



Taxonomic realignment in the southern African *Tetraria* (Cyperaceae, tribe Schoeneae; *Schoenus* clade)



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ABSTRACT

Tetraria – an austral genus with 54 currently accepted species – is polyphyletic, with species located across at least three different clades of the Schoeneae tribe of Cyperaceae. The small African endemic genus *Epischoenus* is embedded within one of these clades—the *Schoenus* clade of *Tetraria*. The majority of species in two of the major clades of *Tetraria* (the *Tricostularia* and *Schoenus* clades) are endemic to the Cape Floristic Region of southern Africa. Species in the *Tricostularia* clade have noded culms and reticulate sheath bases, whereas species of the *Schoenus* clade do not have nodes along their culms or reticulate sheaths. Importantly, the type species of the genera *Schoenus*, *Tetraria* and *Epischoenus* are resolved as part of the *Schoenus* clade, and the former has taxonomic priority. Here, we realign the taxonomy of the *Schoenus* clade of *Tetraria* to reflect our current understanding of the phylogenetic relationships within the Schoeneae. In addition, we outline the characteristics of three subclades (*Tetraria compar*–*Tetraria picta* and allies, *Epischoenus* and allies as well as *Tetraria cuspidata* and allies) that will be used to guide species groupings in forthcoming taxonomic revisions. Finally, we transfer 17 species of *Tetraria* and seven species of *Epischoenus* to *Schoenus*.

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1. Introduction

Changing concepts of genera have characterized plant taxonomy, leading to fluctuations in the size of genera (Humphreys and Linder, 2009). The inclusion of molecular data into plant classifications in the last few decades has led to tendency for larger genera (Humphreys and Linder, 2009), which continues a trend of consolidation that has existed since the mid-nineteenth century (Frodin, 2004). While several genera have grown in the number of species as a result of molecular work, there has been more of a focus on creating monophyletic taxa (Humphreys and Linder, 2009); for example, molecular data has been used to maintain monophyly by splitting genera such as *Aloe* (see Manning et al., 2014). Among the Cyperaceae, the genus *Carex* L. – estimated to have over 2000 species – has recently been made monophyletic by adding the genera *Cymophyllus* Mack., *Kobresia* Willd., *Schoenoxiphium* Nees and *Kobresia* Willd. to *Carex* (Global *Carex* Group, 2015). Similar to *Carex*, the concept of the genus *Cyperus* has been recently revised to include twelve genera that were previously segregated based on autapomorphies (Larridon et al., 2011, 2013).

Conversely, recent studies show that genus boundaries should be reassessed for the morphologically complex genera *Costularia* C.-B. Clarke, *Tetraria* P.Beauv. and *Schoenus* L., as molecular and morphological evidence suggests that they are polyphyletic, with distinct clades dispersed across the tribe Schoeneae (Verboom, 2006; Viljoen et al., 2013).

The majority of *Tetraria* species are endemic to South Africa, although there are a few species in central and south-east Africa, as well as Australia and New Zealand (Goetghebeur, 1998; Viljoen et al., 2013). *Tetraria*, with over 40 species in the Cape Floristic Region (CFR) of South Africa, is considered a ‘Cape floral clade’, because it has most of its evolutionary history in the CFR and has been in the region since the Pliocene (Linder, 2003). This genus is a common, sometimes dominant, component of fynbos communities throughout the CFR, with species often having broadly overlapping distribution ranges (Slingsby et al., 2014). Although *Tetraria* is often common in the fynbos, the South African *Tetraria* species have received relatively little botanical attention compared to other ‘Cape floral clades’, such as the Disineae (Linder, 1981), potentially because of the morphological complexity of the genus (Verboom, 2006).

Recent research shows that *Tetraria* is polyphyletic with species scattered across at least three different clades of tribe Schoeneae (Fig. 1). The *Tricostularia* clade includes an estimated 46 “reticulate-

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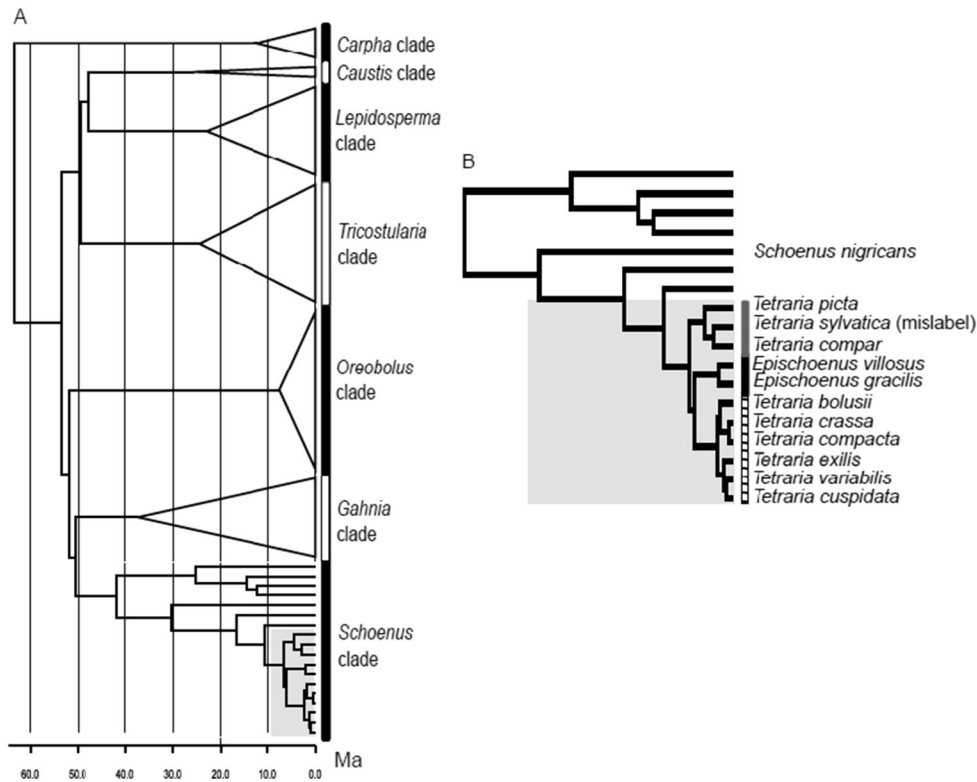


Fig. 1. Maximum likelihood phylogenetic reconstruction of the Schoeneae clade of sedges based on ETS, ITS, *rbcL*, *rps16* and *trnL-trnF* (adapted from Viljoen et al., 2013). The seven major clades of Schoeneae and their approximate divergence times in millions of years are shown in A, with the southern African species highlighted in light grey. Phylogenetic relationships within the *Schoenus* clade are shown in B, which illustrates the four clades found in southern Africa: *S. nigricans*, *T. compar*–*T. picta*, *Epischoenus* and *T. cuspidata* and allies.

sheathed" *Tetraria* species endemic to south and eastern Africa, as well as the Australian *Tetraria octandra* (Nees) Kük. (Viljoen et al., 2013; Slingsby et al., 2014). The *Lepidosperma* clade includes the *Tetraria capillaris* (F.Muell.) J.M.Black complex, native to Australia and New Zealand (Viljoen et al., 2013). Here, we realign the taxonomy of the remaining "non-reticulate" *Tetraria* included in tribe Schoeneae, along with the South African endemic *Epischoenus* (Verboom, 2006; Viljoen et al., 2013). Furthermore, we review the taxonomy of several existing "non-reticulate" *Tetraria* and *Epischoenus* species to address several taxonomic uncertainties that exist due to the lack of taxonomic attention since Levyns (1947).

2. Taxonomic history of southern African *Tetraria*

In 1816, Palisot de Beauvois founded the genus *Tetraria* when he described *Tetraria thuarii* P.Beauv., based on a specimen collected by du Petit-Thouars at the Cape of Good Hope (Palisot de Beauvois, 1816; Levyns, 1947). Palisot de Beauvois noted that each *T. thuarii* spikelet had three types of flowers: the lowest consisted solely of glumes; the intermediate had one glume, four stamens and an ovary with four stigmas; and the highest were composed of a glume, with eight stamens, a bulbous-based style divided into two parts (which was subdivided into four stigmas) and a four-angled fruit that had pairs of stamens between each angle (Palisot de Beauvois, 1816). He followed the description by naming the genus *Tetraria*, based on the four pairs of stamens, four stigmas and the four-angled fruit. He noted that *T. thuarii* closely resembled *Schoenus compar* L. – a species later to be renamed *Tetraria compar* (L.) Lestib. (Lestiboudois, 1819) – but differed based on the numbers of stigmas and angles of the fruit.

Until Clarke added several new species and transferred several others over to *Tetraria* in 1894, *T. compar* and *T. thuarii* remained the only species of the genus in South Africa (see Durand and Schinz, 1894). Clarke expanded the definition of *Tetraria* past the rule of four

reproductive parts, to include 31 species with three, six or eight stamens; three, four, six, or eight style branches; and a trigonous or subtetragonous fruit (see Clarke, 1900a). In addition, Clarke included several taxa that had previously been assigned to other genera, such as *Elynanthus* P.Beauv. ex T.Lestib., *Chaetospira* R.Br., *Lepidosperma* Labill., *Schoenus* L., *Schoenopsis* P.Beauv ex T.Lestib., *Aulacorrhynchus* Nees, *Rhynchospora* Vahl.; *Fuirena* Rottb., *Decalepis* Boeckeler, *Sclerochaetium* Nees, *Buekia* Nees and *Cyathocoma* Nees (Durand and Schinz, 1894). Subsequent work by Turritt (1925) added eight more species to the genus, followed by the addition of several new species, varieties and forms by Kükenthal (Kükenthal, 1931, 1940).

Levyns' taxonomic revision of the *Tetraria* of the Cape Peninsula of South Africa added several new species to the genus (Levyns, 1947). Based on observations of the type specimen of *T. thuarii* at Geneva, Levyns sunk *T. thuarii* into *T. compar*. Levyns (1947) noted that *T. thuarii* was the only species in the genus that fit Beauvois' rule of reproductive parts in groups of four and concluded that *T. compar* was a variable species, having between three to eight stamens and three to four style branches. Of note, Levyns divided the relatively large species – *Tetraria cuspidata* (Rottb.) C.B.Clarke – into eight taxa of which most of the new were localized species (*T. cuspidata*, *Tetraria compacta* Levyns, *Tetraria graminifolia* Levyns, *Tetraria paludosa* Levyns, *Tetraria crassa* Levyns, *Tetraria variabilis* Levyns, *Tetraria autumnalis* Levyns and *Tetraria exilis* Levyns). This split was based on differences in fruit, spikelet and ligule size and shape, as well as plant height, leaf length, inflorescence type, the presence/absence of perianth bristles and number of glumes, stamens and style branches (Levyns, 1947). Although Levyns' revision was relatively thorough, it focused solely on *Tetraria* species found in the Cape Peninsula region of South Africa, leaving many taxonomic uncertainties in this genus throughout the remainder of the CFR (Levyns, 1947). For the most part, taxonomy in the clade has been ignored since Levyns' revision, creating further confusion about the circumscription of this genus.

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