Journal of Natural History
Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/tnah20

Another migid in the wall: natural history of the endemic and rare spider Calathotarsus simoni (Mygalomorphae: Migidae) from a hill slope in central Argentina

Nelson Ferretti[a], Sofía Copperi[b], Leonela Schwerdt[b] & Gabriel Pompozzi[b]

[a] Centro de Estudios Parasitológicos y de Vectores CEPAVE (CCT - CONICET - La Plata) (UNLP), La Plata, Argentina

[b] Laboratorio de Zoología de Invertebrados II, Departamento de Biología, Bioquímica y Farmacia, Universidad Nacional del Sur, Bahía Blanca, Buenos Aires, Argentina

Published online: 17 Mar 2014.

Journal of Natural History, 2014
http://dx.doi.org/10.1080/00222933.2014.886344

Taylor & Francis
Taylor & Francis Group

Another migid in the wall: natural history of the endemic and rare spider *Calathotarsus simoni* (Mygalomorphae: Migidae) from a hill slope in central Argentina

Nelson Ferretti[a]*, Sofía Copperi[b], Leonela Schwerdt[b] and Gabriel Pompozzi[b]

[a]*Centro de Estudios Parasitológicos y de Vectores CEPAVE (CCT – CONICET – La Plata) (UNLP), La Plata, Argentina;* [b]*Laboratorio de Zoología de Invertebrados II, Departamento de Biología, Bioquímica y Farmacia, Universidad Nacional del Sur, Bahía Blanca, Buenos Aires, Argentina*

(*Received 15 August 2013; accepted 19 January 2014*)

A population of *Calathotarsus simoni* Schiapelli and Gerschman (1975) was discovered on a hillside in the Ventania system, Argentina. Our objectives were to quantify burrow density, record burrow morphology and door characteristics and describe the micro-habitat. We counted 57 burrows and report a density of 0.01 burrows/m^2. Aggregation indices suggest that burrows are aggregated under some area plots but more evenly distributed on others. The trapdoor is thick and rigid with bevelled edges connected to the entrance rim by a narrow articulated hinge. Two egg sacs from females were obtained and data on eggs and spiderlings are presented. We registered six burrows of an undetermined species of *Actinopus*. While a few specimens of *Actinopus* sp. were found inhabiting this hillside, the highest proportion of burrows belonged to *C. simoni*. Spider diversity on the hillside shows the predominance of Linyphiidae, Nemesiidae and Gnaphosidae. One juvenile of *C. simoni* was captured using pitfall traps.

Keywords: trapdoor spider; burrow density; aggregation; Ventania system; *Actinopus*

Introduction

Trapdoor spiders belong to the group of Mygalomorphae and include species that dig burrows into the ground, sealed with a lid or "trapdoor". The spiders live in these burrows and can emerge from them to feed. This constructing behaviour is widespread between many mygalomorph families (such as Actinopodidae, Barychelidae, Ctenizidae, Idiopidae, Migidae, Nemesiidae, and even some Theraphosidae and Liphistiidae). They are long-lived, slow reproducing, burrowing spiders with several species of conservation concern in different parts of the world (Clarke and Spier-Ashcroft 2003; Bond et al. 2006; Cooper et al. 2011; Engelbrecht and Prendini 2012; Engelbrecht 2013). Some species construct burrows in the soil, which they cover with a lid that resembles the surrounding substrate and are often nearly impossible to detect with the naked eye, and others make a door of litter fragments and some attach a fan of twig lining to the rim of the burrow.

Trapdoor spiders are among the most cryptic spiders and knowledge about their biology lags well behind that of more conspicuous spider families (Haupt 1995). The

*Corresponding author. Email: nferretti@conicet.gov.ar

trapdoor spider family Migidae has long attracted attention because of its strikingly disjunct southern continent distribution. Migids are known from Australia, Africa, Madagascar, New Zealand, New Caledonia and the southern cone of South America: almost all parts of the former supercontinent Gondwanaland, except the Indian subcontinent and Antarctica (Griswold and Ledford 2001). *Calathotarsus* Simon (1903) is one of the 10 genera that include the mygalomorph family Migidae. This genus comprises three species from Argentina and Chile (Platnick 2013). The genus was described by Simon (1903), the Argentinian fauna was reviewed by Schiapelli and Gerschman (1973), the Chilean fauna was reviewed by Legendre and Calderón (1984); Goloboff and Platnick (1987) and Goloboff (1994), and new species were described by Schiapelli and Gerschman (1975) and Goloboff (1991).

Calathotarsus are medium-sized spiders (12–20 mm) with an arched caput in the female, wide ocular area, and with rows of setae on the caput (Griswold and Ledford 2001). The thoracic fovea is simple or may have a weak posterior extension. The cheliceral fang furrow has denticles between the tooth rows and intercheliceral tumescence in the male, the cuspules of the pedipalp coxae are clustered near the base (Griswold and Ledford 2001).

Biology has been reported by Schiapelli and Gerschman (1973, 1975) and Goloboff (1991). All *Calathotarsus* appear to be burrowers rather than nest builders (Goloboff 1991; Griswold and Ledford 2001). The only Migid present in Argentina is *Calathotarsus simoni* (Schiapelli and Gerschman 1975) (Figure 1), being endemic to the hilly systems of Ventania and Tandilia, in southern Buenos Aires province (central eastern Argentina) (Schiapelli and Gerschman 1975). The burrows of this

Figure 1. Female of *Calathotarsus simoni*, live habitus.

Argentinean species were succinctly described by Schiapelli and Gerschman (1975) but details of door thickness, hinge form, and holding pits were omitted. These authors stated that "spider burrows were found between rocks, in detritus, mosses, with horizontal or oblique position and between 6 and 10 cm deep". No other observations exist of burrows of this species in nature. The door construction from a specimen (from Sierra de la Ventana, Buenos Aires) kept in captivity was observed by Goloboff (1991), and the door was of the thick type, rounded, with a hinge similar to that of *Calathotarsus pihuychen* (Goloboff 1991). However, the author stated that the observation of this single door, constructed in a short period of time, is less reliable than observations in nature of several burrows, maintained over long periods by the spider. These two contributions are the only data known for this species, and no capture records have been reported since.

The Ventania system is a hilly environment located in southwestern Buenos Aires, Argentina. It includes a 180-km-long by 50-km-wide mountain belt running northwest to southeast, and is composed of basement and sedimentary cover. Deformational episodes occurred during the Upper Devonian and Permian (Sellés-Martínez 2001; Gregori et al. 2005). Although the specifics of the development of this mountain range remain controversial, the similarities between the surfaces and weathering products of the Buenos Aires ranges and the corresponding features of Cape Province in South Africa suggest a common Gondwanic origin for both landscapes (Keidel 1916; Du Toit 1927). The mountains that form the Ventania range culminate at varying altitudes and correspond to differentially uplifted blocks. Undulating between 800 and 900 m above sea level in midrange, it rises by 150 m in the southern part of the Sierra de la Ventana, where it is dominated by a few summits of up to 1240 m above sea level, and descends to approximately 700 m in the north (Demoulin et al. 2005). From an ecological point of view, this hilly system is one of the last relicts of more or less well-conserved areas in the Pampas ecoregion, where several endemic taxa and habitat types can be found (Zalba and Cozzani 2004). The Ventania system is at the limit of the two phytogeographic provinces of Pampa and Espinal, and is home to more than 400 native plant species (Kristensen and Frangi 1995), many of which are endemic and face extinction risks (i.e. *Polygala ventanensis* and *Senecio leucopeplus*) (Delucchi 2006).

Following the fortuitous discovery in the field of a trapdoor that belongs to a female *C. simoni* on a hillside in the Ventania system, subsequent surveys revealed a surprising abundance of this rare trapdoor spider on a slope, encouraging further study. This population presented a unique opportunity to examine, for the first time, spatial distribution patterns and burrow characteristics of *C. simoni* in nature, an endemic mygalomorph from the mountain ranges in central Argentina, Buenos Aires province. The purpose of our study was to measure the density of *C. simoni* in a hillside, characterize spatial patterns, and consider these patterns in the light of the spacing and size; to analyse burrow and door characteristics in nature; and to describe the micro-habitat and the spider diversity associated with their environment.

Material and methods

Study area

The study area is located in the Ventania system, in southwestern Buenos Aires, Argentina, at an elevation of 650 m above sea level. The hillside (38°4′20.40″ S, 62°3′

Figure 2. Steeply sloping hillside located in the Ventania system, in southwestern Buenos Aires, Argentina, at an elevation of 650 m above sea level.

8.12″ W) is located inside the "Funke" ranch (Figure 2). The topography ranges from steep slopes at high elevations of the mountain system to gentler slopes at lower levels (piedmont). The climate is humid and temperate, with an average annual rainfall of 850 mm that decreases from northeast to southwest during autumn and spring. Rainfall increases with altitude, from 745 mm at the lowest altitude to 828 mm at peaks (Pérez and Frangi 2000). The mean annual temperature is 14.5°C and similarly decreases from northeast to south. An altitudinal gradient of temperature is evident inside this hilly system, showing a decrease of 6.9°C per 1000 m (Kristensen and Frangi 1995).

Spider sampling

The research was conducted during March–November 2012 and April–June 2013 on a steeply sloping (60–80°) hillside and not a gently sloping or level ground. The plot on this hillside, in which we performed this study, measured 28 m high and 84 m in length, comprising c.2352 m^2. Within this initial plot, we made 14 subplots 6 m wide and 28 m high. We assigned a coordinate system to each subplot and began counting burrows starting at the southwest corner designated as (0 m, 0 m). On each subplot, four collectors walked up and down counting burrows within a 1.5 m-wide path per collector. We recorded the location of each burrow by measuring its distance along the south and west axes. We searched appropriate microhabitats for spider burrows, scraped away the surface layer of soil to locate the burrows of females and juveniles and extracted spiders from burrows using entrenching shovels and smaller specialized digging tools. At each subplot we meticulously inspected the ground for all trapdoor spider burrows, including those of the smallest juveniles. Measurements were taken using digital calipers accurate to 0.01 mm. All spiders were transported to the laboratory and are still alive to be included in future studies. Each burrow was categorized as being occupied by an adult versus a juvenile on the basis of entrance diameter. Burrows ≥ 8 mm were classified as adult. This measure was obtained from specimens captured and reared at the laboratory and according to presence or absence of spermathecae during examination of exuvia.

On this hillside we set two parallel lines of seven pitfall traps (14 in total) at 10 m each to capture mature walking males (March–November 2012 and from April to June 2013). Pitfall traps consisted of cylindrical plastic containers, 9 cm in diameter and 10 cm in height, buried and covered with a plastic roof supported by three metallic rods 15 cm above the soil. They were filled with 350 ml of ethylene glycol, which prevented evaporation and acted as a preservative. All traps were examined every 30 days and were refilled. Spiders were identified at family level.

Data analysis

We quantified spatial distribution of *C. simoni* burrows using the methods of Morisita (1959). For the initial plot, we reiterated the calculation of Morisita's Index (I_δ) for 9.18 m^2 (256 quadrats), 36.75 m^2 (64 quadrats), 147 m^2 (16 quadrats) and 588 m^2 (four quadrats), and observed for changes in the distribution pattern. Measuring spatial pattern at multiple scales is essential because aggregations are a function of the scale at which they are viewed. For each quadrat size, index values ≤ 1 occur when distribution is hyperdispersed and > 1 when it is underdispersed (Vandermeer 1990). An abrupt change in the index value between two quadrant sizes denotes the approximate area encompassed by the aggregations (Vandermeer 1990). All measurements of burrow morphology are given in millimetres. We used the Mann–Whitney *U*-test for differences between the number of holding holes between adult and juvenile doors and the Pearson correlation coefficient to explore the relationship among the size of the burrow and the number of pits. All statistical analyses were made using SPSS statistical package, version 14.0.

Results

Syntopic trapdoor mygalomorph spiders

We counted six burrows of adult females of an undetermined species of *Actinopus*. The entrances were covered with thick rounded trapdoors, slightly concave outer surface and a white (sometimes brownish), silk-covered inner surface bevelled around the edge to fit snuggly into the silk-reinforced rim of the burrow entrance. The burrows extended into the soil at angles of about 60° to the trapdoor, making the burrow run in a straight line from the top view. The mean door thickness of *Actinopus* sp. was 5.58 ± 2.69 SD and the mean door diameter was 19.06 ± 7.76 SD. The mean diameter of entrance rim of *Actinopus* sp. was 14.45 ± 6.32 SD.

Microhabitat, burrow characteristics and aggregation of C. simoni

The main plants identified on the hillside comprised the following shrubs and grasses: *Grindelia buphthalmoides* DC. (Asteraceae), *Eryngium* sp. L. (Apiaceae), *Zexmenia buphtalmiflora* (Lorentz) Ariza (Asteraceae), *Schizachyrium spicatum* (Spreng.) (Poaceae), *Baccharis* sp. L. (Asteraceae), *Paspalum quadrifarium* Lamb. (Poaceae), *Eupatorium tanacetifolium* Gillies ex. Hook and Arn. (Asteraceae), *Gomphrena* sp. L. (Amaranthaceae), *Achyrocline satureioides* Lamb. (DC) (Asteraceae), *Stipa* sp. L. (Poaceae), *Piptochaetium* sp. J. Presl. (Poaceae) and *Discaria americana* Gillies and Hook (Rhamnaceae).

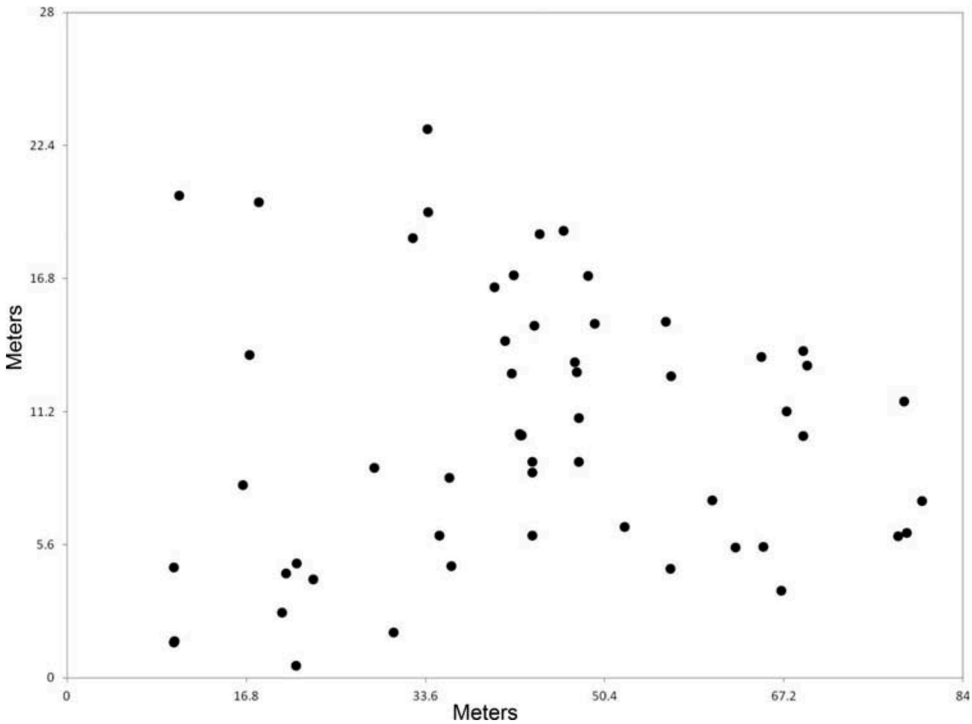

Figure 3. Spatial distribution of *Calathotarsus simoni* burrows (dots) plotted from the study colony.

A total of 57 burrows were counted in all subplots (Figure 3). Burrows occupied by adults comprised 52.63% of the sample (n = 30) versus juveniles (n = 27). The mean density of adults was 0.01/m^2 and mean density of juveniles was 0.009/m^2. Within the 588-m^2 quadrats, the I_δ was 0.62; in the 147-m^2 quadrats, the I_δ was 1.49; in the 36.75-m^2 quadrats, the I_δ was 1.66; and for 9.18-m^2 quadrats, the I_δ was 0.010.

The trapdoor is relatively thick and rigid with bevelled edges (Figures 4A,B). Characteristics of door and burrow dimensions are summarized in Table 1. The mean door thickness of burrows of adult spiders was 4.28 ± 1.49 SD and of juveniles was 2.09 ± 0.56 SD. The mean door diameter of the burrows of adult *C. simoni* was 11.95 ± 2.76 SD and for those of juveniles was 5.78 ± 1.08 SD. When this door is closed, the edges fit snugly into the tough entrance rim, which flares outward to form a complementary bevel (Figure 4B). The door is connected to the entrance rim by a narrow but firmly articulated hinge. The entrance rim is usually nearly flush with the surrounding soil but may extend as much as 2–5 mm above it. The mean diameter of the entrance rim of burrows of adult spiders was 10.22 ± 2.5 SD and for juveniles was 5.12 ± 1.39 SD. Its inner surface is covered with a thick, tough white layer of silk, and its outer surface, which is soil with abundant mosses and lichens, resembles the surrounding ground surface (Figures 4A, 5A). The mosses identified in all door surfaces corresponded to *Anacolia laevisphaera* (Taylor) Flow. and *Tortula atroviren* (Turner Ex SM.) Lindb. Figure 5B illustrates one of the excavated burrows. Most of the burrows extended roughly straight back into the soil accumulated between rocks of the hillside, approximately perpendicular to the surface. The burrow diameter was

Figure 4. Trapdoor of *Calathotarsus simoni* on a hillside from Ventania system. (A) Door closed marked by the arrow. Note the door covered with a lid that resembles the surrounding substrate; (B) door open with a stick, arrows mark the pits or holding marks.

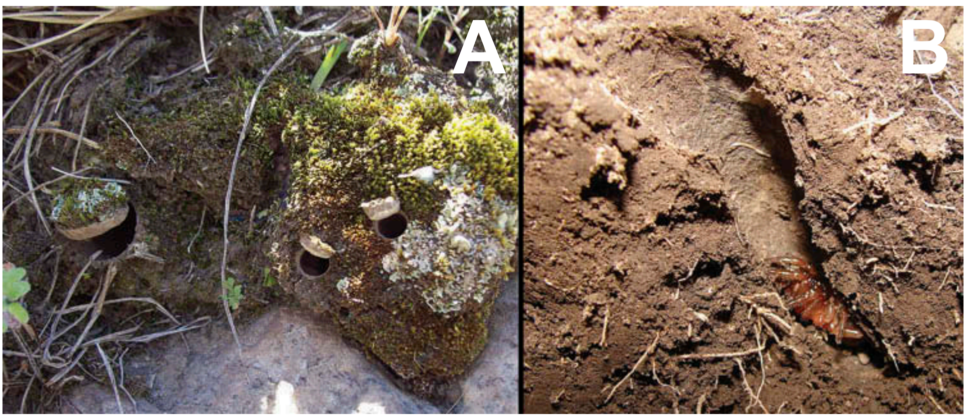

Figure 5. Burrows of *Calathotarsus simoni* on a hillside from the Ventania system. (A) Aggregation of trapdoor burrows (doors opened). Note the substrate with abundant mosses and lichens; (B) excavated burrow of female *C. simoni*.

greater near the entrance than elsewhere. The full length of each burrow was lined with a thin layer of silk (under closer examination, silk lines can be differentiated) fairly constant throughout each burrow's length. The mean length of adult burrows was 74.4 ± 15.3 SD and one juvenile burrow measured 38.1 in length.

All spiders transferred to the laboratory made their burrows with trapdoors. During daylight hours, attempts to open (with forceps or entomological needles) often caused the spiders to quickly pull the doors tightly closed. A great deal of force was required to open these secured trapdoors with a pair of forceps. Even when the door was forced open the spider continued to maintain its grip. With its venter facing the hinge, the spider held the inner surface of the door with its fangs and the claws of its palps and first and second legs. Claw and fang marks (pits or holding holes) were found on the under-surface submarginal of all doors (Figure 4B). Usually we found two larger

Table 1. Dimensions of *Calathotarsus simoni* trapdoors and burrows from adults and juveniles in the Ventania system.

Individual	Door diameter (mm)	Door thickness (mm)	Entrance diameter (mm)	Burrow length (mm)
Female 1	11	4.8	9.8	–
Female 2	12.3	4.4	9.3	–
Female 3	9.1	4.6	8.6	–
Female 4	18.8	5.7	14.8	90
Female 5	10.4	3.3	9.2	73.9
Female 6	8.1	3.2	7	–
Female 7	14.3	7.2	11.8	–
Female 8	9.6	3.6	7.5	–
Female 9	11	3.3	9.9	–
Female 10	12.7	3.4	10.8	–
Female 11	16.4	4.7	14.8	–
Female 12	9.9	3.4	9.1	–
Female 13	–	–	5.1	–
Female 14	12.3	4.1	12.2	–
Female 15	13.5	5.8	12.2	–
Female 16	9.2	2.6	7.8	–
Female 17	12.4	5.1	11.2	–
Female 18	16.2	9.1	12.1	–
Female 19	15.2	5	–	–
Female 20	–	–	–	–
Female 21	12.3	4.8	11.7	–
Female 22	13	3.9	12	–
Female 23	12.1	3.5	10.6	59.4
Female 24	14	4.8	14.6	–
Female 25	–	–	–	–
Female 26	8.5	3.1	8.4	–
Female 27	13.9	4.8	12.7	–
Female 28	8.6	2.3	8.4	–
Female 29	8.8	2.7	7.3	–
Female 30	9.1	2.6	7.1	–
Juvenile 1	4.8	1.9	4.9	–
Juvenile 2	–	–	–	–
Juvenile 3	3.9	1.6	–	–
Juvenile 4	6.9	2.2	–	–
Juvenile 5	–	–	–	–
Juvenile 6	–	–	–	–
Juvenile 7	–	–	–	–
Juvenile 8	–	–	–	–
Juvenile 9	6.5	2.2	7.8	38.1
Juvenile 10	5.8	1.6	3.1	–
Juvenile 11	7.3	2.6	6.3	–
Juvenile 12	6.5	2.1	6	–
Juvenile 13	7.6	3.9	7.5	–
Juvenile 14	4.5	1.6	3.8	–
Juvenile 15	–	–	–	–

(*Continued*)

Table 1. (Continued).

Juvenile 16	5.2	1.7	4.4	–
Juvenile 17	6.1	2.1	5.6	–
Juvenile 18	4.8	2.3	4	–
Juvenile 19	5.5	2.1	3.9	–
Juvenile 20	6	2.1	4.7	–
Juvenile 21	5.8	2.4	4.7	–
Juvenile 22	6.7	2.3	6.2	–
Juvenile 23	–	–	–	–
Juvenile 24	–	–	–	–
Juvenile 25	6.3	1.6	3.9	–
Juvenile 26	–	–	–	–
Juvenile 27	4	1.4	–	–

central pits (for hooked fangs) and a variable number of smaller pits surrounding them (for hooked palp and legs claws). The mean number of pits in adults' doors was 5.19 ± 0.93 SD and the mean number of pits in juveniles' doors was 3.75 ± 0.62 SD. We found significant differences between the number of holding holes between adult and juvenile doors ($U = 25$, $p < 0.001$), and a significant positive correlation between the size of the burrow and the number of pits ($r = 0.568$, $p < 0.01$).

Egg sacs and progeny

One female was captured on 28 November 2012 holding an egg sac (Figure 6). The female was transferred to the laboratory and the egg sac was removed. The sac, spherical, measured 9.4 in diameter and 5.9 wide, containing 23 eggs. From this egg sac, eight juveniles of about 3 mm successfully emerged on 9 December 2012. Another female from the laboratory was seen with an egg sac of a fixed hammock type attached to the burrow wall in the bottom part of the burrow on 23 November 2012 and 10 juveniles successfully emerged on 11 December 2012. These juveniles remained within the mother's burrow for at least 4 months. Then, some juveniles were seen on burrows constructed near the mother's burrow.

Spider diversity associated with the hillside

In total we collected 572 spiders, 388 adults and 184 juveniles, belonging to 23 families (Table 2). The most abundant families were the Linyphiidae (25.7% of the total), Nemesiidae with *Acanthogonatus centralis* Goloboff 1995 (13.8%), Gnaphosidae (10.5%), Salticidae (9.97%) and Corinnidae (7.87%). These families represented 67.84% of the total number of spiders collected. From the total of spiders collected, 50% corresponded to males, 17.83% were adult females and 32.17% corresponded to juveniles. One small juvenile of *C. simoni* was captured with pitfall traps during May.

Discussion

Specimens of the *C. simoni* (Migidae) population on the hillside were also competing for prey with *Actinopus* sp. (Actinopodidae) living in the same habitat. Although a

Figure 6. Female of *Calathotarsus simoni* from a hillside in the Ventania system holding an egg sac.

few specimens of *Actinopus* sp. were found inhabiting this hillside, the highest proportion of individuals found were *C. simoni*. This predominance of *C. simoni* over *Actinopus* sp. is not common. In other habitats in Argentina, a high abundance of *Actinopus* sp. individuals were reported over other trapdoor species such as *Idiops clarus* (Mello-Leitão, 1946) and *Neocteniza toba* Goloboff 1987 (Idiopidae) (Coyle et al. 1990). Moreover, Ferretti et al. (2012) did not find specimens of *C. simoni* in an ecological study of mygalomorph species from grassland slopes in Ventania; *Actinopus* sp. being the abundant species from the study area (of about 0.5 ha), which is located no more than 5 km from the population treated in this study. This feature highlights the rarity of this species in nature and the microclimatic conditions that this species may need to survive.

Burrows of *C. simoni* were found only on a steeply sloping hillside and no burrows were found during a careful search on hands and knees for entrances in the level immediately above this hillside where most burrows occurred. The apparent preference of these spiders for steep slopes, a preference not exhibited by the sympatric *Actinopus* sp. (which is typically found on level and gently sloping ground) may be twofold: (1) the result of the heavy rains experienced in this mountain system, mainly during summer, creating unstable conditions (Ferretti et al. 2012), selecting against any proclivity to construct burrows in flood-prone ground; moreover, most of the burrows were situated in stable soil partly covered with moss and sheltered from rain by rocks; and (ii) the microclimatic environment where burrows were found, due to the high steep slope that exhibits this hillside, most are shaded areas and moisture

Table 2. List of spider families and some genera or species identified that were captured with pitfall traps on the hillside from the Ventania system, Buenos Aires, Argentina.

Family	Females	Males	Juveniles	Total	%
Linyphiidae	35	90	22	147	25.70
Nemesiidae	11	56	12	79	13.81
Acanthogonatus centralis					
Gnaphosidae	15	24	21	60	10.49
Apopyllus silvestrii					
Camillina chilensis					
Echemoides argentinus					
Salticidae	10	34	13	57	9.97
Corinnidae	16	13	16	45	7.87
Castianeira sp.					
Meriola sp.					
Trachelopachys sp.					
Theridiidae	4	30	5	39	6.82
Guaraniella sp.					
Lycosidae	2	1	27	30	5.24
Zoridae	1	9	14	24	4.20
Odo bruchi					
Anyphaenidae	1	8	10	19	3.32
Monapia sp.					
Philodromidae	0	1	17	18	3.15
Thomisidae	1	4	8	13	2.27
Zodariidae	1	5	4	10	1.75
Cybaeodamus ornatus					
Araneidae	0	0	9	9	1.57
Hahniidae	2	3	0	5	0.87
Orsolobidae	1	2	1	4	0.70
Losdolobus sp.					
Titanoecidae	0	1	3	4	0.70
Goeldia sp.					
Oonopidae	1	2	0	3	0.52
Puan chechehet					
Puan nair					
Amaurobiidae	0	0	1	1	0.17
Amphinectidae	0	1	0	1	0.17
Metaltella simoni					
Caponiidae	1	0	0	1	0.17
Caponina notabilis					
Ctenidae	0	1	0	1	0.17
Parabatinga brevipes					
Dictynidae	0	1	0	1	0.17
Migidae	0	0	1	1	0.17
Calathotarsus simoni					
Total	102	286	184	572	100.00

is retained encouraging the development of mosses. Although, we cannot be sure (due to lack of quantitative data) that these trapdoor spiders only make their burrows where these mosses are present, all burrows were found with trapdoors covered by them. The dominant soil of the steeply sloping hillside where burrows were found corresponds to an association of rock and lithic Hapludol at high altitudes and Hapludol and Argiudol at lower altitudes (SAGPyA-INTA 1989; Lizzi et al. 2007).

Our results suggest that the *C. simoni* population in this hillside from the Ventania system is not so large. To our knowledge, the Ventania population occurs in colonies that are less dense than other reported populations. For comparison, Coyle et al. (1990) studied an *Actinopus* sp. population in northern Argentina that contained 5.55 burrows/m^2; Coyle and Icenogle (1994) reported an aggregation of 15 burrows in an area of 0.1 m^2 in *Aliatypus californicus* (Banks 1896); Bond and Coyle (1995) reported one from *Ummidia* sp. in Costa Rica of about 2–4 burrows/m^2; Poteat (1889) studied a population of *Sphodros rufipes* that contained 0.04 webs/m^2 in North Carolina (USA); Mckenna-Foster et al. (2011) reported a population of *S. rufipes* in Massachusetts (USA) of about 0.058–0.28 webs/m^2; Reichling et al. (2011) studied a population of *S. rufipes* in an urban forest that contained 0.08 webs/m^2 for adults and 1.9 webs/m^2 for subadults.

Spatial arrangement of *C. simoni* in the 588 and 9.18-m^2 quadrats indicated a random distribution, while in the 147 and 36.75-m^2 quadrats the spatial arrangement clearly indicated aggregation. Mckenna-Foster et al. (2011) and Reichling et al. (2011) also found aggregation in populations of *S. rufipes* in the 1 and 12-m^2 quadrats respectively. Although, we did not estimate the availability, abundance and spatial arrangement of the suitable sites for burrowing construction, a possible explanation of the aggregation could be that the poor dispersal capabilities of the spiderlings restrict them to settling in high-density groups, composed primarily of siblings (Reichling et al. 2011). Moreover, the presence of young burrows observed in this study in locations where adults are common provides additional support for this hypothesis (Coyle 1971; Coyle and Icenogle 1994; Bond and Coyle 1995), suggesting that the primary dispersal mode of this species is non-ballooning, contrarily to that found in spiderlings of *Actinopus* sp. inhabiting this area, which are known to balloon (Ferretti et al. 2013). However, some populations of *Actinopus* sp. have young burrows of juveniles mixed where adults are common (Goloboff pers. comm.). Also, the similar proportion between adult burrows and juveniles observed in this study is not common in the spatial arrangement of trapdoor spiders in the field; for example, Reichling et al. (2011) reported that only 4% of the burrows corresponded to adult specimens.

The door constructed by *C. simoni* resembles to that of *C. pihuychen* Goloboff (1991) from Chile, with rounded doors and bevelled edges that fits snuggly into the burrow mouth; although the hinge of a *C. simoni* burrow seems to be narrower than that for *C. pihuychen* but firmly articulated and the inner surface of the door with one series of submarginal small pits is different from the two series observed in *C. pihuychen* (Goloboff 1991). Goloboff (1991) stated that the small pits on the door of *C. pihuychen* presumably mark where the spider inserts its fangs or claws to hold the door shut, but no data about pits on the doors of *C. simoni* was provided. Here, we confirmed that *C. simoni* holds the inner surface of the door with its fangs and the claws of its palps and forelegs and the marks or pits are found on the under-surface of all doors. The significant differences and the correlation found between the number of pits and the burrow size could be due to the maintenance of the door over long periods of time by the spider, so generating new and more noticeable marks when holding doors closed. Other genera of strict trapdoor spiders that occur in Argentina are *Actinopus* Perty 1833, *Idiops* Perty 1833 and *Neocteniza* Pocock 1895. The doors of *Actinopus* are also thick and rigid, and have bevelled edges and a narrow hinge, but in relation to *C. simoni*, door thickness is far less if we compare specimens of similar sizes and usually the silk that covers the inner surface is brownish in colour. Moreover, all door surfaces of *C. simoni* were covered with mosses. The burrows of *Idiops* and *Neocteniza* are shorter with an enlarged chamber, and thinner doors (Goloboff 1987; Coyle et al. 1990).

The data about progeny presented in this paper comprise the first known for the Migidae. The deep placement of the egg sac (presumably in the coolest and most humid part of the burrow) may be an adaptation to prevent desiccation and overheating of the eggs and spiderlings (Coyle and Icenogle 1994). The number of eggs observed is lower than for the other trapdoor spider from Argentina, *Actinopus* cf. *insignis* (Holmberg 1881), with approximately 135 eggs per sac (Galiano and Goloboff 1996). Our observations indicate that *C. simoni* spiderlings perhaps do not need assistance from the mother to escape from the egg sac; in the case of the egg sac reared in captivity in isolation from its mother, spiderlings emerged successfully. Spiderlings remain for at least 4 months inside the mother's burrow before dispersing. This could be corroborated with the only small juvenile captured on pitfall trap in the study area, in May, presumably at dispersal stage. Ferretti et al. (2012) stated that juveniles of *Actinopus* sp. from Ventania probably disperse during autumn (March–April), so strong interspecific competition for resources such as burrows and prey, is expected between juveniles of these sympatric trapdoor species. Unfortunately, we did not register walking males with pitfall traps even though we made the field samplings according presumably to the presence of adult males in the study area (April) (Schiapelli and Gerschman 1975). Maybe the small size of the pitfall traps might have influenced the capture efficiency of the adult males of this species.

The spider diversity associated with the hillside where the *C. simoni* population was found was underestimated because of the pitfall trapping only during the autumn–winter (a period when *C. simoni* is active in the field) in the study area. This is reflected in the absence or low abundances of some characteristic aestival spider families, such as Lycosidae and Araneidae. Otherwise, it is remarkable that the second most abundant family was Nemesiidae with *Acanthogonatus centralis*, corroborating the high abundances and motility of this species in the Ventania system, as proposed by Ferretti et al. (2012). Also, although *Acanthogonatus centralis* is a tunnel-web mygalomorph species, it could be recognizable as a potential competitor for these trapdoor spiders in their habitat.

The present study is only a beginning of what needs to be known; many of the morphological, physiological and behavioural traits that explain the fitness advantages of this rare species in this particular habitat will not be apparent without further study. We will develop future studies that cover some key aspects of the biology of *C. simoni* that are particularly worthy of immediate study and could enhance the relevance of this rare species from a future conservation view: (1) geographic and habitat distribution, (2) courtship and mating behaviour, and (3) life cycle.

Acknowledgements

Special thanks are due to Pablo Goloboff for his critical reading, comments and suggestions on the manuscript. We would like to thank Mara Maldonado and the family of the "Funke" ranch for their continued hospitality and for allowing us to conduct this study. Thanks to Jorge Barneche for his invaluable help in discovering the first specimens of *C. simoni*. Thanks also are due to Virginia Bianchinotti (Universidad Nacional del Sur, Buenos Aires) and María Schiavone (Facultad de Ciencias Naturales e Instituto Miguel Lillo, Tucumán) for the identification of the mosses and to Georgina Zapperi for the identification of plant species. Nelson Ferretti, Sofía Copperi and Gabriel Pompozzi are supported by postdoctoral and doctoral CONICET fellowships.

References

Banks N. 1896. New Californian spiders. J New York Ent Soc. 4:88–91.

Bond JE, Beamer DA, Lamb T, Hedin M. 2006. Combining genetic and geospatial analysis to infer population extinction in mygalomorph spiders endemic to the Los Angeles region. Anim Conserv. 9:145–157.

Bond JE, Coyle FA. 1995. Observations on the natural history of an *Ummidia* trapdoor spider from Costa Rica (Araneae, Ctenizidae). J Arachnol. 23:157–164.

Clarke GM, Spier-Ashcroft F. 2003. A review of the conservation status of selected Australian non-marine invertebrates. Canberra, Australia: Environment Australia, National Heritage Trust.

Cooper SJB, Harvey MS, Saint KM, Main BY. 2011. Deep phylogenetic structuring of populations of the trapdoor spider *Moggridgea tingle* (Migidae) from southwestern Australia: evidence for long-term refugia within refugia. Mol Ecol. 20:3219–3236.

Coyle FA. 1971. Systematics and natural history of the mygalomorph spider genus *Antrodiaetus* and related genera (Araneae: Antrodiaetidae). Bull Mus Comp Zool. 141:29–402.

Coyle FA, Goloboff PA, Samson RA. 1990. *Actinopus* trapdoor spiders (Araneae, Actinopodidae) killed by the fungus, *Nomuraea atypicola* (Deuteromycotina). Acta Zool Fennica. 190:89–93.

Coyle FA, Icenogle WR. 1994. Natural history of the California trapdoor spider genus *Aliatypus* (Araneae, Antrodiaetidae). J Arachnol. 22:225–255.

Delucchi G. 2006. Las especies vegetales amenazadas de la provincia de Buenos Aires: Una actualización. APRONA. 39:19–31.

Demoulin A, Zarate M, Rabassa J. 2005. Long–term landscape development: a perspective from the southern Buenos Aires ranges of east central Argentina. J S Am Earth Sci. 19:193–204.

Du Toit AL. 1927. A geological comparison of South America with South Africa. Washington: Carnegie Institution Publisher.

Engelbrecht I. 2013. Pitfall trapping for surveying trapdoor spiders: the importance of timing, conditions and effort. J Arachnol. 41:133–142.

Engelbrecht I, Prendini L. 2012. Cryptic diversity in South African trapdoor spiders: three new species of *Stasimopus* Simon, 1892 (Mygalomorphae, Ctenizidae), and redescription of *Stasimopus robertsi* Hewitt, 1910. Am Mus Novit. 3732:1–42.

Ferretti N, Pompozzi G, Copperi S, Pérez-Miles F, González A. 2012. Mygalomorph spider community of a natural reserve in a hilly system in central Argentina. J Insect Sci. 12:1–16.

Ferretti N, Pompozzi G, Copperi S, Schwerdt L. 2013. Aerial dispersal by Actinopus spiderlings (Araneae: Actinopodidae). J Arachnol. 41:407–408.

Galiano ME, Goloboff PA. 1996. Postembryonic development of *Actinopus* cf. *insignis* and *Diplura paraguayensis* (Araneae, Mygalomorphae). Bull Br Arachnol Soc. 10:121–126.

Goloboff P. 1987. El género *Neocteniza* Pocock, 1895 (Araneae, Mygalomorphae, Idiopidae) en la Argentina y Paraguay. J Arachnol. 15:29–50.

Goloboff PA. 1991. On a new species of *Calathotarsus* (Araneae: Migidae) from Chile. J N Y Entomol Soc. 99:267–273.

Goloboff PA. 1994. Migoides de Chile, nuevas o poco conocidas (Araneae, Mygalomorphae). Rev Soc Entomol Argent. 53:65–74.

Goloboff PA. 1995. A revision of the South American spiders of the family Nemesiidae (Araneae, Mygalomorphae). Part I: species from Peru, Chile, Argentina, and Uruguay. B Am Mus Nat. 224:1–189.

Goloboff P, Platnick N. 1987. A review of the Chilean spiders of the superfamily Migoidea (Araneae, Mygalomorphae). Am Mus Novit. 2888:1–15.

Gregori DA, López VL, Grecco LE. 2005. A late proterozoic–early paleozoic magmatic cycle in Sierra de la Ventana, Argentina. J S Am Earth Sci. 19:155–171.

Griswold CE, Ledford J. 2001. A monograph of the migid trap door spiders of Madagascar and review of the world genera (Araneae, Myfalomorphae, Migidae). Occas pap Calif Acad Sci. 151:1–120.

Haupt J. 1995. Twig-lining in a trapdoor spider *Lautochia swinhoei* (Araneae: Ctenizidae) from Okinawa. Eur J Entomol. 92:605–608.

Holmberg EL. 1881. Géneros y especies de arácnidos argentinos nuevos ó poco conocidos. An Soc Cien Arg. 11:125–133.

Keidel J. 1916. La geología de las sierras de la Provincia de Buenos Aires y sus relaciones con las montañas de Sud-África y los Andes. Anales del Ministerio de Agricultura de la Nación. Geología, Mineralogía y Minería. 9:1–78.

Kristensen MJ, Frangi JL. 1995. Mesoclimas de pastizales de la Sierra de la Ventana. Ecol Aust. 5:55–64.

Legendre R, Calderón R. 1984. Liste systematique des araignees mygalomorphes du Chili. Bull Mus Natl Hist Nat. 4:1021–1065.

Lizzi JM, Garbulsky MF, Golluscio RA, Deregibus AV. 2007. Mapeo indirecto de la vegetación de Sierra de la Ventana, provincia de Buenos Aires. Ecol Aust. 17:217–230.

Mckenna-Foster A, Draney ML, Beaton C. 2011. An unusually dense population of *Sphodros rufipes* (Mygalomorphae: Atypidae) at the edge of its range on Tuckernuck island, Massachusetts. J Arachnol. 39:171–173.

Mello-Leitão CFde. 1946. Nuevos aracnidos sudamericanos de las colecciones del Museo de Historia Natural de Montevideo. Comun Zool Mus Hist Nat Montev. 2(35): 1–10.

Morisita M. 1959. Measuring the dispersion of individuals and analysis of the distributional patterns. Mem Fac Sci, Kyushu Univ Ser Biol. 2:215–235.

Platnick NI. 2013. The world spider catalog, version 14.0. American Museum of Natural History. Online at http://research.amnh.org/entomology/spiders/catalog/index.html, DOI: 10.5531/db.iz.0001.

Poteat WL. 1889. A tube-building spider. J Elisha Mitchell Sci Soc. 6:134–147.

Pérez CA, Frangi JL. 2000. Grassland biomass dynamics an altitudinal gradient in the Pampa. J Range Manage. 53:518–528.

Reichling SB, Baker C, Swatzell C. 2011. Aggregations of *Sphodros rufipes* (Araneae: Atypidae) in an urban forest. J Arachnol. 39:503–505.

SAGPyA–INTA. 1989. Mapa de suelos de la provincia de Buenos Aires a escala 1:500000. Centro de Investigaciones de Recursos Naturales. Proyecto PNUD/ARG/85/019.

Schiapelli RD, Gerschman BS. 1973. La familia Migidae en Argentina (Simon 1892) en la Argentina (Araneae, Theraphosomorpha). Physis (Buenos Aires). Sec. C. 32:289–294.

Schiapelli RD, Gerschman BS. 1975. *Calathotarsus simoni* sp. nov. (Araneae, Migidae). Physis (Buenos Aires). Sec. C. 34:17–21.

Sellés–Martínez J. 2001. The geology of Ventania (Buenos Aires province, Argentina). J Iber Geol. 27:43–69.

Simon E. 1903. Descriptions d´arachnides nouveaux. Ann Soc Ent Belgique. 47:21–39.

Vandermeer J. 1990. Elementary mathematical ecology. Malabar (FL): Krieger Publishing Co.

Zalba SM, Cozzani NC. 2004. The impact of feral horses on grassland bird communities in Argentina. Anim Conserv. 7:35–44.