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A taxonomic revision of *Schoenus compar* - *Schoenus pictus* and allies (Cyperaceae, tribe Schoeneae) with three new species described from South Africa

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ABSTRACT

A taxonomic revision of the *Schoenus compar* - *Schoenus pictus* and allies group is presented, following a recent taxonomic realignment that transferred 24 southern African species into *Schoenus* from *Tetraria* and *Epischoenus*. In light of recent field collections and a thorough review of herbarium specimens, we revise the delimitations and distributions of three species (*Schoenus compar*, *Schoenus arenicolus* and *Schoenus pictus*) and raise *Schoenus pseudoloreus* to species level from its previous status as a variety of *Tetraria sylvatica*. In addition, we describe three new species (*Schoenus aureus, Schoenus megacarpus* and *Schoenus filiculmis*) predominantly occurring in the Cape Floristic Region of South Africa. Species in this group have either dilated primary inflorescence bracts or membraneous marginal extensions on the bracts that either partially or entirely cover spikes. Moreover, the sheaths and ligules are most often open and membranaceous. We present an identification key for these seven species and update their nomenclature, as well as provide detailed descriptions and distribution maps.

1. Introduction

Schoenus L. is a genus of perennial graminoids in the family Cyperaceae, tribe Schoeneae. As with many other genera in the Cyperaceae (e.g. *Carex* L. and *Cyperus* L.), species delimitation in *Schoenus* has been notably difficult due to the seemingly inconspicuous vegetative and reproductive characters of these grass-like plants (Goetghebeur, 1998). Recent phylogenetic analyses provide evidence for this confusion by showing that *Schoenus* is polyphyletic, with species placed in at least two different clades across tribe Schoeneae (Viljoen et al., 2013; Musili et al., 2016). Furthermore, several species of *Tetraria* P. Beauv. and most of the genus *Epischoenus* C.B. Clarke had been embedded within the larger *Schoenus* clade (Verboom, 2006; Viljoen et al., 2013), but these species have been transferred to *Schoenus* as a result of a recent taxonomic realignment (Elliott and Muasya, 2017).

Apart from a couple of notable exceptions (e.g. *Schoenus nigricans* L. and *Schoenus ferrugineus* L.), the distribution of the genus is limited to southern hemisphere locations in Africa, Australia, New Zealand, Southeast Asia and South America (Viljoen et al., 2013; Musili et al., 2016). Australia hosts the greatest richness of *Schoenus* with an estimated 110 species (Musili et al., 2016); however, the number of southern African *Schoenus* species has recently expanded based on the taxonomic realignment by Elliott and Muasya (2017) that transferred 24 species of *Tetraria* and *Epischoenus* into the genus. Recent studies suggest that the ancestor of the southern African *Schoenus* species originated in Australia, having possibly crossed the Indian Ocean by a long-distance dispersal event (Viljoen et al., 2013). Most of the southern African *Schoenus* species are endemic to fynbos plant communities in the Cape Floristic Region (CFR)—a region known for its high number of endemics due to geological and edaphic heterogeneity combined with relative long-term climate stability (Linder, 2003; Manning and Goldblatt, 2012; Allsopp et al., 2014; Power et al., 2017).

In addition to transferring 24 species to *Schoenus*, Elliott and Muasya (2017) used phylogenetic evidence to divide the southern African *Schoenus* species into four major groups to guide future taxonomic revisions: *S. nigricans*; *Schoenus compar* L. - *Schoenus pictus* Boeckeler and allies; *Epischoenus* and allies; and *Schoenus cuspidatus* Rottb. and allies. Our objective here is to revise the taxonomy of *S. compar* - *S. pictus* and allies (henceforth referred to as the *S. compar* - *S. pictus* group)—a clade that generally has dilated or membranaceous primary inflorescence bracts and membranaceous or papery ligules. In addition, several species in this group are notably viscous on the culms and/or

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inflorescences. We recognise seven species in this group, three of which are new to science, and provide species descriptions, updated distribution maps and a taxonomic key for the group.

2. Materials and methods

The vegetative and morphological characters of approximately 525 herbarium specimens were studied from nine herbaria (BM, BOL, BR, GRA, K, NBG, NU, PRE and WAG; see Thiers, 2017 for herbarium codes), supplemented by non-accessioned specimens collected from the authors' field trips. Location information from herbarium labels were used to map species' distributions based on Quarter Degree Grid Cells (Leister and Morris, 1976). Specimen characters were measured with either a hand-held ruler or microscope graticule. Data was compiled and distribution maps were created with R version 3.2.1 (R Core Team, 2014). Digital photos of plants specimens and spikes were taken with a Nikon D90 camera and either a Nikon DX AF-S18-105 mm ED lens (entire specimens) or Nikon AF micro Nikkor 105 mm 1:2:8 macro lens (spikes). Spikelet and nutlet photos were taken with a Nikon DS-US camera head attached to a Nikon Stereoscopic zoom microscope SMZ1500.

3. Results and discussion

3.1. Vegetative morphology

The genus *Schoenus* is characterised by caespitose and rhizomatous graminoid tussocks that are mostly perennial; however, annuals or short-lived perennials sometimes occur (Tucker, 1993; Goetghebeur, 1998). The culms of *Schoenus* are mostly scapose and terete, but are 3–4 angled in some cases (Tucker, 1993; Goetghebeur, 1998). The culm bases are sometimes thickened, or creeping-decumbent and branched from the nodes in semiaquatic species (Goetghebeur, 1998). The leaves are basal and ligulate with blades varying in shape from involute to subcylindric (Tucker, 1993; Goetghebeur, 1998), as well as they can be reduced to a sheath in some species (see Levyns, 1959).

Species in the *S. pictus - S. compar* group are perennial, caespitose graminoids, with culms that are scapose and terete. The leaf sheaths range from ivory to reddish-black in colour and can be either closed and firm (e.g. *S. pictus* and *Schoenus arenicolus*) or papery and open (e.g. *S. compar* and *Schoenus megacarpus*) in texture. These sheaths are often glossy, as in *S. pictus* and *Schoenus pseudoloreus*, and can have longitudinal striations; in addition, some species can have viscous sheaths and lower culms (e.g. *S. compar* and *S. pictus*). Ligules are present in this group and are two-lobed, ranging from firm (e.g. *S. pictus*) to membranaceous in texture (*S. compar*, *S. megacarpus* and *S. aureus*). All species in the *S. pictus - S. compar* group have basal leaves with varying shapes, ranging from very short, narrow and poorly-developed in most *Schoenus filiculmis* plants to relatively flat in *S. aureus* and *S. megacarpus*. Furthermore, species in this group tend to have leaves that are channelled becoming terete above the ligule; however, notable exceptions occur in the flat-leaved species, in particular, *S. aureus* and *S. megacarpus*. Finally, most leaves of plants in the *S. pictus - S. compar* group have serrate margins above the ligule.

3.2. Reproductive morphology

Schoenus species have terminal or sometimes more or less pseudolateral inflorescences that range from paniculate to capitate in shape, with one to many spikelets (Tucker, 1993; Goetghebeur, 1998). The primary inflorescence bracts can be leaflike or short and are sheathing or not, with the lowermost sometimes erect (Goetghebeur, 1998). Spikelets of *Schoenus* have few to many distichous, deciduous glumes of increasing length; however, the upper glumes can be relatively small. In addition, the upper glumes in this genus each subtend a flower, which is enclosed by the wings of the next glume (Goetghebeur, 1998). *Schoenus* rachilla internodes are often elongated and curved. The lower one to two flowers in this genus are usually bisexual, whereas the upper one to two are functionally male (Tucker, 1993; Goetghebeur, 1998). *Schoenus* specimens have fruits in the form of nutlets subtended by zero to six mostly deciduous perianth bristles, which can either exceed or be shorter than the fruit length (Tucker, 1993; Goetghebeur, 1998). Stamen number varies between one and six in *Schoenus*, as well as styles are usually 3-fid and deciduous (Tucker, 1993; Goetghebeur, 1998). Nutlets in this genus are often obovate to rounded trigonous and are rarely beaked (Tucker, 1993; Goetghebeur, 1998).

Species in the *S. compar - S. pictus* group usually have terminal inflorescences that appear pseudolateral due to the presence of leaflike proximal primary inflorescence bracts, which often exceed the total length of the inflorescence up to several times. Inflorescence shape in this group varies from narrowly-contracted paniculate (e.g. *S. pictus, S. pseudoloreus* and *S. filiculmis)* to wider, more compact panicles (*S. compar* and *S. aureus*). The primary inflorescence bracts in this group are often dilated at the base so that they envelop either entire or partial spikes; in addition, they can be thick and firm (*S. pictus*) or membranaceous and papery (*S. pseudoloreus, S. megacarpus* and *S. aureus*). The spikes in the *S. compar - S. pictus* group can be composed of many spikelets - such as in *S. compar* and *S. aureus* - or they can be depauperate with only one to two spikelets (e.g. *S. arenicolus* and *S. filiculmis*). Spikelet number per spike vary from one (*S. filiculmis*) to many (*S. compar* and *S. megacarpus*) in this group. Spikelets have few to many distichous or semi-distichous deciduous glumes, with the upper ones generally increasing in length. The texture of these glumes varies from thick, firm and hard *(S. arenicolus* and *S. compar*) to thin and papery *(S. pictus*). Glume shape is generally linear-lanceolate, and apices vary from obtuse to acuminate. Mucros of varying lengths may or may not be present in these *Schoenus* species and rachilla internodes are often elongated. Stamen number in these species is generally two or three, while the styles are usually 3-fid. Nutlets tend to be obovate to rounded trigonous, and distinct nutlet beaks - often conical in shape - are evident in many of the southern African *Schoenus.*

4. Key to the species of the *Schoenus pictus - Schoenus compar* and allies clade

1a. Short plants (<300 mm in height); glumes dark-red to almost black in colour; proximal primary inflorescence bract less than or only slightly exceeding length of inflorescence……7. ***Schoenus filiculmis***
1b. Taller plants (mostly over 300 mm in height); glumes varying in colour from dark brown to golden; proximal primary inflorescence bract exceeding length of inflorescence up to several times:
2a. Primary inflorescence bracts having membranacous extensions absent or poorly developed (i.e. poorly developed, or relatively narrow, as in *S. compar* and *S. arenicolus*):
3b. Primary inflorescence bracts proximally dilated; glumes thin and papery, often with red spots; nutlet beak similar in colour to nutlet……3. ***Schoenus pictus***
3b. Primary inflorescence bracts narrow at base; glumes thick and firm, light to dark brown; mature nutlets with darker beaks:
4a. Inflorescence a compact, wide panicle, leaves up to half length of culm [86–234(−305) mm]; basal sheaths often light in colour (ivory in some cases); nutlet beak bulges over nutlet body……1. ***Schoenus compar***
4b. Inflorescence a narrow panicle; leaves reduced, less than half length of culm [(10–)25–68(−134) mm]; basal sheaths often reddish in colour; nutlet beak continuous with body of nutlet……2. ***Schoenus arenicolus***
2b. Primary inflorescence bracts having conspicuous membranaceous extensions:
5a. Inflorescence a spike-like panicle; leaves often proximally channelled and terete with acute to acuminate apices……4. ***Schoenus pseudoloreus***
5b. Inflorescence a wider panicle; leaves usually flat with obtuse to acute apices: