Biogeographica 1997, 73(2) : 67-80

SCORPIONS OF THE INSULAR SIERRAS IN THE LLANOS DISTRICT (PROVINCE OF LA RIOJA, ARGENTINA) AND THEIR ZOOGEOGRAPHICAL LINKS

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ABSTRACT.- This paper presents the results of scorpiofaunal surveys, that were carried out in the mountains of central-southern province of La Rioja, Argentina (Sierras de Malanzán, de Los Llanos, de Chepes and de Ulapes); these systems bear sierra chaco vegetation and are surrounded by the so called dry chaco (Llanos District of the Chacoan Province). Nine scorpion species have been recorded, four being characteristic of sierra environments: *Zabius fuscus* (Thorell), *Bothriurus cordubensis* Acosta, *Bothriurus* aff. *olaen* and *Brachistosternus borellii* Kraepelin; the remaining species are already known for the Llanos plains (*Brachistosternus ferrugineus* [Thorell], *Brachistosternus pentheri* Mello-Leitão, *Timogenes dorbignyi* [Guérin-Méneville], *Timogenes elegans* [Mello-Leitão] and *Tityus confluens* Borelli). A preliminary statistical analysis of morphometric and meristic differences of *Zabius fuscus* populations of these sierras and from other parts of the species range was performed. The zoogeographical connections of La Rioja mountains are discussed; both these chains and the Sierrras de Córdoba-San Luis are regarded to be probable zoogeographical nodes, where two different tracks (peripampasic and subandean) meet.

KEYWORDS.- Scorpions, Neotropics, Argentina, Chaco, Llanos District, Insular sierras

RESUME.- Sont présentés les résultats des inventaires de la faune des scorpions, réalisés dans les montagnes du centre-sud de la Province de La Rioja, Argentine (Sierras de Malanzán, Los Llanos, Chepes et de Ulapes), lequelles présentent une végétation du type Chaco serrano, entourées par du Chaco aride (District de Los Llanos de la Province Chaqueña). Neuf espèces ont été répertoriées, quatre d'entre elles caractéristiques du milieu montagnard: *Zabius fuscus* (Thorell), *Bothriurus cordubensis* Acosta, *Bothriurus* aff. *olaen* et *Brachistosternus borelli* Kraepelin; les autres ont déjà été citées pour le Chaco de Los Llanos (*Brachistosternus ferrugineus* [Thorell], *Brachistosternus pentheri* Mello-Leitão, *Timogenes dorbignyi* [Guérin-Méneville], *Timogenes elegans* [Mello-Leitão] et *Tityus confluens* Borelli). Sont ajoutés les résultats d'une analyse statistique préliminaire concernant les différences morphométriques et méristiques entre les populations de *Zabius fuscus* en montagne et celles distribuées ailleurs. Sont discutées les possibles affinités biogéographiques de ces montagnes qui, comme celles de Córdoba-San Luis, pourraient être considérées comme des noyaux biogéographiques où se croisent deux couloirs, le « péripampasico » et le sub-andin.

MOTS-CLES.- Scorpions, Région néotropicale, Argentine, Chaco, District de Llanos, Sierras insulaires

INTRODUCTION

In a previous paper (ACOSTA, 1995b) one of us studied the qualitative and quantitative composition of scorpion communities in the so called « dry chaco », or Llanos District of the Chacoan Biogeographic Province. The area is currently regarded to have a Monte – Chaco transitional character, and according to this feature, a relatively high scorpion diversity but no endemic form was found: 9 species, all sympatric in one of the studied localities (Chancaní, Province of Córdoba). The dry chaco develops on a wide sedimentary basin known as « Llanos » (= plains), which is surrounded by

mountains. In the middle of the plains several low chains rise, with substratum and vegetation remarkably different from that of the Llanos. Because of this evident heterogeneity, the mountains were not considered in the mentioned survey in the District (ACOSTA, 1995b). The present contribution is focused on the sierra scorpions, and is aimed to be complementary to the above cited article.

These systems have never been surveyed systematically, and information about their scorpiofauna is fragmentary: one reference of *Urophonius brachycentrus* for Olta (MAURY, 1977), the presence of *Zabius fuscus* indicated in a map but with no locality data (MAURY, 1979), and the occurrence of the *Bothriurus prospicuus* group in Chepes (MAURY, 1984). Though the latter citation does not give the specific identity, all three references might indicate *a priori* the affinity with the Sierras de Córdoba–San Luis, despite of the effective separation of these systems through semiarid plains (Fig. 1). Scorpions of the Sierra de Córdoba are relatively well known (ACOSTA, 1989; ACOSTA & ROSSO DE FERRADAS, 1996), whilst the available information (and the physiognomic homogeneity) from Sierra de San Luis suggests strongly the same specific composition of the former. It has been proved that, save in transitional sectors, sierra environments represent a distributional limit for most scorpions of the plains, probably because of the differential substratum composition; on the contrary, some sierra species with no strict orophyly are able to reach non rocky sites around the mountains (ACOSTA, 1995a). All these concerns led us to investigate the scorpiofauna of the sierras in the Llanos, and to try to elucidate their vinculations to other mountains.

THE SIERRAS OF THE LLANOS DISTRICT

The study area comprises four main chains: the Sierras de Malanzán, de los Llanos, de Chepes and de Ulapes, which lie approximately between 30ºS – 32ºS and 66ºW – 67ºW, in the middle–south of Province of La Rioja. These low systems (highest peak: about 1900 m) emerge in the plains of the chacoan Llanos District like an archipielago: the group is separated by more than 40 km from the Sierras del Valle Fértil (Province of San Juan) in the West and from the Sierras de San Luis in the South, and by almost 80 km from the Sierras de Córdoba in the East (Fig. 1). All mentioned systems belong –together with other chains– to the Sierras Pampeanas complex, which represent an ancient geomorphological unit (precambric nucleus) that became fragmented during the Andine orogeny. As ACOSTA (1995a) stated, the Llanos District is the driest sector of the Western Chaco, with precipitations ranging from 500 mm on the basis of the Sierras de Córdoba, to scarce 300 mm in westernmost sites. Unfortunately, no detailed climatological study in these sierras is available, but very likely they concentrate the humidity of eastern winds, representing thus a slight humid island in the surrounding aridity (CHIOZZA & FIGUEIRA, 1981), especially the east–faced slopes (MORELLO *et al.*, 1985). Information on their plant covering is also scarce, though most authors coincide in adscribing them to the so called Sierra chaco, that is, the same formation of the slopes of the sierras that surround the Llanos District (MORELLO *et al.*, 1985; see also Fig. 1). In any case, the influence of the Llanos vegetation is remarkable in most spots we were able to survey.

SAMPLING SITES

Localities were selected in order to embrace the area as complete as possible. The study was limited to sectors easy to reach by road, leaving the highest peaks unexplored. Samples were obtained both by rolling over rocks and with U.V. light. All materials are deposited in the collection of the junior author (LEA). The following localities were studied (see Table I and Fig. 1 for details):

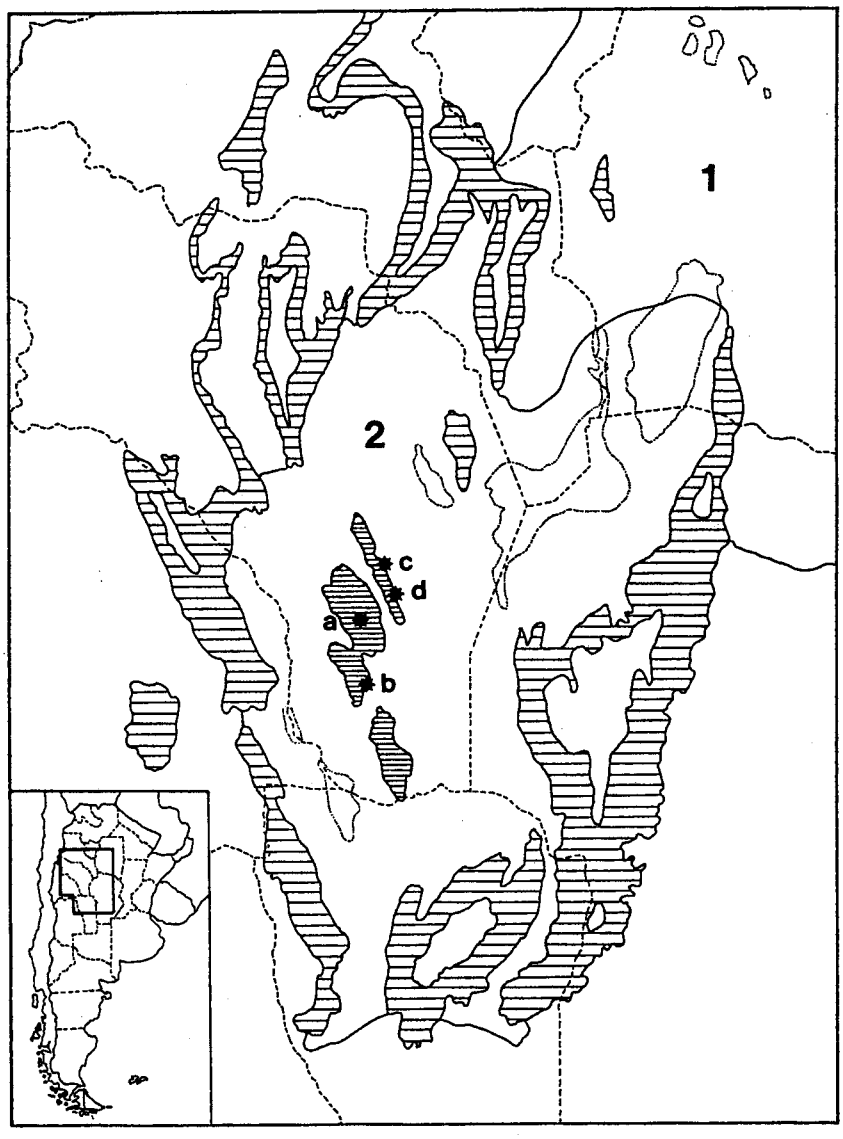


Fig. 1. Southwestern extrem of the Chaco Biogeographic Province, Argentina (interrupted lines: administrative boundaries; solid line: limits of the Chaco sectors, adapted from MORELLO *et al.*, 1985). 1. Semiarid Chaco, 2. Dry Chaco (= Llanos District), hatched: Sierra Chaco (dense hatched: study area). Sampling localities: (a) Malanzán, (b) La Calera, (c) Santa Lucía, (d) Olta.

A. **Malanzán.**– Five sites on the road from Malanzán to Loma Larga, in the valley between the Sierra de Malanzán and the Sierra del Porongo. Three sites (925–1000 m) show typical sierra chaco physiognomy (Fig. 2), still with some Llanos elements. The highest site (1025 m) was the only with sharp rocky character (Fig. 3). The lowest one (1 km from Loma Larga) reflected more the chaco vegetation, though the substrate had many rocks and stones, which are almost lacking in the plains.

B. **La Calera** (near Chepes).– Only one site, near the stream La Calera; rocky and with Llanos vegetation.

C. **Santa Lucía** (near Chamical).– Though with relatively low altitude, the site shows a definite sierra chaco character; it is one of the most humid spots and with most dense vegetation we sampled.

D. **Olta.**– The site sampled in summer is of low altitude, and though being quite rocky, the vegetation had a remarkable influence of the Llanos. In winter we could reach near 1000 m, where Llanos elements were very scarce.

Table I. Specimens captured in each sampling site in the Sierras of Province of La Rioja (letters of localities are the same of Fig. 1). Date of samplings in brackets. Abbreviations: *Tel= Timogenes elegans, Tdo= Timogenes dorbignyi, Bfe= Brachistosternus ferrugineus, Bpe= Brachistosternus pentheri, Bbo= Brachistosternus borellii, Bao= Bothriurus* aff. *olaen, Bco= Bothriurus cordubensis, Zfu= Zabius fuscus, Tco= Tityus confluens.*

LOCALITIES – SAMPLING SITES	*Tel*	*Tdo*	*Bfe*	*Bpe*	*Bbo*	*Bao*	*Bco*	*Zfu*	*Tco*
A – Road between Malanzán and Loma Larga									
890 m (xii–1994)	–	–	6	1	3	–	–	1	–
925 / 985 m (ii–1995)	1	3	–	–	–	–	–	–	–
980 m (xii–1994)	1	2	1	3	2	–	–	–	1
1,000 m (xii–1994)	–	–	1	–	–	–	1	–	–
1,025 m (xii–1994)	–	–	–	–	7	–	–	11	–
1,025 m (ii–1995)	–	–	–	–	3	2	2	9	–
1,025 m (vii–1995)	–	–	–	–	–	–	–	3	–
B – La Calera (near Chepes), 730 m (xii–1994)	–	1	32	8	6	–	1	4	–
C – Santa Lucía (near Chamical), 620 / 660 m (xii–1994)	1	–	50	–	–	–	–	2	–
D – Near Olta, 540 / 550 m (ii–1995)	1	–	10	–	–	–	–	3	–
Dique de Olta, 830 / 950 m (vii–1995)	–	–	–	–	–	–	–	6	–

RESULTS

SPECIES DIVERSITY

Nine species were collected during this study, which together with one entity cited in the literature but not found by us totalizes 10 species for these Sierras (asterisked * forms are first records for the study area):

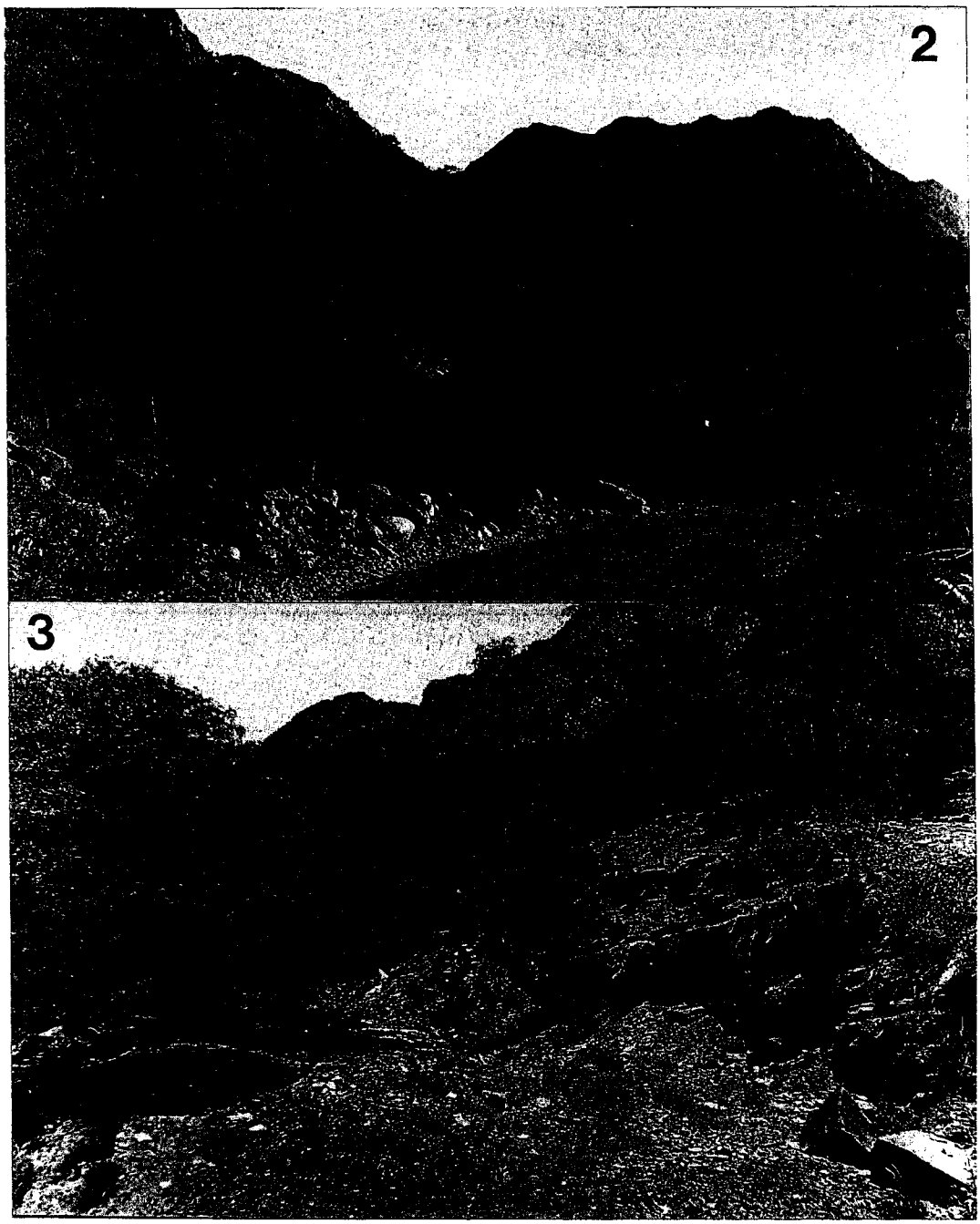


Fig. 2. Sierra chaco, on the road between Malanzán and Loma Larga. Fig. 3. Physiognomy of the highest sampling site (1025 m); rocky wall with crevices, where *Zabius fuscus* was collected.

Family Bothriuridae Simon, 1880

Timogenes dorbignyi (Guérin–Méneville, 1843)

Timogenes elegans (Mello–Leitão, 1931)

Brachistosternus (Ministernus) ferrugineus (Thorell, 1877)

Brachistosternus (Leptosternus) pentheri Mello–Leitão, 1931

Brachistosternus (Leptosternus) borellii Kraepelin, 1911 (S) *

Bothriurus cordubensis Acosta, 1995 (S) *

Bothriurus aff. *olaen* (S) *

Urophonius brachycentrus (Thorell, 1877) (S) [Cited by MAURY (1977) from Olta].

Family Buthidae Simon, 1879

Tityus confluens Borelli, 1899

Zabius fuscus (Thorell, 1877) (S)

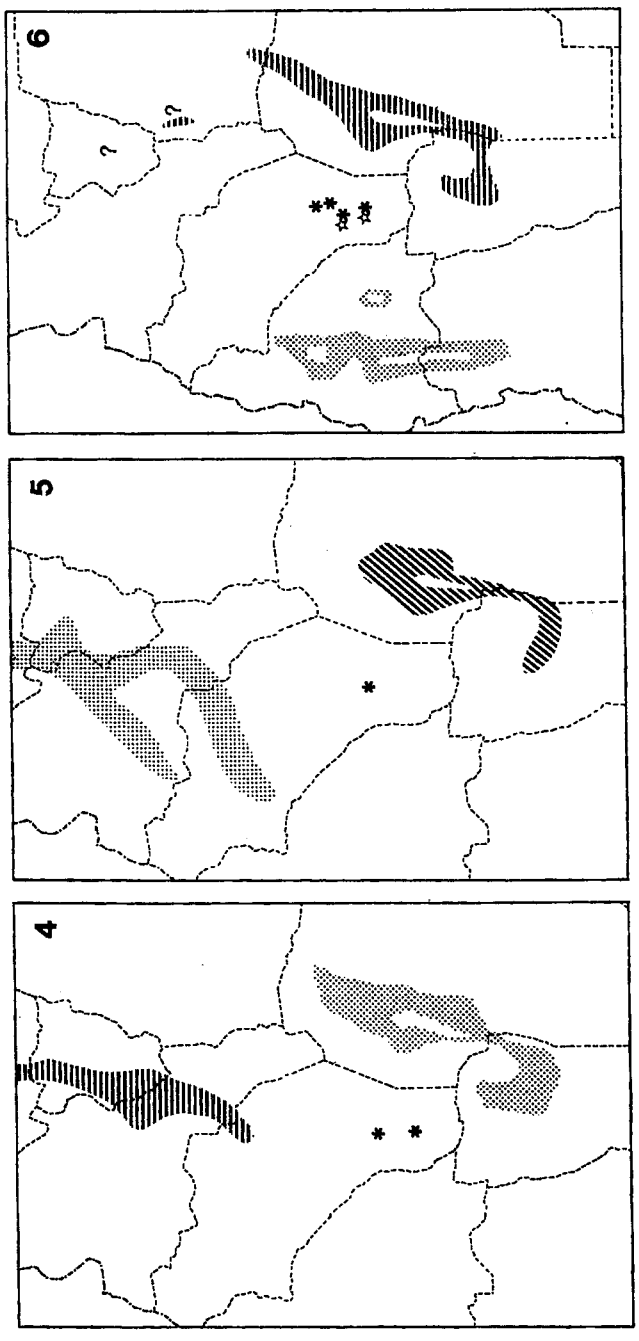
The half of the cited species are true sierra scorpions (indicated with « S » in the list), while the remaining are species already known to occur in the Llanos (ACOSTA, 1995b). Most sites revealed a mixture of sierra and chaco scorpions (Table I), what is here more evident than, for example, in the Sierras de Córdoba, where only narrow ecotones have been described (ACOSTA, 1989; indeed, many sectors of these have not been studied in detail yet). This may be in connection to the low altitude of the sierras of La Rioja, enabling both the vegetation and the scorpions of the plains to advance along valleys that cross between the chains (e.g. the Malanzán–Loma Larga valley). Only the highest site we sampled revealed pure sierra species composition (Table I). Of course, we still do not know whether the peaks of the sierras in the Llanos have any kind of peculiarity. A mixtured composition of plain + mountain scorpions in low chains is also evident in the sierras of the Province of Buenos Aires (MAURY, 1973).

Since the insular character of these mountains only affects orophylous forms, comments are focused on the sierra scorpions, in order to put in evidence the zoogeographical connections of these systems.

Bothriurus cordubensis

The citation of MAURY (1984) of a *Bothriurus* of the *prospicuus* group in the sierras in the Llanos corresponds very likely to this species. It is very common in the Sierras de Córdoba–San Luis (Fig. 4), being usually found together with *Zabius fuscus*. However, its orophyly seems not to be so strict, since many records originate in chaco or « espinal » sites around of the mountains (ACOSTA, 1995a). MAURY (1984) also refers to a member of the group collected in the Sierra de Pie de Palo, that may correspond to *B. cordubensis* too. The nearest captures of its relative, *Bothriurus noa* Maury, 1984, are from El Cantadero, Province of La Rioja (Fig. 4; ACOSTA, 1996).

New records: Argentina, Province of La Rioja. – Road from Malanzán to Loma Larga (1000 m), 2 Dec. 1994 (L. Acosta, C. Mattoni), 1 male; same loc. (1025 m), 12 Feb. 1995 (C. Mattoni, F. Vivanco), 1 male, 1 juv.; La Calera (road to Chepes Viejo, 730 m), 3 Dec. 1994 (L. Acosta, C. Mattoni), 1 juv.



Figs. 4–6. Known ranges of sierra scorpions of La Rioja and relatives. 4. *Bothriurus noa* (hatched) and *Bothriurus cordubensis* (dotted) (ACOSTA, 1995a, 1996), with new records of the latter in the La Rioja sierras (asterisks); 5. *Bothriurus olaen* (hatched) and the unnamed form of the Northwest (dotted) (ACOSTA, 1997); the asterisk indicates the only locality of *Bothriurus* aff. *olaen*; 6. *Brachistosternus (L.) borellii* (dotted) (ROIG ALSINA & MAURY, 1981), with new localities (white stars), and *Zabius fuscus* (hatched) (MAURY, 1979; ACOSTA, 1989), new records with asterisks (not confirmed localities are indicated with interrogations).

Bothriurus **aff.** *olaen*

The *Bothriurus burmeisteri* species-group contains two species so far described (*Bothriurus burmeisteri* Kraepelin, 1894 and *Bothriurus olaen* Acosta, 1997), as well as a couple of innominated forms whose status has not been elucidated (ACOSTA, 1997). The former species has a wide subandean and north patagonic range (MAURY, 1968, 1979), while the latter is geographically more restricted (hitherto known only from the Sierras de Córdoba–San Luis). One of the undescribed forms is very close to *B. olaen,* and occurs more northerly. These two « species » are indeed very difficult to separate morphologically, and their conspecifity is not unlikely (probably they might deserve subspecies status; ACOSTA, 1997). As far as known, their ranges are not in contact (Fig. 5). Further, while *olaen* inhabits sierra environments but was not found in the highest altitude belt of the Sierras de Córdoba–San Luis (from 1900 m on), the unnamed *Bothriurus* is common in prepuna and subandine regions above 2000 m in Northwestern Argentina and Southern Bolivia. ACOSTA (1989) mentions slight differences between these allopatrid forms, both morphometric (ratio « anterior width of prosoma/width of palp chela ») and meristic (frequency of number of pectinal teeth), but he was not able with that information alone to conclude whether they are the same thing or not. Thus, only the Córdoba–San Luis form was formally named (ACOSTA, 1997), leaving the status of the remaining as an open question. Specimens from La Rioja were captured in the highest sampling site (1025 m), and could not be assigned with certainty either to *B. olaen* or its northern relative; the single available adult male has 23/22 pectinal teeth, suggesting perhaps a closer affinity to *B. olaen*, whose males bear from 18 to 23 teeth (the northern form with 15–22 teeth; ACOSTA, 1997).

New records: Argentina, Province of La Rioja. – Road from Malanzán to Loma Larga (1025 m), 12 Feb. 1995 (C. Mattoni, F. Vivanco), 1 male, 1 juv.

Table II. Range, mean (x) or median (m), and standard deviation (SD) of total body lenght and number of pectinal teeth in four geographical groups of *Zabius fuscus* (only adult males). Last file: *P* values of the Kruskal–Wallis test performed for each character.

	Total lenght	Number of pectinal teeth
Córdoba (n = 11)	45.93 – 52.86 mm (x=49.94, SD=2.32)	11–15 (m=13, SD=1.08)
Sierras del Norte (n = 7)	38.49 – 52.67 mm (x=44.98, SD=4.92)	12–15 (m=13, SD=0.84)
San Luis (n = 3)	37.79 – 41.75 mm (x=39.68, SD=1.98)	12–13 (m=12, SD=0.52)
La Rioja (n = 11)	36.51 – 46.06 mm (x=42.40, SD=2.65)	11–14 (m=12, SD=0.77)
Kruskal–Wallis	*P*= 0.0004	*P*= 0.0005

Brachistosternus (L.) borellii

Localities of *B. borellii* hitherto known correspond to Precordillera sites in the Provinces of Mendoza and San Juan, between 900 and 3000 m, and in the isolated Sierra de Pie de Palo, in the latter province (ROIG ALSINA & MAURY, 1981). This species is regarded to be rupiculous, so that populations found in the sierras in La Rioja are probably isolated from the main range (Fig. 6). We collected *B. borellii* in stony and rocky sites, but not on rocky walls, where *Z. fuscus* live. Where the substratum becomes more finely granular this species is replaced by the Monte scorpion *B. (L.) pentheri*.

Some characters show some degree of difference when La Rioja specimens are compared to samples from Mendoza and San Juan, studied by ROIG ALSINA & MAURY (1981). The number of pectinal teeth in La Rioja populations fall within the range found by these authors, but are somewhat biased toward high values (males: 26–38, females: 20–33 in Mendoza–San Juan, males: 30–36, females: 27–30 in our material). This may be in accordance with the observation of ROIG ALSINA & MAURY (*op.cit.*) that marginal populations studied by them showed also the greater deviations. The degree of asymmetry in the number of pectinal teeth in our samples was similar to that reported by these authors (we found one male with a difference of 3 teeth between pectines, while the maximal difference hitherto known was of 2 teeth). No difference between Mendoza–San Juan and La Rioja populations was observed for other characters used by ROIG ALSINA & MAURY (1981), like the number of setae on the caudal segment V and on the telotarsus III. These authors describe a kidney–shaped gland on the dorsal side of the male telson, as a feature apparently unique to *B. borellii* in the genus; however, in our material we were not able to detect such structure. Furthermore, the « caudal glands » (present on the caudal segment V of all *Brachistosternus* species) of La Rioja males are not so « small » as ROIG ALSINA & MAURY (1981) describe and illustrate for the populations of Mendoza–San Juan.

New records: Argentina, Province of La Rioja. – Loma Larga (890 m), 2 Dec. 1994 (L. Acosta, C. Mattoni), 1 male, 2 juv.; road from Malanzán and Loma Larga (1025 m), 2 Dec. 1994 (L. Acosta, C. Mattoni), 2 males, 5 juv.; same loc., date and coll. (980 m), 2 juv.; same loc. (1025 m), 12 Feb. 1995 (C. Mattoni, F. Vivanco), 2 males, 1 juv.

Table III. Results of Mann–Whitney test for each pair of geographical groups of *Zabius fuscus,* as referred to in the text. Below the diagonal: *P* values for « total body lenght »; above: *P* for « number of pectinal teeth ». Underlined values show significant differences in a pair.

		NUMBER OF PECTINAL TEETH		
	Córdoba	Sierras Norte	San Luis	La Rioja
Córdoba	–	0.9871	<u>0.0358</u>	<u>0.0017</u>
Sierras Norte	<u>0.0372</u>	–	<u>0.0233</u>	<u>0.0014</u>
San Luis	<u>0.0127</u>	0.1715	–	0.7581
La Rioja	<u>0.0001</u>	0.4687	0.1195	–

TOTAL LENGHT

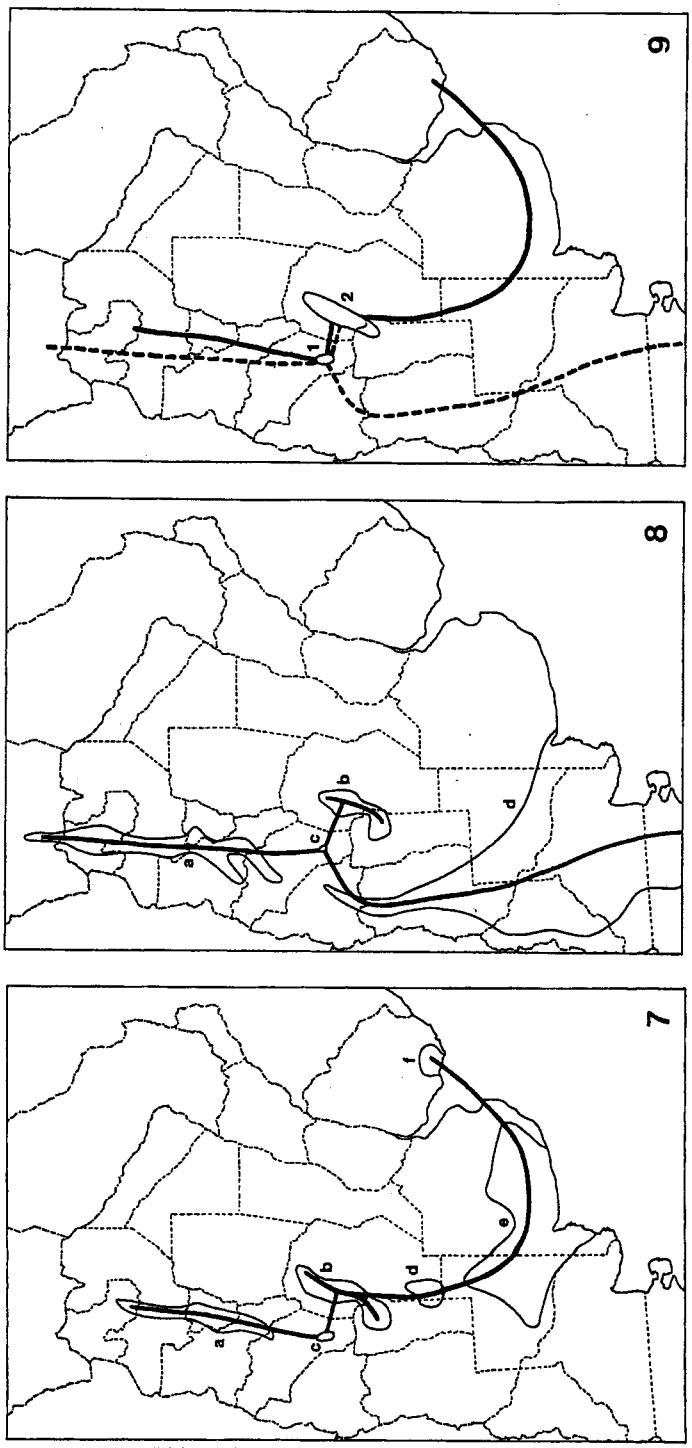


Fig. 7–9. Panbiogeographical analysis for some taxa found in the studied sierras. 7. Individual track (thick line) of the *Bothriurus prospicuus* group; ranges of each species with thin lines: a: *B. noa*, b: *B. cordubensis*, c: occurrence of *B. cordubensis* in the study area, d–e: *B. prospicuus* Mello-Leitão, 1934, f: *B. bucherli* San Martín, 1963) (ACOSTA, 1996; this article). 8. Individual track (thick line) of the *Bothriurus burmeisteri* group: a: unnamed form of the Northwest, b: *B. olaen*, c: *B.* aff. *olaen*, d: *B. burmeisteri* (MAURY, 1979; ACOSTA, 1989, 1997; this article). 9. Combined graph of the two former individual tracks: *prospicuus* group (solid line) and *burmeisteri* group (dashed line), and identification of two zoogeographical nodes: (1) sierras of the Llanos, and (2) Sierras de Córdoba–San Luis.

Urophonius brachycentrus

Primarily associated to the Sierras Pampeanas, but also collected in many localities of the peristepic « espinal » (MAURY, 1977). Like other members of the *brachycentrus* species-group, this is a winter-active scorpion (ACOSTA, 1988). A probably unnamed species of this group is known to occur in central Chile (ACOSTA, 1988), putting in evidence an ancient transandine link; another species (*Urophonius jheringii* Pocock, 1893, occurring both in the sierras of Buenos Aires and in Uruguay and Southern Brazil; MAURY, 1977) suggests the vinculation of the group to the « peripampasic track » (see below). We were not able to collect this species in our study.

Zabius fuscus

This is probably the most characteristic scorpion of the central mountains. The seemingly strict orophyly of this species restricts its distribution to rocky areas, where the scorpions shelter under stones and in crevices (ACOSTA, 1989). *Zabius fuscus* ranges from the Sierras de Sumampa (southern Province of Santiago del Estero) to the Sierras de Córdoba and San Luis; populations found in Province of La Rioja are clearly disjunct from the main area (Fig. 6). The presence of *Z. fuscus* was referred also to other localities, though some of them may require further confirmation. In his Fig. 2, MAURY (1979) indicates a finding in southwestern Santiago del Estero, where no mountain exists; it may probably refer to the Sierra de Guasayán, a low altitude, isolated chain, which is indeed placed more northerly (Fig. 6). In the same map, MAURY (1979) also points out records from Province of Catamarca (probably the Sierra de Ancasti) and Tucumán (citation by ABALOS, 1953?). References from Jujuy (MELLO-LEITÃO, 1934) and « Paraguay » (KRAEPELIN, 1899) are not mapped by MAURY (1979), and are actually much less likely. Such disjunct range of a species restricted to mountains emphasize the insular condition of these sierras.

No morphological distinction between individuals from La Rioja and Córdoba-San Luis was found, but La Rioja specimens show lighter coloration. These individuals also appear to be smaller than usual sizes in Córdoba. We analised whether differences in total lenght of individuals is statistically significant; only adult males, available in our collections, were computed. Materials from the central sierras were divided into three main geographic groups: (1) Sierras Chica, Grande and de Pocho, in the Province of Córdoba, (2) Sierras del Norte (Northern Córdoba + Southern Santiago del Estero), (3) Sierra de San Luis. This separation is tentatively intended to reflect two narrow but maybe effective disruptions of the continuous rocky environment in this unit: the valley of Conlara River (between 1 and 3), and the valley of Deán Funes (between 1 and 2). In addition, a meristic feature (number of pectinal teeth) was considered for the same groups. For both characters, non-parametrical Kruskal-Wallis and Mann-Whitney tests were performed ($\alpha = 0.05$); results are given in Tables II and III.

Regarding size, two different classes arise: on one side males from Córdoba, which proved to be the largest, on the other the remaining sectors (Table III). These results might show that smaller individuals belong to the more peripherical populations of the species. The closest size affinity observed for La Rioja males were those from the Sierras del Norte. When considering the number of pectinal teeth, two affinity groups resulted: La Rioja-San Luis, and Córdoba-Sierras del Norte (Table III). However, comparisons affecting the San Luis sample should be taken with caution, since they are very likely biased by the low n available. Further collectings in all areas are actually necessary to improve these comparisons.

New records: Argentina, Province of La Rioja. – Loma Larga (890 m), 2 Dec. 1994 (L. Acosta, C. Mattoni), 1 female; road from Malanzán to Loma Larga (1025 m), 2 Dec. 1994 (L. Acosta, C. Mattoni), 5

males, 2 females, 4 juv.; same loc., 12 Feb. 1995 (C. Mattoni, F. Vivanco), 4 males, 1 female, 3 juv.; same loc., 28 Jul. 1995 (C. Mattoni, F. Vivanco), 3 juv.; La Calera (road to Chepes Viejo, 730 m), 3 Dec. 1994 (L. Acosta, C. Mattoni), 1 male, 1 female; Olta (540 m), 8 Feb. 1995 (C. Mattoni, F. Vivanco), 3 juv.; Dique de Olta (830 m), 28 Jul. 1995 (C. Mattoni, F. Vivanco), 2 juv.; 1 km W of Dique de Olta (840 m), 29 Jul. 1995 (C. Mattoni, F. Vivanco), 1 juv.; 5 km W of Dique de Olta (920 m), 29 Jul. 1995 (C. Mattoni, F. Vivanco), 1 female; 7 km W of Dique de Olta (950 m), 29 Jul. 1995 (C. Mattoni, F. Vivanco), 1 juv.; Olta, Quebrada del Padre (910 m), 29 Jul. 1995 (C. Mattoni, F. Vivanco), 1 juv.

ZOOGEOGRAPHICAL LINKS

As stated above, three species (*Zabius fuscus, Bothriurus cordubensis* and *Urophonius brachycentrus*) reveal the zoogeographical connection of the La Rioja sierras to the Córdoba–San Luis mountains. On the contrary, *Brachistosternus borellii* represents an unexpected link to the Precordillera. The remaining sierra species, *Bothriurus* aff. *olaen,* is (as a member of the *burmeisteri* group) also connected to a subandine general pattern, although we ignore whether it is more related to *olaen* proper or the unnamed *Bothriurus* of the Northwest.

In Figs. 7–9 these vinculations are shown in a graphic fashion, through the recognition of « individual tracks » for selected taxa. According to panbiogeographic principles, an individual track is a line connecting all parts of the range of a given taxon (CRAW, 1988). In Fig. 7, for example, the track of the *Bothriurus prospicuus* species-group is drawn. The southern part of it (sectors b–f) coincides with the so called « peripampasic track » (ACOSTA, 1989, 1993), that is indeed a « generalized track », where information on several individual tracks is combined (in this case, also range patterns of *Bothriurus flavidus* Kraepelin, 1911 and the harvestmen genera *Ceratomontia* Roewer, 1915 and *Neopucroliella* Roewer, 1931 were taken into account: ACOSTA, 1989). Since one species of the *prospicuus* group inhabits in Northwestern Argentina (*Bothriurus noa:* sector a on Fig. 7), ACOSTA (1989) suggested that the peripampasic track may reach that region too. The findings of *Bothriurus cordubensis* in the sierras of the Llanos may indicate the precise point where the sectors a and b of the track should be connected. Distribution patterns of some fern taxa, as described by DE LA SOTA (1967), might support the peripampasic track and its extension in Northwestern Argentina (even into Southern Brazil, as also ranges of *Urophonius jheringii* and genus *Ceratomontia* suggest). DE LA SOTA (1967) also finds some kind of link with the Chilean biota.

On the other hand, the individual track of the *Bothriurus burmeisteri* group (Fig. 8) illustrates the above mentioned subandine connections. Though one species, *B. olaen* occurs in the Córdoba–San Luis sierras, this may be seen as an exception in the group, as ranges of the remaining forms suggest. Also here, the mountains of La Rioja serve as connection of different parts of the track. A subandine pattern is roughly followed by the subgenus *Brachistosternus (Leptosternus)* Maury, 1973 (the whole genus, with the exception of the apocoric *Brachistosternus ferrugineus*, is actually distributed along the Andine corridor B of LOURENÇO, 1986, 1994; ACOSTA, 1989). Thus, the finding of *B. (L.) borellii* in our study area constitutes a further evidence for the subandine links of the Llanos mountains.

DE LA SOTA (1967) regards the patterns he detected in ferns to be « migration or dispersal routes » for some species. But, since such patterns are shared with other non-related groups, with very different dispersal capabilities, they may rather represent the effects of a phenomenon that affected the whole (ancestral) biota and not a single group. Supporters of the panbiogeography regard the areas connected by a track as remains or fragments of a once continuous ancestral biota (CRAW, 1988). To uncover the history of such fragmentation, panbiogeographers polarize their tracks, either through phylogenetic information of the involved taxa, by the recognition of the so called baselines upon

major tectonic features crossed by the track, or by the « main massing » criterium (MORRONE & CRISCI, 1990). We preferred not to polarize the tracks yet, because of the almost complete lack of required data. Nonetheless, this analysis, though preliminary, uncover an hitherto neglected but very likely historical meaning of these isolated sierras: if we combine the information mapped in Figs. 7–8, two « nodes » (intersection points of different tracks) become evident (Fig. 9): the Córdoba–San Luis mountains, and the sierras of the Llanos. How to interprete such a « node » condition would still require more research in other taxa. Though they share most scorpion species, each of the recognized nodes has its own peculiarity. Subandine elements are more evident in La Rioja sierras, while the Córdoba–San Luis node has a peripampasic species not found yet in the Llanos systems (*Bothriurus flavidus*). It seems thus evident that these mountains were once part of a larger unit that became fragmented later (probably during the tertiary tectonics that originated the present Sierras Pampeanas?). We do not know how long these systems remained isolated, but at least populations of *Zabius fuscus* reflect some degree of divergence, as seen above. The same comments may also apply to the isolation of these populations of *B. borellii* respect to those from Mendoza–San Juan.

ACKNOWLEDGEMENTS

Collecting trips were partially supported by CONICOR (Consejo de Investigaciones Científicas y Tecnológicas de la Provincia de Córdoba). We thank Fernanda Vivanco and Lidia Avalle for their help in the field work, and Dr. Alfredo Peretti for his advice in statistical analysis and useful comments on the text.

REFERENCES

ABALOS, J.W., 1953. El género *Zabius* Thorell, 1894 (Buthidae, Scorpiones). An. Inst. Med. Reg., 3(3): 349–365.

ACOSTA, L.E., 1988. Contribución al conocimiento taxonómico del género *Urophonius* Pocock, 1893 (Scorpiones, Bothriuridae). J. Arachnol., 16(1): 23–33.

ACOSTA, L. E., 1989. La fauna de escorpiones y opiliones (Arachnida) de la Provincia de Córdoba. Tesis Doctoral, Facultad de Ciencias Exactas, Físicas y Naturales, Universidad Nacional de Córdoba, pp. i–vi, 1–333.

ACOSTA, L. E., 1993. Escorpiones y opiliones de la Provincia de Córdoba: diversidad y zoogeografía. C.R. XIIIe Coll. Europ. Arachnol., Bull. Soc.neuchât. Sci. nat., 116(1): 11–17.

ACOSTA, L. E., 1995a. The scorpions of the Argentinian Western Chaco. I. Diversity and distributional patterns. Biogeographica, 71(2): 49–59.

ACOSTA, L. E., 1995b. The scorpions of the Argentinian Western Chaco. II. Community survey in the Llanos District. Biogeographica, 7(4): 187–196.

ACOSTA, L. E., 1996. Nuevas localidades de escorpiones argentinos (Arachnida, Scorpiones). Rev. Soc. Entomol. Argent., 55(1–4): 121–125.

ACOSTA, L. E., 1997. Descripción de *Bothriurus olaen*, nueva especie de escorpión de Argentina central (Scorpiones, Bothriuridae). Revue Arachnol., 12(1): 1–8.

ACOSTA, L.E. & B. ROSSO DE FERRADAS, 1996. Arácnidos de la Provincia de Córdoba. *In*: di Tada, I. & Bucher, E.H. (eds.), Biodiversidad de la Provincia de Córdoba, Fauna, 1: 71–99.

CHIOZZA, E. & R. FIGUEIRA (Dirs.), 1981. Atlas Total de la República Argentina. Ed. Centro Editor de América Latina, 2: 112–117.

CRAW, R., 1988. Panbiogeography: method and synthesis in biogeography. *In*: A.A. Myers & P.S. Giller (eds.), Analytical Biogeography, pp.405–435, Chapman & Hall.

DE LA SOTA, E.R., 1967. Composición, origen y vinculaciones de la flora pteridológica de las sierras de Buenos Aires (Argentina). Bol. Soc. Arg. Bot., 11(2–3): 105–128.

KRAEPELIN, K., 1899. Scorpiones und Pedipalpi. Das Tierreich, 8: 1–265, Berlin.

LOURENÇO, W. R., 1986. Les modèles de distribution géographique de quelques groupes de scorpions néotropicaux. C.R. Soc. Biogéogr., 62(2): 61–83.

LOURENÇO, W.R., 1994. Biogeographic Patterns of Tropical South American Scorpions. Stud. Neotrop. Fauna Environm., 29(4): 219–231.

MAURY, E.A., 1968. Aportes al conocimiento de los escorpiones de la República Argentina. II. Algunas consideraciones sobre el género *Bothriurus* en la Patagonia y Tierra del Fuego, con la descripción de una nueva especie (Bothriuridae). Physis, 28(76): 149–164.

MAURY, E. A., 1973. Los escorpiones de los sistemas serranos de la Provincia de Buenos Aires. Physis, C, 32(85): 351–371.

MAURY, E. A., 1977. Comentarios sobre dos especies de escorpiones del género *Urophonius* (Bothriuridae). Rev. Mus. Argent. C. Nat., Ent., 5(7): 143–160.

MAURY, E. A., 1979. Apuntes para una zoogeografía de la escorpiofauna argentina. Acta Zool. Lill., 35: 703–719.

MAURY, E.A., 1984. Dos nuevos *Bothriurus* de la Argentina y el Paraguay (Scorpiones, Bothriuridae). Acta Zool. Lill., 37(2): 191–198.

MELLO-LEITÃO, C., 1934. Estudo monografico dos escorpiões da Republica Argentina. VIII Reun. Soc. Arg. Pat. Reg.: 1–97.

MORELLO, J.H., J. PROTOMASTRO, L.A. SANCHOLUZ & C. BLANCO, 1985. Estudio macroecológico de los llanos de La Rioja. Administración de Parques Nacionales (Argentina), Serie del Cincuentenario, Nº 5: 1–53.

MORRONE, J. J. & J. V. CRISCI, 1990. Panbiogeografía: fundamentos y métodos. Evolución Biológica, 4: 119–140.

ROIG ALSINA, A. & E. A. MAURY, 1981. Consideraciones sistemáticas y ecológicas sobre *Brachistosternus (Leptosternus) borellii* Kraepelin 1911 (Scorpiones, Bothriuridae). Physis, C, 39(97): 1– 9.

Reçu en janvier 1997
Accepté en mai 1997