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A N I N T E R N A T I O N A L J O U R N A L

# Macroinvertebrate Fauna Associated to the Bromeliad *Vriesea inflata* of the Atlantic Forest (Paraná State, Southern Brazil)

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## ABSTRACT

*The accumulated water inside the bromeliad leaf rosette is a microhabitat for several animal and plant species. In this study, the associated fauna of bromeliad* Vriesea inflata *was analyzed related to seasons, bromeliad height in relation to the ground and environmental factors. The samples were seasonally collected in Quatro Barras (a municipality of Paraná State, southern Brazil) between March 1996 and March 1997. The associated fauna was very rich and it was grouped in 23 taxonomic groups, with a dominance of Coleoptera Scirtidae, Diptera and Hymenoptera Formicidae. We found higher abundance of macroinvertebrates in terrestrial bromeliads during the spring/1996 and in epiphyte bromeliads in the autumn/1997.*

**Key words**: Bromeliaceae, Atlantic Forest, associated fauna

## INTRODUCTION

The Family Bromeliaceae, endemic of the Neotropics, presents high richness of species in the southeast of Brazil (Por, 1992). According to Mori *et al.*(1981), the endemism among families of non arboreal vegetation in the Atlantic Forest reaches 77.4%, being the most part composed of bromeliads. This family is characterized by terrestrial, saxicolous or epiphytes herbs that, in general, possess simple leaves disposed in a rosette form, allowing accumulation of water and organic detritus as much in its hems as in the central part of the plant (Leme, 1984). Thus, the rain water accumulated in the leaf rosette, can be considered a "limnological isolated environment", a microhabitat for countless species of animals and plants (Picado, 1913), which live in a symbiotic relationship type, where the associated community supplies rich nutrients to these plants (Por, 1992). In these coevolutionary relationships, the faunistic diversity of the Atlantic Forest can be justified due to bromeliad diversity (Por, op cit.). However, few studies were made with communities associated to bromeliads. Researches related to these ecosystems began with the historical paper of Picado (1913) that emphasized the associated biological populations. Privat (1979) demonstrated the importance of the relationship among bromeliad fauna and pollinators of cocoa flowers. Salamandra (1977) made a comparative study with *Gusmania berteroniana* and *Vriesea sientenisii* about abiotic factors and associated fauna. Ochoa (1993) focused associated arthropods to *Bromelia hemisphaerica*, comparing their abundance, niches and feeding habits. In Brazil, Domingues *et al.* (1989) and Oliveira *et al* .(1994) analyzed bromeliads fauna.

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This paper focuses the community associated to *Vriesea inflata* (Wawra, 1883), analyzing comparatively their richness and similarity in relation to the seasons and the height from the ground in which the bromeliads were found. This bromeliad is distributed abundantly in the study area and it occurs between 910 and 1100m of altitude, occupying all vegetative strata, from the ground zone to the forest zone (above 4,5 meters).

## MATERIALS AND METHODS

The samples were collected in the Caranguejeira Hill (25°20'45"S, 49°55'W) with 1189m altitude and located in the municipality of Quatro-Barras (Paraná).

Samples were seasonally collected: in March (autumn), August (winter) and November (spring) of 1996 and January (summer) and April (autumn) of 1997. In the season station about ten specimens of *Vriesea inflata* were collected, five epiphytes and five terrestrial, with inflorescence or, at least, with the size to have them. Each one was measured in terms of size (two measurement of diameter and one of height), of height in relation to the ground, and the altitude in relation to the sea level. The temperature was taken both in the leaves rosette as in the atmosphere. Each bromeliad was individually numbered and kept inside a sack for posterior study in the laboratory of the Department of Zoology (SCB/UFPR).

In the laboratory, the leaves were taken off and washed on a sieve (approximately 1 mm of mesh). It was used for safety under this sieve was used a second one of finer mesh. The sieves were placed in a vat with water and the organisms were selected under estereoscopic microscope Wild M5, kept in ethyl alcohol 70$^{o}$ GL and labled. The samples were identified to the smallest possible taxonomic level.

The richness of the fauna was analyzed in relation to physical variables (bromeliad height in relation to the ground, number of leaves, leaf rosette temperature, environmental temperature and altitude in relation to the sea level). Besides this, we compared the fauna composition of terrestrial and of epiphyte bromeliads in each season, using to Kruskal-Wallis test (Siegel, 1975). Frequencies of occurrence in terrestrial and epiphyte bromeliads was tested by the Mann-Whitney test (Siegel, *op cit*).

## RESULTS

We found 1,639 macroinvertebrates in 36 bromeliads along the study period (Table 1). Most of them consisted of immature forms.

The associated fauna was grouped in 23 *taxa* (Table 2), and the most frequent were Coleoptera Scirtidae (28.5%), Diptera (25.3%) and Hymenoptera (19.1%). The Hymenoptera was composed mainly by Formicidae Family and only two individuals of Torymidae were found. Coleoptera Scirtidae (35.5%), Diptera (26.9%) and Hymenoptera (15.7%) were the most frequent *taxa* in terrestrial *Vriesea inflata*. Other *taxa* were represented by less than 30% of the total and some differences could be observed in the occurrence of some groups between epiphytes and terrestrials bromeliads. Trichoptera, represented by *Philloicos bromeliarum* (Calamoceratidae Family; R. Holzenthal, per. com.), occurred mainly in terrestrial *V. inflata* (73.1% of total occurrence). Isopoda occurred in larger number in epiphyte bromeliads (87.5%). Mollusca Gastropoda, represented mainly by Systrophiidae, occurred predominantly in epiphyte bromeliads (95.8%).

Araneae was the group that presented the larger richness totalling 18 families (Table 1), and 64% of individuals occurred in terrestrial bromeliads. The largest abundance of macroinvertebrates in terrestrial bromeliads was registered during spring/1996, and in epiphytes, during autumn/1997 (Fig.1). In terrestrial bromeliads, the highest specific richness was registered during spring/1996 and the smallest, during winter/1996. In the epiphyte bromeliads, the highest richness was registered in the autumn/1997, and the smallest, during summer/1997 (Fig.1). A great number of Microcrustaceans (Ostracoda), Collembolas and Acari was observed and they were not quantified because they were very small and many times they escaped through the sieve.

The largest amplitude of variation in richness was observed in the autumn/1997 (maximum 11 and minimum 5) in epiphyte bromeliads, and in spring (maximum 12 and minimum 4) in terrestrial ones (Table II).

Fauna richness did not differ directly in function of the height in witch bromeliads were found and in relation to other analysed environmental factors (rosette temperature, air temperature, altitude and number of leaves).

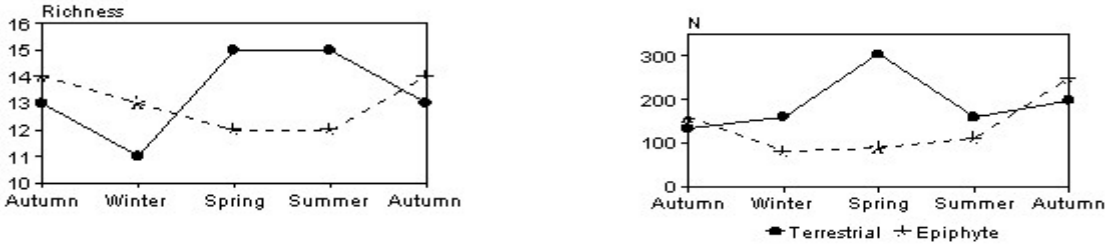


**Figure 1 -** Graphic representation of species richness and total number of specimens sampled in V. inflata during the year.

**Table 1 -** Taxa found in the leaf rosette of epiphytes (E) and terrestrial (T) Vriesea inflata in Caranguejeira hill.

| Taxon | Occurrence | Taxon | Occurrence |
|---|---|---|---|
| **Phylum Platyhelminthes** | | - Class Crustacea | |
| - Class Turbellaria | E,T | - Order Isopoda | |
| **Phylum Nematoda** | | - Family Philosciidae | E,T |
| - Class Adenophorea | T | - Family Armadillidae | E,T |
| **Phylum Mollusca** | | - Class Insecta | |
| - Class Gastropoda | | - Order Odonata | T |
| - Order Pulmonata | | - Order Orthoptera | |
| - Family Systrophiidae | E,T | - Family Gryllidae | E,T |
| - Family Charopidae | E,T | - Order Blattodea | E,T |
| **Phylum Annelida** | | - Order Dermaptera | T |
| - Class Oligochaeta (terr. e aquát.) | E,T | - Order Hemiptera | |
| - Class Hirudinea | | - Family Enicocephalidae | T |
| - Order Rhynchobdellida | T | - Family Scuteleridae | E |
| **Phylum Arthropoda** | | - Order Homoptera | |
| - Class Arachnida | | - Family Coccidae | E,T |
| - Order Pseudoscorpiones | E,T | - Order Coleoptera | |
| - Order Araneae | | - Family Ptiliidae | E,T |
| - Family Idiopidae | T | - Family Scirtidae | E,T |
| - Family Nemesidae | T | - Family Elateridae | E |
| - Family Uloboridae | E | - Family Dytiscidae | E.T |
| - Family Amaurobidae | T | - Family Curculionidae | E,T |
| - Family Dictynidae | T | - Family Carabidae | E |
| - Family Ctenidae | T | - Family Staphylinidae | E,T |
| - Family Theridiidae | E,T | - Family Lampyridae | T |
| - Family Miturgidae | E | - Family Scarabeidae | E |
| - Family Heteropodidae | E,T | - Family Nitidulidae | T |
| - Family Anyphaenidae | E,T | - Family Silvanidae | E |
| - Family Salticidae | E,T | - Family Limulodidae | E |
| - Family Thomisidae | E | - Family Hydrophilidae | E,T |
| - Family Hahniidae | E | - Family Tenebrionidae | E,T |
| - Family Pisauridae | T | - Family Pselaphidae | E,T |
| - Family Mismenidae | T | - Family Ptilodactylidae | E |
| - Family Corinnidae | E,T | - Order Trichoptera | |
| - Family Scytodidae | E,T | - Family Calamoceratidae | E,T |
| - Family Theridiossomatidae | T | - Order Lepidoptera | T |
| - Order Opiliones | | - Order Diptera | |
| -Subord. Laniatores | | - Family Bibionidae | |
| - Family Trichomatidae | E | - Family Chironomidae | E,T |
| - Family Gonyleptidae | T | - Family Tipulidae | E,T |
| - Class Chilopoda | | - Family Dolichopodidae | E,T |
| - Order Scolopendromorpha | | - Family Psychodidae | E,T |
| - Family Cryptodidae | E,T | - Family Muscidae | E |
| - Order Lithobiomorpha | T | - Family Mycetophilidae | E,T |
| - Order Geophilomorpha | E,T | - Family Culicidae | T |
| - Class Diplopoda | E,T | - Family Cecidomyiidae | E,T |
| - Class Crustacea | | - Family Ceratopogonidae | E |
| - Order Amphipoda | E | - Order Hymenoptera | |
| | | - Family Formicidae | E,T |
| | | - Family Torymidae | E |

**Table 2 -** Occurrence of the different macroinvertebrates taxa in terrestrial and epiphytes bromeliads in relation to the season of the year (S.T.= total of occurrence for terrestrial or epiphytes bromeliads ; TOT= total of occurrence during the study; Mol.= Mollusca; Col.= Coleoptera)

| | TERRESTRIAL | | | | | | EPIPHYTE | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Taxa \ Seasons | Aut. | Win. | Spr. | Sum. | Aut. | S.T. | Aut. | Win. | Spr. | Sum. | Aut. | S.T. | TOT |
| Platyhelminthes | 0 | 0 | 1 | 1 | 1 | 3 | 0 | 1 | 0 | 6 | 2 | 9 | 12 |
| Nematoda | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Mol. Gastropoda | 0 | 0 | 0 | 1 | 0 | 1 | 3 | 6 | 1 | 10 | 3 | 23 | 24 |
| Annelida | 1 | 3 | 30 | 8 | 2 | 44 | 0 | 3 | 0 | 5 | 3 | 11 | 55 |
| Pseudoscorp. | 1 | 1 | 0 | 1 | 2 | 5 | 0 | 1 | 2 | 0 | 0 | 3 | 8 |
| Araneae | 11 | 7 | 3 | 9 | 9 | 39 | 2 | 11 | 2 | 3 | 4 | 22 | 61 |
| Opiliones | 1 | 0 | 0 | 1 | 0 | 2 | 1 | 0 | 0 | 0 | 0 | 1 | 3 |
| Amphipoda | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 0 | 5 | 5 |
| Isopoda | 2 | 0 | 3 | 2 | 1 | 8 | 27 | 6 | 6 | 3 | 14 | 56 | 64 |
| Chilopoda | 1 | 2 | 2 | 0 | 1 | 6 | 3 | 5 | 0 | 1 | 0 | 9 | 15 |
| Diplopoda | 0 | 2 | 1 | 0 | 0 | 3 | 3 | 1 | 2 | 1 | 0 | 7 | 10 |
| Odonata | 4 | 0 | 0 | 0 | 1 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |
| Orthoptera | 0 | 1 | 0 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 1 | 1 | 3 |
| Blattodea | 1 | 0 | 1 | 0 | 2 | 4 | 3 | 0 | 1 | 0 | 2 | 6 | 10 |
| Dermaptera | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Hemiptera | 2 | 0 | 1 | 0 | 0 | 3 | 3 | 0 | 0 | 0 | 1 | 4 | 7 |
| Homoptera | 0 | 0 | 1 | 0 | 0 | 1 | 8 | 0 | 4 | 0 | 5 | 17 | 18 |
| Coleoptera | 5 | 5 | 13 | 22 | 9 | 54 | 2 | 21 | 6 | 9 | 7 | 45 | 99 |
| Col. Scirtidae | 65 | 79 | 44 | 53 | 98 | 339 | 10 | 9 | 30 | 22 | 57 | 128 | 467 |
| Trichoptera | 0 | 0 | 24 | 5 | 20 | 49 | 0 | 3 | 5 | 3 | 7 | 18 | 67 |
| Lepidoptera | 0 | 2 | 0 | 1 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| Diptera | 37 | 51 | 78 | 41 | 50 | 257 | 9 | 12 | 17 | 46 | 73 | 157 | 414 |
| Hymenoptera | 2 | 8 | 100 | 12 | 2 | 124 | 80 | 1 | 13 | 1 | 68 | 163 | 287 |
| Total | 133 | 161 | 303 | 159 | 198 | 954 | 159 | 80 | 89 | 110 | 247 | 685 | 1639 |
| Max / Min Richness | 9/3 | 8/3 | 12/4 | 16/9 | 9/5 | | 10/6 | 7/5 | 10/6 | 9/4 | 11/5 | | |
| Total Richness | 13 | 11 | 15 | 15 | 13 | | 14 | 13 | 12 | 12 | 14 | | |

Similarity between the fauna associated to the bromeliads during the seasons was very high. In terrestrial (KW=1.182; p>0.05) and in epiphytes bromeliads (KW=0.9716; p>0.05) statistical differences were not verified in the associated fauna during the year. The comparison of associated fauna to terrestrial and epiphyte bromeliads (U=243.5; p>0.05) also indicated that the differences were not statistically significant.

## DISCUSSION

Even though the leaf rosette of *Vriesea inflata* presents a small volume (from 56 to 140 cm3), it shelters a very rich fauna. The majority of invertebrate organisms that were found associated to *Vriesea inflata* in Caranguejeira hill (Turbellaria, Gastropoda, Oligochaeta, Arachnida, Chilopoda, Diplopoda, Crustacea and Insecta) were also found in studies accomplished with other species of bromeliads from Costa Rica (Picado, 1913; Privat, 1979), from Puerto Rico (Salamandra, 1977), from Mexico (Ochoa, 1993) and from Brazil (Domingues, 1989; Oliveira, 1994). Thus, it is probable that bromeliads possess a characteristic fauna, permanent and transitory, but with a predominance of some groups.

The most abundant macroinvertebrates were Coleoptera larvae, Family Scirtidae. According to Costa *et al.* (1988), they can be associated to bromeliad water, because they eat mainly algae and aquatic fungi. In spite of this, this group had not still been mentioned in other researches as a dominant fauna in this ecosystem type.

The second more abundant *taxon* was Diptera, the best studied arthropods associated to bromeliads in relation to the population ecology (*e.g.* Veloso, 1952; Torales, 1972; Frank, 1990) and to the community ecology (Salamandra, 1977; Privat, 1979; Ochoa, 1993). This *taxon* has seemingly prevailed in terrestrial bromeliads. However, no research has been developed with the purpose of detecting their possible preference for epiphyte or terrestrial bromeliads. The most frequent Diptera were Chironomidae larvae, witch eat mainly

detritus (McAlpine, 1987). In the leaf rosette of *V. inflata* a great quantity of particulate organic matter was observed, which probably facilitates proliferation of these organisms.

Among the Hymenoptera, also observed by Privat (1979), the predominance was of the Formicidae Family. Oliveira *et al.* (1994) did not consider the ants as characteristic fauna in bromeliads and deduced that their high frequency was a result of the foraging behavior of close living colonies. The frequency of this *taxon* varied during the year. However, when they were found in great number, we also observed pupae, suggesting that the presence of ants in the external leaves of the rosette cannot only be due to a foraging behavior.

In spite of there not have been found significant statistical differences in the fauna composition between epiphyte and terrestrial bromeliads, a larger Trichoptera occurrence was observed in terrestrial bromeliads, and Isopoda and Gastropoda in the epiphyte. The Trichoptera *taxon*, was not very common in other bromeliad communities, and it was only represented by the larvae of *Philloicos bromeliarum*. These animals, according to Müller (1880), build shelters with irregular pieces of leaves, found inside bromeliad rosettes. In epiphyte, Isopoda is represented mainly by *Bentana genera* (Philosciidae) which is characterized by a detritivorous feeding behavior and direct dependence on water. Gastropod Mollusks had mainly individuals of Systrophiidae. These are predators of other mollusks (probably herbivore gastropods Charopidae that were also collected in bromeliads) and they were also dependent on water. These *taxa* (Isopoda and Mollusca Gastropoda) were also registered as associated fauna by Salamandra (1977) and Privat (1979). Perhaps the occurrence of these taxa in terrestrial and epiphyte bromeliads can be influenced by small environmental differences provided by the epiphytic habit of bromeliads.

The order Araneae was the group with larger richness of families, probably due to the abundance of preys sheltered in leaf rosettes. The Theridiidae Family was the most representative, probably due to the form and size of leaves of *V. inflata* favoring the installment of small irregular cobweb built by this family. Oliveira *et al.* (1994) verified that spiders are the most abundant animals of the community associated to the bromeliad *Neoregelia cruenta*.

Even though the statistical analysis have not detect differences in frequency occurrence, graphic analysis suggests an apparent seasonal variation in the number of individuals and in the total richness, in epiphyte and terrestrial bromeliads, during the year. Perhaps this happens because of differences in rain along the year. During autumn and winter, weak and scarce rains are not enough to accumulate great amount of water in terrestrial bromeliads. On the other hand, during spring and summer, heavy and frequent rains allow this accumulation. In epiphytes, as they are in a superior stratum, possibly small amounts of rain are enough to guarantee the minimum supply of water, even in a dry season.

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## RESUMO

As bromélias, por acumularem água em sua roseta foliar, constituem um microhabitat para inúmeras espécies de animais e plantas. No presente estudo foi analisada a fauna associada à bromélia *Vriesea inflata* relacionando-a com fatores ambientais e altura da bromélia em relação ao solo. As coletas foram realizadas sazonalmente no Morro da Caranguejeira (Quatro Barras - Paraná) de março de 1996 a março de 1997. A fauna associada foi muito rica e agrupada em 23 grupos taxonômicos, onde observou-se a dominância de Coleoptera Scirtidae, Diptera e Hymenoptera Formicidae. Mesmo não havendo diferenças estatísticas significativas entre bromélias epifitas e terrestres, foi constatada uma maior abundância de macroinvertebrados em bromélias terrestres na primavera/1996 e em epifitas no outono/1997. Devido a grande riqueza e abundância de invertebrados presentes no microhabitat bromelícola, principalmente formas imaturas, é

possível concluir que este ecossistema é de fundamental importância tanto para as comunidades que nele se desenvolvem como para a manutenção da diversidade da Floresta Atlântica.

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