Pak. J. Bot., 48(5): 1861-1870, 2016.

FLORAL DIVERSITY, COMPOSITION AND DISTRIBUTION IN A MONTANE WETLAND IN HOGSBACK, THE EASTERN CAPE PROVINCE, SOUTH AFRICA

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Abstract

The objective of this study was to evaluate plant species diversity, composition and distribution in a montane wetland in Hogsback, Eastern Cape province, South Africa. Twenty four circular plots with radius of 2m were established between March and August 2013 within Hogsback montane wetland. Within each sample plot, the habitat information and species present were recorded including Braun-Blanquet cover-abundance values for all species present in the plot. A total of 41 species belonging to 19 families and 36 genera were recorded. Of the documented species, 7.3% were exotic and endemic to South Africa, indicating diversity and dynamic nature of Hogsback montane wetland flora. Plant families with the highest number of species were: Poaceae (11 species), Asteraceae (six species), Onagraceae and Cyperaceae (three species each) and Lamiaceae with two species. The low number of exotic plant species recorded in Hogsback wetland (three species in total) indicates limited anthropogenic influences. Unique species recorded in Hogsback montane wetland were three species that are endemic to South Africa, namely, *Alchemilla capensis* Thunb., *Helichrysum rosum* (P.J. Bergius) Lees and *Lysimachia nutans* Nees. Five main floristic associations were identified from the Hierarchical Cluster Analysis. The Canonical Correspondence Analysis (CCA) indicated that edaphic factors, particularly area covered with water, erosion category, organic matter content and water table depth were the most important environmental variables measured accounting for the vegetation pattern present in the Hogsback montane wetland. Montane wetlands have a relatively low species richness characterised by unique species compositions which are distinctive and habitat specific.

Key words: Anthropogenic influence; Braun-Blanquet; Plant diversity; South Africa; Wetland montane ecosystem.

Introduction

The term "wetland" has been defined in many different ways, covering habitat types between terrestrial and aquatic ecosystems (Breen & Begg, 1989). According to Anonymous (2005), the term "wetland" is given to landscape where water accumulates for long enough to influence the plants, animals and soil occurring in that area. In the South African context, a "wetland" is defined as "*land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which in normal circumstances supports or would support vegetation typically adapted to life in saturated soils*" (National Water Act No. 36 of 1998). According to Masundire and Mackay (2002) there are six major wetland types, namely, marine (open ocean), estuarine (lagoons and estuarines), lacustrine (lakes and dams), endorheic (pans), riverine (river channels) and palustrine (marshes, swamps, dambos and vleis). The current study was carried out in a palustrine wetland in Hogsback montane area. Palustrine wetlands include marshes, swamps, dambos and vleis which have more permanent water originating from streams, run-off, surface springs or groundwater. Palustrine systems occupy transitional zone between wet and generally dry environments and share characteristics of both, ranging from permanently or intermittently wet land to shallow water and land-water margins (Shine & De Klemm, 1999; Masundire & Mackay, 2002; Mergili & Privett, 2008).

These wetland ecosystems are influenced by their saturated soils characterised by high organic matter and saturated with water for extended periods with or without the presence of surface water (Mergili & Privett, 2008). Palustrine wetlands represent one of the important natural ecosystems in South Africa endowed with vital natural, ecological, social, regulatory and economic roles as documented by various authors (Breen & Begg, 1989; Cowan, 1995; Eckhardt *et al.*, 1996; Le Maitre *et al.*, 1999; Kotze & O'Connor, 2000; Mucina & Rutherford, 2006; Mergili & Privett, 2008). Wetlands are important local and regional centres of biodiversity; provide important habitat for many life forms as well as breeding and nesting habitat for several animals, including frogs and other amphibians (Le Maitre *et al.*, 1999). Wetlands provide biogeochemical, physical and ecological processes that maintain water quality, lessen the devastating effects of floods, recharge ground water, and can improve water quality by filtering pollutants from terrestrial runoff and atmospheric deposition (Reddy & DeLaune, 2008). For a deeper understanding of the role palustrine wetland ecosystems play in South Africa, there is a need to understand their structural, functional components and ecological processes that make wetlands unique habitats characterised by distinctive vegetation types. Vegetation plays an important role in the interactions between groundwater and surface-water systems, because of its direct and indirect influence on recharge and also because of the dependence of vegetation communities on groundwater (Le Maitre *et al.*, 1999).

The ecological impact of hydrological processes and channel incision on wetland vegetation is the subject of intense discussions throughout the world. Variations in hydrological and hydrochemical regimes are major factors driving wetland vegetation composition and structure (Friedman *et al.,* 1996; Janecke *et al.,* 2003; Muneepeerakul *et al.,* 2008; Mata-González *et al.,* 2012; Dominik *et al.,* 2013), and may control the distribution of individual plant species (Kennedy & Murphy, 2004). Channel incision is also regarded as one of the major causes of wetland and river ecosystem degradation (Naiman *et al.,* 2005; Steiger *et al.,* 2005; Loheide & Booth, 2011), with the lowering and widening of the stream bed, wetlands are often dewatered as groundwater will flow towards incised streams as opposed to parallel and unincised streams (Shields *et al.,* 2009, 2010). Most of these studies documenting ecological relationships between hydrological processes, channel incision and wetland vegetation have been carried out in temperate regions with few studies carried out in southern Africa. In particular, studies documenting relationships between wetland vegetation and environmental processes are few in South Africa, with Mucina & Rutherford (2006) highlighting the dearth of information on wetland plant ecology. It is within this context that we evaluated plant species diversity, composition and distribution in a montane wetland in Hogsback, the Eastern Cape province, South Africa.

Materials and Methods

Study area: The study area is a palustrine wetland, approximately 5 ha at the bottom of Gaika's head (1963 metres above sea level) in the Hogsback region (Fig. 1). The site is the property of Amathole Forest Company (AFC). Hogsback has a cool climate with mean annual temperatures of approximately 14˚C, cold winters with mean minimum temperatures of 1˚C and frequent snowfall are characteristic of this region. Rainfall is high with a mean annual of approximately 1200 mm, the bulk of which falls during summer. The geology of the area is sedimentary rocks of the Balfour formation, part of the Beaufort Group (Coleman, 1999). The wetland is densely vegetated characterised by grasses and shrubs with some of the dominant species being *Restio* spp. and sedges, *Carex* spp. and *Pycreus* spp., with ground orchids commonly occurring (Coleman, 1999). A first order tributary to the Klipplaats River (which is a tributary to the Swart Kei River), with various degrees of incision, drains the wetland in a south-eastern direction over a rehabiltation weir where streamflow was recorded (Fig. 1c and Fig. 2).

Data collection: Fieldwork was conducted over a period of five months, commenced at the end of the wet rainy season (20 March 2013) throughout the relatively dry winter and ended on 16 August 2013). In the study area, 24 circular plots or relevès (marked HP1 – HP29) were sampled within the wetland as shown in Fig. 2. A plot radius of 2 m was chosen, based on the results of a species-area curve (Mueller-Dombois & Ellenberg, 1974) that was determined prior to the sampling process. The exact locality of each plot was recorded using Global Positioning System (GPS). Within each sample plot, the habitat information and species present were recorded. A cover-abundance value was assigned to each species present in a sample plot according to the Braun-Blanquet cover-abundance scale (Mueller-Dombois & Ellenberg, 1974; Werger, 1974; Whittaker, 1978; Van der Maarel, 2005) as presented in Table 1. Plant species were identified in the field and the taxon names conform to those of Germishuizen *et al.* (2006). Unknown plant species were collected, pressed, oven-dried, Bryophytes and members of Cyperaceae and Poaceae families were identified at the National Herbarium, South African Biodiversity Institute (SANBI), Pretoria, while the rest of the plant species were identified by Mr Tony Dold, curator of the Schonland Herbarium, Rhodes University, Grahamstown.

The following environmental data were collected: Clay percentage, soil depth (cm), soil colour, organic carbon (%), water table depth (cm), erosion category, litter cover (%), total area covered with water (%), total vegetation cover (%), shrub, herb and moss cover (%). These measurements were recorded in every plot. The clay content was measured by field estimation of soil texture (Levine *et al.,* 1986; Minasney *et al.,* 2007). A graded probe (5 cm interval) was used to measure soil depth till to the solid bedrock and soil colour was described using a visual observation of Munsell soil-colour charts. Organic carbon was evaluated by collecting soil samples at the top 20 cm (0-10, 10-20) using Walkley-Black method. A bottom slotted piezometers were installed in each plot up to the bedrock and bottled-tape measure was used to drop into the piezometers and the tape measure reading was then collected. Erosion category, litter cover (%), total area covered with water (%), total vegetation cover (%), shrub, herb and moss cover (%) were noted using visual observation and an estimate percentage was then allocated.

Data analysis: Multivariate data analysis were performed on the vegetation data to explore the floristic variation, to detect and visualise similarities in the plots. The agglomerative method of Hierarchical Cluster Analysis (HCA) in MINITAB was performed to define the group of plots with similar species composition. Canonical Correspondence Analysis (CCA) was performed using Palaeontological Statistics (Hammer *et al.,* 2001), version 3.06. Patterns of plant species composition in relation to the measured environmental factors were analysed using CCA. According to Legendre and Legendre (1998), CCA is a direct gradient analysis technique that relates species composition and abundance to environmental variation enabling the significant relationship between plant species and environmental variables to be determined. Factors hypothesised to influence vegetation composition and abundance in this study were captured in a spreadsheet as environmental variables. Qualitative data such as soil colour and erosion category were allocated numerical codes.

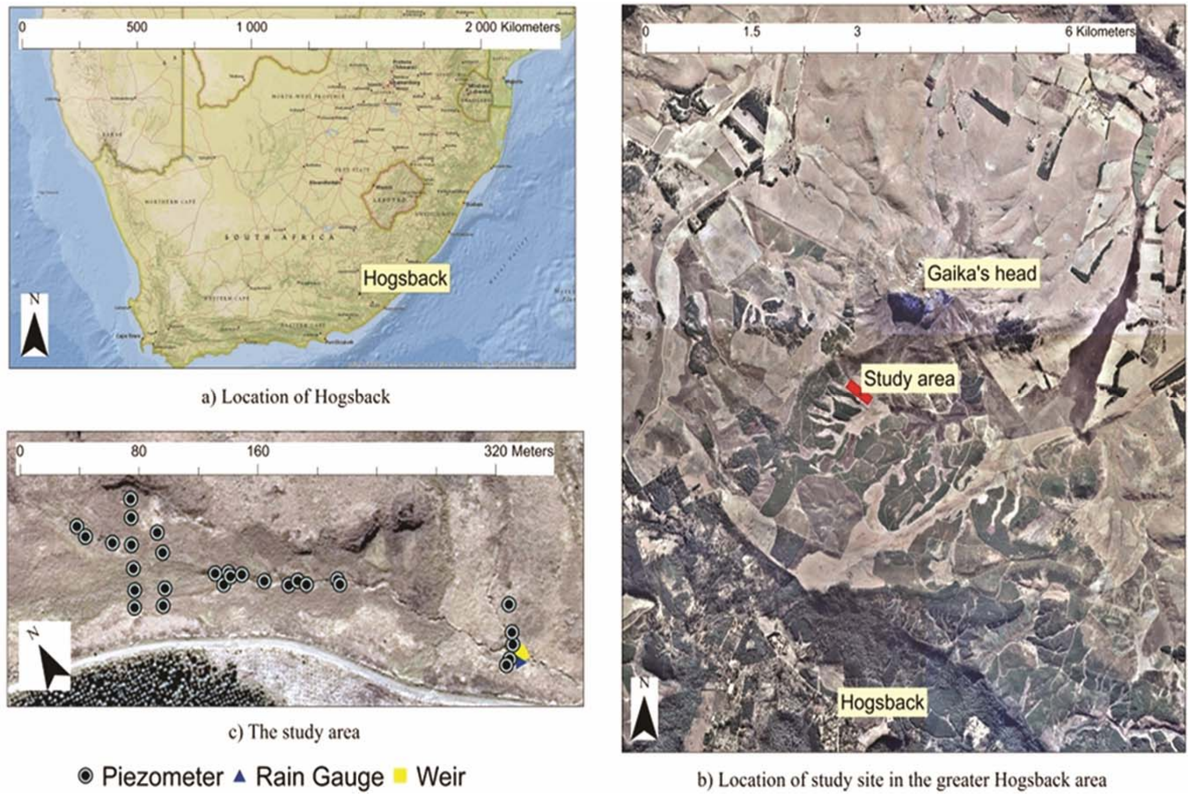

Fig. 1. The location of the study area (a and b) and instrumental layout in the study area (c).

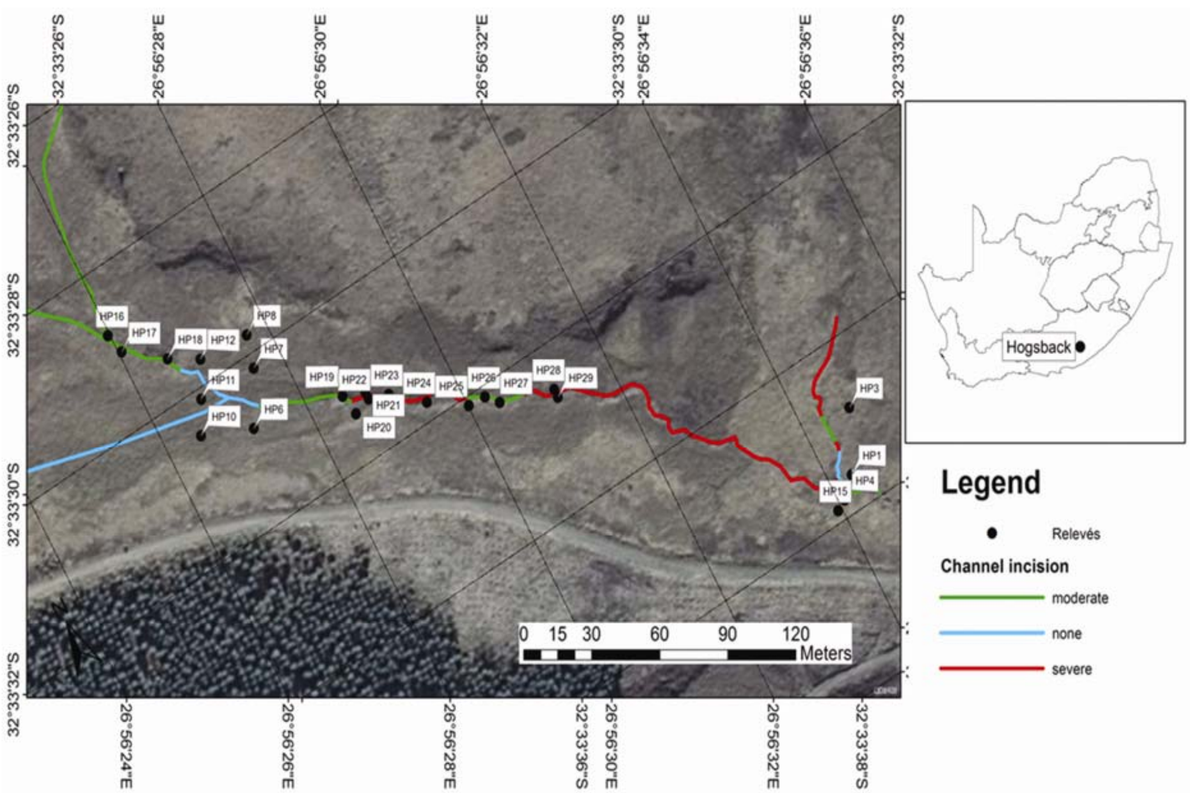

Fig. 2. Experimental layout and degree of channel incision in the study area (none = incision < 10 cm; moderate = incision 10 – 60 cm; severe = incision > 60 cm).

Table 1. Braun-Blanquet cover-abundance codes, values and median values (after Mueller-Dombois & Ellenberg, 1974; Werger, 1974; Whittaker, 1978; Van der Maarel, 2005).

Braun-Blanquet code	Cover (%)	Median cover (%)
R	<5	1
+	<5	2
1	<5	3
2m	<5	4
2a	5-12.5	8
2b	12.5-25	18
3	25-50	38
4	50-75	68
5	75-100	88

Results

A total of 41 species belonging to 19 families and 36 genera were recorded from Hogsback montane wetland (Table 2). Of the documented taxa, 7.3% were exotic and endemic to South Africa, indicating diversity and dynamic nature of Hogsback montane wetland flora. Bryophytes were represented by three plant species (7.3%): *Atrichum androgynum* (Müll. Hal.) A. Jaeger. (Polytrichaceae), *Fissidens ovatus* Brid. (Fissidentaceae) and *Notoscyphus lutescens* (Lehm. & Lindenb.) Mitt. (Jungermanniaceae). Pteridophytes were represented by a single species, *Anemia nudiuscula* (J.P. Roux) Christenh. (Anemiaceae). Plant families with the highest number of species were: Poaceae (11 species), Asteraceae (six species), Onagraceae and Cyperaceae (three species each) and Lamiaceae with two species. The rest of the plant families were represented by a single species each (Table 2). The genera with the highest number of species were *Helichrysum* with three species, *Eragrostis* and *Oenothera* with two species each.

Five main floristic associations were identified from the Hierarchical Cluster Analysis (Fig. 3). The analysis was based on the abundance data of the species. Cluster 1, with only plot 3 (Fig. 3) was dominated by *Helichrysum cooperi*, a fast growing biennial herb and a grass species, *Arundinella nepalensis*. Other plant species recorded in plot 3 included *Arctotis arctotoides, Leonotis ocymifolia* and *Oxalis semiloba*. Plot 3 was located on a sloppy terrain with evident animal trampling towards the stream channel (Fig. 2). Key environmental factors of plot 3 included clay percentage of 40.0, soil depth of 110.0 cm, 2.8% organic matter, average water table depth of 68.0 cm, litter cover of 5.0% and the entire plot was dry (Table 3). Cluster 2 had 12 plots grouped together, the majority of the plots were characterised by moderate to severe incision, dominated by *Conyza pinnata* and *Cyperus pulcher* (Table 3) with a similarity index of between 60 to 100% (Fig. 3). The plots in cluster 2 had the highest litter cover, averaging 75.3±7.9%, total area covered with water, 13.6±3.9% and total vegetation cover averaging 95.2±7.7% (Table 3). Cluster 3 had four plots, three of them characterised by severe incision, all dominated by *Arundinella nepalensis, Conyza pinnata* and *Nidorella auriculata* (Table 3). Two species endemic to South Africa, *Alchemilla capensis* and *Helichrysum rosum* were also recorded in this cluster. This cluster was characterised by the lowest organic matter content averaging 1.7±0.11% (Table 3). The forth cluster had three plots, two of these characterised by moderate incision, all dominated by *Conyza pinnata* and a *Cyperus pulcher* (Table 3). This cluster had lowest clay content averaging 23.3±7.9% and water table depth averaging 18.7±7.5 cm. A total of 13 plant species, 12 genera and 8 families were recorded in this cluster (Table 3). The fifth cluster had four plots, characterised by none to moderate incision. This cluster was dominated by *Andropogon appendiculatus, Dracoscirpoides ficinioides, Galium capense, Helictotrichon imberbe* and *Oxalis semiloba.* Two species endemic to South Africa, *Helichrysum rosum* and *Lysimachia nutans* were recorded in this cluster. Cluster 5 had the highest number of plant species, 25 species in total, 24 genera and 13 families (Table 3). Summary of the floristic associations with mean and standard deviation values of the environmental variables are presented in Table 3.

The first CCA ordination axis explained 70.7% of the total variance in species composition while the second axis explained 19.3% of the variation due to measured environmental variables (Fig. 4). The influence of environmental variables was significant ($p<0.05$) for all canonical axes. Area covered by open water and erosion category were positively associated with the first axis, while water depth was negatively associated with the first axis. Organic matter content was negatively associated with axis 2. CCA axes 1 and 2 separated the plots into roughly four groups. This separation was based more on spatial rather than temporal variation.

Discussion

The species richness of 41 species recorded in Hogsback montane wetland is low and compares well with similar studies carried out in other countries in Africa. Olubode *et al.* (2011) recorded 38 species from three wetlands in forest-savanna transition ecological zone in Nigeria. In Kenya, Ruto *et al.* (2012) recorded 32 and 28 plant species in Hyena and Nalogomon wetlands respectively. Low species numbers were also reported in South African montane wetlands by Eckhardt *et al.* (1996) and Brand *et al.* (2013), with Collins (2005) arguing that low altitude montane wetlands in South Africa are characterised by low species richness. According to Mucina and Rutherford (2006) and Du Preez and Brown (2011), any montane wetlands located between 750 to 2000 m above sea level is regarded as low altitude wetland, and Hogsback montane wetland falls within this category with an altitude of 1963 metres above sea level. Low species richness in low altitude montane wetlands may be due to suppression of the vegetation belt as a result of glaciation and low altitude and therefore many species might have migrated up the mountainous areas (Grab, 2002; Clark, 2010). Other researchers, for example, Hey and Phillips (1995) argued that, although wetlands are not species rich, they often have unique plant species. Unique species recorded in Hogsback montane wetlands are three species that are endemic to South Africa, i.e., *Alchemilla capensis, Helichrysum rosum* and *Lysimachia nutans*. The occurrence of these endemics in Hogsback montane wetland demonstrates that the area is of considerable ecological and conservation importance. Whilst *Alchemilla capensis* has been recorded in the Eastern Cape, KwaZulu Natal and Western Cape provinces (Goldbatt & Manning, 2000), *Helichrysum rosum* is so far known to occur in the Eastern Cape and Western Cape provinces only (Raimondo *et al.,* 2009) and *Lysimachia nutans* is so far known to occur in the Eastern Cape province only (Goldbatt & Manning, 2000). All these three endemic species are listed as Least Concern (LC) on the South African Red Data List (Raimondo *et al.,* 2009), because they are not at risk of extinction based on their distribution and/or stable population status.

Table 2. List of plant species recorded from Hogsback wetland. Species marked with an asterisk (*) are exotic and those marked with hatch (#) are endemic to South Africa respectively.

Scientific name	Family	Plots in which species were recorded
Agrostis lachnantha Nees	Poaceae	29
#*Alchemilla capensis* Thunb.	Rosaceae	22
Andropogon appendiculatus Nees	Poaceae	1, 4, 15, 22, 8
Anemia nudiuscula (J.P. Roux) Christenh.	Anemiaceae	1, 20, 22, 26, 29
Arctotis arctotoides (L.f.) O. Hoffm.	Asteraceae	3
Arundinella nepalensis Trin.	Poaceae	3, 22, 24-27, 29
Atrichum androgynum (Müll. Hal.) A. Jaeger.	Polytrichaceae	22, 23, 29
Conyza pinnata (L.f.) Kuntze	Asteraceae	4, 8, 15, 18-29
Crassula pellucid L.	Crassulaceae	22, 26, 27, 29
Cyperus pulcher Thunb.	Cyperaceae	6-8, 10-12, 16-25, 27-29
Dracoscirpoides ficinioides (Kunth) Muasya	Cyperaceae	1, 4, 15,
Epilobium capense Buchinger ex Hochst.	Onagraceae	1, 8,
Eragrostis filiformis var. *conferta* (Nees) Thell.	Poaceae	27, 29
Eragrostis planiculmis Nees	Poaceae	12, 15, 18, 20, 25, 26,28
Fissidens ovatus Brid.	Fissidentaceae	29
Galium capense Thunb.	Rubiaceae	1, 4, 26, 27
Helichrysum cooperi Harv.	Asteraceae	3, 4, 15, 22, 24
Helichrysum mundtii Harv.	Asteraceae	8, 25
#*Helichrysum rosum* (P.J. Bergius) Lees	Asteraceae	25, 26
Helictotrichon imberbe (Nees) Veldkamp	Poaceae	1, 4, 10, 11, 15, 25, 26
**Holcus lanatus* L.	Poaceae	1, 8
Hypericuma ethiopicum Thunb.	Hypericaceae	23
Leonotis ocymifolia (Burm. F.) Iwarsson	Lamiaceae	3
Lobelia placcida (C. Presl) A.DC.	Campanulaceae	1
#*Lysimachia nutans* Nees	Primulaceae	1
Melica racemosa Thunb.	Poaceae	27
Mentha longifolia (L.) L.	Lamiaceae	7, 16, 18
Nidorella auriculata DC.	Asteraceae	1, 4, 20, 22, 23, 25, 27-29
Notoscyphus lutescens (Lehm. & Lindenb.) Mitt.	Jungermanniaceae	22
**Oenothera rosea* L'Hér. ex Aiton	Onagraceae	10, 11, 26
**Oenothera* spp.	Onagraceae	29
Oxalis semiloba Sond.	Oxalidaceae	1, 3, 15, 17, 25, 26
Papaver aculeatum Thunb.	Papaveraceae	1, 4, 27
Poa binata Nees	Poaceae	26
Pseudignaphalium undulatum (L.) Hilliard & B.L.Burtt	Asteraceae	4, 27
Rubus rigidus Sm.	Rosaceae	18, 26
Schoenoxiphium sparteum (Wahlenb.) C.B. Clarke	Cyperaceae	1
Setaria sphacelata (Schumach.) Stapf & C.E. Hubb. ex Moss	Poaceae	29
Thunbergia spp.	Acanthaceae	6, 7
Tristachya leucothrix Trin. ex Nees	Poaceae	1, 25, 26
Zantedescia spp.	Araceae	26

Table 3. Summary of floristic associations with mean and standard deviation values of the environmental variables.

	Floristic cluster				
	1	**2**	**3**	**4**	**5**
No. of plots	1	12	4	3	4
Total no. of species	4	14	22	13	25
Total no. of genera	4	13	19	12	24
Total no. of families	3	11	11	8	13
Common species	*Arundinella nepalensis, Helichrysum cooperi*	*Conyza pinnata; Cyperus pulcher*	*Arundinella nepalensis; Conyza pinnata; Nidorella auriculata*	*Conyza pinnata; Cyperus pulcher*	*Andropogon appendiculatus; Dracoscirpoides ficinioides; Galium capense; Helictotrichon imberbe; Oxalis semiloba*
Unique species	0	0	*Alchemilla capensis; Helichrysum rosum*	0	*Helichrysum rosum; Lysimachia nutans*
Mean values of the measured environmental variables					
% Clay	40.0	57.5 ± 27.3	62.5 ± 29.7	23.3 ± 7.9	46.7 ± 18.4
Soil depth (cm)	110.0	70.0 ± 21.1	77.5 ± 27.5	73.3 ± 27.2	100.0 ± 39.1
Organic matter (%)	2.8	2.2 ± 0.09	1.7 ± 0.11	1.8 ± 0.07	1.9 ± 0.09
Average water table depth (cm)	68.0	19.1 ± 7.1	36.3 ± 11.3	18.7 ± 7.5	50.3 ± 21.8
Litter cover (%)	5.0	75.3 ± 7.9	37.5 ± 10.1	45.0 ± 17.9	18.8 ± 8.1
Total area covered with water (%)	0.0	13.6 ± 3.9	3.8 ± 1.1	3.3 ± 1.3	1.3 ± 0.9
Total vegetation cover (%)	70.0	95.2 ± 7.7	83.8 ± 12.1	83.3±7.4	86.3 ± 10.3
Shrub cover (%)	0.0	0.0	1.3 ± 0.6	0.7±0.3	0.3 ± 0.1
Herb cover (%)	70.0	6.3 ± 1.1	25.0 ± 13.1	21.3±7.3	11.3 ± 1.9
Moss cover (%)	0.0	0.8 ± 0.3	5.0 ± 1.9	0.0	0.0

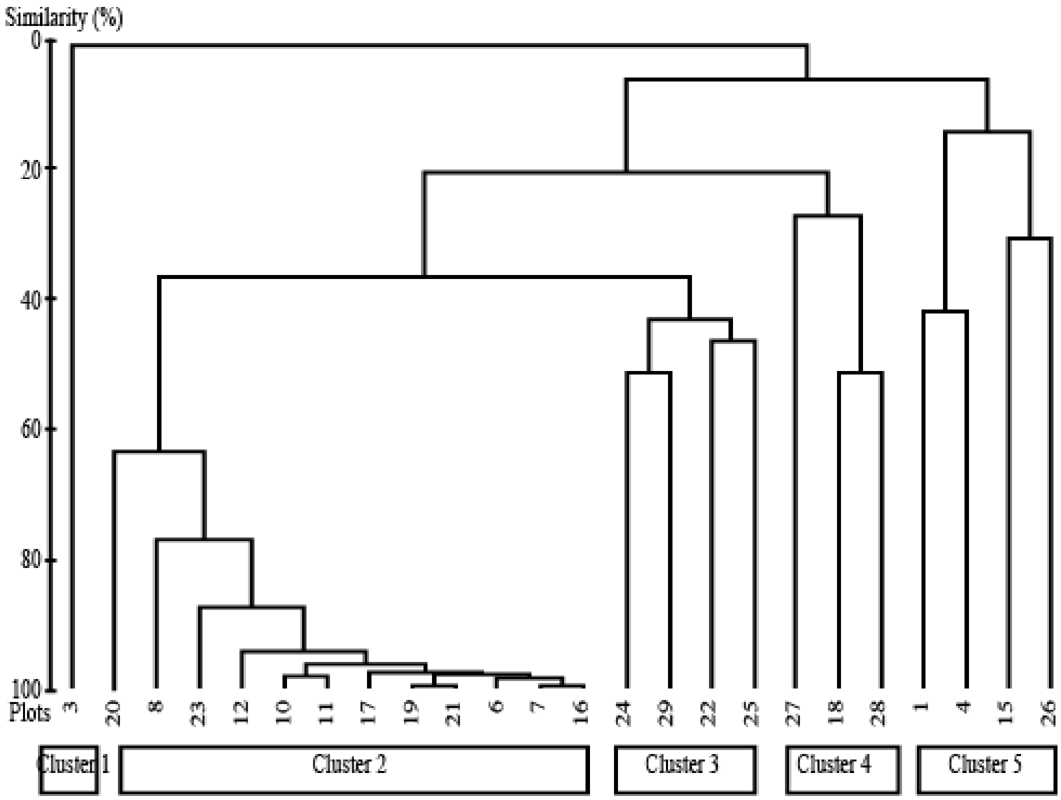

Fig. 3. Hierarchical Cluster Analysis dendogram classification of vegetation plots based on weighted species presence.

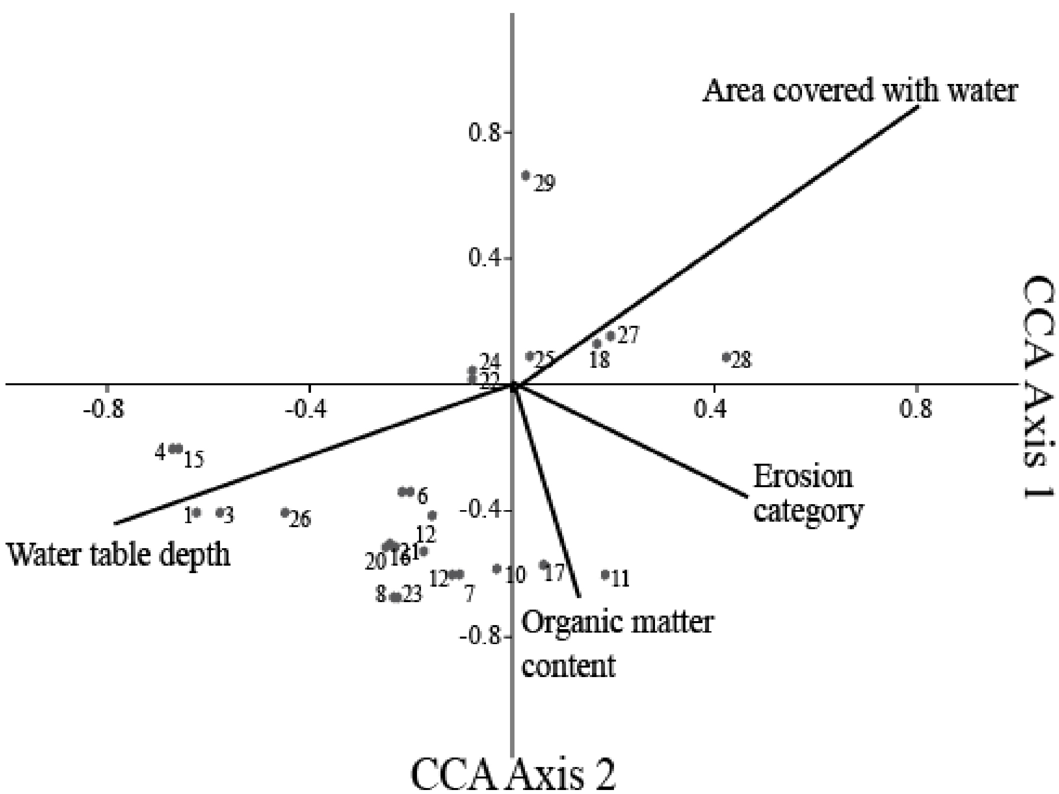

Fig. 4. CCA ordination scatter plot indicating the influence of environmental variables on species composition in Hogsback, the Eastern Cape province.

The vegetation of Hogsback montane wetland was fairly diverse, characterised by bryophytes, monocotyledons as well as dicotyledons (Table 2). High presence of Poaceae (11 species) and Asteraceae (six species) families correspond with most floras of the areas in the Cape region of South Africa (Goldbatt & Manning, 2000). This may imply that the environmental conditions in Hogsback montane wetlands are favourable for these families. Moreover, Poaceae and Asteraceae families are among the largest plant families in southern Africa characterised by at least 1000 species each (Germishuizen *et al.,* 2006). The dominance of Poaceae, Asteraceae and Cyperaceae (the third largest plant family in this study) in wetlands were also reported from similar vegetation studies in tropical Africa. Esaete *et al.* (2008) found that the dominant families were Poaceae, Asteraceae and Cyperaceae with more than ten species each in an inventory of wetland plant diversity in Uganda. The low number of exotic plant species in Hogsback montane wetland (three species in total) indicates limited anthropogenic influence. All three taxa, i.e., *Holcus lanatus, Oenothera rosea* and *Oenothera* spp. are not invasive in South Africa, and therefore, not listed as declared weeds and invaders under the Conservation of Agricultural Resources Act (1983) no. 43 of 1983 (South Africa, 1983).

Hogsback montane wetland is comprised of five floristic associations that vary significantly in species numbers and composition (Fig. 3; Table 3). *Helichrysum cooperi* and *Arundinella nepalensis* were the dominant species recorded in cluster 1, a plot characterised by trampling and high levels of erosion. Extensive trampling and overgrazing are known to deplete perennial grasses and can negatively affect the species composition leading to a decrease in resilience of the ecosystem (Carpenter *et al.,* 2001). The same authors also argued that grazing by cattle, goats and horses causes trampling of the vegetation resulting in wetland degradation. These factors appear to be responsible for poor plant community structure observed in cluster 1 and species such as *Helichrysum cooperi* and *Arundinella nepalensis* appear to be disturbance tolerant. This habitat has undergone transformation and the ecological functionality and habitat integrity of cluster 1 is therefore limited. Disturbance of soil through trampling often lead to the dominance of pioneer species that rapidly dominate the habitat. Under natural conditions, these pioneer species are overtaken by sub-climax or climax species through natural veld succession.

The results of CCA ordination strongly support the results of cluster analysis as the identified clusters or groups could readily be superimposed on the two dimensional CCA ordination configurations. Greig-Smith (1983) argued that clustering and ordination techniques complement each other, although the two techniques are used for different purposes. Classification and ordination techniques are often used to define plant communities and to identify the underlying environmental factors (Kent & Ballard, 1988; Han *et al.*, 2014; Jurišić *et al.*, 2014; Ilyas *et al.*, 2015). The differences in species composition among the different floristic clusters are a result of different environmental factors. Each cluster reflects the homogeneity of the communities in terms of plant species composition and dominance. Natural vegetation is known to respond to several environmental gradients and the identification of the principle environmental factors is regarded as a major challenge in the assessment of floristic composition (Jayakumar & Nair, 2012). The uniqueness of each cluster can be ascribed to various environmental factors such as channel incision, clay content, litter cover, organic matter content, soil depth, total area covered with water and water table depth (Table 3). The CCA analysis indicates that edaphic factors, particularly area covered with water, erosion category, organic matter content and water table depth were the most important environmental variables measured accounting for the vegetation pattern present in Hogsback montane wetland (Fig. 4). Stock *et al.* (2004) argued that the availability of moisture, including semi-permanent or permanent open water is the factor that determines the common species shared by wetlands. Previous research by Barnes *et al.* (1998) found that the growth potential of plants is affected by the amount of soil occupied by the roots and the availability of soil water and nutrients. Similarly, Goldstein and Sarmiento (1987) found that soil physical characteristics that influence permeability and moisture retention have profound influence on seasonal patterns of moisture availability at different soil depths.

Conclusion

The results of this study corroborate findings from other research that montane wetlands have a relatively low species richness, but species compositions are often unique, distinctive and habitat specific. Distinctive and unique plant species recorded in Hogsback montane wetlands include three endemic species to South Africa, namely, *Alchemilla capensis*, *Helichrysum rosum* and *Lysimachia nutans*. Therefore, wetlands are important in nature because they constitute a unique habitat for particular plant species. Future studies should focus on the biogeochemical processes in the wetland that may have an effect on plant species composition and distribution. This is necessary for a deeper understanding of the role wetland ecosystems play as unique habitats, as well as the need to understand their structural components and functional processes.

Acknowledgements

The authors would like to express their gratitude to the Govani Mbeki Research and Development Centre, University of Fort Hare for financial support to conduct this research.

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(Received for publication 8 August 2015)