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Phylogenetic relationships of *Eremopachys* Brancsik (Orthoptera: Tristiridae: Tropidostethini)

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ABSTRACT

The Tropidostethini are the only tristirids found in the *Nothofagus* forest, at the southern part of the South American continent along the Andes . Within this tribe, *Eremopachys bergi* Brancsik, the only known species of *Eremopachys*, occurs in the chilean patagonia mostly in the open steppe areas with *Mulinum spinosum*. Males of this species were unknown until recently, when specimens of this sex were found in the vecinity of the "Torres del Paine" National Park. The description of the male characteristics of this species is provided and the phylogenetic relationships for the genus *Eremopachys* are proposed based on a cladistic analysis performed for the subfamily Tristirinae.

INTRODUCTION

Tristirids are an endemic South American family considered to be a monophyletic group based on the uniqueness of their male genitalia (Cigliano 1989a, b). The species included in the tribe Tropidostethini are the only tristirids found in the *Nothofagus* forest, at the southern part of the South American continent along the Andes ("Subantartic" biogeographic province as defined by Cabrera & Willink, 1973). Within this tribe, *Eremopachys bergi* Brancsik, the only known species of *Eremopachys* Brancsik, occurs in the chilean patagonia mostly in the steppe with *Mulinum spinosum*, in the open areas of *Nothofagus* forest. When the revisionary study and cladistic analysis of the family were performed (Cigliano 1989a, b) males of *E. bergi* were unknown, and thus the genus was not included in the analysis. *Eremopachys* was considered (Cigliano 1989a) closely related to *Tebacris* Cigliano, based on characters from the external morphology, and provisionally included in the Tropidostethini. Recently, males of *E. bergi* were found in the vecinity of the "Torres del Paine" National Park. The examination of its male genitalia allowed us to corroborate its placement in the Tropidostethini and to elucidate its phylogenetic relationships.

The objectives of this paper are to describe the male characteristics of *Eremopachys begi* and to analyze the taxonomic relationships of the genus.

MATERIAL AND METHODS

Depositories.— Specimens examined for this study are deposited in the "Museo de Ciencias Naturales, La Plata, Argentina" (LA PLATA), Academy of Natural Sciences of Philadelphia (PHILADELPHIA), "Museo Nacional de Historia Natural, Santiago, Chile" (SANTIAGO).

Cladistic analysis. —The Tristiridae family is a monophyletic group of genera distinguished from other families of Acridoidea by synapomorphies of the phallic complex (Cigliano 1989a). At present it comprises 18 genera and 25 species included in the subfamilies Tristirinae and Atacamacridinae. The sixteen genera of Tristirinae (Cigliano 1989a) for which males are known are considered as terminal taxa. The taxa used as terminals in the analysis are reviewed in Cigliano (1989a). The characters used in the anlaysis are partly modified from Cigliano (1989b), and new information has being included (Appendix 1). Trees were rooted and character polarity was determined using the outgroup method (Nixon & Carpenter 1993). *Atacamacris* Carbonell & Mesa, the only genus included in Atacamacridinae, was used to root the tree.

Thirty eight characters were used, twenty from the external morphology (characters 1-19 and 38 in Appendix 1), five from the female genitalia (characters 20-24 in Appendix 1) and sixteen from the phallic complex (characters 25-37 in Appendix 1). Multistate characters were treated as non-additive (=unordered). Appendix 2 contains the data matrix used, which was analyzed with Hennig86 version 1.5 (Farris 1988) applying the implicit enumeration option for calculating trees (ie*), algorithm that finds all trees of minimal length. Consistency (Kluge and Farris 1969) and retention (Farris 1989) indices were calculated excluding autapomorphies. The Bremer support index (Bremer 1994), a measure of clade support was calculated. Goloboff´s parsimony based program NONA (1993) was used to calculate the support. NONA was run using heuristic searches with random addition sequences, swapping by tree-bisection reconnection ("mult* N; max*" in NONA). Trees with 5 steps longer were retained in memory to calculate the Bremer support. Optimization of characters (fast optimization) was performed using WINCLADA Beta version (Nixon 1999-2000).

TAXONOMY

EREMOPACHYS Brancsik

Eremopachys Brancsik 1901: 188-189; Kirby 1910: 296; Liebermann 1939: 133; 1958: 22; Rehn 1942: 51-52 (type species designation); Amedegnato 1974: 197, 1977: 48, 55, 58; Eades & Kevan 1974: 260; Cigliano 1989: 87, Otte 1995: 19; Elgueta et al. 1999: 28. **Type species**: *Eremopachys bergi* Brancsik.

Eremopachys bergi Brancsik
Fig. 1

Eremopachys bergi Brancsik 1901: 190; Rehn 1942: 52; Liebermann 1939: 169; 1958: 36; Cigliano 1989a: 87-88 (=*Eremopachys simplex* Brancsik 1901: 189); Kirby 1910: 296; Liebermann 1939: 169; Rehn 1942: 52. Neotype: female, Chile, Magallanes, Lag. Azul, 5-1955, Dettlef, LA PLATA.

Male description.—Medium sized (22.0-23.0 mm.) dark ochraceous insects with fastigial margin and body granulations rubescent. Body depressed, tegument with granulations and rugosities coarser on head and pronotum. Head broad with small globose eyes, fastigium widely trigonal, with carinated margin, front of face vertical in side view; lateral foveolae without delimiting borders; frontal costa with contiguous lateral carinae except bellow median ocellum, where they diverge. Antennae filiform with flagellum of six segments, the last one clavate. Prosternum between front legs having a transverse arcuate ridge. Pronotum short, not extending onto mesonotum, trapezoidal, with straight anterior and posterior margins; lateral margins with an irregular ridge cut by the transverse sulcus, lateral carinae of pronotum only weakly indicated on anterior two thirds of pronotal disk. Meso and metanotum with medio-longitudinal sulcus; posterior margin of metanotum emarginate. Hind femur compressed with dorsal carina straight and ventral carina expanded; proximal upper and lower lobes widely separated. Posterior tibiae with external apical spine. Subgenital plate short and globose, epiproct with transverse ridge, medio-longitudinally sulcated, distal half trigonal. Cercus short and thick. Phallic complex: epiphallus with wide denticulated bridge, anchorae lobulated, lateral plates well developed, lophi acute, oval sclerites small. Cingulum reaching tip of aedeagus, with sclerotization reduced caudally; apodemal plates widely extended laterally; rami short, laminar. Pseudoarch not developed. Endophallus: distal portions of endophallic sclerites lanceolate.

Distribution.—*Eremopachys bergi* is known from the chilean patagonia, in the western edge of the Andes mountain range in the Magallanes Region. It mostly occurs in the open areas of the *Nothofagus* forest in the steppe with *Mulinum spinosum*.

Examined material.—Two males, Chile, Magallanes, Lag. Verde, in the vecinity of "Torres del Paine" National Park, "Hostería El Mirador del Paine" ex Estancia Lazo, 01-III-2000, Cigliano & Lange col., LA PLATA; 1 female, Chile, Magallanes, SANTIAGO; 2 juv. female, Chile, Magallanes, "Torres del Paine" National Park, Lago Lazo, 12/13-I-1986, Patagonian steppe, M. Elgueta col., SANTIAGO; 1 female neotype, Chile, Magallanes, Lago Azul, 5-1955, Dettleff, LA PLATA; 1 female, Magallanes, PHILADELPHIA.

CLADISTIC ANALYSIS RESULTS AND DISCUSSION

Three most parsimonious trees were found with Hennig86, each of 108 steps long (a consistency index of 0.70 and retention index of 0.79). Cladograms were stable to successive weighting. The same trees were

found when NONA was run treating trees as dichotomous (poly -). When NONA was run treating trees as polytomous only one tree was found (Fig. 2) that corresponds to the strict consensus of the three equally parsimonious cladograms. Optimization of characters (slow optimization) (Fig. 2) was performed using WINCLADA Beta version (Nixon 1999-2000). Except for the basal polytomy, and for the relationship inside the Tropidestethini clade (including *Tebacris*, *Eremopachys*, *Tropidostethus*, and *Elysiacris*), the tree obtained is highly congruent with the previous analysis performed for the whole family (Cigliano 1989b). The Tropidostethini is a well supported group and has a rather high Bremer support score (Fig. 2). It is founded on five synapomorphies from the phallic complex and one from the external morphology (character 19). Inside this clade *Tropidostethus* and *Elysiacris* come out as a very well supported clade and has the highest Bremer support score. *Eremopachys* is undoubtedly included in the tribe and it is related to *Tebacris* based on characters mostly from the external morphology (6 and 38). Previous analysis (Cigliano 1989b) showed *Elysiacris* to be the sister genus to *Tebacris*, in the cladogram here obtained these taxa share homoplasies from the phallic complex. Characters mostly from the external morphology characterize the sister genera relationships, while those from the male genitalia define the tribe. From this distribution of characters it might be hypothesized that in the tribe differentiation of the phallic complex preceded those of the external morphology.

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LITERATURE CITED

Amedegnato, C. 1974. Les genres d'acridiens néotropicaux, leur classification par familles, sous-familles et tribus. *Acrida* 3:193-204.

Amedegnato, C. 1977. Etude des Acridoidea centre et sud americaines (Catantopinae sensu lato), anatomie des genitalia, classification, repartition, phylogenie. These de Doctorat d'Etat. Paris. 385 pp. (mimeo.).

Brancsik, C. 1901. Orthoptera quaedam nova. Jahresheft des Naturwissenschaftlichen Vereines des Trencsiner Comitates 23-24:186-192.

Bremer, K. 1994. Branch support and tree stability. *Cladistics* 10: 295-304.

Cabrera, A. & Willink, A. 1973. *Biogeografía de América Latina*. Monografías de OEA, Serie Biología, No. 13. , p. 120. Washington, D.C..

Cigliano, M.M. 1989a. Revisión sistemática de la familia Tristiridae (Orthoptera, Acridoidea). *Boletín de la Sociedad de Biología de Concepción*, Chile 60:51-110.

Cigliano, M.M. 1989b. A cladistic analysis of the family Tristiridae (Orthoptera, Acridoidea). *Cladistics* 5:379-393.

Eades, D.C. & Kevan, D.K. McE. 1974. The phallic musculature of Pyrgomorphidae with particular reference to *Atractomorpha sinensis sinensis* and note on the family Tristiridae Rehn, 1906, and the subfamily Pyrgacridinae nov. (Orthoptera: Acridoidea). *Acrida* 3: 249-265.

Elgueta M., A. Camousseight and C. S. Carbonell. 1999. Catálogo de Orthoptera (Insecta) de Chile. Museo Nacional de Historia Natural. Santiago, Chile. No. 54: 28.

Farris, J.S. 1988. *Hennig86 reference documentation for version 1.5.* Port Jefferson Station, NY.

Farris, J.S. 1989. The retention index and the rescaled consistency index. *Cladistics* 5: 417-419.

Goloboff, P.A. 1993. NONA, version 1.8. Computer program and manual distributed by the author.

Kluge, A.G. & J.S. Farris. 1969. Quantitative phyletics and the evolution of anurans. *Syst. Zool.* 18: 1-32.

Kirby, W.F. 1910. A synonymic catalogue of Orthoptera. Vol. 3. Orthoptotera Saltatoria. Part. 2. (Locustidae vel Acrididae). British Museum, London, 674 pp.

Liebermann, J. 1939b. Catálogo sistemático y biogeográfico de acridoideos argentinos. *Rev. Soc. Entomol. Argent.* 10:125-230.

Liebermann, J. 1958b. Zoogeografía, sistemática y economía de los acridoideos de la Patagonia. *Publicación Técnica, Instituto de Patología Vegetal*, 6: 60 pp,.

Nixon, K.C. & J.M. Carpenter. 1993. On outgroups. *Cladistics* 9: 413-426.

Otte, D. 1995. Orthoptera Species File 4. Grasshoppers [Acridomorpha]. Acridoidea (part). The Orthopterists' Society and the Academy of Natural Sciences of Philadelphia. 518 pp.

Rehn, J. A. G. 1942. The locusts of the South American group Tristirae (Orthoptera, Acrididae, Cyrtacanthacridinae). *Trans. Amer. Ent. Soc.* 68:31-100.

Appendix 1. *Characters and character states used in the cladistic analysis of Trisitirinae.*

1. Longitudinal carina on dorsal head: not developed (0), present on vertex (1), present on vertex and fastigium (2).
2. Shape of fastigium: little salient (0), triangulate, wide (1), triangulate, narrow (2), elongate trigonal (3).
3. Fastigium laterally: declivent (0), horizontal (1), ascending dorso-cephalad (2).
4. Fastigio-facial angle: lacking fastigio-facial angle (0), acute (1), truncated (3).
5. Frontal costa above median ocellum: broad (0), intermediate (1), narrow (2).
6. Lateral foveolae of fastigium: not developed (0), with ventral margin (1), without ventral margin (2), replaced by a convex area (3).
7. Fastigial ridges: un-cleaved (0), cleaved and without accessory carinula (1), cleaved and with accessory carinula (2).
8. Front of face: vertical (0), slanted (1), concave (2).
9. Lateral carinae of pronotal disk: absent (0), present on prozone (1), present on prozone and metazone (2).
10. Relationship between prozone-metazone: metazone not indicated (0), metazone as long as prozone (1), metazone longer than prozone (2).
11. Posterior margin of pronotal disk: entire (0), lobulate (1).
12. Posterior edge of pronotal disk: straight (0), obtusely angular (1), acutely angular (2).
13. Pronotal disk in transverse section: plane (0), ogival (1), dome-shaped (2).

14. Transverse sulci in pronotal disk: absent (0), one sulcus (1), two sulci (2), three sulci (3).
15. Sides of pronotal disk: rounding onto lateral lobes (0), with definite shoulders (1).
16. Tegmina: not developed (0), subapterous (1), micropterous (2), macropterous (3).
17. Tympanum: absent (0), present (1).
18. Proximal lobes of hind femur: superior lobe larger than inferior (0), superior lobe as long as inferior (1), superior lobe smaller than inferior (2).
19. Apical spine on external margin of posterior tibia: absent (0), present or vestigial (1).
20. Espermatheca: apical diverticulum tubular, without pre-apical diverticulum (0), apical diverticulum S-shaped, without pre-apical diverticulum (1), apical diverticulum C-shaped, with small pre-apical diverticulum (2), apical diverticulum S-shaped with small pre-apical diverticulum (3).
21. Egg –guide / posterior edge of subgenital plate in ventral view: not surpassing or scarcely surpassing (0), highly surpassing (1).
22. Hemispheric sclerite in terminal portion of spermathecal duct: absent (0), present (1).
23. Columellas on female subgenital plate: absent (0), few (1), numerous (2).
24. Length of spermathecal duct: short (0), intermediate horse-shoe shaped (1), long (2).
25. Rami: rod-like (1), laminar (2), laminar dorsally, rod-like ventrally (3), laminar, dorsally lobular (4), strongly sclerotized (0).
26. Lateral sclerite of ectophallic ventral lobe: not developed (0), developed without covering the rami (1), developed, covering the rami (2).
27. Type of cingulum: capsule-like (0), with two caudal plaques (1), with sclerotization caudally reduced (2).
28. Pseudoarch: absent (0), reduced (1), prominent, capsule-like (2), prominent, rectangular (3).
29. Apical lobe of rami: absent (0), reduced (1), largely developed (2).
30. Aedeagus: without development of the distal portion of endophallic sclerites (0), aedeagus constituted by the apex of the ventral endophallic sclerites, covered by an ectophallic sheath (1), aedeagus constituted by the distal portion of the dorsal and ventral endophallic sclerites covered by an ectophallic sheath (2).
31. Gonopore process: reduced (0), short and wide (1), long and narrow (2).
32. Middle portion of endophallic sclerites: narrow, straight (0), narrow and curved (1), broad, reduced laterally (2), broad, prominent laterally (3).
33. Proximal portion of dorsal endophallic sclerites: laterally compressed (0), bent dorsoventrally (1), with hemispheric apodeme reduced (2), with hemispheric apodeme well developed (3).
34. Ventral margin of ventral endophallic sclerites: uncleaved (0), cleaved (1).
35. Epiphallus bridge: convex in frontal view (1), wide (2), wide and short (3), narrow (0).
36. Epiphallus with rugosities: absent (0), present (1).
37. Sheath of edeagus with rugosities: absent (0), present (1).
38. Fastigium slighty concave dorsally: absent (0), present (1).

Appendix 2. Data matrix used in the cladistic analysis of Tristirinae.

	Characters
	123456789111111111122222222223333333333
Taxa	01234567890123456789012345678
*Atacamacris**	0000000000000000000000000000000000000
Tristira	0101012021000000000300121111012321101O
Circacris	2100112021000000000300121211012321101O
Punacris	1200110121000000000201012212012320100O
Incacris	1211210111001100000???0???22120123201000
Crites	1322220101001100000???0???22120123201000
Paracrites	1311210111001100000?000?22120123001000
Moluchacris	2210011111000010000101121112212320100O
Peplacris	1211211111000010000101121112112320100O
Tropidostethus	1321220211002100001010204110021210300O
Elysiacris	1321220201002100001010204113021210310O
Tebacris	0100030001000000001000204113021210310I
Eremopachys	0100030011000010021001204110021210300I
Bufonacris	0000000000000010000300121111012321101O
Uretacris	0100000002110201010000203120000110200O
Elasmoderus	0000000002120302110000203110000110200O
Enodisomacris	0000000002120303110000203120000110200O

Note: Entries scored as ? were unknown of inapplicable. Outgroup taxon is denoted with an asterisk.

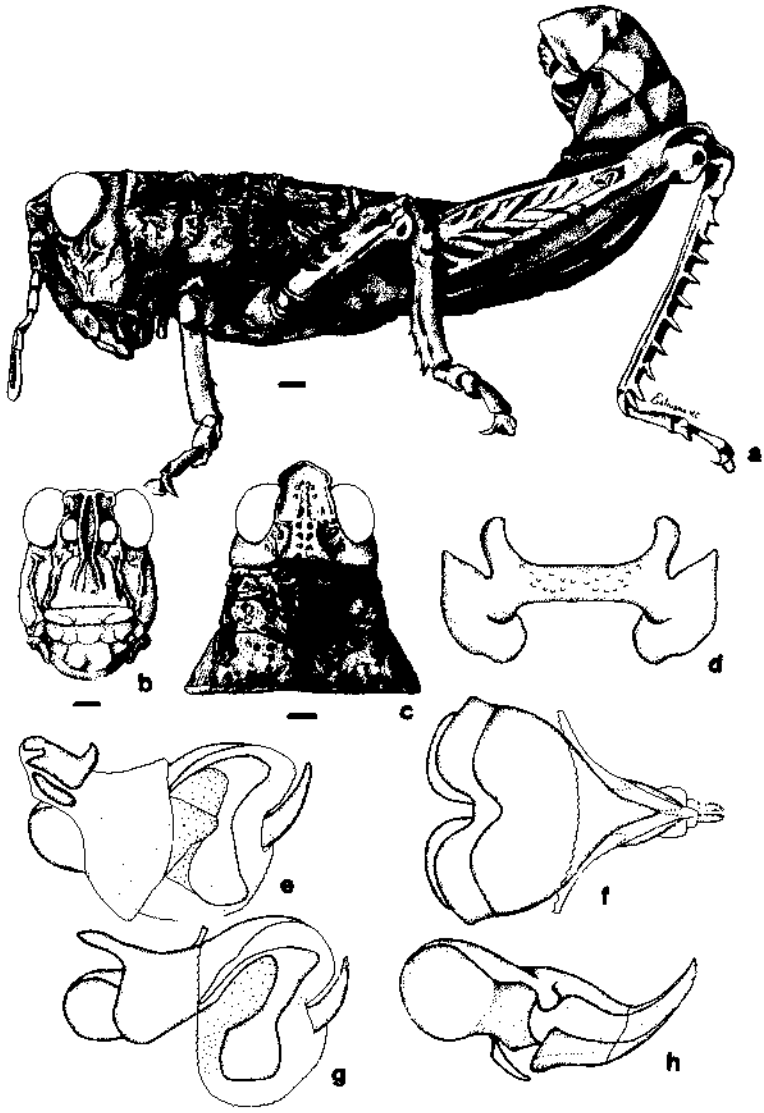

Fig. 1. *Eremopachys bergi* Brancsik. a-c, male specimen, d-h, phallic complex. a, lateral view, b, head, frontal view, c, head and pronotum, dorsal view; d, dorsal view of epiphallus; e, lateral view of phallic complex; f, dorsal view of cingulum and endophallus; g, lateral view of cingulum and endophallus; h, lateral view of endophallus.

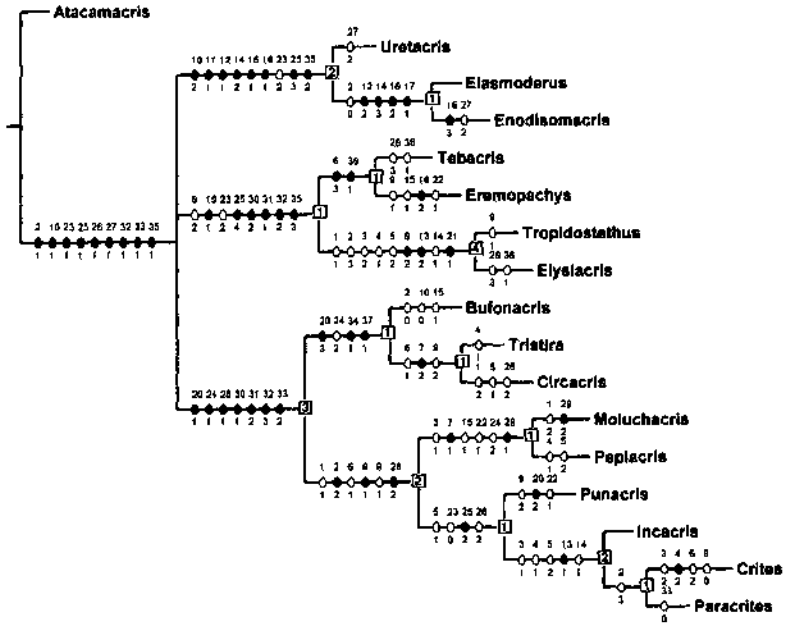

Fig. 2. Cladogram showing character optimization for Tristirinae. Solid circles represent non-homoplastic characters, open circles represent homoplastic characters. Numbers in squares indicate Bremer support values.