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Specific Diversity and Ecological Characterization of Weeds with Ubiquist Behavior in the Plantations of Oil Palm Tree in the Southwest of Côte d'Ivoire

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ABSTRACT

In Côte d'Ivoire, the culture of the oil palm tree is opposed to the proliferation of adventitious especially those with ubiquist behavior. The present study carried out at the southwest of Côte d'Ivoire relates to the characterization of the species with ubiquist behavior in the plantations of oil palm tree. The objective was to determine the diversity of species and to characterize the adventitious ones with ubiquist behavior of the oil palm plantations. The floristic richness of the oil palm fields of SOGB, Grand-darwin, and Dabou was estimated from 700 lines, 6726 circles and 194 wind-rows carried out according to the sampling procedure laminated. Results showed that the adventitious flora of Dabou is diversified although the oil palm three fields flora is homogeneous. The inventoried adventitious flora comprises 37 species with ubiquist behavior divided into 22 families and 35 genes. The class of broadleaf weeds is largely dominant with 25 species. Factor analyses revealed that the distribution of certain species with ubiquist behavior is correlated with certain ecological factors of the locality. However numerous species with ubiquist behavior gather themselves independently of the various localities.

INTRODUCTION

Of its statute of plant of gathering in Africa, the oil palm tree (*Elaeis guineensis* Jacq.) rise at the row of the major industrial crops, nowadays. Côte d'Ivoire occupies today a dominating place in the international market of the palm oil and the culture of the palm tree with oil is a major importance for its economy. The annual production is approximately 400 000 tons of raw palm oil (Jannot, 2014). This production makes of Côte d'Ivoire the 7th world producer, the 2nd African producer of palm tree with oil and the first African exporter with 70.000 ha of agro-industrial plantations and 140,000 ha of village plantations (Naï Naï *et al*., 2000). In spite of this rise, the culture of the palm tree with oil is subjected to many constraints among which the adventitious ones appear. The culture and the agronomic performances of the oil palm tree are confronted to the proliferation of adventitious and sometimes to the resistance of those to the herbicides. In such a context, know the diversity of the adventitious flora and its dynamics under the effect of the environmental factors or the culture technical is an essential precondition to the improvement of the methods of fight against the adventitious (Barralis and Chadoeuf, 1980). However, a simple inventory of weeds is not enough to achieve the goals of improvement of the productions. The search for new methods of more effective fights is the requirement for the improvement of the agronomic performances of the palm tree in Côte d'Ivoire.

I-MATERIALS AND METHODS

1-1-Sites of the study

The study was conducted in three oil palm fields (Figure 1) of the South-west of Côte d'Ivoire (Dabou, Grand-Dreuwin and SOGB). The oil palm field of Dabou is located at 5°20' Northern latitude and 4°20' Western longitude. The vegetation of this locality is an included savanna (Caliman, 1990). The agro-industrial complex of the SOGB located at 4°39' Northern latitude and 6°56' Western longitude is to 20 km west of the city Grand-Béréby. The center of experimentation and production of Grand-Dreuwin, located at Western 4°55' Northern and 6°09' is to approximately 7 km west of the Sassandra town in edge of sea. The climate of these three localities is of subequatorial type with four seasons: two rainy seasons and two dry seasons (including one large and small).

1-2-Floristic inventory

The floristic inventory was carried out according to the method "of stratified sampling" used by Daget and Godron (1982). This stratification is carried out starting from suitably selected variables (Gadroon, 1971). It consisted in classifying the cultivated plots in more or less homogeneous subsets, called layers (Fontanel, 1987). In this study, the following variables were retained:

-age of the plots: divided into three classes (class 1: from 1-5 years; class 2: from 6-10 years and class 3: from 11-20 years.

-farming precedents considered as plots resulting from the forest cutting or savanna or from an operation of replanting.

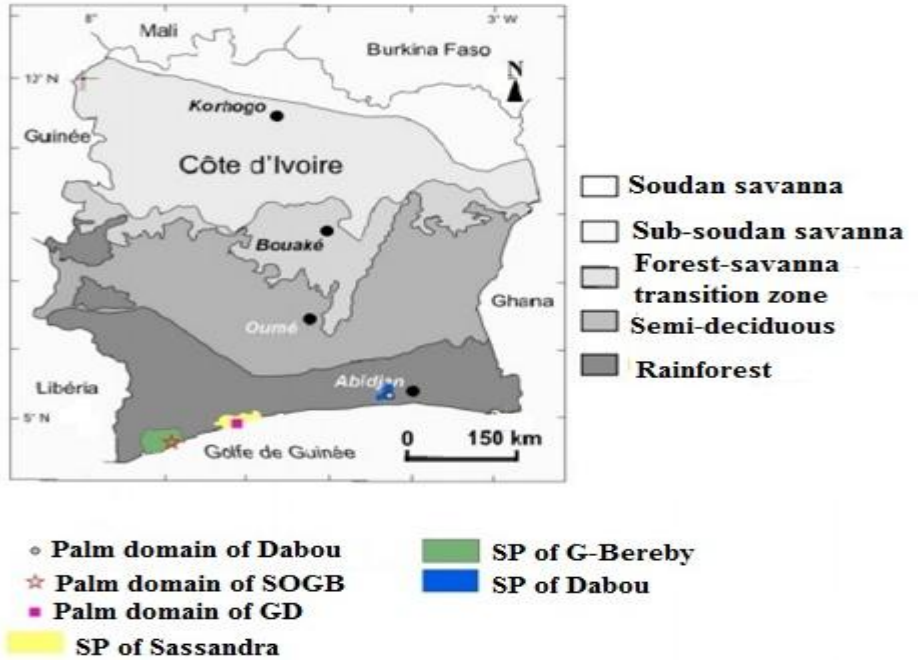


Figure 1: Situation of study sites

The floristic inventory was carried out in the line spaces, in the wind-rows like in the circles around the palm trees. In each plot retained for the study, a line space on three was inventoried. The floristic inventory consisted in noting in each line space, each windrow or each round, the presence of the species being there, independently of their abundance. The floristic richness of the three localities (SOGB, Large-Dreuwin and Dabou) was established on the basis of 700 line space, 6726 circles and 194 windrows and carried out according to the studied variables. The identification of the inventoried species was made on the spot or at

the National center of Floristic (CNF) of UFHB according to the dichotomic key of determination of the families of Hutchinson and Dalziel (1954-1972).

1-3-Analysis of the flora

The diversity of the flora of each site, of each farming precedent and the age class, was estimated by the index of diversity of Shannon-weaver (1948) according to the formula:

$$\mathbf{H = -\sum_{i=1}^{n} Pi \times \log_2(Pi)}$$

With pi =Ni/N where Ni is the number of the species i and N the total number of the whole species. The index is used to appreciate the diversity of a biotope (Vroh *et al*., 2010). The values evolve of 0 to log (N). When the value of the index H is raised, the medium is more diversified.

The floristic homogeneity of each site, each farming precedent and the age class was appreciated starting from the equitability of Piélou (1966) which is deduced from the index of Shannon-Weaver. It describes the distribution of the various species of a population and has as a mathematical expression:

$$\mathbf{E = H / \log_2(N)}$$

N being the full number of inventoried species. The values evolve from 0 to 1. The index of equitability tends towards zero when there is predominance of a species and towards 1 when a maximum of species take part in covering.

Similarity enters the parameters (localities, age group, precedents farming) influencing the distribution of the flora

The coefficient allowed to check the homogeneity of the flora of the sites of floristic inventory taken two to two. It is given according to the formula of Sorensen (1948) hereafter:

$$\mathbf{Cs = \frac{2c}{a+b} X\ 100}$$

where a and b represent the numbers of species listed respectively in the two sites sampled, C being the number of species common to both sites a and b. It (Cs) varies from 0 to 100% according to whether the two sites are completely different on floristic compositions. (C = 0)

or identical (= B has = c). For a coefficient higher than 50%, the two sites concerned are regarded as florist querent identical.

1-3-1-Level of aggressiveness of the species with ubiquist behavior

The noxiousness of each species with ubiquist behavior was deduced from the specific Contribution (Csi). The Specific Contribution (Csi) due to the frequency of a species is the translation of its contribution in terms of covering within a given vegetable formation.

$$\mathbf{Csi} = \frac{\mathbf{Fai}}{\mathbf{\sum n1\ Fai}} \mathbf{X\ 100}$$

It is obtained by the report of the absolute frequency (Fai) of the species and the sum of the absolute frequencies (∑n1 Fai) of all the species met, multiplied by 100. It translates according to Daget and Poisonnet (1971) the importance of the species in the following way:
-Csi lower than 1%: the adventitious is not very aggressive;

-1 ≤ Csi ≤ 4%: adventitious aggressive;

-Csi higher than 4%: adventitious very aggressive.

1-3-2-Determination of the ecological groups and the groups of species with ubiquist behavior

Factor Analyses of Correspondences (AFC) were carried out in order to determine the ecological factors which control the distribution of the species with ubiquist behavior. Software XLSTAT 2014.5.03 was used to carry out various projections. To facilitate the analysis, the name of the species was redefined according to the principle of coding of Bayer (1992). According to this method, the first three letters of the genera are associated with the first two letters of the specific epithet. For example, *Digitaria horizontalis* gives Digho

II-RESULTS

2-1-Flora inventory

The inventoried adventitious flora accounts 37 species with ubiquist behavior. These species are distributed into 22 families and 35 genera. Among the inventoried the family of Poaceae is represented with 8 species (36.36%; Table 1). The class of broadleaf weeds is largely dominant with 25 species (67.57%) while that of the Monocots was represented with 11

species, that is to say, 29.73%. The class of Filicopsides is represented by only one species (2. 7%) of the species with ubiquist behavior (Table 2).

Table 1: List of the species with ubiquist behavior inventoried

Number	Family	species
1	Poaceae	*Acroceras zizanioides* (Kunth) Dandy
		Axonopus compressus (Sw.) P. Beauv.
		Digitaria horizontalis Willd.
		Eleusine indica (L.) Gaertn.
		Eragrostis tenella (L.) Roem. & Schult.
		Panicum laxum Sw.
		Panicum maximum Jacq.
		Rottboellia cochinchinensis (Lour.) W. Clayton
2	Asteraceae	*Ageratum conyzoides* L.
		Aspilia africana (Pers.) C. Adams
		Chromolaena odorata (L.) R. King & H. Robinson
3	Euphorbiaceae	*Alchornea cordifolia* (Schum. & Thonn.) Muell. Arg
		Croton hirtus L'herit.
		Phyllanthus niruroides Müll. Arg.
4	Cyperaceae	*Mariscus cylindristachyus* Steudel
		Mariscus flabelliformis Kunth var flabelliformis
5	Fabaceae	*Centrosema pubescens* Benth.
		Desmodium adscendens (Sw.) DC.
6	Mimosaceae	*Mimosa pudica* Linn.
		Schrankia leptocarpa DC.
7	Passifloraceae	*Adenia lobata* (Jacq.) Engl
		Passiflora foetida Linn.
8	Acanthaceae	*Asystasia gangetica* (L.) T. Anders.
9	Amaranthaceae	*Cyathula prostata* (L.) Bl.
10	Boraginaceae	*Heliotropium indicum* Linn.
11	Caesalpiniaceae	*Mezoneuron benthamianum* Baill.
12	Commelinaceae	*Commelina diffusa* Burm. F.
13	Convolvulaceae	*Ipomoea pes-caprae* (L.) Sweet Subsp brasiliensis (L.) Ooststr
14	Cucurbitaceae	*Momordica charantia* L.
15	Dilleniaceae	*Tetracera affinis* Hutch
16	Malvaceae	*Sida acuta* Burm. f.
17	Moraceae	*Ficus exasperata* Vahl
18	Rubiaceae	*Spermacoce verticillata* L.
19	Sapindaceae	*Paullinia pinnata* L.
20	Solanaceae	*Solanum verbascifolium* L.
21	Thelypteridaceae	*Cyclosorus striatus* (Schum.) Ching
22	Verbenaceae	*Lantana camara* Linn.
TOTAL	**22**	**37**

Table 2: Number of species with ubiquist behavior according to the taxonomic levels

Class	Family	Genus	Species	Percentage (%)
Dicotylédones	18	24	25	67,57
Monocotylédones	3	10	11	29,73
Filicopsides	1	1	1	2,7
TOTAL	**22**	**35**	**37**	**100**

2-2-Floristic diversity and homogeneity

The estimates of the indices of Shannon (H) and of the equitability of Piélou (E) of the various localities, of plots of cultures grouped in the class of age and the plots of cultures in relation with their farming precedents appear in table 3.

Table 3: values of the indices of diversity of Shannon and the equitability of Piélou according to the various studied parameters

Parameters	SOGB	Grand-Dreuwin	Dabou	C1	C2	C3	DE	RE
Shannon (H)	5,67	5,86	6,18	5,55	5,68	5,73	5,75	5,90
Equitability (E)	0,90	0,92	0,89	0,92	0,92	0,92	0,92	0,93

C1: class 1 ; **C2**: class 2 ; **C3**: class 3 ; **DE**: cutting of the flora ; **RE**: planting

2-3-Similarity of the adventitious flora of the sites, the age classes and the farming precedents

The similarity coefficient of the inventoried plots on the sites, that of those gathered in age class and that estimated according to the farming precedents are higher than 50%. The analysis of the seven couples obtained by confronting two to two the flora of the three sites, the three age class and the two farming precedents are consigned in table 4.

Table 4: similarity coefficient concerning the three sites, the three age class and the two precedents farming

Compared Parameters 2 à 2	a	b	a + b	c	Cs (%)
SOGB/Grand-Dreuwin	78	81	159	42	52.83
SOGB/Dabou	78	121	199	52	52.26
Grand-Dreuwin/Dabou	81	121	202	54	53.46
Class 1/Classe 2	122	138	260	110	84.62
Class 1/Classe 3	122	140	262	106	80.92
Class 2/Classe 3	138	140	278	115	82.73
Flora cutting/Planting	141	131	272	107	78.68

2-4-Level of aggressiveness of adventitious with ubiquist behavior

The estimation of the specific contributions (Table 5) showed that 8 species with ubiquist behavior (22%) are very aggressive, 23 (62%) are aggressive and 6 (16%) are low aggressive

Table 5: Specific contribution and characterization of species with ubiquist behavior

Number	Species	Csi (%)	Characteristic
1	*Chromolaena odorata* (L.) R. King & H. Robinson	6.64	
2	*Panicum laxum* Sw.	6.46	
3	*Asystasia gangetica* (L.) T. Anders.	5.29	
4	*Centrosema pubescens* Benth.	5.05	**very aggressive**
5	*Cyclosorus striatus* (Schum.) Ching	5.01	
6	*Acroceras zizanioides* (Kunth) Dandy	4.8	
7	*Croton hirtus* L'herit.	4.2	
8	*Mimosa pudica* Linn.	4.01	
9	*Commelina diffusa* Burm. F.	3.87	
10	*Aspilia africana* (Pers.) C. Adams	3.77	
11	*Desmodium adscendens* (Sw.) DC.	3.43	
12	*Phyllanthus niruroides* Müll. Arg.	3.41	
13	*Alchornea cordifolia* (Schum. & Thonn.) Muell. Arg	3.33	
14	*Ageratum conyzoides* L.	3.13	
15	*Eragrostis tenella* (L.) Roem. & Schult.	3.01	
16	*Axonopus compressus* (Sw.) P. Beauv.	2.84	
17	*Mariscus flabelliformis* Kunth var flabelliformis	2.73	
18	*Lantana camara* Linn.	2.43	
19	*Mariscus cylindristachyus* Steudel	2.32	
20	*Tetracera affinis* Hutch	2.21	**Aggressive**
21	*Panicum maximum* Jacq.	2.14	
22	*Heliotropium indicum* Linn.	2.13	
23	*Sida acuta* Burm. f.	2.07	
24	*Digitaria horizontalis* Willd.	1.9	
25	*Paullinia pinnata* L.	1.84	
26	*Cyathula prostata* (L.) Bl.	1.78	
27	*Ipomoea pes-caprae* (L.) Sweet Subsp brasiliensis (L.) Ooststr	1.53	
28	*Mezoneuron benthamianum* Baill.	1.61	
29	*Ficus exasperata* Vahl	1.58	
30	*Eleusine indica* (L.) Gaertn.	1.09	
31	*Momordica charantia* L.	1.06	
32	*Schrankia leptocarpa* DC.	0.95	
33	*Rottboellia cochinchinensis* (Lour.) W. Clayton	0.63	
34	*Adenia lobata* (Jacq.) Engl	0.56	**low aggressive**
35	*Solanum verbascifolium* L.	0.5	
36	*Spermacoce verticillata* L.	0.37	
37	*Passiflora foetida* Linn.	0.33	

2-5- Intercorrelation of the ecological parameters and the distribution of the species with ubiquist behavior according to the zone

The AFC of the distribution of the studied parameters (figure 1) shows that the factorial design formed by the first two components (axes 1 and 2) contains the main information compared to the distribution of these parameters. These components explain 83.63% of the variability observed of which 46.57% are applied to the axis 1 and 37.06% for axis 2. The projection of the ecological parameters on the F1 axes and F2 of the AFC emphasizes 4 ecological groups. This analysis showed that the group 1, composed by the age group 3 (11 to 20 years) of the oil palm plantations, clearing and the zone of SOGB, located negatively on axes 1 and 2, are strongly correlated. The Group 4 positively located on axes 1 and 2, and gathering the palm plantations of class 1 (1 to 5 years) and 2 (6 to 10 years) and the farming precedent (replanting) are correlated. However, the zones of Grand-Dreuwin and Dabou setting up respectively groups 2 and 3 do not have any correlation with the other studied parameters. The projection of the species with ubiquist behavior and the zones of culture on the F1 and F2 axes helped to determine four groups of species with ubiquist behavior. The axes F1 and F2 explain 100% of the variability observed of which 63.02% are applied to the axis 1 and 36.98% for axis 2. The Group 1, located negatively on axis 1 and positively on the axis 2 consists of 2 species with ubiquist behavior, which are *Passiflora foetida* et *Phyllanthus muellerianus* are more present at the SOGB.

The Group 2 positively located on axes 1 and 2 and containing 4 species at with ubiquist behavior (Eragrostis tenella, Ipomoea pes-caprae, *Lantana camara* and *Schrankia leptocarpa*) which characterize the zone of Grand-Dreuwin. The Group 3 located positively on axis 1 and negatively on axis 2 comprises 3 species with ubiquist behavior (*Digitaria horizontalis*, *Mariscus cylindristachyus* and *Mariscus flabelliformis*) and which characterize the field of Dabou. The Group 4 presents a broad distribution. It is consisted by the 28 other species which are not related to any zone from the ecological point of view.

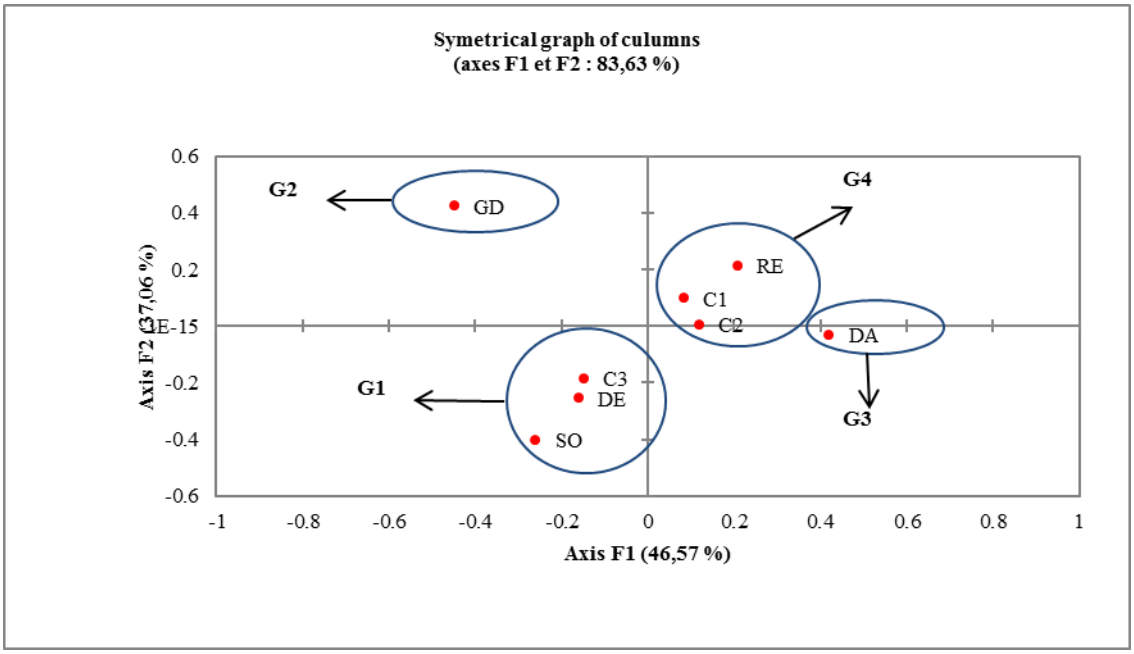
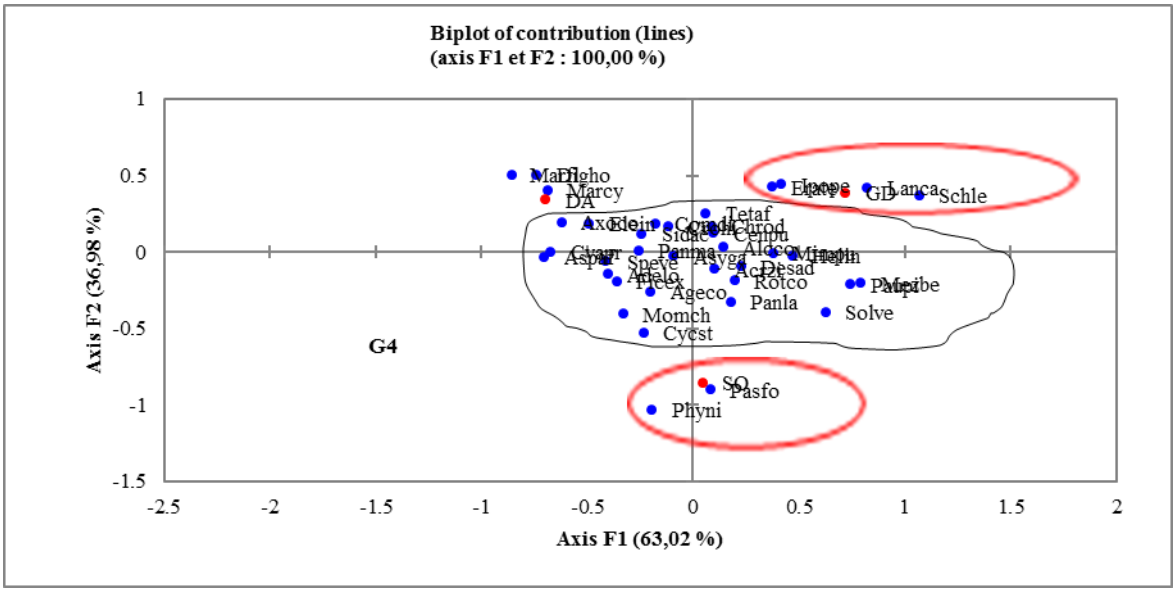


Figure 1: Projection of the ecological parameters of the studies zone on the axis F1 and

DA : Dabou ; GD : Grand-Dreuwin ; SO : SOGB ; C1 : Classe 1 ;
C2 : Classe 2 ; C3 : Classe 3 ; RE : Planting ; DE : weeding



DA: Dabou ; **GD** : Grand-Dreuwin ; **SO** : SOGB

Figure 2: Projection of the species with ubiquists behavior according to the localities

III-DISCUSSION

3-1- Floristic richness

The high number of species with ubiquist behavior (37) in this study indicates the difficulty of controlling the grass of oil palm plantations. This situation could be explained by a resistance which has occurred following the intensive use of the same herbicides. According to FAO (1988), the repeated application of the same herbicides leads to the reduction of the significant species and the proliferation of most resistant, which end up becoming prevalent. The strong representativeness of the class of broadleaf weeds with 67,57% in this study was recorded by Traoré et al. (2005), which observed the ubiquist behavior of 2/3 from broadleaf weeds and 1/3 of Monocots in the palm plantations of Dabou and la Mé (Côte d'Ivoire) like by Bouhache et al. (1994) in Morocco with 82,3% of the species. This distribution on the great taxonomic levels and the ranking of the families show a certain monotony in floristic diversity within weeds in tropical Africa according to Marnotte (2000). This report enables us to affirm with Déat (1976) that it does not exist a specific adventitious flora to a given culture, but the distribution of this flora would be rather related to ecological parameters and the agronomic factors.

3-2-Floristic diversity and homogeneity

The maximum value of the index of diversity of Shannon obtained in Dabou shows that the adventitious flora of this locality is diversified from the ecological point of view than those of other zones (SOGB and Gran-Dreuwin). This strong diversity is due to the irregularity of weeding related on the insufficiency of labour and the non-use of herbicides. Moreover, Ipou Ipou (2005) which worked typically in the center of Côte d'Ivoire showed that when the fight against the adventitious do not allowed the use of herbicides, this situation is more favorable to their diversity and their proliferation. In oil paml field, the use of *Pueraria phaseoloides* (Roscb.) Benth. as plants cover reduces the proliferation of weeds by the shade which it imposes (Marnotte, 2000), from where low values of the indices of Shannon observed in young culture (class 1). However, stronger floristic diversity of the plantations of the age group 3 is due to the shade that imposes the rapid growth of the feather-grass and of the sheets of the palm tree after 5 years, the biology of the plant of cover influences which will disappear gradually. This situation will support the proliferation and the installation of adventitious in the palm plantation. The replanting of palm tree more supports the establishment of species characteristic of the disturbed zone (adventitious). This situation

explains the strong diversity of the adventitious flora of the palm plantations resulting from replanting. The strong values of the index of equitability recorded in all the localities, all the age groups and all the farming precedents represent a fair distribution of the number of the various species met in the palm plantations. This situation can be due to the fact that all these plantations are industrial palm plantations which would profit from the same technical of culture.

3-3-Similarity of the adventitious flora

The strong similarity of the adventitious flora of the various sites (approximately 52%), of the age groups (approximately 82%) and of the two farming precedents (78%) shows that the three sites are homogeneous to the point of floristic view. This strong similarity is due to the same climate (attiéen) of which these three zones profit. Indeed, according to Boraud (2000), the climate is the dominating abiotic factor in the distribution of the species, follow-up of the soil type.

3-4-Level of aggressiveness of adventitious with ubiquist behavior

The high number of very aggressive species with ubiquist behavior in our study could be explained by their membership of the families considered to be world major weeds according to Akobundu (1987) and by their adaptation to very different ecological zone according to Mallet (1981). Among these species, *Chromolaena odorata* is recognized at the same time for its strong seed-bearer capacity (Traoré, 2007) and its important mode of dissemination by the wind. Moreover, the presence of *Chromolaena odorata*, *Croton hirtus* and of *Panicum laxum* in this group was evoked by Traoré (2007) in the palm plantations of Mé and Dabou. The strong presence of adventitious with ubiquist behavior aggressive (approximately 62%) could be explained by their broad or average ecological amplitude. Indeed, their often average abundance frequently confers a statute of species to them codominantes in the communities in which they take part like it has been mentioned by Mangara et al., (2008). The much reduced number of not very aggressive species with ubiquist behavior could be explained by the lowering of adventitious in the line space which intervenes 2 to 3 times in the year and which prevented these species from proliferating.

3-5-Intercorrelation of the ecological parameters and distribution of the species with ubiquist behavior according to the zone

In this study, although the species are very with ubiquist behavior, some present nevertheless an affinity with an ecological parameter. Thus the homogeneity of the floristic compositions of the age group 3 and the plots resulting from weeding in the zone of SOGB is explained by the fact that the totality of the palm plantations of this zone was set up on sites of cleared forests. The presence of *Phyllanthus niruri* which is a species characteristic of the marshy zones of SOGB is due to the fact that all the plantations of this zone were established after a process of drainage of the underworld. On the other hand, the presence of *Passiflora foetida* in this same zone is explained not only by its preference for the wet grounds but also by its tolerance in the arid conditions. The absence of regular weeding in the field of Grand-Dreuwin helps to the proliferation of *Ipomoea pes-caprae*, *Lantana camara* and *Schrankia leptocarpa* which is perennial species characteristic of the forest zones. However, the presence of *Eragrostis tenella* which is an annual species in this group could be also explained by the absence of weeding and its great seed-bearer potential. The presence of *Digitaria horizontalis*, *Mariscus cylindristachyus* and *Mariscus flabelliformis* on the field of Dabou is related to the geographical location of the zone of Dabou. Indeed, the vegetation of this zone is a savanna included. The bringing together of the age group 1 and 2 is explained by the fact that the plantations belonging to these two age groups were subjected to the same cultivation techniques (replanting). The other species with ubiquist behavior nonrelated to a particular parameter have a broader distribution since their frequencies and their abundances are constant whatever the ecological parameter considered.

CONCLUSION

The inventory of adventitious of the palm plantations of the southwest of the Ivory Coast revealed the presence of 37 species with ubiquist behavior distributed into 22 families and 35 genuses. The broadleaf is largely dominant with 25 species against 11 species for the monocotyls. The analysis of the flora of the three sites showed that the adventitious flora of Dabou is diversified and let's appear a floristic homogeneity with a coefficient higher than 52% some is the parameters taken two to two. Four (4) groups of species with ubiquist behavior were identified in this study. It is group 1 constituted by the bringing together of 2 species with ubiquist behavior of the SOGB. The group 2 which contains 4 species with ubiquist behavior is characteristic of the field of Grand-Dreuwin. The Group 3 is composed

of 3 species attached to the field of Dabou. Group 4 is constituted the 28 other species with ubiquist behavior which were distributed independently of the various localities.

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