Neilreichia **4**: 51−73 (2006)

Notes on the *Bolboschoenus* species in Austria

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Abstract: Based on study of herbarium material, four species of the genus *Bolboschoenus* were found in Austria: *Bolboschoenus maritimus* s. str., *B. planiculmis (= B. koshewnikowii)*, *B. laticarpus* and *B. yagara*. The chromosome number $n = 55$ for *B. maritimus* s. str. is recorded (first Austrian record) in plants from two Austrian localities. The habitat characteristics of *Bolboschoenus* species in Austria correspond with those within the wider Central European region. The localities of *B. yagara* in Carinthia and in Styria (near Graz) represent the southern border of the distribution of this species in Central Europe so far known. – English with German summary.

Key words: *Bolboschoenus*, *Cyperaceae,* distribution, habitat differentiation, chromosome number, flora of Austria, flora of Central Europe.

Zusammenfassung: Anmerkungen zu den *Bolboschoenus*-Arten in Österreich.

Als Ergebnis einer Revision des Herbarmaterials in den Herbarien B, BP, BRA, BRNM, BRNU, GJO, GZU, KL, KRAM, LE, LI, M, P, PR, PRA, PRC, SAV, SLO, W, WU, Herbarium H. Melzer wurden vier Arten der Gattung *Bolboschoenus* in Österreich nachgewiesen: *B. maritimus* s. str., *B. planiculmis (= B. koshewnikowii)*, *B. laticarpus* und *B. yagara*. Von zwei österreichischen Fundorten wird erstmals die Chromosomenzahl $n = 55$ für *B. maritimus* s. str. festgestellt. Die Standortbedingungen der *Bolboschoenus*-Arten in Österreich entsprechen denen, wie sie aus den übrigen mitteleuropäischen Regionen bisher bekannt sind. Die Fundorte von *B. yagara* in Kärnten (bei Moosburg) und in der Steiermark (bei Graz) stellen den südlichen Rand des bisher bekannten Verbreitungsgebietes dieser Art in Mitteleuropa dar.

Introduction

Bolboschoenus maritimus (L.) Palla (≡ *Scirpus maritimus* L.) was frequently considered to be the only representative of the genus *Bolboschoenus* in Central Europe (e.g., Rothmaler 1982). Other authors recognised within *B. maritimus* two subspecies in this area, namely *B. maritimus subsp. maritimus* and *subsp. compactus* (Hoffm.) Hejný (e.g., Casper & Krausch 1980). However, further research discovered more detailed differentiation within this formerly broadly conceived species.

Browning & al. (1996) identified some herbarium specimens of *Bolboschoenus* from Germany as identical with the Asian *B. yagara* (Ohwi) Y. C. Yang & M. Zhan, and the other similar plants with wider fruits and some other intermediate characters they considered to be the "putative hybrid *B. maritimus* × *B. yagara*".

Consequently, differentiation of these taxa was accepted by some authors in Germany (Kiffe 1997, 2000, Gregor 1999) and in Austria (Hohla 2001, 2002). In some of the most recent German Floras, therefore, several taxa within *B. maritimus* s. lat. are considered: Jäger & Werner (2002) (*B. maritimus* and *B. yagara*); Senghas & Seybold (2000) (*B. maritimus*, *B. maritimus* × *B. yagara*, and *B. yagara*). The latter three taxa are also keyed in the taxonomic remark in the German "standard list" by Wisskirchen & Haeupler (1998: 100–101). Following the findings by Browning & al. (1996), *B. yagara* was found to be present also in the Czech Republic; this identification was based

on comparison with the type specimen of *B. yagara* from the herb. KYO (HROUDOVÁ & al. 2001, HROUDOVÁ 2002). The putative hybrid *B. maritimus* × *B. yagara* sensu BROWNING & al. (1996) appeared to be a stable taxon with distribution area and habitats differing from those of *B. yagara*, and was tentatively named *B. laticarpus* (HROUDOVÁ & al. 2001) and validly published by MARHOLD & al. (2004). In the Czech Republic, this taxon appeared to be most frequently distributed of all species of the genus *Bolboschoenus* (DUCHÁČEK 2002). Recently a lectotype was chosen for the name *Scirpus maritimus var. cymosus* Rchb. and this name belongs now into synonymy of *B. laticarpus* (MARHOLD et al. 2006).

The plants with head-like, "compact" inflorescence (*subsp. compactus* sensu CASPER & KRAUSCH 1980) also did not appear to be uniform: some plants with biconcave fruits were found to be identical with *B. planiculmis* (F. Schmidt) T. V. Egorova reported from the European part of the former USSR (EGOROVA 1976). They also appeared to be identical with *B. koshewnikowii* (Litv. ex Kots) A. E. Kozhevn. named by Litvinov and described in a paper by Kots from the European part of Russia (KOTS 1882), the earlier published name *B. planiculmis* having priority over *B. koshewnikowii*. Unequivocal determination of the type specimen of *Scirpus planiculmis* collected by Schmidt (deposited in LE) was not possible owing to the lack of fruits. Therefore, apart from the lectotype (from the original collection by Schmidt), also an epitype with well-developed fruits was selected by EGOROVA & TATANOV (2003) in order to fix the application of the name. This species was frequently found in the Czech Republic (HROUDOVÁ & al. 2001, DUCHÁČEK 2002), and herbarium specimens from other Central European countries are also known.

Bolboschoenus maritimus in the present interpretation (plants with flat-convex or biconvex fruits) represents a halophytic species occurring frequently in Europe, mainly in coastal areas and in inland saline habitats. Our understanding of this taxon and the use of this name are based on its recent lecto- and epitypification (SMITH & KUKKONEN 1999) and comparison of our material with an isoepitype specimen in herb. PR.

Apart from the taxa mentioned above, there is one more species of this group occurring in Europe, i. e. *B. glaucus* (Lam.) S. G. Sm.: Records of this taxon from Italy, Yugoslavia and Bulgaria were given by BROWNING & al. (1997). The occurrence of this species is concentrated to South Europe; the westernmost localities are in Portugal (river Tagus valley), the northern border of its continuous distribution is in Central Europe in Hungary (surroundings of the town of Szolnok). One isolated northernmost locality was found in Prague (Czech Republic); owing to the secondary character of the habitat, *B. glaucus* is considered to be introduced there (HROUDOVÁ & al. 1999b, HROUDOVÁ & al. 2001).

We studied ecology and biology of *Bolboschoenus maritimus* s. lat. for a long time; first comparing two subspecies (ZÁKRAVSKÝ & HROUDOVÁ 1994, 1996), later comparing four morphological types differentiated within the genus *Bolboschoenus* and corresponding with *B. yagara*, *B. laticarpus*, *B. planiculmis* and *B. maritimus* s. str. (HROUDOVÁ & al. 1999a). A more detailed determination of the distribution of these taxa in Europe (especially in Central Europe) together with their taxonomy and ecological characteristics are subjects of continuous study now; the preliminary results concerning the occurrence of

the species of *Bolboschoenus* in Austria and information on their European distribution area are presented here.

Material and methods

The data on distribution are based on study of herbarium material from the herbarium collections B, BP, BRA, BRNM, BRNU, GJO, GZU, KL, KRAM, LE, LI, M, P, PR, PRC, SAV, SLO, W, WU, herbarium H. Melzer and plants collected by the present authors (deposited in PRA). When the century was not given in the date of collection on the sheet, the supposed century is given in parentheses in the list of localities. As the determination of plants in flowering stage based on style branching and structure of inflorescence is not fully reliable, their determination was denoted "cf." and their localities are presented in separate lists. Nevertheless, we consider it necessary to list all these localities to complete the information on the possible distribution of the given species.

The quantitative values of the morphological characters presented here are based on measurements of plant samples from natural populations from the Czech Republic, Slovakia and Hungary, which were used in previous works (see HROUDOVÁ & al. 1998, 1999a, 2001).

Chromosome counting of *Bolboschoenus maritimus* s. str. was performed on meiotic chromosomes. For this purpose, young spikelets at the stage of emerging styles in the lower flowers were used. The tissue had to be slightly broken to speed up penetration of the fixative solution. The sampled material was fixed by a mixture of ethanol and acetic acid (3 : 1) and stained by lacto-propionic orcein. The gametic number (*n*) is given; owing to the possibility of agmatoploidy, that is changes in chromosome number due to fusions or fissions of holocentric chromosomes, occurring in the family *Cyperaceae* and probable hybridization within the genus *Bolboschoenus*, the somatic number does not need to be twice the gametic number in all cases.

Results

Common characters of *Bolboschoenus maritimus* s. lat.: Perennial plants with branched underground rhizome system bearing spherical to elongated tubers. Stems erect, trigonous. Inflorescence compound, consisting of sessile spikelets and sometimes also of spikelets on rays. The fruits are achenes with a pericarp consisting of sclerenchymatic endocarp and mesocarp and an exocarp formed by a single layer of cells (epidermis).

Identification key to the Austrian species of the genus *Bolboschoenus*

1a Inflorescence branched, formed by the central group of sessile spikelets and by (1–)2–7(–12) rays bearing single spikelets or their fascicles; rays mostly more than twice as long as the sessile spikelets; total number of spikelets on rays higher than or the same as the number of sessile spikelets; perianth bristles mostly persistent on ripe fruits; achenes triangular in cross-section, with the edge on the abaxial side (rarely nearly flattened or only slightly convex to subtrigonous on abaxial side);

exocarp thin, thinner than mesocarp, formed by isodiametric or slightly elongated cells not always filled with air; exocarp smooth or with a fine network of cell outlines (20× magnification) 2

b Inflorescence simple head-like or branched, formed by the central group of sessile spikelets and by 1–2(–4) rays bearing single spikelets or their fascicles; rays usually less than twice as long as the sessile spikelets; total number of spikelets on rays lower than the number of sessile spikelets; perianth bristles caducous; achenes not triangular in cross section, but concave or convex to subtrigonous on abaxial side; exocarp thicker than or as thick as the mesocarp, formed by elongated cylindrical cells always filled with air; exocarp with a well visible polygonal network structure of cell outlines (20× magnification) 3

2a Achenes narrow (1.6–1.8 mm wide), equilaterally triangular in cross-section; exocarp very thin and hardly visible, formed by more or less isodiametric cells .... *B. yagara*

b Achenes broad (2.0–2.4 mm wide), widely based triangular in cross-section (rarely nearly flattened or only slightly convex to subtrigonous on abaxial side); exocarp thin but visibly developed, formed by isodiametric to slightly elongated cells .... *B. laticarpus*

3a Achenes convex on the abaxial side, lenticular, plano-convex to subtriangular in cross-section; exocarp ± 2 times thicker than sclerenchymatic mesocarp; styles predominantly trifid ..... *B. maritimus*

b Achenes concave to flattened on the abaxial side, oval, concave or plano-concave in cross section; exocarp ± as thick as sclerenchymatic mesocarp, wider at the edges than on concave faces; styles predominantly bifid ..... *B. planiculmis*

Bolboschoenus yagara (Fig. 1*a*, *b*, *c*)

Bolboschoenus yagara (Ohwi) Y. C. Yang & M. Zhan, Acta Biol. Plateau Sin. 7 (1987): 14 (1988). – Syn.: ≡ *Scirpus yagara* Ohwi, Mem. Coll. Sci. Kyoto Imp. Univ., Ser. B 18: 110 (1944) ≡ *B. fluviatilis subsp. yagara* (Ohwi) T. Koyama, Acta Phytotax. Geobot. 31: 140 (1980).

Tubers reaching up to 3–4 cm in diameter. Plants 0.8–1.3(–1.6) m tall. In flowering shoots the leaf-bearing part of the stem highly prevails – upper leafless part takes usually (1/10–)1/5–1/4(–1/3) of total stem length. Inflorescence consisting of a central group of clustered, sessile spikelets and of (1–)3–7(–12) rays bearing usually 1–3(–5) spikelets; rays with one spikelet may be frequently present; rays mostly more than twice as long as sessile spikelets. Perianth bristles persistent up to maturity. Style always trifid. Achenes narrowly obovate to elliptic in outline, with well developed edge on the abaxial side; in cross-section pronouncedly nearly equilaterally triangular; surface of achenes smooth (at 20× magnification), dark brown to black at maturity. Pericarp with a very thin exocarp consisting of isodiametric cells only partly filled with air; mesocarp thick; ratio exocarp : mesocarp thickness 1 : 10 – 1 : 15.

Chromosome number: $n = 55$ (plants from Czechia: JAROLÍMOVÁ & HROUDOVÁ 1998).

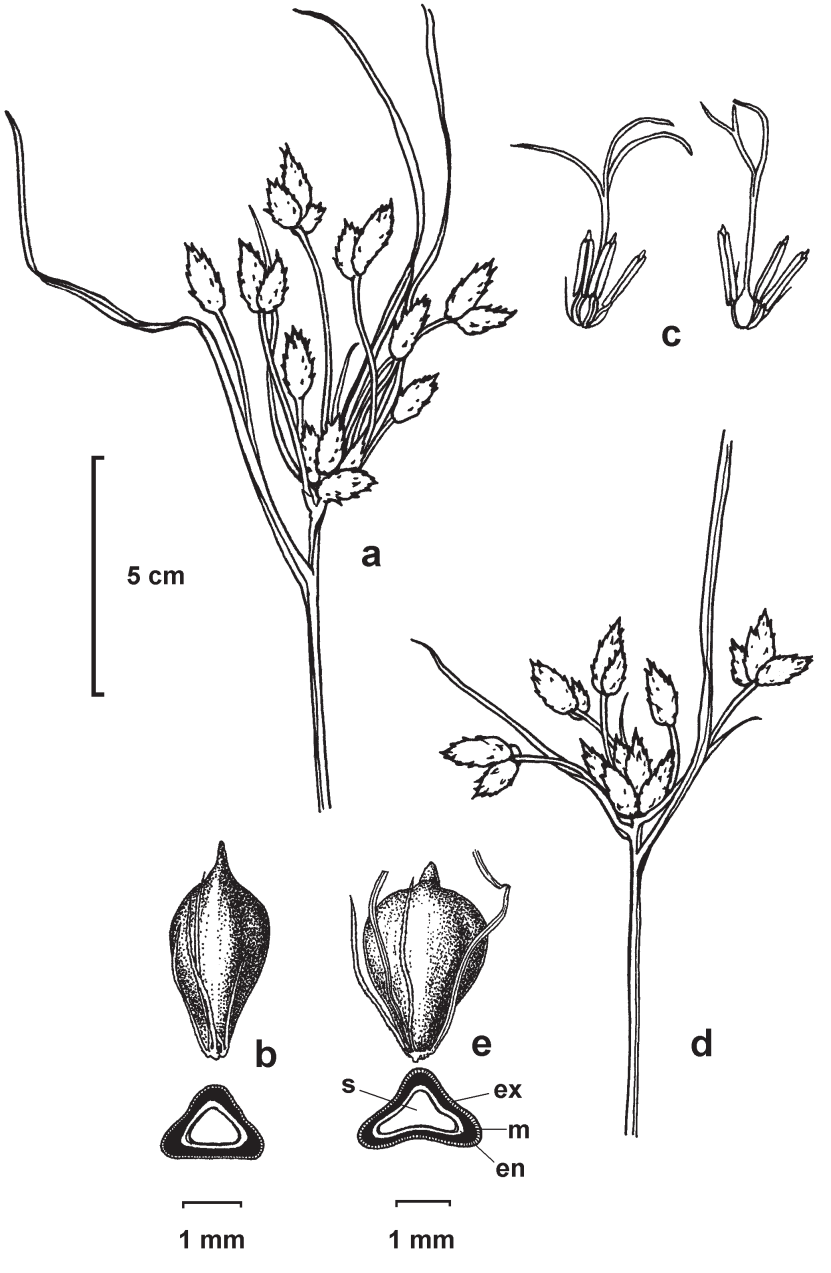

Fig. 1: *Bolboschoenus yagara* ***(a–c)*** and *B. laticarpus* ***(d–e)***: ***(a, d)*** inflorescence, ***(b, e)*** achene (abaxial side and cross section), ***(c)*** trifid styles. – *ex* exocarp, *m* mesocarp, *en* endocarp, *s* seed. (***a***, ***b***, ***d***, ***e*** orig. Z. HROUDOVÁ; **C** after DUCHÁČEK 2002.)

Abb. 1: *Bolboschoenus yagara* ***(a–c)*** und *B. laticarpus* ***(d–e)***: ***(a, d)*** Blütenstand, ***(b, e)*** Nuss (abaxiale Seite und Querschnitt), ***(c)*** dreispaltiger Griffel. – *ex* Exokarp, *m* Mesokarp, *en* Endokarp, *s* Same. (***a***, ***b***, ***d***, ***e*** Orig. Z. HROUDOVÁ; **C** nach DUCHÁČEK 2002.)

Variability. Plants are little variable in morphology and the main distinguishing characters (fruit shape and anatomy) are stable. The lowest ray in the inflorescence may in some cases be situated in the axil of the uppermost leaf, thus distant from the other rays. The number of sessile spikelets in the inflorescence is usually lower than the number of spikelets on the rays; in some cases only one sessile spikelet may be formed. Plants with an inflorescence containing only rays bearing one spikelet are identical with those described by DROBOV (1913) from Far East as *Bolboschoenus maritimus var. desoulavii*, sometimes classified also at species level. However, this character has no taxonomic value (see also TATANOV 2003). Formation of long catkin-like spikelets was never observed in this species.

Habitats and distribution in Europe. This species is typical of freshwater habitats: the littoral of standing waters (fishponds and other reservoirs). Its development is supported by fluctuation of water level: vegetative proliferation and spreading during the period of decrease of water level (on exposed fishpond/reservoir bottoms) followed by the formation of crowded stands in shallow water in the following year – frequently as a belt in front of reed stands. *Bolboschoenus yagara* is able to survive for several years under high water level only in the stage of dormant tubers; repeated decrease of water level induces their sprouting. The optimum of occurrence is on acid, nutrient-poor grounds, on muddy as well as sandy bottoms; only exceptionally it was found on alkalic ground (in S Moravia). Its resistance to manuring and liming of fishponds is limited – strong eutrophication leads to its disappearance.

The distribution of *B. yagara* in Europe is concentrated to Central Europe, especially to fishpond basins (S Bohemia, SW Poland, Upper Lusatia, Thuringia), and some other localities were also found separately on reservoirs in E and W Bohemia, N Moravia, S Poland (HROUDOVÁ et al. 2005). Its area of distribution in Europe reaches S Sweden, westwards France, some localities were also found in Ukraine and in the European part of Russia, from where its area of distribution continues through Siberia to Far East (TATANOV 2003). In Austria, *B. yagara* is certainly a rare species. It occurs predominantly in fishponds, similarly as in other Central European countries: it was found repeatedly in the surroundings of Graz (Styria), recently also in Carinthia (Strußnig-Teich near Moosburg, Sablatnigteich near Gösselsdorf), and in Weinviertel (in Lower Austria) near Poysdorf (see list of localities). Most recently *B. yagara* was found again in 2003 on the emerged bottom of the fishpond close to Herrnbaumgarten near Poysdorf (an excursion by M. A. Fischer, G. Fischer, Z. Hroudová, J. Danihelka), growing together with *B. planiculmis* and *B. laticarpus* (see frontcover), and recently also in Waldviertel. The finding of new localities is not excluded, because this species might be easily overlooked when it is sterile, and also owing to its fluctuating appearance.

Records of *Bolboschoenus yagara* in Austria

Vienna / Wien

Im Tümpel hinter der Maschinenfabrik beim Südbahnhof in Wien, 16.7.1837: Juratzka (W 1998-00960).

Lower Austria / Niederösterreich

Weinviertel: zwischen Poysdorf und Herrnbaumgarten am Grunde eines fast leeren Teiches, 18.8.1994: H. Melzer (Herb. Melzer); [together with *B. planiculmis*]; — Weinviertel, fishpond near the road from Poysdorf to Herrnbaumgarten, ca. 1 km SW of the village of Herrnbaumgarten, 6.8.2003: Z. Hroudová, J. Danihelka, M. A. Fischer, G. Fischer (PRA); — Waldviertel: Winklauer Teich, the fish pond near the road from Seyfrieds to Pfaffenschlag, ca. 2.5 km SE of the town of Heidenreichstein, 606 msm, 19.9.2005: Hroudová et Zákravský (PRA); — Waldviertel: Steinbruchteich, the fish pond near the road at NW border of the village Steinbruchhäuser, ca. 1.5 km ESE of the town of Heidenreichstein, 610 msm, 19.9.2005: Hroudová et Zákravský (PRA).

Styria / Steiermark

Graz: Botanischer Garten der Universität, Aug. 1896: s. coll. (PR); — bei Waltendorf bei Graz, Teiche, 10.9.1909: A. Fröhlich (BRNU 189915); — Wundschuh, in grosser Menge in einem aufgelassenem Teiche, 26.6.1932: B. Fest (W 2924, GZU 13699, 104107), B. Fest u. J. Genta, Flora stiriaca exsiccata no. 759; [sub *B. maritimus*]; — südlichster Wundschuh-Teich im ... [?] nächst Werndorf (A. Nr. 488), 12.7.1927: J. Eggler (GZU 104106); — südlichster Wundschuh-Teich (A. 488), 12.7.1927: J. Eggler (GZU 87818, 78945, 78946, 89637); — Teichboden (A. no. 490) des 3. Wundschuh-Teiches vom Süden, 12.7.1927: J. Eggler (GZU 78947); — unterer Teich von Wundschuh (Steierm[ark]), 5.6.1932: Herb. Salzmann (GZU 59718); [together with *B. planiculmis* from the locality Achau, Nieder-Öst[erreich], 16.7.1892]; — Wundschuh; in der Randzone des (abgelassenen) südlichsten Teiches, 20.6.1937: Schaeftlein (GZU 148664); — westl. Grazer Feld, Teichgraben bei Wundschuh, Poniglteich. Riedreste, 5. 7.1981: Ch. Scheuer (GZU [4 sheets with 3 fruiting plants]); — Graz-Umgebung, am nördlichsten Wundschuher Teich, 24.9.1957: W. Maurer (GJO 25804/128); — Wundschuh, s. dat.: R. Wagner (GJO 26232/1476, 26232/1473); [in the latter sheet together with *B. maritimus* (Italy, Caorle) and another indeterminable plant]; — südwestl. Preding, ehemalige ... [?] des Stainzbaches in ehemaligem Mündungsbereich des Oinitzbaches hinter Holzfabrik Leitinger, 24.7.1986: H. Otto (GJO 25698/1); — Leibnitzer Feld; Rabenhofteiche NE St. Veit am Vogau, Teichrand, 13.7.1992: E. Bregant (GJO 26204/68); — Sulzhof, 30.6.1973: R. Schiefermair (GJO 25343); — Steirisches Hügelland: Rabenhofteiche östlich von Leibnitz, Verlandungszone, um 270 msm, 7.7.1976: H. Mayrhofer, H. Teppner (GZU 225093, 225092); — Teich unter St. Andrä i/S[ausal], Teich unt. Dornegg b. Gr[oß St.] Florian, s. dat.: Toncourt (herb. J. Eggler) (GZU 87817); — Weststeiermark, bei St. Andrä im Sausal, Teichufer, 14.8.1991: W. Holzinger (GJO 26159/116); — Tümpel neben der elektr. Anlage beim unterst. südl. Waldschach-Teich, und bei der Ablaßschleuse des kl. Teiches neben der Straße unter der Wiestränke, s. dat.: Toncourt (herb. Eggler) (GZU 87814, 87815); — 8760/4, Ufer des größten Teiches (Badeteich) in Schielleiten, 11.7.1971: Pittoni (GZU); — Hohenberg b. Gleisdorf, Meierteich, 19.7.1925: Toncourt (herb. Eggler) (GZU 78944); — Hohenbergteich bei Gleisdorf, s. dat.: Toncourt (herb. Eggler) (GZU 87816).

Carinthia / Kärnten

Mittel-Kärnten, Klagenfurter Becken: am Boden des besommerten Strußnigteiches bei Tigring nördl. Moosburg, 19.9.1972: G. Leute (W 25939, KL 18265); — Südost-

Kärnten, Klopeiner Hügelland: Sablatnigteich (Tomarteich) W Gösselsdorf, 9. 1986: T. Rottenburg (KL 72983).

Bolboschoenus* cf. *yagara

Styria / Steiermark

Bei Wundschuh nächst Graz, abgelassener Teich, 13.6.1923: F. Buxbaum (W 27444); — bei Wundschuh nächst Graz, Teichufer, 6.6.1948: F. Höpflinger (W 22297); — Teiche bei Waltendorf bei Graz, Mai 1918: coll. Anonymus (Herb. F. Stippl) (GZU 13714); — Waltendorf bei Graz, am Abfluss eines Teiches, 6.5.1959: H. Melzer (Herb. Melzer).

Bolboschoenus laticarpus (Fig. 1*d*, *e*)

Bolboschoenus laticarpus Marhold, Hroudová, Zákravský et Ducháček Phyton (Horn) 44(1): 1–21, 2004; = *S. maritimus var. cymosus* Rchb., Fl. Germ. Excurs. 1: 79 (1830) ≡ *Bolboschoenus maritimus subsp. cymosus* (Rchb.) Soják, Čas. Nár. Mus., Odd. Přír. 141: 62 (1972). – Putative hybrid *B. maritimus* × *B. yagara* sensu BROWNING & al. (1996). – *B. yagara* × *B. koshewnikowii* in Kubát et al., Klíč ke květ. ČR: p. 795 (2002).

Tubers of (1.5–)2–3 cm in diameter. Plants usually (0.3–)0.7–1.1(–1.5) m tall. In flowering shoots the upper leafless part of the stem takes about 1/3 of total stem length. Inflorescence consisting of a central group of (1–)2–7(–13) clustered, sessile spikelets and of (1–)2–5(–7) rays bearing fascicles of 2–4(–8) spikelets, more rarely single spikelets. Perianth bristles persistent up to maturity, sometimes caducous. Style trifid, frequently also flowers with bifid styles present in the same inflorescence. Achenes obovate to broadly obovate in outline, narrowed at base, trigonous, on the abaxial side with a low edge which may be sometimes nearly round; widely based triangular in cross-section; surface of achenes smooth (at 20× magnification), sometimes faint cell outlines detectable as a fine network (depending on the development of exocarp layer), dark brown to black at maturity. Exocarp thin, consisting of a layer of isodiametric to slightly elongated cells filled with air; ratio exocarp : mesocarp thickness ca. 1 : 3.

Chromosome numbers: $n = 54, 55$ (plants from Czechia, Slovakia, Hungary and the Netherlands: JAROLÍMOVÁ & HROUDOVÁ 1998).

Variability. The structure of inflorescence of *B. laticarpus* varies mostly in the number of rays and spikelets on rays. Some rays may bear only one spikelet, but the fascicles of spikelets on rays usually prevail. In most cases, the number of sessile spikelets in the inflorescence is nearly the same or a little lower than the number of the spikelets on rays. The development of the inflorescence is influenced by nutrient supply; poor nutrient supply limits the development of rays and spikelets on rays. Formation of long spikelets (>2 cm) is relatively rare.

Plants may vary in the proportion of the flowers with bifid styles in the inflorescence, sometimes only trifid styles are present; individual populations may differ in this character. A small proportion of achenes being nearly flat or only slightly convex on abaxial side may be present in the same inflorescence, corresponding with the presence of flowers with bifid styles. Sometimes, somewhat narrower fruits are formed, resembling

those of *B. yagara*, but with deeper exocarp layer (hybridisation between these two taxa is not excluded). Perianth bristles are sometimes partly caducous (see frontcover).

Habitats and distribution in Europe. *Bolboschoenus laticarpus* is a freshwater plant, occurring in slowly running as well as in stagnant water, in meso- to eutrophic habitats. It has in this sense a wide ecological amplitude and, consequently, it inhabits the widest range of habitats of all other European species of *Bolboschoenus*. This species occurs in littorals of standing waters (fishponds, dam reservoirs, flooded sand pits etc.), in oxbows, channels, on river shores, and also in temporarily flooded field depressions and wet ditches, on fields and meadows. The formation of its crowded littoral stands is conditioned by fluctuations of water level (temporary drainage of the bottom); on the other hand, the species is able to survive unfavourable periods (drought or high water level) in the stage of dormant tubers. At present, *B. laticarpus* is also frequently found as a weed in crop fields, similarly like *B. planiculmis.*

Within its distribution area in Europe, the occurrence of *B. laticarpus* is concentrated to river floodplains in inland regions, e.g., along the rivers Seine, Main, Elbe (Labe), Odra, Vistula, Danube, Tisza and their tributaries, where it may be relatively frequent (Hroudová et al. in prep.). Westwards it reaches France, the northernmost localities are in Estonia and Sweden, in S Europe it was found in Bulgaria and Romania, and eastwards single localities were found in the souther part of European Russia.

In Austria, *B. laticarpus* was found in localities along rivers (which is typical for this species) and also in some habitats of secondary character. The localities so far known are few, but further reports may be expected especially in river floodplains. The most recent locality dates from 2003 in the fishpond between the villages Poysdorf and Herrnbaumgarten (Weinviertel), together with *B. yagara* and *B. planiculmis*.

Records of *Bolboschoenus laticarpus* in Austria

Upper Austria / Oberösterreich

Neu gestaltete Enns-Insel westl. Haidershofen, 1 ca. 20 m^2 großer Trupp, seit letztem Jahr, 24.7.1993: F. Essl (LI 136985) [this population no longer exists: E. Hauser, pers. comm.]; — Innviertel, Mehrnbach, Schottergrube bei Gigling; in Lachen ein kleiner Trupp, 530 msm, 11.8.2002: M. Hohla (LI 506728); — Innviertel, Mühlheim am Inn, Gimpling, Gaishofer Auen, S-Rand, am Teichrand, 340 msm, 23.8.2001: M. Hohla (LI 460906, 459902).

Lower Austria / Niederösterreich

Weinviertel: the fishpond near the road from Poysdorf to Herrnbaumgarten, ca. 1 km SW of the village of Herrnbaumgarten, 6.8.2003: Z. Hroudová, J. Danihelka, M. A. Fischer, G. Fischer (PRA); — Marchtal: am Rande eines Tümpels der March oberhalb Stillfried, 13.8.1922: [E.] Korb (W 2821); — Pulkautal, ... [?] N[ieder]oe[sterreich], 27.8.[19]02: J. Schneider (W 3310); — Tulln, 160 msm, 1873: Fürst (PR); — bei W[iene]r Neustadt, 234 msm, 20.6.1912: A. Fröhlich (BRNU 191106); — W[iene]r Neustadt, Fischau-bach[b]et[t] [?], 25.8.1916: H. Kuber (W 11335); — [Bad] Fischau, N[ieder]oe[sterreich], 18.9.1905: J. Schneider (W 3314).

Records of *Bolboschoenus* cf. *laticarpus*

Vienna / Wien

Heustadelwasser i. Prater, Juli 1879: Heimerl (LI 243870).

Lower Austria / Niederösterreich

In aquis Kanal, Juni 1844: s. coll. (W 23785), [in the sheet mixed together with *B.* cf. *planiculmis*]; — [Bad] Fischau, 5.7.1918: F. Wimmer (W 16319); — Wiener Neust[ädter] Kanal, Juli [18]71: F. Höhnel (LI 243887).

Bolboschoenus planiculmis (Fig. 2*c*, *d*, *e*)

Bolboschoenus planiculmis (F. Schmidt) T. V. Egorova Rast. Centr. Azii 3: 20 (1967). – Syn.: ≡ *Scirpus planiculmis* F. Schmidt, Reis. Amur-Land, Bot. 190 (1868); = *S. koshewnikowii* Litv. ex Kots, Bull. Soc. Nat. Mosc. 57: 220 (1882) ≡ *Bolboschoenus koshewnikowii* (Litv. ex Kots) A. E. Kozhevn., Sosud. Rast. Sovet. Dal'nego Vostoka 3: 189 (1988).

Tubers mostly small, 0.5–1.5 cm in diameter. Plants (0.2–)0.5–0.9(–1.1) m tall. On flowering shoots the upper leafless part of the stem takes usually 1/3–1/2 (or even more) of the total stem length. Inflorescence head-like, consisting either of only sessile spikelets, or formed by a central group of 3–7(–11) clustered, sessile spikelets and 1–2(–4) rays bearing single spikelets or fascicles of 2–3(–5) spikelets. Perianth bristles caducous. Style bifid, rarely also some flowers with trifid styles present in the same inflorescence. Achenes obovate to broadly obovate in outline, 3.1–3.8 mm long, 2.2–2.5 mm wide, concave on the abaxial side; in cross-section biconcave to flat-concave with edges radially elongated; rarely, achenes convex on dorsal side may develop from the flowers with trifid styles. The surface of the achenes shows a well visible polygonal network structure (cell wall outlines depressed), ochre or light- to rusty brown at maturity. Exocarp well developed, consisting of cylindrical cells radially elongated and filled with air. Ratio exocarp : mesocarp thickness ca. 1 : 1, exocarp layer wider over angles than on concave faces.

Chromosome number: $n = 54$, only exceptionally 55 (plants from Czechia and Slovakia: JAROLÍMOVÁ & HROUDOVÁ 1998).

Variability. Plants variable in structure of the inflorescence from simple head-like (in some cases also formed by only one spikelet) to branched with several rays. The length of rays and spikelets may vary as well, being influenced by habitat conditions; in some cases, very long spikelets may be formed (more than 2 cm – "macrostachys morphotype"). Apart from flowers with bifid styles also some flowers with trifid styles may be present in the same inflorescence and even in one spikelet. Some fruits may be very slightly concave to flat on the abaxial side and exceptionally some fruits convex to subtrigonous on abaxial side may be found; the shape of fruits corresponds with the number of style branches – convex fruits originating from flowers with trifid styles.

Habitats and distribution in Europe. *Bolboschoenus planiculmis* inhabits most frequently temporarily flooded field depressions (meadows, fields), wet ditches and other secondary habitats (sand pits). Sometimes it is found on fishpond shores and river ox-

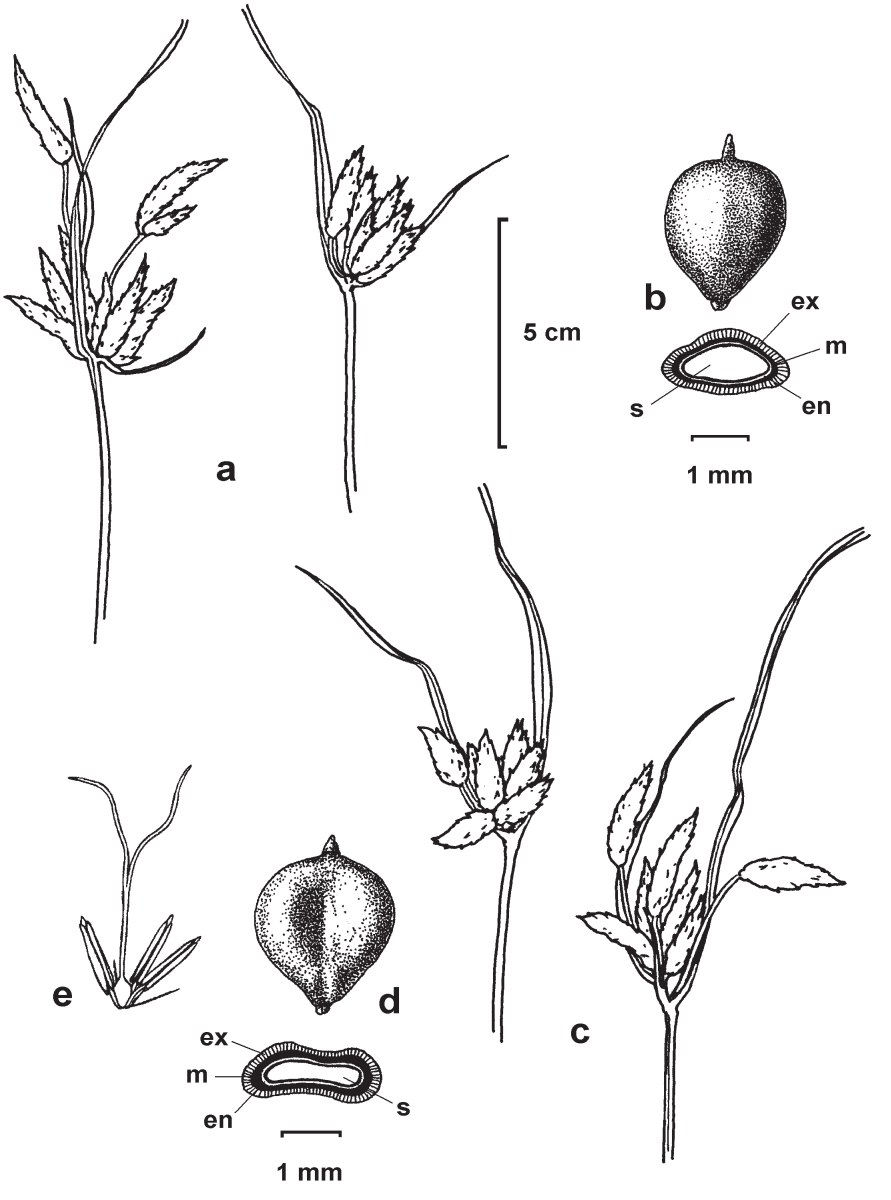

Fig. 2: *Bolboschoenus maritimus* ***(a, b)*** and *B. planiculmis* ***(c–e)***: ***(a, c)*** inflorescence, ***(b, d)*** achene (abaxial side and cross section), ***(e)*** bifid style. – *ex* exocarp, *m* mesocarp, *en* endocarp, *s* seed. (***a–d*** orig. Z. HROUDOVÁ; ***e*** after DUCHÁČEK 2002).

Abb. 2: *Bolboschoenus maritimus* ***(a, b)*** und *B. planiculmis* ***(c–e)***: ***(a, c)*** Blütenstand, ***(b, d)*** Nuss (abaxiale Seite und Querschnitt), ***(e)*** zweispaltiger Griffel. – *ex* Exokarp, *m* Mesokarp, *en* Endokarp, *s* Same. (***a–d*** Orig. Z. HROUDOVÁ; ***e*** nach DUCHÁČEK 2002).

bow lakes, but it usually does not form extensive littoral stands there. It occurs mostly in warm lowlands, on mineral-rich grounds, and is persistent also in slightly saline habitats. In warmer regions, it was found as a weed in rice fields. At present, *B. planiculmis* becomes an undesirable weed also in Central Europe, mainly in maize fields. Its survival under terrestrial conditions is enabled by the ability of underground tubers to persist in dormant state for unfavourable dry periods (even for several years).

The distribution of *B. planiculmis* in Europe corresponds with its ecological character as a steppe plant: its occurrence is concentrated to lowlands of Central Europe (Czech Republic, Slovakia, Austria, Hungary), westwards it reaches the Lake of Neuchâtel in Switzerland, the northernmost localities are in N Poland and Lithuania, in S Europe it occurs in Romania (with the exception of the Carpathian Mountains), in Macedonia, Italy, Bulgaria and Moldova, and eastwards it ranges through the steppe zone of the Ukraine to S Russia (HROUDOVÁ et al. in prep.). In Russia, the continuous distribution area of *B. planicumis* ranges from the European part through Siberia to the Far East (EGOROVA & TATANOV 2003). Its occurrence in Austria is concentrated to lowland regions – Lower Austria (Niederösterreich) and Burgenland – where it inhabits a wide range of habitats (ponds, wet meadows, channels, temporarily flooded field depressions), in some cases in the same localities with *B. maritimus*.

Records of *Bolboschoenus planiculmis* in Austria

Vienna / Wien

Sieveringer Teiche, 6.8.1878: G. Beck (PRC); — Wien, 14-19 [?], J. Ortmann (BRNU 336051); — Wien, s. dat.: J. Ortmann (BP 34343, 34967); — Wien, ad margines fossarum, s. dat.: J. v. Kovács (BP 34301, 34303, 34312); — Dolní Rak., Prátr u Vídně [Wien], 6. 1878: Fleischer (PR).

Lower Austria / Niederösterreich

Weinviertel: zwischen Poysdorf und Herrnbaumgarten am Grunde eines fast leeren Teiches, 18.8.1994: H. Melzer (herb. Melzer), [on the sheet mixed together with *B. yagara*]; — Weinviertel: the fishpond near the road from Poysdorf to Herrnbaumgarten, ca. 1 km SW of the village of Herrnbaumgarten, 6.8.2003: Z. Hroudová, J. Danihelka, M. A. Fischer, G. Fischer (PRA); — Wiener Becken, 1,5 km SW von Moosbrunn, Feuchtwiese, 184 msm, 16.9.1997: W. Till (WU); — Ziegelwerk östl. Mödling, N[ieder]oe[sterreich], 4.9.[19]05: J. Schneider (W 3313); — NE Weinviertel: 9.5 km NNW von Hohenau; E des Ortes Bernhardsthal zwischen Bahn u. Ort, großer Teich, feinsandiges Ufer, dom. *Bolboschoenus maritimus*, submers *Ceratophyllum demersum*, 160 msm, 26.8.1992: J. Walter (LI 394930, 394929); — Marchfeld, Sumpfwiesen zwischen Stadt und Lacherhof Marchegg, 5.7.1917: J. Vetter (W 9171); — Marchfeld, Sumpfwiesen bei Lassee, 29.6.1921: J. Vetter (W 9167); — Marchfeld, auf Sumpfwiesen bei Lassee, 29.6.1921: J. Vetter (W 2818); — Baumgarten a. d. March; N[ieder] oe[sterreich], 15.9.[19]05: J. Schneider (W 3326); — in Getreidefeldern bei Marchegg, 7.7.1895: K. Fritsch (GZU 14120); — oxbow lake of the Dyje river [Thaya] on the Austrian border (between Bernhardsthal and Lanžhot), 4 km NE of the village of Bernhardsthal, 11.9.2004: W. Lazowski (PRA).

Burgenland

W of Neusiedler-See: temporarily flooded field depression by the road to Oggau, ca. 3 km N of the village of Oggau, 31.8.1999: Hroudová, Zákravský & Moravcová (PRA); — Neusiedler-See-Gebiet: Seewinkel, nordöstlich von Wallern im aufgelassenen Teil einer Sandgrube am Ufer eines Tümpels ein Bestand, 11.10.2001: H. Melzer (LI 447860); 10.10.2001: H. Melzer (KL 102282); — Kittsee, 29.8.1880: Jos. Eschfaeller (LI 086422) [on the sheet together with *B.* cf. *maritimus* from St. Georgen bei Press-<burg].

Records of *Bolboschoenus* cf. *planiculmis*

Vienna / Wien

In Wassergräben im Prater, Juni 1872: L. Frank (LI); — Prater, 29.6.1881: W. Steimayer (BRNM 57316); — am Abfluss des Konstantin-Teichs im Prater, 17.6.1879: A. Heimerl (LI 243882); — H[äu]f[i]g an einem Wassergraben beim Konstantin-Hügel im Prater: Juni 1879, [A.] Heimerl (LI 243871); — Prater, 29.6.1881: F. Ostermeyer (B); — Wien, ad margines fossarum, s. dat.: J. v. Kovács (B); — Rodaun bei Wien, 19.8.1876: P. A. Dichtl (W 8881); — Wien, Breitensee, im Bahnbereich, an Abwassergrube, 203 msm, 18.6.1967: W. Forstner (W 14717); — Wiener Kanal, s. dat.: J. Peterstein (PR 506343); — in aquis, Kanal, Juni 1844: s. coll. (W 23785); [on the sheet mixed together with *B.* cf. *laticarpus*]; — an der Alten Donau und am Franz-Josef-Kai [?] in Wien, 21.8.1907: E. Korb (W 2808); — am Wien-Neustädter Kanal bei Wien, 1832: Haftner (BP 479234).

Lower Austria / Niederösterreich

Sooß, 29.7.1904: s. coll., ex Herb. Steinbach (LI, LI 79/118, 170/73, 169/73, 218/73, 219/73); — Angern, 3.7.1904: s. coll., ex Herb. Steinbach (LI 172/73); — Marchtal, 3 km SE von Drösing, Liliensee, Sandgrubengelände am Nordufer, Schlammflur, ca. 150 msm, 13.8.2000: Ch. Dobeš (LI 416939); — Breitensee im Marchfeld, 26.8.1894: A. Teyber (WU); — bei Laxenburg, s. dat.: s. coll. (LI 243780); [on the sheet together with *B.* cf. *maritimus* from Reichliesingthal]; — Vöslau, Teichufer, 5.8.1923: K. Ronniger (W 20871); — in den Leitha-Sümpfen bei Hollern in Niederösterreich, Juli 1887: C. Amt (W 19054); — Achau, 16.7.1892: herb. Salzmann (GZU 59718); — salzhaltige Sumpfwiesen bei Gallbrunn (an der Bahnstrecke nach Bruck a. Leitha), 26.8.1959: D. Podlech (M 80328).

Burgenland

Neusiedler See, s. dat.: herb. H. Rippel (KL 79168); — Neusiedler-See-Gebiet: Seewinkel, nordöstlich von Wallern im aufgelassenen Teil einer Sandgrube, Ufer eines Tümpels, ein Bestand, 10.10.2001: H. Melzer (KL 102281).

Carinthia / Kärnten

Mittel-Kärnten: Seebach bei Villach, E d. Seebachs (Fahrradweges), 600 m W Kote 487 (beim Magdalenensee), Brachacker; NE Arnoldstein, 19.6.1994: W. Franz (KL 087606, 087607, 087608, 087609, 087610).

***Bolboschoenus maritimus* s. str.** (Fig. 2*a*, *b*)

Bolboschoenus maritimus (Linnaeus) Palla in Hallier et Brand, Syn. Deutsch. Schweiz. Fl., ed. 3, 3: 2532 (1905). – Syn.: ≡ *Scirpus maritimus* L., Sp. Pl. 51 (1753); = *S. compactus* Hoffm. Deutschl. Fl. 25 (1800) ≡ *Bolboschoenus maritimus subsp. compactus* (Hoffm.) Hejný in Dostál, Květ. ČSR 1844 (1950).

Tubers (1–)2–3 cm in diameter. Plants (0.3–)0.7–1(–1.5) m tall. In flowering shoots the upper leafless part of the stem takes usually 1/3–1/2 of total stem length. Inflorescence either head-like, consisting only of clustered, sessile spikelets, or formed by a central group of sessile spikelets and of 1–2(–4) rays each bearing 1–4(–5) spikelets. Perianth bristles caducous. Style trifid, but frequently also some flowers with bifid styles present in the same inflorescence. Achenes elliptical, obovate to broadly obovate in outline, on abaxial side round or with round edge, sometimes lenticular; oval, flat-convex to subtrigonous in cross-section; surface of achenes with a well visible polygonal network structure on surface (cell wall outlines depressed), mostly medium- to rusty brown, rarely dark brown at maturity. Exocarp thick, consisting of cylindrical cells radially elongated and filled with air; ratio exocarp : mesocarp thickness ca. 2 : 1.

Chromosome number: $n = 54, 55$ (prevailing 55, in counts on plants from the Czech Republic, Slovakia, Hungary, the Netherlands, Poland and Sweden, see JAROLÍMOVÁ & HROUDOVÁ 1998).

Only $n = 55$ was found in plants from the following Austrian localities: Burgenland, E of Neusiedler See: near St. Andrä, flooded sand pit by the road W of the village of St. Andrä am Zicksee, behind crossing with railway line, collected by Z. Hroudová, P. Zákravský & L. Moravcová in 1999 (PRA); — W of Neusiedler See: temporarily flooded field depression by the road to Oggau, ca. 3 km N of the village of Oggau, collected by Z. Hroudová, P. Zákravský & L. Moravcová in 1999 (PRA). According to our evidence, these are the first data on chromosome numbers of *B. maritimus* s. lat. for the area of Austria.

Variability. *Bolboschoenus maritimus* is a very variable species especially in the following characters:

(1) Number and length of spikelets in inflorescence: The inflorescence structure may vary from head-like with only sessile spikelets (an extreme case is only one sessile spikelet – frequently being denoted as *f. monostachys*) to plants with branched inflorescence with relatively long rays bearing 2–4 spikelets. The inflorescence with only one spikelet is very frequent in young plants (the seedlings flowering for the first time), or under water or nutrient shortage. In other cases, plants may form very long catkin-like spikelets (more than 2 in length, sometimes to 4 cm), usually with a great proportion of sterile flowers. The length of the spikelets depends on habitat conditions and weather course – variations were observed among localities, and also from year to year in plants at the same locality. Nevertheless, the tendency to produce long spikelets was observed to be stronger in some populations, which indicates possible influence of genotype.

(2) Shape of fruits: fruits are variable in shape among populations and within populations; apart from round or subtrigonous achenes also some achenes on dorsal side nearly flat to only slightly convex may be found in the same infructescence. In many cases, this corresponds with the presence of flowers with trifid and bifid styles – flat fruits

originate from the flowers with bifid styles (this relationship, however, is not so clear as in *B. planiculmis* owing to continuous variation in fruit shape from nearly flat to highly convex in *B. maritimus*). Also the thickness of exocarp layer may vary; the ratio exocarp : mesocarp thickness varies from 2 : 1 to ca. 1 : 1.

Habitats and distribution in Europe. *B. maritimus* s. str. is a typical plant of saline habitats. It occurs on sea coast as well as in inland salt lakes, on temporarily flooded field depressions, in wet saline grasslands and also in secondary habitats arisen on the sites of former saline vegetation or in stands originated as a result of degradation process (sand- or clay-pits, wet depressions in fields or meadows).

It is widely distributed in Europe nearly along the whole sea cost (except of northern parts of Scandinavia). In inland areas the distribution is concentrated to Hungarian plains with salt summer drying lakes and to saline habitats around great lakes (Balaton and Neusiedler See), relatively frequently it occurs also in lowlands in Germany (Hroudová & al. 2005). Eastwards, the distribution of *B. maritimus* reaches the European part of Russia, and an isolated area is in Siberia (surroundings of the town Barnaul). *B. maritimus* was found to be the most frequently collected species of *Bolboschoenus* in Austria: its occurrence is concentrated to the surroundings of Neusiedler See, predominantly on saline habitats.

Records of *Bolboschoenus maritimus* s. str. in Austria

Vienna / Wien

Donau-Auen SE von Wien, Untere Lobau: Westufer Kühwörter Wasser nahe der Mühlleitner Furt in Verlandungs-Zone, 150 msm, 22.7.1996: Potter Dods (LI 389539); — ad marginem fossarum, s. dat.: J. v. Kováts (W 8877); — 10. Bezirk, Wienerberg, N-Rand des Erholungsgeländes „Ziegelteiche" am Ostrand der Triester Straße, kleine versumpfte Senke, 200 msm, 19.7.1996: W. Till (WU); — nasser Wiesengraben bei Kaisereb ersdorf, 19.8.1929: M. Prelinger (B); — am Canal bei Simmering, 20.8. [18]78: M. F. Müllner (KL 95554).

Lower Austria / Niederösterreich

Am See von Breitensee im Marchfeld, 16.9.1888: [G.] Beck (PRC); — Marchtal, an nassen Stellen in Wiesen an der March zwischen Zwerndorf und Angern, 31.7.1921: [E.] Korb (W 2820); — bei Wilfleinsdorf, 19.7.1909: Herb. Steinbach (LI 220/73); — bei Korneuburg, September 1893: [G.] Beck (PRC); — Ebersdorf, 1.10.1878: P. Jos. Wiesbauer (BRNU 123077); — in den Ziegelofenlachen beim Schafhofe zw. Baden und Vöslau, a. 1883: H. Nöthig (W 10258); — Wienerwald, am Ufer des Wienflussreservoirs bei Tullnerbach, 13.7.1913: [E.] Korb (W 2807); — Wiener Becken, Feuchtgebiet SE von Oberwaltersdorf, WSW vom Grillenbühel, ehemalige Feuchtwiese, 210 msm, 12.8.1998: W. Till (WU); — Wiener Becken, 1,5 km SW von Moosbrunn, Feuchtwiese, 184 msm, 16.9.1997: W. Till (WU); — zwischen Fischau u. W[iene]r Neustadt, Juni 1863: Sonklar (SLO); — zwischen Mödling und Laxenburg, 23.9.1923: K. Ronniger (W 20870); — Laxenburg, 2.10.1888: Dichtl (W 15182); — Aspern b. Wien, sumpfige Orte, September 1904: Arbesser (GZU 31060); — auf einer kleinen Halbinsel hinter der Militär-Schiessstätte an der Reichsstrasse bei Wien, 11.9.1895: K. Fritsch (GZU 14127);

[this plant has some fruits of intermediate character between *B. maritimus* and *B. planiculmis* similarly to the specimen No. 14126, but it is closer to *B. maritimus*]; — Schönauer Teich, 17.8.[19]63: R. Schiefermair (GJO 25343); — Moosbrunn, 1935: R. Wagner (GJO 26232/1469); — an Wassergräben bei Kottingbrunn, [locality Sievering], Juli 1871: [K.] Ronniger (PRC).

Burgenland

Sine loco, Juli 1956: H. Bach (KL 83964); — Ufer des Neusiedlersees bei Neusiedel (in der Nähe des Badhauses), 1864: J. Kerner (GZU 3800); — Neusiedler See, September 1922: H. Fischer (B); — Neusiedler See, 26.6.1910: F. v. Frimmel (BRNU 309607); — prope pagum Neusiedel a/See, Leithagebirge, 21.8.1935: J. Nevole (BRNU 269750); — Neusiedl a./See, břehy jezera, 19.8.1929: K. Ptačovský (SAV); — Neusiedlersee, 25.6.1960: B. Weinmeister (LI 79/4159); — Neusiedlersee, s. dat.: s. coll. (LI 856891); — Nezider, September 1936: V. [Nábělek] (SAV); — Nezider, September 1936: [V.] Nábělek (SAV); — Neusiedl, September 1936: V. Nábělek (SAV); — Neusiedlersee, Nordende, 1.7.1906: K. Ronniger (W 20860); — Rust a. Neusiedlersee, Schilfgürtel beim Campingplatz, 5.9.[19]78: s. coll. (LI 856890); — Neusiedlersee bei Rust, 13.?. 1881[3]: A. Scherfel (SAV); — Neusiedlersee-Westufer bei Rust, Verlandungszone, 13.6.1983: A. Aron, E. Bregant (GJO 25509/6); — W of Neusiedler See, temporarily flooded field depression by the road to Oggau, ca. 3 km N of the village of Oggau, 31.8. 1999: Z. Hroudová, P. Zákravský & L. Moravcová (PRA); — Bei Podersdorf am Neusiedlersee, Strandterrasse, 5.8.1960: A. Rüttner (LI); — Podersdorf a. Neusiedlersee, 8.8. 1961: A. Lonsing (LI 51145); — Podersdorf, 21.6.[19]50: R. Schiefermair (GJO 25343); — na wsch. brzegu jeziora Neusiedler See, Podersdorf, koło Neusiedl am See, 29.6.1969: J. Mądalski (KRAM 465457, 465456); — Neusiedlersee, Salzsee südlich Podersdorf, 28.9.1947: Göpflinger (GZU); — Neusiedlersee, bei Apetlon an der Mosado-Lacke, Wassergraben, 4.9.1954: H. Melzer (Herb. Melzer); — Seewinkel, [zw.] Pamhagen u. Apetlon, Tegelufer-Lacke, 3.9.1922: K. Ronniger (W 20868); — Seewinkel, bei der Scerdahelyer Lache 4,5–5 km E (–ENE) Apetlon, 118 msm, 6.7.1993: F. Tod (WU); — Seewinkel, SW-Ufer v. Kirchsee, W v. Illmitz, zw[ischen] Schilfgürtel u. *Crypsis aculeata*-Reinbestand, kleine Herde bildend, 119 msm, 14.10.1990: J. Walter (WU, LI 170907, 382211); — Illmitz, Kirchsee, ausgetrockneter Boden eines Zicksees, Solontschak, community: Suaedetum prostratae, 10.10.1992: L. Mucina (WU, LI 367582); — Neusiedlersee bei Illmitz, 9.8.1985: W. Lang (M 80336); — im Gallbrunner Weiher, 26.8.1959: P. Brixle (M 80334); — Seewinkel, Mosadolacke bei Apetlon, 26.8.1959: Doppelbaur (M 80331); — Flora comitatus Mosoniensis: Illmitz: in ripa uliginosa lacus „Zick See", 24.6.1923: J. Scheffer (BP 475405); — Illmitz/Zicklacken, 16.10.1971: A. Drescher (GZU 222479); — Zicksee, ca. 123 msm, 13.9.1964: F. Sorger (LI 47328); — Seewinkel: Illmitzer Salzwiesen, 26.7.1956: A. Neumann (W 2276); — E-Ufer des Neusiedlersees, Illmitz, nördlicher Ortsrand, unmittelbare Umgebung des Nationalpark-Zentrums, Feuchtwiesenreste und Wegränder, 120 msm, 30.9.2000: H. Wittmann (LI 433487, 433488); — Seewinkel: Illmitz – Podersdorf, 28.6.1950: K. Fitz (W 8610); — Illmitz, 18.10.[19]63: E. Feichtinger (LI 79/116); — Illmitz, 25.9.[19]62: E. Feichtinger (LI 79/119); — Illmitz, E v. Neusiedler-See, ca. 120 msm, 22.9.1962: Dr. Friederike Sorger (LI 47327); — Illmitz, 7.10.1978: I. Pils (LI 877797); — Wasserläufe bei Gols, 23.6.1940: L. Weiner (KL 95517); — Neusiedler-See-Gebiet; Neusiedler Wie-

sen ca. 2,5 km S Weiden, 120 msm, 8.9.2000: F. Tod (WU); — Breitenbrunn, Rand des Schilfgürtels, 27.8.1996: F. Grims (LI 256546, 256547, 256548); — Breitenbrunn/Neusiedlersee, Schilfufer, 28.8.1976: G. Geisler (W 9947); — SW St. Andrä bei Frauenkirchen, Holdenlacke, Sande, ca. 120 msm, 31.8.1981: E. et F. Krendl (W 1418); — E of Neusiedler See: near St. Andrä, flooded sand pit by the road W of the village of St. Andrä am Zicksee, behind crossing with railway line, 31.8. 1999: Z. Hroudová, P. Zákravský & L. Moravcová (PRA); — Seewinkel: Stundlache (südwestl. Frauenkirchen), Ufer, 9.6.1959: H. Melzer (Herb. Melzer); — Neusiedlersee: bei Parndorf in einem Wassergraben, 4.9.1952: H. Melzer (Herb. Melzer); — Neusiedlersee: Seewinkel, am Oberstinkersee an einer austrocknenden Lache, 3.7.1950: H. Melzer (Herb. Melzer); — Seewinkel, Unterer Stinker, Sumpf, 11.6.1966: D. Grill (GZU 222888); — Lange Lacke, 17.10.[19]67: E. Feichtinger (LI 79/113); — Neusiedlerseegebiet; Seewinkel, Ostufer des Warmsee (Darscho), 26.9.1982: E. Bregant (GJO 25420/ 35, 25420/9); — Neusiedlersee, Seewinkel, Schwarzseelacke vor Wallern, 12.6.1993: A. Aron (GJO 26270/3).

Carinthia / Kärnten

Gailauen b. Villach, 24.7.1932: Fr. Pehr (KL 79169).

Tyrol / Tirol

Sumpfige Stellen nahe Kufstein, 25.8.1912: L. Keller (PRC).

Bolboschoenus* cf. *maritimus

Upper Austria / Oberösterreich

Gräben an der Linzerbahn bei Ried, 1.7.1884: Vierhapper, herb. Oborny (PRC); — Gräben an der Linzerbahn bei Ried, 24.6.1885: Vierhapper, (M 80326); — bei Hallstatt, 1906: M. Heider (GZU 14422).

Vienna / Wien

Wien, 1873: s. coll. (PR); — Wien, 10. (27).4.1866: Wihan (PR); — Prater, 29.6.1886: F. Ostermeyer (PR); — Frachtmagazin Südbahnhof, 19.9.1861: W. Kinsky (PRC); — im Tümpel hinter der Maschinenfabrik beim Südbahnhof (Wien), 16.7.1857: Juratzka (W 23792); — Wien X, am Ufer eines Ziegelteiches auf dem Laaerberg, 19.7.1913: [E.] Korb (W 2806); — in einer Lache bei Breitensee unweit Wien, 15.7.1857: A. Schedl (WU); — Wien – Jedlesee, neben Lach [?] alter [?] Donauarm, hinter dem Friedhof, August 1916: F. Wimmer (W 16314).

Lower Austria / Niederösterreich

Pulkautal: am Nordrand von Zwingendorf an einem Tümpel, 6.6.1980: H. Melzer (Herb. Melzer); — an feuchten Stellen nächst dem Eisenbahndamme bei Soos, 2.8.[18]83: Beck (PC); — Sumpfwiesen bei Unter-Siebenbrunn im Marchfelde, 5.6.1921: J. Vetter (W 9168); — Weikendorf, 17.5.1903: Herb. Steinbach (LI 171/73); — Sumpf bei Gänserndorf, 23.6.[19]24: Fr. Hasl (LI 840698); — Schönau a. d. Triesting, in kleinem Teich bei der Kanalschleuse, zw[ischen] Kanal u. Bezirkstraße, 10.7.1922: H. Hu-

ber (W 11376); — Reichliesingthal, 2.6.[18]72: Kornhuber ex herb. G. A. Kornhuber (LI 243780); [on the sheet mixed with *B. planiculmis* from the locality Laxenburg]; — Wiener [Neustädter] Kanal, s. dat.: J. Peterstein (PR 506308); — [Wiener] Neustädt. Canal, 27.6. 1875: G. Beck (PRC); — [Wiener] Neustädter Kanal, 1849: s. coll. (GZU 126391); — Wiener Becken, Kiebitzwiese, SE Baden, Feuchtwiese, ca. 230 msm, 29.6. 1964: F. Krendl (W 2002-04799); — in paludosis ad Laxenburg, 21.3.1903: L. Keler (PR); — ... [?] bei Laxenburg, Niederösterreich, 16.6.1927: Thenius (BRNU 328759); — bei Laxenburg, Gewässer, Juli 1899: Arbesser (GZU 31061); — Laxenburg, s. dat.: B. Lth. [?] (LI 243872); [on the sheet together with *B.* cf. *planiculmis* from another locality]; — unter Schilf am Rande eines Tümpels nächst der Viehweide vor Achau, 24.6.1919: [E.] Korb (W 2805); — Ternitz [?], Achau, N[ieder]oe[sterreich]. Tümpel, 24.7.[18]98: J. Schneider (W 3329); — Münchendorf, 26.9.[18]97: Bot. Exc. (LI 243883); — Mödling, s. dat.: Herb. Ettingshausen (GZU 14128).

Burgenland

Zurndorf, Zurndorfer Heide, Auwald, ca. 130–140 msm, 19.6.1966: F. Krendl (W 2002-04806); — Neusiedl – Parndorf [?], nach Jois, 8.6.1924: Thenius (BRNU 328758); — Neusiedler-See bei Goys [= Jois], Juni 1923: O. u. E. Behr (B); — Weiden a. Neusiedlersee, Wassergräben, September 1900: Arbesser (GZU 31062); — Wasserläufe bei Gols, 23.6.1940: L. Weiner (KL 095518, 095516); — Neusiedlersee, s. dat.: R. Wagner (GJO 26232/1468, 1935 GJO 26232/1464); — am Rande des Kanales bei Purbach, 12.6. 1932: [E.] Korb (W 2803); — bei Oggau, 21.8.1975: M. Pull (W 2002-00194); — Rust, pobřežní porosty jezera, 31.5.1936: K. Ptačovský (SAV); — Rust, Neusiedler See, Seeufer, ca. 170 msm, 5.6.1956: F. Krendl (W 2002-03101); — Neusiedler See, Feuchtwiese, Unterlage: Sand, 120 msm, 5. 5. 1994: Steinw. (LI 286512); — Seewinkel: Mai [19]73: I. Donner (LI 255713); — SW St. Andrä, am Ufer einer Lache, 25.5.1953: [H.] Melzer (Herb. Melzer); — Apetlon, Umgeb[un]g Lange Lacke, Wassergrabenrand, Unterlage: Kalk, 25.5.1985: Dr. Mittend[orfer] (LI 861978); — Neusiedlersee, Weg zur Langen Lacke, 5.6.1965: I. Thaler (GZU 222625); — Pamhagen, 13.6.[19]79: I. Donner (LI 255716); — bei Podersdorf, SW von der Birnbaumlacke, beim Paulhof, Salzufer, 120 msm, 3.6.1968: W. Burri, F. Krendl (W 2002-04787, LI 427405); — Ostufer des Neusiedlersees bei Podersdorf, 16.6.1938: H. Schmidt (LI) [four specimens]; — Ostufer, Wassergräben S von Podersdorf, 21.5.1929: G. Cufodontis (W 7416); — am Ufer des Neusiedler Sees bei Podersdorf im Burgenland, 26.5.1961: Lippert (B); — Zicklache při obci Illmitz (Neusiedler See), 116 msm, 11.6.1999: M. Valachovič (SAV); — Illmitz, 18.10.[19]63: El. Feichtinger (LI 79/ 117); — Salzboden 2 km nördlich von Illmitz, Seewinkel, 24.5.1977: G. Straka (GZU); — Neusiedler See, Seewinkel, Illmitz, Ufer des Neusiedlersees beim Bootshafen, Uferbereiche eines Steppensees, 14.6.1990: M. Magnes, C. Wieltschnig (GZU); — Neusiedler See bei Illmitz, 22.5.1970: H. u. E. Walter (B); — Illmitz, Salzboden, Kanäle, mit *Scirpus holoschoenus*, 117 msm, s. dat.: J. Pilz (LI 832936, 832934, 832933); 12.6. 1968: J. Pilz (LI 832930); — Neusiedlersee, 6.6.1875: Beck (PRC); — Neusiedlersee, s. dat.: Herb. Josef Kerner (GZU 3802); — am Ufer des Neusiedler Sees, 31.5.1903: V. Engelhardt (B); — Neusiedler See, s. dat.: Bilimek (PR 344184, W 16949, BP 34310); — 25.6.1961: B. Weinmeister (LI 79/4161); — a. 1959: Huttar-Widl (LI 93605); — s. dat.: s. coll. (LI 243873), ex Herbario Th. Wien; — Neusiedl (?), Ufer des Neusiedlersees, sehr verbreitet, a. 1878: s. coll. (PR);

— a. 1863: W. Kinsky (PRC); — s. dat.: s. coll. (PRC); — in Wiesen am See bei Neusiedl, 15.8.1880: G. Beck (PRC); — s. dat.: Haehnel (PR 344229); — Neusiedl am See, 131 msm, 31.5.1976: A. Kump (LI 76/670, LI 311729); — im Schilf am Rande des Sees bei Neusiedl, 21.6.1923: [E.] Korb (W 2804); — Neusiedl – Parndorf, [zwischen] Gols [?] [und] Jois, 8.6.1924: Thenius (BRNU 328757); — am See b. Langenlois (Spendling), a. 1976: I. Donner (LI 255712); — Neusiedler See, Zitzmannsdorfer Wiesen, beim Viehhüter, 11.6.1985: O. Angerer (M 80335); — am Illmitzer Seedamm im Seewinkel, 20.5.1964: Beuer et Doppelbaur (M 80333); — Seewinkel: an der Fuchslochlacke nördl. Apetlon, 20.5.1964: Beuer et Doppelbaur (M 80330); — Seewinkel: Lange Lacke zwischen Apetlon und Illmitz, 27.5.1958: H. Hertel (M 80329); — Neusiedler-See, Apetlon N Warmsee, ausgetrocknete Lacke, s. dat.: Dr. Höller (M 80327); — Neusiedlerseegebiet, Seewinkel; Darscho (Warmsee) N Apetlon; Uferbereiche und angrenzende Rasen, 9.6.1984: E. Bregant (GJO 25530); — Neusiedlerseegebiet, zwischen Apetlon und Wallern, Rand eines ausgebaggerten Tümpels, 27.5. 1985: A. Aron (GJO 25592/15); — Neusiedler See: Neusiedl, in der Schilfzone, 10.6. 1939: Schoenau (M 80325); — SE v. Oberen Stinker bei Illmitz, 14.6.1973: Exkursion Burgenland–Lunz (M 80286); — Gebiet des Neusiedlersees, Schwarzseelacke, 27.5. 1986: E. Bregant (GJO 25662/2).

Discussion

Regarding character of habitats, the differentiation of species of the genus *Bolboschoenus* found in Austria corresponds with their habitat differentiation in other Central European countries (see Hroudová & al.1999a): *Bolboschoenus yagara* was found in small freshwater reservoirs with standing water, *B. laticarpus* occurs in a wider range of habitats, mostly along rivers, *B. maritimus* s. str. is typical of saline habitats, and *B. planiculmis* inhabits a wide range of habitats, frequently of secondary character (wet meadows, pond shores, channels, wet ditches etc.).

Bolboschoenus maritimus was found most frequently of all species; its occurrence is concentrated to the surroundings of Neusiedler See, on the area of natural salt marshes connected with extensive areas of salt marshes in Hungary, where it represents a dominant species in inland saline communities of the Cirsio brachycephali-Bolboschoenion (Passarge 1978) Mucina 1993 (Grabherr & Mucina 1993). Spreading of *B. maritimus* in flat lowland areas is supported by the buoyancy of its fruits: Air-filled exocarp cells function as a floating organ, which enables plants to spread by floods. Fruits of *B. maritimus* have the best floating capabilities of all Central European species of *Bolboschoenus* (Hroudová & al. 1997).

Similarly, fruits of *B. planiculmis* are able to float and spread by water on temporarily flooded field depressions.

Bolboschoenus laticarpus may be spread by running water, which corresponds with its occurrence along rivers, especially along Danube river and its tributaries. The plant community Bolboschoenetum maritimo-maritimi ass. prov. described by Zahlheimer (1979) from the region along the Danube river in Germany most probably includes stands of *B. laticarpus*.

Bolboschoenus yagara is evidently a rare species in Austria, but findings of new localities are not excluded, because this species easily might be overlooked, and also owing to its fluctuating appearance depending on water level decrease and increase. Isolated localities of *B. yagara* in Styria (in the surrounding of Graz), and especially in Carinthia (basin of Klagenfurt) represent the southern border of its distribution in Central Europe so far known. The localities in Waldviertel evidently link up the localities of *B. yagara* in South Bohemia. The other interesting locality was „im Tümpel hinter der Maschinenfabrik beim Südbahnhof in Wien, 16.7.1837: Juratzka (W)". *Bolboschoenus maritimus* was collected at the same locality, which is the only case so far known where both species grew together in the same place. As *B. yagara* and *B. maritimus* inhabit strictly different habitats and, as a consequence, mixed stands are almost excluded. Unfortunately, this locality does not exist anymore, so we cannot find a possible microhabitat differentiation there nor is it possible to decide whether the occurrence of *B. yagara* in this locality was temporary or not. We are not sure whether there is not a mistake in the date of collection (1837 or 1857), i.e., whether the plants were actually growing together in the same year or not.

The other important locality is the small fishpond between Poysdorf and Herrnbaumgarten (Weinviertel) where three species were found growing together: *B. planiculmis* forming belt along shores on summer-drained bottom, one small clone of *B. laticarpus* on the border of reed stand, and a small stand of *B. yagara* on muddy bottom near the inlet to the fishpond. While *B. planiculmis* was found in more localities in Lower Austria and is relatively frequent in neighbouring S Moravia, *B. laticarpus* is rare in this region of Austria and also its occurrence in S Moravia is more rare, concentrated to small fishponds and pools along the Dyje river [Thaya] out of saline habitats. For *B. yagara* the fishpond near the village of Herrnbaumgarten represents an isolated locality within its area of distribution; the nearest locality (ca. 10 km distant) is the pool in the forest SW of the town of Břeclav in S Moravia (1995: Rydlo & Šumberová ROZ in DUCHÁČEK 2002), which is the only locality of *B. yagara* in S Moravia as well. High content of mineral ions in soils together with warm climate probably suppress seedling establishment and represent thus limiting factors for seed spreading of *B. yagara* by water birds.

On the other hand, *B. planiculmis* is well adapted to warm climate and temporary drying of habitats, which is often connected to increasing concentration of mineral ions content in soil solution. Consequently, it may occur in some localities together with the halophyte species *B. maritimus* (e.g., the locality near Oggau, 1999: Hroudová, Zákravský & Moravcová PRA); in S Moravia both species may be found together in wet field depressions on the sites of former saline habitats.

As most of the herbarium specimens were collected in flowering stage, their determination was difficult. The differentiation of *B. maritimus* from *B. planiculmis* based on style branching is difficult especially in regions where both species occur (e.g., Vienna and surroundings). A considerable proportion of bifid styles is sometimes also present in plants of *B. maritimus.* A similar situation is found in S Moravia, where plants with intermediate characters between *B. maritimus* and *B. planiculmis* in style branching and also in fruit shape were found (DUCHÁČEK 2002). This indicates possible influence of spontaneous hybridization between these two taxa in natural populations.

Although in some cases *Bolboschoenus* species were found in arable land more than a century ago (e.g., *B. planiculmis* in „Getreidefeldern bei Marchegg", 1895: K. Fritsch GZU 14120), the occurrence of *Bolboschoenus maritimus* s. lat. as a weed in Central Europe was only recorded during the last decades in Germany (Hilbig 1993, Schröder 1998, Kläge 1999), Czech Republic (Mikulka & Chodová 1998, Mikulka & al. 1999) and Austria (Ries 1992). In the Czech Republic, weedy species in arable land are *B. laticarpus* and *B. planiculmis*. Their spread is supported by changed management technology as a result of changing economy. *Bolboschoenus maritimus* was included by Ries (1992) into new (and potential) field weeds; the data on occurrence of *Bolboschoenus maritimus* in fields may more likely represent the localities of *B. planiculmis* or *B. laticarpus.*

Acknowledgements

Our sincere thanks are due to curators of herbarium collections B, BP, BRA, BRNM, BRNU, GJO, GZU, KL, KRAM, LE, LI, P, PR, PRA, PRC, SAV, SLO, W, WU for making possible to study *Bolboschoenus* specimens, to Mag. H. Melzer for kind loan of his herbarium collection of *Bolboschoenus,* to Dr. W. Lazowski for sending the plant of *Bolboschoenus* from a locality at the Austrian border, to Prof. M. A. Fischer for his interest in our work, valuable discussions and the kind suggestion to write this paper, to reviewers for valuable critical comments which contributed to improving of the manuscript, to J. Machač for making photos of fruits, and to P. Zákravský for technical help during finishing of the manuscript. Our work was financially supported by Grant Agency of the Academy of Sciences of the Czech Republic (grant no. A 6005905) and by the Academy of Sciences of the Czech Republic (grant no. AV0Z 6005908 and no. KSK 6005114).

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