COMMUNITY OF FIG WASPS (HYMENOPTERA: CHALCIDOIDEA) IN SÃO PAULO STATE (BRAZIL): DIVERSITY AND HOST SPECIFICITY.

Farache, F.H.A.

Teixeira, L.M.R.; Cerezini, M.T.; Medeiros, M.D.F.; Pereira, R.A.S.

Faculdade de Filosofia, Ciências e Letras de Ribeirão Preto, Universidade de São Paulo fhafarache@gmail.com

INTRODUCTION

The genus *Ficus* (Moraceae) shows a mutualistic association with very tiny wasps of the family Agaonidae, which pollinates the fig trees. In return, the plant supply oviposition site for pollinators to rear their offspring. The biology and life cycle of both partners is very intricate and present puzzling questions for studying evolution of plant - insect mutualisms. This association is usually species - specific, being each species of *Ficus* associated with one pollianting species. However, molecular data have helped to revel co - existence of multiple pollinating species in a single *Ficus* host (Molbo *et al.*, 2003).

Fig and agaonid wasp mutualism is exploited by non - pollinating fig wasps of superfamily Chalcidoidea, which reap the benefits without paying the cost of pollinating. These wasps exert negative impact on the reproductive success of the plants, competing for oviposition sites with the pollinators or parasitizing them, or even galling the flowers which could generate viable seeds.

Two sections of *Ficus* are native in the Neotropical region, *Americana* and *Pharmacosycea*, each one associated with a particular community of fig wasps. Despite of molecular studies evidencing host shift in pollinating and non - pollinating fig wasps, there is a lack of detailed studies on fig wasp communities, specialy in Neotropics. There is no published data of structure of community and host specificity on Neotropical fig wasp fauna.

OBJECTIVES

The aim of this study is assess in detail the fig - fig wasp communities in São Paulo State, focusing on the diversity and host specificity.

MATERIAL AND METHODS

Sampling and Material processing

Samples were taken in fragments of Semideciduous Atlantic Forest and surrounds in Ribeirão Preto, Gália, Teodoro Sampaio and Ribeirão Grande cities.

We collected materials from fig trees at the wasp emergence phase, which occurs when the figs are nearly ripen. 30 - 60 figs were put together in a *voil* cloth bag until wasp emergence. Later, wasps were sorted and preserved in 70% alcohol.

Seven fig species were sampled in study areas: *F. citrifolia*, *F. crocata*, *F. eximia*, *F. luschnatiana*, *F. obtusifolia*, *F. insipida* and *F. obtusiuscula*. The five former species belong to section *Americana*, and the later two species to section *Pharmacosycea*.

Wasps were critic point dried and mounted in entomological triangles. Identification was made using generic keys (Bouček 1993 and Rasplus & Soldati 2006). Wasps were classified in morphospecies (herein after referred to as species) and kept as voucher material in a reference collection. Specific identifications are not possible at the moment as taxonomy of Neotropical fig wasps is poorly studied.

Data Analyses

To compare number of species per host species we standardized sample efforts. For that, we used resampling methods for generating collector curves based on 1,000 resamplings. The empiric 2.5 and 97.5% confidence limits (CL2.5; 97.5) of resample distributions were used as significance test to compare community richness. Traditional rarefaction methods were not suitable for our collection protocol. Host specificity was studied using qualitative bipartite trophic webs of plants and insects (Tylianakis 2008), and recording the number of different host in which each species occurred.

Cluster analysis using Jaccard similarity and UPGMA linkage was used to assess potential factors (host tree or geographic locality) structuring fig wasp communities. We used ANOSIM (Legendre & Legendre 1998) for hypothesis tests.

All statistical analyses were performed on R software (R Development Core Team 2009).

RESULTS AND DISCUSSION

We collected 61 species of fig wasps, belonging to 10 genera. The most specious genera was *Idarnes*, with 15 species, followed by *Critogaster*, with 9 species. The total number of *Idarnes* species described for the neotropics are around 23 and 6 for *Critogaster* (van Noort 2004), evidencing the little taxonomic knowledge of Neotropical fig wasps.

Standardization of sample effort showed greater diversity of wasps in *F. citrifolia* (CL2.5; 97.5 = 17; 20) and *F. eximia* (CL2.5; 97.5 = 19; 22) in relation to *F. obtusifolia* (CL2.5; 97.5 = 14; 14), for the species with seven samples or more. Indeed, The overall resampling showed a great overlap between the confidence intervals, so, we can't make general observations of the difference of species richness between hosts, but in general, we probably may find more species in future samplings.

As expected, all the fig wasps genera were specific to the fig sections. *Tetrapus* and *Critogaster* were only associated with *Pharmacosysea*, whereas other genera occurred exclusively on *Americana*.

Interaction matrices and webs revealed that 14 species (26% of the non - pollinating wasps) were not host - specific. *F. eximia* and *F. citrifolia* presented respectively nine and eight non - specific wasp species. *Idarnes* sp. 6 and *Idarnes* sp. 26 were the most generalist species, occurring in four hosts, followed by *Idarnes* sp. 15, with three hosts. In *Critogaster*, *Heterandrium* and *Anidarnes* genera we did not find generalist species. Lack of host specificity in neotropical fig wasps was evidenced by molecular analysis by Marussich & Machado (2007).

Despite of occurrence of host infidelity, the cluster analysis showed that host tree significantly explained the structuring fig wasp communities ($R = 0.935$; $P < 0.001$), whereas geographic locality was non - significantly related ($R = 0.07$; $P = 0.186$). The discrepancy of ANOSIM and web analyses is probable due to the fact of generalist species present quantitative preferences for a particular host, decreasing the statistical weight of host infidelity in the hypothesis tests.

CONCLUSION

Here we documented how diverse is the fauna of fig wasps in São Paulo (almost 9 species per host). Despite of their diversity, taxonomic knowledge of fig wasps is poorly known, and only small part of the diversity is described. Part of the problem is due to lack of good voucher collections, and difficulty of localizing type specimens.

The standardization of the sample effort showed the greater species richness of *F. eximia* and *F. citrifolia*. These species occur in most of semideciduous forest areas. The wider geographic comprehension of these species in this study might have influenced this result.

Here we documented two most diverse non - pollinating fig wasp genera, *Idarnes* and *Critogaster*. The former occurs in section *Americana* and the later in *Pharmacosycea*. This diversity was impressive, mainly for *Critogaster*, which we studied only two hosts.

Despite of great amount of non - specific species, we found that the fig wasp fauna was more related to the host than to the collecting areas.

This study brought answers about the richness and specificity of the fig wasp community in São Paulo State. The study of these patterns will help to answer questions about the diversity of fig wasps in Neotropical region and will gather information which will help future taxonomical studies in this region (Financial support: Fapesp (04/10299 - 4, 2007/06054 - 4, 2008/03272 - 3, 2008/52378 - 9). We thank L.F.M. Coelho, L. Palmieri and M.E. Lapate for helping field work).

REFERENCES

Bouček, Z. 1993. The genera of chalcidoid wasps from Ficus fruit in the new world. J. Nat. Hist. 27: 173 - 217.

Legendre, P. & Legendre, L. 1998. Numerical Ecology. Elsevier.

Marussich, W.A. & Machado, C.A. 2007. Host - specificity and coevolution among pollinating and nonpollinating New World fig wasps. Mol. Ecol.. 16:1925 - 1946.

Molbo, D.; Machado, C.A.; Sevenster, J.G.; Keller, L.; Herre, E.A. 2003. Cryptic species of fig - pollinating wasps: implications for the evolution of the fig - wasp mutualism, sex allocation, and precision of adaptation. PNAS, Washington 100:5867 - 5872.

R Development Core Team (2009). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria.

Rasplus, J.Y. & Soldati, L. 2006. Familia Agaonidae. In: Introducción a los Hymenoptera de la Región Neotropical. eds. Fernández, F. & Sharkey, M.J. Sociedad Colombiana de Entomología & Universidad Nacional de Colombia, Bogotá, D.C. pp. 683 - 698.

Tylianakis, J. M. 2008. Understanding the web of life: the birds, the bees and sex with aliens. PLOS Biology.6:224 - 228.

Van Noort, S. 2004. Figweb. Avaliable at www.figweb.org. [verified 25 may 2009].