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Leaf domatia in montane forest and Caatinga in the semiarid of Pernambuco State: Morphology and ecological implications

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ABSTRACT. Leaf domatia are cavity-shaped structures of different types or tufts of hairs located at the junction between ribs on the abaxial surface of the leaf blades of various families of angiosperms, serving as protection against phytophagous organisms by harboring beneficial mites, suggesting a mutualistic relationship. There is shortage of inventories of species with such structures; thus the present study examined native woody plant in two habitats of the backwoods of Pernambuco to identify the types of leaf domatia. 86 species were observed, 43 in Caatinga area, out of which five had domatia, and 43 in the montane forest, 11 species with domatia. Four types of domatia were observed: hairtufts, pocket, pit and revolute margin. There was predominance of plant species with leaf domatia in the area Carro Quebrado in Triunfo, Pernambuco State. These results corroborate the information available in the literature in which domatia are prevalent in more humid environments, and that these structures as micro-habitats influence the maintenance of diverse organisms.

Keywords: leaf domatia, caatinga, montane forest, Pernambuco State.

Domácias foliares em brejo de altitude e Caatinga no Semiárido pernambucano: morfologia e implicações ecológicas

RESUMO. Domácias foliares são estruturas em forma de cavidades de diferentes tipos ou tufos de tricomas localizados na junção entre as nervuras, na face abaxial das lâminas foliares de diversas famílias de angiospermas, servindo de defesa contra organismos fitófagos por abrigarem ácaros benéficos, sugerindo uma relação mutualística. Há escassez de inventários de espécies apresentando essas estruturas; diante disso, o presente estudo analisou plantas lenhosas nativas em dois ambientes do sertão de Pernambuco, visando identificar os tipos de domácias foliares. Foram observadas 86 espécies, 43 em área de Caatinga em as quais cinco apresentaram domácias e 43 no brejo de altitude, 11 espécies com domácias. Foram encontrados quatro tipos de domácias: tufo de pelos, bolso, cova e orla. Na área do Carro Quebrado, Triunfo, Estado do Pernambuco, as plantas com domácias foliares foram predominantes. Estes resultados corroboram as informações disponíveis na literatura de que domácias são predominantes em ambientes mais úmidos, e que essas estruturas como micro-habitats, influenciam a manutenção de diversos organismos.

Palavras-chave: domácias foliares, caatinga, brejo de altitude, Pernambuco.

Introduction

Various plant species have cavity-shaped domatia on the leaves of different types or tuft of hairs, located at the junction between the ribs on the abaxial leaf surface (LUNDSTROEN, 1887). These structures are associated mainly with different types of beneficial predatory and fungal feeder mites (FERREIRA et al., 2011; MATOS et al., 2004; MINEIRO et al., 2008; ROMERO et al., 2011; O'DOWD; PEMBERTON, 1998; PEMBERTON; TURNER, 1989; WALTER, 1996), which suggests the mutualistic relationships between plants and such organisms, since they can contribute to reduce the density of herbivores that occur therein (AGRAWAL, 1997; AGRAWAL et al., 2000; ENGLISH-LOEB, 2002; GROSTAL; O 'DOWD, 1994; KARBAN et al., 1995; LUNDSTROEN, 1887; MATOS et al., 2006; MINEIRO et al., 2008; O'DOWD; WILSON, 1989).

Despite the mutualistic relationships between domatia and beneficial mites being quite old (LUNDSTROEN, 1887), it has long been left out, and most researchers have given these structures just a taxonomic character, not reporting the occurrence of arthropods inside. The domatia occur mainly in plants of humid environments and any physiological function for them has been mentioned (NAKAMURA et al., 1992; NORTON et al., 2000).

From the 1980s, research on the interaction between mites and leaf domatia took off and the

mutualistic relationships were again discussed, culminating in a series of studies aiming at proving it (AGRAWAL et al., 2000; ENGLISH-LOEB, 2002; GROSTAL; O'DOWD, 1994; KARBAN et al., 1995; MATOS et al., 2004, 2006; O'DOWD; WILSON, 1989; PEMBERTON; TURNER, 1989; SCHICHA; O'DOWD, 1993; WALTER; O'DOWD, 1997). However, these studies have not emphasized the characterization of these structures and there is little information available in the literature on plants that have domatia on their leaves.

This study conducted a survey of leaf domatia-bearing plants in two environments representing distinct vegetation formations in the Brazilian semiarid region (Caatinga and montane forest) and the types of domatia present in these plants, so as to provide a basis for ecology studies and interaction of these structures with small arthropods.

Material and methods

The study was conducted in two distinct environments, located in the semiarid region of Pernambuco State:

a) ***Mata da Pimenteira*** (Caatinga area) - located in the Parque Estadual Mata da Pimenteira (7°53'49"S 38°18'14"W), municipality of Serra Talhada, Pernambuco State, Brazil. The altitude in the county ranges around 500-800 m (FERRAZ et al., 1998) and the annual rainfall between 600 and 700 mm; the average temperature is 26ºC (EMBRAPA, 2000) with hot semiarid climate. The vegetation is classified as deciduous forest, subjected to two well-defined seasons, drought, when most individuals lose their leaves, is prevalent (VELOSO et al., 1991). The area has a well preserved tree layer, rarely seen in the Caatinga, with individuals up to 18 m high being recorded (personal communication, Melo, A.).

b) ***Mata do Carro Quebrado*** (montane forest area) - part of the district of Carro Quebrado (07°53'24.4"S 38°06'10.4"W), municipality of Triunfo, Pernambuco State, Brazil.

It is located at 620 m altitude. The climate is hot and humid in Triunfo, rainfall around 1,222 mm and 25ºC average temperature (CPRM, 2005). This municipality is located in the city of Carro Quebrado about 20 km from a shopping center, where there is a well-preserved hillside vegetation consisting of tall trees, sometimes exceeding 25 meters in height (personal communication, Melo, A.).

Species Selection: phytosociological surveys previously performed in the study areas were used in this stage, considering species in which at least one individual met the diameter inclusion criteria at soil level greater than or equal to 3 cm and height greater than or equal to 1 m in plots of 10 x 10 m, totaling 0.5 ha in the Mata do Carro Quebrado (unpublished data) and 10 x 20 m totaling 0.8 ha in the Mata da Pimenteira (Farias, unpublished data).

The frequency of species occurrence in the two areas was verified based on the following criteria: 10 or more individuals - common species; two to nine individuals - occasional species and, one individual - rare species in the study area.

Under stereomicroscope, each plant sample was evaluated for the presence/absence of leaf domatia, types of domatia found and location of these structures on leaves. The domatia classification was based on Barros (1961) and O'Dowd and Wilson (1989). The following types were found: (1) hairtufts; (2) pockets; (3) pits; (4) revolute margin.

Results and discussion

In each of the areas 43 species (Table 1) belonging to 33 families and 62 genera were recorded. Out of the 84 specimens examined, only 13 showed leaf domatia (Table 1) (Figures 1, 2 and 3); five recorded in the Mata da Pimenteira (corresponding to 5.81% of the total number of specimens from the area) and 11 in Mata do Carro Quebrado (corresponding to 22.05% of the total number of specimens from the area); *Guettarda angelica* Mart. ex. Müll. Arg. and *Parapiptadenia zehntneri* (Harms) M. P. Lima and H. C. Lima were present in both areas.

The domatia varied in type and position on the leaf. Four types of domatia were observed: hairtufts, pocket, pit and revolute margin. The type tufts of hairs predominated, occurring in seven species; the types pocket, fringe and pit appeared in four, two and one species respectively.

The greatest number of species with domatia in the Mata do Carro Quebrado (11 species) compared to Mata Pimenteira (5 species) is a significant result because the first area is a comparatively wetter environment than Mata da Pimenteira, which corroborates the information available in the literature, emphasizing that domatia are found mainly in plants of humid sites (NAKAMURA et al., 1992; NORTON et al., 2000). Only two species occur in both environments (*Guettarda angelica* and *Parapiptadenia zehntneri*).

Parapiptadenia zehntneri from Mata do Carro Quebrado showed conspicuously larger volume of hairs (trichomes) than that from Mata da Pimenteira, which can be easily observed in Figures 2 (A) and 3 (A). This fact is relevant to interaction studies, once according to Matos et al. (2011), variations in the density of trichomes can be decisive for the occurrence of phytophagous and predatory mites on plants.

The four types of domatia found in the two study areas exhibit diverse habitats and may be attractive to different organisms. O'Connell et al. (2010) showed that the domatia, as micro-habitats, influence the population dynamics of mites mediating the existing trophic relationships. These authors also consider that native woody species support larger amounts of mites than other types of plants; an issue to be addressed in future research. It is important to note that there are no reports in the literature on the existence of leaf domatia on the species described herein. And it is known that the knowledge of morphological characters of plants is an important factor for successful interaction studies (PRICE, 1997; MATOS et al., 2011).

Thus, studies aimed at characterizing the morphology and distribution of these leaf structures should be encouraged, since little is known about their occurrence, especially in the Brazilian semiarid native species.

Table 1. Characterization of native species from two areas with different vegetation types in the semiarid region of Pernambuco, for the presence, type and location of leaf domatia. Area I. Caatinga, location of Pimenteira, Serra Talhada; Area II. Montane forest, location Carro Quebrado, Triunfo. BR - between ribs; LB – leaflet base, C - common species in the study area; O - occasional species in the study area.

Family/Species	Presence/ Absence	Domatia type	Location in the leaf	Area I	Area II	Voucher
ANACARDIACEAE						
Myracrodruon urundeuva Allemão	No	-	-	X	-	Menezes 312
Schinopsis brasilensis Engl.	No	-	-	X	-	Menezes 107
Spondias tuberosa Arruda	No	-	-	X	-	Menezes 98
ANNONACEAE						
Rollinia leptopetala R. E. Fr.	No	-	-	X	-	Menezes 03
APOCYNACEAE						
Aspidosperma cuspa S. F. Blake ex Pittier	No	-	-	X	X	Menezes 316/ Lima-Silva 71
A. pyrifilium Mart.	No	-	-	X	X	Menezes 110/ Lima-Silva 72
ARALIACEAE						
Aralia warmingiana (Marchal) J. Wen	No	-	-	-	X	Lima-Silva 45
BORAGINACEAE						
Cordia trichotoma (Vell.) Steud.	No	-	-	-	X	Lima-Silva 35
Varronia leucocephala (Moric.) J. S. Mill.	No	-	-	X	-	Farias 01
BURSERACEAE						
Commiphora leptophloeos (Mart.) J. B. Gillet	No	-	-	X	-	Menezes 26
CAPPARACEAE						
Cynophalla flexuosa (L.) J. Presl.	No	-	-	X	X	Menezes 65/ Lima-Silva 77
CARICACEAE						
Jacaratia corumbensis Kuntze	No	-	-	X	-	Menezes 108
CELASTRACEAE						
Maytenus obtusifolia Mart.	No	-	-	-	X	Lima-Silva 66
CHRYSOBALANACEAE						
Licania sp.	No	-	-	-	X	Lima-Silva 89
COMBRETACEAE						
Combretum pisonioides Taub.	Yes	Pocket	BR	C	-	Menezes 112
EBENACEAE						
Diospyrus sp.	No	-	-	-	X	Lima-Silva 78
ERYTHROXALACEAE						
Erythroxylum caatingae Plowman	No	-	-	X	-	Menezes 161
Erythroxylum citrifolium A. St.-Hil.	No	-	-	-	X	Lima-Silva 21
Erythroxylum subrotundum A. St.-Hil.	No	-	-	-	X	Lima-Silva 13
EUPHORBIACEAE						
Acalypha multicanlis Müll. Arg.	No	-	-	-	X	Lima-Silva 46
Croton sp.	No	-	-	-	X	Lima-Silva 39
Croton blanchetianus Baill.	No	-	-	X	-	Farias 03
C. rhamnifolioides Pax. & K. Hoffm.	No	-	-	X	-	Menezes 99
Ditaxis desertorum Pax. & K. Hoffm.	No	-	-	X	-	Menezes 59
Jatropha mollissima (Pohl.) Baill.	No	-	-	X	X	Menezes 91/ Lima-Silva 87
Manihot epruinosa Pax & K. Hoffm.	No	-	-	X	-	Menezes 02
Sapium glandulosum (L.) Morong	No	-	-	X	X	Menezes 09/ Lima-Silva 63
Sebastiania macrocarpa Mull. Arg.	No	-	-	X	-	Menezes 113
FABACEAE						
Amburana cearensis (Allemão.) A. C. Sm.	No	-	-	X	-	Menezes 87
Anadenanthera colubrina (Vell.) Brenan	No	-	-	X	X	Menezes 311/ Lima-Silva 73
Bauhinia cheilantha (Bong) D. Dietr.	No	-	-	X	-	Menezes 11
Chloroleucon sp.	Yes	Revolute margin	LB	-	C	Lima-Silva 76
Chloroleucon manguense Britton & Rose	Yes	Hairtufts	LB	O	-	Menezes 162
Hymenaea sp.	No	-	-	-	X	Lima-Silva 80
Libidibia ferrea (Mart. ex. Tul.) L. P. Queiroz	No	-	-	X	-	Menezes 157
Lutzelburgia auriculata (Allemão) Ducke	No	-	-	X	-	Menezes 330
Mimosa ophthalmocentra Mart. ex. Benth	No	-	-	X	-	Menezes 147
M. tenuiflora (Willd.) Poir.	No	-	-	X	-	Menezes 331
Myrocarpus sp.	No	-	-	-	X	Lima-Silva 90
Ormosia sp.	No	-	-	-	X	Lima-Silva 49
Parapiptadenia zehntneri (Harms) M. P. Lima & H. C. Lima	Yes	Hairtufts	LB	C	C	Menezes 68/ Lima-Silva 43
Piptadenia stipulacea (Benth.) Ducke	No	-	-	X	-	Menezes 77

Continue...

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Family/Species	Presence/ Absence	Domatia type	Location in the leaf	Area I	Area II	Voucher
Poincianella pyramidalis (Tul.) L. P. Queiroz	No	-	-	X	-	Menezes 111
Senegalia glomerosa (Benth.) Britton & Rose	Yes	Hairtufts	LB	-	O	Lima-Silva 97
Senna macranthera (Collad.) H. S. Irwin & Barneby	No	-	-	X	-	Menezes 85
S. spectabilis (DC.) H. S. Irwin & Barneby	No	-	-	X	-	Menezes 64
Fabaceae Mimosoideae indeterminate	Yes	Revolute margin with hairs	LB	-	O	Lima-Silva 34
MALPHIGIACEAE						
Ptilochaeta bahiensis Turcz.	No	-	-	X	X	Menezes 334/ Lima-Silva 93
MALVACEAE						
Ceiba glaziovii (Kuntze) K. Schum.	No	-	-	X	-	Menezes 310
Helicteres macropetala A. Juss.	No	-	-	-	X	Lima-Silva 14
Helicteres mollis K. Schum.	No	-	-	X	-	Menezes 10
MELIACEAE						
Trichilia emarginata (Turcz.) C. DC.	No	-	-	-	X	Lima-Silva 42
MORACEAE						
Brosimum sp.	Yes	Pocket	BR	-	C	Lima-Silva 37
MYRTACEAE						
Campomanesia sp.	Yes	Pocket	BR	-	C	Lima-Silva 74
Eugenia punicifolia DC.	No	-	-	-	X	Lima-Silva 38
NYCTAGINACEAE						
Guapira laxa (Netto) Furlan	No	-	-	X	X	Menezes 337/ Lima-Silva 81
PHYLLANTHACEAE						
Savia sessiliflora Willd.	No	-	-	-	X	Lima-Silva 25
POLYGONACEAE						
Ruprechtia laxiflora Meisn.	No	-	-	-	X	Lima-Silva 40
RHAMNACEAE						
Rhamnidium molle Reiss.	No	-	-	-	X	Lima-Silva 94
Ziziphus joazeiro Mart.	No	-	-	X	-	Menezes 341
RUBIACEAE						
Coutarea hexandra K. Schum.	Yes	Hairtufts	BR	-	C	Lima-Silva 75
Guettarda angelica Mart. ex. Müll. Arg.	Yes	Pocket	BR	C	O	Menezes 93/ Lima-Silva 82
Randia armata (Sw.) DC.	No	-	-	-	X	Lima-Silva 95
Rubiaceae indeterminate	Yes	Pocket	BR	-	O	Lima-Silva 96
RUTACEAE						
Balfourodendron molle (Miq.) Pirani	Yes	Pit	BR	-	O	Lima-Silva 61
SALICACEAE						
Casearia luetzelburgii Sleumer	No	-	-	-	X	Lima-Silva 33
Prockia crusis L.	No	-	-	X	-	Menezes 08
SAPINDACEAE						
Allophylus quercifolius Radlk.	Yes	Hairtufts	LB	C	-	Menezes 109
Sapindaceae indeterminate	No	-	-	-	X	Lima-Silva 60
SAPOTACEAE						
Syderoxylun obtusifolium (Roem. & Schult.) T. D. Penn.	No	-	-	-	X	Lima-Silva 98
SCHOEPFIACEAE						
Schoepfia obliquifolia Turcz.	No	-	-	-	X	Lima-Silva 99
SOLANACEAE						
Solanum sp.	No	-	-	X	-	Farias 10
ULMANACEAE						
Phyllostylon brasiliensis Capan. ex Beth. & Hook.	No	-	-	-	X	Lima-Silva 92
VERBENACEAE						
Lantana camara L.	No	-	-	X	-	Menezes 76
Vitex sp.	Yes	Hairtufts	BR	-	O	Lima-Silva 65

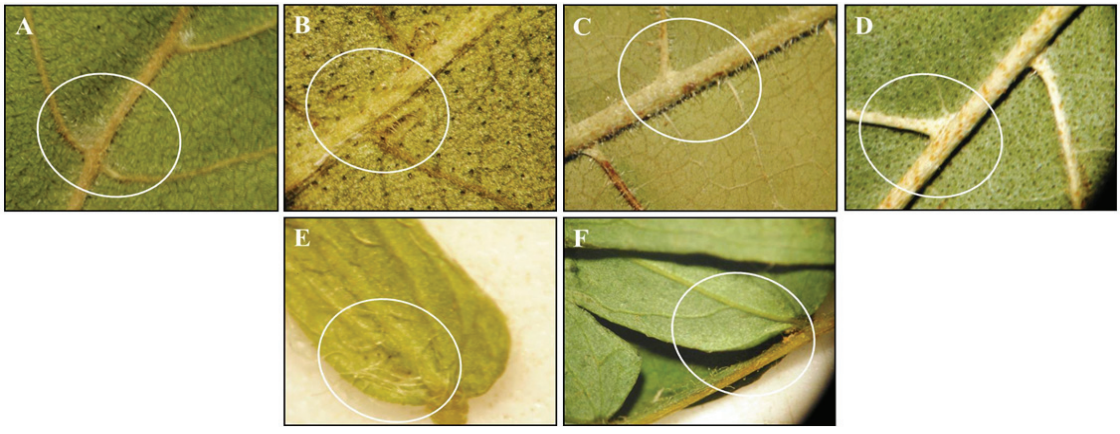

Figure 1. Abaxial surface of the leaves of (A) *Allophylus quercifolius* with domatia tuft of hair, area I, (B) *Balfourodendron molle* pit type domatia, area II (C) *Brosimum* sp. pocket-type domatia, area II (D) *Campomanesia* sp., edge-type domatia, area II (E) *Chloroleucon manguense* domatia tufts of hairs type, area I, (F) *Chloroleucon* sp. with domatia on the revolute margin at base of leaf, area II.

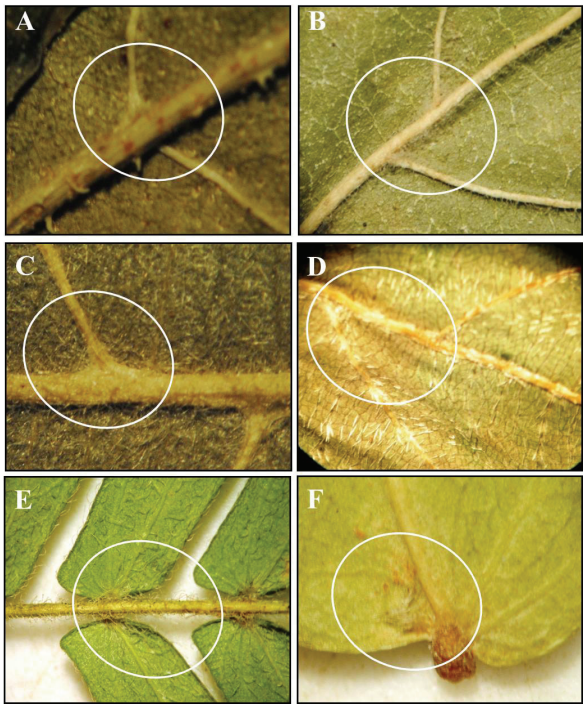

Figure 2. Abaxial surface of the leaves of (A) *Combretum pisonioides* with pocket-type domatia, area I, (B) *Coutarea hexandra* domatia like tufts of hairs, area II (C) *Guettarda angelica* pocket-type domatia area I, (D) *Guettarda angelica* pocket-type domatia, area II (E) indeterminate Mimosoideae with domatia on the edge, area II (F) *Parapiptadenia zehntneri* tufts of hairs type domatia, area I.

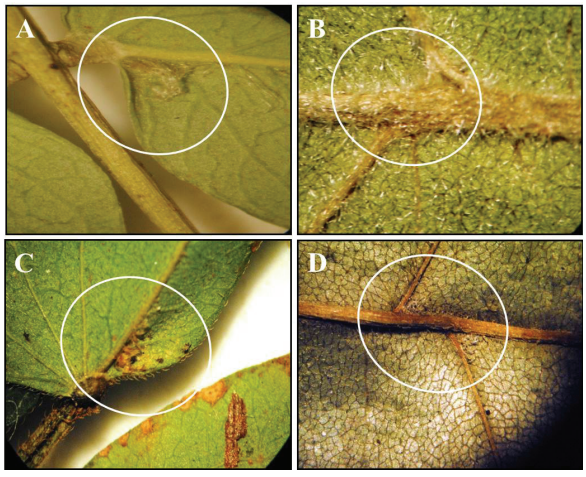

Figure 3. Abaxial surface of the leaves of (A) *Parapiptadenia zehntneri* with tufts of hairs type domatia, area II (B) indeterminate Rubiaceae, pocket type domatia, area II (C) *Senegalia glomerosa* tufts of hairs type domatia, area II; (D) *Vitex* sp., tufts of hairs type domatia, area II.

Conclusion

The greater predominance of plant species with leaf domatia in the area Carro Quebrado in Triunfo, Pernambuco State, (most types pocket and hairtufts) compared to the area of Mata da Pimenteira in Serra Talhada, Pernambuco State, (most types hairtufts) can be explained by the fact that it is more humid which, according to the data available in the literature represents an environment of higher occurrence of plants with these characteristics.

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