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VASCULAR EPIPHYTES AND PARASITIC PLANTS ON *VITELLARIA PARADOXA* GAERTN. (SAPOTACEAE) IN THE SUDANO-GUINEAN SAVANNAS OF NGAOUNDERE, CAMEROON

ADAMOU IBRAHIMA*, PIERRE MARIE MAPONGMETSEM, HORTENSE MOTALINDJA MOMPEA, LAÏSSOU MOUSSOU, AND NYOMO

Department of Biological Sciences, Faculty of Science, University of Ngaoundere, P.O. Box 454, Ngaoundere, Cameroon. Email: aibrahima@hotmail.com

ABSTRACT. This study evaluates the density and distribution of parasitic plants and vascular epiphytes of the shea-butter tree (*Vitellaria paradoxa*) in the Ngaoundere savannas. The study was conducted in three savanna habitats: forest canopy (gallery or riverine), hill savanna, and plains savanna (open or plateau). For each tree, three strata were considered: basal trunk, middle section, and treetop. The design of the experiment consisted of a split-plot with six replicates. Habitats received the main treatment, with species and strata corresponding to sub-treatments. The localities were the replicates. Data collected on the density of epiphytes and parasites of the shea-butter tree showed common flora consisting of six holo-epiphytic orchids (*Calyptrochilum christyanum, Graphorkis lurida, Polystachya odorata, Rangaeris rhipsalisocia, Angraecum angustum,* and *Tridactyle tridactylites*), one hemi-epiphytic fig (*Ficus thonningii*), and one mistletoe (*Tapinanthus globiferus* ssp. *apodanthus*). Ecological requirements were found to differ for the epiphytes and the parasitic plant. Epiphytes preferred humid habitats, mainly the forest canopy and middle section of the trees; whereas infestation points of *Tapinanthus globiferus* were located mostly on the canopy fringes.

Key words: shea-butter tree, vascular epiphytes, parasitic plant, humid savanna habitats, Ngaoundere, Cameroon

RÉSUMÉ. Afin d'évaluer la flore parasite et épiphytique du karité (*Vitellaria paradoxa*) dans les savanes de Ngaoundéré, une étude a été menée dans trois (3) milieux: galerie forestière, savane planitière et colline. Trois strates étaient retenues par arbre: base, milieu et cime de l'arbre. Le dispositif expérimentale était un split-plot à 6 répétitions. Les milieux ou habitats représentent le traitement principal alors que les espèces (épiphytes et parasites) et les strates constituent le sous—traitement. Les localités étaient les répétitions. Les données collectées portaient sur la densité des épiphytes et des parasites du karité. Les résultats montrent que la flore est composée de six holo-épiphytes (*Calyptrochilum christyanum, Graphorkis lurida, Polystachya odorata, Rangaeris rhipsalisocia, Angraecum angustum* et *Tridactyle tridactylites*), d'une hemi-épiphyte (*Ficus thonningii*) et d'un parasite (*Tapinanthus globiferus* ssp. *apodianthus*). Les épiphytes adoptent en général un comportement mésophile: la galerie forestière et le milieu d'arbres constituent leurs milieux de prédilection, alors que le parasite préfère le cime des arbres (xérophile).

Mot-clés: karité, epiphytes, parasites, habitat, savanes humides, Ngaoundéré, Cameroun

INTRODUCTION

The cultivation of trees that provide non-timber forest products is pivotal in agroforestry (Leaky 1999). The shea-butter tree (*Vitellaria paradoxa* Gaertn.), a species traditionally used by local people to meet their daily needs for a full-range of minor forest products, is beginning to be incorporated into agroforestry systems in the Ngaoundere savannas (Mapongmetsem & Tchiégang-Megueni 1996, Tchiégang-Megueni 2000). Local people consume the oleaginous fruit, the primary product of this member of the Sapotaceae, and it ranks as an important source of income for rural woman. Other parts of the tree are used in traditional medicine. Farmers consider the tree a fodder species and associate it with soil fertility (Mapongmetsem & Tchiégang-Megueni 1996, Pabame 2002). Despite its socio-economic value, this tree species has not been integrated systematically into agroforestry systems, for the simple reason that its cultivation has yet to be mastered. By comparison, in West Africa, the shea-butter tree is protected by government laws, and farmers often retain these trees when clearing land for cultivation (Park 1799, Hall et al. 1996, Bokary et al. 2004). In countries such as Mali and Burkina Faso, where the most productive stands are found, the "butter" extracted from the kernel of the tree's fruit is a source of foreign exchange (Bokary et al. 2004).

In agroforestry, biodiversity serves as a building block of sustainability (Leaky 1999, Martius

* Corresponding author.

et al. 2004). Thus complex agroforests that combine profitability with biodiversity are recognized as a model worthy of expansion. Differences in agroecosystems exist between those where biodiversity is part of the management plan and those where biodiversity is unplanned or merely linked to crops. Associated biodiversity, however, includes all flora and fauna, above and below ground, that find niches to fill among the planted trees and crops (Leaky 1999). Vascular epiphytes and parasitic plants form a part of associated biodiversity, commonly occurring on planted trees, particularly shea-butter trees on African savannas (Boussim 1991; Boussim et al. 1993a, 1993b; Mapongmetsem et al. 1998).

Epiphytes use the host plants (or phorophytes, see Barkman 1958) as a means of support only. The epiphytes studied consist of two types: holo-epiphytes that spend their whole life cycle as epiphytes and hemi-epiphytes that live part of their life cycle in the ground (Nieder et al. 2001). An estimated 24,000 or more vascular plant species are epiphytes (Kress 1986) and constitute a major part (up to 10%) of global plant diversity. Africa on the whole has fewer epiphytic species than do America or Asia, probably because of the aridity dating back to the late Pleistocene and the lack of refuge areas (Johansson 1989).

In contrast to epiphytes, parasitic plants complete a stage of their life associated on a single host plant in a relationship beneficial to the parasite but not to the host (Thompson 1994, Douglas 1994). An estimated 1% of all angiosperm species are parasitic plants; and of these, ca. 40% are shoot parasites that make use of the above-ground parts of their host plants; the other 60% are root parasites (Musselman & Press 1995). Although the literature focuses on animal parasites (phytophagous insects, parasitoids, and endoparasites such as lice and liver flukes), plant parasites are ecologically and economically significant (Musselman & Press 1995, Parker & Riches 1993, Penning & Calloway 1996) and have many features in common with animal parasites.

An understanding of the vascular epiphytes and parasitic plants of the shea-butter tree contributes to the tree's domestication, conservation, and sustainable management (Lynch et al. 1999). To date, unfortunately, researchers have paid more attention to the animal pests of this plant (Clark & Clark 1985), despite reports that the colonizing flora of the tree can bring about equally serious damages, diminishing the tree's yield and even causing its death (Boussim 1991, Ngulube 1995). Ruinen (1953) observed that phorophytes grow healthier when epiphytes are removed from them. Akinfenwa (1989) also reported reduction in yield of *Theobroma cacao* trees by the epiphytic moss, *Erythrodontium barteri.* Another threat to the production of *Vitellaria paradoxa* that receives inadequate attention is infestation by parasitic plants. The mistletoe, *Tapinanthus bagwensis,* has been reported to cause major economic loss in cocoa (Philips 1977). Omolaja and Famaye (2001) reported that another mistletoe, *Phragmamthera incana,* caused a ca. 37% yield loss in *Coffea canephora.* Phanerogamic parasites may carry diseases and are known to transfer bacteria and viruses from one host to another (Bennett 1944, Costa 1944, Valenta 1958), sometimes diminishing tree quality or causing the death of the host (Young 1947).

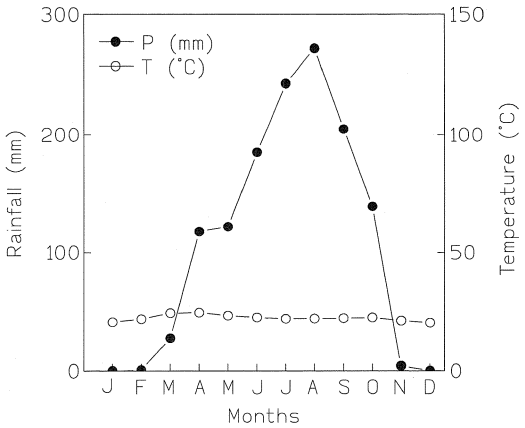

FIGURE 1. Ombrothermic diagram of Ngaoundere region, 1985–2000. Source: Meteorological Station, Ngaoundere Airport.

Knowledge of the plants that colonize the shea-butter tree and the ecological requirements of these epiphytes and parasites thus are required for integration of *Vitellaria paradoxa* into the farming systems of the Ngaoundere savannas. The objective of this study is to assess the vascular epiphytes and parasitic plants of this host tree and their distribution among different habitats.

MATERIALS AND METHODS

Study Site

The study was carried out in the Ngaoundere region of humid savannas in the Adamawa Province of Cameroon, 6–8°N, 10–16°E at an average of 1200 m. With a unimodal rainfall distribution, the climate is of the sudano-guinea type, having a dry season of 3–4 months (November–February) and a rainy season stretching March–October (FIGURE 1). Average annual precipita-

TABLE 1. Diversity of vascular epiphytes and a parasitic plant colonizing the shea-butter tree (*Vitellaria paradoxa*) in Ngaoundere, Cameroon, by strata.

Species name of epiphytes	LF	Base of tree trunk	Middle section of tree	Tree top	F_1
Orchidaceae					
Angraecum angustum	E	0.05 ± 0.04a β	0.83 ± 0.33a α	0.20 ± 0.17b β	6.17*
Calyptrochilum christianum	E	5.94 ± 03.79a α	19.33 ± 14.17a α	6.00 ± 5.75ab α	0.85NS
Graphorkis lurida	E	0.78 ± 0.27a α	3.94 ± 2.13a α	1.17 ± 1.16b α	1.30NS
Polystachya odorata	E	1.61 ± 1.22a α	35.83 ± 25.92a α	20.16 ± 10.02a α	3.40NS
Rangaeris rhipsalisocia	E	0.44 ± 0.40a α	3.67 ± 2.46a α	1.61 ± 1.53b α	1.07NS
Tridactyle tridactylites	E	4.72 ± 2.90a α	38.39 ± 21.72a α	18.38 ± 2.76a α	4.29NS
F_2 (Fischers' values)		1.49NS	1.26NS	3.41*	
All epiphytes		2.26 ± 0.88β	17.00 ± 6.37α	7.91 ± 2.26αβ	4.85*
Moraceae					
Ficus thonningii	H	0.67	0.00	0.00	
Loranthaceae					
Tapinanthus globiferus ssp. *apodanthus*	P	0.17 ± 0.09γ	3.33 ± 0.25β	7.0 ± 1.50α	6.46*

Note: LF = life form; E = holo-epiphytes; H = hemi-epiphyte; P = parasitic plant; F = result of variance analysis; different letters = significantly different values between strata (F_1 with Greek letters) or among species (F_2 with Arabic letters). * = $P < 0.05$.

tion is 1500 mm; average annual temperature is 22°C, with an average relative humidity of 69%. The seasonal aridity of the Adamawa, influenced by the Harmattan (dry dusty wind that blows along the northwest coast of Africa) evokes the climatic harshness of the sudano-sahelian environment; and the rainfall and thermal amplitude are indicative of the sub-equatorial humid region (Hengue 1994). Ferralitic and lithosoil are the dominant soil types (Humbel 1971, Yonkeu 1993). This region becomes more diverse with altitude because of two vegetation breaks: to the north, the limit of the sudan savanna; and to the south, the emergence of the semi-deciduous guinean type of forest. The interval between these two limits corresponds to the typical sudano-guinean zone, covered by sparsely wooded savannas with the following tree species: *Daniellia oliveri, Lophira lanceolata, Vitellaria paradoxa,* and *Annona senegalensis* (Letouzey 1968). This physiognomic aspect of the vegetation is maintained by zooanthropogenic factors such as brush fires and grazing (Rippstein 1985).

Methodology

Surveys were conducted in the savannas of Ngaoundere within the Vina division of Adamawa Province. Three habitats were chosen, each with the same block of savannas: forest canopy, hill savanna, and plains savanna. In each habitat, five adult trees were sampled. Modifying the method suggested by Tixier (1966), we divided each tree roughly into the following strata: basal trunk (<1.5 m), middle section (upper trunk and low branches 1.5–2.5 m), and tree top or canopy (>2.5 m). Vascular epiphytes and parasitic plants were collected separately on each of these three parts of the trees. The design of the experiment was a split-plot with six replicates. The principal treatment focused on habitats, with the strata and species constituting sub-treatments. The replicates consisted of six study sites, each with similar environmental features. The experimental unit contained 30 mature trees. Data collected bore on the number of individual epiphyte plants and parasites per tree in each strata (called here density). Epiphyte and parasite identifications were made in the field and/or at the national herbarium of Cameroon. Two-way nested ANOVA tests were used to compare habitats and species or strata and species. Following these analyses, mean comparisons were made using Scheffe's test at 5%.

RESULTS AND DISCUSSION

In the humid savannas of Ngaoundere, seven vascular epiphytes and one parasitic plant were found on shea-butter trees (TABLE 1). The study found six holo-epiphytes, all Orchidaceae (*Angraecum angustum, Calyptrochilum christyanum, Graphorkis lurida, Polystachya odorata, Rangaeris rhipsalisocia,* and *Tridactyle tridactylites*). The one hemi-epiphyte was *Ficus thonningii* (Moraceae); and the parasitic plant was *Tapinanthus globiferus* ssp. *apodanthus* (Lor-

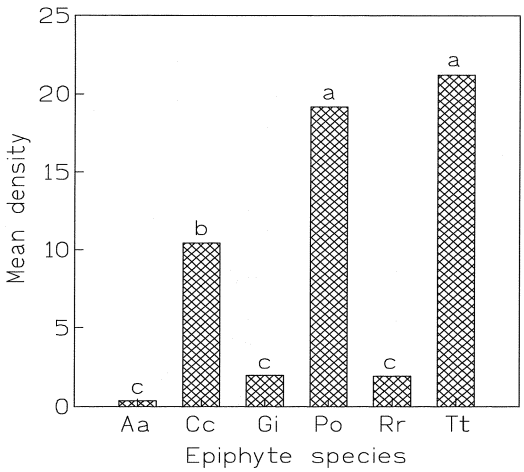

FIGURE 2. Average density (no. individuals/tree) of vascular epiphytes on shea-butter trees in the savannas of Ngaoundere. Different letters indicate significantly different values. Aa = *Angraecum angustum.* Cc = *Calyptrochilum christyanum.* Gl = *Graphorkis lurida.* Po = *Polystachya odorata.* Rr = *Rangaeris rhipsalisocia.* Tt = *Tridactyle tridactylites.*

anthaceae). The mean number of individual holo-epiphytes per shea-butter tree (density) varied significantly ($F = 37.50$ and $P < 0.01$), from 0.35 for *Angraecum angustum* to 21.20 for *Tridactyle tridactylites* (FIGURE 2). In comparing averages by least significant difference (LSD) at 0.5%, three groups stood out as having no significant difference in densities. The most abundant species (>19 individuals/tree) that qualify as characteristic flora of the shea-butter tree were *P. odorata* and *T. tridactylites.* The second group included *A. angustum, G. lurida,* and *R. rhipsalisocia,* which were less frequent on shea-butter trees, and *C. christianum,* which showed an intermediate density. The average density was 0.22 plants per tree for hemi-epiphytes and 3.5 per tree for the parasitic plant. No significant difference was found between interactions of habitat and strata, of habitat and species, or of species and strata (TABLE 2).

Diversity of hemi-epiphytes (1 species) and its density (0.22) were lower than that of holo-epiphytes (6 species and >0.35). This result conforms to those of Prosperi (1998) and Nieder et al. (2001). According to Prosperi (1998), a total of 31 plant families have hemi-epiphytes, whereas holo-epiphytes occur in 83 families of vascular plants (Kress 1986). The epiphyte diversity found in this study is similar to that reported by Mapongmetsem (2000), who found six species of epiphytes on *Canarium schweinfurthii* (Burseraceae) in humid savannas of west Cameroon, a region with climate similar to that

TABLE 2. Results of two-nested ANOVA test.

Treatments	df	SS	MS	*F*
Habitat	2	11.64	5.82	11.11***
Strata	2	14.63	7.31	13.96***
Species	5	37.83	7.57	14.44***
Habitat × strata	4	0.93	0.23	0.44NS
Habitat × species	10	8.14	0.81	1.55NS
Strata × species	10	7.87	0.79	1.50NS

Note: df = degree of freedom; SS = sum of square; MS = mean square; *F* = results of ANOVA; NS = nonsignificant; *** = $P < 0.001$.

of the Adamawa savannas. Zapfack et al. (1996) identified 34 species of epiphytes growing on *C. schweinfurthii* in semi-deciduous forests of Cameroon. Their reports suggested that epiphyte diversity in the grasslands is poor compared to that in the deciduous forest.

The abundance of epiphytes on shea-butter trees is explained in part by cracks in the bark, in which organic matter accumulates, creating conditions conducive to the germination and growth of epiphytes. In the forest zone of Nigeria, Akinsoji (1990) found fewer than three epiphytes on phorophytes with smooth barks; however, he found an average of more than 10 epiphytes on phorophytes, such as the rough-barked oil palm, on which composts accumulate.

In the humid savannas of Ngaoundere, Orchidaceae was the dominant family of epiphytes. This finding corresponds with the Zapfack (1993) report, showing Orchidaceae the dominant epiphyte family in humid and semi-deciduous forests. Wilhelm et al. (2001) identified 178 species of epiphytes belonging to 20 plant families, with Orchidaceae dominant (86 species), followed by Grammitidaceae (12 species) in montane rain forest of Venezuela. In the rain forest of southwestern Nigeria, however, Akinsoji (1990) showed species of the Asteraceae as the most numerous epiphytes. Even though the Wilhelm and the Akinsoji studies were conducted in the same forest zone, the fieldwork took place at sites with different environmental conditions.

Our study found the diversity of parasitic plants on shea-butter trees lower in the Ngaoundere savannas (1 species) than in the Burkina Faso savannas (Boussim 1991). We have found five species of parasites in Burkina Faso (*Agelanthus dodoneifolius, Tapinanthus globiferus, T. ophiodes, T. bangwensis,* and *Globimetula cupulata*). Their favorite host is the shea-butter tree, among which ca. 95% were parasitized by these five species (Boussim 1991). In contrast, on the savannas of Ngaoundere, Mapongmetsem et al. (1998) found only 10.13% of shea-butter

TABLE 3. Distribution of epiphytes among savanna habitats.

Epiphytes	Hill	Forest canopy	Plateau	*F*
Angraecum angustum	0.40 ± 0.26	0.44 ± 0.33	0.05 ± 0.04	0.49NS
Calyptrochilum christianum	2.28 ± 2.10	23.16 ± 22.21	5.83 ± 5.71	2.33NS
Graphorkis lurida	1.33 ± 1.09	4.22 ± 3.31	0.33 ± 0.29	3.30NS
Polystachya odorata	41.61 ± 40.66	12.11 ± 9.35	3.74 ± 2.05	1.23NS
Rangaeris rhipsalisocia	0.22 ± 0.20b	4.83 ± 3.59a	0.67 ± 0.45b	5.71*
Tridactyle tridactylites	13.77 ± 9.75	36.27 ± 35.47	11.44 ± 10.31	0.86NS
Average ± standard error	9.94 ± 5.12	13.51 ± 6.88	3.68 ± 2.96	11.11**

Note: F = results of ANOVA; NS = nonsignificant; * = $P < 0.05$; ** = $P < 0.05$. Different letters indicate significantly different values between habitats (in rows).

trees parasitized by these five species. The savanna habitats, however, differ. Burkina Faso has dry savannas, where large and protected stands of shea-butter are found (Bokary et al. 2004); whereas Ngaoundere has humid savannas, with small stands of the trees.

The density of the parasite (*Tapinanthus globiferus* ssp. *apodanthus*) on shea-butter trees (3.5 individuals/tree) in our study was not much different from that found by Mapongmetsem et al. (1998), who reported an average density of 12.83 plants per tree in the savannas of Adamawa. These differences may be the result of the Mapongmetsem research being conducted on savannas throughout Adamawa, while we limited our study to the Ngaoundere savannas, which form only a part of the Adamawa savannas.

Vertical Distribution on the Tree

TABLE 1 indicates that the distribution of all epiphytes is not significantly uniform along the tree trunk and crown ($F = 4.85$ and $P = 0.012$). The highest average density is found in the middle section (1.5–2.5 m) of the tree (17 individuals per tree in this section), and the least, at its basal trunk (2.26 individuals per tree). This result suggests that epiphytes prefer the central section of the tree, where humidity may be higher. The middle section of the shea-butter trees, where light is attenuated, had a denser population of epiphytes than did parts of the canopy. *Vitellaria paradoxa* has a fairly closed canopy structure that intercepts insolation (Odebiyi et al. 2004). This observation is supported by the finding of Lugo and Scatena (1992), which showed the importance of humidity in the distribution of epiphytes. Oye (1924) reported that the occurrence of epiphytes on trees is a function of the rainfall and degree of exposure to the sun. Zapfack (1993), reporting the same results in the forest zone, concluded that the distribution of epiphytes could be explained partly by the vertical distribution of sunlight in the forest canopy.

In contrast to the distribution of epiphytes, parasitic plants prefer the upper canopy of the tree (TABLE 1). Odebiyi et al. (2004) reported that infestation points of mistletoe on *Vitellaria paradoxa* were located mostly on young branches and more often at canopy fringes; he suggested that this distribution may be explained by the closed canopy. The presence of mistletoe in this part of the tree may be explained by seed dispersion from one branch to another by birds (Reid 1990, Sargent 1994, Baffa et al. 1996, Hawksworth & Geils 1996, Watson 2001). The seeds exude a white latex, which enables them to fix themselves firmly on branches, where they then germinate (Mapongmetsem et al. 1998).

Distribution among Habitats

TABLE 3 presents the distribution of holo-epiphytes, with the average density varying significantly with ecological requirements ($F = 11.11$ and $P < 0.01$). The highest epiphyte density, however, is found in the forest canopy with an average of 13.51 plants, and the lowest, in the plateau zone, where the average is ca. 3.68 epiphytes per tree. The difference among habitats, however, was not significant for each species, with the exception of *Rangaeris rhipsalisocia.* Because forest canopies present climate characteristics similar to that of humid forests, it creates a milieu where atmospheric humidity is near saturation and composts are present. Furthermore, anthropogenic pressure is less intense here than elsewhere, and old trees with thick and sometimes rough barks are found—all reasons that may explain the abundance of epiphytes in forest canopies.

Such epiphytic flora, although not considered parasitic, may have some harmful effects on shea-butter trees (Ruinen 1953, Akinfenwa 1989, Akinsoji 1990); however, the greatest negative effects remain those of the parasites. Booth and Wickens (1988) have shown that parasites of Lauranthaceae reduce the productivity of *Vitellaria paradoxa.* Similar observations were

made by Ngulube (1995) on *Uapaca kirkiana* in South Africa.

According to Boussim (1991), efficient methods are needed to eradicate parasites to improve the yield of shea-butter stands. Our study remains at a stage where we cannot make recommendations, but we can make suggestions. To avoid infection with Moraceae, managers can examine the trees and eliminate structures that facilitate the germination of these parasites, such as humus and bark wounds. Preventing infection with Loranthaceae is more difficult, because these parasites attack the tree higher up in the crown, where locating the small seeds of the parasite presents a problem. The best option is to examine the tree and destroy any Loranthaceae plants, before they fruit. A word of caution, though, Loranthaceae flowers are good forage for bees and might be useful in apiculture. In addition, sampled epiphytes such as *Calyptrochilum, Polystachya,* and *Tridactyles,* because of their colorful flowers (white, red, and yellow), offer interesting economic perspectives, once their domestication is mastered.

Conclusions

The colonizing flora of *Vitellaria paradoxa* in the savannas of Ngaoundere is both abundant and varied, with a larger number of epiphyte species compared to parasitic plants. This flora prefers the middle part of the tree and the forest canopy, which are milieus conducive to the germination of the plant seeds and to their growth. This study does not document the effects of epiphytes or parasites on the productivity of shea-butter trees but hypothesizes possible negative effects of the associated colonizing flora on this socio-economically important tree.

Acknowledgments

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Literature Cited

Akinfenwa, F. 1989. Occurrence of epiphytes on cocoa: a survey. A paper presented at the 3rd Annual Conference of the Botanical Society of Nigeria, 5–9 March 1989, at the University of Lagos, Nigeria.

Akinsoji, A. 1990. Studies on epiphytic flora of a tropical rain forest in Southwestern Nigeria. I: the vascular epiphytes. Vegetation 88: 87–92.

Baffa, J.M, G. Yaméogo, P. Nikiéma, and J.B. Taonda. 1996. What future for the shea tree? Agroforest. Today 8(4): 5–9.

Barkman, J.J. 1958. Phytosociology and Ecology of Cryptogamic Epiphytes. Assen, The Netherlands.

Bennett, C.W. 1944. Studies of dodder transmission of plant viruses. Phytopathology 34: 905–932.

Bokary, A.K. J.M. Bouvet, and N. Picard. 2004. Size class distribution and spatial pattern of *Vitellaria paradoxa* in relation to farmers' practices in Mali. Agroforest. Systems 60: 1–11.

Booth, F.E.M. and G.E. Wickens. 1988. Non-timber uses of selected arid zone trees and shrubs in Africa. F.A.O. Conservation Guide 19: 34–45.

Boussim, J. 1991. "Contribution à l'étude des *Tapinanthus* parasites du Karité au Burkina Faso." Ph.D. diss., (de troisième cycle), Univ. Ouagadougou, Burkina Faso.

Boussim, J., S. Guinko, C. Tuquet, and G. Sallé. 1993a. *Tapinanthus* parasites du karité au Burkina Faso, 1ère partie: identification et distribution. Bois Forêts Trop. 238: 45–52.

———. 1993b. *Tapinanthus* parasites du karité au Burkina Faso, 2ème partie: Phénologie, Biologie et Dégâts. Bois Forêts Trop. 238: 53–65.

Clark, D.B. and D.A. Clark. 1985. Seedling dynamics of a tropical tree: impacts of herbivory and meristem damage. Ecology 66: 1884–1892.

Costa, A.S. 1944. Multiplication of viruses in the dodder, *Cuscuta campestris.* Phytopathology 34: 151–162.

Douglas, A.E. 1994. Symbiotic Interactions. Oxford University Press, Oxford, UK.

Hall, J.B., P.D. Aebisher, H.F. Tomlinson, E. Osei-Amaning, and T.R. Hindle. 1996. *Vitellaria paradoxa*: A Monograph. School of Agricultural and Forest Sciences, University of Wales, Bangor.

Hawksworth, F.G. and B.W. Geils. 1996. Biotic associates. Pp. 73–89 *in* F.G. Hawksworth and D. Wiens, eds. Dwarf Mistletoes: Biology, Pathology, and Systematics. Agric. Handb. 709, 2nd ed. USDA Forest Service, Washington, D.C.

Hengue, P. 1994. Rapport général sur la problématique de l'environnement dans la province de l'Adamaoua. Concertation régionale sur l'environnement pour la province de l'Adamaoua. Ministère de l'Environnement et des Forêts, Yaoundé, Cameroun.

Humbel, F.X. 1971. Carte pédologique de Ngaoundéré 10 à 1/50 000. ORSTOM, Centre de Yaoundé, Cameroun.

Johansson, D.R. 1989. Vascular epiphytism in Africa. Pp. 183–194 *in* H. Lieth and M.J.A. Werger, eds. Tropical Rain Forest Ecosystems. Elsevier, Amsterdam.

Kress, W.J. 1986. The systematic distribution of vascular epiphytes: an update. Selbyana 9: 2–22.

Leaky, R.R.B. 1999. Agroforestry for biodiversity in farming systems. Pp. 127–145 *in* W. Collins and C. Quelset, eds. The Importance of Biodiversity in Agrosystems. Lewis Publishers, New York.

Letouzey, R. 1968. Etude Phytogéographique du Cameroun. Paul le Chevalier, Paris.

Lugo, A.E. and F.N. Scatena. 1992. Epiphytes and climate change research in the Caribbean: a proposal. Selbyana 13: 123–130.

Lynch, M., M. Pfrender, K. Spitze, N. Lehman, J. Hicks, D. Allen, L. Latta, M. Ottene, F. Bogue, and J. Colboume. 1999. The quantitative and mo-

lecular genetic architecture of a subdivided species. Evolution 53: 100–110.

Mapongmetsem, P.M. 2000. The epiphyte flora of *Canarium Schweinfurthii* Engl. Pp. 79–87 *in* The Western Highlands of Cameroon. Proceedings sur le Seminaire international sur le séchage et sur la valorisation du karité et de l'aiélé, Ngaoundéré, Dec. 1–3, 1999. Presses Universitaires de Yaoundé, Ngaoundéré, Cameroun.

Mapongmetsem, P.M. and C. Tchiégang-Megueni. 1996. Extraction des produits non ligneux dans la zone de contact forêt—savane comprise entre Ngaoundal et Bertoua. Rapport de recherche, Faculté des Sciences. Univ. de Ngaoundéré, Cameroun.

Mapongmetsem, P.M., M.H. Motalindja, and Nyomo. 1998. Eyes on the enemy. Identifying parasitic plants of wild fruit trees in Cameroon. Agroforest. Today 10(3): 10–11.

Martius, C., H. Höfer, M.V.B. Garcia, J. Römbke, B. Förster, and W. Hanagarth. 2004. Microclimate in agroforestry systems in central Amazonia: does canopy closure matter to soil organisms? Agroforest. Systems 60: 391–304.

Musselman, L.J. and M.C. Press. 1995. Introduction to parasitic plants. Pp. 1–13 *in* M.C. Press and J. Graves, eds. Parasitic Plants. Chapman and Hall, London.

Ngulube, M.R. 1995. Indigenous fruit trees in southern Africa: the potential of *Uapaca kirkiana*. Agroforest. Today 7(3,4): 17–18.

Nieder, J., J Prosperi, and G. Michaloud. 2001. Epiphytes and their contribution to canopy diversity. Pl. Ecol. 153 (1,2): 51–63.

Odebiyi, J.A., S.O. Bada, A.A. Omoloye, R.O. Awodoyin, and P.I. Oni. 2004. Vertebrate and insect pests and hemi-parasitic plants of *Parkia biglobosa* and *Vitellaria paradoxa* in Nigeria. Agroforest. Systems 60: 51–59.

Omolaja, S.S. and A.O. Famaye. 2001. The incidence of mistletoe on coffee in Nigeria. Biosci. Commun. 13(1).

Oye, P. van. 1924. Sur l'écologie des épiphytes à la surface des troncs d'arbres à Jana. Rev. Gen. Bot. 36: 1–83.

Pabamé, P. 2002. Indicateurs et gestion paysans de la fertilité des sols dans les régions de Mbé (Adamaoua) et Ngong (Nord)—Cameroun. Mémoire de Maîtrise, Faculté des Sciences, Université de Ngaoundéré.

Park, M. 1799/1983. Travels into the interior districts of Africa performed under the direction and patronage of the Africa Association in the years 1795, 1796, and 1797. Pp. 1–264 *in* J. Swift, ed. Travels into the Interior of Africa. Eland, London.

Parker, C. and C.R. Riches. 1993. Parasitic Weeds of the World: Biology and Control. CAB International, Wallingford, UK.

Penning, S.C. and R.M. Calloway. 1996. Impact of a parasitic plant on the structure and dynamics of salt marsh vegetation. Ecology 77: 1410–1419.

Philips, E.J. 1977. Mistletoes on cocoa in Ghana. Ghana J. Agric. Sci. 10: 137–143.

Prosperi, J. 1998. "Biologie du développement des hémi-épiphytes ligneux." Ph.D. thesis, University of Montpellier II, Montpellier.

Reid, N. 1990. Mutualistic interdependence between mistletoes (*Amyema quandang*) and honeyeaters and mistletoebirds in an arid woodland. Aust. J. Ecol. 15: 175–190.

Rippstein, G. 1985. Edude sur la végétation de l' Adamaoua: Evolution, conservation, régénération et amélioration d'un écosystème pâturé au Cameroun. Edude et synthèse de l'IEMVT n° 14, Maison-Alfort, France.

Ruinen, J. 1953. Epiphytoses: a second view of epiphytism. Ann. Bogoriensis 1: 101–157.

Sargent, S. 1994. "Seed dispersal of mistletoes by birds in Monteverde, Costa Rica." Ph.D. thesis, Cornell University, Ithaca, N.Y.

Tchiégang-Megueni, C. and P.M. Mapongmetsem. 2000. Identification des facteurs affectant la conservation in situ de *Vitellaria paradoxa* Gaertner F., dans les savanes humides de l'Adamaoua (Cameroun). Pp. 105–114 *in* C. Kapseu and J. Kayem, eds. Actes du séminaire international sur le séchage et sur la valorisation du karité et de l'aiélé. Ngaoundéré, Cameroun.

Thompson, J.N. 1994. The Coevolutionary Process. University of Chicago Press, Chicago, Ill.

Tixier, P. 1966. Flore et Végétation Orophiles de l'Asie Tropicale. Soc. d'édition d'enseignement supérieur, Paris.

Valenta, V.A. 1958. New yellows virus causing flower proliferation in the dodder, *Cuscuta campestris* Yunk. Phytopathol. Z. 33: 316–318.

Watson, D.M. 2001. Mistletoe—keystone resource in forests and woodland worldwide. Annual Rev. Ecol. Syst. 32: 219–249.

Wilhelm, B., V. Schmit-Neuerburg, J. Nieder, and S. Engwald. 2001. Diversity and abundance of vascular epiphytes: a comparison of secondary vegetation and primary montane rain forest in the Venezuelan Andes. Pl. Ecol. 152: 145–156.

Yonkeu, S. 1993. "Végétation des pâturages de l'Adamaoua (Cameroun): Ecologie et potentialités pastorales." Thèse de Doctorat, Université de Rennes I, France.

Young, H.E. 1947. A mistletoe on an orchid. Austral. Orchid Rev. 12(4): 61–70.

Zapfack, L. 1993. "Flore et végétation épiphytique de quelques phorophytes de la forêt dense semi-décidue." Thèse de Doctorat de 3ème cycle, Université de Yaoundé 1.

Zapfack, L., B.A. Nkongmeneck, J.F. Villiers, and M. Lowman. 1996. The importance of pteridophytes in the epiphytic flora of some phorophytes of the Cameroon semi-deciduous rain forest. Selbyana 17: 76–81.