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Differentiation of the Central European *Bolboschoenus* taxa based on fruit shape and anatomy.

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ABSTRACT: The characters of fruit shape and anatomy are used to distinguish *Bolboschoenus* taxa occurring in Central Europe. Material from the Czech Republic, Slovakia, Hungary, Poland and Germany was studied. Plants from coastal regions of France and The Netherlands were compared with the inland taxa. Three taxa are recognized: non-saline *Bolboschoenus maritimus* subsp. *maritimus* in the sense of Central European authors (CASPER & KRAUSCH 1980), saline *B. m.* subsp. *compactus* (HOFFM.) HEJNÝ and *B. planiculmis* sensu T. V. EGOROVA (non F. SCHMIDT).

KEYWORDS: *Bolboschoenus*, *Scirpus*, fruit morphology, fruit anatomy, intraspecific differentiation, Central Europe

Introduction

Fruit and seed morphology have been widely used as characters for determining taxa owing to their relatively low plasticity under changing habitat conditions compared with other plant organs. Fruit shape and anatomy have been used to distinguish individual taxa in the family *Cyperaceae* (SOJÁK 1958, KOWAL 1958, MAREK 1958) and especially in the genus *Bolboschoenus* (SOJÁK 1958, DOSTÁL 1989, BROWNING & GORDON-GRAY 1993, BROWNING, GORDON-GRAY & SMITH 1995, BROWNING, GORDON-GRAY, SMITH & VAN STADEN 1996,

1997). In a previous study (HROUDOVÁ & al. 1997) we found that fruits of *Bolboschoenus maritimus* (L.) PALLA (= *Scirpus maritimus* L.) from several localities (Czech Republic, Slovakia, Sweden) differed in fruit shape and anatomy, which influenced their buoyancy. Three types were distinguished. Significant differences were found in the proportion of the exocarp layer formed by air-filled lacunate tissue (nomenclature follows CASPER & KRAUSCH 1980) namely: a) *B. maritimus* subsp. *maritimus* with fruits triangular in cross section, with the exocarp very narrow or negligible (5 to 25 % of the pericarp) and a well developed sclerenchymatous mesocarp; b) *B. m.* subsp. *compactus* with fruits mostly concave on the abaxial side and with the exocarp as thick as the mesocarp; c) *B. m.* subsp. *compactus* with fruits convex on the abaxial side and the exocarp ca 2x thicker than the mesocarp.

In this paper we aim to use the differences in fruit shape and anatomy as characters to distinguish the *Bolboschoenus* taxa occurring in Central Europe, for example, to answer the questions: how are the three types mentioned above represented among the plants collected in Central European countries? and to which taxa may they be assigned? For this purpose the plants collected in localities throughout the Czech Republic, Slovakia and Hungary, together with plants from several localities in Poland and Germany, were studied. Plant material from some coastal European regions was also used for comparison with the inland plants.

Material and methods

Fruits were collected from field populations of *B. maritimus* throughout the Czech and Slovak Republics and in Hungary. Others collected by our friends in Germany, France and The Netherlands were also studied. Fruits were sampled from as many fertile plants as possible in each population and a mixture of fruits was used for study (regardless of the position of the fruits in the spikelet or inflorescence). Only fully developed ripe fruits were compared. In each sample the shape of the fruits varied somewhat: among triangular fruits were some with round or less visible edges on the dorsal side (probably originating from the lower flowers in the spikelet); among fruits with a concave or convex dorsal side, some were nearly flat. In each case the prevailing fruit shape was considered to be characteristic for the given sample.

Fruits from Hungary, France, The Netherlands and Germany originated from field populations; those from Poland were collected from plants cultivated in the experimental garden in Průhonice. (For detailed location of all populations see Appendix.) In the material collected, the qualitative characters of fruit shape and anatomy were studied, which allowed us to assign the plants to the types mentioned above. Because of the large number of sample sites, it was not possible to undertake quantitative measurements, statistical analysis of cross-section size and anatomical characters of the pericarp. These were carried out in a previous study (HROUDOVÁ & al. 1997). Consequently, the following characters were used as the main diagnostic features: fruit shape (trigonous, concave or

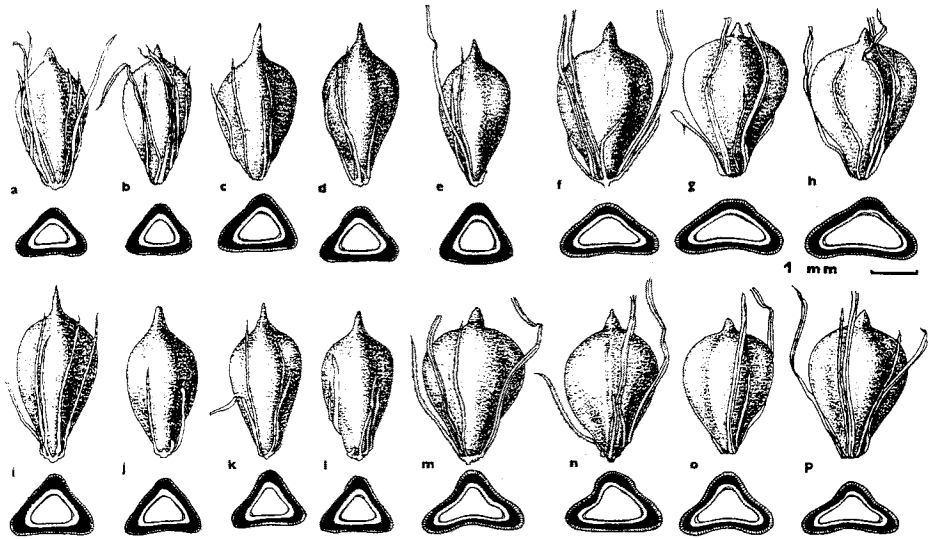


Fig. 1 - Fruit shape and cross section of *Bolboschoenus maritimus* subsp. *maritimus* from the Czech and Slovak Republics. In cross section, pericarp structure is schematically drawn (lined - exocarp, black - mesocarp, white - endocarp). Localities: a - Děkanec aquatic, b - Děkanec terr., c - Služebný, d - Tobolky, e - Zhoř, f - Řečany, g - Dubeč, h - Opatovický, i - Rochovský, j - Kačležský, k - Koclířov, l - Svinětický, m - Kněžský Dolní, n - Tichý, o - Bruksa 6, p - Jakubov-sand pit.

convex on abaxial side) and the proportion of exocarp layer in the pericarp. From each of the samples, a drawing of the typical fruit shape and another of the fruit in cross section were made. Cross sections of fruits were prepared using a Leitz freezing microtome, after fruits had been boiled in distilled water for 10 to 20 minutes to soften the pericarp.

Results

All the plants were divided into two main groups:

1. Plants with fruits with an edge (angle) on the abaxial side (triangular in cross section), dark brown to black, with mostly persistent perigon bristles (Fig. 1). The pericarp is formed by very narrow (or negligible) air-filled lacunate tissue in the exocarp and a well developed sclerenchymatous mesocarp and endocarp (Fig. 2 a, b).

Within this set of samples, two types were found:

a) plants with narrow fruits with negligible aeriferous exocarp (distributed in South Bohemia) - Figs. 1 a - e and i - l, 2 a, 3;
b) plants with wider fruits, the exocarp of which is formed by a narrow layer of aeriferous tissue (distributed exceptionally in South Bohemia but mostly in other regions of Bohemia and Moravia, in Slovakia, Germany, Hungary and The Netherlands). - Figs. 1 f - h and m - p, 2 b, 4, 9 h, i, k, 10 c.

2. Plants with fruits without an edge on the abaxial side, concave, flat or convex on this side, yellow-brown to rusty-brown, mostly without perigon bristles, with well developed air-filled lacunate tissue in the exocarp and a thinner mesocarp and endocarp (Figs. 2 c, d, 7, 8, 9, 10).

Within this set of samples, two different types were also found:

a) plants with fruits concave on the abaxial side and aeriferous tissue in the exocarp nearly as thick as the sclerenchymatous mesocarp (found in the Czech and Slovak Republics) - Figs. 2 c, 5, 7 a - j,
b) plants with fruits more variable in shape (convex, semi-spherical to subtrigonous on abaxial side or lenticular), with aeriferous tissue in the exocarp ca 2x thicker than the sclerenchymatous mesocarp (occurring in some localities in Bohemia and Moravia and in all other countries from which fruits were studied) - Figs. 2 d, 6, 7 k - n, 8, 9 a - g and j, 10 a, b, d - n.

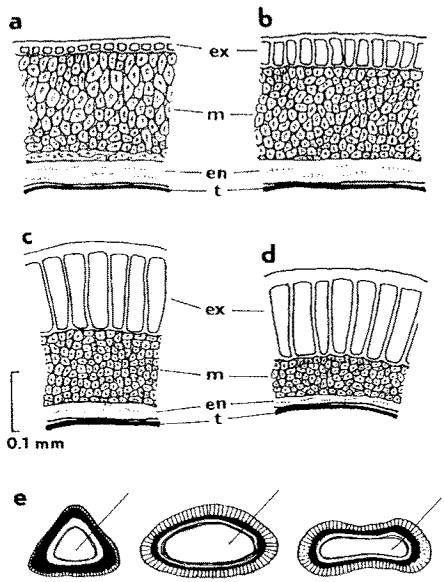


Fig. 2 - Detail of the pericarp anatomy of fruits of *Bolboschoenus maritimus*. a - *B. m.* subsp. *maritimus* (locality Děkanec), b - *B. m.* subsp. *maritimus* (locality Bruksa 6), c - *B. planiculmis* sensu T. V. EGOROVA (locality Kněžský Dolní), d - *B. m.* subsp. *compactus* (loc. Fehér lake), e - cross sections of the fruits showing schematically the positioning of the various layers. ex - exocarp, m - mesocarp, en - endocarp, t - testa.

Discussion

Morphological and anatomical differentiation and taxonomy

Within *Bolboschoenus maritimus* the shape and colour of the achenes and also fruit anatomy were considered by many authors to be important diagnostic features characterizing intraspecific taxa and other closely related species:

1. The plants with narrow, obovate achenes, triangular in cross-section, dark brown to almost black (rarely light-brown), with a smooth surface without a network pattern and with persistent perigon bristles were classified as subsp. *maritimus* (SOJÁK 1958, HEJNÝ 1960, FOERSTER 1972, CASPER & KRAUSCH 1980), subsp. *cymosus* (DOSTÁL 1989), f. *cymosus* (SCHULTZE-MOTEL 1980), paramorph "*maritimus*" (ROBERTUS-KOSTER 1969), or as a separate species - *B. maritimus* (DROBOV 1913, DOBROTCHAEVA & al. 1987). The fruits in Fig. 1 C by NORLINDH (1972) and in Table III/2 by KOWAL (1958) evidently belong to this taxon. These plants have a thin exocarp layer (SOJÁK 1958, DOSTÁL 1989, BROWNING & al. 1996). The inland freshwater plants described by ROBERTUS-KOSTER (1969) as paramorph "*maritimus*" are considered by BROWNING & al. (1997) to be identical with *Bolboschoenus yagara* (OHWI) A. E. KOZHEVN. and the putative hybrid *B. maritimus* x *yagara*.

In our results group 1 may be assigned to *B. maritimus* subsp. *maritimus* in the sense of Central European authors (CASPER & KRAUSCH 1980). These plants are also distinguished by a richly branched inflorescence with long branches and numerous branched spikelets (KRAHULEC & al. 1996, HROUDOVÁ & al. 1998).

The two types of fruits - narrow and wide - were recorded by SOJÁK (1958), but without any taxonomic evaluation. BROWNING & al. (1996) consider the plants with narrow fruits to be identical with the Asian species *Bolboschoenus yagara* and the plants with wider fruits to be putative hybrids *B. maritimus x yagara*. However, a more detailed comparative study of Asian and European plants is necessary. So far we have considered both types (1.a and 1.b) as belonging to *B. maritimus* subsp. *maritimus* sensu CASPER & KRAUSCH (1980).

2. The other group of plants was described as having achenes somewhat more variable: achenes in outline mostly round or obovate, convex to semi-spherical (or rarely subtrigonous), sometimes concave on the abaxial side; colour yellow-brown to rusty-brown; with a fine network pattern on the surface and with perigon bristles mostly lacking. These plants were classified in Central and Eastern Europe as subsp. *compactus* (SOJÁK 1958, HEJNÝ 1960, FOERSTER 1972, CASPER & KRAUSCH 1980, DOSTÁL 1989), paramorph "*compactus*" (ROBERTUS-KOSTER 1969) or as the separate species - *B. compactus* (DROBOV 1913, DOBROTCHAEVA & al. 1987). Fruits have a thick, soft ("fleshy") exocarp and a hard mesocarp (SOJÁK 1958, DOSTÁL 1989). The exocarp is formed by a layer of cylindric cells that become empty and air filled. Plants described by MAREK (1958) and BERGGREN (1969) evidently belong to this subspecies. These

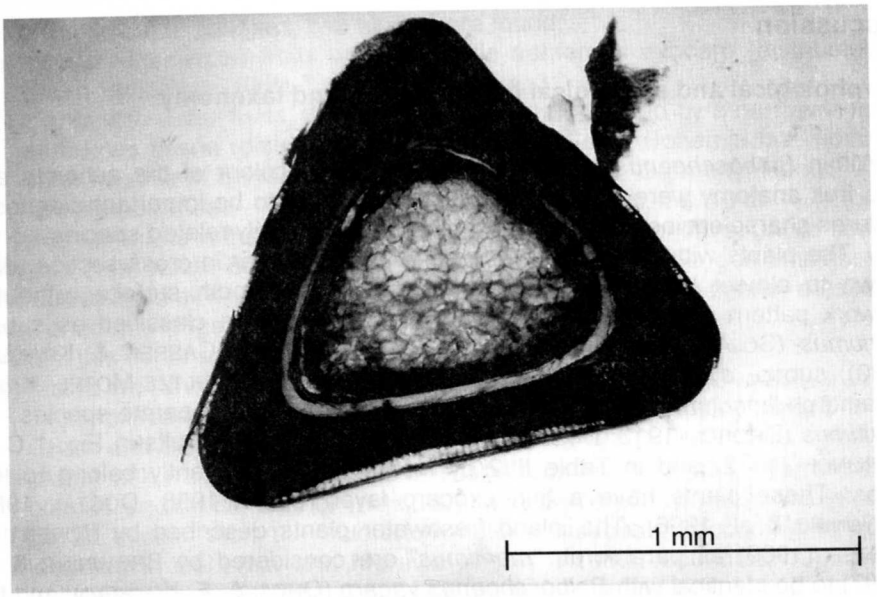


Fig. 3 - Cross section of the fruit of *B. maritimus* subsp. *maritimus* (narrow fruits) from the locality Rochovský.

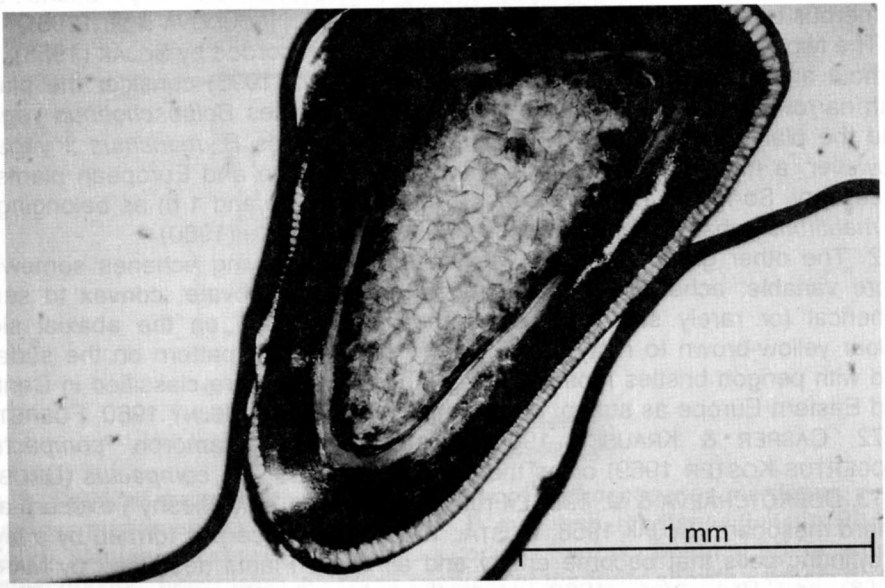


Fig. 4 - Cross section of the fruit of *B. maritimus* subsp. *maritimus* (wide fruits) from the locality Řečany.

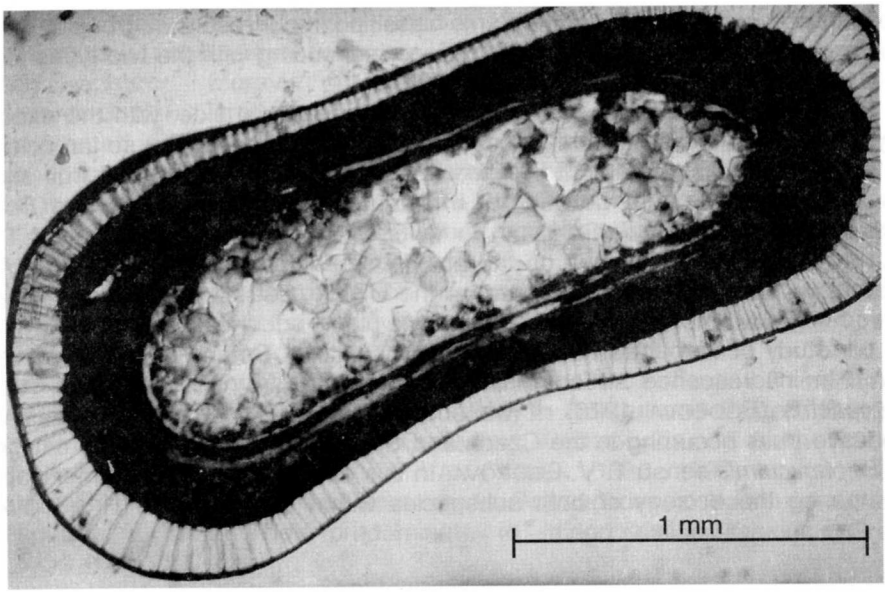


Fig. 5 - Cross section of the fruit of *B. planiculmis* from the locality Dobroměřický.

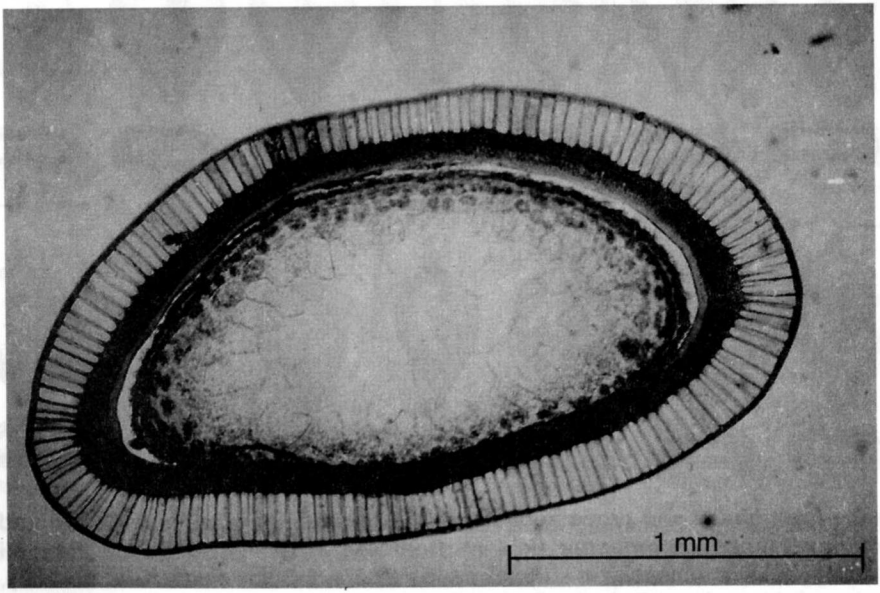


Fig. 6 - Cross section of the fruit of *B. maritimus* subsp. *compactus* from the locality Harta.

descriptions correspond with the plants classified in our results in group 2. Within this group two types were distinguished, corresponding with the two types found in our previous work (HROUDOVÁ & al. 1997):

2a. Plants with obovate fruits concave on the abaxial side, with the exocarp layer approximately as thick as the sclerenchymatous mesocarp, so far included within *B. maritimus* subsp. *compactus*. EGOROVA (1976) considered fruit shape as a diagnostic feature between *B. maritimus* subsp. *compactus* and *Bolboschoenus planiculmis* (F. SCHMIDT) T. V. EGOROVA. *B. planiculmis* sensu T. V. EGOROVA with fruits concave on the abaxial side is recorded from Central Asia (EGOROVA 1967), the European part of the USSR (EGOROVA 1976) and Siberia (PESCHKOVA & MALYSCHEV 1990). The same plants occur also in Ukraine (results of our study of herbarium material in the Institute of Botany of UkAN in Kiev - KW). In inflorescence structure they do not differ from *B. maritimus* subsp. *compactus* (EGOROVA 1976). If we accept this classification, the plants with concave fruits occurring in the Czech and Slovak Republics are to be assigned to *B. planiculmis* sensu T. V. EGOROVA. In this case, some of our former papers comparing the ecology of both subspecies within *B. maritimus* (HROUDOVÁ &

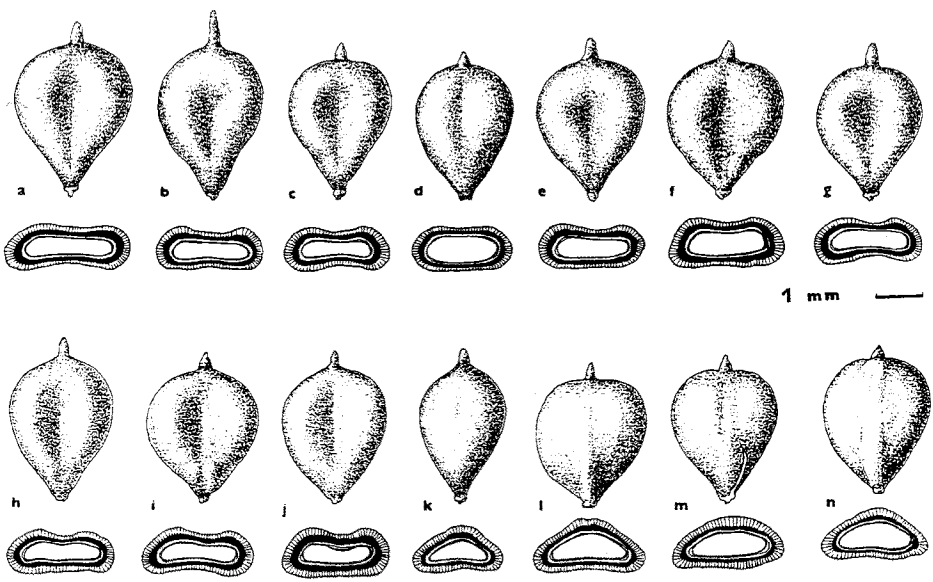


Fig. 7 - Fruit shape and cross section of *Bolboschoenus planiculmis* (a - j) and *B. maritimus* subsp. *compactus* (k - n) from the Czech and Slovak Republics. Localities: a - Dobroměřický, b - Lenešice, c - Kněžský Dolní, d - Sekule, e - Kúty, f - Jakubov -field, g - Nový Dvůr, h - Bruksa 5, i - Nové Mlýny III., j - Brodské, k - Nesyt, l - Rakvice-sand pit, m - Rakvice-Jezera, n - Bečovský brook.

ZÁKRAVSKÝ 1995, ZÁKRAVSKÝ & HROUDOVÁ 1996) concern *B. planiculmis* sensu T. V. EGOROVA, not *B. maritimus* subsp. *compactus.* The drawing of fruit from the Czech Republic - Moravia presented by NORLINDH (1972), Fig. 1/F also represents *B. planiculmis* sensu T. V. EGOROVA. In this paper, fruits of this taxon are presented in Fig. 7 a - j. However, further attention should be drawn to this taxon concerning the taxonomy and nomenclature. The plants described by EGOROVA (1967, 1976) and PESCHKOVA & MALYSCHEV (1990) evidently are not identical with the plants originally described from the Sachalin isle by SCHMIDT (SCHMIDT 1868, KHARKEVICH 1988).

2b. Plants with the fruits convex, hemispherical to subtrigonous on the abaxial side, with a well developed exocarp layer (ca 2 x thicker than mesocarp). These plants, distinguished by compact inflorescences formed mostly (or only) of sessile spikelets, poorly branched with shorter branches, are called *B. maritimus* subsp. *compactus* (CASPER & KRAUSCH 1980) in Central and Eastern Europe. BROWNING & GORDON-GRAY (1993), BROWNING, GORDON-GRAY & SMITH (1995), BROWNING, GORDON-GRAY, SMITH & VAN STADEN (1996, 1997) assigned the plants with this fruit shape and anatomy to *Bolboschoenus maritimus* without infraspecific division. They predominate in inland saline regions (Great

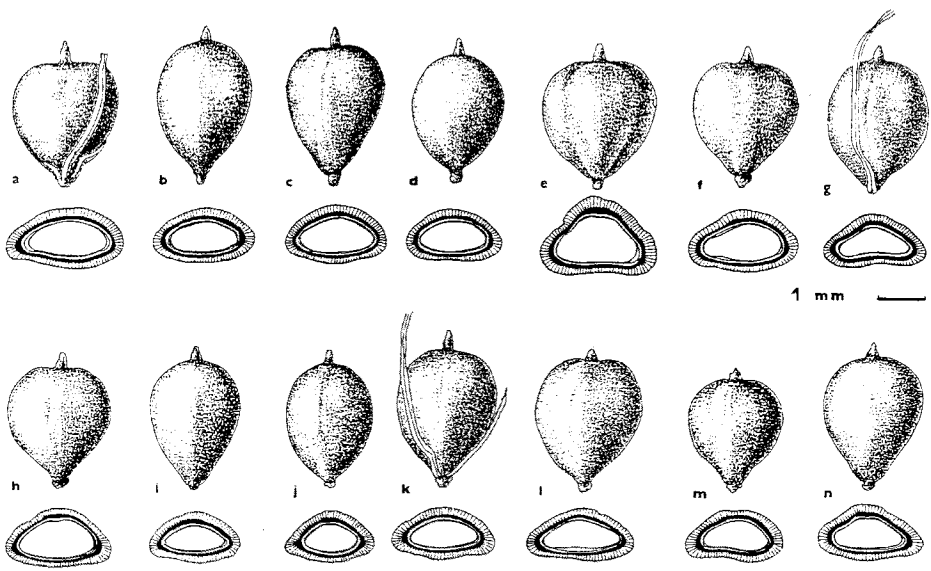


Fig. 8 - Fruit shape and cross section of *Bolboschoenus maritimus* subsp. *compactus* from Hungary. Localities: a - Harta b - Fehér, c - Apaj, d - Zab-Szék, e - Kolbász, f - Kócsújfalu, g - Kelemen lake, h - Bösztör (plants with short spikelets), i - Bösztör (plants with long spikelets), j - Kis-Rét, k - Fenyes-tó, l - Nyugati, m - Kistelek, n - Kelemen puszta.

Hungarian Plain), and occur also in the Czech Republic, Germany and Poland. They seem to be identical with coastal plants from The Netherlands (ROBERTUS-KOSTER 1969, BROWNING & al. 1997), Sweden (BERGGREN 1969, NORLINDH 1972, HROUDOVÁ & al. 1997) and also with plants from the Rhône Delta in France and from some other saline localities in The Netherlands (Figs. 7, 8, 9, 10). The plants from the Swedish coast are described in detail by NORLINDH (1972); in his paper, fruits of this taxon are shown in Fig 1 A, B, (Sweden), and D, E, (Czech Republic - Moravia). Table III/1 by KOWAL (1958) shows fruit of *B. maritimus* subsp. *compactus*.

The main diagnostic features at fruit shape and anatomy were found to be very stable, not influenced by habitat conditions (compare the fruits from two habitats differing in water supply in the locality Děkanec - Fig. 1 a, b) and the fruits from plants with long and short spikelets that were growing together in one locality (Bösztör, fig. 8 h, i); the source of variation in spikelet length or fruit size may be genetic heterogeneity of the population, or microhabitat heterogeneity within one locality. Transfer into cultivation did not cause any changes in the distinguishing characters (HROUDOVÁ unpublished data). The following additional characters distinguishing *Bolboschoenus* taxa were also recorded:

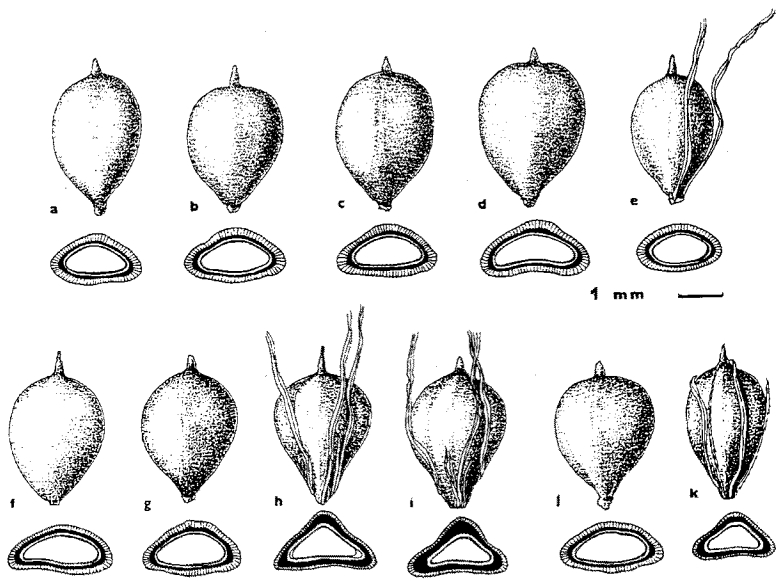


Fig. 9 - Fruit shape and cross section of *Bolboschoenus maritimus* subsp. *compactus* (a - g, and j), *B.m.* subsp. *maritimus* (h, i, k) from Hungary and Germany. Localities: a - Büdöszék lake, b - Pusztaszér, c - Fehér-tó channel, d - Büdöszék channel, e - Hortobágyi, f - Sabolcsveresmarti-Tároló, g - Tiszavasvári, h - Tokaj, i - Tiszalök, j - Teutschenthal, k - Saale Holleben.

a) Network pattern on the surface of fruits typical of *B. maritimus* subsp. *compactus* (DOSTÁL 1989). BROWNING & GORDON-GRAY (1993), BROWNING, GORDON-GRAY & SMITH 1995, BROWNING, GORDON-GRAY, SMITH & VAN STADEN 1996, 1997) described different surface network patterns visible on electron microphotography in all taxa studied. In our material studied without electron microscopy, the network pattern appeared to be dependent on the development of the aeriferous layer in the exocarp; in *B. maritimus* subsp. *compactus* and *B. planiculmis* sensu T. V. EGOROVA this network was easily visible using a hand lens, while in *B. maritimus* subsp. *maritimus* the surface was variable, having a network to almost smooth (dependent on structure of exocarp layer). Therefore this character is a good distinguishing feature using electron microscopy, but it does not seem to be very suitable for field determination.

b) Fruit colour. Ripe fruits of *B. maritimus* subsp. *maritimus* are dark brown to black, in *B. m.* subsp. *compactus* fruits are mostly light brown to rusty brown and those of *B. planiculmis* sensu T. V. EGOROVA are dark yellow, ochre to rusty brown. The colour remains stable in dry fruits or in herbarium plants, but the fruits become dark in water or in wet environments.

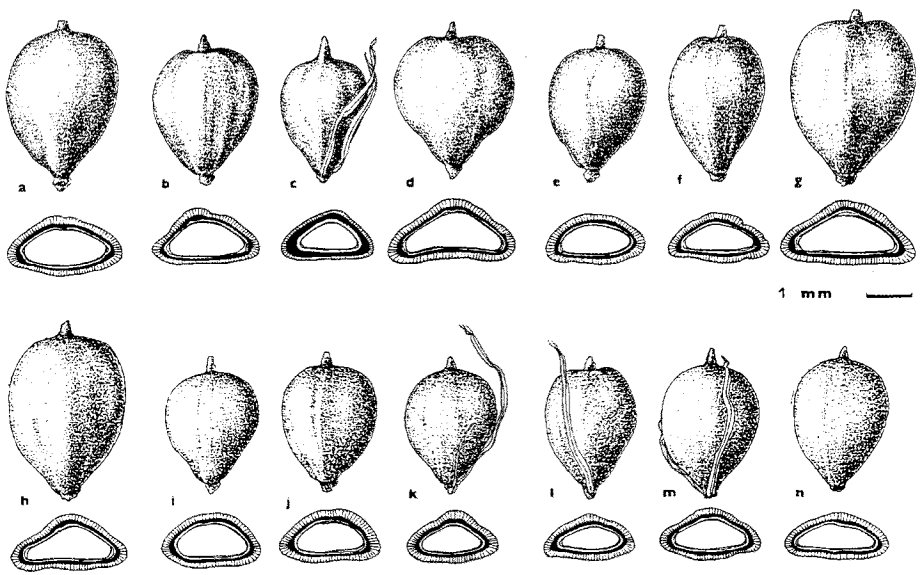


Fig. 10 - Fruit shape and cross section of *Bolboschoenus maritimus* subsp. *compactus* (a, b, d - n) from The Netherlands, France and Poland and *B.m.* subsp. *maritimus* from The Netherlands (c). Localities: a - Kwade Hoek, b - Grevelinger, c - Milingerwaad, d - Hauuersmeer, e - N-Beveland, f - Dykwater, g - Carnisse Grende, h - Willlenstad, i - Emprunt Nord Tamarguiron, j - Relongue Nord, k - Cerisière des Faïsses, l - Baisse salée, m - Leba, n - Kórnik.

pactus is typical of inland salt lakes and is evidently identical with plants growing in European coastal regions. The distribution of *B. planiculmis* sensu T. V. EGOROVA is little known so far; it occurs in inland, slightly saline habitats of Eastern and Central Europe. The taxonomic classification of all plants studied, as well as their distribution throughout wider Europe needs further detailed study.

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Appendix

List of localities from where plant material was sampled:

Czech Republic

Central Bohemia

1. Dubeč: depression in wet meadow at NW end of the Dubeč suburb near the road to Štěrboholy, E border of Prague city, alt. 255 m (50°03' N, 14°35' E)
2. Kněžský Dolní: Kněžský Dolní fishpond at the S border of Hasina village, 1 km N of Rožďalovice, alt. 203 m (50°19' N, 15°10' E)

North-West Bohemia

3. Bečovský brook: field depression near the Bečovský brook about 1 km S of Bečov village near the road to Volevčice village, 9 km NW of Louny, alt. 225 m (50°26' N, 13°42' E)
4. Nový Dvůr: small fishpond in the Nový Dvůr settlement, near the road between Lenešice and Břvany villages, 5 km NW of Louny, alt. 190 m (50°23' N, 13°44' E)
5. Lenešice: field depression in a meadow below the dam of Lenešický fishpond on the W border of Lenešice village, 3 km NW of Louny, alt. 185 m (50°22' N, 13°45' E)
6. Dobroměřický: Dobroměřický fishpond 3 km N of Louny, alt. 195 m (50°23' N, 13°48' E)

South Bohemia

7. Svinětický: Zadní Svinětický fishpond, 1 km N of Svinětice village, 4 km W of Vodňany, alt. 413 m (49°09' N, 14°06' E)
8. Kačležský: Kačležský fishpond 6 km SE of Jindřichův Hradec, alt. 529 m (49°05' N, 15°05' E)
9. Tobolky: Tobolky fishpond 1 km SW of Branná village, 4 km S of Třeboň, alt. 442 m (48°57' N, 14°46' E)
10. Rochovský: Velký Roch (Rochovský) fishpond 2 km NNW of Jindřichův Hradec, alt. 480 m (49°10' N, 14°59' E)
11. Koclířov: Koclířov fishpond 1 km SW of Lomnice n. Luž., alt. 425 m (49°04' N, 14°42' E)
12. Zhoř: Zhoř fishpond 2.5 km E of the railway station Čimelice, alt. 430 m (49°28' N, 14°06' E)
13. Služebný: Služebný fishpond on the S border of Lomnice n. Lužnicí, alt. 424 m (49°04' N, 14°43' E)
14. Děkanec - aquatic: Děkanec fishpond between the villages of Branná and Domanín, 4.5 km S of Třeboň, alt. 442 m (48°57' N, 14°45' E) (submerged habitat, water depth 0.6 m)

Děkanec - terr.: Děkanec fishpond between the villages of Branná and Domanín, 4.5 km S of Třeboň, alt. 442 m (48°57' N, 14°45' E) (drained shore, terrestrial habitat)

15. Opatovický: east shore of the Opatovický fishpond on the at S border of Třeboň town, alt. 435 m (48°59' N, 14°46' E)

East Bohemia
16. Tichý: Tichý fishpond near the road from Lázně Bohdaneč to Bukovka village, 2 km NW of Lázně Bohdaneč, alt. 225 m (50°05' N, 15°38' E)
17. Řečany: former oxbow at the NNE border of the Řečany village, 4 km E of Chvaletice, alt. 205 m (50°02' N, 15°28' E)

South Moravia
18. Bruksa 5, 6: field depression in meadow near Bruksa oxbow, on the W border of Břeclav, alt. 160 m (48°45' N, 16°52' E)
19. Rakvice – sand pit: former sand pit on the SE border of Rakvice village near the road to Podivín, 3 km NW of Podivín, alt. 162 m (48°59' N, 16°49' E)
20. Rakvice - Jezera: the oxbow Jezera, 1 km SSE of Rakvice village, 3 km NW of Podivín, alt. 161 m (48°50' N, 16°48' E)
21. Nesyt – E shore: eastern shore of Nesyt fishpond, 1.5 km WSW of Hlohovec village, alt. 175 m (48°46' N, 16°44' E)
22. Nové Mlýny III: field depression near the shore of the third of the Nové Mlýny reservoirs, 7 km SSE of Hustopeče, alt. 170 m (48°52' N, 16°41' E)

Slovakia
South-West Slovakia
23. Brodské: field depression near the road between Lanžhot and Kúty villages near Brodské village, 9 km SE of Břeclav, alt. 153 m (48°40' N, 16°59' E)
24. Sekule: flooded field depression near the railway station at Sekule, 16 km SE of Břeclav, alt. 163 m (48°36' N, 17°01' E)
25. Kúty: drainage channel about 500 m SE of Kúty village, 12 km SE of Břeclav, alt. 157 m (48°39' N, 17°01' E)
26. Jakubov - field: field depression near the road from Jakubov village to Záhorská Ves village, 7 km SW of Malacky, alt. 145 m (48°24' N, 16°54' E)
27. Jakubov - sand pit: the sand pit on the SW border of Jakubov village, 6 km SW of Malacky, alt. 145 m (48°24' N, 16°55' E)

Hungary
28. Kistelek: sand pit close to the railway station near Kistelek village by the road from Budapest to Szeged, about 30 km NW of Szeged (46°28' N, 19°58' E)
29. Büdöszék lake: exposed bottom of the summer-drained salt lake, about 10 km N of Kistelek village (46°31' N, 19°31' E)
30. Büdöszék channel: the bend in the channel about 500 m NE of Büdöszék lake, 10 km NE of Kistelek village (46°32' N, 20°01' E)
31. Pusztaszér: the drained ditch (channel) in the pasture on the SE border of Pusztaszér village, about 10 km N of Kistelek village (46°31' N, 19°59' E)
32. Kelemen lake: the exposed bottom at the W border of the summer-drained salt lake Kelemenszék in Kiskunsági National Park, about 7 km SW of Fülöpszálás, 45 km WSW of Kécskemét town (46°50' N, 19°50' E)
33. Kelemen puszta: temporarily flooded field depression in puszta N of the channel on the N border of lake Kelemenszék about 7 km SW of Fülöpszálás village, 45 km WSW of Kécskemét town (46°50' N, 19°50' E)
34. Fehér: exposed bottom at the N border of Fehér lake N of Kelemenszék lake, near the road from Dunaföldvár to Kécskemét about 45 km WSW of Kécskemét town (46°50' N, 19°12' E)

35. Harta: the wet ditch at the S border of the road from Dunaföldvár to Kécskemét, between the side road to Harta village and the channel Kiskunsági-Föcsatorna (46°49' N, 19°07' E)
36. Fehér-tó channel: the channel Fehér-tó-Majsai-Föcsatorna near the mouth to Fehér-tó lake about 2.5 km NE of Szatymaz village, 15 km NW of Szeged town (46°21' N, 20°06' E)
37. Bösztör: the channel margin near the road bridge about 1 km N of the railway station Bösztör, 45 km W of Kécskemét town (46°59' N, 19°12' E)
38. Apaj: the channel near the road from Apaj to Szityóürbó, about 55 km NW of Kécskemét town (47°07' N, 19°10' E)
39. Kis-Rét: exposed bottom of the Kis-Rét lake about 2 km SW of the railway station Szabadszállás, 45 km WSW of Kécskemét town (46°53' N, 19°12' E)
40. Zab-Szék: exposed bottom on the NE border of Zab-Szék lake about 47 km WSW of Kécskemét town (46°52' N, 19°12' E)
41. Kolbász: the channel in the field about 3 km SE of Kunhegyes village, 45 km of Szolnok town (47°13' N, 20°41' E)
42. Kócsújfalu: field depression in the pasture N of the road from Tiszafüred to Debrecen, near the settlement Kócsújfalu about 15 km ESE of Tiszafüred town (47°34' N, 21° E)
43. Fényes-tó: the ditch near the road from Tiszafüred to Debrecen N of Fényes fishpond, 15 km W of Hortobágy village (47°36' N, 21°04' E)
44. Nyugati: field depression near the channel Nyugati-Fócsatorna, near the road from Tiszafüred to Debrecen by the bridge on the branch road to Telekháza village (47°38' N, 21°04' E)
45. Hortobágy: the ditch near the road through the Hortobágy National Park from Tiszacsege to Balmazjúváros, about 10 km E of Tiszacsege village (47°41' N, 21°10' E)
46. Tiszalök: an oxbow by the left shore of the Tisza river at N border of Tiszalök village near the ferry from Tiszalök to Tiszatardos, about 11 km S of Tokaj town (48°01' N, 21°26' E)
47. Tokaj: left shore of the Tisza river in the camping site near the mouth of Bodrog river, Tokaj town, near the road to Rakamaz (48°08' N, 21°27' E)
48. Szabolcsveresmarti-Tároló: N border of the reservoir near Szabolcsveresmart village, 5 km NW of Döge village, 8 km NNW of Kisvárda town (48°16' N, 22°05' E)
49. Tiszavasvári: exposed bottom of the lake N of the road from Tiszavasvári to Nyíregyháza, about 5 km E of Tiszavasvári town (47°58' N, 21°29' E)

Poland
50. Leba: the shore of Leba lake about 3 km SW of Leba town, about 60 km NW of Gdynia (54°42' N, 17° 31' E)
51. Kórnik: the shore of the lake at the SW border of Kórnik town, about 25 km SE of Poznań (52° 15' N, 17° 08' E)

Germany
52. Teütschenthal: surrounding of saline "slagheap", Saltzstelle Teütschenthal W of Halle, Sachsen - Anhalt, alt. ca 100 m (51° 29' N, 11° 55' E)
53. Saale Holleben: littoral zone of the Saale river, Holleben, ca 5 km S of Halle, Sachsen - Anhalt, alt. ca 100 m (51° 32' N, 11° 58' E)

The Netherlands
54. Kwade Hoek - salt marsh outside Haringvliet (51° 50' N, 4° 03' E)
55. Grevelingen - former brakish estuary now freshwater lake (51° 45' N, 4° E)

56. Millingerwaad - freshwater along river Waal near Nijmegen (stagnant) (51° 52' N, 5° 51' E)
57. Hauuersmeer - former brakish estuary on the North of Holland (between Groningen and Friesland) (53° 11' N, 6° 07' E)
58. N-Beveland - brackish stagnant provence of Zeeland (51° 35' N, 3° 45' E)
59. Dykwater - stagnant brackish provence of Zeeland (Goeree-Overflakkee) (51° 45' N, 4° 06' E)
60. Carnisse Grende - fresh water tidal river
61. Willenstad - former on the border between fresh and brackish water (Hollandsch Diep-Haringuliet) (51° 50' N,4° 29' E)

France
62. marsh Emprunt Nord Tamarguiron, Tour du Valat Wildlife Reserve, Rhône Delta (43° 30' N, 04° 30' E)
63. marsh Relongue Nord, Tour du Valat Wildlife Reserve, Rhône Delta (43° 30' N, 04° 30' E)
64. marsh Cerisière des Faïsses, Tour du Valat Wildlife Reserve, Rhône Delta (43° 30' N, 04° 30' E)
65. marsh Baisse salée, Tour du Valat Wildlife Reserve, Rhône Delta (43° 30' N, 04° 30' E).

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