointed apically, more strongly in males, with forks 1, 2, and 5 in both sexes (fig. 57).

Abdomen. Male sternite VI with amongst the largest mid-sternal process within the Australian Philorheithridae medially posteriorly, about the length of the segment, sternite VII with shorter and narrower protuberance; female protuberance shorter and on sternite VI only.

Male genitalia. Segment IX in dorsal view very narrow and almost completely divided, in lateral view widest mediolaterally, in ventral view of uniform width. Superior appendages shorter than segment X and inferior appendages. Segment X in dorsal view broadest basally, with a mesal ridge along dorsal margin, ending in a pair of long narrow arms that curve ventrally. Inferior appendages lack an harpago but are branched similarly to *Philorheithrus* and *Tasmanthrus*. Female genitalia with tergite IX almost divided along the midline, setose in posterior half.

Pupa. Antennae without setae, labrum with three pairs of long dark setae in a line on each side, mandibles long, triangular, very finely serrate on inner margin, a pair of long setae dorsally medially on the head between the antennae, a second pair of long dark setae on the labrum anteriorly. Scutum segment with three setae on either side of the midline. Abdomen with pairs of anterior dorsal hook plates on segments III and IV each with 3–4 teeth, segments V, VI and VII each with 3–6 teeth; posterior hook plate on segment 5 one continuous plate across most of the width of segment, composed of a row of about 100 spines, spines as long as plate. Segment X elongate subtriangular, with two pairs of long setae mesally, ventrally, three pairs on each side laterally and none dorsally. The pupa is enclosed within the larval case. The anterior and posterior pupal closures comprise of a disc of silk, without any openings, each opening with a capping stone.

Larva. Final instar about 13 mm long. Head reddish brown, elongate, narrow, with moderately short carinae over the eyes; frontoclypeal apotome long, about 5 times the length of the posterior suture, ventral apotome very short, about one sixth the

minimum length of the head ventrally. Thoracic tergites with many setae quite pale; metanotum with two pairs of sclerites but with a transverse pale area dividing, or almost dividing, the medial sclerites into two. Forelegs each with one seta on anterior face. Tergite IX with a strongly serrated margin posteriorly and a fringe of about 20 strong setae. Case posterior opening without any modifications.

Type material

Holotype. North Queensland. Upper Freshwater Ck, Whitfield Range, Cairns, M.S. Moulds, 1 m, 15 Dec 1974, Holotype QM T262526.

Paratypes. North Queensland. Upper Freshwater Ck, Whitfield Range, Cairns, 15 Dec 1974, M.S. Moulds, 1 m, 2 m TRI39573, 1 f TRI39556, 1 m TRI39575. Same locality and collector, 24 Aug 1974, Paratype QM T262527. Carron Ck, Kirrama SF, 17° 50' S, 145° 35' E, Apr 1993, GT, 1 m.

Other material examined

North Queensland. Mt Lewis near Julatten, 27 Oct 1988, K. Walker, 1 l; Stream on Tully Gorge Rd 6.7 km downstream power station, 17.756° S, 145.628° E, 8 May 2012, JM & MS, 2 m; Yuccabine Ck Kirrama SF, 27 Nov 1983, RB & LB, 2 l; Second stream on Kirrama Range Rd 2.7 km from National Park sign, 18.1973° S, 145.8701° E, 9 May 2017, RS & DC, 1 l; Rainforest stream with waterfall on Kirrama Range Rd, 18.211° S, 145.808° E, 16 May 2010, JW & MS, 2 m, 3 l; Rainforest stream with waterfall on Kirrama Range Rd, 18.211° S, 145.808° E, 9 May 2011, MS & JM, 2 l; Dunn? Ck at Bridge 11 on Kirrama Range Rd, approx. 14 km from NP sign, 18.2138° S, 145.798° E, 24 Oct 2017, RS & DC, 1 m; Carron Creek, Kirrama SF, 17° 50' S, 145° E, Apr 1993, GT, 2 m; Goodard Ck, Kirrama SF, 18° 06' S, 145° 41' E, Apr 1993, GT, 1 f; Yuccabine Ck, 19.4 km W of Kennedy, 26 Aug 1990, RS, 1 p; Birthday Ck, 3.5 km NW of Paluma, 23 Dec 1989, RS, 1 m, 20 Jan 1990, 17 Feb 1990, 4 m, 2 f, 1 p, 17 Feb 1990, 5 m, 1 f, 17 Mar 1990, 1 f; Birthday Ck near Paluma 16 May 1988, AG, 1 l; Birthday Ck above weir, Mt Spec SF, 18° 57' S, 146° 10' E, 4 Mar 1994, 820 m, AL, 2 m, 15 Oct 2003, 1 f; 1 Jan 1994, 1 m; Tributary of Camp Ck, Mt Spec SF, 18° 57' S, 146.10 E, 760 m asl, 22 Feb 1994, AL, 2 m; Birthday Ck, 3.5 km NW of Paluma, Date??, RS, ??.

Derivation of name

Humor is Latin for wetness and describes the Wet Tropics habitat of the specimens collected. The species name is from the Greek word *idios*, which means distinct or peculiar.

Distribution

This genus is known only from the Wet Tropics in north Queensland.

Acknowledgements

Special thanks to Brian Smith for very constructive comments as reviewer. David Cartwright and John Dean are thanked for discussions during the writing of this paper.

David Cartwright and I used permits WITK15549915 and TWB/02B/2015 in Queensland, acquired through the Entomological Society of Queensland. In New South Wales, Scientific Research permit P07/0095–1.0 26/10/07–25/10/08 and NPWS S12404 expired 30 Oct 2008 for Alena Glaister, David Cartwright, John Dean and Ros St Clair. I thank the relevant government departments and the Entomological Society of Queensland for their help.

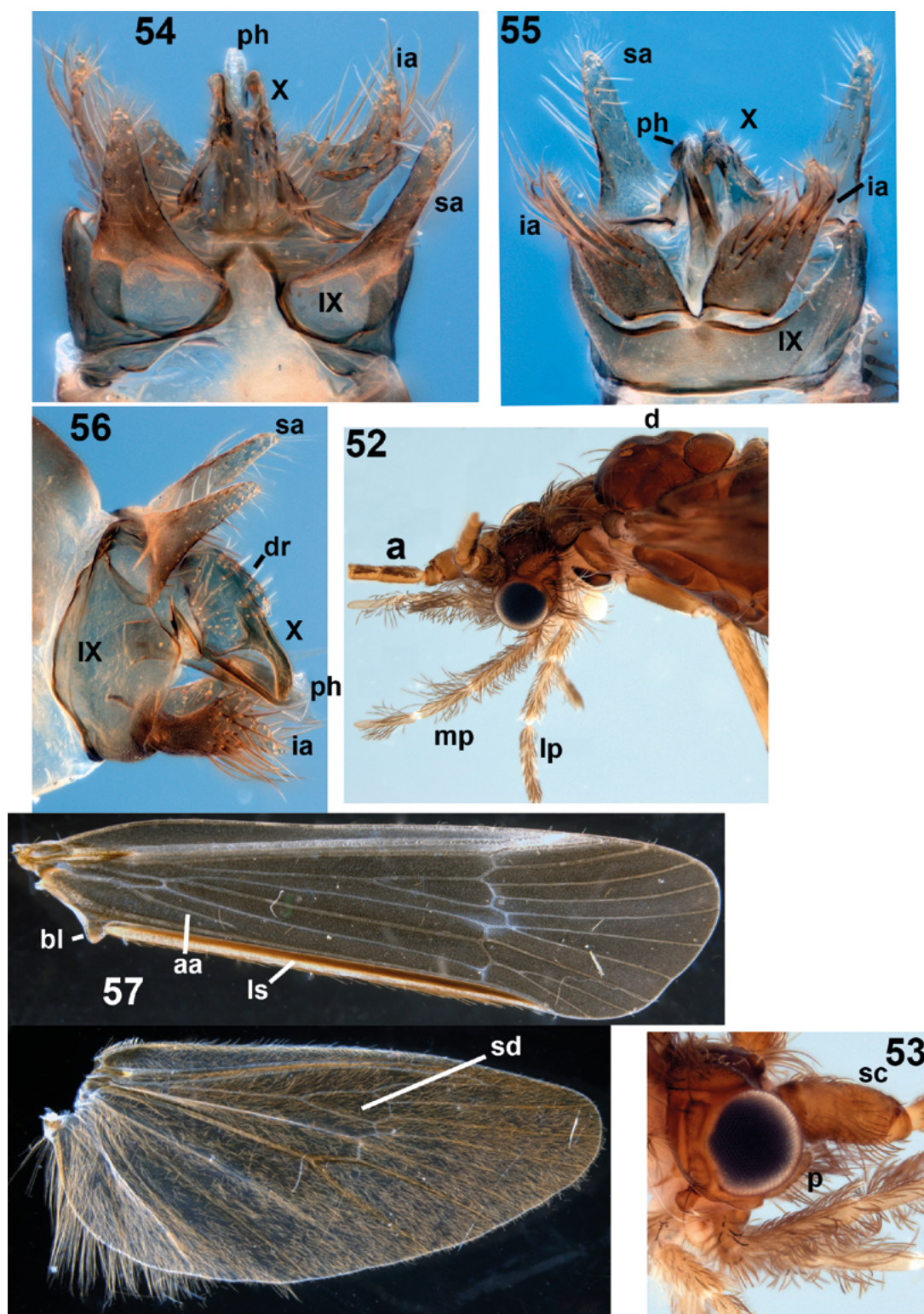


Plate 11. Figures 52–57. *Humorheithrus idiomatus* gen. et sp. nov. Male. Paratype TRI 39559: 52. head and thorax dorsolateral; 53. head lateral. Holotype QM T262526: 54. genitalia dorsal; 55. genitalia ventral; 56. genitalia lateral; Holotype QM T262526: 57. wings.

Abbreviations. a androconia on antennae; aa atrophied anal vein; bl basal lobe of forewing; d depression posterior to scutal setal wart; dr dorsomesal ridge on segment X; ia inferior appendage; IX segment IX; lp labial palp; ls long setae in 'post anal' vein; mp maxillary palp; p pilifer; ph phallus; sa superior appendages; sc scape; sd short discoidal cell; X segment X.

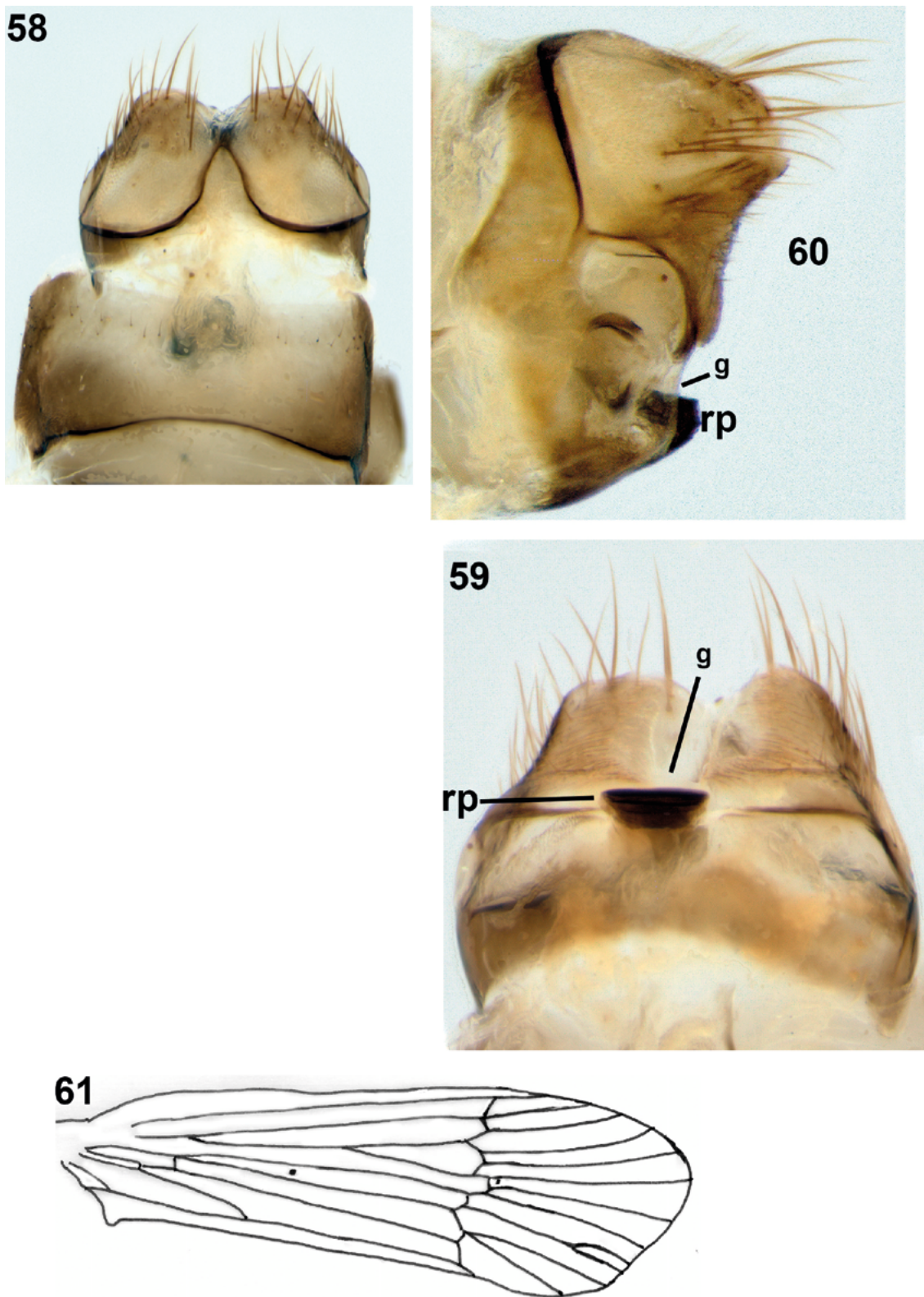


Plate 12. Figures 58–61. *Humorheithrus idiomatus* gen. et sp. nov. Female. Paratype TRI39556: 58. genitalia dorsal; 59. genitalia ventral; 60. genitalia lateral; 61. forewing.
Abbreviations: g gonopore; rp rasp-like striated plate.

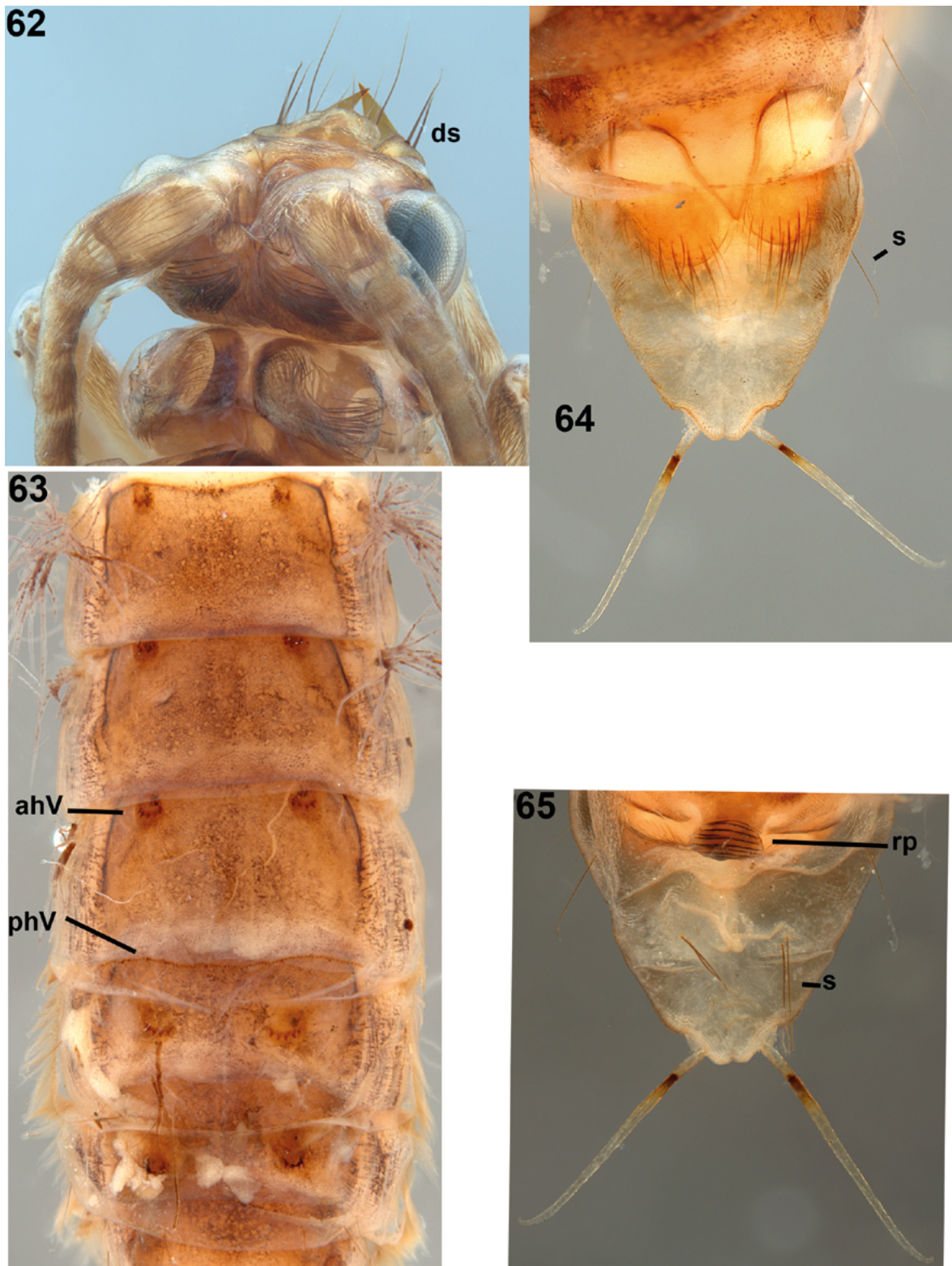


Plate 13. Figures 62–65. *Humorheithrus idiomatus* gen. et sp. nov. Pupa. TRI 45600: 62. head dorsal; 63. abdomen dorsal; 64 segment X dorsal; 65 segment X ventral.

Abbreviations: ds dark setae at base of mandible and on labrum; ahV anterior hook plate segment V; phV posterior hook plate segment V; rp rasp-like striated plate of pharate female; s setae on segment X.

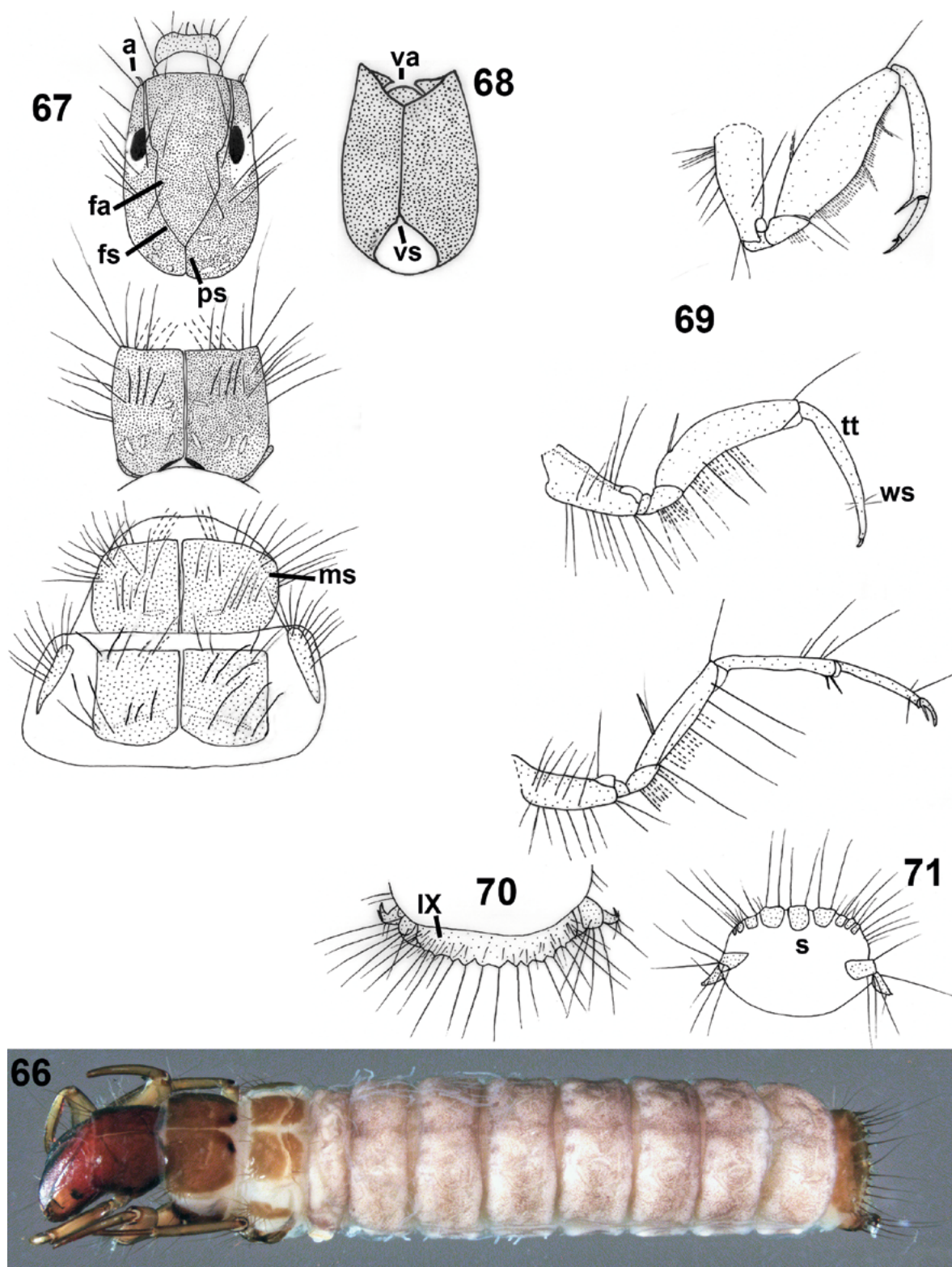


Plate 14. Figures 66–71 *Humorheithrus idiomatus* gen. et sp. nov. Larva. TRI 58131: 66. body dorsolateral; TRI 58130: 67. head and thorax dorsal; 68. head ventral; 69. posterior face of legs lateral; 70. tergite IX dorsal; 71. tergite IX ventral.

Abbreviations: a antenna; fa frontoclypeal apotome; fs frontoclypeal suture; IX tergite IX; ms metanotal sclerite; ps posterior suture; s sclerites ventral to tergite IX; tt tibiatarsus; va ventral apotome; vs ventral suture; ws weak setae possibly remnant distal setae of original tibia.

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