

SHORT COMMUNICATION

Habitat selection and potential antiherbivore effects of *Peucetia flava* (Oxyopidae) on *Solanum thomasiifolium* (Solanaceae)

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Abstract. Several spider species use plants as shelter and foraging sites, but the relationships among these organisms are still poorly known. Lynx spiders of the genus *Peucetia* do not build webs, and many species live strictly in plants bearing glandular trichomes. *Peucetia flava* Keyserling 1877 inhabits *Solanum thomasiifolium* in southeastern Brazil and usually preys on herbivores and other small insects adhered to the glandular trichomes of its host plant. To evaluate the potential anti-herbivore protection of this spider species for *S. thomasiifolium*, we glued termites used as herbivore models on trichomes of *S. thomasiifolium* and on neighboring plants lacking glandular trichomes. Leaf miner damage and spider density were recorded for *S. thomasiifolium* plants in July 1997. There was a positive relationship between plant size and spider density. The removal of termites in *S. thomasiifolium* by *P. flava* was higher than in plants without glandular trichomes. The leaf miner damage was negatively related to spider density. Our results suggest that *P. flava* may be an important plant bodyguard in the defense of *S. thomasiifolium* from its natural herbivores.

Keywords: Animal-plant interactions, host plant specificity, lynx spider, plant protection

It is widely known that several spider species use plants as shelter and foraging sites (Foelix 1996), but only in the last few decades have strict associations of spiders with particular plant types or species been described in detail. A variety of spider-plant associations has been described in the Neotropical regions (Barth et al. 1988; Dias & Brescovit 2004; Romero 2006). The associations typically occur because plants have morphological traits that provide suitable foraging, mating, and egg-laying sites for the spiders, shelter for adults and immatures, and nurseries for spiderlings (Romero & Vasconcellos-Neto 2005), thereby improving the probability of the spiders living on them. One of these associations includes jumping spiders (Salticidae) that are strictly associated with Bromeliaceae (Romero & Vasconcellos-Neto 2004a, 2004b, 2005; Romero 2006). For one of these associations, Romero et al. (2006) demonstrated through experiment that the jumping spider *Psecas chapoda* Peckham & Peckham 1894 contributed to 18% of the total nitrogen of its host terrestrial bromeliad *Bromelia balansae*, and in general, plants with spiders produced leaves 15% longer than plants from which the spiders were excluded.

Other associations involve spiders that forage on plants with glandular trichomes. For instance, at least 10 lynx spider species of the genus *Peucetia* (Oxyopidae) live strictly in several plant families and species bearing glandular trichomes in many distinct vegetation types in Neotropical, Nearctic, Palearctic, and Afrotropical regions. The main plant families used by these spiders are Solanaceae, Asteraceae, and Melastomataceae (Vasconcellos-Neto et al. 2007). The specialization of the *Peucetia* species for plants bearing glandular trichomes may have evolved because insects adhering to these sticky structures may be used as prey by the spiders (Vasconcellos-Neto et al. 2007). Although glandular hairs have probably evolved as a defense against herbivores

and pathogenic fungi (Levin 1973, Duffey 1986), they can also mediate mutualistic interactions between plants and spiders or other predators (Dolling & Palmer 1991; Romero et al. 2008).

In South America, *Peucetia rubrolineata* Keyserling 1877 and *P. flava* Keyserling 1877 are the most common representatives of the genus. Both species are widely distributed throughout Brazil and occur sympatrically in several localities (Santos & Brescovit 2003; Vasconcellos-Neto et al. 2007). In a forest reserve in the state of Espírito Santo, southeastern Brazil, *P. flava* is frequently observed in association with *Solanum thomasiifolium* Sendtn. 1846, a solanaceous plant bearing glandular hairs (Vasconcellos-Neto et al. 2007). While investigating the occurrence of spiders on 70 individuals of *S. thomasiifolium*, we observed that all individuals were inhabited by *P. flava*, while none of their neighboring plants ($n = 80$) had spiders.

To understand this spider-plant interaction better, we addressed the following questions: 1) Is *P. flava* abundance related to *S. thomasiifolium* size? 2) Are insect predation rates by *P. flava* on *S. thomasiifolium* higher than predation rates by other predators (e.g., ants, other spiders) on neighboring plants without glandular hairs?

This study was performed in the Reserva Natural da Vale do Rio Doce (19°26'S, 40°03'W), 30 km north of the city of Linhares, state of Espírito Santo, a forest reserve covered mainly by Atlantic Forest vegetation. The reserve comprises 22,000 ha of forest, elev. 28–65 m above sea level, and a soil rich in sand. The weather is seasonal, with rainfall varying monthly from 30 mm in the dry season (June) to 226 mm in the wet season (January). Mean annual rainfall is 1320 mm. Temperature varies from 10° to 30° C (Jesus 1988). Samplings were done in July 1996 and July 1997, in a 4-ha area of common, nativo vegetation on sandy soil, dominated by cacti, bromeliads, herbs, and small shrubs (Peixoto & Gentry 1990).

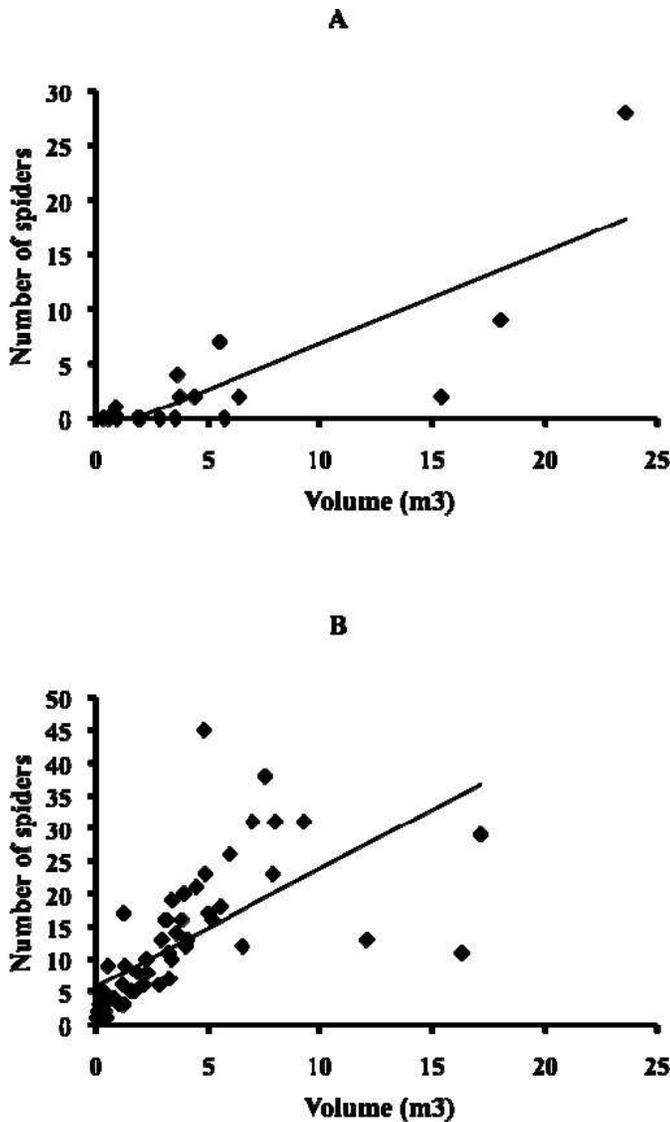


Figure 1.—Relation between *Peuceetia flava* abundance and *Solanum thomasiifolium* size. A. 1996 ($n = 17$), $y = -1.543 + 0.840 x$, $R^2 = 0.671$, $F = 30.569$, $P < 0.001$; B. 1997 ($n = 59$), $y = 5.710 + 1.810 x$, $R^2 = 0.428$, $F = 42.618$, $P < 0.001$.

To verify whether the abundance of *Peuceetia flava* correlates to the size of *Solanum thomasiifolium* plants, we estimated the size of plants in a 50-m random transect, in each year by measuring the maximum height of branches with leaves, the maximum canopy diameter, and the perpendicular length to this diameter. These measures were then multiplied to estimate plant size in cubic meters. The number of spiders was recorded on each plant by inspecting branches, leaves, and stems. This relationship was tested using linear regression.

We assessed the effect of spiders as bodyguards on *S. thomasiifolium* by using termite workers as herbivore models. We used termites instead of leaf-mining larvae because the former are thicker and less tender and, thus, easier to manipulate. In addition, once we attached termites to the surface they were unable to fly; thus, we could accurately judge predation rate. Fifteen plants of *S. thomasiifolium* and an equal number of similarly-sized neighboring plants without glandular trichomes were randomly selected in the study area. Each plant received ten termites randomly positioned on leaves of different branches, and after 30 min we recorded the number of individuals

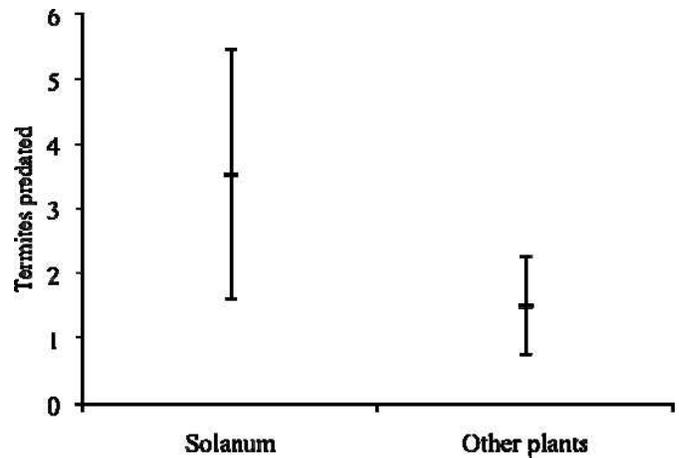


Figure 2.—Number of termites removed (mean \pm SD) from *Solanum thomasiifolium* and other neighboring plants without glandular hairs.

removed. Termites were affixed with non-toxic white glue (Cascolar[®]) to plants without glandular hairs to prevent them from falling off. This glue had no influence on spider behavior (unpublished data, GQR). Additionally, previous studies have used similar methods for the same purpose and shown that this type of glue does not interfere with predatory (e.g., ant) behavior (e.g., Oliveira et al. 1987). All the plants were checked once during the experiment in an attempt to record predation events. The removal rate of termites from both plant types was compared using a *t*-test for independent samples.

To estimate the relationship between *P. flava* and herbivory on *S. thomasiifolium*, we calculated spider density and estimated leaf miner damage in July 1997. We evaluated leaf miner herbivory because it is the commonest kind of damage caused by herbivores on *S. thomasiifolium* in the study area (personal communication). Plants were randomly selected, and four branches of each individual were evaluated for leaf miner damage. The numbers of intact and damaged leaves were recorded for 20 plants, and the ratio between damaged and total leaves was calculated. Spider density was estimated as the ratio between the number of spiders and the plant size in cubic meters. The relationship was tested using linear regression. Data normality and homoscedasticity were verified. Logarithm transformations were applied when necessary prior to the analyses (Zar 1999).

Voucher specimens of the spiders collected (males and females) were deposited in the Arachnological Collection of the Laboratório de Artrópodos Peçonhentos, Instituto Butantan, São Paulo (accession numbers: IBSP 12982, IBSP 12940, IBSP 12891, and IBSP 12887). *Solanum thomasiifolium* exsiccates were deposited at Universidade Estadual de Campinas Herbarium (UEC-Herbarium).

In 1996, we examined 17 *Solanum thomasiifolium* plants and found 57 *Peuceetia flava* individuals. In 1997, we recorded 694 spiders on 59 plants. Linear regressions indicated that spider abundance was positively correlated with plant size during both sampling periods (Figure 1). Figure 2 displays the results of the termite removal experiment on the 30 observed plants, with significantly higher predation rates on *S. thomasiifolium* than for other plants ($t = 3.88$; $df = 28$; $P < 0.001$). *Peuceetia flava* accounted for 11 of the 17 termite predation events observed on *S. thomasiifolium* (Figure 3). The other six events were recorded on plants without glandular trichomes. Those termites were removed by ants ($n = 4$) and salticid spiders ($n = 2$).

Larger plants had more spiders, probably because they provided more suitable habitat sites for the spiders. In a study of salticid-bromeliad association, Romero et al. (2007) showed that *Coryphasia monteverde* Santos & Romero 2007 inhabited large rosettes of



Figure 3.—*Peucetia flava* preying on termite placed on *Solanum thomasiifolium* (Photo G. B. J.).

Aechmaea distichantha and suggested that these spiders may actively select their microhabitats based on host plant size. Additionally, large plants may also represent a more suitable resource for many insects that constitute the main prey of the spiders. This hypothesis was proposed by Romero & Vasconcellos-Neto (2004a), who reported that another bromeliad-dwelling salticid, *Eustiromastix nativo* Santos & Romero 2004, had a similar microspatial distribution on two bromeliad species, possibly because larger plants have a higher probability of being visited by insects as a result of their large surface area.

Although we have no replicates or exclusion experiments demonstrating the influence of spiders on leaf miner density, observational and correlative data associated with the experiment using termites as herbivore models suggest that *P. flava* might act as an important plant bodyguard. The higher predation rates of the termite prey models on *S. thomasiifolium* compared to species without glandular trichomes suggest that *P. flava* is a very active insect predator, apparently surpassing the performance of sympatric ants and salticid spiders.

The role of *Peucetia* species in the reduction of the herbivore population and its destructive impact has already been demonstrated in studies with other plants. For instance, Louda (1982) has shown that *P. viridans* (Hentz 1832) can decrease herbivore damage to its host plant, *Haplopappus venetus* (Asteraceae). In addition, Romero et al. (2008) recently showed that *P. flava* and *P. rubrolineata* maintain mutualistic relationships with their host plant, *Trichogoniopsis adenantha* (Asteraceae), the spiders removing herbivores from their host plants and the glandular hairs of the plants improving the spiders' growth by facilitating predation on adhering insects.

In this study, we have provided evidence that the relationship between *P. flava* and *S. thomasiifolium* might be mutualistic. However, more definite conclusions should be obtained in the future by using spider exclusion experiments in the field.

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