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Redescription of *Neotyphloceras chilensis* Jordan, new status (Siphonaptera: Ctenophthalmidae: Neotyphloceratini)

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Abstract

Neotyphloceras crassispina chilensis Jordan is elevated to species status based on comparison of its morphology with other species and subspecies of the genus. *Neotyphloceras chilensis* is redescribed from specimens from Region IV of Coquimbo, Chile. A key for identification of species and subspecies of *Neotyphloceras* is provided.

Key words: fleas, *Neotyphloceras crassispina chilensis*, *Neotyphloceras chilensis* stat. nov., taxonomy, South America

Introduction

The genus *Neotyphloceras* Rothschild includes two species, *Neotyphloceras rosenbergi* (Rothschild) and *Neotyphloceras crassispina* Rothschild. Three subspecies were recognized in the latter species, distinguishable by differences in the length and shape of the fixed process of the clasper, and the distance of the most distal seta to its apex (Jordan 1936; Hopkins & Rothschild 1966). These subspecies are *Neotyphloceras crassispina crassispina* Rothschild, *N. crassispina hemisus* Jordan, and *N. crassispina chilensis* Jordan. Moreover, Smit (1968) proposed to distinguish females on the basis of the number and location of the upper lateral seta of tergum VIII. However, this characteristic was not considered subsequently, and subspecific identification of females was based on accompanying males (Hastriter 2001; Lareschi *et al.* 2010).

According to Hastriter (2001), the distribution of *N. crassispina* subspecies extends from northern Peru to central Bolivia, and south through central Chile and western Argentina, as also noted by others (Smit 1968; Sanchez *et al.* 2009; Lareschi *et al.* 2003, 2010). The modified segments of *Neotyphloceras* species and subspecies are very complex and they have never been studied in sufficient detail to determine the validity of the subspecific taxa (Hastriter 2001), which has been questioned (Beaucournu & Castro 2003). Based on a comparative study of specimens of both sexes of all species and subspecies of *Neotyphloceras*, which includes modified segments, we raise *N. c. chilensis* to species status and redescribe it based on specimens from the IV Region of Coquimbo, Chile.

Materials and methods

Fleas from Region IV of Coquimbo, Chile, stored in 96% ethanol were mounted in Canadian balsam, examined, drawn using a microscope equipped with a drawing tube, photographed, and then deposited at Colección de Entomología del Museo de La Plata (MLP), Argentina. Measurements are presented in millimeters (mm) as mean values \pm the standard deviation followed by range values in parentheses. For comparative purposes, we examined photographs of the holotypes and paratypes of all species and subspecies of *Neotyphloceras* deposited at the

Rothschild Collection, Natural History Museum (NHM), London, as well as their original descriptions and figures from the literature (Rothschild 1904; 1914; Jordan 1936). For morphology nomenclature, we used Johnson (1957).

***Neotyphloceras chilensis* Jordan, stat. nov.**

Figs. 1–9

Specimens examined. ex *Thylamys elegans* (Waterhouse), Fray Jorge National Park, Region IV of Coquimbo, Chile (30°39'49"S, 71°39'27"W, 187m above sea-level), 3 males (MLP-KB3221-1, MLP-KB3222-2, MLP-KB96305-1), 1 female (MLP-KB3234-1), ex *Phyllotis darwini* (Waterhouse), 2 males (MLP-KB3232-1, MLP-KB95A95853), 1 female (MLP-KB3248-1), ex *Abrothrix longipilis* (Waterhouse), 4 males (MLP-KB3244-1, MLP-KB3256-2, MLP-KB 3258-2, MLP-KB3258-4), 1 female (MLP-KB3242-1), ex *Abrothrix olivaceus* (Waterhouse), 1 male (MLP-KB3247-1), ex *P. darwini*, Los Molles, Region IV of Coquimbo, Chile (30°44'48"S, 70°25'24"W, 2518m above sea-level), 3 females (MLP-KB3080-2, MLP-KB3083-1, MLP-KB3083-3), ex *A. olivaceus*, 4 females (MLP-KB3078-2, MLP-KB3078-3, MLP-KB3079-2, MLP-KB3084-1).

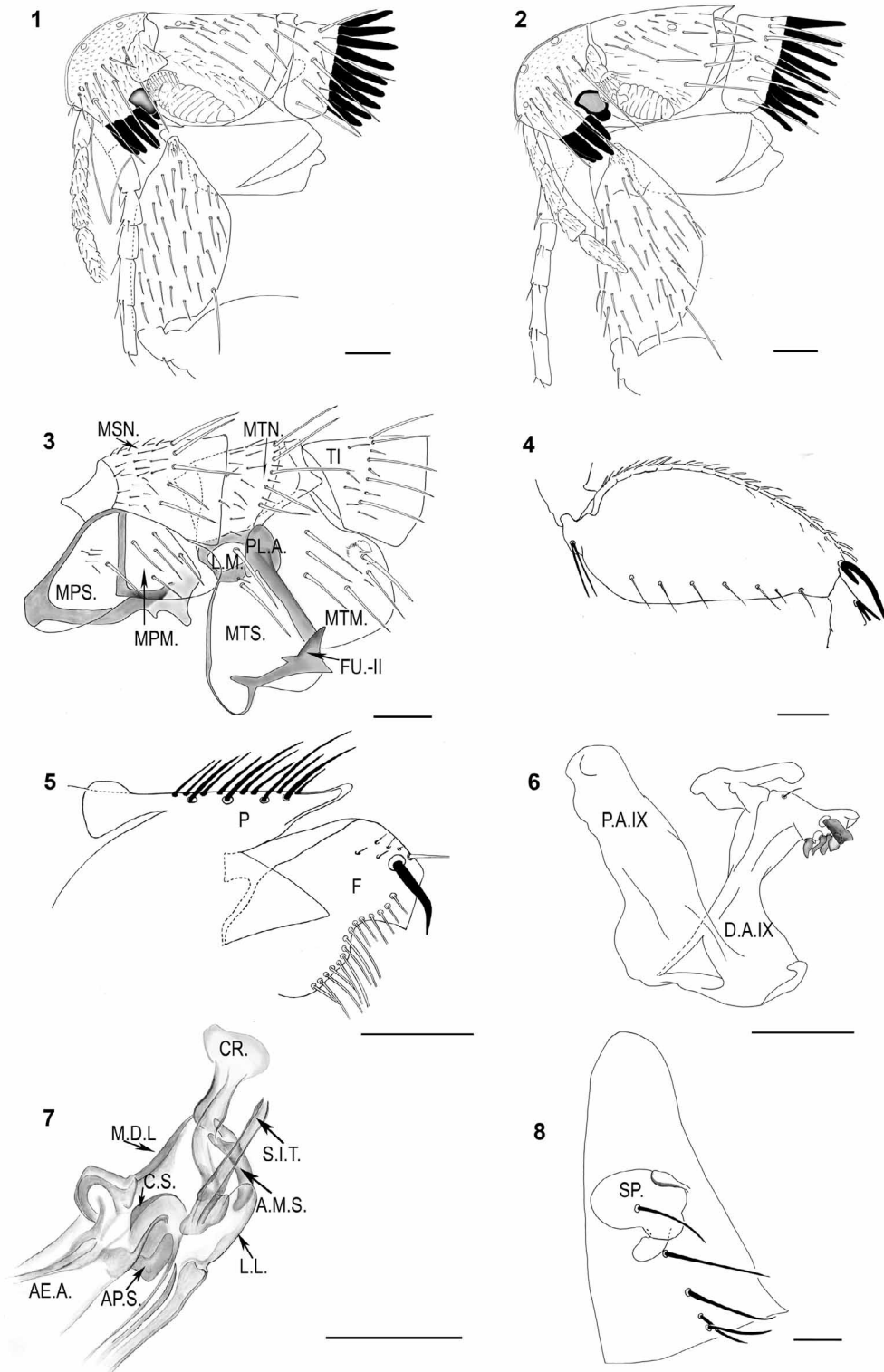
Diagnosis. Males are unique by a combination of the following characters: distal arm of sternum IX with apex forming a slightly concave projection bearing five curved, spine-like ventromarginal setae; apex of the crochet of the aedeagus with proximal margin forming a rounded projection and distal margin strongly convex. Females are unique in that the contour of the distal margin of sternum VII is almost straight.

Redescription. Total length: males: 2.66 ± 0.205 (2.40–3.00); females: 3.05 ± 0.184 (2.76–3.24).

Head with front slightly concave, about four times longer than high, with two frontal rows of setae: first row with six or seven equidistant setae, tips exceeding the insertion of setae of the next row; second row with three equidistant setae, the longest seta extending past the distal end of the longest spine of the genal comb. Three placoid pits along the margin of the front. Occipital region with four rows of setae. First antennal segment with 10–15 small setae; second antennal segment with 13–15 short setae reaching the first segment of the clavus; antennal clavus subequal in length to the first antennal segment in males and twice the length in females. A row of small setae bordering antennal fossa: 30–35 in males (Fig. 1), 15–20 in females and restricted to the posterior edge of the head (Fig. 2). Genal comb with four pointed spines, the first two overlapping, the fourth spine shorter than the others (60–80% of the length of the longest spine). Preoral edge with two setae on each side. Genal process sharp, subequal in length to the longest spine of the genal comb. Maxillary lobe sharp, extending beyond basal half of maxillary palpus. Maxillary palpus four-segmented reaching to about the middle of the forecoxa; first and second segments subequal in length; third segment shorter and fourth segment longer than the others. Labial palpus five-segmented, long, extending to about the distal edge of the forecoxa; first and fifth segments subequal in length and 1.5 times longer than second and third segments. Lacinia slightly serrated and subequal in length to the labial palpus.

Pronotum (Figs. 1, 2) with one row of five or six long, equidistant setae; pronotal comb with eight or nine spines on each side; length of longest spine subequal to the width of pronotum. Mesonotum (MSN.) with three rows of short setae and one apical row with five or six long setae; mesepisternum (MPS.) with a group of small setae on the anterior region and one or two long setae posteriorly; mesepimere (MPM.) with four or five setae; metanotum (MTN.) with two anterior rows of six short setae and one apical row with five or six long setae; lateral metanotal area (L.M.) long, subequal to pleural arch (PL.A.) and with a long seta; pleural arch and ridge well developed; metepisternum (MTS.) with one long seta; furca of metasternum (FU.-II) about one fourth the length of the pleural ridge; metepimere (MTM.) with six long setae and two or three small setae (fig. 3).

Forecoxa with 40–50 setae distributed over entire surface; with one long seta on posterior margin (Figs. 1, 2). Middle and hind coxae with setae distributed only on anterior margin (10–14, 20–25, respectively). Forefemur with a dorsal marginal row of 11–13 small setae and with two rows of setae on the inner side of setae, with 10 and 12 setae. Middle femur with a subventral row of three or four setae on the inner side. Hind femur with a subventral row of five or seven setae on the inner side and six setae on the outer side restricted to the distal region, and with one ventral pair of setae on the proximal margin and one dorsal pair of setae on the distal margin, the longest seta reaching the second notch of the tibia (Fig. 4). Middle and hind femora with 20–23 dorsomarginal pairs of small setae. Foretibia with 10–14 setae on distal half of the outer side. Middle and hind tibiae with 15–20 setae on the outer side and five to seven setae on the inner side. All tibiae with eight dorsomarginal notches bearing large setae



FIGURES 1–8. *Neotyphloceras chilensis* stat. nov., scale= 100 μ m. 1) Head, pronotum and forecoxa of the male. 2) Head, pronotum and forecoxa of the female. 3) Thorax of the male (FU.-II = furca of metasternum, L.M. = lateral metanotal area, MSN. = mesonotum, MPM. = mesepimere, MPS. = mesepisternum, MTM. = metepimere, MTN. = metanotum, MTS. = metepisternum, PL.A. = Pleural arch, TI = first tergum). 4) Hind femur of the male. 5) Fixed process of the clasper (P) and movable process (F). 6) Sternite IX of the male (D.A.IX = distal arm of sternite IX, P.A.IX = proximal arm of sternite IX). 7) Aedeagus (AE.A. = aedeagal apodeme, A.M.S. = apico-median sclerite of aedeagus, APS. = apodemal strut of aedeagus, CR. = crochet, C.S. = crescent sclerite of aedeagus, M.D.L. = median dorsal lobe of aedeagus, L.L. = lateral lobes of aedeagus, S.I.T. = sclerotized inner tube). 8) Sternite VII and spermatheca (SP.) of the female.

from apex to base as follows: foretibia (2; 2; 2; 2; 2; 2); middle and hind tibia (2; 2; 1-2; 2; 2; 2; 3; 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 four times longer than fourth segment.

Abdomen without spinelets. Tergites II-VI with two rows of setae (4; 8–10), setae of anterior row shorter than those of the posterior row. Tergum VII with two antesensilial setae each side. Fossa of spiracle of tergites II-VII short, cone-shaped. Sensillum strongly convex posteriorly, with 13–15 sensilial pits. Sternum III-VI with three or four setae.

Male sternum VII with three or four setae. Tergum VIII with four to six setae above the spiracle. Upper lobe of the fixed process of the clasper (P) with apex turned up sharply; with three or four submarginal setae and one row of 8–10 dorsomarginal setae, the last seta placed from the tip by a distance of about twice the width of the fixed process at the point of attachment of the seta (Fig. 5). Lower lobe of fixed process with sharp distal edge; without setae (Fig. 5). Movable process (F) with one strongly pigmented seta and five or six small setae on the apex; distal margin almost straight; ventral margin very indented, with a row of 12–18 small setae along its edge (Fig. 5). Two manubria, the upper manubrium hook-shaped, shorter and narrower than lower manubrium. Acetabulum with a vertical row of 11–14 small spiniform setae; below this row a wide, strongly pigmented spatulated spine and two narrow, pigment-free setae. Sternum IX (Fig. 6) with proximal arm (P.A.IX) and distal arm (D.A.IX) subequal in length; distal arm with apex forming a slightly concave projection bearing one small dorsomarginal seta in the center and five curved, spine-like ventromarginal setae, the first setae strongly pigmented and located in the center above the others. Dorsal anal lobe long, narrow, cone-shaped, ventral anal lobe conical, shorter than dorsal anal lobe; with two long ventral setae on each side.

On aedeagus (Fig. 7) aedeagal apodeme (AE.A) long, more than six times longer than broad. Median dorsal lobe (M.D.L.) strongly sclerotized. Lateral lobes (L.L.) present. Sclerotized inner tube (S.I.T.) long, straight, narrow. Apical median sclerite (A.M.S.) present, shorter than inner tube 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 rounded projection and distal margin strongly convex. Two long apodemal struts (AP.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 five setae, apical margin strongly rounded and contour of distal margin straight or slightly lobed (Fig. 8). 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 situated at a variable distance from ventral margin to lowest level of spiracular fossa; distal margin with a small lobe and three or four short, wide, spiniform setae. Anal lobes short and conical, dorsal anal lobe wider than ventral anal lobe. Anal stylet subapical, more than three times longer than broad at base, with a long apical setae twice the length of anal stylet. Spermatheca (SP.) with bulga larger than the hilla, cribiform area circular and heavily sclerotized (Fig. 8). Bursa copulatrix strongly sclerotized, bifurcated (Y-shaped).

Remarks

Geographical distribution of the species and subspecies of *Neotyphloceras* (Fig. 9) suggest *N. c. crassispina* to be mostly transandean, contrary to *N. c. hemisus* with cisandean distribution, while *N. rosenbergi* is in the north and *N. chilensis* **stat. nov.** in the southwest. Sympatry was observed between *N. chilensis* **stat. nov.** and *N. c. hemisus* (Beaucournu and Alcover 1990), as well as between *N. chilensis* **stat. nov.** and *N. c. crassispina* (Hastriter 2001; León-Bazán 2011). Two subspecies occurring in the same locale would not be considered as distinct species, since the two populations could interbreed at zones of contact, producing some hybrids as noted between subspecies of *Neotyphloceras* (Hastriter 2001). However, the new diagnostic characters provided in this study (Table 1) strongly differentiate *N. chilensis* **stat. nov.** from the remaining species and subspecies of the genus, and allow it to be recognized as a distinct species. Moreover, these characters are quite similar among the subspecies of *crassispina*. Further studies may shed light on the hypothesis of Hastriter (2002) that *N. c. hemisus* might be a synonym of the nominate species.

TABLE 1. Comparison of important diagnostic characters among species and subspecies of *Neotyphloceras*.

Diagnostic characters	<i>N. rosenbergi</i> (Rothschild)	<i>N. crassispina</i> Rothschild	<i>N. crassispina</i> <i>crassispina</i> Jordan	<i>N. crassispina</i> <i>hemisus</i> Jordan	<i>N. chilensis</i> Jordan, stat. nov.
MALES					
Pigment of the apical seta of movable process of the clasper	slightly pigmented	dark		dark	dark
Length of the fixed process of clasper	short	slightly elongated		slightly elongated	elongated
Situation of the most distal marginal setae on the fixed process of clasper	almost at its tip	at its tip		from the tip by distance subequal to the width of the fixed process at the point attachment of the seta	from the tip by distance about twice the width of the fixed process at the point of attachment of the seta
Angle between distal and proximal margins of the fixed process of clasper	forming an equilateral triangle	forming an angle >45° but <60°		forming an angle >45° but <60°	forming an angle <45°
Shape of the apex of fixed process of clasper	straight	almost straight		almost straight	remarkable turned up
Dorsal margin of the apex of distal arm of sternum IX	convex	remarkable concave		remarkable concave	slightly concave
Chaetotaxy of ventral margin of the distal arm of sternum IX	three strongly similar curved bristle-like setae aligned near the apex	six curved spine-like setae, aligned, the first one wider and strongly pigmented		six curved spine-like setae, aligned, the first one wider and strongly pigmented	five curved spine-like setae, the first one wider and strongly pigmented, located in the center above the others
Shape of the apex of the crochet of the aedeagus	with the proximal margin straight and the distal margin pointed	with an angular projection in the proximal margin and the distal margin almost straight		with an angular projection in the proximal margin and the distal margin almost straight	with a rounded projection in the proximal margin and the distal margin strongly convex
FEMALES					
Shape of the distal margin of the sternum VII	with a well developed rounded lobe	rounded		rounded	almost straight.

Key to species and subspecies of *Neotyphloceras*

1. Frontal tubercle present; front six times longer than high; first frontal row with eight or nine setae; chaetotaxy of dorsal margin of hindtibia 2, 2, 2, 2, 1, 2, 2; inner side of hind femur with two or three subventral setae; apical seta of movable process of clasper slightly pigmented; fixed process with three or four marginal setae, without submarginal setae; seventh sternum of female with long shallow sinus. *N. rosenbergi*
- Frontal tubercle absent; front four times longer than high; first frontal row with six or seven setae; chaetotaxy of dorsal margin of hindtibia 2, 2, 1-2, 2, 2, 2, 3, 2; inner side of hind femur with five to seven subventral setae; apical seta of movable process of clasper dark; fixed process with eight to ten marginal setae, and three or four submarginal setae; seventh sternum of female lacking sinus 2
2. Fixed process of clasper with apex almost straight; distal arm of sternum IX with a projection, dorsal margin markedly concave and bearing six ventral setae, the first seta wider and strongly pigmented; crochet with angular projection on proximal margin and with distal margin almost straight; females with distal margin of sternum VII rounded (*N. crassispina*) 3
- Fixed process of clasper with apex sharply turned up; distal arm of sternum IX with projection, with dorsal margin slightly concave and bearing five ventral, curved, spine-like setae, the first seta located in the center above the others; crochet with rounded projection on proximal margin and distal margin strongly convex; females with distal margin of sternum VII almost straight *N. chilensis* stat. nov.

3. Most distal seta of the fixed process of the clasper at its tip *N. c. crassispina*
 - Most distal seta of the fixed process of the clasper proximal to its tip *N. c. hemisus*

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FIGURE 9. Geographical distribution of genus *Neotyphloceras* (Insecta: Siphonaptera) from the literature: (X) *Neotyphloceras rosenbergi* (Rothschild); (o) *Neotyphloceras crassispina crassispina* Rothschild; (Δ) *Neotyphloceras crassispina hemisus* Jordan; (□) *Neotyphloceras chilensis* Jordan, stat. nov.; present study; (■) *Neotyphloceras chilensis* Jordan, stat. nov.

Acknowledgements

We thank Theresa M. Howard (Department of Entomology, The Natural History Museum, London) for sending us photographs of type specimens of every species and subspecies, Maria Cristina Estivariz (CEPAVE) for the drawings, and Yamila Obed for her help with the English. Research was funded by Universidad Nacional de La Plata, Argentina (N618), Agencia Nacional de Promoción Científica y Tecnológica, Argentina (PICT2010-0338), Fundación BBVA BIOCON06/109, FONDECYT-Chile 1090794, CONICYT-CSIC 2009-137, and the Institute of Ecology and Biodiversity (ICM-P05-002-Chile, and PFB-23-CONICYT-Chile). E.A. Bazán-León acknowledges

support from a MECESUP scholarship. J. Sanchez and M. Lareschi are members of Consejo Nacional de Investigaciones Científicas y Tecnológicas (CONICET), Argentina.

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