

Cytotaxonomical study of *Caltha palustris*

Cytotaxonomická studie druhu *Caltha palustris*

Anna Chrtková¹ & Vlasta Jarolímová²

¹Mimoňská 639, Praha 9, CZ-190 00 Praha, Czech Republic; ²Institute of Botany, Academy of Sciences of the Czech Republic, CZ-252 43 Průhonice, Czech Republic

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Authors have divided the populations of *Caltha palustris* L. from the Czech Republic into four subspecies: subsp. *cornuta* (Schott, Nyman et Kotschy) Hegi with $2n = 32$ chromosomes, subsp. *laeta* (Schott, Nyman et Kotschy) Hegi with $2n = 32$ (34) in lowland and with $2n = 56$ (57, 58, 59, 61, 64) in mountains, subsp. *palustris* with $2n = 32$ (34, 35, 36) chromosomes, and subsp. *procumbens* (Beck) Neumayer with $2n = 56$ (55, 57, 59, 56 + 6B) chromosomes. The chromosome numbers of $2n = 32, 44, 47$ were also found in some intermediates. Chromosome counts for 88 samples are presented. Great variation in morphological features were found in all subspecies. Morphological characters are independent of each other, ecological conditions influence some of their values. Results are given for plants in wild, in herbaria and for 129 samples cultivated in an experimental field.

Key words: *Caltha palustris*, *Ranunculaceae*, taxonomy, chromosome numbers, Czech Republic, Slovak Republic, Rumania

Introduction

About 40 species belong to the genus *Caltha* (*Ranunculaceae*), 20–25 of them occur in the northern hemisphere and are placed to the subgenus *Caltha*. In the Czech Republic and Slovakia only one species is present, the very variable *C. palustris* L. It represents a very polymorphic complex of lower taxa, classified by different authors as species, subspecies, varieties, forms or only as ecological variants (Beck 1886, Huth 1892, Smit 1967, 1968, 1973, Chrtková 1988). *C. palustris* is a common species in the Czech and Slovak Republics, distributed all over the territory, in various ecological conditions and altitudinal belts. This study has resulted especially from cyto geographical analyses and can be a basis for further study of relationships among the subspecies of *Caltha palustris*.

Material and methods

The objects of study were herbarium sheets, plants cultivated in an experimental field, and individuals and populations in nature. Experimental plants (cultivated in an experimental garden of the Institute of Botany in Průhonice near Prague, in the years 1976–1986) originated mostly from natural habitats in the Czech and Slovak Republics. Some plants from Rumania, Bulgaria and Poland were also added. Vaucher specimens are deposited in the herbarium of the National Museum in Prague (PR). Part of cultivated plants (88 samples) were used for cytological study. One or two plants were used for chromosome studies from each sample. Root tips of cultivated plants were pre-treated with p-dichlorobenzene, fixed in alcohol-acetic acid 3 : 1 mixture and stained with lacto-propionic-orceine.

Key to the subspecies of *Caltha palustris*

- 1a Ripe follicles straight or slightly curved; the dorsal side straight or slightly curved; the ventral side strongly curved; beak \pm straight. Stems erect or ascending; leaves reniform, reniform cordate, rounded cordate or sagittate, (5–) 8–15 (–22) cm in diameter, serrulate-dentate, dentate or crenate; flowers bright or golden yellow, 25–32 mm in diameter, perianth segments ovate to broadly ovate, mostly not contiguous **subsp. *laeta*** (Schott, Nyman et Kotschy) Hegi
- 1b Ripe follicles curved outside, both on the dorsal and ventral side; beak curved 2
- 2a Ripe follicles strongly curved in a bow, mostly only 2.5–3.4 mm broad, slowly narrowed to the apex; beak \pm 2 mm long; leaves often longer than broad. Stems erect, rarely ascending, long, robust; leaves cordate to nearly orbicular, (10–) 15–25 (–26) cm in diameter, serrulate, serrulate-dentate or dentate; flowers large, bright to dark golden yellow, 28–40 mm in diameter, perianth segments broadly ovate, with the margins mostly overlapping **subsp. *cornuta*** (Schott, Nyman et Kotschy) Hegi
- 2b Ripe follicles in an S-shape curved, mostly (3–) 4–5 (–6) mm broad, suddenly narrowed to the apex; beak \pm 1.5 mm long; leaves mostly broader than long 3
- 3a Stems mostly decumbent, procumbent or creeping, rooting at the nodes in fruiting stage, rarely in the flower. Leaves orbicular, reniform or cordate-reniform, (2–) 5–20 cm in diameter, crenate or dentate; flowers pale, bright to golden yellow, often smaller than 25–30 mm in diameter, perianth segments oblong or ovate, not or only rarely overlapping **subsp. *procumbens*** (Beck) Neumayer
- 3b Stems erect or rarely ascending, not rooting at the nodes. Leaves reniform or cordate-reniform or orbicular, 6–20 (–26) cm in diameter, serrulate-dentate, dentate, crenate or entire; flowers golden yellow, 25–33 mm in diameter, perianth segments oval or broadly oval, often with overlapping margins **subsp. *palustris***

Morphological characters

A wide variation of some morphological characters in *Caltha palustris* is influenced to a high degree by external environment. The length of stems (mean 30–50 cm) is dependent on the height and elevation of water level, or on the nutrition contents of the soil. Nevertheless, in subsp. *cornuta* long, erect stems are more common; in contrast, in the mountain forms of subsp. *laeta* short stems predominate. In subsp. *procumbens* the stems are sometimes very long, up to 2 m in creeping plants. Plants grown in the experimental field, however, lost their extremely long stems in the years following the transplantation. The size and shape of leaves, the form of the margin of leaves, the colour of petioles and the colour and shape of perianthsegments change both during one or several years and on the same plant. *C. palustris* subsp. *cornuta* has leaves usually longer than broad, the others three subspecies have leaves broader than long. The flowers are largest in subsp. *cornuta* and smallest in subsp. *procumbens*. For the latter this only holds true in the wild while in the experimental field they reach nearly the average values of subsp. *palustris*. These unsteady characters were often used for differentiation of subspecies, varieties, forms and rarely species.



Fig. 1. – Follicles in the *Caltha palustris* L. 1 – subsp. *palustris*, 2 – subsp. *laeta*, 3 – subsp. *cornuta*, 4 – subsp. *procumbens*. According to Chrtková 1988, drawn by J. Chrtěk sen.

Stems rooting at the nodes and namely the shape and position of follicles are relatively constant characters. The stems rooting during the late spring or more often in summer are characteristic of the subsp. *procumbens*. However, this character needs not appear every year. In the experimental field the sample no. 12, 13, 50 ($2n = 56$) did not root over several years. Rarely, plants of subsp. *palustris* were weakly rooting when covered by earth in some seasons.

The form of the follicles – clearly defined only in the ripe follicles – is considered as the most important character for distinguishing particular subspecies (Fig. 1). Subsp. *cornuta* has the follicles strongly bowed outside or gradually narrowed to the apex. Subsp. *laeta* has the follicles straight or slightly curved or suddenly narrowed to the apex. Subsp. *palustris* and subsp. *procumbens* have the follicles curved in an S-shape, suddenly narrowed to the apex. Subsp. *palustris* and subsp. *laeta* are sometimes connected by plants of intermediate character in habitats of common occurrence. In the wild, subsp. *procumbens* has smaller and only few follicles but the difference is not so clear in the experimental field.

Karyology

The collective species *C. palustris* proves to be variable also in its karyology. Numerous papers concerned with its chromosome numbers contain both the individual data and cytogeographical studies (see Fedorov et al. 1969, Goldblatt 1981, 1984, Goldblatt & Johnson 1990, 1991). Especially the European populations have been thoroughly examined (Reese 1954, Wcisło 1967, Smit 1967, 1970). The lowest number of $2n = 16$ has been recorded only in plants collected in Italy (Leoncini 1951) and the Caucasus (Gvinianidze & Avazneli 1982, Davlianidze 1984). The further two cytotypes of polyploid series $2n = 32$ and $2n = 56$ are prevailing in whole area of the complex, whereas next euploids of $2n = 48, 64, 72, 80, 88$ occur rarely. Besides the euploids also aneuploid chromosome numbers fluctuating around $2n = 32$ and 56 and B-chromosomes have been reported (Leoncini 1952, Maugini 1953, Reese 1954, Wcisło 1967, Kootin-Sanwu & Woodell 1970, Malick & Mary 1970, Bismark & Bässler 1974). Previous cytological records were usually given under the name *C. palustris* L. However, the taxonomic interpretation of the karyological differentiation mentioned remains rather obscure in *C. palustris*. According to Reese (1954) its variation in chromosome number is not correlated with its variation in the morphological characters; this phenomenon is termed as intrasubspecific ploidy by him. Wcisło (1967) has divided her Polish collections to three subspecies (subsp. *cornuta*, subsp. *genuina* and subsp. *laeta*) on the basis of their morphological characters and identified them with three cytotypes ($2n = 32, 56$ and 56). According to that author, nevertheless, many Polish plants could not be reliably classified taxonomically. The interpretation of Smit (1967) resembles the opinion of Reese (1954); she has found and statistically verified differences between morphological characters and cytotypes. She did not consider these differences sufficient for dividing this complex and retained both ploidies ($2n = 32$ and 56) in one species, i. e. *C. palustris*.

The results of our karyological examinations are summarized in the Appendix 1. *C. palustris* subsp. *cornuta* appears to be exclusively tetraploid ($2n = 32$) throughout its South-Moravian and South-Slovak distribution area. This is in accordance with previous findings from Slovakia where only tetraploid counts from 15 localities were detected

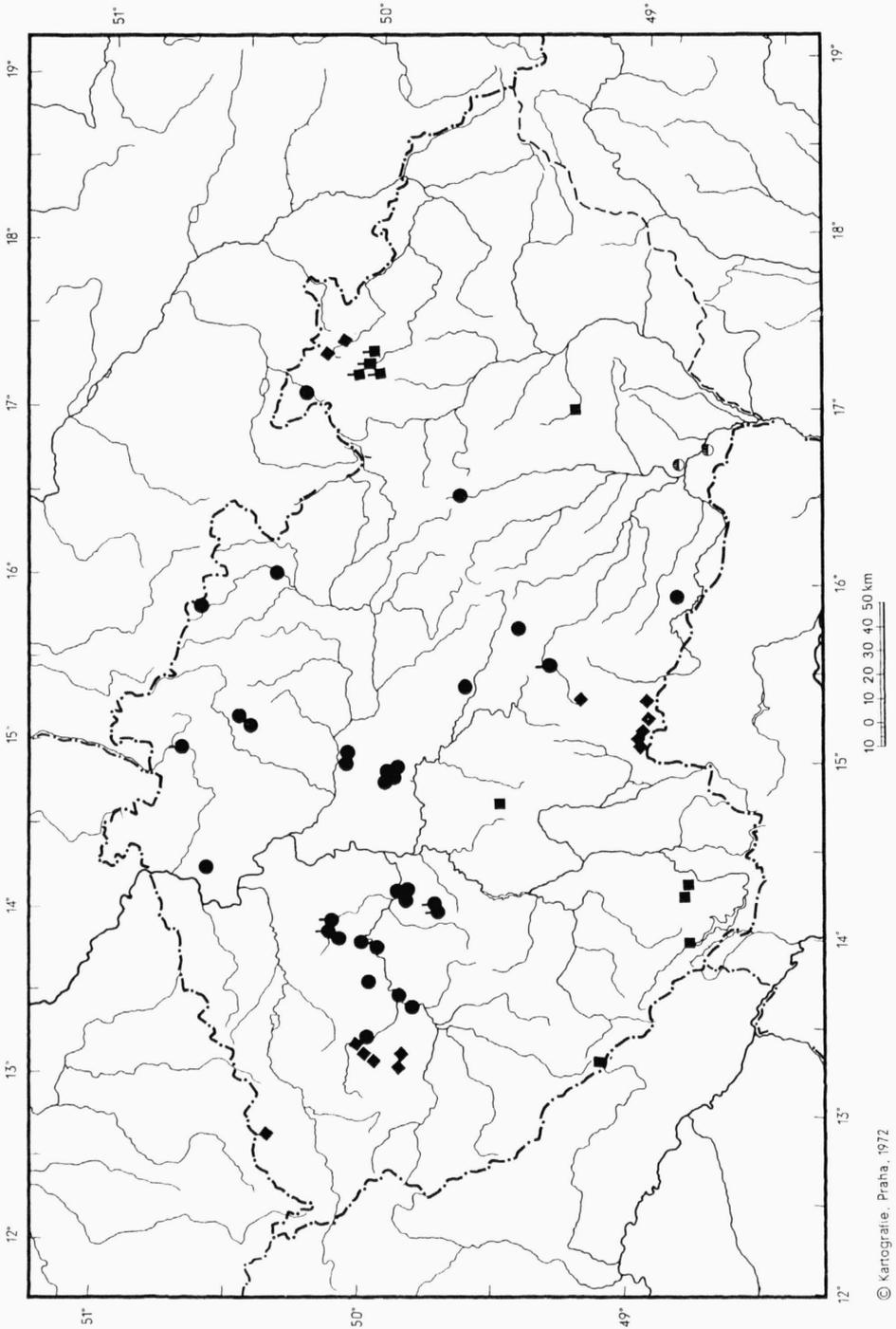


Fig. 2. – Localities of *Caltha palustris* plants from the Czech Republic in which the chromosome numbers were determined. ● *subsp. palustris*, ■ *subsp. laeta* (low ploidy level), ■ *subsp. laeta* (high ploidy level), ⊕ *subsp. cornuta*, ◆ *subsp. procumbens*, ● *intermediates*. Drawn by J. Chrtěk

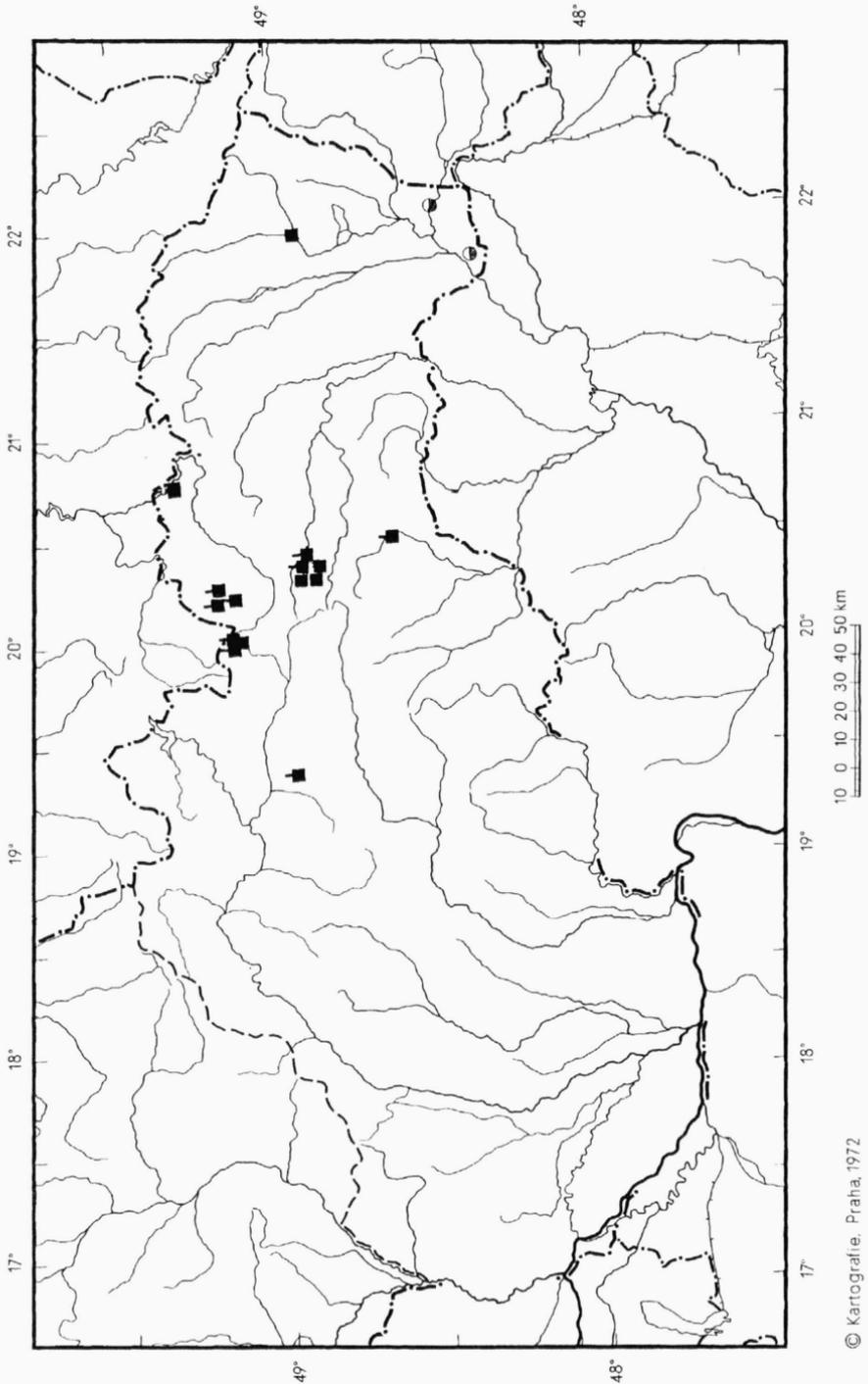


Fig. 3. – Localities of *Caltha palustris* plants from Slovakia in which the chromosome numbers were determined. ■ subsp. *laeta* (low ploidy level), ■ subsp. *laeta* (high ploidy level), ⊕ subsp. *cornuta*. Drawn by J. Chrtěk sen.

(Uhríková in Majovský et al. 1978). *C. palustris* subsp. *procumbens* is characterized by a higher ploidy level ($2n = 56$); aneuploid numbers (55, 57, 59) and small supernumerary chromosomes (6B) have been also found. The tetraploid chromosome number $2n = 32$ (incl. aneuploid numbers $2n = 34, 35, 36$) was recorded in the plants of *C. palustris* subsp. *palustris*. The highest karyological diversity has been found in *C. palustris* subsp. *laeta*. The lowland collections were predominantly tetraploid with $2n = 32$ (34), whereas the plants from the mountains had mostly higher ploidy level with $2n = 56$ (57, 58, 59, 61, 64). Both chromosome numbers (32, 56) were previously reported from Slovakia, too (Majovský, Murín et al. 1987). It should be added that the plants from southernmost part of the species distribution indicate different results. The mountain plants collected in Rumania were exclusively tetraploid. This is in accordance with Weislo's report from Bulgaria. Intermediate forms between subsp. *laeta* and subsp. *palustris* are usually tetraploid with $2n = 32$; in one case a hypohexaploid with $2n = 47$ has been recorded and in one case presumable on F_1 hybrid between two different polyploids (32 and 56) with $2n = 44$ has been detected.

Ecology and distribution

The habitat of *C. palustris* are wet meadows, marshes, peat-bogs, fens, banks of rivers and streams, shallow brooks, margins of lakes and ponds, reed-swamps, riverine forests, wet spruce forests, alders and similar places. Subsp. *cornuta* grows mostly in deeper water, subsp. *procumbens* in wet places in shallow water, subsp. *palustris* and subsp. *laeta* in wet places and margins of water bodies with shallow water (Chrtková 1988).

Caltha palustris is distributed all over the territory of the Czech Republic (Fig. 2). Subsp. *palustris* occurs mainly in lowland and hilly parts of central, northern, eastern and rarely southern Bohemia and northern and southern Moravia, rarely in the Jeseníky and Krkonoše Mts up to 1200 m a. s. l. Subsp. *laeta* grows mainly in hilly and mountain regions in southwestern and southern Bohemia (in the Šumava Mts many plants are not typical) and northern and central Moravia from 370 to 1450 m a. s. l. In the regions, where both these subspecies grow together, intermediate forms have been also found (central, northern, eastern and southern Bohemia and northern Moravia). Subsp. *procumbens* is distributed mostly in hilly regions and lower mountains in 380–800 m a. s. l., mainly in western and southwestern Bohemia and western and northern Moravia. The latter subspecies occurs together with subsp. *palustris* in western Bohemia (above all in the district of the town Plzeň) and in northern Moravia, and with subsp. *laeta* in southern Bohemia. Subsp. *cornuta* occurs only in southeastern Moravia (Chrtková 1988). The most common infraspecific taxon of *C. palustris* in the Slovak Republic (Fig. 3) is subsp. *laeta*; it is growing mainly in the mountains. Subsp. *cornuta* occurs in southern Slovakia, distribution of subsp. *palustris* is unclear and needs further study, subsp. *procumbens* probably does not occur in Slovakia.

Conclusions

Caltha palustris is a very variable species. Its infraspecific taxa are of a different value. The best defined subspecies is subsp. *cornuta*, which is the most uniform in morphological characters, number of chromosomes ($2n = 32$) and ecology. Subsp. *procumbens* is mostly characterized by rooting of the nodes and in number of chromosomes (usually $2n = 56$, oc-

asionally aneuploids of $2n = 55, 57, 59$ and once 6 B-chromosomes have been found). Subsp. *palustris* and subsp. *laeta* are closely related taxa, the values of their morphological characters overlap and their habitat preferences are similar. It seems that both subspecies are taxa in a state of continued differentiation. Subsp. *palustris* is tetraploid with $2n = 32$ (34–36) while subsp. *laeta* is characterized by a higher diversity of chromosome numbers. The lowland collections were predominantly tetraploid ($2n = 32$) whereas the higher ploidy ($2n = 56–64$) was ascertained in the mountain plants from the Czech and Slovak Republics. In contrary, only tetraploids ($2n = 32$) have been found in the mountain individuals collected in Rumania. Subsp. *laeta* and subsp. *palustris* form intermediates ($2n = 32; 44, 47$) and in one case the chromosome number in agreement with F_1 hybrid between two different polyploid levels ($2n = 44$) was detected.

Souhrn

Caltha palustris L. je velmi proměnlivý druh, jehož infraspecifické jednotky hodnocené jako subspecie (subsp. *cornuta*, subsp. *laeta*, subsp. *palustris* a subsp. *procumbens*) jsou různé hodnoty. Nejlépe vymezená morfologickými znaky, ekologickými nároky i počtem chromozómů ($2n = 32$) je subsp. *cornuta*. Další dobře rozlišitelná subspecie, rostoucí v kolinním až montánním pásmu, je subsp. *procumbens*; vyznačuje se zejména vytvářením kofenů na uzlinách a vyšším stupněm ploidie – $2n = 56$ (55, 57, 59, 56+6B). Zbývající dva taxony subsp. *palustris* a subsp. *laeta* jsou blízce příbuzné, hodnoty jejich morfologických znaků se překrývají, rovněž nároky na stanoviště mají podobné. Zdá se, že obě subspecie jsou taxony ve stadiu probíhající diferenciace. Subsp. *palustris* je převážně tetraploidní ($2n = 32$), u subsp. *laeta* se vyskytují dvě úrovně ploidie. V České a Slovenské republice byl vyšší stupeň ploidie $2n = 56$ (až 64) zaznamenán u rostlin z vysokohorských poloh, zatímco rostliny z nižší nadmořské výšky jsou většinou tetraploidní ($2n = 32$); na rozdíl od ČR a SR byla v Rumunsku vysokohorská subsp. *laeta* shledána jen tetraploidní ($2n = 32$). U obou subspecií se vyskytují v malé míře i počty aneuploidní. Intermediární formy mezi oběma subspecieci jsou obvykle tetraploidní ($2n = 32$), byl zaznamenán i hypohexaploidní počet $2n = 47$ a počet $2n = 44$ odpovídající primárnímu hybridu mezi oběma ploidními úrovněmi.

References

- Beck G. (1886): Versuch einer Gliederung des Formenkreises der *Caltha palustris*. – Verh. Zool. Bot. Ges. Wien 36: 347–352.
- Bismark S. & Bässler M. (1974): Beiträge zur Cytologie einiger Sippen aus der Flora der DDR. – Gleditschia, Berlin, 2: 17–28.
- Chrtková A. (1988): 1. *Caltha* L. – blatouch. – In: Hejný S. & Slavík B. (eds.), Květena České socialistické republiky 1: 366–371, Academia, Praha.
- Davlianidze M. T. (1984): Investigatio cytogeographica specierum nonnullarum altimontanarum e Caucaso. – Not. Syst. Geogr. Inst. Bot. Tbilis., Tbilisi, 40: 52–54.
- Fedorov A. A. (ed.) (1969): Chromosomyje čisla cvetkovych rastenij. – Leningrad.
- Goldblatt P. (ed.) (1981): Index to plant chromosome numbers 1975–1978. – Monogr. Syst. Bot. Missouri Bot. Gard., St. Louis, 6: 1–553.
- Goldblatt P. (ed.) (1984): Index to plant chromosome numbers 1979–1981. – Ibid., 8: 1–427.
- Goldblatt P. & Johnson D. E. (eds.) (1990): Index to plant chromosome numbers 1986–1987. – Ibid., 30: 1–243.
- Goldblatt P. & Johnson D. E. (eds.) (1991): Index to plant chromosome numbers 1988–1989. – Ibid., 40: 1–238.
- Gvinianidze Z. I. & Avazneli A. A. (1982): The chromosome numbers of some representatives of alpine floristic complexes of the Caucasus. – Bull. Acad. Sci. Georgian SSR, Tbilisi, 106: 577–580.
- Huth E. (1892): Monographie der Gattung *Caltha*. – Helios, Berlin, 9: 55–78 et 99–163.
- Kootin-Sanwu M. & Woodell S. R. J. (1970): The cytology of *Caltha palustris* L. (sensu lato): distribution and behaviour of the chromosome races. – Caryologia, Firenze, 23: 225–239.
- Leoncini M. L. (1951): Biotipi cariologici e sistematici di *Caltha* in Italia. – Ibid., 3: 336–350.
- Leoncini M. L. (1952): Nuove osservazioni cariologiche sul gen. *Caltha*. – Ibid., 4: 367–371.
- Majovský J. et al. (1978): Index of chromosome numbers of Slovakian flora 6. – Acta Fac. Rer. Natur. Univ. Comen., Bot., Bratislava, 26: 1–42.
- Majovský J., Murín A. et al. (1987): Karyotaxonomický prehľad flóry Slovenska. – Veda, Bratislava.

- Malick C. P. & Mary T. N. (1970): Cytological studies in *Caltha palustris* Linn. var. *normalis* Hook. – Beitr. Biol. Pfl., Berlin, 47: 63–70.
- Maugini E. (1953): Contributo alla conoscenza cariológica e sistematica de genere *Caltha* in Italia. – Caryologia, Firenze, 5: 295–305.
- Reese G. (1954): Euploidie, Aneuploidie und B-Chromosomen bei *Caltha palustris* L. – Planta, Berlin, 44: 203–268.
- Smit P. G. (1967): Taxonomical and ecological studies in *Caltha palustris* L. I. – Proc. Koninkl. Nederl. Akad. Wetensch., Sect. C, Amsterdam, 70: 500–510.
- Smit P. G. (1968): Taxonomical and ecological studies in *Caltha palustris* L. II. – Ibid., 71: 280–292.
- Smit P. G. (1970): De dotterbloem in Nederland. – Gorteria, Leiden, 5: 10–15.
- Smit P. G. (1973): A revision of *Caltha* (*Ranunculaceae*). – Blumea, Leiden, 21: 119–150.
- Wcislo H. (1967): Karyological studies in *Caltha palustris* L. s. l. – Acta Biol. Cracov., ser. bot., Kraków, 10: 1–23.

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Appendix 1. – Results of cytogeographical analysis in *Caltha palustris*.

strain number	Locality, coll.	Altitude (m a. s. l.)	2n
<i>C. palustris</i> subsp. <i>cornuta</i>			
2	S Moravia, at the pond Pouzdřanský rybník near the village Pouzdřany, Šourková M. 1976	170	32
3	S Moravia, below the dam of the pond Pouzdřanský rybník near the village Pouzdřany, Šourková M. 1976	170	32
1	S Moravia, flood plain forest near the village Lednice, Slavíková Z. 1976	160	32
15	E Slovakia, wet meadows below the railway near the village Streda nad Bodrogom, Chrtková A. 1976	90	32
16	E Slovakia, bridge across the river Latorica and the road between villages Kráľovský Chlmec and Veľké Kapušany (ca 6 km S of Veľké Kapušany), in the flood plain forest, Chrtková A. 1976	100	32
<i>C. palustris</i> subsp. <i>laeta</i>			
62	W Bohemia, in the valley of the brook Železný potok between the mountain Špičák and the village Železná Ruda, Chrtková A. 1977	ca 840	32
57	S Bohemia, draining sewer near the village Záhvozdí near the town Volary, Tomšovic P. 1977	750	32
28	S Bohemia, village Brloh, settlement Kovářov, spring on the N slope of the hill Bulový, Skalický V. 1976	ca 700	32
89	S Bohemia, village Holubov, wet place in the forest on the S slope of the Klet' Mt, Chrtková A. 1982	ca 900	32
109	S Bohemia, village Vilice 5 km NE of the town Mladá Vožice, Slavík B. 1975	480	34
54	C Moravia, at the town Vyškov, Štěpánek J. 1977	ca 240	32
78	N Moravia, Hrubý Jeseník Mts, the cottage Švýčárna, near the spring in the meadows, Chrtková A. 1980	1300	59
56	N Moravia, Hrubý Jeseník Mts, Jelení studánka, at the brook on the S slope of the mountain Jelení hřbet, Tomšovic P. 1977	1320	56
73	N Moravia, Hrubý Jeseník Mts, valley Velká Kotlina, at the brook, Bělohávková R. 1979	1100	57
74	N Moravia, Hrubý Jeseník Mts, valley of the rivulet Bílá Opava below the cottage Ovčárna, at the brook on the margin of spruce forest, Chrtková A. 1979	ca 1270	59
77	N Moravia, Hrubý Jeseník Mts, brook in the valley of the river Bílá Opava in the village Karlova Studánka, Chrtková A. 1979	780	56
27	N Slovakia, Nízke Tatry Mts, spring of the little brook in the saline meadows near the village Liptovská Lúžna, Fišerová D. 1976	990	32; 58, 57
70	N Slovakia, Vysoké Tatry Mts, in the valley Furkotská dolina below the Solisko Mt, at the brook, Chrtek J. 1979	ca 1850	64
71	N Slovakia, Vysoké Tatry Mts, near the challet Kežmarská chata, at the lake Biele pleso, Chrtek J. 1979	1600	61
72	N Slovakia, Vysoké Tatry Mts, Tatranská Lesná, at the brook, Chrtek J. 1979	900	58
82	N Slovakia, Vysoké Tatry Mts, in the valley Mengušovská dolina, below the lake Popradské pleso, wet meadows, Chrtková A. 1981	ca 1500	59
83	N Slovakia, Vysoké Tatry Mts, in the valley Mengušovská dolina, in the bottom at the brook, Chrtková A. 1981	1300	56
85	N Slovakia, Vysoké Tatry Mts, below the lake Popradské Pleso, Chrtková A. 1981	1490	57–59

86	N Slovakia, Vysoké Tatry Mts, wet meadows near the lake Velké Hincovo pleso, Chrtková A. 1981	1940	ca 56
69	N Slovakia, Belianské Tatry Mts, the valley Dolina siedmich prameňov, in wet places above the cottage Plesnivec, Chrtok J. 1979	1550	56
88	N Slovakia, between villages Závodie and Sulín, alluvium of the river Poprad, Chrtok J. 1982	380	32
40	C Slovakia, Slovenský raj, valley of the brook Velka Biela Voda (W of the town Spišská Nová Ves), Šourková M. 1977	ca 550	32
41	C Slovakia, Slovenský raj, wet places in the valley Sokolia dolina, Šourková M. 1977	ca 600	32
42	C Slovakia, Slovenský raj, valley of the brook Lesnica, Šourková M. 1977	ca 550	56
43	C Slovakia, Slovenský raj, valley Zelená dolina, S of the mill Letanovský mlyn, Šourková M. 1977	500	56
84	C Slovakia, Slovenský raj, at the brook near the mill Letanovský mlyn, Chrtková A. 1981	ca 500	32
79	C Slovakia, Slovenské Rudohorie Mts, village Betliar, at the brook, Chrtková A. 1979	ca 350	58
29	E Slovakia, wet meadows NE of the town Humenné, Chrtok J. 1976	220	32
30	N Rumania, Apuseni Mts, in the village Dealul Negru, peat, Chrtková A. 1976		32
35	C Rumania, Retezet Mts, brook at the village Nucșoara, Chrtková A. 1976		32
31	N Rumania, Maramureșului Mts, on the hill Dealul near the village Borșa, at the brook in the pasture, Chrtková A. 1976		32
33	N Rumania, Rodnei Mts, Pietroșul Mt., S of the village Borșa, at the brook near the lake Iezer Pietroșul, Chrtková A. 1976		32
34	N Rumania, Rodnei Mts, between Borșa-Hotel and waterfalls Cascada Cailor, brook in the spruce forest, Chrtková A. 1976		32

C. palustris subsp. *palustris*

51	W Bohemia, village Malá Černá Hať nad Střelou (near the town Plzeň), deep valley in the spruce forest, at the brook, Chrtková A. 1977	410	32
52	W Bohemia, in the margins of a little pond at the brook Dobříčský potok near the village Kaceřov, NE of the town Plzeň, Chrtková A. 1977	ca 340	36
53	W Bohemia, valley below the castle Libštejn, at the brook (NE of the town Plzeň), 6 km NW of the village Radnice, Chrtková A. 1977	ca 300	32
47	W Bohemia, valley of the brook Dubský potok, below the ruin Krakovec, at the brook, ca 12 km SW of the town Rakovník, Chrtková A. 1977	ca 370	32
20	C Bohemia, between villages Roztoky u Křivoklátu and Bránov, at the brook in the meadows, at the river Berounka, Chrtková A. 1976	220	32
21	C Bohemia, at the brook Rakovnický potok in the meadows in the forest, S of the village Městečko u Křivoklátu, Chrtková A. 1976	350	32
44	C Bohemia, at the pond Bucký rybník, SW of the village Třtice (near the village Nové Strašecí), in <i>Caricetum gracilis</i> , Husák Š. 1977	430	32
6	C Bohemia, wet meadows S of the village Zadní Třebáň, Chrtková A. 1976	ca 250	32
7	C Bohemia, on the bank of the brook Svinařský potok near the village Zadní Třebáň, Chrtková A. 1976	ca 250	32
8	C Bohemia, village Zadní Třebáň, on the bank of the brook Svinařský potok under the alders, Chrtková A. 1976	ca 250	32
22	C Bohemia, village Louňovice near the town Říčany, at the pond Louňovický rybník, Chrtková A. 1976	410	32
17	C Bohemia, village Mukařov 5 km E of the town Říčany, little brook in the meadows, Chrtková A. 1976	410	32

23	C Bohemia, in wet meadows near the pond Pařez near the village Jevany, Chrtková A. 1976	ca 410	32
24	C Bohemia, village Jevany, wet meadows near the village Vyžlovka, Chrtková A. 1976	420	34
36	C Bohemia, village Třebestovice, wet meadows at the forest Dolní Kersko, Chrtková A. 1976	200	35
37	C Bohemia, village Třebestovice, swamp with alders on the margin of the forest Dolní Kersko, Chrtková A. 1977	ca 200	32
39	N Bohemia, České středohoří, between the villages Držovice and Brusov, alders at the brook, Šourková M. 1977	340	32
80	N Bohemia, Český ráj, the valley Plakánek below the castle Kost, wet meadows in the valley of the brook, Chrtek J. 1981	280	32
81	N Bohemia, Český ráj, wet meadows below the ruins Trosky, Chrtek J. 1981	400	32
63	N Bohemia, Krkonoše Mts, at the brook below the church in the village Dolní Malá Úpa, Chrtková A. 1978	ca 850	32
91	E Bohemia, village Ratibořice N of the town Česká Skalice, meadows in the forest, Chrtková A. 1982	290	32
61	E Bohemia, between villages Vlkanov and Opatovice (NE of the village Ledeč n. Sázavou), at the brook Žebrákovský potok, in meadows, Neuhäuslová Z. 1977	510	32
65	S Moravia, below the castle Šimperk near the village Jenišovice, the pond Vlkov, in the reed, <i>Phragmitetum</i> , Chrtková A. 1978	ca 450	32
67	E Bohemia, margin of the pond Peklo near the town Polná, 14 km NE of the town Jihlava, Chrtková A. 1978	480	32
58	W Moravia, on the margin of the pond Horní rybník near the town Svitavy, in the brook, Bělohávková R. 1977	440	32
76	N Moravia, village Žulová, on the margin of the brook Vidnávkva under alders, Chrtková A. 1979	350	32

C. palustris subsp. *procumbens*

14	W Bohemia, Krušné hory Mts, village Jelení 5 km SE of the village Nové Hamry, at a small brook, Chrtková A. 1976	ca 860	56
45	W Bohemia, margin of little pond near the village Hůrky (ca 22 km NW of the town Plzeň), Chrtková A. 1977	510	56+6B
46	W Bohemia, near the village Hůrky (22 km NW of the town Plzeň), <i>Alnetum</i> , Chrtková A. 1977	510	56
48	W Bohemia, vicinity of the village Manětín, <i>Alnetum</i> , Chrtková A. 1977	ca 450	56
49	W Bohemia, brook in spruce forest near the village Manětín, Chrtková A. 1977	ca 450	57
50	W Bohemia, valley of the river Střela, at the brook near the village Rabštejn nad Střelou (near the town Plzeň), Chrtková A. 1977	450	56
92	S Bohemia, village Slavonice, at the brook in the spruce forest, Chrtková A. 1983	ca 540	56
11	S Bohemia, at the pond Klášterský rybník near the town Nová Bystřice, Šourková M. 1976	640	56
5	S Bohemia, near the village Albeř, in the wet spruce forest near the pond Kaproun, Slavíková Z. 1976	ca 600	56
9	S Bohemia, the village Albeř, at the pond Osika, Šourková M. 1976	630	56
10	S Bohemia, on the bottom of empty pond Horní rybník near the village Albeř, Šourková M. 1976	630	56
12	S Bohemia, at the pond below the railway in the village Albeř, Šourková M. 1976	600	56
13	S Bohemia, peat meadows near the village Albeř, Šourková M. 1976	ca 600	56

4	S Bohemia, ruins of the castle Landštejn, ca 10 km E of the town Nová Bystřice, at the brook in the spruce forest, Slavíková Z. 1976	560	55
64	E Bohemia, Českomoravská vysočina Highland, at the pond Kalištský rybník, 2 km SW of the village Horní Dubenky, Jefábková O. 1978	650	56
75	N Moravia, Hrubý Jeseník Mts, the peat-bog Rejvíz, at the brook in the spruce forest, Chrtková A. 1979	ca 740	55
126	N Moravia, Hrubý Jeseník Mts, village Vrbno pod Pradědem, road 1 km E of the village, at the brook, Slavík B. 1977	540	59*

C. palustris intermediate between subsp. *laeta* and subsp. *palustris*

59	C Bohemia, at the pond Punčocha, SE of the village Třtice (near the village Nové Strašecí), Chrtková A. 1977	420	32
25	C Bohemia, margin of the pond SE of the village Srby near the town Kladno, Chrtková A. 1976	380	47
18	C Bohemia, deep valley in the spruce forest N of the town Dobříš, Chrtková A. 1976	400	32
19	C Bohemia, alder forest near the village Trnová near the town Dobříš, Chrtková A. 1976	400	32
38	N Bohemia, village Světlá pod Ještědem, the spring of the river Ploučnice, at SW slopes of Ještěd Mt, Chrtek J. 1977	654	32
66	E Bohemia, between the rock Zaječí skok and the town Jihlava, in wet meadows, Chrtková A. 1978	480	44

* Chromosomes counted by L. Kirschnerová