Subárea de conhecimento: Ecologia

ALTITUDINAL DISTRIBUTION OF INSECT GALLS ON *Mikania glomerata* (ASTERACEAE) IN PARQUE NACIONAL DO ITATIAIA (SOUTHEASTERN BRAZIL)

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INTRODUCTION

It is widely accepted that most gall-inducing insects are highly specific to their host plants and organs (Dreger-Jauffret & Shorthouse, 1992; Floate et al., 1996). Furthermore, the interaction between gallers and their host plant usually results in a gall morphotype with peculiar shape, size, color and indumentum (Isaias et al., 2013, 2014). As a result of this high specificity, several authors have used gall morphotype as a surrogate for insect species (Floate et al., 1996, Price et al., 1998, Hanson & Gómez-Laurito, 2005). Among the Brazilian species of gall midges (Diptera, Cecidomyiidae), about 92% are monophagous, inducing a peculiar gall on a single host species (Carneiro et al., 2009).

Distribution patterns of galling insects and their host plants have been studied in several continents and some hypotheses have been proposed to explain them (Fleck & Fonseca, 2007), such as the altitudinal and the microenvironment hypotheses. The former predicts a positive relation between gall richness and altitude, and the latter a positive relation between gall richness and hygrothermal stress (Price et al., 1986; Fernandes & Price, 1992).

Studies of natural history can help to understand these distribution patterns since they are important tools to explain factors that limit the species ability to establish and reproduce itself in a particular area (Bartholomew, 1986). There are few studies about the natural history of gall-inducing insects in spite of their ecological importance. Data on the geographic distribution of several Neotropical gall-inducers are scarce, and mostly limited to the localities where species were originally sampled (Gagné & Jaschhof, 2017). Nevertheless, it is largely accepted that the gall-inducers accompany their host plant throughout its distribution, as corroborated by Arriola et al., 2016. Nevertheless, constraints to the dispersal of galling herbivores should occur.

The present study aimed to assess the match between the distributions of the gallers associated with *Mikania glomerata* Spreng. (Asteraceae) and that of the host plant along an elevation gradient.

MATERIALS AND METHODS

Study site

The study was carried out in Parque Nacional do Itatiaia (PNI; 22º16’ - 22º28’ S and 44º34’ - 44º42’ W) in the Southeast Region of Brazil. With an area of about 28,000 hectares, this park comprises the municipalities of Itatiaia and Resende (State of Rio de Janeiro), and Bocaina de Minas and Itamonte (Minas Gerais) (Figure 1). “Itatiaia” is a tupi name which means “pointed stone” or “cliff full of tips”. This is the oldest national park in Brazil, created in 1937.

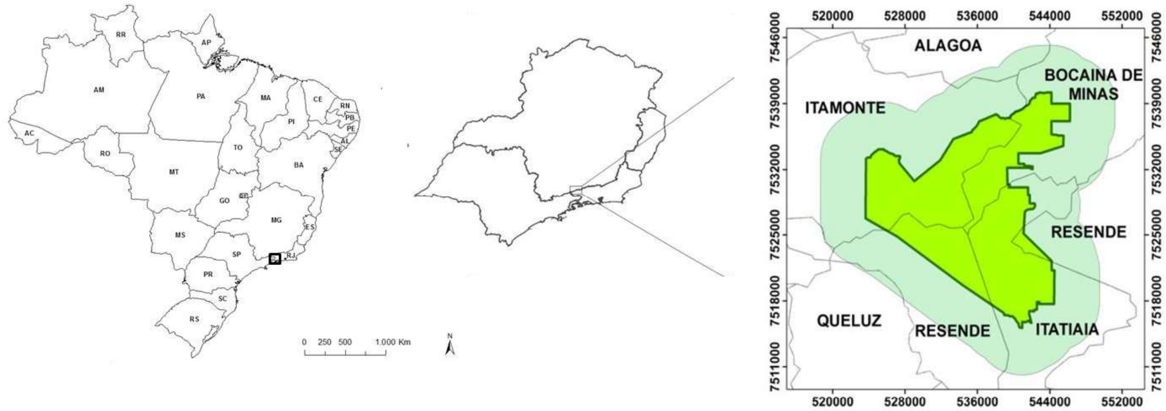

Figure 1. Parque Nacional do Itatiaia map.

The relief of the park is characterized by mountains and rocky slopes with elevations ranging from 535 to 2,791 m. The lowest part possesses a predominance of dense ombrophilous forest, while the highest part is occupied by altitudinal fields (Figure 2) (ICMBIO, 2019).

Figure 2. Parque Nacional do Itatiaia, panoramic view. A. Dense ombrophilous forest, B. Altitudinal fields.

Host plant:

Mikania glomerata Spreng. (Asteraceae), commonly known as "guaco", is a medi+cal plant with expectorant and bronchodilator properties (Rocha et al., 2008). It is native to Brazil, where it occurs in the Northeast, Southeast and South regions in Cerrado and Atlantic Forest (Ritter & Miotto, 2005). *Mikania glomerata* hosts eight insect gall morphotypes, each one induced by a different species of (Diptera) (Maia, 2013) (Table 1).

Table 1. Gall-inducing species (Diptera, Cecidomyiidae) associated with *Mikania glomerata* (Asteraceae) and morphological characterization of galls.

Gall-inducing species	Gall characterization	
	Plant organ	Shape
Alycaulus globulus Gagné, 2001	Leaf epiderm	Discoid
Asphondylia glomeratae Gagné, 2001	Petiole or leaf vein	Fusiform
Asphondylia moehni Skuhravá, 1989	Conical stem	Globoid
Liodiplosis conica Gagné, 2001	Leaf	Conical

Liodiplosis cylindrica Gagné, 2001	Leaf	Cylindrical
Liodiplosis spherica Gagné, 2001	Leaf	Spherical
Mikaniadiplosis annulipes Gagné, 2001	Petiole, leaf vein or stem	Fusiform
Perasphondylia mikaniae Gagné, 2001	Bud	Globoid

Seven of these morphotypes have been previously recorded in PNI (Maia & Mascarenhas, 2017), five of which were chosen for study along an elevation gradient (from 535 to 2,791 m) since they are easily recognized: conical stem swelling, conical leaf gall, cylindrical leaf gall, petiole and vein swelling, and globoid leaf gall (Figure 3).

Figure 3. Galls on *Mikania glomerata* Spreng. (Asteraceae). A. Conical stem swelling, B. Conical leaf gall, C. Cylindrical leaf gall, D. Petiole and vein swelling, E. Globose leaf gall.

Field work

The authors performed field work in PNI for three days every month from February 2014 to December 2015, for a total of 16 hours of field work per month. Twenty six trails were explored in PNI, thirteen of which were situated in the lowest area, eleven in the highest area and two extended between. In addition, four point sites were explored, one of which was situated in the lowest area and the three others in the highest area (Table 2).

Table 2. Collecting sites in Parque Nacional do Itatiaia (Southeast Region, Brazil): geographic coordinates and elevation.

Trails and sites	Geographic coordinates		Elevation	
Lowest Part	Trailhead	end of trail	trailhead	end of the trail
Trails				
1) BR-485 (Headquarter - Maromba)	S22º27’00” W44º36’20”	S22º25’44” W44º37’06”	837 m	840 m
2) Itaporani	S22º25’42” W44º37’10”	S22º25’32” W44º37’20”	1,166 m	1,091m
3) Véu da Noiva	S22º25’35” W44º37’11”	S22º25’40” W44º37’12”	1,172 m	1,154 m
4) Lago Azul	S22º26’58” W44º36’37”	S22º27’01” W44º36’52”	1,041 m	879 m
5) Ecoarte	S22º25’44” W44º37’11”	S22º27’01” W44º36’52”	739 m	879 m
6) Poranga	S22º23’36” W44º40’12”	S22º26’32” W44º36’44”	894 m	826 m
7)Três Picos	S22º25’37” W45º35’01”	S22º25’30” W44º35’01”	1,154 m	1,596 m
8) Casa 16	S 22º27’16” W44º36’20”	S22º27’16” W44º36’20”	841m	853 m
9) Donati-Simon I	S22º26’43” W44º36’04”	S22º26’36” W44º36’54”	935 m	927 m

10) Donati-Simon II	S22º26'43" W44º36'05"	S22º26'22" W44º35'47"	935 m	927 m
11) Viúva Hansen	S22º26'35" W44º35'55"	S 22º26'46" W44º36'05"	948 m	953 m
12) Barbosa-Rodrigues	S 22º27'17" W44º36'37"	S 22º27'09" W44º36'36"	736 m	882 m
13) Pitu	S22º26'33" W44º36'44"	S22º26'14" W44º36'48"	944 m	902 m
Sites				
14) Visitors Centre	S 22º27'04" W44º06'37"		877 m	
Highest Part				
Trails				
15) Aiuruoca	S22º22'27" W44º42'04"	S22º21'08" W44º40'07"	2,469 m	2,382 m
16) Prateleiras	S22º23'36" W44º40'22"	S22º23'56" W44º40'16"	2,372 m	2,453 m
17) Água Branca	S22º26'02" W44º38'15"	S22º25'15" W44º38'26"	1,727 m	1,798 m
18) Agulhas Negras	S22º22'27" W44º42'04"	S22º22'54" W44º39'58"	2,469 m	2,462 m
19) Pedra do Altar	S22º22'37" W44º42'09"	S22º22'27" W44º40'27"	2,501 m	2,585 m
20) Maçã, Pedra Assentada, Tartaruga	S22º23'51" W44º40'15"	S22º23'55" W44º39'57"	2,380 m	2,384 m
21) Morro da Antena	S22º22'26" W44º42'14"	S22º22'37" W44º42'09"	2,377 m	2,526 m
22) Pedra do Sino	S22º21'55" W44º39'37"	S22º22'13" W44º39'45"	2,406 m	2,591 m
23) Morro do Couto	S22º22'26" W44º42'14"	S22º22'27" W44º42'05"	2,296 m	2,449 m
24) Asa de Hermes	S22º23'01" W44º40'06"	S22º22'33" W44º39'53"	2,340 m	2,870 m
25) Cinco Lagos	S22º22'23" W44º42'11"	S22º22'23" W44º40'43"	2,344 m	2,533 m
Sites				
26) Casa da Pedra	S22º22'07" W44º42'43"		2,010 m	
27) Lamego	S22º25'27" W44º37'52"		1,236 m	
28) Posto Marcão	S22º23'02" W44º40'06"		2,290 m	
Trails extended from lowest to highest part				
29) Ruy Braga	S22º25'49" W44º37'16"	S22º23'06" W44º40'44"	840 m	2,469 m
30) Serra Negra	S22º21'44.1" W44º40'09"	S22º19'14" W44º36'43"	2,381 m	1,524 m

The geographical coordinates and the elevations of each trail and site were obtained using GPS. Each trail and site was searched for individuals of *Mikania glomerata*, and when encountered they were examined for insect galls. Host plants were identified by the authors, and branches were pressed as voucher material. Samples of each morphotype were collected and transported in labelled plastic bags to the Diptera laboratory/Museu Nacional/UFRJ.

Laboratory work

Samples of each gall morphotype were dried for preservation and incorporated into the gall collection at MNRJ, while others were dissected under a stereoscopic microscope to obtain immature insects or kept individually in covered plastic vials with damp cotton at the bottom to obtain adults. The vials were examined daily for the emergence of the adults. Galls were kept in the rearing vials until their deterioration. All insects were preserved in 70% ethanol. The gall midges were later mounted on microscope slides following the methodology described by Gagné, 1989, identified based on the descriptions of Gagné et al., 2001, and incorporated into the entomological collection of MNRJ.

RESULTS AND DISCUSSION

Individuals of *Mikania glomerata* were found along nine trails over an elevation range of 535 to 2,392 m, namely: 1) BR-185, 2) Viúva Hansen, 3) Donati-Simon I, 4) Donati-Simon II, 5) Poranga, 6) Visitors Centre, 7) Ecoarte, 8) Lago Azul, and 9) Ruy Braga. They were found exclusively in shady humid environments, even including the highest part, where they were observed only near waterfalls and rivers. According to Ritter & Miotto, 2005, *Mikania glomerata* preferentially occurs in the inner parts of forests.

Galls were found on individuals of *Mikania glomerata* over an elevation range of 681 to 1,254 m: 1) conical stem swelling — galler *Asphondylia moehni* Skuhravá, 1989 (Diptera, Cecidomyiidae); trails: Ruy Braga 1,062 m. 2) conical leaf gall — galler *Liodiplosis conica* Gagné, 2001 (Diptera, Cecidomyiidae); trails: Lago Azul 819-1,041 m, Ecoarte 739 m, and Poranga 826-894 m. 3) cylindrical leaf gall — galler *Liodiplosis cylindrica* Gagné, 2001 (Diptera, Cecidomyiidae); trails: BR-485 681 m, Donati-Simon I 935-1,111 m, Donati Simon II 927m, Viúva Hansen 948-953 m, Visitors Centre 877 m, Poranga 971-976 m, Ecoarte 879 m, Lago Azul 1,041 m, Itaporani 1,092-1,097 m, and Ruy Braga 681-1,213 m. 4) petiole and vein swelling — galler *Asphondylia glomeratae* Gagné, 2001 (Diptera, Cecidomyiidae); trails: BR-485 681 m, Viúva Hansen 948-953 m, and Donati-Simon II 927 m. 5) globose leaf gall — galler *Liodiplosis spherica* Gagné, 2001 (Diptera, Cecidomyiidae); trails: BR-485 681 m, Visitors Centre 877 m, Lago Azul 1,041 m, Donati-Simon II 927 m, Poranga 971-976 m, Ecoarte 879 m, and Ruy Braga 681-1,254 m. These data show that gallers occurred over a narrower elevation range (681-1,254 m) than that of the host plant (535-2,392 m), suggesting limited adaptability to higher elevations, probably related to hygrothermal stress.

Among the gall-inducing species, *Liodiplosis spherica, Liodiplosis cylindrica* and *Liodiplosis conica* had the broadest elevation distributions whereas *Asphondylia moehni* wasfound at a single elevation (1,062m) and *Asphondylia glomeratae* had the lowest elevation range (681-953 m). Our data suggest that these species respond differently to the abiotic conditions related to higher elevations, resulting in lesser or greater constraints to their altitudinal distribution.

Although formal tests were not performed, our results neither favor the altitudinal nor the microenvironment hypothesis. Furthermore our study do not add evidences that globoid and spindle-shaped galls are advantageous in harsh climate conditions as argued by Wang et al., 2010. In fact, spindle-shaped galls were found in the lowest elevations, where climate conditions are not harsh, while globoid galls were found in low as well as in high elevations.

CONCLUSIONS

Mikania glomerata occurred over a broad elevation range in the study area, while the associated gallers occurred over a more restricted elevation range. This finding demonstrates that even when a host plant is present, gall-inducing species may be absent due to abiotic conditions. Thus, in this case, the altitudinal distribution of gall-inducing insects did not follow the distribution of their host plant.

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