Lundiana 3(1):61-66, **2002**

ISSN 1676-6180

Gall-forming insects on woody and herbaceous plant species of the semi-arid chaco forest, Argentina

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Abstract

Patterns of biogeographical distribution of gall-forming insects are well-studied around the world. Hygrothermally and nutritionally-stressed habitats usually support rich galling insect communities. However, studies on gall diversity in the dry chaco of South America are still lacking. This study aimed to describe the insect galls found in five areas in the Central chaco in the Province of Salta, Argentina: San Domingos, Salta Florestal, Las Lajitas, and two sites at the Estación Biológica Los Colorados. Twenty-nine morphospecies of galling insects were found in the five areas sampled. They occurred on 17 host plant species that belong to 10 families. The most attacked family was the Leguminosae (8 species), which supported 52% of the chaco galling fauna (15 species). *Prosopis elata*, *P. nigra* and *P. roscefalia* were the most attacked species, supporting 3 galling species each. Galls were predominantly induced by Cecidomyiidae (Diptera) (62.1%), which is consistent with the patterns found elsewhere in the world. The most speciose site for galling insects was in the Estación Biológica Los Colorados (14 morphospecies in site I and 11 morphospecies in site II), probably indicating the influence of the degree of land conservation on the biodiversity of gall-forming insects.

Keywords: Biodiversity, Chaco, Diversity, Insect galls, Insect herbivory

Introduction

South America is diagonally crossed by a SW-NE corridor of open and dry vegetation called "the diagonal of open formations"(Vanzolini, 1974) (Fig. 1). At the two edges of this corridor, the vegetation is dominated by xeric woodlands. In the SW it is called "chaco" while in the NE Brazil it is called "caatinga". At the center of the corridor, in Brazil, a rich mosaic of savanna vegetation called "cerrado" dominates the landscape (Solbrig et al.,1986). The chaco region is a wide semi-arid area of approximately 1,200,000 km^2. Two thirds of this are in Argentina, while the remaining 400,000 km^2 are in Bolivia, Paraguay, and Brazil (Bucher, 1982, 1987; Hueck, 1966). The main characteristics of the vegetation of this region are sub-tropical thorny woodyland and semi-arid savannas. In Argentina, the composition and structure of the chaco vegetation varies according to climate and soil, following a gradient east-west. Most plant species are deciduous (63%) or semi-deciduous (21%). Some are aphyllous (5%), while only 11% are evergreen (Sarmiento, 1972). Leaves are generally small and thorny (61%) and there are 56 plant genera in 33 plant families (Sarmiento, 1972).

The degree of physiognomic similarity between the chaco and caatinga is impressive (Bucher, 1982; Hueck, 1966). A large number of species which are not found in the more humid cerrado are instead found in the disjunct chaco and caatinga. There are examples among several groups, such as anurans (Lutz, 1967), birds (Short, 1975) and lizards (Vanzolini, 1974). Interestingly, gall-forming insects of rupestrian fields (one of the driest cerrado physiognomic formation, characteristic of high altitudes) may also share common genera with other regions of the Andes (Fernandes et al., 1996). AB'Saber (1977) and Vuilleumier (1971) have postulated that these biogeographical patterns in species distribution are linked to the recent climatic changes in South America which have determined great shifts in the limits of all xeric woodland formations. Otherwise, much remains to be learned about the Pleistocene environments of this continent (Bucher, 1982). For instance, the fauna of invertebrates is mostly unknown as are their pattern of distribution and diversity. Hence, generalizations cannot be made with other groups as more studies are needed. In this study we attempt to initiate a more detailed and long term study of a group of well known insect herbivores, the gall-formers.

Gall-forming insects have now been widely studied around most of the major biogeographical regions of the world, and many patterns in their distribution have been described. The most striking pattern observed is an increase in species number with increasing habitat harshness (Fernandes & Price, 1988, 1991; Fernandes et al., 1994). Insect galls are more speciose in hygrothermally and nutritionally stressed habitats, independent of latitude, throughout the world and in close association with sclerophyllous host plants (Fernandes & Price, 1988, Price et al., 1998). The mechanisms responsible for the increased richness are lower plant resistance and natural enemy attack and higher plant species richness in xeric habitats compared to mesic habitats (Fernandes & Price, 1991, 1992).

Received 18.05.2001
Accepted 07.01.2002

Although studies on galling insects have been performed in several vegetation physiognomies around the globe, the varied and rich South-American vegetation await further studies that will allow to test the hypotheses unraveled elsewhere. This is the case for the chaco and caatinga, which were never censused for galling insects. Therefore, we undertook this study in an attempt to start filling the gap in our knowledge on the distribution of galling insects in the chaco, and to provide the fuel for future investigations. In this study we describe the galls found in five areas in the Central chaco in the Province of Salta, Argentina.

Material and methods

Five major sub regions are known in the chaco province: Eastern chaco, Central chaco, Western chaco, Sierra chaco and Austral chaco (Cabrera & Willink, 1973; Morello & Adamoli, 1974). We studied galling insects in the Central chaco, which corresponds to the "Distrito fitogeográfico chaqueño occidental" (Cabrera & Willink, 1973). Galls were sampled in five areas in western Salta, Argentina: San Domingos (24º 42' S, 63º 27' W), Salta Florestal (24º 57' S, 63º 52' W), Las Lajitas (24º 41' S, 64º 15' W), and two sites at the Los Colorados (24º 41'S, 63º 18' W). The climate in the region is semiarid mesothermal where average annual precipitation is between 500 and 650 mm and average annual temperature is 21-22ºC (Galmarini & Raffo del Campo, 1964). Rainfall is strongly seasonal as more than 80% of the precipitation is concentrated in the warm months (Oct-Apr). Maximum temperature reaches 49ºC while cold fronts may produce frost in all the territory, particularly in July and August (Bucher, 1982). The sampling sites are within the hottest region of the Gran Chaco, called the "Polo del Calor de América del Sur" (Prohaska, 1959).

The vegetation of the Estación Biológica Los Colorados is dominated by quebracho (*Schinopsis quebracho-colorado, Aspidosperma quebracho-blanco*), but most species belong to the Leguminosae and Capparidaceae. The vegetation of Salta Florestal and San Domingos are similar to that found in Estación Biológica Los Colorados, but with strong influence of grazing and wood extraction. In Las Lajitas, the vegetation has been extremely modified due to grazing and agriculture. The woody vegetation is dominated by *Anadennathera colubrina, Ruprechtia apetala* and *Caesalpinia paraguariensis.*

Gall samplings were conducted through one-hour walk at each site (Price et al., 1998). During this period, all galls encountered were collected and dissected to determine the identity of the galling insect larvae (predominantly to the level of family). Specimens are deposited in the collection of the Laboratório de Ecologia Evolutiva de Herbívoros Tropicais, at the Universidade Federal de Minas Gerais. Parts of each host plant were also collected and identified to the level of species.

Results and discussion

Twenty-nine morphospecies of galling insects were found in the five areas of the Central chaco (Table 1). Galls occurred on 17 host plant species beloging to 10 families. The most attacked family was the Leguminosae (8 plant species), which supported 52% of the chaco galling fauna (15 out of the 29 galling species in this study). Three host plant species, *Prosopis elata, P. nigra,* and *P. ruscifolia*, supported three galling species each, therefore

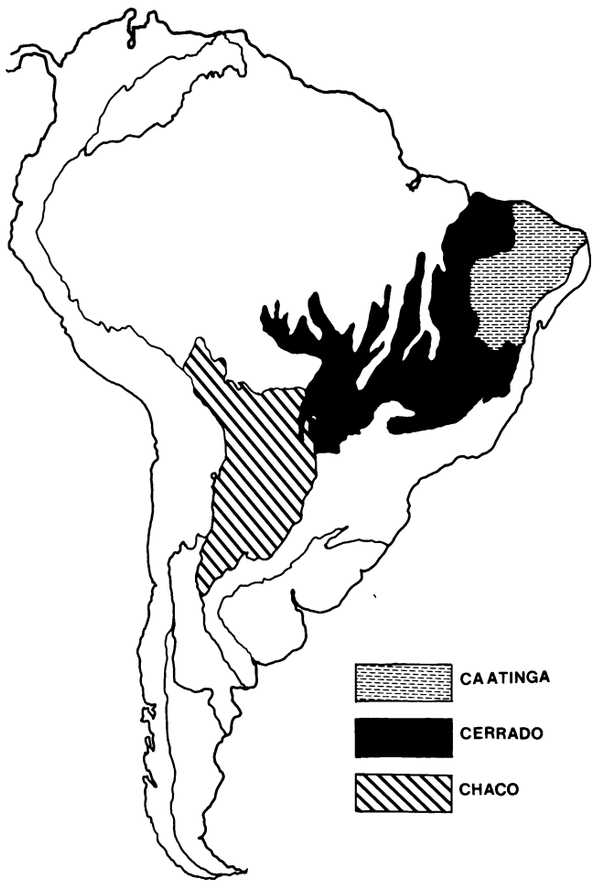
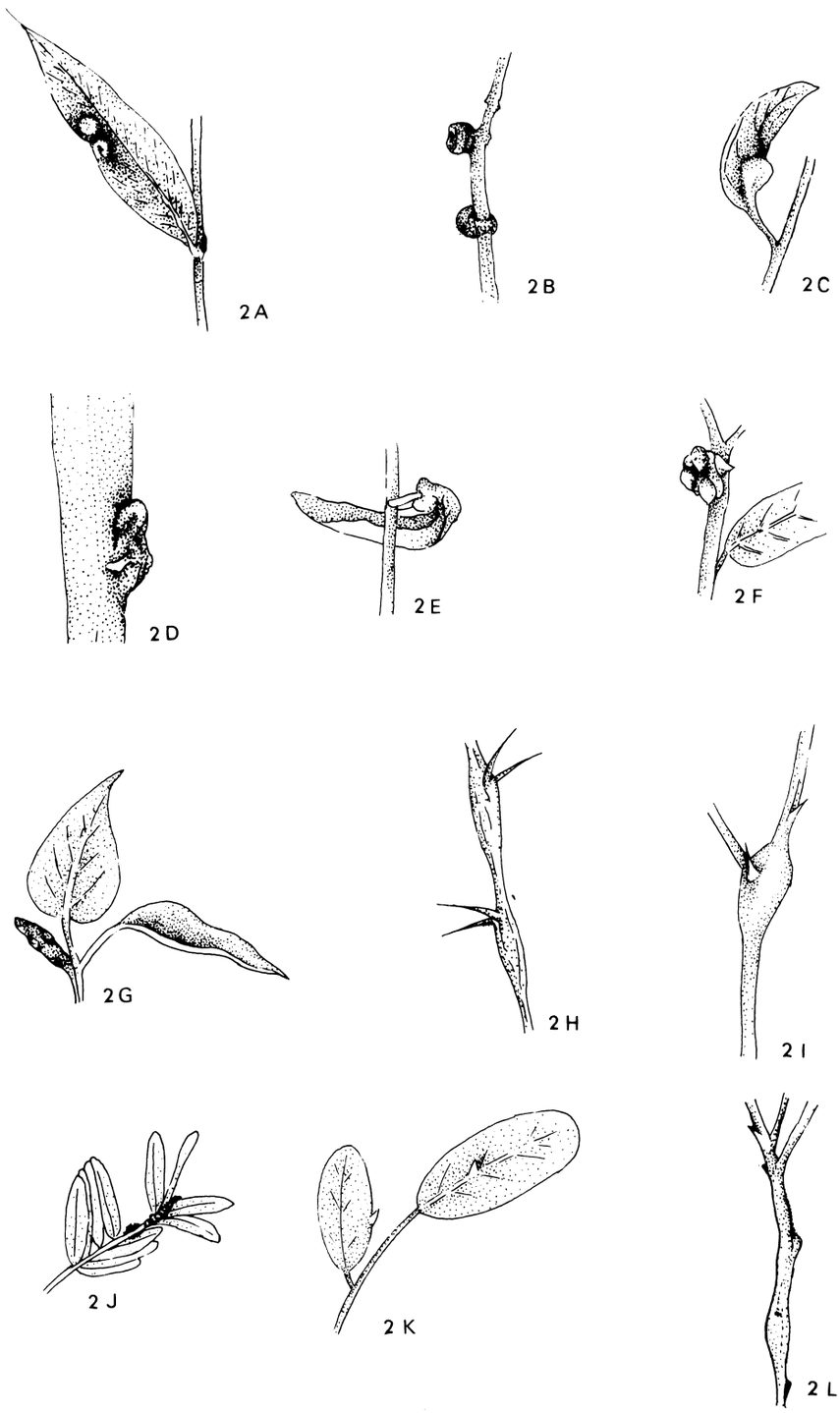


Fig. 1 - Diagonal of open and dry vegetation in South America. Modified from Bucher[2].

representing 31% of all galling fauna surveyed. Leguminosae is amongst the most heavily attacked plant family by gall-forming insects in several biogeographical regions, including the cerrado of Brazil (Fernandes et al., 1997; Gagné, 1989; Gonçalves-Alvim & Fernandes, 2001; Mani, 1964). In many biogeographical regions, a few host plants are also known to harbor rich galling fauna. For instance, in the southwestern United States the genera *Chrysothamnus* (Asteraceae), *Atriplex (*Chenopodiaceae), *Quercus* (Fagaceae) and *Larrea* (Zygophilaceae) support the richest galling fauna, while in Brazil *Baccharis* (Asteraceae), *Bauhinia* and *Copaifera* (Leguminosae) and *Myrcia* (Myrtaceae) are extremely species rich in galling insects. The reason for such diversity patterns are still under study, although some attempts have been made to unravel the causing mechanisms (Fernandes & Price, 1992; Gonçalves-Alvim & Fernandes, 2001). Compared to other biogeographical regions (Price et al., 1998), the galling fauna in the Chaco is poor. On the other hand, we must carry on long term studies to observe whether this pattern is influenced either by seasonality, higher habitat stress (compared to the speciose cerrado vegetation of Brazil) or to the availability and dynamics of resources (evergreen foliage).



Figs. 2a – 2l - Galls on several host plants of the chaco vegetation (see table 1 for details) (2a-2b: *Aspidosperma quebracho-blanco*; 2c: *Baccharis salicifolia*; 2d: *Arrabidaea elata*; 2e-2f: *Capparis salicifolia*; 2g: *Croton sarcopetalus*; 2h: *Acacia aroma*; 2i: *A. macrantha*; 2j: *A. praecox*; 2k: *Geoffroea decorticans*; 2l: *Prosopis elata*).

Table 1 - Host plant species and families of gall-forming insects in the Central chaco, Salta, Argentina.

Host				Gall			Galling	Figure
Species	**Family**	**Common Name**	**Organ**	**Shape**	**Chamber**	**Color**	**Family**	
Aspidosperma quebracho-blanco	Apocynaceae	Quebracho-blanco	Leaf	Discoid	One	Pale Green	Cecidomyiidae	2a
			Stem	Globoid	One	Brown	Cecidomyiidae	2b
Baccharis salicifolia	Asteraceae	Suncho	Leaf	Ellipsoid	One	Green	*Neopelma* sp.[1]	2c
Arrabidaea elata	Bignoniaceae		Lateral bud	Ellipsoid	Many	Green	Cecidomyiidae	2d
Capparis salicifolia	Capparidaceae	Sacha sandia	Leaf	Ellipsoid	One	Green	Cecidomyiidae	2e
			Stem	Globoid	?	Pale Green	Cecidomyiidae?	2f
Croton sarcopetalus	Euphorbiaceae	–	Leaf	Ellipsoid	One	Brown	Cecidomyiidae	2g
Acacia aroma	Leguminosae	Tusca	Stem	Ellipsoid	Many	Green	Cecidomyiidae	2h
Acacia curvifructa		Brea del bordo	Shoot	Ellipsoid	Many	Brown	Hymenoptera	–
Acacia macrantha		Tusca	Stem	Ellipsoid	One	Brown	Cecidomyiidae	2i
Acacia praecox		Garabato	Leaf	Globoid	One	Green	Cecidomyiidae	2j
			Stem	Globoid	-	Brown	Hymenoptera	–
Geoffroea decorticans		Chañar	Leaf	Conical	One	Green	Cecidomyiidae	2k
Prosopis elata		Quisca-taco	Stem	Ellipsoid	One	Green	Coleoptera	2l
			Stem/Spine	Ellipsoid	Many	Green	Cecidomyiidae	3a
			Leaf shoot	Ellipsoid	Many	Green	Hymenoptera	–
Prosopis nigra		Algarrobo negro	Shoot	Globoid/ Bristly	Many	Brown	Cecidomyiidae	3b
			Shoot	Globoid	Many	Brown	Hymenoptera	3c
			Stem	Ellipsoid	Many	Brown	Hymenoptera	3d
Prosopis ruscifolia	Leguminosae	Vinal	Stem	Ellipsoid	One	Green	Coleoptera	3e
			Stem	Globoid	Many	Brown	Hymenoptera	3f
			Spine	Cylindrical	One	Green	Cecidomyiidae	–
Sida rhombifolia	Malvaceae	Escoba dura	Stem	Ellipsoid	One	Green	Lepidoptera	3g
Capsicum chacoensis	Solanaceae	Ají	Leaf	Discoid	One	Green	Cecidomyiidae	3h
			Stem	Ellipsoid	One	Green	Cecidomyiidae	3i
Solanum argentinum		Cabra yuyo	Stem	Ellipsoid	Many	Green	Cecidomyiidae	3j
Celtis pallida	Ulmaceae	Tala	Stem	Ellipsoid	One	Green	Cecidomyiidae	3k
			Stem	Globoid	One	Green	Cecidomyiidae	3l
Aloysia scorodonoides	Verbenaceae	–	Stem	Ellipsoid	One	Brown	Lepidoptera	3m

Most galls were of ellipsoid shape (58.6%), 27.6% were globoid, 3.5% were cylindrical, 6.8% were discoid, and 3.5% were conical (Figs. 2, 3). Galls were mostly induced by Cecidomyiidae (Diptera) (62.1%), followed by Hymenoptera (20.7%), Lepidoptera, 6.9%, Coleoptera, 6.9% and Psyllidae (Homoptera), 3.4%. This pattern is also consistent with the patterns found elsewhere in the world (Fernandes et al., 1994; Mani, 1964).

The most speciose sites for galling species were in the Estación Biológica Los Colorados, where we found 14 morphospecies in site I and 11 morphospecies in site II (Table 2). Almost 50% of all galling morphospecies were found in Los Colorados, perhaps indicating the influence of the degree of conservation and forest rehabilitation on the biodiversity of galling insects. Nevertheless, more studies are necessary to better understand the distribution of insect galls and their host plants in the chaco province of Argentina. Future studies shall extend the survey and focus on the diversity patterns across the major provinces in an attempt to find out whether diversity is influenced by habitat type, temperature, precipitation and resource availability.

Acknowledgments

We are very grateful to two anonymous reviewers for their comments on the manuscript and by the logistical support provided by the US Fish & Wildlife Service. This project was supported by the grants CNPq-521772/95-8 and Fapemig-CRA2519/97 to GWF.

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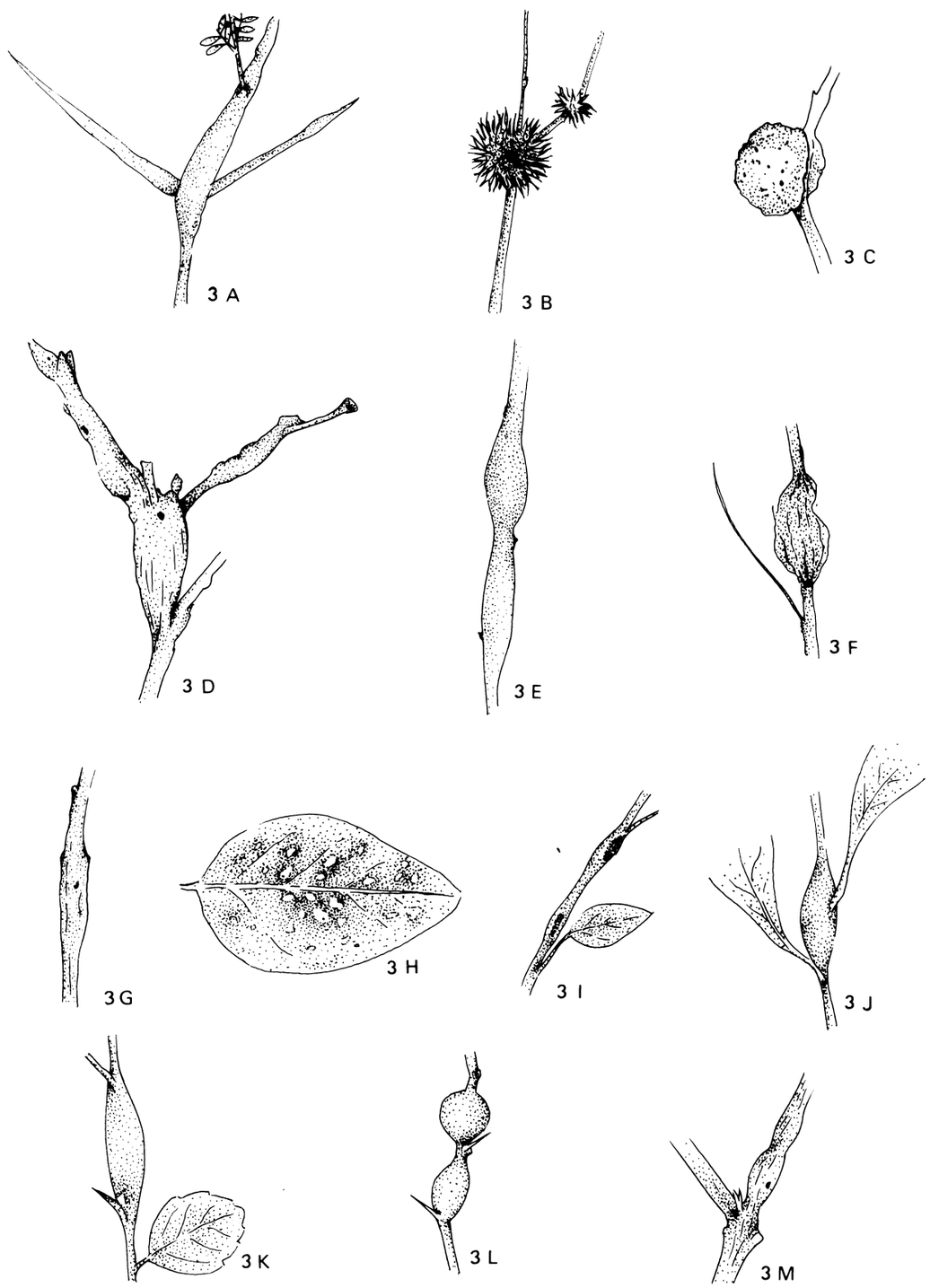

Figs. 3a – 3m - Galls on several host plants of the chaco vegetation (see table 1 for details) (3a: *Prosopis elata*; 3b-3d: *P. nigra*; 3e-3f: *P. ruscifolia*; 3g: *Sida rhombifolia*; 3h-3i: *Capsicum chacoensis*; 3j: *Solanum argentinum*; 3k-3l: *Celtis pallida*; 3m *Aloysia scorodonoides*).

Table 2 - Occurrence of galling insects per sample site in the Central chaco, Salta, Argentina.

Host Species	Gall Morpho	Sample Sites				
		San Domingo	Salta Florestal	Lajitas	Colorado I	Colorado II
Aspidosperma quebracho–blanco	1	–	–	–	X	–
	2	–	–	–	X	–
Baccharis salicifolia	1	–	–	X	–	–
Arrabidea elata	1	–	–	–	X	X
Capparis salicifolia	1	–	–	–	X	X
	2	–	–	–	X	X
Acacia aroma	1	–	X	–	–	–
A. curvifructa	1	X	–	–	–	–
A. macrantha	1	–	X	–	–	–
A. praecox	1	–	X	–	X	–
	2	–	–	–	X	X
Geoffroea decorticans	1	–	X	–	–	–
Prosopis elata	1	–	–	X	X	X
	2	–	–	–	X	X
	3	–	–	–	X	X
P. nigra	1	X	X	X	–	–
	2	X	–	–	–	–
	3	–	–	–	X	X
P. ruscifolia	1	X	–	–	–	–
	2	X	–	–	–	–
	3	X	–	–	–	–
Sida rhombifolia	1	–	X	–	–	–
Capsicum chacoensis	1	X	X	X	–	–
Solanum argentinum	1	–	X	–	X	X
Celtis pallida	1	–	–	X	X	X
	2	–	X	X	X	X
Aloysia scorodonoides	1	–	X	–	–	–
17 species	**29**	**7**	**10**	**6**	**14**	**11**

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