Bionomics of *Neolasioptera aculeatae* (Diptera: Cecidomyiidae), a promising biological control candidate against *Parkinsonia aculeata* (Fabaceae)

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**RESUMEN.** Inspecciones de campo realizadas sobre *Parkinsonia aculeata* L. en el Norte-centro de Argentina entre 2008 y 2011 revelaron la presencia del mosquito agallícola *Neolasioptera aculeatae* Gagné (Diptera: Cecidomyiidae). La presencia de las agallas de *N. aculeatae* está restringida a la distribución norte de *P. aculeata*. La diseción de agallas recolectadas a lo largo del año, reveló la presencia de larvas y/o pupas en distintos estados fenológicos de *P. aculeata*. La emergencia de adultos de *N. aculeatae* tuvo lugar 13 a 34 días desde la recolección en el campo y se extendió por un período promedio de 22 días. Entre once especies de leguminosas inspeccionadas en el campo, adultos de *N. aculeatae* emergieron únicamente de agallas recolectadas sobre *P. aculeata*. Los atributos biológicos y el restringido conjunto de plantas hospedadoras utilizadas en el campo, hacen de *N. aculeatae* un agente promisorio para el control biológico de *P. aculeata*.


**INTRODUCTION**

*Parkinsonia aculeata* L. (“cina-cina”) (Leguminosae: Caesalpinioideae) is a thorny leguminous shrub native to the hot and dry regions of North, Central and South America (Hawkins *et al.*, 2007). This species has a pan-tropical distribution following introduction as an ornamental, hedging, fodder and shade tree (Stewart *et al.*, 1992; Wagner *et al.*, 1999; PIER, 1999; Hawkins,
The distribution of *N. aculeatae* was determined through extensive exploratory trips made along the main roads of North-central Argentina, between 2008 and 2011 (Fig. 1). In total, 20 surveys were conducted with 29 sites inspected, some of which were visited up to four times a year to account for seasonal variations. Surveys generally lasted seven days, and included two to three collectors. Time spent on-site rarely exceeded two hours. *P. aculeata* plants occurring mainly along the roadsides, rangelands and river beds were visually inspected for the presence of galls. Seasonal occurrence and field host range surveys were conducted at several sites along a longitudinal range of c. 500 km in northern Argentina (Chaco, Formosa and Salta provinces) (Fig. 1). The area has a tropical summer rainfall climate (world climate zone 2, as described by Walter et al., 1975) with a mean annual temperature of 22 °C and annual rainfalls (500-1,000 mm), concentrated in the spring-summer months (October-March) (Servicio Meteorológico Nacional, 2000).

### Seasonal occurrence

Plants of *P. aculeata* were sampled four times between March and November 2010 (Table I). For each site, the number of surveyed plants and the number of galls were recorded. Phenological stage of the plants was registered as flowering, fruiting or vegetative. Only fresh active galls with soft green tissue and developing insects were included in the study. Galls were collected by cutting *P. aculeata* branches with a heavy-duty pruner, kept in plastic containers and transported to the laboratory. A subsample of galls were dissected under a stereo microscope (Olympus SZ61; maximum magnification: 45X) to determine the life stage of specimens inside the galls. The rest of the galls were kept in controlled environmental chambers (25 ± 2 °C; 60-80% RH; 16:8 L:D) for subsequent emergence of adult specimens.

### Field host range

During the summer 2009/10 and 2010/11, nine sites with populations of *P. aculeata* and ten co-occurring legume species were surveyed for...
the presence of galls (Fig. 1). Plant species were selected for their phylogenetic proximity, ecological/distribution overlap and morphological similarity to *P. aculeata* (Table II). For each site, the number of surveyed plants and the number of collected galls were recorded. Samples were brought to the laboratory and kept in controlled environmental chambers (25 ± 2 °C; 60-80% RH; 16:8 L:D) for subsequent emergence of adults. Voucher specimens of the plants and insects collected were deposited in collections at the Fundación para el Estudio de Especies Invasivas (FuEDEI), Hurlingham, Buenos Aires.

**Laboratory rearing**

Preliminary rearing of *N. aculeatae* was attempted three times. On one occasion in September 2009, 10 adults were confined within a gauze-covered sleeve wrapped around the stem of a potted *P. aculeata* plant. A piece of cotton soaked in a water-sucrose solution was suspended from the upper access hole of the sleeve as a food source for the adults. A second attempt was conducted in 2011 when a collection of 800 galls rendered 400 adults (67 % female). A balanced number of male and female adults (9:51) were confined in 12 rearing aluminium frame cages lined with gauze and measuring 250 x 250 x 800 mm containing one *P. aculeata* potted plant. In 2012, a third rearing attempt was conducted using rearing cages upon a collection of 300 galls that rendered 150 adults.

**RESULTS**

**Distribution.** Presence of *N. aculeatae* galls was restricted to the northern distribution area of *P. aculeata* in Argentina (Fig. 1). Stem galls were collected from sites as far north as Embarcación, Salta (S 23.16°) and south to near Fortín Lavalle, Chaco (S 26.13°).

**Galls.** *N. aculeatae* stem galls were woody rounded/ovoid-shaped growths at the junction of the stem and the spines of *P. aculeata* plants (Fig. 2). Gall size ranged from 3-17 mm in length (9.3 ± 2.3) to 2-13 mm in width (6.6 ± 2.3) (mean ± S.D.; *n* = 191). Galls were green-purple in colour, similar to *P. aculeata* branches and young
shoots. Inside each gall, 1-5 light orange larvae developed individually inside galleries into yellowish mature larvae which completely filled the cavity. Pupation occurred in the gall after which adults eclosed, leaving the pupal exuviae protruding from the gall.

**Natural enemies.** Hymenopteran parasitoids that emerged from *N. aculeatae* galls were identified as *Platygaster* sp. (Platygastridae) (M. Loiácono, Museo de La Plata, pers. comm.).

**Seasonal occurrence**

Fresh active galls were found on all four of the sampling dates during 2010 (Table I). The highest number of galls per surveyed plant was registered in June, which coincides with the cool-dry season, while the lowest number was registered in November, the beginning of the hot-wet season. In March, *N. aculeatae* galls were mostly recorded to be at an early developmental stage and growing near the shoot-tips of vegetative *P. aculeata* plants. At some sites, almost all the shoot-tips of plants had galls at high densities (2-3 galls per shoot-tip). In June, most plants were in a vegetative stage, bearing medium- to large-sized galls. In September, small-to medium-sized galls were found near the shoot tips of flowering plants. In November, *P. aculeata* plants of vegetative/flowering stage bore very few medium-sized galls. Various larval instars were found when dissecting galls collected on each sampling date, while pupae were mostly found on galls collected in March. In addition, adults of *N. aculeatae* emerged from the remaining galls 13-34 days after collection and continued emerging for an average period of 22 (range: 15-28) days (Table I).

**Field host range**

From the nine sites visited, a total of 919 galls were collected from 416 *P. aculeata* plants. Adults of *N. aculeatae* emerged only from *P. aculeata* stem galls (Table II). *N. aculeatae* was not even found on the conspecific *Parkinsonia praecox*. However, different stem galls were found on *A. aroma* and *P. alba* species. Cecidomyiidae larvae dissected from galls on *Acacia aroma* were identified as "not *Neolasioptera*" (R. J. Gagné, USDA-ARS Systematic Entomology Laboratory pers. comm.).
Table I. Seasonal occurrence of *N. aculeatae* at selected sites in northern Argentina.

<table>
<thead>
<tr>
<th>Sampling dates</th>
<th>N° of examined <em>P. aculeata</em> plants/sites</th>
<th>N° of collected/Dissected galls</th>
<th>N° of life stages found on dissected galls (Larvae/Pupae)</th>
<th>N° of adults emerged from remaining galls/Dates</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-23 March</td>
<td>159 (6)</td>
<td>279/62</td>
<td>130/20</td>
<td>137 (37♂; 100♀) 7-21 April</td>
</tr>
<tr>
<td>16-18 June</td>
<td>152 (5)</td>
<td>609/50</td>
<td>90/0</td>
<td>471 (200♂; 271♀) 19 July-9 Aug</td>
</tr>
<tr>
<td>25-26 September</td>
<td>228 (4)</td>
<td>496/61</td>
<td>100/0</td>
<td>247 (97♂; 150♀) 18 Oct-15 Nov</td>
</tr>
<tr>
<td>24-25 November</td>
<td>171 (4)</td>
<td>46/12</td>
<td>13/3</td>
<td>21 (14♂; 7♀) 6-29 Dec</td>
</tr>
</tbody>
</table>

Table II. Field host range of *N. aculeatae* in the native range of Argentina.

<table>
<thead>
<tr>
<th>Plant species</th>
<th>N° of surveyed plants</th>
<th>N° of collected galls</th>
<th>Insect species emerged</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>P. aculeata</em></td>
<td>416</td>
<td>919</td>
<td><em>N. aculeatae</em></td>
</tr>
<tr>
<td><em>P. praecox</em></td>
<td>41</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td><em>A. aroma</em></td>
<td>69</td>
<td>152</td>
<td>Unidentified Cecidomyiidae (not <em>Neolasioptera</em>)</td>
</tr>
<tr>
<td><em>A. caven</em></td>
<td>35</td>
<td>64</td>
<td>?</td>
</tr>
<tr>
<td><em>N. pubescens</em></td>
<td>10</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td><em>P. alba</em></td>
<td>20</td>
<td>100</td>
<td>Unidentified Gracillariidae</td>
</tr>
<tr>
<td><em>P. fiebrigi or near</em></td>
<td>3</td>
<td>4</td>
<td>Unidentified Gracillariidae</td>
</tr>
<tr>
<td><em>P. ruscifolia</em></td>
<td>26</td>
<td>36</td>
<td>Unidentified Gracillariidae?</td>
</tr>
<tr>
<td><em>S. morongii</em></td>
<td>20</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td><em>S. obtusifolia</em></td>
<td>10</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td><em>S. exasperate</em></td>
<td>10</td>
<td>0</td>
<td>-</td>
</tr>
</tbody>
</table>

Gracillariidae moths emerging from *P. alba* and *P. fiebrigi* were identified as members of the Neurobathra group (unknown genus and species) (Don Davis, USDA-ARS Systematic Entomology Laboratory pers. comm.).

**Laboratory rearing**

Preliminary rearing of *N. aculeatae* using rearing sleeves produced two immature stem galls. However, neither full gall development nor adult emergence was recorded. Rearing attempts using cages proved unsuccessful.

**DISCUSSION**

Galls may act as physiological nutrient sinks on their host plants, (McCrea *et al.*, 1985; Larson & Whitham, 1991; Harris & Shorhouse, 1996; Goolsby *et al.*, 2000), and thus the impact of gall-forming insects on their host plants is not necessarily centered on the attacked host plant organ or tissue (Hartnett & Abrahamson, 1979; Sacchi *et al.*, 1988; Fernandes *et al.*, 1992). Therefore, the formation of stem galls by *N. aculeatae*, may be acting as a metabolic sink, indirectly reducing the potential of *P. aculeata* plants to flower and set mature, viable seeds.

Biological traits of gall-forming insects that increase their potential as biocontrol agents have been described by several authors. Based on studies conducted on the hymenopteran gall-maker *Trichilogaster acaciaelongifoliiae* on *A. longifolia* in South Africa, Dennill (1988) indicated different biological attributes that appear to increase the potential of gall-forming insects as biocontrol agents. Among these, the agent must live within the tissue that is galled, and the gall development must span the entire reproductive and/or growth phase of the plant. This was the case for *N. aculeatae*, where larvae and or
pupae were recorded in dissected *P. aculeata* galls throughout the year on plants at different phenological stages. This could be regarded as an attribute that would increase the potential effectiveness of *N. aculeatae* as biocontrol agent of *P. aculeata*.

Surveying closely related co-occurring species in the native range of the target contributes useful host-specificity data to prioritize agents for biocontrol (Witt, 2004; Goolsby et al., 2006). Surveys of host plant use in northern Argentina indicated that *N. aculeatae* galls were found exclusively on *P. aculeata*, thus constituting it's only known natural host. Although data could only be obtained from a small number of species, the fact that *N. aculeatae* galls were not found on the conspecific *P. praecox* indicated that *N. aculeatae* galls were found exclusively on *P. aculeata*, thus constituting it's only known natural host. Although data could only be obtained from a small number of species, the fact that *N. aculeatae* galls were not found on the conspecific *P. praecox* constitutes strong evidence of a restricted host range. Given the potential of *N. aculeatae* as biocontrol agent, we consider that further investigations, especially to improve rearing methods of *N. aculeatae*, should be pursued.

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**LITERATURE CITED**


