CHAPTER 3

CLASSIFICATION AND DESCRIPTION OF FLOODPLAIN VEGETATION IN THE OKAVANGO DELTA.

3.1. Introduction

Vegetation description is the starting point of both small and large scale vegetation science research. Vegetation description aims to enable people, other than the observer, to build a mental picture of the area and its vegetation and to allow comparison and ultimate classification of different vegetation units (Kershaw, 1973). The description of vegetation, with or without concurrent recording of factors of the environment, has played a major part in the development of plant ecology and continues to be important (Greig-Smith, 1983). Vegetation description is therefore an essential and integral part of vegetation science as it provides a scientific inventory for conservation, monitoring and further research (Coetzee, 1993), and in general the preservation of biotic diversity.

Although a considerable proportion of ecological work has been directed towards the description of vegetation of various ecosystems in the world (Kershaw, 1973), not much has been done on the phytosociology of the Okavango Delta seasonal floodplain vegetation. Papers by Smith (1976), Biggs (1979), and Ellery *et al.* (1991), are some of a few publications on the vegetation of the Okavango Delta, but none of these paid special attention to a quantitative classification of seasonal floodplain vegetation. Biggs (1979) described vegetation types of the Okavango Delta using a visual physiognomic classification based on dominant species. Ellery *et al.* (1991) employed some quantitative objective methods of classification but concentrated on the vegetation of the back-swamps.

Methods employed to describe vegetation depend on a number of factors which include the purpose of the survey, scale of the study, the overall habitat type and resources available (Kershaw, 1973; Kent & Coker, 1992). Vegetation descriptions fall in two categories namely physiognomic or structural description, and floristic description

(Kershaw, 1973; Greig-Smith, 1983; Whittaker, 1980; Kent & Coker 1992). Physiognomic description is based on external morphology, life form, stratification and size of the species present while floristic description involves identification of the species present in the study area and their presence/absence is recorded (Kent & Coker, 1992). Physiognomic and structural methods have been used to describe vegetation at small scale (over large areas) such as world vegetation formations while floristic analyses have been used to describe vegetation at a large scale (small areas) particularly at the level of plant community (Kent & Coker, 1992).

Kent & Coker (1992) state that all methods for recognising and defining plant communities are methods of classification which aim at grouping together a set of individuals (sample plots) on the basis of their attributes (plant species). Therefore the end product of classification should be a set of groups derived from individuals where, ideally, every individual within a group is more similar to the other individuals in that group than to any individual in any other group (Kent & Coker, 1992). Phytosociological classification also seeks to investigate the interrelationships between species and their distribution patterns since species tend to occur in associations determined by their ecological tolerance of biotic factors, combined with intraspecific and interspecific interactions (Burgoyne, 1996). Methods of carrying out classification are many and varied. Kershaw (1973), Whittaker (1980) and Kent & Coker (1992) discussed these methods in detail of which the physiognomic or structural include Raunkaier's life-form classification, the structural-physiognomic classification schemes of Dansereau, Kuchler and Fosberg, and the floristic approach includes the Zurich-Montepellier (Braun-Blanquet) School, the Uppsala school, the Raunkaier (Danish) School and the Hybrid Schools.

The Braun-Blanquet approach to the study of vegetation is the most widely used throughout the world, and it has proven to be a reliable and efficient method for vegetation survey and classification in most countries (Werger, 1974). The analysis of vegetation has always been surrounded by disputes centred on the concept of plant community as viewed or presented by different authors (Werger, 1974). The concepts of plant community include the organismal concept which sees the community as a "superorganism", the concept of social structure, the individualistic concept which views the community as a changeable mixture of individualistically distributed plant species and the population structure which views the community as a system of interacting species and vegetation as a complex population pattern (Whittaker, 1980). Braun-Blanquet approach takes a practical, intermediate position that recognises the heterogeneity of species distributions but emphasises nonetheless the interaction between plants in the community, which has a certain individuality because of relative discontinuities between communities in the field. In this method an analysis of the vegetation as a rule is preceded by a preliminary survey of the area. This reconnaissance survey includes the study of general vegetation pattern and the establishment of the apparent relations of various vegetation types with geology topography and soil conditions (Whittaker, 1980).

The Braun-Blanquet method was virtually unknown in Africa south of the equator before 1969, except for work in Zaire, Rwanda and Burundi by Belgian phytosociologists (Werger, 1974). In 1969 a phytosociological survey of the Upper Orange River valley in which this method was applied, was initiated and since then a number of surveys were successfully carried out in Southern Africa (Werger, 1974). The method is based on several fundamental concepts and assumptions, e.g. the releve, which is a list of observations on species composition and habitat factors compiled in a sample plot or stand, equivalent in terms of vegetation description to a quadrat; minimal area which is the minimal size of an area in which the community is represented; homogeneity where the distribution of the plant species within a certain area is such that the probability of finding an individual of a plant species within that area of a given size is the same in all parts of the area; and the association which is a plant community of a specific constant species composition, having a definite specific structure and which is found under a particular set of environmental conditions (Westhoff & Van der Maarel 1978) found by grouping together various releves that have a number of species in common (Kent & Coker, 1992; Werger 1974; Whittaker 1980).

In this study, the vegetation of the Okavango Delta floodplains was described at a community level, thus a floristic approached was employed. In phytosociological work done in the savanna (Bredenkamp, 1982, 1987; Brown *et al.*, 1996) and grassland (Fuls, 1993; Eckhardt, 1993; Coetzee, 1993; Coetzee *et al.*, 1995) biomes of South Africa agglomarative cluster analysis (Orloci, 1967) and divisive clustering (Bredenkamp *et al.*, 1991, 1995), were applied on the samples of total floristic composition to derive the first approximation of plant communitry types of the relevant area. After deriving the approximate main communities by applying the divisive clustering algorithim, TWINSPAN (Hill, 1979b) to the floristic data, further refinement is achieved by application of the Braun-Branquet procedures. A key concept of TWINSPAN is that with each division of a set of releves, a dichotomy can be made with a group of releves on one side characterised by one set of indicator species and a second group on the other side characterised by a second set of indicator species. The general principle of division is applied in a series of levels starting with a whole set of releves or species dividing them into two groups, those two into four, and those into eight and so on (Kent & Coker, 1992). The end product is a hierarchical classification, which can be presented in a diagram or in table form, and where plant communities are defined in terms of their total floristic composition, with emphasis on indicator or diagnostic species.

3.2. Objectives

The objectives of this study are to:

i) Classify the vegetation of seasonal floodplains of the Okavango Delta at Nxaraga Lagoon area using a floristic approach.

ii) Relate derived plant communities to certain environmental attributes, which probably determine their distribution within the area.

3.3. Methods

The total species composition and relative abundance of each species were recorded using the Braun-Branquet cover abundance scale, with the modification by Mueller-Dombois & Ellenberg (1974) and Ellenbroek (1987). The following modified Braun-Blanquet cover-abundance scale was used:

r	very rare with a negligible cover(usually a single individual);
+	present but not abundant and with a small cover value (less than 1 % of the sample plot area);
1	numerous but covering less than 1 % of the sample plot or not so abundant but covering 1 % to 5 % of the area;
2a	very numerous and covering less than 5 % of the plot area;
2b	covering between 6 to 12 % of the plot area independent of abundance;
2m	covering between 13 to 25 % of the plot area independent of abundance;
3	covering 26 to 50 % of the plot independent of abundance;
4	covering 51 to 75 % of the plot independent of abundance;
5	covering 76% to 100 % of the independent of abundance.

In a reconnaissance survey of the study area eight different zones were identified. Within each zone five plots of which one was permanently marked for monitoring purposes, were randomly selected. Floristic cover/abundance data were collected for each plot. A 5 m x 5 m plot size was selected after determining the minimum species area as described in Kershaw (1973), Mueller-Dombois & Ellenberg (1974), Werger (1974), Whittiker (1980), and Kent & Coker (1992). The sampling design was stratified in relation to zones but randomised within the zones. Overall 40 releves were selected from which data were collected. The cover-abundance data were then captured in TURBO(VEG), a software package for input, processing, and presentation of phytosociological data (Hennekens 1996a). Data were then subjected to a two-way indicator species analysis (TWINSPAN) (Hill, 1979b) in MEGATAB, a visual editor for phytosociological tables (Hennekens, 1996). Floristic data were collected when most of the species were in their flowering stage to allow easy identification.

flowering stage to allow easy identification.

3.4. Results

3.4.1. Classification

The TWINSPAN classification followed by Braun-Blanquet procedures divided the floodplain vegetation into eight communities of which five were further divided into sub-communities. Ninety-nine species were recorded from which fifty-five were used in the phytosociological table (Table 3.1) and forty-four were classified as rare species are also included in the checklist (see Appendix 1) The eight communities and their sub-communities are the following:

1 *Cyperus articulatus-Schoenoplectus corymbosus* community

- 1.1 *Typicum* sub-community
- 1.2 *Cyperus articulatus-Alternanthera sessilis* sub-community

2. *Alternanthera sessilis-Ludwigia stolonifera* community

- 2.1 *Alternanthera sessilis-Nymphaea nouchali* sub-community
- 2.2 *Alternanthera sessilis-Pentodon pentandrus* sub-community

3. *Miscanthus junceus-Digitaria scalarum* community

- 3.1 *Miscanthus junceus-Panicum repens* sub-community
- 3.2 *Miscanthus junceus-Ethulia conyzoides* sub- community

4. *Paspalidium obtusifolium-Panicum repens* community

5. *Setaria sphacelata-Eragrostis inamoena* community

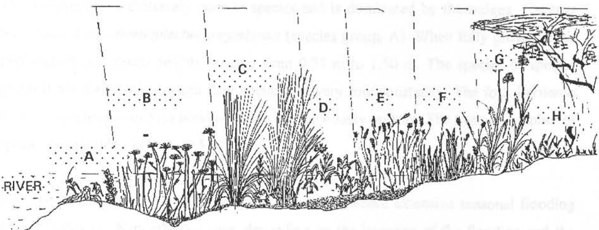
6. *Veteveria nigritiana-Setaria sphacelata* community

- 6.1 Typicum sub-community
- 6.2 *Veteveria nigritiana-Imperata cylindrica* sub-community

7. *Imperata cylindrica-Setaria sphacelata* community

8. *Sporobolus spicatus* community

- 8.1 Typicum sub-community
- 8.2 *Sporobolus spicatus-Cynodon dactylon* sub-community



A = *Alternanthera sessilis-Ludwigia stolonifera* community; B = *Cyperus articulatus-Schoenoplectus corymbosus* community; C = *Miscanthus junceus-Digitaria scalarum* community; D = *Paspalidium obtusifolium-Panicum repens* community; E = *Setaria sphacelata-Eragrostis inamoena* community; F = *Imperata cylindrica-Setaria sphacelata* community; G = *Veteveria nigritiana-Setaria sphacelata* community; H = *Sporobolus spicatus* community.

Fig. 3.1 Schematic cross-section showing the location of vegetation communities in relation to each other and the channel.

3.4.2. Description of the plant communities.

Vegetation of the seasonal floodplains of the Okavango Delta is mainly dominated by herbaceous species with seedlings of some woody species appearing rarely in secondary and tertiary floodplains. All species groups mentioned in the description of the communities refer to Table 3.1. Fig, 3.2 to 3.8 show pictures of the different vegetation communities.

1.*Cyperus articulatus-Schoenoplectus corymbosus* community

This community is extremely poor in species and is dominated by the sedges *Cyperus articulatus* and *Schoenoplectus corymbosus* (species group, A). When fully grown, these two species may reach heights ranging from 0.75 m to 1.50 m. The species of species group B are diagnostic, though they occur with very low constancy. The forb *Vernonia glabra,* (species group S) is however often conspicuously present. The average number of species per sample plot is only 5.

This community covers large areas of the floodplain where extensive seasonal flooding occurs during 6 - 8 months per year, depending on the intensity of the flooding and the annual rainfall in the catchment in the Angolan highlands and also in the Delta. This community is mainly located in the depressions of the floodplains (Fig.3.1) where the flooding depth ranges from 0.50 m to 1.0 m when floods are high during July-September and ranges between 0.20 m to 0.45 m during the rainy season in summer.

Grazing pressure is low in the centre of the zone where the water is deep, thus allowing the sedges to escape grazing. However, this community is heavily grazed on its edges where the water is shallower and ungulates have easy access. When the water recedes at the end of the flooding season, the vegetation is heavily utilised and trampled by ungulates, thus resulting in a thick layer of organic sedge peat.

Fig. 3.2 Vegetation of the *Cyperus articulatus-Schoenoplectus corymbosus* community

1.1. The Typicum sub-community

This sub-community is entire dominated by the sedges *Cyperus articulatus,* and *Schoenoplectus corymbosus* (species group A), and represents the typical sub-community of the *Cyperus articulatus-Schoenoplectus corymbosus* community. Characteristically the species of species group C are absent or poorly represented. Other species that may be found in this sub-community include *Paspalidium obtusifolium* (species group K) and *Vernonia glabra* (species group S). This sub-community is located towards the edges of the main community in shallower water, away from the main channel and is therefore also the most severely grazed of the two sub-communities. In most cases it borders on the *Paspalidium obtusiflolium-Panicum repens* community.

1.2. *Cyperus articulatus-Alternanthera sessilis* sub-community

This sub-community is also dominated by *Cyperus articulatus* (Species group A) though the presence of the forbs *Alternanthera sessilis, Ethulia conyzoides Potomagetum* *thunbergii* and *Nymphaea nouchali* (species group C), are diagnostic. This vegetation is located in deeper water in the centre of the depressions where inundation periods are longest, causing habitat for the aquatics *Potamogeton thunbergii* and *Nymphaea nouchalli*. Due to deep water this area is not grazed, as it is inaccessible for most ungulates.

2. *Alternanthera sessilis-Ludwigia stolonifera* community

This community is characterised by species group E which includes the hygrophylic forbs *Ludwigia stolonfera, Ludwigia leptocarpa*, and *Polygonum meismerianum* and also the hygrophylic grasses *Leersia hexandra* and *Oryza longistaminata*. Other species that may be considered as diagnostic are those of species group C, namely *Alternanthera sessilis, Ethulia conyzoides, Potamogeton thunburgii* and *Nymphea nouchalli. Vossia cuspidata,* and *Digitaria debilis* (species group D) and *Paspalidium obtusifolium* (species group K) are also prominently present. The average number of species per sample plot is 11.

The community is always situated adjacent to the channel (Fig.3.1) where depth of water may be deeper than 1 m when the river is in flood (June - July) and up to 0.50 m during the rainy season (during the summer months). This the wettest parts of the primary floodplain. Duration of inundation ranges between 6 to 8 months, including the rainy season. However, by the end of the dry season when the vegetation is not inundated, it may be so heavily utilised by grazers that most of the soil surface becomes bare.This community is divided into two sub-communities.

2.1. *Alternanthera sessilis-Nymphaea nouchali* sub-community

This sub-community occurs in the deepest water is characterised by the presence of species group F and also a high cover abundance of the water lily *Nymphaea nouchali* (species group C). Dominant species are *Alternanthera sessilis* and *Ludwigia stolonifera* (Species group E). Other common species include *Ethulia conyzoides* and *Potamogeton thunburgii* (species group C), *Vossia cuspidata* (species group D), *Leersia hexandra* (species group E), and *Cyperus articulatus* (species group A).

Fig. 3.3 . Vegetation of the *Alternanthera sessilis-Ludwigia stolonifera* community

2.2 *Alternanthera sessilis-Pentodon pentandrus* sub-community

This sub-community is located in somewhat shallower water more towards the edges of the *Alternanthera sessiles - Ludwigia stolonifera* community. In most cases it borders on the somewhat elevated *Cyperus articulatus-Schoenoplectus corymbosus* community. The species of group H are diagnostic and includes *Pentodon pentandrus, Pycnostychys coerolea, Brachiaria humidicola* and *Brachiaria arrecta. Alternenthra sessilis* (species group C), *Ludwigia stolonifera* (species group E) and *Pentodon pentandrus* (species group G) are dominant in this sub-community. Other common species that may be found include the hygrophilic grasses *Oryza longistaminata,* and *Leersia hexandra* (species group E).

3. *Miscanthus junceus-Digitaria scalarum* community

Miscanthus junceus, which is a tall-growing (3 m) aquatic perennial grass, *Digitaria scalarum* as well as *Nidorella residifolia, Cycmium tubulosom* and *Brachiaria dura* (species group I) are the diagnostic species in this community. Common species are *Digitaria debilis* (species group D), *Cyperus articulatus* (species group A), *Paspalidium* *obtusifolium* (species group K), *Panicum repens, Acroceres macrum, Eragrostis lappula* (species group L), and *Vernonia glabra* (species group S,). An average of 10 species was recorded per sample plot.

This community is located within the primary floodplain, often occurring as a narrow belt between the seasonally flooded *Paspalidium obtusifolium - Panicum repens* community, *Cyperus articulatus - Schoenopletus corymbosus* community and the *Alternanthera sesssils - Ludwigia stolonifera* community (Fig. 3.1). *Miscanthus junceus* is not utilised by herbivores except that elephants dig up the roots during the dry season when forage is scarce. In this community *Acroceres macrum* and *Panicum repens* (species group L*)* grow in the spaces between the *Miscanthus junceus* compact tussocks. These grasses are heavily utilised by lechwe and other herbivores during the rainy season and even during flooding. *Digitaria scalarum* grows within the *Miscanthus junceus* thickets thus earning valued protection from herbivores.

Fig. 3.4.Vegetation of the *Miscanthus junceus-Digitaria scalarum* community

3.1 *Miscanthus junceus-Panicum repens* sub-community

Miscanthus junceus (species group I,) is the dominant species, and *Cyperus dives* (species group J) is diagnostic, while *Eragrostis lappula* and *Panicum repens* (species group L) and *Eragrostis inamoena* (species group M) may be considered as differential species for this sub-community. *Acroceres macrum,* (species group L) *Digitaria debilis* (species group D), *Digitaria scalatrum* (species group I) and *Vernonia glabra* (species group S) are the dominant species of this sub-community.

It is located on the edges of the *Miscanthus junceus - Digtaria scalarum* community that is in the shallow waters of secondary floodplains.

3.2 *Miscanthus junceus-Ethulia conyzoides* sub-community

This sub-association is characterised by the absence of *Cyperus dives* (species group J) while the absence of *Eragrostis lappula* and *Panicum repens* (species group L) and *Eragrostis inamoena* (species group M) may be considered as of diagnostic value. Other species that differentiate this sub-community from the *Miscanthus junceus-Panicum repens* sub-community are *Ethulia conyzoides* and *Alternanthera sessilis* (species group C). Other common species include *Cyperus articulatus, Schoenoplectus corymbosus* (species group A), *Vossia cuspidata* (species group D), *Digitaria scalarum* (species (group I), *Acroceres macrum* (species group L), *Vernonia glabra* (species group S) and *Paspalidium obtusifolium* (species group K). This sub-community is located adjacent to the *Alernenthera sessilis - Ludwigia stolonifera* community, in shallower water on somewhat elevated terraces that are not inundated for long periods.

4. *Paspalidium obtusifolium-Panicum repens* community

Characteristic for this community is the high cover values of *Paspalidium obtusifilium* (species group K). *Panicum repens* is very prominent towards the edges of this community while *Paspalidium obtusifilium* dominates in the centre of the community. Other common species include *Cyperus articulatus, Schoenoplectus corymobosus* (species group A) *Panicum repens* and *Acroceres macrum* (species group L). The average number of species per sample plot is 8. This community is found in depressions in the secondary floodplains which are far from the main channel and which often do not receive river fed floods but get inundated during the rainy season. In dry years flooding may be restricted to the lower part of the zone or may not occur at all. When floods do occur the flooding depth ranges from 0.20 to 0.50 m in the centre of the depressions. This community occupies the shallower depressions bordering the *Cyperus articulatus-Schoenoplectus corymbosus* community and the *Setaria sphacelata-Eragrostis inamoena* community (Fig. 3.1). In some cases it borders the *Miscanthus junceus-Digitaria scalarum community*. There is a large transitional zone between this community and the seasonally wet *Cyperus articulatus-Schoenoplectus corymbosus* community. *Panicum repens* remains green during the dry season, thus attracting heavy utilisation from resident lechwe herds and other herbivores. This extensive grazing leaves much of the soil uncovered by the end of the dry season. When the rains or floods come, *Paspalidium obtusifolium* and *Panicum repens* start growing vigorously, thus attracting lechwe and other herbivores. Grazing occurs throughout the year. During flooding and early dry season, grazing is restricted to lechwe, but as the soils dry up and become harder, large animals such as buffalo, zebra, tsesebe, impala and wildebeest utilise the area.

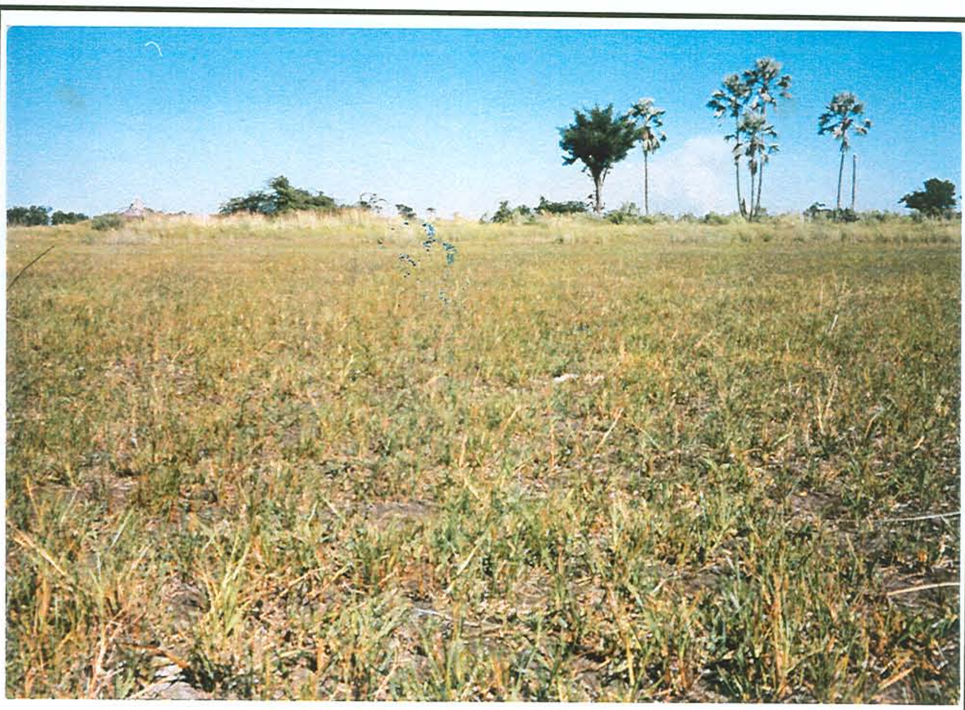


Fig 3.5 Vegetation of the *Paspalidium obtusifolium-Panicum repens* community

5. *Setaria sphacelata-Eragrostis inamoena* community

The high cover-abundance of *Setaria sphacelata* and *Eragrotis inamoena* (species group M) as well as the presence of species group N, are diagnostic for this community. Other species present in this community include *Panicum repens, Acroceres macrum Eragrostis lappula,* (species group L). The average number of species per sample plot is 9.

Fig 3.6 Vegetation of the *Eragrostis inamoena - Setaria sphacelata* community

This community is also situated within the secondary floodplains usually boarding the *Paspalidium obtusifolium-Panicum repens* community and *Veteveria nigritiana-Setaria sphacelata* community (Fig 3.1). The area occupied by this community can be described as temporarily flooded areas with shallow water, situated just above the flood line. In periods of low floods this area do not get inundated, and it seems that it does not depend much on flooding for maximum productivity. During larger river fed floods, this area floods only after most of the depressions are flooded and filled with water. The area is inundated during the rainy season but due of its elevation, rain water quickly drains off into the adjacent *Paspalidium obtusifolium-Panicum repens* community in the depressions, leaving only a thin layer of water ranging from 0.10 m to 0.25 m. The area is utilised by lechwe during the growing season. Utilisation seems to be moderate but may become heavy during the dry season, with the occasional visits by bulk grazers like buffalo, zebra and wildebeest and probably hippopotamus.

6. *Veteveria-nigritiana-Seteria sphacelata* community

The diagnostic species of this community are the tall (2 m) and dominant grass *Veteveria nigritiana* and *Setaria verticillata* (species group O). Other common species include annual grass *Setaria sphacelata* (species group M) and the forb *Vernonia glabra* (species group S). Species such as *Urochloa trichopus, Chloris virgata* (species group T) occur scattered. The average number of species per sample plot is 7.

This community forms a belt around the floodplain, just above the floodline, linking the floodplains with the woodlands. It boarders the *Imperata cylindrica-Setaria sphacelata* community and *Eragrostis inamoena-Setaria sphacelata* community (Fig, 2). Evidence of little utilisation of the dominating grass *Veteveria nigritiana* is sometimes noticeable when it starts developing new tillers at the beginning of the growing season. This community gets temporarily flooded during the rainy season but it may get flooded for a longer spell during years of extremely high floods. This community is subdivided into two sub-communities.

6.1 Typicum sub-community

Dominated by *Veteveria nigriatiana* (species group O) this vegetation represents the typical community. It is located towards the transition zone between the main community and *Eragrostis innamoena-Setaria sphacelata* community (Fig 3.1).

6.2 *Veteveria nigritina-Imperata cylindrica* sub community

Imperata cylindrica (species group P) is differential for this sub-community. It occurs towards the transition zone between the typical sub-community and the *Imperata cylidrica-Setaria sphacelata* community.

Fig. 3.7 Vegetation of the *Veteveria-nigritiana-Setaria sphacelata* community

7. *Imperata cylindrica-Setaria sphacelata* community.

The dominant and diagnostic species in this community is the perennial grass *Imperata cylindrica* (species group P). *Setaria sphacelata* and *Eragrostis inamoena* (species group M) are other common species found in this species-poor community. The average number of species per sample plot is only 5.

This community occupies the upper parts of the floodplains above the floodline and is not flooded annually (Fig. 3.1). It may, however, be temporarily flooded during the rainy season after heavy showers. No evidence of utilisation by large herbivores was noticed in this community but termite activity is high during the dry season. However, heavy utilisation was noticed after a fire.

Fig.3. 8 Vegetation of the *Imperata cylindrica-Setaria sphacelata* community.

8. *Sporobolus spicatus* community.

The only diagnostic species in this community is *Sporobolus spicatus* (species group Q), which occupies the highest parts of the floodplain above the floodline (Fig 3.1) and which forms extended monodominant stands. The average number of species per sample plot is only 3. In most cases it borders the *Eragrostis enamoena-Setaria sphacelata* community and the *Imperata cylindrica-Setaria sphacelata* community (Fig. 2). With such a high elevation, flooding is rare in this community. Evidence of grazing has been observed in the dry season. Utilisation of this species is mostly quite low, however evidence of heavy utilisation was noticed during extremely dry years.

This community is sub-divided into two sub-communities.

Fig. 3.9. Vegetation of the *spicatus* community.

8.1 Typicum sub-community

The only diagnostic in this sub-community is *Sporobolus spicatus,* thus representing the typical community. This sub-community is found on high ground close to the channel.

8.2 *Sporobolus spicatus-Cynodon dactylon* sub-community

In this sub-community, the diagnostic species are *Cynodon dactylon, Amaranthus thunbergii, Sporobolus acinifolius, Hermbstaedtia odorata* and *Gisekia species* (species group R). *Sporobolus spicatus* (species group P) is still the dominant. This sub-community occurs close to the woodlands, away from the flooded areas and is frequently visited by lechwe which graze weedy species such as *Amaranthus thunbergii.*

3.5. Discussion

Although the survey was done when most of the plant species were on their flowering stage, some of the species were difficult to identify because of differences in flowering time. For example, *Sorghum species* which was not recorded, later showed up to be strongly associated with the *Eragrostis innamoena-Setaria sephacelata* community and the *Veteveria nigritiana-Imperata cylindrica* community. There might be more such species. However this problem was also experienced by other researchers employing the floristic approach (Perkins 1997).

As stated before, the most important factor determining the species composition of the vegetation of the seasonal floodplains is the timing and duration of the seasonal flooding (Ellenbroek, 1987). Because of its dependence on an annually changing amount of rainfall in the catchment area in Angola, the flooding regime is also the driving force of the dynamics of the vegetation. This phenomenon sometimes interferes with classification and blurs the possibility for recognition of plant communities (Ellenbroek, 1987) as the communities may shift due to changes in habitat.

It must be emphasised however, that most of the plant communities in the Okavango Delta have existed for centuries, though they shift around in space and time to the areas suitable for them, depending on the prevailing environmental conditions. Channel blockage aggravating channel abandonment is still reported to be a common phenomenon in various parts of the Okavango Delta. The blockages therefore result in changes in water flow. As a result some floodplains fail to receive water or receive very little water, while others are deeply inundated. Consequently, vegetation of the seasonal floodplains changes once regular flooding ceases. Seasonal flooding seems to be the major determinant as well as the major driving force of the seasonal floodplain vegetation. It is therefore possible that the species composition at the time of survey was different from what it used to be in the past, and might be different in future, depending on the flooding regimes. This further proves as well as emphasises the importance of a

Table 3.1. Phytosociological table for floodplain vegetation in the Okavango Delta

Unique relevé nr.								
		111111111111111	111111111	111111111111111	1111111111	111111111111111	11111111111	111
		566667777766667	555555556	334453334444444	2233333422	000000110112222	00111111221	788
		267890123423455	134567890	458906781234567	8901239067	456789053670135	1223489241	906
Species Group A								
Cyperus articulatus	-hl	354444444443444	344454555	bbbbbabaaaabbb.	.aaa..ab..	......1.aab.a.1	abbbbmb.bb	aaa
Schoenoplect corymbosu	-hl	.mm3mmbbbmbbbbb	mbbbbabm.	..aaa...a.a.abl	....	.a......a.a....	ba.abbaaa.	a.b
Species Group B								
Cyperus species	-hl	b...b.b........	b........	....	.a........	....	....	...
Schizodium cornutum	-hl	.m........b..b	........m	....	....	....	....	.a.
Species Group C								
Alternanthera sessilis	-hl	.........+.....	baaam3m.m	454444544444445	bam44454mm	.........b.1..	.b.bb1.bb	...
Ethulia conyzoides	-hl	.........aaaa.	..aaabbbb	aabbbaa.m..babb	aaaaaa.a.a	....	a.bba..1ab	...
Potamogeton thunbergii	-hl	....	..aa.b.bb	.a.....ab.b..ba	.bb..ab.a.	....	....	...
Nymphaea nouchali	-hl	a..............	abaa.....	.....aaaaaaaaaa	......a...	....	....	...
Species Group D								
Vossia cuspidata	-hl	........1a....1	....	1a...bb.1aa.1.1	m.11a1ba..	.....a1a.......	..abba....	...
Digitaria debilis	-hl	....	....	a1...aab.a.ba..	..b.aba.b.	.....a.abb..bbb	mmmabbb.m.	.b.
Species Group E								
Ludwigia stolonifera	-hl	....	....	b....m3b43bbbmm	44b333b4bb	....	...a......	...
Polygonum meisnerianum	-hl	....	....	.....a..a..1a..	a.1a..aaaa	.............1.	....+....1	1..
Leersia hexandra	-hl	.........+.....	....	.b.....31abbabb	a..aaa33.a	............aa.	....	..a
Oryza longistaminata	-hl	.........a.....	....	aa...a..b..1...	aa11a.aa..	....	....	ab.
Ludwigia leptocarpa	-hl	....	....	..aaa...a1aaa..	.a.aa..1..	....	....	...
Species Group F								
Eleocharis dulcis	-hl	....	....	.1.....baaba...	....	....	....	...
Species Group G								
Persicaria limbata	-hl	......+........	....	abaaa..........	......a...	a1.............	....	...
Species Group H								
Pentodon pentandrus	-hl	....	....	......a.....a..	bbmaba.abb	....	a.bab..a..	...
Pycnostachys coerulea	-hl	....	....	a........a....1.	aabaaa.a.1	....	.........a	...
Brachiaria arrecta	-hl	....	....	.a...bb........	3m5..aa...	....	....	...
Brachiaria humidicola	-hl	....	....	....	55	b.....1........	.ba.......	...
Species Group I								
Miscanthus junceus	-hl	....	....	....	..+.......	455555554545555	5455545555	...
Digitaria scalarum	-hl	....	....	....	....	.bm.mmbmbbbbbb.	.b....bbbbb	...
Nidorella resedifolia	-hl	....	....	...........a...	.......a...	11......a.a.aaa	a1....a.a1	...
Cycnium tubulosum	-hl	....	....	....	....	........+......	......+...	...
Brachiaria dura	-hl	....	....	....	....	....b.1........	.b........	...
Species Group J								
Cyperus dives	-hl	....	....	.......m.......	.......aa..	aba.aa.a.......	....	...
Species Group K								
Paspalidium obtusifoli	-hl	............bbm	....	aa1a1aa..a.ab.a	.1.1ab....	b.a...a.b.bb...	ab.b.mb...	544
Species Group L								
Panicum repens	-hl	..........baaa.	....	.............4.	....	.b.bb.a.abbbbb.	11........	mma
Eragrostis lappula	-hl	....	....	....	....	a..b.a+aa.a....	....	...
Acroceras macrum	-hl	....	....	....	b........a	3.bbmmbmbbma.bb	.b.a.b.bb.	ma.
Species Group M								
Setaria sphacelata	-hl	....	....	1..............	....	......1........	....	...
Eragrostis inamoena	-hl	....	....	....	....	..abab.b.......	....	...
Species Group N								

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1111¦111111111111111111 111211¦                    1         ¦
1221¦78888999999978888867 999088¦7778888999978888908899999¦     12    1111112222¦ 111¦5567766677775566666655555¦42222333333334 44444¦444533
9241¦90679012345623451 7 789018¦67902351245814688079069371¦23483456790124580123 5¦1679¦790451350123362467891245 8¦06789012345781 26789¦345069
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b.bb¦aaaabaaa..baaaa.ma aaabib¦.....+a.....++........11.¦........................¦....¦...........................¦.............. .....¦......
aaa.¦a.b.ala.bbaaaa.abb .b.bl.¦..11..1.....+.............¦.....................+..¦....¦...al.....11................¦.............. .....¦......

....¦.................... ......¦+..b......................¦........................¦....¦.........+.................¦.............. .....¦......
....¦.a.....a.ba...a.......¦.........................¦........................¦....¦...........................¦.............. .....¦......

l.bb¦.................... .....¦.........................¦........................¦....¦...........................¦.............. .....¦......
..lab¦.................... .....¦.........................¦........................¦....¦...........................¦.............. .....¦......
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....¦......11+........... .....¦.........................¦........................¦....¦...........................¦.............. .....¦......

a...¦.................... .....¦.........................¦........................¦....¦...........................¦.............. .....¦......
bb.m.¦.b............1... .....¦+a....................mb..¦......a..a..a.....+..¦abba¦...+.......................¦.............. .....¦......

....¦.................... .....¦.........................¦........................¦....¦......................                 .....¦......
...1¦.................... .....¦.........................¦........................¦....¦...........................¦.............. .....¦......
....¦..abaa.....a........ ..+..¦.........................¦.......................+¦....¦....a.....+..............¦.............. .....¦......
....¦ab.mba.............. .....¦.........................¦........................¦....¦...........................¦.............. .....¦......
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..a..¦.................... .....¦.........................¦........................¦....¦...........................¦.............. .....¦......
....a¦.................... .....¦.........................¦........................¦....¦...........................¦.............. .....¦......
....¦........1........... .....¦.a.......................¦........................¦....¦..................abbb.....¦.............. .....¦......
....¦.................... .....¦.........................¦........................¦....¦...........................¦.............. .....¦......

45555¦.................... .....¦...a....................a.¦........................¦....¦............1.........1..¦.................... ¦......
bbbbb¦.................... .....¦.........................¦........................¦....¦...........................¦.................... ¦......
..a.a1¦.................... .....¦.........................¦........................¦....¦...........................¦.................... ¦......
.+...¦.................... .....¦............++......+....¦..........1+.......++.¦....¦...........................¦.................... ¦......
....¦.................... .....¦...1.....................¦........................¦....¦...........................¦.................... ¦......

.....¦...........ba..a..a. ....1.¦...............b.....1....¦........................¦....¦1..a......aa...............¦.............. .....¦.1....

.ab...¦5444444444445343435555 5a5544¦..m...+.........b..a....¦........................¦....¦...........................¦.............. .....¦......

.....¦mma.bb.a.bab4343abbb bb+b3m¦.bamlbab.blb.....bbbbbbbb¦...............b.lma¦....¦1.aalll..a..1.............¦.....+........ .....¦......
.....¦...................la baab..¦..b333+...bm43.3a....a...¦........................¦....¦...........................¦.............. .....¦......
.b.bb.¦ma.bambalba....l.bbb .b.a.b¦a.la.....b.a.....b.....bb¦..................la¦...a¦...........................¦.............. .....¦......

.....¦.................... ......¦34334334444.4353443m44444¦aabbbbb.bbm.aabbmbm3m¦.bb.¦.laaal13bbbbaaaaa.bb...ba¦.............. .....¦......
.....¦.................... .abbbb¦44433434433334bmm3333433m¦.........b.......lll.¦....¦.....llalaab..a.............¦.............. .....¦......
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Eragrostis [illegible]

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Species Group N
Eragrostis cilianensis -hl ...............|.........|...............|..........|..............|........

Species Group O
Digitaria eylesii      -hl ...............|.........|...............|..........|..............|........
Aristida stipoides     -hl ...............|.........|...............|..........|..............|........
Acacia tortilis        -jl ...............|.........|...............|..........|..............|........

Species Group P
Vetiveria nigritana    -hl ...............|.........|...............|..........|..............|........
Setaria verticillata   -hl ...............|.........|...............|..........|.........a....|........

Species Group Q
Imperata cylindrica    -hl .......1.......|.........|...............|..........|..............|........

Species Group R
Sporobolus spicatus    -hl ...............|.........|...............|..........|..............|........

Species Group S
Cynodon dactylon       -hl ...............|.........|...............|..........|..............|........
Gisekia species        -hl ...............|.........|...............|..........|..............|........
Amaranthus thunbergii  -hl ...............|.........|...............|..........|..............|........
Hermbstaedtia odorata  -hl ...............|.........|...............|..........|..............|........
Sporobolus acinifolius -hl ...............|.........|...............|..........|..............|........

Species Group T
Vernonia glabra        -hl .......1.1.311.|..aaaaabb|........1.....1|..+.....+.|1.a.aa1a+aa+1.1|1....11.

Species Group U
Urochloa trichopus     -hl ...............|.........|...............|..........|..............|........
Chloris virgata        -hl ...............|.........|...............|..........|........a.a...|........
Sida cordifolia        -hl ...............|.........|...............|..........|..............|........
Corchorus olitorius    -hl ..........+....|.........|...............|..........|.............1|........
Pechuel-Loes leubnitzi -hl ...............|.........|...............|..........|.1.......+....|........
Hibiscus species       -hl ..........+...+|.........|...............|..........|..............|........

Species Group V
Kohautia species       -hl ...............|......+..|...............|..........|.........aa...|........
Gomphocarpus species   -hl ..........++...|..aa.....|...............|.1........|..a..+.++...1.|........
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..|.........|..............11.... ......|.b..a...b.b3.33b..m......|a.aa.............a..|b...|11a.a........1...a.......|........+.. .....|.....a

..|.........|.................... ......|....................aaab|...................|....|...........a..............|............ .....|......
..|.........|.................... ......|.............+.a.ba......|...................|....|...........................|............ .....|.....a
..|.........|.................... ......|.+..+1+.1................|...................|....|...........................|............ .....|.+....

..|.........|.................... ......|....................1....|4455555555455555455555|5554|...+..1....................|..............
..|.........|.................... ......|.+..+....................|...a...a...+.11..1a..|1...|...........................|....+.........

..|.........|.................... ......|.........................|b...3...............|maam|55555544455555444444555555|.............. .....|...

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..|.........|.................... ......|.........................|.a..................|...b|...........b.a1.bab.....|.............. ..b..|abma
..|.........|.................... ......|a+......b....a...........|a..b................|....|.......................|.............. .....|.1.1
..|.........|..............aa.... ....+.|....1...1...+.........+..|1+..................|....|.......................|...........+.. ....+|a.++
..|.........|.................... ......|.1.......................|+.1.................|....|.......................|4............. .....|..1.
..|.........|.................... ......|.........................|....................|....|.......................|.............. .....|.13[illegible]

.1|1....11.a1|.......+..+..1..a..a .1a...|..+........1..1a11.......|.1....a.+aa+1..a+.+..|....|....a..1...+.......+1.aa1|.............. .....|.....

..|.........|..........1..a...... ......|....1.......1.+...ababb.a|a.+.....1.a.1..bb....|1aam|.......................|......+.............|.....
..|.........|.1...........a.1.... ....1+|...........a1..a1aaabb..|aa..b..........+...+|b...|.......................|............. .....|.....
..|.........|1...........1.1..... ......|......+.+......11a.......|1.+.1...........1....|....|.......................|............. .....|.....
.1|.........|.........+.......... ......|...++.+.....a...1.+.1++..|....a.a.1.+..........|....|.......................|............. .....|.....
..|.........|.................... ......|........+......11.1.1.1...|..........1+...1...+..|....|.......................|............. .....|.....
..|.........|1a.....+.+.1.....1.. .....+|...........1.++1...+......|1....+1......1.....++.|....|.......................|............. .....|....+.

..|.........b|.....a............. ......|.........................|11..................+|....|....+.......+.........1a.|...a+................|.....
1.|.........|.................... ......|........+................|....................+|....|.......................+|....................|.....
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sound long-term vegetation monitoring programme to allow and facilitate comparison. Fossil evidence has shown that the present vegetation in Europe, for example, has no long history in the quartenary, but just temporary aggravation resulting from particular environmental and historical factors (Miles, 1979). Such might be the case with the vegetation of the Okavango Delta floodplains.

In view of the fact that vegetation is dynamic, with pronounced spatial and temporal variation (Miles, 1979), it is essential that classification studies of this nature be extended to a number of sites within the Delta to get a more comprehensive picture. However visits to different parts of the Delta revealed that a similar scenario exists in various parts of the Delta. Therefore one can argue that these results are representative, bearing in mind that flooding and factors such as utilisation of floodplain resources by wildlife as well as anthropogenic activities which influence vegetation in different ways, vary in space and time.

3.6. Conclusion and remarks

The application of the Braun-Blauquet approach in phytososiological research in various ecosystems in South Africa (Bredenkamp 1982; 1987, Coetzee 1993, Coetzee *et al.* 1995, Fuls 1993, Eckhardt 1993, Brown *et al.*, 1996 and Perkins 1997), was also successfully applied in the phytosociological study of the floodplain vegetation of the Okavango Delta in the Nxaraga lagoon area. However the application of this method in the floodplains of the Okavango is hampered by the fact that such kind of work has not been done extensively in the Okavango Delta, and other ecosystems in Botswana, thus leaving the researcher with no comparable reference on the Okavango Delta. It would be interesting to compile a formal syntaxonomy for the vegetation of the Okavango Delta, with the application of the Braun-Blanquet approach. For this, more work will have to be done.

Since not much work on classification of vegetation has been done in the floodplains of the Okavango Delta in the past, this leaves this study a very important one, particularly in view of the fact it provides baseline information on the vegetation of the Okavango Delta floodplains. The classification resulted in identification plant communities which can be related to environmental factors such as elevation, distance from the channel, flooding frequency and duration and soil physical and chemical properties.