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Floristic composition of wetlands of the South African section of the Maloti-Drakensberg Transfrontier Park

E.J.J. SIEBEN*, D.C. KOTZE** and C.D. MORRIS***

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ABSTRACT

A survey was conducted on the wetlands in the South African section of the Maloti-Drakensberg Transfrontier Park (MDTP), along altitudinal gradients from the foothills to the summit plateau in six different catchments. Environmental indices of soil wetness, texture and organic contents of the soil were determined to relate wetland community types to their environment. Thirty-six plant communities were recognized with a total of 56 subcommunities. These communities fall into five different categories: 1, the high-altitude fens and seepages are a loose grouping of distinct vegetation types from the summit plateau and just below; 2, hygrophilous grasslands are the marginal areas of the wetlands that are temporarily wet and dominated by grasses, most of which are common outside wetlands; 3, shrubby wetlands are in most cases hygrophilous grasslands that have been invaded by shrubby species due to disturbance; 4, mixed sedgelands are the largest grouping and are dominated by sedges or grass species that are specifically adapted to wet conditions; 5, low-altitude sedge and reedlands are vegetation types that occur only marginally in the Maloti-Drakensberg area and are dominated by *Carex acutiformis* and *Phragmites australis*. The most important variables that explain the variation in wetland vegetation are altitude and soil wetness.

INTRODUCTION

The Maloti-Drakensberg area is one of the major mountain catchment areas in southern Africa, supplying a significant amount of fresh water to South Africa's major industrial and agricultural areas through the Lesotho Highlands Water Project scheme (Sandwith & Pfotenhauer 2002). It is one of the main centres of biodiversity in South Africa (Drakensberg Alpine Centre), containing many different grassland, shrubland, savanna and forest habitats (Van Wyk & Smith 2001). The wetlands at the summit plateau, often incorrectly referred to as bogs (ombrotrophic mires) have been extensively studied (Jacot Guillarmod 1962, 1963; Van Zinderen Bakker & Werger 1974; Grobbelaar & Stegman 1987; Backeus & Grab 1995; Schwabe 1995). These wetlands are interesting in their own right, but there have been few studies on wetlands across the entire altitudinal gradient from the foothills of the Drakensberg to the summit (Dely *et al.* 1999). The abundant rainfall and the strong gradients in climate and geomorphological setting, across altitude and latitude in this region have resulted in a diverse array of wetland habitats, which was first recognized by Dely *et al.* (1999). To a large extent, however, wetlands are concentrated on the summit plateau and the lower altitudes due to the steepness of the intermediate slopes, and Hill (1996) described two wetland communities in the Cathedral Peak area, one for lower altitudes and one for higher altitudes. In the national vegetation classification by Mucina & Rutherford (2006), two important wetland types were recognized as being characteristic of the Maloti-Drakensberg region, namely the Drakensberg Wetlands and the Lesotho Mires (from the summit plateau).

Considering the importance of the water resources in the Maloti-Drakensberg region for the South African economy, it should have priority in conservation planning. Therefore it is necessary to have a more detailed overview of all aspects (vegetation, biodiversity, soils) of aquatic habitats including wetlands in the Drakensberg region. Existing research on the wetland vegetation of the Maloti-Drakensberg has been either of localized individual wetlands (Guthrie 1996) or, if broad-scale (Dely *et al.* 1999; Mucina & Rutherford 2006), limited in detail. This research addresses this deficit by providing a detailed analysis of wetland vegetation in the Maloti-Drakensberg at a macro-scale.

There has been a shift in the focus of biological conservation from the conservation of single species and their habitats toward conservation of the interactive ecological networks on which species and even human communities and industries depend (Ostfeld *et al.* 1997). The Maloti-Drakensberg Transfrontier Park (MDTP) (Sandwith & Pfotenhauer 2002) provides just such an opportunity to adopt a holistic conservation approach for the MDTP area on the eastern border between Lesotho and South Africa. Within the MDTP, wetlands were singled out as a landscape feature that conservation planning should focus on, given the significance of the area for water resources. An inventory of wetland habitats as defined by the RAMSAR convention but excluding rivers (Ewart-Smith *et al.* 2006) in the MDTP area should, therefore, at least include a description of the vegetation types and the physical environment of those wetlands to elicit the relationships between vegetation distribution patterns, altitude, edaphic factors and the inundation regime. When the relationships between vegetation patterns, edaphic factors and ecosystem functioning are understood, vegetation patterns can be used to assess the integrity and conservation status of a wetland site.

* Corresponding author: Department of Plant Sciences, University of the Free State, Qwaqwa Campus, Private Bag X13, Phuthaditjhaba 9866, South Africa. E-mail: siebenej@qwa.uovs.ac.za.
** Centre for Environment, Agriculture and Development, University of KwaZulu-Natal, Private Bag X01, 3209 Scottsville, Pietermaritzburg.
*** Agricultural Research Council, Range & Forage Unit (ARC-RFU), c/o University of KwaZulu-Natal, Private Bag X01, 3209 Scottsville, Pietermaritzburg.
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Vegetation in itself is worthy of conservation since vegetation represents a large component of the biodiversity in a wetland, but wetland vegetation also provides a good descriptor of the habitat for many animals and other components of biodiversity that are part of a wetland ecosystem. Furthermore, since plants are immobile and have to cope with year-round stresses and variability in climate and hydrological regime, they also provide excellent information regarding the factors that play an important role in structuring the wetland. For this reason, a survey of wetland vegetation provides valuable information for conservation planning (Gopal *et al.* 2001).

Two important determinants of wetland vegetation structure and composition are local climate and hydrological regime (Mitsch & Gosselink 1986; Kotze & O'Connor 2000). Altitude, in the context of the MDTP area, is a suitable surrogate measure for climate (Barry & Van Wie 1974), and represents an indirect gradient (*sensu* Austin *et al.* 1984), the influence of which is through temperature and rainfall (Woodward 1988; Körner 2007). Temperature, for example, influences the distribution of C_3 and C_4 grasses in South Africa and Lesotho (Vogel *et al.* 1978). The hydrological regime of a wetland is complex and multidimensional, encompassing a variety of different factors, throughflows and outflows and such variables as the duration and timing of soil saturation and flooding. However, for practical purposes the hydrological regime can be described using various classification systems, with the hydro-geomorphic approach of Brinson (1993) being one of the most widely and successfully applied.

Although most wetlands in the MDTP are located in a wilderness area (several nature reserves and the Ukhahlamba World Heritage Site) there are several threats to the wetlands in the area, in particular, overgrazing by livestock and resulting erosion (Nüsser & Grab 2002).

In this paper, we aim to describe the plant communities found in wetlands across the Maloti-Drakensberg Transfrontier Park, along altitudinal transects from the lowest foothills to the summit plateau. These vegetation units will be described together with environmental information such as soil type, wetness and altitudinal zone.

METHODS

Wetlands were sampled extensively along altitudinal transects in six major catchments across the entire Maloti-Drakensberg Transfrontier Park Project area (Figure 1). These transects, chosen to represent an equal spread of wetlands across the mountain range, are located within the catchments of the following rivers: the Bell River flowing through the town of Rhodes in the Eastern Cape, the Wildebeest River near Ugie in the Eastern Cape, the Tswereka River near Cedarville on the border between the Eastern Cape and KwaZulu-Natal, the Umkomazi River in Lotheni Nature Reserve in KwaZulu-Natal, the Mlambonja River near Cathedral Peak in KwaZulu-Natal and the Klerkspruit River in the Golden Gate area in the Free State. Within these catchments, all altitudes between 1 200 and 3 000 m were examined for wetlands on a 1:10 000 topographic map (e.g. by looking at the relationship between drainage lines and surrounding slopes) and inventoried in the field. An attempt was made to visit all areas in the field where wetlands were to be expected from the inspection of the maps, in order to obtain a representative sample of wetland vegetation types in each transect. Wetland type (or hydrogeomorphic unit) was identified according to the classification scheme of Ewart-Smith *et al.* (2006) and the habitat was described on the basis of several environmental variables, such as soil texture, soil depth and hydroperiod (time of saturation of the soil, see Kotze *et al.* 1996).

Individual wetlands were subdivided into their hydrogeomorphic units (*sensu* Ewart-Smith *et al.* 2006) and further subdivided into as many distinct vegetation types as could be recognized on a single field visit to the wetland that took place between January and March 2006. These vegetation types were sampled in representa-

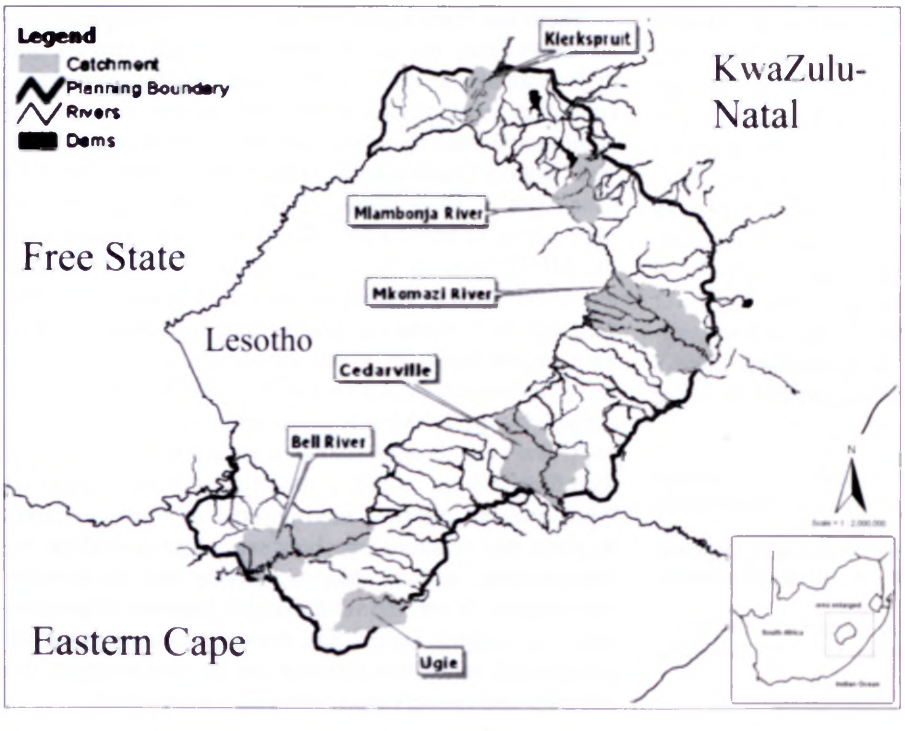

FIGURE 1.—Outline of study area with six catchments in which data on wetlands was collected.

TABLE 1.—Indices used for estimation of soil variables in field

Wetness index	
1	No wetland
2	Temporary wetness; mottles present below 20 cm
3	Temporary / seasonal wetness
4	Seasonal wetness; mottles present at the surface, some gleying
5	Semi-permanent wetness
6	Permanent wetness, peaty or gleyed soil
Texture index	
1	Gravel / grit
2	Sand
3	Loamy sand
4	Sandy loam / silt / silty loam
5	Loam
6	Clay loam / peat
7	Loamy clay
8	Clay
Organic material index	
1	Mineral soil
2	Humic, black or dark brown soils
3	Organic soil, no minerals present

tive relevés (3 × 3 m) according to the Braun-Blanquet method (Westhoff & Van der Maarel 1978), and a cover-abundance value was recorded for each species present. Some environmental variables were assessed at a plot level, such as soil depth (measured with a soil auger), soil texture (the field method, described by Ball 1986) and hydroperiod (as described by Kotze *et al.* 1996). Indices were developed for soil variables based on ranked classes (Table 1). The total number of vegetation relevés was 262 (Appendices A–C), and these relevés were distributed over more than 5 000 ha of wetlands. Areas that did not have an extensive period of saturation according to the hydroperiod assessment, were excluded from the study.

The vegetation samples were classified using TWINSPAN (Hill 1979), based on cover-abundance values for each species. After the TWINSPAN analysis, the classification was refined and data clusters were re-arranged by manual tabulation, as recommended by Feoli & Orloci (1985).

The relationship between identified wetland community types and environmental variables that varied on a large-scale (i.e. altitude) or locally (i.e. soil wetness, texture and humic indices) in the study area was examined using canonical variate analysis (CVA). CVA, akin to linear discriminant function analysis, is an ordination method that separates groups (classes from an *a priori* classification) along axes that are linear combinations of explanatory environmental variables, thus relating the distribution of communities to the environmental variables that best explain their distribution (Manly 1994).

Twenty-one of the identified community types, each represented by a minimum of four relevés to ensure an adequate sample size to estimate within and between community variability, were included in the CVA, which was undertaken using SPSS 13.0 for Windows (SPSS Inc., Chicago, IL, USA). This was followed by projection of community centroids and environmental variables in a low-dimensional biplot using software from the Canoco 4.5 package (ter Braak & Šmilauer 1997).

RESULTS

Thirty-six wetland communities were identified and a number of these were further subdivided into subcommunities based on the presence or absence of a co-dominant species or small differences in the list of diagnostic species, resulting in a total of 56 distinct plant communities. Tables 2 to 6 present a summary of these communities and subcommunities. In the descriptions below, communities are referred to by their name and number, whereas subcommunities are referred to by their number and dominant species.

The 36 communities have been divided into five major groups which have various components of their vegetation and their habitat in common, according to the refined TWINSPAN survey. These groups are: high-altitude fen and seepage communities, hygrophilous grasslands, shrubby wetland communities, mixed sedgelands, and low-altitude sedge and reedlands; all taxa recorded in the Appendices occur in the herb layer, with the exception of *Leucosidea sericea* which occurs in the shrub layer.

A large proportion of the communities are concentrated at lower altitudes, with 50 % of the communities more or less restricted to altitudes lower than 2 000 m. The following provides a brief description of communities, with an emphasis on those communities which are unique to the MDTP.

High-altitude fen and seepage communities

These are typical wetland communities of high altitudes, where precipitation is high, and where the headwaters of most streams are located (Table 2; Appendix A). Most of these communities only occur above 2 000 m and typically occur in slope or valleyhead seepages, which are the most common wetland systems at these altitudes. Peat is sometimes present (rarely on the South African side, more common in Lesotho) and many of these wetlands are affected by natural erosion. Usually they are dominated by forbs and C_3 grasses and only a few are dominated by sedges. Sedges are common in the permanently and seasonally wet parts of the wetlands, but many communities can also extend into the temporary zone of the wetland. Some of the most common wetland communities in this group are *Haplocarpha nervosa* Subcommunity (1c), together with the *Kniphofia caulescens* Subcommunity (2a), the *Scirpus ficinioides* Community (4), the *Merxmuellera macowanii* Community (5), and the *Gunnera perpensa* Subcommunity (8b).

Hygrophilous grasslands

These communities occur mostly in temporarily wet parts of wetlands towards the periphery and have floristic similarity with the surrounding non-wetland vegetation. They are found at all altitudes but mostly in floodplains or at the edge of valleyhead or slope seepages. They are generally dominated by C_4 grasses (Subcommunity 9a is dominated by *Festuca caprina*, a C_3 grass), in most cases grass species that would also be found outside wetlands. The most common wetland communities of this type (Table 3; Appendix B) are dominated either by *Themeda triandra* (Community 9), *Aristida junciformis* (Community 11), *Eragrostis plana* or *E. planiculmis* (Community 12), and, in the northern part of the Drakensberg, by *Hyparrhenia dregeana* (Community 13).

Shrubby wetlands

Although wetlands with woody plants are not usually encountered in the Drakensberg, there were a few cases where wetlands were found dominated by woody species, such as *Leucosidea sericea*, suggesting some form of disturbance. Some of the other shrubby wetland types are unusual communities that have been encountered only occasionally. Only a few shrubs can be regarded as typical wetland species, such as *Mentha longifolia*. Riparian species not usually associated with wetlands such as *Cliffortia linearifolia* are found occasionally. Few vegetation plots were located in this group of communities and an overview of the types of shrubby wetlands in the area is presented in Table 4; Appendix B.

Mixed sedgelands

These are the most common seasonal and permanent wetland communities in the MDTP area, with a mixture of various sedges and grasses. The dominant species are mostly sedges, but there are various species of grass that appear to be adapted to wetland conditions. Most of these communities are dominated by a single grass or sedge species. The communities occur mostly in seasonally or permanently wet areas on a loamy soil at low and intermediate altitudes (below 2 300 m). The most common wetland communities in this group (Table 5) are the *Fuirena pubescens* Mixed sedgeland Subcommunity (21b), the *Andropogon appendiculatus* Mixed sedgeland Community (24) and the *Leersia hexandra–Eleocharis dregeana* wetland Community (32). Another very common community is the *Miscanthus capensis* grassland Community (26), a tall grass that often occurs in a temporarily flooded setting. As a consequence of its species composition, the *Miscanthus capensis* Community fits better with the mixed sedgelands than with the hygrophilous grasslands, even though it is dominated by a grass species. The same applies to communities dominated by *Leersia hexandra* or *Arundinella nepalensis*.

TABLE 2.—High-altitude fens and seepages in MDTP area

Community no.	Community name	Subcommunity	Dominants	No. relevés	Wetland type	Soil type	Wetness	Altit. zone (m)	Transects
1	High altitude dicot lawns	1a	*Koeleria capensis*, *Poa binata*, *Merxmuellera disticha*, *Scirpus falsus*, many co-dominants	10	valleyhead seepages	loam, clay or peat	temporary to permanent	2 500–2 900	Bell River and Umkomazi River
		1b	*Juncus dregeanus*, *Athrixia fontana*, *Restio sejunctus*, many co-dominants	4	valleyhead seepages	peat or humic sand over sheet-rock	seasonal or permanent	2 500	Bell River
		1c	*Haplocarpha nervosa*, *Cotula hispida*, *Ranunculus meyeri*, many co-dominants	10	valleyhead seepages	loam, clay or peat	temporary to permanent	1 900–2 600	Bell River and Ongeluksnek
2	*Kniphofia* or *Carex* seepages	2a	*Kniphofia caulescens*	3	valleyhead seepages	clay loam	semi-permanent	2 300–2 600	Bell River and Umkomazi River
		2b	*Carex cognata*	3	valleyhead seepages	clay loam or peat	seasonal or permanent	1 600–2 600	Cedarville, Umkomazi River and Bell River
3	*Kyllinga* depressions	3	*Kyllinga pulchella*	2	bedrock pools or other depressions	organic material and loam, shallow	seasonal or permanent	2 300–2 500	Bell River and Klerkspruit
4	*Scirpus* seepages	4	*Scirpus ficinioides*	6	various seepages	silty or sandy loam	temporary to permanent	1 800–2 400	Bell River, Mlambonja River, Umkomazi River and Klerkspruit
5	*Merxmuellera* wetlands	5	*Merxmuellera macowanii*	7	valleyhead seepages	humic loam	temporary or seasonal	2 000–2 500	Bell River, Mlambonja River, Umkomazi River and Klerkspruit
6	Broad-leaved seepages	6	*Alepidea amatymbica*, *Peucedanum thodei*, *Senecio inornatus*	2	various seepages	humic loam	temporary	2 300	Umkomazi River
7	*Carpha filifolia* wetlands	7a	*Carpha filifolia*	2	various seepages	sand or peat	semi-permanent	2 300–2 400	Ugie and Umkomazi River
		7b	*Carpha filifolia*, *Isolepis pellocolea* and *Ranunculus baurii*	2	various seepages	clay loam	semi-permanent	2 300–2 400	Ugie and Umkomazi River
8	*Gunnera perpensa* wetlands	8a	*Kniphofia northiae* with many co-dominants	1	slope seepage	humic clay	permanent	2 200	Ugie
		8b	*Gunnera perpensa* with many co-dominants	7	various seepages and oxbow in floodplain	loam or clay loam	very broad, sometimes also outside wetlands	1 700–2 300	Bell River, Ugie, Umkomazi River and Klerkspruit

TABLE 3.—Hygrophilous grasslands in MDTP area

Community no.	Community name	Subcommunity	Dominants	No. relevés	Wetland type	Soil type	Wetness	Alt. zone (m)	Transects
9	Hygrophilous grasslands with *Themeda*	9a	*Festuca caprina*	5	various seepages	loam or clay loam	temporary to seasonal	1 600–2 600	Bell River, Umkomazi River and Klerkspruit
		9b	*Aristida monticola*	1	slope seepage	loam	temporary	2 300	Klerkspruit
		9c	*Themeda triandra*, *Harpochloa falx* and *Festuca caprina*	21	floodplains and seepages	loam	temporary to seasonal	1 400–2 600	across all transects
		9d	*Microchloa caffra* and *Eragrostis racemosa*	2	footslope seepages	sandy loam	temporary to seasonal	1 900–2 200	Bell River and Klerkspruit
10	Hygrophilous grasslands with *Eragrostis chloromelas*	10a	*Pennisetum sphacelatum*, *Eragrostis chloromelas*	6	valleyhead or footslope seepages	loam or clay loam	temporary	1 800–1 900	Bell River
		10b	*Fingerhuthia sesleriiformis*	2	valleyhead seepage	?	?	1 600–2 500	Bell River and Umkomazi River
		10c	*Catalepis gracilis*	4	various seepages	various loamy substrates	temporary to seasonal	1 800–2 600	Bell River and Klerkspruit
11	Hygrophilous grasslands with *Aristida junciformis*	11a	*Stiburus alopecuroides*	2	valleyhead or footslope seepages	loam or sandy loam	temporary	1 900–2 400	Bell River and Ugie
		11b	*Aristida junciformis*, *Helichrysum aureonitens*	10	various	various loamy and sandy substrates	temporary to seasonal	1 300–2 100	Ugie, Cedarville, Umkomazi River and Klerkspruit
12	*Eragrostis plana* / *Eragrostis planiculmis* grasslands	12a	*Eragrostis plana*, *Sporobolus africanus*	7	floodplains, pans and footslope seepages	various types of loam	temporary to seasonal	1 300–1 800	Bell River, Cedarville and Mlambonja River
		12b	*Eragrostis planiculmis*	6	floodplains and seepages	clay loam	seasonal	1 400–2 100	Cedarville, Mlambonja River and Klerkspruit
13	*Hyparrhenia dregeana* grasslands	13	*Hyparrhenia dregeana*	5	valleyhead seepages and floodplain	various types of loam	temporary to seasonal	1 600–2 400	Klerkspruit, Cedarville and Umkomazi River
14	Grasslands with disturbance species	14	*Imperata cylindrica*, *Paspalum dilatatum*	2	floodplain and footslope seepage	sandy loam	temporary to seasonal	1 300–1 400	Mlambonja River

Reed and sedgelands

These communities typically occur at low altitudes within the study area (lower than 2 000 m), with a dominance of some very widespread wetland species such as *Phragmites australis* and *Carex acutiformis*, occurring in permanently wet situations. These communities, except for the one dominated by *Carex acutiformis*, occur only marginally in the study area while being widespread across the mesic parts of the central plateau of the South African interior [Mucina & Rutherford 2006; N. Collins, Free State Dept of Economic Development, Tourism and Environmental Affairs (DTEEA) pers. comm.]. The wetlands dominated by *Persicaria* species represent disturbed patches within reedlands. Table 6; Appendix C indicates the different types of reed and sedgelands found in the study area.

Community–environment relations

A Canonical Variate Analysis (CVA) of the 21 wetland communities with four or more representative relevés in the study area reveals two significant ($P<0.001$) orthogonal canonical functions that explained 90 % of the distribution of these communities along the examined environmental gradients (Table 7). Altitude is closely related to the first ($r = 0.964$), and wetness index to the second ($r = 0.991$) CVA function with the former axis accounting for almost twice as much variability as the latter (59.5 % vs 30.5 %). Soil texture and humic indices are not strongly correlated with any of the main environmental gradients of altitude and wetness.

Wetland communities are widely distributed along the altitude gradient (Figure 2), ranging in altitude from just over 1 400 m to more than 2 400 m ('high altitude dicot lawns') (Figure 3a). Most of the communities at low altitudes are dominated by grasses or sedges, and whereas there are still grass and sedge-dominated communities at high altitudes, communities dominated by bulbous monocots and dicots become more prominent. The soil wetness coenocline is independent of the altitudinal distribution of wetlands (Figure 2), with most communities located on temporary to semi-permanently wet soils (wetness index 2–5) (Figure 3b). The communities on the drier end of the spectrum tend to be dominated by grasses, whereas most of the communities on the wetter end of the spectrum, are dominated by sedges. Some exceptions are the *Phragmites australis* Community (36), the *Kniphofia caulescens* Subcommunity(2a) and the *Kniphofia linearis-*

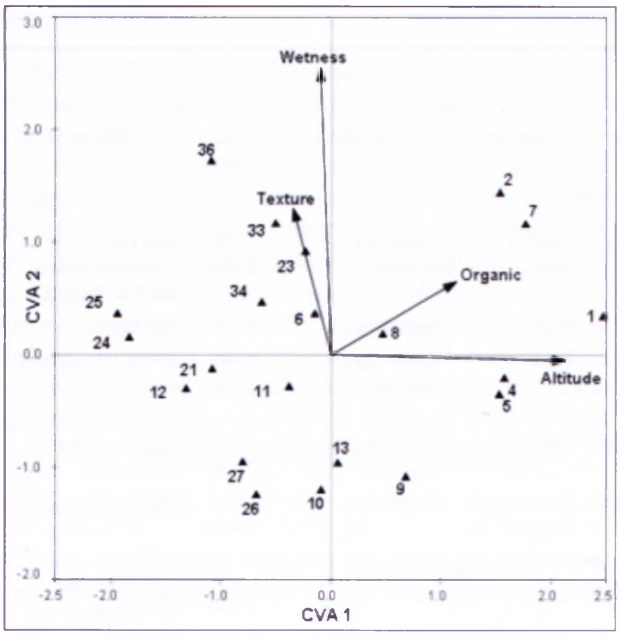

FIGURE 2.—Canonical variate analysis (CVA) plot of MDTP wetland community centroids and direction of maximum variation in environmental variables (see Table 7 for details of environmental variables and Tables 2–6 for a description of community types).

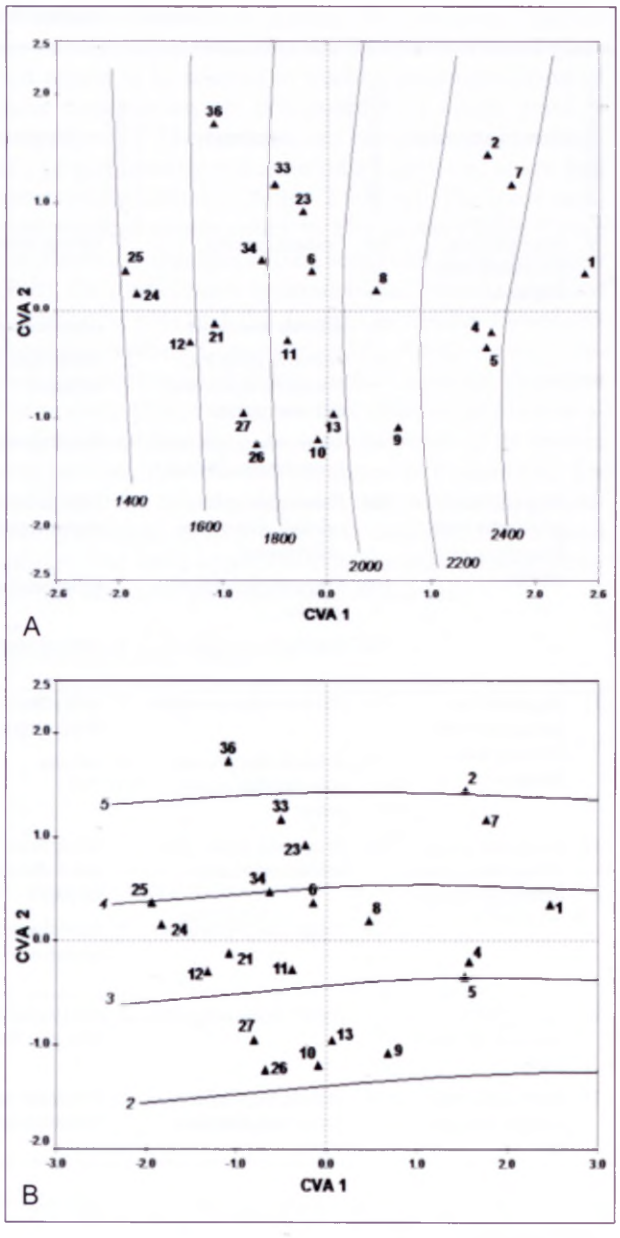

FIGURE 3.—Centroids for MDTP wetland communities in relation to trends (fitted by locally weighted smoothing) in A, altitude (m); and B, wetness index (ranked scale) across the canonical variate analysis (CVA) plot (Figure 2). Numbers refer to Community types in Tables 2–6.

folia Community (33), which occur in the permanently wet areas of a wetland. An overview of the occurrence of the various community types across the spectrum of altitude and hydroperiod is presented in Table 8.

DISCUSSION

Most of the vegetation types that have been described above are easily differentiated on the basis of their dominant species. In wetland communities it is very common for just one or two species to dominate the entire vegetation community (Boutin & Keddy 1993; Cronk & Fennessy 2002). However, when two communities are dominated by different species but the overall species composition is similar, they have been retained as a single community since it is possibly a matter of stochastic factors as to which species starts to dominate (e.g. which species arrived first). It is assumed that most of the communities that occur at low altitudes within the study area are actually widespread in other parts of the Grassland Biome and in some cases this can be confirmed (Mucina & Rutherford 2006; N. Collins, DTEEA Bloemfontein, pers. comm.).

The most important environmental gradients impacting on wetlands in the MDTP area are altitude and wetness. Wetlands are most common at low altitudes (below 2 500 m) and at high altitudes (2 800 m and higher) and there is a clear dichotomy between them in the vegetation classification, as has been described by Hill (1996) and Mucina & Rutherford (2006). The Eastern Cape portion of the MDTP has slightly more wetlands at intermediate altitudes but the dichotomy between high- and low- altitude wetlands remains in place, and some of the typical 'high-altitude communities' descend to altitudes of ± 1 700 m (*Gunnera perpensa* communities). Being the southernmost extension of the Drakensberg, this could also be due to the latitudinal effect on vegetation patterns, with more frost present at lower altitudes in the southern extensions of the MDTP area (Hilliard & Burtt 1987). Some of the high-altitude wetland communities, such as the *Kyllinga pulchella* depression Community (3) and *Carpha filifolia* Community (7), were not encountered very often during this study.

The high-altitude communities in the MDTP have the highest conservation value of the communities described, since most are endemic to this high-lying 'island' in the South African landscape. Studies of the mires in Lesotho (Jacot Guillarmod 1962, 1963; Van Zinderen Bakker & Werger 1974; Backeus 1988; Backeus & Grab 1995) show that these vegetation types (Communities 1 to 8) are more diverse in composition than described in the present study, and some communities, for example those dominated by *Merxmuellera macowanii*, also occur widely in the mountainous areas of Lesotho. There is a steep rain-

TABLE 4.—Shrubby wetlands in MDTP area

Community no.	Community name	Subcommunity	Dominants	No. relevés	Wetland type	Soil type	Wetness	Alt. zone (m)	Transects
15	*Mentha longifolia* wetlands	15a	*Mentha longifolia*	1	valleyhead seepage	silty clay	seasonal	2 200	Klerkspruit
		15b	*Mentha aquatica*, *Senecio inornatus*	2	valleyhead seepage or valley bottom	clay or clay loam	permanent	1 300–1 400	Ugie and Umkomazi River
16	Sheetrock wetland with *Crassula dependens*	16	*Crassula dependens*, *Cyperus schlechteri*, *Aristida junciformis*	1	bedrock pool	gravel and grit	seasonal	2 000	Umkomazi River
17	*Leucosidea sericea* wetlands	17	*Leucosidea sericea*	2	valleyhead or footslope seepage	clay loam or loam	temporary to seasonal	1 400–2 100	Klerkspruit and Umkomazi River
18	*Helichrysum splendidum* encroachment	18	*Helichrysum splendidum* encroachment	1	footslope seepage	humic loam	temporary	2 200	Bell River
19	*Cliffortia* wetlands	19	*Cliffortia linearifolia*, *Helichrysum umbraculigerum*	1	footslope seepage	loam	temporary	1 400	Umkomazi River
20	*Artemisia* wetlands	20	*Artemisa afra*	2	floodplains and footslope seepage	loam	temporary	1 500–1 700	Ugie and Umkomazi River

TABLE 5.—Mixed sedgelands in MDTP area

Community no.	Community name	Subcommunity	Dominants	No. relevés	Wetland type	Soil type	Wetness	Alt. zone (m)	Transects
21	Mixed sedgelands with *Fuirena pubescens*	21a	*Scleria welwitschii*	5	valleyhead seepages, valley bottom and isolated pan	loam, sandy loam or sandy clay	temporary to seasonal	1 300–2 000	Ugie, Umkomazi River and Cedarville
		21b	*Fuirena pubescens*	7	valleyhead and footslope seepages	sandy clay or sandy loam	temporary to seasonal	1 300–2 300	all except Klerkspruit
22	Mixed sedgelands with *Pycreus macranthus*	22a	*Pycreus macranthus*	2	depressions and footslope seepages	loam	seasonal	1 400–2 000	Cedarville and Mlambonja River
		22b	*Cyperus denudatus*	1	pan	humic clay	permanent	2 100	Klerkspruit
23	Mixed sedgelands with *Kyllinga pauciflora*	23	*Pennisetum thunbergii*, *Kyllinga pauciflora*	8	seepages, valley bottoms or floodplains	clay loam or peat	seasonal to permanent	1 400–2 300	Cedarville, Umkomazi River, Klerkspruit and Bell River
24	Mixed sedgelands with *Andropogon appendiculatus*	24	*Andropogon appendiculatus*, *Fimbristylis complanata*	9	seepages and floodplain	sandy clay or loam	temporary to permanent	1 300–1 800	Ugie, Umkomazi River and Bell River
25	*Arundinella* grasslands	25a	*Ludwigia palustris*	1	footslope seepage	loam	seasonal	1 400	Mlambonja River
		25b	*Arundinella nepalensis*	8	valley bottom wetlands, floodplains and seepages	loam or clay	temporary to permanent	1 300–1 700	Klerkspruit, Ugie, Mlambonja River and Umkomazi River
26	*Miscanthus* grasslands	26	*Miscanthus capensis*	16	floodplains, valleyhead and footslope seepages	various types of loam	temporary	1 400–2 200	in all transects except Cedarville
27	*Cyperus marginatus* sedgelands	27	*Cyperus marginatus*	4	footslope seepages and floodplains	loam, loamy sand or clay silt	temporary to seasonal	1 500–1 900	Bell River, Umkomazi River and Klerkspruit
28	*Eleocharis limosa* wetlands	28	*Eleocharis limosa*	2	isolated pans and floodplains	humic clay	semi-permanent to permanent	1 700–2 100	Klerkspruit
29	*Cyperus fastigiatus* wetlands	29	*Cyperus fastigiatus*	3	floodplains	sand, clay or clay loam	seasonal to permanent	1 600	Cedarville
30	*Typha capensis* wetlands	30	*Typha capensis*	3	floodplains or isolated pans	clay or clay loam	semi-permanent to permanent	1 600–2 000	Klerkspruit and Cedarville
31	*Schoenoplectus decipiens* wetlands	31	*Schoenoplectus decipiens*	3	floodplains or valleyhead seepages	clay or clay loam	seasonal to permanent	1 600–1 800	Cedarville and Bell River
32	*Leersia hexandra* / *Eleocharis* wetlands	32a	*Leersia hexandra*, *Hemarthria altissima*	12	isolated pans and floodplains	clay or clayey soils	seasonal to permanent	1 300–2 100	Cedarville, Ugie and Klerkspruit
		32b	*Eleocharis dregeana*, *Leersia hexandra*	12	floodplains, isolated pans and seepages	loam, clay loam or clay	seasonal to permanent	1 400–2 600	all except Ugie

TABLE 6.—Reed and sedgelands in MDTP area

Community no.	Community name	Subcommunity	Dominants	No. relevés	Wetland type	Soil type	Wetness	Alt. zone (m)	Transects
33	*Kniphofia linearifolia* wetlands	33	*Kniphofia linearifolia*	3	valleyhead or footslope seepages	loam or clay loam	temporary to semi-permanent	1 400–1 600	Umkomazi River
34	*Carex acutiformis* wetlands	34a	*Carex acutiformis*, *Miscanthus capensis*	5	floodplains or footslope seepages	clay or loam	temporary to seasonal	1 400–1 900	Bell River and Umkomazi River
		34b	*Carex acutiformis*	10	floodplains, valley bottom wetlands, and seepages	loam, clay or clay loam	temprary to permanent	1 600–2 300	Bell River, Ugie, Cedarville and Klerkspruit
35	*Persicaria* wetlands	35a	*Persicaria decipiens*	1	valleyhead seepage	clay loam	permanent	2 000	Cedarville
		35b	*Persicaria lapathifolia*	1	floodplain	?	permanent	1 600	Cedarville
36	*Phragmites australis* wetlands	36a	*Phragmites australis*, *Carex acutiformis*	3	floodplains or footslope seepages	loam, peat or clay loam	semi-permanent to permanent	1 400–1 500	Mlambonja River and Umkomazi River
		36b	*Phragmites australis*	3	floodplains	clay loam or clay	semi-permanent to permanent	1 700	Ugie and Klerkspruit

fall gradient from the escarpment area in the KwaZulu-Natal Drakensberg towards inland Lesotho, with the actual escarpment being the wettest (Schulze 1997).

The foothills of the MDTP area have numerous wetlands, which may otherwise be quite uncommon in areas such as KwaZulu-Natal or Eastern Cape, where the deeply dissected landscape precludes the development of extensive wetlands. Most of the vegetation communities in the wetlands of the foothills are, however, more widely distributed, especially in areas such as the eastern Free State or the KwaZulu-Natal midlands (pers. obs.). Many of the communities described in the present study can also be expected in the mesic grassland areas of KwaZulu-Natal and Eastern Cape, and the higher-lying areas of eastern Free State and Mpumalanga.

Regarding the influence of soil wetness on wetland composition and structure, the typical pattern is that the temporary wetlands are dominated by grasses and the seasonal and permanent wetlands are dominated by sedges and other monocots. High altitudes are, however, depauperate in sedge species and a mix of other taxa occupy the niches of seasonal to permanent wetlands, such as *Kniphofia caulescens* and *Haplocarpha nervosa*. Other studies have found these herb-rich communities in permanently flooded soils at high altitudes (Backeus 1988; Backeus & Grab 1995). It seems that wetness has a major impact on the distribution of functional types in these communities (Sieben *et al.* 2009), whereas in the current study, altitude (a variable closely linked to many factors that directly influence plant growth and survival) explains more variation of the wetland vegetation composition.

At all altitudes, erosion is a severe threat to these wetlands. Due to the location on a scarp, there is already a significant proportion of natural erosion and this can only be exacerbated by overgrazing. The process of overgrazing has been described in detail for the high-altitude mires of Lesotho (Jacot Guillarmod 1968; Nüsser & Grab 2002); however, it certainly also applies to the South African portion of the MDTP. At altitudes lower than 2 000 m, in particular, there are many wetlands that are badly degraded as a result of overgrazing, which is not surprising given the extensive permanent human settlement in this region. Many wetlands at the foothills of the MDTP have steep erosion gullies and the overall health of these wetlands is lower than those at higher altitudes (Kotze *et al.* 2006). This presents one of the biggest conservation challenges in the MDTP area.

An overview of wetland types as it is presented in this paper is particularly important for conservation planning. The high-altitude wetlands are unique to the moun-

TABLE 7.—Results of canonical variate analysis (CVA) of environmental differences among 21 wetland community types in Maloti-Drakensberg Transfrontier Park

	Canonical function			
	1	2	3	4
Eigenvalue	1.458	0.747	0.134	0.110
% of variance	59.5	30.5	5.5	4.5
Cumulative %	59.5	90.0	95.5	100.0
Canonical correlation	0.770	0.654	0.344	0.315
P-value*	<0.001	<0.001	0.106	0.215
Correlation with environmental variables				
Altitude	0.964	-0.023	-0.208	0.166
Wetness	-0.040	0.991	0.091	-0.094
Organic	0.393	0.224	0.880	-0.143
Texture	-0.115	0.430	0.207	0.871

* Wilks' Lambda test of significance of canonical function.

TABLE 8.—Number of relevés of community types in all altitudinal and wetness zones

Community type	Altitudinal zone					Total	Hydroperiod		
	1 000–1 400 m	1 400–1 800 m	1 800–2 200 m	2 200–2 600 m	2 600–3 200 m		Temporary	Seasonal	Permanent
1			1	12	11	24	9	6	8
2		1		3	2	6		2	4
3				2		2		1	1
4			2	3	1	6	2	2	1
5			3	4		7	3	4	
6				2		2	2		
7				4		4		1	3
8		1	4	3		8	3	2	3
High-altitude fens and seepages	0	2	10	33	14	59	19	18	20
9	1	6	5	12	5	29	23	4	
10		1	8	1	2	12	8	2	
11	1	5	5	1		12	4	7	
12	1	10	2			13	4	9	
13		2	1	2		5	4	1	
14	1	1				2		2	
Hygrophilous grasslands	4	25	21	16	7	73	43	25	0
15	1	1		1		3		1	2
16			1			1		1	
17		1	1			2	1	1	
18			1			1	1		
19		1				1	1		
20		2				2	2		
Shrubby wetlands	1	5	3	1	0	10	5	3	2
21	4	5	2	1		12	2	6	1
22		1	2			3		2	1
23		3	4	1		8		6	2
24	6	1	2			9	2	4	2
25	3	6				9	2	4	3
26		8	7	1		16	12	4	
27		2	2			4	3	1	
28		1	1			2			2
29		3				3		1	2
30		2	1			3			3
31		1	2			3		2	1
32	1	12	8	2	1	24		13	11
Mixed sedgelands	14	45	31	5	1	96	21	43	28
33		3				3	1	1	1
34		4	8	1		13	2	5	6
35		1	1			2			2
36		6				6			6
Reed and sedgelands	0	14	9	1	0	24	3	6	15

tains of the Drakensberg and Lesotho (where they occur more extensively). Lesotho has a high proportion of the community types 1 to 8 as described in this study, therefore the wetlands of Lesotho need to be an integral component of any conservation planning undertaken for the region. However, the wetlands in Lesotho face particular problems of overgrazing and the grazing regime is very difficult to regulate (Nüsser & Grab 2002). From a South African perspective, it is interesting to note that a considerable number of large wetlands have been found in the Eastern Cape portion of the MDTP area. Some of these wetlands contain vegetation types that seem to be largely confined to this area, such as Subcommunities 1b, 1c and 10a. This part of the MDTP area certainly deserves more official protection, to ensure conservation of the structural integrity, composition, diversity and functionality of the wetland communities.

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Appendix A.—Phytosociological table of Communities 1–8 (High-altitude fen and seepage communities)

Community	1																								2						3		4						5							6		7				8							
Subcommunity	1a										1b				1c										2a			2b																				7a		7b		8a	8b						
Relevé no.	2004	2008	2012	2138	2157	2158	2159	2160	2161	2162	2001	2002	2003	2069	2005	2006	2072	2074	2075	2231	2232	2233	2234	2250	2009	2073	2166	2011	2115	2222	2031	2262	2067	2076	2078	2095	2112	2152	2000	2068	2097	2113	2173	2175	2261	2164	2169	2016	2165	2014	2167	2013	2017	2019	2025	2080	2163	2172	2254
Schoenoxiphium sparteum	m			b	r		a	a	b		1																												r																				
Berkheya multijuga	1				b	3				1																																								+		+							
Merxmuellera disticha	m		1	+	a		m	3	3													+																																					
Scirpus falsus					b	3	b	a		m																																										m							
Senecio cryptolanatus				+			a	m	b																																																		
Pentaschistis galpinii			1				1			1																																																	
Pentaschistis sp.							m		a	3																																																	
Moraea alticola	+	m							1																																																		
Eriocaulon dregei				4					a			m																																				m											
Helichrysum krookii						a	+			1																																																	
Juncus dregeanus											1	r	b	a					1	r															1															+									
Anagallis huttonii											+	a	a	+																									+																				
Athrixia fontana											1	1	a	a																																		+											
Cerastium arabidis	+		+								1	1	+			+		+																																									
Senecio polyodon		1									+	+	1			m								+																																			
Schoenoxiphium filiforme											+	1	1																																														
Erica alopecurus	r										+	r																																															
Sebaea marlothii											m		r																																														
Tulbaghia sp.											m			+																																													
Wurmbea elatior	r				+						+		1	+																																			+										
Alepidea natalensis												+		+								1																										1											
Dierama pauciflorum	1											+	1																																														
Hesperantha tysonii												1	+																																														
Rhodohypoxis deflexa												r	+																							1																							
Juncus oxycarpus											+	r							r																																		r						
Restio sejunctus	1											4	1																										+																				
Koeleria capensis		b	b	m	+	+	1			+	1		1	+		1																									r												1			m			
Luzula africana	1				m		1				+	+	+																																														
Agrostis bergiana	r										+	1	1	3			1	+		r		+					+												+								1		+		+		1						
Haplocarpha nervosa			r									1		a	3	+		+	3	3	+															r			b									+											
Isolepis angelica													1						m	b	b		a	4											m	1																							
Helichrysum cymosum subsp. calvum	+										1			+			r	+				+														+																							
Geranium multisectum													+				+	4				+																														+							
Cotula hispida		m													r	m				m	m	+	b													+														+									
Lobelia erinus	+										1		1					1						+																r										+						+			
Alchemilla colura	m												1	r				r				1																											1										
Limosella maior															b					b	a																																						
Ranunculus multifidus		1															r	1	1																																								
Eragrostis caesia																					a	b	m									m				a																							
Ranunculus meyeri								a	m			1	a	+	3	3			1	a	m		b	a	m					1					b																		r						

Appendix A.—Phytosociological table of Communities 1–8 (High-altitude fen and seepage communities) (cont.)

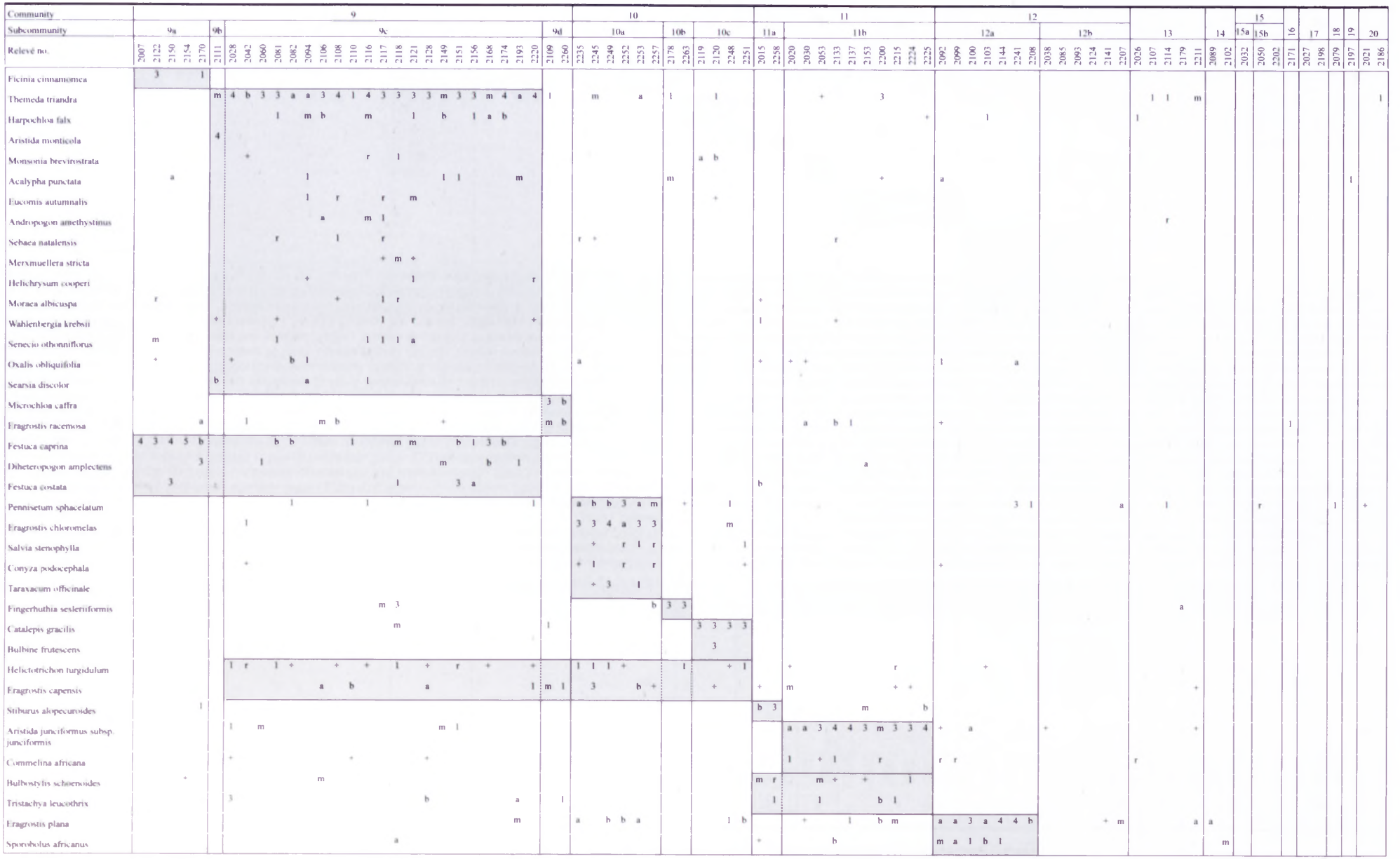
Community	1																								2						3		4						5							6		7				8							
Subcommunity	1a										1b				1c										2a			2b			3		4						5							6		7a		7b		8a	8b						
Relevé no.	2004	2008	2012	2138	2157	2158	2159	2160	2161	2162	2001	2002	2003	2069	2005	2006	2072	2074	2075	2231	2232	2233	2234	2250	2009	2073	2166	2011	2115	2222	2031	2262	2067	2076	2078	2095	2112	2152	2000	2068	2097	2113	2173	2175	2261	2164	2169	2016	2165	2014	2167	2013	2017	2019	2025	2080	2163	2172	2254
Trifolium burchellianum			+		1								1	1	m	3		1	+	a		r	b																																				
Kniphofia caulescens								b				1	a	a				r	r						5	5	4	3																									+						
Deschampsia cespitosa		+													+	+			a						1	a																																	
Carex cognata																											b	4	4	4					r							+							b				m						
Kyllinga pulchella																															3	4				r																							
Senecio harveianus		1																					r								r	1				1																							
Scirpus ficinioides											+																						3	5	3	b	3	a																					
Crassula gemmifera																				1	r														m			1																					
Merxmuellera macowanii	a										1	a																							1				4	4	3	4	5	3	5					1						a			
Drimia macrocentra																																									+			+															
Poa binata		3	4		1	a	b		a				+			1	b	b	1									r				a	+	m					1	+		1														1			
Epilobium capense												+							r											+				+	+				r	+	r			r								+	+						
Isolepis fluitans											+	a		m					1																	m			b	m																			
Peucedanum thodei																																														m	4					1	+						
Alepidea amatymbica	+																																													3	3												
Senecio inornatus						3																																	1			m				b	a				1		+						
Carpha filifolia																																																4	4	m	a								
Isolepis pellocolea																																																		+	4		1						
Ranunculus baurii	+												a																																					a	1		1						
Hypericum lalandii																																																	1		+								
Senecio gregatus																											m																						a		m								
Kniphofia northiae																																																				4							
Gunnera perpensa																											b														a					m			m		1	3	5	3	4	4	4	4	3
Juncus inflexus																1																																								+			3
Nidorella agria			a																																																	1	1	a		a			
Mentha aquatica																								1											+																	1	1	3					3
Themeda triandra	1																																				1												1							a	m	b	
Festuca caprina	m	r	m		m	m						a		1		a	4	r	m			1			a								1		+				a	3				3	3	a	b			1									
Agrostis lachnantha											+													+				1		1				+	1		m					1											+			1			+
Helictotrichon turgidulum												+						a				r											r				1								+											r			
Andropogon appendiculatus																																												b		b			b	+	1						m	b	
Carex glomerabilis																	1								+								1							+		+														1			
Eleocharis dregeana															m						b		m																														m	+	4				
Carex acutiformis																			r					m									1																			1	a						3
Oxalis depressa											+	1					+																	+					+	+																			
Oxalis obliquifolia																	a								r							r				m					+																		
Pennisetum sphacelatum																						a											a																							a	b	b	
Senecio discodregeanus	r													+			+																	r						1																			
Cyrtanthus breviflorus				r				+									r																							r													+						
Eragrostis planiculmis																																	3											a															
Geum capense			+								r											b																	1																				
Helichrysum subglomerata											1							+				a														+																							

Appendix A.—Phytosociological table of Communities 1–8 (High-altitude fen and seepage communities) (cont.)

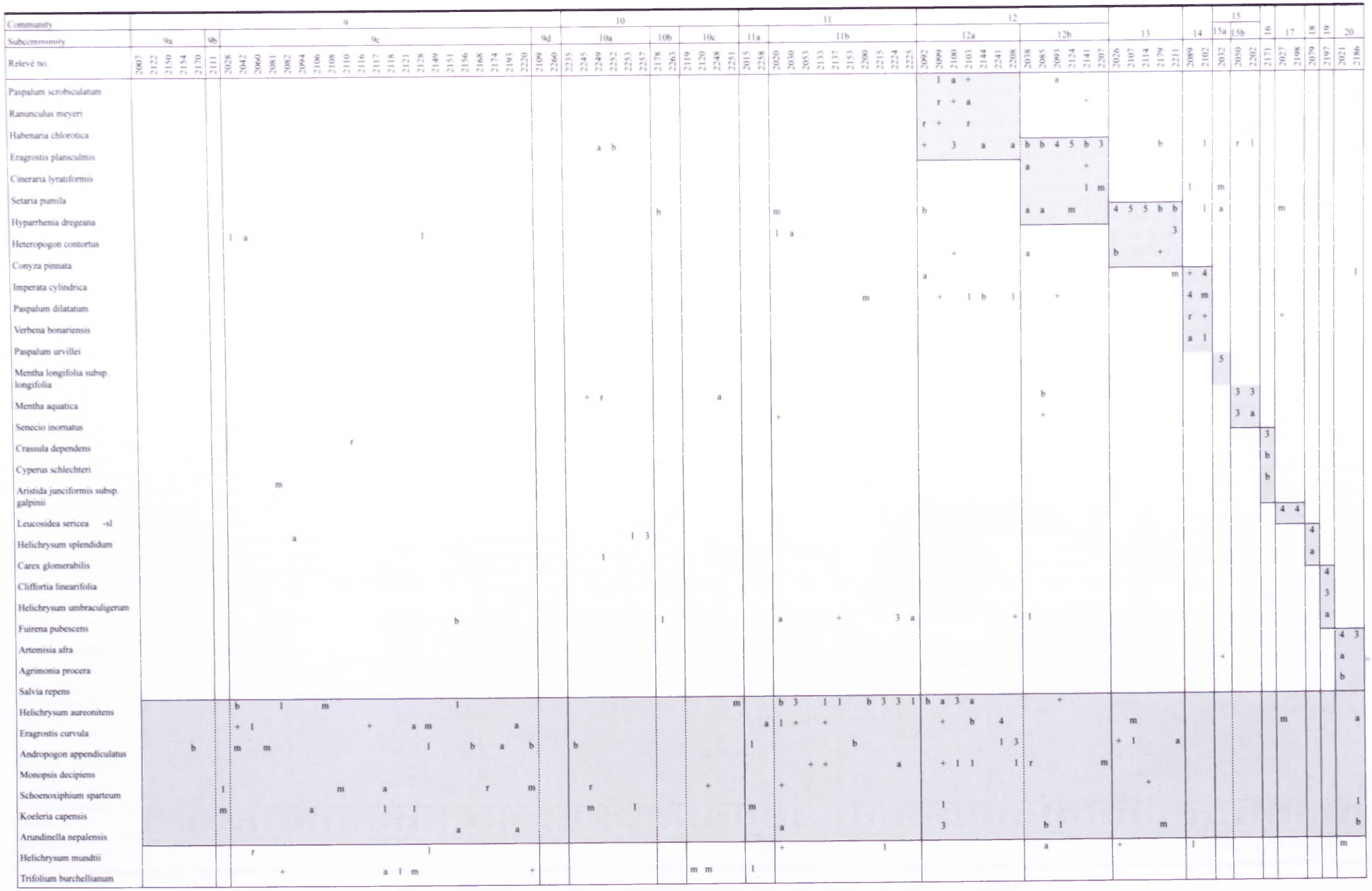
Community	1																								2						3		4						5							6		7				8							
Subcommunity	1a										1b				1c										2a			2b			3		4						5							6		7a		7b		8a	8b						
Relevé no.	2004	2008	2012	2138	2157	2158	2159	2160	2161	2162	2001	2002	2003	2069	2005	2006	2072	2074	2075	2231	2232	2233	2234	2250	2009	2073	2166	2011	2115	2222	2031	2262	2067	2076	2078	2095	2112	2152	2000	2068	2097	2113	2173	2175	2261	2164	2169	2016	2165	2014	2167	2013	2017	2019	2025	2080	2163	2172	2254
Senecio barbatus	+										1						r																							r																			
Sebaea repens							+		r											r																1																							
Rhodohypoxis baurii	r										+																																					r		1									
Harpochloa falx					a	1																																						1															
Fingerhuthia sesleriiformis																								r												+																	1						
Gazania krebsiana			r								r																																					r											
Euphorbia natalensis	1																																																			1				+			
Berkheya sp.					+															r		1																																					
Rumex rhodesius																	r								r																														1				

Afrotysonia glochidiata 2172(a), 2173(+), Andropogon amethystinus 2112(b), 2114(m), Berkheya macrocephala 2003(b), 2017(1), Berkheya purpurea 2004(+), 2080(+), Bulbostylis humilis 2016(1), 2031(a), Carex sp. 2095(r), 2175(1), Conyza pinnata 2112(b), 2173(1), Crassula natalensis 2013(+), 2157(r), Crassula peploides 2001(1), 2004(r), Crassula tuberella 2001(+), 2005(r), Cyperus schlechteri 2001(m), 2014(+), Epilobium tetragonum 2250(r), 2254(1), Eragrostis planiculmis 2067(3), 2175(a), Geranium robustum 2004(1), 2113(b), Geranium schlechteri 2097(+), 2166(+), Helichrysum adenocarpum 2159(+), 2162(1), Helichrysum aureonitens 2001(r), 2003(1), Helichrysum splendidum 2001(1), 2080(1), Helictotrichon longifolium 2012(1), 2262(+), Isolepis costata 2113(m), 2222(3), Isolepis sp. 2072(r), 2097(r), Juncus exsertus subsp. lesuticus 2231(+), 2232(r), Limosella inflata 2008(+), 2075(+), Limosella vesiculosa 2069(b), 2074(1), Merxmuellera sp. 2158(m), 2161(m), Miscanthus capensis 2067(a), 2097(+), Myosotis afropalustris 2013(1), 2017(r), Passerina montana 2001(+), 2012(r), Pennisetum thunbergii 2025(1), 2175(m), Pentaschistis setifolia 2157(b), 2169(a), Phragmites australis 2019(+), 2202(3), Sebaea natalensis 2001(1), 2004(+), Senecio natalicola 2001(+), 2160(m), Sporobolus africanus 2008(+), 2031(1), Stiburus alopecuroides 2014(+), 2095(1), Taraxacum officinale 2012(1), 2074(+), Arctotis arctotoides 2009(+), Aristida junciformis subsp. galpinii 2004(+), Aristida junciformis subsp. junciformis 2097(+), Aristida sp. 2080(+), Ascolepis capensis 2017(1), Aster erucifolius 2001(1), Berkheya speciosa 2112(b), Bromus catharticus 2067(+), Bulbostylis schoenoides 2014(b), Bulbostylis sp. 2095(1), Carex austro-africana 2175(b), Carex monotropa 2001(+), Carex subinflata 2009(1), Cliffortia linearifolia 2097(+), Commelina africana 2031(1), Conyza albida 2019(1), Cotula socialis 2001(1), Crassula dependens 2031(+), Crassula setulosa 2095(+), Cymbopogon dieterlenii 2097(1), Cynoglossum hispidum 2112(m), Cyperus congestus 2019(1), Cyperus marginatus 2067(1), Cyperus sp. 2031(+), Denekia capensis 2009(r), Diascia barberae 2157(r), Digitaria longiflora 2031(1), Dimorphotheca caulescens 2162(b), Disa crassicornis 2003(1), Disa fragrans 2004(r), Drimia sp. 2001(r), Epilobium salignum 2025(1), Eragrostis chloromelas 2067(+), Eragrostis curvula 2112(+), Eragrostis sp. 2072(r), Erodium cicutarium 2262(+), Eucomis autumnalis 2097(+), Eumorphia prostrata 2001(1), Euphorbia epicyparissias 2097(3), Felicia wrightii 2004(r), Festuca costata 2112(1), Festuca sp. 2003(+), Ficinia cinnamomea 2163(1), Fuirena pubescens 2016(m), Galium capense 2080(1), Galium spurium subsp. africanum 2097(+), Geranium pulchrum 2164(3), Geranium sp. 2019(1), Geranium wakkerstroomianum 2097(+), Gnaphalium limicola 2001(m), Gnidia sp. 2004(+), Helichrysum cephaloideum 2004(+), Helichrysum cooperi 2097(1), Helichrysum flanaganii 2012(+), Helichrysum griseolanatum 2001(1), Helichrysum mundtii 2025(1), Helichrysum nudifolium 2175(+), Helichrysum sp. 2162(1), Hesperantha baurii 2095(1), Heteropogon contortus 2080(1), Hibiscus trionum 2019(r), Hypochaeris radicata 2233(r), Ipomoea crassipes 2031(a), Jamesbrittenia pristisepala 2031(+), Juncus exsertus 2250(+), Juncus punctorius 2250(a), Kniphofia linearifolia 2097(+), Kniphofia trangularis 2113(r), Kyllinga pauciflora 2017(r), Leonotis ocymifolia 2097(+), Leptochloa fusca 2031(r), Lessertia perennans 2097(+), Leucosidea sericea 2164(a), Limosella africana 2078(+), Lobelia galpinii 2069(1), Lobelia preslii 2157(r), Merxmuellera stereophylla 2152(b), Merxmuellera stricta 2003(1), Microchloa caffra 2031(a), Mohria rigida 2095(+), Monopsis decipiens 2113(+), Monsonia angustifolia 2031(+), Monsonia brevirostrata 2112(+), Moraea sp. 2002(r), Myosotis arvensis 2164(+), Oenothera rosea 2019(r), Ornithogalum paludosum 2160(m), Papaver aculeatum 2009(1), Pentaschistis airoides 2095(1), Pentaschistis aurea subsp. pilosistigma 2004(+), Pentaschistis oreodoxa 2004(b), Pentaschistis praecox 2069(r), Persicaria decipiens 2025(r), Plectranthus grallatus 2097(1), Psammotropha mucronata 2004(+), Pycreus nitidus 2095(+), Rubus rigidus 2113(1), Rumex acetosella 2113(r), Satyrium longicauda 2004(r), Scabiosa columbaria 2004(1), Schizochilus flexuosus 2167(r), Schoenoxiphium bracteosum 2014(1), Schoenoxiphium rufum 2004(1), Sebaea sp. 2012(+), Senecio cathcartensis 2016(1), Senecio napifolius 2097(a), Senecio rhomboideus 2031(+), Senecio sp. 2162(b), Senecio tanacetopsis 2001(1), Setaria pumila 2019(+), Sium repandum 2250(1), Solanum sp. 2112(1), Stachys rugosa 2004(+), Tetrachne dregei 2067(b), Tetraria cuspidata 2001(a), Thesium sp. 2004(1), Ursinia alpina 2161(+), Ursinia nana 2095(+), Urtica urens 2076(r), Utricularia livida 2069(1), Verbena bonariensis 2019(1), Wahlenbergia krebsii 2113(+), Xerophyta viscosa 2152(m), Zaluzianskya microsiphon 2004(+).

Appendix B: Phytosociological table Communities 9–20 (Hygrophilous grasslands and shrubby wetland communities)



Appendix B: Phytosociological table Communities 9–20 (Hygrophilous grasslands and shrubby wetland communities) (cont.)



Appendix B: Phytosociological table Communities 9–20 (Hygrophilous grasslands and shrubby wetland communities) (cont.)

Community	9																												
Subcommunity	9a					9b	9c																					9d	
Relevé no.	2007	2122	2150	2154	2170	2111	2028	2042	2060	2081	2082	2094	2106	2108	2110	2116	2117	2118	2121	2128	2149	2151	2156	2168	2174	2193	2220	2109	2260
Trachypogon spicatus			m																							m			b
Eragrostis caesia					1						+																		
Pelargonium alchemilloides																+	+												
Agrostis lachnantha																													
Haplocarpha scaposa																				+		1							
Lobelia erinus											r																		
Scabiosa columbaria		1		1																							1		
Senecio discodregeanus																	r	1									r		
Senecio isatideus																1											3		

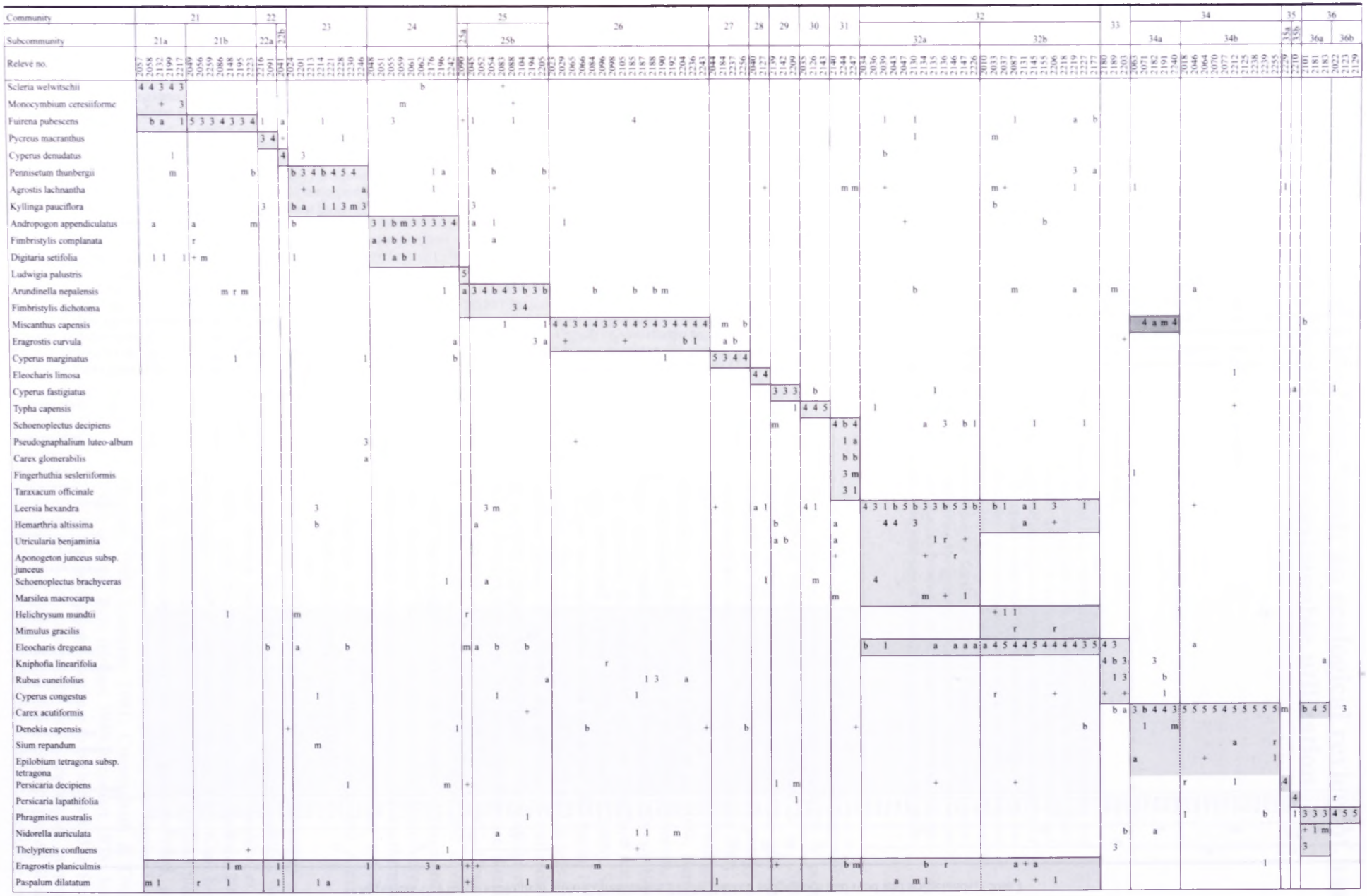
Community	10												11											
Subcommunity	10a						10b		10c				11a		11b									
Relevé no.	2235	2245	2249	2252	2253	2257	2178	2263	2119	2120	2248	2251	2015	2258	2020	2030	2053	2133	2137	2153	2200	2215	2224	2225
Trachypogon spicatus														b		1								
Eragrostis caesia	m							+												m				
Pelargonium alchemilloides										r														
Agrostis lachnantha								1	1															
Haplocarpha scaposa																						1	1	
Lobelia erinus													+					1						
Scabiosa columbaria																								
Senecio discodregeanus										r			+											
Senecio isatideus															r									

Community	12													13					14		15			16	17		18	19	20	
Subcommunity	12a							12b													15a	15b								
Relevé no.	2092	2099	2100	2103	2144	2241	2208	2038	2085	2093	2124	2141	2207	2026	2107	2114	2179	2211	2089	2102	2032	2050	2202	2171	2027	2198	2079	2197	2021	2186
Trachypogon spicatus	a									1																				
Eragrostis caesia																								a						
Pelargonium alchemilloides								r																		m			+	
Agrostis lachnantha								b		3															+					
Haplocarpha scaposa				1																										
Lobelia erinus																							+	1						
Scabiosa columbaria							r						1																	
Senecio discodregeanus																														
Senecio isatideus																		+												m

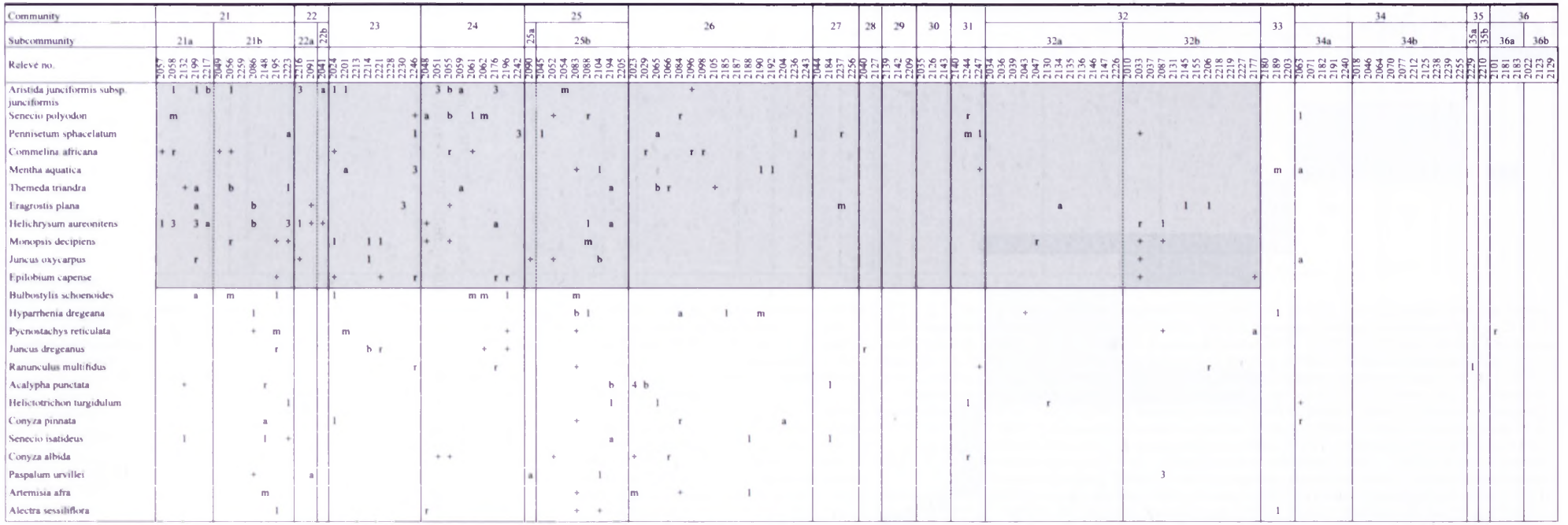
-sl : shrub layer.

Alloteropsis semialata, 2060(b), 2150(a), 2178(+), 2215(a), Arctotis arctotoides, 2007(1), 2079(1), 2081(r), 2198(a), Bulbostylis humilis 2015(+), 2110(+), 2121(+), 2171(m), Cyperus congestus 2021(1), 2027(+), 2179(+), 2207(r), Digitaria setifolia 2028(a), 2053(m), 2060(1), 2215(a), Helichrysum pilosellum 2028(+), 2030(r), 2060(r), 2092(+), Helichrysum rugulosum 2028(+), 2042(1), 2102(1), 2211(a), Pimpinella reenensis 2111(r), 2122(+), 2128(1), 2168(r), Pseudognaphalium luteo-album 2015(+), 2118(1), 2253(+), 2263(r), Ranunculus multifidus 2038(+), 2099(+), 2119(1), 2144(+), Rorippa nudiuscula 2007(m), 2079(+), 2241(r), 2263(1), Scleria woodii 2053(a), 2106(3), 2149(r), 2260(1), Senecio polyodon 2015(+), 2042(+), 2224(r), 2263(r), Afrotysonia glochidiata 2151(m), 2156(m), 2174(1), Bulbostylis oritrephes 2060(3), 2106(+), 2260(+), Cineraria geifolia 2111(1), 2121(1), 2122(r), Conyza albida 2027(+), 2092(r), 2102(1), Cymbopogon dieterlenii 2042(+), 2094(a), 2109(a), Cynodon dactylon 2102(1), 2141(1), 2211(1), Digitaria monodactyla 2053(r), 2109(a), 2110(a), Drimia macrocentra 2015(+), 2151(r), 2174(r), Equisetum ramosissimum 2042(+), 2149(r), 2211(r), Hemarthria altissima 2137(b), 2141(a), 2208(m), Hesperantha baurii 2094(r), 2099(r), 2150(r), Hyparrhenia hirta 2042(3), 2102(1), 2103(3), Hypoxis species 2028(r), 2249(r), 2258(r), Kniphofia triangularis 2110(1), 2111(+), 2122(1), Kyllinga pauciflora 2026(+), 2103(+), 2225(a), Miscanthus capensis 2178(+), 2193(a), 2211(1), Monocymbium ceresiiforme 2030(3), 2092(b), 2106(1), Nidorella agria 2015(1), 2020(r), 2021(+), Oenothera rosea 2026(+), 2027(+), 2038(1), Ornithogalum paludosum 2110(+), 2120(1), 2141(r), Paspalum notatum 2089(1), 2099(+), 2100(+), Pennisetum thunbergii 2179(3), 2200(1), 2224(a), Pentaschistis exserta 2153(1), 2156(1), 2168(m), Persicaria decipiens 2021(r), 2089(1), 2207(r), Plectranthus grallatus 2027(1), 2032(+), 2094(3), Schoenoxiphium schweickerdtii 2153(a), 2156(b), 2168(a), Schoenoxiphium rufum 2027(+), 2094(r), 2117(a), Stachys rugosa 2007(r), 2117(1), 2121(1), Acalypha schinzii 2060(r), 2128(+), Agapanthus campanulatus 2094(r), 2120(+), Agrostis eriantha 2118(1), 2121(1), Ajuga ophrydis 2108(r), 2111(1), Alchemilla colura 2119(1), 2151(r), Argyrolobium tuberosum 2149(1), 2193(r), Aristida canescens 2109(1), 2110(+), Barleria monticola 2107(1), 2108(+), Berkheya purpurea 2079(+), 2128(1), Berkheya speciosa 2193(a), 2200(r), Bromus catharticus 2241(r), 2252(r), Carex acutiformis 2021(b), 2154(m), Carex species 2170(+), 2193(+), Cotula hispida 2015(+), 2118(r), Datura stramonium 2027(a), 2032(1), Digitaria diagonalis 2020(a), 2149(m), Digitaria longiflora 2099(1), 2141(+), Eragrostis gummiflua 2092(1), 2103(r), Erica alopecurus 2108(+), 2110(r), Eriocaulon dregei 2154(1), 2224(+), Euphorbia clavarioides 2109(1), 2110(m), Falckia oblonga 2141(3), 2144(1), Galium capense 2015(+), 2082(1), Galium spurium subsp. africanum 2027(1), 2094(+), Geranium schlechteri 2027(+), 2193(1), Gerbera ambigua 2015(1), 2099(r), Gladiolus crassifolius 2108(r), 2109(r), Helichrysum callicomum 2149(1), 2150(r), Helichrysum nudifolium 2092(r), 2108(+), Helichrysum odoratissimum 2081(r), 2082(1), Helichrysum simillimum 2060(+), 2193(a), Helichrysum species 2111(1), 2153(b), Helictotrichon longifolium 2110(1), 2121(+), Hypericum lalandii 2093(+), 2224(r), Hypochaeris radicata 2099(1), 2141(r), Hypoxis iridifolia 2108(1), 2110(r), Hypoxis rigidula 2121(+), 2133(r), Kyllinga odorata 2092(1), 2099(+), Leersia hexandra 2050(+), 2124(m), Merxmuellera macowanii 2015(1), 2081(a), Nidorella anomala 2030(r), 2085(1), Nidorella auriculata 2151(+), 2202(1), Panicum schinzii 2032(r), 2038(b), Poa binata 2079(a), 2082(m), Polygala hottentotta 2042(+), 2211(r), Pycnostachys reticulata 2179(a), 2197(1), Rubus ludwigii 2021(+), 2079(1), Schistostephium crataegifolium 2094(+), 2117(1), Schoenoxiphium bracteosum 2015(1), 2081(1), Scirpus falsus 2094(1), 2111(m), Scleria pergracilis 2170(a), 2171(1), Senecio asperulus 2038(+), 2079(r), Senecio gregatus 2154(r), 2224(1), Senecio harveianus 2082(+), 2263(1), Setaria sphacelata 2020(m), 2107(1), Tagetes minuta 2027(m), 2032(r), Tetraria cuspidata 2153(b), 2260(1), Abildgaardia ovata 2042(+), Achyranthes aspera 2027(1), Alectra sessiliflora 2085(+), Alepidea longifolia 2122(1), Andropogon eucomus 2099(a), Anemone fanninii 2094(3), Aponogeton junceus 2207(+), Aristida diffusa 2092(+), Asparagus africanus 2197(+), Aster pleiocephalus 2094(1), Berkheya multijuga 2021(r), Berkheya rosulata 2122(1), Berkheya setifera 2211(+), Bidens pilosa 2089(r), Brachiaria eruciformis 2248(r), Brachiaria serrata 2133(a), Bromus leptoclados 2015(a), Brownleea macroceras 2111(+), Bulbostylis scleropus 2020(1), Calpurnia intrusa 2149(1), Centella asiatica 2215(1), Chironia krebsii 2154(+), Chrysocoma ciliata 2082(b), Cirsium vulgare 2032(+), Clematis brachiata 2027(1), Clutia katharinae 2193(1), Cordylogyne globosa 2141(r), Cotula socialis 2121(+), Crocosmia paniculata 2021(+), Cynoglossum lanceolatum 2198(1), Cynoglossum species 2122(r), Cyperus obtusiflorus var. flavissimus 2106(1), Cyperus denudatus 2202(3), Cyperus marginatus 2144(1), Cyperus rupestris 2109(1), Cyperus semitrifidus 2260(r), Cyperus species 2119(b), Denekia capensis 2007(m), Diclis rotundifolia 2100(+), Dierama pauciflorum 2015(+), Digitaria eriantha 2200(m), Digitaria sanguinalis 2089(+), Disperis wealii 2015(+), Eleocharis dregeana 2038(m), Elionurus muticus 2245(1), Epilobium salignum 2026(+), Eragrostis patentissima 2133(+), Erica aestiva 2170(b), Eriosema salignum 2193(r), Eriospermum species 2028(r), Euphorbia natalensis 2094(+), Euphorbia striata 2118(+), Fimbristylis complanata 2103(1), Fimbristylis dichotoma 2099(a), Fimbristylis species 2053(r), Galium thunbergianum 2027(1), Geranium caffrum 2094(+), Geranium species 2174(r), Geum capense 2220(+), Glinus species 2079(1), Gnaphalium griquense 2141(a), Gunnera perpensa 2021(1), Gymnopentzia bifurcata 2197(1), Habenaria falcicornis 2030(+), Helichrysum aureum 2156(r), Helichrysum glomeratum 2174(m), Helichrysum griseolanatum 2260(1), Helichrysum herbaceum 2108(r), Helichrysum krookii 2156(+), Helichrysum miconiifolium 2053(+), Helichrysum platypterum 2193(1), Helichrysum subglomeratum 2081(r), Hypericum natalense 2198(1), Hypoxis angustifolia 2249(r), Hypoxis argentea 2141(r), Hypoxis costata 2117(b), Hypoxis obtusa 2215(1), Jamesbrittenia pristisepala 2260(r), Juncus dregeanus 2224(r), Juncus effusus 2038(1), Juncus inflexus 2263(m), Juncus oxycarpus 2224(r), Juncus punctorius 2050(3), Kniphofia linearifolia 2094(r), Kniphofia porphyrantha 2154(+), Kniphofia species 2174(1), Kyllinga pulchella 2082(+), Leonotis ocymifolia 2094(1), Lessertia perennans 2094(+), Lessertia stricta 2186(1), Lithospermum papillosum 2015(+), Lobelia angolensis 2141(r), Lotononis eriantha 2117(1), Lotononis laxa 2168(+), Luzula africana 2122(1), Medicago laciniata 2042(+), Melilotus alba 2042(r), Merxmuellera disticha 2122(b), Moraea inclinata 2170(r), Moraea species 2168(r), Myrsine africana 2027(r), Nerine appendiculata 2207(1), Nidorella species 2220(1), Oenothera species 2027(r), Oxalis depressa 2027(+), Oxalis species 2102(+), Panicum aequinerve 2089(+), Panicum hymeniochilum 2197(1), Papaver aculeatum 2007(+), Passerina montana 2082(+), Pelargonium capituliforme 2021(1), Pentaschistis setifolia 2111(1), Phragmites australis 2021(1), Plantago lanceolata 2251(+), Pteridum aquilinum 2198(m), Pycreus macranthus 2224(+), Pycreus species 2085(a), Rabdosiella calycina 2094(a), Rhodohypoxis baurii 2015(+), Searsia dentata 2027(a), Rhynchosia totta 2128(r), Rhynchospora brownii 2200(a), Rubus cuneifolius 2198(m), Rumex acetosella 2118(+), Rumex lanceolatus 2116(r), Rumex rhodesius 2032(+), Sacciolepis chevalieri 2020(1), Satyrium parviflorum 2122(r), Satyrium species 2099(r), Schizochilus zeyheri 2015(+), Schoenoxiphium perdensum 2020(1), Scilla natalensis 2133(+), Scirpoides burkei 2128(a), Scirpus ficinioides 2149(m), Scleria species 2020(r), Scleria welwitschii 2085(m), Sebaea longicaulis 2085(1), Sebaea species 2170(+), Selago witbergensis 2119(1), Senecio inaequidens 2103(+), Senecio scitus 2015(1), Senecio species 2178(b), Solanum nigrum 2079(+), Sopubia cana 2030(r), Spermacoce natalensis 2100(+), Stachys sessilis 2220(+), Tephrosia macropoda var. diffusa 2042(a), Tetraria triangularis 2260(m), Tragopogon porrifolius 2249(r), Tragus racemosus 2248(+), Tritonia disticha 2128(r), Utricularia livida 2224(r), Verbena species 2102(+), Vernonia hirsuta 2094(r), Vernonia species 2106(a), Wahlenbergia appressifolia 2220(r), Watsonia species 2106(+), Wurmbea elatior 2154(1), Xerophyta viscosa 2110(b), Xyris capensis 2224(+), Zantedeschia aethiopica 2032(r), Zornia capensis 2060(+).

Appendix C: Phytosociological table Communities 21–36 (Mixed sedgelands and reed and sedgelands)



Appendix C: Phytosociological table Communities 21–36 (Mixed sedgelands and reed and sedgelands) (cont.)



Alchemilla colura 2049(1), 2051(1), 2057(1), 2061(+), Carex cognata 2090(1), 2180(1), 2196(b), 2221(m), Clutia katherinae 2192(r), 2203(1), 2236(b), 2239(a), Epilobium salignum 2033(1), 2037(+), 2047(r), 2189(1), Eragrostis capensis 2056(r), 2088(r), 2223(1), 2259(+), Harpochloa falx 2029(+), 2051(r), 2055(m), 2056(m), Hibiscus trionum 2187(+), 2191(1), 2203(r), 2246(r), Isolepis costata 2063(m), 2195(a), 2196(1), 2219(+), Isolepis fluitans 2048(+), 2218(b), 2226(3), 2227(a), Juncus inflexus 2063(1), 2244(1), 2246(m), 2247(m), Oenothera rosea 2023(r), 2083(r), 2084(1), 2204(+), Oxalis obliquifolia 2084(m), 2088(1), 2096(+), 2236(1), Pycreus nitidus 2056(a), 2057(1), 2090(1), 2104(a), Pycreus unioloides 2047(+), 2048(+), 2195(1), 2196(1), Rhynchospora brownii 2049(+), 2195(1), 2196(1), 2214(b), Diclis rotundifolia 2083(1), 2084(1), 2088(+), Festuca sp. 2051(+), 2059(b), 2063(1), Geranium caffrum 2086(+), 2087(r), 2101(+), Gnaphalium filagopsis 2226(a), 2227(1), 2230(r), Helichrysum cooperi 2098(+), 2192(+), 2204(1), Hypoxis longifolia 2055(1), 2058(r), 2062(+), Imperata cylindrica 2148(3), 2184(3), 2190(3), Juncus effusus 2035(a), 2047(+), 2221(a), Koeleria capensis 2065(m), 2066(1), 2096(1), Panicum hymeniochilum 2187(+), 2192(1), 2194(1), Paspalum scrobiculatum 2086(r), 2091(a), 2206(+), Schoenoxiphium rufum 2084(1), 2096(r), 2185(r), Senecio gregatus 2033(1), 2087(r), 2221(1), Setaria sphacelata 2051(a), 2061(m), 2105(1), Stiburus alopecuroides 2024(1), 2062(1), 2259(a), Trifolium burchellianum 2176(+), 2228(1), 2230(1), Tristachya leucothrix 2056(+), 2059(+), 2259(+), Agrostis bergiana 2155(1), 2221(+), Agrostis eriantha 2216(+), 2226(1), Alternanthera sessilis 2139(a), 2140(1), Berkheya speciosa 2051(+), 2096(+), Berula erecta 2063(1), 2104(1), Carex austro-africana 2195(3), 2204(1), Chamaechrista mimosoides 2086(+), 2088(+), Crassocephalum x picridifolium 2090(1), 2181(1), Cyperus esculentus 2043(r), 2088(+), Digitaria eriantha 2132(+), 2194(m), Digitaria longiflora 2086(+), 2088(+), Echinochloa crus-galli 2139(r), 2209(m), Festuca caprina 2063(1), 2077(b), Geranium schlechteri 2182(1), 2194(1), Gunnera perpensa 2185(1), 2203(b), Helichrysum nudifolium var. pilosellum 2059(r), 2088(+), Hypericum lalandii 2033(r), 2247(r), Leucosidea sericea 2083(+), 2096(+), Lobelia erinus 2059(+), 2201(+), Mentha longifolia 2033(1), 2236(+), Merxmuellera macowanii 2077(a), 2236(1), Nerine appendiculata 2051(1), 2058(1), Ophioglossum vulgatum 2083(1), 2084(+), Panicum schinzii 2091(r), 2147(+), Paspalum distichum 2146(+), 2209(a), Pelargonium alchemilloides 2084(+), 2223(1), Poa binata 2024(1), 2247(3), Pteridium aquilinum 2096(+), 2188(3), Sacciolepis chevalieri 2047(1), 2048(3), Schoenoxiphium sparteum 2185(+), 2223(1), Sebaea natalensis 2219(m), 2223(1), Senecio isatidioides 2083(r), 2088(r), Setaria pumila 2140(+), 2192(1), Sporobolus africanus 2083(1), 2086(1), Stachys grandifolia 2096(b), 2192(m), Trachypogon spicatus 2088(a), 2259(1), Verbena bonariensis 2023(r), 2086(+), Vernonia hirsuta 2083(+), 2096(a), Wahlenbergia grandiflora 2065(r), 2066(r), Zantedeschia aethiopica 2101(+), 2181(+), Agapanthus campanulatus 2096(1), Agrimonia procera 2205(+), Alloteropsis semialata 2059(1), Amaranthus sp. 2247(r), Argyrolobium tuberosum 2054(+), Aristida sp. 2091(1), Ascolepis capensis 2196(1), Asparagus asparagoides 2203(1), Barleria monticola 2083(1), Berkheya multijuga 2096(3), Bromus catharticus 2237(+), Buddleja salviifolia 2084(+), Bulbostylis oritrephes 2059(+), Calpurnia intrusa 2184(a), Carex spicato-paniculata 2192(1), Cheilanthes quadripinnata 2096(1), Chironia krebsii 2155(r), Cineraria lyratiformis 2244(1), Cirsium vulgare 2236(r), Cliffortia linearifolia 2194(1), Conyza canadensis 2086(r), Conyza sp. 2192(1), Cynoglossum lanceolatum 2204(1), Cyperus difformis 2033(1), Cyperus solidus 2195(1), Deschampsia cespitosa 2010(m), Diheteropogon amplectens 2132(1), Drimia macrocentra 2096(r), Elionurus muticus 2059(m), Equisetum ramosissimum 2045(+), Eragrostis chloromelas 2065(+), Eragrostis racemosa 2217(m), Eucomis bicolor 2096(b), Euphorbia epicyparissias 2243(3), Festuca costata 2096(+), Galium capense 2192(b), Geranium wakkerstroomianum 2155(+), Gladiolus saundersii 2236(r), Helichrysum coriaceum 2059(1), Helichrysum griseolanatum 2259(3), Helichrysum miconiifolium 2223(1), Helichrysum natalitium 2098(r), Helichrysum nudifolium 2184(+), Helichrysum simillimum 2057(1), Helichrysum umbraculigerum 2185(r), Hesperantha baurii 2217(r), Heteropogon contortus 2217(1), Hordeum capense 2244(+), Hypoxis costata 2223(1), Hypoxis filiformis 2214(r), Isolepis pellocolea 2221(b), Isolepis sp. 2052(1), Juncus exsertus 2155(+), Kyllinga odorata 2088(r), Kyllinga pulchella 2088(a), Lactuca serriola 2064(r), Lessertia perennans 2096(1), Lessertia stricta 2184(a), Limosella inflata 2010(1), Melasma scabrum 2221(m), Nidorella sp. 2051(1), Ornithogalum paludosum 2140(+), Panicum aequinerve 2084(1), Panicum sp. 2203(1), Pelargonium dispar 2096(1), Pennisetum macrourum 2098(1), Persicaria amphibia 2127(a), Persicaria meisneriana 2195(r), Pimpinella reenensis 2223(r), Plectranthus grallatus 2096(+), Populus x canescens 2237(+), Pulicaria scabra 2104(+), Pycreus chrysanthus 2147(3), Pycreus mundii 2180(1), Rabdosiella calycina 2132(+), Rhus discolor 2188(1), Rhynchosia sp. 2086(r), Rorippa nudiuscula 2236(+), Rubus ludwigii 2083(r), Rubus rigidus 2188(1), Rumex crispus 2010(a), Satyrium longicauda 2217(1), Satyrium sp. 2217(r), Scabiosa columbaria 2223(+), Schistostephium crataegifolium 2096(1), Schoenoxiphium sp. 2223(+), Scirpus ficinioides 2077(1), Scleria bulbifera 2132(1), Sebaea filiformis 2065(+), Sebaea grandis 2062(r), Sebaea macrophylla 2096(+), Sebaea sp. 2196(+), Senecio inaequidens 2024(+), Senecio inornatus 2083(1), Senecio sp. 2140(+), Setaria nigrirostris 2132(+), Setaria sp. 2056(r), Sisymbrium capense 2247(+), Sonchus asper 2246(r), Stephania abyssinica 2203(1), Utricularia livida 2214(1), Wahlenbergia krebsii 2065(1), Wurmbea elatior 2155(+), Xyris capensis 2214(a), Zantedeschia albomaculata 2101(+).