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Abstract

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The South American *Paspalum quadrifarium* has been reported as a naturalized xenophyte in Tuscany and Liguria, Italy, since at least the 1960s. In the present contribution the discovery of the closely related *P. exaltatum,* also of South American origin, in Liguria, Italy, is reported. These are the only known occurrences in Europe of both species, which are very similar to each other and likely to be confused. In the present paper their diagnostic features are discussed and original line drawings and SEM photographs for both taxa are presented. Their current distribution in Italy is shown and some ecological remarks are added.

Key words: *Paspalum quadrifarium, Paspalum exaltatum,* xenophyte, Italy, taxonomy, distribution.

Introduction

A concise botanical inventory by the first author of the surroundings of Cogoleto (Liguria, province of Genoa, Italy), well known for its remarkable diversity of alien plants (Peccenini & al. 1991), in June 2005 yielded several records of a tall, densely caespitose species of *Paspalum*. Initially, these were taken for *P. quadrifarium* Lam., known as a locally naturalized xenophyte in the surroundings of Pisa, Tuscany (Garbari 1966, 1972, Viegi & Cela Renzoni 1981), and Arenzano, Liguria (Barberis & Mariotti 1982), and likely to occur elsewhere in the northwestern coastal areas of Italy.

Voucher specimens from Liguria and Tuscany were carefully studied and compared with numerous native collections of taxa of the *Quadrifaria* group. It soon became evident that the Italian plants belong to two closely related but distinct taxa, *Paspalum exaltatum* J. Presl and *P. quadrifarium*. The former seems to have never been recorded before in Italy (Gentile 1992, Conti & al. 2005) nor elsewhere in Europe.

In the present paper the main diagnostic characters of both taxa are discussed and original line drawings and SEM photographs for both are presented. Some further chorological and ecological comments are also provided.

Taxonomy

The informal *Quadrifaria* group of *Paspalum* comprises a few South American species characterized by their tall (usually more than 100 cm), densely caespitose habit, long, rigid leaves, terminal pyramidal panicles with numerous racemosely arranged branches and paired ochreous to purplish spikelets (Fig. 1A-B). Barreto (1966) distinguished ten taxa and subsequently a few additional taxa were described (*P. dasytrichium* Swallen (1967), *P. zuloagae* Davidse & Filg. (Filgueiras & Davidse 1995) and *P. quarinii* Morrone & Zuloaga (2000). A further taxon, *P. chapadense* Swallen (1967), is today considered conspecific with *P. coryphaeum* Trin. The species are remarkably confined to rather moist habitats (Barreto 1966).

The group is represented in Europe by two species, which can be keyed out as follows:

1. Spikelets 3-3.5 mm long, (sub)acute, the lower lemma and upper glume slightly longer than the upper floret; upper glume less pubescent to subglabrous without bulbous-based hairs . . . . . 1. *P. exaltatum*
– Spikelets 2-2.5 mm long, (sub)obtuse, the lower lemma and upper glume equal to the upper floret; upper glume densely pubescent with bulbous-based hairs . . . 2. *P. quadrifarium*

Paspalum quadrifarium always has much smaller spikelets with upper glumes and lower lemmas equal to the upper floret (Fig. 1E). Spikelets usually tend to be (sub)obtuse. In addition, the spikelets (essentially the upper glume) are densely pubescent; at least part of the hairs are bulbous-based, the bulbs are remarkably dark-coloured (Fig. 2A, C, E). According to Zuloaga & Morrone (2001) the bulbous-based hairs provide the best feature to distinguish *P. quadrifarium* from *P. exaltatum*. As a rule, *P. exaltatum* always has much less pubescent spikelets and bulbous-based hairs are lacking (Fig. 2B, D, F). The spikelets are always larger and the upper glume and lower lemma are always longer (sometimes only slightly so) than the upper floret (Fig.1J). Finally, the spikelets are usually (sub)acute.

In the examined herbaria native material of both taxa (and others of the *Quadrifaria* group, especially *Paspalum haumanii* Parodi) were frequently intermixed. In fact, some other diagnostic features given in the literature seem variable and are hence unreliable for their distinction: the height of the culms is sometimes indicated to distinguish between *P. exaltatum* and *P. quadrifarium,* the former being a much more robust species up to 300 cm tall (Barreto 1966). In practice, and certainly in Italy, both are huge grasses that easily reach 200 cm and there seems to be no remarkable difference in height. The length of the lower lemma and upper glume compared to the length of the upper floret surely provides a reliable diagnostic feature but the differences are sometimes exaggerated (Barreto 1966, Smith & al. 1982) or not visible in all spikelets. According to Webster (1987) both are primarily distinguished by the type of indumentum of the upper glume: "distinctly ciliate" in *P. quadrifarium* (in the same dichotomy as *P. dilatatum* and *P. urvillei*) versus "margins or submargins glabrous" in *P. exaltatum*. Spikelets are, indeed, usually much more hairy in the former and sometimes even subglabrous in the latter, but they are scarcely ciliate in *P. quadrifarium* and differ clearly from those of *P. dilatatum*. Webster (1987) indicates aberrant and overlapping spikelet measurements for *P. exaltatum* and *P. quadrifarium* (2.5-3.2 mm versus 2.2-2.8 mm long, respectively). Nevertheless, spikelet length proved to be an invariable and reliable identification feature (see also Barreto 1966, Smith & al. 1982). In the Italian collections the spikelets are unequivocally longer than 3 mm in *P. exaltatum* (on average 3.3-3.4 mm) and shorter than 2.5 mm in *P. quadrifarium* (on average 2.2-2.3 mm) (Fig.1C-L).

Paspalum haumanii, sometimes considered to be conspecific with *P. exaltatum* (see for instance Smith & al. 1982) is still taller with culms 200-300 cm, larger spikelets (3.5-4 mm) and inflorescences (up to 50 cm long with up to 100 racemes). The upper glume and lower lemma are evidently longer than the upper floret (0.8-1.3 mm versus 0.4-0.8 mm longer in *P. exaltatum*). *P. haumanii* has a similar native geographic distribution as *P. exaltatum* and *P. quadrifarium* and is found in similar habitats. Its occurrence outside its native range, for instance as an ornamental plant, cannot be excluded.

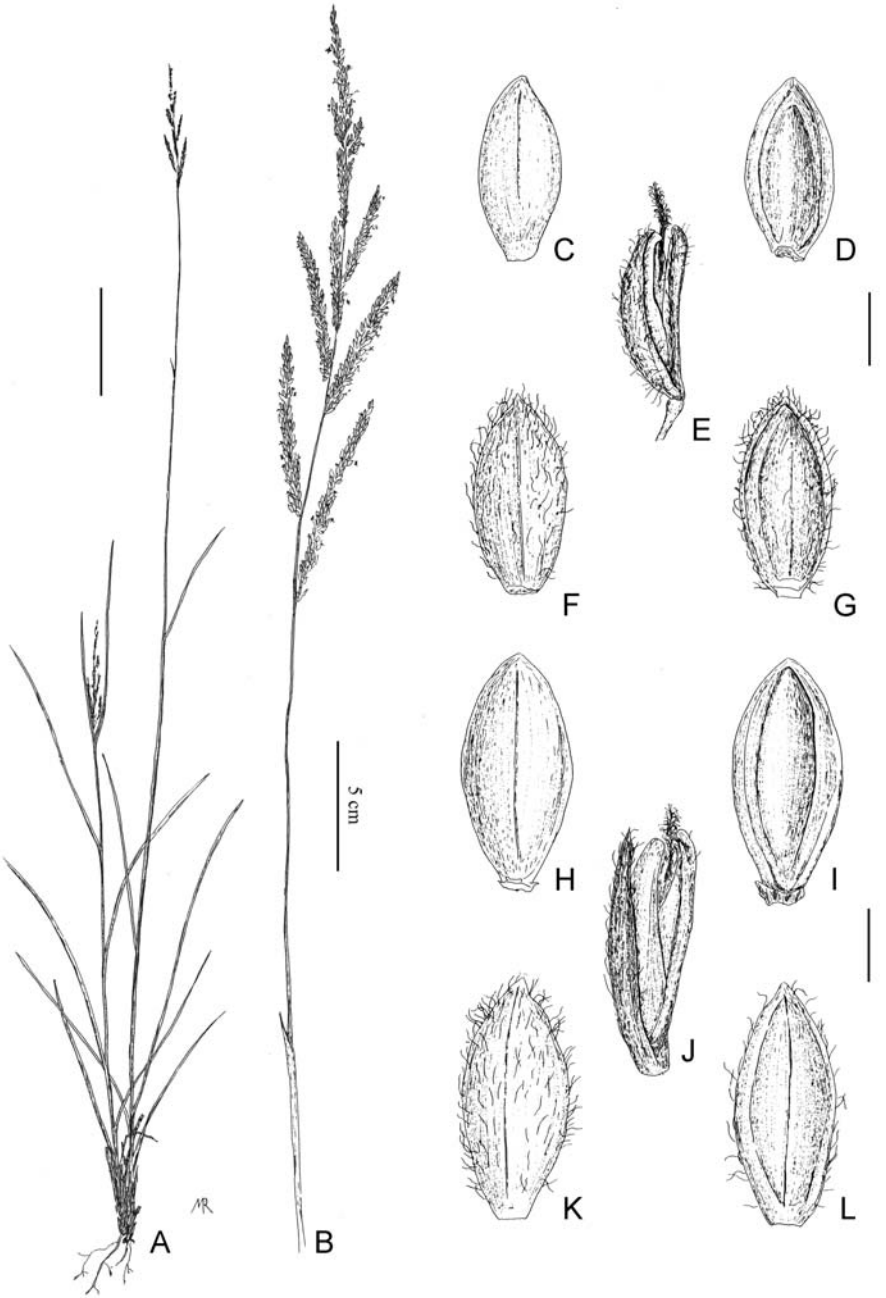

Fig. 1. Comparison of *Paspalum quadrifarium* and *P. exaltatum* – A-B: habit (A), inflorescence (B) in both species; C-G: *P. quadrifarium* – upper floret in dorsal view showing lemma (C); upper floret in ventral view showing palea and margins of lemma (D); spikelet in lateral view (E); spikelet in dorsal view showing upper glume (F); spikelet in ventral view showing sterile lemma (G); after *F. Verloove 6004*. – H-L: *P. exaltatum* – upper floret in dorsal (H) and ventral (I) view; spikelet in lateral (J), dorsal (K) and ventral (L) view; after *F. Garbari*, 23.9.1966. – Scale bars: A = 20 cm, B = 5 cm, C-L = 1 mm. – Drawn by Marc Reynders.

1. *Paspalum exaltatum* J. Presl, Reliq. Haenk. 1: 219. 1830.

Densely caespitose perennial, usually glaucous; *culm* 120-250 cm tall, erect, glabrous. *Leaf sheaths* glabrous; *leaf blades* 30-70 cm long and 4-10(-15) mm wide, plane or involute, rigid, glabrous; ligule membranous, 2-4 mm long. *Inflorescence* terminal, at first linear, becoming pyramidal, 17-30 × 2-10 cm, with (10-)20-30(-35) racemosely arranged branches; branches ascending to divergent, 2-7(-10) cm long, the lowermost longer than the uppermost; branch axes 5-10 mm wide, plane. *Spikelets* (2.8-)3-3.5(-4) × 1.2-1.6 mm, paired, broadly elliptic and subacute, planoconvex, usually pubescent or subglabrous; lower glume wanting or vestigial, upper glume and lower lemma subequal, 0.4-0.8 mm longer than the upper floret, upper floret 2.8 mm long, elliptic, stramineous.

Origin. – South America (Argentina, Brazil, Paraguay, Uruguay). Reported as a xenophyte in Australia (Tothill & Hacker 1983, Webster 1987).

Ic. – Fig. 1, 2; Barreto (1966: fig. 2), Burkart (1969: fig. 169), Smith & al. (1982: fig. 199).

Flowering. – June to September (inflorescences probably present all year round).

Distribution in Europe. – So far only known from Italy, recorded for the first time in 2005 in the surroundings of Cogoleto, prov. Genoa, Liguria, see Fig. 3.

Specimens and observations. – ITALY: LIGURIA: PROVINCE OF GENOA: Cogoleto, Schiva, near camping Europa Unita, dry, rocky roadverge, locally abundant, 18.6.2005, *F. Verloove 5997* (BR, RO, herb. F. Verloove); Cogoleto, Sciarborasca, via Schiva (SP 66), roadverge, scattered specimens, also in adjacent grassland, 20.6.2005, *F. Verloove 6004* (herb. F. Verloove); Cogoleto, via Chiapinno towards Moggie, roadverge, 18. & 22.6.2005, *F. Verloove 6005* (LG); Cogoleto, Sciarborasca (via Schiva towards Ponte Arma), roadverges, pastures, 19. & 20.6.2005, *F. Verloove obs.;* Cogoleto, Alta Via Romana, roadverges, 19.6.2005, *F. Verloove obs.;* Cogoleto, Schiva towards Capuà, road verges of small country road, 20. & 24.6.2005, *F. Verloove obs.*

2. *Paspalum quadrifarium* Lam., Tabl. Encycl. 1: 176. 1791.

Densely caespitose perennial; culm (50-)100-150(-180) cm tall, erect, glabrous (or sometimes pubescent on the nodes). *Leaf sheaths* glabrous; *leaf blades* 15-50(-65) cm long and 3-8 mm wide, plane or involute, rigid, usually glabrous; ligule membranous, 2-6 mm long. *Inflorescence* terminal, pyramidal, 12-30 × 2-4 cm, with (10-)15-40 racemosely arranged branches; branches ascending to divergent, 2-7(-10) cm long, the lowermost longer than the uppermost; branch axes 5-6 mm wide, plane. *Spikelets* (1.6-)2-2.5 × 0.8-1.3 mm, paired, elliptic and subobtuse, planoconvex, densely pubescent with bulbous-based hairs, bulbs dark-coloured; lower glume wanting or vestigial, upper glume and lower lemma subequal, as long as the upper floret, upper floret 2.2-2.5 mm long, elliptic, white.

Origin. – South America (Argentina, Brazil, Paraguay, Uruguay). Reported as a naturalized alien and a declared noxious weed in Australia (New South Wales and Queensland, see Webster 1987, Jacobs & Wall 1993; more recently also in Victoria, see Walsh & Entwisle 1994) and as an occasional garden escape in Florida (North America, see Allen & Hall 2003). *Paspalum quadrifarium* was not yet mentioned by Chase (1929) or Hitchcock (1951) and appears to be a fairly recent introduction in the USA.

Ic. – Fig. 1, 2; Barreto (1966: fig. 1B), Smith & al. (1982: fig. 200), Allen & Hall (2003: fig. p. 589).

Flowering. – June to September (inflorescences probably present all year round).

Distribution in Europe. – So far only known from Italy, recorded for the first time in 1966 around San Giuliano Terme between Pisa and Lucca, prov. Pisa, Tuscany. Subsequently recorded elsewhere in the surroundings and more recently extending northwards up to Arenzano in prov.

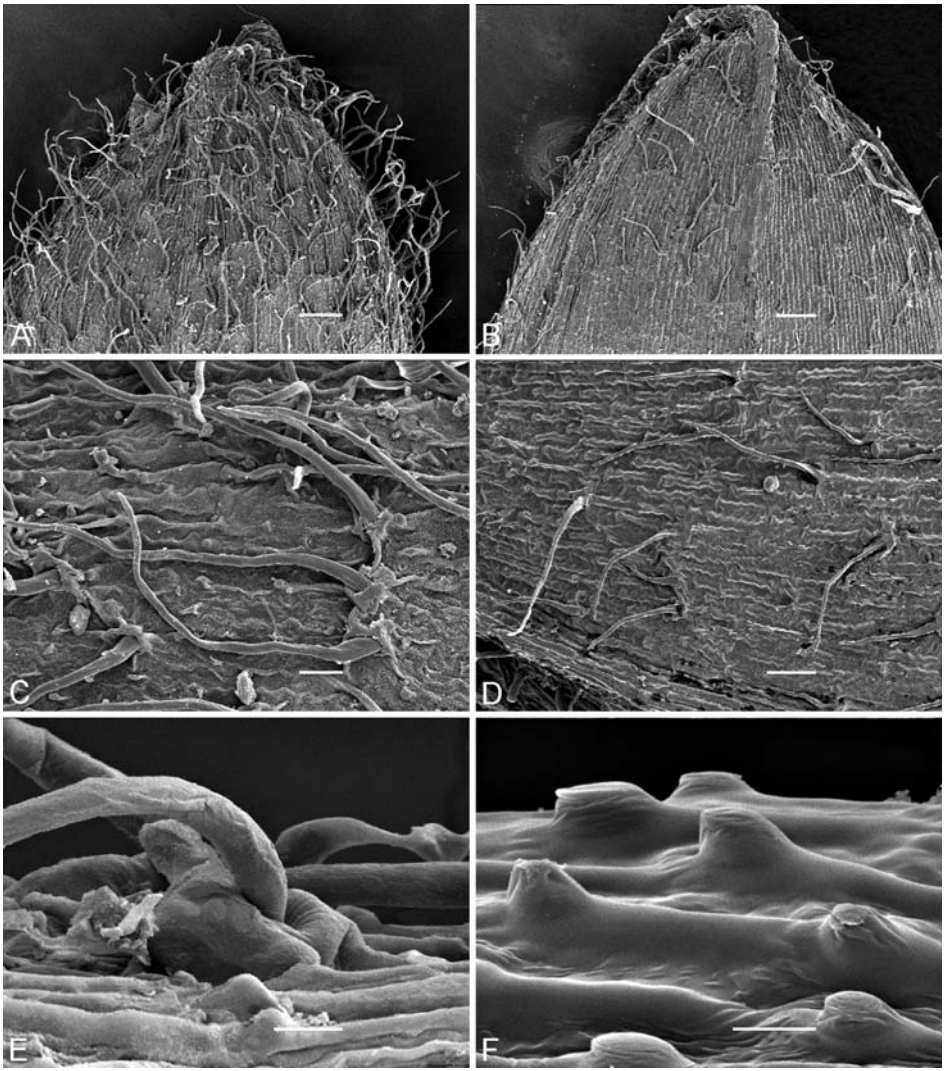

Fig. 2. Scanning electron micrographs. – A, C, E: *Paspalum quadrifarium* – spikelet tip (A); detail of hairs on upper glume (C); detail of bulbous-based hair (E); from *F. Verloove 6004.* – B, D, F: *P. exaltatum* – spikelet tip (B); detail of hairs on upper glume (D); detail of silica bodies on the upper floret (F); from *F. Garbari* 23.9.1966.

Genoa, Liguria (Barberis & Mariotti 1982). For detailed localities see Garbari (1966, 1972), Fig. 3 and the specimens seen.

Specimens examined. – Italy: Tuscany: Province of Pisa: Rigoli, sulle sponde del "Fosso", presso la stazione ferroviaria, sulla linea Pisa-Lucca, 23.9.1966, *F. Garbari* (FI); Orzignano, E of the village, secondary road towards Pappiana, ditch, locally common in this area, 19.6.2006, *F. Verloove 6341* (BR, herb. F. Verloove); Orzignano towards San Giuliano Terme, ditch, canal banks, locally common, 19.6.2006, *F. Verloove 6345* (BR, RO, herb. F. Verloove). — Liguria: Province of Genoa: Arenzano, località Terrarossa, 120 m, 9.4.1981, *G. Barberis & M. Mariotti* (FI).

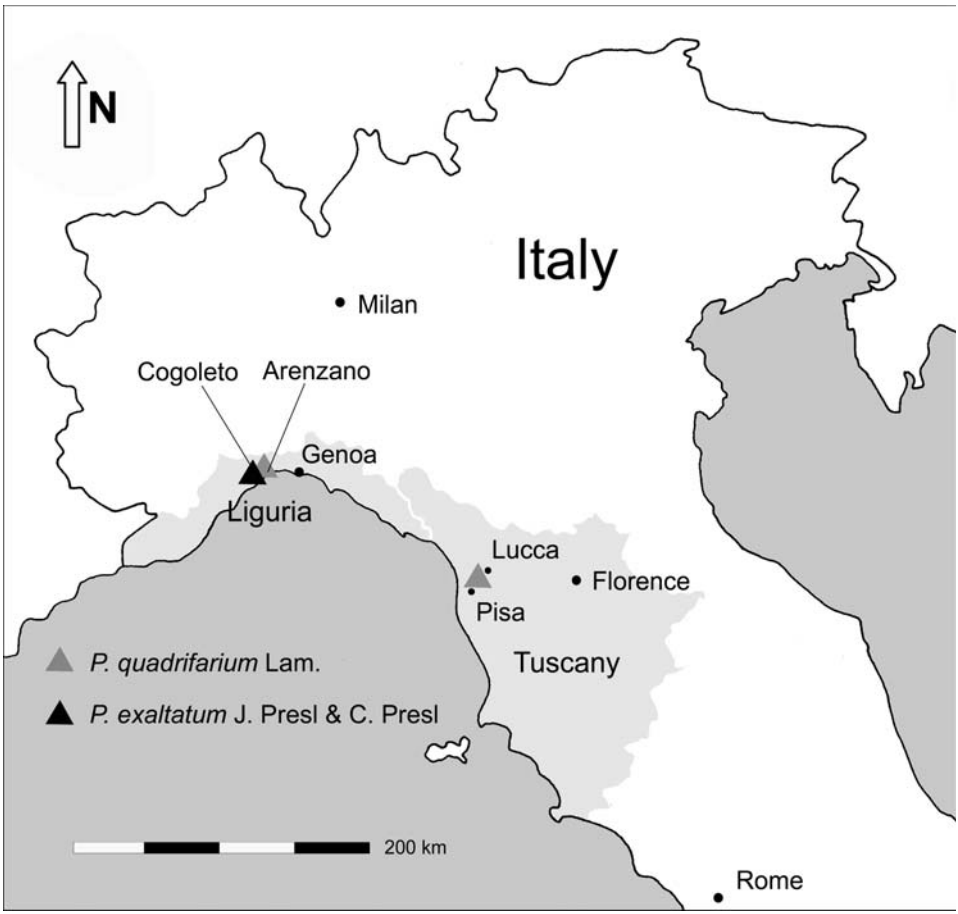

Fig. 3. Distribution of *Paspalum quadrifarium* and *P. exaltatum* in Europe.

Ecological notes

In its area of origin *Paspalum exaltatum* inhabits irrigated fields, river banks, lake shores and other moist habitats. It generally appears to be non-weedy. In Australia *P. exaltatum* is a rare and very local xenophyte of uncertain status; it is confined to coastal lowlands (Tothill & Hacker 1983).

Near Cogoleto *Paspalum exaltatum* usually grows along dry as well as moderately humid, undisturbed or only slightly disturbed roadsides. It is usually accompanied by native species such as *Dactylis glomerata*, *Dittrichia viscosa, Eupatorium cannabinum, Festuca arundinacea/pratensis* and *Holcus lanatus.* More rarely the species locally starts to penetrate adjacent pastures and orchards or even more or less ruderalized macchie.

Paspalum exaltatum seems to be a relatively recent introduction around Cogoleto, since its current distribution is concentrated primarily along one road over a distance of not more than five kilometres. At present the species is most abundant around Schiva, where monospecific stands are frequent and where it also grows along some small roads branched off. It doubtlessly is its initial area of introduction.

The mode of introduction of *Paspalum exaltatum* in Italy remains uncertain. As its area of naturalization is one with rather few antropogenous influences and no industrial activities, the

species most likely escaped from a garden. Surprisingly, it is not or unfrequently grown in Europe (see for instance Walters & al. 1984, Grounds 1989, Oakes 1990). In Argentina, *P. exaltatum* and *P. quadrifarium* are increasingly promoted for deliberate introduction. They are (among others) used for the restoration of natural prairies, dune fixation, control of erosion (Rúgolo de Agrasar & Puglia 2004).

In South America *Paspalum quadrifarium* prefers the same moist habitats as *P. exaltatum* (river banks, lake shores, moist fields). In addition it also grows in savannas on clay or sand. Outside its original range *P. quadrifarium* mostly grows in disturbed, unmown areas (Allen & Hall 2003, Jacobs & Wall 1993). Remarkably, its Italian ecological niche corresponds well with the native one since it is chiefly found along river banks (see Garbari 1972).

With its graceful stature *Paspalum quadrifarium* has some horticultural value and it is sometimes cultivated as an ornamental grass ("crown grass", "golden-top grass", "tussock paspalum" or "evergreen paspalum"), especially in the Americas. It is not treated as such for Europe by Walters & al. (1984). The origin of the Italian populations remains unclear so far; Garbari (1972) suggested several possibilities ranging from an unintentionally introduced grain alien to a garden escape.

In its native range *Paspalum quadrifarium* is only known as a weed in Uruguay (Holm & al. 1979). *P. quadrifarium* is – primarily outside its original distribution range – known for its reputed invasiveness, especially in Australia. In Sydney, for instance, it is a declared noxious weed that, once established, forms extremely dense infestations that outcompete native vegetation (Sydney Weeds Committees 2005). In Queensland *P. quadrifarium* inhabits humid coastal and subcoastal ranges, highlands and closed forests (Tothill & Hacker 1983).

In view of the invasive behaviour of *Paspalum quadrifarium* and the potential invasiveness of *P. exaltatum,* monitoring of the future spread of both taxa in Italy appears appropriate.

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