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Nesting ecology of *Megachile (Chrysosarus) catamarcensis* Schrottky (Hymenoptera: Megachilidae), a *Prosopis*-specialist bee

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Summary

Nests of the leafcutting bee *Megachile (Chrysosarus) catamarcensis* Schrottky (Hymenoptera: Megachilidae) were obtained during a 24 month trap-nesting programme in a xeric forest in the Province of La Pampa, Argentina. Nests were constructed in December and January; females made an average of 4.0 ± 2.2 cells, and used mud with flower petals and/or leaf pieces to build their nests. Provisions of cells were practically pure pollen mass of *Prosopis caldenia*. Adult emergence showed a unimodal pattern, suggesting a univoltine life cycle. However, two individuals that emerged a month after the traps were collected indicate the existence of a small early-summer generation. This could indicate that *M. catamarcensis*, in some years (warmer) or in some populations (at lower latitudes), could exhibit a bivoltine life cycle. Approximately 15.3 % of all offspring failed to complete development to the adult stage, and an additional 13.9 % were killed by natural enemies. These included diverse parasitic wasps (Chrysididae, Sapygidae, and Leucospidae), a cleptoparasite bee (Megachilidae: *Coelioxys*), and a bee fly (Bombyliidae: *Anthrax*).

Ecología de nidificación de *Megachile (Chrysosarus) catamarcensis* Schrottky (Hymenoptera: Megachilidae), una abeja especialista de *Prosopis*

Resumen

Nidos de la abeja cortadora de hojas *Megachile (Chrysosarus) catamarcensis* Schrottky (Hymenoptera: Megachilidae) fueron obtenidos durante 24 meses en un estudio de trampas-nidos en un bosque xérico en la Provincia de La Pampa, Argentina. Los nidos fueron construidos durante diciembre y enero; las hembras hicieron un promedio de 4.0 ± 2.2 celdillas, y utilizaron barro con pétalos y/o piezas de hojas para construir sus nidos. Las provisiones de las celdillas fueron masas de polen prácticamente puras de *Prosopis caldenia*. La emergencia de los adultos exhibió un patrón unimodal sugiriendo un ciclo de vida univoltino. Sin embargo, dos individuos nacieron un mes después de que las trampas fueron colectadas indicando la presencia de una pequeña generación de principios de verano. Este hecho podría estar indicando que *M. catamarcensis* en algunos años (más calurosos) o en algunas poblaciones (a menores latitudes) podría exhibir un ciclo de vida bivoltino. Aproximadamente, el 15.3 % de toda la descendencia no logró completar el desarrollo hasta el estadio de adulto y un 13.9 % adicional fue asesinado por enemigos naturales. Estos incluyeron diversas avispa parásitas (Chrysididae, Sapygidae, y Leucospidae), una abejas cleptoparásita (Megachilidae: *Coelioxys*), y una mosca abeja (Bombyliidae: *Anthrax*).

Keywords: solitary bees, trap-nest, pollination, Argentina

Introduction

Solitary bees are important pollinators of crops and wild plants (Michener, 2007; Roig Alsina, 2008). Most solitary bees, excluding those that are cleptoparasitic species, provide pollen mixed with nectar and/or oil as food for their developing larvae, and line the nest with a hydrophobic lining secreted by the Dufour's gland to protect these provisions from microbial and fungal attack, and from inundation or desiccation (Hefetz, 1987). Bees of the genus *Megachile*, however, use diverse building materials such as leaves, petals, plant resins, plant fibres, mud and sand, among others (Krombein, 1967; Litman *et al.*, 2011), which lack a hydrophobic lining on the inner surface of the cell wall.

The genus *Megachile* is widely distributed in temperate and tropical areas of the world, though their greatest diversity lies in the Neotropical region, where many subgenera are represented. In the New World, the taxonomical history of this genus has undergone numerous changes. Mitchell (1943) proposed *Chrysosarus* as one subgenus of *Megachile* restricted to the Neotropical Region. Michener (2000) proposed a different arrangement for the genus, and arranged the subgenera into three informal groups (1-3); *Chrysosarus* was assigned to "group 1" though Michener indicated that brood cells of this subgenus differ from those of most "group 1" *Megachile* in having a mud layer between the two layers of petals or leaves. *Chrysosarus* is almost entirely restricted to South America and accounts for between 55-60 species (Moure *et al.*, 2007; Raw, 2007; Ascher and

Pickering, 2012), which represents approximately 20 % of all species of *Megachile* of South America. However, Michener (2000, 2007) suspected that there could be at least 25 species. This large difference clearly expresses the urgent need to study the taxonomic affinities of this subgenus. This state in the taxonomy of this group is also reflected in the scarce knowledge of their species life cycle. Very little is known about the biology of *Chrysosarus*, including nesting ecology. To date, studies on the nesting ecology have been reported for only a few species of *Chrysosarus* (Table 1), but with the exception of Zillikens and Steiner (2004), most of these studies described only a single or few nests.

A century ago, Jörgensen (1912) briefly reported on the biology of our focal leafcutting species, *Megachile (Chrysosarus) catamarcensis* Schrottky in Mendoza Province, Argentina. This author observed nests of this species in bamboo canes on roofs of precarious houses and in old abandoned nests of *Centris* (Apidae) located in their adobe walls. Moreover, the author also reported on floral hosts which included several species of Fabaceae and Asteraceae, and describes the brood cells. Here, we provide additional knowledge on the nesting biology of *M. catamarcensis*, including details of cell provisions, life cycle, number of cells per nest, mortality factors (parasites and cleptoparasites), and other associated organisms. Additionally, we report a new geographic record for the species.

Material and methods

Study area

The study was conducted in a xeric forest ("Caldenal") in Estancia Anquilóo (S 36° 25', W 64° 48'), Toay, La Pampa Province, Argentina (Fig. 1). The Caldenal is an ecosystem located in central Argentina (Biogeographic province of Espinal, Caldenal district), primarily in La Pampa Province (Cabrera, 1976). This xerophytic open forest system is a transitional ecosystem between the Pampas grasslands to the east, and the dry Monte shrublands to the west. It is dominated by the caldén tree (*Prosopis caldenia* Burkart, Fabaceae: Mimosoideae) with an understory of predominately perennial grasses (Fig. 2) frequently interrupted by dunes, wetlands and lagoons (Cabrera, 1976). The caldén is a thorny tree with deciduous foliage, medium-sized, round topped, 4-12 m high, with numerous florets greenish-white to yellowish, arranged in spike like racemes (Burkart, 1976). Flowers of *Prosopis* spp. offer both pollen and nectar as resources, and several bee groups are highly attracted by them (Vossler 2013, and citations therein). The caldén occurs forming open uni-specific, semixerophytic woods in the plains of western Pampas region (Burkart, 1976). Livestock is the main economic activity in the region, contributing to a pattern of cattle relocation from the forest in spring and summer (to grass understory recover biomass), with re-introduction to the woodlands the following autumn-winter.

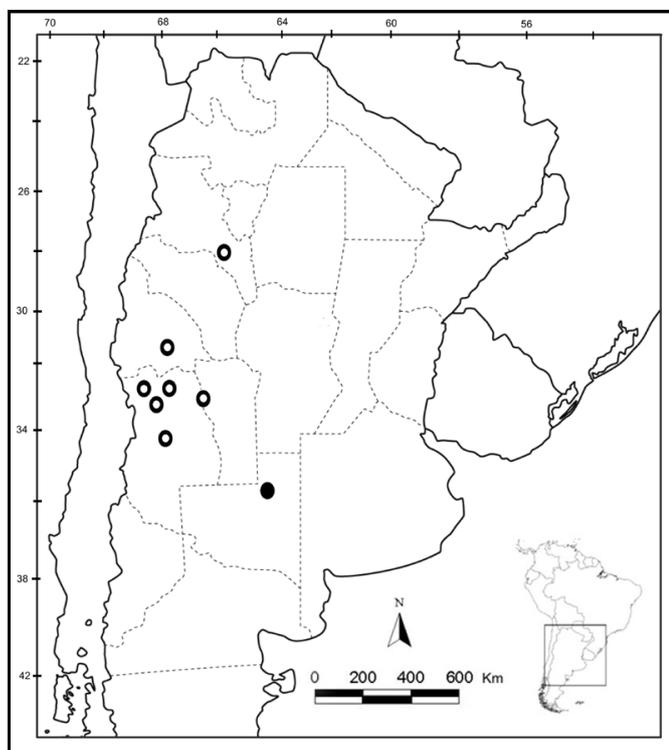


Fig. 1. Study site (black circle) and geographic distribution of *Megachile (Chrysosarus) catamarcensis*: previous records (white circles); new record (black circle).

Nest collection

Trap-nests were placed in the field during the two activity periods of leaf-cutting bees (November 2009 to March 2010 and November 2010 to March 2011) and inspected monthly. Each trap-nest used consisted of one hollow bamboo cane, which was cut so that a nodal septum closed one end of the cane (Aguiar and Garófalo, 2004). Previously, each cane was cut longitudinally and tape closed, and measurements were taken on both its total length (from the entry to the node) and the inner diameter in the entry. In total, 140 and 280 trap-nests were placed in November 2009 and November 2010, respectively, arranged in 10 and 20 blocks of 14 canes.

The trap-nests were located in two sites of forest along 2 and 4 transects in 2009-2010 and 2010-2011, respectively, and were placed at intervals of 50-100 m and from 1-2 m off the ground in trees (Fig. 3). During each visit, the canes containing nests were removed and taken to the laboratory. The brood cells were placed separately into plastic vials, sealed with cotton plugs and numbered from 1 to n



Fig. 2 (top). Aspect of Caldénal, with caldén trees and an understory of perennial grasses. **Fig. 3 (bottom).** Block of trap-nests arranged in a tree.

Table 1. Species of *Megachile* (*Chrysosarus*) with published reports of nesting ecology.

Species	Reference
<i>M. affabilis</i> Mitchell	Laroca <i>et al.</i> , 1992
<i>M. catamarcensis</i> Schrottky	Joërgenesen, 1912
<i>M. collaris</i> (Friese)	Joërgenesen, 1909
<i>M. inquirenda</i> Schrottky	Lüderwaldt, 1910
<i>M. pseudanthidioides</i> Moure	Zillikens and Steiner, 2004
<i>M. rancaguensis</i> Friese	Claude-Joseph, 1926
<i>M. tapytensis</i> Mitchell	Laroca, 1971

(starting with the innermost cell). Vials were kept at room conditions (*ca.* 15°-25° C) until adult eclosion. Upon emergence, adult bees were sexed, and the emergence date recorded. Cells that remained closed were opened to determine if the immature bees (e.g., egg or pre- or post-defecating larvae) had died or were diapausing. The number and identity of parasites and/or cleptoparasites was also recorded. The voucher materials from this study are placed at the Entomological Collection of Cátedra de Botánica General of Facultad de Agronomía (FAUBA), Universidad de Buenos Aires, Argentina, and at the Museo de La Plata (MLP), Argentina.

Nest and cell structure

For each nest we recorded the number of cells formed. Additionally, internal measurements of randomly chosen cells were made on a sample of nests (*n* = 12). We then analysed the plant material used for nest construction by females of *M. catamarcensis*.

Pollen analysis

To explore the taxonomic identity of pollen consumed by larvae during development, we studied the pollen in the faecal pellets attached to the cocoon after adults had eclosed. Faeces pellets were individually placed in a centrifuge microtube and disaggregated according to conventional techniques (Rust *et al.*, 2004), but without acetolization. In cells in which no adults hatched, we analysed the pollen mass not consumed by the larvae. The faeces pellets/masses pollen were treated with a 10 % potassium hydroxide (KOH) solution in a double boiler (water bath) for 10 minutes and were then mounted in glycerine jelly on a slide and stained with safranin. Slides were examined at 500X magnification using a light microscope. For each pollen sample, at least 500 grains were counted, and the proportion of pollen types, determined as a percentage frequency, was analysed following Villanueva-Gutiérrez and Roubik (2004). The identity of the pollen grains was then determined to the lowest taxonomic level possible (i.e. species, genera, or family), examining 33 cells from 19

Table 2. Nesting of *Megachile (Chrysosarus) catamarcensis* in trap-nests in a xeric forest, during 2 years of study. Number of trap-nest occupied by females, number of cells for nest, number of emerged adults, sex ratio, and nesting period. The nesting period is given as the time between the day on which the nests were collected and day of adult emergence. Other bees and wasps associate that nesting in same block.

* Nests shared with *Monobia cingulata*, ** nest shared with *Anthidium vigintipunctatum*.

Block	Nest	Cells	Adults	Sex ratio		Nesting period		Dead offspring		Bees and wasps associated in block of bamboo canes
				f	m			larvae/pupae death	predators	
2009-2010										
1	1	3	1	1	0	16 XII 09	15 I 10	1	<i>Anthrax oedipus</i>	<i>Anthidium vigintipunctatum</i> <i>Hypodynerus</i> sp.
	2	6	5	3	2	16 XII 09	15 I 10	1		
	4	12	12	2	10	16 XII 09	15 I 10			
	5	5	3	3	0	16 XII 09	15 I 10	2		
total 09/10	4	26	21	9	12			4	1	
2010-2011										
31	438	1	0	0	0	10 XI 10	10 XII 10	1		<i>Anthidium vigintipunctatum</i>
	446	2	1	0	1	11 XII 10	22 I 11	1		<i>Solierella</i> sp. <i>Trypoxylon</i> spp.
35	493	2	2	0	2	10 XI 10	10 XII 10			<i>Monobia cingulata</i> ,
	495	6	5	3	2	10 XI 10	10 XII 10	1		
	498	5	3	3	0	10 XI 10	10 XII 10		<i>Huarpea fallax</i> <i>Leucospis pulchriceps</i>	<i>Solierella</i> sp.
	502	3	2	0	2	10 XI 10	10 XII 10		<i>Huarpea fallax</i>	
	504 *	3	2	2	0	10 XI 10	10 XII 10	1		
36	506	2	1	0	1	10 XI 10	10 XII 10		<i>Coelioxys</i> sp.	<i>Anthidium vigintipunctatum</i>
	511	4	2	0	2	10 XI 10	10 XII 10	1	<i>Coelioxys</i> sp.	
	513	4	2	2	0	10 XI 10	10 XII 10	2		<i>Hypodynerus</i> sp.
	518 **	1	1	1	0	10 XI 10	10 XII 10			<i>Solierella</i> sp.
38	539	4	3	2	1	10 XI 10	10 XII 10			<i>Hypodynerus</i> sp.
										<i>Trypoxylon</i> sp.
39	550	5	5	4	1	10 XI 10	10 XII 10			
	554	5	3	3	0	10 XI 10	10 XII 10		<i>Chrysis bouthery</i> <i>Huarpea fallax</i>	<i>Anthidium vigintipunctatum</i> <i>Monobia cingulata</i>
	555 a	4	2	2	0	10 XI 10	10 XII 10		<i>Anthrax oedipus</i> <i>Huarpea fallax</i>	Pompilidae sp. <i>Solierella</i> sp.
	555 b	2	1	1	0	10 XI 10	10 XII 10		<i>Huarpea fallax</i>	
	557	1	1	1	0	10 XI 10	10 XII 10			
41	575	4	4	1	3	10 XI 10	10 XII 10			<i>Hypodynerus</i> sp.
	581	3	0	0	0	10 XI 10	10 XII 10		2 <i>Anthrax oedipus</i> <i>Leucospis pulchriceps</i>	
	582	6	5	4	1	10 XI 10	10 XII 10	1		
	584	7	4	2	2	10 XI 10	10 XII 10	3		
50	702	5	4	1	3			1		<i>Anthidium vigintipunctatum</i>
52	740	2	1	0	1	11 XII 10	22 I 11		<i>Huarpea fallax</i> <i>Perilampus</i> sp.	
76	T1	4	4	1	3	10 XI 10	10 XII 10			
	T2	4	2	1	1	10 XI 10	10 XII 10	2		
total 10/11	25	89	60	34	26			14	15	
Total	29	115	81	43	38			18	16	

different nests. Pollen samples from nests were compared to a pollen reference collection made from entomophilous plants growing in the study area. Plant specimens were collected at the site to prepare reference pollen slides. In the laboratory, for each plant species and under a optical light microscope (magnification 20X), pollen samples were obtained from closed anthers and mounted in a slide in glycerine jelly with safranine.

Results

Nest collection

During two years of observation, twenty-nine nests of *M. catamarcensis* (n = 4 in 2009-2010 and n = 25 in 2010-2011) were obtained from the trap-nests placed in the Caldénal (Table 2). Each nest contained 4.0 ± 2.2 cells (range: 1 - 12, n = 29). The mean

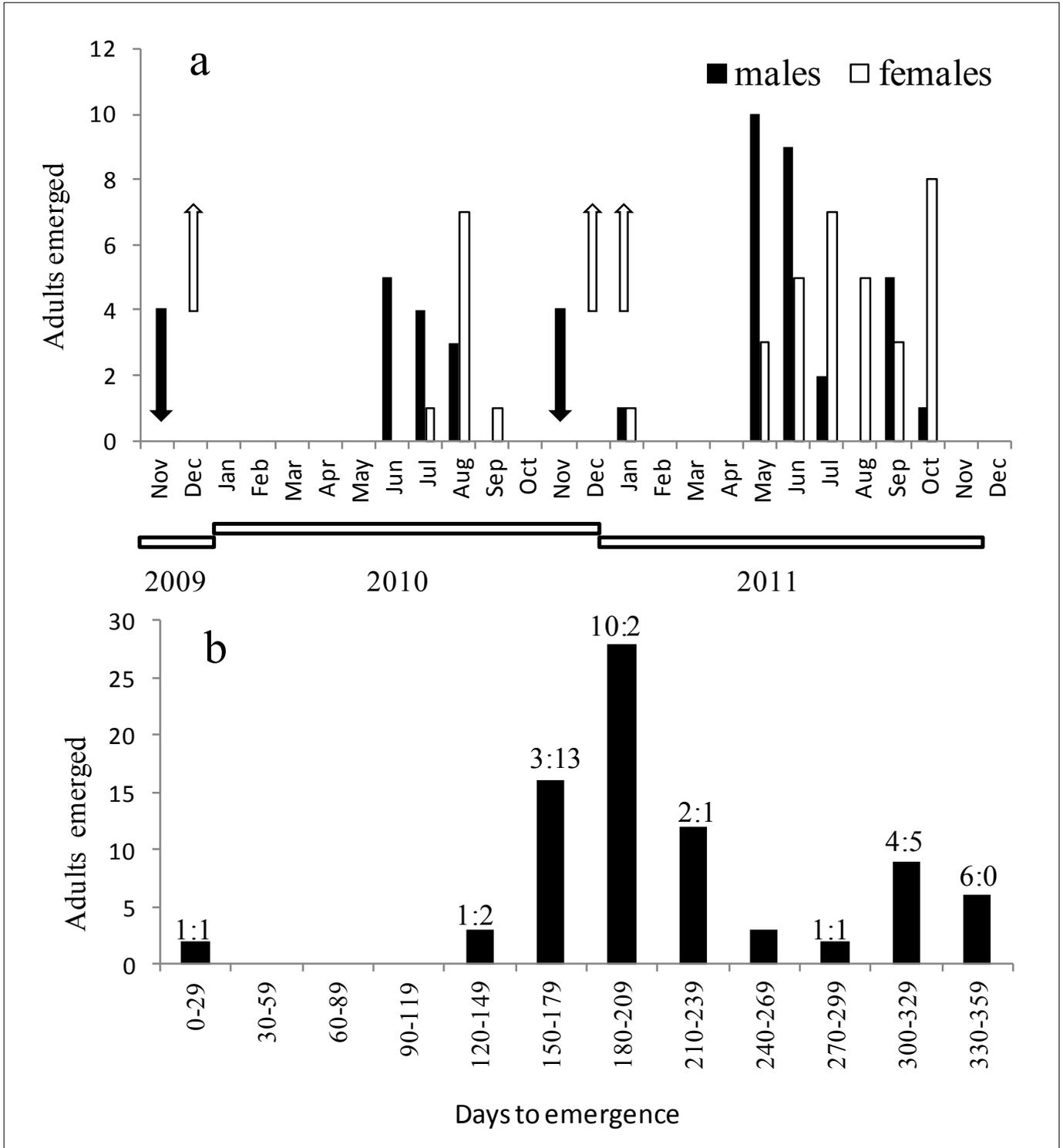
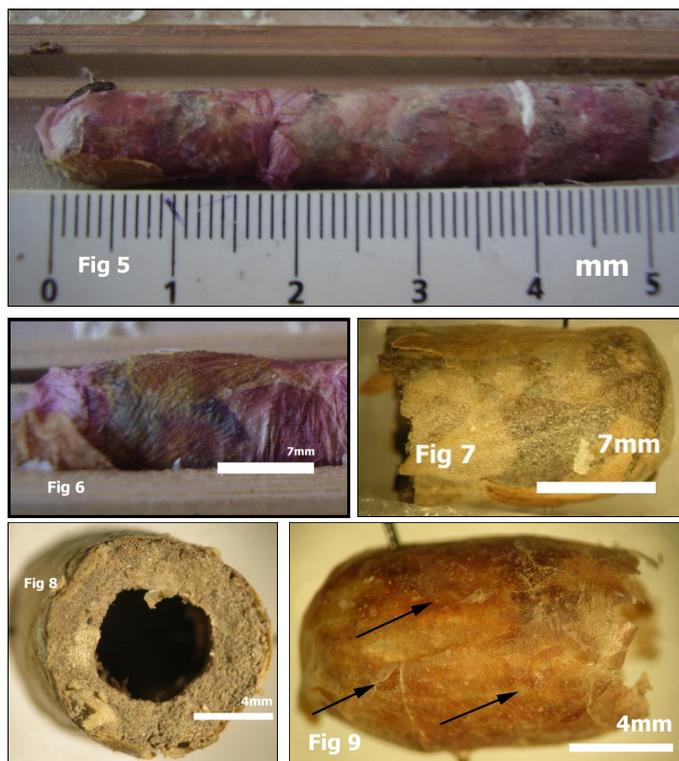


Fig 4. a. Emergence patterns of *Megachile (Chrysosarus) catamarcensis* from trap-nests in a xeric forest, during 2 years of study. *Black top-down arrows* date of placement of trap-nests. *White bottom-up arrows* date of withdrawal of traps with nests. **b.** Development time of adults reared from trap-nests during 2 years of study in a xeric forest. Numbers on bars indicate relation females : males.



Figs 5-9. Nests of *Megachile (Chrysosarus) catamarcensis* in trap-nests in a xeric forest during 2 years of study.

Fig. 5 (top). Nest with three cells. **Fig. 6.** Close-up of one cell showing external flower petal. **Fig. 7.** Close-up of cells lined externally with leaf pieces. **Fig. 8.** Hole gnawed by emerging adult through mud cap of cell. **Fig. 9.** Cocoon with faecal material (very compacted) adhering to the external surface (black arrows).

length of bamboo canes used by females of *M. catamarcensis* was 227.5 ± 55 mm (range: 84-330) with apertures of 8.0 ± 1.1 mm (range: 6-10) inner diameter. Most completed trap-nests were done so by a single female of *M. catamarcensis*, though exceptions included: a. a single trap-nest which had two nests of *M. catamarcensis* separated by a space of 75 mm (nests 555); b. two different trap-nests shared with two nests of the vespid wasp *Monobia cingulata* Brèthes (nests 502 and 550); and c. a single trap-nest shared with the wool-carder bee *Anthidium vigintipunctatum* Friese (Megachilidae) (nest 518). In all trap-nests that were shared, the first nest built was that of *M. catamarcensis*.

In 2009-2010, all nests were constructed in the same block of cane, and in 2010-2011, the nests were in nine different blocks of cane (Table 2). Because we did not mark the females during the nesting period and females of solitary bees tend to build their nests close to each other, we believe that the nests of each block were constructed by one female. The percentage of trap-nests occupied was greater in the second sample period (2.8 % vs. 8.9 %).

Of the total cells, 81 adults of *M. catamarcensis* emerged from the trap-nests ($n=21$ in 2009-2010 and $n=60$ in 2009-10; Table 2). In the first sampled period, nests were constructed during January, while in

the second sampled period most nests ($n=22$) were constructed in December. In both years, adult emergence showed a clear unimodal pattern, with a peak in June-August of the first year, and another one more prolonged in May-October in the second year (Fig. 4a). The period between egg-laying to adult emergence was similar between years and lasted for 150-350 days, with 70 % of individuals among 150-249 days (Fig. 4b). Exceptionally, in period 2010-2011, a male and a female emerged in January, *ca.* one month after removing the traps (Fig. 4b). Males hatched earlier and, in general, developmental time for males was lower than females (Fig. 4b), and occupied the outermost cells in the traps. In both sampled periods, the sex ratio was lightly female-biased (1.1/1); however, the first period was male-biased (1.3/1, Table 2) while in the second year this trend was reversed to become female-biased (1.3/1, Table 2).

The mortality rate observed in the nests of *M. catamarcensis* was high (29.6 %, Table 2), with values of 19.2 % and 32.6 % in 2009-2010 and 2010-2011, respectively. The principal death factors were mortality of preimaginal stages due to mould and / or desiccation (15.3 %) and insect natural enemies (13.9 %). During 2009-2010, a cell was attacked by *Anthrax oedipus* Fabricius (Diptera: Bombyliidae: Anthracinae). In 2010-2011, the diversity of natural enemies was higher than in 2009-2010. Three cells of two nests of two different blocks were attacked by *A. oedipus*, two cells of two nests by *Leucospis pulchriceps* Cameron (Hymenoptera: Leucospidae), two cells of one nest by one species of *Coelioxys* (Hymenoptera: Megachilidae), one cell of one nest by *Chrysis boutheryi* Brèthes (Hymenoptera: Chrysididae) and six cells in six different nests of three blocks of canes by *Huarpea fallax* (Gerstaecker) (Hymenoptera: Sapygidae). In one of the cells of which *H. fallax* emerged, an individual of *Perilampus* sp. also emerged (Table 2).

Nest and cell structure

The cells were arranged in linear series (Fig. 5), and the construction of most cells were initiated with a separation from the nodal septum marked by an empty space of 35-153 mm, and only in shorter trap-nests (84 and 87 mm) the nests were initiated at the septum.

Cells of *M. catamarcensis* ($n=12$, of 6 different nests, 1 nest of 2009-2010 and 5 nests of 2009-10; Table 2) measured 13.7 ± 1.5 mm (range: 11.6-16.0) in length and 7.3 ± 0.5 mm (range: 6.7-8.2) in inner diameter. The cells consisted of mud layer (1.0-1.5 mm thick), between two layers of plant material. In some nests ($n=20$) the plant material used by females in the outer layer consisted of petals of *Sphaeralcea crispa* Baker f. (Malvaceae, Figs 5-6), while for the remaining nests ($n=9$) were leaf pieces of plant species we were unable to identify (Fig. 7); in all nests the inner wall always was lined with petals of *S. crispa*. Cells had 7.0 ± 1.1 (range: 5-9) petals or 10.2 ± 1.2 (range: 8-12) leaf pieces in outer layer, and the inner wall had 2-3 petals. Petals and leaf pieces were differentially placed by female bees. Petals were complete and located transversally to

longitudinal axis of cells (Fig. 6); in turn, leaf pieces that covered the brood chamber were located longitudinally with the apical ends towards the outer part of cells (Fig. 7). Petals and leaf pieces were glued with mud. The cell closure was made using mud only (Fig. 8). The basal area of each cell (except for the first cell) was embedded in the concave cap of the preceding one. When adults emerged, they chewed through the mud, capping each cell (Fig. 8). We did not observe females cutting petals or pieces of leaves on the plants, however, they used petals and/or leaves of two source plants. Petals were collected for female bees from *S. crispa*, a common plant species at our study site, whose flowering phenology extends from November to March, while leaf pieces were cut from a plant with stellate trichomes, however, we were unable to observe this plant species in the field.

Pollen provisions

Pollen provision masses in cells analysed ($n=33$ of 19 different nests, $n=6$ cells of three nests in 2009-2010, and $n=27$ cells of 16 nests in 2010-2011) we found five pollen types, though pollen of *Prosopis caldenia* (Fabaceae: Mimosoideae) was present in all cells (90.7 ± 19.2 %), and in twenty one cells ($n=6$ of 2009-2010, and $n=15$ of 2010-11) pure pollen loads (100 %) of this host plant were found. In ten cells of seven nests pollen, loads of *Prosopidastrum angusticarpum* R.A. Palacios & Hoc (Fabaceae: Mimosoideae) was found (25.7 ± 24.3 %). Three other pollen types were found in minor quantities in some cells were type-*Carduus*, type-Malvaceae, and type-*Lotus*.

After provisions are consumed and defecation is finished, the last larval instar spins its cocoon, as shown by the presence of faecal pellets only on the surface external of cocoon, very compacted between cocoon and inner layer of petals. The cocoon measured 9.2 ± 0.1 mm x 5.8 ± 0.4 mm, and filled the inner dimensions of the cell, and was composed of one thin layer of silk threads embedded in a thicker light brown matrix (Fig. 9).

Discussion

Biological information on the life cycle of *M. catamarcensis* indicates shared common behavioural features with other species of subgenus *Chrysosarus*, including the use of petals and/or leaf pieces and mud as nest materials from plant material of different sources, and the utilization of pre-existing cavities (Zillikens and Steiner 2004).

Emergence of most adult bees between 5-10 months after egg-laying indicates a univoltine life cycle. However, the laboratory room conditions were warmer than those the trap-nests might have experienced in the field, and this may have allowed adults to develop faster than would have occurred under natural conditions. The two individuals that emerged a month after the traps were collected

indicate the existence of a small early-summer generation, in some years. While these individuals only represent 2.5 % of the adults obtained during this study, their direct development (i.e. without diapausing prepupae) could be indicating that *M. catamarcensis*, in some years (warmer) or in some populations (at lower latitudes), could exhibit a bivoltine life cycle. The studied population in this work is the southernmost recorded for this species, and possibly, temperature accumulation required for that diapause termination takes longer than for other populations of *M. catamarcensis*. Jørgensen (1912) observed adults flying from mid-October to end of March in diverse localities of Mendoza province, Argentina (400-500 km north from our study site); however, the nesting activity in our study site occurred from mid-December to late-January, suggesting that activity in La Pampa starts later. Regrettably, during our monthly visits to xeric forest (10 visits, 5 in each sampled period, over 200 hours of observation), we did not observe any active individuals of *M. catamarcensis*, therefore we cannot comment on the activity pattern of this species in our study site. Lack of observations at flowers may relate to female behaviour of foraging for pollen and nectar in the crown of caldén trees (4-8 m), and we were incapable to observe them.

Other species of bees (*Anthidium vigintipunctatum*) and wasps (*Monobia cingulata*, *Hypodynerus* sp. [Vespidae], *Solierella* sp., *Trypoxylon* sp. [Crabronidae], and one species of Pompilidae) were associated with nests in eight blocks, and in only two blocks, *M. catamarcensis* nested without associated organisms. In three different trap-nests, we observed nests of *M. catamarcensis* accompanied by nests of other species (*A. vigintipunctatum*, *M. cingulata*). In all cases, the first nest built within the each trap was of our focal species. One possible explanation is that these species were more aggressive than *M. catamarcensis* and displaced the females from their nests.

Pollen masses were predominately composed of pollen of *Prosopis caldenia*, although another species of legume, *Prosopidastrum angusticarpum*, was also present in a few cells (between both species 98.7 % of pollen in all studied cells). The presence of other pollen types in small proportions in the analysed cells is likely an indication that females were looking for petals to build the cells (Malvaceae) or foraging on these plant species for nectar (e.g. pollen type-*Carduus*: *Carduus acanthoides* (L.), *C. thoermeri* Weinm. and *Cirsium vulgare* (Savi) Ten. were weeds abundant in our study site). This result suggests that this population of *M. catamarcensis* probably specialize on *Prosopis caldenia* pollen. In La Pampa, caldén' flowering phenology occurs from December to January, months during which females of *M. catamarcensis* built the nests. Jørgensen (1912) mentioned *Prosopis alpataco* Phil., *P. campestris* Griseb. and *P. strombulifera* (Lam.) Benth. as flowers visited by this species, but he did not study the provision in the brood cells. The distributions of *M. catamarcensis* and many species of *Prosopis* (Burkart, 1976) and *Prosopidastrum* (Palacios and Hoc, 2005) widely overlap in the phytogeographic

province of Monte and Caldenal district (our study site). The phenology of different local bee populations could be synchronized with the flowering of various taxa of these plant genera.

The principal mortality causes were unknown diseases causing the death of larvae and prepupae and several natural enemies that attacked the nests. Brood parasitism of solitary bees and wasps by species of the genus *Chrysis* is well documented (Kimsey and Bohart 1990). Species of *Leucospis* have most frequently been found parasitizing bees of several genera of Megachilidae and Apidae (Bouček, 1974; Pujade-Villar and Caicedo, 2010) and Eumeninae and Sphecidae wasps (Burks, 1961). Also, *M. catamarcensis* were attacked by the sapygid wasp *Huarpea fallax*. All species of Sapygidae are solitary and their larvae are cleptoparasites of apid and megachilid bees (Pate, 1947). Moreover, it is known that most species of *Coelioxys* are cleptoparasites of *Megachile*, although some species attack species of Apidae (Michener, 2007). Finally, our focal species were attacked by *Anthrax oedipus* (Diptera: Bombyliidae). Individuals of *A. oedipus* were reared from nests of *Tetrapedia diversipes* Klug and *T. rugulosa* Friese (Apidae), in Brazil (Gazola and Garófalo, 2009) and other species of *Anthrax* attacks other species of *Megachile* (Krombein, 1967; Gazola and Garófalo, 2009).

This study offers new information on the nesting ecology of *M. catamarcensis* at the southern limit of its distribution. Our focal population show a univoltine life cycle, although the results suggest that other populations could be bivoltine. The studied population is *Prosopis*-specialist and present news about some host-parasitic interactions: association with *M. catamarcensis* constitutes the first records for leucospid *L. pulchriceps*, and host/parasite association of *M. catamarcensis* and *A. oedipus* constitutes the first records for both species.

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