

REDESCRIPTION OF *NEOTYPHLOCERAS CRASSISPINA HEMISUS* JORDAN (SIPHONAPTERA: CTENOPHTHALMIDAE: NEOTYPHLOCERATINI)

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ABSTRACT: *Neotyphloceras crassispina hemisus* Jordan is redescribed from male and female specimens collected at the type locality (Otro Cerro, Catamarca Province, Argentina) and nearby localities. New diagnostic morphological characters for both sexes are provided, which include the shape of the upper lobe of the fixed process of clasper, the crochet of the aedeagus and the shape and chaetotaxy of the distal arm of sternum IX for males, and the contour of the distal margin of sternum VII for females.

Neotyphloceras Rothschild is distributed from Venezuela to southern Chile and Argentina (Hopkins and Rothschild, 1966; Smit, 1968; Sanchez et al., 2012; Bazán-León et al., 2013; Sanchez and Lareschi, 2014). The genus includes 5 species and 2 subspecies: *Neotyphloceras chilensis* Jordan, 1936, *Neotyphloceras crackensis* Sanchez and Lareschi, 2014, *Neotyphloceras crassispina* Rothschild, 1914, *Neotyphloceras crassispina crassispina* Rothschild, 1914, *Neotyphloceras crassispina hemisus* Jordan, 1936, *Neotyphloceras pardinasii* Sanchez and Lareschi, 2014, and *Neotyphloceras rosenbergi* (Rothschild, 1904). The males of these species are mostly defined by the length, shape, and chaetotaxy of the fixed process of the clasper and by the characteristics of the aedeagus. The females are defined, at species level, by the shape of sternum VII (Rothschild, 1914; Sanchez et al., 2012; Sanchez and Lareschi, 2014). The subspecies *N. c. crassispina* and *N. c. hemisus* are distinguishable only by their males, based on the length and shape of the fixed process of the clasper, and by the distance of the most distal seta in relation to its apex (Jordan, 1936; Hopkins and Rothschild, 1966). The identification of females to subspecies level was based on the accompanying males (Hastriter, 2001; Lareschi et al., 2010). Moreover, Sanchez and Lareschi (2014) distinguished the males and females of *N. c. hemisus* from those of the other subspecies by the presence of second and/or third abdominal tergites with 1 to 3 dorsal spinelets on each side.

Neotyphloceras c. hemisus is distributed from Peru to southern Argentina and Chile (Sanchez and Lareschi, 2012) (Fig. 3). Originally, the subspecies was described from specimens collected on a rodent (*Andinomys edax*) from Otro Cerro (Catamarca, Argentina) based on a few characters, and designated paratypes were some specimens collected on other species of rodents, far from the type locality, suggesting that some of them might not belong to this subspecies.

For this reason, we redescribe *N. c. hemisus* based on a topotype male specimen recently collected at the type locality

(Otro Cerro, Catamarca Province, Argentina) as well as comparisons with the holotype and paratypes from the type locality and other specimens from nearby localities of northwestern Argentina. These studies are important because they provide the basis for future epidemiological studies, by defining with greater certainty the specific identity of the parasites and their vectors, and the linkages to diseases in humans, as well to domestic and wild animals.

MATERIALS AND METHODS

Fleas stored in 96% ethanol were mounted in Canada balsam, examined, drawn using a microscope equipped with camera lucida, photographed, and then deposited at the Annexes of the Colección Mamíferos Lillo (CML), Universidad Nacional de Tucumán and Fundación Miguel Lillo. For comparative purposes, we examined the holotypes and paratypes of all species and subspecies of *Neotyphloceras* deposited in rather than at the Rothschild Collection, at the Natural History Museum (NHM) of London, England. For morphology nomenclature we followed Rothschild and Traub (1971). The hosts were deposited at the Colección Mamíferos Lillo (CML), Universidad Nacional de Tucumán, and Fundación Miguel Lillo and at the Sam Noble Oklahoma Museum of Natural History (OMNH), University of Oklahoma, Norman, Oklahoma.

The specimens examined are listed in the taxonomic summary section, indicating province, specific locality, department, coordinates, host species, and collection number.

REDESCRIPTION

Neotyphloceras crassispina hemisus Jordan

(Figs. 1A–C, 2A–D)

Head with the frons slightly convex, about 3 times longer than high, with 2 frontal rows of setae: the first row with 6 or 7 equidistant setae, tips exceeding the insertion of setae of the next row; the second row with 3 equidistant setae, the longest seta extending beyond the distal end of the longest spine of the genal comb (Fig. 1A, B). Two or 3 placoid pits along the front margin. Occipital region with 4 rows of setae (Fig. 1A, B). First antennal segment with 10–12 small setae; second antennal segment with 9–11 short setae reaching the first segment of the clavus; antennal clavus subequal in length with the first antennal segment in males (Fig. 1A) and twice the length in females (Fig. 1B). A row of small setae bordering antennal fossa: 30–37 setae in males (Fig. 1A) and 9–15 in females and restricted to the posterior edge of the head (Fig. 1B). Genal comb with 4 pointed spines, the first 2 overlapping, and the fourth shorter than the others (< 60% of the length to the longest spine) (Fig. 1A, B). Preoral edge with 2 setae on each side. Genal process sharp, with length subequal to the longest spine of the genal comb. Maxillary lobe sharp, extending beyond basal half of maxillary palpus (Fig. 1A, B). Maxillary palpus with 4 segments reaching to about the middle of the fore coxa; first and second segments subequal; third segment shorter and fourth longer than the others. Labial palpus with 5 segments, long, extending to about the distal edge of the fore coxa; first and fifth segments subequal and 1.5 times longer than second and third segments. Lacinia slightly serrated and subequal to the labial palpus.

Received 11 September 2014; revised 14 November 2014; accepted 19 November 2014.

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DOI: 10.1645/14-648.1

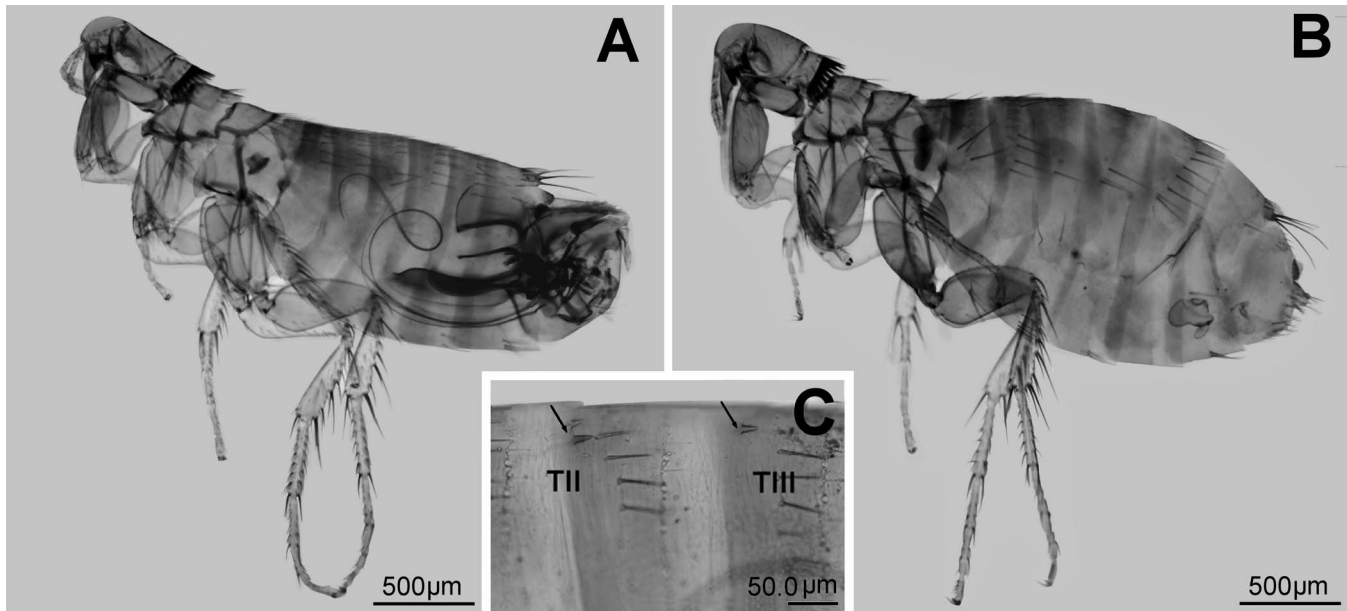


FIGURE 1. (A, B) *Neotyphloceras crassispina hemisus* Jordan. Scale = 50 μm. (C) Tergites II and III with spinelets.

Pronotum (Fig. 1A, B) with 1 row of 5 or 6 long equidistant setae; pronotal comb with 9 or 10 spines on each side; length of longest spine subequal to the width of pronotum. Mesonotum (Fig. 1A, B) with 4 rows of short setae and 1 apical row with 5 or 6 long setae; mesepisternum with a group of small setae on the anterior region and 2 long setae posteriorly; mesepimere with 5 setae; metanotum with 2 anterior rows of 6 short setae and 1 apical row with 6 long setae; lateral metanotal area long, subequal to pleural arch and with a long seta; pleural arch and ridge well developed; metepisternum with 1 long seta and 1 small seta; furca of metasternum about one-fourth the length of the pleural ridge; metepimere with 7 long setae distributed in the superficies.

Fore coxa (Fig. 1A, B) with 40–50 setae distributed over entire surface with 1 long seta on posterior margin. Middle and hind coxae (Fig. 1A, B) with setae distributed only on anterior margin (10–14, 20–25, respectively). Fore femur (Fig. 1A, B) with a dorsal marginal row of 10–12 small setae and with 1 row of 6 setae on the inner side. Middle femur (Fig. 1A, B) with a subventral row of 6 or 8 setae on the inner side and 2 long ventral setae. Hind femur (Fig. 1A, B) with a subventral row of 7 setae on the inner side and 2 setae on the outer side restricted to the distal region, and with 1 ventral pair of setae on the proximal margin and 1 dorsal pair of setae on the distal margin, the longest seta reaching the second notch of the tibia. All tibiae (Fig. 1A, B) with 8 dorsomarginal notches bearing large setae from apex to base as follows: fore tibia (2; 2; 1–2; 2; 1–2; 2; 2); middle tibia (2; 2; 1–2; 2; 2; 2; 2); and hind tibia (2–2–1–2–2–2–2–2); longest caudal setae extending to beyond the middle of the first tarsal segment. First hind tarsal segment more than twice the length of the third and fifth segment and more than 4 times longer than fourth segment.

Abdomen with spinelets in tergites II and III (Fig. 1C). Tergites II–VI with 2 rows of setae (4; 8–10), setae of anterior row shorter than those of the posterior row. Tergum VII with 2 antesensillar setae each side. Fossa of spiracle of tergites II–VII short, cone-shaped. Sensillum strongly convex posteriorly, with 15–17 sensillar pits. Sternum III with 3 setae; Sternum IV–VI with 5 setae.

Modified abdominal segments of the male: Sternum VII with 3 or 4 setae on each side. Tergum VIII with 4 to 6 setae above the spiracle. Upper lobe of the fixed process of the clasper (P) (Fig. 2A) cone-shaped, robust, and dorsal margin convex, with 3 or 4 submarginal setae and one row of 8–10 dorsomarginal setae, the last seta placed from the tip by distance equal to the width of the fixed process at the point of attachment of the seta (Fig. 2A). Lower lobe of fixed process with sharp distal edge, without setae (Fig. 2A). Movable process (F) with 1 strongly pigmented seta on each side, and 3 or 4 small setae on the apex; distal margin almost rounded; ventral margin very indented, with a row of 12–17 small setae along its edge (Fig. 2A). Two manubria, the upper manubrium hook-

shaped, shorter and narrower than the lower. Acetabulum with a vertical row of 11–13 small spiniform setae; below this row a wide, strongly pigmented spatulated spine and 2 narrow pigment-free setae. Sternum IX (Fig. 2B) with proximal arm (P.A.IX) and distal arm (D.A.IX) subequal in length; distal arm with apex forming a strongly concave projection bearing a small dorsomarginal seta in the center and 6 curved, spine-like ventromarginal setae, 1 strongly pigmented and located in the center and the other 5 located in a ventral row, with the first seta more pigmented and wider. Dorsal anal lobe long, narrow, cone-shaped; ventral anal lobe conical, shorter than the dorsal, with 2 long ventral setae on each side.

Aedeagus (Fig. 2C) with long aedeagal apodeme (A.E.A), more than 6 times longer than broad. Median dorsal lobe (MDL) strongly sclerotized. Lateral lobes (L.L.) present. Sclerotized inner tube (S.I.T.) long, straight, narrow. Apical median sclerite present, shorter than and located near the middle of the inner tube. Crochet of aedeagus (CR) apical and large, with long, robust base, apex with proximal margin forming a sharp projection and distal margin almost straight. Two long apodemal struts (A.P.S.), proximal strut greater than distal strut and with the dorso-proximal margin sclerotized. Crescent sclerite (C.S.) conspicuous above apodemal strut. Penis rod uncoiled, with a fold in the anterior portion and subequal to longer than the tendon of sternite IX. Without dorsal membranous lobe arising from the dorsal portion of the aedeagus.

On modified abdominal segments of the female, sternum VII with 5 setae, apical margin strongly rounded and contour of distal margin rounded or slightly convex in the lower portion (Fig. 2D). Sternum VIII narrow, elongated and less sclerotized than the other segments. Tergum VIII with long, narrow, oblique spiracles, with small setae placed above the spiracle, the upper lateral seta placed at a variable distance from ventral margin to lowest level of spiracular fossa; distal margin with a small lobe and 3 or 5 short, wide, spiniform setae. Anal lobes short and conical, dorsal anal lobe wider than ventral anal lobe. Anal stylet subapical, more than 3 times longer than broad at the base, with a long apical seta twice the length of anal stylet. Spermatheca (SP.) with bulga longer and wider than the hilla, cribiform area circular and heavily sclerotized (Fig. 2D). Bursa copulatrix strongly sclerotized, bifurcated (Y-shaped).

Diagnosis: *Neotyphloceras crassispina hemisus* differs from all other species and subspecies of the genus by the presence of abdominal spinelets. The males are distinctive by the following combination of characters: (1) shape of the apex of the crochet of the aedeagus with proximal margin forming a sharp projection, and distal margin almost straight, and (2) apex of the distal arm of sternum IX bearing 1 small dorsomarginal seta in the center, and 6 curved spine-like ventromarginal seta, 1 seta strongly pigmented and located in the center and the other 5 located in a ventral

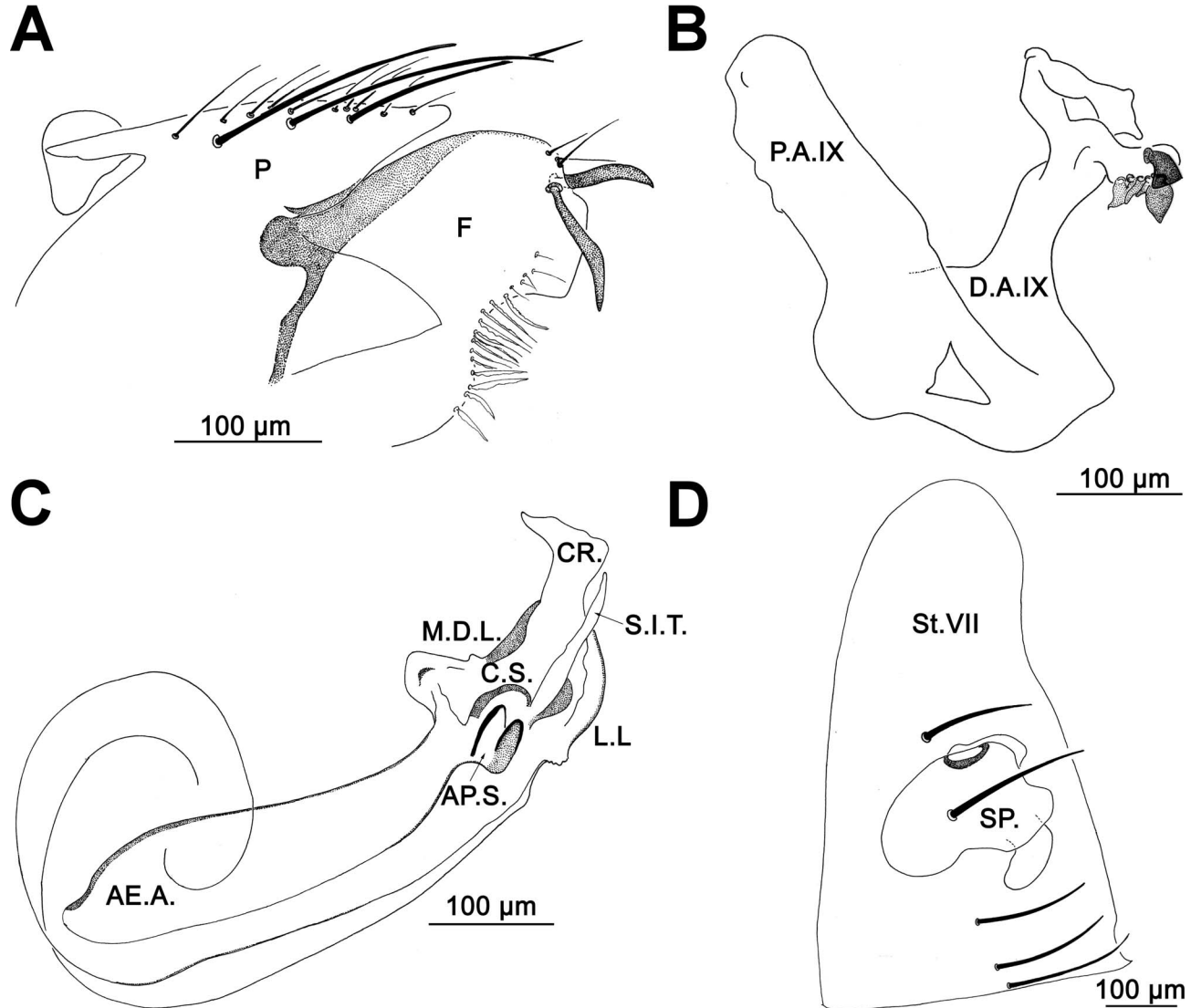


FIGURE 2. (A) Fixed process of the clasper (P) and movable process (F) male. (B) Sternite IX male distal arm of sternite IX, proximal arm of sternite IX. (C) Aedeagus male Aedeagal apodeme, apodemal strut of aedeagus, crochet, C.S. = crescent sclerite of aedeagus, median dorsal lobe of aedeagus, lateral lobes of aedeagus, sclerotized inner tube. (D) Sternite VII and spermatheca female.

row, with the first seta more pigmented and wider. Females are unique by the apical margin of sternum VII wide, and the contour of the distal margin rounded or slightly convex in the lower portion.

Taxonomic summary

Specimens examined: Catamarca Province 3–4 km S of the junction of Provincial Highway 18 and 9 on Provincial Highway 18 (Dep. Paclín) (27°49'48.3"S, 65°47'53.3"W; 1,529 ± 53 m), 1 female ex *Necromys lactens* (Thomas, 1918) (OMNH 34512); Laguna Blanca (Dep. Belén) (26°34'53.4"S, 66°56'38.6"W; 3,350 m), 1 female ex *Eligmodontia bolsonensis* Mares, Braun, Coyner, and Van Den Bussche, 2008 (CML 9436); Otro Cerro (Dep. Capayán) (28°41.551'S, 66°15.150'W; 2,160 m), 1 male (holotype) and 2 males (paratypes) ex *Andinomys edax* Thomas, 1902 (BM 1923-615), 1 male (paratype) and 1 female (paratype) ex *Reithrodon auritus* (Fischer, 1814) (BM 1923-615); Otro Cerro, Rancho de los Crisho (Dep. Capayán) (28°41.551'S, 66°15.150'W; 2,160 m), 1 male (Topotype) ex unknown host; Paycuquí (Dep. Antofagasta de la Sierra) (25°54'53"S, 67°21'15"W; 3,664 m), 3 males and 2 females ex *Abrothrix andinus* (Philippi, 1858) (CML 6878, 6879, 9217, OMNH 30214). Jujuy Province: 9 km NW of Barcena (Dep. Tumbaya) (23°67'5.9"S, 65°30'1.2"W; 2,655 m), 4 males and 4 females ex *Phyllotis cf. osilae* Allen, 1901 (CML 6499, 6501,

OMNH 34028); Chilcayoc (Dep. Tumbaya) (23°56'30"S, 65°28'33"W; 2,239 ± 50 m), 1 male ex *Phyllotis cf. osilae* (OMNH 30196). Salta Province: Approximately 15 km W of Escoipe, on Provincial Highway 33 (Dep. Chicoana) (25°10'25.2"S, 65°49'31.6"W; 2,680 m), 1 female ex *Akodon spegazzinii* Thomas, 1897 (CML 7213); Finca Barbo Yaco (Dep. Rosario de la Frontera) (25°58'36.8"S, 64°55'36.9"W; 1,347 m), 1 male ex *Oligoryzomys destructor* (Tschudi, 1844) (CML 9574), 3 males and 4 females ex *Akodon simulator* Thomas, 1916 (CML 9050, 9051, OMNH 29995, 29996), 1 female ex *Phyllotis xanthopygus* (Waterhouse, 1837) (OMNH 30198); Vega Cortadera (Dep. Los Andes) (25°07'13"S, 67°02'39"W; 3,897 m), 1 female ex *Akodon albiventer* Thomas, 1897 (CML 8963), 3 males ex *Abrothrix andinus* (CML 6874).

Remarks

In this study new diagnostic morphological characters are added that allow us to identify males and females of *N. crassispina hemisus* to subspecific level. Jordan (1936) distinguished the 2 subspecies of *N. crassispina* by differences in the fixed process of the clasper of males: *N. crassispina hemisus* presents a process of clasper little longer than in *N. crassispina crassispina*, the tip slightly curved up, and the last bristle farther away from the tip, while in *N. crassispina crassispina* the process of



FIGURE 3. Distribution of the 2 subspecies of *Neotyphloceras*: *Neotyphloceras crassispina crassispina* (light gray); *Neotyphloceras crassispina hemisus* (dark gray). Ecuador (EC), Chile (CH), Paraguay (PY), Uruguay (UY).

clasper is shorter and more obtuse, the tip is slightly curved down and the bristle close to the tip. However, a revision of the holotypes, paratypes, and other specimens of *N. crassispina crassispina* is necessary to evaluate the existence of the 2 subspecies.

The known records of *N. crassispina crassispina* suggest a trans-Andean distribution for this subspecies, while *N. crassispina hemisus* has mainly a cis-Andean distribution (Rothschild, 1914; Jordan, 1936; Hopkins and Rothschild, 1966; Hastriter, 2001; Lareschi et al., 2010; Bazán-León, 2011). *Neotyphloceras crassispina crassispina* was recorded in Argentina, Bolivia, Chile, and Peru (Fig. 3); the single known record from Argentina (in Bariloche, Rio Negro Province) was defined as “unexpected” since this locality is very far south from the rest of the known distribution for the subspecies (Smit, 1955; Beaucournu and Castro, 2003). *Neotyphloceras crassispina hemisus* is also known from Argentina, Bolivia, Chile, and Peru (Sanchez et al., 2012) (Fig. 3); its distribution in Argentina is vast and extensive and includes an extensive western strip from north to south (Autino and Lareschi, 1998; Beaucournu and Castro, 2003; Lareschi et al., 2010; López Berrizbeitia et al., 2013). However, since some localities are far from the type locality some specimens could belong to other species or subspecies. For example, the paratypes from Neuquen or Rio Negro, southern Argentina, may correspond to *N. pardinasi*.

Finally, the rodents *Eligmodontia bolsonensis* and *Necomys lactens* constitute new hosts for *N. crassispina hemisus*.

ACKNOWLEDGMENTS

We thank Maria Cristina Estivariz (CEPAVE) for the drawings and Luis Giambelluca (CEPAVE) for the photographs of topotype and other specimens. The study was funded by PICT2010-338 and Universidad Nacional de La Plata (N618). The collection of topotype and other

specimens from nearby localities by Agencia Nacional de Promoción Científica y Tecnológica, Argentina (PICT 2010-0338), National Science Foundation, U.S.A. (NSF DEB 9870184 granted to M.A.M. and J.K.B.), and CONICET (Consejo Nacional de Investigaciones Científicas y Tecnológicas), Argentina (PIP 6179 granted to Ulyses Pardiñas and Rubén Barquez). We also thank Theresa Howard (NHM) for her assistance to M.L. during her visit to study specimens deposited at the Rothschild Collection at the Natural History Museum (NHM), London. The visit of M.L. to the NHM was funded by Universidad Nacional de la Plata (N618) and Agencia Nacional de Promoción Científica y Tecnológica, Argentina (PICT 2010-0338 to M.L.).

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