

**REPRODUCTIVE SUCCESS OF *LATRODECTUS GEOMETRICUS* (*Theridiidae*)  
ON *Paepalanthus bromelioides* (*Eriocaulaceae*): ROSETTE SIZE,  
MICROCLIMATE, AND PREY CAPTURE**

**EXITO REPRODUCTIVO DE *LATRODECTUS GEOMETRICUS* (*Theridiidae*)  
SOBRE *Paepalanthus bromelioides* (*Eriocaulaceae*): TAMAÑO DE LA ROSETA,  
MICROCLIMA Y CAPTURA DE PRESA**

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**ABSTRACT**

*Latrodectus geometricus* is frequently found on the rosettes of *Paepalanthus bromelioides* at the Serra do Cipó, Brazil. This spider occurs preferentially on large, and medium sized rosettes which present more complex microhabitats. Thermal heterogeneity increases, and temperature decreases, with microhabitat complexity. Spider distribution on the rosettes was similar to the distribution of one of its most abundant prey, a scarabeid beetle. The probability of prey capture apparently increased with the rosette size, and there was a positive correlation between the female spiders weight and rosette size. *Latrodectus geometricus* clutch size increased with female weight. This suggests that the spiders which find appropriate rosette size during dispersion, or are able to discriminate them in the population maximize their reproductive potential.

Key words: Clutch Size, Habitat Selection, Predation, Reproductive Success.

**RESUMEN**

*Latrodectus geometricus* frecuentemente es encontrada en las rosetas de *Paepalanthus bromelioides* de la Serra do Cipó, Brazil. Esta araña ocurre con preferencia en rosetas de tamaño medio y grandes que presentan microhabitats más complejos. La heterogeneidad térmica aumenta y la temperatura disminuye con la complejidad del microhabitat. La distribución de las arañas en las rosetas de *P. bromelioides* es similar a la distribución de una de sus más abundantes presas, un scarabeidae. La probabilidad de captura de la presa aparentemente aumenta con el tamaño de la roseta. Existe una correlación positiva entre el peso de la araña hembra y el tamaño de la roseta. El tamaño de la camada de *L. geometricus* aumenta con el peso de la hembra. Esto sugiere que arañas que encuentran rosetas de tamaño apropiado durante la dispersión o que son capaces de discriminarlas dentro de la población, pueden aumentar su potencial reproductivo.

Palabras claves: Depredación, Suceso Reproductivo, Selección de Habitat, Tamaño de la Camada.

## INTRODUCTION

Developmental rates, survivorship, and fecundity are directly linked to the quantity of available food. Hence, predators that forage in places where the probability of prey capture is higher, obtain considerable selective advantage (Hassel 1978).

Spiders are limited in the choice of appropriate places for prey capture due to physiological needs, and to the availability of supports for web fixation (Turnbull 1973). This limitation seems particularly important in desertic environments, where simple plant structures may promote favorable microclimatic conditions (Riechert 1976). Rocks and sand in the mountain tops create one of the most extreme combinations of environmental conditions (Steyemark 1986). Similar conditions occur in the altitudinal rock fields of Serra do Cipó, Brazil. Located at heights greater than 1000 m, the altitudinal rock fields present shrubby and herbaceous vegetation growing on rocky and sandy soils, with low capacity of water retention (Rizzini 1976, Giulietti et al. 1987, Giulietti & Pirani 1988).

The spider *Latrodectus geometricus* (Theridiidae) is frequently found associated with *P. bromelioides* (Eriocaulaceae). The poor and structurally simple vegetation around this plant offers few options for web construction. On the other hand, rosettes of *P. bromelioides* rosettes represents shelters and hunting places (Figueira 1989). Site selection due to physiological needs of the spider, and web support capabilities, could automatically enhance prey capture (see Turnbull 1973).

The goals of this study were to determine the relative importance of various factors determining the use of the rosettes of *P. bromelioides* by *L. geometricus*, and by a beetle used as prey by *L. geometricus*; and to assess the possible selective advantages resulting from this use. Our questions were: a) Is the distribution of *L. geometricus* and its prey random with respect to rosette size? b) What is the relationship between microclimate and rosette size? c) How does the reproductive potential of *L. geometricus* vary with different *P. bromelioides* rosette size?

## METHODOLOGY

The data were collected in two populations of *P. bromelioides* at the Serra do Cipó (19° 12' - 19° 20'S and 43° 30' - 43° 40'W) between March and September 1988.

In order to determine the distribution of *L. geometricus* and its prey we measured the rosette size (RS = diameter x number of leaf layers x width of the base of one of the leaves of the most external layer) of 132 unoccupied plants along a random transect. We also measured the rosette size (RS) of 70 plants occupied by *L. geometricus*, and 83 plant occupied by the beetle. The relative frequencies of the spider, and the beetle in the different rosette size classes of *P. bromelioides* were compared by the Chi-square test (Zar 1984).

Temperature of five rosettes differing in size were measured (RS) with two thermometers, placed on the inside of the rosette central tank and between the leaves at the base of the rosette. Two other thermometers measured air and soil temperatures. Temperature readings were taken simultaneously at different times during the day. The relationship between the temperature inside the rosette, the soil temperature, and rosette size (RS), were verified by multiple regression analysis (Gunst and Mason 1980, Kleinbaun and Kupper 1978, Zar 1984).

Body mass of 22 spiders and their egg sacs (when present), were measured in relation to the size of rosettes in which the spiders were found. Egg sacs were separated in glass vials until hatching occurred and then their hatchling were counted.

The relationships between spider weight and rosette size (RS), egg sac weight and spider weight, and number of spiderlings and egg sac weight were verified by regression analysis (Gunst and Mason 1980, Zar 1984).

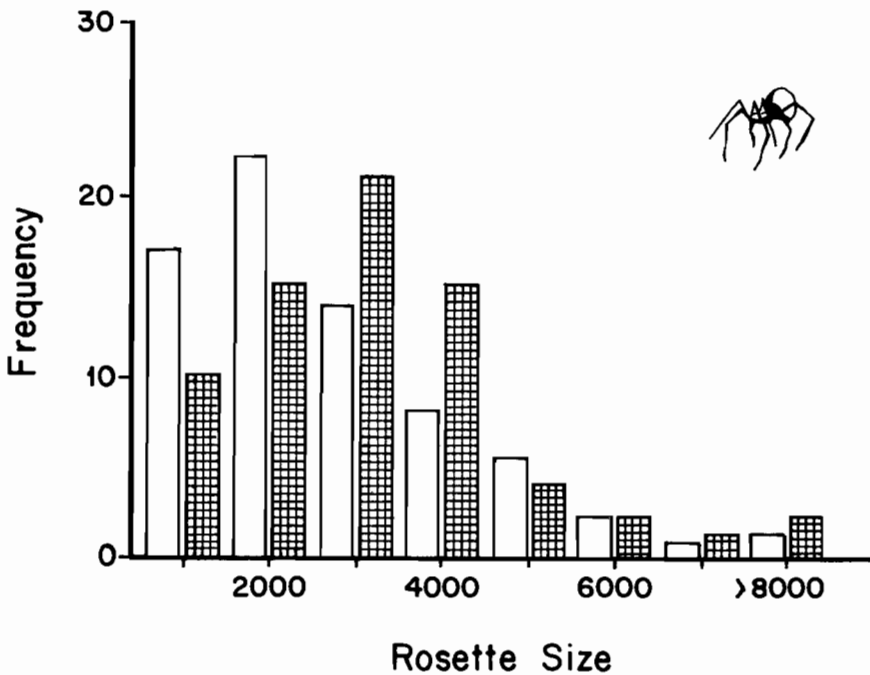
## RESULTS

The webs of *L. geometricus* are small, and of irregular shape. Webs are constructed between the leaves on the rosette base (52%), on the inner

walls of the central tank (32%), and between the tank and rosette base (16%).

*Latrodectus geometricus* distribution was not random. Spider occurrence did not follow the frequency distribution of rosette sizes of the plant population. Occupation of small rosettes (size < 2000), was smaller than the expected even though

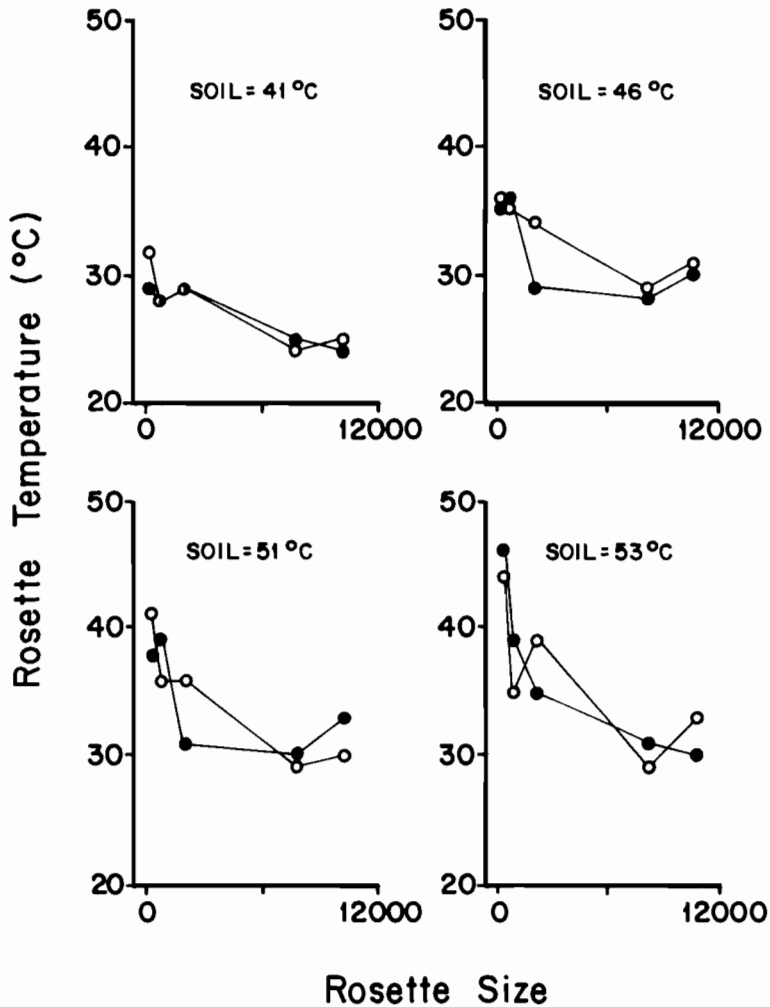
they were the most abundant. Occupation of medium sized rosettes (size between 2000 and 5000), of intermediate abundance, was higher than expected. Occupation of large rosettes (size > 5000), the lowest abundance, was equal to the expected (Fig. 1).



**Figure 1:** Plant selection by *Latrodectus geometricus* as a function of rosette size and abundance (solid bars) compared to the expected distribution (open bars). ( $X^2 = 15.26$ ,  $P < 0.005$ ).

Microclimate changed with varying rosette size: a) there was an inverse relationship between temperature and rosette size; b) smaller rosettes were less buffered against temperature variation than larger rosettes, and c) temperatures varied within the rosettes (Fig. 2). This is shown by a standardized multiple regression equation relating the rosette temperature in the tank (Ttk) or rosette base (Tba), with rosette size (RS), and soil temperature (Ts):  $\ln(Ttk) = -0.74 \ln(RS) + 0.51 Ts$ ,  $r^2 = 0.81$ ,  $P < 0.001$ ;  $\ln(Tba) = -0.69 \ln(RS) + 0.59 Ts$ ,  $r^2 = 0.82$ ,  $P < 0.001$ ; ( $\ln$  is the natural logarithm).

Probability of prey capture may increase with rosette size. Insects were the main prey of *L. geometricus* (Table 1). The beetle distribution on the rosettes followed the same spider distribution pattern. There were less beetles than expected on small rosettes (size < 2000). Medium and large sized rosettes were occupied more frequently than expected, and the resultant distribution pattern was similar but did not match that of *L. geometricus* (Fig. 3). The frequency of *L. geometricus* and the beetle increased on rosettes with size classes between 1000 and 4000. The difference among their frequencies was greater on small and large



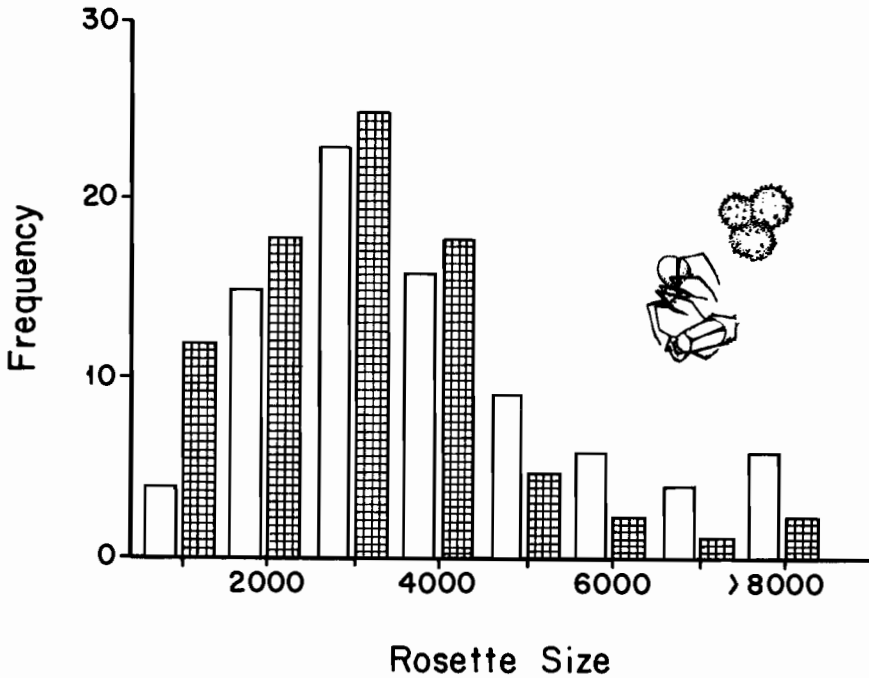
**Figure 2:** Temperature in the central tank (open circles) and rosette base (solid circles) in different rosette sizes and soil temperatures. See text for statistics.

rosettes. The relative frequency of *L. geometricus* on small rosettes (size < 1000) was greater than the beetle frequency. Beetle frequency was greater than the frequency of *L. geometricus* on large rosettes (size > 4000) (Fig. 3).

*Latrodectus geometricus* may produce larger clutch sizes on larger rosettes. There is a positive correlation between the female weight and rosette size (Fig. 4), and clutch size is directly related to female weight (Figs. 5 and 6).

## DISCUSSION

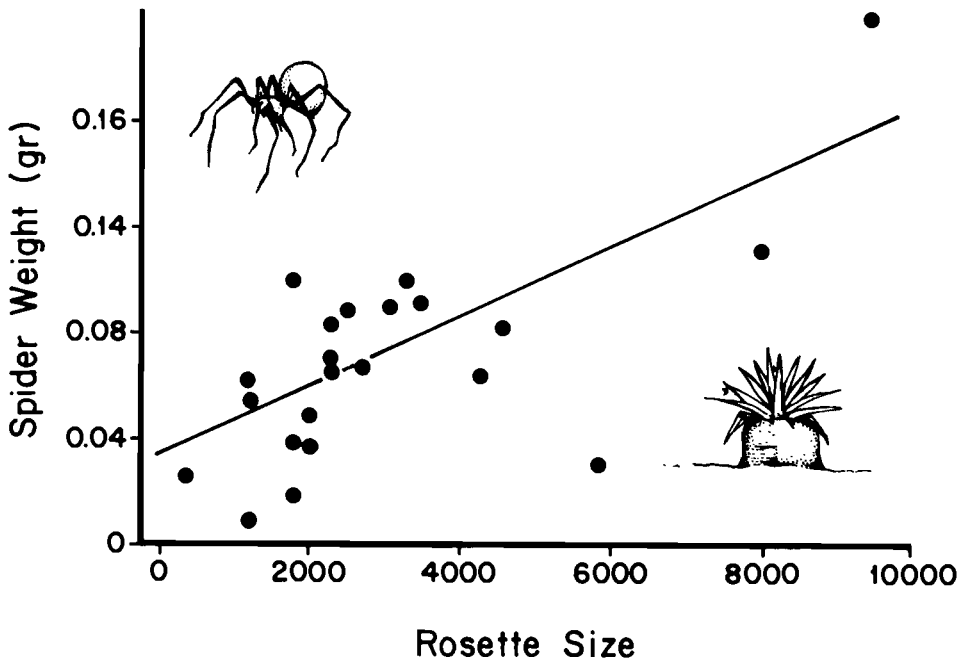
The distribution of *L. geometricus* on *P. bromelioides* probably reflects a balance between dispersion of young, differential survivorship on different rosette sizes, and differential rosette selection by adults. Passive dispersion of youngs, through "ballooning", and adult dispersion would result in greater occurrence of individuals on smaller rosettes, the most abundant in the envi-



**Figure 3:** Distribution of *Latrodectus geometricus* (solid bars) compared with the distribution of it's prey, a scarabaeid beetle (open bars). ( $X^2 = 52.550$ ,  $P < 0.001$ ).

**Table 1.** Animal groups that utilize the rosettes of *P. bromelioides* for shelter and/or hunting site and that could also be found among the prey of *L. geometricus* (groups in bold)

INSECTA	Hymenoptera	Pompilidae
		Formicidae*
	Orthoptera	Pseudophyllidae
		Blattidae*
	Coleoptera	Copiphoridae
		Acrididae*
		Romalidae
Scarabaeidae*		
Cerambycidae*		
	Curculionidae*	
Hemiptera	Coreidae*	
	Pentatomidae*	
	Reduviidae	
Diptera*		
	Lepidoptera	
ARACHNIDA	Phalangida	
	Araneae	Araneidae*
		Theridiidae*
		Anyphenidae
CHILOPODA*		
AMPHIBIA	Anura	Hylidae



**Figure 4:** Relationship between the weight of *Latrodectus geometricus* and rosette size ( $Y = 0.000015 X + 0.03$ ,  $r^2 = 0.49$ ,  $P < 0.001$ ,  $df = 20$ ).

ronment. On the other hand, the large relationship between surface/volume for the adults, and eggs (although protected by their egg sacs), should impose restrictions to spider distribution on small rosettes. There is a higher probability of desiccation on small rosettes due to higher temperatures and lower humidity. Higher mortality on smaller rosettes would generate a distribution similar to that observed. Nevertheless, this pattern may also be generated by spider habitat selection, searching for suitable microclimates, and prey availability on the rosettes (see Turnbull 1973, Riechert & Tracy 1975, Riechert 1976).

As verified in other plants (see Willmer 1986), the rosette architecture of *P. bromelioides* determines an unequal incidence of sunlight resulting on differential heating and shadowing within the rosette. Larger rosettes present a higher spectrum of microclimates resulting in a thermal heterogeneity that could be used by *L. geometricus* for temperature regulation. This has been observed

for spiders (Riechert & Tracy 1975), and insects (May 1979, Willmer 1986). In addition, time of activity is probably higher on larger rosettes than on smaller ones, due to more suitable temperature. The combination of time of activity and probability of prey encounter should determine the quantity of prey capture, and as a consequence, the rate of food intake by *L. geometricus*.

The beetle distribution pattern seems to reflect the search of appropriate microclimates on medium, and larger rosettes. In these rosettes, insects would have higher probability of being captured by *L. geometricus*. The greater weight of *L. geometricus* achieved on larger rosettes probably reflected the quantity of prey captures, and thus greater quantity of energy available for growth (see Turnbull 1965, 1973, Riechert & Tracy 1975, Fritz & Morse 1985). Nevertheless, on larger rosettes the microhabitat is spatially more complex, increasing prey probability to encounter enemy-free-space. Hence, it should reduce the

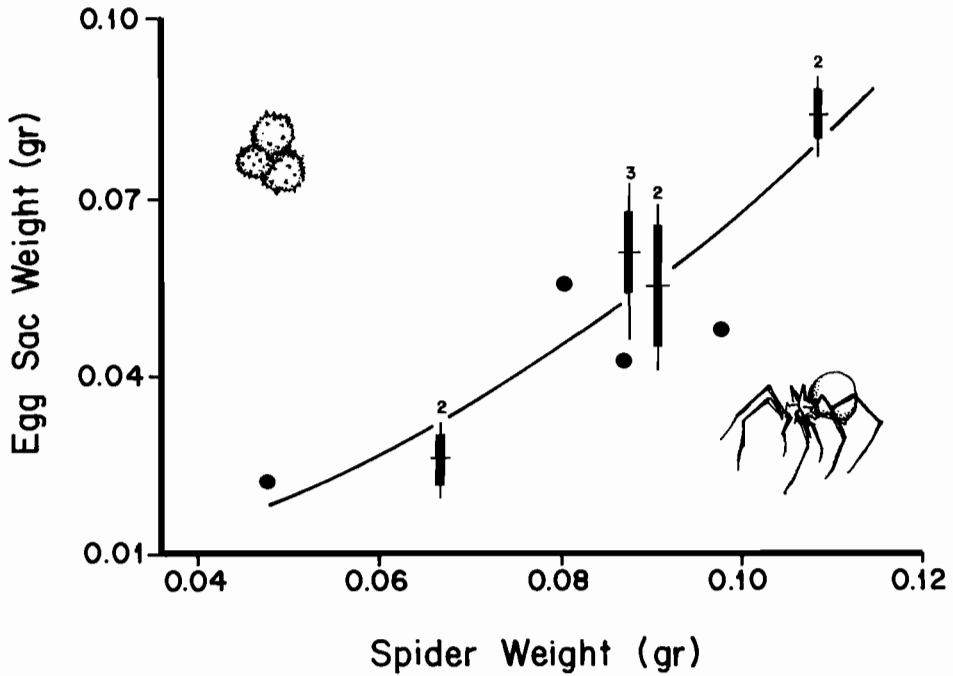


Figure 5: Relationship between the egg sac weight and *Latrodectus geometricus* weight ( $Y = 6.50 X$ ,  $r^2 = 0.71$ ,  $P < 0.001$ ,  $df = 11$ ).

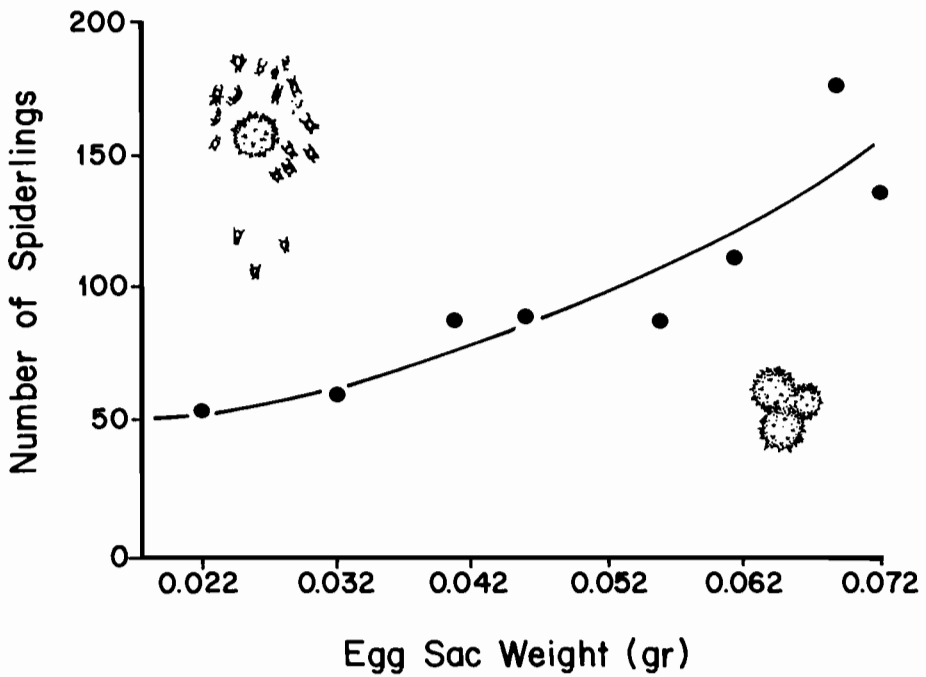


Figure 6: Relationship between clutch size and egg sac weight ( $Y = 2155 X^2$ ,  $P < 0.002$ ,  $df = 6$ ).

probability of encounter with the spider (Figueira 1989). The occurrence of *L. geometricus* on small rosettes could be explained by the general spider's capacity to tolerate low food availability, making unnecessary the emigration from temporally unproductive sites (Greenstone & Bennet 1980).

The energy surplus obtained by greater prey capture by *L. geometricus* on larger rosettes could be allocated for reproduction. Spiders that meet appropriate rosette sizes during dispersion, or that are able to discriminate them within the population, probably maximize their reproductive potential. Similar results were found for *Misumena vatia* (Thomisidae) hunting on different size inflorescence. The selection of larger inflorescence resulted on greater clutch sizes (Fritz & Morse 1985, see also Wise 1975, 1979).

This study suggests that reproductive success, prey capture, and microclimate are important during *P. bromelioides* selection by *L. geometricus*, hence subject to selective pressures.

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