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COMPOSITION AND STRUCTURE OF HERBACEOUS FLORA AND VEGETATION OF THE LOWER DELTA OF OUÉMÉ IN SOUTHERN BENIN

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ABSTRACT

The composition of the herbaceous vegetation of the Lower delta of Ouémé was assessed using phytoecological data records performed following the method of Braun-Blanquet from a systematic sampling transect. The observations were made in 10 m x 10 m plots. Herbaceous flora consisted of 257 species distributed in 179 genera and 60 families which most represented species were Leguminosae, Cyperaceae, Asteraceae and Convolvulaceae. The most frequent species were: Ipomoea aquatica (39%), Echinochloa pyramidalis (34%), Leersia hexandra (27%), Justicia anselliana (25%) and Alternanthera sessilis (22%). The number of species was around 7 in aquatic vegetation and 174 in fields and fallows. The diversity index was 0.33 to 3.42 bits with a Pielou equitability from 0.28 to 0.96. Species with wide biogeographical distribution types were dominant (53% of the area).

Key Words: Flora, Herbaceous vegetation, Composition, Lower delta of ouémé, Southern Benin.

INTRODUCTION

The Lower Delta of Ouémé is a wide flood plain in southern Benin, where the hydrological system is very complex and controlled by Sô River in the West and the Ouémé River and its tributaries in the East. As an aquatic ecosystem, it ensures key aquatic functions (Roggeri, 1995).

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The socio-economic activities in the Lower Delta of Ouémé are extremely diversified and varied, and are mostly based on the exploitation of natural resources including especially vegetation (Adjakpa, 2006). Charney (1975) pointed out that the reduction of vegetation cover due to soils overexploitation (agriculture and overgrazing) influences the atmospheric circulation. In addition, Eltahir (1996) and Wang and Eltahit (2002) have shown that soil degradation has not only consequences on agriculture but also on the climate. Thus, local populations are the actors and victims of the degradation of vegetation cover (Tracol, 2004). A policy of sustainable management of natural resources in general and the vegetation cover in particular is necessary.

Indeed, population growth is accelerating the damage which consequences are the loss of biodiversity at the level of the Lower Delta of Ouémé where agriculture makes up the largest part of the flood plain because of the fertility of these alluvial soils (Le Barbe et al., 1993). Moreover, livestock operations seeking herbaceous vegetation are the second major activity. The objective of this research is to study the composition of the herbaceous vegetation of the Lower Delta of Ouémé. This will reveal the pastoral potential and envisage pastoral developments.

MATERIALS AND METHODS

Study area

The study area is between 6°29'43.0" and 6°38'24.1" North and 2°22'02" and 2°34'13.4" East. The soils are hydromorphic and settled on alluvial material (clay and sandy clay) and clayey sediments of the Continental Terminal (Volkoff, 1976; Willaine and Volkoff, 1976). The hydrographical network consists of two parallel watercourses: Ouémé in the East and Sô in the West. The two watercourses, interconnected by arms, play the role of tributary, or distributary depending on the period (of flood or recession). They are bordered by vast flooding areas. Between Ouémé and Sô, the vast plain receives most of its water during flood periods. The climate is subequatorial and characterized by two rainy seasons from March to July and from September to October and two dry seasons from November to February and August. The annual rainfall averages are 1124 mm in Adjohoun, 1296 mm in Porto-Novo and 1251 mm in Cotonou from 1960 to 2009. The minimum and maximum temperature averages are 24.4 and 30.2°C. The vegetation is composed of a mosaic of swampy formations, flooding forest, a few islands of mangrove planted, and low meadows and aquatic vegetation. Agriculture is the major activity and occupies nearly 60% of land (Anonyme, 2002).

Methods

The inventory was conducted between December 2008 and April 2009, in plots of 10 m x 10 m or 100 m^2, along five transects West-East orientation. Each transect from West (Sô River) to East (river Ouémé). The distance between two consecutive transects was 4 km. The average length of a transect was 16.5 km. The plots of vegetation records were arranged every 500 m on each transect. Within each plot, all species were detected following the phytosociological method of Braun-

Blanquet (1932). The determinations were made at the National Herbarium of Benin. Data collected on the record sheets were captured and processed with Excel software. The descriptors defined were: the taxonomic richness, the specific frequency, the Shannon index, evenness of Pielou and biogeographical spectrum. The specific frequency was the number of records for which the species occurred out of the total number observed. The Shannon diversity index (I_{SH}) was given by the formula: $I_{SH} = -\sum(p_i)log_2(p_i)$ with $p_i = \frac{r_i}{R}$ where, r_i is the average recovery of species i and R the sum of species recoveries (Legendre & Legendre, 1984 ; Frontier & Pichod-Vitale, 1991). The Pielou evenness (E) was given by the formula: (E = I_{SH}/log2(Rs) où Rs represents the specific richness (Pielou, 1966). The biogeographical spectrum was derived from types of White (1983, 1986). The nomenclature used was that of Akoègninou et al. (2006).

RESULTS

Floristic composition

The herbaceous flora was rich with 257 species distributed in 179 genera and 60 families (Table 1). The best represented genera were with *Cyperus* 9 species, *Ipomoea* with 8, *Ludwigia* with 5, *Brachiaria*, *Euphorbia*, *Panicum*, *Phyllanthus*, *Spermacoce*, *Indigofera* and *Vigna* with 4, *Commelina*, *Corchorus*, *Heliotropium*, *Hibiscus*, *Polygonum*, *Sida*, *Solanum* with 3 species.

The largest families were those of the Poaceae with 37 species (14.10%), Leguminosae with 30 species (11.67%), Cyperaceae with 19 species (7.39%), Asteraceae with 15 species (5.84%) and Convolvulaceae with 14 species (5.45%). Then followed the Malvaceae, Rubiaceae and Euphorbiaceae with 9 species, Solanaceae, Melastomataceae with 7 species, Amaranthaceae and Asclepiadaceae with 6 species, Lamiaceae, Onagraceae, Scrophulariaceae and Tiliaceae with 5 species and 13 families like Acanthaceae, Araceae, Vitaceae ... possess between 2 and 4 species. The rest of the 31 remaining families were represented only by a single species.

Table-1. List of herbaceous flora of the Lower the delta of Ouémé

F: Forests; D: Plantation; C: Flooded savannah; G: Meadow B: Fields and fallows; A: Aquatic vegetation; E: Agglomeration; TB: Biological types; TP: Phytogeographical types.

TB	TP	Scientist name	Family	F	D	C	G	B	A	E
Lnp	At	*Abrus fruticulosus* Wall.ex wight.	Leguminosae	0	0	1	0	1	0	0
Lnp	Pan	*Abrus precatorius* L.	Leguminosae	1	1	1	0	1	0	0
Th	Cos	*Acanthospermum hispidum* DC.	Asteraceae	0	0	0	0	1	0	0
He	Pan	*Acroceras zizanioides* (Kunth.) Dandy.	Poaceae	1	1	0	1	1	0	0
Lnp	GC	*Adenia cissampeloides* (Planch. ex Hooh.) Harms	Passifloraceae	1	0	0	0	0	0	0
Lmp	GC	*Adenia lobata* (Jacq.) Engl.	Passifloraceae	0	1	0	0	0	0	0
Ch	PRA	*Aeschynomene afraspera* J. Leonard.	Leguminosae	0	0	0	1	1	0	0

TB	TP	Scientist name	Family	F	D	C	G	B	A	E
Th	Pan	*Aeschynomene indica* L.	Leguminosae	0	0	0	0	1	0	0
Th	Pan	*Ageratum conyzoides* L.	Asteraceae	0	1	0	0	1	0	0
Th	At	*Alloteropsis paniculata* (Benth.) Stapf.	Poaceae	0	1	0	0	1	0	0
Th	GC	*Alternanthera repens* (L.) Link.	Amaranthaceae	0	0	0	0	1	0	0
Th	Pan	*Alternanthera sessilis* (L.) DC.	Amaranthaceae	0	0	0	1	1	0	0
Th	Cos	*Amaranthus hybridus* L.	Amaranthaceae	0	0	0	0	1	0	0
Gt	GC	*Anchomanes difformis* (Blume) Engl.	Araceae	1	0	0	0	0	0	0
He	SG	*Andropogon gayanus* Kunth var. *polycladus* (Hack.) Clayton	Poaceae	1	1	1	1	1	0	0
Lnp	Pan	*Aniseia martinicensis* (Jacq.) Choisy.	Convolvulaceae	1	0	0	0	1	0	0
Th	GC	*Anthephora cristata* (Doell.) Hack. ex De. Wild. Dur. Sis	Poaceae	0	0	0	1	1	0	0
Th	At	*Aspilia africana* (Pers.) C. D. Adams.	Asteraceae	0	0	1	0	0	0	0
Th	SG	*Aspilia bussei* (Schum. & Thonn.) Oliv.	Asteraceae	0	0	0	0	1	0	0
Th	Pan	*Asystasia gangetica* (L.) T.Anders.	Acanthaceae	1	1	0	0	1	0	0
He	GC	*Axonopus compressus* (Sw.) P. Beauv.	Poaceae	0	1	0	0	0	0	0
Hyd	Pan	*Azolla pinnata* R.	Azollaceae	0	0	0	0	1	1	0
Th	PRA	*Bacopa crenata* (P.Beauv.) Hepper.	Scrophulariaceae	1	0	0	0	0	0	0
Lmp	GC	*Baissea baillonii* Hua	Apocynaceae	1	0	0	0	0	0	0
Th	At	*Basilicum polystachyion* (L.) Moench.	Lamiaceae	0	0	0	1	1	0	0
Th	Pal	*Brachiaria deflexa* (Schumach.) Robyns.	Poaceae	0	0	0	1	0	0	0
Th	At	*Brachiaria jubata* (Figari & De Notaris) Stapf.	Poaceae	0	0	0	0	1	0	0
Th	PRA	*Brachiaria lata* (Schumach) C. E. Hubbard	Poaceae	0	0	0	0	1	0	0
Th	SZ	*Brachiaria villosa* (Lam.) A. Camus .	Poaceae	0	1	0	0	0	0	0
He	At	*Bulbostylis pilosa* (A. Rich.) C. B.Cl.	Cyperaceae	0	1	0	0	0	0	0
Np	GC	*Calopogonium mucunoides* Desv.	Leguminosae	0	1	0	0	0	0	0
Th	Pan	*Capsicum annuum* L.	Solanaceae	0	0	0	0	1	0	0
Th	Pan	*Capsicum frutescens* L.	Solanaceae	0	1	0	1	1	0	0
Par	Pan	*Cassytha filiformis* L.	Lauraceae	1	1	0	0	0	0	0
Th	Pan	*Celosia argentea* L.	Amaranthaceae	0	1	0	1	1	0	0
He	Cos	*Centella asiatica* (L.) Urb.	Apiaceae	0	0	1	0	1	0	0
Lmp	AA	*Centrosema pubescens* Benth.	Leguminosae	0	1	0	0	1	0	0
Hyd	Cos	*Centrostachys aquatica* (R.Br.) Wall.	Amaranthaceae	0	0	0	0	0	1	0
Th	At	*Ceratopteryx cornuta* (P. beauv.) Lepr.	Pteridaceae	0	0	0	1	0	0	0
Th	Pan	*Chamaechrista mimosoides* (L.) Greene	Leguminosae	0	0	1	0	1	0	0
Th	Pan	*Chamaechrista rotundifolia* (Pers.) Greene	Leguminosae	0	1	0	0	0	0	0
Ch	Pan	*Chromolaena odorata* (L.) R. M.	Asteraceae	1	0	1	0	1	0	0

TB	TP	Scientist name	Family	F	D	C	G	B	A	E
		King. et H. Robinson								
Lnp	SZ	*Cissampelos mucronata* A. Rich.	Menispermaceae	1	1	0	0	1	0	0
		Cissampelos owariensis P. Beauv.								
Lnp	GC	ex DC.	Menispermaceae	1	0	0	0	0	0	0
LmP	GC	*Cissus arguta* Hook f.	Vitaceae	1	1	0	0	1	0	0
Np	At	*Clappertonia ficifolia* (Willd.) DC.	Tiliaceae	1	0	0	0	1	0	0
Th	S	*Cleome rutidosperma* DC.	Capparidaceae	0	0	0	0	1	0	0
Th	SG	*Cleome viscosa* L.	Capparidaceae	0	0	0	0	1	0	0
Th	Pal	*Coldena procombens* L.	Boraginaceae	0	0	1	1	1	0	0
He	GC	*Commelina benghalensis* L.	Commelinaceae	0	0	0	0	1	0	0
		Commelina diffusa Burm. f. subsp								
He	Pan	*diffusa*	Commelinaceae	0	1	1	1	1	0	0
He	Cos	*Commelina erecta* L. subsp *erecta*	Commelinaceae	1	0	0	1	1	0	1
Th	Pan	*Corchorus fascicularis* Lam.	Tiliaceae	0	0	0	0	1	0	0
Th	Pan	*Corchorus olitorius* L.	Tiliaceae	0	0	0	1	1	0	0
Th	Pan	*Corchorus tridens* L.	Tiliaceae	0	0	0	0	1	0	0
Gr	At	*Costus afer* Ker Gawl.	Zingiberaceae	1	0	0	0	0	0	0
Ge	SG	*Crinum glaucum* A. Chev.	Amaryllidaceae	0	0	1	0	0	0	0
Ge	GC	*Crinum jagus* (Thomps.) Dandy.	Amaryllidaceae	1	1	0	0	1	0	0
Th	Pan	*Crotalaria pallida* Alton.	Leguminosae	0	0	0	0	1	0	0
Th	Pan	*Croton lobatus* L.	Euphorbiaceae	0	1	1	1	1	0	0
Lmp	G	*Culcacia scandens* R. Beauv.	Araceae	1	1	0	0	1	0	0
Ch	GC	*Cyclosorus striatus* Cop.	Thelypteridaceae	1	0	0	0	0	0	0
He	Pan	*Cynodon dactylon* (L.) Pers.	Poaceae	0	0	0	1	1	0	0
He	Pal	*Cyperus alopecuroides* Rottb.	Cyperaceae	0	0	0	1	0	0	0
He	Pan	*Cyperus articulatus* L.	Cyperaceae	0	0	0	1	0	0	0
Ge	Pan	*Cyperus difformis* L.	Cyperaceae	1	0	0	0	0	0	0
He	PRA	*Cyperus diffusus* Vahl.	Cyperaceae	1	0	0	0	0	0	0
		Cyperus dilatatus Schum. et								
Ge	At	Thonn.	Cyperaceae	0	0	0	0	1	0	0
Ge	Pan	*Cyperus distans* L.f. s.l.	Cyperaceae	0	1	0	0	0	0	0
Ge	Pan	*Cyperus papyrus* L.	Cyperaceae	0	0	0	1	0	0	0
Ge	Pan	*Cyperus rotundus* L.	Cyperaceae	0	0	0	0	1	0	0
Th	Pan	*Cyperus sphacelatus* Rottb.	Cyperaceae	0	1	0	0	0	0	0
		Cyphostemma adenopodum								
LGt	GE	(Sprague) Descoings	Vitaceae	1	0	0	0	0	0	0
Th	PRA	*Desmodium ramosissimum* G. Don.	Leguminosae	0	0	1	0	0	0	0
Th	PRA	*Digitaria exilis* (Kippist.) Staph.	Poaceae	0	0	0	1	1	0	0
Th	Pan	*Digitaria horizontalis* Willd.	Poaceae	0	0	0	0	1	0	0
LTh	Pan	*Diodia sarmentacea Sw.*	Rubiaceae	1	1	0	0	1	0	0
		Dioscorea abyssinica Hochst. Ex								
Gt	GC	Kunth	Dioscoreaceae	1	0	0	0	0	0	0
LGe	GC	*Dioscorea praehensilis Benth.*	Dioscoreaceae	1	0	0	0	0	0	0
Th	Pan	*Echinochloa colona* Link.	Poaceae	0	0	0	1	1	0	0
He	Pan	*Echinochloa pyramidalis* Roxb.	Poaceae	0	1	0	1	1	0	0
Th	Pan	*Eclipta prostata* L.	Asteraceae	0	1	0	1	1	0	0
		Eichornia crassipes (Mart.) Solms.								
Hyd	Aa	Laub.	Pontederiaceae	0	0	0	1	1	1	0
		Emilia praetermissa Milne-								
Th	G	Redhead.	Asteraceae	0	0	0	0	1	0	0
He	Pan	*Enydra fluctuans* Lour.	Asteraceae	0	0	1	1	1	0	0
		Eriosema glomeratum (Guill. &								
Ch	PRA	Perr.) Hook. f.	Leguminosae	0	0	1	0	1	0	0

TB	TP	Scientist name	Family	F	D	C	G	B	A	E
Th	Cos	*Ethulia conyzoides* L.	Asteraceae	0	1	0	1	1	0	0
Th	Pan	*Euphorbia hirta* Linn.	Euphorbiaceae	0	0	0	0	1	0	0
Th	AA	*Euphorbia hyssopifolia* L.	Euphorbiaceae	0	0	0	0	1	0	0
Th		*Euphorbia* sp	Euphorbiaceae	0	0	0	0	1	0	0
Th	Pan	*Euphorbia thymifolia* L.	Euphorbiaceae	0	0	0	0	1	0	0
Lnp	GC	*Flagellaria guineensis* Schumacher.	Flagellariaceae	1	1	0	0	1	0	0
Ge	Pan	*Fuirena umbellata* Rottb.	Cyperaceae	1	0	0	1	0	0	0
Th	Pan	*Glinus opositifolius* (L.) Aug. DC.	Molluginaceae	1	0	1	1	1	0	0
Lmp	At	*Gongronema latifolia* Benth.	Asclepiadaceae	1	0	0	0	0	0	0
Lnp	Pan	*Gymnema sylvestre* (Rstz.) Schult.	Asclepiadaceae	0	0	1	0	1	0	0
Th	Pan	*Heliotropium indicum* L.	Boraginaceae	1	1	0	1	1	0	0
Ch	Pal	*Heliotropium strigosum* Willd.	Boraginaceae	0	0	1	0	1	0	0
He	Pal	*Heliotropium subulatum* (Hochst. ex A. DC.) Vatke.	Boraginaceae	0	0	0	1	1	0	0
Th	SG	*Herderia truncata* Cass.	Asteraceae	0	0	0	0	1	0	0
Lnp	Pan	*Hewittia scandens* (Milne.) Mabberley	Convolvulaceae	0	0	0	0	1	0	0
Th	At	*Hibiscus asper* Hook. f.	Malvaceae	1	0	0	0	0	0	0
Th	At	*Hibiscus esculentus* L.	Malvaceae	0	1	0	1	1	0	0
Th	Pan	*Hibiscus surrattensis* L.	Malvaceae	0	0	0	1	1	0	0
Ch	Pan	*Hybanthus enneaspermus* (L.) F. Muell.	Violaceae	0	1	0	0	1	0	0
Th	PRA	*Hydrolea glabra* Schum. & Thonn.	Hydrophyllaceae	0	0	0	1	0	0	0
Th	Pan	*Hygrophila auriculata* (Schumach.) Heine	Acanthaceae	0	0	0	1	1	0	0
Ge	GC	*Hypselodelphis violacea* (Ridl.) Milne-Redh.	Marantaceae	1	0	0	0	0	0	0
Th	AA	*Hyptis lanceolata* Poir.	Lamiaceae	1	0	1	1	1	0	0
Th	Pal	*Hyptis spicigera* Lam.	Lamiaceae	0	0	0	0	1	0	0
He	Pan	*Imperata cylindrica* (L.) Raeuschel.	Poaceae	0	0	1	0	1	0	0
Ch	SG	*Indigofera hirsuta* L.	Leguminosae	0	0	0	0	1	0	0
Lnp	GC	*Indigofera macrophylla* Schum.	Leguminosae	0	0	0	0	1	0	0
Th		*Indigofera* sp.	Leguminosae	0	0	0	0	1	0	0
Th	Pan	*Indigofera subulata* Vahl. ex Poir.	Leguminosae	0	1	1	0	1	0	0
Lnp	GC	*Ipomoea aquatica* (L.) Ker Gawl	Convolvulaceae	0	1	1	1	1	0	0
Lnp	Pan	*Ipomoea asarifolia* (Desr.) Roen. & Schult.	Convolvulaceae	0	0	0	1	1	0	0
Lnp	At	*Ipomoea batatas* (L.) Lam.	Convolvulaceae	0	0	0	0	1	0	0
Lnp	At	*Ipomoea involucrata* P. Beauv.	Convolvulaceae	1	1	0	0	0	0	1
Lnp	Pan	*Ipomoea mauritiana* Hall. f.	Convolvulaceae	0	1	1	0	1	0	0
Lnp	Pan	*Ipomoea muricata* (L.) Jacq.	Convolvulaceae	0	0	0	0	1	0	0
Lnp	GC	*Ipomoea rubens* Choisy.	Convolvulaceae	0	1	0	1	1	0	0
Lnp	AA	*Ipomoea triloba* L.	Convolvulaceae	0	0	0	0	1	0	0
Lnp	AA	*Jacquemontia tammifolia* (L.) Griseb.	Convolvulaceae	0	0	0	0	1	0	0
Th	At	*Justicia anselliana* (Ness.) T. Anderson.	Acanthaceae	0	1	0	1	1	0	0
Ge	PRA	*Kyllinga erecta* Schumach. var. *erecta*	Cyperaceae	0	1	1	0	1	0	1
Ge	GC	*Lasiomorpha senegalense* (Schott.) Engl.	Araceae	1	0	0	0	0	0	0
He	Pan	*Leersia hexandra* Sw.	Poaceae	1	1	1	1	1	0	0

TB	TP	Scientist name	Family	F	D	C	G	B	A	E
Hyd	Pan	*Lemna aequinoctialis* Welw.	Lemnaceae	0	0	0	0	0	1	0
Lnp	At	*Lepistemon owariense* (P. Beauv.) Hall. f.	Convolvulaceae	0	1	0	0	1	0	0
Th	At	*Leptochloa caerulescens* Steud.	Poaceae	0	0	0	1	1	0	0
Th	GC	*Lindernia diffusa* (L.) Wettst.	Scrophulariaceae	0	0	0	0	1	0	0
Th	PRA	*Ludwigia abyssinica* (A. Rich.) Dandy et Brenan	Onagraceae	0	0	0	0	1	0	0
Th	At	*Ludwigia leptocarpa* (Nutt.) Hara	Onagraceae	0	0	0	1	0	0	0
Th	At	*Ludwigia octovalis* (Jacq.) Raven. subsp. *octovalis*	Onagraceae	0	0	0	1	1	0	0
Ch	At	*Ludwigia stenorraphe* (Brenan.)	Onagraceae	1	0	0	1	1	0	0
Hyd	At	*Ludwigia stolonifera* (Guill. & Perr.*)* Raven	Onagraceae	0	0	0	1	1	0	0
He	Pan	*Lycopodium cernuum* L. Body	Lygopodiaceae	1	0	0	0	0	0	0
Lmp	Pan	*Lygodium microphyllum* (Cav.) R. Br.	Schizaceae	1	0	0	0	0	0	0
Ch	Pan	*Malachra radiata* (L.) L.	Malvaceae	0	0	1	1	1	0	0
He	Pan	*Mariscus alternifolius* Vahl.	Cyperaceae	1	1	1	0	1	0	0
Hyd	Pan	*Marsilea latifolia*	Marsileaeceae	1	0	0	0	0	0	0
Th	At	*Melanthera scandens* (Schum. & Thonn.) Rob.	Asteraceae	0	0	0	0	1	0	0
Ch	G	*Melastomastrum segregatum* (Benth.) A. et R. Fern.	Melastomataceae	1	0	0	0	1	0	0
Ch	Pan	*Melochia corchorifolia* L.	Sterculiaceae	0	1	1	1	1	0	0
Lnp	AA	*Merremia tridentata* (L.) Hallier. f.	Convolvulaceae	1	0	0	0	0	0	0
Th	Cos	*Micrococca merculiaris* (L.) Benth.	Euphorbiaceae	0	0	0	0	1	0	0
Lmp	Pan	*Mikania cordata* (Burm. f.) B. L. Robins. var *cordata*	Asteraceae	0	0	0	0	1	0	0
Th	PRA	*Mitracarpus scaber* Zucc.	Rubiaceae	0	0	0	0	1	0	0
Th	Pan	*Mnesithea granularis* (L.) Koning & Sosef	Poaceae	0	0	0	1	1	0	0
Lnp	GC	*Momordica charanta* L.	Cucurbitaceae	0	0	0	0	1	0	0
LTh	Pal	*Mukia maderaspatana* (L.) M. J. Roem.	Cucurbitaceae	0	0	0	0	1	0	0
Ge	Pan	*Nephrolepis biserrata* (Sw.*)* Schott.	Davalliaceae	1	0	0	0	0	0	0
Th	GC	*Neurotheca loeselioides* (Spruce. ex Prog.) Baill.	Gentianaceae	0	0	0	0	1	0	0
Ge	Pan	*Nymphaea lotus* L.	Nymphaceae	0	0	0	1	1	0	0
Ge	Pan	*Nymphaea maculata* Schum. & Thonn.	Nymphaceae	0	0	0	0	1	0	0
Th	GC	*Oldenlandia affinis* (Roem. Schult.) DC.	Rubiaceae	0	1	0	0	0	0	1
Th	Pal	*Oldenlandia herbacea* (L.) Roxb.	Rubiaceae	1	0	0	0	1	0	0
Lnp	AA	*Operculia macocarpa* (L.)	Convolvulaceae	0	0	1	0	0	0	0
He	PRA	*Oryza barthii* A. Chev.	Poaceae	0	0	0	0	1	0	0
He	PRA	*Oryza longistaminata* A. Chev. & Roehr.	Poaceae	0	1	0	1	1	0	0
Ch	SZ	*Pandiaka involucrata* (Moq.) B. D. Jackson	Amaranthaceae	0	0	1	0	0	0	0
He	At	*Panicum fluvicola* Steud.	Poaceae	1	0	0	0	0	0	0
He	G	*Panicum maximum* Jacq.	Poaceae	1	0	1	1	1	0	1
He	Pan	*Panicum parvifolium* Lam.	Poaceae	1	0	0	0	0	0	0
He	Pan	*Panicum repens* L.	Poaceae	0	0	0	1	1	0	0

TB	TP	Scientist name	Family	F	D	C	G	B	A	E
He	Pan	*Paspalum scrobiculatum* L.	Poaceae	1	1	1	1	1	0	0
He	Pan	*Paspalum vaginatum* SW.	Poaceae	1	0	0	1	1	0	0
Lnp	Pan	*Passiflora foetida* L.	Passifloraceae	1	0	0	1	1	0	0
Lmp	AA	*Paullina pinnata* L.	Sapindaceae	1	1	0	0	1	0	0
He	AA	*Pedilanthus thytimaloides* (L.) Poit.	Asclepiadaceae	0	0	0	0	0	0	1
Th	Pan	*Pennisetum polystachyon* (L.) Schult.	Poaceae	0	1	0	0	0	0	0
Th	At	*Pentodon pentandrus* (Schum. & Thonn.) Vatke.	Rubiaceae	1	0	1	1	1	0	0
Th	Pal	*Perotis indica* (L.) O. Ktze.	Poaceae	0	1	0	0	0	0	0
Np	Pan	*Petiveria alliacea* (La m.) H. Walt.	Phytolacaceae	1	0	0	0	0	0	0
Th	Aa	*Phaseolus vulgaris* L.	Leguminosae	0	0	0	0	1	0	0
Ch	GC	*Phaulopsis imbricata* (Forssk.) Sweet.	Acanthaceae	1	0	0	0	0	0	0
He	PRA	*Phragmites australis* (Cav.) Trin. ex Steud.	Poaceae	0	0	0	0	1	0	0
He	Pal	*Phragmites karka* (Retz.) Trin. ex Steud.	Poaceae	0	0	0	0	1	0	0
Th	Pal	*Phyllanthus amarus* Schum. & Thonn.	Euphorbiaceae	0	1	1	0	1	0	0
Th	At	*Phyllanthus pentandrus* Schum. & Thonn.	Euphorbiaceae	0	0	0	1	1	0	0
Ep	Pan	*Phymatodes scolopendria* (Brurm.) Ching.	Polypodiaceae	0	1	0	0	0	0	0
Th	Pan	*Physalis angulata* L.	Solanaceae	0	0	0	1	1	0	0
Th	Pan	*Pistia stratioites* L.	Araceae	0	0	0	1	0	1	0
Th	Pal	*Plastoma africanum* P. Beauv.	Lamiaceae	0	1	0	0	1	0	0
Th	Pan	*Polygala arenaria* Willd.	Polygalaceae	0	0	1	0	1	0	0
Th	Cos	*Polygonum pulchrum* Blume	Polygonaceae	0	0	0	1	1	0	0
Th	At	*Polygonum salicifolium* Brouss. ex Willd.	Polygonaceae	0	0	0	1	1	0	0
He	At	*Polygonum senegalense* Meissn.	Polygonaceae	0	0	0	1	1	0	0
He	Pan	*Pycreus polystachyos* (Rottb.) P. Beauv.	Cyperaceae	0	0	1	1	1	0	0
Lnp	GC	*Rhigiocarya racemifera* Miers.	Menispermaceae	1	0	0	0	0	0	0
He	Pan	*Rhynchospora corymbosa* (L) Britt.	Cyperaceae	1	0	0	0	0	0	0
He	SZ	*Sacciolepis africana* C. E. Hubbard. Snowden.	Poaceae	0	0	0	1	1	0	0
Hyd	Pan	*Salvinia nymphellula* Desv.	Salviniaceae	0	0	0	1	0	1	0
Ge	GC	*Sansevieria liberica* Gérôme & Labory	Agavaceae	0	0	0	0	1	0	0
Th	AA	*Sauvagesia erecta* L.	Ochnaceae	1	0	0	0	0	0	0
Ge	At	*Scadoxus multiflorus* (Martyn.) Raf.	Amaryllidaceae	1	1	0	0	1	0	0
Th	AA	*Schwenkia americana* L.	Solanaceae	0	0	0	0	1	0	0
He	Pan	*Schyzachyrium sanguineum* (Retze.) Alston.	Poaceae	0	1	1	0	0	0	0
He	GC	*Scleria depressa* (C. B. Cl.) Nelmes.	Cyperaceae	1	1	0	0	0	0	0
He	GC	*Scleria naummanniana* Boeck.	Cyperaceae	1	1	0	0	1	0	0
He	GC	*Scleria verrucosa* Willd.	Cyperaceae	0	0	0	0	1	0	0
Th	At	*Scoparia dulcis* L.	Scrophulariaceae	1	0	0	0	1	0	0
Th	Pal	*Sebastiana chamelea* (L.) Mull.	Euphorbiaceae	0	1	0	0	0	0	0

TB	TP	Scientist name	Family	F	D	C	G	B	A	E
		Arg.								
Lmp	GC	*Secamone afzelii* (Schultes) K. Schum.	Asclepiadaceae	1	1	0	0	0	0	0
Th	Pan	*Senna occidentalis* (L.) Link	Leguminosae	1	0	0	1	0	0	0
Np	Pan	*Sesbania sesban* (L.) Merriell.	Leguminosae	0	0	0	0	1	0	0
He	GC	*Setaria megaphylla* (Steud.) T. Dur. & Schinz.	Poaceae	1	1	0	0	0	0	0
Lnp	Pan	*Shrankia leptocarpa* DC.	Leguminosae	0	0	0	0	1	0	0
Th	Pan	*Sida acuta* Burm. f. subsp. *Acuta*	Malvaceae	0	0	0	1	0	0	0
Ch	AA	*Sida linifolia* Juss. ex Cav.	Malvaceae	0	1	0	0	1	0	0
Th	GC	*Sida rhombifolia* L.	Malvaceae	1	0	0	0	0	0	0
Th	Cos	*Solanum lycopercicum* Linn.(Cult. Sp.)	Solanaceae	0	0	0	0	1	0	0
Th	PRA	*Solanum macrocarpum* L.	Solanaceae	0	0	0	1	1	0	0
Ch	Cos	*Solanum nigrum* L.	Solanaceae	0	0	1	0	0	0	0
Th	At	*Solenostermon monostachyus* (P. Beauv.) subsp. *monostachyus*	Lamiaceae	0	1	0	0	0	0	0
He	SG	*Sorghum arundinaceum* (Desv.) Stapf.	Poaceae	0	0	0	0	1	0	0
Th	Pan	*Sparghonophorus sparghonophora* (L.) Jeffrey	Asteraceae	0	1	0	0	1	0	0
Th	SZ	*Spermacoce filifolia* (Schumach. et Thonn.) J. P. Lebrun et Stork	Rubiaceae	0	0	0	0	1	0	0
Th	PRA	*Spermacoce ruellia* DC.	Rubiaceae	0	0	1	0	0	0	0
Th	SG	*Spermacoce stachydea* DC.	Rubiaceae	0	0	1	0	0	0	0
Th	PRA	*Spermacoce verticillata* L.	Rubiaceae	0	0	1	0	1	0	0
Th	PRA	*Sphenoclea zeylanica* Gaertn.	Sphenocleaceae	0	0	0	1	1	0	0
Th	AA	*Spigelia anthelmia* L.	Loganiaceae	0	0	0	0	1	0	0
He	SZ	*Sporobolus pyramidalis* P. Beauv.	Poaceae	0	0	0	1	1	0	0
Th	AA	*Stachytarpheta anguistifolia* (Mill.) Vahl.	Verbenaceae	0	0	1	1	1	0	0
Par	Pan	*Striga asiatica* (L.) O. Ktze.	Scrophulariaceae	0	0	0	0	1	0	0
Th	GC	*Stylosanthes erecta* P. Beauv.	Leguminosae	0	0	1	0	0	0	0
Lmp	At	*Tacazzea apiculata* Oliv.	Asclepiadaceae	1	0	0	0	1	0	0
LmP	G	*Tacazzea pedicellata* K. Schum.	Asclepiadaceae	1	0	0	0	0	0	0
Th	Pan	*Talinum triangulare* (Jacq.) Willd.	Portulacaceae	0	0	0	0	1	0	1
Th	At	*Tephrosia linearis* (Willd.) Pers.	Leguminosae	0	1	0	0	0	0	0
Th	PRA	*Tephrosia uniflora* Pers.	Leguminosae	0	0	1	0	1	0	0
LTh	GC	*Teramnus micans* (Bak.) Bak. f.	Leguminosae	0	0	0	0	1	0	0
Th	Pan	*Teranmus labialis* (L. f.) Spreng.	Leguminosae	0	0	0	0	1	0	0
Ge	At	*Thalia geniculata* L.	Marantaceae	0	0	0	1	0	0	0
Th	Pan	*Torenia touarsii* (Cham. Schlechten.) O. Ktze.	Scrophulariaceae	1	0	0	0	0	0	0
Ge	Pan	*Torulinium odoratum* (L.) Hooper.	Cyperaceae	0	0	0	1	1	0	0
Lnp	GC	*Triclisia patens* Oliv.	Menispermaceae	1	0	0	0	0	0	0
Lnp	GC	*Triclisia subcordata* Oliv.	Menispermaceae	1	1	0	0	1	0	1
Th	Pan	*Tridax procumbens* L.	Asteraceae	0	0	0	0	1	0	0
Th	GC	*Tristema hirtum* P. Beauv.	Melastomataceae	0	0	0	0	1	0	0
Th	Pan	*Triumfetta rhomboidea* Jacq. var. *rhomboidea*	Tiliaceae	0	0	0	0	1	0	1
He	Pan	*Typha australis* Schum.	Typhaceae	0	0	0	1	0	0	0
Th	Pan	*Uraria picta* (Jacq.) DC.	Leguminosae	0	0	1	0	1	0	0
Ch	Pan	*Urena lobata* L.	Malvaceae	0	1	0	0	0	0	0

TB	TP	Scientist name	Family	F	D	C	G	B	A	E
Hyd	At	*Utricularia reflexa* Oliv.	Utriculariaceae	0	0	0	1	0	0	0
Th	Pan	*Vernonia cinerea* (L.) Less.	Asteraceae	0	1	0	0	0	0	0
He	SZ	*Vetiveria nigratana* (Benth.) Stapf.	Poaceae	0	1	1	1	1	0	0
LTh	G	*Vigna ambacensis* Baker	Leguminosae	0	0	0	0	1	0	0
LTh	G	*Vigna filicaulis* Hepper.	Leguminosae	0	0	0	0	1	0	0
Lnp	PRA	*Vigna racemosa* (G. Don.) Hutch. & Dalz.	Leguminosae	0	1	0	0	1	0	0
LTh	Pan	*Vigna unguiculata* (L.) Walp. var. *unguiculata*	Leguminosae	0	1	0	0	1	0	0
Th	SZ	*Wissadula amplissima* (L.) R. E. Fries.	Malvaceae	0	0	0	0	1	0	0
Hyd	Pan	*Wolffiella welwitschii* (Hegelm.) Monod	Lemnaceae	0	0	0	1	0	1	0
Th	Pan	*Zea mays* L.	Poaceae	0	0	0	0	1	0	0
Th	At	*Zornia glochidiata* Rich. Ex DC.	Leguminosae	0	0	0	0	1	0	0

SPECIFIC FREQUENCY

The study of the spatial distribution of species showed that on all 249 sample points, 181 were herbaceous plants. Thus, of the 181 statements of the herbaceous flora, the most frequent species were *Ipomoea aquatica* (L.) Ker Gawl (39.23%), *Echinochloa pyramidalis* Roxb. (34.25%), *Leersia hexandra* Sw (27.07%), *Justicia anselliana* (Ness.) T. Anderson. (24.86%) and *Alternanthera sessilis* (L.) DC. (22.10%). None of these species with high frequency has then been found in at least 50% of the plots of herbaceous vegetation.

BIOGEOGRAPHICAL ASPECT

The chorological spectrum was dominated by species with wide distribution (pantropical, paleotropical, afro-american, cosmopolitan) representing 52.94%. They were followed by african species (21.96%) including afrotropical species (14.12%) and multi-regional african (7.84%) and guinean species (Guinean-Congolese (15.29%), Guinea-Western (2.74%) and Guinea-Eastern (0.39%)) representing 18.43%. Sudanian species (Sudano-Guinean (3.13%), Sudan-Zambezian (3.13%) and sudanese typical (0.39%) amount to 6.67%.

CHARACTERISTICS OF THE HERBACEOUS VEGETATION

Floristic similarity between groups

Considering the seven communities studied, two by two, the similarity indices were between 0 and 23.35% (Table 2). The values obtained were all low and reflected the strong floristic dissimilarity between herbaceous vegetation communities of the study area.

The aquatic meadow represented the group with the highest floristic dissimilarity with others. By contrast, plantations and fields / fallow had the highest percentage of similarity (23.35%), followed by plantations and forests (19.49%).

A total of 136 species, representing 53% of the herbaceous flora came from one of the following groups: dense forests (*Anchomanes difformis* (Blume) Engl., *Baissea baillonii* Hua, *Costus afer* Ker Gawl., *Cyphostemma adenopodum* (Sprague) Descoings, etc.), flooded savannah (*Aspilia africana* (Pers.) C.D. Adams, *Crinum glaucum* A. Chev., *Pandiaka involucrata* (Moq.) B.D. Jackson, *Spermacoce ruellia* DC., *Spermacoce stachydea* DC. ...), Marshy (*Ceratopteryx cornuta* (P.beauv.) Lepr, *Cyperus alopecuroides* (Sprague) Descoings, *Cyperus papyrus* L., *Hydrolea glabra* Schum & Thonn., *Thalia geneculata* L., etc.), aquatic vegetation (*Nymphaeae maculata* Schum. & Thonn., *Marsilea latifolia*, *Lemna aequinoctialis* Welw., etc.). The common species were: *Andropogon gayanus* Kunth var. *polycladus* (Hack.) Clayton, *Leersia hexandra* Sw., *Panicum maximum* Jacq. and *Paspalum scrobiculatum* L.. They were present in five of the seven communities.

Table-2. Index of Jaccard similarity between groups (in %)

	Forests	Plantation	Flooded savannah	Meadow	Fields and fallows
Forests					
Plantation	19.49				
Flooded savannah	9.35	15.15			
Meadow	11.19	14.96	16.19		
Fields and fallows	15.49	23.35	19.02	32.11	
Aquatic vegetation	0.00	0.00	0.00	5.00	1.12
Agglomeration	5.20	5.41	3.85	2.38	3.39

FLORISTIC DIVERSITY PARAMETERS OF AREAS

The parameters of floristic diversity of the herbaceous vegetation were shown in Table 3.

Overall species richness ranged from 7 to 174 species. The average species richness per survey showed that the plantation was the group that had a high floristic diversity (13.83 ± 9.37 species) while the forest had the lowest species diversity (4 ± 4.55 species).

Table-3. Floristic diversity parameters of herbaceous vegetation of groups

Groups	Rs	R_m	I_{HS} (bits)	E
Forests	72	4 ± 4.55	1.45 ± 0.53	0.80
Plantation	69	13.83 ± 9.37	1.29 ± 0.20	0.67
Flooded savannah	45	8.25 ± 3.25	2.09 ± 0.74	0.57
Meadow	77	6.15 ± 4.01	1.59 ± 0.32	0.59
Fields and fallows	174	12.75 ± 7.80	3.42 ± 0.75	0.70
Aquatic vegetation	7	6 ± 0	1.90 ± 0.27	0.96
Agglomeration	9	4.50 ± 4.95	0.33 ± 0.15	0.28

Rs: total specific richness, Rm : average specific richness and its standard deviation, I_{HS} : Shannon index, E : équitability of Pielou

The values of Shannon index reflected an average diversity at the level of fields and fallow. By contrast, other groups had low floristic diversity.
Except urban areas, there was a good organization of the herbaceous flora as seen through the high values of equitability (0.59 to 0.96). These showed no species clearly dominated the other. At the city level evenness was low (0.28). This reflected the dominance of some species over others.

PHYSIOGNOMY OF THE HERBACEOUS VEGETATION OF AREAS

At the level of savannah, the herbaceous layer was 1.5 m high and was often dense with 60-95% recovery. The dominant species were *Andropogon gayanus* and *Vetiveria nigritana*. The companion species were: *Schizachyrium sanguineum* (Retz.) Alston., *Spermacoce verticillata* L., *Hyptis lanceolata* Poir and *Paspalum scrobiculatum* L.

Fallows were structured in one or two layers (shrub and herb layer), by age or type of development. The herbaceous layer, less than 2 m in height, was generally very dense (90-100% recovery). Many species were identified. The most common were *Melochia corchorifolia* L., *Eclipta prostrata* L., *Justicia anselliana* (Ness.) T. Andeson, *Leersia hexandra* Sw, *Phyllanthus amarus* Schum. & Thonn., *Ethulia conyzoides* L., *Alternanthera sessilis* (L.) DC., *Ipomoea aquatica* (L.) Ker Gawl, *Mariscus alternifolius* Vahl., *Paullinia pinnata* L., *Hyptis lanceolata* Poir., *Sacciolepis* C. *africana* E. Hubbard. & Snowden. and *Alloteropsis paniculata* (Benth.) Stapf.

Fields were encountered frequently and out of sight in the floodplains of the river Sô and the river Ouémé. The fields were annual crops, it was crop of peppers (*Capsicum annuum* L. and *Capsicum frutescens* L.), tomato (*Solanum lycopersicum* L.), okra (*Hibiscus esculentus* L.), leaf vegetables (*Solanum macrocarpum* L., *Solanum aethiopicum* L., *Amaranthus hybridus* L., *Celosia argentea* L., *Corchorus olitorius* L, *Corchorus tridens* L., etc.), corn (*Zea mays* L.). In these fields, we could also meet: *Justicia anselliana* (Ness) T Anderson, *Ipomoea aquatica*, L. *Melochia corchorifolia*, *Alternanthera sessilis* (L.) R. Br ex Benth., *Stachytarpheta indica* Ness., *Croton lobatus* L., *Coldenia procumbens* L., *Glinus oppositifolius* (L.) A. CD., *Leersia hexandra* Sw, *Phyllanthus pentandrus* Shum. & Thonn., *Eclipta prostrata* (L.) L.

The meadow was frequently encountered in floodplains on sandy soils with sandy clay or sandy loam. The meadow with *Echinochloa pyramidalis* (Lam.) Hitchc. & Chase and *Ipomoea aquatica* (L.) Ker Gawl showed a single stratum. It was very dense (recovery ranging from 90 to 100%) and 2 m high. Many companion species were identified: *Leersia hexandra* Sw, *Ipomoea rubens* Choisy, *Alternanthera sessilis* (L.) DC., *Ludwigia stenorraphe* (Brenan) Hara, J. *Aeschynomene afraspera* J. Leonard., *Polygonum senegalense* Meisn., *Polygonum pulchrum* Blume. Aquatic vegetation was

encountered on the water bodies of Ouémé and Sô. This was a floating meadow, 20 to 40 cm above the water. Its recovery was between 20 and 80%. It was dominated by two species: *Eichhornia crassipes* (Mart.) Solms-Laub. and *Centrostachys aquatica* R. Br. Wall. The companion species were *Azolla pinnata* R. Br subsp. *africana* R.M.K. Saunders & K. Fowler, *Salvinia nymphellula* Desv., *Wolffiella welwitschi*i (Hegelm.) and *Lemna aequinoctialis* Welw.

DISCUSSION

In the Lower Delta of Ouémé wetlands of southern Benin, 257 herbaceous species were identified distributed in 179 genera and 60 families. Adjakpa (2006) had identified 246 species for the same study area. This study contributes to knowledge about 11 species in the herbaceous flora of the Lower Delta of Ouémé. The difference between different measures of community composition, which was 4.28%, was attributable to the fact that this study used two complementary methods of sampling. Systematic sampling transect was complemented by statements at the level of random vegetation units that had not been taken into account by systematic sampling transects. These units were mostly complementary pockets of forest and few aquatic meadows.

Shannon indices were 0.33 bit in urban areas to 3.42 bit in fields and fallows. The Pielou equitability ranged from 0.28 in urban areas to 0.80 in forests. Shannon indices seemed low except in flood-prone savannas and in fields and fallows. They were below the lower limit of the range of 2 to 4 bits proposed by Kent and Coker (1992) to judge a good diversity of population. By contrast, these herbaceous stands, except that of urban areas, had a good level of organization as evidenced by the values of the evenness of Pielou recorded (0.57 to 0.80).
The predominance of species with wide distribution (52.94%) was linked to human actions (Adjakidjè, 1984).

The most represented families are Poaceae with 37 species (14.10%), Leguminosae with 30 species (11.67%), Cyperaceae with 19 species (7.39%), Asteraceae with 15 species (5.84%) and Convolvulaceae with 14 species (5.45%).

The herbaceous flora is rich with 257 species, or 52.88% of all species. The total species richness is unevenly distributed in groups and is as follows: dense forest (72 species), plantations (69 species), flooding savanna (45 species), fields and fallow (174 species), the grassland (77 species), aquatic vegetation (7 species) and agglomerations (9 species). This difference is explained by the fact that the nature of the groups is not the same. Fields and fallow then are more diverse.

Among the seven types of herbaceous vegetation identified in the Lower Delta of Ouémé, fallow, grassland and flood savannah were natural pastures (Essou, 1991). They contained valuable forage species such as *Paspalum vaginatum* (abundant in the meadow) and *Vetiveria nigritana* (abundant in the savannah). In addition, *Echinochloa pyramidalis* predominant fallow was excellent forage

capable of providing not only a daily gain of weight but also a daily milk yield between 1 and 6 liters per animal.

According to Bigot (1982), the rational exploitation of natural grazing helps to preserve their production potential. Yet in the Lower Delta of Ouémé, man is not involved in grazing management and it is permanent pasture practice during the recession without rotation (Essou, 1991). This overgrazing would eventually cause the destabilization of the ecosystem in precarious balance.

CONCLUSION

In the Lower delta of Ouémé, seven communities were identified by considering the herbaceous vegetation. These aquatic vegetation, meadow, fields and fallow, flooded savannah, plantations, agglomeration and forests. The study found great variability in floristic richness (7 to 174 species). Only the flora of fields and fallow and flooded savannas was moderately diverse. The other groups were characterized by low species diversity of herbaceous flora.

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