South African Journal of Botany 113 (2017) 54–61

Contents lists available at ScienceDirect

South African Journal of Botany

journal homepage: www.elsevier.com/locate/sajb

The sclerophyllous wetlands on quartzite substrates in South Africa: Floristic description, classification and explanatory environmental factors

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ARTICLE INFO

Article history:
Received 22 November 2016
Received in revised form 28 May 2017
Accepted 28 July 2017
Available online xxxx

Edited by JB Adams

ABSTRACT

A description of wetland habitats on nutrient-poor sandstone and quartzite substrates across South Africa is given. Most of these are situated in the Fynbos Biome and are dominated by sclerophyllous shrubs but there are some sedge-dominated vegetation types as well as geographical outliers found in Pondoland, the Kamiesberg, the Mpumalanga escarpment, the Soutpansberg and the Waterberg. A subset from a national survey of wetland vegetation was selected for analysis in terms of classification and ordination. This resulted in a classification of 27 communities which are summarized in eight community groups. The variation in the dataset can be largely differentiated by means of altitude and cations and the associated ordination separates a small number of plots belonging to communities that are also distributed outside of the Fynbos Biome from the rest of the dataset. Within the Fynbos Biome, there are different wetland vegetation types found on steep slopes, with shallow soils and a high sand content versus the valley bottoms with deeper soils and a higher silt and clay content. There are also small differences in the nutrient status of different communities. This research showed that wetland plant communities in nutrient-poor communities have a distinct species composition. Species originate from a diverse range of functional types and phylogenetic groups compared to the typical wetland vegetation found in nutrient-rich grassy habitats in the rest of the continent.

1. Introduction

Across the world, wetlands are considered to be important for conservation, firstly because of their ecosystem services that play a role in water resource management, and also for their biodiversity (Gopal et al., 2001; Keddy, 2004). In South Africa, which is a water-scarce country, the focus until now has mainly been on the functional characteristics of wetlands and a successful wetland restoration programme has been implemented to recover ecosystem services in many areas where wetlands have been degraded (Kotze et al., 2009; Sieben et al., 2011). From the perspective of biodiversity planning, however, all wetlands should not be considered equal as some regions harbour a larger species pool that can contribute to wetland vegetation than others. In this regard, the nutrient-poor substrates of sandstones and quartzites, particularly the Table Mountain Group sandstones of the Western Cape stand out as unique habitats that support specialist plants adapted to survive in oligotrophic acidic soils (Manning and Goldblatt, 2012). The shrubland vegetation growing on these substrates is known as fynbos and this vegetation makes up the main part of the Cape Floral Kingdom, which is the smallest Floral Kingdom in the world. Much has been written about this type of vegetation, its dynamics and ecology (for example Cowling, 1992; Manning and Goldblatt, 2012; Allsopp et al., 2014), but the wetlands embedded within the fynbos areas have largely been ignored in terms of scientific studies. Furthermore, the characteristic vegetation associated with sandstone substrate extends outside the Western Cape, occurring in temperate islands in the Northern Cape to the west and north east into Mpumalanga, and stretching into tropical Africa (Galley et al., 2007).

Fynbos is well-known for its large species diversity (Goldblatt and Manning, 2000; Manning and Goldblatt, 2012). The ecosystem is characterized by extremely nutrient-poor soils, summer drought, and a fire regime with return periods of 5–40 years and relatively high intensity (Cowling, 1992). The wetlands within this area are subject to these same stresses and disturbances, and, in addition, they need to cope with anoxic soils.

In South Africa, wetlands are generally small units in the landscape, but their vegetation is often very distinct from the surrounding terrestrial vegetation. Mucina and Rutherford (2006) recognize two different wetland types that are restricted to the Cape Floral Region (CFR): Cape

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http://dx.doi.org/10.1016/j.sajb.2017.07.008
0254-6299/

Table 1
Historical datasets included in the present dataset.

Publication/dataset	Area	Comments	No. of plots
Boucher (1988)	West Coast	Vegetation plots of 10 × 10 m, heterogeneous	7
Kareko (2002)	Middelvlei Wetland, Stellenbosch	Plots of only 1 × 1 m	7
Cleaver et al. (2004)	Kamanassie Mountains	Maybe not all clear wetlands, small springs, plot size variable	16
Sieben et al. (2004)	Montane wetlands of Hottentots Holland	Vegetation plots 10 × 10 m	35
Corry (2011)	Western Cape lowlands	Soil data and many other variables available for most plots	37

Lowland Freshwater wetlands and Cape Vernal Pools, of which only the first occurs on the nutrient-poor sandstone substrates. They ignore the montane freshwater wetlands in the Western Cape, as these are generally small wetlands that are not mappable at the national scale.

Wetland environments are distinct from upland (drier) vegetation, in that their soils are depleted of oxygen for prolonged periods of time (Mitsch and Gosselink, 2000; Keddy, 2004). In many areas that are underlain by quartzites, such conditions can be expected in areas where shallow soils cover impermeable rocks without fractures and precipitation is relatively high. The nutrient-poor environment creates conditions in which organic matter breaks down slowly and in some cases, peat layers develop over the acidic sandy substrate. Many wetlands in this area are dominated by the same type of plants that are found in upland fynbos, namely sclerophyllous (hardy, mostly needle-leaved) shrubs and graminoids from the family Restionaceae, but the more typical graminoids of families like Poaceae and Cyperaceae also occur (Mucina and Rutherford, 2006).

The most comprehensive sampling of the wetlands in South Africa was recently conducted under the auspices of the Water Research Commission. In the technical report compilation (Sieben et al., 2014) it became clear that sclerophyllous wetlands are not entirely restricted to the Fynbos Biome in the Western Cape. Some of the communities are found in the high mountains of the Kamiesberg, on the Msikaba Group Sandstones in Pondoland in the Eastern Cape, and even in various mountain ranges and along the escarpment in Limpopo Province.

In the current study, we present an overview and classification of the vegetation types of wetlands that are found within sandstone fynbos or related vegetation types on extremely nutrient-poor substrates. This wetland vegetation is referred to as sclerophyllous vegetation and not as Fynbos vegetation because it is not restricted to the temperate Fynbos biome, but it is mostly dominated by sclerophyllous shrubs and graminoids as an adaptation to the unique environmental conditions in these wetlands. In the coastal sands and sandstone substrates of Pondoland and Kwa-Zulu-Natal, these vegetation types sometimes

Table 2
Environmental variables and their measurement or assessment that have been included in the National Wetland Vegetation database. Variables that were derived from soil samples from the topsoil were not collected for all vegetation plots and are marked with an asterisk. HGM_type refers to Hydrogeomorphic Unit.

Variable	Type of variable	Method of measurement	Method of assessment	Units	Transfor-mation	Abbreviations or categories used in ordination diagram
HGM_type	Nominal		Level 4 of SAWCS classification system (Ollis et al., 2013), Depression, Floodplain, Valley bottom, Valley bottom with channel, Seepage, Channel	n.a.		Depression, Fldplain, VB, VB-wc, Seepage, Channel
Soil depth	Nominal		Soil augering, subdividing into two categories: deep soils (>50 cm), shallow soils (<50 cm)	n.a.		Soil_dp, Soil_sh
Wetness	Index		Assessment of soil hydromorphic features following Kotze et al. (1996). Index: 1 = no wetland, 2 = temporary, 3 = temporary/seasonal, 4 = seasonal, 5 = semi-permanent, 6 = permanent	n.a.		Wetness
Soil texture (1)	Nominal		Feel of soil by touch	n.a.		Peat, Sand, Loam, Clay, Silt, Gravel
Soil texture (2)	Ratio*	Sieving and subdividing into three fractions Clay (<0.002 mm), Silt (0.002–0.05 mm), Sand (0.05–2 mm)		Mass %	Log	%Sand, %Clay, %Silt
Soil organic matter (1)	Index		Checking colour of soil: mineral soils = 1, dark or humic soils = 2, peaty soils = 3	n.a.		Organic
Soil organic matter (2)	Ratio*	Walkley-Black method		Mass %	Log	%Carbon
pH	Ordinal*	Water extraction of soil, using pH meter.		n.a.	*	PH
Inundation	Ratio		Assessed in field from standing water	cm		Inundation
Altitude	Ratio	using GPS	Finding locality in Google Earth	m		Altitude
Slope	Ratio		Assessed in field	Degrees		Slope
Electrical conductivity	Rato*	Water extraction of soil, using conductivity meter		mS/cm	Log	EC
Nitrogen	Ratio*	Sums of measured concentrations of ammonium, nitrite and nitrate, converted towards mol N, converted back into mass N		mg/kg	Log	Nitrogen
Phosphorus	Ratio*	Bray I method		mg/kg	Log	Phosphorus
Major cations	Ratio*	Using 1:10 water extraction of soil		mg/kg	Standardized, then log	Na, Ca, K, Mg