Aphididae (Hemiptera) on ornamental plants in Córdoba (Argentina)

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Aphididae (Hemiptera) en plantas ornamentales de Córdoba (Argentina)

RESUMEN. En 30 censos realizados en la ciudad de Córdoba y alrededores (Argentina) se registraron, entre noviembre de 2001 y mayo de 2002, un total de 109 plantas ornamentales infestadas de colonias de áfidos. Los censos fueron realizados en jardines, viveros y el jardín botánico de la ciudad. Se identificaron 47 especies de plantas ornamentales infestadas con 17 especies de áfidos (4 nuevas en el área). Se establecen 59 relaciones áfido/planta, de las cuales 38 son nuevas. Se obtuvo el primer registro de áfidos que colonizan Cactaceae en Argentina. La mayoría de las colonias de áfidos fueron medianas y una alta proporción (más del 40 %) mostró individuos alados. *Aphis gossypii* Glover y *Aphis craccivora* Koch, fueron las especies más frecuentes y generaban los daños más conspicuos, como el enrollamiento y la necrosis foliar. Más del 30% de las colonias estuvieron atendidas por hormigas, siendo *Camponotus* Mayr y *Prenolepis* Mayr los géneros de hormigas que frecuentaban el mayor número de especies de áfidos.

PALABRAS CLAVE. Áfidos. Plantas ornamentales. Riqueza. Daños. Áreas urbanas.

ABSTRACT. In 30 surveys across Cordoba city and surroundings (Argentina) I recorded, from November 2001 to May 2002, a total of 109 ornamental plants infested with aphid colonies. Surveys were conducted in the local botanical garden as well as homestead gardens and nurseries. Seventeen species of aphids were identified, 4 of which are new species in the area, from 47 ornamental plants. In a total of 59 plant/aphid associations, 38 new associations were found. I present the first record of aphids colonizing Cactaceae in Argentina. Most aphid colonies were medium and a high proportion (more than 40%) showed alate individuals. The most frequent aphid species, *Aphis gossypii Glover* and *Aphis craccivora* Koch were especially associated with the most frequent damages: curled leaves or buds and necrosis, respectively. More than 30% of aphid colonies were attended by ants. *Camponotus* Mayr and *Prenolepis* Mayr were the ant genus attending the highest number of aphid species.

KEYWORDS. Aphids. Ornamental plants. Richness. Damages. Urban areas.

INTRODUCTION

Urban landscapes are becoming widespread, with increasing number of overpopulated cities (United Nations, 2001; Wilby & Perry, 2006). The environment created around human settlements is very dynamic, complex and in some cases highly

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polluted, with a continuous introduction of exotic plant and animal species (Vitousek *et al.*, 1997; Nieto Nafría *et al.*, 1994). For example, in Argentina over 75% of aphids are exotic (Ortego *et al.*, 2006).

Aphids (Hemiptera, Aphididae) are one of the major pests in ornamental plants (Arruda *et al.*, 1996; Clements *et al.*, 2000). However, a few biological studies on aphids have been made in South America (Dixon, 1998). For example, Peronti & Sousa da Silva (2002) surveyed the aphid richness in ornamental plants from Sao Pablo, Brazil. The arthropod communities in different areas of Argentina have been described, but records of arthropod communities in city gardens are almost non-existing.

Aphids are small, soft-bodied and plant sucking insects. Aphids' life cycles are very intricate and can imply both sexual and asexual reproduction as alate and apterous forms (Nieto Nafría *et al.*, 1994). However, the loss of the sexual phase (or anholocycly) is a common phenomenon (Blackman & Eastop, 2000). A typical aphid colony consists of apterous viviparous females (apterous virginoparae) and, as the colony ages, alate viviparous females (alate virginoparae) appear.

In temperate regions, aphids are the most important honeydew producers, many of which have developed a mutualism with ants (Hölldobler & Wilson, 1990). Aphids benefit from this mutualism with ants by reduced predation and parasitism, and by reduced risk of fungal infection (Völkl *et al.*, 1999). This aphid-ant mutualism may result in differences in aphid colony size (Addicott, 1978; Delfino & Buffa, 2000).

Aphids can be found virtually in all temperate cropping systems and have the potential to reduce plant yield substantially (Sadras *et al.*, 1999). Those insects often reduce plant vigor, promote curled and distorted leaves, harden the buds and cause chlorosis as well as promoting malformations and heterogeneous coloration in organs like leaves, flowers and fruits (Sanchez *et al.*, 2000). These damages produce important losses in the commercial value of ornamental plants which, in contrast to other crops, are usually related to aesthetics.

The aim of this work is to identify and characterize aphid colonies present in the most frequently cultivated ornamental plant species in gardens of Córdoba city (Argentina) and surroundings.

MATERIAL AND METHODS

Area description. Córdoba city (31°24'S, 64 11'W) is placed in the center of Argentina in a sub humid region. Rainfalls are mainly concentrated in summer and mean annual temperature is 17.4 °C. Surveys reported here were carried out in this city and nearby surroundings (i.e. Villa Giardino).

Sampling procedure. To collect aphid colonies, 30 surveys were conducted from November 2001 to May 2002. Surveys consisted of random tours along the whole Córdoba's botanical garden as well as several nurseries and homestead gardens in the study area. Aphids were maintained in test tubes filled with 65% alcohol. Only ornamental plants with aphids' colonies were recorded.

The following variables were considered:

(a) Size of the colony: (1) small colonies: up to ten aphids per colony, (2) medium colonies: 10-50 aphids per colony or (3) large colonies: more than 50 aphids per colony.
(b) Aphid forms: (1) apterous or (2) alate virginoparae aphids.
(c) Infested plant organs: (1) buds, (2) leaves, (3) stems, (4) flowers and/or (5) fruits.
(d) Presence of damages: (1) stains, (2) necrosis, (3) curled leaves or buds, (4) chlorosis, (5) fading, (6) reduced plant vigor and/or (7) honeydew deposit.
(e) Functional plant forms: (1) herbs, (2) shrubs, (3) trees or (4) cactus/succulent plants.
(f) Ant attendance: (1) Yes, (2) No.

Species identification. Except for a few host plants that were herborized and identified at the laboratory, most

TABLE I. Aphids and host ornamental plants collected in Cordoba (Argentina).

APHID SPECIES	HOST SPECIFICITY	HOST ALTERNATION	HOST PLANTS
Aphis craccivora Koch	Polyphagous	Monoecious/Heteroecious[1]	*Asparagus densiflorus** (Kunth) Jessop, *Eriobotrya japonica** (Thunb.) Lindley, *Malus domestica** Borkh., *Nopalea dejecta** (Salm-Dyck) Salm-Dyck, *Oenothera speciosa** Nutt., *Opuntia ficus indica** (L.) Miller, *Austrocylindropuntia subulata** (Muehlenpfordt) Backerberg, *Pereskia sacharosa** Grisebach, *Robinia hispida* L., *Spartium junceum** L., *Stetsonia coryne** (Salm-Dick) Britton & Rose, *Crassulaceae**
Aphis fabae Scopoli	Polyphagous	Strictly Monoecious[1]	*Pittosporum sp.*
Aphis gossypii Glover	Polyphagous	Monoecious/Heteroecious[1]	*Abutilon megapotamicum** (Spreng.) St. Hill. Et Naud, *Bauhinia candicans** Benth., *Bignonia sp, Eriobotria japonica** (Thunb.) Lindley, *Gardenia jasminoides** Ellis, *Gardenia stellata** Hort., *Hibiscus rosa-sinensis* L., *Hibiscus syriacus** L., *Hypericum moserianum** André, *Magnolia purpurea** Curt., *M. domestica* Borkh., *O. speciosa** Nutt., *Pittosporum** sp., *Potentilla fruticosa** L., *Punica granatum** L., *Rosa* sp., *Salvia splenders** Kerk-Gawl, *Solanum jasminoides* (Sendth) OK., *S. coryne** Salm-Dick, *Sysirinchium** sp., *Crassulaceae*
Aphis hederae Kaltenbach	Monophagous	Strictly Monoecious[2]	*Hedera helix* L.
Aphis nerii Boyer de Fonscolombe	Oligophagous	Strictly Monoecious[1]	*Nerium oleander* L.
Aphis spiraecola Patch	Polyphagous	Monoecious/Heteroecious[1]	*B. sempervivens** L., *Crategus** sp., *Thymophylla tenuiloba** DC., *Evonymus japonica** L., *Hoya carnosa** L., *Photinia serrulata** Lindl., *Pittosporum** sp.
Brachycaudus helichrysi (Kaltenbach)	Polyphagous	Monoecious/Heteroecious[1]	*Hydrangea macrophylla** (Thunb.) DC
***Cinara* spp.**	Monophagous	Strictly Monoecious[1]	*Cedrus deodara* (D. Don) G. Don, *Cupressus* sp.
Cryptomyzus korschelti Börner	Oligophagous	Strictly Heteroecious[3]	*Physostegia virginiana** Benth
Macrosiphonella sanborni (Gillete)	Monophagous	Strictly Monoecious[1]	*Chrysantemum* sp.
Macrosiphum rosae (Linnaeus)	Oligophagous	Monoecious/Heteroecious[1]	*Rosa* sp.
Myzus persicae (Sulzer)	Polyphagous	Monoecious/Heteroecious[1]	*G. jasminoides* Ellis, *H. rosa-sinensis* L., *Rosa** sp., *Viola* sp.*, *Viola x witrokiana**.
Rodobium porosum (Sanderson)	Oligophagous	Strictly Monoecious[1]	*Rosa* sp.
Tinocallis kahawaluokalani (Kirkaldy)	Monophagous	Strictly Monoecious[1]	*Lagerstroemia indica** L.
Uroleucon ambrosiae (Thomas)	Oligophagous	Strictly Monoecious[4]	*Euryops** sp., *Gerbera jamesonii** Bolus
Tuberculatus querceus (Kaltenbach)	Monophagous	Strictly Monoecious[5]	*Quercus* sp.
Wahlgreniella nervata (Gillette)	Oligophagous	Monoecious/Heteroecious[1]	*Rosa* sp.

* New plant/aphid associations in Argentina (according to Nieto Nafria *et al.*, 1994; Delfino, 1982 and Delfino & Binnazi, 2002); [1] Mondor *et al.*, 2006; [2] Heie, 1986; [3] Heie, 1994; [4] Funk & Bernays 2001; [5] Heie, 1982.

determinations were carried out during the samplings. Both, aphid species and ant genus were identified under magnifying glass. When it was required, aphids were mounted on slides according to the technique described by Remaudière (1992), and species identification was done under optical microscope up to species level, using the following identification keys: Blackman & Eastop (2000); Delfino (1981); Heie (1980, 1982, 1986, 1992, 1994, 1995) and Hille Ris Lambers (1939, 1947,1953). The collected aphids and ants were placed in the Insect Collection of the Entomology Laboratory at National University of Cordoba (UNC).

Furthermore, aphids were classified according to their apterous virginoparae known host plant specificity based on

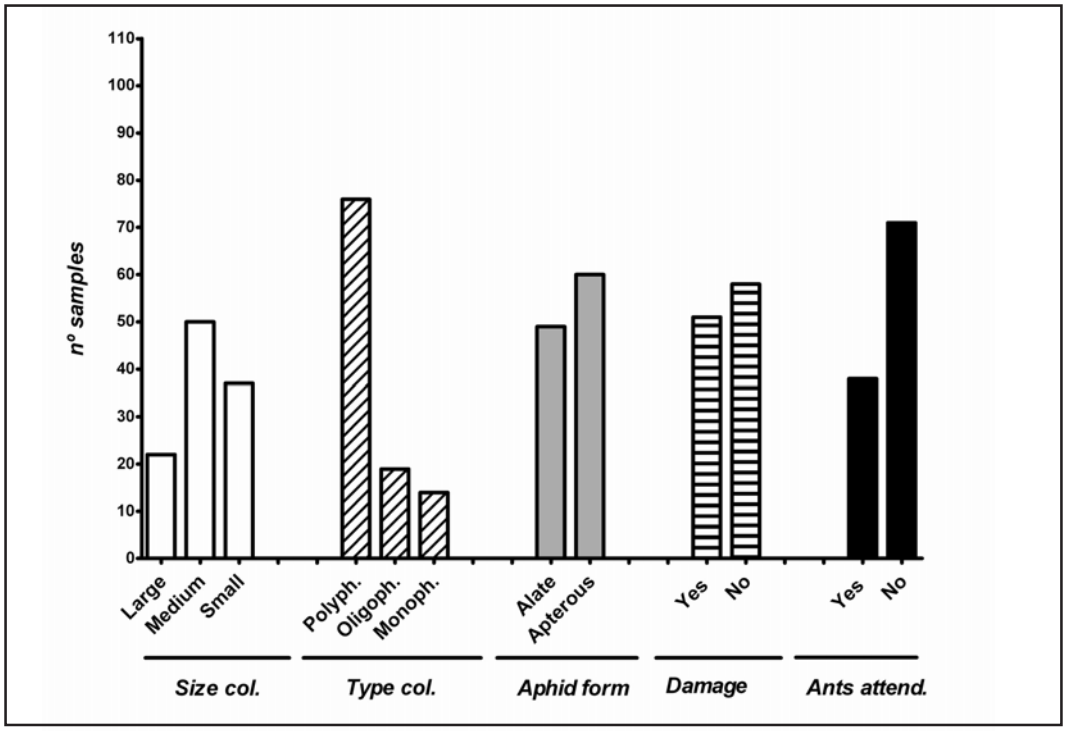

Fig. 1. Number of samples (n =109) for some variables that characterize Aphididae (Hemiptera) colonization in ornamental plants. Size col. = Size of the colony; Polyph. = Polyphagous; Oligoph. = Oligophagous; Ants Attend. =Ant attendance.

Kennedy *et al.* (1962): (1) monophagous: colonize a plant genus; (2) oligophagous: colonize up to five plant genus and belong to no more than 20 plant families; (3) polyphagous: colonize more than 5 plant genus and belong to more than 20 families. Finally, aphid species were grouped based on Mondor *et al.* (2006) as: (1) strictly monoecious (i.e. no host alternation); (2) monoecious/heteroecious populations known; (3) strictly heteroecious (i.e. obligate host alternation).

RESULTS

Richness of aphids and their ornamental host plants

I recorded 109 ornamental plants with aphid in 30 surveys along the botanical garden, several nurseries and homestead gardens in Córdoba and surroundings from November 2001 to May 2002. In 47 different ornamental plants belonging to 13 plant families, I identified 17 species of aphids (Table I). From these aphid species, I found four new species in the area: *Cryptomyzus korschelti* Börner, *Tinocallis kahawaluokalani* (Kirkaldy), *Tuberculatus querceus* (Kaltenbach) and *Uroleucon ambrosiae* (Thomas). The finding of *Cryptomyzus korshelti* Börn was previously reported (Szpeiner & Delfino, 2002).

Aphis gossypii Glover and *Aphis craccivora* Koch were the most frequent aphid species found. Whereas *A. gossypii* colonized 21 ornamental host plants, *A. craccivora* only colonized 11. Most aphid species identified in this study were exotic. *Uroleucon ambrosiae* (Thomas) was the only species with an exclusively American distribution (Nieto Nafría et al., 1994). In other words, 94% (1/17) of aphids colonizing ornamentals in Córdoba were cosmopolitan or exotic species.

With regard to ornamental plants, *Rosa* L. was the most frequent genus of plants

TABLE II. Ant-aphid-host ornamental plants associations found in Córdoba (Argentina).

ANT GENUS	APHID SPECIES	HOST PLANTS
Crematogaster *Lund*	*Aphis gossypii* Glover	*Pittosporum* sp., *Potentilla fruticosa* L., *Rosa* sp., *Sysirinchium* sp.
	Aphis spiraecola Patch	*Buxus sempervivens* L.
	Rodobium porosum (Sanderson)	*Rosa* sp.
Solenopsis Westwood	*Aphis gossypii* Glover	*Hypericum mozerianum* André
Linepithema Mayr	*Aphis gossypii* Glover	*Solanum jasminoides* (Sendth)
	Aphis craccivora Koch	Crassulaceae
Pseudomyrmex Lund	*Aphis gossypii* Glover	*Solanum jasminoides* (Sendth)
Brachymyrmex Mayr	*Aphis gossypii* Glover	*Rosa* sp., *Potentilla fruticosa* L., *Rosa* sp., *Hibiscus rosa-sinensis* L., *Magnolia purpura* Curt.
	Aphis spiraecola Patch	*Buxus sempervivens* L.
	Myzus persicae Laing	*Hibiscus rosa-sinensis* L., *Viola x hibrido*
	Rodobium porosum (Sanderson)	*Rosa* sp.
	Wahlgreniella nervata (Gillette)	*Rosa* sp.
Camponotus Mayr	*Aphis gossypii* Glover	*Abutilon megapotamicum* (Spreng.), *Evonymus japonica* L., *Hibiscus syriacus* L., *Punica granatum* L.
	Aphis craccivora Koch	*Asparragus densiflorus* (Kunth), *Robinia hispida* L.
	Aphis fabae Scopoli	*Pittosporum* sp.
	Aphis spiraecola Patch	*Pittosporum* sp.
	Cinara sp.	*Cedrus deodara* (D. Don) G. Don, *Cupressus* sp.
Prenolepsis Mayr	*Aphis gossypii* Glover	*Bignonia* sp., *Oenothera speciosa* Nutt, *Salvia splenders* Kerk-Gawl
	Aphis craccivora Koch	*Oenothera speciosa* Nutt
	Aphis spiraecola Patch	*Crategus* sp., *Pittosporum* sp., *Hydrangea macrophylla* (Thunb.) DC
	Aphis hederae Kaltenbach	*Hedera helix* L.
	Brachycaudus helichrysi (Kaltenbach)	*Hydrangea macrophylla* (Thunb.) DC
	Rodobium porosum (Sanderson)	*Rosa* sp.

colonized by aphids (data not shown). Rosaceae were the ornamental host plant family with the greatest number of plant species registered, and Cactaceae, with five ornamental host plant species, was a new aphids' host plant family in Argentina. Furthermore, I found 38 new associations in Argentina, from 59 associations between a particular plant species and a particular aphid species recorded (Table I). Among these plant/aphid associations, the most frequently observed was the association between Rosa sp. and *Wahlgreniella nervata* (Gillette). This association was found in a 4.6% of the total samples recorded.

Aphid colonies characteristics

Most aphid colonies were medium size (10-50 aphids per colony) of polyphagous aphid species, and a high proportion (more than 40%) of colonies had alate aphid forms (Fig. 1). *Aphis craccivora* showed the highest number of large colonies, whereas *Macrosiphonella sanborni* (Gillette) and *Rodobium porosum* (Sanderson) never showed colonies with alate individuals during the study (data not shown). In terms of host aphid specificity, in the 17 aphid species, we found five monophagous, six oligophagous and six polyphagous species colonizing ornamentals in the area (Table I). Finally, most aphid species were strictly monoecious (59%), whereas *C. korshelti* was the only species strictly heteroecious (Table I).

Ant attendance

Ants attended more than 30% of aphid colonies (Fig. 1). Seven ant genus, nine aphid species and twenty-seven ornamental host plant species produced forty-one ant-aphid associations in the study area (Table II). Aphid species attended by ants were *Aphis craccivora*, *A. fabae* Scolopoli, *A. gossypii*, *A. hederae* Kaltenbach, *A. spiraecola* Patch, *Brachycaudus helichrisy* (Kaltenbach), *Cinara sp.*, *Myzus persicae* (Sulzer), and *Wahlgreniella nervata* (Gillette). *Aphis gossypii* was attended by all ant genus

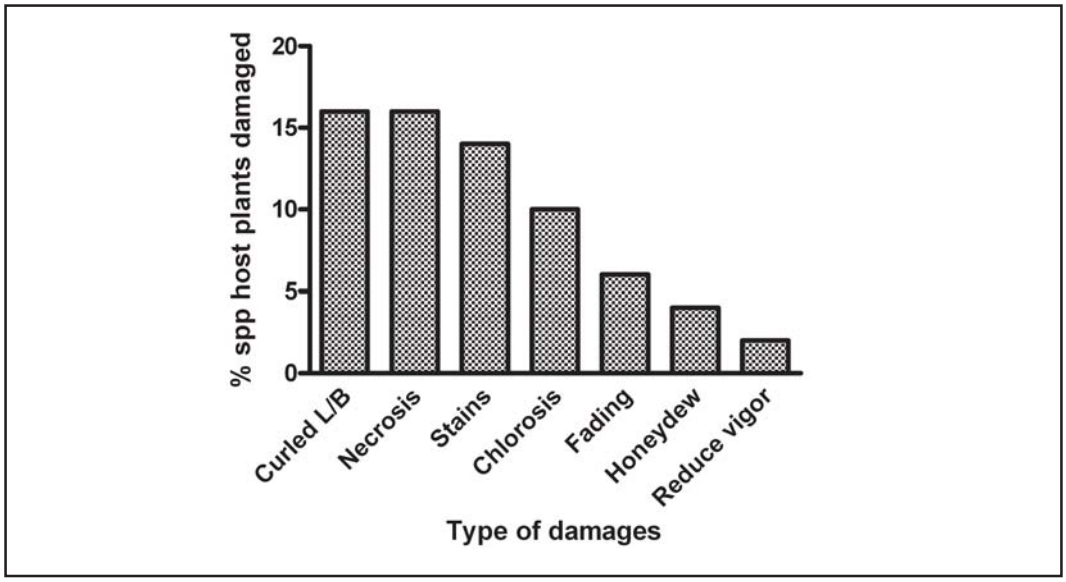

Fig. 2. Aphid damages in ornamental plants. Columns show relative percentages of host plant species with different damages found in the study. Curled L/B= Curled leaves or buds, Honeydew= honeydew deposits, reduce vigor= reduce plant vigor.

recorded in the study area. *Camponotus* Mayr and *Prenolepis* Mayr were the ant attendant genus that attended the highest number of aphid species. Most aphid colonies attended by ants were medium or large size (data not shown).

Aphid damages in ornamental plants

In 109 samples, more than 40% of ornamental host plant families showed damages (Fig. 1). Leaves and buds were the most commonly infested plant organs followed by flowers (data not shown). *Aphis gossypii* and *A. craccivora,* the most frequent aphid species, were especially associated with the most frequent damages: curled leaves or buds and necrosis, respectively (Fig. 2). *M. sanborni* and *M. persicae* were only associated with necrosis, whereas *Cinara* sp. was the only one that produced outstanding honeydew deposits.

DISCUSSION

This study confirmed that 13 out of 72 aphid species recorded in Córdoba (Argentina) by Nieto Nafría *et al.* (1994) colonize ornamental plants. Moreover, these surveys added four aphid species new in the area, one of them, *Cryptomyzus korshelti* Börn, was previously reported (Szpeiner & Delfino, 2002). The importance of the presence of *C. korshelti* in Argentina was related with this species range distribution, until now exclusively European (Heie, 1994).

For *Tinocallis (Sarucallis) kahawaluokalani* (Kirkaldy) and *Tuberculatus querceus* (Kaltenbach), their presence in Córdoba expanded their distribution along Argentina. La Rossa *et al.* (1997) reported the first finding of *Tinocallis (Sarucallis) kahawaluokalani* (Kirkaldy) in Argentina but limited to Buenos Aires. On the other hand, Nieto Nafría *et al.* (1994) mentioned the first occurrence in South America of *Tuberculatus querceus* (Kaltenbach) in Santa Fe (Argentina). Essig (1953) mentioned for the first time in Argentina (Salta) the fourth new species, *Uroleucon ambrosiae* (Thomas), colonizing *Artimisia* sp. However, Nieto Nafría *et al.* (1994) affirmed this finding could be accidental because *Uroleucon ambrosiae* (Thomas) only colonize composite plants. My report of *U. ambrosiae* (Thomas) in Córdoba colonizing two composite plant species (*Euryops* sp. and *Gerbera jamesonii* Bolus)

confirmed Essig's (1953) finding but also it expanded this species distribution to Córdoba and surroundings. For more details about this genus in South America refer to (De Carvalho *et al.*, 1998; Nieto Nafría et al.*,* 1994)

Aphis gossypii and *A. craccivora* were the most frequent aphids colonizing ornamental plants. These species are cosmopolitan and very important agricultural pests, with very wide host ranges (Blackman & Eastop, 2000). Nonetheless, ornamentals are generally exotic, and host of exotic aphid species were most probably introduced together from holartic populations (Ortego *et al.*, 2004).

The plant family with a greater number of species colonized by aphids was Rosaceae, which agrees with Dixon (1998) who mentions Rosaceae as the second most popular aphids' plant hosts group in the world, after Asteraceae. However, the reduced relevance of Asteraceae in this study may be related to restricted range of ornamentals that occurred in the surveyed area.

An interesting finding was that for the first time in Argentina I recorded Cactaceae as host of two exotic Aphididae species, *Aphis gossypii* and *A. craccivora.* However, these plants were growing outside their natural ecological conditions and exposed to the gardens´ fertile soils and higher water availability, which may have altered the plant's physiology, inducing the colonization. Food quality is known as an important feature in aphids' host selection (Dixon 1970, 1998).

Self-regulation allows aphid colonies to maintain aphid individual number according to available food resources (Shaposhnikov, 1989). This self-regulation could be the ecological mechanism behind the maintenance of most colonies found in ornamentals with a medium size. This idea is also supported by the frequent presence of alate individuals found. The production of alate individuals, which is a response to overcrowding or shortage of food resources, is the main mechanism in self-regulation of aphid colonies (Dixon, 1998)

In the study area, as expected according to soluble nitrogen level, aphids infested mainly buds, leaves and flowers (Dixon, 1998). However, most aphids found were oligophagous or polyphagous, which disagrees with a previous study in Sao Carlos, Brazil (Peronti & Sousa da Silva, 2002), where monophagy prevailed as the most common pattern of host specificity. It is not clear from our study if this difference was caused by the ecological conditions affecting overall aphid diversity in each geographical region, or if it is just a sampling effect.

Most aphid species on ornamentals in Córdoba were strictly monoecious. This result agrees with some authors (i.e. Dixon, 1998; Mondor *et al.,* 2006) that assert monoecious aphid species must be better able to survive in new environments. Ornamental plants may be considering «new environments» as a result of, as I discussed above, their exotic origin.

The high percentage of aphid colonies attended by aphids (more than 30%) showed the relevance of these interactions on ornamentals in the study area. According to Delfino & Buffa (2000), ant attendance favors aphids' host plant colonization, strengthening the colonies by allowing a higher number of individuals per colony. Most aphid colonies on ornamentals were medium or large. *A. gossypii,* the aphid species that colonized most ornamental host plant species, was attended by a high number of different ant genera. It is well documented that aphid species are associated with several ant genera that may vary according to host plants distributions irrespectively of aphid host plant specificity (Delfino & Buffa, 1996). In agreement with Delfino & Buffa (1996), *Camponotus* was the ant genus associated with the highest number of aphid species even when *Prenolepis* attended the same number of species.

It is known that, in ornamentals, aesthetic damage has low tolerance (Krips *et al.*, 1998). The results presented here showed that most ornamental plants had some direct damage when they are infested by aphids, warning about the relevance of Aphididae as pest in ornamental plants in the study area. In addition, curled leaves or buds and necrosis were the most common damage, which suggests virus diseases associated with the

aphid infection (Miles, 1989). Honeydew deposits, which produce a significant reduction in light use efficiency and maximum rate of assimilation in leaves promoting leave aging (Wellings, 1989) were also observed. However, in the study area, this type of damage was less frequent than direct damage and closely related to *Cinara* sp. and, therefore, associated with Coniferae.

Final remarks

This work provides evidence that a high percentage of aphid fauna cited in Argentina colonize and cause damages in ornamental plants in urban habitats. Further studies will help us to confirm aphid species distribution, to assess ornamental host plant range as well as to find ecological patterns that allow us to characterize more completely aphid infestation on ornamentals. This information on aphids and other arthropod species is important in the context of continuous urban expansion.

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LITERATURE CITED

1. ADDICOTT, J. H. 1978. Competition for mutualists: aphids and ants. *Can. J. Zool.* 56: 2093-2096.
2. ARRUDA, S. T., M. P. OLIVETTE & C. E. CASTRO. 1996. Diagnostico da floricultura do Estado de Sao Paulo. *Rev. Bras. Hort. Ornam.* 2: 1-18.
3. BLACKMAN, R. L. & V. F. EASTOP. 2000. *Aphids on the World's Crops: An Identification and Information Guide*. John Wiley, Chichester.
4. CLEMENTS, K. M., C. E. SORENSON, B. M. WIEGMANN & M. ROE. 2000. Insecticide resistence in the *Myzus persicae* complex (Homoptera-Aphididae) with emphasis on tobacco pest management. *Rev. Toxicol.* 3: 1-23.
5. DE CARVALHO, R. C. Z.., R. BLACKMAN & J. M. SPENCE.. 1998. The genus *Uroleucon* Mordvilko (Insecta, Aphididae) in South America, with a key. *Zool. J. Linn. Soc.* 123:117-141.
6. DELFINO, M. A. Inéd. Aphididae (Homoptera) de la provincia de Córdoba. Tesis, Universidad Nacional de Córdoba, Córdoba, 1982, 195 pp.
7. DELFINO, M. A. 1981. Una nueva especie del género *Wahlgreniella* H. L. R. 1949 (Hom. Aphididae). *Rev. Soc. Entomol. Argent.* 41: 111-113.
8. DELFINO, M. A. & L. M. BUFFA. 1996. Asociaciones hormigas-planta en la Argentina. *Rev. Per. Ent.* 39: 81-84.
9. DELFINO, M. A. & L. M. BUFFA. 2000. Algunas interacciones planta-hormiga en Córdoba (Argentina). *Zool. Baetica* 11: 3-15.
10. DELFINO, M. A. & A. BINAZZI. 2002. Áfidos de Coníferas en la Argentina (Hemiptera: Aphididae). *Rev. Soc. Entomol. Argent.* 61(3-4): 27-36.
11. DIXON, A. F. G. 1970. Quality and availability of food for sycamore aphid population. *In:* Waton, A. (ed.), *Animal Populations in Relation to their Food Resources*, Blackwell, Oxford, pp. 271-287.
12. DIXON, A. F. G. 1998. *Aphid Ecology*. Chapman & Hall, New York.
13. ESSIG, E. O. 1953. Some new and noteworthy Aphididae from western and southern South America. *Proc. Calif. Acad. Sci.* 28: 59-164.
14. HEIE, O. E. 1980. *The Aphidoidea (Hemiptera) of Fennoscandia and Denmark: Fauna Entomologica Scandinavica.* Scandinavian Science Press, Leiden-Copenhagen.
15. HEIE, O. E. 1982. *The Aphidoidea (Hemiptera) of Fennoscandia and Denmark: Fauna Entomologica Scandinavica II.* Scandinavian Science Press, Leiden-Copenhagen.
16. HEIE, O. E. 1986. *The Aphidoidea (Hemiptera) of Fennoscandia and Denmark: Fauna Entomologica Scandinavica III.* Scandinavian Science Press, Leiden-Copenhagen.
17. HEIE, O. E. 1992. *The Aphidoidea (Hemiptera) of Fennoscandia and Denmark: Fauna Entomologica Scandinavica IV.* Scandinavian Science Press, Leiden-Copenhagen.
18. HEIE, O. E. 1994. *The Aphidoidea (Hemiptera) of Fennoscandia and Denmark: Fauna Entomologica Scandinavica V.* Scandinavian Science Press, Leiden-Copenhagen.
19. HEIE, O. E. 1995. *The Aphidoidea (Hemiptera) of Fennoscandia and Denmark: Fauna Entomologica Scandinavica VI*. Scandinavian Science Press, Leiden-Copenhagen.
20. HILLE RIS LAMBERS, D. 1939. Contributions to a monograph of the Aphididae of Europe II. *Temminkia* 4: 1-134.
21. HILLE RIS LAMBERS, D. 1947. Contributions to a monograph of the Aphididae of Europe III. *Temminkia* 7: 179-319.
22. HILLE RIS LAMBERS, D. 1953. Contributions to a monograph of the Aphididae of Europe V. *Temminkia* 11: 1-176.
23. HÖLLDOBLER, B. & E. WILSON. 1990. *The ants*. Springer, Berlin - New York.
24. KENNEDY J. S., M. F. DAY & V. F. EASTOP. 1962. *A Conspectus of aphids as vector of plants viruses*. Commonwealth Institute of Entomology, London.
25. KRIPS, O. E., A. WITUL, P. E. L. WILLEMS & M. DICKE. 1998. Intrinsic rate of population increase of the spider mite *Tetranychus urticae* on the ornamental crop *Gerbera*: intraspecific variation in host plant and herbivore. *Entomol. Exper. Applic.* 89: 159-168.

26. LA ROSSA, F. R., A. L. VASICEK & A. NORIEGA. 1997. Presencia de *Sarucallis kahawaluokalani* sobre «crespón» (*Lagerstroemia indica)* en la Argentina (Homoptera: Aphidoidea). *Rev. Soc. Entomol. Argent.* 56: 97-100.
27. MILES, P. W. 1989. Specific responses and damage caused by Aphidoidea. *In:* Minks, A. K. & P. Harrewijn (eds.), *Aphids, their Biology, Natural Enemies and Control*, Elsevier, Amsterdam, pp. 255-268.
28. MONDOR E. B.., E. TREMBLAY & R. H. MESSIG. 2006. Morphological and ecological traits promoting aphid colonization of the Hawaiian Islands. *Biol. Invasions* DOI 10.1007/s10530-006-9010-z.
29. NIETO NAFRÍA, J. M., M. A. DELFINO & M. P. MIER DURANTE. 1994. *La Afidofauna de la Argentina. Su conocimiento en 1992.* Universidad de León, León, España.
30. ORTEGO J., M. E. DIFABIO & M. P. MIER DURANTE. 2004. Nuevos registros y actualización de la lista faunística de los pulgones (Hemiptera-Aphididae) de la Argentina. *Rev. Soc. Entomol. Argent.* 63: 13-30.
31. ORTEGO J., N. PERÉZ HIDALGO, J. M. NIETO NAFRÍA & M. P. MIER DURANTE. 2006. Six alien aphid species (Hemiptera: Aphididae) recorded for the first time from South America. *Fla. Entomol.* 89: 111-116.
32. PERONTI, A. L. B. G. & C. R. SOUSA DA SILVA. 2002. Aphids (Hemiptera: Aphidoidea) of ornamentals plants from Säo Carlos, Säo Paulo State, Brazil. *Rev. Biol. Trop.* 50 (1): 137-144.
33. REMAUDIÈRE, G. 1992. Une Méthode simplifiée de montage des aphides et autres petits insectes dans le baume du canada. *Rev. Fr. Entomol.* 14(4): 185-186.
34. SADRAS, V. O., A. FERERES & R. H. RATCLIFFE. 1999. Wheat Growth, Yield, and Quality as affect by insect herbivores. *In:* Satorre, E. H. & G. A. Slafer, (eds.), *Wheat: Ecology and physiology of yield determination*, The Haworth, New York, pp. 183-227.
35. SANCHEZ, M. C., M. CERMELIO, W. MACHADO, F. CENTENO & E. BROWN. 2000. Diversidad de áfidos (Homoptera: Aphididae) capturados con trampas amarillas en el cultivo de pimentón (*Capsicum annuum* L.) y su relación con los factores climáticos. *Bol. Entomol. Venez.* 15 (1): 61-83.
36. SHAPOSHNIKOV, G. C. 1989. Organization (structure) of populations and species, and speciation. *In:* Minks, A. K. & P. Harrewijn (eds.), *Aphids, their Biology, Natural Enemies and Control*, Elsevier, Amsterdam, pp. 415-430.
37. SZPEINER, A. & M. A. DELFINO. 2002. *Cryptomyzus korschelti* Börner (Hemiptera, Aphididae) nuevo áfido para la fauna argentina. *In:* XI Jornadas Fitosanitarias Argentinas, Río Cuarto, Córdoba, Argentina, pp. 127.
38. UNITED NATIONS. 2001. *World urbanization prospects: the 2001 revision*. United Nations, Department of Social and Economic Affairs.
39. VITOUSEK, P. M.., H. A. MOONEY, J. LUBCHENCO & J. M. MELILLO. 1997. Human domination of earth's ecosystems. *Science* 277: 494-499.
40. VÖLKL W., J. WOODRING, M. FISHER, M. W. LORENZ & K. H. HOFFMANN. 1999. Ant-aphid mutualisms: the impact of honeydew production and honeydew sugar composition on ant preferences. *Oecologia* 118: 483-491.
41. WELLINGS P. C., S. A. WARD, A. F. G. DIXON & R. RABBINGE. 1989. Crop Loss Assessment. *In*: Minks, A. K. & P. Harrewijn (eds.), *Aphids, their Biology, Natural Enemies and Control*, Elsevier, Amsterdam, pp. 49-64.
42. WILBY, R. L. & G. L., PERRY. 2006. Climate change, biodiversity and the urban environment: a critical review based on London, U..K. *Prog. Phys. Geog.* 30(1): 73-98.