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PLATYCERIUM STEMARIA (POLYPODIACEAE): AN AFRICAN EPIPHYTIC MYRMECOPHYTE

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ABSTRACT. An ecological study in southern Cameroon explored the relationships between arthropods and the trash-basket epiphytic fern, *Platycerium stemaria* (P.Beauv.) Desv. (Polypodiaceae). Arthropods shelter in cavities situated among the tangled roots of the fern or between them and the bark of the host trees, or they develop in the compost and hanging soil that form from vegetal debris trapped by the barren fronds. This fauna provides the fern with nutrients. Large numbers of detritivorous arthropods accelerate the re-mineralization of the vegetal debris trapped by the fronds, improving the quality of the compost that feeds the epiphyte. Ant fauna is relatively diverse because of the presence of opportunistic species; particularly predators specialized in the capture of arthropod taxa that feed on the debris trapped by *P. stemaria*. On the other hand, *P. stemaria* mostly shelters three ant species in cavities limited to the tangle roots and so can be considered a myrmecophytic epiphyte. The nitrogen-rich wastes of ant colonies likely improve the quality of the compost that feeds the fern. *Platycerium stemaria* presents therefore similarities with certain neotropical bromeliads.

Key words: fern, *Platycerium stemaria,* epiphyte, myrmecophyte, ants, associated fauna

INTRODUCTION

Certain arboreal ants are able to build their own nests, most often with carton (chewed wood mixed with ant secretions). Others, however, shelter in pre-existing cavities such as dry, hollow twigs. Some ant-plants (myrmecophytes) shelter a limited number of ant species in hollow structures called domatia (i.e., leaf pouches, hollow branches, or thorns). Myrmecophytes often provide ants with food in the form of extrafloral nectaries and/or food bodies. In return, ants protect their host plant against herbivores, competing plants, and encroaching vines, and sometimes provide them with minerals. Certain epiphytes also develop myrmecophytic associations with ants, and in this case, mineral provision by the ants is of particular value (Beattie & Hughes 2002, Heil & McKey 2003, and references cited therein).

The evolution of these interactions, and their role in ecological processes, have interested scientists since they were first documented by Schimper (1888). Many studies have been conducted on the fauna associated with vascular epiphytes in the tropical regions of America (Benzing 1990, Blüthgen et al. 2000, Dejean et al. 1995, Dejean & Olmsted 1997, Armbuster et al. 2002) and Asia (Treseder et al. 1995, Kaufmann et al. 2001, Ellwood et al. 2002). Information is lacking, however, regarding African species. The authors thus conducted a study on fauna sheltering in the tangle roots of the epiphytic fern, *Platycerium stemaria* (P.Beauv.) Desv. (Polypodiaceae), which is well represented in southern Cameroon. *Platycerium angolensis* is present but at a level of abundance too low for an in-depth study. Both of these epiphytic ferns collect debris falling from upper vegetation, thanks to their large, barren fronds that form a trash-basket-like structure (Benzing 1990).

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TABLE 1. Animal taxa associated with the epiphyte, *Platycerium stemaria,* at three study sites in Cameroon.

Animal taxa		Occupation on *Platycerium stemaria* (%)				Statistical comparisons
Class	Order or sub-classes	Nlong	Kala	Yaoundé	Total	
Annelida	Oligocheta	4.88	22.67	6.96	11.69	**
Mollusca	Gasteropoda	0	0	3.48	1.73	NS
Arachnida	Acariformes	100	100	100	100	/
	Araneae	36.59	58.67	27.82	39.39	‡
Myriapoda	Diplopoda	7.32	2.67	6.96	5.63	NS
	Chilopoda	2.44	13.33	1.74	5.63	**
Crustacea	Isopoda	0	0	9.57	4.76	‡
Hexapoda	Collembola	100	100	100	100	/
	Blattodea	70.73	78.67	59.13	67.53	*
	Isoptera	7.32	14.67	13.04	12.55	NS
	Strepsiptera	0	1.33	0.87	0.87	NS
	Lepidoptera	4.88	1.33	6.09	4.33	NS
	Diptera	0	0	0.87	0.43	NS
	Hemiptera	2.44	1.33	0.87	1.30	NS
	Hymenoptera (Form.)	97.56	84.00	87.83	88.31	*
	Coleoptera	12.20	2.67	51.30	28.57	‡
Reptilia	Lacertilia	0	0	13.91	6.93	‡

Note: The number of individuals of Acariformes and Collembolans was extremely variable from one sample to the other. Because two or more taxa were found under the same epiphyte, the cumulative values exceed 100%. NS = $P > 0.05$; * = $0.05 > P > 0.01$; ** = $0.01 > P > 0.001$; ‡ = $P < 0.001$; Form. = Formicidae. Total no. of cases = Nlong, 41; Kala, 75; Yaoundé, 110; total = 226.

MATERIAL AND METHODS

The present study was conducted in Cameroon from 1996 to 1998 between March and November (corresponding to the major rainy season) on three sites situated around Yaoundé (3°55′N, 11°29′E, 650 m) and in cocoa plantations in, respectively, Kala (3°50′N, 11°21′E, 650–710 m) and Nlong (ca. 25 km west of Kala). The authors collected a total of 226 *Platycerium stemaria*: 110 from Yaoundé, 75 from Kala, and 41 from Nlong. Each epiphyte was cut away from its host plant with a knife. Arthropods remaining on the bark of the host trees were collected, using an aspirator, and preserved in tubes filled with 70% ethanol. Each epiphyte and its corresponding tubes were placed in a plastic bag and labeled. In the laboratory, each epiphyte was dissected completely, and all macroscopic fauna were collected and preserved in tubes filled with 70% ethanol for further identification.

Because of variations in sample sizes at the three sites, data were transformed by calculating "standardized deviates." This value, expressed as the deviation of the obtained data from a central point and representing the value in a homogeneous distribution, is obtained using the formula:

$$\textit{Standardized Deviate (SD)} = \textit{(Observed} - \textit{Expected)/(SQR Expected)}$$

The "presence-absence" of standardized deviates at the various sites was compared using Fisher's exact test (Systat 9 software).

RESULTS AND DISCUSSION

Non-Ant Relationships

The complete dissection of the 226 epiphytes revealed a total of 17 animal orders, 12 of which were present at all three sites (TABLE 1). Some taxa, such as Acariformes, Araneae, Collembola, Blattodea, Hymenoptera (Formicidae), and Coleoptera larvae, were represented by a large number of individuals per epiphyte. Overall, the epiphytic fern, *Platycerium stemaria,* sheltered arthropods, at least Acariformes and Collembola, in all cases (TABLE 1). Lombricidae, Gasteropoda, and most arthropod taxa (Acariformes, Collembolla, Isopoda, Blattodea, Isoptera, Coleoptera, and even Lepidoptera) are detritivorous and feed on the debris collected in the trash basket formed by the plant's barren fronds and occasionally directly on the dry fronds. The influence of this detritivorous component of the macrofauna on the development of the epiphyte seems crucial, as it accelerates the process of remineralization from trapped plant debris. On the other hand, these insects (plus predators such as Araneae, Formicidae, Chilopoda, and Lacertilia) add their nitrogen-rich feces and prey carcasses to the suspended soil, facilitating host plant development. Note that during breeding

TABLE 2. Ant species associated with the epiphyte, *Platycerium stemaria,* at three study sites in Cameroon.

Ant taxa		Occupation on *Platycerium stemaria* (%)				Statistical comparisons
Sub-family	Species	Nlong	Kala	Yaoundé	Total	
Ponerinae	*Anochetus katonae*	0	0	6.09	3.03	*
	Hypoponera sp.	2.44	0	6.09	3.03	NS
	Odontomachus troglodytes	2.44	0	0	1.73	NS
	Pachycondyla sorror	7.32	1.33	0	1.73	NS
	Platythyrea conradti	0	18.67	0	6.06	‡
	Platythyrea modesta	2.44	6.67	0	2.60	*
Myrmicinae	*Atopomyrmex mocquerysi*	7.32	4.00	6.96	6.06	‡
	Cataulachus guineensis	0	0	1.74	0.87	NS
	Crematogaster spp.‡‡	2.44	1.33	10.43	6.06	*
	Monomorium sp.	12.20	2.67	1.74	3.90	**
	Pheidole megacephala	26.8	72.00	47.83	51.95	‡
	Pyramica lujae	2.44	5.33	2.17	3.46	NS
Formicinae	*Brachymyrmex* sp.	0	0	4.35	2.17	‡
	Camponotus brutus	71.61	45.33	43.48	49.78	NS
	Polyrachys militaris	7.30	6.67	11.30	9.09	‡
Dolichoderinae	*Technomyrmex* sp.	0	0	10.43	5.19	‡

Note: Because two or more ant species were found under the same epiphyte, cumulative values exceed 100%. NS = $P > 0.05$; * = $0.05 > P > 0.01$; ** = $0.01 > P > 0.001$; ‡ = $P < 0.001$; ‡‡ = *Crematogaster,* with three morphospecies pooled, resulted in a total of 18 ant species recorded.

periods, lizards use this epiphytic plant to shelter their eggs.

The comparison of the frequency of different animal orders at the three study sites resulted in significant differences in several cases (TABLE 1), indicating an inter-site variation.

Ant Relationships

The frequency of *Platycerium stemaria* individuals sheltering at least one ant colony was very high at all three sites: 97.56% in Nlong, 84% in Kala, and 87.3% in Yaoundé (TABLE 2). The overall comparison between the three sites resulted in a non-significant difference (Fisher's exact test $P = 0.07$; NS).

An inter-site variation also was observed in the distribution of 10 out of the 16 ant taxa compared (with three *Crematogaster* species pooled; TABLE 2). *Atopomyrmex mocquerysi* workers only visited the epiphytes to search for prey, while all other species sheltered in cavities limited to the tangle roots. Two species, namely *Pheidole megacephala* and *Camponotus brutus,* strongly dominated, showing a kind of specialty. Both were previously indicated as sheltering between *Platycerium* roots in the Ivory Coast (Lévieux 1976). Also, *Polyrhachis militaris* was relatively frequent, while most of the *Platythyrea conradti* colonies that were gathered during studies on this species nested in *Platycerium* cavities (A. Dejean pers. obs.). As a result, this epiphytic fern favors the presence of certain ant species, such as *Pheidole megacephala* and *C. brutus,* that can compete with those able to build their own nests, particularly "dominant arboreal ants." Such species are characterized by extremely populous colonies, the ability to build large or polydomous nests, and a highly developed territoriality resulting in their territories being distributed in a mosaic pattern in the forest canopy (Dejean & Corbara 2003). Most dominant species are beneficial in tree crop plantations, as they protect host trees against herbivores, while they attend hemipterans of the family Stictococcidae that do not pose agronomical problems.

On the contrary, *Pheidole megacephala* attend Pseudococcidae that transmit plant diseases (see Campbell 1994, Taylor 2005). Among the other ants, one can distinguish arboreal species, such as *Cataulachus guineenis, Crematogaster* spp., *Brachymyrmex* sp., and *Polyrhachis militaris,* from ground-nesting species. Ground nesters are adapted to living in hanging soil, and most are specialized predators. Except for *Platythyrea conradti,* an arboreal species that exploits extrafloral nectaries (Dejean & Suzzoni 1997), other Ponerinae are mostly termite predators, and *Pyramica lujae* is a predator of Collembola (A. Dejean pers. obs.). These ants may protect their *Platycerium stemaria* host plant against defoliators (see Cherrett 1986; Dejean et al. 1992, 1995) and/or directly deposit their nitrogen-rich wastes and feces between the roots

(see also Benzing 1990, 1991; Treseder et al. 1995).

In conclusion, independent of opportunistic ant species, *Platycerium stemaria* mostly shelters three ant species in its cavities and thus can be considered a myrmecophytic epiphyte, although it is also a trash-basket epiphyte, permitting a diverse fauna to develop. In this way, it presents similarities with certain neotropical bromeliads (Dejean & Olmsted 1997, Blüthgen et al. 2000).

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