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REVISION OF THE MEDITERRANEAN AND SOUTHERN AFRICAN *TRIGLOCHIN BULBOSA* COMPLEX (JUNCAGINACEAE)

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The *Triglochin bulbosa* complex (Juncaginaceae) from the Mediterranean region and Africa is revised. One new species, *Triglochin buchenaui* Köcke, Mering & Kadereit, and two new subspecies, *Triglochin bulbosa* subsp. *calcicola* Mering, Köcke & Kadereit and *Triglochin bulbosa* subsp. *quarcicola* Mering, Köcke & Kadereit, are described from South Africa. The only two Mediterranean taxa in the complex (*Triglochin barrelieri*, *T. laxiflora*) are elevated to species rank. Altogether seven species and four subspecies are recognised: *Triglochin barrelieri*, *T. buchenaui*, *T. bulbosa* subsp. *bulbosa*, *T. bulbosa* subsp. *calcicola*, *T. bulbosa* subsp. *quarcicola*, *T. bulbosa* subsp. *tenuifolia*, *T. compacta*, *T. elongata*, *T. laxiflora* and *T. milnei*. An identification key, detailed descriptions and accounts of the ecology and distribution of the taxa are provided. An IUCN conservation status is proposed for each taxon.

Keywords. Cape Floristic Region, Cape Peninsula, ecology, IUCN conservation assessment, Juncaginaceae, Mediterranean Floristic Region, morphology, revision, South Africa, taxonomy, *Triglochin*, typification.

Introduction

Triglochin L. is the largest of the currently recognised four (Haynes *et al.*, 1998; Stevens, 2001 onwards) or five (Dahlgren *et al.*, 1985) genera of the small monocotyledon family Juncaginaceae, and contains 25–35 annual and perennial species. The genus has an almost cosmopolitan distribution with Australia as the centre of specific diversity. Common habitats of *Triglochin* are coastal salt marshes, tidal mudflats, freshwater wetlands, seasonal pools and inland saltpans.

In the Mediterranean region and southern Africa *Triglochin* is represented by a group of widely distributed taxa with ovoid to very narrowly ovoid fruits consisting of three fertile carpels that separate at maturity. A carpophore may be

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present or absent. Since all taxa belonging to this group have been included in *Triglochin bulbosa* L. at some point, the group is here called the *T. bulbosa* complex. In a molecular phylogenetic study of *Triglochin* (von Mering & Kadereit, unpubl. data), this complex forms a well-supported monophyletic clade. Additional species of *Triglochin* in the Mediterranean region but which are not in the *T. bulbosa* complex are *T. maritima* L., *T. palustris* L. and *T. striata* Ruiz & Pav. *Triglochin striata* is also found in southern Africa as the only non *T. bulbosa* complex species. These three species can easily be distinguished from the *Triglochin bulbosa* complex by fruit characters. The fruits of *Triglochin maritima* are composed of six fertile carpels, *T. palustris* has fruits with only three carpels that do not separate at maturity, and *T. striata* is easily recognisable by roundish fruits consisting of three fertile and three sterile carpels.

The *Triglochin bulbosa* complex is a systematically difficult group as is evident from its complex taxonomic history. In South Africa, five species of the *Triglochin bulbosa* complex have been recognised in the past, but currently only a broadly circumscribed *T. bulbosa* is accepted within the complex (e.g. Obermeyer, 1966; Goldblatt & Manning, 2000; Glen & Cook, 2003; Trinder-Smith, 2003). In this broad circumscription, *Triglochin bulbosa* shows substantial morphological (e.g. in leaf and fruit characters and underground parts) and ecological variation (Fig. 1). In the Mediterranean area, *Triglochin barrelieri* and *T. laxiflora* have been variously treated as separate species (e.g. Talavera, 1987; S. Talavera, ms. Flora Iberica) or as subspecies of the South African *T. bulbosa* (e.g. de Bolòs & Vigo, 2001).

No revision of the entire complex has ever been attempted. This paper reports the findings of an analysis of extensively researched herbarium material and our own collections from the Mediterranean area and South Africa. Based on morphology, phenology, ecology and geographical distribution, seven species and four subspecies are recognised. These are *Triglochin barrelieri* Loisel., *T. buchenaui* Köcke, Mering & Kadereit sp. nov., *T. bulbosa* L. (with subspecies *T. bulbosa* subsp. *bulbosa*, *T. bulbosa* subsp. *calcicola* Mering, Köcke & Kadereit subsp. nov., *T. bulbosa* subsp. *quarcicola* Mering, Köcke & Kadereit subsp. nov. and *T. bulbosa* subsp. *tenuifolia* (Adamson) Horn), *T. compacta* Adamson, *T. elongata* Buchenau, *T. laxiflora* Guss. and *T. milnei* Horn.

Taxonomic History

Triglochin bulbosa L. was described by Linnaeus in 1771 based on collections by Thunberg from the Cape of Good Hope (Buchenau, 1896). However, Barrelier's account of 'Juncago maritima' (1714) from the western Mediterranean is the first description of a member of the *Triglochin bulbosa* complex. Despite its morphological distinctness stressed by Barrelier (1714), Linnaeus did not recognise Barrelier's taxon as a separate species but included it as var. β in *Triglochin palustris* L. (Linnaeus, 1762). Loiseleur-Deslongchamps (1806) at first included this taxon as

Triglochin palustris L. var. β in his *Flora Gallica*, but in the amendments to this Flora (Loiseleur-Deslongchamps, 1807) recognised it as a distinct new species, *T. barrelieri* Loisel. An affinity to, or a possible synonymy with, *Triglochin bulbosa* was suggested ('An *Triglochin bulbosum.* Lin. Mant. 226 ?'; Loiseleur-Deslongchamps, 1807). The second Mediterranean taxon, *Triglochin laxiflora* Guss., was described by Gussone (1825) from Sicily and Corsica.

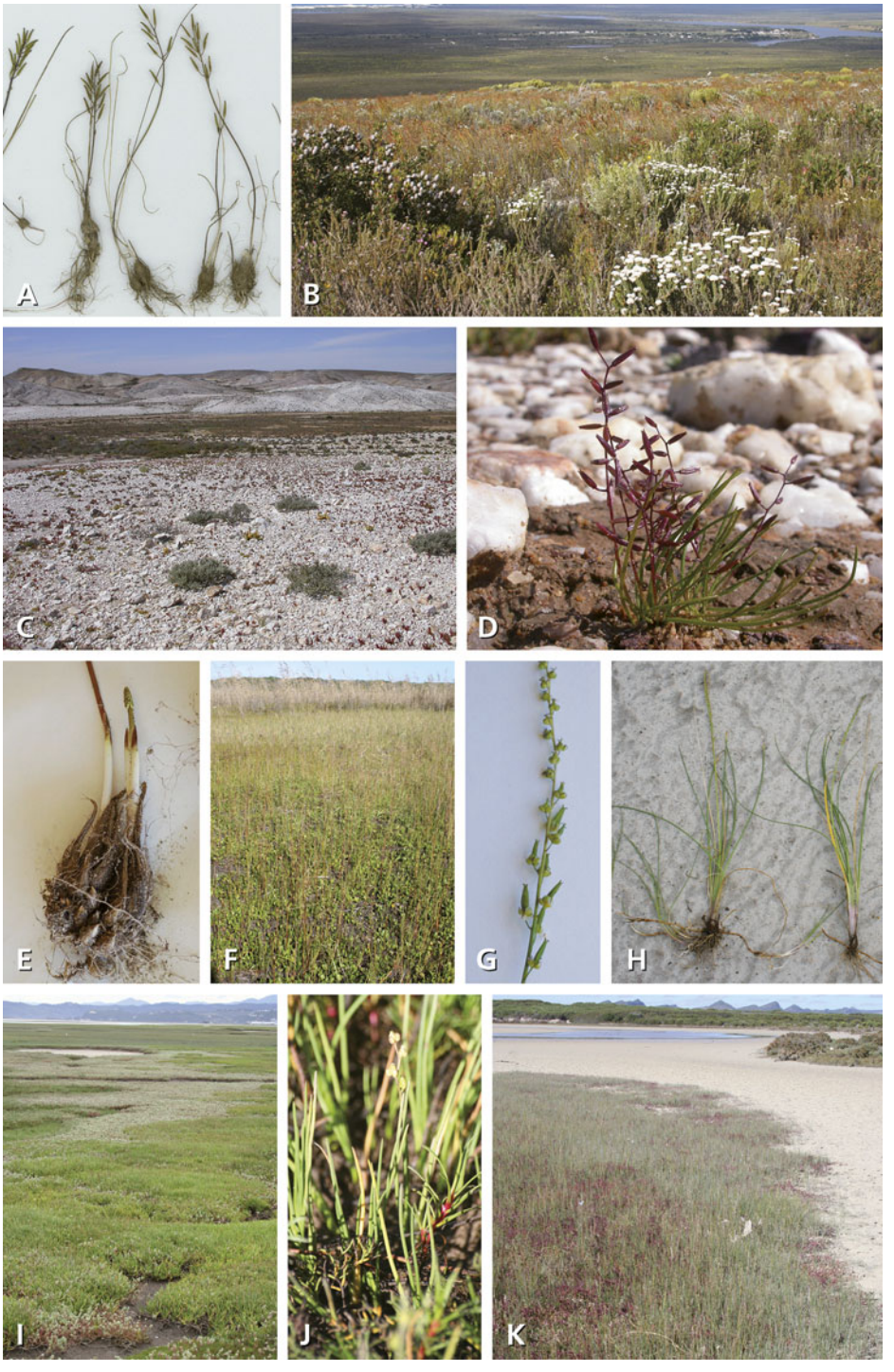
Subsequently, *Triglochin barrelieri* and *T. laxiflora* were both recognised as distinct species (e.g. Loiseleur-Deslongchamps, 1828; Battandier & Trabut, 1884; Bonnet, 1896; Jahandiez & Maire, 1931). Other authors accepted only *Triglochin laxiflora* as a species while *T. barrelieri* was treated as a synonym (e.g. Micheli, 1881; Buchenau, 1903) or as a subspecies of the South African *T. bulbosa* (e.g. Hayek, 1933; Maire, 1952). Rouy (1912) was the first to reduce the two Mediterranean taxa to subspecies of the South African *Triglochin bulbosa* (*T. bulbosa* subsp. *barrelieri* (Loisel.) Rouy, and *T. bulbosa* subsp. *laxiflora* (Guss.) Rouy). Some recent Floras treat them as distinct species, *Triglochin barrelieri* and *T. laxiflora* (Talavera, 1987; S. Talavera, ms. Flora Iberica), and others as subspecies of *T. bulbosa* L. (e.g. de Bolòs & Vigo, 2001).

Based mainly on differences in fruit size and pedicel length, Pau (1914) described *Triglochin barrelieri* var. *maura* Pau, a variety endemic to Morocco. It was later also treated as *Triglochin bulbosa* var. *maura* (Pau) Maire (Maire, 1952) or as a synonym of *T. bulbosa* subsp. *barrelieri* (Govaerts, 2008).

Buchenau (1903) newly described *Triglochin elongata* Buchenau from South Africa and recognised *T. bulbosa* (syn. *T. barrelieri*) and *T. laxiflora*. The occurrence of the last in South Africa was recorded with reservations because only one specimen could be assigned to *Triglochin laxiflora* by Buchenau (1903). Bennett (1897) also believed *Triglochin laxiflora* to occur in South Africa, while Horn af Rantzien (1961) excluded this species from the South African flora.

Adamson (1939), who contributed considerably to the compilation of the *Flora of the Cape Peninsula*, studied the South African species of *Triglochin* in more detail and also published notes on habitat preferences. He provided detailed descriptions and diagnostic characters for the South African taxa of the *Triglochin bulbosa* complex known to him (Adamson, 1939). Adamson described two new *Triglochin* species, *T. tenuifolia* Adamson (1939) and *T. compacta* Adamson (1943), and accepted *T. elongata*. Thus, Adamson (1939, 1943) recognised the following four species of the *Triglochin bulbosa* complex in South Africa: *T. bulbosa*, *T. elongata*, *T. tenuifolia* and *T. compacta*. We follow Adamson in the recognition of his newly described *Triglochin compacta* and *T. tenuifolia*, but treat the latter as a subspecies of *T. bulbosa*.

The last treatment of the African species of *Triglochin* was carried out by Horn af Rantzien (1961). This author did not regard his publication as a full revision since it was based on herbarium material from Kew and Stockholm only. He provided an identification key to the species and subspecies of *Triglochin* in Africa which was mainly based on differences in fruit characters and underground organs. In his study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only taxa with bulbs were investigated in great detail, especially with respect to flower and fruit morphology. As a result of this he described a new species, *Triglochin milnei* Horn, from southern Central Africa (Tanzania, Angola, Zambia, eastern South Africa), recognisable by its conspicuously larger flowers and fruits. Apparently Horn af Rantzien (1961) was not aware of the existence of *Triglochin compacta* and did not include this taxon in his study. He did, however, include *Triglochin tenuifolia* in *T. bulbosa* as subsp. *tenuifolia* (Adamson) Horn, and also treated the other taxa at intraspecific rank. This resulted in the recognition of five subspecies of *Triglochin bulbosa*: subsp. *bulbosa* (South Africa), subsp. *tenuifolia* (South Africa), subsp. *barrelieri* (Mediterranean), subsp. *laxiflora* (Mediterranean) and subsp. *maura* (Pau) Horn (Morocco). Such treatment seemed justified by great similarities within the complex and the occurrence of transitional forms. Like Adamson (1939), Horn af Rantzien (1961) also accepted *Triglochin elongata* as a separate species. However, this taxon was overlooked by later authors.

Most recent Floras and checklists of Central and southern Africa accept *Triglochin bulbosa* as the only species (plus the distinct *T. striata*, which does not fall into the *T. bulbosa* complex; e.g. Obermeyer, 1966; Goldblatt & Manning, 2000; Glen & Cook, 2003; Trinder-Smith, 2003) and treat *T. milnei* as a synonym (e.g. Obermeyer, 1966; Lisowski *et al.*, 1982). Only Cook (2004) recognised *Triglochin milnei* as a distinct species. The World Checklist of Monocotyledons (Govaerts, 2008) currently recognises only *Triglochin bulbosa* with a broadly circumscribed *T. bulbosa* subsp. *bulbosa* (Tanzania to South Africa), and *T. bulbosa* subsp. *barrelieri* and *T. bulbosa* subsp. *laxiflora* (both in the Mediterranean).

Material and Methods

This revision is based mainly on the study of c.800 specimens from AV, B, BC, BM, BOL, EA, FB, HBG, JE, K, M, MJG, MO, MSB, NAP, NBG, NBG-SAM, NBG-STE, NY, P, POZG, RNG, RO, S, STEU, WHB, Z and ZT (abbreviations according to Holmgren & Holmgren, 1998). Names were typified as far as possible, and most type material cited has been seen, in some cases as digital images (indicated by '!' and 'photo!', respectively).

The distribution maps are based on information from herbarium labels and unambiguous records in the literature. Coordinates of older collections were taken

Fig. 1. *Triglochin bulbosa* L. subsp. *calcicola* Mering, Köcke & Kadereit subsp. nov.: A, habit; B, habitat (De Hoop). *T. bulbosa* L. subsp. *quarcicola* Mering, Köcke & Kadereit subsp. nov.: C, habitat (Moedverloren); D, habit. *T. compacta* Adamson: E, bulbs; F, habitat (Goukamma); G, infructescence. *T. elongata* Buchenau: H, habit (with rhizomes). *T. buchenaui* Köcke, Mering & Kadereit sp. nov.: I, habitat (Knysna); J, habit. *T. elongata* Buchenau: K, habitat (Overberg). Photographs A, B, F, H–K: L. Mucina; C–D: U. Schmiedel; E, G: J. Naudé.

mainly from the NGA GEOnet Names Server (GNS) (National Geospatial-Intelligence Agency, http://earth-info.nga.mil/gns/html/index.html) and the Gazetteer of the Cape Region (Institute of Systematic Botany, University of Zurich, www.systbot.uzh.ch/Bestimmungsschluessel/GazeteerRSA.html). In addition, the Google Earth web-based satellite imagery database (earth.google.com) was used. All maps were generated using the programme ArcGIS 9.0 (ESRI, 2006). The locations of new collections made between 2000 and 2008 were ascertained by using a GPS device. Some information on collector names and/or localities in Africa was verified using Aluka (Ithaka Harbors, Inc., www.aluka.org). Measurements were made on herbarium material and may deviate from fresh material. Longer field trips were made in 2006 (March–May) in South Africa, in October 2006 in Sardinia (Italy), and in 2007 (March–April) in France and Spain. The conservation status of each taxon was assessed using the IUCN Red List categories and criteria (IUCN, 2001).

Taxonomic Treatment

Triglochin L., Sp. Pl. 338 (1753). – Type species: *Triglochin palustris* L. – Type specimen: 'Habitat in Europae inundatis uliginosis' (lecto LINN 466.1 photo!).

Hexaglochin Nieuwl., Amer. Midl. Naturalist 3: 10 (1913). – Type species: *Hexaglochin maritima* (L.) Nieuwl. (= *Triglochin maritima* L.). – Type specimen: USA, Indiana, Chain of Lakes, 19 v 1909, *Nieuwland* 547 (lecto ND photo!, designated here).

Notes. We have not seen type material of other names that have been cited as synonyms of *Triglochin* by Govaerts (2008). The synonyms given by Govaerts (2008) are *Juncago* Ség., *Juncago* Tourn. ex Moench, *Abbotia* Raf., *Tristemon* Raf., *Cycnogeton* Endl. and *Maundia* F.Muell. Of these, *Juncago* Tourn. ex Moench is an illegitimate superfluous name (nom. illeg.). *Tristemon* was described as a segregate of *Triglochin*, but no diagnosis was given and no type material was indicated. The descriptions provided and their geographical distribution and habitat suggest that *Juncago* Ség. and *Abbotia* should indeed be regarded as synonyms of *Triglochin* as suggested by Govaerts (2008). *Cycnogeton* Endl. and *Maundia* F.Muell. are distinct genera (see von Mering & Kadereit, in press).

Description of the Triglochin bulbosa *complex*

Erect perennial herbs, 5–90 cm high, with scapose inflorescences and rhizomes or (often aggregated) bulbs. Base of plants covered with fibrous remains of old leaves. *Leaves* basal, distichous, ± succulent, linear, ± terete (semi-terete), ligulate, sheathing at the base. *Inflorescence* a spike. *Flowers* hermaphrodite, 3-merous, ebracteate, proterogynous. Perianth of six green or sometimes reddish tepals; tepals

conchiform, deciduous. Stamens six or three, sessile or subsessile; anthers dorsifixed, dithecous, dehiscing longitudinally, extrorse. *Infructescence* a raceme. *Fruits* ovoid to very narrowly ovoid (Figs 2, 4). Fertile carpels three, connate, sessile, with one ovule and sessile stigma each, usually separating into one-seeded mericarps at maturity. Sometimes an outer whorl of three vestigial carpels present (*Triglochin milnei* and *T. compacta*). *Carpophore* mostly present, sometimes carpophore very thin or lacking and then mericarps not always separating. *Seeds* erect, embryo straight.

Notes. Flowers of *Triglochin* usually have six stamens. However, this number may be reduced to three as reported for *Triglochin milnei* (Horn af Rantzien, 1961). Such reduction was also noted in this study in *Triglochin bulbosa* subsp. *calcicola*. The gynoecium of *Triglochin* is variable. In principle, carpels are arranged in two whorls of three carpels each (e.g. Tomlinson, 1982). Whereas in some species (e.g. *Triglochin maritima*) all six carpels are fertile, in others (e.g. *Triglochin striata*) the three carpels of the outer whorl are sterile (e.g. Tomlinson, 1982; pers. obs.). In the *Triglochin bulbosa* complex only three fertile carpels are present. However, in some species (especially *Triglochin compacta* and *T. milnei*) membranous outgrowths are present at the base of the carpophore, which have been interpreted as remains of the second whorl of carpels. Size and form of these outgrowths are variable. Sometimes they are extremely small, but in *Triglochin milnei* these structures are often very distinctive. Horn af Rantzien (1961) considered them sterile carpels and accordingly described *Triglochin milnei* as having six carpels, of which three are sterile. However, not all specimens studied have outgrowths that can be identified as sterile carpels. Fruits in the complex mostly separate from bottom to top. In some species this character seems to be variable (i.e. carpels separate from bottom to top or from top to bottom). Currently we are not able to give accurate information on the mode of carpel separation for all taxa and accordingly do not know whether this character can be used for the distinction of taxa. This character should be further studied on fresh material.

Distribution. The *Triglochin bulbosa* complex is native to the Mediterranean region, extending along the Atlantic coast to NW France and Morocco (Fig. 3), and to southern Central Africa extending to South Africa (Figs 5, 8, 9). A subspecies of *Triglochin bulbosa* has been reported to be naturalised in Western Australia (Western Australian Herbarium, 1998 and onwards; Australian Plant Census, 2008; see also under *T. bulbosa* subsp. *bulbosa*).

Habitat and ecology. Plants of this group are typically found in hygro-halophytic habitats such as coastal salt marshes, tidal mud-flats and along lagoons. They also occur on coastal rocks exposed to salt spray or in temporary pools, in inland saltpans, in dry, non-saline habitats on mountain slopes or in seasonally wet grassland and along river banks. Some collections were made at altitudes above 1000 m.

Chromosomes. In *Triglochin* chromosome numbers of up to $2n = 144$ are known (e.g. Löve & Löve, 1958; Robb & Ladiges, 1981). No chromosome counts are available

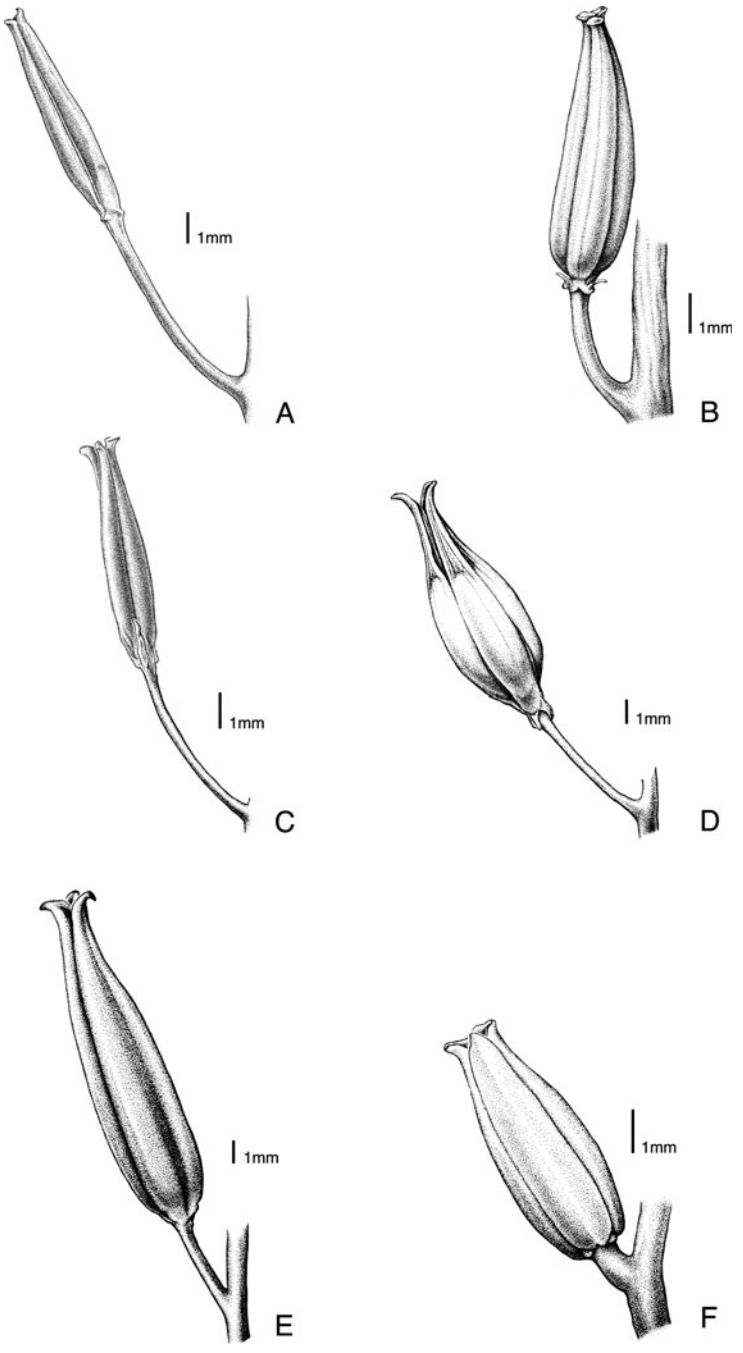

FIG. 2. Fruits of A, *Triglochin barrelieri* Loisel.; B, *T. laxiflora* Guss.; C, *T. compacta* Adamson; D, *T. milnei* Horn; E, *T. elongata* Buchenau; F, *T. buchenaui* Köcke, Mering & Kadereit. Drawings by L. Klöckner (Mainz).

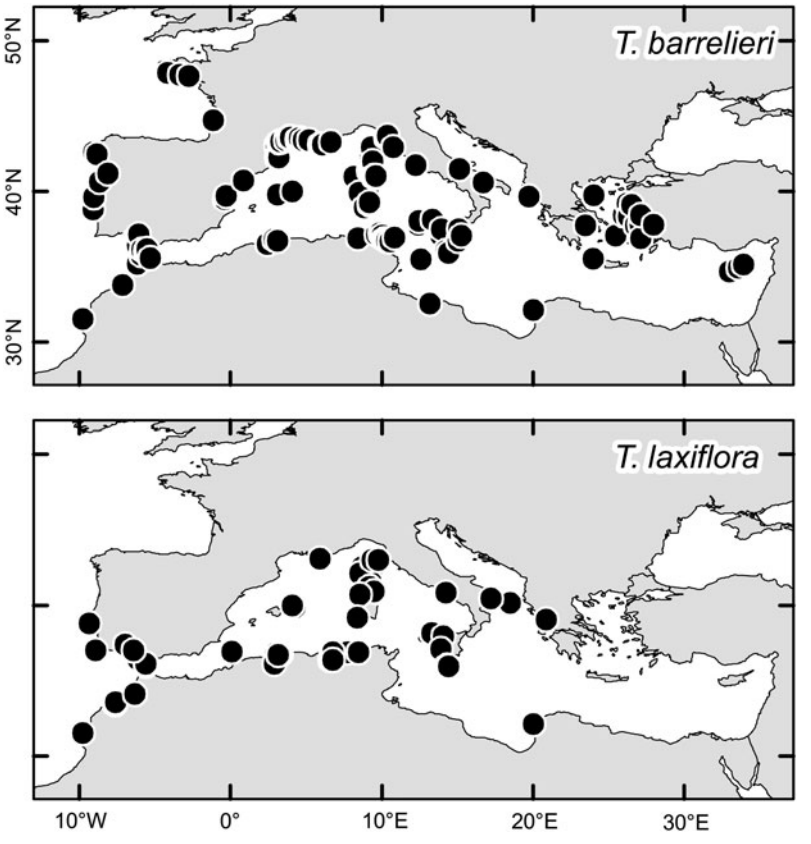

FIG. 3. Geographical distribution of *Triglochin barrelieri* Loisel. and *T. laxiflora* Guss.

for the southern African species of the complex, and only few for the Mediterranean species. For *Triglochin laxiflora* $2n = 18$ (Gardé & Malheiros-Gardé, 1953; Bartolo *et al.*, 1977; Talavera *et al.*, 1995; Castro *et al.*, 2007), and for *T. barrelieri* $2n = 30$ (de Castro & Carvalho Fontes, 1946), 32 (Dahlgren *et al.*, 1971; Bartolo *et al.*, 1977) and 36 (Castro *et al.*, 2007) have been reported.

Nomenclatural note. Although Linnaeus (1753) treated *Triglochin* as neuter in his original publication of the name, the feminine gender has to be used (ICBN Vienna Code 2006, Art. 62.2b and Ex. 5).

Key to the species of the Triglochin bulbosa *complex*

The following key is based on herbarium material. Characters such as size of flowers, fruits or pedicels often are not sufficient to identify species because of the existence of (in this respect) intermediate forms. Underground parts are sometimes lacking in herbarium specimens but are important for the identification of species. When the

geographical origin of the material and/or its phenology are unknown, special attention must be paid to the presence of either bulbs or rhizomes. Notes on habitat and distribution should also facilitate the identification of species. As already stated by Horn af Rantzien (1961: 102): 'In identifications statements on locality, habitat, and time of anthesis are of more use than those on morphological characters.' This implies that the combination of morphological attributes, ecology and geographical distribution defines species best.

1a. Plants from the Mediterranean region or the Atlantic coast of western Europe and North Africa ____ 2
1b. Plants from Central or southern Africa ____ 3

2a. Leaves present at flowering time, mostly as long as or longer than plant height; pedicels spreading (Fig. 2A); plants flowering in spring (ii–v) ____ **1. T. barrelieri**
2b. Leaves formed after flowering, usually much shorter than plant height; pedicels ascending, ± appressed to infructescence axis (Fig. 2B); plants flowering in autumn (ix–xii) ____ **2. T. laxiflora**

3a. Plants with rhizomes, of salt marsh estuaries or estuarine rivers ____ 4
3b. Plants with bulbs, of inland habitats, never under direct influence of tidal flooding ____ 5

4a. Inflorescences dense, with 10–100 flowers; infructescences (6–)10–25 cm long; fruits with carpophore; plants growing in the upper zone of salt marsh estuaries and estuarine rivers ____ **6. T. elongata**
4b. Inflorescences lax, with 3–17 flowers; infructescences 2–7 cm long; fruits without carpophore; plants restricted to the lower tidal zone of salt marsh estuaries ____ **7. T. buchenaui**

5a. Flowers usually > 3 mm long; fruits (8–)10–14 mm long and ± 3 mm wide (Fig. 2D); plants flowering and fruiting in summer (x–ii/iii); plants from Central and southern Africa (incl. eastern South Africa) ____ **5. T. milnei**
5b. Flowers usually < 3 mm long; fruits 4–10(–12) mm long and (0.5–)1–2 mm wide; plants flowering and fruiting in spring (vii–xi) or autumn (ii/iii–v); plants from South Africa ____ 6

6a. Leaves present at flowering time, mostly as long as or longer than plant height; plants flowering and fruiting in spring (vii–xi) ____ **3. T. bulbosa**
6b. Leaves formed after flowering, mostly only half as long as plant height; plants flowering and fruiting in autumn (ii/iii–v) ____ **4. T. compacta**

1. Triglochin barrelieri Loisel., Fl. Gall. ed. 1, 725 (1807), ed. 2, 1: 264 (1828). – *Triglochin bulbosa* subsp. *barrelieri* (Loisel.) Rouy, Fl. France (Rouy) 13: 271 (1912). – Type: France, Arles (Arelatem), 'habitat Arelatem ad Rhodanu', *Artaud* s.n. (holo AV photo!). **Figs 2A, 3.**

Triglochin barrelieri var. *maura* Pau, Bol. Real Soc. Esp. Hist. Nat. 14: 425 (1914). – *Triglochin bulbosa* var. *maura* (Pau) Maire, Fl. Afrique N. 1: 213 (1952). – Type: Morocco, inter Ceuta et Tetauen, l. d. Rincón de Medik, 13 iii 1930, *Font Quer* s.n. (lecto MPU-Maire photo!, designated here).

Notes. Some other names have previously been cited as synonyms of this taxon. No type material of *Triglochin atlantica* Willd. ex Kunth was found in B-W. The short description of *Triglochin palustris* L. var. β (Sp. Pl. ed. 2, 1: 483, 1762) matches that of *T. barrelieri*. The description, distribution and flowering time of *Juncago chabraei* Bubani (Fl. Pyren. (Bubani) 4: 8, 1901) suggest that this name is an additional synonym. However, we could not fully verify the identity of these names because we have not seen any type material. The name *Triglochin bulbosa* var. *genuina* Maire, Jahandiez & Maire (Cat. Maroc 859, 1934) implies that the authors considered it to be the type variety.

Plants 10–45 cm high, with fusiform *bulbs*; bulbs covered in dry, brown, stiff, sometimes spiky fibres, these up to 4 cm long. Plants without rhizomes. *Leaves* usually many, present at flowering time, mostly as long as or longer than plant height, uniform. *Inflorescences* rather dense, with 10–25(–30) flowers. *Flowers* (2.5–) 3–4.5 mm long. *Pedicels* elongated at fruit maturity, up to 2–7 mm long, rarely longer, spreading at angles of 45–90° from the inflorescence axis, slightly curved inwards towards the apex. *Infructescences* 8–16 cm long. *Fruits* narrowly ovoid, 5–10 mm long, rarely longer, 1–2 mm wide (Fig. 2A), sometimes turning dark or black at fruit maturity. *Mericarps* linear, connate at the *carpophore*; tips only slightly curved outwards.

Distribution. The species is widely distributed in the Mediterranean region (with a noteworthy gap in Egypt) reaching the Atlantic coast of NW France and Morocco (Fig. 3). It is known from all large Mediterranean islands.

Habitat and ecology. *Triglochin barrelieri* is commonly found in coastal wetlands, for example in salt marshes and along lagoons, and less frequently on coastal rocks exposed to salt spray, in depressions in coastal dunes or in cork oak forests (e.g. in Andalusia, Spain). In North Africa it typically occurs in *sabkhas* (rarely flooded salt marshes of desert coasts). The species usually grows in very open vegetation and is often associated with *Sarcocornia fruticosa* (L.) A.J.Scott and *Juncus acutus* L.

Phenology. Flowering in spring (ii–v); leaves present at flowering time.

Chromosome number. $2n = 30$ (de Castro & Carvalho Fontes, 1946), 32 (Dahlgren *et al.*, 1971; Bartolo *et al.*, 1977), 36 (Castro *et al.*, 2007).

Notes. This species is very variable in overall size and fruit and pedicel length. *Triglochin barrelieri* var. *maura* has been described from Morocco as a taxon of larger size and with longer pedicels. However, such large forms are also found in other parts of the species' distribution range and are not limited to Morocco. The

presence of *Triglochin barrelieri* in Israel seems possible because the description of *T. palustris* for this area by Post (1933) partly matches *T. barrelieri*. We have, however, not seen any material of the species from Israel, where it may be extinct.

Taxonomic remarks. *Triglochin barrelieri* is clearly distinct from the only other Mediterranean species of the complex, *T. laxiflora*, by its spring flowering (vs. autumn), the presence of leaves at flowering time (vs. leaf formation after flowering), and by having spreading pedicels (vs. appressed to infructescence axis).

The distinction between *Triglochin barrelieri* and *T. bulbosa* subsp. *bulbosa* is difficult, and these two species are morphologically very similar to each other. They can be distinguished by their distribution and ecology, and results of our molecular studies (von Mering, Köcke & Kadereit, unpubl. data) support their recognition as separate species because they are not even each other's closest relative.

Nomenclatural notes. In the protologue of *Triglochin barrelieri* the following localities are given: 'Habitat in maritimis Neutstriae, Occitaniae, Provinciae; ad ripas Rhodani prope Arelatem collegit *D. ARTAUD*' (Loiseleur-Deslongchamps, 1807). The herbarium of Loiseleur-Deslongchamps in Avignon (AV) contains several specimens bearing the name *Triglochin barrelieri*. Only the specimen cited above corresponds to the protologue (location and collector), was annotated by Loiseleur-Deslongchamps himself (P. Moulet, pers. comm.) and thus probably represents the holotype.

Proposed IUCN conservation status. Least Concern (LC). The species used to be widely distributed in the Mediterranean region and is probably not under immediate threat. However, coastal wetlands (where the species is typically found) are among the most vulnerable habitats in the Mediterranean region. Large areas have already been lost or degraded or are under severe threat due to drainage, construction, urbanisation and tourism (e.g. Finlayson & Moser, 1991; MedWet, 1996). Only few data are available on the current area of occupancy due to the very low number of recent collections. Several collecting localities of older specimens have been destroyed by settlements. Other populations might also be destroyed or threatened by habitat destruction. Therefore, the area of occupancy might be declining, and the global conservation status of this species may be prone to change. Further conservation assessments are also necessary at the national level. *Triglochin barrelieri* is already protected in Aquitaine, France (Muséum National d'Histoire Naturelle, 2003–2006) and in the Italian regions of Molise, Basilicata, Calabria and Sicily (Conti *et al.*, 1997).

Selected specimens examined. **Europe**. FRANCE. **AQUITAINE**. **Gironde**: Bordeaux, Bassin d'Arcachon, vi 1831, *Endress* s.n. (B, BM, HBG, JE, M, P). **BRETAGNE**. **Finistère**: Loctudy and Combrit, sine dato, *Bonnemaison* s.n. (AV). **Morbihan**: Gâvres, 15 vii 1847, *Debrez* s.n. (ZT); Gâvres, 1847, *Pontarlier* s.n. (P); Gâvres, 1847, *Taslé* s.n. (P); Gâvres, 3 vi 1851/4 vii 1847, *Toussaints* s.n. (P); Port-Louis, vi 1847, *Pontarlier* s.n. (ZT), 1849, *Grenier* s.n. (ZT); Port-Louis, 30 vi 1877, *Lloyd* s.n. (BM); Port-Louis, 1891, *Renou* s.n. (P); Port-Louis, 27 v 1912, *Charrier* s.n. (BM). **CORSICA**. **Haute-Corse**: Ghisonaccia, 30 v 1900, *Rotgès* 339 (P); Saint-Florent, river l'Aliso, 20 v 1973, *Auquier* 3037, *Baguette & Lambinon* (M). **Corse-du-Sud**:

Bonifacio, 29 iii 1849, *Kralik* 787 (P); Porto-Vecchio, 19 iv 1868, *Mabille* s.n. (BM, K, P); Bonifacio, Santa-Manza, 12 iv 1876, *Revelière* s.n. (BM); Bonifacio, 12 v 1880, *Reverchon* s.n. (BM); Bonifacio, Santa-Manza, 12 v 1880, *Reverchon* 246 (JE, P); Bonifacio, Santa-Manza, 2 vi 1894, *Stefani* s.n. (P); Bonifacio, Piantarella, 5 iv 1895, *Stefani* s.n. (BC-SENNEN, P), 9 iv 1895, *Stefani* s.n. (M, ZT); Porto-Vecchio, iv 1911, *Stefani* s.n. (P); iv 1912, *Roux* s.n. (P); Porto-Vecchio, E side of Stabiacco estuary, 13 iv 1939, *Brenan* C.408 (K). LANGUEDOC-ROUSSILLON. **Aude**: Leucate, 30 v 1887, *Chevallier* s.n. (M); La Nouvelle, iv 1899, *Sennen* s.n. (BC-SENNEN); La Nouvelle, 10 vi 1904, *Sennen* s.n. (P). **Hérault**: Maguelonne, 1 vi 1821, *Cufino* s.n. (HBG, RO); Sète (formerly Cette): 1834, *Gath* s.n. (BM), 3 v 1882, *Neyra* s.n. (JE), 4 v 1882, *Neyra* s.n. (B, JE, RO), 9 v 1891, *Dirmède* s.n. (K), v 1905, *Bee* s.n. (P); Roquehaute, near Béziers, v 1855, *Personnat* s.n. (P); Montpellier, v 1857, *Cramer* s.n. (HBG); Maguelonne, 13 vi 1857, *Cosson* s.n. (P); Palavas, 27 v 1899, *Morot* s.n. (P); Palavas, 20 v 1908, *Vichet* s.n. (P); Lattes, Montpellier, 23 iv 1914, *Sudi* s.n. (ZT); E of Palavas, 10 v 1914, *Noaik* s.n. (Z); Pérols, 1 vi 1915, *Braun* s.n. (ZT); St. Marcel, Pérols, 1 vi 1915, *Braun-Chur* s.n. (Z); Montpellier, v 1921, *Jenny* s.n. (ZT); Etang de Pérols, Palavas, 12 v 1934, *Zobrist* s.n. (ZT). **Pyrénées-Orientales**: Vendres, 28 iv 1891, *Sennen* s.n. (M), 7 vii 1891, *Sennen* s.n. (BC-SENNEN). PROVENCE-ALPES-CÔTE D'AZUR. **Bouches-du-Rhône**: Étang de Marignane, 7 vi 1894, *Rouy & Blaise* s.n. (P); Saint-Louis-du-Rhône, v 1906, *Thiébaut* s.n. (P, ZT); without locality, v 1909, *Thiebaut* s.n. (M); Les Saintes-Maries-de-la-Mer, 12 iv 1957, *H. & E. Walter* 68 (B); Ile des Rièges, 24 iv 1967, *Lüpnitz* F 233, F 234, F 235 (MJG); Etang de Vaccarés, 11 iv 1969, *Hecker* F 320 (MJG). **Var**: Hyères, v 1839, *Kugel* s.n. (BM, M); Toulon, Les Sablettes, 16 v 1848, *Bourgeau* 361 (M, P); Hyères, 1853, *Jordan* s.n. (HBG); Hyères, v 1863, *Huet & Jacquin* s.n. (B); Hyères, 29 iv 1869, *Shuttleworth* s.n. (P); Toulon, Les Sablettes, 9 v 1870, *Antheman* s.n. (B); Hyères, iv 1873, *Allard* s.n. (P, Z); Toulon, 23 vi 1887, *Chevalier* s.n. (P); Hyères, 14 iv 1898, *Mouillefarine* s.n. (P); Hyères, 30 iv 1903, *Raine* s.n. (P); Saint Tropez, Les Salins, iii 1910, *A. & E.G. Camus* s.n. (P), iv 1910, *A. & E.G. Camus* s.n. (P), 22 iii 1911, *A. & E.G. Camus* s.n. (P); Hyères, 25 iii 1913, *Beger* s.n. (B); Hyères, 25 iii 1913, *Noaik* s.n. (Z); Hyères, 3 iv 1913, *Thompson* s.n. (BM); Saint Tropez, Les Salins, 31 iii 1919, *Hibon* s.n. (P); Hyères, Ceinturon, 14 iv 1925, *Ruppert* s.n. (M); Hyères, La Londe, river Pansard, 30 iv 1929, *Ruppert* s.n. (M); Saint Tropez, Les Salins, 5 iv 1931, *Paul* s.n. (M); Hyères, 30 iii 1932, *Oberneder & Oberneder* 457 (BM); Hyères, 5 iv 1955, *Schumacher* s.n. (HBG).

ITALY. APULIA. **Brindisi**: Saline di Punta della Contessa, 23 v 2007, *di Pietro & Wagensommer* s.n. (MJG), 9 iv 2008, *di Pietro* s.n. (MJG). **Foggia**: Monte Gargano, Manfredonia, iv 1876, *Comes, Freda, Pedicion* s.n. (RO); Mte. Gargano, mouth of river Cervaro, 14 km S of Manfredonia, road to Bari, 20 iv 1964, *Dietrich* s.n. (M), *Hertel* 3575 (M), *Podlech* 9554 (MSB); between Sciale Borgia and the mouth of river Cervaro, 12–14 km S of Manfredonia, 22 v 1972, *Hein* s.n. (B). **Taranto**: Taranto-Ginosa, 18 iv 1879, *Pasquale* s.n. (RO). LAZIO. **Rome**: Ostia, near Rome, v 1925, *Meebold* s.n. (K). SARDINIA. **Cagliari**: Cagliari, vi 1854, *Huet du Pavillon* s.n. (P); Cagliari, La Madeleine, 3 iv 1958, *Titden* 128 (K); Cagliari, near Maddalena, 6 iv 1858, *Schweinfurth* s.n. (HBG); Quartu Sant Elena, Stagno di Simbirizzi, c.20 m, 18 iv 1975, *Urmi* s.n. (Z); Domus de Maria, SW of Stagnioni de su Sali, 4 iv 1992, *Stud. biol. Acad. Turic. in itinere* 92-12 (Z). **Olbia-Tempio**: Terranova, 11 iii 1885, *Forsyth Major* s.n. (HBG); Golfo Aranci, 1 iv 1909, *Poeverlein* 25009 (B); near Olbia, 8 iv 1962, *Podlech* 7872 (MSB); Porto di Cugnana, iv 1966, *Merxmüller* 20931 *& Oberwinkler*, *Merxmüller* 20932 *& Oberwinkler* (M); 3 km S of Palau, 19 iv 1973, *Humphries & Richardson* 378 (RNG). **Oristano**: Oristano, prope locum dictum Torre Grande, 19 iii 1912, *Fiori* s.n. (BC, BM, RO, Z). **Sassari**: Stintino Peninsula, Capo Falcone, 3 iv 1968, *Hecker* I 27, I 28 (MJG); Capo Falcone, c.10 m, 13 iv 1971, *Hecker* I 500 (Hec.691) (MJG); Capo Falcone, 0–15 m, 9 iv 1973, *Humphries & Richardson* 167 (BM); Capo Falcone, 4 x 2006, *von Mering* s.n. (MJG). SICILY. **Agrigento**: Licata, iv 1902, *Ross* 376 (B, HBG, M, ZT); Isola di Lampedusa, 10 iii 1907, *Martarana* s.n. (RO).

Caltanisetta: San Cataldo, 1847, *Rabenhorst* s.n. (BM); San Cataldo, 26 v 1875, *Porta & Rigo* 299 (JE, P). **Catania**: Catania, 26 iii 1856, *E. & A. Huet du Pavillon* s.n. (BM, M, P). **Siracusa**: Siracusa, 26 iv 1898, *Rigo* 161 (HBG, M, P); near Siracusa, iv 1898, *Rigo* s.n. (B, BM, M, P, Z, ZT); Pachino, 31 iii 1952, *Harries & Doppelbaur* 343 (M); near Siracusa, iii 2005, *Uhink* s.n. (MJG). **Trapani**: Marsala, v (sine anno), *Todaro* s.n. (BM, RO); Trapani, 9 iv 1966, *H. & H. Doppelbaur* 14565 (M). TUSCANY. **Grosseto**: Follonica, 27 v 1911, *Fiori* s.n. (BC-SENNEN). **Livorno**: Livorno, Paduletta, 19 v 1861, *Savi* s.n. (B, P). **Pisa**: near Pisa, 1868, *van Heurck* s.n. (BC).

SPAIN. ANDALUSIA. **Cádiz**: Bonanza, 17 iv 1951, *Alston* 10267 (BM); entre San Fernando y Chiclana, 28 v 1951, *de Bolos* s.n. (BC); between Tarifa and Puerto Real, 8 iv 1953, *Merxmüller & Wiedmann* 648/53 (M); near Los Barrios, c.150 m, 14 v 1967, *Brinton-Lee* 1306 (BM); Tarifa, Rio de la Jara, iii 1973, *Deil* s.n. (FB); Tarifa, 19 iv 1974, *Carr* 1636 (RNG); Puerto de Santa María, 13 iv 1978, *Luque & Valdés* s.n. (B, BC, HBG, M, RNG); entre San Fernando y Chiclana, 4 v 1979, *Cabezudo, Gallego & Talavera* s.n. (RNG); Tarifa, mouth of Rio Jara, 20 vi 1990, *Deil* 5967 (FB); Tarifa, Zahara de los Atunes, 16 v 1992, *Deil* 6329 (FB). **Sevilla**: Isla Menor, Rio Guadalquivir, 17 iv 1972, *Heywood, Moore, Bramwell et al.* 218 (RNG). BALEARIC ISLANDS. **Mallorca**: near Porrata, 5 iv 1921, *Welti-Hug* s.n. (Z); SE of Albufera, v 1985, *Beckett* s.n. (RNG). CATALONIA. **Girona**: Castelló d'Empúries, 27 iv 1908, *Sennen* 613 (BM); Castelló d'Empúries, vii 1916, *Pascual* s.n. (BC-SENNEN); Rosas, v 1943, *Bolos* s.n. (BC); Aiguamolls de Castelló d'Empúries, 14 v 1983, *Blanché & Vallès* s.n. (M). **Tarragona**: Delta de l'Ebre, Sant Carles de La Ràpita, 2 iv 1934, *Font Quer* s.n. (BC); Alfaques peninsula, near Sant Carles de la Ràpita, 2 iv 1934, *Koch* 34/50 (ZT); Delta de l'Ebre, Sales, 16 ii 1975, *Balada* s.n. (BC). GALICIA. **A Coruña**: Olveira, 24 iv 1981, *Amich, Rico, Sánchez & Giraldez* s.n. (BC); Olveira, Santa Uxía de Ribeira, 4 v 1985, *Valdés-Bermejo* 10148 *& Grupo Botanico Gallego* (BC, M, Z). VALENCIAN COMMUNITY. **Valencia**: Valencia, iv 1892, *Reverchon* s.n. (M); Sagunt(o) (French: Sagonte), iv 1893, *Reverchon* 834 (B, BM, HBG, M, P, Z).

PORTUGAL. **Aveiro**: Aveiro, Mina, 20 v 1954, *J. Matos, A. Matos & Marques* 4752 (P); Ílhavo, Gafanha da Boavista, 20 v 1954, *J. Matos, A. Matos & Marques* 4768 (P); Ílhavo, between Forte da Barra and Ponte Nova (Costa Nova), 30 v 1979, *Marques* 1260 (B). **Coimbra**: Figueira da Foz, Gala, 11 v 1950, *J. Matos & A. Matos* s.n. (BM). **Faro (Algarve)**: between Vila Real de San António and Castro Marim, 22 iv 1956, *Malato-Beliz et al.* 2890 (RO); Martinhal near Sagres, 1 iv 1971, *Davis* 50919 (RNG); Alvor, iii 1990, Univ. of Oxford Plant Sciences undergraduate field course (RNG). **Leiria**: S of Nazaré, 7 iv 1961, *C. & J. Poelt* 207, 227 (M). **Lissabon**: Sacavém, 31 iii 1943, *Carvalho Fontés* 8909 (BC). **Porto**: Porto, Boucas, Mattosinhos, v 1895, *Sampaio* s.n. (M, P). **Sétubal**: Bank of river Tejo ('ad Tagum'), Coina, iv 1840, *Welwitsch* 237 (P); 'ad Tagum', 1848–1850, *Welwitsch* 993 (BM); Transtagana (SE Portugal, later Prov. Alemtejo), near Fornos d'El Rei, vi 1851, *Welwitsch* 333 (P); Trafaria, iii 1888, *Daveau* 348 (P).

CYPRUS. **Famagusta**: near Paralimni village, 10 iv 1953, *Kennedy* 1782 (D 3755) (K). **Limassol**: Akrotiri, W side of Limassol salt lake, 15 iv 1992, *Lambinon* 92/Cy/359 *& van den Sande* (MSB).

GIBRALTAR. Palmones, 7 ii 1913, *Wolley-Dod* 1573 (K), 11 iii 1922, *Wolley-Dod* 349 (BM).

CROATIA. **Zadar**. Pag (island), near Vlasici, 13 v 2005, *Bernhardt* s.n. (WHB). **Šibenik-Knin**. Near Sibenik, 8 vi 2006, *Bernhardt & Hermanowski* s.n. (WHB).

GREECE. ATTICA. **Athens**: near Athens, 1820, *Sartori* s.n. (M); Faliro (also Faliron/Phaliron, latin Phalerum), iv 1849, *Orphanides* s.n. (P); Eleusine, 19 iii 1876, *Heldreich* s.n. (HBG); v 1876, *Pichler* s.n. (P); Faliro, iv 1886, *Heldreich* s.n. (B), 8 iv 1897, *Heldreich* s.n. (Z); Athens, Loutsa, 15 ii 1931, *Guiol* 1714 (BM). CENTRAL GREECE. **Euboea**: Evvia: ep. Karistias, W of Karistos, 0–10 m, 4 v 1996, *S. & B. Snogerup* 12651 (B). CRETE. **Chania**: near Suda (also Souda), iii 1846, *Heldreich* s.n. (BM, P); location illegible, iii 1846, *Heldreich* s.n. (BM, K, P).

IONIAN ISLANDS. **Corfu**: Kastrades, am Hylläischen Hafen, 3 m, 22 iv 1896, *Baenitz* s.n. (B, HBG, M, P, ZT); Potami, 21 v 1887, name illegible (ZT); Alikes, iv 1980, *Bowen* 1897 (RNG). NORTH AEGEAN. **Chios**: c.1930, *Guiol* s.n. (BM). **Samos**: Tigani, 2 iv 1934, *K.H. & F. Rechinger* 3642 (BM, K). PELOPONNESE. **Argolis**: Argolis, Ep. Ermionidhos, 3.3 km ENE Portoheli, 0–5 m, 14 iv 1996, *Eisenblätter & Willing* 43.814, 43.815 (B). **Laconia**: Ep. Epidhavros Limiras, opposite island Elafonisos, 10 iv 1979, *Greuter & Merxmüller* 17076 (B, M, P); mouth of river Evrotas, near Elos, iv 1979, *Bowen* 1307 (RNG); Vinglafia, opposite Elafonisos, 21 ii 1991, *Jagel* s.n. (B). **Messenia**: Ep. Pilia: Voidhokoilia Bay between Petrohori and Paleokastro Navarinou, 0–5 m, 17 iv 1979, *Greuter & Merxmüller* 17215 (B, M); Methoni, iv 1981, *Bowen* 2051 (RNG). SOUTH AEGEAN. **Cyclades**: Naxos, Chora, 15 v 1992, *Böhling* 1491 (B); Naxos, Alluvai, 17 iv 1993, *Böhling* 2312 (B). **Dodecanese**: Kos, N coast, near Marmari, 0–3 m, 12 iv 1974, *Buttler* 18237 (M). WEST GREECE. **Achaea**: near Kalogria SW of Patras, 25 iv 1991, *Raabe* s.n. (B); Ahaia, near Kalogria, 33 km W of Patra, 2 v 1995, *Turland* 849 (BM); Loutra Kounoupelli, road to Kalogria/Metohi, 7 v 1996, *Raabe* s.n. (B). **Ilia**: between Brinia and Manolada (Ilia), 17 v 1996, *Raabe* s.n. (B).

TURKEY. **Izmir**. Smyrna (= Izmir), 29 iii 1854, *Balansa* s.n. (P, ZT); Smyrna, near Halcar-Bunar (Halkar Bunar), 12 v 1906, *Bornmüller* 10018 (B, BM, HBG, JE, P, ZT); Cesme Peninsula, end of Gülbahce Bay, 25 ii 1966, *Bocquet* 1133 (ZT); between Karsyaka and Izmir near Bairakli, 5 iv 1966, *Bocquet* 1887 (ZT).

North Africa. ALGERIA. **ALGIERS**. Algiers, Marais ou Baba Alg., iv 1850, *Jamin* s.n. (P); Marais de la Meteija, iv 1851, *Jamin* s.n. (P); Algiers, Maison-Carrée, iii 1856, *Wolfe* s.n. (K); Salines d'Argess, 6 v 1875, *Cosson* s.n. (P); Algiers, Maison-Carrée, 8 iv 1894, *Chevalier* s.n. (P); Algiers, marais de la Raasaura près Fort-de-l'Eau, 28 ii – 10 iv 1960, *d'Alleizette* s.n. (M); near Garaetz el Mkhada, 23 iii 1968, *Leippert* 7107 (B). ANNABA. **Annaba**: Bône (= Annaba), 1834, *Steinheil* s.n. (P); Annaba, near Boudjima, 28 iii 1884, *Letourneux* s.n. (P). EL TAREF. **El Kala**: La Calle (= El Kala), 11 v 1841, *Durieu de Maisonneure* s.n. (P); La Calle, 18 v 1918, *Clavé* s.n. (P); La Calle, 5–10 m, 11 v 1971, *Davis* 52174 (BM, RNG).

LIBYA. CYRENAICA. **Benghazi**: Benghazi, 9 iv 1883, *Ruhmer* 315 (HBG, JE, P); Benghazi, 1884, *Petrovich* s.n. (Z); Tadjoura, near Tripoli, 8 iv 1886, *Letourneux* s.n. (P); Cyrenaica, without locality, 13 v 1887, *Taubert* 87 (P); road between Benghazi and Tocra, 19 iii 1929, *Rikli* s.n. (ZT); Barsis (also Bersis), 11 iii 1958, *Guichard* CYR/96/58 (BM); 4–5 km N of Benghazi, 3 iv 1970, *Davis* 50488 (K, RNG). **Al Jabal al Akhdar**: El-Hania, Sebka Chascem el-Chelb, 8 Mag.(v) 1934, *Pampanini & Pichi-Sermolli* 165 (K). TRIPOLITANIA. **Tarabulus**: Tripoli, Mlacha, 22 iii 1887, *Taubert* 87 (JE); near Tripoli, 29 iii 1938, *Kracht* 38/001, 38/002 (B); El Magazin, near Bezenicem, 20 iv 1938, *Maire & Weiller* 1461 (P).

MOROCCO. CHAOUIA-OUARDIGHA. **Ben Slimane**: Bouznika, 60 m, 23 iv 1979, *Lewalle* 9020 (P); Oulad Amara, N de Bouznika, 40 km SW of Rabat, 23 iv 1979, *Damblon* 79/63 (B, RNG). TANGIER-TÉTOUAN. **Larache**: Larache, bridge over river Loukkos, 17 iii 1995, 3 m, *Mateos, Reina, Sangalli, Sardón & Valdés* 4824/95 (RNG); Larache, 15 v 2003, *Deil & Hamman* 5 (FB). **Tangier-Assilah**: Tanger, Cap Spartel, 20 iv 1911, *Pitard* s.n. (P); Tanger, Cap Spartel, 10 m, 30 iv 1986, *Deil* 1321 (FB); Tahaddart, Sansouire, 17 v 2003, *Deil & Hamman* 34 (FB). **Tétouan**: Oued Laou, c.km E of Tetouan on road to Martil, 25 m, 25 ii 1994, *Jury* 13327 *& Taleb, Upson, Walters* (RNG).

TUNISIA. **BEN AROUS**. Hammam-el-Lif, 8 v 1883, *Cosson, Letourneux, Reboud, Barratte & Bonnel* s.n. (P); Hammam-el-Lif, 20 v 1888, *Barratte* s.n. (P); Hammam-el-Lif, 6 v 1893, *Chevalier* s.n. (P). **BIZERTE**. Ruins Utique, 21 vi 1887, *Letourneux* s.n. (P); between Dindja and lake Ichkeul, 23 vi 1887, *Letourneux* s.n. (P); between Djebel Ichkeul and Mateur, 26 vi 1887, *Letourneux* s.n. (P); Utique, 4 v 1888, *Barratte* s.n. (P); Menzel, Djemil, 11 v 1888, *Barratte* s.n. (P); Menzel, Djemil, 2 vi 1888, *Cosson, Barratte & Duval* s.n. (P); near Protville, between Tunis and Bizerta, 16 iv 1938, *Simpson* 38298 (BM); Carthage–Tunis road, 28 iv 1939, *Sandwith* 2845 *& Simpson*

39779 (BM). **Nabeul**. Cap Bon, between Kurba and Menzel, Temim, v 1883, *Cosson, Letourneux, Reboud, Barratte & Bonnel* s.n. (P); c.7 km SW of Hammamet, 14 iv 1968, *Wagenitz* 1177 (B); Kelibia, E side of Cap Bon peninsula, 28 iv 1975, *Davis* 56931 *& Lamond* (BM, RNG). **Sousse**. Zaouiet-el-Mgaiz, 18 v 1883, *Cosson, Letourneux, Reboud, Barratte & Bonnel* s.n. (P). **Tunis**. Tunis, 4 iii 1874, *Doûmet-Adanson* s.n. (P); Tunis, Goletta, 9 iii 1880, *Armitage* s.n. (RO); Tunis, La Goulette, 2 v 1883, *Cosson, Letourneux, Reboud, Barratte, Bonnel* s.n. (P); Tunis, La Goulette, 19 v 1888, *Barratte* s.n. (P); Tunis, 12 iv 1971, *Bolay & Kramer* s.n. (B); Djebel Djeloud, iv 1909, *Pitard* s.n. (ZT).

2. Triglochin laxiflora Guss., Index Seminum Horto Boccad. 1825: s.p. (1825); Fl. Sic. Prod. 1: 451 (1827). – *Triglochin bulbosa* subsp. *laxiflora* (Guss.) Rouy, Fl. France (Rouy) 13: 272 (1912). – Type: Italy, Sicily, Palermo, 'Palermo a Monte Peregrino' [= Monte Pellegrino], *Gussone* s.n. (lecto NAP photo!, designated here). **Figs 2B, 3.**

Triglochin palustre Desf., Fl. Atlant. 1: 322 (1798), non L. (nom. illeg.).

Plants 10–25(–35) cm high, with fusiform *bulbs*; bulbs covered in dry, brown fibres which are usually stiff, sometimes soft or spiky; fibres up to 5 cm long. Plants without rhizomes. *Leaves* few (mostly 2–4 per bulb), formed after flowering, usually much shorter than plant height (mostly reaching only half the height of plants). Outer leaves shorter and wider than inner leaves, up to 6 cm long, mucronate, inner leaves abruptly narrowing above the ligule, less than 1.5 mm wide. *Inflorescences* lax, with 4–15(–25) flowers. *Flowers* 2–3 mm long. *Pedicels* 2–3 mm long, rarely longer, usually much shorter than fruit, ascending, ± appressed to infructescence axis, diverging from it at angles of up to 45°, slightly curved inwards towards the apex. *Infructescences* 3–10 cm long. *Fruits* narrowly ovoid, 5–10 mm long, rarely longer, 1–2 mm wide (Fig. 2B). *Mericarps* linear, connate at the *carpophore*; tips curved outwards.

Distribution. Widely distributed in the Mediterranean region, largely sympatric with *Triglochin barrelieri* but absent from the Atlantic coast of France and from parts of the eastern Mediterranean (Fig. 3).

Habitat and ecology. This species is typically found in salt marshes and along lagoons, but also in cork oak or pine forests (e.g. Morocco, Andalusia) and in Mediterranean temporal pools (e.g. Corsica, Malta). *Triglochin laxiflora* is sometimes found in limestone areas (e.g. Malta, Sicily). Growing from 0 to 500 m (e.g. Monte Pellegrino, Sicily), in Algeria reaching c.1100 m (e.g. Djebel Ouach).

Phenology. The species flowers and fruits in autumn (ix–xii) and leaves are formed after flowering.

Chromosome number. $2n = 18$ (Gardé & Malheiros-Gardé, 1953; Bartolo *et al.*, 1977; Talavera *et al.*, 1995; Castro *et al.*, 2007).

Notes. The distributional gaps in many parts of the eastern Mediterranean might be a collecting artefact resulting from the autumnal flowering time of the species.

Dandy (1980) indicated Albania, Crete, Greece and ex-Yugoslavia as part of the distribution area in the eastern Mediterranean. *Triglochin laxiflora* is not known from Turkey (Uotila, 1984).

Although reported from South Africa by some authors (Bennett, 1897; Buchenau, 1903), these records are due to misidentification and refer, at least in part, to *Triglochin elongata* or *T. compacta*. *Triglochin laxiflora* does not occur there and has to be excluded from the South African flora (Adamson, 1939; Horn af Rantzien, 1961).

Taxonomic remarks. See *Triglochin barrelieri* for a short comparison with the only other Mediterranean species of the complex.

Nomenclatural notes. In the protologue of *Triglochin laxiflora* Gussone (1825) does not cite any specimens or localities, but in his *Florae Siculae Prodromus* (Gussone, 1827) the following localities are given: 'Palermo a Monte Peregrino a Monte Castellana sotto Baida Mondello Sferracavallo, Catania, Agosta, Siracusa'. Several *Triglochin* specimens from Gussone's collections in the Herbarium Neapolitanum (NAP) were studied. Four specimens of *Triglochin laxiflora* are labelled with localities that were cited in Gussone (1827). The specimen from the Monte Pellegrino in Palermo is here chosen as the lectotype because it contains several fruiting and some flowering plants in good condition.

Variation. One herbarium sheet (BC 76587) is a plant grown from bulbs in the Botanic Garden of Barcelona. This specimen has exceptionally large fruits which are 10–12 mm long.

Proposed IUCN conservation status. Least Concern (LC). The species used to be widely distributed in the Mediterranean region and probably is not under immediate threat. However, the habitat degradation problems described for *Triglochin barrelieri* also apply here. Mediterranean temporary pools have also been destroyed in considerable numbers by human activities (e.g. Grillas *et al.*, 2004; Ruiz, 2008). Only few data are available on the current area of occupancy. In contrast to the many collections of the species from the 19th century only a small number of recently collected specimens has been seen. Several collecting localities of older specimens have been destroyed by settlements. Other populations might also be destroyed or threatened by habitat destruction. This might imply that the species has become rare, and the global conservation status of this species may be prone to change. Further conservation assessments are also necessary at the national level. *Triglochin laxiflora* is a protected species in France (Muséum National d'Histoire Naturelle, 2003–2006) and in Lazio and Sicily, Italy (Conti *et al.*, 1997).

Specimens examined. **Europe**. FRANCE. **CORSICA**. **Corse-du-Sud**: Bonifacio, 11 x 1856, *Revelière* 494 (BM, P); Porto-Vecchio, 16 x 1858, *Revelière* s.n. (P); Ajaccio, 20 ix 1868, *Mabille* s.n. (JE, K, P); Bonifacio, 26 x 1880, *Reverchon* 393 (BM, JE, P); Ajaccio, 1881, *Reverchon* s.n. (ZT); Bonifacio, x 1885, *Reverchon* 393 (B); Ajaccio, Parata, 16 x 1888, *Le Grand* s.n. (P, RO); Bonifacio, 9 x 1901, *Stefani* s.n. (BM, WTU), 6 x 1903, *Stefani* s.n. (ZT), 14 x 1910, *Stefani* s.n.

(P); Ajaccio, Parata, 1 x 1916, *Forsyth-Major* 292 (K); Cargese, x 1923, *Wyatt* 63 (K); Bonifacio, Tonnara-plage, 3 x 1993, *Dutartre* s.n. (B, M, MSB, RNG). **Haute-Corse**: Calvi, golfe de la Revellata, plage de l'Alga, 14 x 1979, *Lambinon* 79/1043, *Bellotte*, *Dellens & Monfort* (BC, MSB, RNG).

ITALY. **SARDINIA**. **Carbonia-Iglesias**: Portoscuso, 9 x 1912, *Bonomi* s.n. (BM). **Olbia-Tempio**: Santa Teresa Gallura, Tempio, Bancamino, 20 ix 1881, *Reverchon* 194 (B, HBG, JE, K, M, RO, ZT); Terrnanova (= Olbia), 2 x 1922, *Rikli* s.n. (ZT); Terranova, x 1922, *Schinz* s.n. (ZT); road between Olbia and San Teodoro, km 310, Le Vecchie Saline, close to lagoons (stagno), 6 x 2006, *von Mering* s.n. (MJG). **Sassari**: Sassari, ix 1895, *Nicotra* s.n. (RO), ix 1899, *Nicotra* s.n. (B, M); Isola di Reulino, 23 x 1988, *Bocchieri* s.n. (B). **SICILY**. **Agrigent**: Licata, x 1911, *Ross* s.n. (ZT). **Palermo**: Palermo, Mte. Pellegrino, ix 1855, *E. & A. Huet du Pavillon* s.n. (BM, P, ZT); Mondello, x 1879, *Lojacono* s.n. (K, P); Castelbuono, x 1885, *Lojacono* s.n. (P); Palermo, x 1885, *Todaro* s.n. (ZT), 1886, *Lojacono* s.n. (K), x 1892, *Todaro* s.n. (RO); Palermo, Aquasanta, 19 x 1897, *Fisch* s.n. (ZT); Palermo, x 1901, *Ross* 377 (B, BC, HBG, JE, M, ZT); Palermo, Mte. Pellegrino, 300 m, 25 x 1903, *Spencer* s.n. (M); Palermo, x 1903, *Ross* s.n. (HBG, M), x 1906, *Ross* s.n. (BC); Palermo, Mte. Pellegrino, 430 m, 30 x 1935, *Lusirne* s.n. (RO); Palermo, Mte. Pellegrino, 400 m, 7 ix 1964, *Davis* 40243 (RNG). **PUGLIA**. **Taranto**: Taranto, Leucaspide, 23 x 1905, *Lacaita* 4808 (BM), 2 xi 1909, *Lacaita* 11461 (BM, P). **TUSCANY**. **Livorno**: Isola di Capraia, 7 i 1898, *Bèguinot* s.n. (RO).

MALTA. Mtahleb, W of Rabat, near coastal cliffs (limestone), c.600 m, 28 x 1974, *Westra & Rooden* 252 (Z); Mosta, Wied il-Ghasel, 22 xi 2007, *Mifsud* s.n. (MJG).

SPAIN. **ANDALUSIA**. **Cádiz**: Cádiz, Laguna de la Paja, Chiclana, 20 m, 29 x 1925, *Gros* s.n. (M, RNG), ix 1929, *Font Quer* s.n. (RNG); entre Los Barrios y Casas del Castaño, Puerto de la Cebada, 1 xi 1967, *Galiano & Valdés* 128/67 (RNG); Cádiz, Laguna de la Janda, 3 xi 1978, *Galiano, Rivera & Valdés* 7097/78 (RNG). **BALEARIC ISLANDS**. **Menorca**. Marina de Benisarmeña y San Antonio, ix/x (sine anno), *Tremols* s.n. (BC); without locality, 13 x 1865, *Rodriguez* s.n. (P); near Mahón, 21 x 1872, *Rodriguez* s.n. (P); near Mahón, 21 x 1872, *Rodriguez* s.n. (P); S. Antonio, x 1872, *Rodriguez* s.n. (P).

North Africa. ALGERIA. **ALGIERS**. Algiers, Pointe Pescade, ix (sine anno), *Jamin* 208 (P); Algiers, Cap Caxine, x 1850, *Jamin* s.n. (P); Algiers, Cap Caxine, xii 1850, *Jamin* s.n. (P); Algiers, x 1851, *Jamin* s.n. (P); Algiers, 1869, *Durando* s.n. (P); Algiers, La Reghaia, xi 1880, *Battandier & Trabut* 986 (P, RO); Maison-Carrée, x 1886, *Luizet* s.n. (P). **ANNABA**. **Annaba**: La Calle (= El Kala), 17 xi 1840, *Durieu de Maisonneure* s.n. (P); Bône (= Annaba), 1860, *Letourneux* s.n. (B, K, P); Annaba, Oued-Fourcha, 25 x 1865, *Tribout* s.n. (BM, P); Annaba, Saint-Clous, 6 xi 1890, *Luitfroy* 337 (P); Bône, 29 x 1891, *Luitfroy* 370 (P); Bône, 1906/1907, *Gandoger* s.n. (BM). **CONSTANTINE**. **Constantine**: Constantina, mountain Djebel Ouach, c.1100 m, 10 xi 1868, *Paris* s.n. (BM, P). **MÉDÉA**. **Berrouaghia**: Berrouaghia, road to Médéa, 1100 m, 6 x 1886, *Luizet* s.n. (P). **MOSTAGANEM**. **Mostaganem**: Mostaganem, 14 ix 1848, *Barlanez* (partly illegible) s.n. (P).

MOROCCO. **GREATER CASABLANCA**. Chaouia, Bouskoura, 190 m, x 1932, *Gattefossé* s.n. (M, P); 20 xii 1936, *Gattefossé* s.n. (B, JE, K, P). **TANGIER-TÉTOUAN**. **Larache**: Lukos (= Loukkos), El Araix, 4 xii 1929, *Font Quer* s.n. (BM). **Tangier-Assilah**: Tanger, between Cap Spartel and the Airport, 75 m, 30 x 1993, *García Murillo, Gibb & Talavera* ST 40/93 (RNG).

3. Triglochin bulbosa L., Mant. Pl. 226 (1771). – Type: South Africa, Cape of Good Hope (neo LINN 466.3 photo!, BOL photo!, designated by Obermeyer, 1966); Malmesbury Distr., at turn out to Gansekraal, 15 ix 1940, *Compton* 9451 (epi NBG!, designated here). **Figs 4, 5.**

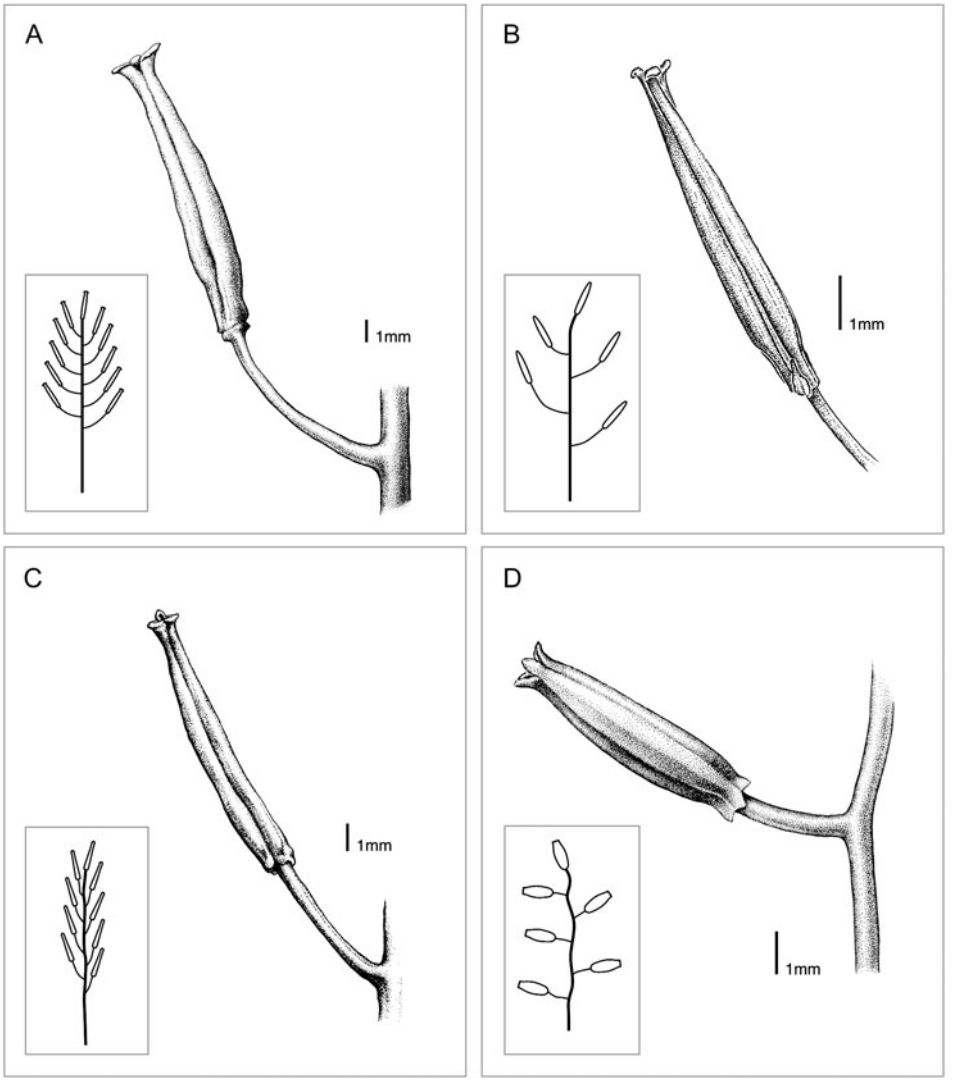

FIG. 4. Fruits and infructescence structure of *Triglochin bulbosa* L. A, *T. bulbosa* subsp. *bulbosa*; B, *T. bulbosa* subsp. *tenuifolia* (Adamson) Horn; C, *T. bulbosa* subsp. *calcicola* Mering, Köcke & Kadereit subsp. nov.; D, *T. bulbosa* subsp. *quarcicola* Mering, Köcke & Kadereit subsp. nov. Drawings by L. Klöckner (Mainz).

Triglochin bulbosa β *robustior* Roem. & Schult., Syst. Veg. ed. 15 bis [Roemer & Schultes], 7(2): 1585 (1830), teste Kunth, Enum. Pl. (Kunth) 3: 144 (1841). – Type not seen.

Triglochin patens Steud., Nomencl. Bot. ed. 2, 2: 709 (1841), nom. illeg. = *T. bulbosa* L. β *robustior* (teste Kunth, Enum. Pl. (Kunth) 3: 144, 1841).

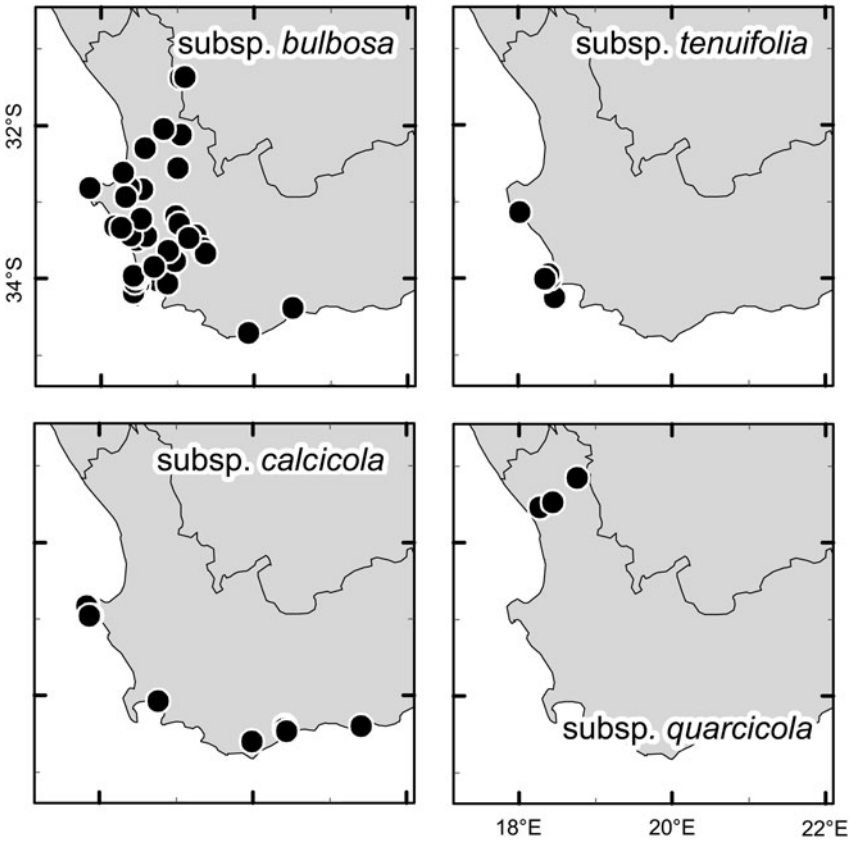

FIG. 5. Geographical distribution of *Triglochin bulbosa* L. subsp. *bulbosa*, *T. bulbosa* subsp. *tenuifolia* (Adamson) Horn, *T. bulbosa* subsp. *calcicola* Mering, Köcke & Kadereit subsp. nov., and *T. bulbosa* subsp. *quarcicola* Mering, Köcke & Kadereit subsp. nov.

Plants 5–50 cm high, with fusiform *bulbs* and without rhizomes; bulbs covered in dry, brown or black, soft or stiff fibres, these 0.5–3 cm long. *Leaves* present when flowering, uniform, as long as or longer than plant height. *Inflorescences* lax or dense, with 4–50 flowers. *Flowers* 1.5–3 mm long. *Pedicels* elongated at fruiting time, 2–10 mm long, diverging at angles of 45° or 45–90° from the infructescence axis, not or only slightly curved inwards towards the apex. *Infructescences* 2–20 cm long. *Fruits* narrowly to very narrowly ovoid, 4–10(–12) mm long, 0.5–2 mm wide (Fig. 4), turning dark or black at fruit maturity. *Mericarps* linear, connate at the *carpophore*; tips not or only slightly curved outwards.

Distribution. Endemic to South Africa, where it is restricted to the Western Cape Province (mainly on Cape Peninsula, West Coast and in Overberg) and the Hantam region of the Northern Cape Province (Fig. 5).

Habitat and ecology. Variable (see subspecies), ranging from temporary pools to dry (shaded) inland habitats, but never in habitats under direct influence of tidal flooding.

Phenology. Flowering in spring (vii–xi).

Chromosome number. Unknown.

Taxonomic remarks. We characterise *Triglochin bulbosa* as a bulbous species with narrowly to very narrowly ovoid fruits, the outline of the seeds not visible through the pericarp, and the pedicels spread at an angle of 45–90° from the inflorescence axis. The fruits of *Triglochin bulbosa* often turn dark or black at maturity, unlike those of the other South African species of the complex. The species differs from *Triglochin compacta*, which has a similar distribution area, in flowering time (spring vs. late summer/autumn) and the presence of leaves at flowering time (vs. leaf formation after flowering). Additionally, the fruits of *Triglochin bulbosa* have no basal outgrowths and the outline of the seeds is not visible on the mericarp surface (as in *T. compacta*).

Adamson (1939) described *Triglochin tenuifolia* on the basis of narrow leaves, few-flowered spikes, and its characteristic habitat. However, this species was later reduced to a subspecies of *Triglochin bulbosa* by Horn af Rantzien (1961). The newly circumscribed *Triglochin bulbosa* shows substantial variation in width of leaves as well as size and number of flowers and fruits. Several forms are geographically and ecologically well differentiated, but transitions in morphological characters are found. Thus, we recognise four subspecies in *Triglochin bulbosa*: subsp. *bulbosa*, subsp. *calcicola*, subsp. *quarcicola* and subsp. *tenuifolia*.

Nomenclatural notes. The neotype (LINN 466.3 photo!) designated by Obermeyer (1966) is ambiguous. Most importantly, its fruits are not mature which makes identification difficult. Additionally no data on locality or collecting date are given. Thus, an additional epitype (*Compton* 9451, NBG) is designated here which should be used in conjunction with the neotype.

Key to the subspecies

1a. Plants (8–)20–50 cm high, robust; leaves 1–3 mm wide; fruits 1–2 mm wide; widely distributed in the Western Cape and southern regions of the Northern Cape _____ **3A.** subsp. **bulbosa**

1b. Plants 5–25(–35) cm high, delicate; leaves 0.5–1 mm wide; fruits up to 1 mm wide; distributed in the Western Cape _____ 2

2a. Inflorescences lax with 4–15(–25) flowers; pedicels diverging at 45–90° from the inflorescence axis; plants growing on granite soils or in quartz fields _____ 3

2b. Inflorescences dense with (4–)10–30 flowers; pedicels diverging at 45° from the inflorescence axis; plants growing on limestone or aeolinite in coastal regions of the Western Cape _____ **3B.** subsp. **calcicola**

3a. Pedicels diverging at angles of 45–90° from the inflorescence axis; plants growing on granite soils on mountain slopes of the Cape Peninsula and Langebaan Peninsula _____ **3D.** subsp. **tenuifolia**

3b. Pedicels diverging mostly at angles of 90° from the inflorescence axis; plants growing in quartz fields of the Knersvlakte _____ **3C.** subsp. **quarcicola**

3A. subsp. **bulbosa. Figs 4A, 5.**

Plants (8–)20–50 cm high, with fusiform *bulbs*; bulbs covered in dry, rather stiff, brown or black fibres, these up to 3 cm long, usually separate, sometimes fused into layers. *Leaves* as long as or longer than plant height, 1–3 mm wide. *Inflorescences* dense to lax, with (8–)15–50 flowers. *Flowers* 1.5–3 mm long, rarely longer. *Pedicels* 2–10 mm long, diverging at angles of 45–90° from the inflorescence axis, not or only slightly curved inwards towards the apex, but often fruits bent further upwards. *Infructescences* 6–20 cm long. *Fruits* narrowly ovoid, 5–10(–12) mm long, 1–2 mm wide (Fig. 4A). *Mericarps* connate at the *carpophore*; tips slightly curved outwards.

Distribution. Endemic to South Africa, restricted to the Western Cape Province and southern regions (Hantam) of the Northern Cape Province (Fig. 5).

Habitat and ecology. Found in temporary wetlands, such as edges of vernal pools, in ditches and in other depressions, mainly in vegetation types classified as Cape Vernal Pools and Cape Inland Saltpans, and rarely also Swartland Granite Renosterveld (Mucina & Rutherford, 2006). The habitats are characterised by heavy clayey to lighter clayey-sandy soils, derived from nutrient-rich substrates such as shale, granite or geologically young sandy sediments of marine origin covering coastal lowlands; here it is often found in clay-filled depressions among stabilised sandy dunes. Waterlogging seems to be a major habitat-structuring factor. The taxon was found at altitudes of up to 500 m (Cederberg Mountains), but most localities are limited to altitudes below 100 m a.s.l.

Phenology. Flowering and fruiting in spring (viii–xi).

Notes. One specimen (*Wörz* 04.10.06.01, PERTH n.v., STU!) which is morphologically very similar to *Triglochin bulbosa* subsp. *bulbosa* was collected in 1994 in Australia (Western Australia, Swan-Valley near Perth), where the taxon has become established as a recent introduction (H. Aston, pers. comm.; see notes for *T. bulbosa* complex).

Taxonomic remarks. *Triglochin bulbosa* subsp. *bulbosa* differs from the other subspecies in having wider leaves (1–3 mm vs. $<$ 1 mm wide) and wider fruits

(1–2 mm vs. < 1 mm wide). The plants are more robust and often larger than those of the other subspecies.

Proposed IUCN conservation status. Least Concern (LC). The subspecies is widely distributed in the Western Cape Province, with some localities in southern regions of the neighbouring Northern Cape Province. It does not appear to be immediately threatened. However, as seasonal pools (as all lowland wetlands in general) are becoming rare due to cultivation of land and construction work (Mucina & Rutherford, 2006), the conservation status should be reassessed in the near future.

Specimens examined. SOUTH AFRICA. **Northern Cape**. Nieuwoudtville, Cloudskraal Farm, 7 xi 1962, *Barker* 9799 (NBG); Nieuwoudtville, 3 miles S of Nieuwoudtville, 7 ix 1963, *Nordenstam* 3032 (S). **Western Cape**. Stellenbosch, Hottentotts Holland, sine dato, *Zeyher & Ecklon* s.n. (P); Paarl, Klein Draakensteen, 10 ix 1827, *Drège* 8798 (P); Cape Town, Simon's Bay, Constantia, 1853–1856, *Wright* s.n. (NY); Cape Town, Raapenburg Vlei, viii 1882, *Guthrie* 1242 (BOL); Caledon, near village, vii 1892, *Guthrie* 2526 (NBG); Cape Town, Kenilworth, 1892, *Bolus* 7926 (BOL); Ceres, Mostertsberg, 1200 ft, x 1894, *MacOwan* 1991 (BM, NBG-SAM, P, Z); Cape Town, Kenilworth Race Course, 5 ix 1897, *Wolley-Dod* 2858 (NBG); Cape Town, near Maitland Cemetery, 2 x 1897, *Wolley Dod* 3221 (BOL); Cape Town, Vaarsche Vley, 17 x 1897, *Wolley-Dod* 3139 (BOL); Cape Town, Simonstown, Constantia, Bergvliet Farm, 11 ix 1916, *Purcell* 66 (NBG-SAM); Cape Town, Simonstown, Constantia, Bergvliet Farm, E of lake, 11 ix 1917, *Purcell* 3 (NBG-SAM); Stellenbosch, behind Boys High School, 8 xi 1918, *Garside* 1139 (K); Worcester, Goudini Road, x 1921, *Michell* 2833 (BOL); Clanwilliam, Zeekoe Vlei, 1500 ft, ix 1925, *Levyns* 1192 (BOL); Cape Town, Somerset West, ix 1931, *Schmidt* 437 (M); Bredasdorp, between Bredasdorp and Elim, damp places near salt vlei, ix 1933, *Levyns* 4542 (BOL); Bredasdorp, The Poort, sides of temporary pool, 100 ft, ix 1933, *Levyns* 4460 (NBG); Stellenbosch, Faure, 9 ix 1934, *Garside* 4649 (K); Cape Town, Rondebosch Common, 15 vi 1936, *Adamson* 940 (BOL); Cape Town, Kenilworth Race Course, 6 x 1936, *Adamson* 1200 (BOL); Tulbagh, Saron Flats, viii 1937, *Compton & party* 1992/36 (BOL); Clanwilliam, Alpha, 28 vi 1938, *Martin* NBG 1258/37 (NBG); Olifantsrivier Valley, 11 miles N of Clanwilliam, 2 ix 1938, *Salter* 7529 (BOL); Napier, 24 viii 1940, *Bond* 470 (NBG); Darling, 15 ix 1940, *Esterhuysen* 3864 (BOL); [Yzerfontein], at turn out to Gansekraal, 15 ix 1940, *Compton* 9451 (epi NBG); Piketberg, Berg River, 21 ix 1940, *Compton* 9474 (NBG); Clanwilliam, Pakhuis, 29 ix 1940, *Compton* 9553 (NBG); Clanwilliam, Pakhuis, x 1940, *Esterhuysen* 3170 (BOL); Cape Town, Hout Bay, 4 ix 1941, *Compton* 11294 (NBG); Malmesbury Distr., Mamre Hills, 7 ix 1941, *Compton* 11608 (NBG); Strand, 8 viii 1942, *Parker* 3708 (BOL, NBG); Cape Town, Milnerton, 31 viii 1942, *Compton* 13424 (NBG); Cape Town, Firgrove, 3 ix 1942, *Compton* 13458 (BOL); Malmesbury Distr., Mamre Hills, 12 ix 1942, *Barker* 1596 (NBG); Stellenbosch, Stellenbosch Vlakte, 8 iv 1943, *Jordaan* 18 (NBG); Malmesbury Distr., foot of Mamre Hills, 22 ix 1943, *Henderson* 1858 (NBG); Malmesbury Distr., Kalabas Kraal, 28 ix 1943, *Barker* 3546 (NBG); Piketberg, Papkuils Vlei, 30 ix 1943, *Leighton* 119 (BOL); Piketberg, Sout Kloof, between Sauer and Berg River, 1 x 1943, *Compton* 15122 (NBG); Piketberg, Zoutkloof, 1 x 1943, *Leighton* 397 (BOL); Bredasdorp, The Poort, 2 xi 1943, *Barker* 2491 (NBG); Cape Town, Melkbosch Road, swamp, 31 viii 1944, *Compton* 15865 (NBG); Stellenbosch, Faure, swamp, 16 xi 1944, *Compton* 15984 (NBG); Citrusdal, 1 ix 1945, *Leighton* 1389 (BOL); Ceres, Cold Bokkeveld, near Elandskloof, 9 ix 1945, *Leighton* 1270 (BOL); Ysterfontein [Yzerfontein], 12 ix 1945, *Compton* 17379 (NBG); Darling, ix 1945, *Stokoe* 59918 (NBG-SAM); Cape Town, Kirstenbosch, ix 1945, *Esterhuysen* 11856 (BOL,

NBG); Citrusdal, Citrusdal Vlei, 1 xi 1945, *Compton* 17106 (NBG); Paarl, flats N of Paarl, 30 viii 1946, *Leighton* 1961 (BOL, NY); Cape Town, Kenilworth Race Course, ix 1946, *Lewis* 1900 (NBG-SAM); Piketberg, Berg Valley, ix 1947, *Lewis* 2380 (NBG-SAM); Clanwilliam, Nardouw Kloof, ix 1947, *Stokoe* 61194 (NBG-SAM); Cape Town, Kraaifontein, 4 x 1947, *Compton* 20091 (NBG); Stellenbosch, Golfplatz, 6 viii 1948, *Rehm* 1950 (M); Stellenbosch, Stellenbosch Vlakte, ix 1948, *Malherbe* s.n. (NBG); Cape Town, Claremont, 19 ix 1951, *Salter* 9302 (BM); Cape Town, between Fernwood and Liesbeek River, 24 ix 1951, *Salter* 9045 (BOL); Darling, Darling Flora Reserve, 25 vii 1956, *Rycroft* 1973 (NBG); Darling, Darling Flora Reserve, 4 x 1956, *Lewis* 5087 (NBG); Cape Town, Rondebosch Common, 15 x 1962, *Nordenstam* 1564 (S); Cape Town, Durbanville, Peaslake, 15 viii 1963, *Taylor* 5009 (NBG); Cape Town, Rondebosch Common, 7 ix 1963, *Stauffer* 5136 (NBG, P, Z); Darling, 16 ix 1963, *H. & E. Walter* s.n. (B); Stellenbosch, 3 miles from Simondium to Stellenbosch, 16 ix 1968, *Marsh* 653 (NBG-STE); Caledon, Happy Valley Farm, High Noon Estates, on road from Caledon to Frensch Hoek Pass, below Ezeljacht, 30 ix 1971, *Barker* 10834 (NBG); Worcester, Bokkekraal, NW side of Brandvlei Dam, 18 ix 1974, *Mauve & Oliver* 254 (K); Cape Town, Rondebosch Common, 21 ix 1974, *Nordenstam & Lundgren* 1973 (S); Betty's Bay, Groot Vleie, moist peaty area to south of vleis, 13 xi 1974, *Boucher* 2657 (NBG-STE); Darling, Platteklip, ix 1976, *Liebenberg* 8301 (K); Clanwilliam, outside Sandberg on road to Witels Kloof, 13 x 1976, *Hugo* 671 (NBG-STE); Cape Town, Isoetes Vlei, 1977, *Gubb* 50 (NBG); Malgas, De Hoop-Potberg Nature Reserve, Potberg, flats near Melkbosheuwel, moist sandy flats, 16 ix 1979, *Burgers* 2252 (STE); Tulbagh, foothills of Witzenberg Mountains, 7 ix 1980, *Schonken* 314 (NBG-STE); Malmesbury, Klipfonein, 16 ix 1982, *van Zyl* 3247 (NBG); Cape Town, Rondebosch Common, 15 ix 1983, *Koutnik* 1262 (BOL); Worcester, Worcester Commonage, 26 viii 1985, *Bayer* 4837 (NBG); Cape Town, Somerset West, public open space at Westridge, 5 ix 1993, *Runnalls* 574 (NBG-STE); Cape Town, Kraaifontein, Scottsdene, between Scottsdene Library and Wolwefontein Rd., 29 ix 1997, *Cupido* 48 (NBG); Malgas, De Hoop Nature Reserve, Potberg section, valley of Potbergsrivier, 3 iv 2006, *Köcke & Mucina* 030406/22 (MJG); Darling, Tienie Versveld Flower Reserve, at the entrance to the reserve, 14 iv 2006, *Köcke & Mucina* 140406/01 (MJG); Yzerfontein, E of Salt Pan, 14 iv 2006, *Köcke & Mucina* 140406/33 (MJG), 140406/34 (MJG); Stellenbosch, Klipheuwel, S of road crossing, 19 iv 2006, *Köcke & Steffen* 190406/02 (MJG); Velddrif, road Velddrif to Piketberg, Tasaars Kuil Farm 253, at turnoff to Aurora, 19 iv 2006, *Köcke & Steffen* 190406/27 (MJG); Wellington, road between Perderberg and Wellington, Boland Agricultural College, 30 vii 2006, *Mucina* 300706/21 (MJG); Darling, road between Malmesbury and Darling, Langekloof Farm, 4 viii 2006, *Mucina & Jakubowsky* 040806/02 (MJG); Darling, road between Malmesbury and Darling, near Waylands, 4 viii 2006, *Mucina & Jakubowsky* 040806/05 (MJG); Velddrif, road Velddrif to Piketberg, Tasaars Kuil Farm 253, at turnoff to Aurora, 4 viii 2006, *Mucina & Jakubowsky* 040806/28 (MJG); Elim, road Bosheuwel and Wiesdrif, 14 x 2006, *Mucina* 141006/20 (MJG); Paternoster, Tietiesbaai, coastal rocks at the entrance to Cape Columbine Nature Reserve, 25 x 2008, *Mucina* 251008/05 (MJG), 251008/06 (MJG); Darling, Tienie Versveld Flower Reserve, at the entrance to the reserve, 26 x 2008, *Mucina* 261008/04 (NBG).

3B. subsp. **calcicola** Mering, Köcke & Kadereit, **subsp. nov. Figs 1A–B, 4C, 5.**

Differt a subspecie typica habitu minore et graciliore, foliis perangustis, infructescentia densa; solo in substrato calcareo. – Type: South Africa, Western Cape, De Hoop-Potberg Nature Reserve, Dronkvlei, 'along track to Koppie Alleen, shallow sandy soils over limestone, low restiad [restioid] vegetation, frequent in damp places and hollows', 11 ix 1979, *Burgers* 2172 (holo NBG-STE!; Fig. 6).

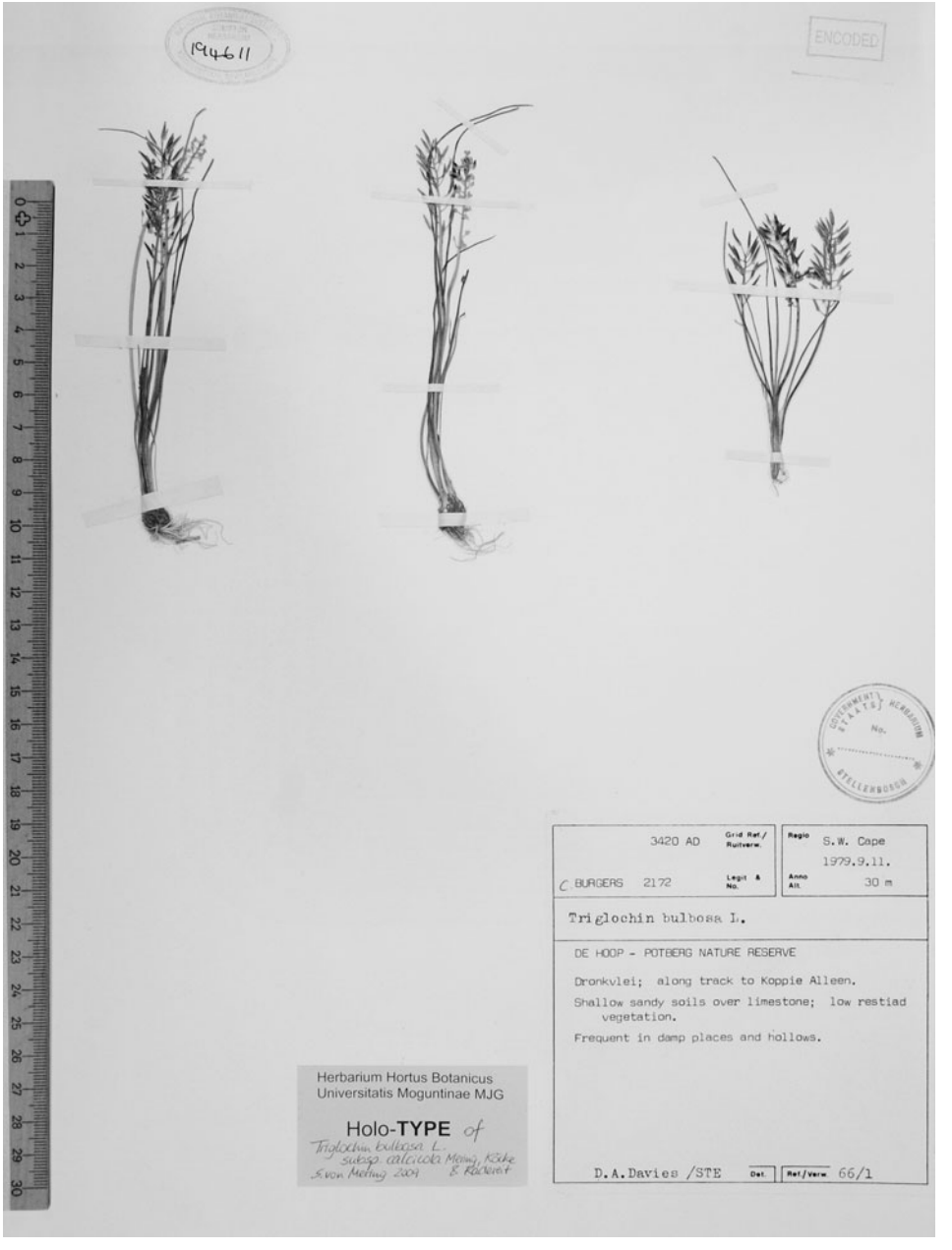

FIG. 6. Holotype of *Triglochin bulbosa* subsp. *calcicola* Mering, Köcke & Kadereit subsp. nov. (NBG-STE).

Plants (5–)10–25 cm high, stiffly erect, with small, fusiform *bulbs*; bulbs covered by thin soft or thicker stiff, brown fibres, these ± 1 cm long, fibres sometimes not separate but fused into layers. *Leaves* as long as infructescence, very narrow, 0.5(–1) mm wide.

Inflorescences dense, with (4–)10–30 flowers. *Flowers* 1.5–2.5 mm long, number of stamens sometimes reduced to three. *Pedicels* 2–4 mm long, diverging at angles of approximately 45° from the inflorescence axis, slightly curved inwards towards the apex. *Infructescences* 2–8 cm long. *Fruits* very narrowly ovoid, 4–7 mm long, rarely longer, mostly $<$ 1 mm wide, very regularly spaced (Fig. 4C). *Mericarps* connate; tips short and slightly curved outwards. *Carpophore* only very thin and short or lacking.

Distribution. This taxon is limited to parts of the West Coast (Langebaan Peninsula), the coast of False Bay (Swartklip and Macassar) and to the South Coast (De Hoop and Stillbaai regions) (Fig. 5).

Habitat and ecology. *Triglochin bulbosa* subsp. *calcicola* is a strict endemic of Tertiary calcareous bedrocks such as lime-rich aeolinites (False Bay) and limestones of the Bredasdorp Group (De Hoop and Stillbaai regions, Fig. 1B) and of the Sandveld Group (Langebaan and Saldanha regions). The sparse populations of this subspecies here occur in shallow loam-filled depressions (filled with fine loam and lime-rich sand) in limestone pavements; these depressions are wet in winter and spring and dry out completely in summer. The vegetation types housing this taxon are De Hoop Limestone Fynbos, Canca Limestone Fynbos, and Saldanha Limestone Strandveld (Mucina & Rutherford, 2006).

Phenology. Flowering and fruiting in spring (viii–xi).

Etymology. The epithet *calcicola* refers to the typical substrate of the species (hard lime-rich substrates such as limestones and aeolinites).

Taxonomic remarks. *Triglochin bulbosa* subsp. *calcicola* differs from the other subspecies in having dense inflorescences with (4–)10–30 flowers and pedicels diverging at angles of approximately 45° from the inflorescence axis.

Proposed IUCN conservation status. Vulnerable (VU B2ab(iii)). This subspecies is ecologically specialised and occurs only on limestone substrates, which are generally rare in the Western Cape. Its populations on the South Coast (Overberg and Canca) and part of the False Bay coast do not experience direct threats because of current effective conservation (De Hoop Nature Reserve, Pauline Bohnen Nature Reserve, Wolvengat Nature Reserve). However, the populations on the West Coast (Langebaan and Saldanha) are found outside formally protected areas; limestone mining as well as development of coastal settlements may pose serious threats to these populations. Based on the limited area of occupancy (AOO, estimated to be less than 2000 km^2) and severely fragmented distribution area, plus the threat to the habitat (at least in some areas), this subspecies is here classified as Vulnerable.

Specimens examined. South Africa. **Western Cape**. Bredasdorp, The Poort, limestone ridge, in depressions in rock on top, 400 ft, ix 1933, *Levyns* 4491 (BOL); Strand, Macassar Downs, between St. Joseph's Tomb and sea, 2 ix 1934, *Garside* 4630 (B, K); Strand, 8 viii 1942, *Parker* 3707 (BOL, NBG); Bredasdorp, The Poort, 0.5 miles E of the road Bredasdorp–Elim, on rocks

below limestone hill, 19 ix 1962, *Nordenstam* 1503 (S); Cape Town, Swartklip, 6 ix 1972, *Taylor* 8169 (NBG-STE); Stillbaai, ridge below reservoir, southerly aspect, gentle slope, limestone, 60 m, 24 viii 1979, *Bohnen* 6191 (NBG-STE); Malgas, De Hoop-Potberg Nature Reserve, Dronkvlei, along track to Koppie Alleen, 11 ix 1979, *Burgers* 2172 (holo NBG-STE); Malgas, De Hoop, 4 km from Moerasfontein turnoff on Bredasdorp–Skipskop road, 8 viii 1984, *Fellingham* 732 (NBG-STE); Malgas, De Hoop, Buffelsfontein, 9 viii 1984, *van Wyk* 1773 (NBG-STE); Vredenburg, lower NW slopes of limestone koppie at Paternoster, 28 vii 1998, *Goldblatt & Manning* 10928 (MO, NBG); Malgas, De Hoop Nature Reserve, plains below the slope at road from entrance of reserve to the information center, limestone pavement, 28 ix 2008, *Mucina & Meruňková* 280908/04 (MJG); Malgas, De Hoop Nature Reserve, 28 ix 2008, *Meruňková* KM03/27 (NBG), 14 x 2008, KM27/24 (NBG), KM28/51 (NBG); Langebaan Peninsula, Jacobsbaai, 26 x 2008, *Meruňková* KM44/44 (NBG), KM45/41 (NBG), 30 x 2008, *Meruňková* KM52/28 (NBG), KM53/33 (NBG); Langebaan Peninsula, Paternoster, Cape Columbine, 29 x 2008, *Meruňková* KM50/34 (NBG), KM51/44 (NBG).

3C. subsp. **quarcicola** Mering, Köcke & Kadereit, **subsp. nov. Figs 4D, 5.**

Differt a subspecie typica habitu minore et graciliore, foliis perangustis, pedicellis divergens sub angulo circa 90°; solo in substrato quarcitico. – Type: South Africa, Western Cape, Vanrhynsdorp Div., farm Moedverloren, Knersvlakte Conservation Area, on quartz fields, BIOTA Biodiversity Observatory No 28 (Moedverloren), ha. 78, 31°28′3.7″S, 18°26′52.8″E, 1 ix 2008, *Schmiedel* 124811 (holo MJG; iso NBG; Fig. 7).

Plants 5–20 cm high, delicate, slender, with small, fusiform *bulbs*; bulbs covered in dry, soft or stiff brown fibres, these 1–2 cm long. *Leaves* uniform, as long as or shorter than infructescence, very narrow, about 0.5–1 mm wide. *Inflorescences* lax, with 4–15(–25) flowers. *Flowers* (1.5–)2–3 mm long. *Pedicels* shorter than fruit at fruiting time, 2–5 mm long, held at angles of almost 90° from the inflorescence axis, usually not curved inwards towards the apex. *Infructescences* lax, axis sometimes flexuose. *Infructescences* 3–8 cm long. *Fruits* very narrowly ovoid (to almost ellipsoid), 5–8 mm long, 0.5–1 mm wide (Fig. 4D). *Mericarps* linear, sometimes with short basal spurs, connate; tips not curved outwards. *Carpophore* very thin or lacking.

Distribution. *Triglochin bulbosa* subsp. *quarcicola* is only found in the Western Cape Province of South Africa and appears to be endemic to the Knersvlakte (a major centre of plant endemism of the country; van Wyk & Smith, 2001; Fig. 5), a slightly undulating, low-lying basin in southern Namaqualand (near the town of Vanrhynsdorp). *Triglochin bulbosa* subsp. *quarcicola* is the only subspecies of *Triglochin bulbosa* found outside the Fynbos Biome. The farm Moedverloren is known to harbour a high number of very restricted local endemics (U. Schmiedel, pers. comm.; B. Nordenstam, pers. comm.).

Habitat and ecology. The subspecies is restricted to saline quartz fields (Fig. 1C), especially the dry slopes of koppies, covered with a layer of white, angular quartz gravel (Schmiedel & Jürgens, 1999). The vegetation housing populations of

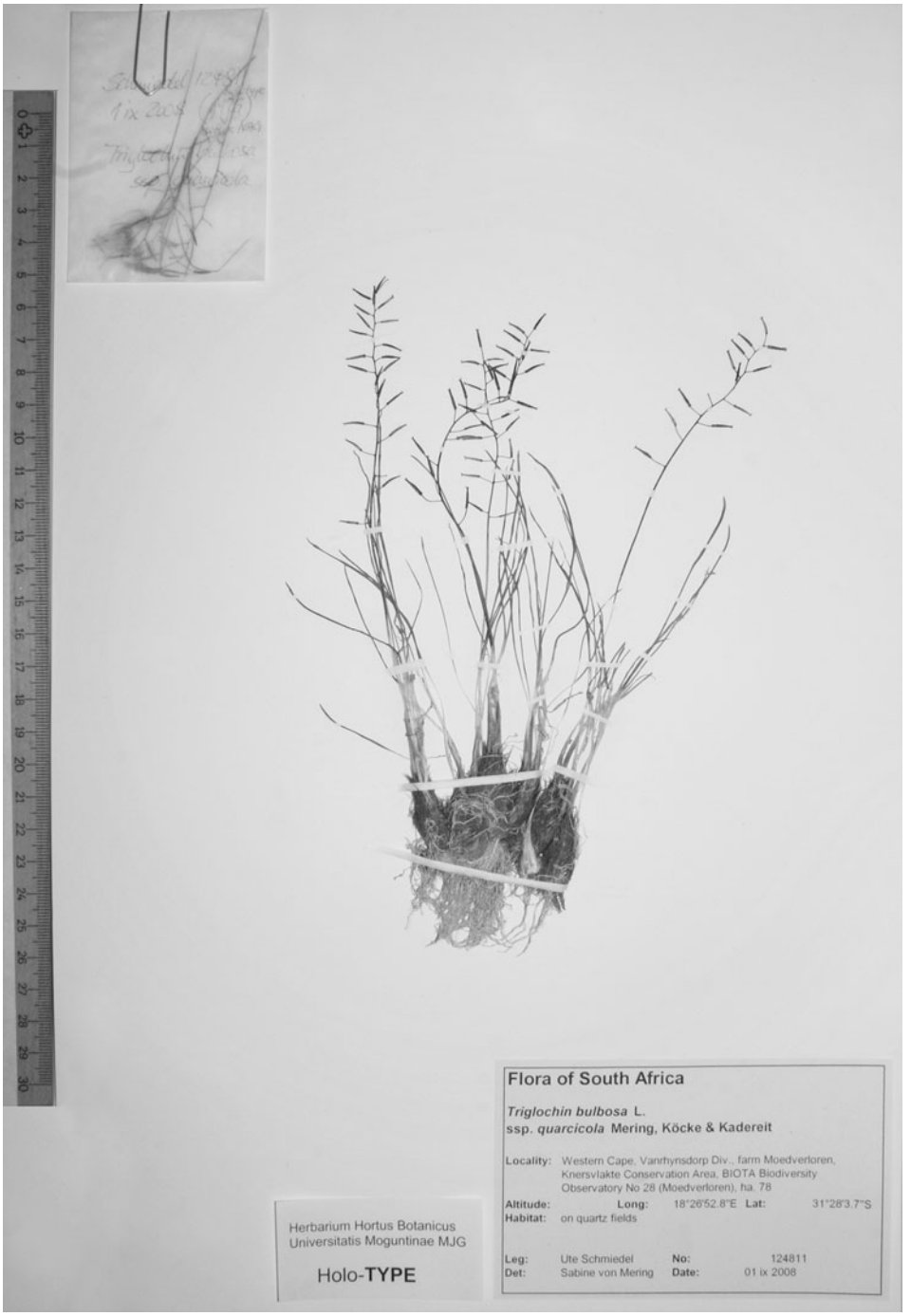

FIG. 7. Holotype of *Triglochin bulbosa* subsp. *quarcicola* Mering, Köcke & Kadereit subsp. nov. (MJG).

Triglochin bulbosa subsp. *quarcicola* is a dwarf succulent shrubland, rich in succulent shrubs and 'stone plants' (Knersvlakte Quartz Vygieveld according to Mucina & Rutherford, 2006). The climate of the Knersvlakte is typical for winter-rainfall semi-desert, with mean annual precipitation of around 120 mm and mean annual temperature of about 18°C (Mucina & Rutherford, 2006).

Phenology. Flowering and fruiting in early spring (vii–viii). The subspecies seems to grow only following sufficient rainfall (U. Schmiedel, pers. comm.). According to notes on one specimen (*Le Roux* 2205, STE), the leaves are deciduous.

Notes. According to notes on two specimens, flowers are brownish-purple or purple (*Nordenstam* 587, S; *Le Roux* 2205, STE).

Taxonomic remarks. *Triglochin bulbosa* subsp. *quarcicola* differs from the other subspecies in having lax inflorescences with 4–15(–25) flowers and pedicels diverging mostly at angles of 90° from the inflorescence axis.

Proposed IUCN conservation status. Vulnerable (VU D2). *Triglochin bulbosa* subsp. *quarcicola* shows a very restricted area of occupancy (AOO, estimated to be less than 100 km^2) and is currently only known from three locations (Fig. 5), where it was found only in small populations (B. Nordenstam, pers. comm.; U. Schmiedel, pers. comm.; see also a remark on the label of one of the specimens (*Le Roux* 2205, STE)).

The farm Moedverloren (or Moedverloor on some maps) is currently managed by CapeNature, the provincial nature conservation authority, as part of the 'Knersvlakte Protected Area' (U. Schmiedel, pers. comm.). However, some of the populations are found outside the borders of formally protected areas, and the survival of this taxon depends on the owners of these neighbouring farms. Further field studies are required to estimate more precisely the area of occupancy and extent of occurrence.

Specimens examined. South Africa. **Western Cape**. Knersvlakte, Koekenaap, 15 vii 1962, *Nordenstam* 587 (S); 20 vii 1962, *Hall* 2397 (NBG-SAM); Knersvlakte, Vanrhynsdorp, Moedverloor ['Moedverloer' in *Hall* 4124], 28 vii 1962, *Nordenstam* 790 (S); 10 viii 1962, *Nordenstam* 898 (S); 23 viii 1971, *Hall* 4124 (NBG); 5 viii 1981, *Hall* 5078 (NBG); Knersvlakte, Lutzville, 7 km N of Hol River railway station on the farm Klipdrift, 10 viii 1977, *Le Roux* 2205 (NBG-STE); Knersvlakte, Vanrhynsdorp, farm Moedverloren, Knersvlakte Conservation Area (BIOTA Biodiversity Observatory No 28), quartz fields, 1 ix 2008, *Schmiedel* 124811 (holo MJG; iso NBG).

3D. subsp. **tenuifolia** (Adamson) Horn, Svensk. Bot. Tidskr. 55: 85 (1961). – *Triglochin tenuifolia* Adamson, J. S. African Bot. 5: 30–31 (1939). – Type: South Africa, Table Mountain West side, Pipe Track, sheltered slopes, 5 ix 1936, *Adamson* 986 (holo BOL!). **Figs 4B, 5.**

Plants 8–25(–35) cm high, delicate, slender, with fusiform *bulbs*; bulbs covered in dry, rather stiff or soft, brown fibres, these $<$ 1 cm long. *Leaves* as long as or much longer than plant height, very narrow, about 0.5–1 mm wide. *Inflorescences* lax, with 4–15 flowers. *Flowers* 1.5–2.5 mm long. *Pedicels* as long as or longer than fruit at fruiting

time, 5–10 mm long, diverging at angles of 45–90° from the inflorescence axis, slightly curved inwards towards the apex. *Infructescences* 2–5 cm long. *Fruits* very narrowly ovoid, 5–8 mm long, 0.5–1 mm wide (Fig. 4B). *Mericarps* connate at the *carpophore*; tips slightly curved outwards.

Distribution. This subspecies is (as far as known) restricted to the lower slopes of Table Mountain on the Cape Peninsula and to the Postberg (near Langebaan, West Coast National Park) (Fig. 5).

Habitat and ecology. The subspecies is found in sheltered, shady inland habitats on mountain slopes at altitudes below 400 m. It is restricted to coarse, sandy soils derived from granites (Archaean Cape Granite Suite). The vegetation types supporting this taxon are classified as Cape Peninsula Granite Renosterveld and Saldanha Granite Strandveld (Mucina & Rutherford, 2006).

Phenology. Flowering and fruiting vii–ix; one specimen (with flowers and fruits) was collected in v.

Notes. The preference of this taxon for granite soils was already noted by Adamson (1939).

Taxonomic remarks. *Triglochin bulbosa* subsp. *tenuifolia* differs from the other subspecies in having lax inflorescences with 4–15 flowers and pedicels diverging at angles of 45–90° from the inflorescence axis.

Nomenclatural notes. At least one paratype of *Triglochin tenuifolia* (*Dümmer* 1050, SAM) cited by Adamson (1939) represents a misidentified specimen of *T. compacta*. Not all material cited by Adamson has been seen by us.

Proposed IUCN conservation status. Near Threatened (NT). The taxon meets the area requirements under criterion B for threatened (extent of occurrence (EOO) $< 20{,}000$ km^2 and/or area of occupancy (AOO) < 2000 km^2) and is declining, but the population is not severely fragmented, and the taxon occurs at 12 locations.

Judging from the available herbarium material, the subspecies has a very restricted distribution area. The EOO is estimated to be only several square kilometres. It is known from parts of the Cape Peninsula and one locality at the Postberg (Langebaan Peninsula). All of the historical localities are today protected within the Table Mountain National Park and the private Postberg Nature Reserve (contractual portion of the West Coast National Park). No data are available on the current AOO of *Triglochin bulbosa* subsp. *tenuifolia* as all herbarium specimens seen are at least 60 years old, apart from one collection from Postberg dating from 1966. Several collecting sites are located within the borders of Cape Town and might have been destroyed long ago. Field work is needed to assess the current range and the conservation status of this taxon.

Specimens examined. South Africa. **Western Cape**. Cape Town, Stinkwater, 1875–1880, *Rehmann* 1194 (BM, Z); Cape Town, locality illegible, 14 vii 1883, *Wilms* 36451 (BM, Z); Cape

Town, top ridge over Klassenbosch, 15 viii 1897, *Wolley Dod* 2918 (BOL); Cape Town, Lion's Head, lower west slopes, 29 viii 1897, *Wolley-Dod* 2915 (para BOL); Cape Town, Signal Hill, ix 1897, *Thode* 6089 (NBG-STE); Cape Town, Table Mountain, Pipe Track, above Camp Bay, viii 1920, *Michell* s.n. (BOL); Cape Town, Simonstown, Baviaans Kloof, 4 v 1927, *Salter* 344/10 (para BM); Cape Town, Hout Bay Nek, 23 viii 1928, *Hutchinson & Pillans* 104 (BOL); Cape Town, Kloof Nek, 27 vii 1929, *Scott* s.n. (para BM); Cape Town, Table Mountain W side, Pipe Track, 5 ix 1936, *Adamson* 986 (holo *T. tenuifolia*, BOL); Cape Town, Table Mountain, W side at 1000 ft, 11 viii 1940, *Adamson* 2899 (BM); Cape Town, Table Mountain, west slopes, 5 ix 1943, *Esterhuysen* 27104 (BOL); Cape Town, Table Mountain, Spring Buttress, ix 1945, *Stokoe* 59916 (NBG-SAM); Cape Town, Table Mountain, Llandudno end, 1000 ft, 19 x 1958, *Esterhuysen* 27923 (BOL); Langebaan, E slopes of Postberg, 9 ix 1966, *Barker* 10471 (NBG).

4. Triglochin compacta Adamson, J. S. African Bot. 9: 152 (1943). – Type: South Africa, Karbonkelberg, 1000 ft, 28 ii 1943, *Compton* 14436 (holo NBG!). **Figs 1E–G, 2C, 8.**

Plants (10–)15–50 cm high, with fusiform *bulbs*; bulbs covered in dry, rather soft, brown fibres, these up to 5 cm long. *Leaves* few, formed after flowering, mostly reaching only half of the height of plants. Outer leaves strap-shaped, shorter and wider than inner leaves, up to 4 cm long, mucronate, inner leaves abruptly narrowing above the ligule, less than 0.5 mm wide, distinctly longer than outer leaves, leaves generally larger and more numerous after fruit maturity. *Inflorescences* dense, with (6–)10–50 flowers. *Flowers* 1.5–3 mm long. *Pedicels* elongated at fruiting time, up to 2–7 mm long, mostly curved inwards towards the apex. *Infructescences* 5–20 cm long. *Fruits* narrowly ovoid, 6–10 mm long, 1–2 mm wide (Figs 1G, 2C). *Mericarps* dorsally curved upwards, connate at the *carpophore*; tips curved outwards. *Carpophore* often with three basal membranous outgrowths.

Distribution. Endemic to South Africa: restricted mainly to the Western Cape Province where it occurs in the Cape Peninsula as far east as Goukamma on the Garden Route and in Seweweekspoort in Klein Swartberg Mountains, the Cederberg and in a handful of localities in the Northern Cape Province in the surroundings of Nieuwoudtville and near Kommagas (Namaqualand) (Fig. 8). The Kommagas collection is an unusual outlier and requires further attention. Unfortunately recent material from this locality was not available.

Habitat and ecology. *Triglochin compacta* is invariably found on deep (mainly nutrient-poor) sands. When of marine origin, these sands form stabilised (and highly leached) inland sand dunes, always outside the current direct influence of the sea. In some places at higher altitudes these deep sandy sediments are derived *in situ* from arenites such as Table Mountain and Nardouw sandstones. The vegetation types characteristically supporting this taxon are Hangklip Sand Fynbos, Cape Flats Sand Fynbos, Albertinia Sand Fynbos, Knysna Sand Fynbos, Cederberg Sandstone Fynbos and Bokkveld Sandstone Fynbos (*sensu* Mucina & Rutherford, 2006).

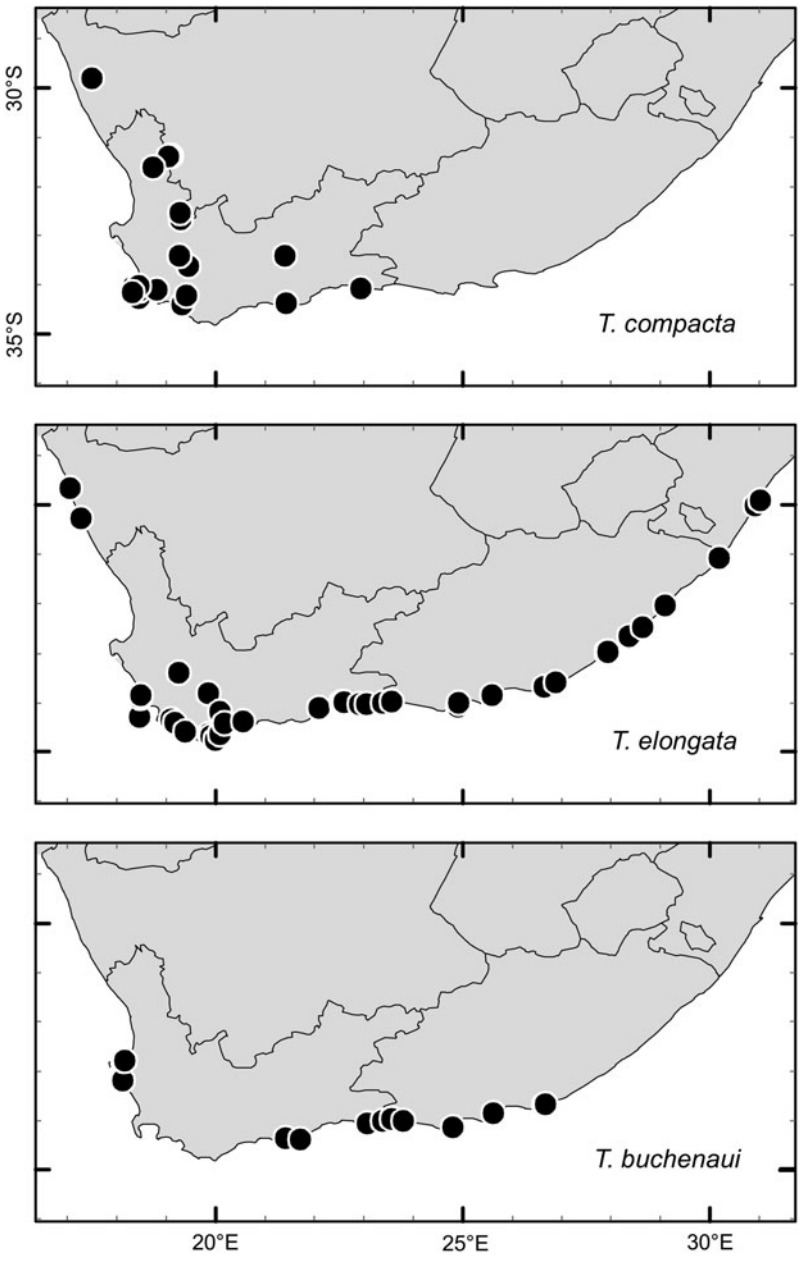

FIG. 8. Geographical distribution of *Triglochin compacta* Adamson, *T. elongata* Buchenau, and *T. buchenaui* Köcke, Mering & Kadereit sp. nov.

Phenology. Flowering mostly in autumn from (ii)iii–v; some fruiting material was collected in vi.

Chromosome number. Unknown.

Taxonomic remarks. Apart from its initial description by Adamson (1943), this species has been incorrectly classified as being synonymous with *Triglochin bulbosa*. However, the two species can be easily distinguished by phenology as well as morphology (see *Triglochin bulbosa* for a comparison between these two sympatric species). The affinities of *Triglochin compacta* to *T. milnei* will be discussed under the latter species.

Proposed IUCN conservation status. Data Deficient (DD). The low number of collections of this taxon could be a result of poor sampling (failure to distinguish this species in the field from the much more common *Triglochin bulbosa* subsp. *bulbosa*), habitat loss, natural rarity, or a combination of these factors. Some of the sandveld areas (system of lowland stabilised dune-fields) have been suffering from pressure of urban sprawl through both the spread of formal housing development and the explosive spread of informal settlements on the Cape Flats (now part of the Cape Town metropolis). The conservation status of this taxon can only be judged once an intensive search for extant localities has been conducted. We therefore suggest classifying *Triglochin compacta* as Data Deficient.

Specimens examined. SOUTH AFRICA. **Northern Cape**. Niewoudtville, sine dato, *Leipoldt* 808 (BOL); Niewoudtville, 19 ii 1932, *Maughan-Brown* s.n. (BOL); [Namaqualand], Komaggas ('Bethel, Kammaggas'), 24 iii 1952, *van Niekerk* 3833 (BOL); Nieuwoudtville, Farm Arendskraal, 30 iii 1982, *Snijman* 597 (NBG). **Western Cape**. Cape of Good Hope, c.1770, *Auge* or *Oldenburg* s.n. (BM); iii or iv 1771, *Banks & Solander* s.n. (BM); Cape Town, Wynberg, 23 iii 1892, *Schlechter* 607 (Z); Hermanus, Vogelgat, 11 iv 1897, *Schlechter* 10424 (BM, PRE, Z); Cape Town, Muizenberg, iii 1908, *Dümmer* 1050 (NBG-SAM); Caledon, 21 ix 1916, *Purcell* 104 (NBG-SAM); Cape Town, Constantia, Bergvliet Farm, Peter's Hill, 26 iii 1917, *Purcell* 12 (NBG-SAM); Cape Town, Ladies Mile Hill, 12 iv 1918, *Purcell* 65 (NBG-SAM); Knysna, Goukamma, West Hill, iv 1928, *Fourcade* 3925 (BOL, NBG-STE); Strand, on sand dunes near the sea, 22 vi 1940, *Parker* 3515 (BOL, NBG); Cape Town, Slangkop, 9 v 1942, *Bond* 1498 (NBG); Cape Town, Karbonkelberg, 25 ii 1943, *Isaac* 10 (BOL); 28 ii 1943, *Compton* 14436 (holo NBG); 4 iii 1943, *Leighton* 934 (NBG); 30 iv 1944, *Compton* 15657 (NBG); 2 iv 1945, *Levyns* s.n. (*Adamson* 3615) (BOL); Cape Peninsula, Buffels Bay, 27 v 1945, *Compton* 17061 (NBG); Cape Town, slopes above Rheboksdam Bay, 27 v 1945, *Leighton* 970 (BOL); Cederberg, Sandfontein Peak, 5 iv 1947, *Esterhuysen* 13870 (BOL); Cape Town, hillside above Kommetjie, vi 1947, *Lewis* 2379 (NBG-SAM); Clanwilliam, Krom River, 1 iv 1956, *Esterhuysen* 25489 (BOL); Cape Town, Kalk Bay Mountain, slope below Boyes Drive, 12 v 1974, *Goldblatt* 1792 (NBG); Stillbaai, Panorama Circle, 10 iii 1979, *Bohnen* 5112 (NBG, PRE); Stellenbosch, Bo-Onderpapagaaiberg, 20 v 1988, *Becker* 0001 (NBG); Sedgefield, Buffelsbaai, Goukamma River estuary, camping site, 6 v 2006, *Köcke & Mucina* 060506/02 (MJG); Stillbaai, Pauline Bohnen's ex-garden on Panoramasingel, 18 iii 2008, *Naudé et al.* s.n. (NBG).

5. Triglochin milnei Horn, Svensk. Bot. Tidskr. 55: 85 (1961). – Type: Zambia, Mwinilunga Distr., ½ mile S of Matonchi farm, c.1350 m, 30 x 1937, *Milne-Redhead* 3012 (holo K photo!, BOL photo!; iso S photo!). **Figs 2D, 9.**

Plants (15–)20–60 cm high, with *bulbs*; bulbs covered in dry, rather soft, brown fibres, these up to 5 cm long. *Leaves* few at flowering time, much shorter than, and mostly reaching only half of the height of plants, becoming larger and numerous after fruit maturity. Outer leaves strap-shaped, shorter and wider than inner leaves, up to 4 cm long, with mucronate tips, inner leaves abruptly narrowing above the ligule, > 1–2 mm wide, distinctly longer than outer leaves. *Inflorescences* lax, with 5–30 flowers. *Flowers* usually > 3 mm long. *Pedicels* elongated at fruit maturity, then 3–15 mm long, diverging at angles of 45° and curved inwards towards the apex. *Infructescences* 6–14 cm long. *Fruits* narrowly ovoid to ovoid, (8–)10–14 mm long, ± 3 mm wide (Fig. 2D). *Mericarps* connate at the *carpophore*. *Carpophore* with three basal membranous outgrowths.

Distribution. Angola, Democratic Republic of Congo (DRC), Tanzania, Zambia, Zimbabwe; in South Africa in KwaZulu-Natal, southern Mpumalanga and Zuurberg, Griqualand East, Eastern Cape (Fig. 9). Usually found at altitudes above (500–) 1000 m, in Tanzania at up to 1900 m. According to Govaerts (2008), *Triglochin milnei* is also found in Malawi, but no herbarium material from there has been seen.

Habitat and ecology. *Triglochin milnei* is found in seasonal (summer-wet) wetlands and seasonally wet, sometimes burnt, grasslands, often on grey or black clayey soils. At least some of these grasslands of the mid and high altitudes in Tanzania and Zimbabwe (and possibly also in Malawi) would qualify as 'afromontane'. At low altitudes in the DRC and Zambia this taxon is found in so-called *dambos* – seasonally waterlogged, predominantly grass-covered depressions bordering head-water drainage lines (Mackel, 1985). On the Mpumalanga Highveld and in the KwaZulu-Natal Midlands (South Africa), this taxon appears to be limited to azonal wetlands embedded within the Grassland Biome.

Phenology. Flowering and fruiting from x–ii(iii).

Chromosome number. Unknown.

Taxonomic remarks. *Triglochin milnei* is morphologically similar to *T. compacta* by having outgrowths at the base of the carpophore and narrowly ovoid to ovoid fruits, in which the outline of the seeds is often visible on the mericarp surface. However, the fruits differ in width (± 3 mm vs. 1–2 mm) and in most cases in length ((8)10–14 mm vs. 6–10 mm). Furthermore, the two species are geographically, ecologically and phenologically clearly differentiated.

Most Floras covering the distribution area of the species do not recognise *Triglochin milnei*, but treat it as a synonym of *T. bulbosa* (e.g. Bennett, 1902; Obermeyer, 1966; Lisowski *et al.*, 1982). Napper (1971) accepted *Triglochin milnei* (p. 3: 'The circumscription of *T. bulbosa* in F.S.A. 1: 93 (1966), which includes *T. milnei*, is less satisfactory') but doubted the sole record of this species in South

Africa. However, the study of extensive *Triglochin* material from South Africa and comparison with material of *T. milnei* from other parts of Africa revealed that the species occurs in eastern South Africa. Nevertheless, only limited material is available for South Africa and more collecting is needed.

Nomenclatural notes. The holotype (*Milne-Redhead* 3012, K) does not have fruits and should be used together with fruiting material.

Proposed IUCN conservation status. Data Deficient (DD). *Triglochin milnei* seems to be widely distributed in Central and southeastern Africa and is probably not under immediate threat. However, little is known about the current area of occupancy. The species is under-represented in herbarium collections and few other data are available. In economically more developed African countries, such as South Africa, subtropical and warm-temperate grasslands are under pressure from intensive stock grazing associated with frequent (often too frequent) burning. Sparse and vulnerable wetlands within these grasslands also suffer from over-utilisation by high grazing stock concentrations. Threats and current conservation status at the national level are likely to differ among countries, and therefore differential assessments are needed. In South Africa the species is only known from six, mostly very old, collections.

Specimens examined. ANGOLA. Distr. Huilla, Alto plana, ad ripas Rivi de Lopollo, prope Ohai (Háy), 5000 ft, xi/xii 1859, *Welwitsch* 3017 (para BM, P); Benguela [formerly Benguella], country of the Ganguellas and Ambuellas, 1910, *Gossweiler* s.n. (para K).

DEMOCRATIC REPUBLIC OF CONGO. 1.5 km E of Kabiasha, Katanga, 1020 m, 7 xii 1967, *Malaisse* 6189 (POZG); Haut-Shaba, close to Lubumbashi (formerly Elisabethville), 8 km W of Kasapa University, 25 xii 1968, *Lisowski* 84458 (POZG); Kinshasa, Haut-Katanga, close to Lubumbashi, on the fringes of Natwebo, 1220 m, 22 x 1969, *Lisowski* 731 & 732 (POZG), 27 xi 1970, *Lisowski* 733 (POZG); Plateau de Kundelungu, Katanga, bank of Kalundariver, 1590 m, 9 i 1971, *Lisowski*, *Malaisse & Symoens* 12645 & 12698 (POZG); Plateau des Kundelungu, 3 km N of source of river Lutshipuka, 9 i 1971, *Lisowski, Malaisse & Symoens* 12644 (BOL).

TANZANIA. Uyansi, Lake Chaya, c.1240 m, 4 i 1926, *Peter* 45784 (B); Sumbawanga, 6200 ft, 30 i 1950, *Bullock* 2364 (para K, S photo!); 12 km E of Songea by Nonganonga stream, 1050 m, 28 xii 1955, *Milne-Redhead & Taylor* 7934 (para B, EA, P, S photo!); Iringa Distr., 4 miles N of Iringa, Great North Road, 5150 ft, 5 ii 1962, *Polhill & Paulo* 1362 (B, EA, P); 7 miles from Iringa on Dabaga road, 26 xii 1965, *Harris* 10256 (EA); Sumbawanga, Tatanda Mission, 1700 m, *Bidgood, Mbago & Vollesen* 2409 (K); Nkansi Distr., 5 km on Namanyere–Karonga road, 1500 m, 4 iii 1994, *Bidgood, Mbago & Vollesen* 2603 (P).

SOUTH AFRICA. **KwaZulu-Natal**. Inanda, i 1800, *Medley Wood* 997 (BM); Griqualand East, Zuurberg Mountains, x 1883, *Tyson* 1866 (BOL); Alexandra Distr., Station Dumisa, Farm Friedenau, Umgaye, 600 m, 15 x 1908, *Rudatis* 440 (para BM, P); Krantzkop ('Kranskop'), 4500 ft, xii 1910, *Thode* 3870 (NBG-STE); Krantzkloof, Gillitto Kloof, 1800 ft, x 1921, *Haygarth* s.n. (STE 260, 261). **Mpumalanga**. Wakkerstroom Distr., N of Dirkiesdorp, SE of main road, on the farm Roodekraal, 1340 m, 13 xii 1995, *Balkwill* 9389 (PRE).

ZAMBIA. Mwinilunga Distr., ½ mile S of Matonchi farm, 16 xii 1937, *Milne-Redhead* 3693 (para S photo!); 5 miles E of Lusaka, 4200 ft, 10 i 1958, *King* 403 (para K); Chadiza, 850 m, 25 xi 1958, *Robson* 686 (BM); Lusaka, 4 xii 1964, *Robinson* 6266 (M); Kitwe, 9 ii 1969, *Fanshawe* 10515 (K).

ZIMBABWE. Charter Distr., Charter, 4000 ft, 27 xii 1926, *Eyles* 4587 (para K).

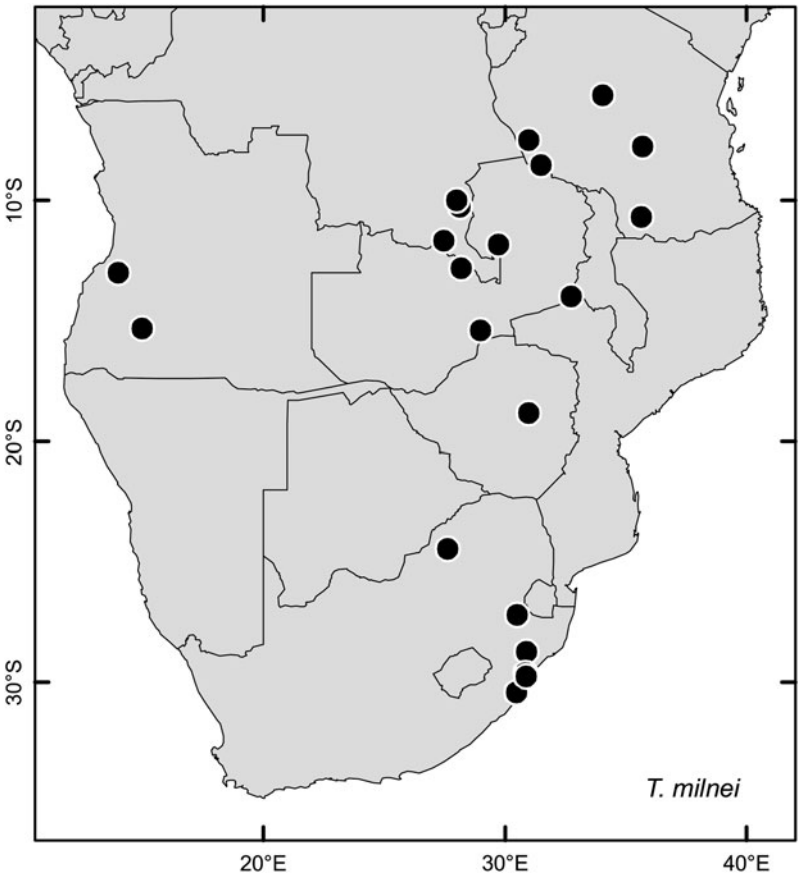

FIG. 9. Geographical distribution of *Triglochin milnei* Horn.

6. Triglochin elongata Buchenau in Engler, Das Pflanzenreich IV.14: 10, fig. 3 (1903). – Type: South Africa, Div. Malmesbury, 'Umgegend von Hopefield, Weg nach Coeuratenberg', xi 1886, *Bachmann* 1693 (lecto Z!, designated here); drawing of fruit and habit (from *Bachmann* 1693, B) in Buchenau (1903), fig. 3, p. 11 (epi, designated here). **Figs 1H, 1K, 2E, 8.**

Plants 15–90 cm high, with *rhizomes* (Fig. 1H). Rhizomes whitish to beige with bracts. *Leaves* uniform, thickened at the base but not forming a bulb, as long as or longer than plant height, 1–2 mm wide, leaf bases covered by soft, whitish to brown fibres, fibres mostly 3–6 cm, rarely up to 15 cm long. *Inflorescences* dense, with 10–100 flowers. *Flowers* 1.5–2.5 mm long. *Pedicels* elongated at fruiting time, then 2–6 mm long. *Infructescences* (6–)10–25 cm long. *Fruits* narrowly ovoid to ovoid, often secund, 5–9 mm long, 1–2.5 mm wide (Fig. 2E). *Mericarps* connate at the *carpophore*; tips mostly curved outwards.

Distribution. Endemic to South Africa: distributed mainly in coastal regions of the KwaZulu-Natal, Eastern, Western and Northern Cape Provinces (Fig. 8). In the last province there are two outlying localities – always located near the mouths of intermittent rivers draining the coastal plains of Namaqualand. We have failed to detect any morphological uniqueness of these Namaqualand populations. They are exceptional in terms of their geographical distribution and deserve further study. Many isolated inland localities are presumably of relictual character as they are found abundantly in regions frequently flooded by the sea during the altithermal marine transgressions (Overberg, parts of West Coast).

Habitat and ecology. *Triglochin elongata* commonly grows in the upper tidal and supratidal zones of estuarine salt marshes (Fig. 1K), usually on heavy clayey (partly also clayey-sandy) saline soils. In coastal habitats it is found on elevated banks of sandy beaches, edges of estuarine rivers as well as on rocks exposed to salt spray. Along some estuarine rivers it penetrates deeply inland (Bushmans River in the Eastern Cape), and in some regions (West Coast, Breede River, Overberg) it is found in (obviously relictual) inland localities, on banks of intermittent rivers (in Namaqualand) and on the edges of saline and brackish temporary pans, here often intermingled with dense *Juncus* stands. According to Mucina & Rutherford (2006) these habitats belong to the following vegetation units: Arid Estuarine Salt Marshes, Cape Estuarine Salt Marshes, Cape Inland Saltpans, Cape Lowland Freshwater Wetlands and Cape Seashore Vegetation.

Phenology. Flowering throughout the year as long as water is available.

Chromosome number. Unknown.

Taxonomic remarks. *Triglochin elongata* is similar to *T. buchenaui* in having rhizomes instead of bulbs, but differs in having dense inflorescences with 10–100 flowers (vs. lax inflorescences with 3–17 flowers), (6–)10–25 cm long infructescences (vs. 2–7 cm long), and fruits with a carpophore. Unlike *Triglochin buchenaui*, which is restricted to the lower tidal zone of salt marsh estuaries, *T. elongata* is ecologically more variable and grows in the upper zone of salt marsh estuaries and estuarine rivers.

Nomenclatural notes. In the protologue of *Triglochin elongata*, Buchenau (1903) cites three specimens which were probably destroyed in B during World War II. A duplicate of one of these syntypes has been discovered (*Bachmann* 1693, Z) and is designated as the lectotype here. This specimen, however, has flowers but no fruits. The fruit (and habit) of one of the original syntypes (*Bachmann* 1693, B) is illustrated in Buchenau (1903, fig. 3, p. 11). This drawing is designated here as an epitype.

Variation. Several exceptionally large individuals (up to 90 cm) with long infructescences and numerous fruits have been seen.

Proposed IUCN conservation status. Least Concern (LC). *Triglochin elongata* is a widespread species recorded from many riversides near the sea and almost all

major estuaries in South Africa (Fig. 8). However, some of these estuaries are under serious pressure through silt deposition or reduced freshwater flow (Turpie *et al.*, 2002; Turpie, 2004).

Specimens examined. SOUTH AFRICA. **Eastern Cape**. Uitenhage Div. [probably Swartkops Estuary near Port Elizabeth], xii (sine anno), *Ecklon & Zeyher* 620 (BOL); Port Elizabeth, Zwartkopsrivier, sine dato, *Zeyher* 4326 (NBG-SAM); East London, Kwenxura (= Kwenqura) River mouth, 23 xii 1900, *Galpin* 5815 (NBG); [Transkei], Kentani, coast, 100 ft, 1903, *Pegler* 335 (BOL); [Transkei], Kentani, 4 xii 1905, *Pegler* 335 (SAM, Z); [Transkei], Kei River Bridge, 19 x 1931, *Taylor* 3669 (NBG); Tsitsikamma, Nature's Valley, Groot River lagoon, ii 1932, *J. & B. Rennie* 545 (BOL); [Transkei], near Kei River mouth, 25 xi 1945, *Compton* 17675 (NBG); [Transkei], Coffee Bay, iii 1947, *Lewis* 2374 (NBG-SAM); East London, 27 x 1962, *Batten* 1.Pl.115 (NBG); East London, Nahoon River, 26 vi 1963, *Tölken* 402 (NBG-STE); Port Alfred, Kowie River estuary, 28 i 1964, *Mauve & Wells* 7 (NBG); East London, Bridle Drift, 2 iv 1966, *Pamphlett* 5 (NBG); Humansdorp, on water edge, 21 xi 1972, *Montgomery* 182 (NBG-STE); Tsitsikamma, Nature's Valley, Groot River estuary, 6 v 2006, *Köcke & Mucina* 060506/29 (MJG, NBG); Jefferey's Bay, Kabeljous River estuary, 7 v 2006, *Köcke & Steffen* 070506/01 (MJG); Port Alfred, Kowie River estuary, 9 v 2006, *Köcke & Steffen* 090506/22 (MJG). **KwaZulu-Natal**. [Herbarium Natal, locality burnt, possibly Durban], xi 1882, *Medley Wood* 396 (BM); Durban, shores at bay, 20 xi 1884, *Medley Wood* 396 (BOL); Durban, xi (sine anno), *Medley Wood* 925 (BM); Durban, Congella, sine dato, *Medley Wood* 11985 (BOL); Durban, x 1888, *Wilms* 2278 (BM); Durban, Levy, iii 1894, *Kuntze* s.n. (NY); Durban, Beach Terminus, vi 1913, *Thode* 4901 (NBG-STE); Durban, Isipingo, 22 iv 1921, *Forbes* STE 12526 (NBG-STE); 1 xi 1926, *Schröder* s.n. (ZT); Durban, Fusel, ix 1933, *Meebold* 12994 (M); Durban, Isipingo Beach, 13 viii 1949, *Ward* 917 (K); Port Edward, Palm Beach, 21 iii 1992, *Weigend* 2335 (M); Port Edward, Umtamvuna River mouth, 9 iv 2006, *Pienaar, Jakubowsky & Swelankomo* 090406/1 (MJG, NBG). **Northern Cape**. Namaqualand, Hondeklipbaai, Spoeg River mouth, 5 m, 18 x 1980, *Le Roux & Parsons* 59 (NBG-STE); Namaqualand, Kleinzee, 5 ix 2005, *Mucina* 050905/04 (MJG). **Western Cape**. Cape Town, False Bay prope Muizenberg, iii 1892, *Schlechter* 7184 (BOL); Bonnievalle, swamp near Breede River, iii (sine anno), *Marloth* 11592 (NBG-STE); Cape Peninsula, Muizenberg Vley, 11 iii 1896, *Wolley-Dod* 969 (BOL); 14 xi 1897, *Wolley-Dod* 3658 (BOL); Cape Town, Paarden Island, ii 1908, *Dümmer* 1171 (NBG-SAM); Cape Town, Lakeside, i 1918, *Michell* s.n. (BOL); West Coast, Graafwater, ix 1923, *Adamson* 39042 (NBG-SAM); Cape Peninsula, E of Paulsberg, 3 v 1929, *Salter* 344/9 (K); Robertson, Breede River, 25 ix 1935, *Lewis* s.n. (BOL); Cape Town, Paarden Island, 24 iii 1936, *Adamson* 843 (BOL); Cape Town, Lakeside Vlei, 17 x 1936, *Adamson* 1235 (BOL); 17 xi 1936, *Adamson* 1370 (BOL); 17 i 1937, *Adamson* 1614 (BOL); Cape Town, Sand Vlei, 17 xi 1936, *Adamson* 1373 (K); Cape Town, Sand Vlei, E side, 17 xi 1936, *Adamson* 1370 (NBG-SAM); Cape Town, Muizenberg, Sand Vlei, 20 iii 1938, *Adamson* 1689 (BM); West Coast, between Bokbaai and Darling, 15 ix 1940, *Esterhuysen* 3866 (BOL); Caledon, at streamside, xi 1940, *Esterhuysen* 3865 (BOL); Hermanus, Onrust, beside the lagoon, 22 iii 1944, *Leighton* 413a (BOL), *Leighton* 413 (NBG); Gansbaai, Frikkiesbaai [Uilkraalsmond], 21 iv 1946, *Leighton* 1669 (BOL); Gansbaai, Franskraal, 21 iv 1946, *Leighton* 1669 (NY); George, Kaaimansgat, Kaaimans River, xi 1947, *Wilman* s.n. (BOL, K); Plettenberg Bay, 24 ix 1967, *Thompson* 588 (NBG-STE); Cape Town, Cape Flats, Isoetesvlei, 9 iii 1970, *Strauss* 10 (NBG); Pearly Beach, Klein Hagelkraal, 50 ft, 10 iii 1979, *Thompson* 3898 (M, NBG); Stillbaai, Kransfontein Farm, humus rich river bank in forest, 7 x 1980, *Bohnen* 7731 (NBG-STE); Gansbaai, Franskraal, N bank of Uilkraal River, 2 m, 3 xi 1987, *O'Callaghan* 3/11/2 (NBG-STE); Struisbaai, at entrance to Corona Farm, 28 xii 2003, *Mucina* 281203/05 (MJG); Cape Town, Zandvlei, near station and boat

club area, 20 viii 2004, *Walton* 341 (MJG); Gansbaai, Franskraal, Uilkraalsmond Estuary, N of the road bridge, 8 v 2005, *Mucina* 080505/05 (MJG); Malgas, De Hoop Nature Reserve, Potberg section, Cupido's Kraal, 3 iv 2006, *Köcke & Mucina* 030406/14 (MJG); Struisbaai, Vogelzang Farm, 4 iv 2006, *Köcke & Mucina* 040406/22, 040406/24 (MJG, NBG); Gansbaai, Franskraal, Uilkraalsmond Estuary, N of the road bridge, 5 iv 2006, *Köcke & Mucina* 050406/03 (MJG), 050406/07 (MJG), 050406/09 (MJG); Hermanus, Fisherhaven, near jetty at the Botrivier Lagoon, 5 iv 2006, *Köcke & Mucina* 050406/11 (MJG, NBG); Bredasdorp, Patryskraal on road between Oupos and Bredasdorp, 5 iv 2006, *Köcke & Mucina* 050406/18 (MJG, NBG); Gansbaai, Franskraal, Uilkraalsmond estuary, 5 iv 2006, *Köcke & Mucina* 050406/19 (MJG, NBG); Struisbaai, W of Zoetendalsvlei, at road Struisbaai to Elim, km 59.9, 5 iv 2006, *Köcke & Mucina* 050406/24 (MJG, NBG); Struisbaai, at entrance to Corona Farm, 5 iv 2006, *Köcke & Mucina* 050406/27 (MJG); Cape Town, Milnerton, Rietvlei Nature Reserve, close to parking area, 20 iv 2006, *Köcke & Steffen* 200406/01, 200406/03 (MJG); on the way to bird hide, 20 iv 2006, *Köcke & Steffen* 200406/10 (MJG); at bird hide, 20 iv 2006, *Köcke & Steffen* 200406/17 (MJG); Hermanus, Voëklip, 23 iv 2006, *Köcke & Mucina* 230406/18 (MJG); Mosselbaai, Hartenbos, near the bridge over river, 4 v 2006, *Köcke & Mucina* 040506/24 (MJG, NBG); [Cape Town], Faure, Vergenoeg Farm, 4 x 2006, *Boucher* 7412 (NBG); Elim, near homestead of Heuningrug Farm, 14 x 2006, *Mucina* 141006/23 (MJG); Malgas, De Hoop Nature Reserve, Potberg section, near Bultfontein, 21 x 2006, *Mucina* 211006/17 (MJG); Struisbaai, Vogelzang Farm, N of Heuningnes River estuary, 17 iii 2007, *Mucina* 170307/03 (MJG), 170307/04 (MJG); Struisbaai, De Mond Nature Reserve, Heuningnes River estuary, left bank, 17 iii 2007, *Mucina* 170307/13A (MJG).

7. Triglochin buchenaui Köcke, Mering & Kadereit, **sp. nov. Figs 1I–J, 2F, 8.**
Herba scaposa, rhizomatosa, non bulbosa, ad 30 cm alta. Differt a *Triglochin elongata* inflorescentia laxa cum 3–17 flores, fructibus angustus ovoideus usque fere globosus, carpophoris deficiens. – Type: South Africa, Western Cape, West Coast National Park, E of Seeberg Bird Hide, intertidal salt marsh flats, 14 iv 2006, *Köcke & Mucina* 140406/06 (holo MJG; iso NBG; Fig. 10).

Plants 9–30 cm high, with *rhizomes*. Rhizomes whitish to beige with bracts. *Leaves* uniform, thickened at base but not forming a bulb, as long as or longer than infructescence, leaf bases with mostly (very) few, soft, whitish to beige fibres which can be more than half as long as height of plant. *Inflorescences* lax, with 3–17 flowers. *Flowers* ± 2 mm long. *Pedicels* up to 2 mm long at fruiting time, usually shorter. *Infructescences* 2–7 cm long, fruits distant. *Fruits* narrowly ovoid to ovoid, 4–8 mm long and 1 to > 2 mm wide (Fig. 2F). *Mericarps* dorsally curved upwards, filled with air, tips not curved or weakly curved outwards; *carpophore* absent.

Distribution. Endemic to South Africa, restricted to major estuaries of the West and South Coast, spanning Groot Berg River estuary near Velddrif (Western Cape Province) and Kariega estuary near Kenton-on-Sea (Eastern Cape Province) (Fig. 8).

Habitat and ecology. Triglochin buchenaui is a typical species of periodically flooded lower salt marsh estuaries (Fig. 1I). The soils in these habitats are sandy to sandy-clayey. *Triglochin buchenaui* usually occurs together with *Sarcocornia tegetaria* S.Steffen, Mucina & G.Kadereit, *Triglochin striata*, *Cotula coronopifolia* L., *Poecilolepis*

FIG. 10. Holotype of *Triglochin buchenaui* Köcke, Mering & Kadereit sp. nov. (MJG).

ficoidea (DC.) Grau, *Chenolea diffusa* Thunb. and various *Limonium* species. The vegetation in these habitats is classified exclusively as Cape Estuarine Salt Marshes (Mucina & Rutherford, 2006).

Phenology. Flowering throughout the year.

Etymology. The species is named after Franz Georg Philipp Buchenau (1831–1906), a German botanist who contributed significantly to the knowledge of *Triglochin* and Juncaginaceae.

Chromosome number. Unknown.

Taxonomic remarks. See *Triglochin elongata* for a comparison of these two rhizomatous species.

Proposed IUCN conservation status. Least Concern (LC). *Triglochin buchenaui* is a widespread species recorded from a number of large lagoons and estuaries in South Africa (Fig. 8) and therefore is not immediately threatened. The Berg River and Swartkops River estuaries support large populations of *Triglochin buchenaui* and are also among the highest ranked South African estuaries in terms of botanical and conservation importance (Turpie *et al.*, 2002). The estuaries of the Langebaan and Knysna Lagoons as well as estuaries of Kromme and Swartkops enjoy formal protection as part of either national parks or local authority nature reserves.

Specimens examined. SOUTH AFRICA. **Eastern Cape**. Port Elizabeth, Redhouse, i 1915, *Paterson* 288 (BOL); Boesmansriviermond, Bushmans River mouth, 14 i 1936, *Dyer* 3365 (PRE); Port Elizabeth, Swartkops River mouth, 4 ii 1964, *Mauve & Wells* 38 (NBG-STE); Tsitsikamma, Blaubaai by Robbehoek, 8 iii 1979, *Taylor* 9954 (NBG-STE); Kenton-on-Sea, Ghio Wetland, below the bridge over Bushmans River, 26 xi 2005, *Mucina* 261105/05 (MJG); St. Francis Bay, Kromme River estuary, at the bridge, 7 v 2006, *Köcke & Steffen* 070506/07 (MJG); Port Elizabeth, Swartkops River estuary, 8 v 2006, *Köcke & Steffen* 080506/06 (MJG); Kenton-on-Sea, Ghio Wetland, at bridge over Bushmans River, 9 v 2006, *Köcke & Steffen* 090506/04 (MJG); 9 v 2006, *Köcke & Steffen* 090506/08 (MJG); Kenton-on-Sea, Kariega River estuary, 9 v 2006, *Köcke & Steffen* 090506/13 (MJG). **Western Cape**. Knysna, Woodbourne, edge of lagoon, 31 i 1924, *Duthie* 876 (NBG-STE); Knysna, Belvidere, edge of lagoon, 22 i 1925, *Duthie* 876 (BOL); Langebaan, wet places, ix 1925, *Leipoldt* 27103 (BOL); Knysna, Knysna Lagoon, 6 ii 1964, *Mauve* 36 (PRE), *Wells* 37 (PRE); Langebaan Lagoon, near Oesterwal, 4 v 1967, *Simons* 1991 (BOL); Knysna, Nature's Valley, Groot (Wes) River mouth, 8 iv 1981, *Parsons* 161 (NBG-STE); Velddrif, Port Owen, Berg River, 13 ii 1981, *Le Roux* 2855 (NBG-STE); 16 ii 1986, *Boucher* 5123 (NBG-STE); 22 ii 1988, *Becker* 0002 (NBG-STE); Velddrif, salt marsh opposite Berg River Mouth, 14 x 1986, *O'Callaghan* 157 (NBG); Velddrif, N bank of Berg River, Wreck, 4 ii 1987, *O'Callaghan* 1468 (NBG-STE); Velddrif, Berg River, W of Port Owen, 8 ix 1987, *O'Callaghan* 8/13 (NBG-STE); Langebaan, West Coast National Park, Churchhaven, 21 viii 1997, *Mucina* 6435/11 (PRE); Langebaan, West Coast National Park, Geelbek at Bird Hide, 14 iv 2006, *Köcke & Mucina* 140406/27 (MJG); Velddrif, Berg River estuary, at Carinus Bridge, 19 iv 2006, *Köcke & Steffen* 190406/15 (MJG, NBG), 190406/19 (MJG); Stillbaai, Goekoe River estuary, E bank of the river, 4 v 2006, *Köcke & Mucina* 040506/10 (MJG); Knysna, Knysna Lagoon, turnoff to Leisure Island, 5 v 2006, *Köcke & Mucina* 050506/05 (MJG); Plettenberg Bay, Bitou River estuary, 6 v 2006, *Köcke & Steffen* 060506/25 (MJG), 060506/27 (MJG).

Discussion

The seven species of the *Triglochin bulbosa* complex recognised here are not only morphologically distinct but also differentiated in terms of geographical distribution, ecology, phenology and, where known, chromosome number.

In the Mediterranean region, *Triglochin laxiflora* is autumn-flowering whereas *T. barrelieri* is spring-flowering. The two Mediterranean species also have different ploidy levels, with *Triglochin laxiflora* having $2n = 18$ and *T. barrelieri* having $2n = 30$, 32 or 36 chromosomes.

In Africa, *Triglochin milnei* is the only species of the complex found in several countries of Central and southern Africa. The distribution of *Triglochin milnei* does not overlap with the other four species in South Africa. In eastern South Africa it is the only species to be found in inland localities and at altitudes above 500 m. Both rhizomatous species, *Triglochin elongata* and *T. buchenaui*, grow sympatrically (in a broad sense) along the South and West coasts of South Africa. However, they differ in ecology by *Triglochin buchenaui* being limited to lower tidal habitats, while *T. elongata* is found in upper tidal or semi-terrestrial inland habitats such as edges of water courses and pans. Where the two bulbous species, *Triglochin bulbosa* and *T. compacta*, occur in the same area (e.g. Cape Peninsula), they differ in both phenology and ecology. *Triglochin bulbosa* flowers between July and November, while the flowering time of *T. compacta* is between February/March and May. *Triglochin bulbosa* subsp. *bulbosa* occurs on the Cape Peninsula on Archaean granites, while *T. compacta* is found on quartzite sands derived from Ordovician Table Mountain sandstone.

The importance of edaphic factors (geology, soils and associated pedo-hydrological conditions) in the diversification of the Cape flora has been widely suspected (Marloth, 1908) and in many instances also well documented (Rourke, 1972; Williams, 1972; Goldblatt, 1979; Linder & Ellis, 1990; Kurzweil *et al.*, 1991; see also Linder, 2003 and van der Niet *et al.*, 2006). *Triglochin bulbosa* may be a good candidate for the study of adaptive radiation of a non-insect pollinated taxon. The four subspecies now distinguished within *Triglochin bulbosa* are clearly differentiated along pedo-hydrological habitat axes. The only water-bound subspecies of *Triglochin bulbosa* is the widely distributed *T. bulbosa* subsp. *bulbosa* occurring in temporarily wet (flooded) coastal and inland habitats, while the other three subspecies radiated into fully terrestrial inland habitats characterised by contrasting geologies, such as granite (*T. bulbosa* subsp. *tenuifolia*), limestone (*T. bulbosa* subsp. *calcicola*) and quartz fields (*T. bulbosa* subsp. *quarcicola*).

Morphology of underground parts appears to be correlated with water availability. Whereas the species with rhizomes (*Triglochin elongata*, *T. buchenaui*) are limited to habitats with constantly available water, the bulbous species (*Triglochin bulbosa*, *T. compacta*, *T. milnei*, *T. barrelieri*, *T. laxiflora*) grow in places where at least abundant water is available only for a short period of the year.

The similarities in differentiation between *Triglochin* species from the Mediterranean Floristic Region and the Cape Floristic Region are striking. Thus, morphologically

similar species from the two regions flower either in spring (Mediterranean: *Triglochin barrelieri*, South Africa: *T. bulbosa*) or in autumn (Mediterranean: *T. laxiflora*, South Africa: *T. compacta*). This divergence of flowering time was already noted by Buchenau (1896) and Rainha (1944) for the Mediterranean region and by Adamson (1943) for South Africa. The species of the complex thus are a good example of parallel ecological differentiation under similar climatic conditions in mediterranean-type ecosystems.

Several species of the *Triglochin bulbosa* complex are of conservation concern. Even though only *Triglochin bulbosa* subspp. *calcicola* and *quarcicola* are threatened according to the IUCN Red List categories (IUCN, 2001), the habitats of many taxa (e.g. seasonal pools, estuaries) are under manifold pressures from human activities.

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References

Adamson, R. S. (1939). The Cape species of *Triglochin*. *J. S. African Bot.* 5: 29–31.

Adamson, R. S. (1943). *Triglochin compactum*. In: Barker, W. F., Gerstner, F. J., Adamson, R. S. & Compton, R. H., Plantae Novae Africanae. *J. S. African Bot*. 9: 152–153.

Australian Plant Census (2008). *IBIS database*. Centre for Plant Biodiversity Research, Council of Heads of Australian Herbaria. www.chah.gov.au/apc/index.html, accessed 21 February 2008.

Barrelier, J. (1714). *Plantae per Galliam, Hispaniam et Italiam observatae*. Paris: Ganeau.

Bartolo, G., Brullo, S., Majorana, G. & Pavone, P. (1977). Numeri cromosomici per la Flora Italiana: 315–328. *Inform. Bot. Ital.* 9: 71–87.

BATTANDIER, J.-A. & TRABUT, L.-C. (1884). Juncaginées. In: *Flore d'Alger et catalogue des plantes d'Algérie. Monocotylédones*. Alger: Jourdan.
BENNETT, A. (1897). Naiadaceae. In: THISELTON-DYER, W. T. (ed.) *Flora Capensis [Harvey]* 7: 41–51. London: L. Reeve & Co.
BENNETT, A. (1902). Naiadaceae. In: THISELTON-DYER, W. T. (ed.) *Flora of Tropical Africa [Oliver et al.]* 8: 215–230. London: L. Reeve & Co.
BOLÒS, O. DE & VIGO, J. (2001). Juncaginàcies. In: *Flora dels Països Catalans* 4: 26–28. Barcelona: Ed. Barcino.
BONNET, E. (1896). Naiadaceae. In: BONNET, E. & BARRATTE, G. (eds) *Exploration Scientifique de la Tunisie: Catalogue Raisonne des Plantes Vasculaires de la Tunisie* 428–432.
BUCHENAU, F. G. P. (1896). Ein Fall von Saison-Dimorphismus in der Gattung *Triglochin*. *Abh. Naturwiss. Vereine Bremen* 13: 408–412.
BUCHENAU, F. G. P. (1903). Scheuchzeriaceae. In: ENGLER, A. (ed.) *Das Pflanzenreich (Engler)* IV.14, 16: 1–20.
CASTRO, D. DE & CARVALHO FONTES, F. (1946). Promeiro contacto citológico com a flora halófila dos salgados de Sacavém. *Brotér. Ciénc. Nat.* 15: 38–46.
CASTRO, M., FRAGA, P., TORRES, N. & ROSSELLÓ, J. A. (2007). Cytotaxonomical observations on flowering plants from the Balearic Islands. *Ann. Bot. Fenn.* 44: 409–415.
CONTI, F., MANZI, A. & PEDROTTI, F. (1997). *Liste Rosse Regionali delle Piante d'Italia*. Camerino: WWF Italia, Società Botanica Italiana, Università di Camerino.
COOK, C. D. K. (2004). *Aquatic and Wetland Plants of Southern Africa*. Leiden: Backuys.
DAHLGREN, R., KARLSSON, T. & LASSEN, P. (1971). Studies on the flora of the Balearic Islands I. Chromosome numbers in Balearic angiosperms. *Bot. Not.* 124: 249–269.
DAHLGREN, R. M., CLIFFORD, H. T. & YEO, P. F. (1985). *The Families of the Monocotyledons: Structure, evolution, and taxonomy*. Berlin: Springer.
DANDY, J. E. (1980). *Triglochin*. In: TUTIN, T. G., HEYWOOD, V. H., BURGES, N. A., MOORE, D. M., VALENTINE, D. H., WALTERS, S. M. & WEBB, D. A. (eds) *Flora Europaea* 5: 6–7. Cambridge: Cambridge University Press.
ESRI (2006). *ArcGIS 9.0. Using ArcGIS Desktop*. Redlands, CA: ESRI.
FINLAYSON, M. & MOSER, M. (eds) (1991). *Wetlands*. Oxford: International Waterfowl and Wetlands Research Bureau (IWRB).
GARDÉ, A. & MALHEIROS-GARDÉ, N. (1953). Contribuição para o estudo cariologico de algumas species de Angiospermicas I. *Genetica Iberica* 5(3–4): 115–124.
GLEN, R. P. & COOK, C. D. K. (2003). Juncaginaceae. In: GERMISHUIZEN, G. & MEYER, N. L. (eds) *Plants of Southern Africa: An annotated checklist*, pp. 1118–1119. Pretoria: National Botanical Institute.
GOLDBLATT, P. (1979). Biology and systematics of *Galaxia* (Iridaceae). *J. S. African Bot.* 45: 385–423.
GOLDBLATT, P. & MANNING, J. (2000). *Cape Plants: A conspectus of the Cape flora of South Africa*. Pretoria: National Botanical Institute and St Louis, MO: Missouri Botanical Garden.
GOVAERTS, R. (2008). *World Checklist of Juncaginaceae*. The Board of Trustees of the Royal Botanic Gardens, Kew. Published on the Internet: www.kew.org/wcsp/monocots/, accessed 21 February 2008 (then still being 'UR = under review (partially reviewed)').
GRILLAS, P., GAUTHIER, P., YAVERCOVSKI, N. & PERENNOU, C. (eds) (2004). *Mediterranean Temporary Pools* 1. Arles: Station biologique de la Tour du Valat.
GUSSONE, G. (1825). *Index Seminum Horto Boccad.* 1825: 12.
GUSSONE, G. (1827). *Florae Siculae Prodromus* 1. Neapoli: Ex Regia Typographia.
HAYEK, A. (1933). *Prodromus Florae peninsulae Balcanicae* 3. Berlin-Dahlem: Verlag des Repertoriums.

HAYNES, R. R., LES, D. H. & HOLM-NIELSEN, L. B. (1998). Juncaginaceae. In: KUBITZKI, K. (ed.) *Families and Genera of Vascular Plants* 4: 260–263. Berlin: Springer.
HOLMGREN, P. K. & HOLMGREN, N. H. (1998) [continuously updated]. *Index Herbariorum: A global directory of public herbaria and associated staff*. New York Botanical Garden's Virtual Herbarium. http://sweetgum.nybg.org/ih/.
HORN AF RANTZIEN, H. (1961). Notes on the African species of *Triglochin*. *Svensk. Bot. Tidskr.* 55: 81–117.
IUCN (2001). *IUCN Red List Categories and Criteria, Version 3.1*. IUCN Species Survival Commission. Gland, Switzerland and Cambridge, UK: IUCN.
JAHANDIEZ, E. & MAIRE, R. (1931). *Catalogue des plantes du Maroc* 1. Alger: Minerva.
KURZWEIL, H., LINDER, H. P. & CHESSELET, P. (1991). The phylogeny and evolution of the *Pterygodium–Corycium* complex (Coryciinae, Orchidaceae). *Pl. Syst. Evol.* 175: 161–223.
LINDER, H. P. (2003). The radiation of the Cape flora, southern Africa. *Biol. Rev. (Cambridge)* 78: 597–638.
LINDER, H. P. & ELLIS, R. P. (1990). A revision of *Pentaschistis* (Arundineae: Poaceae). *Contr. Bolus Herb.* 12: 1–124.
LINNAEUS, C. (1753). *Species Plantarum*. Stockholm: Holmiae.
LINNAEUS, C. (1762). *Species Plantarum* ed. 2. Stockholm: Holmiae.
LINNAEUS, C. (1771). *Mantissa Plantarum Altera*. Stockholm: Holmiae.
LISOWSKI, S., MALAISSE, F. & SYMOENS, J. J. (1982). Juncaginaceae. In: *Flore d'Afrique Centrale (Zaire – Rwanda – Burundi)* 1–6. Meise: Jardin botanique national de Belgique.
LOISELEUR-DESLONGCHAMPS, J. L. A. (1806). *Flora Gallica*. Part 1. Paris: Migneret.
LOISELEUR-DESLONGCHAMPS, J. L. A. (1807). *Flora Gallica*. Part 2. Paris: Migneret.
LOISELEUR-DESLONGCHAMPS, J. L. A. (1828). *Flora Gallica* ed. 2. Part 1. Paris: Baillière.
LÖVE, A. & LÖVE, D. (1958). Biosystematics of *Triglochin maritimum* agg. *Naturaliste Canad.* 85: 156–165.
MACKEL, R. (1985). Dambos and related landforms in Africa – an example for the ecological approach to tropical geomorphology. *Z. Geomorphol. N.F.* Suppl. 52: 1–23.
MAIRE, R. (1952). Juncaginaceae. In: *Flore de l'Afrique du Nord* 1: 210–214. Paris: Lechevalier.
MARLOTH, R. (1908). Das Kapland, insonderheit das Reich der Kapflora, das Waldgebiet und die Karroo, pflanzengeographisch dargestellt. In: CHUN, C. (ed.) *Wissenschafftliche Ergebnisse der deutschen Tiefsee-Expedition auf dem Dampfer 'Valdivia' 1898–1899* 2(3): 1–427. Jena: Gustav Fischer.
MEDWET (1996). *Mediterranean Wetland Strategy 1996–2006*. Endorsed by the Mediterranean Wetlands Conference, Venice, June 1996. Downloadable from www.medwet.org/medwetnew/en/00.TEXTS/MedWet_Strategy_1996.doc.
MERING, S. VON & KADEREIT, J. W. (In press). Systematics, phylogeny, and recircumscription of Juncaginaceae – a cosmopolitan wetland family. In: SEBERG, O., PETERSEN, G., BARFOD, A. S. & DAVIS, J. I. (eds) *Diversity, Phylogeny, and Evolution in the Monocotyledons – Proceedings of the Fourth International Conference on the Comparative Biology of the Monocotyledons and the Fifth International Symposium on Grass Systematics and Evolution*. Aarhus: Aarhus University Press.
MICHELI, M. (1881). Juncagineae. In: *Monographiae Phanerogamarum* 3: 94–112. Paris: G. Masson.
MUCINA, L. & RUTHERFORD, M. C. (eds) (2006). *The Vegetation of South Africa, Lesotho and Swaziland*. Pretoria: SANBI.
MUSÉUM NATIONAL D'HISTOIRE NATURELLE (ed.) (2003–2006). *Inventaire national du Patrimoine naturel*. http://inpn.mnhn.fr, accessed 17 July 2008.

NAPPER, D. M. (1971). Juncaginaceae. In: MILNE-REDHEAD, E. & POLHILL, R. M. (eds) *Flora of Tropical East Africa* 1–3. London: Crown Agents for Overseas Governments and Administrations.

NIET, T. S. VAN DER, JOHNSON, S. D. & LINDER, H. P. (2006). Macroevolutionary data suggest a role for reinforcement in pollination system shifts. *Evolution* 60: 1596–1601.

OBERMEYER, A. A. (1966). Juncaginaceae. In: CODD, L. E. & DE WINTER, B. (eds) *Flora of Southern Africa* 1: 92–95. Pretoria: Botanical Research Institute.

PAU, C. (1914). *Triglochin barrelieri* var. *maurum*. In: FONT QUER, P., Plantas de Larache. *Bol. Real Soc. Esp. Hist. Nat*. 14: 424–429.

POST, G. E. (1933). Juncaginaceae. In: *Flora of Syria* ed. 2: 539. Beirut: American Press.

RAINHA, B. V. (1944). A *Triglochin laxiflora* Guss. em Portugal. *Bol. Soc. Brot.* 19: 289–294.

ROBB, L. & LADIGES, P. Y. (1981). Morphological forms and polyploidy in *Triglochin procera* agg. in Victoria. *Austral. J. Bot.* 29: 639–651.

ROURKE, J. P. (1972). Taxonomic studies on *Leucospermum* R.Br. *J. S. African Bot.* 8 (Suppl.): 1–194.

ROUY, G. (1912). Juncaginacées. In: ROUY, G. & FOUCAUD, J. (eds) *Fl. France* 13: 268–272.

RUIZ, E. (2008). *Management of Natura 2000 habitats – 3170 *Mediterranean temporary ponds*. Technical Report, European Commission.

SCHMIEDEL, U. & JÜRGENS, N. (1999). Community structure on unusual habitat islands: quartz-fields in the Succulent Karoo, South Africa. *Pl. Ecol.* 147: 57–69.

STEVENS, P. F. (2001 onwards). *Angiosperm Phylogeny Website*. Version 9, June 2008 [and more or less continuously updated since]. www.mobot.org/MOBOT/research/APweb/.

TALAVERA, S. (1987). Juncaginaceae. In: VALDÉS, B., TALAVERA, S. & FERNÁNDEZ-GALIANO, E. (eds) *Flora Vascular de Andalucía Occidental* 3: 186–187. Barcelona: Ketres.

TALAVERA, S., ORTIZ, P. L., ARISTA, M. & BASTIDA, F. (1995). Estudio cariosistematico de algunas monocotiledoneas bulbosas de Marruecos. *Lagascalia* 18: 83–104.

TOMLINSON, P. B. (1982). Juncaginaceae. In: METCALFE, C. H. (ed.) *Anatomy of the Monocotyledons* 7. Oxford: Clarendon Press.

TRINDER-SMITH, T. H. (2003). The Levyns guide to the plant genera of the southwestern Cape. *Contr. Bolus Herb.* 21: 1–355.

TURPIE, J. K. (2004). *South African National Biodiversity Assessment 2004: Technical Report.* Vol. 3*: Estuary Component*. Pretoria: SANBI.

TURPIE, J. K., ADAMS, J. B., JOUBERT, A., HARRISON, T. D., COLLOTY, B. M., MAREE, R. C. *et al*. (2002). Assessment of the conservation priority status of South African estuaries for use in management and water allocation. *Water SA* 28: 191–206.

UOTILA, P. (1984). Juncaginaceae. In: DAVIS, P. H. (ed.) *Flora of Turkey and the East Aegean Islands* 8: 13–15. Edinburgh: Edinburgh University Press.

WESTERN AUSTRALIAN HERBARIUM (1998 onwards). *FloraBase: The Western Australian Flora*. Perth: Department of Environment and Conservation. http://florabase.dec.wa.gov.au/.

WILLIAMS, I. J. M. (1972). A revision of the genus *Leucadendron* (Proteaceae). *Contr. Bolus Herb.* 3: 1–425.

WYK, A. E. VAN & SMITH, G. F. (2001). *Regions of Floristic Endemism in Southern Africa: A review with emphasis on succulents*. Pretoria: Umdaus Press.

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