

Revision of the South American species of *Austrothaumalea* Tonnoir (Diptera: Thaumaleidae)

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Abstract

The *Austrothaumalea* fauna of South America is revised and includes five species: *A. apicalis* Edwards, *A. chilensis* Edwards, *A. fredericki* Pivar **sp. nov.**, *A. setipennis* Edwards **stat. rev.** and *A. spatulata* Schmid. The genus *Oterere* McLellan **syn. nov.** is considered a new junior synonym of *Austrothaumalea* Tonnoir on the basis of several shared apomorphic characters. All previously described South American species are redescribed, including females where possible. Illustrations and micrographs of all species are provided, as well as distribution maps, keys to genera and species, and discussions regarding phylogenetic affinities.

Key words: Argentina, Chile, *Oterere*, *Niphta*, madicolous, Andes, midge, diversity

Introduction

An uncommonly encountered family of lower Diptera, Thaumaleidae consists of approximately 200 species classified in eight genera. Considered to be the sister family to Simuliidae (black flies) (Moulton 2000; Bertone *et al.* 2008; Wiegmann *et al.* 2011; Borkent 2012; Kutty *et al.* 2018), thaumaleids are significantly less studied due to their restricted larval habitat and lack of known medical or economic importance to humans. Commonly referred to as seepage or solitary midges, madicolous midge is more apt as it encompasses all of their potential preimaginal habitats, including rock-face seepages, margins of waterfalls, and splash zones of cascading streams (Sinclair 2000; Pivar *et al.* 2018a, b). Madicolous habitats are characterized as thin films of water, frequently flowing over rocky surfaces (Mackie 2004; Shimabukuro & Trivinho-Strixino 2018).

The first record of thaumaleids in South America was that of Röder (1886), who reported a thaumaleid from the Ecuadorian Andes; however, our attempts to locate the specimen to authenticate the record failed. Edwards (1930) was the first to describe thaumaleids from South America, recognizing four species in the genus *Austrothaumalea* Tonnoir. Two of these were later transferred to the genera *Niphta* Theischinger and *Oterere* McLellan (Theischinger 1986; McLellan 1988). Nearly four decades elapsed before additional studies were published—those of Stone (1966), who presented a catalogue of thaumaleids known from south of the United States, and Schmid (1970), who added another species of *Austrothaumalea*. These publications corrected a nearly total dearth of knowledge about South American thaumaleids, but included descriptions were brief, illustrations omitted key details, little to no attention was given to phylogenetic affinities, and identification keys were not provided. Most recently, Pivar *et al.* (2018b) described *Neothaumalea atlantica* Pivar & Pinho, the first thaumaleid recorded from Brazil.

Herein, one new species of *Austrothaumalea* is described, the male for *A. apicalis* Edwards is described for the first time, all remaining males and females are redescribed for all available species, and *Oterere* is synonymized with *Austrothaumalea*. Distribution maps, keys to genera and species, and discussions regarding phylogenetic affinities are also provided.

Material and methods

Collection attempts in suitable habitats from as near as possible to the perceived type localities were made in an effort to recollect fresh topotypical material. An aerial net was used to sweep above the madicolous substrate and adjacent riparian vegetation. Sweeping for adults should be attempted first if possible, as searching for larvae may cause adults to fly deeper into vegetation or into more difficult-to-sweep areas. Special attention should be given to dead branches and leaf apices, where adults have frequently been observed resting (Pivar, pers. obs.). Once collected, specimens were placed directly into 75% non-denatured ethanol for morphological studies or 95% non-denatured ethanol for molecular studies. The authors were unsuccessful in their search for the immature stages of *Austrothaumalea*.

Adult genitalia were cleared with hot 85% lactic acid. Representative specimens were also cleared with the GeneJET Genomic DNA Purification Kit #K0722 (ThermoScientific, Waltham, MA) to extract DNA for subsequent molecular study, which enabled greater scrutiny of membranous and lightly sclerotized structures. The manufacturer's standard protocol was followed and cleared voucher specimens are stored in 70% non-denatured ethanol. Female specimens were positively identified by comparing their DNA sequences to those of identified males. Asterisks ("*") in the Additional Material Examined sections denote specimens identified using molecular data. Pinned specimens were dried using hexamethyldisilazane (HMDS) following the protocol outlined by Brown (1993). Cleared terminalia are preserved in glycerine-filled microvials pinned beneath the specimen.

Specimens were viewed using a Meiji Techno RZ stereomicroscope. Light micrographs of pinned adults were captured using a Progres Gryphax® Naos 22 megapixel camera (Jenoptik, Jena, Germany) mounted on the Meiji scope, aided by iSolution Lite x64 software (Focus Precision Industries, Victoria, MN, USA). Image stacks were created using Helicon Focus 6.7.1 (HeliconSoft, Roseau Valley, Dominica). Cleared terminalia in glycerine were viewed using an Olympus BH-2 compound microscope equipped with DIC and images were taken following the same procedure as above. Line drawings were first traced from stacked micrograph images captured using the compound microscope, structures were re-evaluated by closely re-examining specimens (as stacking failed to clearly differentiate critical internal characters), then line drawings were inked and digitized for publication.

Terms used for adult structures follow Cumming & Wood (2017). *Austrothaumalea* is the only thaumaleid genus where a cubital spur can be observed, although it is not present in every species. Crossvein R_{2+3} is also variable among species. At this stage, generic concepts in the family are still evolving. It is for this reason our generic diagnosis contains polymorphic character states and species descriptions include characters that appear repetitive but may prove useful in the future as generic concepts evolve. Distribution maps were created with SimpleMapper (Shorthouse 2010).

Specimens will be deposited in the following repositories: Canadian National Collection of Insects, Ottawa, Canada (CNC); Instituto de Entomología, Universidad Metropolitana de Ciencias de la Educación, Santiago, Chile (UMCE); Museo Nacional de Historia Natural, Santiago, Chile (MNHC); National Museum of Natural History, Smithsonian Institution, Washington, D.C., USA (USNM); Robert J. Pivar, private collection, Ancaster, Ontario, Canada (RJP); University of Tennessee, Knoxville, Tennessee, USA (UTK).

Label data for primary types are presented exactly as they appear. Data are listed from the top downward on the staging pin, with data from each label enclosed in quotation marks; lines are delimited by a forward slash mark. Repository is given in parentheses and USNM database numbers are listed.

Key to male and female adults of South American genera of Thaumaleidae

(modified from Pivar *et al.* (2018b)).

- 1 Antealar ridge absent; proepisternal setae present (Fig. 1) *Austrothaumalea* Tonnoir
- Antealar ridge present (Pivar *et al.* 2018b, fig. 4); proepisternal setae absent. 2
- 2 $R_1(+R_{2+3})$ with several widely spaced weakenings or depigmented gaps (e.g., Fig. 2); eye bridge broad, more than five facets wide; male terminalia without hypandrium and parameres fused *Niphta* Theischinger
- $R_1(+R_{2+3})$ without widely spaced weakenings or depigmented gaps; eye bridge narrow, comprising two to three facets (Pivar *et al.* 2018b, fig. 4); male terminalia with hypandrium narrow and parameres separate, not fused (Pivar *et al.* 2018b, figs 8, 9) . . .
..... *Neothaumalea* Pivar, Moulton & Sinclair

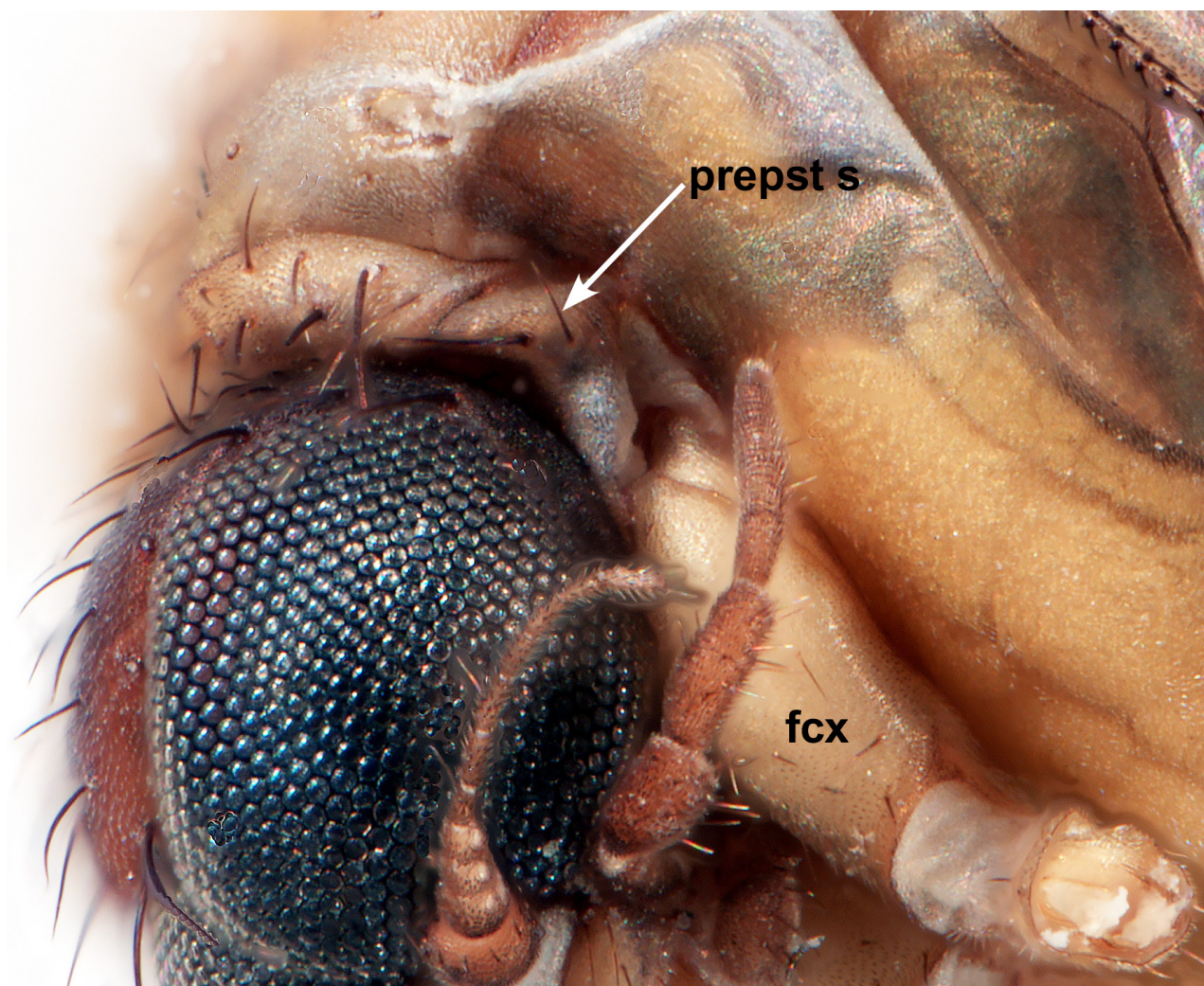


FIGURE 1. Male of the non-South American species *Austrothaumalea zentae* Theischinger illustrating the proepisternal seta, dorsolateral view. Abbreviations: fcx, fore coxa; prepst s, proepisternal seta.

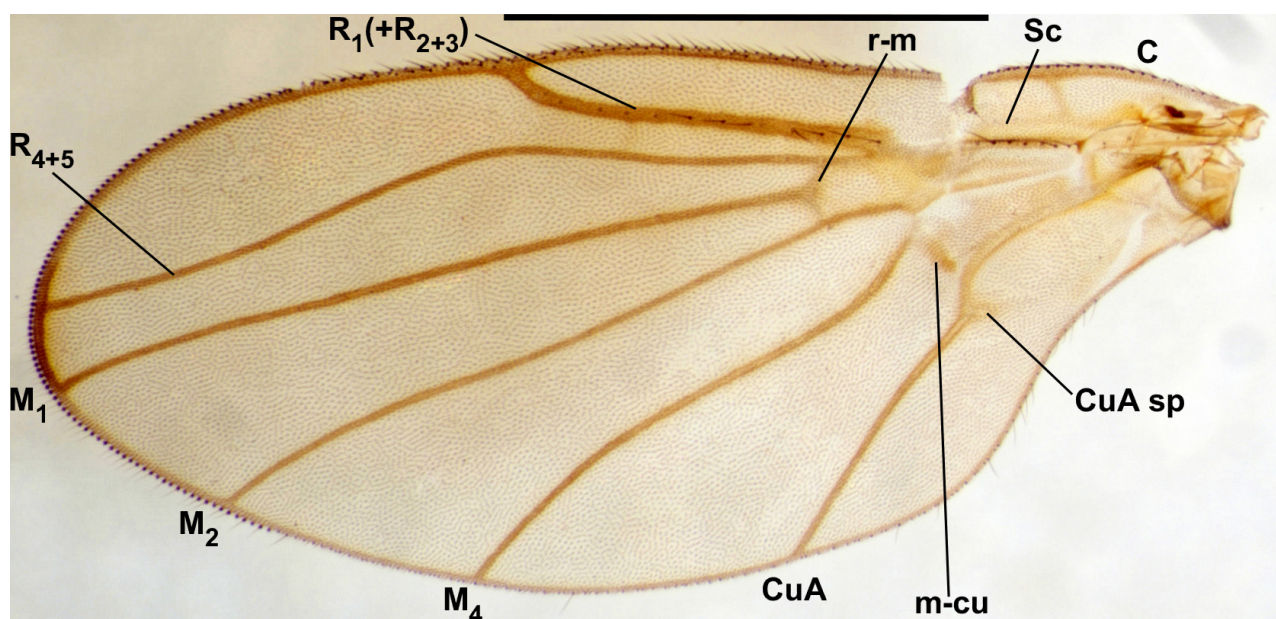


FIGURE 2. Left wing of *Austrothaumalea spatulata*. Abbreviations: C, costa, CuA sp, anterior branch of cubital vein and spur; M, medial veins; m-cu, medial-cubital crossvein; R, radial veins; r-m, radial-medial crossvein; Sc, subcosta. Scale bar = 1.0 mm.

Taxonomy

Genus *Austrothaumalea* Tonnoir

Austrothaumalea Tonnoir, 1927: 109. Type-species: *Austrothaumalea neozealandica* Tonnoir (original designation).
Oterere McLellan, 1988: 573. Type-species: *Oterere oliveri* McLellan (original designation) **syn. nov.**

Diagnosis. *Austrothaumalea* is characterized as follows: absence of a distinct antealar ridge; proepisternal setae present; microtrichia of $R_1(+R_{2+3})$ extending length of vein; R_{2+3} crossvein usually situated closer to apex of $R_1(+R_{2+3})$ than to origin of R_{4+5} ; R_{4+5} often with arch strongly produced; basal spur of CuA often present; gonocoxites slender, longer than wide; hypandrium broad; parameres fused medially.

Distribution. Argentina, Chile, New Caledonia, New Zealand and Australia (including Tasmania).

Notes on synonymy. McLellan (1988) erected the genus *Oterere* to include two species, *O. oliveri* McLellan and *O. setipennis* (Edwards). Sinclair (2008a,b) questioned the validity of the genus as several purported diagnostic characters (a well-developed spur on CuA, macrotrichia on R_{4+5} and patterned wings) are also found in species of *Austrothaumalea*. *Oterere* is synonymized on the basis of these shared characters and through molecular data (unpublished data). The following taxonomic changes are proposed:

Austrothaumalea oliveri (McLellan), 1988: 573 (*Oterere*) **comb. nov.**

Austrothaumalea setipennis Edwards, 1930: 113 (*Austrothaumalea*) **stat. rev.**

Key to adult males of South American species of *Austrothaumalea*

- | | | |
|---|--|--|
| 1 | Macrotrichia present on dorsal surface of wing vein M_1 | <i>A. setipennis</i> Edwards stat. rev. |
| - | Macrotrichia absent on wing vein M_1 (Fig. 2) | 2 |
| 2 | Epandrium with posterolateral projections (Figs 4A, 5A) | <i>A. apicalis</i> Edwards |
| - | Epandrium without posterolateral projections (Figs 4B–E, 5B–E) | 3 |
| 3 | Paramere spatulate, without lateral projections (Figs 4E, 5E) | <i>A. spatulata</i> Schmid |
| - | Paramere cruciate, with lateral projections (Figs 4B,C 5B,C) | 4 |
| 4 | Lateral projections on paramere located toward apex, extended beyond apex of gonocoxal plate (Figs 4B, 5B) | <i>A. chilensis</i> Edwards |
| - | Lateral projections on paramere located at mid-length, dorsal to gonocoxal plate (Figs 4C, 5C) | <i>A. fredericki</i> Pivar sp. nov. |

Species diagnoses and descriptions

Austrothaumalea apicalis Edwards

(Figs 3A, 4A, 5A, 6A, 7A, 8)

Austrothaumalea apicalis Edwards, 1930: 113.

Other references: Stone, 1966: 1 (catalogue); Arnaud, 1977: 284 (distribution); Theischinger, 1986: 316 (phylogenetic discussion); Sinclair, 2008b: 12 (*fusca* species group).

Type material examined. Holotype: ♀, minuten pinned with right wing mounted on plastic card, pinned beneath specimen, abdomen mounted in resin, labelled: “Bariloche./ 1.xii.1926.”; “*Austrothaumalea/ apicalis* Edw./ F.W. Edwards/ det. 1930.”; “Argentina./ Terr. Rio Negro./ F. & M. Edwards./ B.M. 1927 – 63.”; “HOLO-/ TYPE [white label with red margin]”; “NHMUK010210687” (BMNH). **Paratype:** same label data as holotype (1♀, BMNH).

Recognition. The only described species of South American *Austrothaumalea* with posterior epandrial projections (also present in some Australian species). This feature, along with the more rounded apex of the paramere and concave posterior margin of the gonocoxal plate distinguish it from *A. spatulata*. *Austrothaumalea apicalis* is similar to *A. fredericki*, with both having darkened wing tips and yellowish body colour.

Redescription. Male. $n = 1$. Length 2.1 mm. Colouration (Fig. 3A). Head dull, dark brown; pronotum and postpronotum brown; postpronotal lobe brown; prescutum with lateral margins brown; mesoscutum uniformly yel-

lowish brown, shiny; scutellum and mediotergite pale brown, shiny; pteropleuron brown with ill-defined darker markings; halter yellowish brown; legs pale brown, apices of femora and tarsi darkened; abdomen dark brown; terminalia brown.

Head. Eyes above antennae broadly joined, barely exposing frons above antennae. Flagellomeres 1–3 expanded, subquadrate; 1 as long as 2 and 3 combined; flagellomeres 4–10 thin, cylindrical, becoming progressively more elongate. Vertex with yellow setae of uniform length, with a few longer, black orbital setae.

Thorax. Pronotal setae longer than scutal setae. Scutum clothed dorsally in short setulae; notopleural, supra-alar and postsutural setae long, black. Pteropleuron bare. All legs with tarsomere 4 bilobed.

Wing. Wing length: 2.7 mm. Lightly infusate throughout except for distinct dark, apical spot encircling apex of R_{4+5} and M_1 (Fig. 3A); apex broadly rounded; C and posterior wing margin with fringe of microtrichia; Sc incomplete; R_1 and $R_1(+R_{2+3})$ without weakenings or depigmented gaps, with uniseriate row of microtrichia along entire length, remaining veins bare; R flexed into cell br; R_{2+3} crossvein very weak or absent, at most a faint infuscation, situated slightly beyond midpoint of $R_1(+R_{2+3})$; bend in R_{4+5} gentle; R_{4+5} and M_1 running parallel toward wing margin; M_1 and M_2 straight; M_4 slightly sinuous; CuA with basal spur shorter than crossvein m-cu.

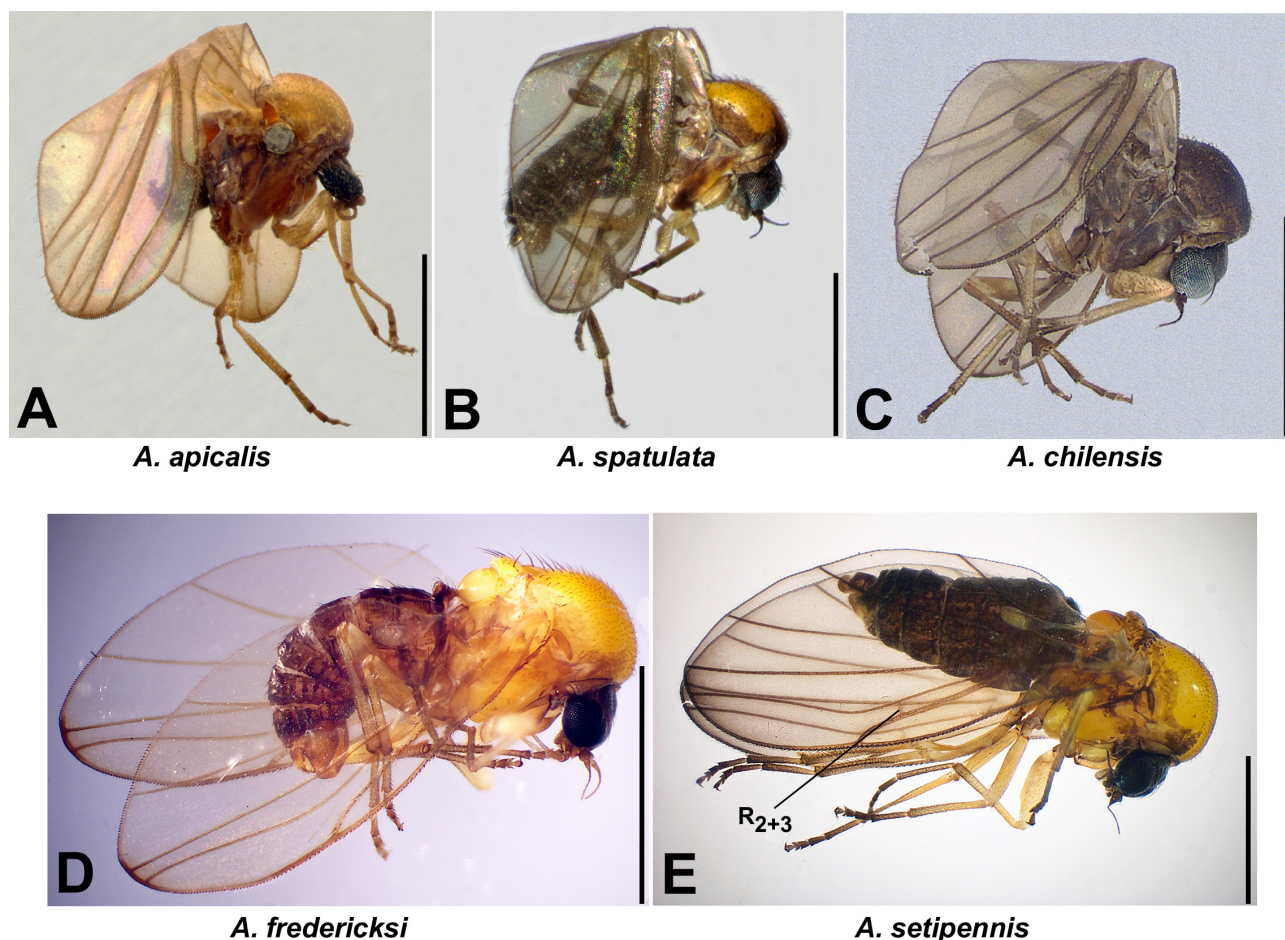


FIGURE 3. Adult habitus photographs of *Austrothaumalea*, lateral view. **A**, *A. apicalis* (♂); **B**, *A. spatulata* (♂); **C**, *A. chilensis* (♂); **D**, *A. fredericki* sp. nov. (♂); **E**, *A. setipennis* stat. rev. (♀). R_{2+3} , second + third radial vein. Scale bars = 1.0 mm.

Abdomen. Abdominal sternites 1–4 not observable due to dissection; sternites 5–6 rectangular, weakly sclerotized, anterior margin well sclerotized, setae restricted to posterior third; sternite 7 rectangular, a few setae on posterior third, weakly sclerotized, anterior margin well sclerotized, arched slightly into preceding sternite; sternite 8 crescent-shaped, bare, weakly sclerotized except for anterior margin slightly more sclerotized and arched slightly into preceding sternite.

Terminalia (Figs 4A, 5A). Epandrium trapezoidal from ventral aspect; apical half tapered; posterior margin narrow, slightly indented, with single small tooth-like projection from posterolateral margin. Hypandrium broad in ventral view, wider than basal width of gonostylus; anterior margin not concave. Gonocoxite broadest basally, inner margin nearly parallel, smooth. Gonostylus shorter than gonocoxite, basal quarter straight then gently curved

medially; broadest at basal quarter, apical three-quarters uniform in width; apex truncate. Parameres distally fused, three-quarters length of epandrium; expanded irregularly toward apex. Gonocoxal plate weakly sclerotized, apical third tapered, posterior margin slightly concave with posterolateral projection on each corner; nearly half-length of gonocoxite; basally not fused to hypandrium. Cercus weakly sclerotized, situated along midline of epandrium.

Female. *n* = 1. Similar to male except as follows: *Length*: 2.3 mm. *Abdomen*: Tergites 8–9 noticeably more sclerotized than preceding segments; only anterior margin of sternite 7 well sclerotized. *Terminalia* (Figs 6A, 7A): Hypogynial valve not projected beyond tergite 9; posterior margin rounded with shallow cleft in ventral view; densely setose. Tergite 9 rectangular in lateral view, wider than tergite 8, lacking lateral projections. Sternite 9 (genital fork) thin, rod-shaped, posteriorly divided into two triangular-shaped sclerites; distal margin of lateral arms extended beyond hypogynial valve, arms nearly meeting along midline, golf club-head shaped in lateral view. Hypoproct arched, thin medially. Cercus rounded, projected slightly posterodorsally; bearing numerous setae. Spermathecal ducts not observed.

Immature Stages. Unknown.

Additional Material Examined. ARGENTINA: Rio Negro: Bariloche, XI-1926, R. & E. Shannon, USNM-ENT01115807 (1♂, USNM); CHILE: Region X (Los Lagos): Casa Pangué, Llanquihue, XII-1926, R. & E. Shannon, USNM-ENT01115806 (1♀, USNM).

Distribution. Known from adjacent localities on the Chile-Argentina border in the southern Andes (Fig. 8).

Remarks. Edwards (1930) did not describe the male specimen. Alan Stone identified the male specimen herein treated as *A. apicalis* (year not specified on determination label), but he never formally described it. Since it was collected in the same region as the holotype female, and it is uniquely distinct from all other described males, we also have identified it as the putative male.

The holotype date label reads “.xi-1.xii.1926”, with “.xi-” scratched out with pencil.

Austrothaumalea chilensis Edwards

(Figs 3C, 4B, 5B, 6B, 7B, 8, 9A)

Austrothaumalea chilensis Edwards, 1930: 111.

Other references: Stuardo, 1946: 42 (catalogue); Stone, 1966: 1 (catalogue); Arnaud, 1977: 284 (distribution); Theischinger, 1986: 316 (phylogenetic discussion); Sinclair, 2008b: 11 (*capricornis* species group).

Type material examined. Holotype: ♂, minuten pinned with abdomen mounted in resin, labelled: “Ancud./ 17–19.xii.1926.”; “*Austrothaumalea/ chilensis* Edw./ F.W. Edwards/ det. 1930.”; “S. Chile:/ Chiloe I./ F. & M. Edwards./ B.M. 1927 – 63.”; “HOLO-/ TYPE [white label with red margin]”; “NHMUK010210688” (BMNH). **Allotype:** ♀, same label data as holotype (BMNH). **Paratypes:** CHILE: Region X (Los Lagos): Casa Pangué (1♂, BMNH); Ancud (3♂, 1♀, BMNH).

Recognition. The gonocoxal plate with long, lateroapical teeth, and the cruciate paramere are characters that readily distinguish this species. The lateral, cross-like projections on the paramere are located apically, not concealed by the gonocoxal plate and are much shorter than those of *A. fredericki*. This is also the only known thaumaleid in South America to have the gonocoxal plate secondarily fused to the ventral surface of the hypandrium.

Redescription. Male. *n* = 4. *Length* 2–2.3 mm. *Colouration* (Fig. 3C). Head dull, dark brown; pronotum and postpronotum brown; postpronotal lobe brown; mesoscutum and pleura brown, somewhat shiny; scutellum and mediotergite brown, shiny; katapisternum dark brown; halter brown, dark at apex of knob; legs pale brown, apices of femora and tarsi darkened; abdomen dark brown; terminalia brown.

Head. Eyes above antennae broadly joined, frons above antennae barely exposed. Flagellomeres 1–3 expanded, subquadrate; 1 as long as 2 and 3 combined; flagellomeres 4–10 thin, cylindrical, becoming progressively more elongate. Vertex clothed in golden setae of uniform length, with sparse, long, black orbital setae.

Thorax. Pronotal setae longer than scutal setae. Scutum clothed dorsally in short, golden setulae; notopleural, supra-alar and postsutural setae long, black. Pteropleuron bare. Fore- and mid legs with tarsi simple, hind leg with tarsomere 4 bilobed.

Wing. Wing length: 2.2–3.0 mm. Lightly infusate throughout, apex broadly rounded; C and posterior wing margin with fringe of microtrichia; Sc incomplete; R_1 and $R_1(+R_{2+3})$ without weakenings or depigmented gaps, with uniseriate row of microtrichia along entire length, remaining veins bare; R flexed into cell br; R_{2+3} crossvein strong,

situated toward apex of $R_1(+R_{2+3})$; bend in R_{4+5} well-defined; R_{4+5} and M_1 running parallel toward margin; M_1 and M_2 straight; M_4 slightly sinuous; CuA with basal spur shorter than crossvein m-cu.

Abdomen. Abdominal sternite 1 narrow, spectacle-shaped; sternite 2 reduced to slender median sclerite, few setae on posterior margin; sternites 3–6 rectangular, weakly sclerotized, setae largely restricted to posterior half; sternite 7 semi-circular, a few setae on posterior margin, weakly sclerotized except for anterior margin, arched slightly into preceding sternite; sternite 8 crescent-shaped, bare, well sclerotized, strongly arched into preceding sternite.

Terminalia (Figs 4B, 5B). Epandrium elongate-oval from ventral aspect; apical third slightly tapered; posterior margin broad and rounded; lacking pointed posterolateral processes. Hypandrium broad in ventral view, wider than basal width of gonostylus; anterior margin not concave. Gonocoxite broadest basally, inner margin parallel, smooth. Gonostylus shorter than gonocoxite, gently curved throughout, tapered to point. Parameres distally fused, three-quarters length of epandrium, apex cruciform. Gonocoxal plate with well sclerotized base divided into two lateral, sclerotized arms terminating in 2–4 long apical teeth, arranged irregularly; nearly three-quarters length of gonocoxite; inner basal third lightly sclerotized, apical two-thirds membranous; secondarily fused to ventral surface of hypandrium. Cercus weakly sclerotized, situated along midline of epandrium.

Female. $n = 2$. Similar to male except as follows: *Length*: 1.8–2.1 mm. *Abdomen*: Tergites 8–9 noticeably more sclerotized than preceding segments; only anterior margin of sternite 7 well-sclerotized. *Terminalia* (Figs 6B, 7B): Hypogynial valve slightly shorter than tergite 9; posterior margin with rounded shallow cleft in ventral view; densely setose. Tergite 9 rectangular in lateral view, wider than tergite 8, posterodorsal corner projected posteriorly. Sternite 9 (genital fork) connected anteriorly, then divided into two thin arms, projecting laterally before cleft of hypogynial valve and expanded into rounded sclerite; lateral arms extended slightly beyond hypogynial valve, arms nearly meeting along midline; spectacle-shaped in lateral view, with anterior portion circular and posterior portion trapezoidal. Cercus rounded, projected posteriorly; bearing numerous setae. Spermathecal ducts not observed; spermathecal pump located in middle of lateral arm, short, thickened.

Immature Stages. Unknown.

Additional Material Examined. CHILE: Region RM (Santiago): El Canelo, 10-I-1967, 33°37'S 71°35'W, 950 m, E.I. Schlinger (1♂, CAS). Region IX (Araucanía): Rte. 71, 15-XII-2016, 38°13'20.3"S 71°44'41.1"W, elev. 1047 m, seep, J.K. Moulton & R.J. Pivar (1♂); Region X (Los Lagos): Isla Chiloé, Ancud, XII-1926, R&E Shannon (1♂ (USNMENT01115810), 2♀ (USNMENT01115808-09) USNM).

Distribution. Known from the Andes of central Chile, south to Isla Chiloé along the Chilean Coastal Range (Figs 8, 9A).

Remarks. We visited the locality based on GPS coordinates given on the Schlinger specimen label and arrived at a site near the coastal town of San Antonio, where no appropriate thaumaleid habitat was visible. We also visited a site in the Andes, in a small town named 'El Canelo', which has a number of mountain creeks with suitable habitat, although the creek, Estero el Canelo (33°34'31"S 70°26'47"W), was fenced off and inaccessible for collecting attempts.

Austrothaumalea fredericki Pivar sp. nov.

(Figs 3D, 4C, 5C, 8, 9B)

Type material. Holotype: ♂, glued to point with abdomen in glycerine microvial pinned beneath, labelled: "CHILE: Region X (Los/ Lagos) East side Lago/ Llanquihue/ small falls on road (nr PN/ VPR) 41°08.47'S/ 72°35.28'W ~100m/ 2.xii.2008 GW Courtney/ (CH08-30)"; "HOLOTYPE/ *Austrothaumalea/ fredericki/* Pivar [red label]" (CNC).

Recognition. This species is recognized by its cruciate parameres. The lateral, cross-like projections on the paramere are located at mid-length, concealed by the gonocoxal plate (in ventral view) and are much longer than those of *A. chilensis*.

Description. Male. $n = 1$. *Length* 2.8 mm. *Colouration* (Fig. 3D). Head dull, dark brown; pronotum, postpronotum, postpronotal lobe and lateral margins of prescutum yellowish brown; prescutum and mesoscutum shiny, primarily yellow, with pleura yellowish brown; two lateral brown spots above scutoscuteellar suture; scutellum and mediotergite shiny, yellow; paratergite yellowish brown; katapisternum mainly yellow, remaining pteropleuron yellowish brown; halter brown; legs pale brown, tarsi darker; abdomen brown; terminalia light brown.

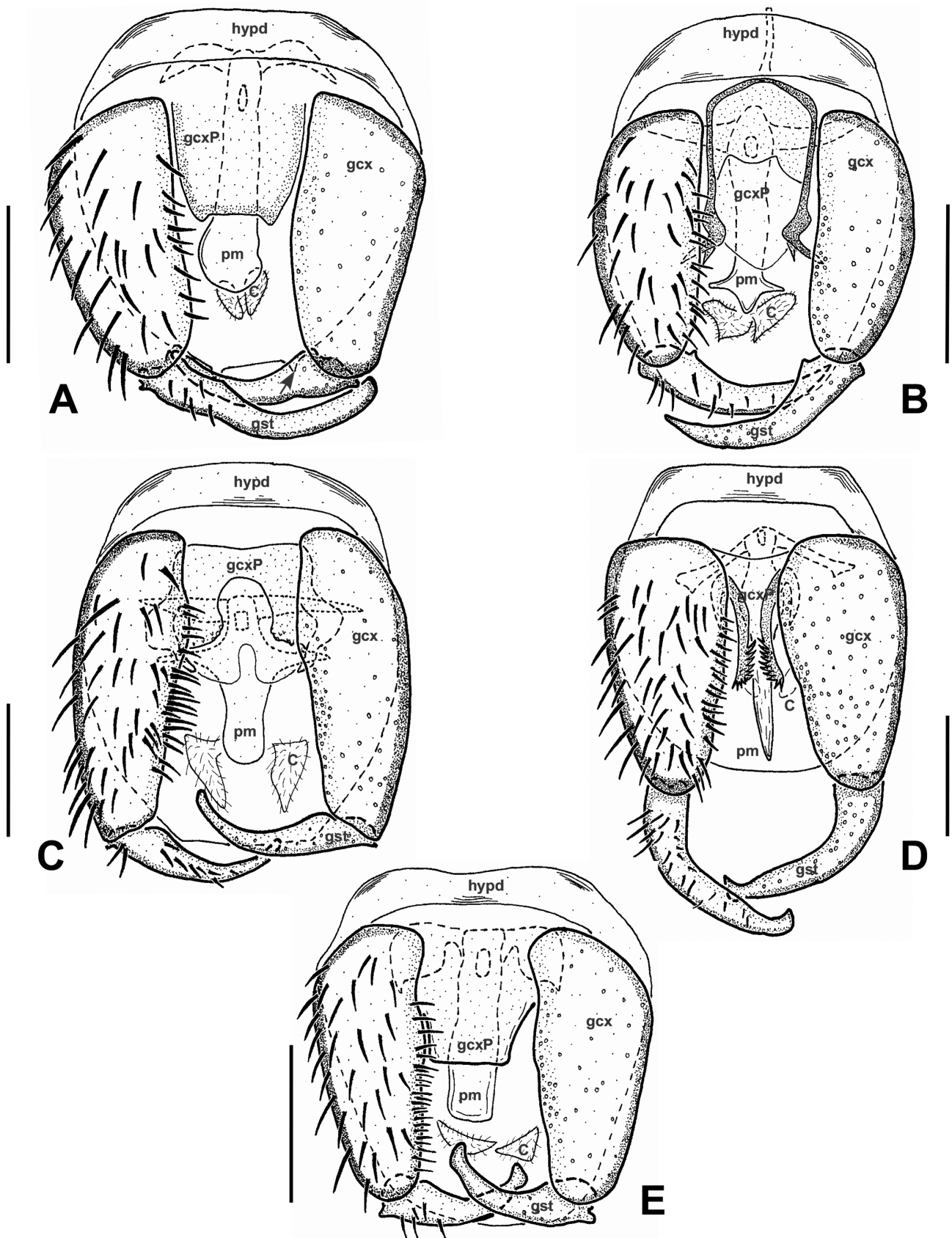


FIGURE 4. Ventral views of male *Austrothaumalea* terminalia. **A**, *A. apicalis*; **B**, *A. chilensis*; **C**, *A. fredericki* **sp.nov.**; **D**, *A. setipennis* **stat. rev.**; **E**, *A. spatulata*. Abbreviations: c, cercus; gcx, gonocoxite; gcxP, gonocoxal plate; gst, gonostylus; hypd, hypandrium; pm, paramere. Arrow denotes apical epandrial projection. Scale bars = 0.1 mm.

Head. Eyes above antennae broadly joined, barely exposing frons above antennae. Flagellomeres 1–3 expanded, subquadrate; 1 as long as 2 and 3 combined; flagellomeres 4–10 thin, cylindrical, becoming progressively more elongate. Vertex clothed in golden setae of uniform length, with sparse long, black orbital setae.

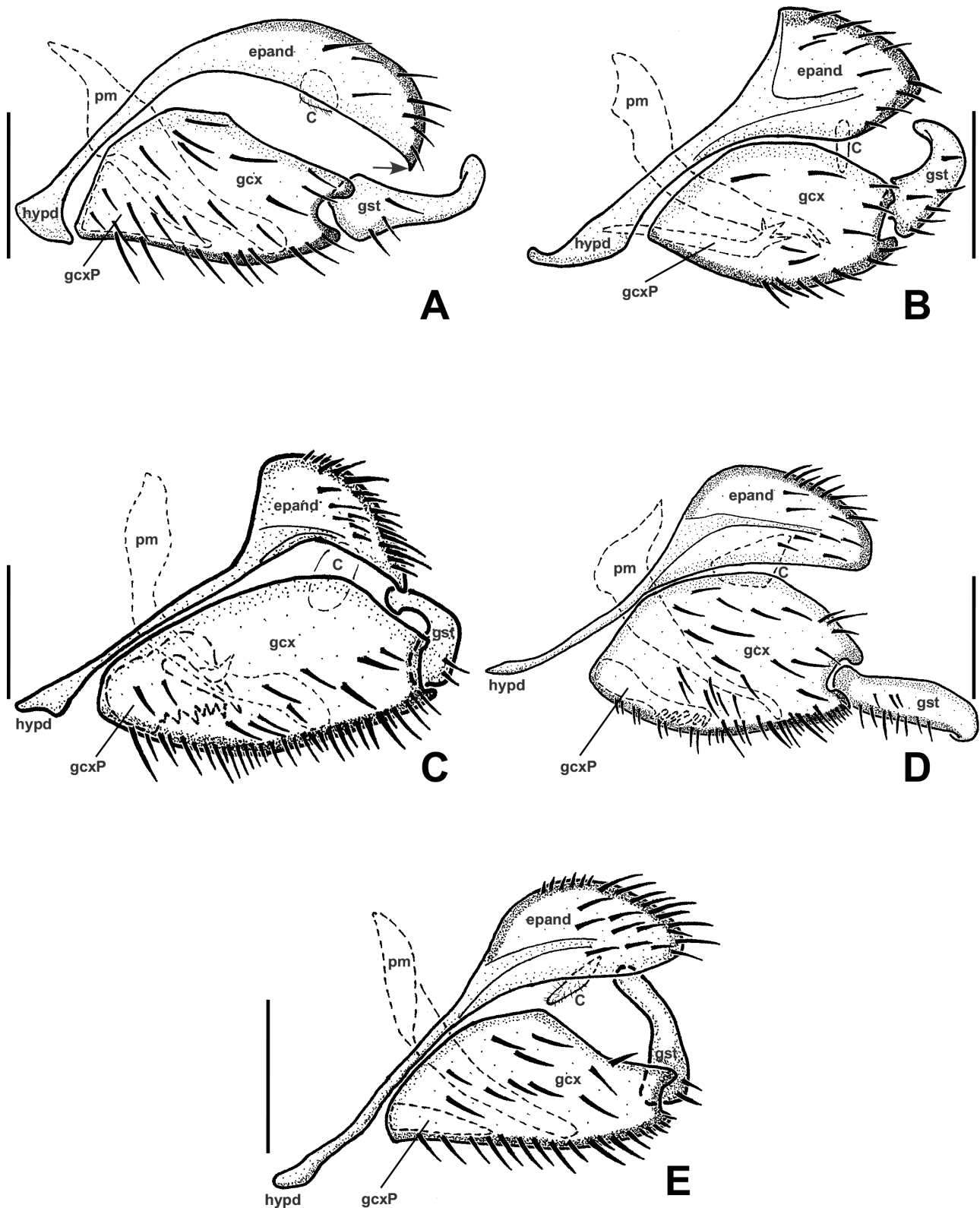


FIGURE 5. Lateral views of male *Austrothaumalea* terminalia. **A**, *A. apicalis*; **B**, *A. chilensis*; **C**, *A. fredericki* **sp. nov.**; **D**, *A. setipennis* **stat. rev.**; **E**, *A. spatulata*. Abbreviations: c, cercus; epand, epandrium; gcx, gonocoxite; gcxP, gonocoxal plate; gst, gonostylus; hypd, hypandrium; pm, paramere. Arrow denotes apical epandrial projection. Scale bars = 0.1 mm.

Thorax. Pronotal setae longer than scutal setae. Scutum clothed dorsally in short setulae; notopleural, supra-alar and postsutural setae long, black. Pteropleuron bare. Fore- and mid legs with tarsomere 4 bilobed; hind tarsi broken, not observed.

Wing. Wing length: 2.9 mm. Lightly infusate throughout, slightly darker where R_{4+5} meets apex; apex rounded; C and posterior wing margin with fringe of microtrichia; Sc incomplete; R_1 and $R_1(+R_{2+3})$ without three weakenings or depigmented gaps; $R_1(+R_{2+3})$ with uniseriate row of microtrichia along entire length, remaining veins bare; R flexed into cell br; R_{2+3} crossvein very weak, situated slightly before midpoint of $R_1(+R_{2+3})$; bend in R_{4+5} gentle; R_{4+5} and M_1 running parallel toward margin; M_1 and M_2 straight; M_4 slightly sinuous; CuA with basal spur shorter than crossvein m-cu.

Abdomen. Abdominal sternite 1 narrow, spectacle-shaped; sternite 2 with slender median sclerite and weakly sclerotized posterior trapezoid, few setae on posterior margin; sternites 3–7 rectangular, weakly sclerotized, setae restricted to posterior third; anterior margin of sternites 5–7 thin, well-sclerotized, sternite 7 arched slightly into preceding segment; sternite 8 triangular, bare, anterior margin well sclerotized, arched strongly into preceding sternite.

Terminalia (Figs 4C, 5C). Epandrium trapezoidal from ventral aspect; apical third slightly tapered; posterior margin broad, irregular; lacking pointed posterolateral processes. Hypandrium broad in ventral view, equal to basal width of gonostylus; anterior margin not concave. Gonocoxite broadest at basal third, tapered toward apex, inner margin smooth. Gonostylus about two-thirds length of gonocoxite, distal half strongly curved; broadest basally, gradually tapered to slightly pointed apex. Parameres distally fused, slightly more than half-length of epandrium, cruciform at mid-length, projected ventrally. Gonocoxal plate U-shaped, short, about one-third length of gonocoxite, well sclerotized; lateral arms divergent posteriorly into projections, distal inner margins weakly toothed; membrane extended to middle of paramere, with medial invagination; basally not fused to hypandrium. Cercus weakly sclerotized, situated along midline of epandrium.

Female. Unknown.

Immature Stages. Unknown.

Additional Material Examined. Known only from the holotype.

Distribution. Known only from the type locality in the Southern Andes (Figs 8, 9B).

Etymology. *Austrothaumalea fredericki* is named in honour of British dipterist Frederick W. Edwards, who was a primary author of the Natural History Museum's (London) series of books entitled "Diptera of Patagonia and South Chile". Specifically, Edwards was heavily involved in writing the lower Diptera chapters and laid the groundwork for future studies of many families, including Thaumaleidae.

***Austrothaumalea setipennis* Edwards stat. rev.**

(Figs 3E, 4D, 5D, 6C, 7C, 8, 9A)

Austrothaumalea setipennis Edwards, 1930: 113.

Other references: Stone, 1966: 1 (catalogue); Arnaud, 1977: 284 (distribution); Theischinger, 1986: 316 (phylogenetic discussion).

Oterere setipennis (Edwards): McLellan, 1988: 575 (new combination).

Other reference: Sinclair, 2008b: 11, 12 (*capricornis* species group).

Type material examined. Holotype: ♂, minuten pinned with abdomen mounted in resin, labelled: "Bariloche./ 29.xi.1926."; "Austrothaumalea/ setipennis Edw./ F.W. Edwards/ det. 1930."; "Argentina:/ Terr. Rio Negro./ F. & M. Edwards./ B.M. 1927 – 63."; "HOLO-/ TYPE [white label with red margin]"; "NHMUK010210691" (BMNH).

Recognition. This species is recognized by the presence of macrotrichia on wing vein M_1 (unique among South American species) and the rod-shaped paramere.

Redescription. Male. $n = 4$. Length 2.5–2.7 mm. Colouration (Fig. 3E). Head dull, brown; pronotum, postpronotum, postpronotal lobe and lateral margins of prescutum brown; prescutum and mesoscutum shiny, primarily yellow, with three yellowish-brown, longitudinal vittae ending in postscutal spot; pleura yellowish brown; two lateral brown spots above scutoscuteellar suture; scutellum yellowish brown, sometimes with dark speckles; mediotergite shiny, mainly yellow, slightly darker anteriorly; katapisternum yellow; paratergite dark brown; remaining pteropleuron yellowish brown to brown; posterior basalare yellow; halter yellowish; legs yellow, tarsi darker; abdomen brown, hind margins of tergites whitish; terminalia pale brown.

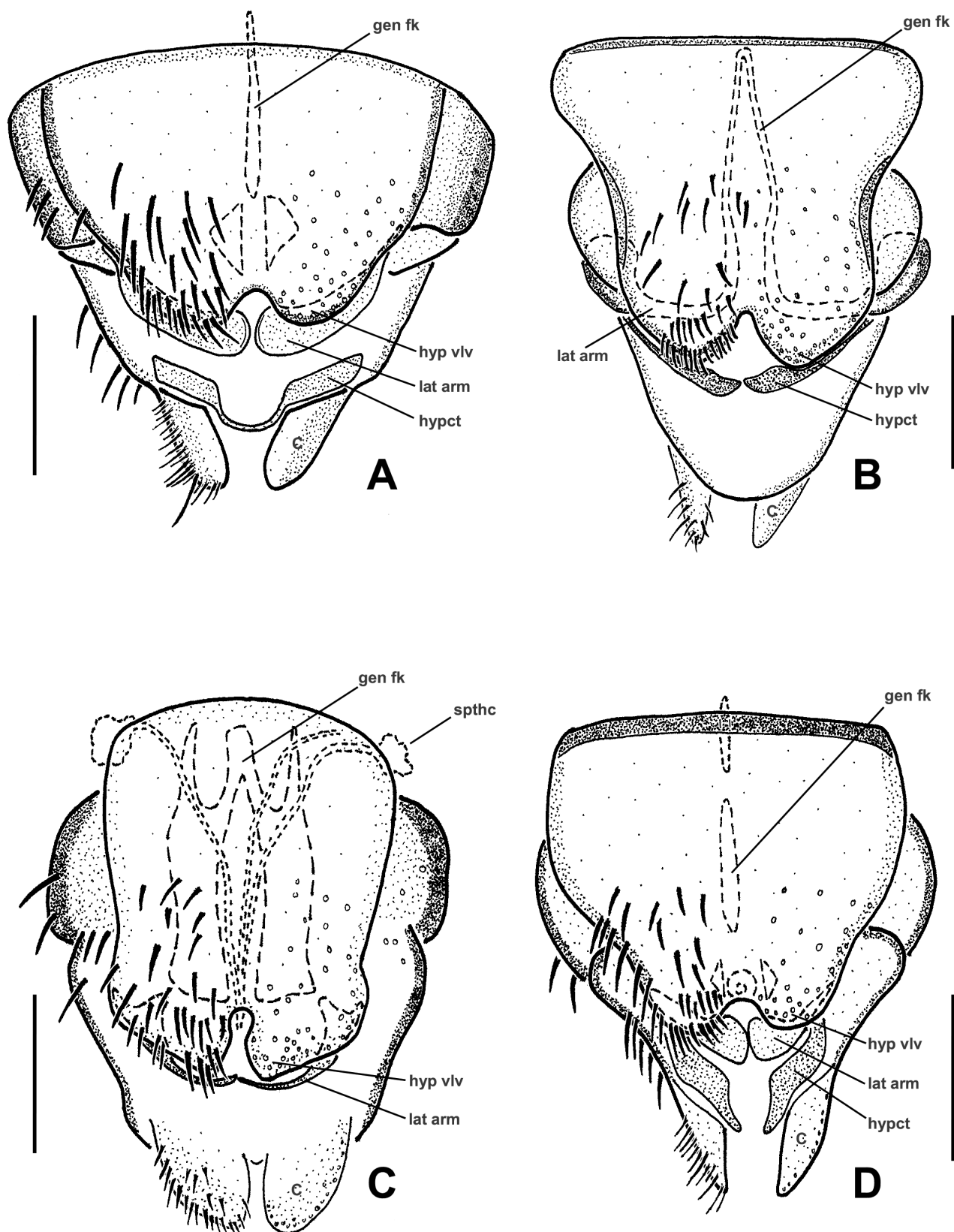


FIGURE 6. Ventral views of female *Austrothaumalea* terminalia. **A**, *A. apicalis*; **B**, *A. chilensis*; **C**, *A. setipennis* **stat. rev.**; **D**, *A. spatulata*. Abbreviations: c, cercus; gen fk, genital fork; hypct, hypoproct; hyp vlv, hypogynial valve; lat arm, lateral arms; spthc, spermatheca.. Scale bars = 0.1 mm.

Head. Eyes above antennae broadly joined, slightly exposing frons above antennae. Flagellomeres 1–3 expanded, subquadrate; 1 as long as 2 and 3 combined; flagellomeres 4–10 thin, cylindrical, becoming progressively more elongate. Vertex clothed in golden setae of uniform length, with sparse long, black orbital setae.

Thorax. Pronotal setae longer than scutal setae. Scutum clothed dorsally in short, black setulae; notopleural, supra-alar and postsutural setae long, black. Pteropleuron bare. Fore- and mid legs with tarsi simple, hind leg with tarsomere 4 bilobed.

Wing. Wing length: 2.8–3.3 mm. Lightly infusate throughout, slightly darker where R_{4+5} meets apex; apex rounded; C and posterior wing margin with fringe of microtrichia; Sc incomplete; R_1 and $R_1(+R_{2+3})$ without weakenings or depigmented gaps; $R_1(+R_{2+3})$ and M_1 with uniseriate, dorsal row of microtrichia along entire length, remaining veins bare; R flexed into cell br; R_{2+3} crossvein strong, situated toward apex of $R_1(+R_{2+3})$; bend in R_{4+5} well-defined; R_{4+5} and M_1 running parallel toward margin; M_1 and M_2 straight; M_4 slightly sinuous; CuA with basal spur shorter than crossvein m-cu.

Abdomen. Abdominal sternite 1 narrow, spectacle-shaped; sternite 2 with slender median sclerite and lightly sclerotized posterior trapezoid, few setae on posterior margin; sternites 3–7 rectangular, weakly sclerotized, setae restricted to posterior half; sternite 8 crescent-shaped, with a few setae, weakly sclerotized, arched slightly into preceding sternite.

Terminalia (Figs 4D, 5D). Epandrium broadly elongate-oval from ventral aspect; apical third slightly tapered; posterior margin broad and rounded; lacking pointed posterolateral processes. Hypandrium broad in ventral view, nearly subequal to basal width of gonostylus; narrowest at midpoint, anterior margin not concave. Gonocoxite broadest basally, tapered at midlength toward apex, inner margin smooth. Gonostylus nearly same length as gonocoxite, anterior three-quarters curved inward; nearly same width throughout, gently tapered to distinct tooth at apex. Parameres distally fused, three-quarters length of epandrium, rod-shaped, broadest medially; slowly tapered toward apex, projected ventrally. Gonocoxal plate formed of two lateral, sclerotized arms terminating in pectinate, saw-like structure; short, about half-length of gonocoxite; plate broad basally; basally not fused to hypandrium. Cercus weakly sclerotized, situated along median line of epandrium.

Female. $n = 2$. Similar to male except as follows: **Length:** 2.5–2.8 mm. **Abdomen:** Tergites 8–9 noticeably more sclerotized than preceding segments; only anterior margin of sternite 7 well-sclerotized. **Terminalia** (Figs 6C, 7C): Hypogynial valve not projected beyond tergite 9; posterior margin rounded with cleft in ventral view; densely setose. Tergite 9 rectangular in lateral view, wider than tergite 8, lacking lateral projections. Sternite 9 (genital fork) connected anteriorly, then divided into two thick arms ending before cleft of hypogynial valve; lateral arms extended beyond hypogynial valve, nearly meeting along midline, triangular in lateral view. Cercus rounded, projected slightly posteroventrally; bearing numerous setae. Three spermathecal ducts arising near cleft of hypogynial valve, only two terminating in irregularly rounded, weakly sclerotized spermathecal receptacles.

Immature Stages. Unknown.

Additional Material Examined. CHILE: Region IX (Araucanía): Rte. 71, 15-XII-2016, 38°13'20.3"S 71°44'41.1"W, elev. 1047 m, seep, J.K. Moulton & R.J. Pivar (1♀); Region XI (Aysén): Coihaique-Aysén Rd., 6-II-1985, J.A. Downes (3♂, 1♀, CNC).

Distribution. Known from the Andes of southern Chile, this species holds the southern-most record of thaumaleids in South America (Figs 8, 9A).

Remarks. The holotype date label reads “28.xi-1.xii.1926”, where ‘8’ has a 9 written over it in pencil, and ‘-1.xii.’ is scratched out.

Austrothaumalea spatulata Schmid

(Figs 2, 3B, 4E, 5E, 6D, 7D, 8, 9C,D)

Austrothaumalea spatulata Schmid, 1970: 501.

Other references: Arnaud, 1977: 284 (distribution); Cooper, 1991: 79 (CNC type catalogue); Sinclair, 1992: 492 (male terminalia studied); Theischinger, 1986: 316 (phylogenetic discussion).

Austrothaumalea spatula Schmid: Sinclair 2008b: 12 (*lapis calami*, *fusca* species group).

Type material examined. Holotype: ♂, minuten pinned, with abdomen mounted in resin below specimen, labelled: “Estero la Jaula/ Curico, CHILE/ I.1964, L. Pena/ Nothofagus”; “HOLOTYPE/ CNCNo. 11,305/ Thaumalea

spatulata Schm. [red label]”; “CNC/ 803775” [genitalia dissected, slide mounted below] (CNC). **Allotype:** ♀, same label data as holotype, except, CNC 803775 (CNC). **Paratypes:** CHILE: Region VI (O’Higgins): Bosque de los Conservadores Graneros, 1–4-III-62, 1100 m, Pena, CNC #11.035 (1♂, 1♀, CNC).

Recognition. The quadrate apex of its parameres and the quadrate posterior margin of the gonocoxal plate are key characteristics for recognizing this species. It lacks the posterior epandrial projections found in *A. apicalis*.

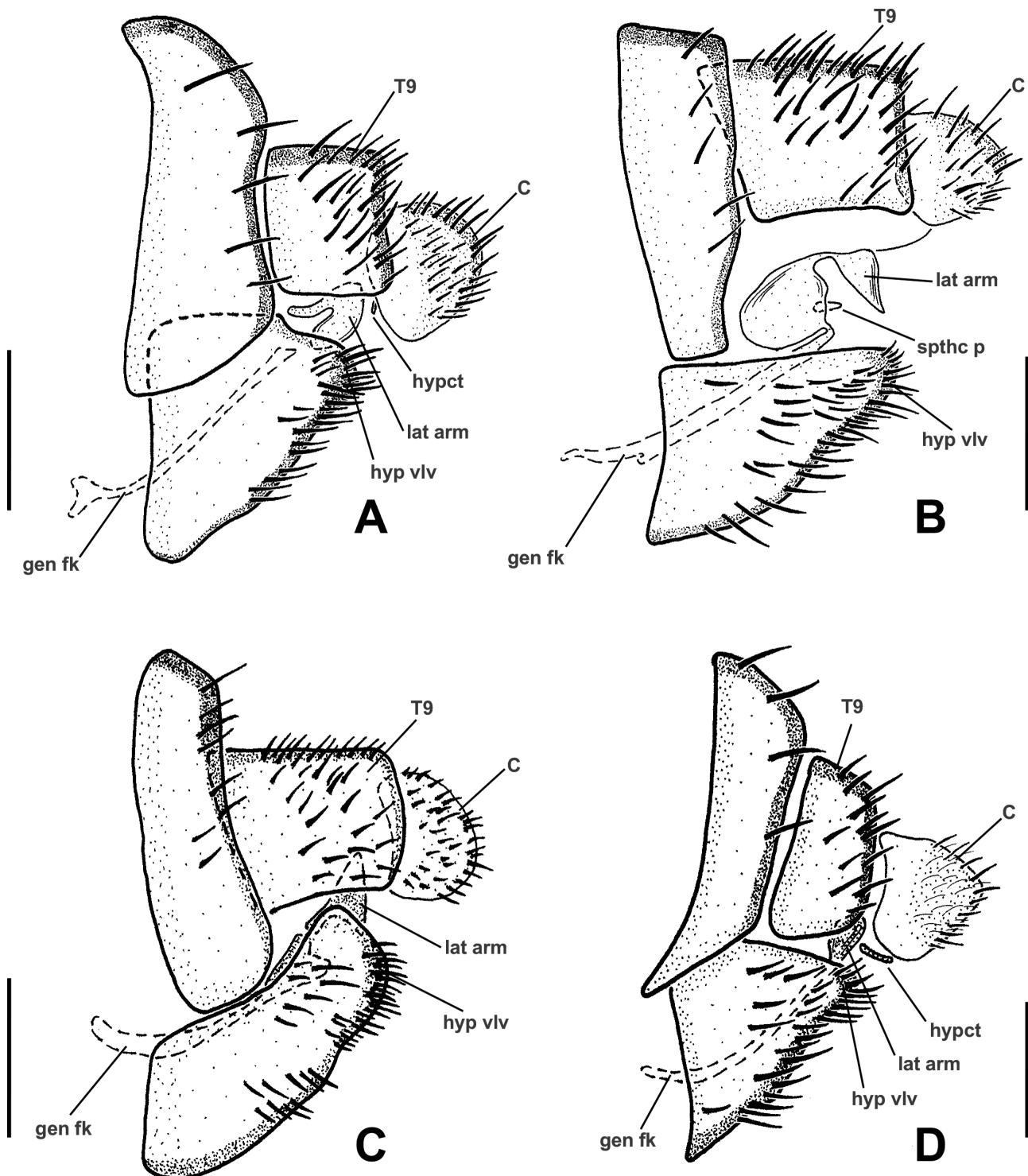


FIGURE 7. Lateral views of female *Austrothaumalea* terminalia. **A**, *A. apicalis*; **B**, *A. chilensis*; **C**, *A. setipennis* **stat. rev.**; **D**, *A. spatulata*. Abbreviations: c, cercus; gen fk, genital fork; hypct, hypoproct; hyp vlv, hypogynial valve; lat arm, lateral arm; spthc p, spermathecal pump. Scale bars = 0.1 mm.

Redescription. Male. $n = 8$. *Length* 1.8–2.2 mm. *Colouration* (Fig. 3B). Head dull, dark brown; pronotum, postpronotum, postpronotal lobe and lateral margins of prescutum brown; prescutum and mesoscutum shiny, primarily yellow, with pleura and posterior margin of mesoscutum brown with posterior brown rectangle, anterior corners of rectangle extended into two longitudinal brown vittae connecting, or nearly so, to posterior vittae extending from hind margins or prescutal dark patches; scutellum shiny, dorsal aspect brown with lateral yellowish brown patches, ventral aspect yellow; mediotergite shiny, brown; katepisternum yellow near coxa then turning brown, remaining pteropleuron yellowish brown to brown; posterior basalare yellowish brown; halter brown; legs pale brown, tarsi darker; abdomen dark brown, hind margins of tergites whitish; terminalia dark brown, gonostyli light brown.

Head. Eyes above antennae broadly joined, barely exposing frons above antennae. Flagellomeres 1–3 expanded, subquadrate; 1 as long as 2 and 3 combined; flagellomeres 4–10 thin, cylindrical, becoming progressively more elongate. Vertex clothed in golden setae of uniform length, with sparse long, black orbital setae.

Thorax. Pronotal setae longer than scutal setae. Scutum clothed dorsally in short, golden setulae; notopleural, supra-alar and postsutural setae long, black. Pteropleuron bare. Fore- and mid legs with tarsi simple, hind leg with tarsomere 4 bilobed.

Wing (Fig. 2). Wing length: 2.8–3.3 mm. Lightly infusate throughout, slightly darker where R_{4+5} meets apex; apex rounded; C and posterior wing margin with fringe of microtrichia; Sc incomplete; R_1 and $R_1(+R_{2+3})$ without weakenings or depigmented gaps; $R_1(+R_{2+3})$ with uniseriate row of microtrichia along entire length, remaining veins bare; R flexed into cell br; R_{2+3} crossvein very weak or absent, at most a faint infuscation, situated slightly beyond midpoint of $R_1(+R_{2+3})$; bend in R_{4+5} well-defined; R_{4+5} and M_1 running parallel toward margin; M_1 and M_2 straight; M_4 slightly sinuous; CuA with basal spur shorter than crossvein m-cu, may be distinct or indistinct.

Abdomen. Abdominal sternite 1 narrow, spectacle-shaped; sternite 2 with slender median sclerite and lightly sclerotized posterior rectangle, a few setae on posterior margin; sternites 3–7 rectangular, weakly sclerotized, setae restricted to posterior half and laterad; anterior margin of sternites 5–7 thin, well sclerotized; sternite 8 crescent-shaped, bare, anterior margin well-sclerotized, arched slightly into preceding sternite.

Terminalia (Figs 4E, 5E). Epandrium trapezoidal from ventral aspect; apical third slightly tapered; posterior margin broad and rounded; lacking pointed posterolateral processes. Hypandrium broad in ventral view, nearly subequal to basal width of gonostylus; anterior margin slightly concave. Gonocoxite broadest medially, tapered toward apex. Gonostylus about two-thirds length of gonocoxite, curved gently throughout; broadest basally, gradually tapered with small tooth at apex. Parameres distally fused, slightly more than half-length of epandrium, spatula-like, broadest apically. Gonocoxal plate rectangular, short, about half-length of gonocoxite; broad basally; apical margin truncate; basally not fused to hypandrium. Cercus weakly sclerotized, situated medially.

Female. $n = 2$. Similar to male except as follows: *Length*: 2.5–2.7 mm. *Abdomen*: Tergites 7–9 noticeably more sclerotized than preceding tergites; only anterior margin of sternite 7 well-sclerotized. *Terminalia* (Figs 6D, 7D): Hypogynial valve projected slightly beyond tergite 9; posterior margin with rounded cleft in ventral view, forming two truncate lobes; densely setose. Tergite 9 subquadrate in lateral view, wider than tergite 8, without lateral projections. Sternite 9 (genital fork) slender, weakly sclerotized, with two rod-shaped sclerites anteriorly and two triangular sclerites next to hypogynial valve; lateral arms extended past hypogynial valve, arms closely approximated along midline, thin anteriorly, distal half expanded. Hypoproct thin, divided into pair of sclerites. Cercus rounded, projected posteriorly; bearing numerous setae. Spermathecal ducts not observed.

Immature Stages. Unknown.

Additional Material Examined. CHILE: Region VI (O'Higgins): Rte. I-45, 16-XII-2016, 34°46'29.2"S 70°40'03.9"W, elev. 827 m, stream, J.K. Moulton & R.J. Pivar (1♂); Region VII (Maule): Los Queñes, Rte. J-25, 6-XII-2016, 34°59'48.8"S 70°48'37.0"W, elev. 684 m, seep, J.K. Moulton & R.J. Pivar (4♂, 1♀*); Region VIII (Bío Bio): Rte. Q-689, 8-XII-2016, 37°54'55.6"S 71°35'43.2"W, elev. 552 m, cascading creek, J.K. Moulton & R.J. Pivar (1♂, 1♀*).

Distribution. Known from the Andes of central Chile (Figs 8, 9C,D).

Remarks. The O'Higgins specimen collected by the authors differs somewhat in appearance from the other specimens in that the posterior margin of the epandrium is slightly concave. Molecular fingerprinting matches that of other *A. spatulata* specimens. This is the northern-most locality for this species and likely indicates population variation.

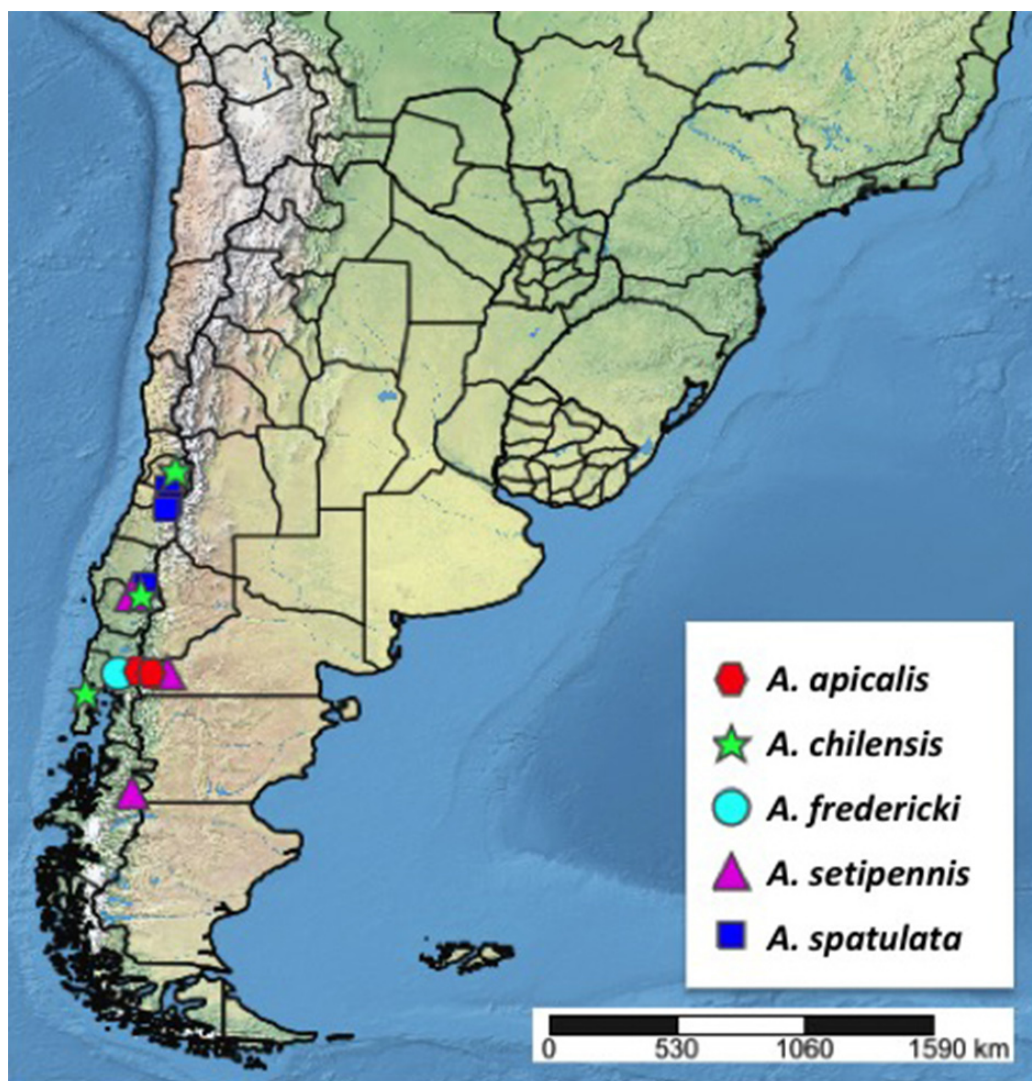


FIGURE 8. Known distribution of South American *Austrothaumalea*.

Discussion and conclusions

Species-groups. McLellan (1988) and Sinclair (2008b) proposed six species groups for *Austrothaumalea*. Sinclair (2008b) hypothesized that the South American *Austrothaumalea* spp. belonged to two species groups: (1) *A. chilensis* and *A. setipennis* within the *A. capricornis* Theischinger group, the males of which are characterized by a shallowly to deeply forked gonocoxal plate with its outer margins more heavily sclerotized than medially (Sinclair 2008b), and (2) *A. apicalis* and *A. spatulata* as possible members of the *A. fusca* Theischinger group (Sinclair 2008b). The assignment of *A. apicalis* to species group was initially based on the holotype female, but now that the male is described, it is possible to confirm its placement in the *A. fusca* group on the basis of the truncate gonocoxal plate (Sinclair 2008b). While minute posterior epandrial processes are present in *A. apicalis*, this character has evolved in three other species groups (*appendiculata*, *neozealandica* and *minnamurrae* (Sinclair 2008b)), and the gonocoxal plate morphology appears to be a more informative character for delineating species groups.

Austrothaumalea fredericki is somewhat of an outlier compared to other members of the genus, in that the gonocoxal plate is U-shaped and broad. The parameres, however, are similar to those of *A. apicalis* and *A. spatulata*: spatulate apically, but with the addition of mid-lateral arms in *A. fredericki*. Sinclair (2008b) suggested an *A. fusca* subgroup characterized by forked gonostyli consisting of Australian species, while the Chilean species have simple gonostyli; presence of the latter character state in *A. apicalis*, *A. fredericki* and *A. spatulata* supports this hypothesis. The Australian *A. fusca* appears to be an intermediate species between the two subgroups, as it has simple gonostyli like the Chilean species, but a more conical/rod shaped paramere, as seen in the Australian group members.

Conclusions. Our understanding of South American thaumaleid diversity is still incomplete. *Austrothaumalea* is known from only a handful of localities in South America, and has never been collected in large numbers. They have been collected in a variety of aquatic habitats (Fig. 9), from the dry, hot, Mediterranean climate of central Chile, to the temperate rainforests of Patagonia. Collection efforts should continue along the Andes mountain range, particularly on the Argentinean side and the northern Andes.

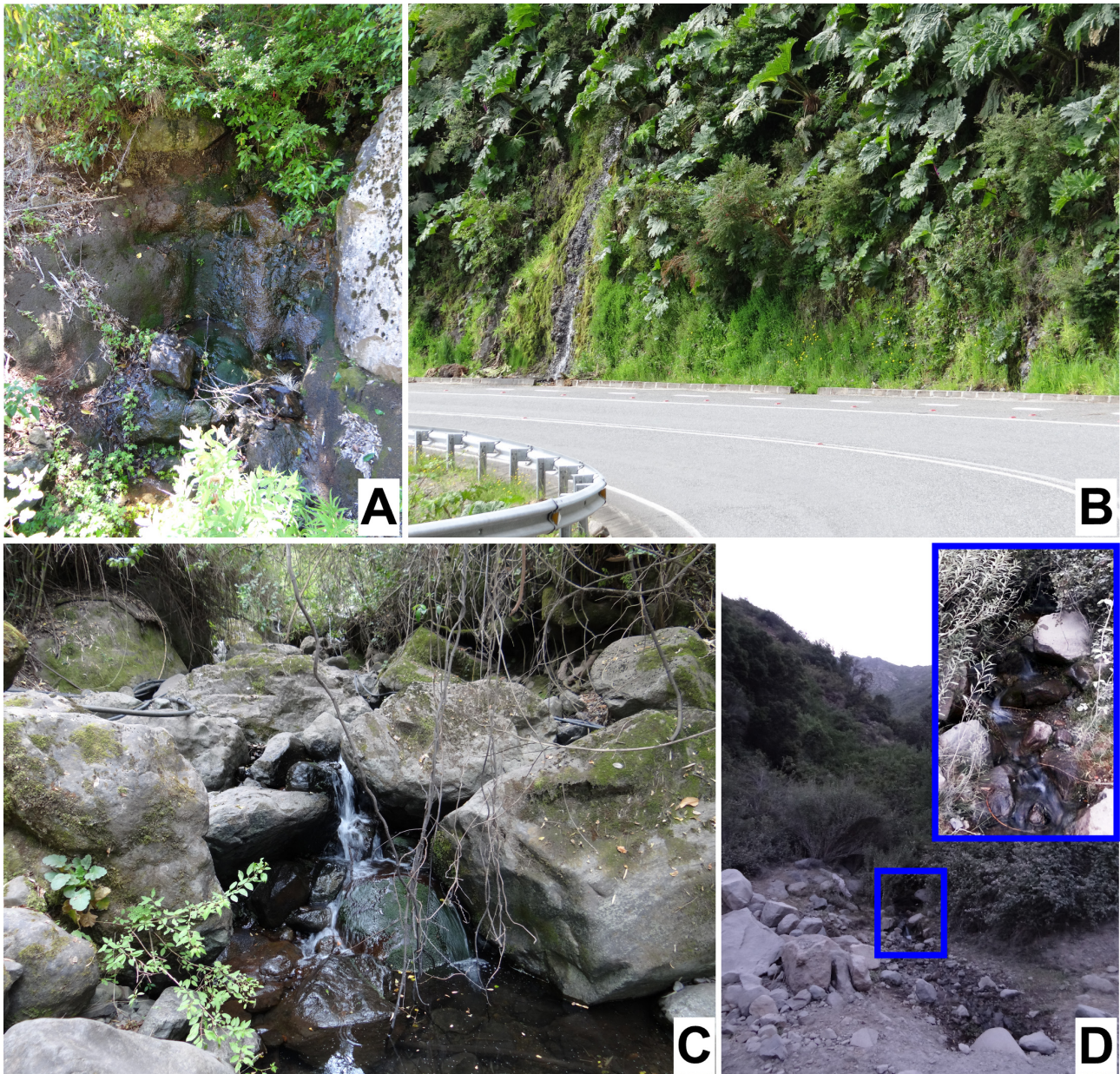


FIGURE 9. Examples of *Austrothaumalea* habitats in Chile. **A**, rock face seep where *A. chilensis* and *A. setipennis* **stat. rev.** were collected (38°13'20.3"S 71°44'41.1"W); **B**, collection site of *A. fredericki* **sp.nov.** (41°08.47'S 72°35.28'W); **C**, collection site of *A. spatulata* (34°59'48.8"S 70°48'37.0"W); **D**, northernmost collection site of *A. spatulata* in the Chilean Matorral, inset showing small trickle of water where specimen was collected (34°46'29.2"S 70°40'03.9"W).

Acknowledgments

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materials both to and from Spanish. Christian Gonzalez (UMCE) provided information regarding collecting sites throughout Southern Chile, and we thank him for that. Thanks to La Corporación Nacional Forestal (CONAF) and Servicio Agrícola y Ganadero (SAG) of Chile for granting collecting permits (#036/2016) and providing information for exporting specimens. Funding for this research was provided from the following sources: National Science Foundation award DEB-1146290 (JKM), the Smithsonian's S.W. Williston Diptera Research Fund (RJP), the University of Tennessee Hatch Project TEN00479 and the University of Tennessee Department of Entomology and Plant Pathology. Art Borkent and Greg Curler kindly reviewed the manuscript.

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