Chromosome numbers in selected monocotyledons (Czech Republic, Hungary, and Slovakia)

Počty chromozomů vybraných jednoděložných rostlin (Česká republika, Maďarsko a Slovensko)

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The annotated chromosome numbers of 25 species from 6 families of monocotyledons, most of them (14) belonging to *Poaceae* family, are presented here. The data, except three chromosome counts (*Allium oleraceum* from Hungary and *Calamagrostis villosa* from Slovakia), are all based on plants collected in the Czech Republic. The karyological data of 21 species represents new information. While the majority of species presented here originated from one or two localities each, the species *Calamagrostis villosa* has been studied more extensively: all plants, collected altogether at 13 localities (mountain and lower altitudes), are characterized by an invariable decaploid level (2n = 70). The record of triploid *Allium oleraceum* is only the second reference to this rare ploidy level in this species. All original karyological data are compared with literature references to particular species, preferentially from Europe.

K e y w o r d s : karyotaxonomy, cytogeography, *Araceae*, *Cyperaceae*, *Iridaceae*, *Liliaceae*, *Orchidaceae*, *Poaceae*

Introduction

The majority of both published and unpublished chromosome numbers for the Czech flora have been summarized ten years ago in the "List of chromosome numbers of the Czech vascular plants" (Měsíček & Javůrková-Jarolímová 1992). Nevertheless, a lot of additional karyological data have been collected since then. Beside their utility in specialized biosystematic studies, the chromosome counts recorded for Czech plants are also needful for the work "Flora of the Czech Republic", published consecutively since 1988 (Hejný & Slavík 1988–1992, Slavík 1995–2000; six volumes up to the present time). The annotated chromosome counts presented in this contribution have been assembled during the last 18 years. Twenty one species represent new information for the Czech Republic. The karyological data presented here are compared with those taken from the literature. Wherever possibl, published records, which are based on plants from Europe, have been used. The karyological studies on *Hieracium* subgen. *Pilosella* published during the last two years (Krahulcová et al. 2001, Rotreklová et al. 2002) provided data suitable for the 7th volume of the "Flora", now in preparation, which covers the *Asteraceae* family. Hopefully, the material published in the present paper will appear useful for authors of the last volume of this planned eight-volume series, which should cover the monocotyledons of the Czech Republic.

Material and methods

Plants collected in the field were cultivated in the experimental garden of the Institute of Botany, Průhonice. The root-tip meristems of potted plants were usually used for chromosome preparations; only the root-tips of *Dactylorhiza* were taken from wild plants in their natural habitat. If the ripe seeds were collected in the field instead of living plants (as referred in parentheses in the description of localities), the chromosomes were counted in root-tips of young seedlings. The vouchers are deposited in the herbarium of the National Museum Průhonice (PR, designated with specimen number) and in the herbarium of the Institute of Botany, Průhonice (PRA).

A pretreatment at room temperature for 3 hours was usually applied before fixation of the root-tips, either in a 0.05% water solution of colchicine (*Acorus*, *Gladiolus*, *Iris*, *Echinochloa*, *Allium*) or in a saturated water solution of α-bromonaphtalene (*Acorus*, *Aira*, *Cyperus*, *Anthericum*, *Hierochloë*, *Muscari*, *Eriophorum*, *Dactylorhiza*). A combined pretreatment in a saturated water solution of α-bromonaphtalene for 1.5 h at room temperature, and immediately for 4.5 h at 4ºC, gave the best results in the following grasses: *Calamagrostis*, *Nardus*, *Festuca*, *Avenella* and *Sesleria*. After fixation in a cold mixture of ethanol-acetic acid (3:1), the root-tips were stored in cold 70% ethanol until used. The following procedure involved the maceration in 1N HCl at 60ºC for 8–20 min, washing in water, cutting off the meristems and squashing them in a drop of lacto-propionic orcein (Dyer 1963).

Results and discussion

Acorus calamus L. (*Araceae*) 2n = 35

Locality: E Bohemia, distr. Náchod: bank of the small fishpond "Řemínek", N of the village of Lhota-Doubravice, 290 m a.s.l. Coll. F. Krahulec and A. Krahulcová 11. 8. 1989.

The basic chromosome number of x = 12 is usually stated for *Acorus* (e.g. Wieffering 1972, Májovský, Murín et al. 1987). All three ploidy levels known in the genus (i.e. diploid, triploid and tetraploid) have been recorded in South and East Asia (for references see Wieffering 1972). *Acorus calamus* is a polymorphic species, widespread in the North temperate region, tropical Asia and Eastern North America (Ramachandran 1978). Although the triploids are most common in Europe, there are some indications of diploids in the Baltic area (Wieffering 1972) and in Moldavia (Chebotar et al. 1977 sec. Agapova 1990). The European triploids are sterile, spreading vegetatively (Marchant 1973, Riedl 1967–1980). The karylogical data published up to 1970 (including also those from Europe) are reviewed in Wieffering (1972). More recently, triploid *Acorus calamus* (2n = 36) has been recorded in following European countries: Slovakia (Murín & Májovský 1976 sec. Májovský, Murín et al. 1987), the Ukraine (Rudyka 1990), Byelorussia (Dmitrieva & Parfenov 1985 sec. Agapova 1990), England (Marchant 1973) and Sweden (Löve & Löve 1985). On the other hand, several chromosome counts have been reported for *A. calamus* outside Europe, suggesting additional basic chromosome numbers, e.g., x = 9 (2n = 45 from South India – Ramachandran 1978, 2n = 54 from Kashmir – Janaki Ammal et al. 1964 sec. Wiefering 1972), and x = 11, or aneuploidy based on x = 9 (2n = 44 from Thailand – Larsen 1969 sec. Moore 1973). The chromosome count presented in this paper (2n = 35) is indicative for aneuploidy derived from the triploid cytotype (2n = 36).

Aira caryophylea L. (*Poaceae*) 2n = 14

L o c a l i t y : N Bohemia, distr. Česká Lípa: the eastern shore of the "Máchovo jezero" lake, alongside the hiking path on the SW foothill of "Borný" hill, 2 km N of the village of Doksy, 280 m a.s.l. Coll. F. Krahulec in June 1989 (seeds). PR 377892.

Both the diploid (2n = 14) and tetraploid (2n = 28) cytotypes are known in this annual grass (Tutin 1980). Diploids have been recorded e.g. in the Netherlands (Gadella & Kliphuis 1971 sec. Löve & Löve 1974) and in Spain [Romero Zarco 1988 – the subspecies *uniaristata* (Lag. et Rodr.) Maire], while the tetraploids have been reported e.g. from the former Czechoslovakia – southern Bohemia (Kirschner et al. 1982), Germany, Canary Islands (Albers 1973), Austria (Albers 1978 sec. Dobeš & Vitek 2000) and from Spain [Luque & Díaz Lifante 1991 sec. Goldblatt & Johnson 1994 – the subspecies *multiculmis* (Dumort.) Bonnier et Layens]. Both cytotypes occur in France (Albers 1973), Portugal (Queiros 1973 sec. Moore 1977), and the Czech Republic (the diploid presented here, the tetraploid in Kirschner et al.1982).

Allium flavum L. (*Liliaceae*) 2n = 16 + 2B (Fig. 1a)

L o c a l i t y : S Moravia, distr. Třebíč: the protected area "Mohelenská hadcová step", serpentine rocks in the central part of southern slopes above "Jihlava" river, below the parking site in the village of Mohelno, 350 m a.s.l. Coll. A. Krahulcová, J. Štěpánková and A. Klaudisová 14. 5. 1990. PR 377876.

This species occurs in Europe in both the diploid and the tetraploid form (the cytotypes 2n = 16 and 2n = 32, respectively). Moreover, the B-chromosomes have been occassionally recorded in diploids, but never in tetraploids. Diploids (2n = 16) have been reported e.g. from Slovakia (Hindáková 1970 sec. Májovský, Murín et al. 1987, Hrušovská-Osuská 1988 sec. Májovský et al. 2000), Austria (2n = 16, 2n = 16 + 1–2B: several reports in Dobeš & Vitek 2000), France (Natarajan 1978), Italy (2n = 16, 2n = 16 + 2B: Capineri et al. sec. Goldblatt 1984), Rumania (Jacobsen & Ownbey 1977), Macedonia (Šopova 1972 sec. Goldblatt 1981), Serbia (Lovka 1995), Albania (2n = 16 + 1B: Baltisberger & Baltisberger 1995 sec.Goldblatt & Johnson 1998) and from Turkey (n = 8 + $1B_{II}$: De Sarker et al. 1997, 2n = 16: Özhatay 1984 sec.Goldblatt 1988). Tetraploids (2n = 32) are known from the Mediterranean area, e. g. from Spain (Ruiz Rejon 1976) and from Yugoslavia – Montenegro (van Loon & Kieft 1980). Both the diploids and the tetraploids have been recorded in Bulgaria (van Loon & van Setten 1982) and in Greece (Strid & Franzén 1981, Tzanoudakis & Vosa 1988 sec. Goldblatt & Johnson 1991, Karavokyrou & Tzanoudakis 1991 sec. Goldblatt & Johnson 1994). The plant reported here corresponds to the diploid cytotype. It has two additional B-chromosomes, smaller than the other sixteen chromosomes of the set (see Fig. 1a).

Allium oleraceum L. (*Liliaceae*) 2n = 24

L o c a l i t y : Hungary, Pilishegység Mts (Pilis Biosphere reserve): Király-kút, ca. 11 km SSW of the town of Visegrád. Coll. F. Krahulec 21. 4. 1995.

Although this chromosome count is not appropriate for the Czech flora, it is noticable because of its rarity. It corresponds to the triploid level (x = 8) and it is only the second report of a triploid *A. oleraceum*. This cytotype has been found for the first time in plants from the southwestern part of European Russia (Vachtina 1985 sec. Agapova 1990). The following

higher ploidy levels have been recorded more frequently: tetraploid (2n = 32) e.g. from Macedonia (Šopova 1972 sec. Goldblatt 1981), Italy (Capineri et al. 1978 sec. Goldblatt 1984), Slovakia (Váchová & Feráková 1978), Poland (Joachimiak 1990 sec. Goldblatt & Johnson 1994), Finland (Arohonka 1982, Halkka 1985 sec. Goldblatt 1988), Lithuania (Vachtina & Kudryashova 1985 sec. Agapova 1990) and Byelorussia (Parfenov 1980 sec. Agapova 1990). Pentaploids (2n = 40) are known e.g. from Italian Alps (Gadella & Kliphuis 1970 sec. Moore 1973) and from the northeastern part of Europaean Russia (Vachtina & Kudryashova 1985 sec. Agapova 1990). Three ploidy levels (tetraploid, pentaploid and hexaploid) have been recorded in plants from the Czech Republic (Měsíček & Javůrková-Jarolímová 1992, Fialová 1996), Austria (Dobeš & Vitek 2000) and from the Iberian Peninsula (Pastor 1982 sec. Goldblatt 1985).

Anthericum ramosum L. (*Liliaceae*) 2n = 30 (Fig. 1c)

Localities: **1**. C Bohemia, distr. Benešov: on serpentine in the pine wood close to the highway Praha – Brno, between the villages of Bernartice and Borovsko, 410–420 m a.s.l. Coll. F. Krahulec and A. Krahulcová 24. 8. 1989 (seeds). PR 377866. – **2**. S Moravia, distr. Znojmo: on the W slope of a rock ridge between the hill "Svatý Florián" and the village of Rokytná, 0.5 km E of the town of Moravský Krumlov, 280–290 m a.s.l. Coll. A. Krahulcová and J. Štěpánková 14. 5. 1990. PR 377884.

Two chromosome numbers have been reported in this species: 2n = 30 and 2n = 32. The former, which corresponds to that recorded in plants from the both localities in the Czech Republic, has been found in *A. ramosum* in Sweden, Germany, Austria (Küpfer 1974) and Croatia (former Yugoslavia – van Loon & Kieft 1980). The record of 2n = 32 is appropriated to plants from Slovakia (three localities – Murín 1970 and Hindáková 1978 sec. Májovský, Murín et al. 1987, Hindáková & Feráková in Májovský et al. 2000) and from Italy (Löve & Löve 1982).

Avenella flexuosa (L.) Drej. (*Poaceae*) 2n = 28 (Fig. 2a)
[Syn.: *Deschampsia flexuosa* (L.) Trin.]

Locality: C Bohemia, distr. Benešov: on serpentine in the pine wood close to the highway Praha – Brno, between the villages of Bernartice and Borovsko, 410–420 m a.s.l. Coll. F. Krahulec and A. Krahulcová 20. 4. 1989. PR 377743.

Avenella flexuosa is a karyologically polymorphic species, in which the tetraploid cytotype (2n = 28) prevails. These tetraploid plants are also known from other parts of Europe, e.g., from Slovakia (Hindáková 1974 sec. Májovský, Murín et al. 1987), Poland (Frey 1982 sec. Goldblatt 1988), Finland, Norway, Germany and France (Albers 1972), Spain (García-Suarez 1997), Switzerland (Duckert-Henriod 1991) and England (Montgomery et al. 1997). Both the diploids (2n = 14) and the tetraploids (2n = 28) have been recorded by Stoeva (1982) in Bulgaria. In addition to tetraploids (2n = 28), a hexaploid cytotype (2n = 42) has been recorded in Austria (Albers 1978 sec. Dobeš & Vitek 2000). An aneuploid chromosome count (2n = 26) is given by Druskovic & Lovka (1995) from Slovenia.

Calamagrostis canescens (Web.) Roth (*Poaceae*) 2n = 28 (Fig. 2b)

Localities: **1**. E Bohemia, distr. Rychnov nad Kněžnou: on the bank of the fishpond "Houkvice" situated in the wood at the railway (connecting the town of Týniště nad Orlicí and the village of Bolehošť), 250 m a.s.l. Coll. F. Krahulec and A. Krahulcová 24. 8. 1990. – **2**. E Bohemia, distr. Rychnov nad Kněžnou: Opočno, the protected

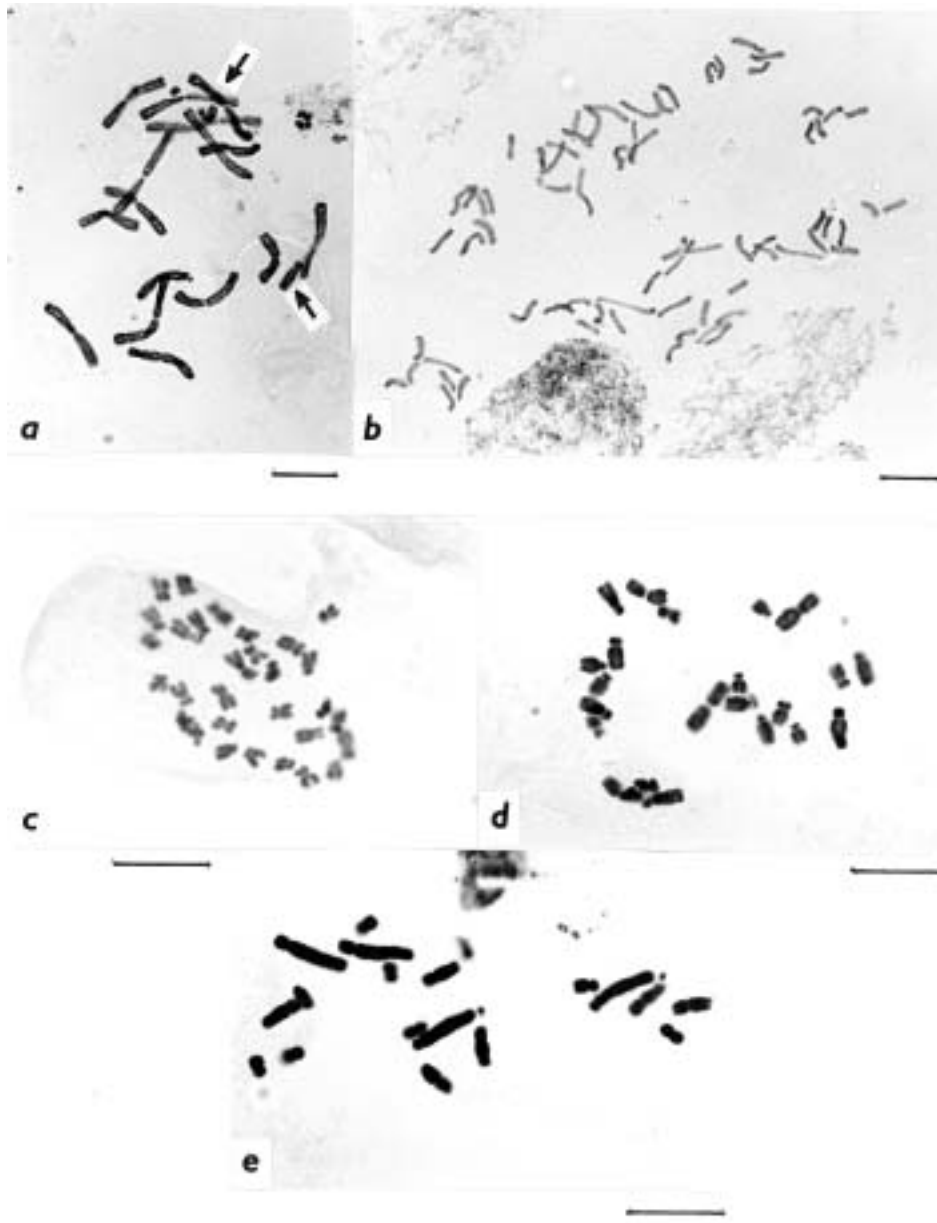

Fig. 1. – Microphotographs of somatic metaphases: a – *Allium flavum*, 2n = 16 + 2B (arrowed); b – *Calamagrostis villosa*, locality 4, 2n = 70; c – *Anthericum ramosum*, locality 1, 2n = 30; d – *Iris arenaria*, 2n = 22; e – *Muscari tenuiflorum*, locality 1, 2n = 18. Scale bars = 10 μm.

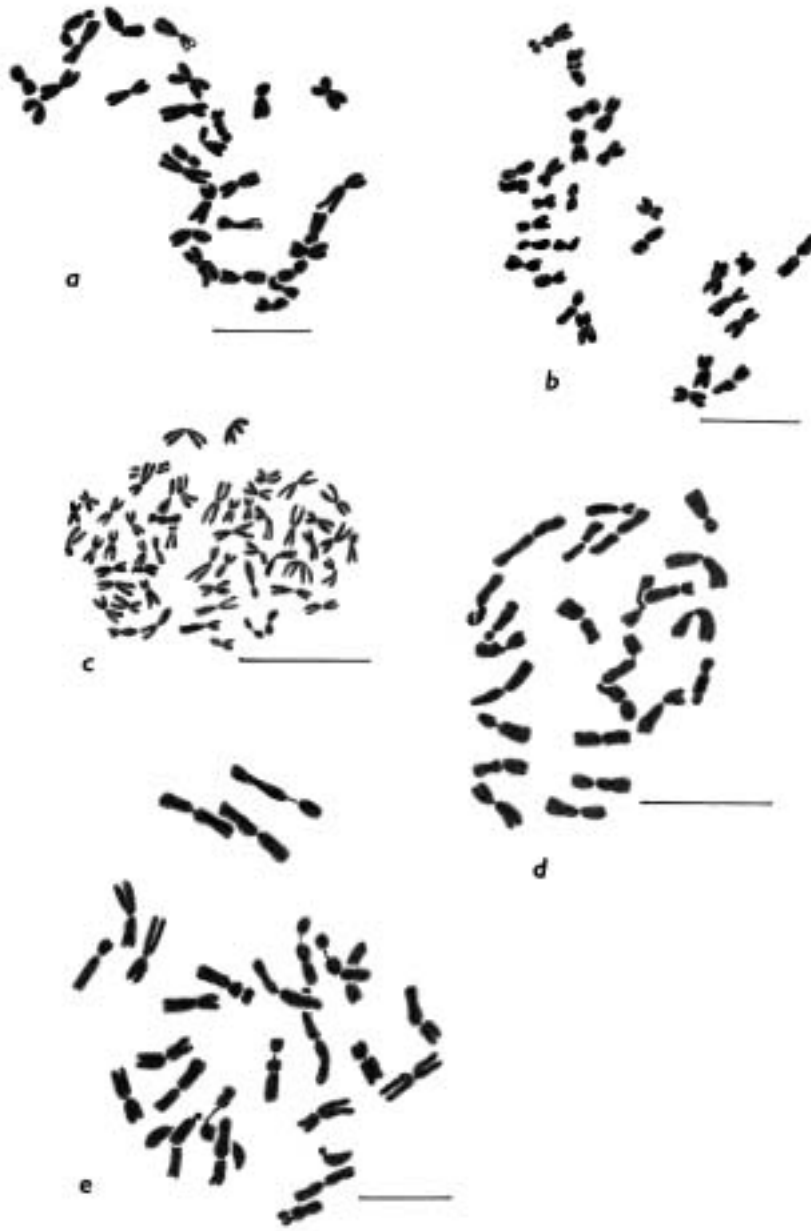

Fig. 2. – Drawings of somatic metaphases: a – *Avenella flexuosa*, 2n = 28; b – *Calamagrostis canescens*, locality 1, 2n = 28; c – *Echinochloa crus-galli*, 2n = 54; d – *Nardus stricta*, 2n = 24; e – *Sesleria uliginosa*, 2n = 28. Scale bars = 10 μm.

area named "Zbytka", the wood 0.5 km W of the railway station at the settlement of Pohoří, 257 m a.s.l. Coll. F. Krahulec in May 1994.

The tetraploid chromosome number reported here is in agreement with references from other parts of the distribution area, e.g. from Slovakia (Mičieta 1986 sec. Goldblatt & Johnson 1996), England (Crackles 1994 sec. Goldblatt & Johnson 1998), Sweden (Nygren 1946), and from northwestern Russia (Sokolovskaya 1972 sec. Agapova 1993).

Calamagrostis epigejos (L.) Roth (*Poaceae*) 2n = 28

Localities: **1**. C Bohemia, Praha: the SSW periphery of the capital, oak forest on the top of southern slopes in the protected area "Cikánka", ca. 0.5–0.7 km SE of the village of Zadní Kopanina, 320–330 m a.s.l. Coll. L. Kirschnerová and A. Krahulcová 16. 9. 1987 (seeds). PR 377671. – **2**. C Bohemia, distr. Benešov: on serpentine in the pine wood close to the highway Praha – Brno, between the villages of Bernartice and Borovsko, 410–420 m a.s.l. Coll. F. Krahulec and A. Krahulcová 20. 4. 1989. PR 377853.

Three ploidy levels, namely tetraploid (2n = 28), hexaploid (2n = 42) and octoploid (2n = 56) have been reported in this species. In Scandinavia, all three cytotypes occur (Nygren 1946). The tetraploids are known from three localities in Slovakia (Murín & Májovský 1978 sec. Májovský, Murín et al.1987, two other localities in Májovský, Murín et al. 1987), the Netherlands (Gadella & Kliphuis 1973 sec. Moore 1977), Greece (Strid & Franzén 1981), Ukraine (Petrova 1977 sec. Agapova 1993) and from Byelorussia (Semerenko 1989 sec. Goldblatt & Johnson 1991). The hexaploids have been recorded in Kazakhstan (Rudyka 1990). The octoploid cytotype occurs in Hungary (Pólya 1949), Finland (Arohonka 1982 sec. Goldblatt 1988), in the northwestern and in the eastern part of European Russia (Sokolovskaya & Probatova 1977 sec. Agapova 1993, Guzik 1984 sec. Goldblatt 1988, Sorokin 1990 sec. Goldblatt & Johnson 1994) and in the North Caucasus (Magulaev 1984 sec. Goldblatt 1988). Both the tetraploids and the octoploids have been reported from Poland (an overview in Frey & Paszko 1999) and from the Russian Far East (Probatova & Sokolovskaya 1983, Probatova et al. 1996 sec. Goldblatt & Johnson 2000).

Calamagrostis varia (Schrader) Host (*Poaceae*) 2n = 28

Locality: E Bohemia, distr. Rychnov nad Kněžnou: Opočno, the protected area named "Zbytka", a dried fen 1.5 km W of the railway station at the settlement of Pohoří, 250 m a.s.l. Coll. F. Krahulec in May 1994.

Only tetraploids (2n = 28) are known in this species. The chromosome number presented here corresponds to references e.g. from Slovakia (Murín & Feráková 1981 sec. Májovský, Murín et al. 1987), Poland (an overview in Frey & Paszko 1999), Sweden – Gotland (Nygren 1946), Slovenia (Druskovic & Lovka 1995) and from Greece (Strid & Franzén 1981).

Calamagrostis villosa (Chaix) J. F. Gmelin (*Poaceae*) 2n = 70 (Fig. 1b)

Localities: **1**. N Bohemia, distr. Most: Krušné hory Mts, a clearing in the relics of declining spruce forest on the western shore of "Fláje" reservoir, ca. 10 km N of the town of Litvínov, 760 m a.s.l. Coll. P. Pyšek in October 1989. – **2**. N Bohemia, distr. Most: Krušné hory Mts, a deforested clearing on the place of a former spruce forest, 1 km W of the western shore of "Fláje" reservoir below the top of "Bradáčov" Mt, ca. 10 km N of the town of Litvínov, 870 m a.s.l. Coll. P. Pyšek in October 1989. – **3**. N Bohemia, distr. Most: Krušné hory Mts, in a dead spruce forest on the E slope of "Bradáčov" Mt, 0.75 km W of the western shore of "Fláje" reservoir, ca. 10 km N of the town of Litvínov, 850 m a.s.l. Coll. P. Pyšek in October 1989. – **4**. N Bohemia, distr. Most: Krušné hory Mts, on the southwestern shore of "Fláje" reservoir, ca. 10 km N of the town of Litvínov 750 m a.s.l. Coll. P. Pyšek in October 1989. – **5**. NE Bohemia, distr. Trutnov: Krkonoše Mts, in the valley of "Kozelský potok" brook NW of

the settlement of Skelné Hutě, ca. 3.2 km N of the village of Vítkovice, on the eastern slope of "Preislerův kopec" Mt, 700 m a.s.l. Coll. L. Papáčková 12. 8. 1993. – **6**. NE Bohemia, distr. Náchod: sandstone rocks "Teplické skály", a peat-bog in "Vlčí rokle" ravin, at the hiking path to a small lake, 540 m a.s.l. Coll. F. Krahulec and A. Krahulcová 20.8. 1990. – **7**. NE Bohemia, distr. Náchod: sandstone rocks "Teplické skály", at the entry to a gorge below the ruin of the castle "Střmen", 530 m a.s.l. Coll. F. Krahulec and A. Krahulcová 7. 6. 1990. – **8**. E Bohemia, distr. Rychnov nad Kněžnou: Orlické hory Mts, the Koruna Mt, in the mountain spruce forest (*Calamagrostio villosae-Piceetum*) NWW of the village of Orlické Záhoří, 1060 m a.s.l. Coll. L. Papáčková 31. 8. 1994. – **9**. E Bohemia, distr. Rychnov nad Kněžnou: in the spruce-oak forest along the railway between the railway station "Petrovice" and the fishpond "Houkvice" near the town of Týniště nad Orlicí, 250 m a.s.l. Coll. F. Krahulec and A. Krahulcová 24. 8. 1990. – **10**. E Bohemia, distr. Litomyšl: Nové Hrady, on sandstone in the forest in an inversion valley of Voletínský potok brook, ca. 1 km S of the village of Vranice, 480 m a.s.l. Coll. F. Krahulec in March 1991. – **11**. S Bohemia, distr. Jindřichův Hradec: in a waterlogged spruce forest near the village of Stará Hlína-Kouty, 430 m a.s.l. Coll. L. Papáčková in July 1991.

Additional localities outside the Czech Republic: **12**. Slovakia, Belianské Tatry Mts: at the mountain lake "Biele pleso", along the hiking path ca. 1.5 km SE of "Kopské sedlo" saddle, 1740 m a.s.l. Coll. A. Krahulcová 5. 8. 1992. – **13**. Slovakia, Vysoké Tatry Mts: at the mountain lake "Nižné Temnosmrečianske pleso", along the hiking path ca. 50 m of the bank of the lake, 1670 m a.s.l. Coll. A. Krahulcová 7. 8. 1992.

A decaploid level (2n = 10x = 70) was recorded in plants from all 13 localities studied; an approximate chromosome number of 2n = ca. 70 was counted in plants from loc. no. 6. and 9. The plants examined originated from mountain areas, as well as from lower altitudes, where there are relic occurrences of this species. The variation in ploidy in *C. villosa* has already been reported by Nygren (1962). Nevertheless, the decaploid level, which seems to be common in Central Europe now, remained unrevealed until the 1980s (Rychlewski in Pogan, Izmaiłow et al. 1983). Following this first report from the Tatra Mts in Poland, the same decaploid level was later reported by Měsíček & Javůrková-Jarolímová (1992) in *C. villosa* from the Jizerské hory Mts, Czech Republic.

The other published chromosome numbers in *C. villosa* correspond to three ploidy levels altogether, all lower than the decaploid level: tetraploid (2n = 28), hexaploid (2n = 42) and octoploid (2n = 56). The occurrence of the both tetraploid and octoploid cytotype in Central Europe has already been mentioned by Nygren (1962), but without any reference to localities. Previously, tetraploids have been reported from the Alps in Austria (Nygren 1946) and later also from the Western Carpathians (Západné Tatry Mts) in Slovakia (Murín & Májovský 1987 sec. Májovský, Murín et al. 1987). In this mountain area, however, the octoploid cytotype has been recorded as well (Murín & Májovský 1978 sec. Májovský, Murín et al. 1987). Moreover, the hexaploid cytotype is also reported from the Slovakia – Slovenské rudohorie Mts (Murín & Májovský 1976). The identity of these plants should be studied with respect to uniformity in chromosome numbers presented here.

Cyperus fuscus L. (*Cyperaceae*) 2n = 36

Locality: E Bohemia, distr. Náchod: on the bank of the small fishpond "Řemínek" N of the village of Lhota – Doubravice, 290 m a.s.l. Coll. F. Krahulec and A. Krahulcová 11. 8. 1989. PR 377865.

Two chromosome numbers: 2n = 36 from England (Montgomery et al. 1997) and 2n = 72 from Scandinavia (Löve & Löve 1961) and Slovakia (Murín 1978 sec. Májovský, Murín et al. 1987) have been reported in *C. fuscus* from Europe. The different chromosome number of n = 24 (corresponding to 2n = 48) has been recorded by Rath et al. (1973 sec. Moore 1977), probably in plants outside Europe. The chromosome number reported here from the Czech Republic is in agreement with that found in *C. fuscus* in England (Montgomery et al. 1997).

Dactylorhiza fuchsii (Druce) Soó (*Orchidaceae*) 2n = 80

L o c a l i t y : NE Bohemia, distr. Trutnov: Krkonoše Mts, mountain grassland (wet meadow, a slope spring area) above the chalet "Severka", 2 km NW of the village of Pec pod Sněžkou, 1100 m a.s.l. Coll. F. Krahulec and A. Krahulcová 15. 6. 1989, 13. 7. 1991.

The chromosome number of 2n = 80 has been recorded at this locality in the Sudeten Mts, in plants characterized by two different morphotypes as well as in an intermediate form. The two morphotypes mentioned may correspond to subsp. *fuchsii* and to subsp. *sudetica* (Pöch ex Rchb. f.) Verm. [Syn.: *D. maculata* subsp. *sudetica* Vöth, *D. longebracteata* subsp. *sudetica* (Pöch ex Rchb.) Holub, *D. sudetica* (Pöch ex Rchb. f.) Averyanov], respectively. For morphological and ecological characters distinguishing between the both subspecies see, e.g., Procházka (1980: 238, 2002: 778). As the justification to distinguish the separate subspecies *sudetica* remains unclear (F. Procházka, pers. comm.), the chromosome number presented here corresponds to the species *D. fuchsii* s.l.

D. fuchsii is often classified as a member of *D. maculata* group (e.g. Soó 1980, Vöth & Greilhuber 1980, Jagiełło 1986–1987). So far, diploids (2n = 20), tetraploids (2n = 40) and octoploids (2n = 80) have been reported in *D. fuchsii*. Only a single report on the lowest chromosome number (2n = 20) is known (Stepanov 1994). Averyanov (1990) has treated the number of x = 20 as the basic one in the genus *Dactylorhiza*, because no plants having 2n = 20 had previously been reported. Consequently, according to Averyanov, plants having 2n = 40 should be considered as diploids and those having 2n = 80 as tetraploids. If this is correct, the chromosome count of 2n = 20, reported later in *D. fuchsii* from southern Siberia (West Sayan) by Stepanov (1994), should be omitted as erroneous. Besides this count, however, the chromosome number of 2n = 40 is given by the same author from this area (Stepanov 1994). In the paper presented here, the existence of diploid *Dactylorhiza* with 2n = 20 is accepted; therefore, the cytotype with 2n = 40 is called tetraploid and that with 2n = 80 octoploid.

Concerning the species *D. fuchsii*, the common tetraploids (2n = 40) have frequently been reported e.g. from Slovakia (Uhríková 1978 sec. Májovský, Murín et al. 1987), Byelorussia (Semerenko 1989 sec. Goldblatt & Johnson 1991), Estonia (Jagiełło et al. 1989 sec. Goldblatt & Johnson 1991), Belgium, France and Luxembourg (Gathoye & Tyteca 1989), England (Montgomery et al. 1997) and Norway (Borgen 1990).

Both cytotypes (2n = 40, 2n = 80) have been recorded by Jagiełło & Lankosz-Mróz (1986–1987) in Poland, among others also on the Polish side of the Krkonoše Mts. No significant correlations could be found between the cytotypes in Poland, neither with respect to their habitats nor to their morphology (Jagiełło 1986–1987). However, only one plant collected in the mountain wet meadow in the Krkonoše Mts, has been examined karyologically (Jagiełło 1986–1987). This plant corresponded morphologically and ecologically to *D. fuchsii* subsp. *sudetica*, and its chromosome number is 2n = 80 [Jagiełło 1986–1987: 369–370, the plant reported under the name of *Dactylorhiza maculata* (L.) Soó subsp. *sudetica* (Poech ex Rchb. fil.) Vöth]. Both the chromosome numbers of 2n = 40 and 2n = 80 have been recorded for *D. fuchsii* from Austria [Vöth & Greilhuber 1980, Dobeš & Vitek 2000, by the former authors under the name of *D. maculata* (L.) Soó subsp. *meyeri* (Rchb. fil.) Tournay], but only the octoploid chromosome number (2n = 80) has been recorded there in plants corresponding to *D. fuchsii* subsp. *sudetica* [Vöth & Greilhuber 1980, under the name of *D. maculata* (L.) Soó subsp. *sudetica* (Pöch ex Rchb.

fil.) Vöth var. *psychrophila* (Schlechter) Vöth]. The same octoploid level was recorded by Měsíček & Javůrková-Jarolímová (1992) in *D. fuchsii*, reported under the name of *D. longebracteata* (F. W. Schmidt) Holub, which originated from the Orlické hory Mts, eastern Bohemia.

Echinochloa crus-galli (L.) Beauv. (*Poaceae*) 2n = 54 (Fig 2c)

Locality: E Bohemia, distr. Náchod: field margin on the right bank of the "Metuje" river close to "Nahořanský most" bridge, near the village of Nahořany, 275 m a.s.l. Coll. F. Krahulec 20. 8. 1986 (seeds). PR 377635.

This chromosome number, corresponding to the hexaploid level, considerably prevails in this species in Europe. The references concern plants e.g. from Slovakia (two localities – Hindáková 1974 sec. Májovský, Murín et al. 1987), Poland (Pogan, Wcisło et al. 1982 sec. Goldblatt 1985), the Ukraine (Petrova 1977 sec. Agapova 1993) and Spain (Carretero 1981). The different chromosome number, 2n = 56, has been reported in plants from Bulgaria (Kozuharov & Petrova 1991 sec. Goldblatt & Johnson 1996). Outside Europe, the tetraploids (2n = 36) have been recorded in southern Siberia (Stepanov & Muratova 1992 sec. Goldblatt & Johnson 1996). A polyploid series (2n = 18, 36, 54, 72) is reported for this species, mainly outside Europe (e.g. Nazarova & Goukasian 1995). The highest chromosome number of 2n = 90, corresponding to decaploid level, has been recorded in var. *breviseta* (Malik & Grover 1972 sec. Moore 1974).

Eriophorum angustifolium Honck. (*Cyperaceae*) 2n = 58

Locality: E Bohemia, distr. Havlíčkův Brod: wet meadow 0.5 km E of the village of Opatovice near the town of Světlá nad Sázavou, 530 m a.s.l. Coll. F. Krahulec and A. Krahulcová 20. 4. 1989. PR 377854.

The chromosome number of 2n = 58 is the most frequent one among the karyological data on *E. angustifolium* from Europe. It is reported e.g. from Slovakia (Murín 1978 sec. Májovský, Murín et al. 1987), Poland (Pogan et al. 1986 sec. Goldblatt & Johnson 1990) and from the Netherlands (Gadella & Kliphuis 1966 sec. Moore 1973). In plants outside Europe (Chukotka peninsula and northern Alaska, respectively), this chromosome number has been recorded as well (Zhukova 1980 sec. Goldblatt 1984, Packer & McPherson 1974 sec. Moore 1977). The only different chromosome number (2n = 54) is given by Stoeva (1985, 1992 sec. Goldblatt 1988, 1996) from Bulgaria.

Eriophorum vaginatum L. (*Cyperaceae*) 2n = 58

Locality: S Bohemia, distr. Prachatice: Šumava Mts, the peatbog "Jezerní slať" near the village of Horská Kvilda, 1000 m a.s.l. Coll. J. Kyncl 1988 (seeds). PR 377852.

The chromosome number presented here in plants from the Šumava Mts confirms the references e.g. from Slovakia (Murín 1978 sec. Májovský, Murín et al. 1987), Poland (Pogan, Rychlewski et al. 1980 sec. Goldblatt 1984), Byelorussia (Semerenko 1990 sec. Goldblatt & Johnson 1994), Russian Far East (Kozhevnikov et al. 1986 sec. Goldblatt & Johnson 1990) and Alaska (Packer & McPherson 1974 sec. Moore 1977). Two cytotypes (2n = 58, 2n = 83) are given from Bulgaria (Stoeva 1992 sec. Goldblatt & Johnson 1996). The record of plants with 2n = 26 is reported from the Caucasus (Georgia – Southern Osetia: Gvinianidze & Avazneli 1982 sec. Agapova 1990).

Festuca heterophylla Lam. (*Poaceae*) 2n = 28

Locality: N Bohemia, distr. Litoměřice: České středohoří Mts, on the southwestern slope of "Ostrý" hill, ca. 2 km W of the village of Březno, 500 m a.s.l. Coll. F. Krahulec and A. Krahulcová 7. 5. 1989. PR 377714.

This species appears to be invariable in chromosome number. The tetraploid level presented here is in agreement with references e.g. from Slovakia (Uhríková 1974 sec. Májovský, Murín et al. 1987, Uhríková & Májovský in Májovský et al. 2000), Belgium (Auquier & Ramerloo 1973 sec. Moore 1977), Bulgaria (Nikolov 1991 sec. Goldblatt & Johnson 1994) and Greece (Strid & Franzén 1981).

Festuca rubra agg. (*Poaceae*)[1]

F. rubra L. subsp. *rubra* 2n = 42

Localities: **1**. NE Bohemia, distr. Trutnov: Krkonoše Mts, the meadow called "Braunovy louky" (*Nardo-Agrostion tenuis*) near the settlement of "Janovy Boudy", 1.5 km E of the church in the village of Velká Úpa, ca. 880 m a.s.l. Coll. F. Krahulec in June 1985. – **2**. NE Bohemia, distr. Trutnov: Krkonoše Mts, mountain grassland above the chalet "Severka", 2 km NW of the village of Pec pod Sněžkou, 1080 m a.s.l. Coll. F. Krahulec in June 1985. – **3**. E Bohemia, distr. Náchod: Nové Město nad Metují, a wet meadow (*Molinion*) near the village of Doubravice on the eastern shore of "Rozkoš" reservoir, 283 m a.s.l. Coll. F. Krahulec in August 1985.

F. rubra L. subsp. *juncea* (Hackel) K. Richter 2n = 56

Localities: **1**. E Bohemia, distr. Náchod: Nové Město nad Metují-Krčín, garden lawn on a S exposed, eroded slope, 290 m a.s.l. Coll. F. Krahulec in August 1985. – **2**. E Bohemia, distr. Náchod: Nové Město nad Metují, a xerothermic grassland (*Bromion erecti*) on a northern margin of the village of Doubravice, near the eastern shore of Rozkoš reservoir, 290 m a.s.l. Coll. F. Krahulec in August 1985.

F. nigrescens Lam. 2n = 42
[Syn.: *F. rubra* subsp. *commutata* Gaudin]

Locality: E Bohemia, distr. Náchod: Náchod-Dobrošov, an acidophytic grassland (*Violion caninae*), 200 m eastern of tourist watch-tower, 620 m a.s.l. Coll. F. Krahulec in June 1985.

F. diffusa Dumort. 2n = 56

Locality: W Bohemia, distr. Louny: Podbořany, at the W edge of "Vroutecký" les wood near the village of Valov, 350 m. a.s.l. Coll. J. Štěpánek in June 1985.

At least five ploidy levels have been recorded within the polyploid complex of *Festuca rubra* group (for review see Krahulec 1994). Besides the prevailing hexaploid chromosome number of 2n = 42 (x = 7), the numbers of 2n = 14, 28, 56 and 70 have been found there as well. In addition, the chromosome numbers of 2n = 35, 49 and 2n = 63 have been rarely recorded, and are usually hybrid plants. The two lowest ploidy levels, i.e. the diploid and tetraploid, as well as the highest decaploid level, occur in the southwestern Europe, namely in *F. rivularis* Boiss. (2n = 14: Kerguélen 1975 sec. Goldblatt 1984), in *F. pyrenaica* Reuter (2n = 28: Markgraf-Dannenberg 1980: 141) and in *F. nevadensis* [Hackel) Markgr.-Dannenb. (2n = 70: Markgraf-Dannenberg 1980: 142].

While the both hexaploids and octoploids (2n = 42, 56) occur in *F. rubra* subsp. *rubra* in Poland (Skalińska et al. 1971 sec. Moore 1973, Konarska 1974 sec. Goldblatt 1981),

[1] The names of taxa are according to Markgraf-Dannenberg (1980).

only the hexaploid level is reported from other parts of its distribution area in Europe, e.g. from Slovakia (Májovský, Murín et al. 1987, Hindáková in Májovský et al. 2000), Belgium (Auquier & Rammeloo 1973), Portugal (Queiros 1974 sec. Goldblatt 1981), Great Britain (Stace 1984 sec. Goldblatt 1988) and Greece (Strid & Franzén 1983 sec. Goldblatt 1985).

Festuca rubra subsp. *juncea* is represented by two cytotypes, hexaploid and octoploid (the octoploid cytotype with 2n = 56 is presented here from eastern Bohemia). While the hexaploid plants (2n = 42) are reported e.g. from Great Britain – Wales and Scotland (Al-Bermani et al. 1992), both hexaploids and octoploids have been recorded in Belgium (Auquier & Rammeloo 1973, Al-Bermani et al. 1992).

The chromosome number of 2n = 42, presented here in *F. nigrescens* (2n = 42), also confirms the hexaploid level reported previously in this taxon, e.g. from Poland (Konarska 1974 sec. Goldblatt 1981), Slovakia (Májovský, Murín et al. 1987), France (Kerguélen 1983) and Belgium (Auquier & Rammeloo 1973).

Festuca diffusa has been recorded as the octoploid cytotype (2n = 56) in Belgium [Auquier & Rammeloo 1973 under the name of *F. rubra* subsp. *multiflora* (Steudel) Piper]. However, both hexaploids and octoploids are known in this species (Kerguélen 1972 sec. Auquier & Rammeloo 1973). The octoploid cytotype has also been recorded in the introduced distribution area in eastern Canada (Dubé et al. 1985).

Gladiolus imbricatus L. (*Iridaceae*) 2n = 60

L o c a l i t y : NE Bohemia, distr. Trutnov: Krkonoše Mts, the meadow called "Braunovy louky" near the settlement of "Janovy Boudy", 1.5 km E of the church in the village of Velká Úpa, 860 m a.s.l. Coll. F. Krahulec and A. Krahulcová 4. 7. 1989. PR 377762.

This tetraploid chromosome number (x = 15) recorded in an isolated population in the Krkonoše Mts is in agreement with references from other parts of the distribution area: Slovakia – three localities (Uhríková 1974 sec. Májovský, Murín et al. 1987, Mičieta et al. in Májovský et al. 2000), Slovenia (Sušnik & Lovka 1973, Lovka 1995) and Byelorussia (Semerenko 1990 sec. Goldblatt & Johnson 1994).

Hierochloë australis (Schrad.) Roem. et Schult. (*Poaceae*) 2n = 14

L o c a l i t y : N Bohemia, distr. Litoměřice: the České středohoří Mts, in the oak forest on the southwestern foothill of "Ostrý" hill, ca. 0.75 km NE of the village of Kocourov, 490 m a.s.l. Coll. F. Krahulec and A. Krahulcová 7. 5. 1989. PR 377752.

The same chromosome number, corresponding to the diploid level (x = 7), has been recorded in plants e.g. from Poland (Skalińska et al. 1974 sec. Goldblatt 1981), Byelorussia (Semerenko 1989 sec. Goldblatt & Johnson 1991), Finland, Germany, Austria, Italy and Romania (Weimarck 1971).

Iris arenaria Waldst. et Kit. (*Iridaceae*) 2n = 22 (Fig. 1d)

L o c a l i t y : S Moravia, distr. Břeclav: Pavlovské vrchy hills, steppe sites on eastern slope of "Turold" hill, 370 m a.s.l. Coll. A. Krahulcová , J. Štěpánková and A. Klaudisová 15. 5. 1990.

The chromosome number of 2n = 22 is in agreement with data from Slovakia (Uhríková 1974 sec. Májovský, Murín et al. 1987), Hungary (Pólya 1949) and Austria [three refer-

ences: Dobeš et al. 1997 sec. Goldblatt & Johnson 2000, Mitra 1956 sec. Dobeš & Vitek 2000, in the former reference under the name of *Iris humilis* subsp. *arenaria* (Waldst. et Kit.) Á. Löve et D. Löve].

Muscari tenuiflorum Tausch (*Liliaceae*) 2n = 18 (Fig. 1e)
[Syn.: *Leopoldia tenuiflora* (Tausch) Heldr.]

Localities: **1**. C Bohemia, Praha: the SSW periphery of the capital, southern slopes in the protected area "Cikánka", ca. 0.5–0.7 km SE of the village of Zadní Kopanina, 320–330 m a.s.l. Coll. L. Kirschnerová and A. Krahulcová 16. 9. 1987 (seeds). – **2**. S Moravia, distr. Vyškov: in the protected area "Ševy", 1.5 km S of the village of Bučovice-Marefy, 270 m a.s.l. Coll. P. Tomšovic, A. Krahulcová and V. Jarolímová 26. 4. 1989. PR 377750.

The chromosome number of 2n = 18 coincides with references from the literature, e. g. from Slovakia (Murín & Májovský 1978 sec. Májovský, Murín et al. 1987), Turkey (Dalgiç 1991 sec. Goldblatt & Johnson 1994) and Iran (Goldblatt 1974).

Nardus stricta L. (*Poaceae*) 2n = 24 (Fig. 2d)

Locality: NE Bohemia, distr. Trutnov: Krkonoše Mts, the meadow called "Braunovy louky" near the settlement of "Janovy Boudy", 1.5 km E of the church in the village of Velká Úpa, 860 m a.s.l. Coll. F. Krahulec and A. Krahulcová 4. 7. 1989.

The diverse somatic chromosome numbers ranging from 2n = 22 to 2n = 30 have been recorded in this species in Europe. The prevailing number of 2n = 26 has been reported in plants e.g. from Slovakia (Uhríková 1976 sec. Májovský, Murín et al. 1987, Uhríková & Králik 2000), the Ukraine (Pashuk 1987 sec. Goldblatt & Johnson 1990), Finland (Arohonka 1982 sec. Goldblatt 1988), the Netherlands (Gadella & Kliphuis 1967 sec. Löve & Löve 1974) and from Spain (Löve & Kjellkquist 1973 sec. Moore 1977). The different chromosome counts have been found in plants from Poland (2n = 22–28, Rychlewski 1967), Spain (2n = 27, Küpfer 1974), Greece (2n = ca. 24, Strid & Franzén 1981) and from Iceland (2n = 26–30, Löve & Löve 1956 sec. Löve & Löve 1961). Aneusomaty (i.e. different aneuploid chromosome numbers within one plant), probably due to mitotic disturbances, has been recorded in this apomictic species, which has a wide distribution area and a high degree of morphological uniformity (Rychlewski 1967).

The invariable chromosome number of 2n = 24 was found in the plant from the Krkonoše Mts (total of 4 root-tips and 6 metaphases examined). This number conforms with the accepted range of chromosome number variation in *Nardus stricta*.

Sesleria uliginosa Opiz (*Poaceae*) 2n = 28 (Fig. 2e)
[Syn.: *Sesleria caerulea* (L.) Ard.]

Locality: E Bohemia, distr. Náchod: grassy slope at the southeastern edge of the wood "Rousín", S of the village of Spyta, 300 m a.s.l. Coll. F. Krahulec 13. 8. 1987 (seeds). PR 377672.

This chromosome number (2n = 28) has already been recorded in plants from Poland (Bielecki 1955) and Bulgaria (Kozuharov & Petrova 1973 – an approximate count). The same tetraploid level (detected by means of flow cytometry, x = 7) has been reported in this species by Lysák & Doležel (1998) in plants collected in the Czech Republic (two localities in central and eastern Bohemia) and in Slovakia (Veľká Fatra Mts).

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Souhrn

Příspěvek shrnuje komentované chromozomové počty jednoděložných rostlin nashromážděné autorkou během posledních 18 let. Tento materiál byl zpracován zejména pro potřeby Květeny ČR tak, aby toto dílo poskytovalo originální karyologické údaje z území České republiky. Chromozomové počty prezentované v tomto příspěvku pokrývají celkem 25 druhů z 6 čeledí, převážně z čeledi *Poaceae*. Kromě vzácného triploidního chromozomového počtu *Allium oleraceum* z Maďarska (2n = 24) a údajů o dekaploidní *Calamagrostis villosa* ze dvou slovenských lokalit (2n = 70), se zde uvedená ostatní data vztahují k rostlinám z území České republiky. Většina chromozomových počtů (náležejících 21 druhům) je přitom pro území ČR nová. Chromozomové počty jednotlivých taxonů jsou obvykle založeny na sběrech z jedné až dvou lokalit. *Calamagrostis villosa* byla studována z celkem 13 lokalit, reprezentujících jak horská, tak níže situovaná stanoviště s reliktním výskytem tohoto druhu. U všech rostlin byl potvrzen výskyt pouze dekaploidního cytotypu (2n = 70). V příspěvku jsou poprvé prezentovány i chromozomové počty čtyř taxonů z okruhu *Festuca rubra* z území České republiky. Všechny zjištěné chromozomové počty jsou porovnány se známými karyologickými údaji o daných taxonech z literatury. Přednostně byla excerpována literatura vztahující se k rostlinám z Evropy.

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