

Simultaneous pollinator occurrence (Hymenoptera, Agaoninae) in a threatened species: *Ficus mexiae* Standley (Moraceae)

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Received January 3, 2012 – Accepted August 24, 2012 – Distributed August 31, 2013

(With 1 figure)

Abstract

In Brazil, *Ficus mexiae* is classified as Vulnerable under IUCN criteria, and to date there is only one report on pollinator activity for this species. It is not unusual to find cases where more than one species of wasp simultaneously occurs on and pollinates the same fig. In this study we present evidence that two *Pegoscapus* wasp species contribute to the pollination of *F. mexiae* and relationship between pollinators may be competitive. These results indicate that the *F. mexiae* population represent an important element in the complex dynamics of maintaining diversity in neotropical *Ficus* spp.

Keywords: co-occurrence, pollinators, *Pegoscapus*, *Ficus mexiae*.

Ocorrência simultânea de polinizadores (Hymenoptera, Agaoninae) em uma espécie ameaçada: *Ficus mexiae* Standley (Moraceae)

Resumo

No Brasil, *Ficus mexiae* é classificada como uma espécie vulnerável sob os critérios da IUCN, e até agora não há um único relatório sobre a atividade dos polinizadores desta espécie. Não é raro encontrar casos em que mais de uma espécie de vespa, simultaneamente, ocorre e poliniza o mesmo figo. Neste estudo, apresentamos evidências de que duas espécies de vespas *Pegoscapus* contribuem para a polinização de *F. mexiae*, possivelmente em uma relação competitiva. Estes resultados indicam que a população *F. mexiae* representa um elemento importante na dinâmica complexa de manutenção da diversidade de *Ficus* spp. neotropicais.

Palavras-chave: coocorrência, polinizadores, *Pegoscapus*, *Ficus mexiae*.

1. Introduction

The Atlantic Forest biodiversity hotspot includes a large number of species of fig, *Ficus* L. (Moraceae) (Carauta, 1989) that play an important role in providing key resources to many species - provisioning edible fruits, and contributing to the maintenance of faunal diversity (Shanahan et al., 2001). Many *Ficus* species are threatened with extinction, among them *Ficus mexiae* Standley that is classified as vulnerable by the International Union for Conservation of Nature and Natural Resources (IUCN, 2011). This is a rare medium-sized plant measuring up to 10 meters in height, which is restricted to Minas Gerais and Bahia (Carauta and Diaz, 2002). Little is known about the reproductive aspects of this plant, although there is one report of two *Pegoscapus* Cameron (1906) species of fig wasp, simultaneously occurring in its syconiums (Schiffler, 2002).

There are over than 800 known species of *Ficus* (Moraceae) genus distributed in the tropical and subtropical regions of the world (Harrison, 2005), and for a long time it was believed that each species of fig had only one pollinating species of wasp (Ramirez, 1970; Ramirez, 1974; Wiebes, 1979). It is true for many species, because the fig wasps show a peculiar morphological adaptation, with a high level of phenological synchrony and many are indeed extremely specific about the host (Wiebes, 1979). On the other hand, several cases are reported in which multiple wasp species can act as pollinators for a fig tree, and this may occur from 25 to 50% all fig species (Cook and Rasplus, 2003; Machado et al., 2005). The simultaneous occurrence of more than one species of wasp that are *Ficus* pollinators had already been demonstrated by several authors (Rasplus, 1996; Weiblen, 2001; Weiblen, 2002; Vaamonde et al., 2002; Haine et al.,

2006), as well in different continents (Compton et al., 1991; Kerdelhué et al., 1997). However, only one co-occurrence record is known within the South American, between two *Pegoscapus* (species not yet described) species in *Ficus mexiae*, without knowing which one is actually the pollinator (Schiffler, 2002). Considering that *Pegoscapus* sp 1 and *Pegoscapus* sp 2 possessed pollen in their mesoternary cavities (pollen pockets), Schiffler (2002) proposed the hypothesis that both species play a role in pollinating *Ficus mexiae*. Based on this information, this work presents preliminary results on *Ficus mexiae* pollination by *Pegoscapus* sp 1 and *Pegoscapus* sp 2 that occurs simultaneously in the plant's syconium.

2. Material and Methods

We analyzed 57 syconium collected from two native *Ficus mexiae* individuals, located in the Universidade Federal de Lavras' campus, in the city of Lavras, state of Minas Gerais, Brazil (21°13'43" S and 44°59'04" W). Before collection, the syconiums were individually covered by polyester nets (forming little bags) to retain emerging wasps. The bags were placed on the syconiums on May 14, 2001, and remained there during the time of wasp hatching (2 to 3 days). After the hatching, all the material was taken to the laboratory for sorting. Following this the hatching wasps were captured using an entomological aspirator and afterwards packed together with the original syconium, in flasks with a solution of 10% of formaldehyde. We counted the number of individuals for each wasp species present in each syconium and the number of ovaries with seeds. We also recorded measurements of the syconiums' size and weight. To verify if the data presented Gaussian distribution, the Kolmogorov-Smirnov's test (Zar, 1974) was applied. Spearman correlation was used to test the correlation between the abundance of *Pegoscapus* species and the syconium's structural data (Zar, 1974). The difference between the average individual number of *Pegoscapus* sp 1 and *Pegoscapus* sp 2 in the syconiums was tested using the Mann-Whitney (U test) (Zar, 1974).

3. Results and Discussion

We captured a total of 305 individuals (DP ± 101) of *Pegoscapus* per syconium, 16% of which were from *Pegoscapus* sp 1 and 71% *Pegoscapus* sp 2. The *Ficus mexiae* syconium presented an average size of 15.3 mm (DP ± 1.3 mm) and weight of 1.6 g (DP ± 0.3 g). As was expected, the heaviest syconiums were also the biggest ($r_s = 0.83$; $p < 0.0001$) and the thickest ($r_s = 0.50$; $p < 0.01$). The number of individuals from both *Pegoscapus* species increased as the syconium increased in size ($r_s = 0.27$; $p < 0.05$). This correlation may become stronger when also taking account of the number of non-pollinating wasps. With an increase in the syconium size the production of seeds also increases ($r_s = 0.61$; $p < 0.001$), possibly because it aids the entrance of more

pollinator wasps (founders). There was a statistically significant correlation between the number of individual *Pegoscapus* sp 1 and the size of the syconium ($r_s = 0.37$; $p < 0.005$), but the same pattern was not true for *Pegoscapus* sp 2. The number of individuals of *Pegoscapus* sp 1 was positively correlated with the number of seeds produced ($r_s = 0.48$; $p < 0.0002$), suggesting that it does provide a pollinator function. However, and contrary to what was expected, the most abundant species (*Pegoscapus* sp 2) did not correlate with the seed production. Yet, in cases where only *Pegoscapus* sp 1 occurred (7%) or only *Pegoscapus* sp 2 (35%) seed production was recorded, and average size of seeds produced from both was similar ($U = 14.5$; $p < 0.05$; Figure 1), as was their average abundance ($U = 17.5$; $p < 0.05$; Figure 1). There was no difference between the average abundance of *Pegoscapus* sp 1 and *Pegoscapus* sp 2 ($U = 414.5$; $p < 0.05$), although their pair-wise abundance showed a negative correlation ($r_s = -0.70$; $p < 0.0001$). This evidence of an antagonistic relation between these two *Pegoscapus* species suggests that these species may compete for ovaries on *Ficus mexiae*. However, independently of the interaction between these two wasps it provides evidence that both promote the pollination of *Ficus mexiae*.

One species of *Ficus* may be host for two or more different pollinator or non pollinator wasp species (Wiebes, 1995), and one pollinator wasp species may have more than one *Ficus* species as a host (Compton, 1990, Ware and Compton, 1992; Rasplus, 1996). When the host specificity is broken, the process of introgression between figs could occur giving rise to new species, thereby contributing to the increased diversity of figs (Machado et al., 2005).

While preliminary, these results indicate that the *F. mexiae* population besides being maintained by more than one *Pegoscapus*, and therefore represent an important element in the complex dynamics of maintaining diversity in neotropical *Ficus* spp.

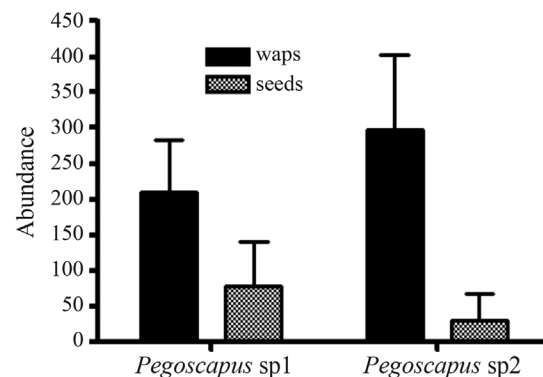


Figure 1 - Average abundance of wasps and seeds per syconium, when only one species of *Pegoscapus* occurs (error bars represent SD).

Acknowledgments

We thank the assistance of Dr. Tob Gardner, Cambridge University, UK and Dr. Jos Barlow, Lancaster University, UK in the revision of this manuscript.

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