Acta Botanica Gallica

ISSN: 1253-8078 (Print) 2166-3408 (Online) Journal homepage: http://www.tandfonline.com/loi/tabg20

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To cite this article: Jean Cossi Ganglo , Bruno de Foucault & Jean Lejoly (2006) The *Psychotria vogeliana*-community in the spontaneous undergrowth of teak (*Tectona grandis* L. f.) plantations in south-Benin: ecological and sllvicultural indicatory values, Acta Botanica Gallica, 153:1, 125-134, DOI: 10.1080/12538078.2006.10515527

To link to this article: https://doi.org/10.1080/12538078.2006.10515527

Published online: 27 Apr 2013.

*Acta Bot. Gallica, 2006, **153** (1), 125-134.*

The *Psychotria vogeliana*-community in the spontaneous undergrowth of teak (*Tectona grandis* L. f.) plantations in south-Benin: ecological and sllvicultural indicatory values

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arrivé le 19 septembre 2004, accepté le 22 octobre 2005

Abstract.- The spontaneous undergrowth of teak (*Tectona grandis* L. f.) plantation in Djigbé forest (south Benin) has been studied. The *Psychotria vogeliana*-community is identified from ten representative phytosociological relevés. This community is an indicator of sandy plateau soils generally associated with the least productive plantations. It's composed of 91 species with a mean of 32 species per relevé. The study of distribution spectra reveals the abundance of phanerophytes, secondary forest species and phytogeographically widespread species; they represent respectively 86%, 48% and 50% of the total number of species. The analysis of species diversity indicates that the *Psychotria vogeliana*-community is somewhat diversified, but the species abundance is weakly balanced (2.1 for Shannon-Wiever index and 0.48 for evenness index).

Key words : Benin - plant sociology - *Tectona grandis* - spontaneous undergrowth.

Résumé.- Un inventaire floristique et une description phytosociologique ont été faits dans le sous-bois naturel des plantations de Teck (*Tectona grandis* L. f.) de Djigbé au sud du Bénin. Le groupement à *Psychotria vogeliana* a été identifié à partir de dix relevés phytosociologiques représentatifs. Il caractérise les plateaux à sol dominé par le sable et indique des stations forestières de faible productivité. Il comporte au total 91 espèces avec une moyenne de 32 espèces par individu d'association. L'étude de divers spectres met en évidence une prédominance des phanérophytes, des espèces des forêts secondaires et une proportion élevée des espèces à large distribution phytogéographique, respectivement 86%, 48% et 50% pour les spectres bruts. L'analyse de la diversité floristique montre que le sous-bois étudié a une diversité spécifique moyenne, mais son abondance spécifique est peu équilibrée (2,1 pour l'indice de Shannon-Wiever et 0,48 pour le coefficient d'équitabilité).

Mots clés : Bénin - phytosociologie - *Tectona grandis* - végétation naturelle de sous-bois.

I. INTRODUCTION

The application of the Braun-Blanquet approach (Gounot, 1969) to the study of tropical vegetation has enabled the description of plant communities of various ranks. Among these plant communities, the vegetation class of *Soncho-Bidentetea pilosae* Hoff 1991 is composed of adventitious vegetation of cultivated plants. Within this class, many plant communities have been described but mainly in the earlier stages of vegetation succession (Lubini, 1982; Nyakabwa, 1982, 1994). As a result of this, very little is known about the later stages of the adventitious plant communities described so far. The phyto-ecological study we undertake in the spontaneous undergrowth of teak plantation in south-Benin enabled us to describe some aspects of the adventitious plant communities in their later stages of evolution (Ganglo, 1999). This study also helps to highlight the usefulness of spontaneous undergrowth as a valid indicator of ecological factors and forest productivity. The purpose of this paper is to present the *Psychotria vogeliana*-community which is common on sandy plateau soils of Djigbé forest in south-Benin.

II. THE STUDY AREA

The study area is Djigbé forest (6°49' - 6°55' N, 2°17' - 2°22' E) in south Benin (West Africa) (Fig. 1). The natural vegetation of the study area is composed of a mixture of semi-deciduous forest and savannas (Aubréville, 1937; Akoegninou, 1984; Adjakidjè, 1984; Adjanohoun *et al.*, 1989). This forest which has been degraded since a long time was mainly composed of *Triplochiton scleroxylon, Celtis mildbraedii, C. zenkeri, Antiaris toxicaria, Albizia adianthifolia, A. ferruginea, A. zygia, Ceiba pentandra* (Aubréville, 1937; Akoegninou, 1984). Djigbé forest soil belongs to the class of ferrallitic soils of the Continental Terminal geological period. It has been developed in a local material called "terre de barre" (Volkoff, 1976). The study area is under the influence of a subequatorial climate. The rainy season extends from March to October but around August there is a so-called small dry season. The longest dry season, which lasts four months, begins in November. The annual rainfall of some meteorological stations of south Benin (Niaouli, Pobè and Bohicon) ranges from 1,100 to 1,200 mm (Fig. 2) ; the average daily temperature is about 27 °C.

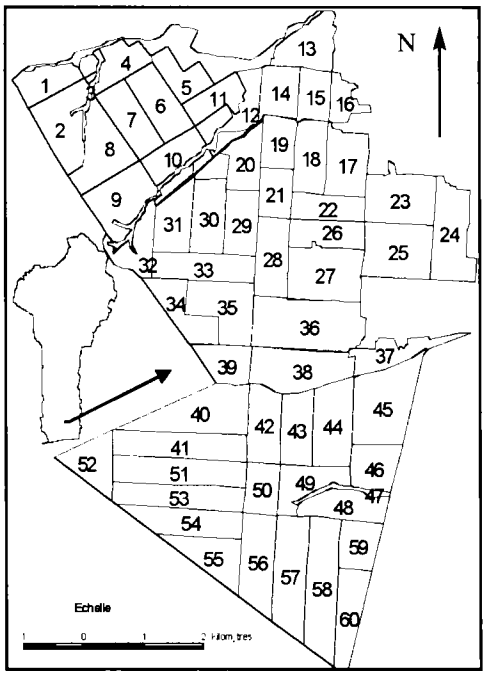


Fig. 1.- Position of the studied area in Benin.
Fig. 1.- Localisation de l'aire d'étude au Bénin.

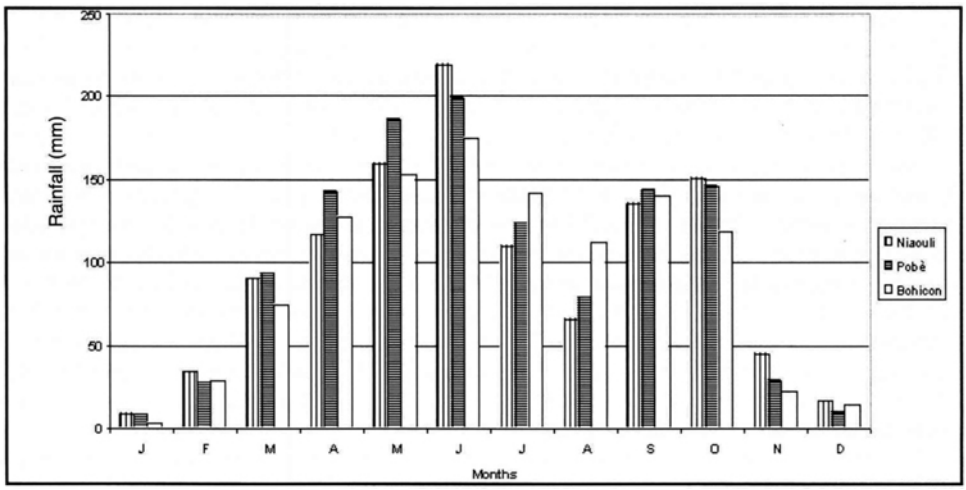


Fig 2.- Rainfall recorded at the meteorological stations of Bohicon, Niaouli and Pobè (1960-2003).
Fig 2.- Précipitations memsuelles aux stations de Bohicon, Niaouli et Pobè (1960-2003).

III. MATERIAL AND METHODS

The Braun-Blanquet approach (Gounot, 1969) has been used to assess the spontaneous undergrowth vegetation of teak plantations in south-Benin. The minimum area used is 250 m^2 (Ganglo, 1999). On each relevé, we have noted the abundance-dominance of flowering species, separately in three strata. The species names have been derived from Lebrun & Stork (1991-1997). The topographic position of the relevés has been noted and the slopes are measured with a slopemeter device Suunto. The description of soil physico-chemical properties has been done on the basis of soil profile description followed by soil sample analysis. The methods of soil analysis is summarised in Ganglo (1999). The plant diversity has been assessed by means of species richness, Shannon-Wiever's index (H') and the evenness of Pielou's index (E). H' was estimated as: $H' = -\Sigma P_i \ln P_i$, where $P_i = n_i/n$ is the proportion of the individuals of the species i; n_i is the number of individuals of the species i et n is the total number of individuals. E was computed as : $E = H'/H'_{max}$ where $H'_{max} = \ln S$; H'_{max} is the value of H' when all species are equally abundant; S is the total number of species.

The correspondence factorial analysis has been performed by means of *Statistica* software package on 52 spontaneous undergrowth relevés.

The main biological types have been distinguished according to Schnell (1971). Among the woody phanerophytes (Ph), we have distinguished the following subtypes: megaphanerophytes (MPh) (height greater than 30 m), the mesophanerophytes (mPh) (10 £ height < 30 m), the microphanerophytes (mph) (2 £ height < 10 m), the nanophanerophytes (nPh) (0.40 £ height < 2 m) and the lianas (Phgr). The other biological types observed are chamaephytes (Ch), geophytes (Ge), hemicryptophytes (Hec) and therophytes (Th).

The phytogeographical distribution have been based on the chorological classification of Africa (White, 1986): Sudanian and Zambezian species (SZ), Guinea-Congolian species

(G), tropical African species (At), species common to many African regions (PRA), African-Malagasy species (AM), paleotropical species (Pal) and pantropical species (Pan).

The ecosociological groups have been distinguished on the basis of the syntaxonomic units established for tropical Africa (Lebrun & Gilbert, 1954; Schmitz, 1988; Hoff, 1991...).

The estimation of the productivity levels of teak plantations in the communities has been made on the basis of twelve temporay rectangular plots of 300 m^2 each (15 m * 20 m). The plantation top heights are estimated in the plots and help to deduce site productivity indices on the basis of sites curves elaborated for teak plantations in south and center Benin (Ganglo, 1999). The productivity indices are the estimated top heights at 25 year-old.

IV. RESULTS

A. Correspondence factorial analysis

The results of factorial analysis and hierarchical classification are presented on Figure 3 where the relevé-sets are easy to be distinguished in the factorial plan 2/3. Relevés 135, 136, 137, 138 and 139 are positioned at the positive part of the axis 2; they have been assessed in Ouèdo (Calavi) teak plantations on a southern humid soil of Benin. At the negative part of the same axis, the relevés 60, 61, 59... come from a leached plateau soil of Djigbé forest; this sandy plateau is relatively dry because its poor water reserve due to a high proportion of sand (90%). We therefore deduce that factor 2 describes a humidity gradient.

In the negative part of the axis 3, one finds the relevés 106, 107, 115 and 116 which are assessed in young plantations, whereas the relevés of old plantations are positioned in the positive and center part of the axis. Consequently, the factor 3 describes spontaneous forest

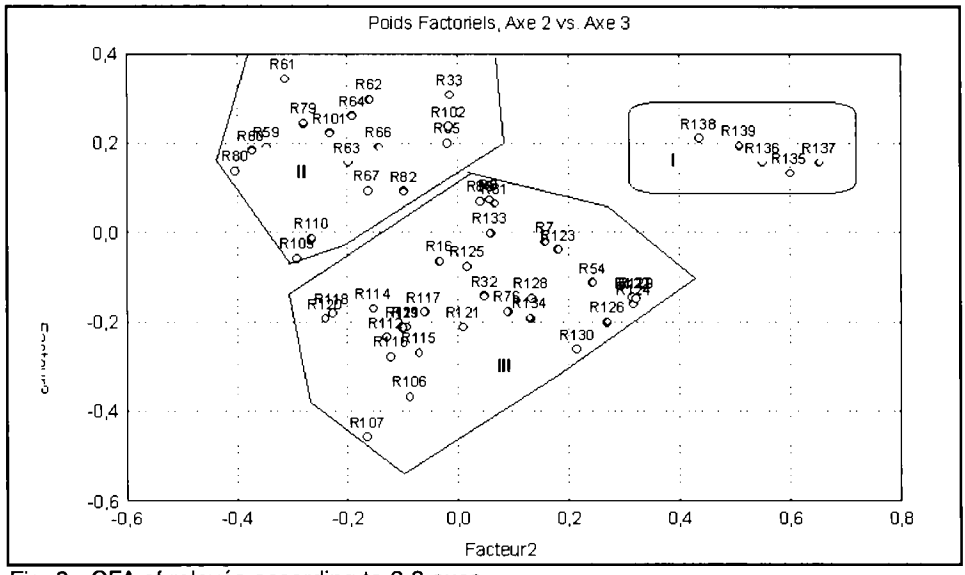


Fig. 3.- CFA of relevés according to 2-3 axes.
Fig. 3.- Analyse factorielle des relevés selon les axes 2 et 3.

succession. Figures 3 shows three relevés sets (I, II, III). The *Psychotria vogeliana*-community is represented by the relevé-set II.

B. Floristic composition and structure

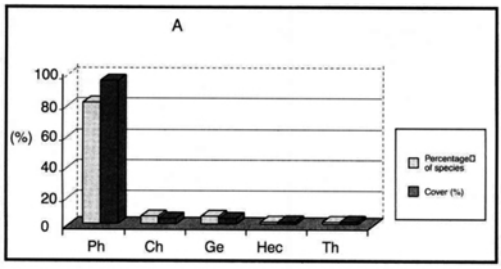
The floristic composition of this plant community is established from ten representative phytosociological relevés (Table I). The characteristic specific combination of the *Psychotria*-community is composed of four species: *Psychotria vogeliana, Feretia apodenthera*, *Uvaria chamae* and *Reissentia indica.* They have their optimal growth within the community. Their presence ranges from 80% to 100% and their average cover varies from 3 to 23%.

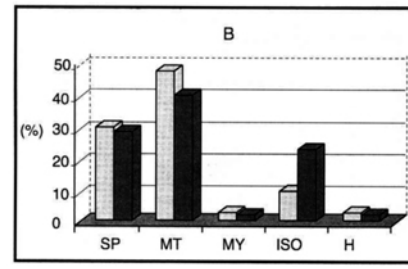
The lowest shrubby stratum of the plant community has an average height of 3 m and an average cover ranging from 40% to 95%. The intermediate shrubby stratum is essentially made of teak which has a mean height of 8 m and an average cover of 4%. The teak tree stratum that covers the *Psychotria vogeliana*-community has an average cover of 84% and its height ranges from 18 to 25 m.

The species richness of the *Psychotria vogeliana*-community reaches 91 species. The average number of species per relevé is 32 (standard deviation (SD) = 8.2 and the number of observations n = 10). The Shannon-Wiever's index (H') has an average value of 2.1 (SD = 0.3 and n = 9) and the evenness Pielou's index (E) is 0.48 (SD = 0.1 and n = 9).

C. Species-distribution-spectra

The biological spectrum (Fig. 4A) shows that the phanerophytes (Ph) are the most abundant (86% of species and 95% of the total cover).





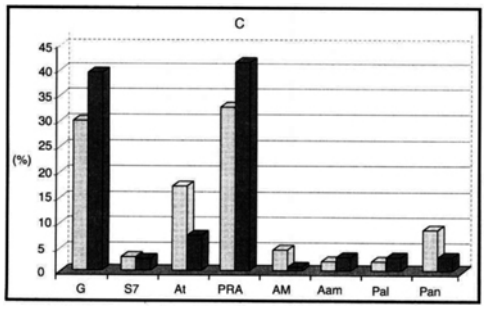


Fig 4.- Vegetation spectra. A: biological sp.; B: ecosociological sp. (SP = semi-deciduous forest species, MT = fallow and secondary forest species, MY = hygrophilous forest species, ISO = savana and miombo forest species, H = herbaceous species); C: phytogeographical sp.

Fig 4.- Spectres de la végétation. A : sp. biologique ; B sp. écosociologique (SP = espèces des forêts semi-décidues, MT = espèces des friches et forêts secondaires, MY = espèces des forêts hygrophiles, ISO = espèces savanicoles, H = espèces herbacées) ; C : sp. phytogéographique.

Table I.- Floristic composition of the *Psychotria vogeliana*-community. TB = biological type; TP = phytogeographical type; Freq = frequency (%); RM = mean cover; h = herbaceous stratum. For other abbreviations, see Material and Methods.
Tableau I.- Tableau phytosociologique de la communauté à *Psychotria vogeliana*.

TB	TP	Running order	strata	1	2	3	4	5	6	7	8	9	10	Freq	RM
		Recording numbers		33	60	61	62	63	64	66	67	79	80		
		1-Differential species of the *P. vogeliana*-community													
Phgr	PRA	*Uvaria chamae*	h	1	3	2	1	2	3	1	2	3	4	100	22,9
mph	G	*Psychotria vogeliana*	h	3	4	2	1	2		1	1	3	3	90	21,4
mph	G	*Feretia apodenthera*	h	3	1	2	4	1	3	+	1	1		90	16,5
Phgr	Pal	*Reissantia indica*	h	+	1		1	+	1	+	+	2		80	2,6
		2-Semi-deciduous forest species (*Piptadenio-Celtidetalia* Lebrun & Gilbert 1954)													
mPh	At	*Albizia zygia*	h	+	+	+	+	+	1	1	+	1	+	100	1,25
mPh	PRA	*Albizia ferruginea*	h		+	+	+	+	+	+	+	1	1	90	0,95
mPh	PRA	*Holarrhena floribunda*	h	+	+	+	1	+	+	1		2		80	2,35
Phgr	G	*Triclisia subcordata*	h	1	+		2		3	1	+	1		70	6,25
mPh	AAM	*Lonchocarpus sericeus*	h	+			1	2		+	+		+	60	2
mph	G	*Pouteria alnifolia*	h	+			+	+	+	1	1			60	0,8
Phgr	At	*Combretum paniculatum*	h		+	+				+	+	+	+	60	0,3
mPh	G	*Dialium guineense*	h	+		+	1			+			+	50	0,5
mph	PRA	*Lecaniodiscus cupanioides*	h	+			+			1	+			40	0,45
mPh	At	*Sterculia tragacantha*	h	1		+					+		+	40	0,45
Phgr	PRA	*Artabotrys velutinus*	h	+			+		+	1				40	0,45
Phgr	G	*Pyrenacantha vogeliana*	h				+		+	1				30	0,4
mph	At	*Cremaspora triflora*	h	+			1				+			30	0,4
Phgr	G	*Jasminum pauciflorum*	h					+				1		20	0,35
mPh	G	*Olax subscorpioidea*	h							1	+			20	0,35
Phgr	PRA	*Adenia lobata*	h	+								1		20	0,35
G	SZ	*Scadoxus multiflorus*	h							+	+			20	0,1
		3-Fallow and secondary forests species (*Musango-Terminalietalia* Lebrun & Gilbert 1954)													
nph	At	*Rourea coccinea*	h	1	+	1	+	+	+	+	1	1	1	100	1,75
Phgr	AAm	*Tragia volubilis*	h	+	+	1	+		1	1	+	2	+	90	2,65
MPh	G	*Antiaris toxicaria* subsp *welw.* var *africana*	h		+	+	+	+	+	+	+	1	+	90	0,7
nph	G	*Chassalia kolly*	h	2	+		1	+	1	1	1	3		80	6,55
Phgr	G	*Cnestis ferruginea*	h	1	+		+	+	1	+	+	1		80	1,15
Phgr	G	*Secamone afzelii*	h	1	+	1			+			1		50	1
mph	PRA	*Morinda lucida*	h	+		+	+					1	+	50	0,5
mph	At	*Clausena anisata*	h	+			1	+		+		+		50	0,5
Phgr	G	*Agelaea pentagyna*	h	+		+	+		+			+		50	0,25
Phgr	PRA	*Cissus rufescens*	h							2	2	1	1	40	3,6
mph	PRA	*Clerodendrum capitatum*	h	+	+		1	+						40	0,45
Phgr	PRA	*Usteria guineensis*	h		1				+	+	+			40	0,45
Phgr	G	*Lonchocarpus cyanescens*	h	+		+	+			+				40	0,2
mph	PRA	*Ficus sur*	h		+		+		+		+			40	0,2
Phgr	Pan	*Paullinia pinnata*	h		+						+		1	30	0,4
Ch	At	*Phaulopsis angolana*	h							+		2		20	1,55
mPh	At	*Psydrax parviflora*	h								+	1		20	0,35
mph	G	*Caloncoba gilgiana*	h				+					1		20	0,35
Ch	G	*Heterotis rotundifolia*	h	+	1									20	0,35
Phgr	PRA	*Ritchiea capparoides*	h	+								1		20	0,35
nph	Am	*Hoslundia opposita*	h			+						1		20	0,35
G	G	*Anchomanes difformis*	h						+	+				20	0,1
mPh	PRA	*Newbouldia laevis*	h			+	+							20	0,1
mPh	PRA	*Rauvolfia vomitoria*	h							+		+		20	0,1
Phgr	PRA	*Mondia whitei*	h				+			+				20	0,1
Phgr	PRA	*Dalbergia saxatilis*	h	+					+					20	0,1

		4-Hygrophilious forest species (*Mytragynetea* Schmitz 1963)													
mph	At	*Allophylus africanus*	h	+	1		+		+			1	+	60	0,8
mPh	PRA	*Mitragyna inermis*	h					1				+		20	0,35
G	Pan	*Ipomoea mauritiana*	h						+		+			20	0,1
		5-Ruderali-Manihotetea Léonard *in* Taton 1949 and *Soncho-Bidentetea pilosae* Hoff 1991 herbaceous species													
Ch	Pan	*Chromolaena odorata*	h		1	1	+			1	1	2	+	70	2,8
G	Pan	*Mariscus cylindristachyus*	h		+	+	+			+	1			50	0,5
		6-Savanna and miombo forest species (*Lophiretalia lanceolatea* Lebrun & Gilbert 1954)													
Phgr	PRA	*Macrosphyra longistyla*	h	3	3	4	2	1	4	3	3	2	1	100	31,1
mPh	At	*Zanthoxylum zanthoxyloides*	h	+	+	1	1	1	+	1	+	1		90	1,7
mPh	At	*Vitex doniana*	h	+	+	+	+		+		+	+	+	80	0,4
mph	PRA	*Flacourtia flavescens*	h	+	1	1	+		1			1	1	70	1,6
Phgr	SZ	*Opilia amentacea*	h	+	1	1		+		+		3		60	4,5
mph	PRA	*Bridelia ferruginea*	h			+		1						20	0,35
		Number of species sarcely represented		2	0	3	8	1	1	4	5	7	1		

Species sarcely represented: 1 - *Albizia adianthifolia* +, *Oxyanthus speciosus* +; 3 - *Loeseneriella africana* +, *Diospyros mespiliformis* +, *Crossopteryx febrifuga* +; 4 - *Oplismenus burmannii* 1, *Ehretia cymosa* +, *Carpolobia lutea* +, *Mallotus oppositifolius* +, *Monodora tenuifolia* +, *Milicia excelsa* +, *Dioscorea bulbifera* +, *Lophira lanceolata* +; 5 - *Imperata cylindrica* 1; 6 - *Oncoba spinosa* +; 7 - *Mussaenda elegans* +, *Premna angolensis* +, *Smilax anceps* +, *Trema orientalis* +; 8 - *Hippocratea myriantha* +, *Diospyros soubreana* +, *Pancovia bijuga* +, *Spathodea campanulata* 1, *Crotalaria goreensis* +; 9 - *Erythrococca africana* 1, *Dichapetalum madagascariense* var. *madagascariense* +, *Dalbergia afzeliana* +, *Mezoneuron benthamianum* 1, *Aneilema beniniense* +, *Adenia cissampeloides* +, *Asystasia gangetica* 2; 10 - *Vangueriella discolor* +.

The ecosociological spectrum (Fig. 4B) shows the dominance of the secondary forest species belonging to the *Musango-Terminalietea* class (MT) (48% of the species and 42% of the total cover). The primary forest species of the *Piptadenio-Celtidetalia* order (SP) amount 33% of the species and 30% of the total cover. Apart from the *Isoberlinion dokae* alliance (ISO) (11% of the species and 24% of the total cover), few species belong to the remaining ecosociological groups.

The phytogeographical spectrum (Fig. 4C) shows the abundance of geographically widespread species (50% of the species and 50% of the total cover). The Guinean species (G) represent 30% of the species and 40% of the total cover while the Sudania-Zambezian species (SZ) represent 33% of the species and 42% of the total cover.

D. Ecological and silvicultural indicatory values of the *Psychotria vogeliana*-community

The *Psychotria vogeliana*-community is a reliable indicator of leached sandy plateau soils. The major physico-chemical properties of these soils are summarised in Table II. From this table, we note that the soils are slightly acidic (pH 5.5-6.5) with a cationic exchange capacity of 4 to 6 cmol+/kg and a saturation rate of 35% to 84%. The soils of the plant-community are also poor in clay and silt.

The teak plantations of the *Psychotria vogeliana* community is among the least productive of south and center Benin. On the basis of twelve replications, the mean site index estimated in the plantations of the community is 21 m (top height at 25 year-old) with a standard deviation of 1.4 m (Table III). The *Psychotria vogeliana*-community is therefore a reliable indicator of the least productive plantations where appropriate silvicultural measures must be undertaken if valuable timber production is expected.

Table II.- Results of soil analysis in the *Psychotria vogeliana*-community (Djigbé forest).
Tableau II.- Données des analyses de sol sous la communauté à *Psychotria vogeliana*.

Depth (cm)	0-15	15-40	40-70
Coarse sand (200-2000) %	72,9	71,1	62,7
Fine sand (50-200) %	16,4	17,5	13,3
Coarse silt (20-50) %	0,7	1,2	1,7
Fine silt (2-20) %	2	1,5	1,3
Clay (0-2) %	6,8	8,3	21,3
C%	0,95	0,38	0,37
N%	0,07	0,039	0,034
C/N	13,6	9,7	10,9
MO%	1,6	0,7	0,6
pH	6,5	6,2	5,5
Ca^{++} (cmol+/kg)	3,63	1,75	1,02
Mg^{++} (cmol+/kg)	1,62	0,89	0,82
K^{+} (cmol+/kg)	0,15	0,13	0,1
Na^{+} (cmol+/kg)	0,05	0,05	0,06
CEC (cmol+/kg)	6,45	4,2	5,7
P ppm	tr	tr	tr
Saturation (%)	84	67	35

Table III.- Productivity of forest plantations according to undergrowth plant-communities in south-Benin (in the same column, the numbers followed by the same letters are not significantly different at 5% of probability level).
Tableau III.- Productivité des plantations forestières en fonction du sous-bois naturel au sud Bénin.

Undergrowth plant-communities	Productivity indices (m)	Standard deviation (m)	Number of observations
Groupement à *Psychotria vogeliana*	20,9c	1,4	12
Groupement à *Icacina trichantha* (Ganglo, 1999)	24,5 a	0,7	7
Groupement à *Hypselodelphys poggeana* (Ganglo, 1999)	22,7 b	1,3	8
Groupement à *Lecaniodiscus cupanioides* et *Landolphia calabarica* (Ganglo, 1999)	21,9 bc	1,6	34
Groupement à *Lecaniodiscus cupanioides* et *Pouteria alnifolia* (Ganglo, 1999)	25,7 a	1,0	8
Groupement à *Landolphia calabarica* (Ganglo, 1999)	22,2 bc	1,2	7

E. Occuring area

The *Psychotria vogeliana*-community is found on leached plateau soils in Djigbé forest. The zone of its optimal development in this forest extends to plots 40, 41, 51, 56 and 57 (Fig. 1). Apart from Djigbé forest, we find a variation of this community in Bonou forest (6° 45' N lat. - 2° 30' of E long.) in east Benin. In this forest, the community also grows on sandy plateau soils.

V. DISCUSSION

Species richness (91 species) of the *Psychotria*-community is higher than that of the *Stereospermum kunthianum*-community (49 species) studied in the Guineo-Sudanian zone of center Benin (Ganglo, 2001). Seasonal violent fire that regularly burns the center-Benin teak plantations is the factor which explains the low species richness of the *Stereospermum*

kunthianum-community. The species richness varies with the area of relevés (Troupin, 1966; Gounot, 1969) and with the number of relevés taken into account (Troupin, 1966). Consequently, we cannot make rigorous comparisons of the species richness of the *Psychotria vogeliana*-community with that found by those who don't use the same minimum area as we do. It's however note worthy that in the semi-deciduous forest of Pobè (southeast-Benin), the species richness ranges from 150 to 158 species on 500 m^2 (Sokpon, 1995). The Shannon-Wiever index (*H'*) is not so dependent on the relevé-area (Spellerberg, 1991), therefore, we can make reasonable comparisons with the results of other authors. The species diversity of the site associations studied in British Colombia (Quian *et al.*, 1997) is similar (Shannon-Wiever index ranges from 1 to 2) to that of the *Psychotria vogeliana*-community. This community is however more diverse than the undergrowth of Pines and *Eucalyptus* plantations of the Republic of Congo where Shannon-Wiever index ranges from 0.38 to 0.89 (N'zala *et al.*, 1997). The low value (0.48) of evenness index (*E*) of the plant community presented in this paper is due to the abundance of *Psychotria vogeliana, Macrosphyra longistyla, Feretia apodenthera* and *Uvaria chamae.*

The biological spectrum of the *Psychotria vogeliana*-community is dominated by the phanerophytes. This result is consistent with those found in classic forest types. In various tropical forests, the percentage of phanerophytes ranges from 80% to 92% (Mullenders, 1954; Germain & Evrard, 1956; Gérard, 1960; Mandango, 1982; Mosango, 1990; Sokpon, 1995). The proportion (8%) of annual species of the community is however higher than what is generally noted in the forest types studied by the authors. Seasonal fires and annual defoliation of teak plantations are the most relevant factors which favor the annual species development. Such factors which disturb the plant community also favour the abundance of the geographically widespread species (50% of the species).

The study of the undergrowth plant communities of teak plantations enabled us to emphasize the usefulness of such plant communities in forest management (Ganglo & Lejoly, 1999; Ganglo *et al.*, 1999). The spontaneous undergrowth plant communities are indeed, linked to ecological factors such as topography and soil types. An instance of this is that the *Psychotria vogeliana*-community is common on sandy plateau soils and therefore can be considered as a valid indicator of such topographical and pedological conditions. Furthermore, the undergrowth plant communities are very highly significant to the productivity of teak plantations with only a little variation of productivity within each community (Table III). From that table, we can realise that the *Psychotria vogeliana*-community is associated to the least productive plantations.

VI. CONCLUSION

The *Psychotria vogeliana*-community is one of the most diversified undergrowth plant-community of south Benin. It is a reliable indicator of the sandy slightly acidic soils generally associated to low forest productivity.

Acknowledgements - We gratefully acknowledge the financial support of the following institutions: the World Bank and Japanese government, the African Academy of Sciences (AAS, Nairobi, Kenya) and « Administration générale pour la coopération au développement » (AGCD). We thank also « Centre panafricain de recherches et d'actions pour l'environnement et le développement économique et social » (CEPRAEDES, Abomey-Calavi, Bénin) for its support.

REFERENCES

Adjakidjè V., 1984.- *Contribution à l'étude botanique des savanes guinéennes de la République populaire du Bénin.* Thèse de 3e cycle, Université de Bordeaux III, 285 p.

Adjanohoun E.J. *et al.*, 1989.- *Contribution aux études ethnobotaniques et floristiques en République populaire du Bénin.* ACCT, 895 p.

Akoegninou A., 1984.- *Contribution à l'étude botanique des îlots de forêts denses humides semi-décidues en République populaire du Bénin.* Thèse de 3e cycle, Université de Bordeaux III, 250 p.

Aubréville A., 1937.- Les forêts du Dahomey et du Togo. *Bull. Com. Et. hist. sci. A.O.F.*, **20**, 1-112.

Ganglo C. J., 1999.- *Phytosociologie de la végétation naturelle de sous-bois, écologie et productivité des plantations de teck (*Tectona grandis *L. f.) du sud et du centre Bénin.* Thèse de Doctorat, Université libre de Bruxelles, 391 p.

Ganglo C. J., 2001.- Description d'une association nouvelle dans le sous-bois naturel des teckeraies du Centre nord Bénin : l'*Opilio amentaceae – Stereospermetum kunthiani. Acta Bot. Gallica*, **148** (3), 277-281.

Ganglo C. J. & J. Lejoly, 1999.- Biotope et valeur indicatrice écologique de l'association à *Lecaniodiscus cupanioides* et *Landolphia calabarica* dans le sous-bois naturel des teckeraies du sud-Bénin. *Acta Bot Gallica*, **146** (3), 227-245.

Ganglo C. J., J. Lejoly & T. Pipar, 1999.- Le teck (*Tectona grandis* L. f.) au Bénin, gestion et perspectives. *Bois et Forêts Trop.*, **261** (3), 17-27.

Gérard Ph., 1960.- Étude phytosociologique de la forêt dense à *Gilbertiodendron dewevrei* dans la région de l'Uelé. *Publ. INEAC*, ss, **87**, 159 p.

Germain R. & C. Évrard, 1956.- Étude phytosociologique de la forêt à *Brachystegia laurentii. Publ. INEAC*, ss, **67**, 105 p.

Gounot M., 1969.- *Méthodes d'étude quantitative de la végétation.* Masson et Cie, Paris, 314 p.

Hoff M., 1991.- *Végétation synanthropique tropicale.* ORSTOM Cayenne, 55 p.

Lebrun J. & G. Gilbert, 1954.- Une classification écologique des forêts du Congo. *Publ. INEAC*, ss. **63**, 89 p.

Lebrun J.P. & A.L. Stork, 1991-1997.- *Énumération des plantes à fleurs d'Afrique tropicale.* Vol 1, 2, 3. Conservatoire et Jardin botaniques de la ville de Genève.

Lubini A., 1982.- *Végétation messicole et postculturale des sous-régions de Kisangani et de la Tshopo (Haut-Zaïre).* Thèse de doctorat, Université de Kisangani, 489 p.

Mandango A., 1982.- *Flore et végétation des îles du fleuve Zaïre dans la sous-région de la Tshopo (Haut-Zaïre).* Thèse de doctorat, Université de Kisangani, 425 p.

Mosango M., 1990.- *Contribution à l'étude botanique et biogéographique de l'écosystème forêt en région équatoriale (île Kongolo, Zaïre).* Thèse de doctorat, Université libre de Bruxelles, 446 p.

Mullenders W., 1954.- *La végétation de Kaniama (Entre-Lubishi-Lubilash, Congo Belge).* Thèse de Doctorat en Sciences, Université catholique de Louvain, INEAC, ss, **16**, 499 p.

Nyakabwa M., 1982.- *Phytocénoses de l'écosystème urbain de Kisangani,* 2e partie. Thèse de Doctorat, Université de Kisangani, 744 p.

Nyakabwa M., 1994.- Introduction à l'étude de la valeur indicatrice du niveau de fertilité des sols par les principales espèces adventices des cultures en allées à Kisangani. *Ann. Fac. Sci. Kisangani*, n° spéc., 73-84.

N'zala D., A. Nongamani, J.M. Moutsamboté & A. Mapangui, 1997.- Diversité floristique dans les monocultures d'*Eucalyptus* et de Pins au Congo. *Cah. Agri.*, **6**, 169-174.

Quian H., K. Klinka & B. Sivak, 1997.- Diversity of the understorey vascular vegetation in 40 year old and old-growth forest stands on Vancouver Island, British Columbia. *J. Veg. Sci.*, **8**, 773-780.

Schmitz A., 1988.- Révision des groupements végétaux décrits du Zaïre, du Rwanda et du Burudi. *Ann. Sci. Eco.*, **17**, 315 p.

Schnell R., 1971.- *Introduction à la phytogéographie des pays tropicaux.* 2 - Les milieux, les groupements végétaux. Gauthier-Villars, Paris, 503-951.

Sokpon N., 1995.- *Recherches écologiques sur la forêt dense semi-décidue de Pobè au sud-est du Bénin. Groupements végétaux, structure, régénération naturelle et chute de litière.* Thèse de Doctorat, Université libre de Bruxelles, 350 p.

Spellerberg I.F., 1991.- *Monitoring Ecological Change.* Cambridge University Press, Cambridge, 334 p.

Troupin, G., 1966.- *Étude phytocénologique du Parc national de l'Akagera et du Rwanda oriental. Recherche d'une méthode d'analyse appropriée à la végétation d'Afrique intertropicale.* Thèse d'Agrégation de l'enseignement supérieur, Université de Liège, 293 p.

Volkoff B., 1976.- *Notice explicative n° 66 (2). Carte pédologique de reconnaissance de la République populaire du Bénin au 1/200 000. Feuille d'Abomey.* ORSTOM, Paris, 40 p.

White F, 1986.- *La végétation de l'Afrique. Mémoire accompagnant la carte de végétation de l'Afrique.* Unesco / AETFAT / UNSO. ORSTOM-Unesco, 384 p.