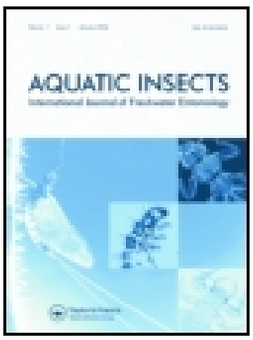

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A new species of *Neoderus* Alexander, 1927 (Diptera: Tanyderidae) from southern Chile, with a first description of a male and key to extant genera of the family

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ABSTRACT

Neoderus Alexander, 1927 (Diptera: Tanyderidae) is revised to include a new species, *Neoderus chonos* Madriz, sp. n. Adults of *N. chonos* were collected in January 2016 from two sites in Chilean Patagonia. This paper provides a description of the new species, including the first male description of the genus, diagnosis of adult *Neoderus*, and redescription of *N. patagonicus* (Alexander, 1913). Habitat characteristics, known distribution and historical information for the new species are also discussed. A generic key to adults of world Tanyderidae is given.

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Primitive crane flies; *Neoderus*; new species; Aysén; Patagonia

Introduction

Tanyderidae Osten-Sacken, 1880 is a poorly known, predominantly temperate family represented by 39 extant species divided amongst 10 genera. Because of limited material in collections and the paucity of information about their natural history, the task to find novel morphological and bionomic information is of great importance for further understanding of the family.

Neotropical Tanyderidae are restricted to Chile and Argentina. Since the original discovery of *Tanyderus* Philippi, 1865, two additional Neotropical genera have been described, *Neoderus* Alexander, 1927 and *Araucoderus* Alexander, 1929. Despite considerable interest in the group from a phylogenetic and biogeographical standpoint, information regarding this family has remained fragmentary. Most published information on Neotropical tanyderids is from species descriptions (Philippi 1865; Alexander 1913, 1920) or geographic range extension (Alexander 1935). More recently, the immature stages of *Araucoderus* and *Tanyderus* were discovered and described (Lukashevich and Scherbakov 2014, 2016; Madriz and Courtney 2016).

Adult tanyderids are rarely collected, cryptic and believed to be short lived. Because of this, there is limited information about the natural history of Neotropical tanyderids. Of

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the three genera, *Neoderus* is the least studied, with only one account providing superficial information about its habitat (Madriz 2016). Knowledge of most aspects of its natural history is lacking partly due to sampling difficulties and uncertainty regarding the type locality.

Much of the taxonomy and classification of Tanyderidae has been based on adult wing venation and colouration (Alexander 1927), with information on and use of terminalia being superficial or absent. *Neoderus patagonicus* (Alexander, 1913) was originally placed in *Tanyderus*. Alexander (1927) proposed *Neoderus* as a monotypic genus based on wing venation. Since then, no further information on the genus has been published, nor has any other attempt been made to recollect the species, which is confined to the fjords of Patagonia.

During a recent faunistic survey of the Aysén Region, we collected adult specimens of *Neoderus* and recorded detailed observations of the behaviour and habitat. The purpose of this paper is to present a diagnosis of adult *Neoderus*, redescription of *N. patagonicus*, and description of *Neoderus chonos* Madriz, sp. n. We also discuss evidence to clarify uncertainty about the published type locality of *N. patagonicus*.

Material and methods

Study area

Adult *Neoderus chonos* were collected from two localities in southern Chile (Figures 4–14). Both localities are within the Valdivian Forest province, while the type locality for N. *patagonicus* is in the Magellanic Forest Province of the Subantarctic Sub-region (sensu Morrone 2015).

Specimen collection and preparation

All individuals were hand-collected and preserved in either 70% or 95% ethanol, the latter for specimens intended for future DNA extraction.

Observations and measurements were completed using an Olympus SZH, SZX-9 and SZX-12 stereo microscopes and a Nikon Eclipse E800 compound microscope, the latter equipped with differential interference contrast and all fitted with ocular micrometers. When applicable, sample sizes are provided before each description with measurements in millimeters presented as a mean followed by a range in parentheses. Adult: head width was measured at the point of greatest width of eyes, and head length from anterior margin of the clypeus to the occiput; leg segments were measured along the dorsal margin; approximate wing length and width were measured at the point of greatest length and width, respectively.

Drawings were rendered with the aid of drawing tubes on both systems. Photomicrographs were captured using a Nikon DS-Fi1 mounted interchangeably on both microscopes. Composite images were generated using NIS-Elements 3.2 imaging software and edited in Adobe Photoshop® CC. Illustrations and plates were produced using Adobe Illustrator® CC and Adobe Photoshop® CC.

Material described herein is deposited in the Museo Nacional de Historia Natural, Santiago, Chile (MNNC) or National Natural History Museum, Smithsonian Institution, Washington (USNM).

Terminology

Descriptive terms follow Madriz and Courtney (2016), with a label correction on wing vein m-m. For the collection site: 17 km North of Puerto Rio Tranquilo (46°30′11.92″S, 72°44′28.33″W), the creek had no name; however, we refer to this site as 'Kairai Creek', in accordance with project FONDECYT No. 11140495 to Anna Beatrice Astorga Roine 2014–2018. 'Kairai Creek' is the same as 'Kairay' in Madriz (2016). We use the term 'natural history' in reference to all observational data.

Taxonomy of *Neoderus* Alexander, 1927

Neoderus Alexander 1927: 189, p. 8. Type species: *Tanyderus patagonicus* Alexander, 1913 by original designation.

Diagnosis

Egg: unknown. Larva: unknown. Pupa: unknown. Adult: cuticle with variegated colouration, light to dark brown; vestiture light brown; abdominal tergites dark brown, with irregular, light brown colouration posteriorly on either side of median. Male (based solely on *N. chonos*): abdomen over twice as long as thorax; wing more than 13 mm in length, infuscated, with pigment arranged in six transverse bands contiguous in some areas, wing noticeably convex anteriorly; supernumerary cross-veins present in cells r3 and r5; terminalia: dark brown; epandrium bilobed, narrowly contiguous at base and tapering apically, one and a half times longer than wide, with setae alveoli scattered over entire surface; ventral paramere not clearly evident; lateral ejaculatory processes triangular in shape; aedeagus uniformly wide, phallotrema fused; phallotrema apex with curved horn-like projection extending caudally. Female: abdomen less than twice as long as thorax length; wing more than 13 mm in length, colouration and venation as in male; head, thorax, and legs as in male; posterior margin of sternite VIII broadly bilobate, emarginated at median, with 'square U' shape; genital fork triangular transversely, as long or slightly longer than wide, 'V-shaped' medially, slightly constricted near terminus; spermatheca three in number, corpora spherical, with visible necks differentiating from ducts; ducts elongated, more than five times longer than corpora, annulated and hyaline.

Neoderus patagonicus (Alexander, 1913)

Tanyderus patagonicus Alexander 1913, p. 332.
Neoderus patagonicus (Alexander, 1913): Alexander 1927, p. 8; Alexander 1929, p. 229 (species checklist); Alexander and Alexander 1967: 5.2 (species checklist).

Type locality

Only record 50°51′55.92″S, 74°23′47.96″W, 0 m above sea level (a.s.l.). Alexander (1913) mentions the type locality of *N. patagonicus* being Latitude Cove, Argentina. Given the Boundary Treaty between Argentina and Chile, established on 23 July 1881 (Ranson Garcia 2011), the original citation should have been Chile.

Table 1. Leg segment measurements for adult female of *Neoderus patagonicus* (Alexander, 1913).

		Adult female		
Leg segment lengths		Foreleg	Midleg	Hind leg
Femur		6.00	6.30	6.30
Tibia		6.90	6.20	?
Tibial spur		0.35	0.33	?
Tarsus	1	5.00	?	?
	2	1.80	?	?
	3	?	?	?
	4	?	?	?
	5	?	?	?

Type material

Holotype. ♀, Chile, Magallanes, Latitude Cove, Patagonia, approximately 50°51′55.92″S, 74°23′47.96″W, coll. (collector) No name given, no date given. Specimen pinned, terminalia in attached genitalia vial (USNM).

Diagnosis

Male: unknown. Female: labrum more than twice as long as clypeus; antenna with 15 flagellomeres; frontal suture complete, coronal suture extending into postoccipital region; genital fork as long as wide.

Re-description of female

Figures 15–17 and 26–27. See also Alexander (1913).

Measurements. (n = 1). Total length 13.96 mm; head length 1.63 mm; head width 1.50 mm; clypeus length 0.42 mm; clypeus width 0.42 mm; palpus length 2.20 mm (palpomere length 0.14–0.39–0.70–0.44–0.53); wing length 17.92 mm; wing width 4.48 mm. Leg measurements (see Table 1).

Overall colouration. Greyish brown to dark brown.

Head. (Figures 15–17). Labrum more than twice as long as clypeus; antenna with scape and pedicel glabrous, each with several setiform sensilla inserted distally; scape cylindrical (scp; Figures 15 and 16), slightly longer than wide, as long as pedicel; pedicel spherical (ped; Figures 15 and 16); flagellomeres numbering 15 (based on original description), cylindrical; f 1 and f 2 equal in proportions ; f 3–8 each narrowing in width from preceding segment, with 4 trichoid sensilla inserted near base of flagellomere, arranged concentrically, as long or longer than flagellomere; f 9–15 damaged; frontal suture complete, coronal suture extending into postoccipital region (Figure 16); cervical sclerites two times longer than wide.

Wing. Held away from body at angle; with crossveins in cells r3 and r5; infuscate, with dark brown blotch at proximal base of vein h, with two irregular transverse bands of pigment, diffusing caudally and distally, basal-most band extending from h vein to posterior wing margin and slightly beyond proximal area of anal loop, medial band extending from midlength of Sc vein to posterior edge of C vein at distal end of anal lobe, passing through

r-m and m-cu; apical-most band from R1 to posterior edge of C vein passing through fork of R2+R3 and distal edge of d cell, costal and apical area of subcostal cells yellow in colour. Halteres pale yellow at base, dark at apex.

Legs. Tibial spurs 1–2–? symmetrical.

Abdomen. Less than twice as long as thorax

Terminalia. With spermatheca three in number; corpora spherical, with visible necks; spermathecal ducts annulated and uniformly sclerotised, more than six times as long as corpora, unpigmented; posterior margin of sternite VIII broadly bilobate, emarginated at median, emargination with 'square U' shape; genital fork triangular transversely, as long as wide 'V-shaped' medially, slightly constricted near terminus.

Distribution

The species is known only from the type locality. See Figure 4. A survey of the central regions of Chile yielded no specimens.

Neoderus chonos Madriz, sp. n.

Type locality

Chile. Aysén, Hwy X-728CH/valle exploradores @ 9 km West of Lago Bayo, 46°27′38.01″S, 73°13′09.96″W, 217 m a.s.l.

Type material

Holotype. ♂, Chile. Aysén, Hwy X-728CH/valle exploradores @ 9 km West of Lago Bayo 46°27′38.01″S, 73°13′09.96″W, 217 m a.s.l., 2 February 2016, R.I. Madriz & K.K. Lindsay, hand-picked from vertical wall (MNNC).

Paratypes. 1 ♂, 3 ♀ (in EtOH), same data as holotype (USNM).

Other material examined

1 wing only, Kairai Creek @ 17 km North of Puerto Rio Tranquilo, 46°30′11.92″S, 72°44′28.33″W, 534 m a.s.l., 2 February 2016, R.I. Madriz (USNM).

Diagnosis

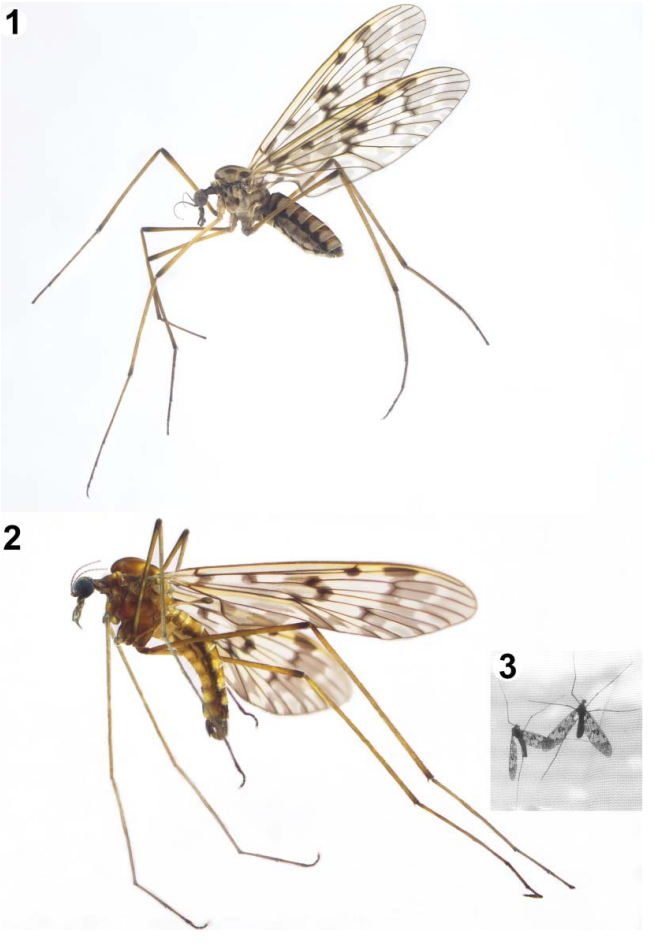
Male terminalia: lateromedial element of paramere divided into two lobes, anterior lobe small, convex, with more than 15 setiform sensilla, posterior lobe fleshy, thorn-like, curved mesally; dorsomedial element 'Y-shaped'; aedeagal phallotrema fused into one phallotrema, apex with curved horn-like projection extending caudally; aedeagal sheath loosely surrounding phallotrema. Female: labrum approximately twice as long as clypeus; antenna with 14 flagellomeres; frontal suture incomplete, coronal suture not visible; genital fork slightly longer than wide.

Description of male

(Figures 1, 2 and 23–25)

Table 2. Leg segment measurements for adult male and female of *Neoderus chonos* Madriz, sp. n.

Leg segment lengths		Foreleg	Midleg	Hind leg
Adult male				
Femur		5.11	5.81	7.09
Tibia		6.50	5.98	8.95
Tibial spur		–	0.34	0.36
Tarsus	1	4.52	3.30	4.39
	2	1.12	1.16	1.62
	3	0.82	0.70	1.00
	4	0.40	0.45	0.52
	5	0.40	0.45	0.52
Adult female				
Femur		5.26 (5.20–5.30)	5.96 (5.90–6.00)	7.24 (7.20–7.29)
Tibia		6.66 (6.60–6.70)	6.10 (6.00–6.03)	9.05 (9.00–9.08)
Tibial spur		0.31 (0.30–0.31)	0.34 (0.33–0.34)	0.36 (0.35–0.36)
Tarsus	1	4.68 (4.60–4.72)	3.42 (3.40–3.49)	4.53 (4.50–4.58)
	2	1.22 (1.20–1.25)	1.33 (1.30–1.37)	1.75 (1.70–1.78)
	3	0.91 (0.90–0.93)	0.82 (0.80–0.83)	1.12 (1.10–1.15)
	4	0.50	0.56 (0.55–0.56)	0.61 (0.60–0.63)
	5	0.50	0.56 (0.55–0.56)	0.61 (0.60–0.63)



Figures 1–3. *Neoderus chonos* Madriz, sp. n.: (1) female habitus, lateral view; (2) adult male habitus, lateral view; (3) size comparison of male (left) and female (right).

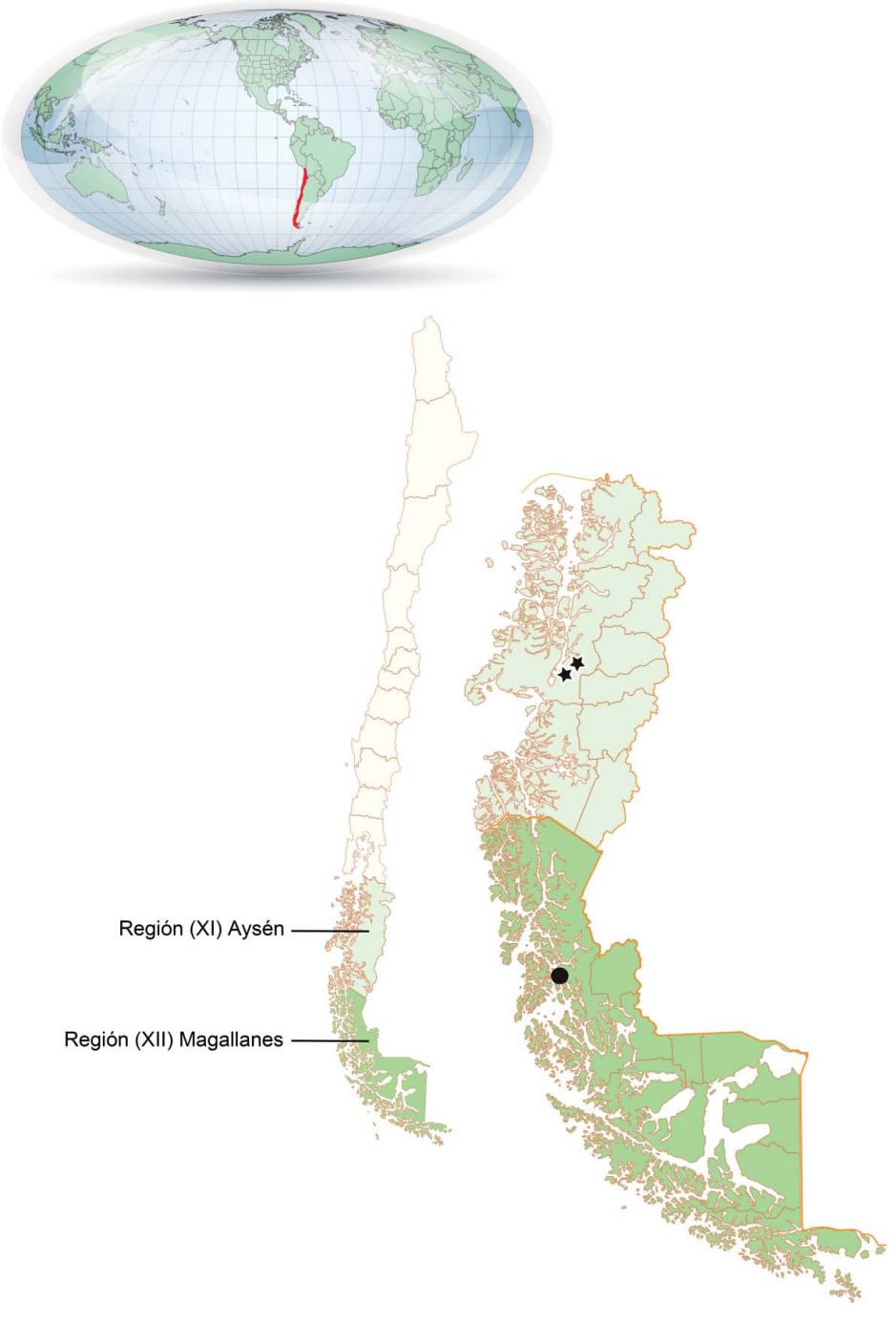
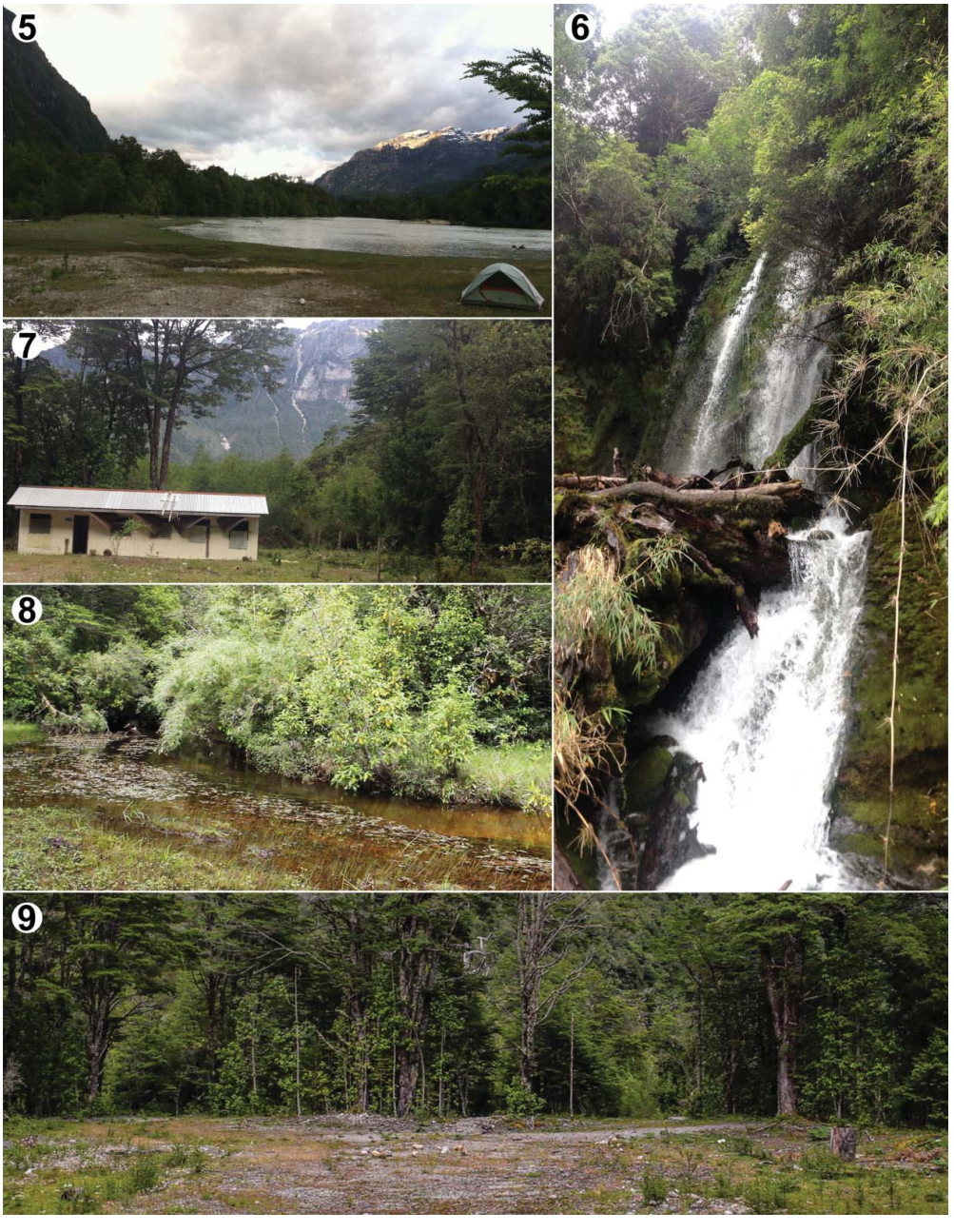
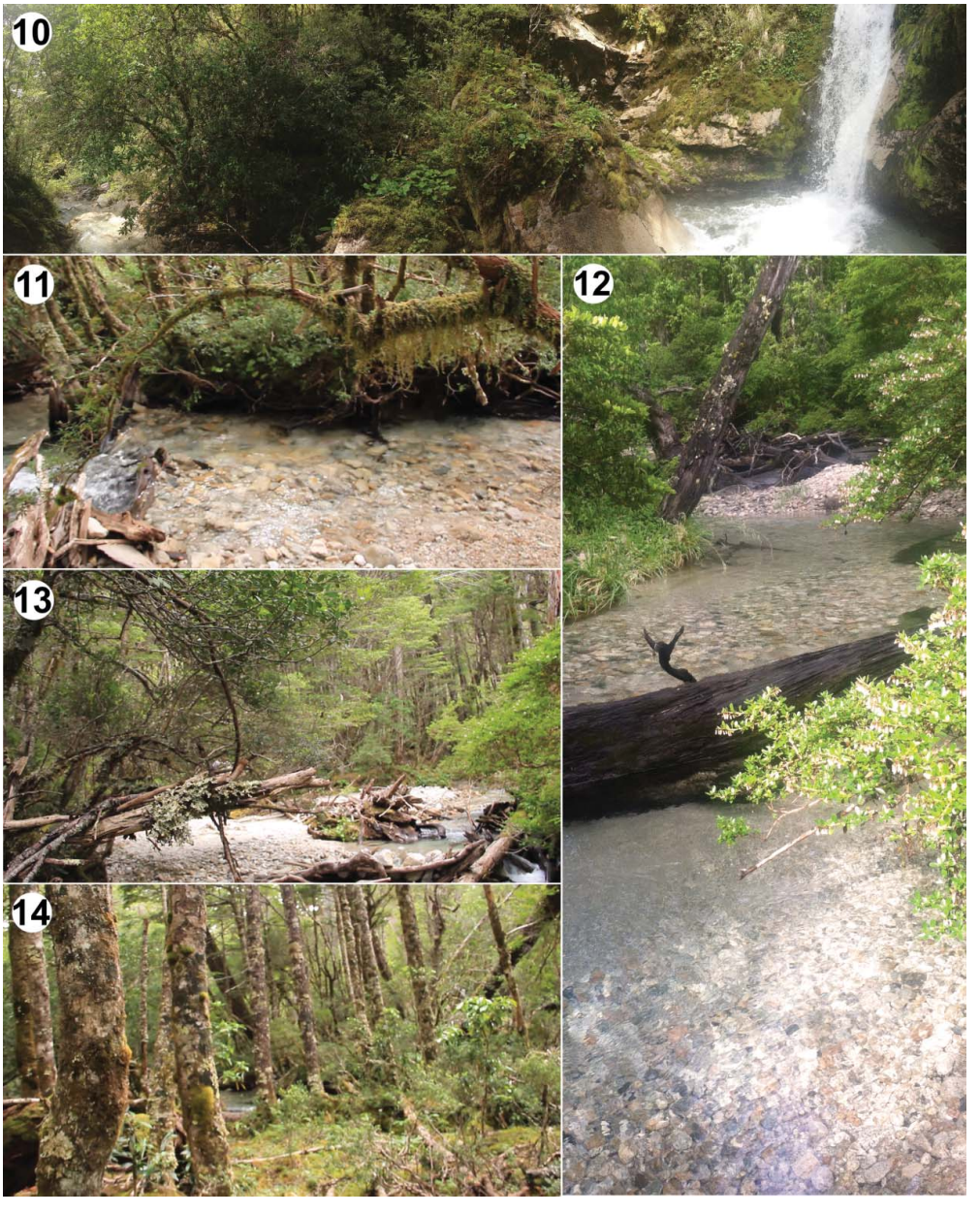


Figure 4. Distribution of *Neoderus* (Alexander, 1927): *Neoderus patagonicus* (Alexander, 1913) (black circle), *N. chonos* Madriz, sp. n. (black stars).



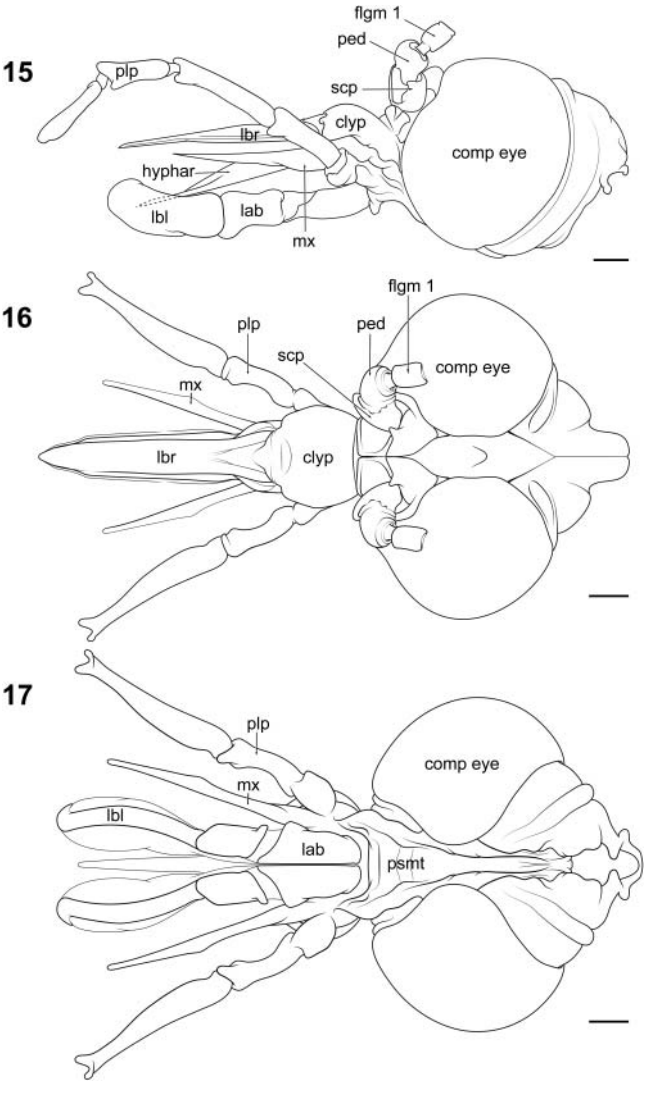
Figures 5–9. *Neoderus chonos* Madriz, sp. n., habitat, Valle Exploradores collection site: (5) Rio Exploradores near collection site; (6) waterfall near collection site; (7) collection site north view; (8) stream near collection site; (9) collection site south view.



Figures 10–14. *Neoderus chonos* Madriz, sp. n., habitat, Kairai Creek collection site: (10) waterfall near collection site; (11–14) Kairai Creek at collection site.

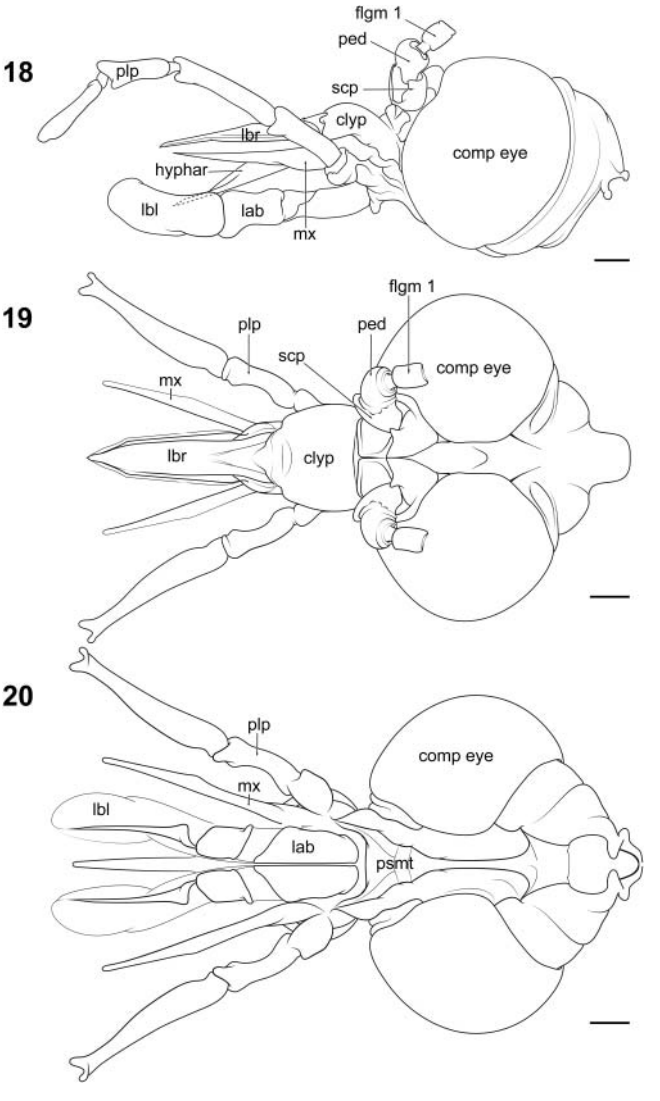
Measurements. (n = 1). Total length 11.05 mm; head length 1.26 mm; head width 1.18 mm; palpus length 1.36 mm; clypeus length 0.30 mm; clypeus width 0.40 mm; wing length 13.00 mm; wing width 4.25 mm. Leg measurements (see Table 2).

Head. With mandible and maxilla poorly developed; antenna with scape and pedicel glabrous, each with several setiform sensilla inserted distally; scape cylindrical, slightly longer



Figures 15–17. *Neoderus patagonicus* (Alexander, 1913), adult female head capsule with flagellomeres 2–14 removed: (15) lateral view; (16) dorsal view with palpi 4–5 removed; (17) ventral view with palpi 4–5 removed. Abbreviations: clyp: clypeus; comp eye: compound eye; flgm 1: flagellomere #1; hyphar: hypopharynx; lab: labium; lbl: labellum; lbr: labrum; mx: maxilla; ped: pedicel; plp: palpus; pstm: postmentum; scp: scape. Scale bars = 0.10 mm.

than wide, as long as pedicel; pedicel spherical; with 14 flagellomeres, all elongate, more than 3 times longer than wide, cylindrical; f 1 and f 2 equal in proportions ; f 3 with one trichoid sensilla inserted near base of flagellomere, orientated dorsolaterally; f 4–13 each narrowing in width from preceding segment, with 4 trichoid sensilla inserted near base of flagellomere, arranged concentrically, as long or longer than flagellomere; f 14 with 2 trichoid sensilla inserted apically. Cervical sclerites two times longer than wide.



Figures 18–20. *Neoderus chonos* Madriz, sp. n., adult female head capsule with flagellomeres 2– 14 removed: (18) lateral view; (19) dorsal view with palpi 4–5 removed; (20) ventral view with palpi 4–5 removed. Abbreviations: clyp: clypeus; comp eye: compound eye; flgm 1: flagellomere #1; hyphar: hypopharynx; lab: labium; lbl: labellum; lbr: labrum; mx: maxilla; ped: pedicel; plp: palpus; pstm: postmentum; scp: scape. Scale bars = 0.10 mm.

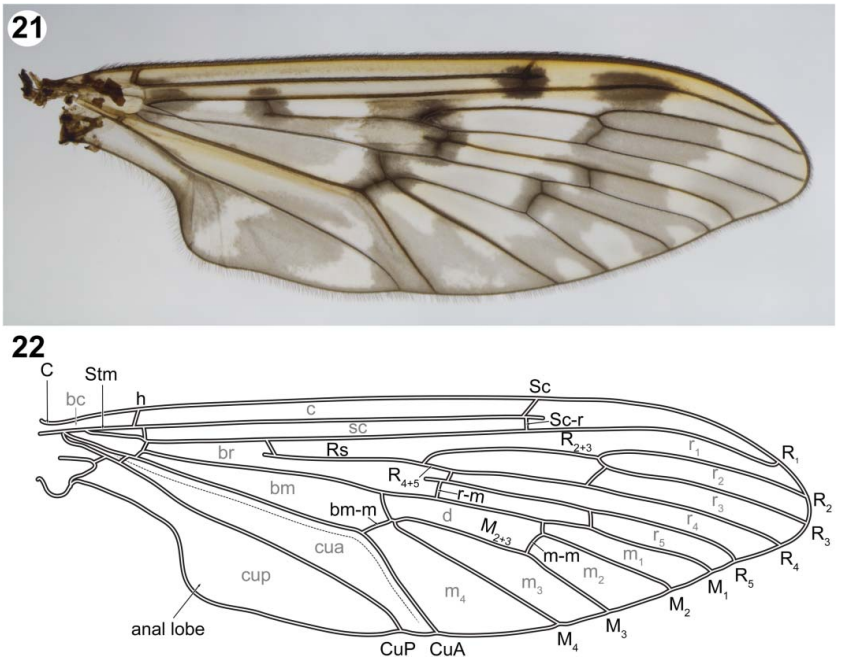
Wing. (Figures 21 and 22). Held away from body at angle in live resting individual; with crossveins in cells r3 and r5; infuscate, with dark brown blotch at proximal base of vein h, with two irregular transverse bands of pigment, diffusing caudally and distally, basal-most band extending from h vein to posterior wing margin and slightly beyond proximal area of anal loop, medial band extending from midlength of Sc vein to posterior edge of C vein at distal end of anal lobe, passing through r-m and m-cu; apical-most band from R1 to posterior edge of C vein passing through fork of R2+R3 and distal edge of d cell, costal and apical area of sub costal cells yellow in colour. Halteres pale yellow at base, dark at apex.

Table 3. Local environmental variables measured in a 50 m section in Kairai Creek during austral spring 2016.

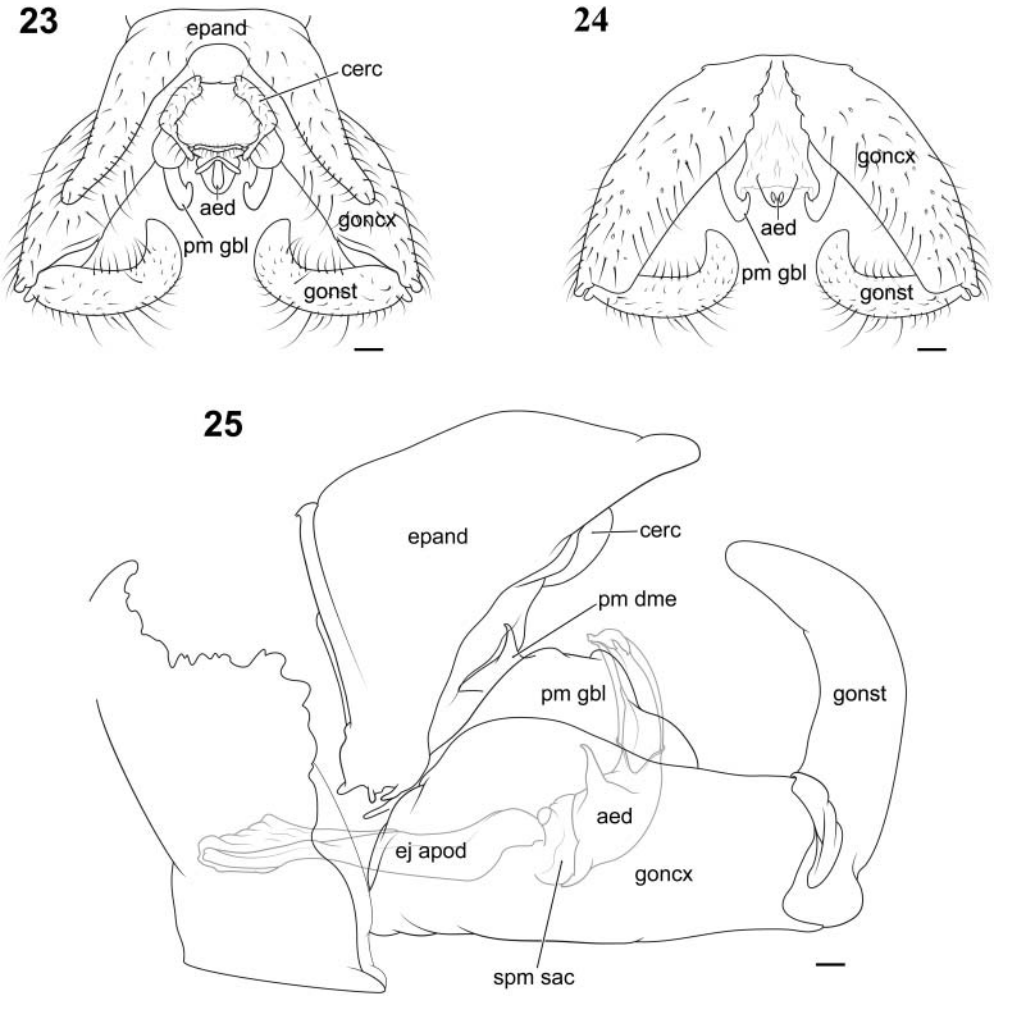
Variable	Kairai Creek
Altitude (m)	539
Water temperature (°C)	2.3
pH	7
Conductivity (μs)	13
Alkalinity (mg/l)	6.74
Mean steam shade (%)	69
Mean stream width (m)	4.5
Segment Slope (cm/m)	4
Mean current velocity (m/s)	0.6
Mean depth (cm)	17.4

Legs. Light to dark brown, femur darker distally, all other leg segments darker at both ends. Tibial spurs 0–2–2, symmetrical.

Abdomen. Abdominal segment I half as long as next segment, caudally from this segment, abdomen droops ventrally; tergites yellowish brown with lateral edges darker brown and a narrow dark brown medial stripe; sternites pale yellow with dark brown edges.



Figures 21–22. *Neoderus chonos* Madriz, sp. n., wing: (21) photomicrograph with pigmentation; (22) line illustration without pigmentation, veins and cells indicated. Abbreviations: bc: basal costal cell; bm: basal medial cell; bm-m: basal medial-medial crossvein; br: basal radial cell; c: costal cell; C: costal vein; cua: anterior cubital cell; CuA: anterior branch of cubitus vein; cup: posterior cubital cell; CuP: posterior branch of cubitus vein; d: discal cell; h: humeral crossvein; m-m: medial crossvein; m1, m2, m3, m4: medial cells; M1, M2, M3, M4: distal branches of medial vein; MA: anterior branch of medial vein; r-m: radial-medial crossvein; r1, r2, r3, r4, r5: radial cells; R1, R2, R3, R4, R5: distal branches of radius; Rs: radial sector vein; sc-r: subcostal-radial crossvein; sc: subcostal cell; Sc: subcosta vein; Stm: stem vein.



Figures 23–25. *Neoderus chonos* Madriz, sp. n., male terminalia: (23) epandrial view; (24) hypandrial view; (25) lateral view. Abbreviations: aed: aedeagus; cerc: cercus; ej apod: ejaculatory apodeme; epand: epandrium; goncx: gonocoxite; gonst: gonostylus; pm dme: dorsomedial element of paramere; pm gbl: paramere lobe at gonocoxite base; spm sac: sperm sac. Scale bars = 0.1mm.

Terminalia. (Figures 23–25). With 180 degree of torsion involving segments VIII and IX; epandrium (epand; Figures 23 and 25) bilobed, narrowly contiguous at base and tapering apically, one and a half times longer than wide, with setae alveoli scattered over entire surface; proctiger recessed anteriorly, nested within epandrium, exposed dorsally; cercus (cerc; Figure 25) inconspicuous, unmodified, setose, exposed dorsally between medial emargination of epandrium; gonocoxites (goncx; Figures 23–25) fused to hypandrium, narrowly contiguous at base (Figure 24), divergent from each other at origin, each nearly cylindrical, tapering slightly toward apex; setiform sensilla or setae alveoli distributed over dorsal, ventral and lateral surface, absent mesally; gonostylus (gonst; Figures 23–25) cylindrical, almost as long as gonocoxite, slightly tapering at apex, curved medially, with prominent setae alveoli evenly distributed over surface, small stout acutiform sensilla apically;

hypandrium not evident; paramere subdivided into dorsal bridge, lateral medial element, dorsal medial element (pm dme; Figure 25) and paramere lobe at gonocoxite base (pm gbl; Figures 23–25); dorsal bridge horizontal, with a pair of projections anterolaterally; lateral medial element broadly interconnected with gonocoxite anteromesally and paramere lobe at gonocoxal base posteroventrally, divided into two lobes, anterior lobe small, convex, with over 15 setiform sensilla, posterior lobe fleshy, thorn-like, curved mesally; dorsal medial element 'Y-shaped', articulating terminally with dorsal bridge and ventrally with lateral ejaculatory processes; paramere lobe at gonocoxite base laterally compressed, reniform in shape laterally, with several prominent setiform sensilla subapically, many smaller trichoid sensilla throughout; ejaculatory apodeme (ej apod; Figure 25) extended anteriorly to abdominal segment VII terminus, dorsoventrally compressed, clavate at base, with surface corrugated; sperm sac balloon-like, surrounded by aedeagus posteriorly, attached to ejaculatory apodeme anteriorly; aedeagus (aed; Figures 23–25) uniformly wide, phallotrema fused; phallotrema apex with curved hornlike projection extending caudally; aedeagal sheath present, loosely surrounding phallotrema.

Description of female

Figures 1, 3, 18–20 and 28–30.

Measurements. (n = 3). Total length 13.78 mm (13.25–13.75); head length 1.45 mm (1.25–1.57); head width 1.39 mm (1.14–1.38); clypeus length 0.40 mm (0.37–0.42); clypeus width 0.40 mm (0.37–0.42); palpus length 1.82 mm (palpomere length average 0.14–0.32–0.56–0.36–0.44); wing length 15.82 mm (14.55–16.80); wing width 4.25 mm (4.00–4.36). Leg measurements (see Table 2).

Overall colouration. Greyish brown to dark brown. Head: labrum approximately twice as long as clypeus; antenna as in male, with 14 flagellomeres; frontal suture incomplete, coronal suture not visible (Figure 19).

Wing. As in male.

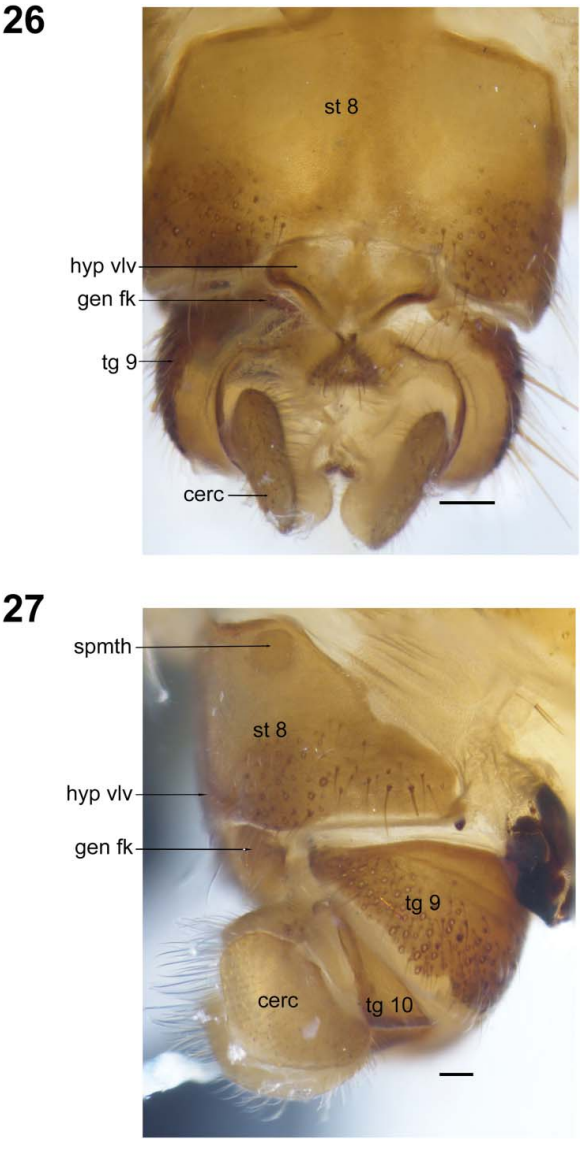
Legs. Tibial spurs 1–2–2, symmetrical.

Abdomen. Less than twice as long as thorax.

Terminalia. With spermatheca three in number; corpora spherical, with visible necks; spermathecal ducts annulated and uniformly sclerotised, less than six times as long as corpora, unpigmented; posterior margin of sternite VIII broadly bilobate, emarginated at median, emargination with 'square U' shape; genital fork (gen fk; Figures 28–30) triangular transversely, slightly longer than wide 'V-shaped' medially, slightly constricted near terminus.

Etymology

Named in honour of the indigenous extinct Chonos tribe that inhabited the area surrounding the type locality. The name is a noun in the nominative singular standing in apposition.



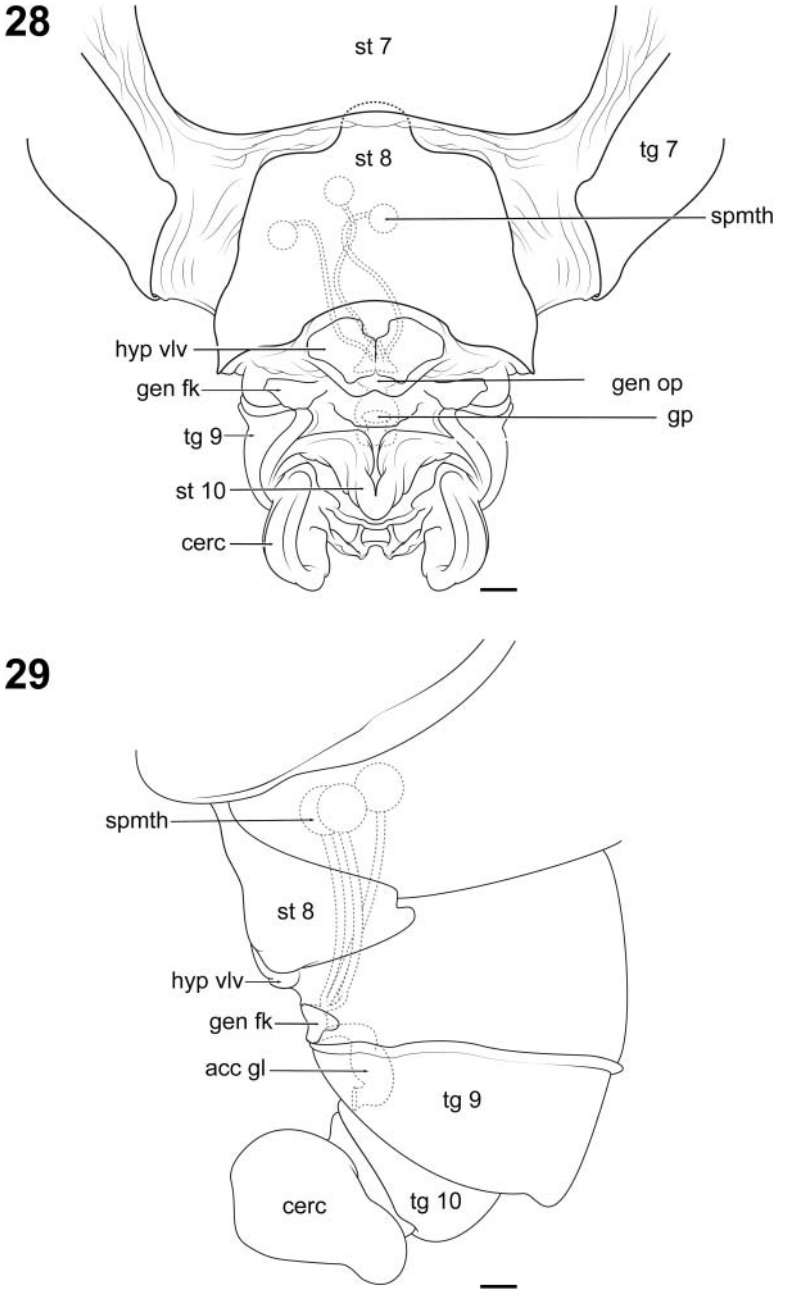
Figures 26–27. *Neoderus patagonicus* (Alexander, 1913), female terminalia: (26) ventral view labelled; (27) lateral view labelled. Abbreviations: cerc: cercus; gen fk: genital fork; hyp vlv: hypogynial valve; spmth: spermatheca; Scale bars = 1.00 mm.

Distribution

Neoderus chonos is restricted to southern Chilean Patagonia. Confirmed records lie between latitudes 46°27′S and 46°30′S, ranging in altitude from 0 to 534 m a.s.l. A survey of the central regions of Chile yielded no specimens.

Natural history

Habitat (Figures 5–14). Both collection sites are located in temperate old-growth forest fragments. The creek at the *N. chonos* type locality is a first-order tributary of Rio Norte



Figures 28–29. *Neoderus chonos* Madriz, sp. n., female terminalia: (28) ventral view; (29) lateral view. Abbreviations: acc gl: accessory gland; cerc: cercus; gen fk: genital fork; gen op: genital opening; gp: gonopore; hyp vlv: hypogynial valve; spmth: spermatheca; st 7–st 10: sternites #7–#10; tg 7–10: tergites #7–#10. Scale bars = 1.00 mm.

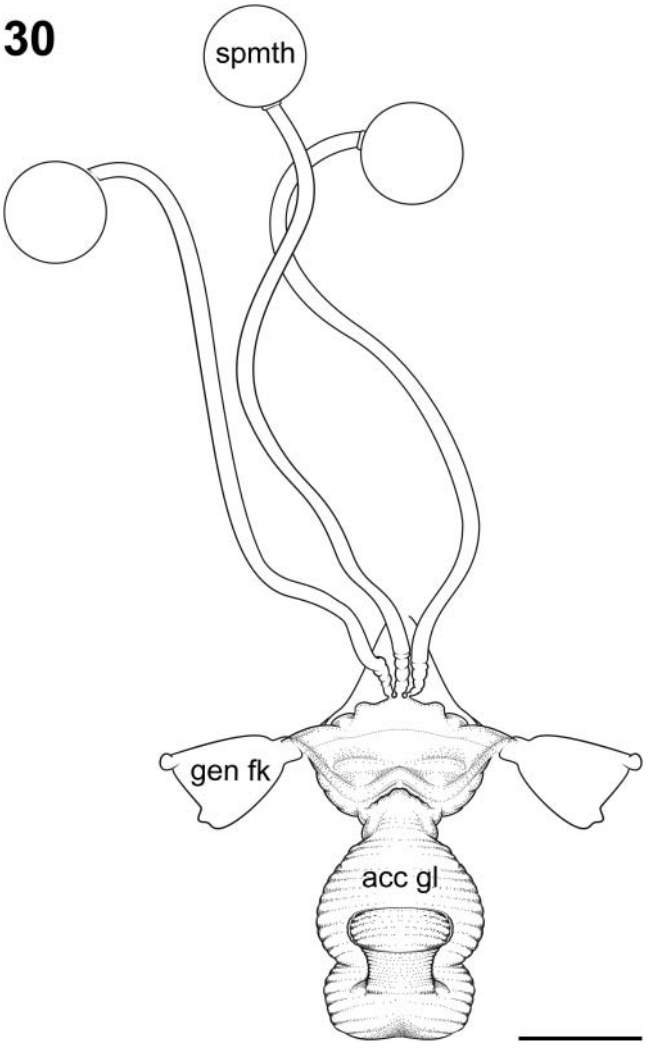


Figure 30. *Neoderus chonos* Madriz, sp. n., female internal genitalia lateral view. Abbreviations: acc gl: accessory gland; gen fk: genital fork; spmth: spermatheca. Scale bar = 0.10 mm.

in the Exploradores Valley, with geology composed mainly of Patagonian batholith (granite) and alluvial deposits at lower elevations (SERNAGEOMIN 2003). Vegetation is mainly composed of *Nothofagus betuloides* (Mirb.) Orsted. Annual rainfall is ca. 1800 mm.

Kairai is a first-order stream and tributary of Lago General Carrera, with geology composed of Patagonian batholith (SERNAGEOMIN 2003). The vegetation at lower elevation is composed mainly of the woody bamboo C*husquea* sp. in the understory and evergreen species of *Nothofagus betuloides*, *Embothrium coccineum* (J.R. Forst & G. Forst), *Rhaphithamnus spinosus* (Juss.) Moldenke, *Laureliopsis philippiana* (Looser) Schodde and *Lomatia ferruginea* (Cav.) R. Br., whereas higher elevation vegetation is mostly deciduous southern beech, *Nothofagus pumilio* (Poepp. & Endl.) Krasser. Annual rainfall is ca. 1200 mm. For local in-stream environmental variables, see Table 3.

Behaviour. Adult *N. chonos* were encountered resting on the outer walls of a dilapidated structure 200 m from a lentic aquatic habitat (Figure 7) and, at one locality, next to a first-order stream (Figures 11–14), a single wing was found. All adults were resting (hanging) on a vertical surface. *Neoderus chonos* was found only during the late afternoon (after 21:00 h). If disturbed by close proximity or physical touch, the flies would disperse. Their flight is typical of Tanyderidae and Psychodidae: short distances with an erratic pattern. Females were kept alive for up to 5 days on a diet of water and diluted sugar. The male died one day after capture. Although no copulation was observed, initial mating attempts by the male suggest similar mating behaviour to *Araucoderus gloriosus* (Alexander, 1920) as depicted by Madriz and Courtney (2016): male resting on the vertical wall of the enclosure side by side with the female was flexing the abdomen laterally attempting to clasp the female abdomen at mid-length with no success.

Comments on Tanyderidae wing morphology

In the original description, Alexander (1913) does not mention the presence of vein Sc-r but in his treatment of the Tanyderidae, Alexander (1927) depicts the Sc-r vein in his illustration; this change was overlooked by Williams (1933). Cross vein r5 is absent in the right wing of male.

Key to genera of extant Tanyderidae (based solely on wing characters)

1 Wings with colouration in pterostigma only (Figure 33) ..... ***Peringueyomyina* Alexander, 1921** (South Africa)
– Wings with variegated colouration patterns **2**
2 Vein R_{2+3} arising after or at same level as base of vein R_5 ..... **3**
– Vein R_{2+3} arising more than 3 mm before base of vein R_5 ..... **4**
3 Cell r_4 with crossvein present (Figure 34) ..... ***Tanyderus* Philippi, 1865** (Chile)
– Cell r_4 with crossvein absent (Figure 35) ..... ***Radinoderus* Handlirsch, 1909** (Oceania)
4 Wings with crossvein in cells r_3, r_4, and/or r_5 ..... **5**
– Wings with no crossveins in radial cells **7**
5 Cell r_3 with crossvein absent; Sc_2 vein appearing as a distinct oblique vein in cell sc (Figure 36) ..... ***Nothoderus* Alexander, 1927** (Australia: Tasmania)
– Cell r_3 with crossvein present; Sc_2 vein absent **6**
6 Cell r_4 with crossvein present (Figure 37) ..... ***Mischoderus* Handlirsch, 1909** (New Zealand)
– Cell r_4 with crossvein absent (Figure 21) ..... ***Neoderus* Alexander, 1927** (Chile)
7 Vein R_{2+3} shorter than length of cell r_2 ..... **8**
– Vein R_{2+3} equal or longer than length of cell r2 ..... **9**
8 Cell m_2 as long as or longer than cell d (Figure 38) ..... ***Araucoderus* Alexander, 1929** (Chile)
– Cell m_2 less than half as long as cell d (Figure 39) ..... ***Eutanyderus oreonympha* Alexander, 1938** (Australia)

9 Cell d longer than cell bm (Figure 40) . . . . . ***Eutanyderus wilsoni* Alexander, 1928** (Australia)
– Cell d shorter than cell bm **10**
10 Cell m_3 with crossvein present (Figure 41) . . . . . ***Protoplasa* Osten Sacken, 1859** (Eastern Nearctic)
– Cell m_3 with crossvein absent (Figure 42) . . . . . ***Protanyderus* Handlirsch, 1909** (Palaearctic and Nearctic)

Discussion

Geography

The Aysén Region has some of the most extensive remaining old-growth primary deciduous forest left on the planet (Armesto et al. 2009). The region was strongly modified by glacial activity during the Quaternary, leaving a heavily fragmented topography with large areas of old-growth forests being difficult to reach.

Presently, a steep environmental gradient characterises the landscape, with precipitation and temperature gradients orientated in an eastwest direction and highly variable precipitation between neighbouring valleys. Such is the case for the two sites where *N. chonos* was collected; the difference in precipitation between the two sites was approximately 600 mm, with the valleys separated by 37 km. Magellanic Coigue (*Nothofagus betuloides*), the evergreen southern beech, is usually dominant in higher precipitation areas of Aysén Region.

Aysén has not only remained the most isolated region in the country, but houses the lowest population of all 15 regions in Chile. Although colonisation and agricultural development in the second half of the twentieth century have altered the area somewhat, the most serious impacts have been caused by fires that burnt for decades near the middle of the twentieth century (Otero 2006). Estimates of the burnt area range between 2 and 3 million hectares (Hoffmann 1998). Many of these fires occurred at lower elevations and close to the limited road network.

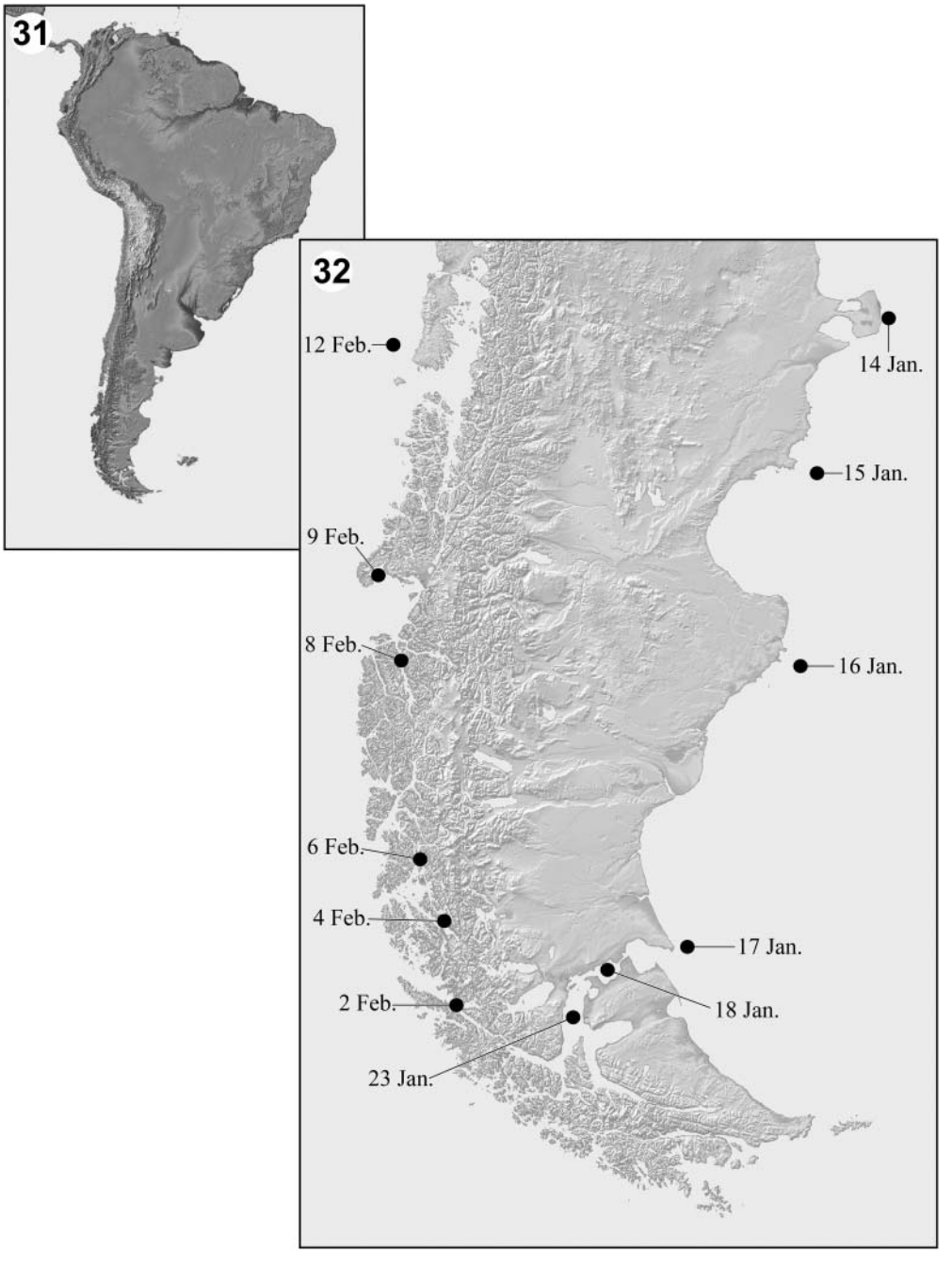
Glacial refugia

Little is known about the location of glacial refugia in southern Chile or how glacial activity influenced the present-day distribution of resident species. However, interesting biogeographical patterns and areas of endemism have been described for some lotic macroinvertebrates with low mobility (Valdovinos 2006; Valdovinos et al. 2010). Thus far, *Neoderus* exhibit a restricted distributional pattern, possessing the southernmost latitudinal record in the family and inhabiting a heavily fragmented topography caused by glacial activity in Patagonia. Moreover, neotropical tanyderid distributions may provide insights into patterns of endemism in southern Patagonia.

Historical distribution

In the original description of *N. patagonicus*, Alexander (1913) provided a questionable type locality and no date of collection, leading to several uncertainties about the habitat of

the genus. However, existing historical records (Figures 31 and 32 and Table 4) suggest the holotype of *N. patagonicus* was collected on 6 February 1888 by the crew of the Albatross Research Vessel in its circumnavigation around the Americas from Norfolk, VA, to San Francisco, CA (Howard 1890; Ridgway 1890; Tanner 1891; Townsend 1901; United



Figures 31–32. Albatross Research Vessel collection sites: (31) map of South America; (32) map of southern South America depicting a partial list of collecting dates from January 14 to February 12, 1888. Black dots represent the approximate location of dredging samples.

Table 4. Partial list of collecting dates from January to February 1888: relative to the work of the Albatross Research Vessel.

Collection date	Latitude	Longitude
12 January	36°47′00″S	056°23′00″W
13 January	40°03′00″S	058°56′00″W
14 January	42°24′00″S	061°38′30″W
15 January	45°22′00″S	064°20′00″W
16 January	48°37′00″S	065°46′00″W
17 January	52°23′00″S	068°11′00″W
18 January	52°41′00″S	069°55′30″W
19 January	52°38′00″S	070°10′30″W
23 January	53°01′00″S	070°42′15″W
23 January	53°06′00″S	070°40′30″W
02 February	53°01′00″S	073°42′30″W
04 February	51°52′00″S	073°41′00″W
06 February	51°12′00″S	074°13′30″W
06 February	51°02′30″S	074°08′30″W
08 February	48°41′00″S	074°24′00″W
08 February	48°09′00″S	074°36′00″W
09 February	46°46′00″S	075°16′30″W
09 February	46°47′30″S	075°15′00″W
11 February	45°35′00″S	075°55′00″W
12 February	42°36′00″S	075°28′00″W

States Hydrographic Office 1922; SNMNH 2016). The type locality resides in Chile's Region XII (Región de Magallanes y la Antártica Chilena), on Hanover Island, East side of Parque Nacional Alacalufes next to Canal Esteban, approximately 90 km west of Parque Nacional Torres del Paine. Unfortunately, we were unable to find the name of the collector, although this could be accredited to the scientific team of Albatross Research Vessel.

Collection of specimens

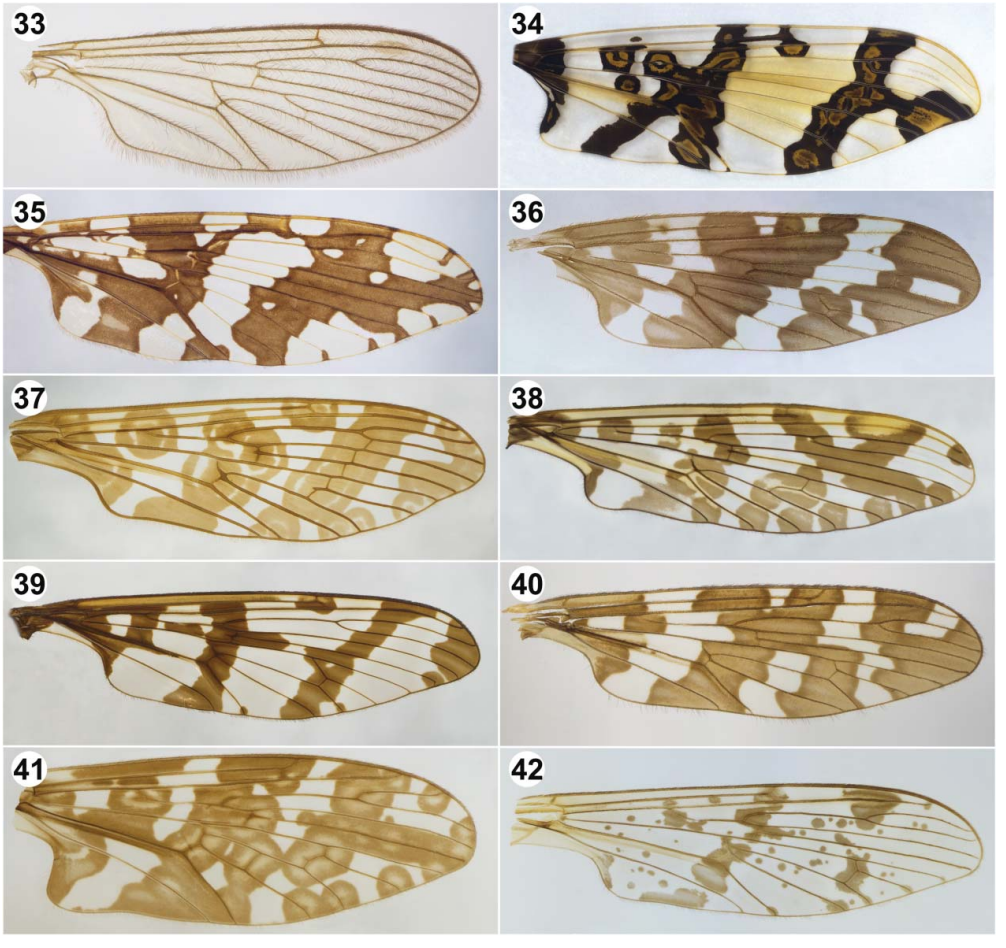
During our *Neoderus* collections at Kairai Creek, the senior author also observed over 49 adult *Araucoderus gloriosus* Alexander, 1920 (Madriz 2016). Extensive searches for additional specimens of *Neoderus* on different occasions, including searches for immature stages, were without success.

Collection records of Chilean tanyderid species suggest emergence throughout the spring and summer months (Alexander 1935; Lukashevich and Scherbakov 2014, 2016; Madriz 2016; Madriz and Courtney 2016; Madriz, unpublished observation). Additionally, all known immature stages of Neotropical tanyderids are associated with water.

Several black lighting attempts at the *Neoderus* collection sites yielded no tanyderid specimens, suggesting that *N. chonos* is not attracted to black lights, as is the pattern for *Araucoderus* (Madriz and Courtney 2016) and *Tanyderus* (Madriz, unpublished observation).

Phylogenetic implications

Alexander (1927) proposed *Neoderus* as a monotypic genus to include *N. patagonicus*, but an explanation for this designation was lacking. *Neoderus* can be readily identified from other tanyderid genera through superficial characters such as wing pattern and venation



Figures 33–42. Wings of genera of Tanyderidae, composite photomicrographs: (33) *Peringueyomyina barnardi* Alexander, 1921; (34) *Tanyderus pictus* Philippi, 1865; (35) *Radinoderus solomonis* (Alexander, 1924); (36) *Nothoderus australiensis* (Alexander, 1922); (37) *Mischoderus annuliferous* (Hutton, 1900); (38) *Araucoderus gloriosus* (Alexander, 1920); (39) *Eutanyderus oreonympha* Alexander, 1938; (40) *Eutanyderus wilsoni* Alexander, 1928; (41) *Protoplasa fitchii* Osten-Sacken, 1859; (42) *Protanyderus vipio* Osten-Sacken, 1877.

(Figures 21 and 22), epandrial structure, body size and colouration. Both sexes exhibit an abdomen with a higher degree of frontocaudal compression than all other southern hemisphere genera.

Aside from wings, discriminatory characters between tanyderid genera and species can be found in the structure of male terminalia, especially parameres, degree of fusion and length of phallotrema. Female spermathecal capsule shape, ducts and genital fork are some of the structures, thus far, capable of providing clearer differences between cryptic species as is in the case of *A. gloriosus* (Madriz, unpublished observations).

Following the characters described herein and by Madriz and Courtney (2016), *Neoderus* shows significant differences to the other Patagonian tanyderids, mainly a deeply bilobed epandrium and fused phallotrema in males and stouter overall body shape in

males and females. The latter shows a closer resemblance to the northern hemisphere fauna (*Protanyderus* + *Protoplasa*). Genitalia provide further characters that are being incorporated into a morphological phylogenetic treatment of the family (Madriz, in preparation).

Neoderus can be considered the rarest genus amongst the Tanyderidae, with only a single female specimen ever collected prior to this study. Information about immature stages is needed to further understand the relationship between this obscure genus and the rest of the family.

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Disclosure statement

No potential conflict of interest was reported by the authors.

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