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Delimitation of biogeographic districts in central Patagonia (southern South America), based on beetle distributional patterns (Coleoptera: Carabidae and Tenebrionidae)

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Abstract: Based on distributional patterns of 93 beetle species belonging to the families Carabidae and Tenebrionidae, we identified three generalized tracks within the Central Patagonia biogeographic province, located in southern South America. These generalized tracks are considered natural biogeographic units, and herein treated as districts: (1) Payunia district: in the northwestern corner of the Central Patagonia biogeographic province, in southern Mendoza and northern Neuquén provinces in Argentina; (2) Central district: including the greatest part of the biogeographic province, extending from southern Río Negro to central Santa Cruz province in Argentina; and (3) Fuegian district: extending from southern Santa Cruz province in Argentina to northern Tierra del Fuego, in Argentina and Chile. Notably, these districts coincide with three geological basins: the Payunia district with the Neuquén basin, the Central district with the San Jorge basin, and the Fuegian district with the Magellanes basin.

Key words: Coleoptera, Carabidae, Tenebrionidae, distribution, Patagonia, South America.

The vast cool semidesert of southern South America, known as Patagonia, extends approximately from 35° S to 54° S, eastern to the southern Andes. In spite of its apparent uniformity, Patagonia harbors a quite rich spectrum of vegetation types, from real deserts to shrub and grass steppes (Cabrera & Willink, 1973; Soriano, 1983; Roig, 1998).

Soriano (1956) identified five floristic districts within the Patagonian biogeographic province, to which Cabrera (1971) added a sixth one. These biogeographic districts are Payunia, Subandean, Western, Central (with the Chubutian and Santacruzian subdistricts), San Jorge Gulf, and Fuegian (Soriano, 1956, 1983; Cabrera, 1971; Cabrera & Willink, 1973). Morrone (1999) ranked Patagonia as a subregion of the Andean region, and he later considered that it was divided into two provinces: Subandean and Central Patagonia (Morrone, 2001). The Subandean Patagonia province is quite small and homogeneous, ranging along the southern Andes in Argentina and Chile. In contrast, the Central Patagonia province is larger and more complex, comprising the xerophilous steppes east to the Andes in Argentina and extending in some places to Chile (Malleco, Aysén, and Magallanes). Because the heterogeneity of the Central Patagonia province, it would be possible to recognize smaller units within it.

Beetles (Insecta: Coleoptera) have been widely used for biogeographic studies (*e.g.*, Jeannel, 1942; Darlington, 1965; Peña, 1966; Erwin *et. al.*, 1979; Liebherr, 1988; Covarrubias & Elgueta, 1991), including studies applying cladistic and track methods (Morrone, 1992, 1993a, b, 1994a, b, 1996, 2000, 2001; Morrone *et al.*, 1994; Roig-Juñent, 1994; Roig-Juñent & Flores, 1995, 2001; Morrone & Urtubey, 1997; Roig-Juñent *et al.*, 2001). Specially in arid zones, beetles belonging to the families Carabidae and Tenebrionidae have been used for biogeographic analyses (Roig-Juñent, 1994; Roig-Juñent & Flores, 1995, 2001; Roig-Juñent *et al.*, 2001).

Our objective is to analyze the distributional patterns of several Patagonian beetle species, applying a track or panbiogeographic approach (Morrone & Crisci, 1995; Craw *et al.*, 1999), in order to identify biogeographic districts within the Central Patagonia province.

MATERIAL AND METHODS

Distributional data for this study were obtained from the literature (Kulzer, 1956, 1958, 1963; Marcuzzi & Lafisca, 1976; Peña, 1985, 1986, 1994; Marcuzzi, 1991; Roig-Juñent, 1993, 1994, 1998; Roig-Juñent & Cicchino, 1989; Flores, 1999; Flores & Vidal, 2001) and from specimens col-

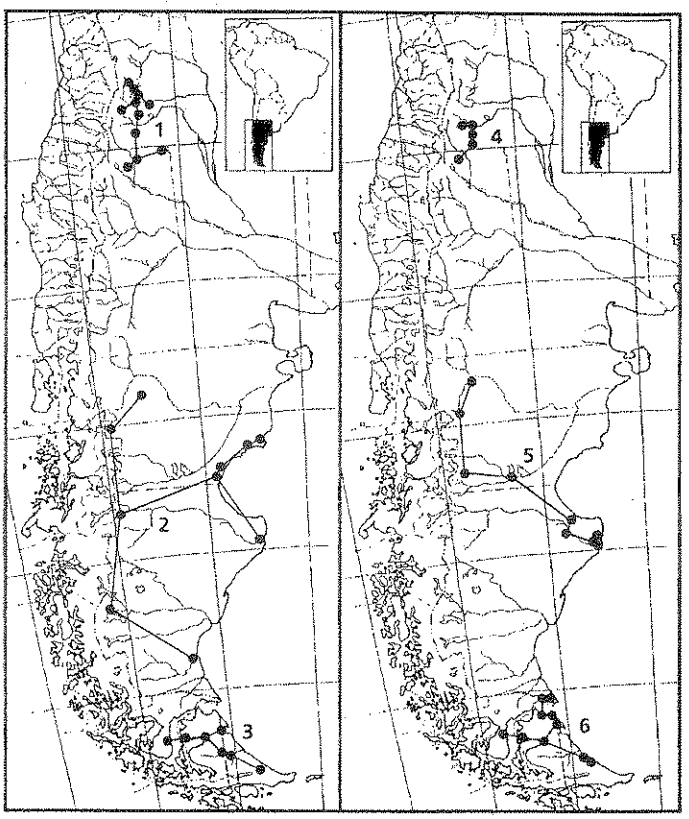

Fig. 1. Individual tracks. 1, *Cnemalobus mendozensis*; 2, *C. curtisii*; 3, *Neopraocis reflexicollis*; 4, *Nyctelia garciae*; 5, *N. caudata*; 6, *N. granulata*.

lected and/or identified by SRJ and GEF, which are deposited in the collection of the Instituto Argentino de Investigaciones de las Zonas Áridas (IADIZA), Argentina.

Most of the Tenebrionidae species used in this study belong to the tribes Nycteliini and Praocini, within the subfamily Pimeliinae, which are very diverse in arid lands in the world (Watt, 1974; Doyen, 1993). In Argentina, they are a dominant in Patagonian steppes (Flores, 1997, 1998). These species exhibit morphological, physiological, and behavioral adaptations for life in desert areas, most of them having restricted geographical distributions. Of the tenebrionid species used in this study, only *Omopheres ardoini* is able to fly.

The track analysis basically consists of plotting distributions of different taxa on maps, and connecting their localities together with lines called individual tracks. These tracks represent the geographical coordinates of species or higher taxa, and operationally are lines drawn on a map of their localities, connected according to their geographical proximity (Craw *et al.*, 1999). When different individual tracks are superimposed, the resulting summary lines are considered generalized tracks, which indicate the preexistence of ancestral biotas, and are equated herein to natural biogeographic units or areas of endemism. For details of the track methodology see Morrone & Crisci (1995) and Craw *et al.* (1999).

RESULTS

After analyzing the distribution of 93 species of Carabidae and Tenebrionidae (12 representative individual tracks are represented in Figs. 1 and 2), three generalized tracks were identified (Fig. 3). Localities belonging to each generalized track were then mapped, and the most extreme ones were taken into consideration for delineating the boundaries of the three districts (Fig. 4).

Payunia district

It occupies the northwestern corner of the Central Patagonia biogeographic province, in southern Mendoza and northern Neuquén provinces in Argentina (Soriano, 1983). It is a shrub steppe, with *Nassauvia axillaris*, *Maihuenia*

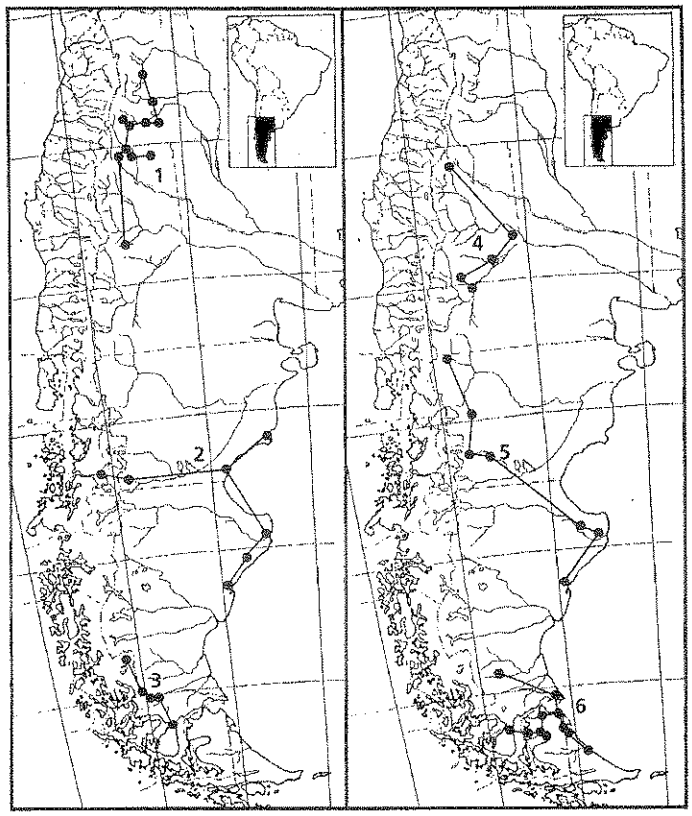

Fig. 2. Individual tracks. 1, *Nyctelia laevis*; 2, *N. darwini*; 3, *N. multicristata*; 4, *Omopheres ardoini*; 5, *Patagonogenius acutangulus*; 6, *Platesthes depressa*.

patagonica, Haplopappus pectinatus, Stillingia patagonica, Prosopis castellanosii, P. ruiz leali, Cassia arnottiana, C. kurtzii, Condalia megacarpa, Berberis comberi and other plant species (Roig, 1998).

Endemic taxa. Carabidae: *Cnemalobus mendozensis* Roig-Juñent (Fig. 1.1; Roig-Juñent, 1993; IADIZA). **Tenebrionidae:** *Nyctelia cicatricula* Berg, *N. difficilis* Kulzer, *N. garciae* Berg (Fig. 1.4), *N. gebieni* Kulzer, *N. grandis* Fairmaire, *N. kulzeri* Marcuzzi, *N. laevis* Waterhouse (Fig. 2.1), *N. planata* Kulzer, *N. producta* Fairmaire, and *N. roigi* Marcuzzi (Kulzer, 1963; Marcuzzi & Lafisca, 1976; IADIZA); *Omopheres ardoini* Freude (Fig. 2.4; Marcuzzi & Lafisca, 1976); *Psectrascelis atra* Kulzer, *P. gigas* Peña, *P. grandis* Kulzer, *P. hirta* Kulzer, *P. lucida* Peña, and *P. neuquenensis* Peña (Peña, 1985, 1994; IADIZA).

Central district

It includes the greatest part of the province, extending from southern Río Negro to central Santa Cruz provinces in Argentina (Soriano, 1983). It is a shrub steppe with *Nassauvia glomerulosa, N. ulicina, Acaena platyacantha, Adesmia ameghinoi,* and *Stipa chubutensis* (Roig, 1998).

Endemic taxa. Carabidae: *Antarctiola laevis* Straneo and *A. laevigata* Putzeys (Straneo, 1951); *Barypus (Cardiophthalmus) longitarsis* (Waterhouse) (Roig-Juñent & Cicchino, 1989; IADIZA); *Cnemalobus curtisii* (Waterhouse) (Fig. 1.2; Roig-Juñent, 1993; IADIZA); *Metius crassusculus* Putzeys (Straneo, 1951); *Mimodromius (Cymindidius) martinezi* Mateu; *Parhypates (Argutoridius) chilensis chubutensis* Straneo (Straneo, 1969); *Trechisibus (Trechisibus) bruchi* Jeannel, *T. (T.) cristinensis* Jeannel and *T. (T.) topali* Mateu & Nègre (Jeannel, 1962). **Tenebrionidae:** *Epipedonota elegantula* Kulzer and *E. willinki* Kulzer (Flores & Vidal, 2001); *Nyctelia blairi* Kulzer, *N. caudata* Curtis (Fig. 1.5), *N. consularis* Kulzer, *N. darwini* Waterhouse (Fig. 2.2), *N. discoidalis* Fairmaire, *N. fitzroyi* Waterhouse, *Nyctelia freyi* Kulzer, *N. guerini* Waterhouse, *N. latiplicata* Kulzer, *N. newporti*

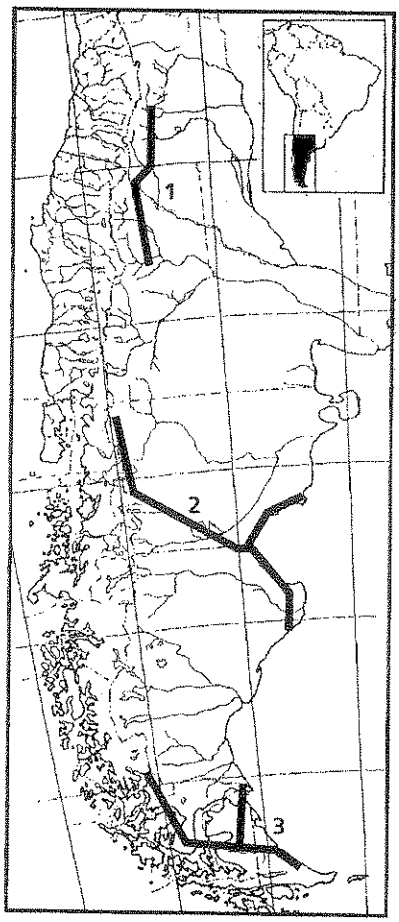

Fig. 3. Generalized tracks corresponding to districts of the Central Patagonia biogeographic province. 1, Payunia; 2, Central; 3, Fuegian.

Waterhouse, *N. plicata* Waterhouse, *N. quadriplicata* Fairmaire, *N. sallaei* Fairmaire, *N. stephensi* Waterhouse, *N. undatipennis* Curtis, *N. vidalae* Kulzer, and *N. westwoodi Waterhouse* (Kulzer, 1963; Marcuzzi & Lafisca, 1976; IADIZA); *Patagonogenius acutangulus* (Kulzer) (Fig. 2.5), *P. quadricollis* (Fairmaire), and *P. gentilii* (Peña) (Flores, 1999); *Platesthes pilosa* Kulzer (Kulzer, 1956; IADIZA), *Praocis (Hemipraocis) sellata* Berg, *P. (H.) sellata bergi* Kulzer, and *P. (H.) denseciliata* Fairmaire (Kulzer, 1958; IADIZA); *Psectrascelis convexipennis* Fairmaire, *P. latithorax* Peña, *P. maximus* Peña, *P. punctipennis* Kulzer, *P. punctulata* (Waterhouse), and *P. sulcicollis* (Waterhouse) (Peña, 1985, 1986); *Scotobius contrerasi* Marcuzzi (Marcuzzi & Lafisca, 1976).

Fuegian district

It extends from southern Santa Cruz province in Argentina to northern Tierra del Fuego in Argentina and Chile. This district is characterized mainly by plants such as *Empetrum rubrum, Chiliotrichium diffusum, Gamochaeta nivalis,* and *Uncina macrolepis* (Roig, 1998).

Endemic taxa. Carabidae: *Feroniola bradytoides* (Fairmaire) (Straneo, 1995); *Metius annulicornis* (Curtis) and *M. pogonoides* Fairmaire (Straneo, 1951); *Notaphiellus cekalovici* Jeannel (Jeannel, 1962); *Notholopha (Notholopha) atrum* (Germain) and *N. (N.) epistomale* Jeannel (Jeannel, 1962); *Pseudomigadops nigrocoeruleus* (Waterhouse) (Jeannel, 1938); *Pycnochilla fallaciosa* (Chevrolat) (Roig-Juñent, 1994, 1998); *Trechisibus (Trechisibus) magellanus* Jeannel, *T. (T.) rectangulus* Jeannel, and *T. (T.) stricticollis* Jeannel (Jeannel, 1962). **Tenebrionidae:** *Epipedonota tricostata* Burmeister (Flores & Vidal, 2001); *Neopraocis reflexicollis* (Solier) (Fig. 1.3; Marcuzzi, 1991; IADIZA); *Nyctelia bremi* Waterhouse, *N. corrugata* Curtis, *N. fallax* Kulzer, *N. granulata* Waterhouse (Fig. 1.6), *N. multicristata* Blanchard (Fig. 2.3) and *N. solieri* Waterhouse, (Kulzer, 1963; IADIZA); *Platesthes depressa* Guérin (Fig. 2.6; Marcuzzi, 1991), *P. silphoides* Waterhouse, *P. burmeisteri* Haag-Rutemberg, *P. similis* Kulzer, *P. unicosta* Kulzer, *P. nigra* Kulzer, and *P. granulipennis* Kulzer (Kulzer, 1956); *Praocis (Hemipraocis) striolicollis* Fairmaire (Kulzer, 1958; IADIZA).

DISCUSSION

The three units recognized herein coincide partially with the previous biogeographic schemes (Soriano, 1956; Cabrera, 1971; Cabrera & Willink, 1973; Roig, 1998), because we could find no evidence to validate the San Jorge Gulf district, or to distinguish the Chubutian or Santacruzian subdistricts within the Central district. According to the results of our analysis, these three previously recognized units are just part of the Central district. The revised biogeographic classification, according to Morrone (2001) and these results, suggest the recognition of the following provinces and districts within the Patagonian subregion:

1. Subandean Patagonia province (= Western district)
2. Central Patagonia province
   - 2.1. Payunia district
   - 2.2. Central district (= San Jorge Gulf district, Chubutian subdistrict, and Santacruzian subdistrict)
   - 2.3. Fuegian district

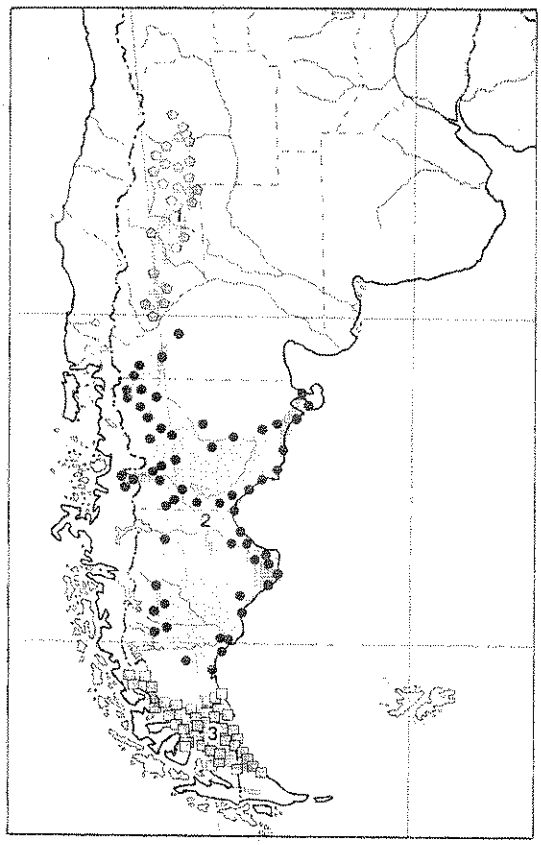

Fig. 4. Localities considered for delineating the boundaries of the districts of the Central Patagonia biogeographic province. 1, Payunia; 2, Central; 3, Fuegian.

The three districts recognized herein coincide with three geological basins: the Payunia district with the Neuquén basin, the Central district with the San Jorge basin, and the Fuegian district with the Magellanes basin (Volkheimer in Soriano, 1983). This would suggest that, in addition to ecological factors, there are historical events that may have taken place in the spatial evolution of Patagonia.

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