RICHNESS AND ABUNDANCE OF GALL-FORMING INSECTS IN THE MAMIRAUÁ VARZEA, A FLOODED AMAZONIAN FOREST

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RESUMO

Estudos sobre os padrões de distribuição de insetos galhadores indicam a tendência de uma maior riqueza destes organismos em vegetações escleromórficas que ocorrem em solos com baixos níveis de fertilidade. O objetivo deste estudo foi investigar a fauna de insetos galhadores associada à vegetação de várzea, uma floresta sazonalmente inundada. As coletas foram realizadas em 8 pontos amostrais na Reserva de Desenvolvimento Sustentável Mamirauá (AM). Foram amostradas copas de 242 árvores que apresentaram 21.098 galhas pertencentes a 236 morfotipos de insetos indutores. O número de morfotipos de galhas foi fortemente relacionado à quantidade de galhas e ao número de plantas amostradas. Os altos valores de riqueza e abundância de galhas obtidos neste estudo contrariam os resultados esperados para a várzea, uma vegetação não-escleromórfica situada em áreas de solos férteis. Tal fato pode ser explicado pelas adaptações fisiológicas e estruturais por parte das plantas hospedeiras submetidas ao estresse promovido pela cheia dos rios ou pelos diferentes níveis e períodos de inundação e pela ocorrência de diferentes comunidades de plantas hospedeiras. No entanto, a amostragem dos estratos superiores da floresta constitui um novo e determinante fator que permitirá conclusões mais sólidas sobre os padrões e processos reguladores da diversidade de insetos galhadores.

PALAVRAS-CHAVE

Relação planta-inseto. Dossel. Floresta alagada. Várzea. Galhas.

ABSTRACT

Several studies have indicated a worldwide trend for higher gall-forming insect richness on scleromorphic vegetation growing in infertile soils. The goal of this study was to survey the gall-forming insect fauna in the varzea, a seasonally flooded forest in the Amazonian region. Samples were taken at Mamirauá Sustainable Development Reserve, AM, Brazil. 21,098 insect galls belonging to 236 morphotypes were found on 242 tree crowns. The number of gall morphotypes was correlated with the number of plants sampled and gall abundance. Contrary to the predictions, we found a high richness and abundance of galling insects in the varzea, a non-scleromorphic vegetation that grow in fertile soils. The explanation to the trends found may lie on plant physiological adaptations to flooding and occurrence of different plant communities due to different flood levels and flooding time extents, or even due to the harsh conditions found in the upper canopy.

KEYWORDS

Plant-insect interaction, Flooded forest. Varzea. Galls. Fertile soils. Tropical forests.

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INTRODUCTION

Insect galls result from abnormal growth in host plant tissues, with increase in the plant tissue cell number and/or size (MANI, 1964). These peculiar structures provide shelter and food to the insect larva (PRICE *et al*., 1987; SHORTHOUSE 1986), which is responsible for genetic and chemical manipulation and subsequent alterations on the plant tissues (HARTLEY, 1998; NYMAN; JULKUNEN-TIITTO, 2000). Furthermore, galls are conspicuous, persistent, host specific and morphologically diverse (LARA; FERNANDES, 1996) that allow, in some cases, intra and interspecific distinction of host plants (FLOATE *et al.,* 1996; RIBEIRO *et al.,* 1999).

Hence, gall-forming insect herbivores constitute an easy tool to ecological studies and offer a particularly simple system for identifying geographical patterns and for evaluating the possible mechanisms producing those patterns. Fernandes and Price (1988, 1991) have argued that these insects may have speciated and radiated at higher rates in harsh environments with a predominantly sclerophyllous vegetation and infertile soils (BLANCHE; WESTOBY, 1995). These environments should present lower incidence of natural enemies (parasitoids, predators, and other herbivores), diseases caused by pathogens (FERNANDES; PRICE, 1991; 1992; RIBEIRO-MENDES *et al.,* 2002) and possibly lower plant induced defenses (FERNANDES *et al*., 2005). Similarly, Price and colleagues (1998) reported on a global distribution pattern in different vegetation types. Higher richness of gall-forming insects was observed on scleromorphic vegetation such as campina in Amazonia, cerrado savanna in central Brazil, fynbos in Africa, coastal vegetation in Australia, shrubland in Israel and the Sonoran Desert (Arizona and Mexico). An alternative explanation to these results was provided by the resource synchronization hypothesis (MENDONÇA-JR., 2001). This author argued that gall richness would be higher in vegetation showing higher synchronization of leaf flushing which would result in a higher number of host shift events. Both studies concluded that non-scleromorphic vegetation, growing in fertile soils, such as some tropical forests, would be expect to shown a comparatively low richness of gall-forming insects, in spite of its rich flora (PRICE *et al*., 1998, MENDONÇA-JR., 2001). Thus, the study of galling insect distribution in tropical rain forests became more important in an attempt to test some hypotheses on galling insect diversity. So far the rare studies done in the tropical rain forests were performed on the understory (PRICE *et al*., 1998; YUKAWA *et al.,* 2001; MEDIANERO; BARRIOS 2001). However, upper canopy studies may offer a unique scenario in which we can test the several hypotheses that tries to account for the geography of galling insects.

METHODS

The present study surveyed gall-forming insect richness and abundance in the upper canopy of varzea, a forest periodically flooded by white rivers, which carry alluvial loads. Amazonian varzea constitutes a highly productive environment, with fertile soils (JUNK, 1983; 1989) and flooding dynamic seems to be a determinant factor in the vegetation structure and composition (WITTMANN; JUNK, 2003; WITTMANN *et al.,* 2004). Insect galls and host plants were collected at Mamirauá Sustainable Development Reserve, western Brazilian Amazon on May (flood period) and October 2004 (non-flood period). Samples were taken in 8 sites inside the reserve (Figure 1). Eight transects of 5 x 20 m were sampled at each site. Transects were distanced 20 m from each other. Transect lines were visually projected in the canopy and all individual plant crowns located in the upper layer of the story were sampled. Individual crown sample consisted in clipping of 10 plant terminal units with a telescoping aluminum pole (9.8 m). Insect gall abundance and richness were recorded in each terminal unit and galls were properly conditioned in the laboratory to obtain adult insects (JULIÃO *et al.,* 2002).

RESULTS

Overall, 242 individual trees were sampled in an area of 6,400 m^2 (Table 1). Tree crowns harboured 21,098 insect galls belonging to 236 morphotypes. Leguminosae, Moraceae, Myrtaceae, Sapotaceae, Lauraceae, and Annonaceae were the main families of host plants attacked by gall–inducing insects. Insect gall richness was strongly correlated with the richness ($r=0.85$; $p<0.05$) and abundance (0.84; $p<0.05$) of trees. However, no correlation was

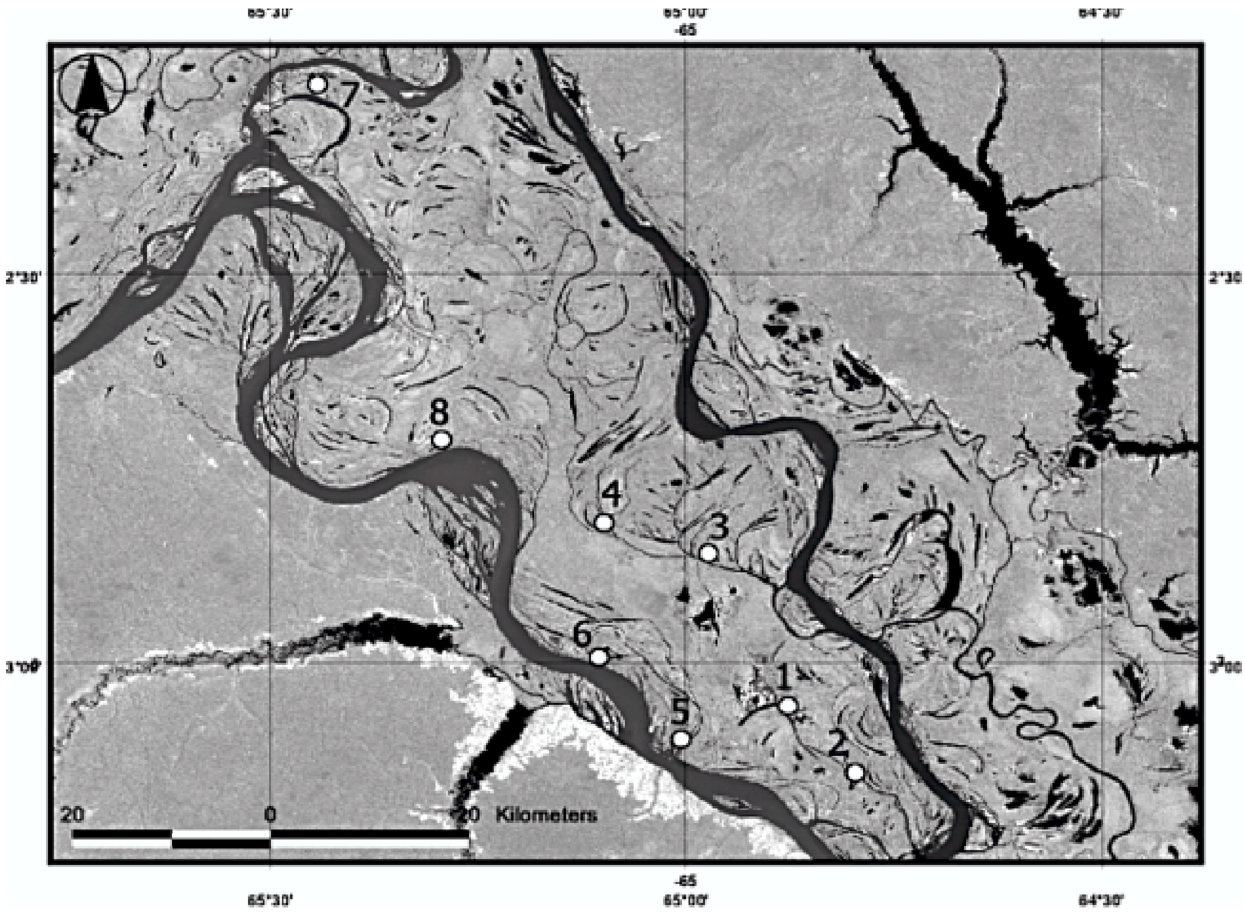

Figure 1. Sampled areas at the Mamirauá Sustainable Development Reserve, western Brazilian Amazon. 1- Mamirauá I; 2- Mamirauá II; 3- Jarauá I; 4- Jarauá II; 5- Ingá I; 6- Ingá II; 7- Aranapú; 8- Horizonte.

Table 1. Host plant species and number of individuals and insect gall abundance and number of morphotypes sampled at the Mamirauá Sustainable Development Reserve sites, AM, Brazil.

Site	HOST PLANT		INSECT GALL	
	Species	Number	Abundance	Morphotypes
Mamirauá I	44	58	4763	57
Mamirauá II	30	37	2059	38
Jarauá I	22	27	1181	27
Jarauá II	19	23	1430	31
Ingá I	21	27	3392	36
Ingá II	6	14	744	14
Aranapú	24	31	4565	50
Horizonte	18	25	2964	38

found between richness and abundance of trees and insect gall abundance, in spite of a strong relationship between abundance and richness of insect galls (Table 2).

Table 2. Pearson correlation matrix of host plant species and abundance and insect gall abundance and number of morphotypes (richness). The probabilities were correct by Bonferroni criterion.

	Richness of trees	Abundance of trees	Abundance of insect galls
Abundance of trees	0.98***		
Abundance of insect galls	0.67	0.69	
Richness of insect galls	0.85*	0.84*	0.93**

*- (p<0.05); ** - (p<0.01); *** - (p<0.001); N=8

Therefore, it indicates that due to high specificity of the relationship between gall-forming insects and host plants, the more plant species we sample the higher is the probability that we will obtain more different gall morphotypes, independently of insect gall abundance. In opposition to the expected patterns, these preliminary results indicated a high abundance and richness of gall-forming insects in the Mamiraua varzea, covered by non-sclermorphic vegetation sustained by fertile soils.

DISCUSSION

The trends here reported may rise from inherent features of the studied system. Plant adaptations to seasonal flooding such as leaf abscission, dormancy, alternative metabolism (DE SIMONE *et al.,* 2003) and occurrence of different plant communities due to different flood levels and time extents (WITTMANN; JUNK, 2003) may offer some cues to the high gall-forming insect diversity in the varzea. Possible explanations to the trends so far observed may lie in the physiological stresses the host trees are periodically subjected to due to flooding and/or even due to the equally harsh environments the upper foliage are subjected. Corroborating our data, higher insect gall richness was reported on the canopy compared to understory of dry tropical Panama forest by Medianero and Barrios (2001). Hence, comparative studies at the canopy level may represent a new but last frontier to biodiversity research of galling insects. This study constitutes a unique data set that reinforce the need to survey the canopy of tropical forests to better comprehend gall-forming insect distribution patterns.

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