Insects associated with syconia of Ficus citrifolia (Moraceae) in central Brazil

Priscila Canesqui da Costa¹ & Gustavo Graciolli²

ABSTRACT. Insects associated with syconia of Ficus citrifolia in central Brazil. Fig trees present a diverse interaction with different groups of organisms. The inflorescence, or syconium, has characteristics that form a microenvironment in which interactions occur between fig trees and invertebrates. This study aimed to identify the insect fauna associated with the figs of Ficus citrifolia and to quantitatively describe the distribution pattern of the insects in the syconium, in an urban area in central Brazil. The syconia were used by 12 species of insects. Our results showed that the insects found on Ficus citrifolia presented a pattern of occurrence that depends on the composition of species found within each syconium.

KEYWORDS. Agaonidae; fig wasp; micro-hymenopteran; plant-insect interaction; polinization.

The genus Ficus L., 1754 is composed of about 750 species worldwide, about 100 species of which occur in the Neotropics (Berg & Villavicencio 2004). Fig trees have a complex obligate mutualistic relationship with their pollinators and diversified interactions with different groups of organisms (Compton et al. 1996; West et al. 1996; Weiblen 2002; Kjellberg et al. 2005; Harrison et al. 2008). The main characteristic of this genus is its inflorescence, or syconium, which is shaped like an urn and in which the flowers grow. The only opening to the outside (ostiole) is formed by overlying bracts (Janzen 1979). Due to these unique features, figs present a micro-environment where interactions between fig trees and invertebrates occur, forming a microcosm, where mutualistic and antagonistic relationships are established (Jackson 2004).

Pollination of figs is performed by female wasps of the family Agaonidae (Chalcidoidea), who deposit pollen and eggs in the distillate flowers. In the ovaries in which pollen was deposited, seed development occurs, while in the ovaries where the eggs were deposited larvae developed (Weiblen 2002). The fig syconia are also exploited by different groups of organisms that are non-pollinators, such as wasp species of the families Pteromalidae, Torymidae and Eurytomidae (Boucek 1993; Weiblen 2002), since they deposit their eggs from the outside, and other arthropods such as beetles and butterfly larvae, mites and drosophilid flies (Lachaise et al. 1982; Bronstein 1988a; Frank & Thomas 1996; Pereira et al. 2000; Schifler 2002; Sugíura & Yamazaki 2004).

Most studies about the exploitation of fig syconia by different organisms are related to their influence on the reproductive success of the plant and reproductive success of their pollinators (Bronstein 1988a, b; Kerdelhué & Rasplus 1996; Pereira et al. 2000; Pereira & Prado 2005a, b; Elias et al. 2007). In Brazil, some authors used Ficus citrifolia P. Miller, 1768 for studies of this relationship (Pereira et al. 2000 referred to as Ficus eximia Schott, 1827; Pereira et al. 2003; Pereira & Prado 2005a, b; Elias et al. 2007; Pereira et al. 2007a, b; Elias et al. 2008). However, quantitative studies of the relationship between fig trees and insects associated with their syconia are scarce (Farache et al. 2009). Here we identified the insect fauna associated with syconia and quantitatively described the distribution of these insects in F. citrifolia.

The study was conducted in an urban area in the central region of Campo Grande, state of Mato Grosso do Sul, Brazil (20° 28’S, 54° 36’W). Thirty three syconia were collected.
from one *F. citrifolia* individual (subgenus *Urostigma*, section *Americana*). This tree usually has an hemi-epiphytic habit and grows on other trees or buildings often being found in disturbed areas (Pereira et al. 2007b). Male-phase syconia were collected and placed individually in plastic vials and maintained in the laboratory for about 48 hours to collect all emerged wasps. After 48 hours we added 70% alcohol to each vial and the syconia were dissected to search for other insects. Wasps were identified up to the genus level according to Bouček (1993), Rasplus & Soldati (2006) and Farache & Pereira (2010). The other groups of insects found were identified to the lowest possible taxonomic level. The specimens were deposited in the Zoological Reference Collection of the Federal University of Mato Grosso do Sul, Campo Grande, MS, Brazil.

The indices used to describe the distribution of species in the syconia were the frequency of occurrence (number of infested syconia/number of collected syconia X 100) and mean intensity (number of individuals of species x/number of collected syconia X 100) and frequency of occurrence of species that infested the syconia according to Bouček (1993), Rasplus & Soldati (2006) and Bouček (1993). Some species of *Idarnes* (group *carme*) are gallers, depositing their eggs in syconia prior to pollination (Elias et al. 2007). Some species of *Idarnes* (group *carme*) are infilators, laying eggs into galls induced by *Pegoscapus* spp. (Pereira et al. 2007a; Elias et al. 2008), whereas other groups (e.g. *incerta* and *flavicollis* groups) are gallers, depositing their eggs in syconia prior to pollination (Elias et al. 2008).

**Table I.** Insects associated with syconia of *Ficus citrifolia* in Campo Grande, MS, Brazil. Numbers in parenthesis correspond to 95% confidence interval. * insufficient number of samples to calculate the confidence interval.

<table>
<thead>
<tr>
<th>Associated Species</th>
<th>N</th>
<th>Number of infested syconium</th>
<th>Frequency of occurrence</th>
<th>Mean intensity</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Pegoscapus</em> sp.</td>
<td>3,617</td>
<td>33</td>
<td>100.0 (89.4 – 100.0)</td>
<td>109.6 (98.1 - 121.3)</td>
</tr>
<tr>
<td><em>Idarnes</em> sp. 1 (group <em>carme</em>)</td>
<td>797</td>
<td>28</td>
<td>84.8 (68.1 – 94.9)</td>
<td>28.5 (22.0 – 36.7)</td>
</tr>
<tr>
<td><em>Idarnes</em> sp. 2 (group <em>carme</em>)</td>
<td>237</td>
<td>20</td>
<td>60.6 (42.1 – 77.1)</td>
<td>11.9 (8.6 – 16.6)</td>
</tr>
<tr>
<td><em>Idarnes</em> sp. 3 (group <em>carme</em>)</td>
<td>9</td>
<td>1</td>
<td>3.0 (0.7 – 15.8)</td>
<td>9.0*</td>
</tr>
<tr>
<td><em>Idarnes</em> sp. 4 (group <em>carme</em>)</td>
<td>12</td>
<td>4</td>
<td>12.1 (3.4 – 28.2)</td>
<td>3.0*</td>
</tr>
<tr>
<td><em>Idarnes</em> sp. 5 (group <em>carme</em>)</td>
<td>105</td>
<td>21</td>
<td>63.3 (45.1 – 79.6)</td>
<td>5.0 (4.0 – 6.6)</td>
</tr>
<tr>
<td><em>Aeopocerus</em> sp. 1</td>
<td>23</td>
<td>7</td>
<td>21.2 (9.0 – 38.9)</td>
<td>3.3 (2.0 – 4.9)</td>
</tr>
<tr>
<td><em>Heterandrium</em> sp.</td>
<td>7</td>
<td>3</td>
<td>9.1 (1.9 – 24.3)</td>
<td>1.7*</td>
</tr>
<tr>
<td><em>Physothorax</em> sp. 1</td>
<td>40</td>
<td>14</td>
<td>42.4 (25.5 – 60.8)</td>
<td>2.9 (1.9 – 3.8)</td>
</tr>
<tr>
<td><em>Physothorax</em> sp. 2</td>
<td>13</td>
<td>4</td>
<td>12.1 (3.4 – 28.2)</td>
<td>3.3*</td>
</tr>
<tr>
<td><em>Lygaeidae</em> (nymph)</td>
<td>2</td>
<td>1</td>
<td>3.0 (0.7 – 15.8)</td>
<td>2.0*</td>
</tr>
<tr>
<td><em>Staphylinidae</em></td>
<td>1</td>
<td>1</td>
<td>3.0 (0.7 – 15.8)</td>
<td>1.0*</td>
</tr>
</tbody>
</table>

**Table II.** Frequency of co-occurrence of wasps in figs of *Ficus citrifolia* in Campo Grande, MS, Brazil.

<table>
<thead>
<tr>
<th>Association</th>
<th>Frequency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Pegoscapus</em> + <em>Idarnes</em> (group <em>carme</em>)</td>
<td>97.0</td>
</tr>
<tr>
<td><em>Pegoscapus</em> + <em>Idarnes</em> (group <em>carme</em>) + <em>Idarnes</em> (group <em>incerta</em>)</td>
<td>63.3</td>
</tr>
<tr>
<td><em>Pegoscapus</em> + <em>Idarnes</em> (group <em>carme</em>) + <em>Idarnes</em> (group <em>incerta</em>) + <em>Aeopocerus</em></td>
<td>15.2</td>
</tr>
<tr>
<td><em>Pegoscapus</em> + <em>Idarnes</em> (group <em>carme</em>) + <em>Idarnes</em> (group <em>incerta</em>) + <em>Aeopocerus</em> + <em>Physothorax</em></td>
<td>15.2</td>
</tr>
</tbody>
</table>

This study is the first to report the insect fauna associated with the syconia of a species of the genus *Ficus* in the midwestern region of Brazil. As in other sites, the fig species studied here also presented a diverse interaction with different insect species (Bronstein 1988a, b; Frank & Thomas 1996; West et al. 1996; Pereira et al. 2000; Schiffer 2002; Sugira & Yamazaki 2004; Nazareno et al. 2007). In urban areas in the cities of Campinas (22°54’S, 47°03’W) and Londrina (23°18’S, 51°09’W) syconia of *F. citrifolia* presented 15 species of insects in five crops and 14 species in eight crops, respectively (Pereira 1998).

As in the present study, Staphylinidae beetles were also found in Florida and Costa Rica (Frank & Thomas 1996; Bronstein 1988b) and were considered predators of fig wasps. Seed bugs in the family Lygaeidae are known to be seed predators and were also found feeding on seeds of *Ficus* in Africa and India (Slater 1972). However, in other studies, these insects were found outside of the syconia, different from the results found here.

*Pegoscapus* sp. 1 shows high frequency of occurrence and intensity in the analyzed syconia (Table I). However, this species was observed in lower infestations in urban areas of Campinas, Londrina and Ribeirão Preto (21°10’S; 51°09’W), due to parasitism and/or competition with non-pollinating wasps, mostly belonging to the genus *Idarnes* (Elias et al. 2007). *Idarnes* are the most abundant inquilines and competitors in the New World (West & Herre 1994). Some species of *Idarnes* (group *carme*) are inquilines, laying eggs into galls induced by *Pegoscapus* spp. (Pereira et al. 2007a; Elias et al. 2008), whereas other groups (e.g. *incerta* and *flavicollis* groups) are gallers, depositing their eggs in syconia prior to pollination (Elias et al. 2008).
type of exploration may explain the high frequency of co-occurrence of *Idarnes* (group carne) and *Pegoscapus*, showing a dependency relationship between these species. The biology of *Aepocerus*, *Heterandrium* and *Physotothorax* genera are not well known, but these species are considered inquilines or parasites by some authors (West et al. 1996; Pereira et al. 2000; Elias et al. 2008). This fact may explain the lower occurrence and average intensity of these species, since parasites are less frequent, depending on the presence of their hosts in the syconium.

The fauna of insects associated with *F. carinata* in Campo Grande is similar to that found in other locations in Brazil (Pereira 1998; Pereira & Prado 2005a; Pereira et al. 2000; Farache & Pereira 2010). The quantitative analysis of interactions between these organisms demonstrated a pattern of occurrence in each syconium that depends on the composition of species found within the syconium.

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## REFERENCES


