Distributions of vascular plants in the Czech Republic. Part 3

Rozšíření cévnatých rostlin v České republice. Část 3

Zdeněk Kaplan[1], Jiří Danihelka[1, 2], Martin Lepší[3, 4], Petr Lepší[5], Libor Ekrt[4], Jindřich Chrtek Jr.[1], Jiří Kocián[6], Jan Prančl[1, 7], Lucie Kobrlová[8], Michal Hroneš[8] & Václav Šulc[1]

[1]*Institute of Botany, The Czech Academy of Sciences, Zámek 1, CZ-252 43 Průhonice, Czech Republic, e-mail: kaplan@ibot.cas.cz, chrtek@ibot.cas.cz, jan.prancl@ibot.cas.cz, sulc@ibot.cas.cz;* [2]*Department of Botany and Zoology, Masaryk University, Kotlářská 2, CZ-611 37 Brno, Czech Republic, e-mail: danihel@sci.muni.cz;* [3]*South Bohemian Museum in České Budějovice, Dukelská 1, CZ-370 51 České Budějovice, Czech Republic, e-mail: lepsi@seznam.cz;* [4]*Department of Botany, Faculty of Science, University of South Bohemia, Branišovská 1760, CZ-370 05 České Budějovice, Czech Republic, e-mail: libor.ekrt@gmail.com;* [5]*Nature Conservation Agency of the Czech Republic, Administration of the Blanský les Protected Landscape Area, Vyšný 59, CZ-381 01 Český Krumlov, Czech Republic, e-mail: plepsi@seznam.cz;* [6]*Nature Conservation Agency of the Czech Republic, Kaplanova 1, CZ-148 00 Prague, Czech Republic, e-mail: jikocian@seznam.cz;* [7]*Department of Botany, Faculty of Science, Charles University, Benátská 2, CZ-128 01 Prague, Czech Republic;* [8]*Department of Botany, Faculty of Science, Palacký University, Šlechtitelů 27, CZ-783 71 Olomouc, e-mail: lucka.kobrlova @seznam.cz, michal.hrones@upol.cz*

Kaplan Z., Danihelka J., Lepší M., Lepší P., Ekrt L., Chrtek J. Jr., Kocián J., Prančl J., Kobrlová L., Hroneš M. & Šulc V. (2016): Distributions of vascular plants in the Czech Republic. Part 3. – Preslia 88: 459–544.

The third part of the publication series on the distributions of vascular plants in the Czech Republic includes grid maps of 105 taxa of the genera *Acorus*, *Amelanchier*, *Asplenium*, *Calla*, *Cerastium*, *Ceratophyllum*, *Eichhornia*, *Hieracium*, *Hippuris*, *Hottonia*, *Lemna*, *Limosella*, *Peplis*, *Pistia*, *Pontederia*, *Sorbus*, *Spirodela*, *Symphytum*, *Trapa*, *Valerianella* and *Wolffia*. The maps were produced by taxonomic experts based on all available herbarium, literature and field records. Three of the studied genera include Czech endemics, which are confined to small geographic areas, mostly have small population sizes and thus are of conservation concern. These maps resulted from detailed fieldwork and herbarium revisions by monographers of the respective groups and for many of these endemics they are first available maps. The endemic species of *Hieracium* occur mainly in the subalpine habitats in the Krkonoše, Králický Sněžník and Hrubý Jeseník Mts. By contrast, a great majority of *Sorbus* endemics are found mainly in thermophilous open broad-leaved and pine forests on rocky habitats at middle altitudes. *Cerastium alsinifolium* is confined in its total distribution to serpentine outcrops in western Bohemia. *Asplenium* is another ecologically specialized group, which includes petrophytes, some of which are restricted to specific substrates, such as siliceous, limestone, basalt or serpentine rocks. The plants studied include 53 taxa classified in the Red List of vascular plants of the Czech Republic, some of which have shown remarkable declines. *Symphytum bohemicum*, distributed mainly in central Europe, is confined to calcareous fens in the lowlands. There are many endangered and vulnerable species amongst aquatic plants, which are threatened mainly by fish-farming intensification, eutrophication and habitat destruction. Populations of some of the most endangered and attractive aquatics, including *Hippuris vulgaris* and *Trapa natans*, have been lost and locally replaced by plants of unknown provenance purchased in garden stores, which causes a potential threat of genetic erosion of native populations. Attractive appearance is the reason why alien aquatics, such as

Eichhornia crassipes, *Pistia stratiotes* and *Pontederia cordata*, are sometimes planted not only in garden pools but also in wetlands in the countryside; each has been recorded at about a dozen such sites during the past 25 years. *Lemna turionifera*, by contrast, has been introduced and dispersed by waterfowl and is now widespread in the country. The histories of the introduction and subsequent spread are also described and analysed for the widespread neophyte *Acorus calamus* and for the alien species of *Amelanchier* and *Symphytum*. Spatial distributions and temporal dynamics of individual species are shown in maps and documented by records included in the Pladias database and available in electronic appendices. The maps are accompanied by comments, which include additional information on the distribution, habitats, taxonomy and biology of the species.

K e y w o r d s: alien species, central Europe, chorology, Czech Republic, distribution atlas, distribution patterns, endangered species, endemic, flora, grid maps, herbaria, introduction, phytogeography, plant record, vascular plants

Introduction

Since the project of mapping plant distributions in the Czech Republic was launched in 2014, a modern plant record database Pladias has been established and 162 grid distribution maps have been produced by taxonomic experts, based on critically evaluated and sorted records, and published in two papers (Kaplan et al. 2015, 2016). The ultimate aim of this effort, started within the PLADIAS project (www.pladias.org) and planned to continue as a series of publications, is to prepare the basis for a complete atlas of the distribution of vascular plants in the Czech Republic.

From April to August 2016 the Pladias database has increased by about 2,900,000 new records. Of these almost 11,000 records resulted from critical examination of herbarium specimens by taxonomic experts. Maps of further 105 taxa were finished at the beginning of August 2016 and these are published in this paper. These maps include both native and alien species, rare species confined to small geographic areas as well as widespread species, and endangered as well as common species. About one third of the Czech endemics (Kaplan 2012), which is a group of plants that deserves the highest attention and conservation priorities, are mapped. A great majority of the maps resulted from recent detailed revisions of taxonomically critical groups, such as *Amelanchier* (Lepší & Lepší 2008), *Asplenium* (Ekrt 2008b, Ekrt & Štech 2008), *Cerastium* (Letz et al. 2012, Vít et al. 2014), *Hieracium* (e.g. Chrtek 2004, Chrtek et al. 2007), *Lemna* (Kaplan 2010), *Sorbus* (e.g. Lepší et al. 2015) and *Symphytum* (Kobrlová et al. 2016), which have refined taxonomic concepts and the delimitation of taxa, and in some cases also led to the discovery of new species or first country records.

Materials and methods

Taxonomic scope

The following groups of vascular plants are mapped: native taxa, naturalized aliens and most casuals, and selected hybrids. Distribution maps are produced for species and subspecies, and in exceptional cases also for varieties or infrageneric taxa (e.g. sections). Plants of species groups that are difficult to assign to species may be mapped as species aggregates. Field crops and plants deliberately cultivated in gardens and parks are not included in the mapping project. Nomenclature, taxonomic concepts and delimitation of

species aggregates mostly follow Danihelka et al. (2012), with differences indicated where necessary. For taxa not included in that checklist, a taxonomic reference is given. Publication of maps does not follow any alphabetical or systematic order but those maps that have resulted from recent revisions are printed preferentially.

Data sources

All relevant floristic data sources are used. Major national herbaria and some local and foreign collections, incl. BRA, BRNL, BRNM, BRNU, CB, CBFS, CESK, CHEB, CHOM, FMM, GM, HOMP, HR, KHMS, LIM, LIT, MJ, MMI, MP, MZ, NJM, OH, OL, OLM, OMJ, OP, OSM, OVMB, PL, PR, PRA, PRC, ROZ, SAV, SOB, SOKO, SUM, VM, WRSL, WU and ZMT (acronyms follow Thiers 2016), were consulted as the main source of taxonomically revised records. Most records for maps of common and easy-to-identify taxa come from the recently developed Pladias database (hosted at the Institute of Botany, Průhonice), which has integrated all available records on the distribution of the vascular plants in the Czech Republic. Among the most important incorporated databases are the Database of the Distribution of Vascular Plants in the Czech Republic (FLDOK), the Czech National Phytosociological Database (CNPD), plant records from the Floristic Summer Schools and other activities of the Czech Botanical Society, the Species Occurrence Database of the Nature Conservation Agency of the Czech Republic (NDOP) and the Database of Forest Typology of the Forest Management Institute of the Czech Republic (DLT). Unpublished field records previously entered into the Pladias database by the authors of maps or regional contributors were also considered.

Procedure of mapping

All records used for mapping are entered into the Pladias database and geographically sorted according to the traditionally used CEBA (Central European Basic Area) grid template (Niklfeld 1999) divided into quadrants of 5 × 3 arc minutes (corresponding to approximately 5.5 × 5.9 km). The territory of the Czech Republic is covered by 2551 quadrants, of which 2181 are completely within the border of the country. Individual records as well as the whole distribution pattern of each taxon are checked and evaluated by the author of a particular map in a web-based mapping interface of the Pladias database. Maps of taxonomically critical groups are based solely or mainly on herbarium records revised by taxonomic experts; these cases are indicated in the text accompanying the particular map. Maps of all other taxa are based on records from databases, literature and herbaria, which were scrutinized by the authors of the respective maps. Records used for producing maps are listed in Electronic Appendices 1–105. In selected maps, native versus introduced occurrences are distinguished and corresponding records in the database classified accordingly. Draft distribution maps and the background records are released in a web-based review process for scrutiny to field botanists, regional collaborators and members of the Czech Botanical Society. Their comments and additional records are collected in the database and returned to the responsible specialists for consideration before producing final distribution maps.

Final maps and comments

The treatment of each taxon consists of a grid distribution map and an accompanying text; authors of maps are indicated in the figure captions, and they also took the major part in preparing the first drafts of the respective texts. Maps are displayed using spherical Mercator projection (EPSG:3857) where meridians and parallels are shown perpendicularly, and the mapping CEBA grids are thus nicely displayed. The background relief was derived from the SRTM data (http://www2.jpl.nasa.gov/srtm/, the version provided by http://srtm.csi.cgiar.org), and the river network was adapted from data provided by CENIA (www.cenia.cz). When appropriate, different symbols are used in the maps in order to distinguish one of the following attributes of the plant distribution records: (1) recent versus old records, (2) native occurrences versus introductions, or (3) records based on revised herbarium specimens versus all other records. These classifications of records are used only for those taxa where such distinction provides important information and, in addition, the amount and quality of records are sufficient. The mapping symbols used to indicate the different attributes of the records in the particular grid cell are shown in Table 1. Symbols specific to individual maps are explained in their captions. To save space, rare taxa of the genera *Hieracium* and *Sorbus* with distinct distributions are shown in maps in groups of 2–4, with symbols and annotations of individual taxa in the maps distinguished using different colours. In the caption to each map, counts of occupied quadrants are indicated according to the symbols used in the map; uncertain occurrences are not included in the counts. The accompanying text includes the accepted scientific name, a brief outline of the total distribution, information on habitats occupied by the species and a description of its distribution in the Czech Republic. Where appropriate, comments on the taxonomy, biology and details of the spatial and temporal dynamics of the distribution are given.

Table 1. – The mapping symbols used in the distribution maps to indicate the different attributes of the occurrence in a particular grid cell.

Attribute distinguished	Symbol	Attribute state
None	●	all records
Time	●	recent occurrence (at least one record since 2000)
	◍	old occurrence (all records before 2000, or demonstrably being extirpated from all localities after 2000, or all records undated)
Origin	●	native (at least one record)
	×	alien
Source data	●	a revised herbarium specimen (at least one record)
	▲	all other
All	?	only record(s) uncertain regarding identification and/or locality

Distribution maps and comments

Acorus calamus (Fig. 1)

Acorus calamus is currently found in most of Europe except its northern parts and dry and warm Mediterranean areas, in Siberia, in central, southern, south-eastern and eastern Asia, in South Africa, Australia and in North America (Meusel et al. 1965, Hultén & Fries 1986). In its broad circumscription it includes four cytotypes, which are sometimes treated as varieties or even separate species: the diploid form is found in North America, central Siberia, Mongolia and central and southern Asia; the triploid form is probably native to south-eastern Asia but naturalized across Europe, South Africa, Australia and the eastern and central USA; the tetraploid form is native to Asia from India eastwards as far as Japan and northwards to Siberia; and the recently discovered hexaploid form is so far known only from central and north-western Yunnan and from Kashmir (Röst 1978, Petersen 1989, Wang et al. 2001, Ogra et al. 2009). Triploid plants are sterile and can only spread vegetatively (Marchant 1973, Röst 1978). They have been deliberately planted as an ornamental, fragrant and medicinal plant, particularly in the past, but they are also dispersed naturally along rivers by the establishment of rhizome fragments washed out in floods. *Acorus calamus* was imported to Prague via Constantinople in 1557 (Matthiolus 1562). In the Czech Republic it was first explicitly reported as escaped in the town of Hradec Králové about a century later (Balbinus 1679). According to Hendrych (2003), *A. calamus* was widely used in Bohemia as a medicinal plant by the beginning of the 16th century ("*Calamus aromaticus*" was described and illustrated by Czerny 1517) and it may even have become naturalized much earlier as it is listed as one of easily accessible and widely used plants in Bohemian medicinal books dating back to the 14th century. However, these records may belong to *Iris pseudacorus*, with which *A. calamus* was initially frequently confused. At present, *A. calamus* is naturalized in shallow edges and on the banks of fishponds and slow-flowing rivers, in shallow alluvial pools and oxbow lakes, and less frequently in marsh vegetation and drainage ditches. It prefers eutrophic water on clayey, loamy or sandy substrates, often covered with a thick layer of sapropelic mud (Šumberová 2011a). *Acorus calamus* is widespread in the lowlands and at middle altitudes throughout Bohemia, being most frequent in the fishpond basins of southern Bohemia, in the Labe river basin and adjacent parts of eastern Bohemia, in the Česko-moravská vrchovina highlands and the Železné hory hills. By contrast, it is rare in or absent from dry areas of north-western Bohemia and the mountains where suitable habitats are missing. It is markedly less frequent in the eastern parts of the country, where it is almost restricted to highlands and the lower stretches of the Dyje and Morava rivers. It is classified as a naturalized neophyte (Pyšek et al. 2012).

Amelanchier alnifolia (Fig. 2)

Amelanchier alnifolia is native to the north-western part of North America. In Europe it is reported as a rare garden escape from Sweden and Germany (Amarell & Welk 1995, Schroeder 1995). In the Czech Republic it is rarely grown in gardens and parks. It has been found as an escape in Prague, in the towns of Průhonice and Roztoky in central Bohemia and in the town of Hluboká nad Vltavou and possibly also in the town of Český Krumlov (spontaneous origin of this occurrence is uncertain) in southern Bohemia. It

usually grows in scrub, open forests, mainly in plantations of *Pinus nigra*, and in scrub on rocks. It was first documented from cultivation by a herbarium specimen collected in 1926 in the chateau park of Březina in western Bohemia, while its first known occurrence in the wild in the Prokopské údolí valley in Prague dates back to the 1970s (Kubíková & Manych 1979, as *A. ovalis*). *Amelanchier alnifolia* is classified as a casual neophyte (Pyšek et al. 2012). The distribution maps of *Amelanchier* were based solely on revised herbarium specimens and our own field records.

Amelanchier lamarckii (Fig. 3)

Amelanchier lamarckii is native to the eastern part of North America. In Europe, it has been planted for fruit and as an ornamental shrub since the late 18th century and naturalized mainly in western and less frequently also in central and northern Europe (Schroeder 1995). In the Czech Republic it has been rarely planted for ornamental purposes in parks and more recently also in private gardens. The first record of its cultivation dates back to 1813 and the first escape to 1867, both located to the surroundings of the town of Nové Hrady in southern Bohemia, where it has become widely naturalized (Lepší & Lepší 2008). In northern, western and central Bohemia it has been recorded as a rare garden escape. It occurs in scrub, forest fringes and open-canopy forests such as *Pinus sylvestris* plantations. *Amelanchier lamarckii* is classified as a casual neophyte (Pyšek et al. 2012).

Amelanchier spicata (Fig. 4)

This shrub, which is native to the eastern part of North America, has been grown in Europe for ornamental purposes since the 18th century. It has become widely naturalized in Scandinavia and the Baltic countries, and occasionally escapes from cultivation mainly in central and western Europe (Schroeder 1995). In the Czech Republic it has been sometimes planted in gardens and parks. It has become naturalized in Bohemia while it is still a very rare garden escape in Moravia and Silesia. It is found in open-canopy oak and pine forests and plantations and their fringes, scrub, mainly on slopes and rocks in river valleys. It was first collected in the wild near the town of Havlíčkův Brod in 1880. A recent study by Lepší & Lepší (2008) revealed that *A. spicata* used to be confused with *A. ovalis* but it is actually the most frequently planted and escaping species of the genus in the Czech Republic. It is classified as a naturalized neophyte (Pyšek et al. 2012).

Asplenium adiantum-nigrum (Fig. 5)

Asplenium adiantum-nigrum is a tetraploid species with a worldwide distribution. It is widely distributed particularly in the Atlantic, Submediterranean and Mediterranean parts of Europe, extending eastwards over Anatolia and the Caucasus Mts as far as the Himalayas. It is also found in northern, central and southern Africa, south-eastern Asia, in Australia and western North America (Hultén & Fries 1986). The Czech Republic is situated on the north-eastern limit of the species' distribution range, where it is rare and usually forms only poor and short-lasting populations. It inhabits sunny and semi-shady crevices of basalt, limestone, sandstone and granite rocks, rocky screes and also walls and abandoned quarries. *Asplenium adiantum-nigrum* is documented from northern, central and southern Bohemia, western and eastern Moravia and Silesia. Currently it occurs

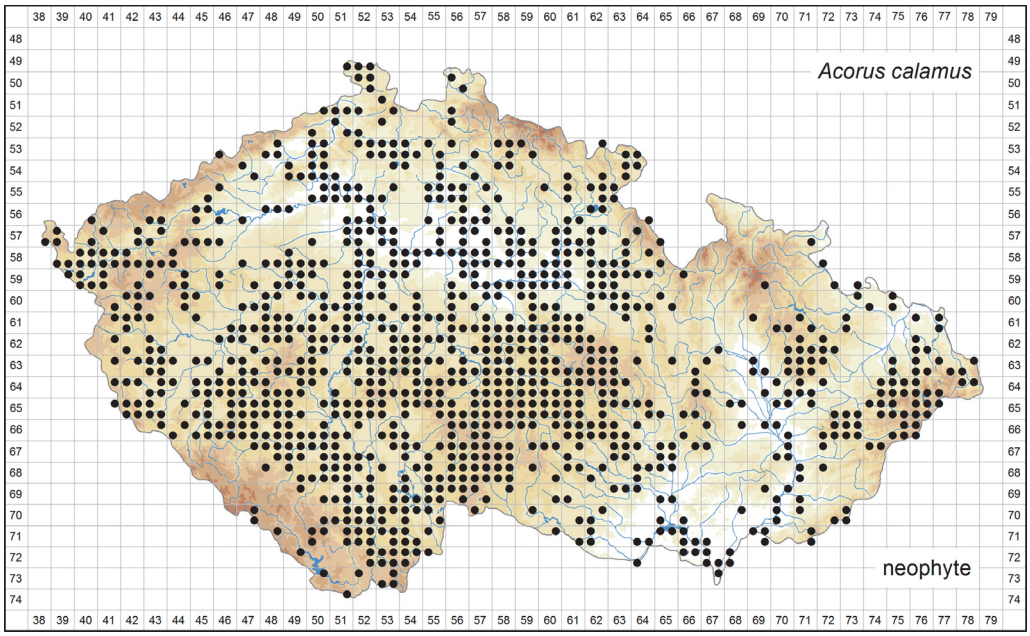


Fig. 1. – Distribution of *Acorus calamus* in the Czech Republic (1051 occupied quadrants). Prepared by Zdeněk Kaplan.

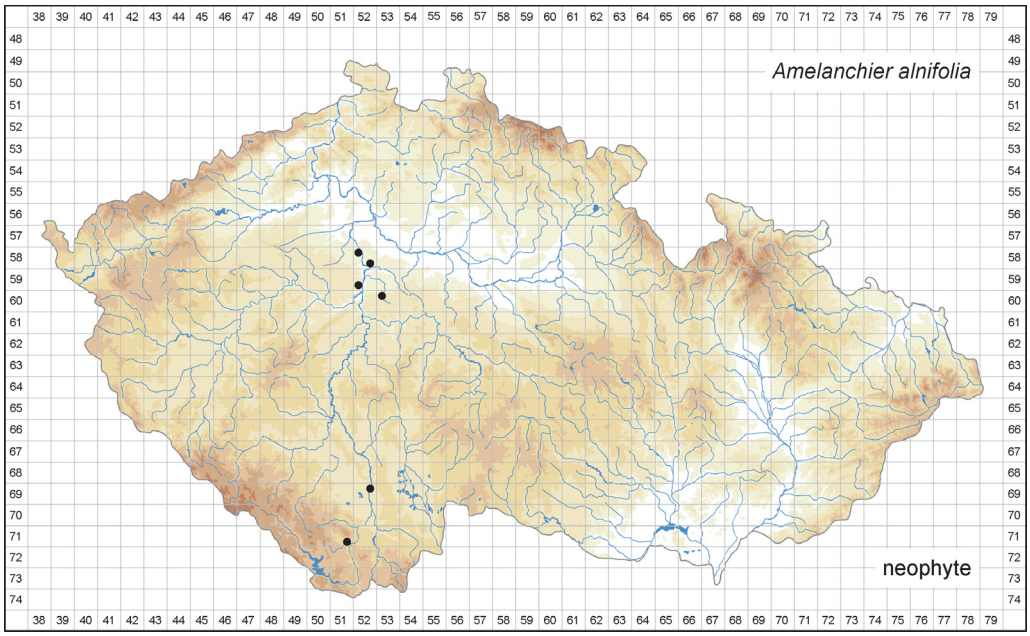


Fig. 2. – Distribution of *Amelanchier alnifolia* in the Czech Republic (6 occupied quadrants). Prepared by Petr Lepší & Martin Lepší.

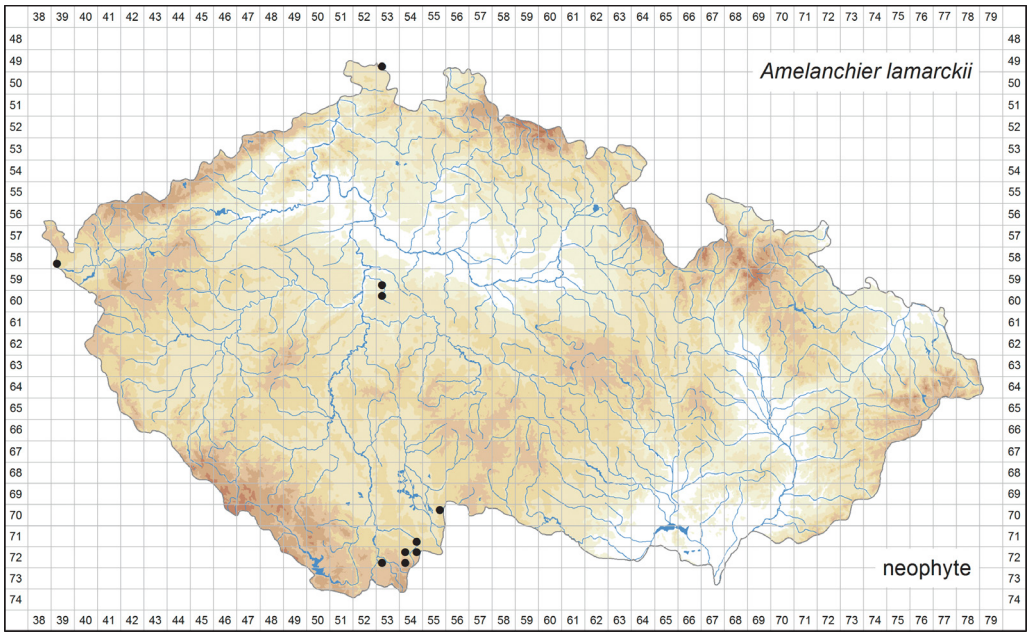


Fig. 3. – Distribution of *Amelanchier lamarckii* in the Czech Republic (10 occupied quadrants). Prepared by Petr Lepší & Martin Lepší.

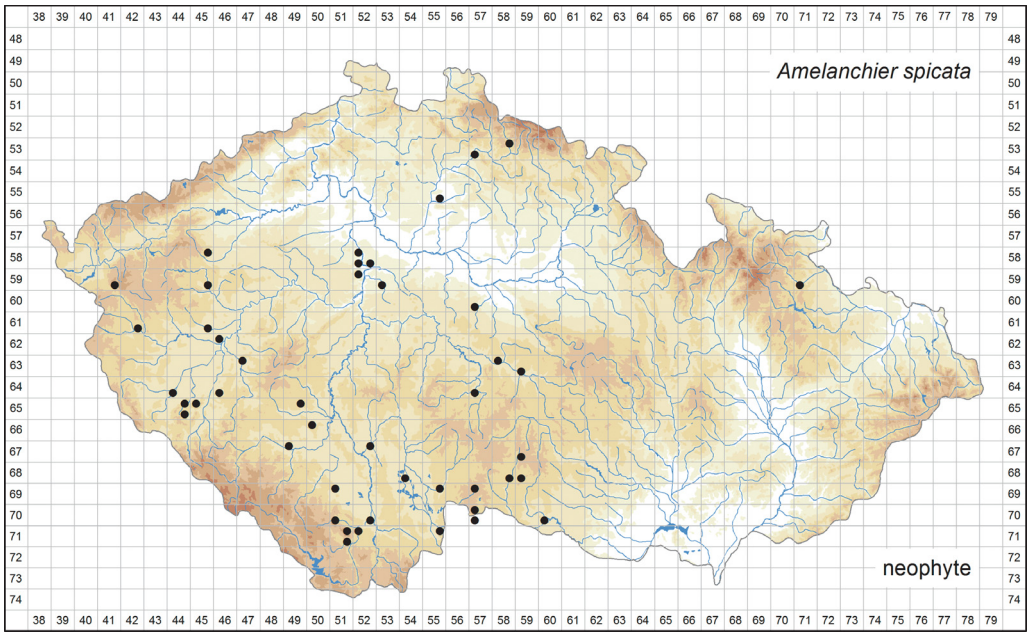


Fig. 4. – Distribution of *Amelanchier spicata* in the Czech Republic (45 occupied quadrants). Prepared by Petr Lepší & Martin Lepší.

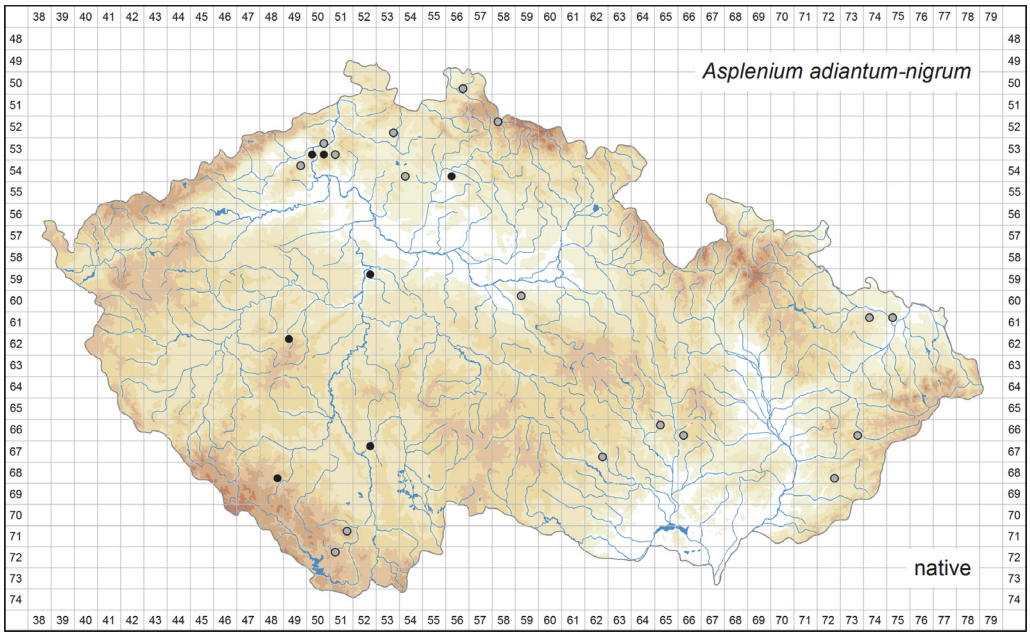


Fig. 5. – Distribution of *Asplenium adiantum-nigrum* in the Czech Republic: ● at least one record in 2000–2016 (7 quadrants), ● pre 2000 records only (17 quadrants). Prepared by Libor Ekrt.

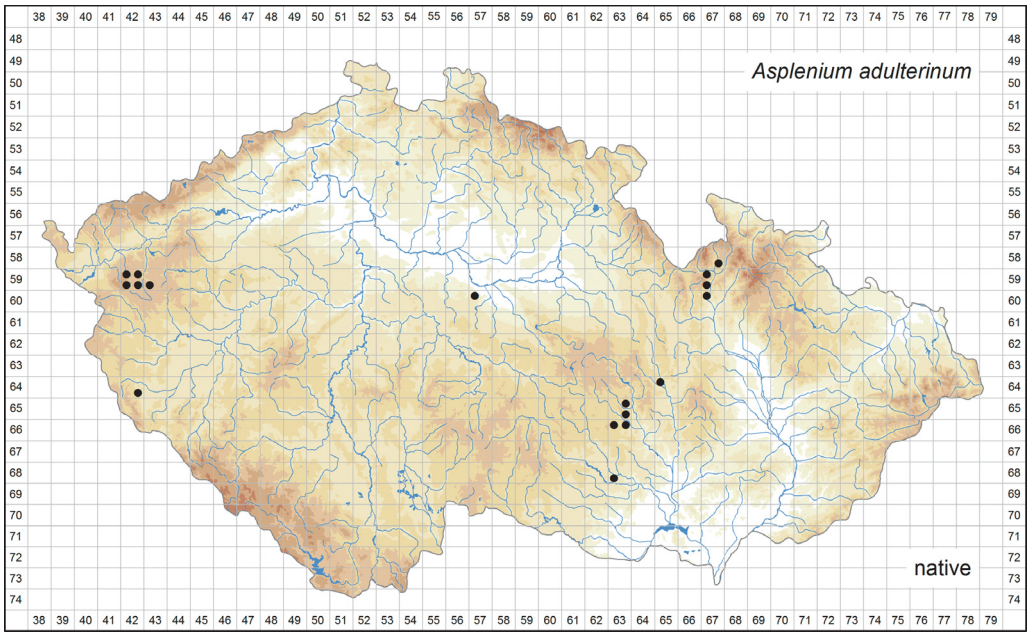


Fig. 6. – Distribution of *Asplenium adulterinum* in the Czech Republic (17 occupied quadrants). Prepared by Libor Ekrt.

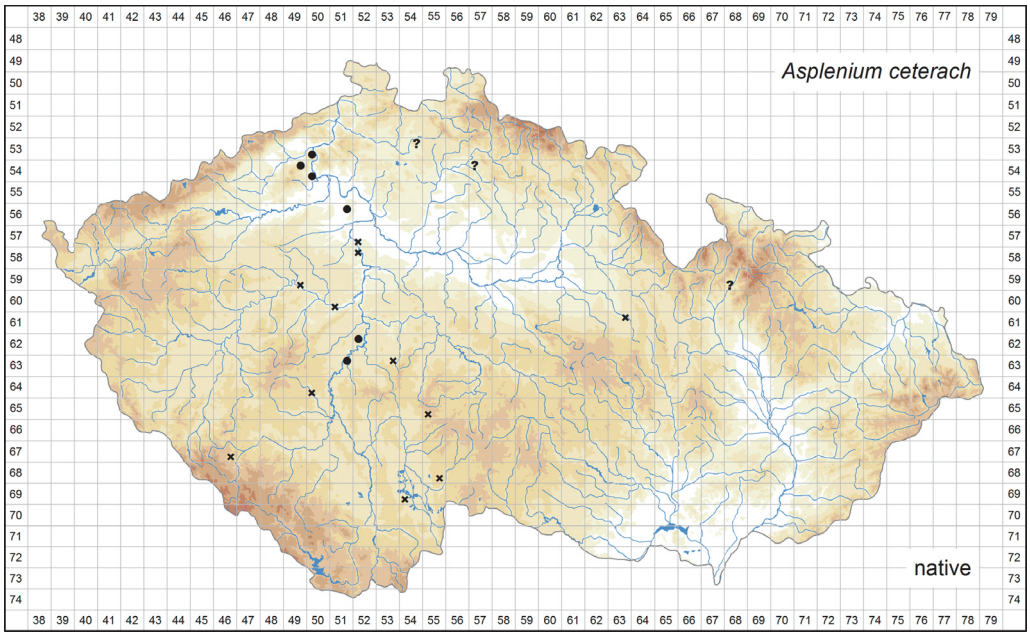


Fig. 7. – Distribution of *Asplenium ceterach* in the Czech Republic: ● occurrence in natural habitats (6 quadrants), × occurrence in secondary habitats (11 quadrants). Prepared by Libor Ekrt.

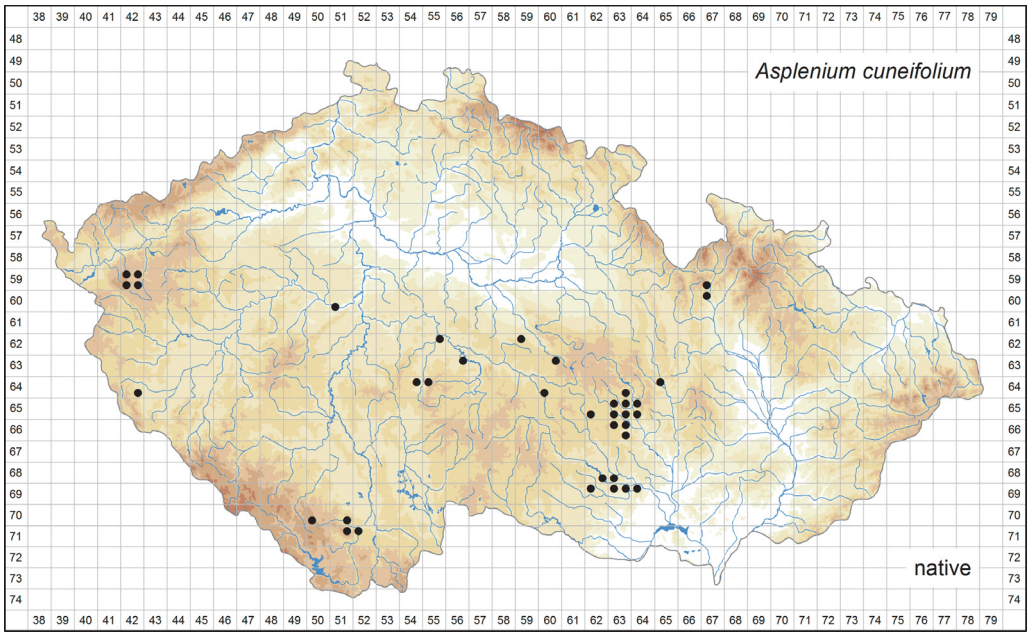


Fig. 8. – Distribution of *Asplenium cuneifolium* in the Czech Republic (37 occupied quadrants). Prepared by Libor Ekrt.

only in Bohemia, mainly in the České středohoří Mts, but probably the largest population, consisting of about 20 individuals, is found on sandstone rocks above the village of Příhrazy near the town of Mnichovo Hradiště. The other three currently known occurrences are in secondary habitats: one on walls in Prague and two in abandoned quarries in central and southern Bohemia; two of these sites host each only a single plant. Many undocumented records are erroneous, based on misidentifications of *A. cuneifolium* (most records from serpentine rocks) but numerous mistakes stem from the classification of the latter as a subspecies of *A. adiantum-nigrum*. The distribution map is based mainly on revised herbarium specimens. The species is classified as critically threatened because of its rarity (Grulich 2012).

Asplenium adulterinum (Fig. 6)

Asplenium adulterinum is a tetraploid species with a very limited distribution. It is found mainly in central Europe, with remote populations recorded in France, Norway, Sweden, Finland and Bosnia and Herzegovina (Meusel et al. 1965, Hultén & Fries 1986). It inhabits only crevices of sun-exposed and semi-shaded serpentine rocks. In the Czech Republic it is found mainly on the serpentine outcrops north of the town of Mariánské Lázně in the Slavkovský les hills, in the Morava river valley north-west of the town of Šumperk and in valleys north-west of the town of Tišnov; rather remote and small populations are found elsewhere. The distribution map is based only on revised herbarium specimens because *A. trichomanes* and *A. viride* were sometimes erroneously identified as *A. adulterinum*. It is classified as critically threatened because of its rarity (Grulich 2012).

Asplenium ceterach (Fig. 7)

In the Czech Republic only the tetraploid *A. ceterach* subsp. *ceterach* is present. It occurs mainly in the Atlantic, Mediterranean and Submediterranean parts of Europe from the British Isles and the Iberian Peninsula in the west to Greece and Bulgaria in the east, further eastwards through south-western Asia as far as the western Himalayas and central Asia; it is also found in northernmost Africa (Hultén & Fries 1986). The Czech Republic is situated at the north-eastern limit of the species' distribution range (Blažková 1971). *Asplenium ceterach* occurs in semi-shaded crevices of basalt or calcareous outcrops and in secondary habitats such as old limestone quarries or man-made walls. It is very rare in the Czech Republic, found at less than two dozen sites particularly in north-western, central and southern Bohemia. In a natural habitat it still survives on basalt rocks near the ruins of the Střekov castle in the České středohoří Mts and on the rocks above the Vltava river near the town of Kamýk nad Vltavou. It was repeatedly found in secondary habitats such as abandoned limestone quarries or walls, but these occurrences usually vanished after some time. While the spontaneous origin of some populations is uncertain, other old records are likely to represent cultivation escapes or deliberately planted populations (Blažková 1971, Tomšovic & Kubát 1981). It is classified as critically threatened because of its rarity (Grulich 2012).

Asplenium cuneifolium (Fig. 8)

Asplenium cuneifolium is a diploid species endemic to central and southern Europe (Meusel et al. 1965, Hultén & Fries 1986). It is confined to sunny and semi-shaded crevices, screes, rocky steppes and shallow soils only on serpentine or occasionally picrite basalt. In the Czech Republic it is a typical species of the majority of serpentine outcrops. It is rare or scattered in western, southern and central-eastern Bohemia and in western and north-western Moravia. The distribution map is based mainly on revised herbarium specimens. The species is classified as endangered (Grulich 2012).

Asplenium ruta-muraria (Fig. 9)

In the Czech Republic only the tetraploid *A. ruta-muraria* subsp. *ruta-muraria* occurs. It is distributed in Europe, where it is common, in northernmost Africa, in the temperate parts of Asia from Anatolia in the west as far as eastern Siberia and Japan in the east, and it also occurs in eastern North America (Hultén & Fries 1986). *Asplenium ruta-muraria* is typical of sunny or semi-shaded limestone and serpentine rocks; it is also found in abandoned quarries and old walls. It is widespread throughout the country, being absent only from areas without suitable habitats. It is most frequently found at middle altitudes, and is rare in the lowlands and the highest parts of the mountains. Still, some of the gaps in the map may be due to under-recording rather than true absences.

Asplenium scolopendrium (Fig. 10)

In the Czech Republic only the diploid *A. scolopendrium* subsp. *scolopendrium* occurs. This subspecies is distributed in Macaronesia, northernmost Africa and the south-western half of Europe; eastwards it extends to Anatolia, the Caucasus Mts and north-western Iran. Populations in eastern North America, Mexico and Japan are tetraploid and are considered to be different taxa (Emmott 1964). In the Czech Republic *A. scolopendrium* inhabits shady humid sites with high air humidity in limestone areas, such as deep and narrow valleys, gorges, abysses, shaded screes and rocks. It is occasionally also found in secondary habitats, including walls and old wells. Large natural populations are rare, only found in the karst area of Moravský kras and in Silesia. In Bohemia no populations were considered natural but recently the species has been found at a few natural sites in central and eastern Bohemia and the Krkonoše Mts, all harbouring small populations or single plants. Some of the recent occurrences, particularly those in secondary habitats, may be due to deliberate planting. The species is classified as critically threatened because of its rarity (Grulich 2012).

Asplenium septentrionale (Fig. 11)

In the Czech Republic only the tetraploid *A. septentrionale* subsp. *septentrionale* occurs. It is distributed almost continuously throughout western, central and south-eastern Europe, in northernmost Africa and in the western USA. It occurs also in the Caucasus Mts and Ural Mts, reaching as far as central Siberia and the Himalayas towards the east (Meusel et al. 1965, Hultén & Fries 1986). In the Czech Republic it is found in crevices and stony screes in sunny and dry sites over hard siliceous rocks; it is quite common in deep and narrow river valleys with rocky slopes. It is most frequent at the middle altitudes

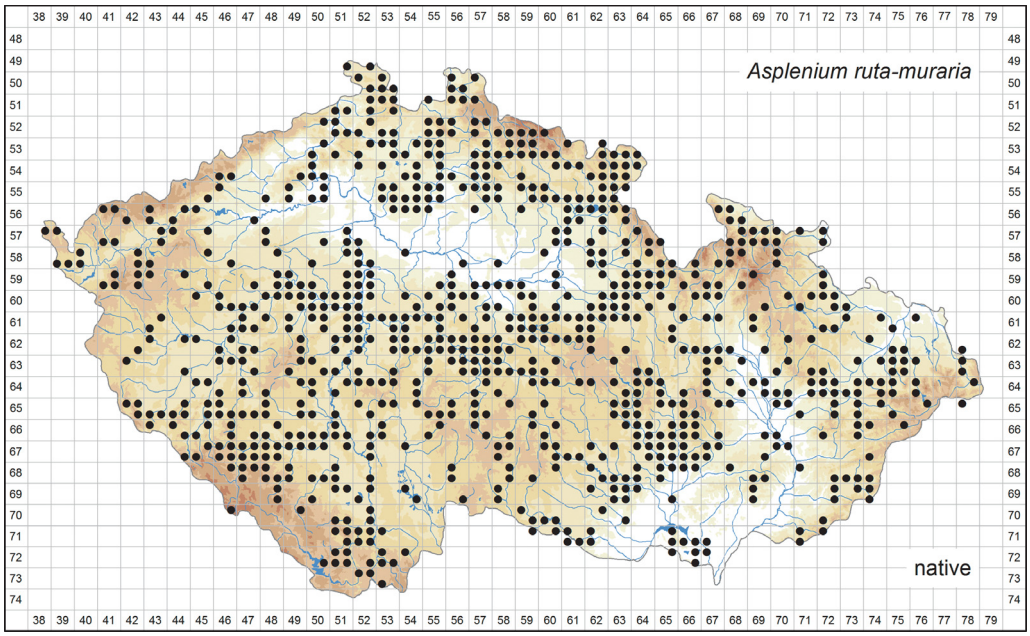


Fig. 9. – Distribution of *Asplenium ruta-muraria* in the Czech Republic (859 occupied quadrants). Prepared by Libor Ekrt.

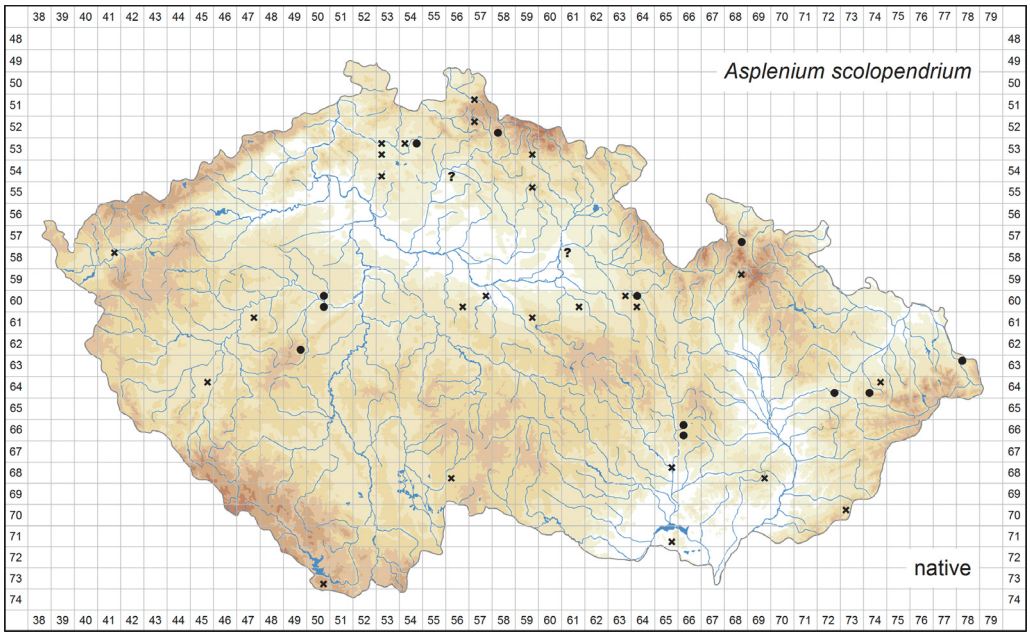


Fig. 10. – Distribution of *Asplenium scolopendrium* in the Czech Republic: ● occurrence in natural habitats (12 quadrants), × occurrence in secondary habitats (25 quadrants). Prepared by Libor Ekrt.

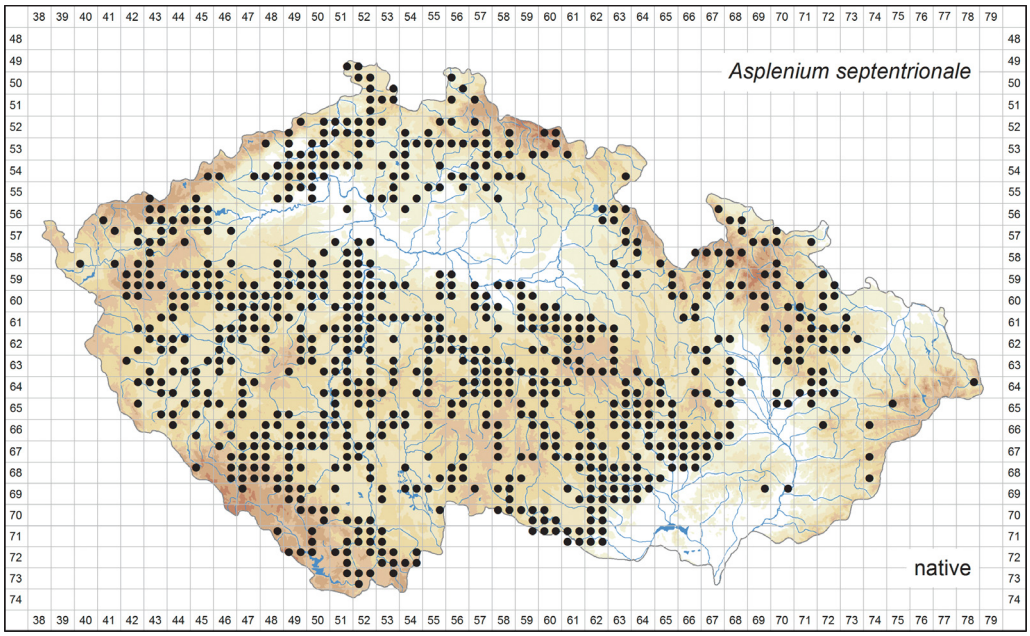


Fig. 11. – Distribution of *Asplenium septentrionale* in the Czech Republic (816 occupied quadrants). Prepared by Libor Ekrt.

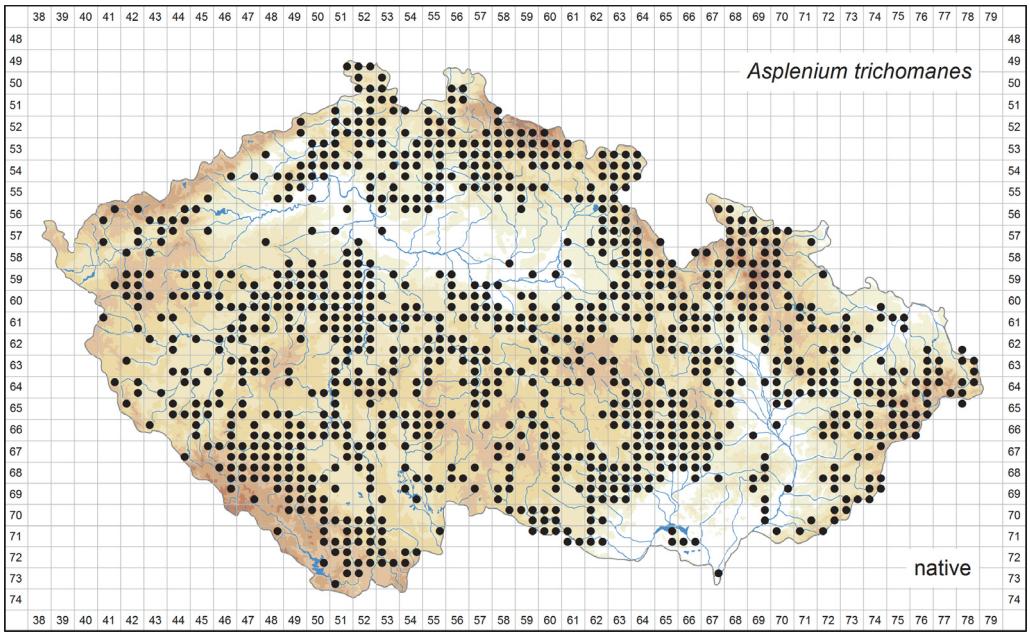


Fig. 12. – Distribution of *Asplenium trichomanes* in the Czech Republic (1067 occupied quadrants). Prepared by Libor Ekrt.

of Bohemia, particularly along rivers, while being rare in or missing from the lowlands, the highest parts of its mountains and areas with crumbly or calcareous rocks, or without rocks at all, such as westernmost, north-eastern and south-eastern Bohemia. In the eastern part of the country it is mainly confined to deep and narrow river valleys of western Moravia and the western part of Silesia, being rare or absent elsewhere.

Asplenium trichomanes (Fig. 12)

Asplenium trichomanes is distributed worldwide, but it is predominantly a holarctic species with the major part of its distribution range situated in the temperate zone. It is widespread in most of Europe but appears to be rare in European Russia. It also occurs in northernmost Africa and remote occurrences are found in south-western and Central Asia, the Himalayas, southern China, Japan and North America. In the Southern Hemisphere it occurs in South America, southern Africa, New Guinea, south-eastern Australia, Tasmania and New Zealand (Meusel et al. 1965, Hultén & Fries 1986). The species includes nine subspecies of three ploidy levels (diploid, tetraploid and hexaploid) and different habitat preferences (Lovis 1964, Bennert & Fischer 1993). Of those the diploid *A. t.* subsp. *trichomanes* and the tetraploid *A. t.* subsp. *hastatum*, *A. t.* subsp. *pachyrachis* and *A. t.* subsp. *quadrivalens* are present in the Czech Republic (Ekrt & Štech 2008). *Asplenium trichomanes* usually grows in rock crevices, on rock outcrops, screes and on old walls. In the Czech Republic it is widely distributed and common in the areas with rock outcrops and along narrow and deep river valleys. It is far less frequent in the areas with no or few rock habitats, such as western and south-western part of Bohemia, the Třeboňská pánev basin, the Českomoravská vrchovina highlands or eastern Silesia. It is almost absent from the lowlands, where it is confined to man-made habitats such as walls. The four subspecies present in the country's flora have been recognized only recently (Ekrt 2008b, Ekrt & Štech 2008) and distribution maps are based solely on revised herbarium specimens.

Asplenium trichomanes subsp. *hastatum* (Fig. 13)

Asplenium trichomanes subsp. *hastatum* is a tetraploid subspecies that has not been widely recognized until recently (Jeßen 1995). Its distribution is poorly known and it has been reported to occur in Ireland, France, Germany, Switzerland, Italy, Austria, Poland, the Czech Republic, Slovakia, Hungary, Croatia, Romania, Bulgaria and Greece (Jeßen 1995). It inhabits crevices of shaded limestone rocks, cave entrances or occasionally walls. In the Czech Republic its presence is documented mainly from Moravia, particularly from the karst area of Moravský kras, and from 8 other sites. In Bohemia it has been found at a single site in the karst area of Český kras. *Asplenium trichomanes* subsp. *hastatum* is classified as critically threatened because of its rarity (Grulich 2012).

Asplenium trichomanes subsp. *pachyrachis* (Fig. 14)

Asplenium trichomanes subsp. *pachyrachis* is a tetraploid subspecies whose general distribution is poorly known. Until now, it has been found only in Europe (except its northern parts), extending westwards to Great Britain and Spain and eastwards to Greece (Lovis & Reichstein 1985, Rickard 1989) and Bulgaria (Ekrt, unpublished). In the Czech

Republic it occurs rarely on limestone rocks of the Pavlovské vrchy hills and the karst areas of Moravský kras and Český kras; it was also recorded on calcareous sandstones in northern Bohemia. All other records are from walls in castles, castle ruins and towns. It is classified as critically threatened because of its rarity (Grulich 2012).

Asplenium trichomanes subsp. *quadrivalens* (Fig. 15)

Asplenium trichomanes subsp. *quadrivalens* is a tetraploid subspecies widely distributed and fairly common throughout the whole species' range (see under *A. trichomanes*; Reichstein 1984). It inhabits siliceous, calcareous and serpentine rocks, being also very common on walls and in other man-made habitats (Ekrt 2008b). This is the most widespread and frequent of all four subspecies of *A. trichomanes* occurring in the Czech Republic.

Asplenium trichomanes subsp. *trichomanes* (Fig. 16)

Asplenium trichomanes subsp. *trichomanes* is a diploid subspecies distributed throughout the whole distribution range of the species (see under *A. trichomanes*) except Macaronesia, the Mediterranean area and northernmost Europe (Reichstein 1984). It inhabits siliceous and serpentine rocks, while avoiding calcareous rocks and walls (Ekrt 2008b). It was documented from the majority of areas where the species occurs in the Czech Republic but it is rather scattered and far less frequent than *A. t.* subsp. *quadrivalens.*

Asplenium viride (Fig. 17)

Asplenium viride is a diploid species with a large distribution range in the Northern Hemisphere including the temperate zones of Europe and North America and mountains of northern Africa; in Asia it is found in the Caucasus Mts, Ural Mts and northern Himalayas, in the east reaching as far as central Siberia (Meusel et al. 1965, Hultén & Fries 1986). *Asplenium viride* grows in crevices of calcareous or serpentine rocks, exhibiting a preference for higher elevations. In the Czech Republic *A. viride* occurs almost throughout the whole country, but with varying frequencies. Most of its localities are situated in the mountains and its foothills, including the Krkonoše Mts, Hrubý Jeseník Mts and Moravskoslezské Beskydy Mts. It is less frequent at the middle altitudes of eastern Bohemia, north-western Moravia, as well as on serpentine outcrops in the Slavkovský les hills and near the town of Křemže in southern Bohemia. It has been also recorded on walls in old ruins of houses or castles throughout the country. However, it is almost missing from central Bohemia and central and southern Moravia. The species is classified as vulnerable (Grulich 2012).

Asplenium ×*alternifolium* nothosubsp. *alternifolium* (Fig. 18)

Asplenium ×*alternifolium* nothosubsp. *alternifolium* is a primary triploid hybrid of the tetraploid *A. septentrionale* subsp. *septentrionale* and the diploid *A. trichomanes* subsp. *trichomanes*. It is an easily recognized hybrid found throughout the whole area where its parental species co-occur. It usually grows with both parents in crevices of siliceous rocks, particularly in rocky slopes of deep river valleys. By contrast, it is not usually found on walls and in other secondary habitats (Ekrt 2008a). In the Czech Republic it is

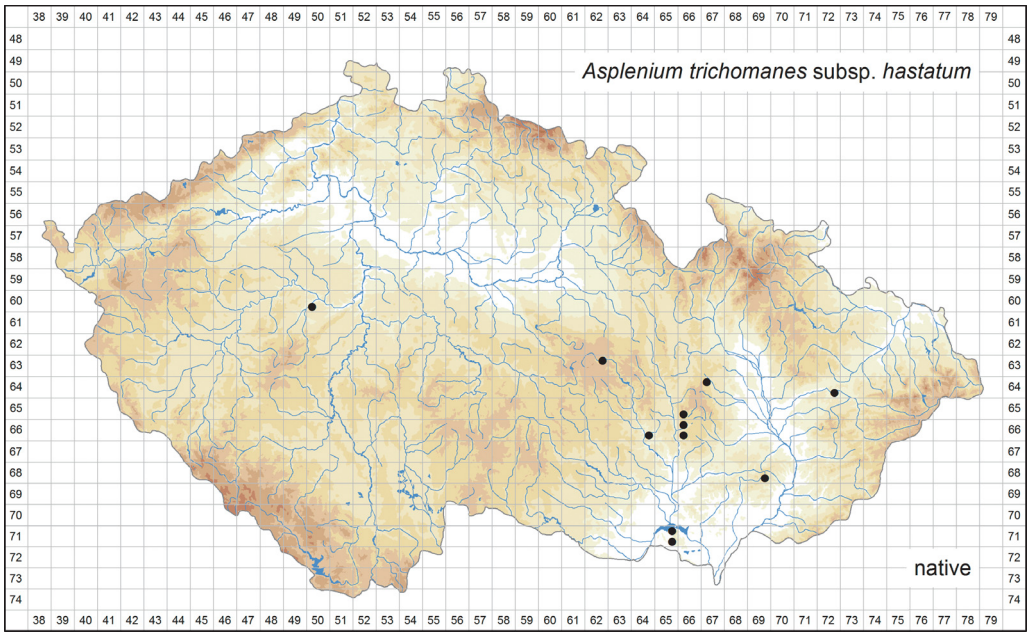


Fig. 13. – Distribution of *Asplenium trichomanes* subsp. *hastatum* in the Czech Republic (11 occupied quadrants). Prepared by Libor Ekrt.

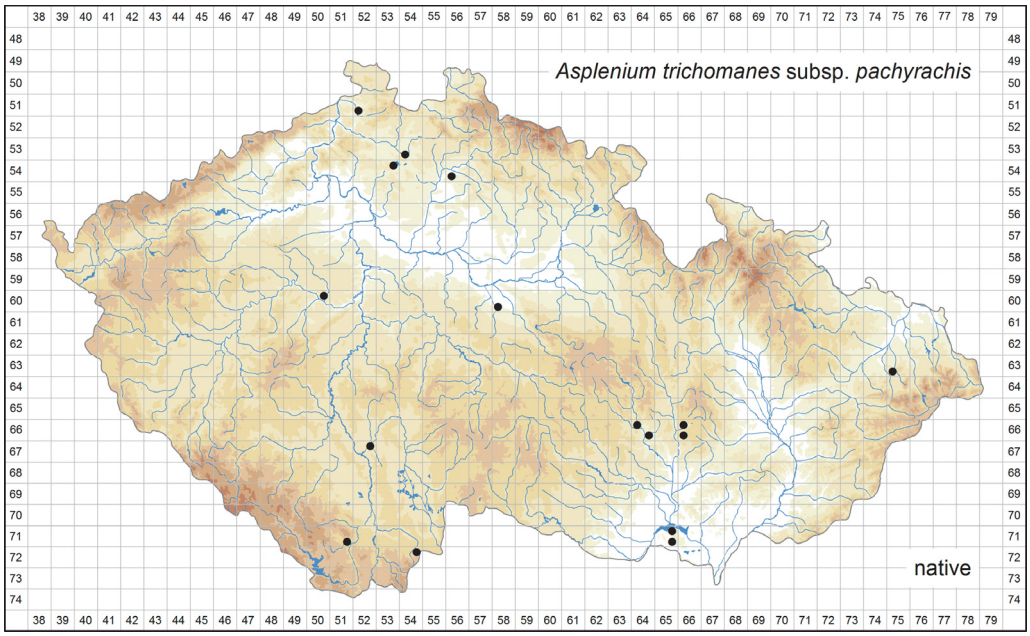


Fig. 14. – Distribution of *Asplenium trichomanes* subsp. *pachyrachis* in the Czech Republic (16 occupied quadrants). Prepared by Libor Ekrt.

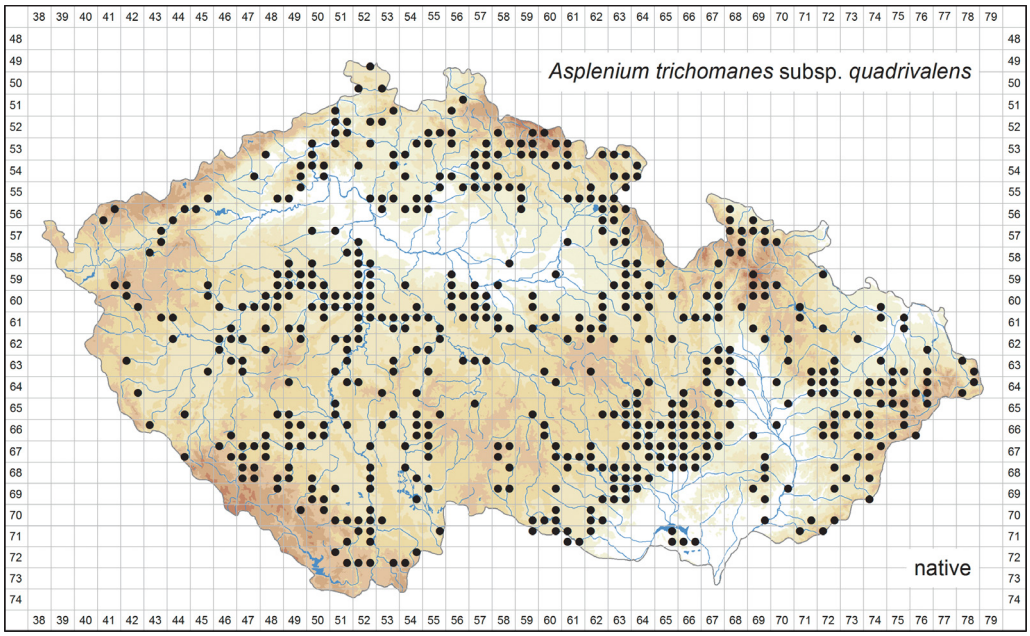


Fig. 15. – Distribution of *Asplenium trichomanes* subsp. *quadrivalens* in the Czech Republic (566 occupied quadrants). Prepared by Libor Ekrt.

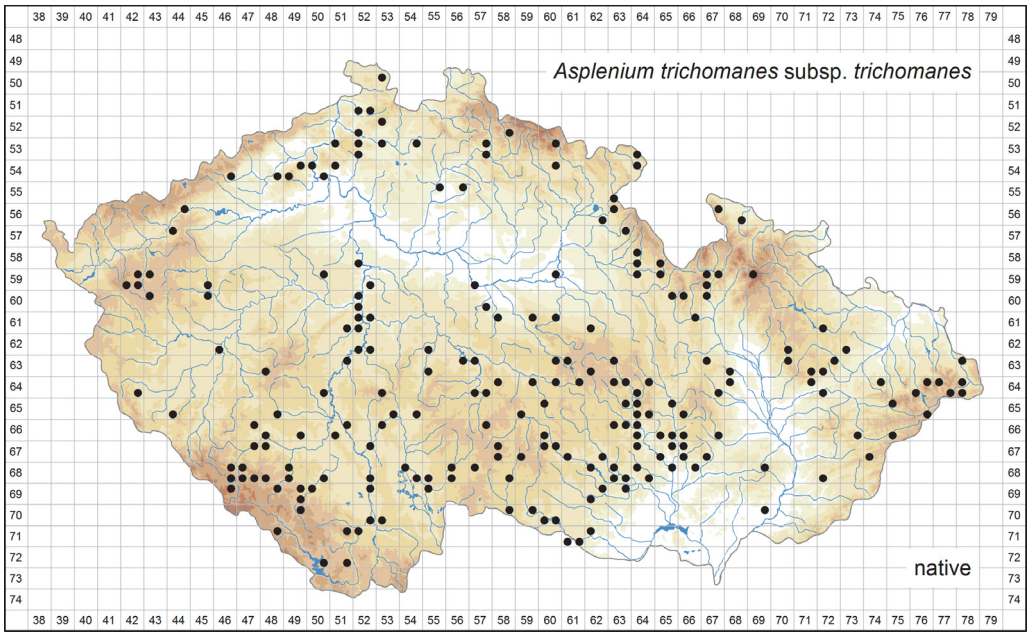


Fig. 16. – Distribution of *Asplenium trichomanes* subsp. *trichomanes* in the Czech Republic (219 occupied quadrants). Prepared by Libor Ekrt.

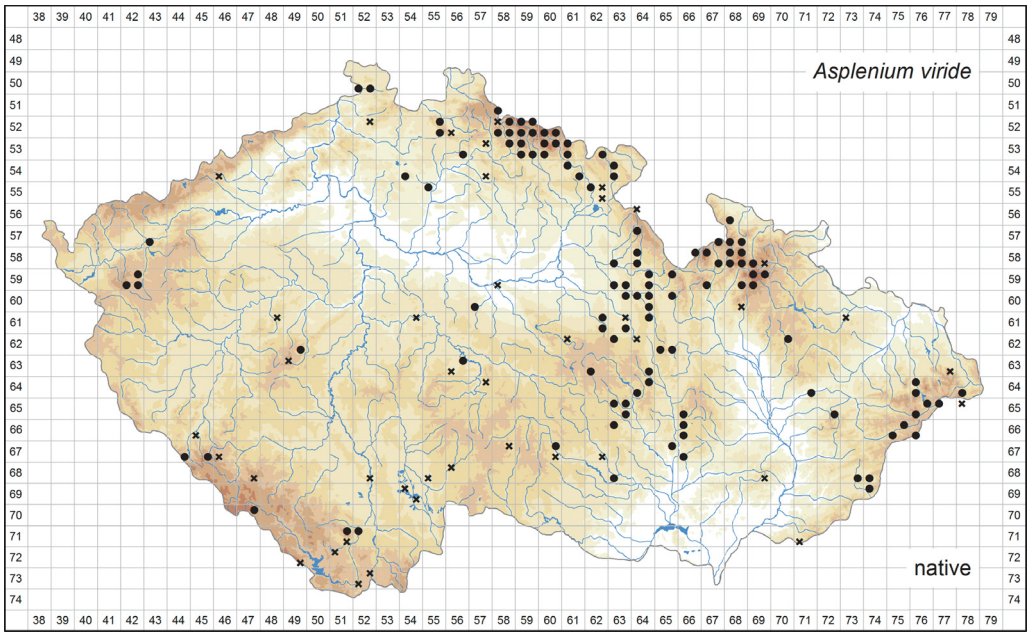


Fig. 17. – Distribution of *Asplenium viride* in the Czech Republic: ● occurrence in natural habitats (112 quadrants), × occurrence in secondary habitats (41 quadrants). Prepared by Libor Ekrt.

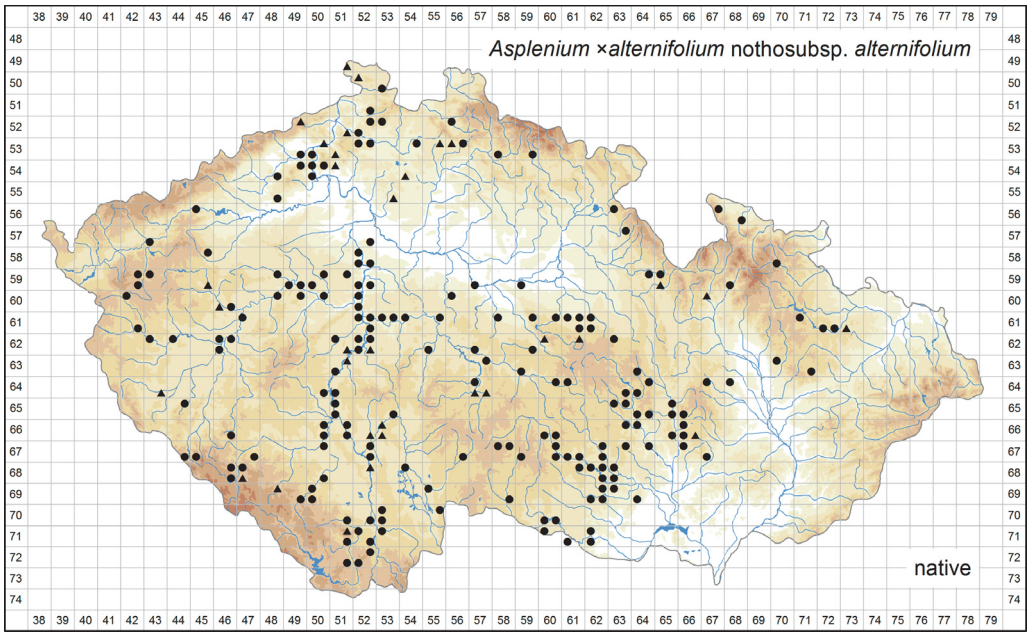


Fig. 18. – Distribution of *Asplenium* ×*alternifolium* nothosubsp. *alternifolium* in the Czech Republic: ● occurrence documented by herbarium specimens (187 quadrants), ▲ occurrence based on other records (32 quadrants). Prepared by Libor Ekrt.

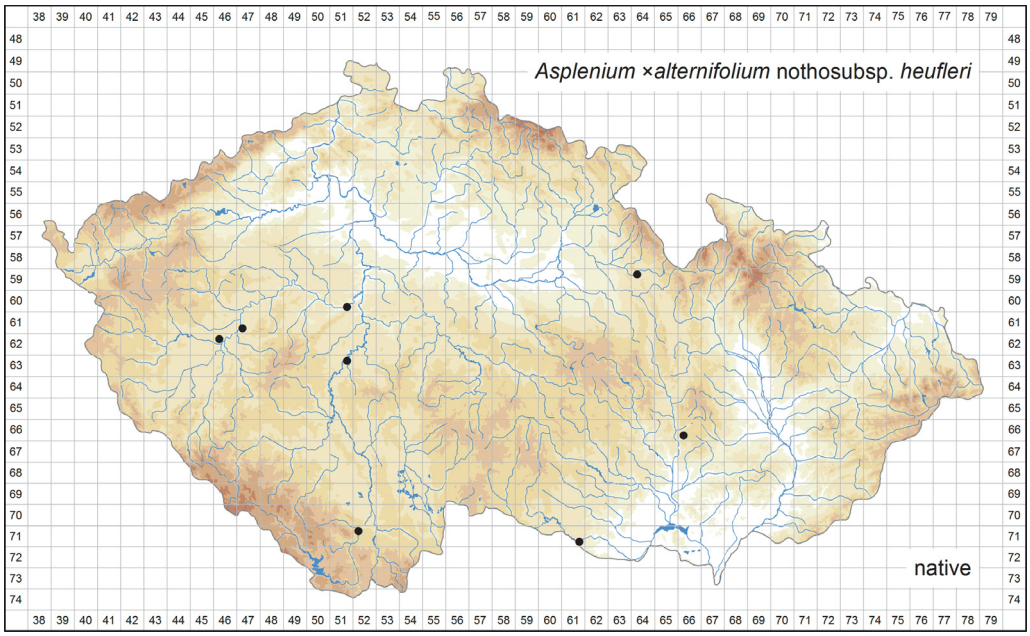


Fig. 19. – Distribution of *Asplenium ×alternifolium* nothosubsp. *heufleri* in the Czech Republic (8 occupied quadrants). Prepared by Libor Ekrt.

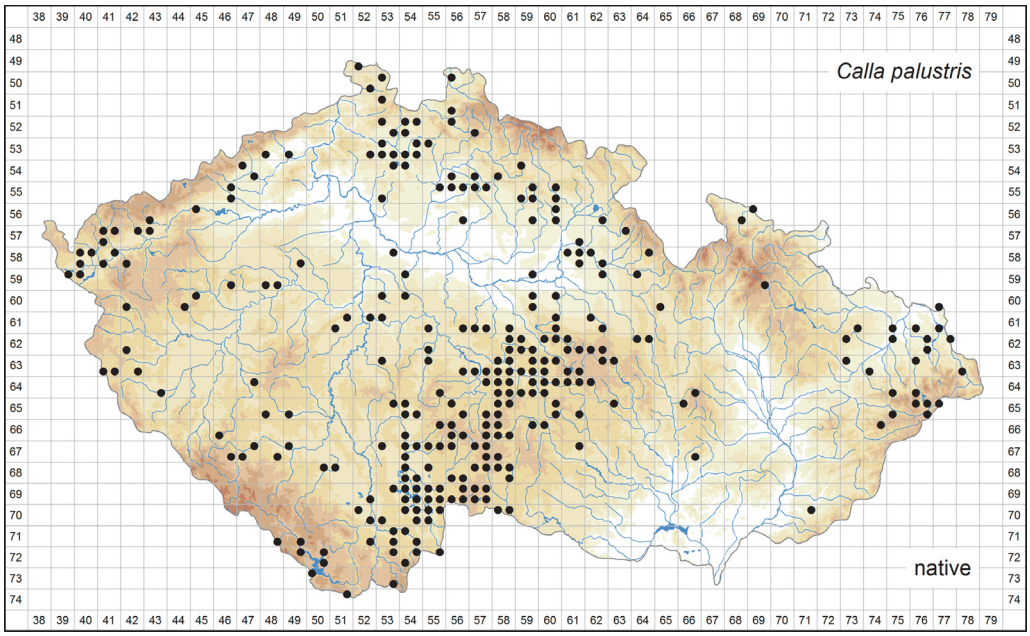


Fig. 20. – Distribution of *Calla palustris* in the Czech Republic (291 occupied quadrants). Prepared by Zdeněk Kaplan.

most frequent at the middle altitudes of Bohemia, particularly along the Vltava river and its tributaries, including the Berounka, Sázava, Lužnice and Malše rivers, while almost absent from both the lowlands and the mountains. In Moravia it is confined to the deep and narrow river valleys in the western and south-western parts. In addition, there are a few records from Silesia. The distribution map is based mainly on revised herbarium specimens, supplemented with a few selected literature records.

Asplenium ×*alternifolium* nothosubsp. *heufleri* (Fig. 19)

Asplenium ×*alternifolium* nothosubsp. *heufleri* is a primary tetraploid hybrid of tetraploid parents, *A. septentrionale* subsp. *septentrionale* and *A. trichomanes* subsp. *quadrivalens*. It is rather easy to recognize but only rarely formed where both parents co-occur. It usually inhabits rock crevices on the slopes of deep river valleys and has only rarely been found in man-made habitats such as walls. In the Czech Republic it has been collected several times along the valleys of the Vltava, Berounka and Dyje rivers, on rocks near the town of Adamov and on the ruins of Litice castle near the town of Potštejn. The distribution map is based only on revised herbarium specimens.

Calla palustris (Fig. 20)

Calla palustris has a circumboreal distribution. It is found in central, northern and eastern Europe, westwards to Belgium and southwards to Romania. In Asia it occurs in western and central Siberia and is scattered in eastern Asia as far as Japan. In North America it is distributed from Alaska through western Canada to the eastern coast of the USA (Meusel et al. 1965, Hultén & Fries 1986). In the Czech Republic *C. palustris* inhabits alder carrs, pools in forests, edges of ponds, oxbow lakes and peat bogs. It prefers mesotrophic to dystrophic and mostly acidic substrates, often at sites partly shaded by trees (Šumberová 2011b). As a decorative plant it is sometimes planted in both settlements and natural habitats. Consequently, in many cases native populations cannot be distinguished from those deliberately established. *Calla palustris* occurs mainly at middle altitudes, in precipitation-rich areas, being most frequent in the Českomoravská vrchovina highlands. Less often it is found in the foothills of the mountains along the country's borders, particularly in western, northern and north-eastern Bohemia and in the easternmost part of the country. It is rare in, or absent from, warm and dry areas lacking suitable habitats, such as north-western and central Bohemia and most of Moravia. The native populations are classified as vulnerable (Grulich 2012). Some records from electronic databases are dubious and were not included in the map because they may actually refer to *Caltha palustris* or *Callitriche palustris*, as *Calla palustris* was erroneously selected from a list of standard abbreviations of plant names by entering the code "Cal pal".

Cerastium alsinifolium (Fig. 21)

Cerastium alsinifolium is endemic to serpentine sites in the Slavkovský les Mts in western Bohemia. It used to be considered a relative of *C. arvense* but it differs significantly from this species in its monoploid genome size (Vít et al. 2014). An alternative hypothesis suggests that it may be related to *C. alpinum* and its allies (Novák 1960). Nevertheless, it readily hybridizes with *C. arvense* (Vít et al. 2014). It is confined to moist and more or

less shaded sites, including springs and other wet places in canopy openings of spruce forest and wet margins of forest roads. The sites are situated at 680–880 m a.s.l. By contrast, open habitats on serpentine outcrops, formerly considered the main habitat of *C. alsinifolium*, mainly harbour its hybrids with *C. arvense*. Five populations of *C. alsinifolium* exist, all situated in nature reserves. The species is classified as critically threatened because of its rarity (Grulich 2012) but no considerable decline has been observed.

Cerastium alsinifolium × *C. arvense* (Fig. 22)

This hybrid has been found in or close to all sites of *C. alsinifolium*. However, it is well separated ecologically: whilst *C. alsinifolium* occurs mainly in semi-shaded humid forest habitats, its hybrid is found, together with *C. arvense*, in open and rather dry places on serpentine outcrops. Most hybrids have the same ploidy level as their parents, but plants formed by the fusion of one or two unreduced gametes were also found. The hybridization is bidirectional, and hybrids are common; however, their fertility is reduced and no evidence for back crosses has been found (Vít et al. 2014).

Cerastium arvense (Fig. 23)

Cerastium arvense has a large, mainly circum-temperate distribution range, which includes most of Europe and most of the temperate and also boreal zones of Asia and North America; it is also found in north-western Africa (Meusel et al. 1965). The species is very variable in general appearance, indumentum and leaf shape, and six subspecies have been recognized in Europe (Jalas et al. 1993). The plants found in the Czech Republic are most likely octoploid (Vít et al. 2014) and morphologically correspond to the type subspecies. Nevertheless, they are also rather variable, and numerous infraspecific taxa of little taxonomic value have been described. *Cerastium arvense* occurs in dry grasslands and dry meadows, road verges, forest margins, sandy places and rather dry semi-ruderal grasslands, usually on well-drained soils poor or moderately rich in nutrients. It is more or less evenly distributed throughout the country from the lowlands up to the mountains, reaching its altitudinal maximum in the Hrubý Jeseník Mts at about 1460 m a.s.l. though the records from such high altitudes may be due to recent introductions. The species is rare in or probably even locally absent from lowland areas with predominantly arable land and with soils very rich in nutrients.

Cerastium dubium (Fig. 24)

Cerastium dubium is distributed mainly in south-eastern Europe, in the north-west reaching as far as central Germany. It is also found in Spain, northern Italy, the Crimean Peninsula, westernmost Asia and north-western Africa (Jalas & Suominen 1983, Marhold 2011). It has become naturalized in North America (Morton 2005). In the Czech Republic *C. dubium* is found in alluvial meadows and pastures, wet depressions on arable land, saline meadows, the bottoms of drained fishponds and recently also in other secondary habitats such as road verges and railway stations. *Cerastium dubium* is scarce in the country. It is permanently present only in southern Moravia, and these populations are considered native. It has been repeatedly found also in central and eastern Bohemia, and rarely elsewhere. Some of the introductions may be attributed to human activities but others are

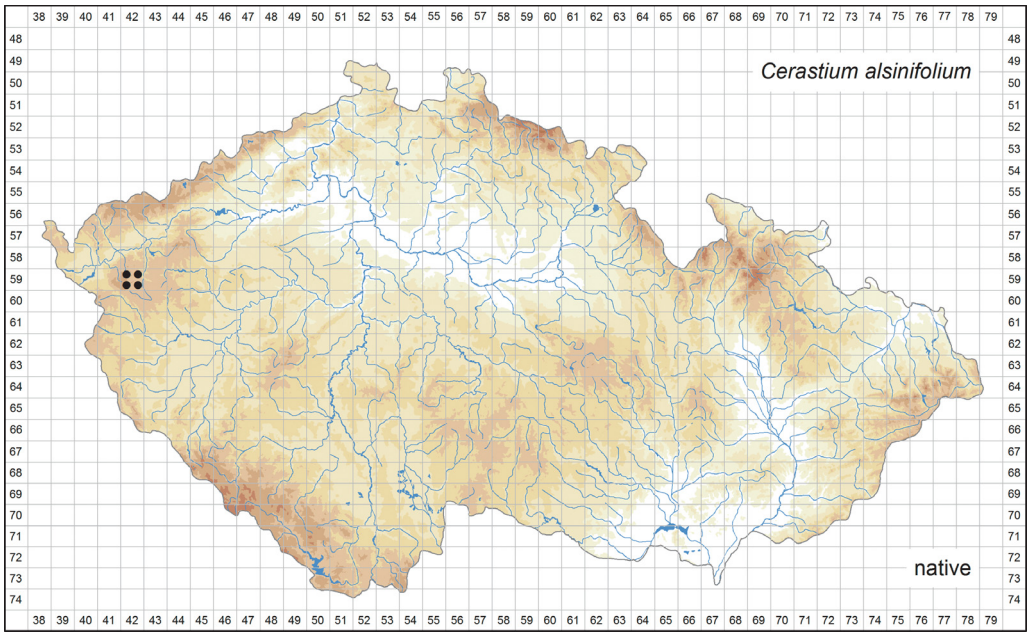


Fig. 21. – Distribution of *Cerastium alsinifolium* in the Czech Republic (4 occupied quadrants). Prepared by Jiří Danihelka & Přemysl Tájek.

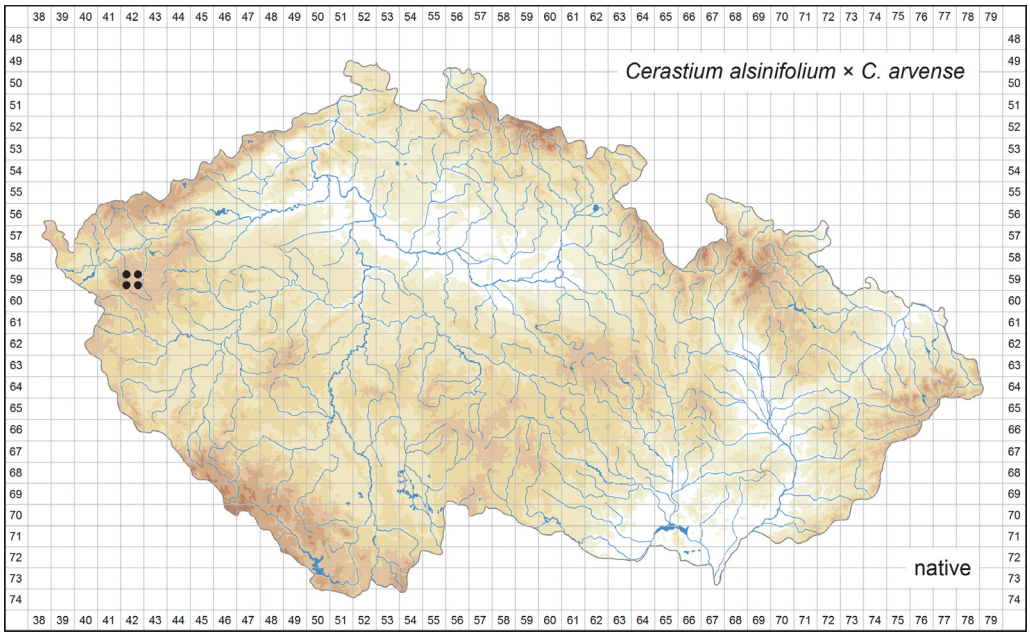


Fig. 22. – Distribution of *Cerastium alsinifolium* × *C. arvense* in the Czech Republic (4 occupied quadrants). Prepared by Jiří Danihelka & Přemysl Tájek.

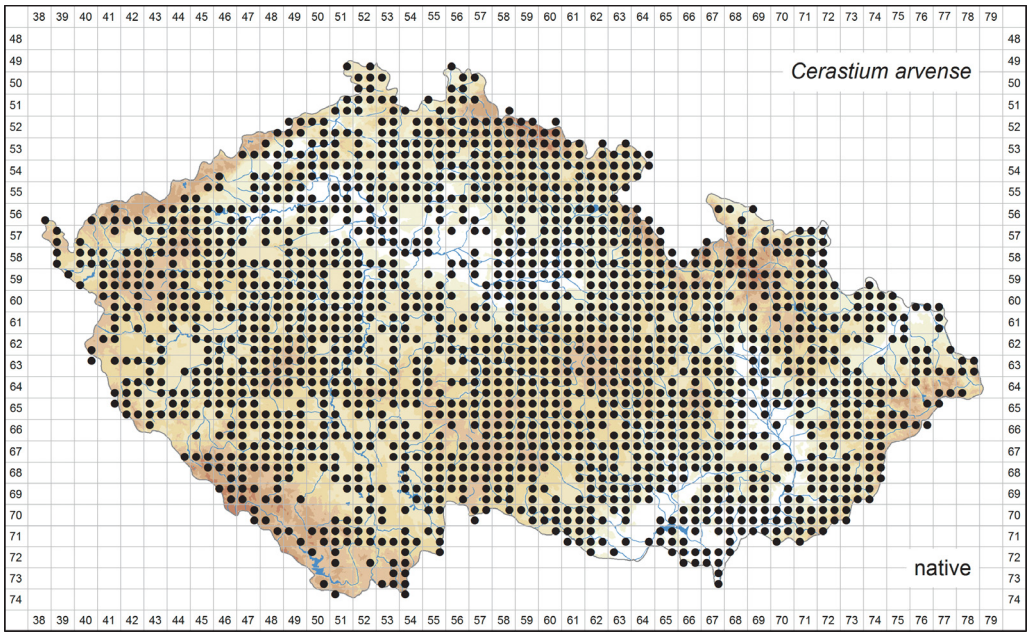


Fig. 23. – Distribution of *Cerastium arvense* in the Czech Republic (1822 occupied quadrants). Prepared by Jiří Danihelka.

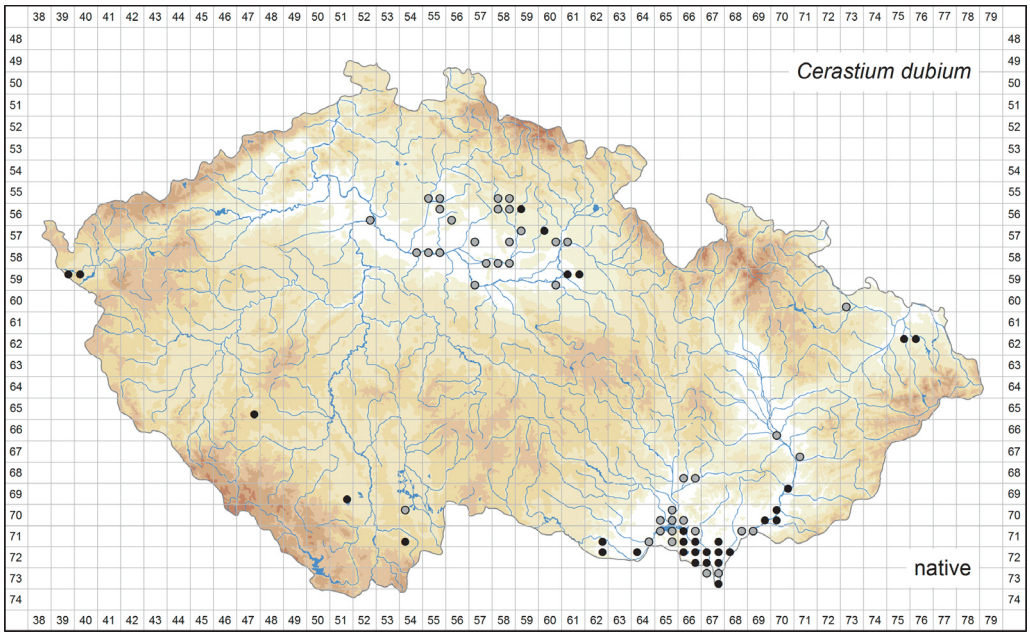


Fig. 24. – Distribution of *Cerastium dubium* in the Czech Republic: ● at least one record in 2000–2016 (31 quadrants), ● pre 2000 records only (41 quadrants). Prepared by Jiří Danihelka, Michal Ducháček & Zdeněk Kaplan.

difficult to explain. All native occurrences are situated in the lowlands up to 200 m a.s.l., but the secondary ones in fishponds in western and southern Bohemia are from altitudes of 400 m to 500 m. The species has declined to some extent in its southern Moravian sites and it is therefore classified as endangered (Grulich 2012).

Cerastium fontanum (Fig. 25)

Cerastium fontanum s. str. is one of the three species of the *C. fontanum* aggregate in the country's flora. It is distributed in southern Greenland, Iceland, the Faroe Islands, Scandinavia, northern Russia, the mountains of central Europe, including the eastern Sudetes, Alps and Carpathians, and in the Stara Planina Mts in Bulgaria (Jalas & Suominen 1983, Jonsell et al. 2001). In the Czech Republic *C. fontanum* is found in mountain meadows, subalpine tall grasslands, subalpine vegetation of tall broad-leaved forbs and grasslands dominated by *Nardus stricta*, usually around springs and in other moist places. In the Czech Republic its occurrence is restricted to the highest parts of the Hrubý Jeseník Mts at altitudes of about 1120–1480 m, and only a single record exists at about 770 m a.s.l. There are also records from the Králický Sněžník Mts, the earliest and most reliable one by R. Uechtritz from the 1870s (Uechtritz 1876) but no herbarium specimen has been seen. The species is classified as endangered because of its rarity (Grulich 2012) but no decline has been observed and it is even able to colonize secondary habitats.

Cerastium glutinosum (Fig. 26)

Cerastium glutinosum is one of the two species of the *C. pumilum* aggregate. Its delimitation from *C. pumilum* s. str. was disputed for a long time and eventually resolved by Karlsson (in Jonsell et al. 2001: 149–158). His findings also proved to be applicable in central Europe (Letz et al. 2012). The total distribution of *C. glutinosum* is uncertain due to former taxonomic confusion and frequent misidentifications. It is certainly native to much of central and southern Europe (Jalas & Suominen 1983, mapped together with *C. pumilum* s. str.), probably being more continental than *C. pumilum* s. str. (Karlsson in Jonsell et al. 2001: 149–158, Letz et al. 2012). It has been reported as introduced to North America but the exact identity of the American populations is unclear (Morton 2005). In the Czech Republic *C. glutinosum* is found in dry grasslands and various man-made habitats, including stone quarries, dry ruderal sites, railway stations and yards, street lawns, trampled places in settlements and roadsides. It seems to profit from the excessive use of herbicides on the railways, which protects it from competition by perennial species. The species prefers pervious soils of basic to moderately acidic reaction, poor or moderately rich in nutrients. *Cerastium glutinosum* is fairly common in the lowlands and at middle altitudes below 500 m, i.e. in areas with warm and moderately warm climates. However, it has been repeatedly recorded in settlements and railway stations up to 770 m a.s.l. On the one hand, the species is strongly under-recorded because of its ephemeral life cycle, on the other hand, some of the undocumented records accepted for the map may be based on misidentified specimens of *C. semidecandrum* and *C. holosteoides*.

Cerastium holosteoides (Fig. 27)

Cerastium holosteoides is another species of the *C. fontanum* aggregate. It is probably native to Europe and western Asia but its recent distribution is circum-temperate, including also the eastern half of Asia and North America (Jalas & Suominen 1983, Hultén & Fries 1986). In the Czech Republic all plants have pubescent flowering stems and leaves hairy all over, and are referable to *C. holosteoides* subsp. *vulgare*. It is found in meadows, pastures, ruderal grasslands, on road verges, in forest clearings, abandoned fields and many other, often secondary open habitats. It is common from the lowlands up to the mountains all over the country. Most of the gaps in the map represent the lack of records rather than true absences.

Cerastium lucorum (Fig. 28)

Cerastium lucorum, the third species of the *C. fontanum* aggregate in the country's flora, is distributed in central Europe and the north of the Iberian Peninsula (Jalas & Suominen 1983). In the Czech Republic it is found in shaded to semi-shaded habitats, mainly in alluvial and other broad-leaved forests, and along forest paths and roads, usually in humid places. *Cerastium lucorum* is scattered to locally common in northern, central and eastern Bohemia, becoming more frequent towards the east; by contrast, records from western and southern Bohemia are erroneous. The species is more widespread in the eastern part of the country, particularly north of Brno and in the Carpathians. It occurs mainly in the lowlands and valleys of hilly areas, while ascending to altitudes of about 650 m in the Carpathians. As misidentifications are frequent, the map is based mainly on revised specimens. We accept only those undocumented records that fit the species' ecological requirements and distribution pattern outlined by the herbarium specimens. The species is classified as lower risk – near threatened (Grulich 2012) but no conspicuous decline has been observed.

Cerastium pumilum (Fig. 29)

Cerastium pumilum s. str., the other species of the *C. pumilum* aggregate, used to be frequently confused with *C. glutinosum*. Its diagnostic characters were elaborated by Karlsson (in Jonsell et al. 2001: 149–158), based mainly on plants from southern Sweden. As shown by Letz et al. (2012), these characters are also applicable to central European populations. The total distribution of *C. pumilum* is uncertain due to former taxonomic confusion and frequent misidentifications. It is certainly native to much of western and southern Europe (Jalas & Suominen 1983, mapped together with *C. glutinosum*), being probably more oceanic than *C. glutinosum* (Karlsson in Jonsell et al. 2001: 149–158, Letz et al. 2012). It has been reported as naturalized in North America but the records may include *C. glutinosum*. In the Czech Republic *C. pumilum* is found in dry grasslands and rock outcrops, only rarely also in man-made habitats such as railway stations. Preferring natural and semi-natural habitats on base-rich substrata, it is ecologically more or less separated from *C. glutinosum*. If both species co-occur, then the latter is usually found in microhabitats more strongly influenced by man, such as along walking paths and in trampled places; nevertheless, mixed gatherings are frequent. *Cerastium pumilum* is not only less frequent than *C. glutinosum*, but rare in general; it is confined to hilly areas in the

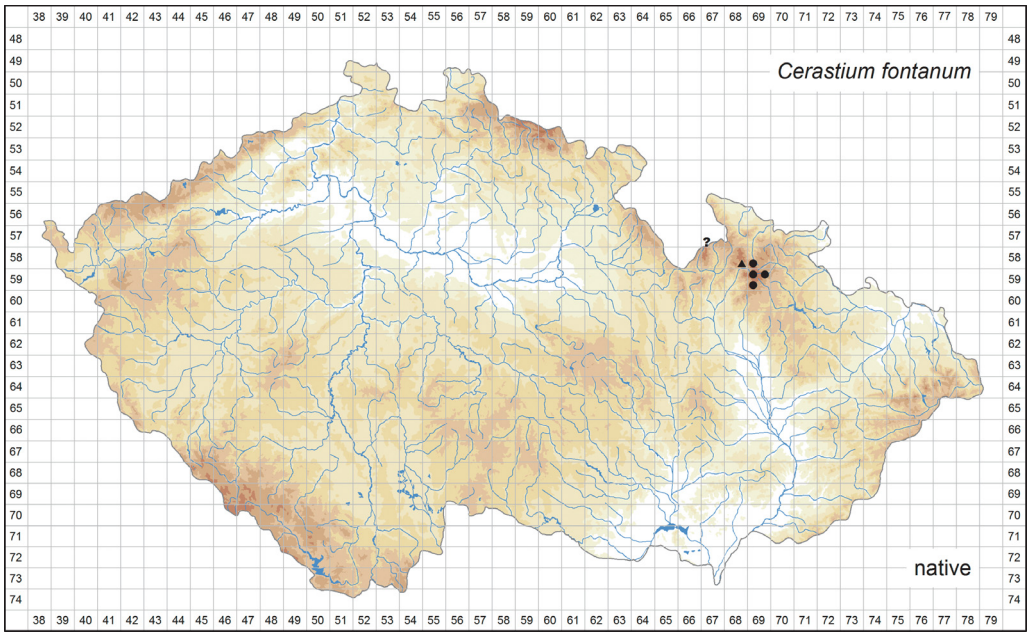


Fig. 25. – Distribution of *Cerastium fontanum* in the Czech Republic: ● occurrence documented by herbarium specimens (4 quadrants), ▲ occurrence based on other records (1 quadrant). Prepared by Jiří Danihelka.

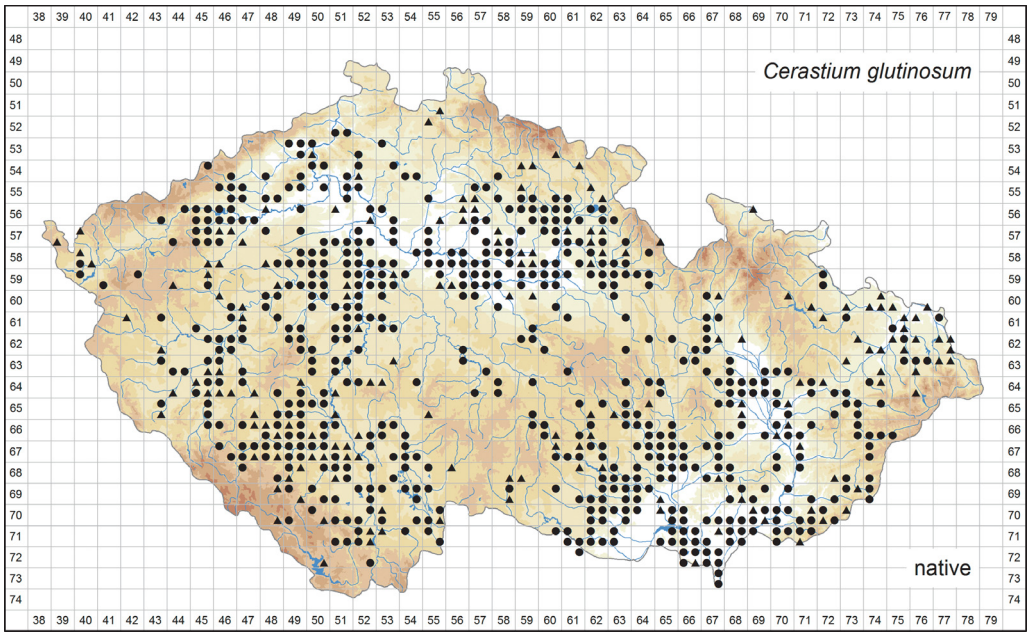


Fig. 26. – Distribution of *Cerastium glutinosum* in the Czech Republic: ● occurrence documented by herbarium specimens (566 quadrants), ▲ occurrence based on other records (171 quadrants). Prepared by Jiří Danihelka & Martin Dančák.

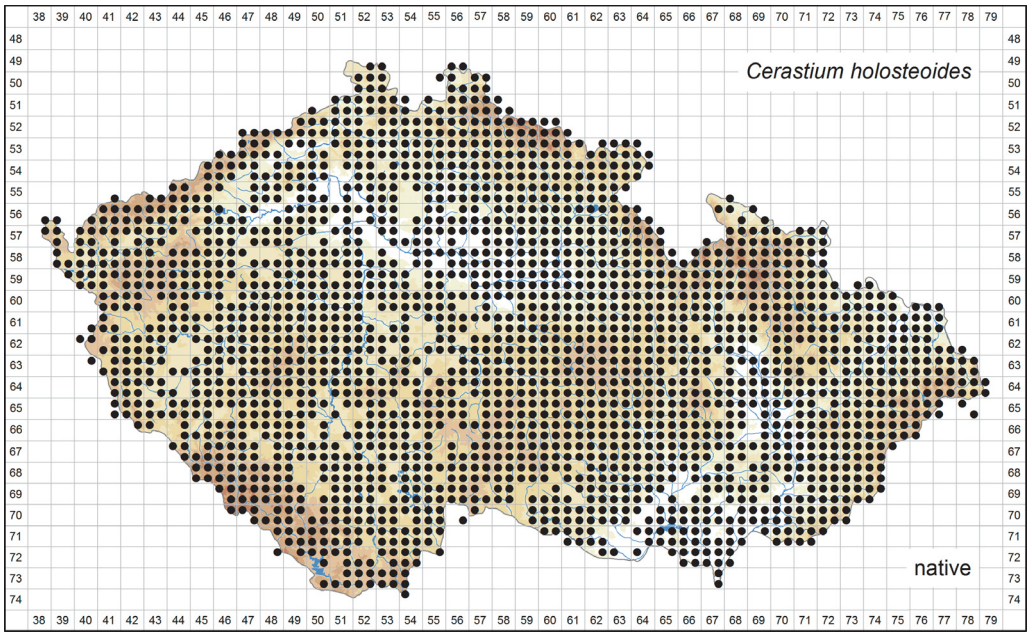


Fig. 27. – Distribution of *Cerastium holosteoides* in the Czech Republic (2169 occupied quadrants). Prepared by Jiří Danihelka & Zdeněk Kaplan.

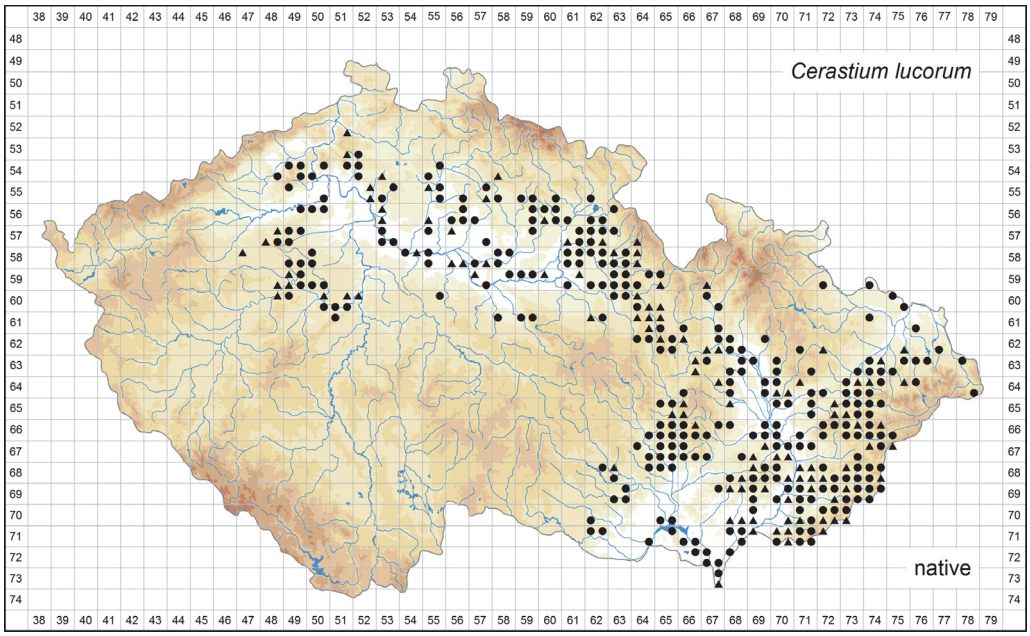


Fig. 28. – Distribution of *Cerastium lucorum* in the Czech Republic: ● occurrence documented by herbarium specimens (287 quadrants), ▲ occurrence based on other records (110 quadrants). Prepared by Jiří Danihelka, Michal Ducháček & Zdeněk Kaplan.

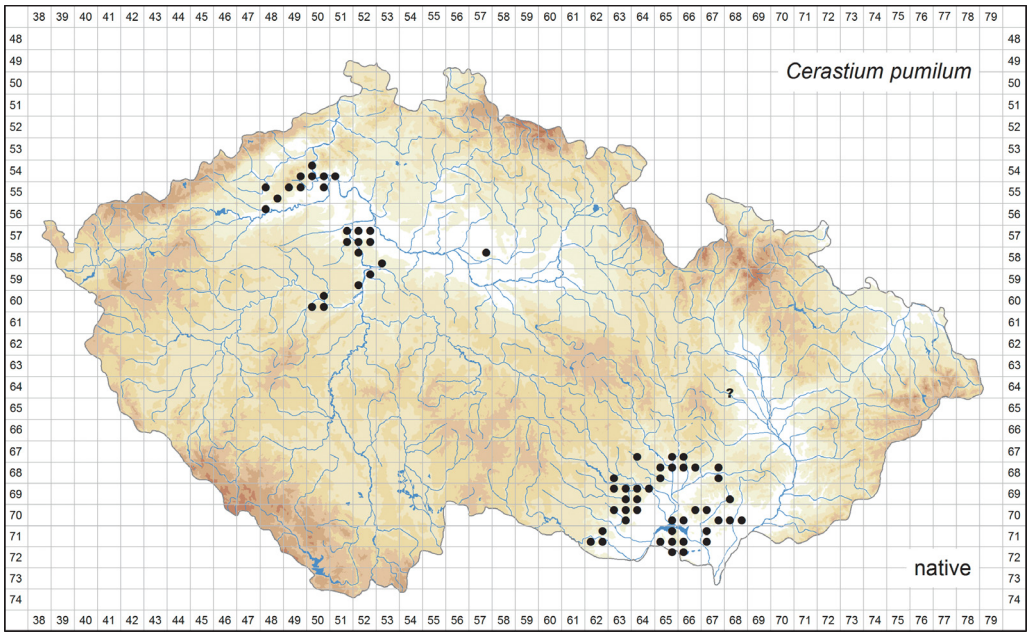


Fig. 29. – Distribution of *Cerastium pumilum* in the Czech Republic (65 occupied quadrants). Prepared by Jiří Danihelka & Martin Dančák.

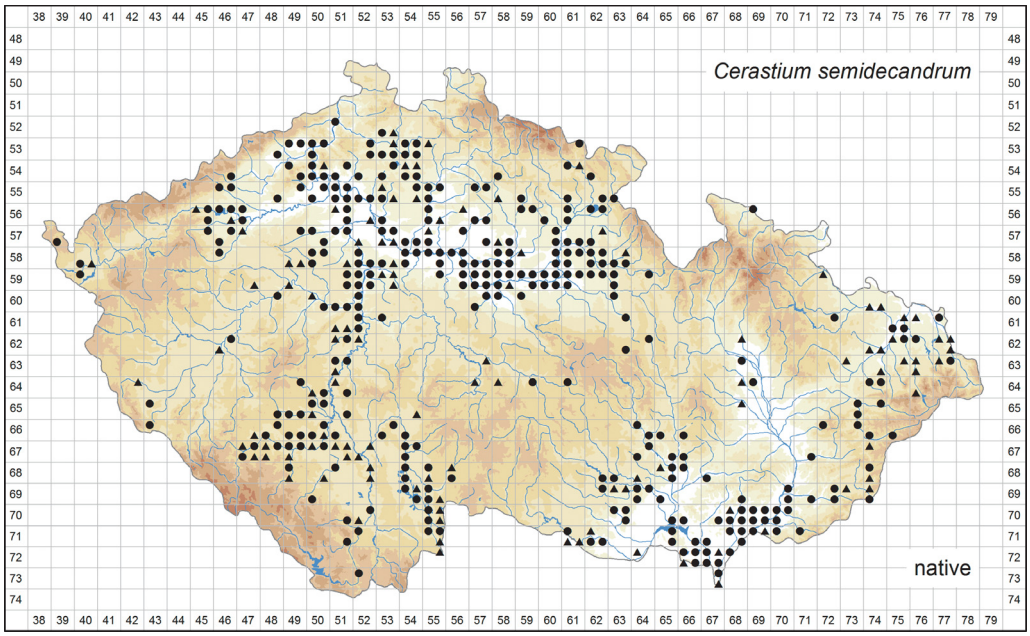


Fig. 30. – Distribution of *Cerastium semidecandrum* in the Czech Republic: ● occurrence documented by herbarium specimens (322 quadrants), ▲ occurrence based on other records (116 quadrants). Prepared by Jiří Danihelka, Martin Dančák, Michal Ducháček & Zdeněk Kaplan.

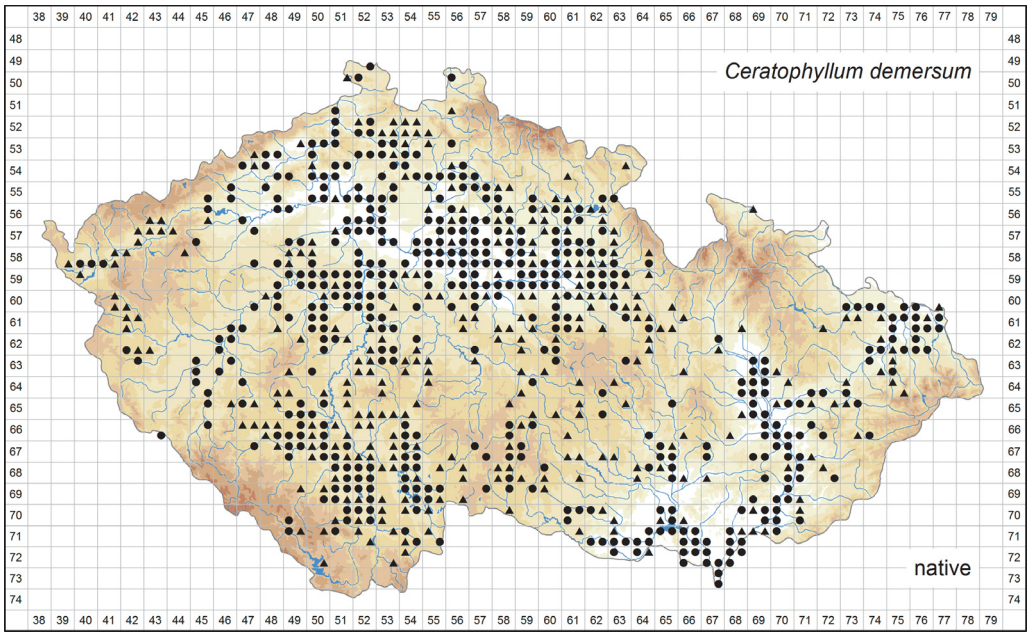


Fig. 31. – Distribution of *Ceratophyllum demersum* in the Czech Republic: ● occurrence documented by herbarium specimens (467 quadrants), ▲ occurrence based on other records (302 quadrants). Prepared by Jan Prančl & Zdeněk Kaplan.

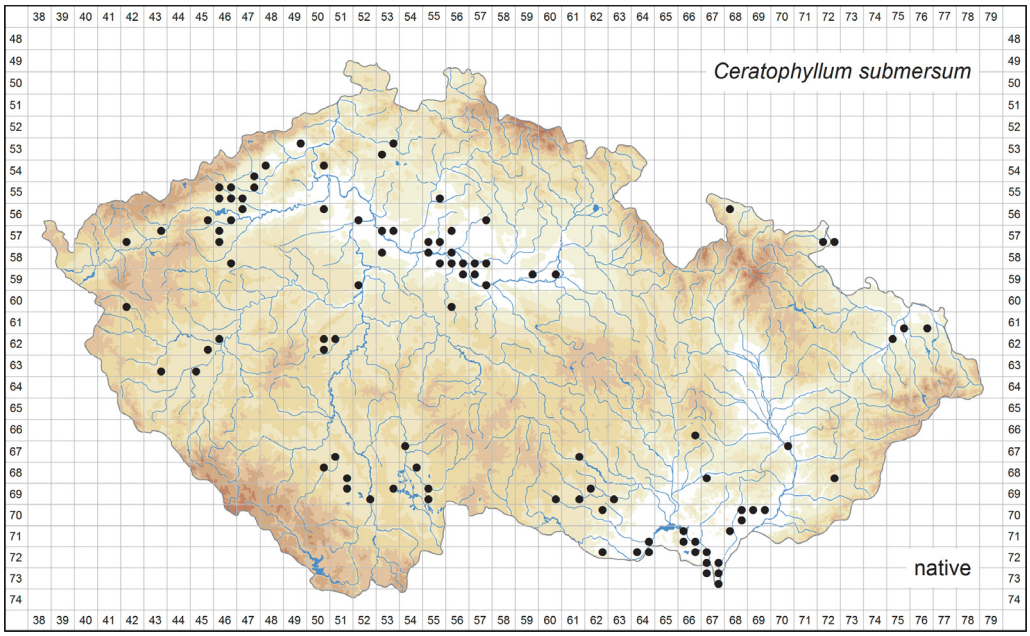


Fig. 32. – Distribution of *Ceratophyllum submersum* in the Czech Republic (97 occupied quadrants). Prepared by Jan Prančl & Zdeněk Kaplan.

warmest parts of the country in northern and central Bohemia, and southern Moravia. Apart from an isolated population in eastern-central Bohemia, all records from other areas are probably erroneous, referring to *C. glutinosum* or other species of the genus. The species is found at low altitudes, reaching its altitudinal maximum at 550 m in Děvín hill in southern Moravia. Because of frequent misidentification, the map is based solely on revised herbarium specimens. The species is classified as vulnerable (Grulich 2012) as some former sites may have been lost due to stone quarries or abandonment of pastures.

Cerastium semidecandrum (Fig. 30)

Cerastium semidecandrum is a European species most frequent in central Europe, reaching as far as Ireland in the west, eastern Ukraine in the east, southern Scandinavia in the north and the Mediterranean coast in the south (Jalas & Suominen 1983). In the Czech Republic *C. semidecandrum* is found in dry grasslands, open vegetation of inland sand dunes, rock outcrops, road verges, along paths, in pine forests with an open canopy, railway stations and yards, trampled places and ruderal grasslands in settlements, usually on sandy and other pervious soils poor or moderately rich in nutrients. It occurs mainly at low altitudes in warm and moderately warm parts of the country, ascending to about 600 m a.s.l. or even higher on limestone outcrops in southern Bohemia. The species seems to profit from excessive use of herbicides on the railways, and numerous recent records from railway stations document its spread. Some gaps in the map may be artificial as it is strongly under-recorded because of its small size, short life cycle and occurrence in unattractive habitats.

Ceratophyllum demersum (Fig. 31)

Ceratophyllum demersum is a cosmopolitan species. It is most frequent in the temperate zone of the Northern Hemisphere but absent from its dry areas and the Arctic (Hultén & Fries 1986). It is reported as introduced in New Zealand, Hawaii and Mauritius (Howell 2008, USDA, NRCS 2016). *Ceratophyllum demersum* is widespread throughout Europe, being rare in or absent only from the northernmost arctic regions and the eastern Mediterranean area (Hultén & Fries 1986). In the Czech Republic *C. demersum* inhabits various types of standing and slowly running waters, such as alluvial pools and oxbow lakes, fishponds, reservoirs, sand-pits and drainage channels. It is most common in shallow water bodies in eutrophic to hypertrophic, often strongly turbid and polluted water (Šumberová 2011c). It is distributed almost throughout the country, from the lowlands to middle elevations. It is most frequent along the middle and lower courses of large rivers and in flat fishpond-rich basins, where it is one of the most common aquatic plants. Recently, the species also has spread to higher elevations (above 500 m) as a result of the intensification of fish farming and combination of hot summers and mild winters, reaching its current altitudinal maximum at 745 m in the Šumava Mts.

Ceratophyllum submersum (Fig. 32)

The distribution range of *C. submersum* includes Europe, western and central Asia and northernmost Africa, but knowledge of the overall distribution is still incomplete. The species appears to be most common in the temperate zone of Europe. In Asia it is reported to

be scattered, extending eastwards to the Altai Mts (Hultén & Fries 1986). It is considered to be alien in Finland (Uotila 2010). *Ceratophyllum submersum* grows in mesotrophic to eutrophic water, usually rich in calcium. It inhabits shallow still water bodies, which are warm and not shaded in summer (Šumberová 2011e). In comparison with *C. demersum*, *C. submersum* does not tolerate turbid water. In the Czech Republic it occurs in small ponds, oxbows and alluvial pools, often also in flooded abandoned quarries and water bodies created by land subsidence after mining. The species was rare in the past, only known from the warmest areas of central and north-western Bohemia (in particular in the Labe river basin) and from southern Moravia. During the last decades *C. submersum* appears to have spread as it has also been found in areas from which it had not been previously known, particularly in southern Bohemia and in Silesia. However, it has undoubtedly been overlooked until recently, therefore the lack of earlier records does not necessarily imply its previous absence. Despite these facts, *C. submersum* is still a scarce species in the Czech Republic, being endangered by habitat destruction, river regulation and intensive fish farming. It is currently classified as vulnerable (Grulich 2012). Because of frequent confusion between *C. demersum* and *C. submersum*, the distribution map of the latter was based solely on revised herbarium specimens.

Eichhornia crassipes (Fig. 33)

Eichhornia crassipes appears to be native to the Amazon basin in Brazil (Barrett & Forno 1982). Because of its attractive appearance and showy flowers, it was deliberately introduced into botanical gardens in many countries, from which it spread as a weed. It was introduced to the USA in 1884, Australia, Egypt and Japan all about 1890, Indonesia in 1894, India in 1896, Madagascar in around 1900, China in 1901, Singapore in 1903, Sri Lanka in 1904, South Africa in 1910, the Philippines in 1912, Myanmar in 1913 and later to many other countries (Gopal 1987, Xie et al. 2001, Rojas-Sandoval & Acevedo-Rodríguez 2013). At present, it has become naturalized in tropical and subtropical zones of both hemispheres, including southern North America, South America southwards to Chile and Argentina, southern, central and north-eastern Africa, southern and south-eastern Asia, and southwards as far as Australia and New Zealand (Barrett 1988, Téllez et al. 2008, Rojas-Sandoval & Acevedo-Rodríguez 2013). *Eichhornia crassipes* is generally regarded as the most noxious aquatic weed in the world (Gopal & Sharma 1981, Holm et al. 1997). In most of the frost-free regions it is invasive, being able to produce dense mats and rapidly covering the water surface resulting in great economic losses to fisheries, water transport and tourism, as well as declines in native aquatic plants and threats to local biodiversity (Rai & Datta Mushi 1978, Xie et al. 2001). In Europe it has been introduced as an ornamental, and it was first reported from Portugal in 1939 (Téllez et al. 2008). Since then, it has spread over the central-west of the country through irrigation canals and is classified as invasive. Elsewhere in Europe it has been recorded as a casual in Spain, the British Isles, France, Belgium, the Czech Republic, Hungary, Italy, Romania and European Russia (Clement & Foster 1994, Téllez et al. 2008, Rojas-Sandoval & Acevedo-Rodríguez 2013). In the Czech Republic it is occasionally grown in aquaria and garden ponds and occasionally deliberately planted in fishponds or it is transported by major floods to slow-flowing stretches of rivers and alluvial pools. It was first recorded in the field in 1991 and since then it has been found at 15 sites, mainly in central Bohemia.

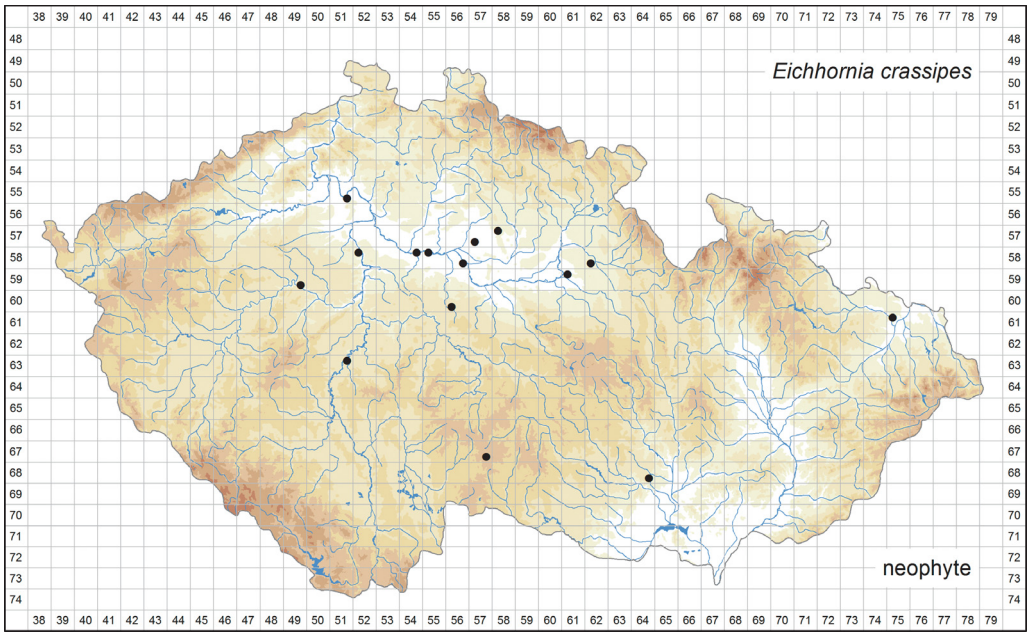


Fig. 33. – Distribution of *Eichhornia crassipes* in the Czech Republic (15 occupied quadrants). Prepared by Zdeněk Kaplan.

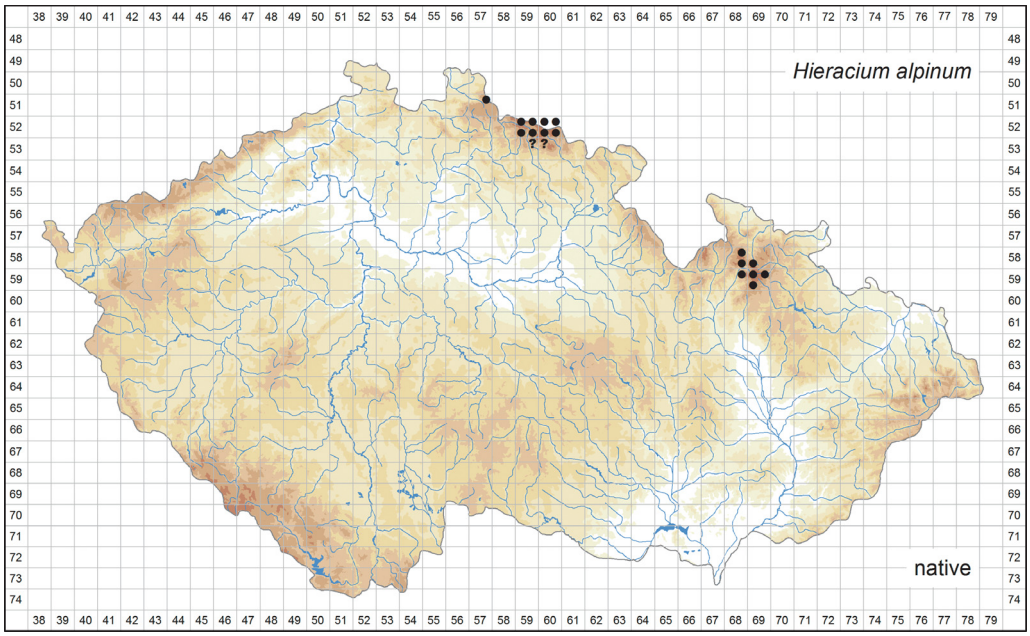


Fig. 34. – Distribution of *Hieracium alpinum* in the Czech Republic (16 occupied quadrants). Prepared by Jindřich Chrtek Jr. & Jiří Kocián.

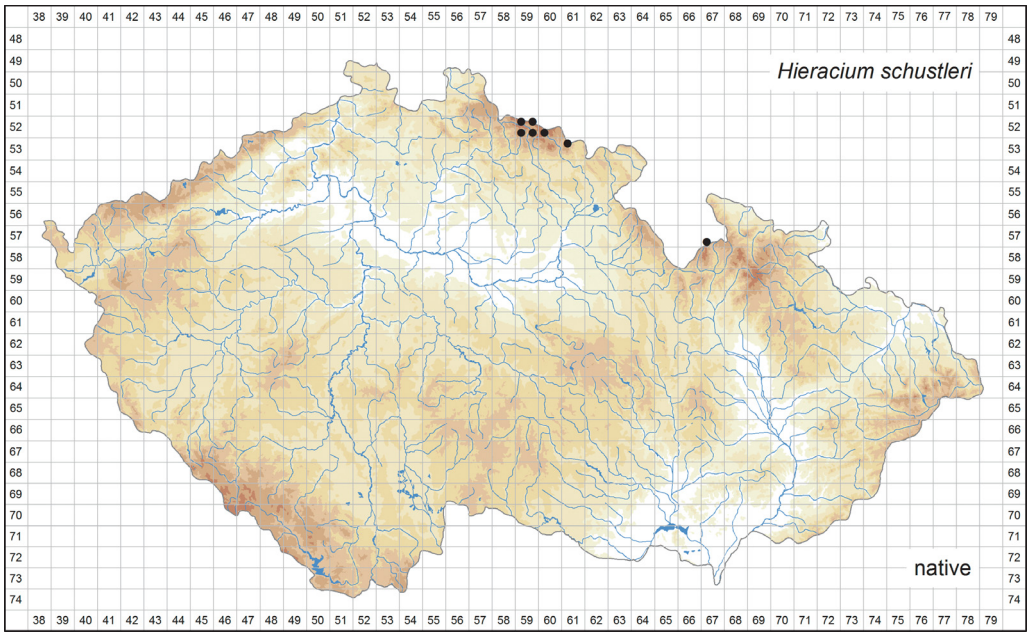


Fig. 35. – Distribution of *Hieracium schustleri* in the Czech Republic (7 occupied quadrants). Prepared by Jindřich Chrtek Jr.

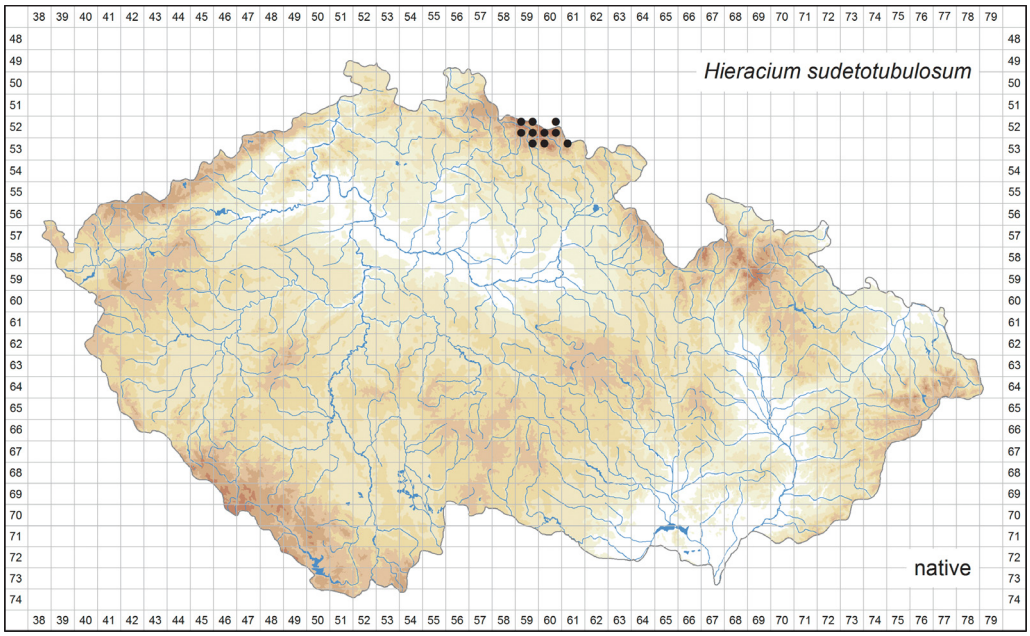


Fig. 36. – Distribution of *Hieracium sudetotubulosum* in the Czech Republic (10 occupied quadrants). Prepared by Jindřich Chrtek Jr.

At most of the sites *E. crassipes* occurred in only one season because it is frost-sensitive (Owens & Madsen 1995) and it does not survive an average central-European winter with frost and snow cover. However, it was reported to have survived mild winters between 1991 and 1993 hidden in a reed stand in the Berounka river at the village of Račice in central Bohemia (Rydlo 1999). It is classified as a casual neophyte (Pyšek et al. 2012).

Hieracium alpinum agg.
Hieracium alpinum (Fig. 34), *H. schustleri* (Fig. 35) and *H. sudetotubulosum* (Fig. 36)

The *Hieracium alpinum* aggregate consists of numerous arctic and alpine species, mostly with an apomictic mode of reproduction. The most widely accepted hypothesis to explain the high diversity of this group proposes that early pollen-bearing plants, which had developed apomixis, hybridized with sexual plants and produced a large number of asexual lineages. These lineages differ slightly in morphology and are classified at either species or subspecies level. In the Czech Republic the group includes three species, namely *H. alpinum*, *H. sudetotubulosum* and *H. schustleri* (Chrtek 1997). The taxonomic value of *H. melanocephalum*, closely allied to *H. alpinum*, deserves further study and thus the taxon is not included in this paper.

Hieracium alpinum is a widespread arctic-alpine species distributed in Greenland, Iceland, the British Isles, Scandinavia, north-western Russia (eastwards as far as the Ural Mts) and the central European mountains, including the Eastern and Southern Carpathians and an outpost in the Vranica Plateau in Bosnia and Herzegovina (Bräutigam 1992). In the Czech Republic it occurs in alpine open acidophilous grasslands with *Festuca supina*, alpine heathlands, on rock edges and in crevices of sloping rocks. It is widespread in the highest parts of the Krkonoše Mts and scattered in the Hrubý Jeseník Mts at altitudes of about (1050–)1400–1600 m.

By contrast, *Hieracium sudetotubulosum* and *H. schustleri* occur in *Nardus*-grasslands, subalpine dwarf-shrub vegetation and occasionally in dwarf mountain pine scrub, often in disturbed places with lower competition. Both of them are subendemic to the Czech Republic. *Hieracium sudetotubulosum* is widespread in the Krkonoše Mts at altitudes of 980–1580 m, from which it extends westwards to the Jizerské hory Mts (where it is very rare and most likely confined to the Silesian side) and eastwards to the Góry Stołowe Mts in Poland (Szeląg & Wójcik 2014). *Hieracium schustleri* is a very rare species confined to the Krkonoše Mts and the summit part of Mt Králický Sněžník at altitudes of about 1000–1520 m. Both species are threatened by changes in vegetation composition partly caused by atmospheric nitrogen deposition, especially by the expansion of tall grasses and forbs. They are also preferentially grazed by red deer. *Hieracium alpinum* and *H. sudetotubulosum* are classified as endangered, *H. schustleri* as critically threatened (Grulich 2012).

Hieracium chlorocephalum agg.
Hieracium chlorocephalum (Fig. 37) and *H. stygium* (Fig. 38)

The *Hieracium chlorocephalum* aggregate is a polymorphic hybridogenous apomictic group centred in the highest Sudetes mountains and the Western Carpathians, with several outposts in the Eastern Carpathians and Eastern Alps. The group occupies a morphologically intermediate position between *H. alpinum* agg., *H. lachenalii* and *H. prenanthoides*

agg. In the Czech Republic it includes two species, namely *H. chlorocephalum* and *H. stygium*.

Hieracium chlorocephalum is most probably endemic to the Krkonoše Mts and Hrubý Jeseník Mts; it has also been reported from one locality in the Góry Izerskie Mts in south-western Poland. It occurs in subalpine grasslands and on rocky and scree slopes. In the Czech Republic it has been reported from about 10 sites in the Krkonoše Mts and 4 sites in the Hrubý Jeseník Mts. All sites should be surveyed to evaluate its current status. *Hieracium chlorocephalum* is classified as critically threatened (Grulich 2012).

Hieracium stygium is distributed in the Eastern Sudetes Mts and the Western Carpathians, whereas plants from the Eastern Carpathians referred to this species need further study. It grows in subalpine grasslands and dwarf-shrub vegetation, most frequently in disturbed places such as margins of tourist paths and roads. In the Czech Republic it occurs on Mt Králický Sněžník and in the Hrubý Jeseník Mts and the Rychlebské hory Mts in the subalpine and less often in the supramontane and montane vegetation belts. It was abundant in the past and despite a decline in the second half of 20th century it is still the most abundant hawkweed in the subalpine belt of the Hrubý Jeseník Mts. *Hieracium stygium* is classified as endangered (Grulich 2012).

Hieracium glandulosodentatum (Fig. 39)

Hieracium glandulosodentatum is an apomictic hybridogenous species morphologically occupying an intermediate position between *H. lachenalii* and *H. nigrescens* agg., and is probably endemic to the Krkonoše Mts. It occurs in subalpine grasslands and dwarf-shrub vegetation, on rocky slopes and occasionally in dwarf mountain pine scrub, often at moderately disturbed places, at altitudes of about 1000–1550 m. It is scattered in the subalpine vegetation belt in the eastern part of the mountains, mostly at the edges of glacial cirques; a few records from the western part are now considered doubtful. It is also found at several sites in the montane vegetation belt. *Hieracium glandulosodentatum* is threatened by succession in subalpine grasslands, especially by the expansion of tall grasses and forbs, partly caused by changes in trophic levels due to atmospheric nitrogen deposition. Both seed reproduction and plant growth are supressed by grazing of red deer. It is classified as endangered (Grulich 2012).

Hieracium nigrescens agg.
Hieracium apiculatum (Fig. 40), *H. chrysostyloides* (Fig. 41), *H. decipiens* (Fig. 42), *H. nigrescens* (Fig. 41) and *H. nivimontis* (Fig. 40)

The *Hieracium nigrescens* aggregate includes numerous arctic and alpine polyploid apomictic species, from a morphological point of view occupying an intermediate position between *H. alpinum* agg. and *H. murorum*. They most probably originated from various sterile hybrids between sexual parents by subsequent polytopic switches towards apomixis, or from hybridization between pollen-bearing polyploid apomicts and diploid sexuals, resulting in morphologically slightly different lineages often restricted to small geographical ranges and recognized as separate species or subspecies. In the Czech Republic the group includes five species, namely *H. apiculatum*, *H. chrysostyloides*, *H. decipiens*, *H. nigrescens* and *H. nivimontis* (Chrtek 1995, Chrtek et al. 2007). They

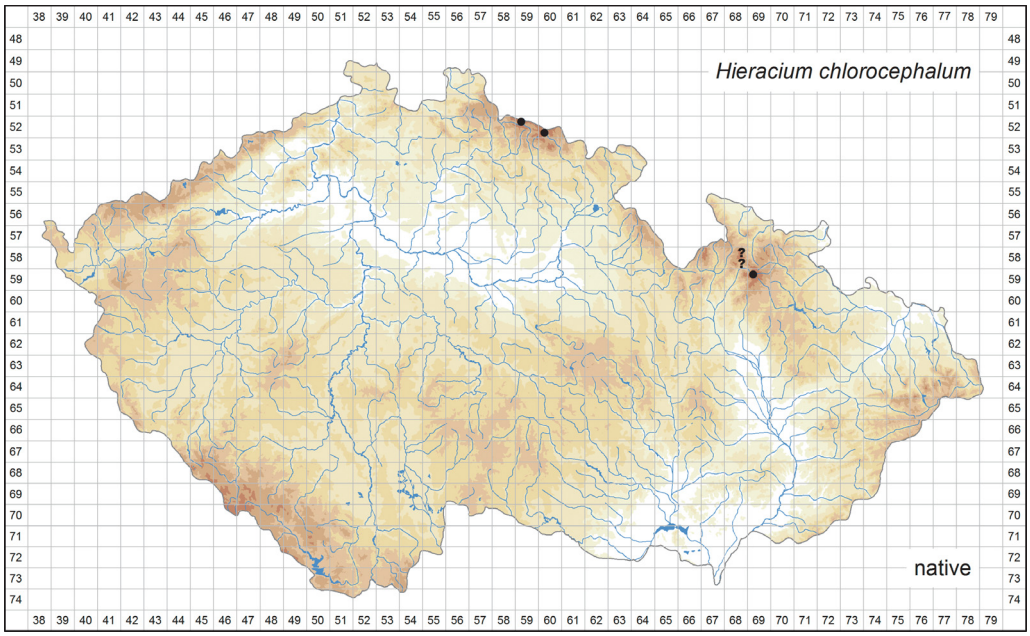


Fig. 37. – Distribution of *Hieracium chlorocephalum* in the Czech Republic (3 occupied quadrants). Prepared by Jindřich Chrtek Jr. & Jiří Kocián.

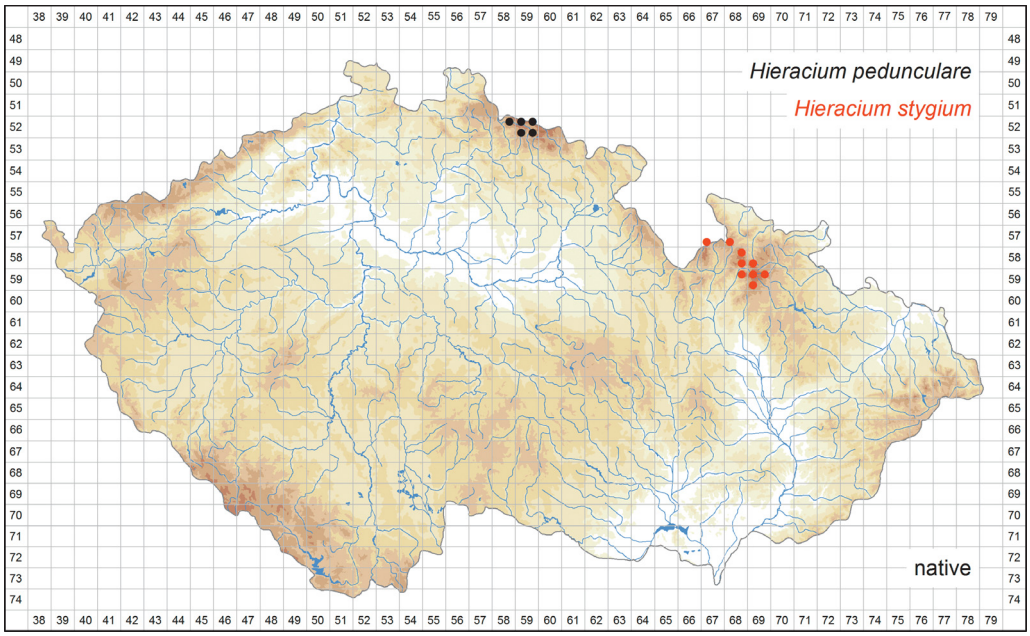


Fig. 38. – Distribution of *Hieracium pedunculare* (5 occupied quadrants) and *H. stygium* in the Czech Republic (9 occupied quadrants). Prepared by Jindřich Chrtek Jr. (*H. p.*) and by Jiří Kocián & Jindřich Chrtek Jr. (*H. s.*).

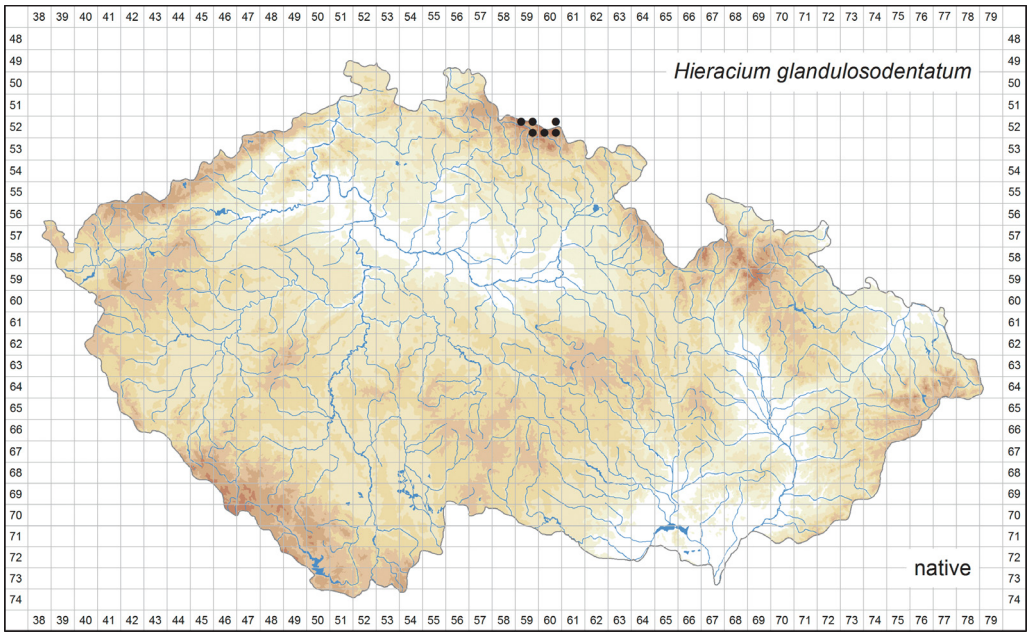


Fig. 39. – Distribution of *Hieracium glandulosodentatum* in the Czech Republic (6 occupied quadrants). Prepared by Jindřich Chrtek Jr.

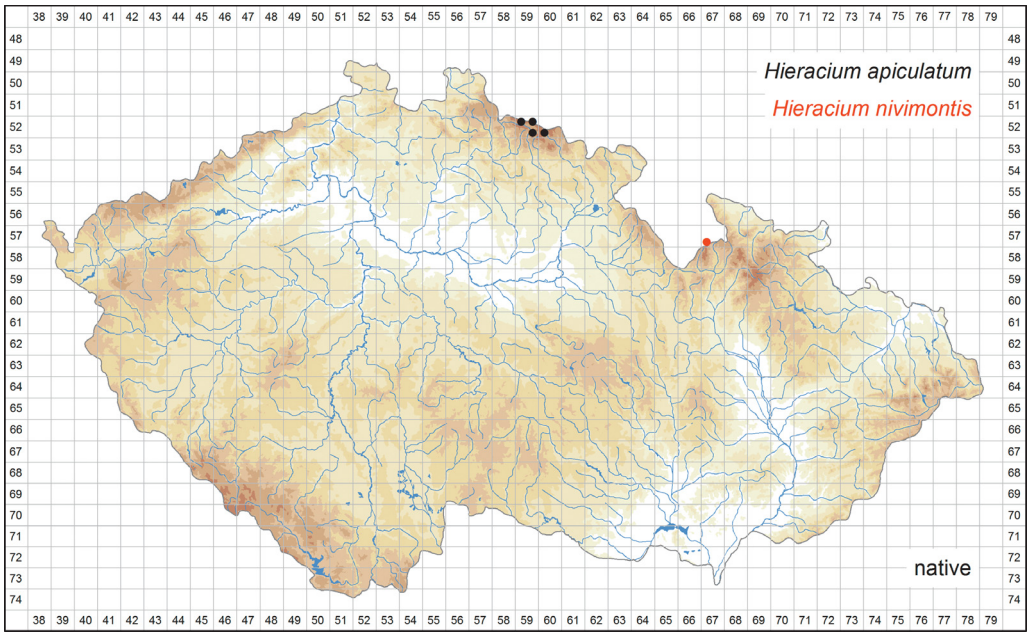


Fig. 40. – Distribution of *Hieracium apiculatum* (4 occupied quadrants) and *H. nivimontis* in the Czech Republic (1 occupied quadrant). Prepared by Jindřich Chrtek Jr. (*H. a.*) and by Jindřich Chrtek Jr. & Jiří Kocián (*H. n.*).

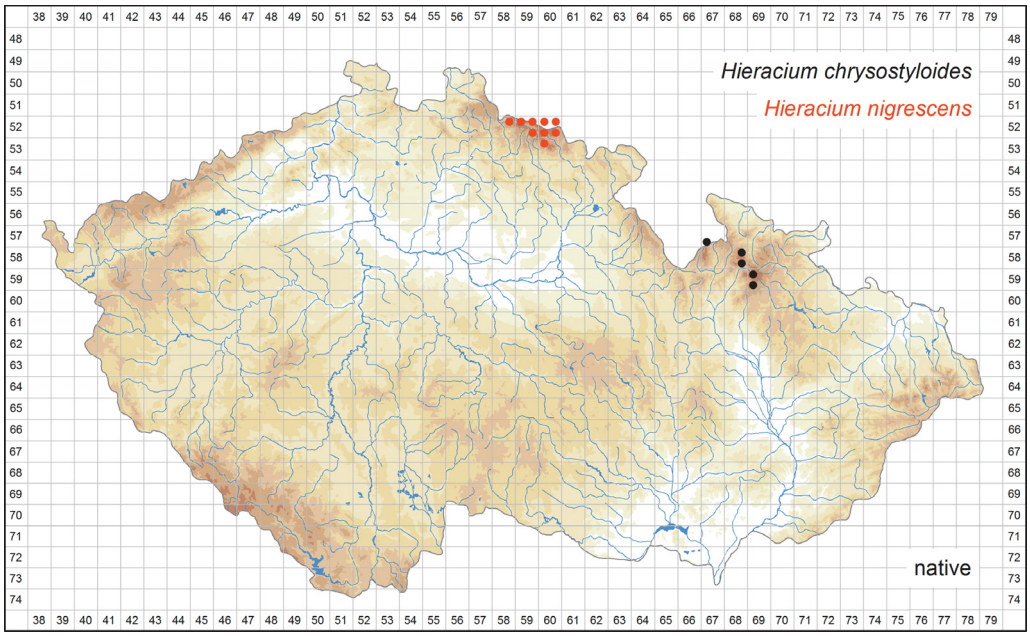


Fig. 41. – Distribution of *Hieracium chrysostyloides* (5 occupied quadrants) and *H. nigrescens* in the Czech Republic (9 occupied quadrants). Prepared by Jiří Kocián & Jindřich Chrtek Jr. (*H. ch.*) and by Jindřich Chrtek Jr. (*H. n.*).

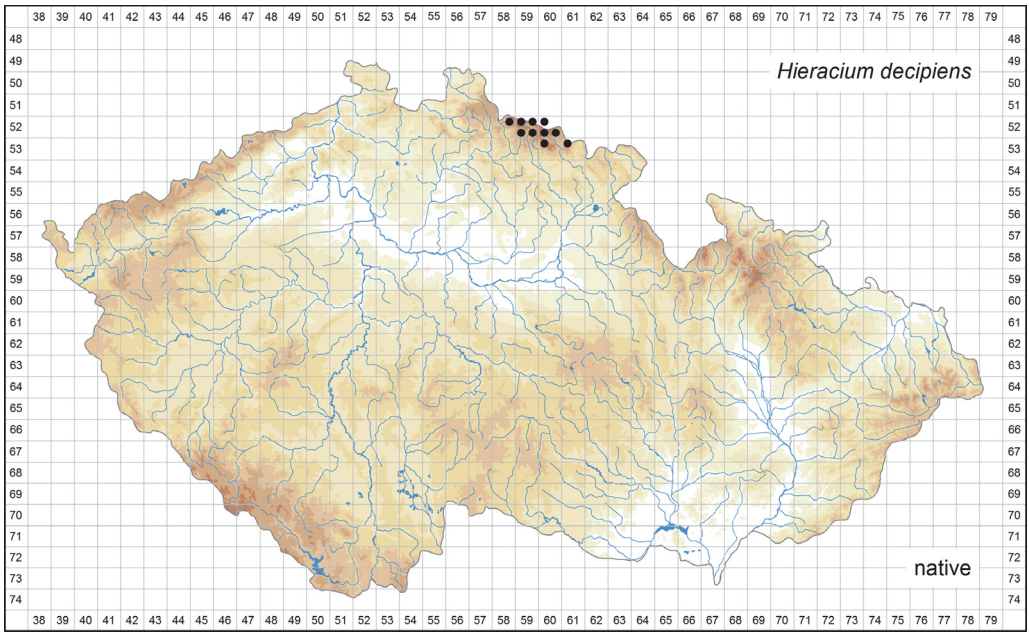


Fig. 42. – Distribution of *Hieracium decipiens* in the Czech Republic (10 occupied quadrants). Prepared by Jindřich Chrtek Jr.

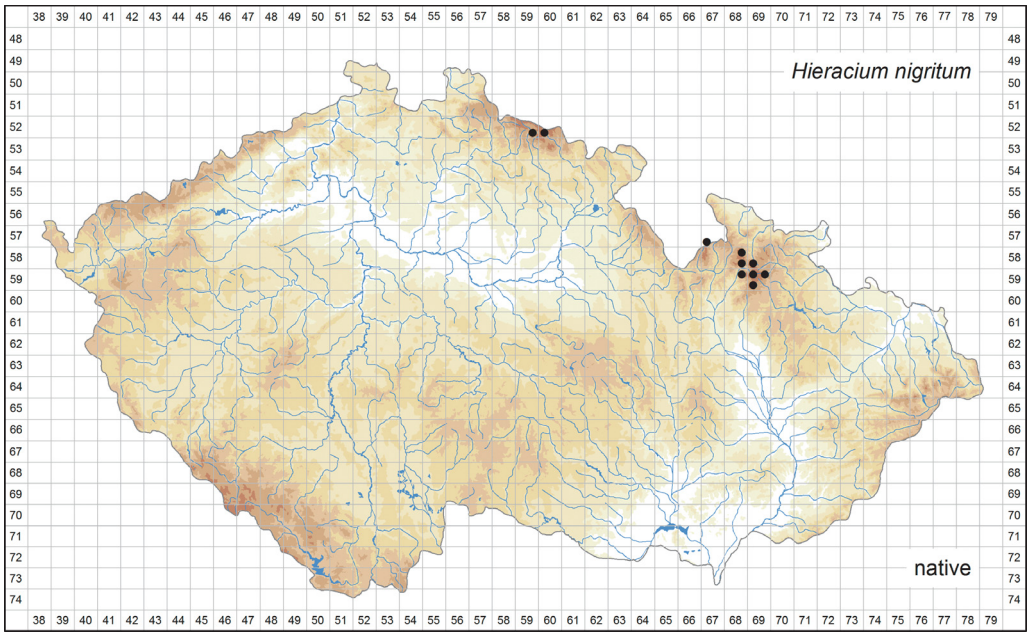


Fig. 43. – Distribution of *Hieracium nigritum* in the Czech Republic (10 occupied quadrants). Prepared by Jiří Kocián & Jindřich Chrtek Jr.

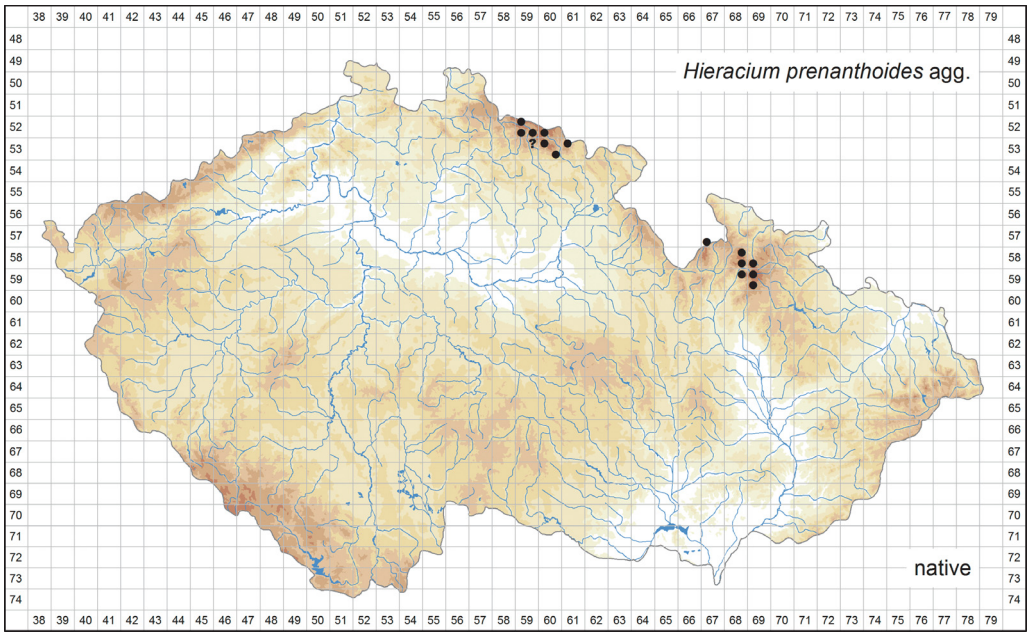


Fig. 44. – Distribution of *Hieracium prenanthoides* agg. in the Czech Republic (14 occupied quadrants). Prepared by Jiří Kocián & Jindřich Chrtek Jr.

occur in subalpine *Nardus*-grasslands, subalpine dwarf-shrub vegetation and occasionally in dwarf mountain pine scrub, often in disturbed places with lower competition.

Hieracium apiculatum, *H. decipiens* and *H. nigrescens* are endemic to the Krkonoše Mts. *Hieracium apiculatum* is found locally in very small number of individuals; *H. nigrescens* is more frequent by comparison with the former, yet still rare. By contrast, *H. decipiens* is widespread in the subalpine vegetation belt throughout the mountains.

Hieracium chrysostyloides is endemic to the Hrubý Jeseník Mts and Mt Králický Sněžník. In the past it has been recorded from about 9 sites in the highest parts of the Hrubý Jeseník Mts; nowadays only 5 of them remain. The population status on Mt Králický Sněžník requires revision. *Hieracium nivimontis* is endemic to the summit area of Mt Králický Sněžník and its current population status requires revision. There is good evidence that all but one of these species (*H. decipiens*) have declined, mostly due to succession in subalpine grasslands, especially expansion of tall grasses, forbs and dwarf scrub, partly caused by atmospheric nitrogen deposition and climatic changes. Grazing of red deer and chamois has impact on both reproductive success and plant growth. *Hieracium chrysostyloides* and *H. nivimontis* are classified as critically threatened, *H. apiculatum* and *H. nigrescens* as endangered and *H. decipiens* as vulnerable (Grulich 2012).

Hieracium nigritum (Fig. 43)

Hieracium nigritum is an apomictic hybridogenous species morphologically occupying an intermediate position between *H. alpinum* agg., *H. murorum* and *H. prenanthoides* agg., distributed in the highest Sudetes and Carpathian mountain ranges and reported also from one locality in the Alps. It occurs in subalpine grasslands and dwarf-shrub vegetation. In the Czech Republic it grows in the Krkonoše Mts, Mt Králický Sněžník and the Hrubý Jeseník Mts at altitudes of about 920–1400 m. In the Krkonoše Mts it is rare, reported from just a few sites; the only large population is found in the glacial cirque of the Mały Staw lake on the Polish side of the mountains. By contrast, *H. nigritum* is relatively frequent on Mt Králický Sněžník and even more so in the Hrubý Jeseník Mts where it occurs throughout the whole mountain range from Mt Šerák in the northwest to Mt Pecny in the south. In the Hrubý Jeseník Mts and on Mt Králický Sněžník it often occurs at moderately disturbed sites along trails and around tourist infrastructure. However, it used to be even more abundant in the past and that is why it is classified as endangered (Grulich 2012).

Hieracium prenanthoides agg. (Fig. 44)

The *Hieracium prenanthoides* aggregate has a large disjunct Eurasian range including mainly higher mountains but also descending to lower altitudes in the north, reaching Greenland, Iceland and the British Isles in the west and Siberia and the central Asian mountains in the east (Bräutigam 1992). The aggregate is highly polymorphic and consists of numerous, taxonomically poorly understood species. Both sexual diploids and apomictic polyploids are known. This aggregate has been studied in the Czech Republic for a short time and it is not sufficiently resolved yet. Therefore only a map for the whole aggregate was prepared. *Hieracium prenanthoides* aggregate occurs in wind-sheltered mountain sites in subalpine species-rich tall-forb communities, scrub and rarely also in

open-canopy mountain forests. In the Czech Republic it is found in the Krkonoše Mts, Mt Králický Sněžník and the Hrubý Jeseník Mts at altitudes of about 850–1500 m. In the Krkonoše Mts it is scattered throughout the whole mountain range, including the Rýchory ridge. On Mt Králický Sněžník it was always very rare and is probably now extinct. Several localities have been recorded from the Hrubý Jeseník Mts, mainly from the southern part, but only three of them are known today. The populations declined or have been lost, probably due to succession in subalpine herbaceous communities and to strong grazing pressure either by red deer or, in the Hrubý Jeseník Mts, mainly by introduced chamois. *Hieracium prenanthoides* is classified as endangered (Grulich 2012).

Hieracium riphaeum (Fig. 45)

Hieracium riphaeum is an apomictic hybridogenous species occupying a transitory position between *H. alpinum* agg. and *H. prenanthoides* agg., more resembling the latter. It is endemic to the Krkonoše Mts. *Hieracium riphaeum* occurs in subalpine *Nardus*- and tall grasslands and in dwarf mountain pine scrub. It used to be found at about 10 sites, all but two on the Czech side of the mountains, at altitudes of about 900–1500 m. Recently, its presence was confirmed at three sites in the Czech Republic. Its strong decline in the last decades of the 19th century was due to over-collection for herbaria; the most likely cause of the recent decline is expansion of tall grasses and preferential grazing of red deer affecting both generative reproduction and plant growth. *Hieracium riphaeum* is classified as critically threatened (Grulich 2012).

Hieracium silesiacum (Fig. 46)

Hieracium silesiacum, described from the Velká kotlina glacial cirque, is found very locally in the Hrubý Jeseník Mts, Nízke Tatry Mts, Západné Tatry Mts and the western part of the Vysoké Tatry Mts (Chrtek et al. 2002, Szeląg 2004). It belongs to *H.* sect. *Cernua*, which has its highest diversity in the Balkan Peninsula and in the Southern Carpathians, and it is the only one species of the section occurring in the Sudetes mountains. *Hieracium silesiacum* grows on mountain grassy slopes. It was recorded from several localities in the Hrubý Jeseník Mts at altitudes of about 1300–1400 m but it survives at only two of them now. It is therefore classified as critically threatened (Grulich 2012).

Hieracium sudeticum agg.
Hieracium pedunculare (Fig. 38) and *H. sudeticum* (Fig. 46)

The *Hieracium sudeticum* aggregate consists of apomictic and most probably hybridogenous species morphologically occupying an intermediate position between *H. alpinum* agg. and *H. prenanthoides* agg., *H. pedunculare* being closer to the former and *H. sudeticum* to the latter.

Hieracium pedunculare is endemic to the Krkonoše Mts and the Góry Izerskie Mts in south-western Poland (only one population, which vanished a long time ago). It occurs in subalpine *Nardus*-grasslands and dwarf-shrub vegetation, occasionally also in subalpine tall grasslands at altitudes of about 800–1500 m. The majority of localities are situated on the Czech side in the western part of the Krkonoše Mts. Based on the copious herbarium collections and numerous records, it used to be scattered to common. Although vanished

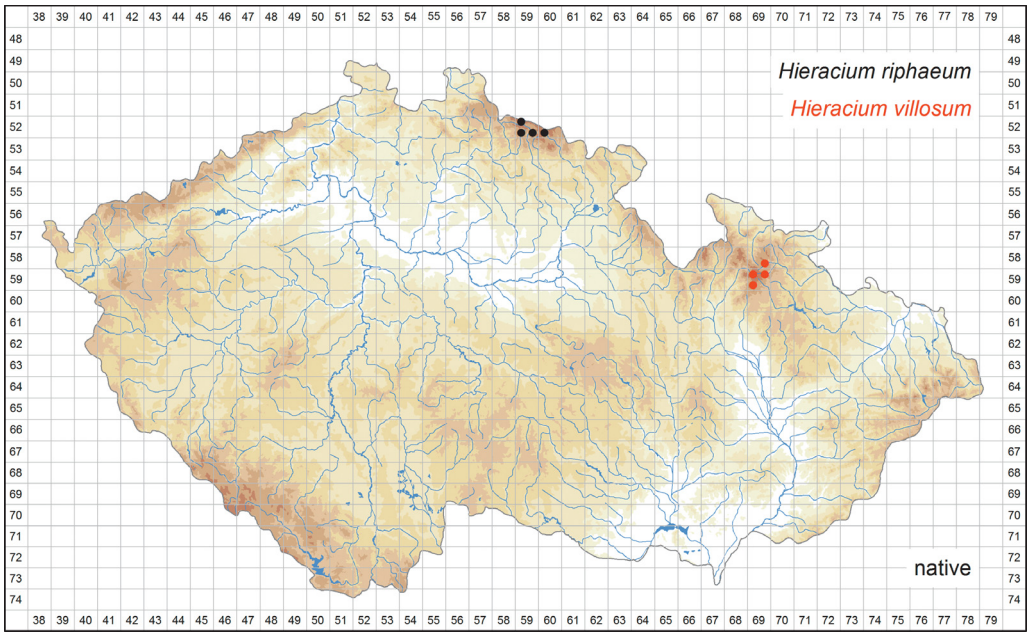


Fig. 45. – Distribution of *Hieracium riphaeum* (4 occupied quadrants) and *H. villosum* in the Czech Republic (4 occupied quadrants). Prepared by Jindřich Chrtek Jr. (*H. r.*) and by Jiří Kocián & Jindřich Chrtek Jr. (*H. v.*).

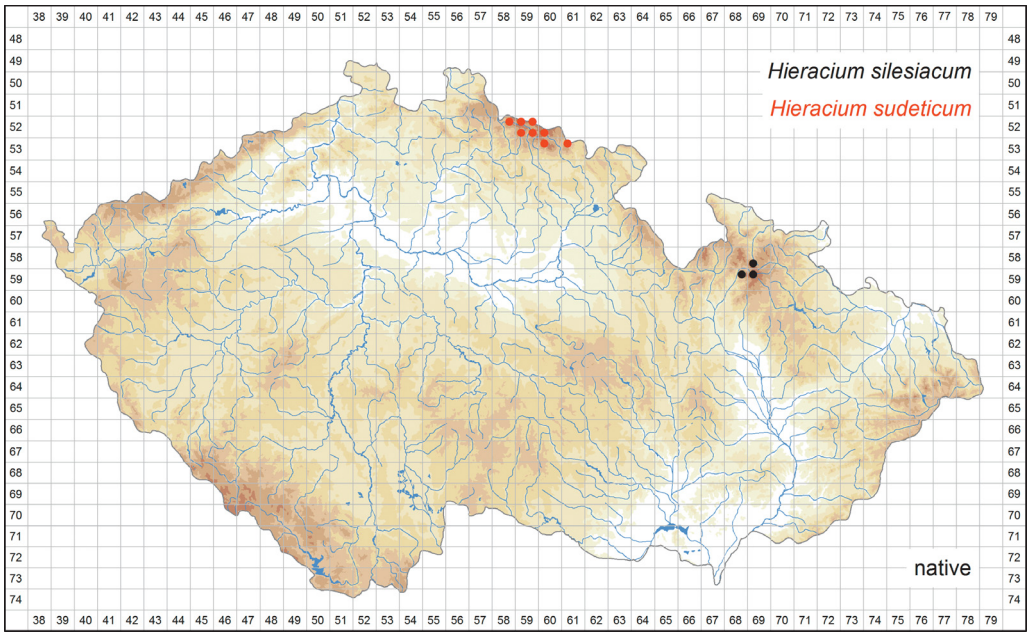


Fig. 46. – Distribution of *Hieracium silesiacum* (3 occupied quadrants) and *H. sudeticum* in the Czech Republic (8 occupied quadrants). Prepared by Jiří Kocián & Jindřich Chrtek Jr. (*H. sil.*) and by Jindřich Chrtek Jr. (*H. sud.*).

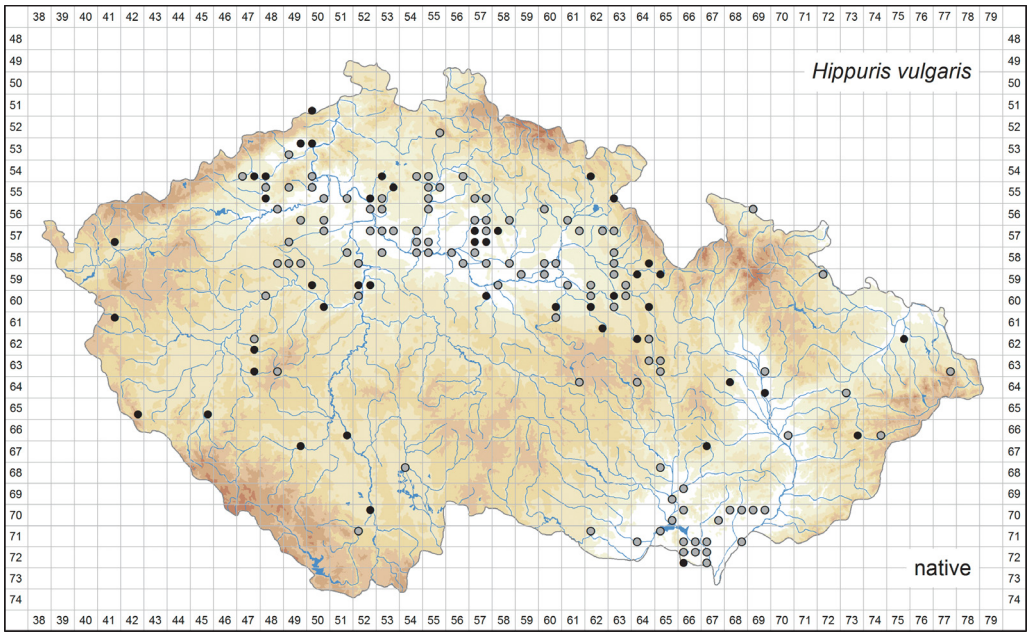


Fig. 47. – Distribution of *Hippuris vulgaris* in the Czech Republic: ● at least one record in 2000–2016 (44 quadrants), ● pre 2000 records only and/or extirpated occurrences (109 quadrants). Prepared by Zdeněk Kaplan.

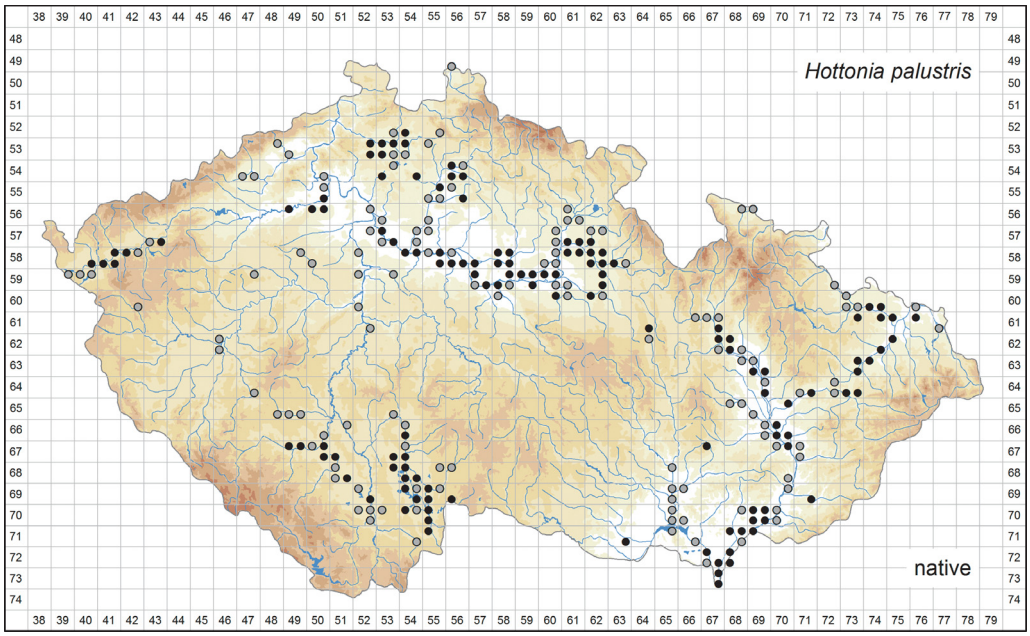


Fig. 48. – Distribution of *Hottonia palustris* in the Czech Republic: ● at least one record in 2000–2016 (126 quadrants), ● pre 2000 records only (128 quadrants). Prepared by Jan Prančl.

from some sites, it is still locally scattered. It is threatened by succession in subalpine grasslands, especially by the expansion of tall grasses and forbs, by the lack of moderately disturbed patches and by the grazing of red deer. Because of its rarity it is classified as critically endangered (Grulich 2012).

Hieracium sudeticum is distributed in the Krkonoše Mts, the Góry Izerskie Mts in south-western Poland (only one population, which vanished a long time ago) and in the Romanian Carpathians. It occurs in subalpine *Nardus*- and tall grasslands, dwarf-shrub vegetation and dwarf mountain pine scrub at altitudes of about 820–1500 m. In the Czech Republic it is scattered over the subalpine vegetation belt and rarely found also in forest gaps and small meadows below the timber line of the Krkonoše Mts, being the most common *Hieracium* species here, especially in tall grasslands. Although often grazed by red deer, it does not seem to be immediately threatened; it is classified as vulnerable (Grulich 2012).

Hieracium villosum (Fig. 45)

Hieracium villosum is a montane calciphilous species growing on rocky places in the central-, south- and southeast-European mountain ranges (Bräutigam 1992). In the Czech Republic it occurs only in the Hrubý Jeseník Mts; this outpost is presumably phytogeographically related to its occurrence in the Western Carpathians. For a long time it was known only from the Velká kotlina glacial cirque. However, several populations have been discovered since the 1980s in the southern part of the Hrubý Jeseník Mts, but the majority or even all of them arose very probably via the introduction of plants of unknown origin. The population in the Velká kotlina glacial cirque is threatened by grazing by introduced chamois. *Hieracium villosum* is classified as critically threatened due to its rarity (Grulich 2012).

Hippuris vulgaris (Fig. 47)

Hippuris vulgaris is widespread in arctic, boreal and temperate regions throughout the Northern Hemisphere and also occurs in southern South America; in Europe it is distributed over most of the continent but it is rare in dry and warm Mediterranean areas (Hultén & Fries 1986). In the Czech Republic *H. vulgaris* grows as a submerged or emergent hydrophyte mainly in ponds, rarely also in other standing waters such as drainage ditches and flooded gravel-pits or lakes in abandoned quarries, formerly also around brackish lakes and in wet depressions in meadows and along roads. It prefers clear, shallow, base-rich water on clayey or loamy substrates (Šumberová 2011d). It occurs mainly in the lowlands of northern, central and eastern Bohemia and of southern Moravia, elsewhere being rare or absent, or intentionally introduced only recently. The native populations have considerably declined since the 1950s because of eutrophication, habitat destruction, intensive fish farming and competition of fast-growing aquatics, and fewer than 10 may have survived till now. They are therefore classified as critically endangered (Grulich 2012). *Hippuris vulgaris* started to be sold in garden stores in the 1990s; since then it has been grown as an ornamental in garden ponds and occasionally also deliberately planted in the countryside. These populations, established from plants of unknown, but probably distant provenance, may often be indistinguishable from indigenous ones.

Hottonia palustris (Fig. 48)

Hottonia palustris is almost exclusively a European species, being distributed from the British Isles and western France in the west as far as the Ural Mts and the Sea of Azov in the east. It is confined to the temperate zone, and absent from the arctic regions, the Iberian Peninsula and the warmest parts of the central and eastern Mediterranean area. In Ireland it has probably been introduced. Outside Europe it is known only from Anatolia (Meusel et al. 1978, Hultén & Fries 1986, Preston & Croft 1997). In the Czech Republic *H. palustris* grows in alluvial pools, oxbows and small water bodies in wetland forests such as alder carrs; less frequently it is found in drainage channels, small forest fishponds and similar habitats. It occurs in shallow, mesotrophic to eutrophic still water, usually with a thick layer of organic mud on the bottom. In habitats that dry out in summer the species can survive as a terrestrial growth form. The distribution of *H. palustris* in the Czech Republic follows the large river floodplains. It also occurs more frequently in some flat wetland-rich areas, such as in South Bohemian basins or surroundings of the town of Česká Lípa in northern Bohemia, while being rare elsewhere. The species is endangered mainly by river regulation, destruction of its habitats or succession in them, eutrophication and drainage. It has declined during the last decades and is therefore classified as vulnerable (Grulich 2012). The species is occasionally cultivated and also (although probably rarely) deliberately planted in the wild. The unequivocal cases of non-native populations were not included on the map.

Lemna gibba (Fig. 49)

Lemna gibba occurs in temperate zones of the Northern Hemisphere, in Europe being absent only from its northernmost and north-eastern parts, in Asia recorded in its south-western and central-southern parts and as an alien in Japan, and reaching North America in the western USA and Mexico. Southwards its range continues as far as southern Argentina, and the species is also found in northernmost, eastern and southern Africa (Hultén & Fries 1986, Landolt 1986, Crawford et al. 2006). In the Czech Republic *L. gibba* occurs in alluvial pools, oxbow lakes, drainage ditches, fish storage ponds, ponds in villages, fishponds and along the banks of slowly flowing lowland rivers. It grows in eutrophic to hypertrophic water on clayey, loamy or gravel substrates, often covered with a thick layer of sapropelic mud. In contrast to *L. minor*, it tolerates water with high concentrations of nitrogen, phosphorus, calcium and even chlorides (Šumberová 2011g). It is most frequent in the warm lowlands of the country and in fishpond basins of southern and south-western Bohemia. With increasing eutrophication it has tended to spread to higher altitudes.

Lemna minor (Fig. 50)

Lemna minor is a widespread species distributed over temperate regions of the world except eastern Asia and South America. It occurs throughout Europe except the extreme north, in south-western and central Asia, in North America where it is most frequent in the eastern USA, and also in northernmost, eastern and southern Africa. It has been introduced to New Zealand and apparently also to Australia, where it is still very localized (Landolt 1986). In the Czech Republic *L. minor* is found in a wide range of habitats

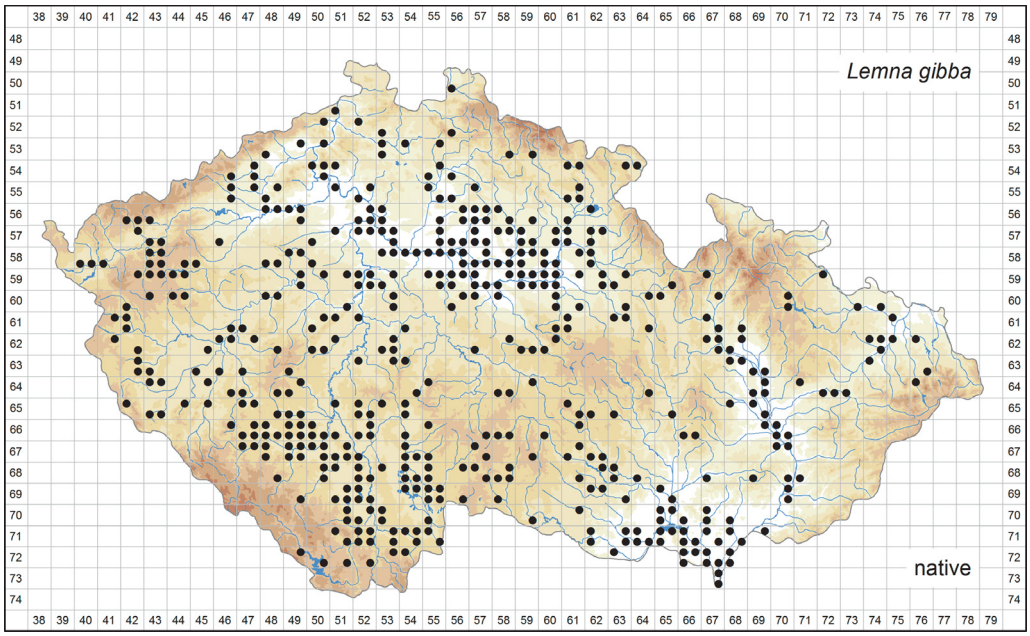


Fig. 49. – Distribution of *Lemna gibba* in the Czech Republic (488 occupied quadrants). Prepared by Zdeněk Kaplan.

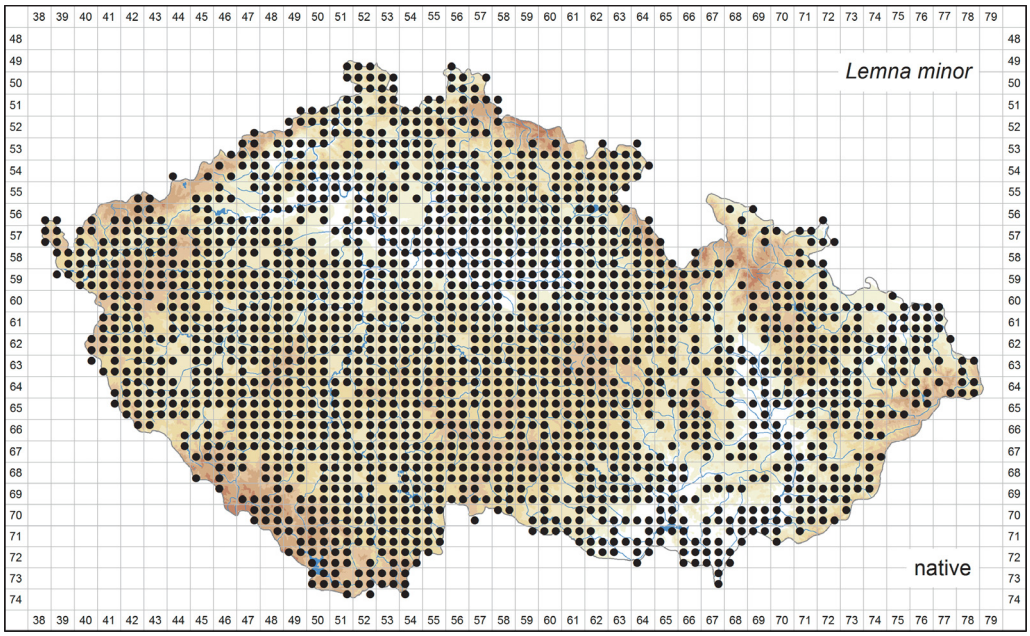


Fig. 50. – Distribution of *Lemna minor* in the Czech Republic (1955 occupied quadrants). Prepared by Zdeněk Kaplan.

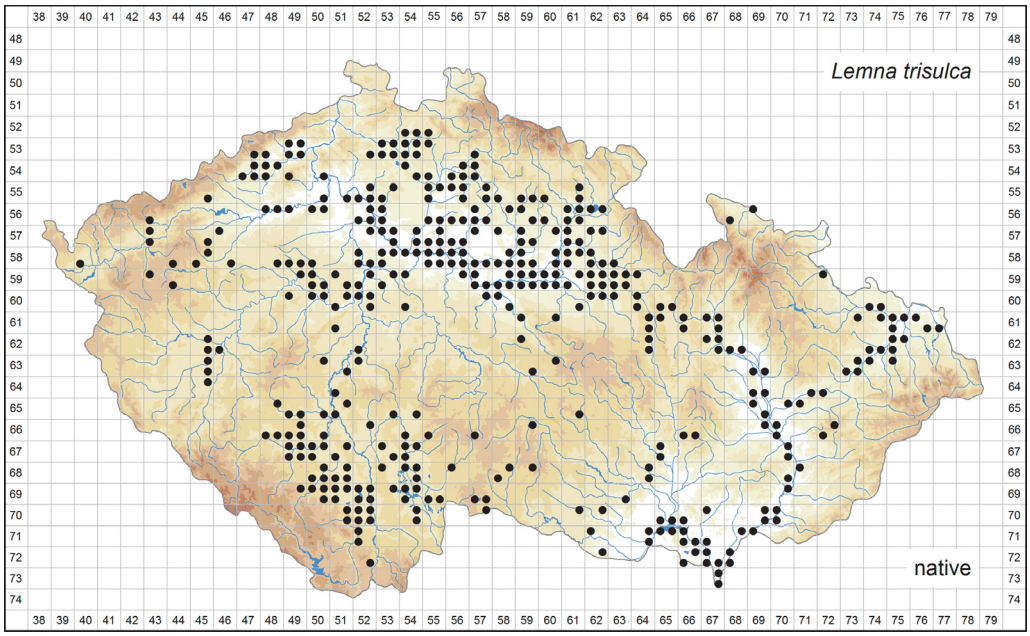


Fig. 51. – Distribution of *Lemna trisulca* in the Czech Republic (405 occupied quadrants). Prepared by Zdeněk Kaplan.

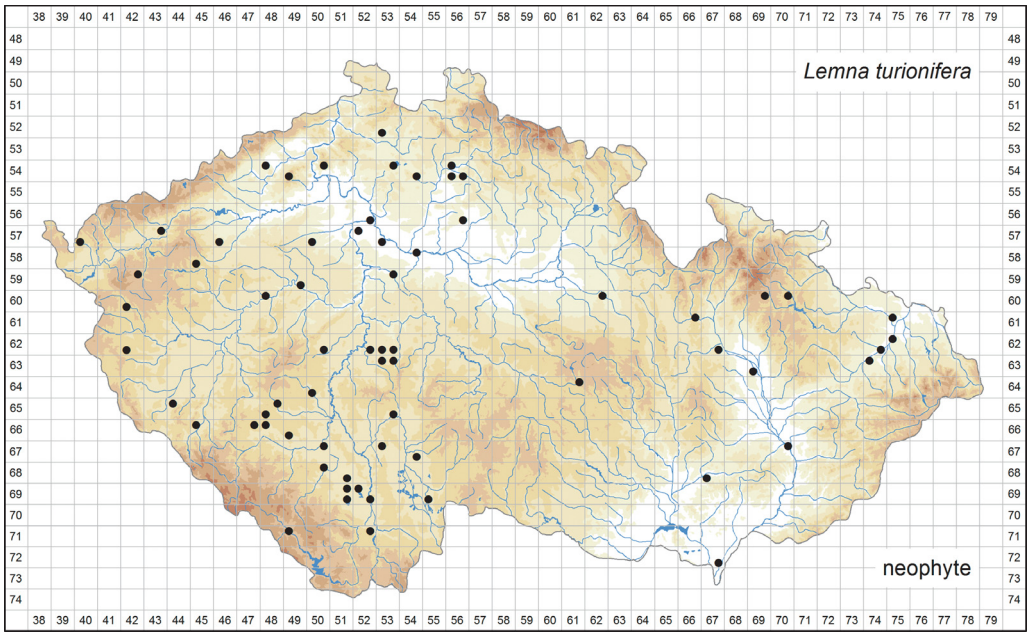


Fig. 52. – Distribution of *Lemna turionifera* in the Czech Republic (66 occupied quadrants). Prepared by Zdeněk Kaplan.

including fishponds, fish storage ponds, alluvial pools, oxbow lakes, drainage ditches, marsh vegetation, puddles on wet forest tracks and in quiet backwaters and along banks of slowly flowing lowland rivers. It prefers mesotrophic to eutrophic water on clayey, loamy or sandy substrates, often covered with a thick layer of sapropelic mud (Šumberová 2011g). *Lemna minor* is the most widespread and frequent of all *Lemnaceae* in the country, occurring in all its parts from the lowlands up to the mountains.

Lemna trisulca (Fig. 51)

Lemna trisulca is a circumboreal species, being widespread in Europe except its northernmost parts and the dry and warm Mediterranean areas, and scattered eastwards through Siberia as far as the Russian Far East and Japan, with only isolated occurrences in south-western and southern Asia. It is also widespread in North America, while being scarce in northernmost and central Africa and in Australia (Landolt 1986). In the Czech Republic *L. trisulca* most often occurs in clear mesotrophic to eutrophic shallow water of alluvial pools, oxbow lakes, lowland drainage ditches, abandoned and flooded sand-pits and at the edges of fishponds. It avoids water bodies with deep layers of organic silt on the bottom (Šumberová 2011g). It is most frequent in the floodplains of large rivers, particularly in the middle Labe river basin and in adjacent areas of central, north-eastern and eastern Bohemia, and along the middle and lower stretches of the Morava, Dyje and Odra rivers in Moravia. It is also scattered in the fishpond landscapes of southern Bohemia, elsewhere being rare or absent. It has slightly declined due to eutrophication, habitat destruction, river regulation and intensive fish farming and is therefore classified as vulnerable (Grulich 2012).

Lemna turionifera (Fig. 52)

Lemna turionifera is assumed to be native to North America from Alaska southwards to north-western Mexico and eastwards as far as the eastern USA and possibly also in temperate Asia including Siberia, Turkey, the Caucasus Mts, central and eastern Asia as far as the Russian Far East (Landolt 1986). Until recently the first European records were believed to date from 1965 (Wolff & Orschiedt 1993) and the species has widely been considered as introduced. It has been progressively found in many other countries of Europe and currently it is known from the British Isles and France in the west through the central Europe as far as Finland, Belarus and European Russia in the east (e.g. Wolff & Landolt 1994, DAISIE 2016a). However, Scandinavian records of *L. turionifera* from the second half of the 19th century came to light recently (Wolff & Bruinsma 2005), and native status in at least a part of Europe cannot be excluded (Verloove 2016a). In the Czech Republic *L. turionifera* was first recorded in 1997 (Kaplan 1999). At present it is scattered and locally even frequent, particularly at middle altitudes, in most of Bohemia and scarce in Moravia, occurring mainly in fishponds, fish storage ponds and alluvial pools. It is undoubtedly more abundant but remains unnoticed because of the lack of experience with identification of this species among field botanists. It is classified as a naturalized neophyte (Pyšek et al. 2012).

Limosella aquatica (Fig. 53)

Limosella aquatica is a holarctic species with a remarkably extensive range covering the temperate and subarctic zones of Europe, Asia, North America (including Greenland) and northernmost Africa. In Europe, it is most common in areas with a temperate climate. Northwards it reaches Iceland and northern Scandinavia while it is rare in or absent from the Mediterranean area. Along the Atlantic coast of North America it is replaced by *L. subulata* (Meusel et al. 1978, Hultén & Fries 1986). *Limosella aquatica* is a short-lived wetland annual, requiring a substrate with high moisture levels during the whole life cycle. It is well adapted to flooding and has no requirements for specific substrate type or pH (Šumberová 2013). In the Czech Republic *L. aquatica* is characteristic of the vegetation of temporarily exposed fishpond bottoms. It grows also in other similar habitats, including river beds, fish storage ponds, sand-pits, puddles on paths and wet depressions in arable fields. It is found throughout the country, being most frequent in fishpond-rich areas with a relatively humid climate, particularly in South Bohemian basins. In the lowlands it occurs mainly in river floodplains. It is remarkably common in military training areas due to the military activities which give rise to many temporary puddles and water bodies. In the former military area in the Šumava Mts, *L. aquatica* reaches its altitudinal maximum at 930 m. The species is not currently threatened, and the number of its populations has even increased in several areas. Nevertheless, it is classified as lower risk – near threatened (Grulich 2012).

Peplis portula (Fig. 54)

Peplis portula is distributed mainly in Europe, where it occurs throughout the continent except in its northernmost parts (being absent from Iceland and not exceeding 65°N in Scandinavia) and the driest parts of the Mediterranean area. Outside Europe it is reported to be scattered in the Azores, northernmost Africa, Anatolia, Central Asia and the Caucasus. It has been introduced to the Pacific coast of North America, and also to Ohio and New Zealand (Meusel et al. 1978, Hultén & Fries 1986, Webb et al. 1988). *Peplis portula* is an annual or short-lived perennial growing mainly in periodically flooded habitats, requiring permanently wet or shallowly flooded substrates throughout the growing season (Němec et al. 2014). It has no requirements for specific substrate type or pH. In the Czech Republic it grows mostly on the bottoms of summer-drained fishponds, in fish storage ponds, sand-pits, river beds, often also in puddles on field and forest tracks and in wet depressions in arable fields. The species is relatively common mainly in forested or fishpond-rich areas of the country, being most frequent in southern Bohemia. It occurs from the lowlands up to 990 m a.s.l. in the Šumava Mts. In the warm lowlands *P. portula* is rather scattered, being confined mostly to river floodplains and large forest patches, while it is absent from the driest deforested areas.

Pistia stratiotes (Fig. 55)

Pistia stratiotes is native to South and Central America, Africa and south-eastern Asia and probably also to northern Australia. It has also been grown, mainly as an ornamental and medicinal plant and as fodder for cattle and pigs, in other regions, and is now widespread as a naturalized species in tropical and subtropical regions of the world (Holm et

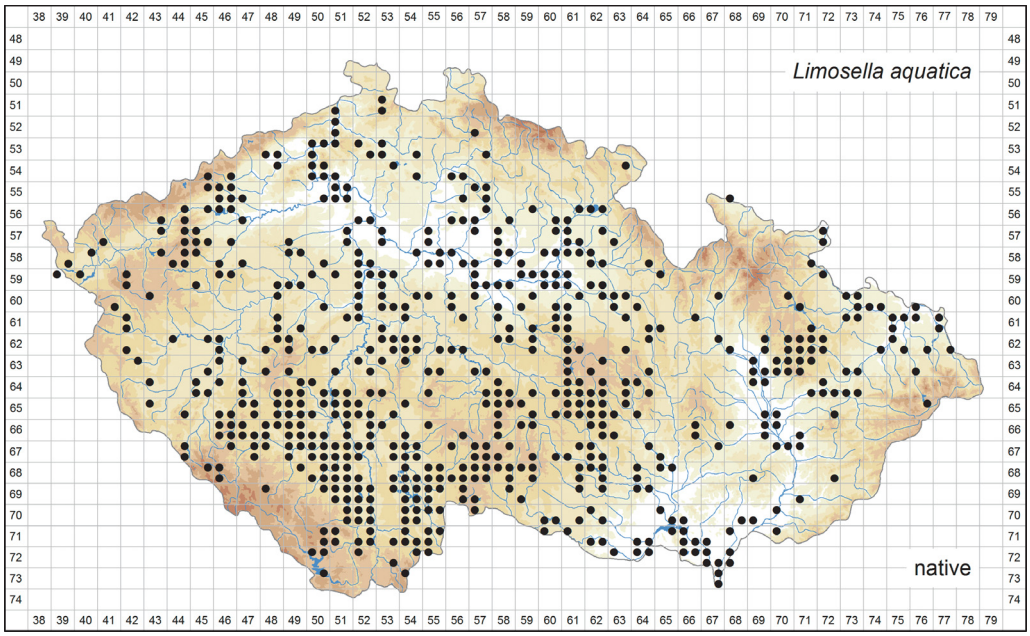


Fig. 53. – Distribution of *Limosella aquatica* in the Czech Republic (627 occupied quadrants). Prepared by Jan Prančl.

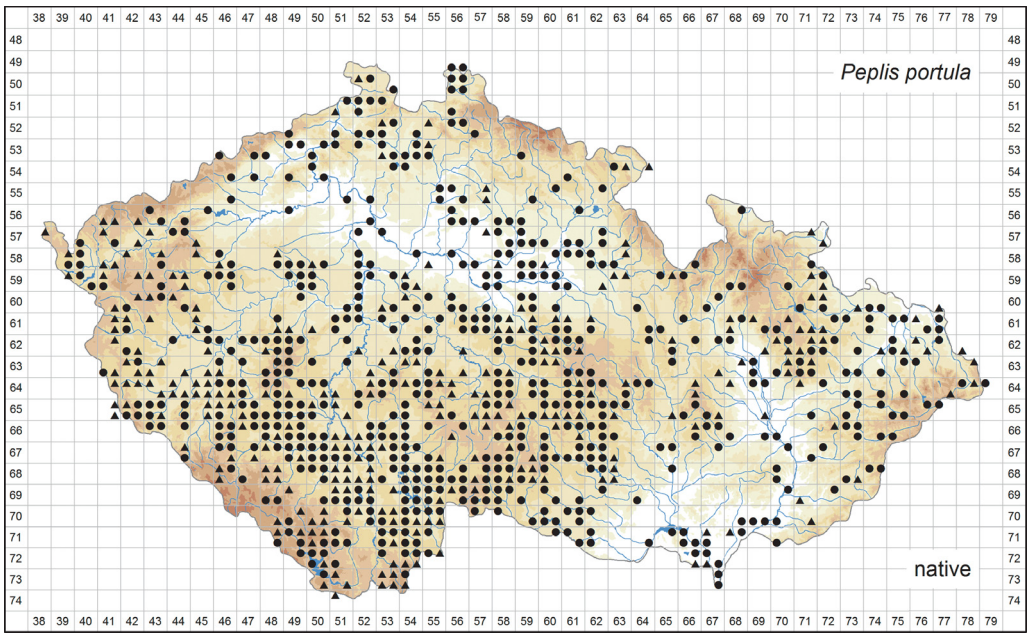


Fig. 54. – Distribution of *Peplis portula* in the Czech Republic: ● occurrence documented by herbarium specimens (600 quadrants), ▲ occurrence based on other records (297 quadrants). Prepared by Jan Prančl.

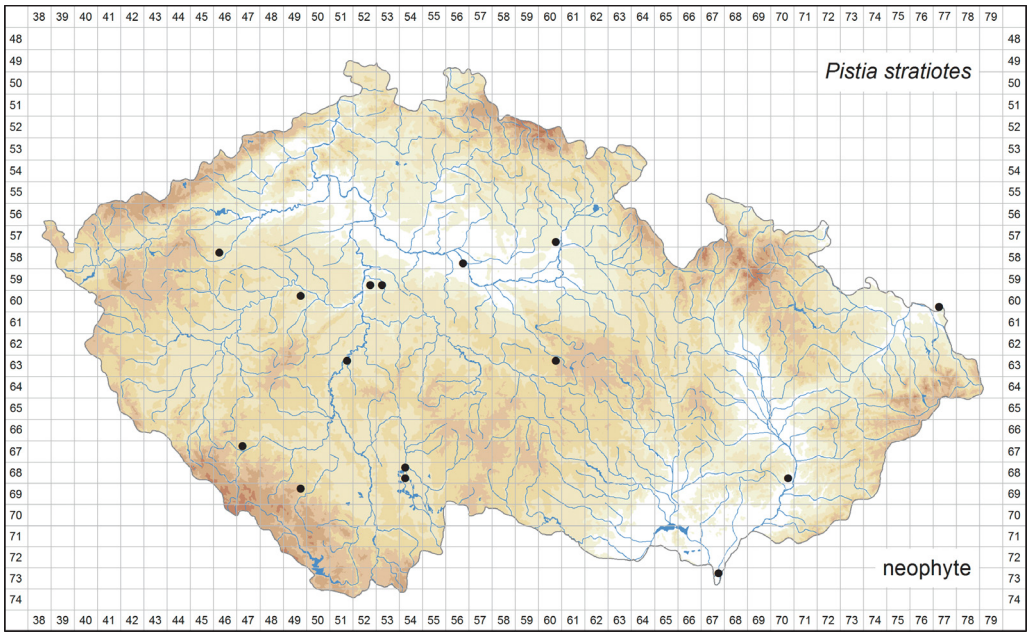


Fig. 55. – Distribution of *Pistia stratiotes* in the Czech Republic (15 occupied quadrants). Prepared by Zdeněk Kaplan.

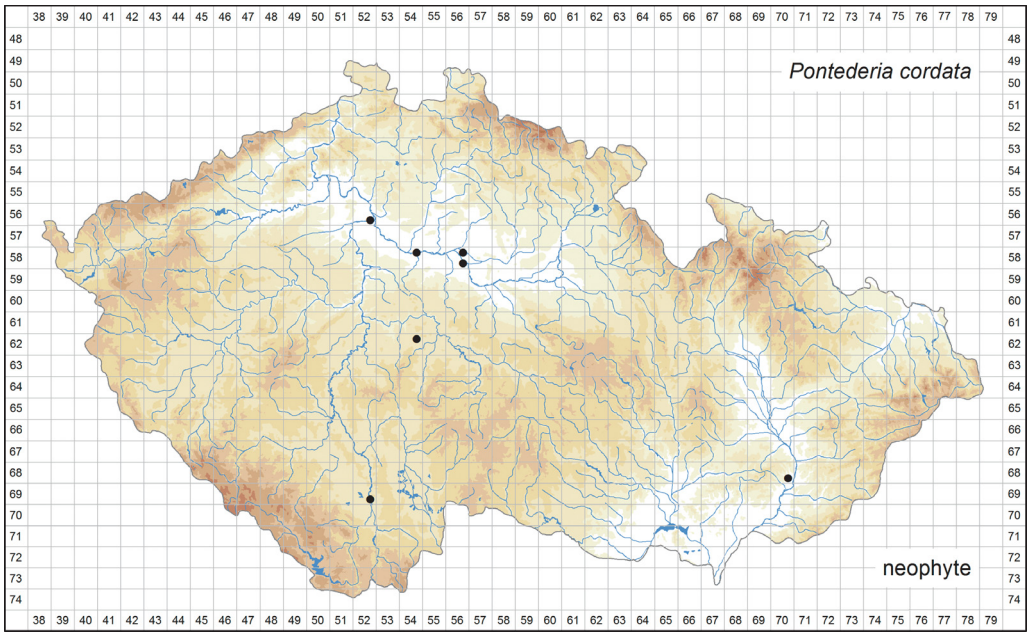


Fig. 56. – Distribution of *Pontederia cordata* in the Czech Republic (7 occupied quadrants). Prepared by Zdeněk Kaplan.

al. 1997, Rojas-Sandoval et al. 2013). In Europe it has been recorded as escaped in Portugal, Spain, France, Belgium, the Netherlands, Germany, the Czech Republic, Hungary, Italy, Slovenia, Romania, Ukraine and Russia, but only in Slovenia it is considered as invasive (Pieterse et al. 1981, Georges & Pax 2002, Kaplan 2002, Rojas-Sandoval et al. 2013). *Pistia stratiotes* is intolerant of low temperatures, which limits its distribution. In countries with cold climates only scattered ephemeral populations have been reported. In the Czech Republic *P. stratiotes* is a popular aquarium plant, which is sometimes discarded in water bodies during the summer season. It acts like an annual, dying during the winter, and it can re-appear only as a result of re-introductions. It was first recorded in a fish storage pond near the village of Ponědraž in southern Bohemia in 1999 (Kaplan 2002). So far it has been found at 12 sites in ponds and slow-flowing stretches of rivers in Bohemia and at 3 sites in Moravia. It is classified as a casual neophyte (Pyšek et al. 2012).

Pontederia cordata (Fig. 56)

Pontederia cordata is native to North and South America, from south-eastern Canada and eastern USA southwards as far as Argentina and Uruguay (Lowden 1973, Horn 2002). In Europe it is cultivated as an ornamental in pools and ponds and as a bog plant (Jäger et al. 2011). It is sometimes planted in water bodies outside gardens and parks or it survives as a cultivation relic, and locally it has become naturalized (Verloove 2016b). So far it has been recorded as escaped in the British Isles, Spain, France, Belgium, the Netherlands, Switzerland and Italy (Wallentinus 2002, DAISIE 2016b). In the Czech Republic *P. cordata* has been available in garden stores and plant nurseries since the 1990s. In 2004 it was first found in a pond in the village of Býkev near the town of Mělník in central Bohemia (Rydlo 2006, Kaplan 2009). Since then it has been recorded at 7 other sites in the shallow edges and on the banks of ponds, oxbow lakes and slow-flowing rivers. In rivers it may be transported to new sites by water currents, which appears to be the case on the Labe river near the village of Chvalovice near the town of Poděbrady. *Pontederia cordata* is classified as a casual neophyte (Pyšek et al. 2012).

Sorbus subg. *Aria* (*S. aria* agg.)
Sorbus aria (Fig. 57), *S. collina* (Fig. 58), *S. cucullifera* (Fig. 59), *S. danubialis* (Fig. 60), *S. moravica* (Fig. 59), *S. pontis-satanae* (Fig. 61) and *S. thayensis* (Fig. 61)

Sorbus subg. *Aria* is widely distributed from Europe to Central Asia (Aldasoro et al. 2004). It is a complex of sexual and agamospermous taxa, in Europe comprising two diploid species (*S. aria* and *S. umbellata*), widely distributed tetraploids and local polyploid endemics, which are generally considered to be results of hybridization between *S. aria* and the tetraploids (Kutzelnigg 1995, Rich et al. 2010). In the Czech Republic the subgenus includes seven species: *S. aria*, two widely distributed tetraploids, *S. danubialis* and *S. collina*, and four local endemics, all apart from the first two being described only recently (Lepší et al. 2015). All are light-demanding species and prefer open habitats such as rocks and screes, rock steppes, rock scrub, forest-steppes, thermophilous and open pine, oak, hornbeam and ravine forests and their fringes. Besides semi-natural to relic vegetation, they occasionally grow in *Picea abies*, *Pinus nigra* and *P. sylvestris* plantations or in their clearings. The closed canopy that now prevails in woodlands in the Czech Republic is unfavourable for the long-term survival and regular reproduction of

such species. The spread of trees and shrubs into open rocky and steppe habitats represents another major threat.

Sorbus aria is a widely distributed species occurring mainly in the mountains of central and southern Europe and possibly also of northern Africa; northwards it reaches south-eastern England, northern France, central Germany and the Western Carpathians (Kutzelnigg 1995, Rich et al. 2010). Its occurrence beyond this northern limit (e.g. in Scandinavia and most of the British Isles) is ascribed to escapes from cultivation (Rich et al. 2010, Grundt & Salvesen 2011). The native occurrence of *S. aria* in the Czech Republic is confined to the supracolline to submontane vegetation belts at altitudes of 300–660 m in four areas of southern Moravia: slopes of the Dyje river valley between the towns of Vranov nad Dyjí and Znojmo, the karst area of Moravský kras, Bílé Karpaty Mts and Pavlovské vrchy hills. These localities are situated at the northern limit of the species' distribution range. In the valley of the Dyje river *S. aria* is scattered, whereas all other Moravian populations are small and that in the Pavlovské vrchy hills no longer extant. It occasionally escapes from cultivation. The literature records of *S. aria* from other parts of the country (Kovanda 1992, 2002, Kutzelnigg 1995) are dubious and refer to *S. danubialis* or *S. collina* (Lepší et al. 2015). *Sorbus aria* is classified as endangered because of its scarcity (Grulich 2012).

Sorbus collina is probably endemic to central Europe but its distribution is insufficiently known. Up to now it has been recorded in Bavaria, Bohemia and Lower and Upper Austria, and similar plants are also found in north-western Hungary (Lepší et al. 2015). In the Czech Republic *S. collina* occurs only in warm to moderately warm parts of central, western and north-western Bohemia. It grows particularly in areas with rocky slopes and rock outcrops such as deep river valleys, karst areas and solitary volcanic hills. It mainly occurs in the karst areas of Český kras, the Křivoklátsko region, the central part of the České středohoří Mts and in the valley of the Vltava river south of Prague. Elsewhere it is rare, often being confined to isolated sites. Some of these outposts harbour only one individual or a very small population and may be actually garden escapes, as it is also rarely grown for ornamental purposes. Most of the records are from the colline and supracolline vegetation belts and only exceptionally was it recorded from the submontane belt, with an altitudinal maximum at 800 m on Mt Milešovka in the České středohoří Mts. The species was described only recently (Lepší et al. 2015) and was therefore not included in the third edition of the Red List (Grulich 2012); it deserves the category of vulnerable.

Sorbus cucullifera and *S. thayensis* are endemic to the valley of the Dyje river in the surroundings of the town of Hardegg along the border between Lower Austria and Moravia, while the latter occurs also in the adjacent valley of the Fugnitz stream, a right-hand tributary of the Dyje river. The appropriate threat status of both species would be critically threatened. *Sorbus cucullifera* has been recorded at 13 sites in the Czech Republic and 15 in Austria, all in the colline vegetation belt. The distance between the two most distant localities is almost 5.4 km and the estimated total number of individuals is around 150 in the Czech Republic and 300 in Austria. *Sorbus thayensis* is known from two sites in the Czech Republic and five in Austria, the most distant ones being 3.2 km apart. Ten of thirty-three known individuals are found in the Czech Republic (Lepší et al. 2015).

Sorbus danubialis is a central-European species known from Bavaria, Lower Austria, the Czech Republic, Slovakia and Hungary (Lepší et al. 2015), in Bohemia reaching the northern limit of its distribution range. In the Czech Republic it occurs particularly in

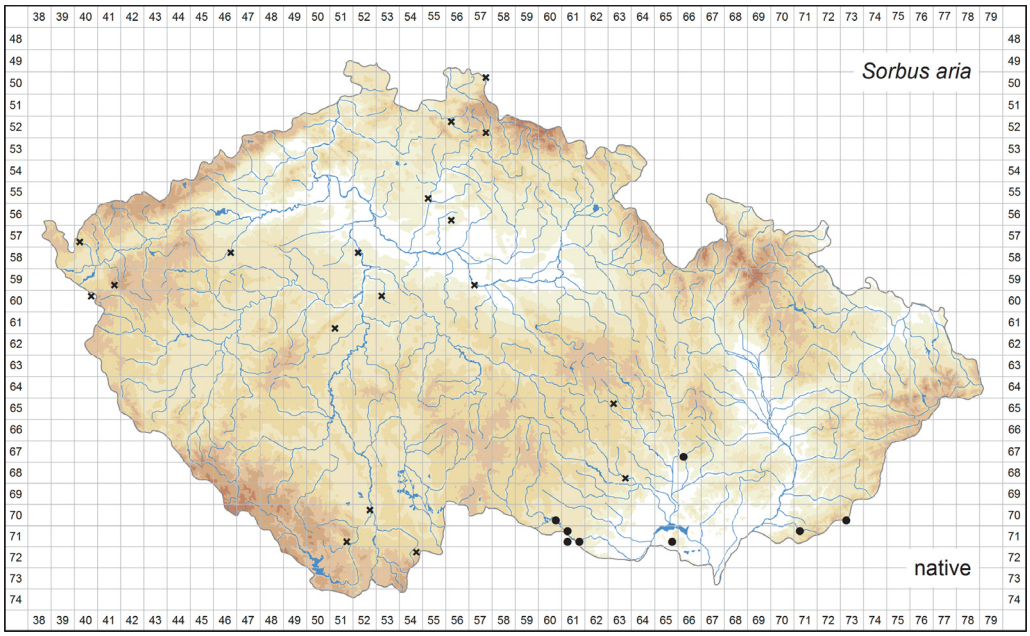


Fig. 57. – Distribution of *Sorbus aria* in the Czech Republic: ● native (8 quadrants), × alien (18 quadrants). Prepared by Martin Lepší & Petr Lepší.

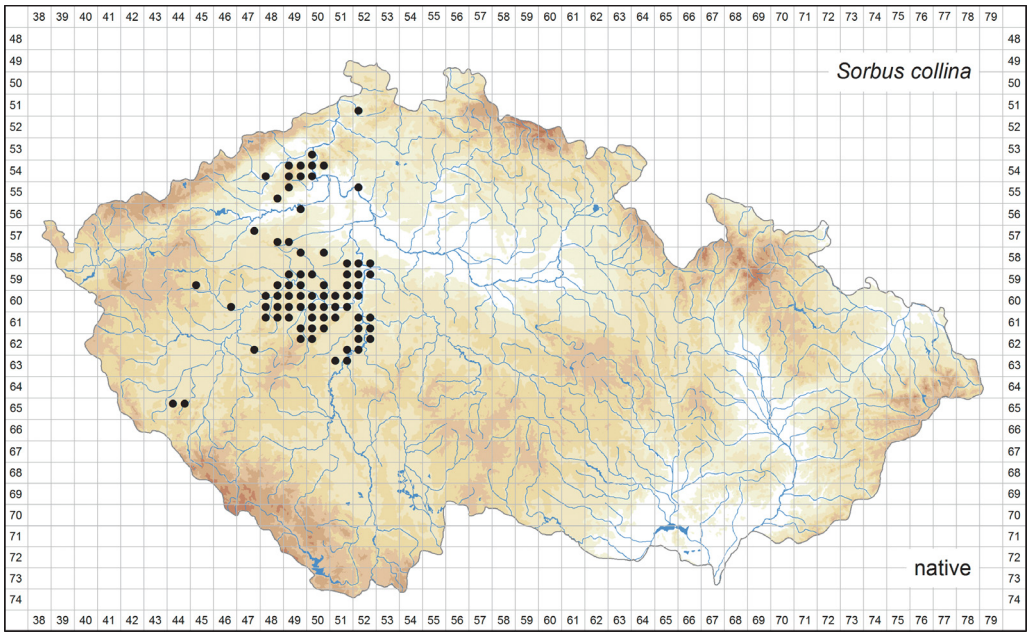


Fig. 58. – Distribution of *Sorbus collina* in the Czech Republic (77 occupied quadrants). Prepared by Martin Lepší & Petr Lepší.

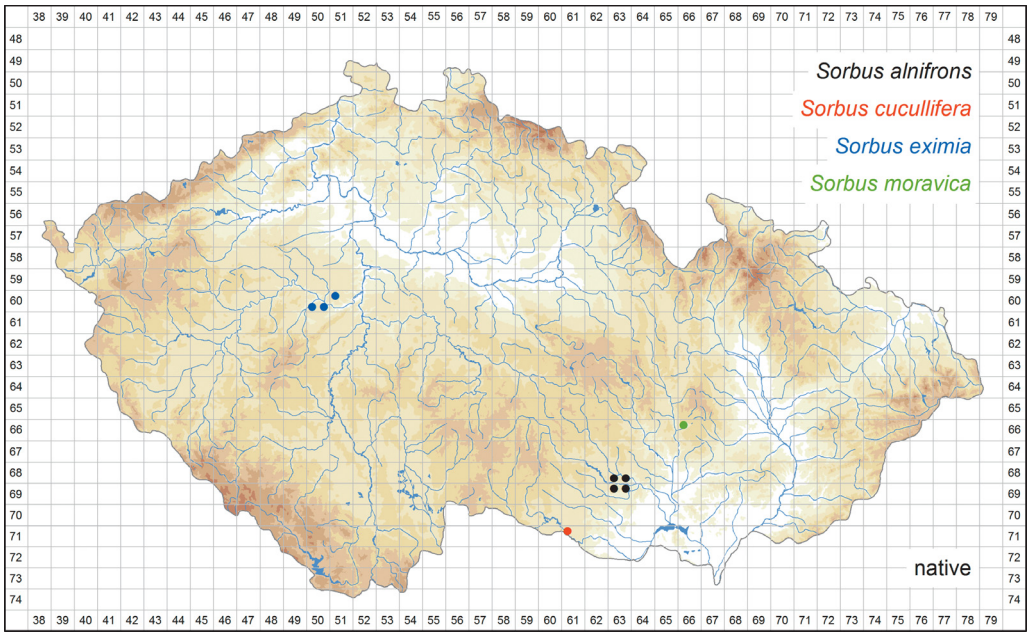


Fig. 59. – Distribution of *Sorbus alnifrons* (4 occupied quadrants), *S. cucullifera* (1 occupied quadrant), *S. eximia* (3 occupied quadrants) and *S. moravica* in the Czech Republic (1 occupied quadrant). Prepared by Martin Lepší & Petr Lepší.

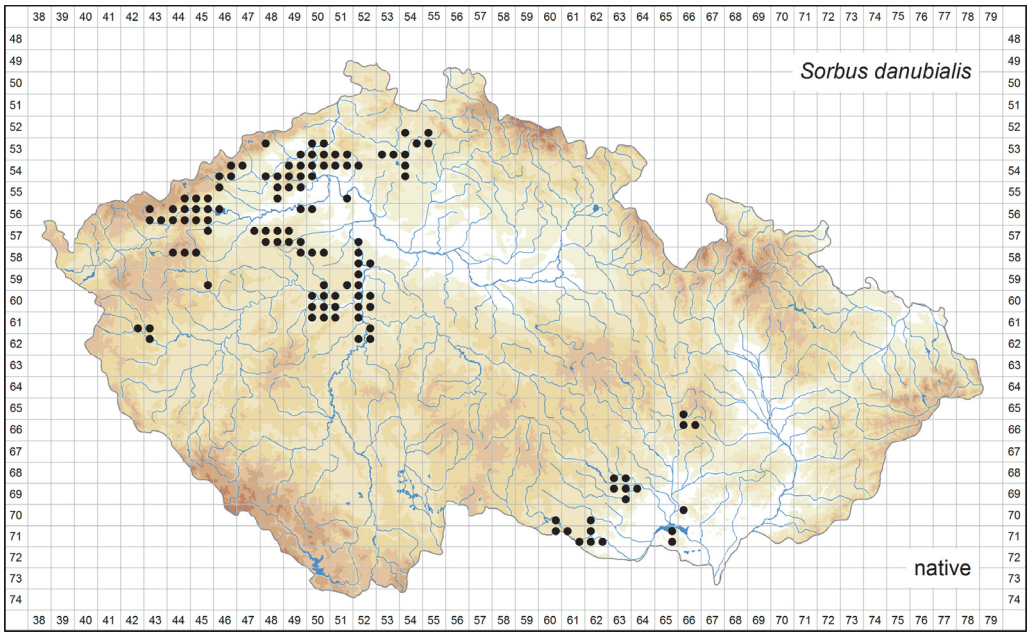


Fig. 60. – Distribution of *Sorbus danubialis* in the Czech Republic (120 occupied quadrants). Prepared by Martin Lepší & Petr Lepší.

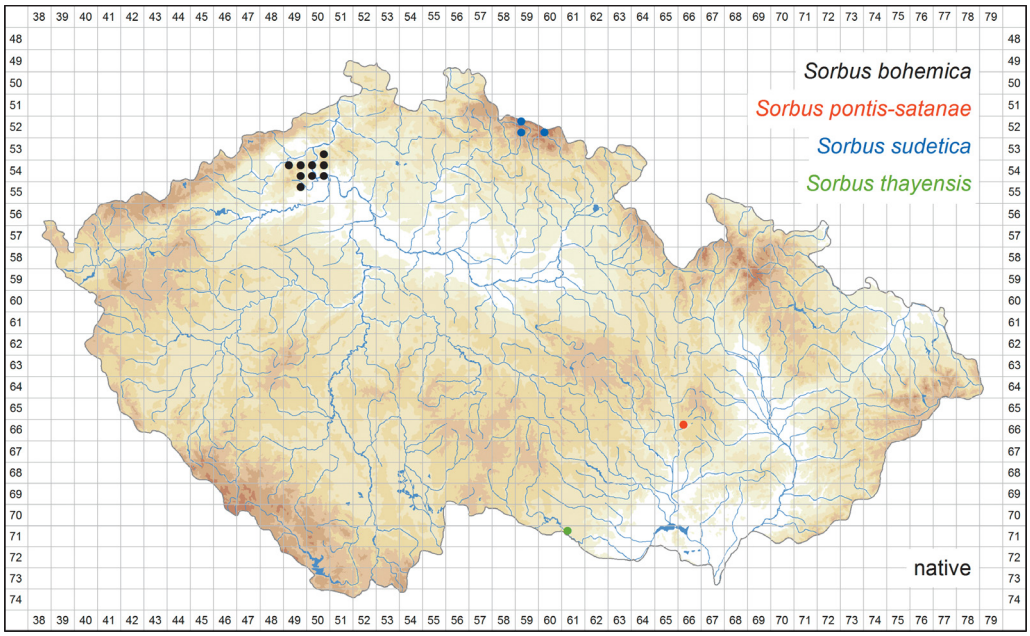


Fig. 61. – Distribution of *Sorbus bohemica* (9 occupied quadrants), *S. pontis-satanae* (1 occupied quadrant), *S. sudetica* (3 occupied quadrants) and *S. thayensis* in the Czech Republic (1 occupied quadrant). Prepared by Martin Lepší & Petr Lepší.

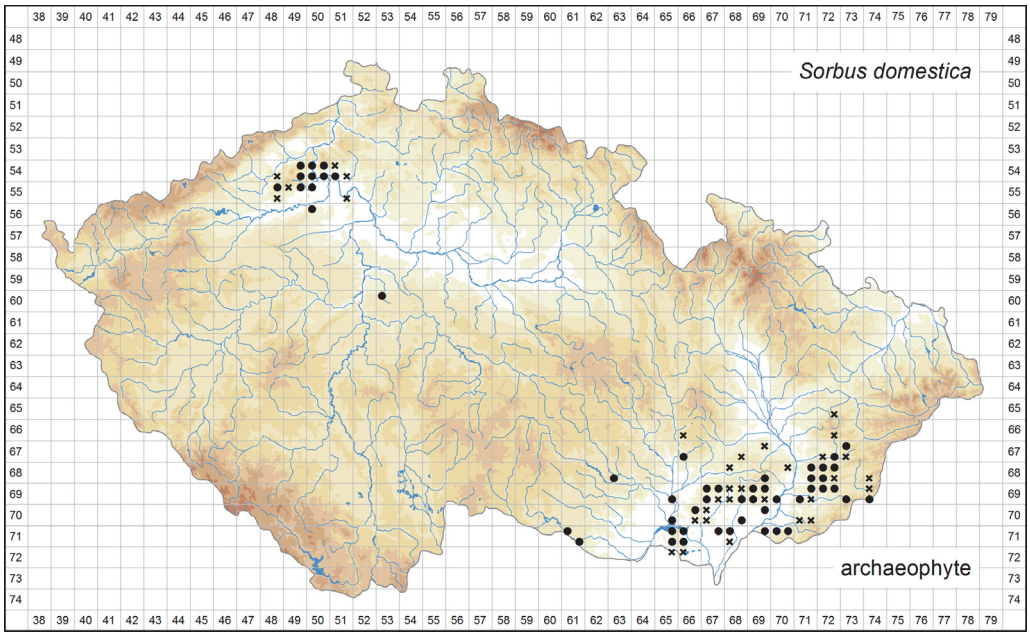


Fig. 62. – Distribution of *Sorbus domestica* in the Czech Republic: ● spontaneous escapes (52 quadrants), × deliberately planted in the countryside and uncertain origin (32 quadrants). Prepared by Martin Lepší, Petr Lepší, Zdeněk Špíšek & Karel Kubát.

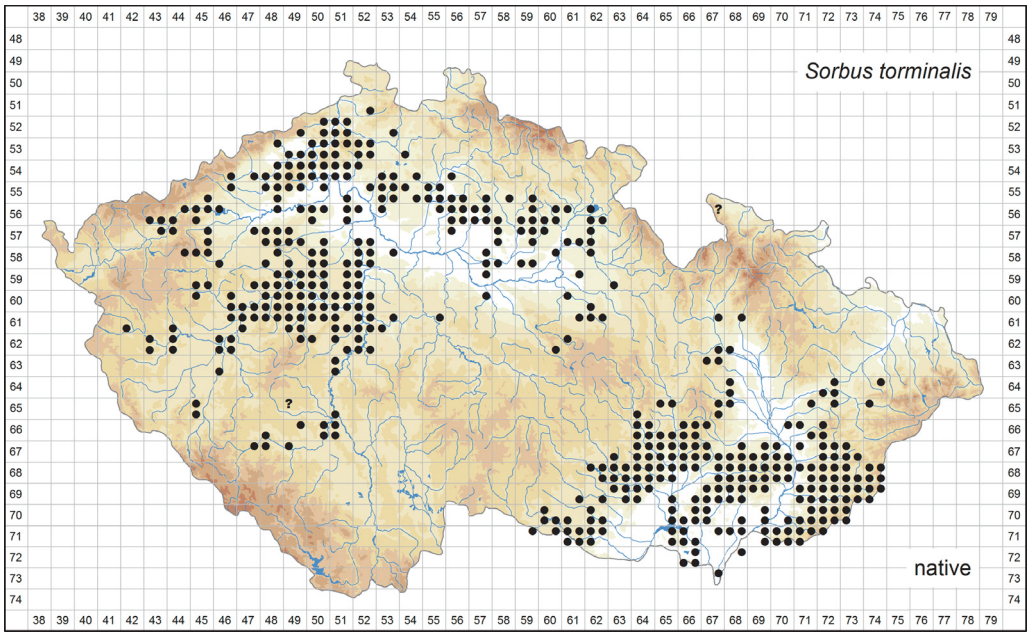


Fig. 63. – Distribution of *Sorbus torminalis* in the Czech Republic (475 occupied quadrants). Prepared by Martin Lepší & Petr Lepší.

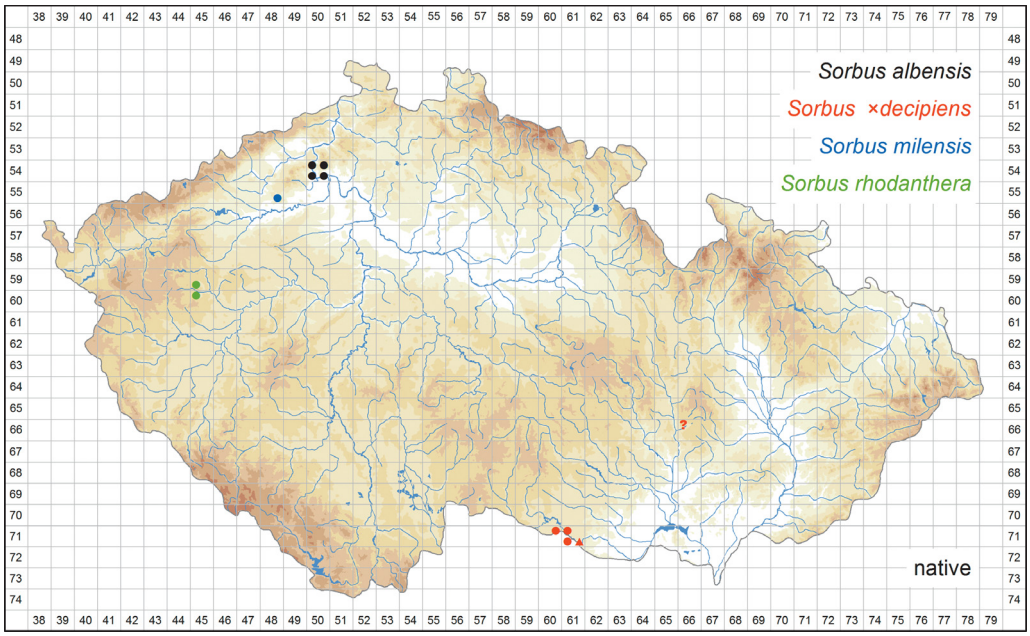


Fig. 64. – Distribution of *Sorbus albensis* (4 occupied quadrants), *S. milensis* (1 occupied quadrant), *S. rhodanthera* (2 occupied quadrants) and *S. ×decipiens* in the Czech Republic (● occurrence documented by herbarium specimens: 3 quadrants, ▲ occurrence based on other records: 1 quadrant). Prepared by Martin Lepší & Petr Lepší.

warm to moderately warm areas of central, western and north-western Bohemia and of southern Moravia. Its populations are scattered throughout these areas, depending on the presence of rocky slopes and rock outcrops. It was recorded particularly in the deep river valleys of the middle stretches of the Vltava, Dyje and Jihlava rivers and in areas with calcareous rocks (the karst areas of Český kras and Moravský kras, the Pavlovské vrchy hills and Džbán hills) or other base-rich, usually volcanic bedrocks (Doupovské hory Mts, České středohoří Mts, the surroundings of the town of Doksy). It grows in the colline and supracolline, and rarely also in the montane vegetation belts. The altitudinal range of the species extends from 175 m to 940 m. It is classified as vulnerable because of its scarcity (Grulich 2012).

Sorbus moravica and *S. pontis-satanae* are narrow endemics of the Suchý žleb gorge near the village of Lažánky in the karst area of Moravský kras. The populations, found at altitudes of 360–490 m, consist of about 200 and 30 individuals, respectively. Both species should be classified as critically threatened (Lepší et al. 2015).

With the exception of *Sorbus domestica*, *S. torminalis* and *S. aucuparia*, the distribution maps of the *Sorbus* taxa were based solely on revised herbarium specimens and our own field records.

Sorbus subg. *Chamaespilaria*
Sorbus sudetica (Fig. 61)

Sorbus subg. *Chamaespilaria* includes taxa that have arisen from hybridizations between the species of *S.* subg. *Aria* and *S.* subg. *Chamaemespilus*. It occurs in the subalpine and alpine belts of mountains in the southern half of Europe (Kutzelnigg 1995).

Sorbus sudetica is endemic to the Krkonoše Mts, representing there an outpost at the northern limit of the distribution range of the subgenus. Unlike most other species of this subgenus, at present it occurs there without its parental species, *S. chamaemespilus* and an unknown member of *S.* subg. *Aria*. In the Czech Republic it has been recorded in the Labský důl valley and the Obří důl valley, which are about 13.5 km apart. The small population once present near the Mały Staw lake in Poland does not exist any more (Kovanda 1998). *Sorbus sudetica* grows on steep slopes of glacial cirques at altitudes of about 1060–1350 m. It inhabits rocks, screes, subalpine grasslands, montane to subalpine heathland, scrub and the fringes of forest gaps. The species has probably vanished from four of its ten sites and the number of individuals at the remaining localities has declined. Currently, the estimated total number of individuals is about 110, including 10 planted individuals in the Labský důl valley (J. Zahradníková, pers. comm. 2014). It is classified as critically threatened because of its rarity and population decline (Grulich 2012).

Sorbus subg. *Cormus*
Sorbus domestica (Fig. 62)

Sorbus domestica, the only member of *S.* subg. *Cormus*, is distributed in central and southern Europe from eastern Spain to southern Great Britain, northern France, Germany, Slovakia, Hungary and the Balkan Peninsula, with outposts in the Black Sea area, Anatolia and in Morocco and Algeria in northern Africa (Rotach 2003, George et al. 2016). The species has been planted in some warm areas of the Czech Republic as a fruit tree since the Medieval period (Pyšek et al. 2012) and it has become widely naturalized in

the České středohoří Mts in north-western Bohemia and in several parts of southern Moravia (e.g. the Pavlovské vrchy, Ždánický les, Chřiby and Vizovická vrchovina hills and the Bílé Karpaty Mts). The southernmost and easternmost localities in Moravia are close to the northern limit of its assumed native distribution area in Slovakia or Hungary (Kurtto 2009) and perhaps some of them may be native. However, direct evidence of its native occurrence in southern Moravia is lacking. In the České středohoří Mts it is almost solely confined to areas where *Quercus pubescens* also grows. Because it has been grown not only in villages but commonly also planted in vineyards and elsewhere, it is often difficult to distinguish intentionally planted individuals from bird-sown escapes. The map therefore distinguishes spontaneous escapes and naturalized populations from trees of uncertain origin, including those planted outside settlements. The trees planted in gardens and parks are not mapped. The escaped plants are found in thermophilous oak and open hornbeam forests, forest edges and scrub. Most of the records are from the planar to colline, rarely up to the supracolline vegetation belts, with an altitudinal maximum at 470 m. *Sorbus domestica* is classified as a casual archaeophyte in the Czech Republic (Pyšek et al. 2012).

Sorbus subg. *Tormaria*
Sorbus torminalis (Fig. 63)

There are two taxa within *S.* subg. *Tormaria*: the widespread *S. torminalis* and the Iranian species *S. tiliifolia* (Rich et al. 2010). The distribution range of *S. torminalis* extends from the British Isles and the Baltic countries southwards to northern Africa and eastwards to the Caspian Sea (Meusel et al. 1965). In the Czech Republic it occurs in warm to moderately warm areas of Bohemia and Moravia but it is usually absent from the largely deforested lowlands. *Sorbus torminalis* grows in oak, hornbeam, calcareous or open beech forests, forest fringes and scrub and occasionally colonizes abandoned dry grasslands. It is rarely planted in the countryside by foresters and grown as an ornamental in parks and towns. Most of the records are from the colline and supracolline vegetation belts, and several from the submontane belt, with an altitudinal maximum at 760 m on Mt Milešovka in the České středohoří Mts. It is classified as near threatened (Grulich 2012) because its habitats disappear as open forests develop a dense canopy, or are replaced by conifer and *Robinia pseudoacacia* plantations.

Sorbus subg. *Torminaria* (*S. latifolia* agg.)
Sorbus albensis (Fig. 64), *S. alnifrons* (Fig. 59), *S. barrandienica* (Fig. 65), *S. bohemica* (Fig. 61), *S. eximia* (Fig. 59), *S. gemella* (Fig. 65), *S. latifolia* (Fig. 66), *S. milensis* (Fig. 64), *S. omissa* (Fig. 65), *S. portae-bohemicae* (Fig. 65), *S. rhodanthera* (Fig. 64), *S.* ×*decipiens* (Fig. 64) and *S.* ×*kitaibeliana* (Fig. 67)

This subgenus contains species that have originated as hybrids and backcrosses between *S.* subg. *Aria* and *S.* subg. *Tormaria*. It occurs in western, central and southern Europe and in Anatolia, where the distribution of *S. torminalis* overlaps with that of members of *S.* subg. *Aria* (Rich et al. 2010, Zieliński & Vladimirov 2013). The Czech species of the subgenus inhabit mainly open oak, hornbeam, ravine and pine forests, forest fringes and rock scrub and occasionally also rocks, screes and rock and forest steppes. Besides semi-natural forests, *S. alnifrons*, *S. eximia*, *S. gemella* and *S. rhodanthera* occasionally grow

in *Larix decidua*, *Picea abies*, *Pinus nigra*, *P. sylvestris* and rarely *Robinia pseudoacacia* plantations or in their clearings. The main threat to these hybridogenous species stems from the cessation of coppicing and hay making, which maintained open forests. High forests, the currently prevailing forest management practice, creates stands with a closed canopy, which are too shady for the long-term survival and reproduction of light-demanding *Sorbus* species. The members of this subgenus occur from the planar to the supracolline vegetation belts in the Czech Republic.

Sorbus albensis, *S. bohemica* and *S. portae-bohemicae* are endemic to the České středohoří Mts in north-western Bohemia, occurring in the surroundings of the deep valley of the Labe river between the town of Lovosice and the city of Ústí nad Labem (Lepší et al. 2009). *Sorbus bohemica* is the most widespread hybridogenous *Sorbus* species in the Czech Republic with a distribution area of about 16 × 15 km. It has been recorded at 36 localities and the total population is about 1100 trees. The species has disappeared from four sites and its natural reproduction is poor and therefore it is classified as endangered (Grulich 2012). *Sorbus albensis* grows at 15 localities east of the town of Litoměřice and the population consists of about 600 individuals. The distance between the most distant localities is nearly 6 km. The species is classified as endangered (Grulich 2012). *Sorbus portae-bohemicae* is confined to two sites about 1.2 km apart in the northern surroundings of the town of Lovosice in the Oparenské údolí valley and on Lovoš hill. Only about 30 trees are currently known. The species is listed as critically threatened (Grulich 2012). *Sorbus milensis* is a narrow endemic of the basaltic hill of Milá in the southern part of České středohoří Mts. At least 60 individuals of diverse age have been recorded (Lepší et al. 2008). It is classified as critically threatened because of its rarity and sparse regeneration (Grulich 2012).

Sorbus alnifrons is endemic to the valley of the Jihlava river near the town of Ivančice in south-western Moravia. The population consists of about 200 individuals and spans a length of valley of about 2.5 km. It is classified as critically threatened because of its scarcity (Grulich 2012).

Sorbus barrandienica and *S. eximia* are central-Bohemian endemics recorded in the karst area of Český kras between Prague and the town of Beroun, the latter species being described only recently (Vít et al. 2012). About 330 individuals of the former are documented at 5 sites, and only 50 plants at 10 sites are reported for the latter. *Sorbus barrandienica* is classified as critically threatened (Grulich 2012) as there are few individuals, many of them old or dying, while juveniles are lacking at most localities. *Sorbus eximia* is considered endangered (Grulich 2012).

Sorbus gemella, an endemic of the Džbán hills, has been recorded at 13 localities and the estimated total number of individuals is 300. The distance between the localities that are furthest apart is about 9 km. The species is classified as critically threatened due to its rare regeneration (Grulich 2012).

Sorbus latifolia is native to France, while the records from other European countries require confirmation (Kutzelnigg 1995). Escapes from cultivation are reported in several European countries (Lepší et al. 2013b). In the Czech Republic it has been rarely planted in towns and parks and from there it has escaped near Prague and the towns or villages of Strakonice, Nečtiny, Březina, Orlík nad Vltavou, Ivančice and Valtice. Its habitats include scrub, rocks, open woodland and parks. It is classified as a casual alien (Pyšek et al. 2012).

Sorbus omissa is confined to the deep valley of the lower stretches of the Vltava river north of Prague in central Bohemia. At least 149 plants are known at two sites 3.6 km apart (Velebil 2012). The species is classified as critically threatened due to the small population size, poor regeneration and lack of other suitable habitats for further spread (Grulich 2012, Velebil 2012).

Sorbus rhodanthera is now known to be an endemic confined to Chlumská hora hill near the town of Manětín in western Bohemia, where there are at least 700 individuals. The species is classified as critically threatened (Grulich 2012).

Sorbus ×*decipiens* is a diploid hybrid between *S. torminalis* and *S. aria*. It occurs in Europe where the parents grow sympatrically (Rich et al. 2010). In the Czech Republic it is very rare due to the scarcity of *S. aria*. Approximately 15 individuals are found in the valley of the Dyje river south of the town of Vranov nad Dyjí in southern Moravia. These individuals together with plants from adjacent Lower Austria were mistakenly described as a hybridogenous species *S. hardeggensis* (Kovanda 1996). The taxonomic identity of a single diploid tree in the Suchý žleb gorge near Lažánky in the karst area of Moravský kras is uncertain as *S. aria* s. str. does not occur at the locality and the *S.* subg. *Aria* parent may have been one of the co-occurring polyploids, i.e. *S. danubialis*, *S. moravica* or *S. pontissatanae*.

Sorbus ×*kitaibeliana* is a rare hybrid between *S. danubialis* and *S. torminalis*, hitherto known only from its type locality in northern Hungary (Kárpáti 1960). In the Czech Republic one individual has been recorded near the city of Ústí nad Labem in northern Bohemia. This name was misapplied by Kovanda (1996) to an individual of *S. latifolia* escaped at Pekárka hill near Ivančice in south-western Moravia.

Sorbus subg. *Soraria* (*S. hybrida* agg.)
Sorbus austriaca (Fig. 68), *S. mougeotii* (Fig. 69), *S. pauca* (Fig. 67),
S. ×*abscondita* (Fig. 70) and *S.* ×*thuringiaca* (Fig. 67)

This subgenus involves European and Asian taxa that originated from hybridizations between the species of *S.* subg. *Sorbus* and those of *S.* subg. *Aria*. In Europe the subgenus includes hybrids and hybridogenous species with the parentage of *S. aucuparia* and *S. subg. Aria*, usually found in the areas where the parental species co-occur. They are most frequent in northern Europe and in the mountains of central and southern Europe. In the Czech Republic three native and two alien taxa occur.

Sorbus austriaca in the narrow circumscription is endemic to the Austrian Alps. In the Czech Republic it has rarely been grown and found as rare garden escapes in parks, hedges in towns and in scrub in the countryside near or in the towns of Český Krumlov, Průhonice, Benešov, Krahulčí near Telč and Rokycany. Previous reports on its native occurrence in the Dyje river valley between the towns of Vranov nad Dyjí and Znojmo and the karst area of Moravský kras (Kovanda 1996, 1997a) have been shown to be dubious (Lepší et al. 2015).

Sorbus mougeotii, a montane western-European species, is occasionally planted in the Czech Republic and also in other European countries as a roadside, street or garden tree. It has become naturalized in scrub and open oak-hornbeam woodland at three sites in Prague and has escaped in the city of České Budějovice. Two Prague populations, together consisting of about 100 individuals, were superfluously described as *S. quernea* (Lepší et al. 2013b).

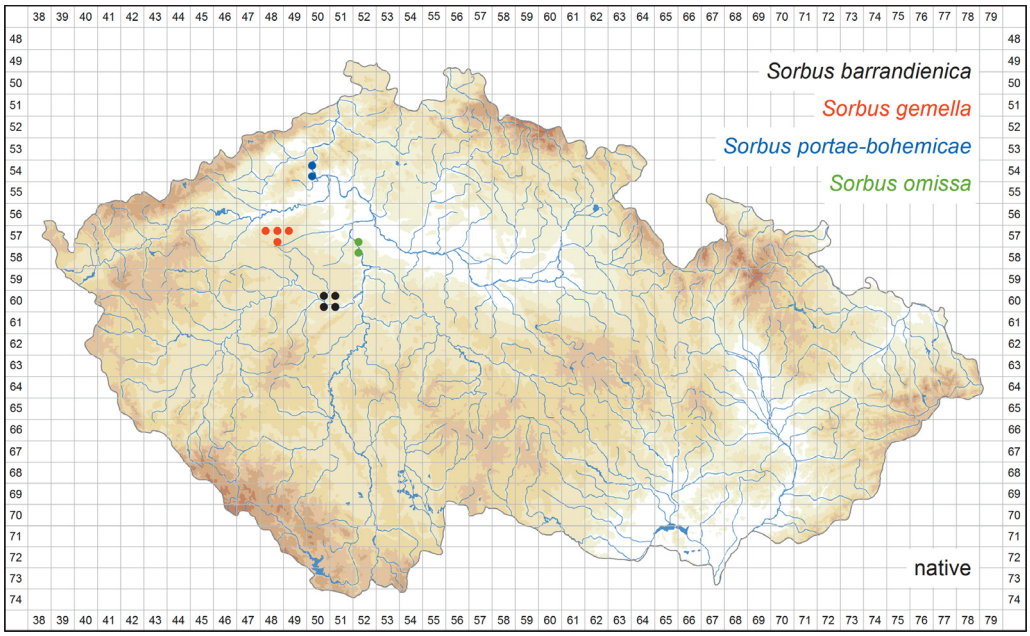


Fig. 65. – Distribution of *Sorbus barrandienica* (4 occupied quadrants), *S. gemella* (4 occupied quadrants), *S. omissa* (2 occupied quadrants) and *S. portae-bohemicae* in the Czech Republic (2 occupied quadrants). Prepared by Martin Lepší & Petr Lepší.

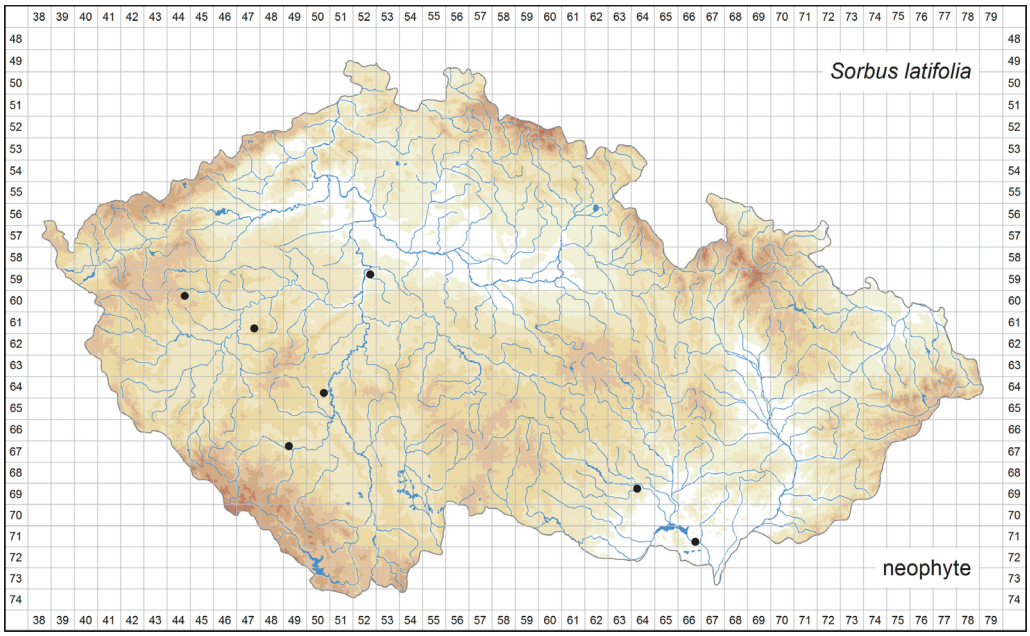


Fig. 66. – Distribution of *Sorbus latifolia* in the Czech Republic (7 occupied quadrants). Prepared by Martin Lepší & Petr Lepší.

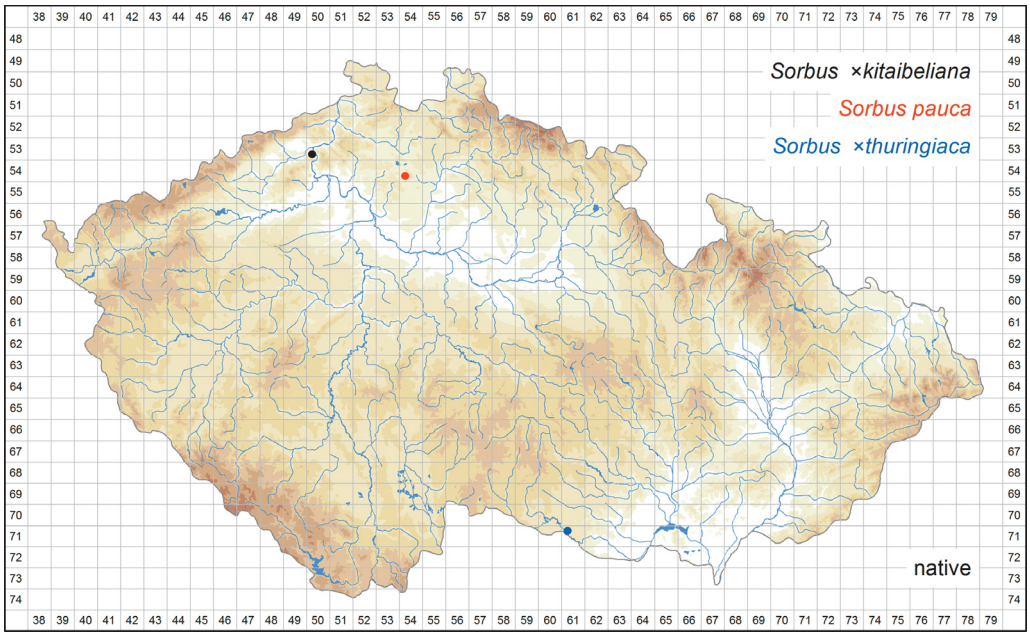


Fig. 67. – Distribution of *Sorbus pauca* (1 occupied quadrant), *S.* ×*kitaibeliana* (1 occupied quadrant) and *S.* ×*thuringiaca* in the Czech Republic (1 occupied quadrant). Prepared by Martin Lepší & Petr Lepší.

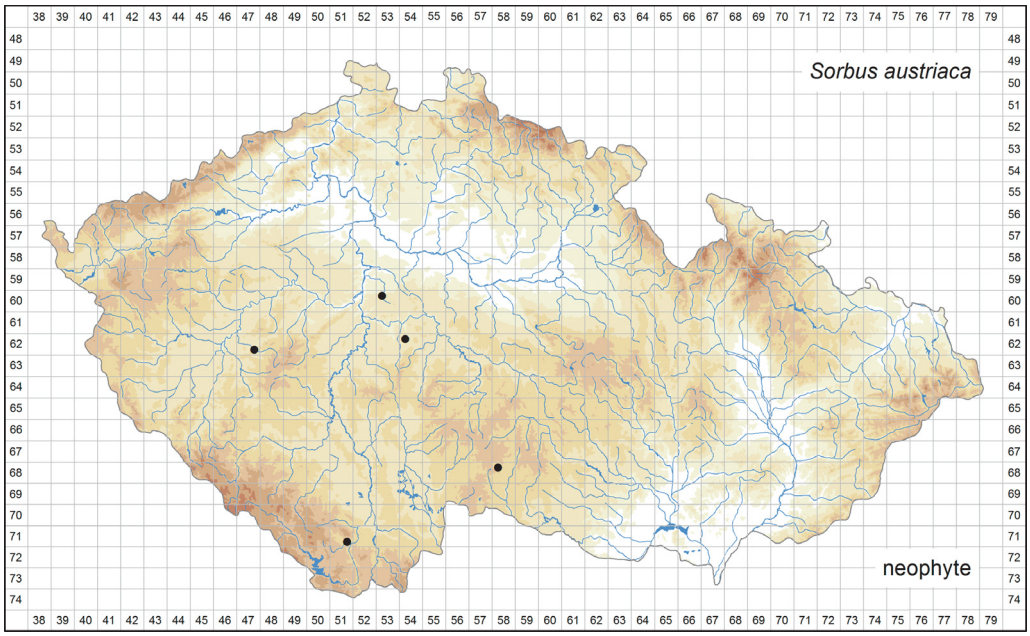


Fig. 68. – Distribution of *Sorbus austriaca* in the Czech Republic (5 occupied quadrants). Prepared by Martin Lepší & Petr Lepší.

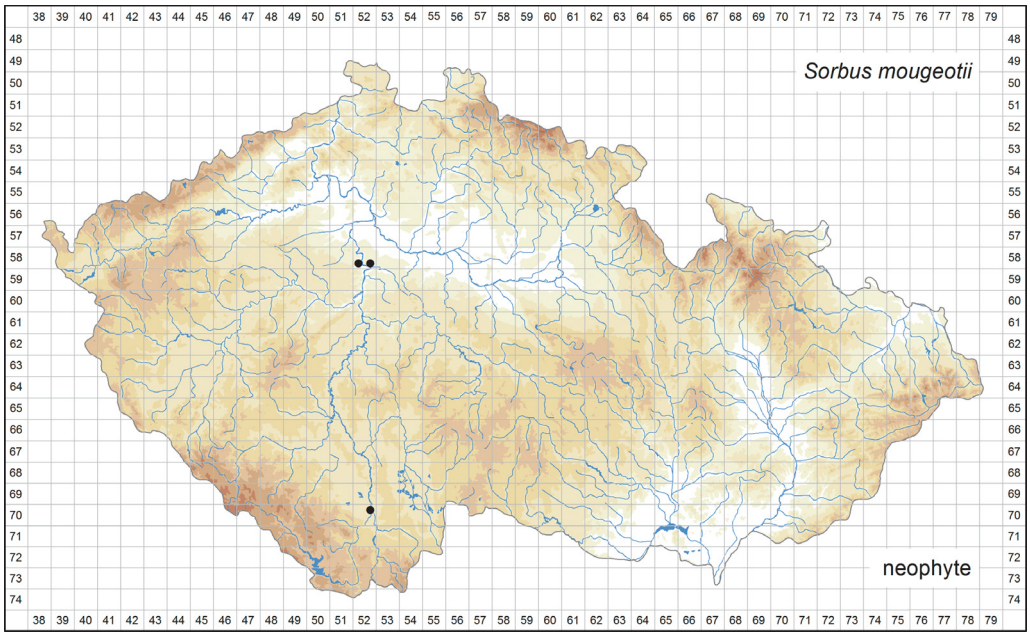


Fig. 69. – Distribution of *Sorbus mougeotii* in the Czech Republic (3 occupied quadrants). Prepared by Martin Lepší & Petr Lepší.

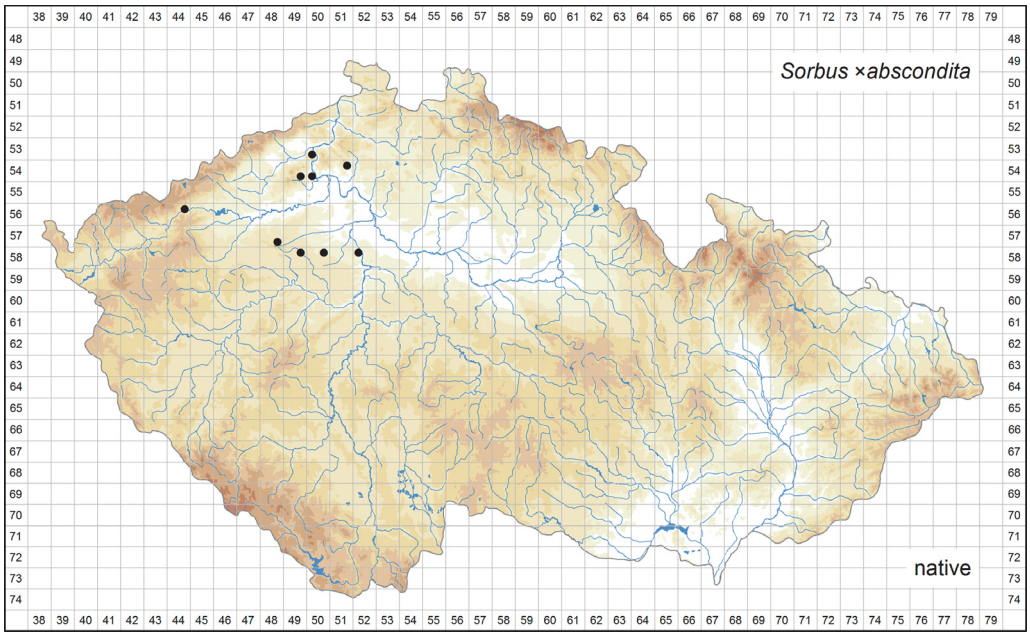


Fig. 70. – Distribution of *Sorbus ×abscondita* in the Czech Republic (9 occupied quadrants). Prepared by Martin Lepší & Petr Lepší.

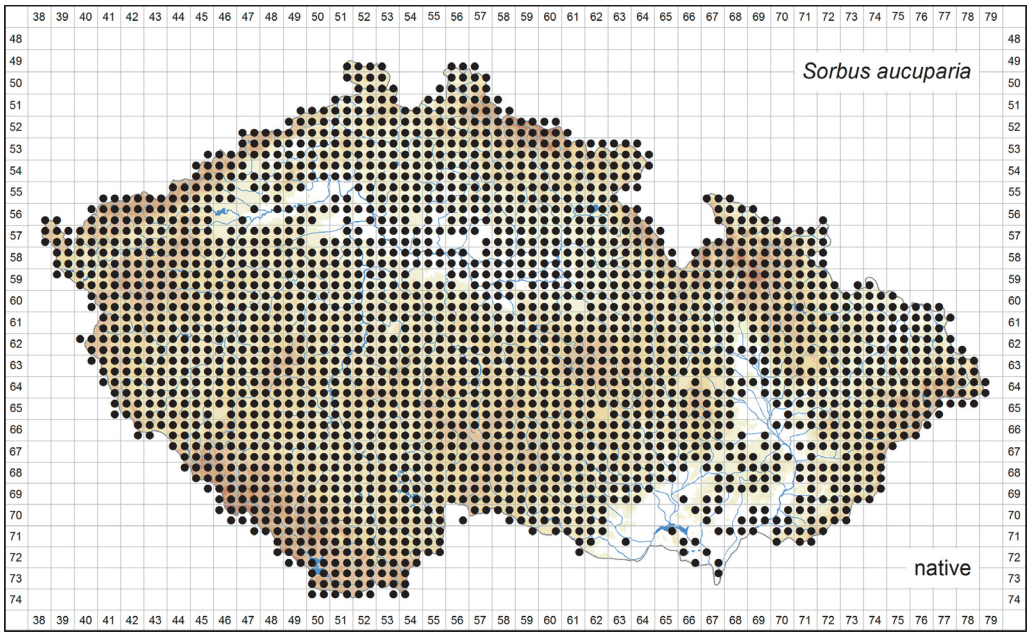


Fig. 71. – Distribution of *Sorbus aucuparia* in the Czech Republic (2334 occupied quadrants). Prepared by Petr Lepší & Martin Lepší.

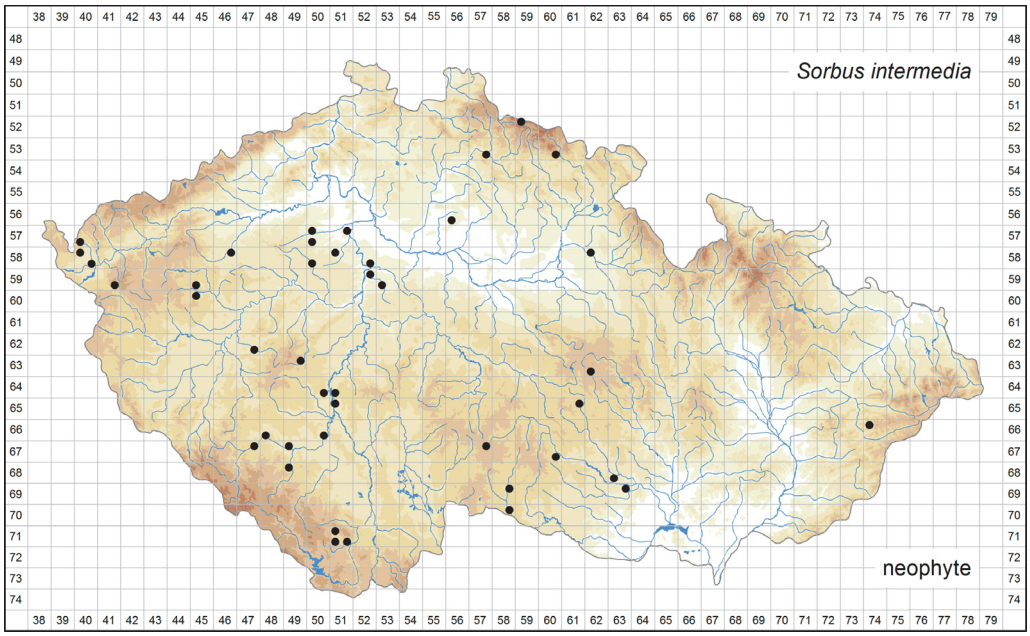


Fig. 72. – Distribution of *Sorbus intermedia* in the Czech Republic (42 occupied quadrants). Prepared by Martin Lepší & Petr Lepší.

Sorbus pauca is a narrow endemic of two close phonolite hills Malý Bezděz and Bezděz near the town of Doksy in northern Bohemia (Lepší et al. 2013a). Its parents are *S. aucuparia* and *S. danubialis*. It grows in scrub and grasslands on sunny rocks and on the slopes of an abandoned quarry in the supracolline vegetation belt at altitudes of 440–580 m. Its population consists of only 16 individuals and it is therefore classified as critically threatened (Grulich 2012).

Sorbus ×*abscondita* is a rare hybrid between *S. danubialis* and *S. aucuparia*. So far it has been recorded at 9 localities in Bohemia and at all except two only one individual was present.

Sorbus ×*thuringiaca* is a diploid sexual hybrid between *S. aucuparia* and *S. aria*. It is widespread but sporadic in Europe where its parents co-occur (Rich et al. 2010). In the Czech Republic it is very rare due to the scarcity of *S. aria*. Only two trees and three saplings at three sites have been recorded in ravine and oak forests in the valley of the Dyje river south of the town of Vranov nad Dyjí in southern Moravia.

Sorbus subg. *Sorbus*
Sorbus aucuparia (Fig. 71)

This subgenus is widely distributed in the temperate zones of the Northern Hemisphere and includes about 70 species (McAllister 2005).

Sorbus aucuparia occurs from Iceland, Madeira and northern Africa eastwards to northern China and Kamchatka and as an alien it is reported from North America (McAllister 2005). In the Czech Republic it is widespread throughout the country but with different frequencies. It is abundant primarily in rather cold and largely forested regions but rare in or even absent from the largely deforested lowlands of Bohemia and Moravia. At least some of these gaps represent true absences, while the others may be due to low frequency or under-recording. It is frequent in open broadleaved and coniferous forests and their fringes, forest openings and clearings and on rocks and screes. It is a pioneer tree able to colonize abandoned pastures, waste ground, railways and roadsides. *Sorbus aucuparia* is often grown as a street, roadside and fruit tree, and it is therefore hardly possible to distinguish native occurrences from escaped trees. It is distributed from the planar to subalpine vegetation belts with an altitudinal maximum at 1450 m in the Krkonoše Mts (Kovanda 1992).

Sorbus subg. *Triparens*
Sorbus intermedia (Fig. 72)

Sorbus subg. *Triparens* includes *S. intermedia* and *S.* ×*liljeforsii*, which both originated from the crossing of three taxa: a species of *S.* subg. *Aria*, *S. torminalis* and *S. aucuparia* (Rich et al. 2014).

Sorbus intermedia is generally regarded as native to southern Sweden and parts of the Baltics and it has occasionally become naturalized elsewhere in Europe (Kurtto 2009). In the Czech Republic it is commonly planted for ornamental purposes in towns and parks and along highways. It occurs rarely across the country in scrub, forest fringes, open mixed and oak forests, *Pinus sylvestris* plantations, on rocks, in dry grasslands, on stony walls and in quarries, usually as an escape from cultivation. Based on old literature records and 19th-century herbarium specimens from the subalpine areas of the Krkonoše

Mts, Kovanda (1997b) considers *S. intermedia* as possibly native, explaining its presence by long-distance dispersal by birds from the Baltic countries.

Spirodela polyrhiza (Fig. 73)

Spirodela polyrhiza is a nearly cosmopolitan species. It is found in most of Europe except its northern and north-eastern parts, in Asia it is rare in Siberia but more frequent in south-western, southern and south-eastern Asia eastwards as far as the Russian Far East and Japan and southwards through islands as far as Australia. It also occurs in most of North America, extending south to Colombia, Ecuador and Peru in South America. In Africa it is found in its northernmost, central and southern parts (Hultén & Fries 1986, Landolt 1986, Crawford et al. 2006). In the Czech Republic *S. polyrhiza* grows in ponds and small concrete reservoirs in villages, in fishponds, fish storage ponds, alluvial pools, oxbow lakes, drainage ditches, sometimes also in flooded sand-pits and along banks of slowly flowing lowland rivers. It mostly occurs in eutrophic to hypertrophic water above a thick layer of sapropelic mud or organic silt on the bottom. It tolerates eutrophication and organic pollution (Šumberová 2011g). It is most frequent at middle altitudes, particularly in Bohemia and in the Českomoravská vrchovina highlands, while in the warm and dry lowlands it is restricted to river floodplains. It is rare in or locally absent from the mountains, dry areas with base-rich to saline soils and from most of Moravia, where suitable habitats are missing.

Symphytum asperum (Fig. 74)

Symphytum asperum is probably native to the Caucasus and Anatolia or to adjacent regions (Bucknall 1913, Kurtto 1982). It has become widely naturalized all over Europe (Pawłowski 1972, Smejkal 1978, Hultén & Fries 1986), in North America (Gadella 1984) and Japan (Fedorov 2001), mainly as a nectar-bearing and forage plant. The earliest records from the Czech Republic date back to the second half of the 19th century when it was grown mainly as livestock fodder (Smejkal 1978). Since then it has escaped several times and became locally naturalized (Pyšek et al. 2012). The records of *S. asperum* are scattered throughout Bohemia, mainly in the surroundings of the towns of Klatovy, Strakonice and Prachatice. The species was collected in ruderal grasslands in settlements, parks, castle gardens, railway stations, and along roads and railways. In the Czech Republic it was recorded particularly in the 1970s, and there have been only two finds since 2000. The map is based solely on revised herbarium specimens because some literature records may be wrong, based on misidentifications of *S. officinale* or *S.* ×*uplandicum*.

Symphytum bohemicum (Fig. 75)

Symphytum bohemicum is a diploid member of the *S. officinale* group. It is quite well defined morphologically by its greenish or yellowish white flowers and only shortly decurrent leaves. It was described from central Bohemia by F. W. Schmidt as early as the late 18th century (Kirschner et al. 2007). Further records of the diploid white-flowered "*S. officinale*" that we consider to be *S. bohemicum* are from eastern England, the Netherlands, Germany, southern Poland, south-eastern Slovakia, northern Hungary, south-western Slovenia and northern Italy (Gadella & Kliphuis 1969, 1972, Májovský &

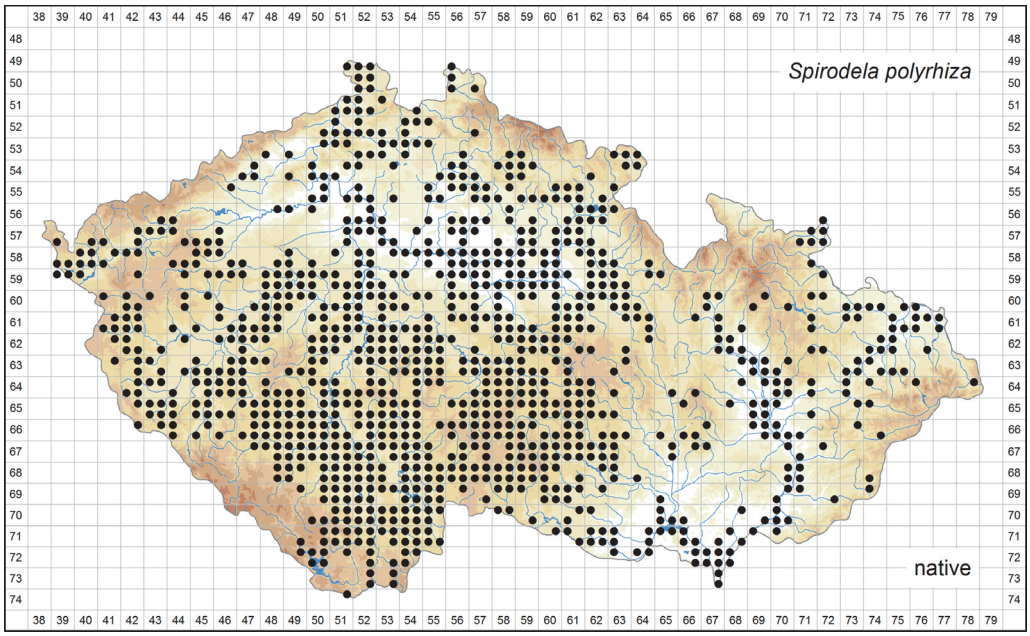


Fig. 73. – Distribution of *Spirodela polyrhiza* in the Czech Republic (1055 occupied quadrants). Prepared by Zdeněk Kaplan.

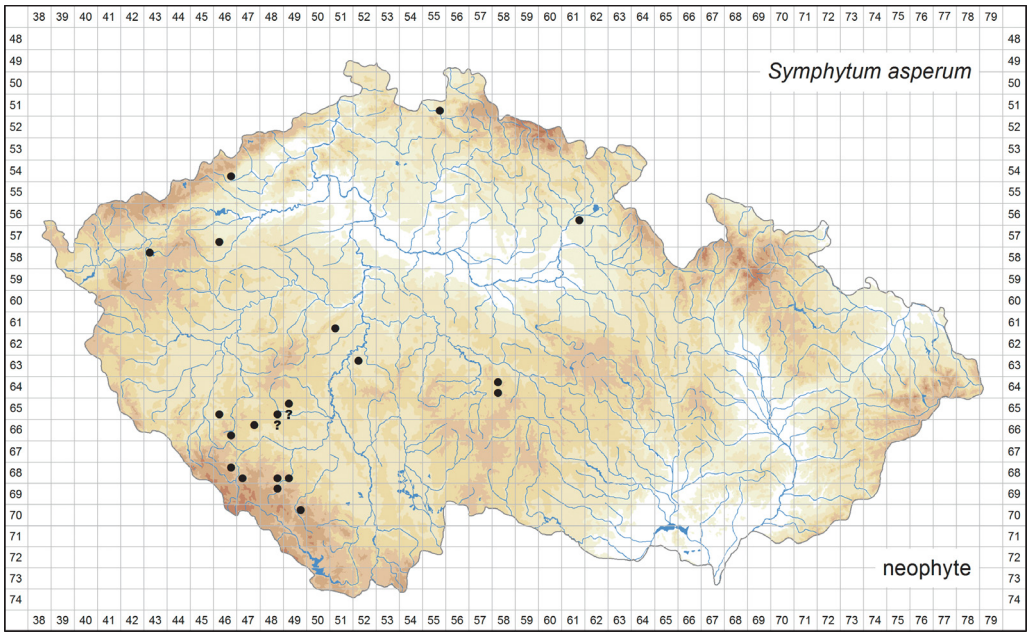


Fig. 74. – Distribution of *Symphytum asperum* in the Czech Republic (20 occupied quadrants). Prepared by Lucie Kobrlová & Michal Hroneš.

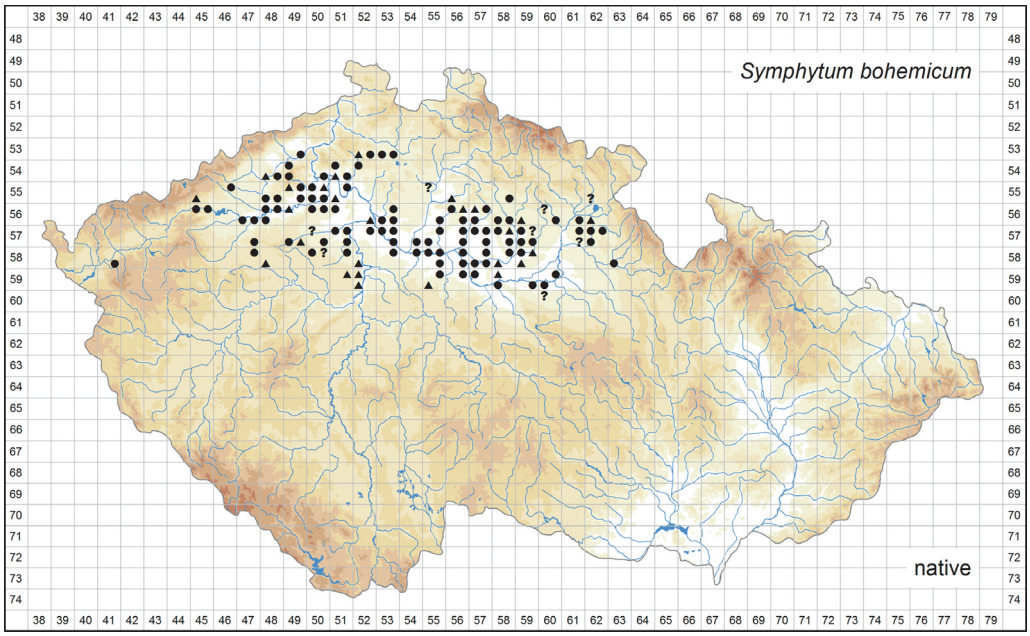


Fig. 75. – Distribution of *Symphytum bohemicum* in the Czech Republic: ● occurrence documented by herbarium specimens (94 quadrants), ▲ occurrence based on other records (26 quadrants). Prepared by Lucie Kobrlová & Michal Hroneš.

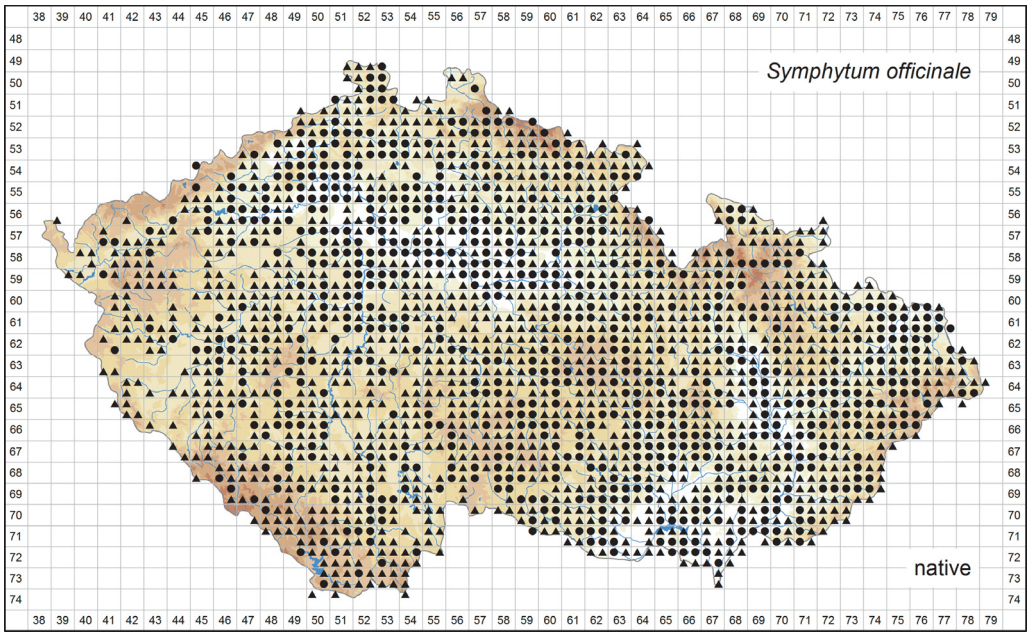


Fig. 76. – Distribution of *Symphytum officinale* in the Czech Republic: ● occurrence documented by herbarium specimens (714 quadrants), ▲ occurrence based on other records (1317 quadrants). Prepared by Lucie Kobrlová & Michal Hroneš.

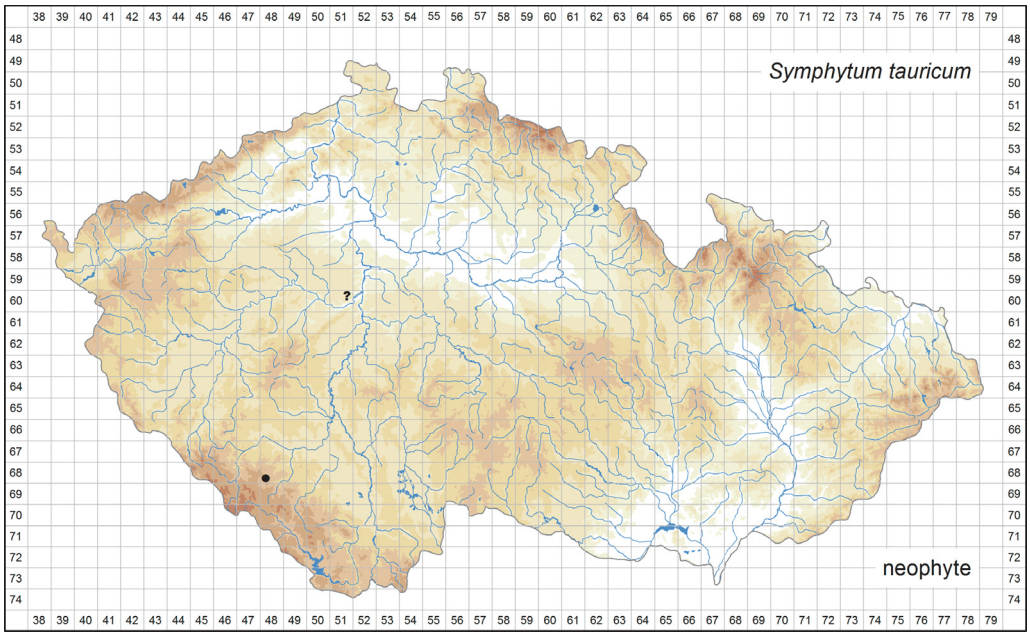


Fig. 77. – Distribution of *Symphytum tauricum* in the Czech Republic (1 occupied quadrant). Prepared by Lucie Kobrlová & Michal Hroneš.

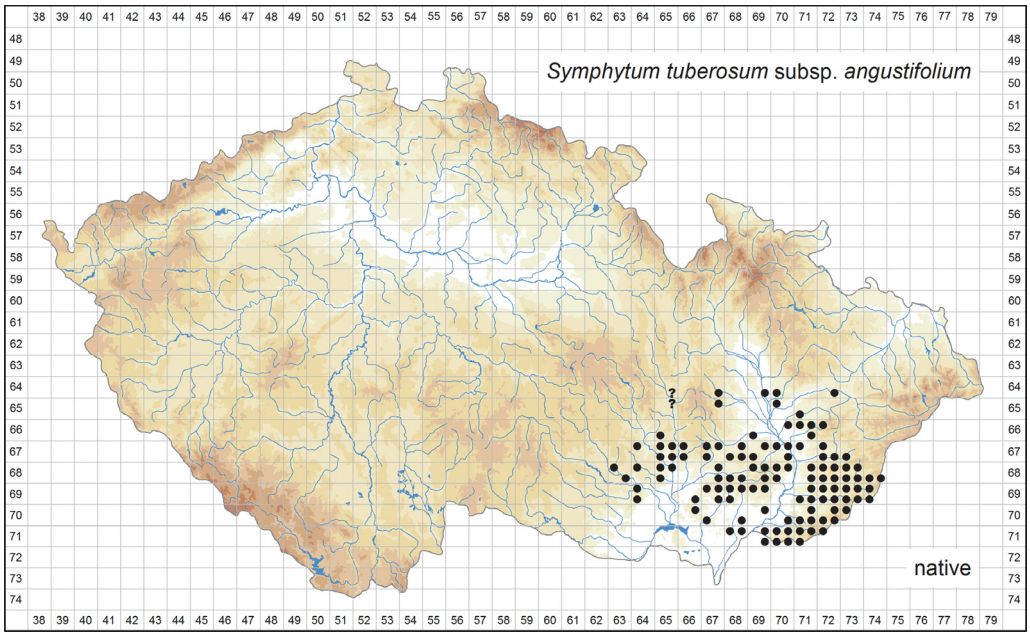


Fig. 78. – Distribution of *Symphytum tuberosum* subsp. *angustifolium* in the Czech Republic (113 occupied quadrants). Prepared by Lucie Kobrlová & Michal Hroneš.

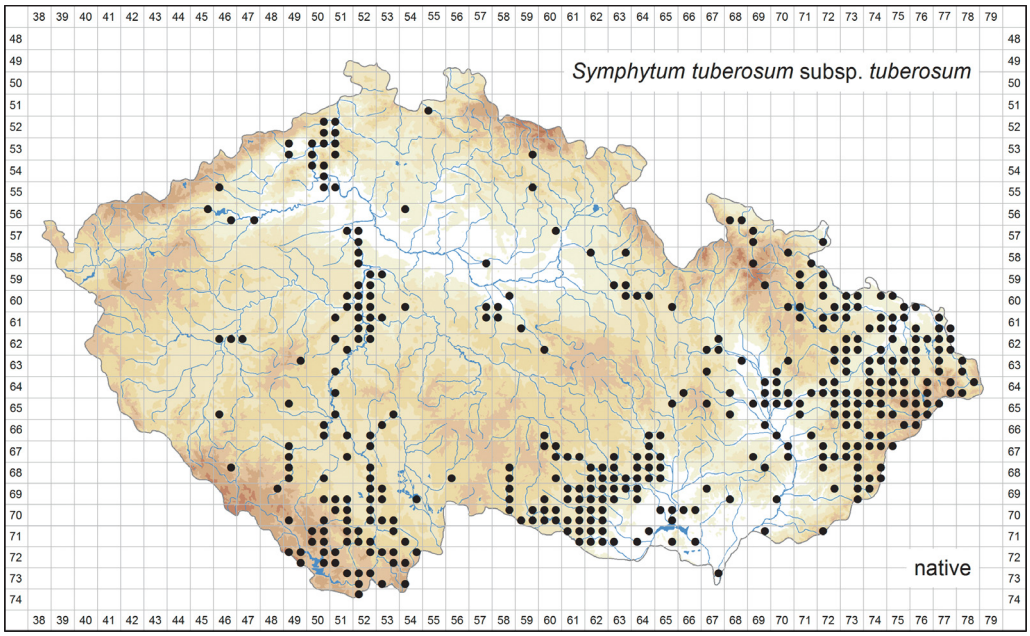


Fig. 79. – Distribution of *Symphytum tuberosum* subsp. *tuberosum* in the Czech Republic (389 occupied quadrants). Prepared by Lucie Kobrlová & Michal Hroneš.

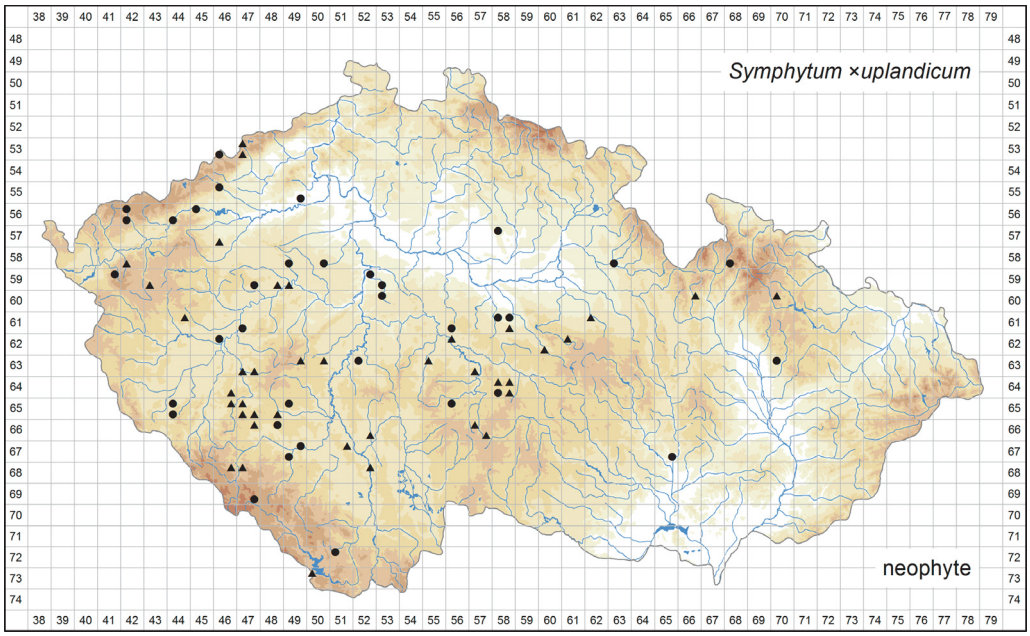


Fig. 80. – Distribution of *Symphytum ×uplandicum* in the Czech Republic: ● occurrence documented by herbarium specimens (35 quadrants), ▲ occurrence based on other records (39 quadrants). Prepared by Lucie Kobrlová & Michal Hroneš.

Hegedüšová 1993, Jogan et al. 2001, Stace 2010). Even so, *S. bohemicum* remains neglected in most national floras despite its morphological distinctiveness and strong reproductive isolation from *S. officinale* (Gadella & Kliphuis 1969, 1972). In the Czech Republic *S. bohemicum* is found in calcareous fens in the lowlands along the middle and lower stretches of the Labe, Ohře, Metuje and Cidlina rivers in eastern, central and northern Bohemia. The species is classified as endangered (Grulich 2012).

Symphytum officinale (Fig. 76)

This species is widespread and somewhat difficult taxonomically. Several cytotypes have been reported (e.g. Gadella & Kliphuis 1969, 1972, Gadella 1972), mainly diploids (2n = 24), hypotetraploids (2n = 40) and tetraploids (2n = 48). In our opinion, only the tetraploid populations should be considered as *S. officinale*, whereas diploid populations correspond to *S. bohemicum* and hypotetraploids to *S. tanaicense* (syn. *S. officinale* subsp. *uliginosum*; Gadella & Kliphuis 1969, Májovský & Hegedüšová 1993). *Symphytum officinale* s. str. is distributed almost throughout the whole of Europe (Hultén & Fries 1986). It was introduced to China (Zhu et al. 1995) and North America (Gadella 1984), mostly as green forage for livestock and due to its use in traditional medicine. It grows on wet meadows, along rivers and in humid ruderal habitats such as damp ditches or road edges. In the Czech Republic it is common from the lowlands to the mountains, being less frequent or under-recorded only in western Bohemia.

Symphytum tauricum (Fig. 77)

Symphytum tauricum is native around the Black Sea, i.e. in southern Ukraine, southern European Russia, Anatolia, Romania and Bulgaria (Smejkal 1978, Wickens 1978, Fedorov 2001). In the Czech Republic the occurrence of *S. tauricum* was first reported by Smejkal (1978), based on a herbarium specimen collected in the town of Černošice near Prague in 1912. On the sheet one specimen of *S. tauricum* is mounted together with three specimens of *S. tuberosum* subsp. *tuberosum*. Unfortunately, it is not clear whether these plants originated from cultivation or not. They also may have been mixed accidentally in herbaria. In the 1980s, *S. tauricum* was repeatedly recorded from the vicinity of villages Miřetice and Ptákova Lhota in south-western Bohemia where it was found on garden waste and road verge. It is not clear if it was only an ephemeral occurrence or if it still grows on any of these localities.

Symphytum tuberosum subsp. *angustifolium* (Fig. 78)

The taxonomy of *Symphytum tuberosum* in central Europe was revised recently by Kobrlová et al. (2016). They showed that two subspecies of *S. tuberosum* occur in the Czech Republic. The taxonomy within this group is quite intricate, especially due to the occurrence of high polyploids and considerable morphological variability. In its broad circumscription, *S. tuberosum* is distributed all over Europe except for Scandinavia, the Netherlands, Belgium, north-western Germany, southernmost Spain and Portugal (Bucknall 1913, Murín & Májovský 1982). *Symphytum tuberosum* subsp. *angustifolium* is tetraploid (2n = 32), and has an obvious affinity to the Pannonian basin (Kobrlová et al. 2016). Until recently, this taxon was known only from northern Hungary and the southern

part of Slovakia (Májovský & Hegedüšová 1993, Marhold & Hindák 1998, both as *S. angustifolium*), but it has been omitted from flora accounts of the former country. It was recently discovered in south-eastern Moravia in the Czech Republic and confirmed for northern Hungary (Kobrlová et al. 2016). In comparison with the type subspecies, *S. tuberosum* subsp. *angustifolium* is more thermophilous, occurring mainly in the lowlands. It occurs rarely at higher altitudes, reaching them through warmer valleys. It grows in drier habitats than the type subspecies, such as thermophilous broad-leaved forests and semi-dry grasslands. In the Czech Republic it is confined to the westernmost Carpathians in south-eastern Moravia, mainly to the Bílé Karpaty Mts, Litenčické vrchy hills, Chřiby hills and Ždánický les hills. Its northern distribution limit runs through central Moravia, its western limit west of the city of Brno. The map is based only on revised herbarium specimens and our own field records as no earlier records exist.

Symphytum tuberosum subsp. *tuberosum* (Fig. 79)

Symphytum tuberosum subsp. *tuberosum* is dodecaploid (2n = 96) and it is the most widespread member of the *S. tuberosum* group (Kobrlová et al. 2016). In central Europe it is found in Austria, Germany (mostly in the south and along the lower stretches of the Elbe river), southern Poland, northern Slovakia, and in southern and western Hungary (Kobrlová et al. 2016). In the Czech Republic *S. tuberosum* subsp. *tuberosum* prefers shady, moist and also nutrient-rich habitats. It inhabits the banks of rivers or streams, forests in deep river valleys, the fringes of wet meadows, alder carrs, and alluvial, ravine and mesophilous forests. It was also recorded from ruderal or disturbed places (e.g. roadsides and abandoned wet meadows) and parks. It occurs mainly in southern and central Bohemia and in northern Moravia and Silesia. The distribution map is based solely on revised herbarium specimens and our own field records.

Symphytum ×*uplandicum* (Fig. 80)

Symphytum ×*uplandicum* is a hybrid with the assumed parentage of *S. officinale* and *S. asperum*. Its origin is unclear but it was first reported from Sweden and Great Britain in the first half the 19th century and afterwards introduced as a forage plant to large parts of western and central Europe (Bucknall 1913, Gadella 1972, Gadella et al. 1983) and also become naturalized in North America (Gadella 1984). It is a quite robust plant with greater biomass production than the parental *S. asperum*, therefore favoured in cultivation (Smejkal 1978). Since its escape from cultivation, natural backcross hybrids with both parents have been found repeatedly (Gadella & Kliphuis 1969, Gadella 1972). In the Czech Republic *S.* ×*uplandicum* was cultivated mainly in the late 19th and early 20th centuries (Smejkal 1978). It was found mainly in ruderal places, parks, urban grasslands, roadsides or railways. The records of *S.* ×*uplandicum* are scattered throughout Bohemia, while only 5 records exist from Moravia. Some finds are related to the occurrence of *S. asperum* (see Fig. 74) as one of the parental species.

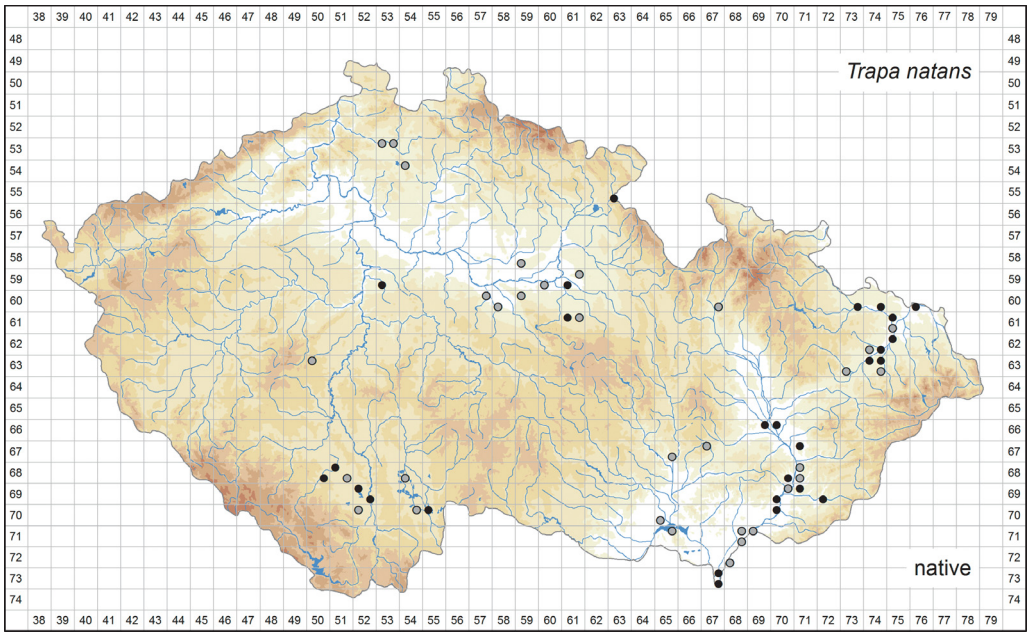


Fig. 81. – Distribution of *Trapa natans* in the Czech Republic: ● at least one record in 2000–2016 (27 quadrants), ● pre 2000 records only (31 quadrants). Prepared by Zdeněk Kaplan.

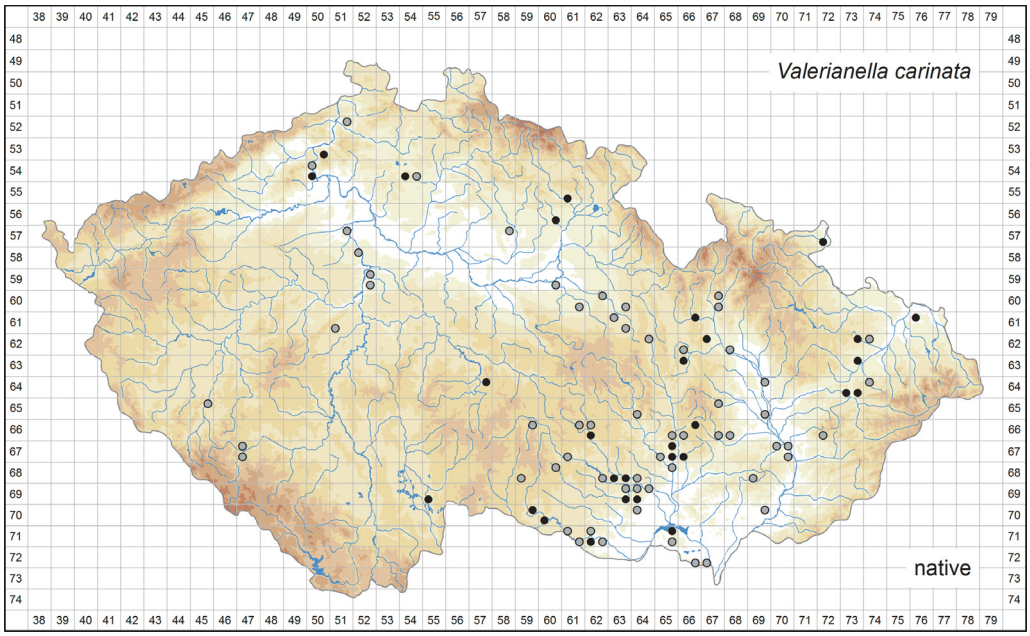


Fig. 82. – Distribution of *Valerianella carinata* in the Czech Republic: ● at least one record in 2000–2016 (29 quadrants), ● pre 2000 records only (60 quadrants). Prepared by Jiří Danihelka & Zdeněk Kaplan.

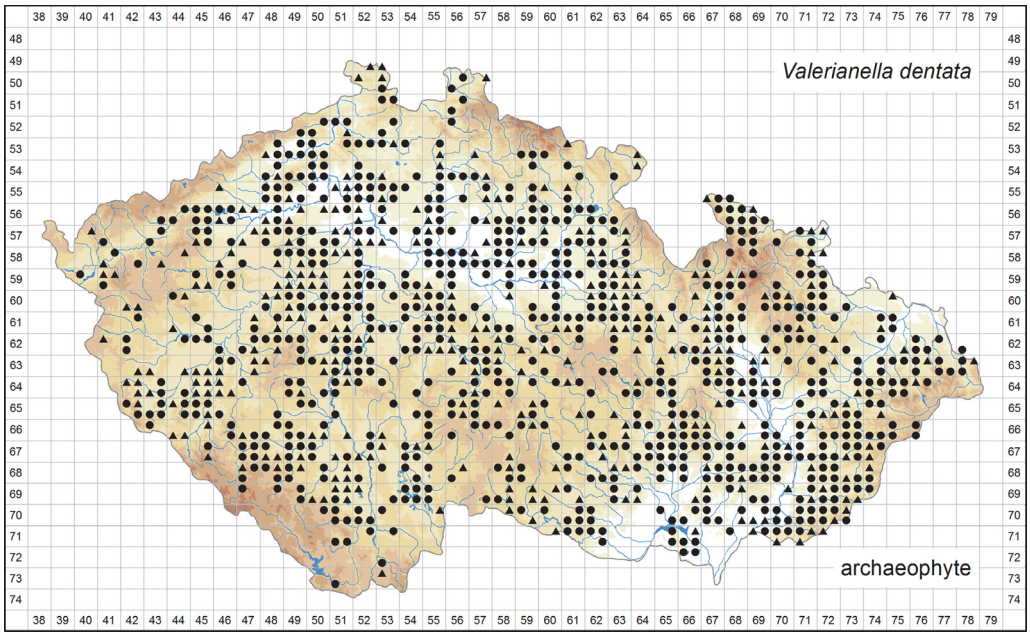


Fig. 83. – Distribution of *Valerianella dentata* in the Czech Republic: ● occurrence documented by herbarium specimens (755 quadrants), ▲ occurrence based on other records (329 quadrants). Prepared by Jiří Danihelka & Zdeněk Kaplan.

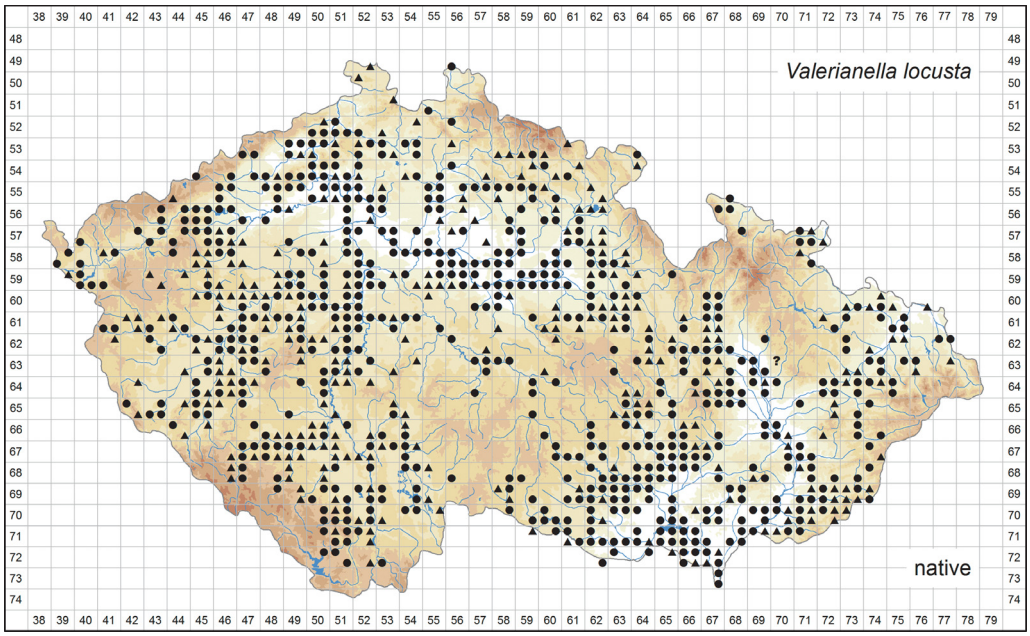


Fig. 84. – Distribution of *Valerianella locusta* in the Czech Republic: ● occurrence documented by herbarium specimens (598 quadrants), ▲ occurrence based on other records (294 quadrants). Prepared by Jiří Danihelka & Zdeněk Kaplan.

Trapa natans (Fig. 81)

Trapa natans is most frequent in central Europe, westwards to France and Spain, northwards to southern Sweden and southern Finland, eastwards to central European Russia and southwards to Greece. It also occurs in southern and eastern Africa and has been introduced to North America and Australia. It is also recorded from Siberia and southern and south-eastern Asia but these records are uncertain because of taxonomic difficulties and unclear delimitation from similar taxa (Meusel et al. 1965, Hultén & Fries 1986). In the Czech Republic *T. natans* occurs in oxbow lakes and fishponds with eutrophic water on clayey or loamy substrates, often covered with a thick layer of organic silt (Šumberová 2011f). As a thermophilous species it is mainly found at low elevations, particularly in southern and eastern Bohemia and in the warm lowlands of Moravia. *Trapa natans* is known to have been planted, at first because of the edible seeds, later because of the decorative foliage (Štěpán 1925, Hejný 1944). Some of the current populations may therefore be remnants of former introductions outside the natural distribution of the species. At several sites, such as in Prague, near the town of Náchod in eastern Bohemia and near the village of Popovice in southern Moravia, *T. natans* has been demonstrably planted only recently. By contrast, it has vanished from many of its former sites, particularly due to fish-farming intensification and habitat destruction. The native populations are therefore classified as critically endangered (Grulich 2012).

Valerianella carinata (Fig. 82)

Valerianella carinata occurs in western, central and southern Europe, extending eastwards to the Black Sea areas and the Caucasus Mts, and also found in the western part of northernmost Africa (Meusel & Jäger 1992). In the Czech Republic it is native to open dry grasslands, and it only rarely occurs in secondary habitats such as arable land and railway stations. It is mainly found in south-western Moravia, with scattered occurrences in central and north-eastern Moravia, elsewhere being scarce. It always used to be rare in Bohemia, documented mainly from its northern, central and eastern parts. It has declined and has been recorded at fewer than a dozen sites in Bohemia and fewer than two dozen in Moravia since 2000 and is therefore classified as endangered (Grulich 2012). Because of frequent confusions of *V. carinata* and *V. locusta*, the distribution map of the former, which is much the rarer of the two, is based solely on revised herbarium specimens.

Valerianella dentata (Fig. 83)

Valerianella dentata is found in Europe northwards to southern Sweden and southern Finland, eastwards to Ukraine, the Caucasus Mts and in several isolated occurrences as far as central Asia and the Himalayas, and it also occurs in northernmost Africa (Hultén & Fries 1986, Meusel & Jäger 1992). It includes two forms, with glabrous or hairy fruit, often classified as subsp. *dentata* and subsp. *eriosperma*, respectively. The latter is more frequent than the former in western and southern Europe, whereas *V. d.* subsp. *dentata* is more common in central and northern Europe. In the Czech Republic both taxa are present. They are almost confined to arable land, occurring mainly in cereal fields; *V. d.* subsp. *eriosperma* is sometimes found also in bare places in dry grasslands. *Valerianella dentata* used to be widespread throughout the country, particularly in the past, being

absent from or only rarely introduced to high elevations in the mountains. Many of the gaps in the lower elevations indicate under-recording, particularly in the past, rather than true absences. Of the two infraspecific taxa, *V. d.* subsp. *dentata* is more frequent and is found in all areas where the species has been recorded whereas *V. d.* subsp. *eriosperma* is almost confined to warm and dry areas of the country. *Valerianella dentata* has declined during the past 50 years because of the use of herbicides and is classified as vulnerable (subsp. *eriosperma*) or lower risk – near threatened (subsp. *dentata*) in the Czech Red List (Grulich 2012).

Valerianella locusta (Fig. 84)

Valerianella locusta is found in most of Europe except its northern and north-eastern parts. It also occurs in northernmost Africa and south-western Asia, and has been introduced to North and South America, Australia and New Zealand (Hultén & Fries 1986). In some regions it is grown as a leaf vegetable (corn salad). In the Czech Republic *V. locusta* primarily grows in bare places in dry grasslands and meadows. It also used to be common as a weed on arable land; however, it has declined there because of the use of herbicides. At present it is most frequent along railway tracks and in railway stations and yards, where it may even have spread recently. It is widespread in the lowlands and at middle altitudes throughout the country, rarely being introduced up to the mountains. Its apparent absence in much of the Českomoravská vrchovina highlands, as well as the gaps elsewhere, particularly in the lowlands, may be due to under-recording.

Valerianella rimosa (Fig. 85)

Valerianella rimosa is distributed in western, central and southern Europe, northwards to southern Scandinavia, eastwards to Belarus, western and southern Ukraine and the Caucasus Mts, and extending southwards to northernmost Africa (Hultén & Fries 1986). In the Czech Republic it occurs as a weed in cereal fields, usually on base-rich soils. It used to be scattered in the lowlands and adjacent areas, and locally also in western and southern Bohemia and in highlands of eastern Moravia. In the second half of the 20th century it declined considerably due to the use of herbicides. Since 2000 it has been recorded at slightly more than a dozen sites and is therefore classified as critically threatened (Grulich 2012). It is sometimes confused with other *Valerianella* species, mainly *V. dentata*. For this reason, the distribution map of *V. rimosa* is based only on revised herbarium specimens. Because earlier literature records have been omitted, the species may have been more widespread in the past than the map indicates.

Wolffia arrhiza (Fig. 86)

Wolffia arrhiza occurs in temperate, subtropical and tropical regions of Europe, western and central-southern Asia, northernmost, central and southern Africa and eastern Brazil; in Europe it is generally rare and it is absent from its northern and north-eastern parts (Landolt 1986, 1994, Crawford et al. 2006). In the Czech Republic *W. arrhiza* grows in shallow alluvial pools, oxbow lakes and drainage ditches, almost exclusively in large river floodplains. It occurs in eutrophic water on clayey or loamy substrates, often covered with a thick layer of sapropelic mud and well supplied with nutrients including

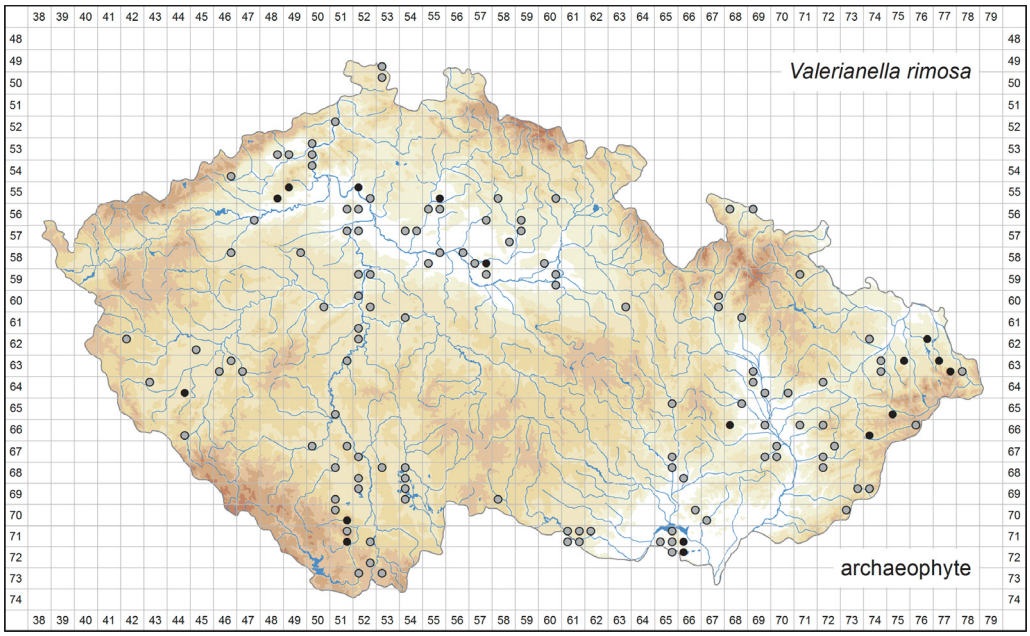


Fig. 85. – Distribution of *Valerianella rimosa* in the Czech Republic: ● at least one record in 2000–2016 (17 quadrants), ◍ pre 2000 records only (116 quadrants). Prepared by Jiří Danihelka & Zdeněk Kaplan.

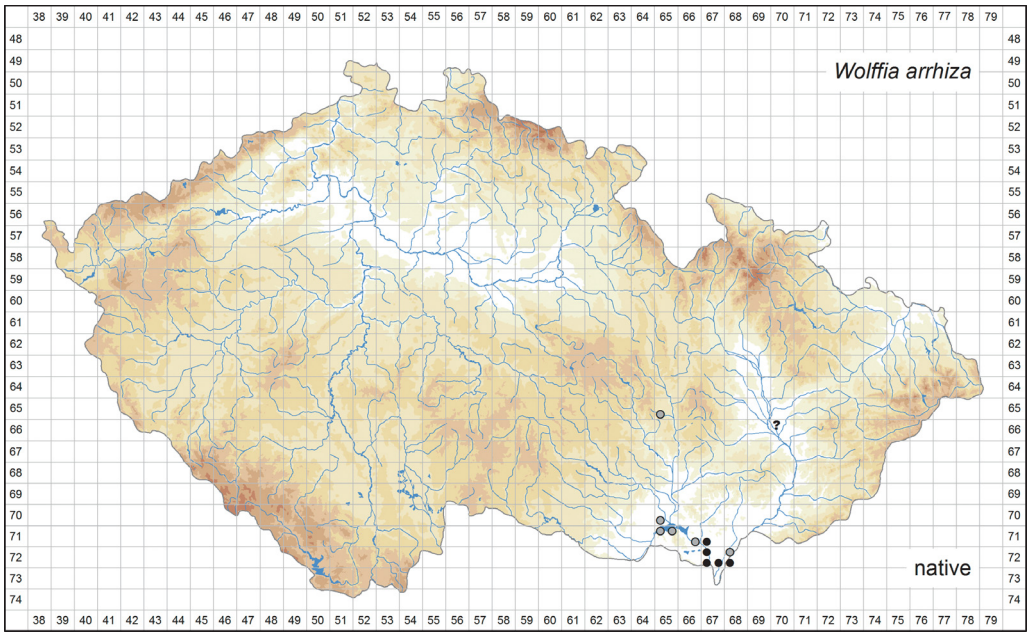


Fig. 86. – Distribution of *Wolffia arrhiza* in the Czech Republic: ● at least one record in 2000–2016 (1 quadrant), ◍ pre 2000 records only (5 quadrants). Prepared by Zdeněk Kaplan.

nitrogen, phosphorus and chlorides (Šumberová 2011g). It is intolerant of low temperatures and is therefore confined to the warmest lowlands. It was recorded at several sites in the lower stretches of the Dyje and Morava rivers in southernmost Moravia and only once in the town of Černá Hora north of Brno. *Wolffia arrhiza* is both rare and declining due to habitat destruction, water pollution and changes in water regime and is therefore classified as critically endangered (Grulich 2012).

See www.preslia.cz for Electronic Appendices 1–105

Acknowledgements

We are grateful to all who made this study possible and helped us in any way. Field botanists collected distribution records and plant specimens for herbaria, which served as a basis for the distribution maps. Curators of the herbaria visited allowed us to study their specimens and collect records. Administrators of the integrated databases, particularly Jan Štěpánek, Milan Chytrý, Dana Michalcová and Karel Chobot as representatives of the major ones, agreed to share plant distribution records. Martin Dančák, Přemysl Tájek, Michal Ducháček, Zdeněk Špíšek and Karel Kubát contributed records for the maps. Regional collaborators, particularly Jan Doležal, Kateřina Šumberová, Luděk Čech, Michal Ducháček, Petr Koutecký, Jan Blahovec, Jan Košnar, David Hlisnikovský, Radim Paulič, Petr Kocián, Jiří Juřička, Hana Galušková, Zuzana Mruzíková, Jana Janáková, Daniel Koutecký, Tomáš Svačina, Karel Fajmon, Rudolf Hlaváček, Radek Štencl, Vít Grulich, Pavel Lustyk, Josef Komárek, Jiří Velebil, Marta Knauerová, Petr Petřík, Jiří Brabec, Petra Juřáková, Věra Samková, Martin Dančák, Martin Duchoslav, Karel Boublík, Michal Štefánek, Linda Trunečková, Otakar Šída and Lenka Pivoňková, commented on early versions of maps and/or provided additional records from their areas. Anna Daňková, Josef Brůna, Petr Filippov, Hana Galušková, Ondřej Hornych, Klára Kabátová, Anna Kladivová, Adam Knotek, Ludmila Mikovcová, Helena Prokešová, Lucie Rejchrtová, Petra Štěpánková, Kristýna Vazačová, Jan Wild and Radek Ziegler georeferenced distribution records, computerized data, helped with the preparation of maps or provided other technical assistance. Programmers Petr Novotný and Martin Rohn produced the Pladias database and an internet-accessible mapping interface. Christopher D. Preston and Kateřina Šumberová carefully read the manuscript and suggested numerous valuable improvements. The research was supported by the Centre of Excellence PLADIAS, project no. 14-36079G from the Czech Science Foundation. ZK, JD, ML, LE, JC, JP and VŠ were also supported by the long-term research development project no. RVO 67985939 from the Academy of Sciences of the Czech Republic, JP by the institutional resources of Ministry of Education, Youth and Sports of the Czech Republic for the support of science and research, and LK and MH by the project no. IGA PrF-2016-001 from the Internal Grant Agency of the Palacký University.

Souhrn

Třetí část ze série publikací věnovaných rozšíření cévnatých rostlin v České republice obsahuje síťové mapy a doprovodné komentáře ke 105 taxonům z rodů *Acorus*, *Amelanchier*, *Asplenium*, *Calla*, *Cerastium*, *Ceratophyllum*, *Eichhornia*, *Hieracium*, *Hippuris*, *Hottonia*, *Lemna*, *Limosella*, *Peplis*, *Pistia*, *Pontederia*, *Sorbus*, *Spirodela*, *Symphytum*, *Trapa*, *Valerianella* a *Wolffia*. Základem jsou údaje získané excerpcí herbářů a literatury, terénní zápisy a nálezy dostupné v databázích, které prověřili taxonomičtí experti. Tři ze zpracovávaných rodů obsahují české endemity, které se zpravidla vyskytují na velmi omezeném území, jejich populace jsou často chudé, a zasluhují proto největší pozornost ochrany přírody. Endemické jestřábníky (rod *Hieracium*) se většinou vyskytují v subalpínském stupni Krkonoš, Králického Sněžníku a Hrubého Jeseníku. Naproti tomu většina endemických jeřábů (rod *Sorbus*) roste především ve světlých lesích nebo na skalnatých stráních v teplejších územích středních a severních Čech a jižní Moravy. *Cerastium alsinifolium* je endemit hadcových výchozů u Mariánských Lázní. Další ekologicky specializovanou skupinou jsou sleziníky (rod *Asplenium*), z nichž některé se nacházejí jen na omezeném spektru substrátů (např. silikátové horniny, vápence, čediče nebo hadce), což se odráží i v jejich rozšíření. Mezi mapovanými rostlinami je 53 taxonů zařazených do červeného seznamu, z nichž mnohé velmi ustoupily. *Symphytum bohemicum* roste hlavně ve střední Evropě a u nás se vyskytuje zejména na slatinných loukách v nivách větších řek. Mnoho ohrožených druhů je také mezi vodními rostlinami, které ustupují zejména v důsledku intenzifikace hospodaření v rybnících, eutrofizace a přímého ničení lokalit. Původní populace některých dekorativních vodních rostlin, jako jsou *Hippuris vulgaris* a *Trapa*

natans, mizí a místo nich se v krajině objevují vysazené rostliny neznámého původu, často zakoupené v zahradnických velkoprodejnách. Takové výsadby mohou způsobit genetickou erozi našich původních populací. Atraktivní vzhled je příčinou stále častější výsadby i nepůvodních okrasných druhů, zejména *Eichhornia crassipes*, *Pistia stratiotes* a *Pontederia cordata*. Všechny tři byly u nás zaznamenány jako vysazené do přírody během posledních 25 let, poté co se objevily ve specializovaných obchodech. Naproti tomu okřehek *Lemna turionifera* k nám byl zavlečen a dále rozšířen vodními ptáky a dnes se již nachází téměř po celém území státu. Popis zavlečení a šíření je uveden i u dnes zdomácnělého a velmi rozšířeného puškvorce *Acorus calamus* a zavlečených druhů rodů muchovník (*Amelanchier*) a kostival (*Symphytum*). Celkový obraz rozšíření jednotlivých zpracovávaných taxonů poskytují mapy; konkrétní floristické údaje odrážející odlišné trendy v různých oblastech a v různých obdobích jsou uloženy v databázi Pladias a dostupné v elektronických přílohách. Každou mapu doprovází textový komentář, který obsahuje nástin celkového rozšíření, výčet nejčastějších stanovišť a stručnou charakteristiku rozšíření v České republice, případně i doplňující informace k taxonomii, biologii, změnám v rozšíření a míře ohrožení.

References

Aldasoro J. J., Aedo C., Garmendia F. M., de la Hoz F. P. & Navarro C. (2004): Revision of *Sorbus* subgenera *Aria* and *Torminaria* (*Rosaceae-Maloideae*). – Syst. Bot. Monogr. 69: 1–148.

Amarell U. & Welk E. (1995): *Amelanchier alnifolia* (Nutt.) Nutt.: ein unbeachteter Neophyt in Mitteldeutschland. – Mitt. Flor. Kart. Halle 20: 21–23.

Balbinus B. (1679): Miscellanea historica regni Bohemiae. Vol. 1. – Pragae.

Barrett S. C. H. (1988): Evolution of breeding systems in *Eichhornia* (*Pontederiaceae*): a review. – Ann. Missouri Bot. Gard. 75: 741–760.

Barrett S. C. H. & Forno I. W. (1982): Style morph distribution in New World populations of *Eichhornia crassipes* (Mart.) Solms-Laubach (water hyacinth). – Aquat. Bot. 13: 299–306.

Bennert H. W. & Fischer G. (1993): Biosystematics and evolution of the *Asplenium trichomanes* complex. – Webbia 48: 743–760.

Blažková D. (1971): Charakter severní hranice rozšíření kyvoru lékařského, *Ceterach officinarum* DC. [Character of the northern distribution limit of *Ceterach officinarum* DC.]. – Preslia 43: 112–119.

Bräutigam S. (1992): *Hieracium* L. – In: Meusel H. & Jäger E. J. (eds), Vergleichende Chorologie der zentraleuropäischen Flora 3: 325–333, 550–560, Gustav Fischer, Jena, Stuttgart & New York.

Bucknall C. (1913): A revision of the genus *Symphytum* Tourn. – J. Linn. Soc. Lond. Bot. 41: 491–556.

Chrtek J. jun. (1995): Notes on *Hieracium alpinum* and *Hieracium nigrescens* (section *Alpina* Fries) in the Eastern Sudeten (Mt Králický Sněžník, the Hrubý Jeseník Mts.). – Preslia 67: 97–106.

Chrtek J. jun. (1997): Taxonomy of the *Hieracium alpinum* group in the Sudeten Mts., the West and the Ukrainian East Carpathians. – Folia Geobot. Phytotax. 32: 69–97.

Chrtek J. jun. (2004): *Hieracium* L. – jestřábník. – In: Slavík B., Štěpánková J. & Štěpánek J. (eds), Květena České republiky [Flora of the Czech Republic] 7: 540–701, Academia, Praha.

Chrtek J. jun., Szeląg Z., Mráz P. & Severa M. (2002): *Hieracium silesiacum* Krause [*Hieracium sparsum* subsp. *silesiacum* (Krause) Zahn] v Západních Karpatech [*Hieracium silesiacum* (*Hieracium sparsum* subsp. *silesiacum*) in the Western Carpathians]. – Bull. Slov. Bot. Spoloč. 24: 81–90.

Chrtek J. Jr., Tonková M., Mráz P., Marhold K., Plačková I., Krahulcová A. & Kirschner J. (2007): Morphological and allozyme diversity in the *Hieracium nigrescens* group (*Compositae*) in the Sudety mountains and the Western Carpathians. – Bot. J. Linn. Soc. 153: 287–300.

Clement E. J. & Foster M. C. (1994): Alien plants of the British Isles. A provisional catalogue of vascular plants (excluding grasses). – Botanical Society of the British Isles, London.

Crawford D. J., Landolt E., Les D. H. & Kimball R. T. (2006): Speciation in duckweeds (*Lemnaceae*): phylogenetic and ecological inferences. – Aliso 22: 231–242.

Czerny J. (1517): Knieha lekarska kteraz slowe herbarz aneb zelinarz... [The medicinal book that is called herbarium…]. – M. Klaudyan, Norimberg.

Danihelka J., Chrtek J. jun. & Kaplan Z. (2012): Checklist of vascular plants of the Czech Republic. – Preslia 84: 647–811.

DAISIE (2016a): Species Factsheet. *Lemna turionifera*. – In: Delivering Alien Invasive Species Inventories for Europe, URL: http://www.europe-aliens.org/speciesFactsheet.do?speciesId=706 (accessed 18 August 2016).

DAISIE (2016b): Species Factsheet. *Pontederia cordata*. – In: Delivering Alien Invasive Species Inventories for Europe, URL: http://www.europe-aliens.org/speciesFactsheet.do?speciesId=5419 (accessed 18 August 2016).

Ekrt L. (2008a): Revize rozšíření sleziníku střídavolistého (*Asplenium ×alternifolium*) v České republice [Revision of distribution of *Asplenium ×alternifolium* in the Czech Republic]. – Zpr. Čes. Bot. Společ. 43: 231–250.

Ekrt L. (2008b): Rozšíření a problematika taxonů skupiny *Asplenium trichomanes* v České republice [Distribution and problematics of taxa of the *Asplenium trichomanes* group in the Czech Republic]. – Zpr. Čes. Bot. Společ. 43: 17–65.

Ekrt L. & Štech M. (2008): A morphometric study and revision of the *Asplenium trichomanes* group in the Czech Republic. – Preslia 80: 325–347.

Emmott J. I. (1964): A cytogenetic investigation in a *Phyllitis-Asplenium* complex. – New Phytol. 63: 306–318.

Fedorov A. A. (ed.) (2001): Flora of Russia: the European part and bordering regions. Vol. 5. – A. A. Balkema, Rotterdam.

Gadella T. W. J. (1972): Cytological and hybridization studies in the genus *Symphytum*. – In: Vida G. (ed.), Evolution in plants 12: 189–199, Symposia Biologica Hungarica, Akadémiai Kiadó, Budapest.

Gadella T. W. J. (1984): Notes on *Symphytum* (*Boraginaceae*) in North America. – Ann. Missouri Bot. Gard. 71: 1061–1067.

Gadella T. W. J. & Kliphuis E. (1969): Cytotaxonomic studies in the genus *Symphytum* II. Crossing experiments between *Symphytum officinale* L. and *Symphytum asperum* Lepech. – Acta Bot. Neerl. 18: 544–549.

Gadella T. W. J. & Kliphuis E. (1972): Cytotaxonomic studies in the genus *Symphytum* IV. Cytogeographic investigation in *Symphytum officinale* L. – Acta Bot. Neerl. 21: 169–173.

Gadella T. W. J., Kliphuis E. & Huizing H. J. (1983): Cyto- and chemotaxonomical studies on the sections *Officinalia* and *Coerulea* of the genus *Symphytum*. – Bot. Helv. 93: 169–192.

George J.-P., Woodman J., Hampton M., Konrad H. & Geburek T. (2016): True Service-tree (*Sorbus domestica*, *Rosaceae*) in the British Isles: rare but diverse. – New J. Bot. 6: 21–30.

Georges N. & Pax N. (2002): *Pistia stratiotes* L. et *Eichhornia crassipes* (Mart.) Solms, deux nouvelles hydrophytes dans la vallée de la Moselle. – Willemetia 28: 3–4.

Gopal B. (1987): Water hyacinth. – Elsevier, Amsterdam.

Gopal B. & Sharma K. P. (1981): Water-hyacinth (*Eichhornia crassipes*) – most troublesome weed of the world. – Hindasia, Delhi.

Grulich V. (2012): Red List of vascular plants of the Czech Republic: 3rd edition. – Preslia 84: 631–645.

Grundt H. H. & Salvesen P. H. (2011): Kjenn din *Sorbus*, Rogn og asal i Norge [Know your *Sorbus*, rowans and whitebeams in Norway]. – Rapport fra Genressurssenteret ved Skog og landskap 23: 1–104.

Hejný S. (1944): Dnešní stav aklimatisace vzácných vodních rostlin na Vodňansku [Current state of acclimatization of rare aquatic plants in the Vodňany surroundings]. – Věda Přír. 22: 233–235.

Hendrych R. (2003): Původ a výskyt *Acorus calamus* v našich zemích [Origin and occurrence of *Acorus calamus* in our lands]. – Zpr. Čes. Bot. Společ. 38: 95–109.

Holm L., Doll J., Holm E., Pancho J. & Herberger J. (1997): World weeds. Natural histories and distribution. – John Wiley and Sons, New York.

Horn C. N. (2002): *Pontederiaceae*. – In: Flora of North America Editorial Committee (eds), Flora of North America 26: 37–46, Oxford University Press, New York & Oxford.

Howell C. (2008): Consolidated list of environmental weeds in New Zealand. – DOC Research & Development Series 292, Science & Technical Publishing, Department of Conservation, Wellington.

Hultén E. & Fries M. (1986): Atlas of North European vascular plants north of the Tropic of Cancer. Vols 1–3. – Koeltz Scientific Books, Königstein.

Jäger E. J., Ebel F., Hanelt P. & Müller G. K. (eds) (2011): Rothmaler, Exkursionsflora von Deutschland. Vol. 5. Krautige Zier- und Nutzpflanzen. – Spektrum Akademischer Verlag, Heidelberg.

Jalas J. & Suominen J. (1983): Atlas Florae Europaeae. Vol. 6. *Caryophyllaceae* (*Alsinoideae* and *Paronychioideae*). – The Committee for Mapping the Flora of Europe & Societas Biologica Fennica Vanamo, Helsinki.

Jalas J., Wyse Jackson M. B., Sell P. D. & Whitehead F. H. (1993): *Cerastium* L. – In: Tutin T. G., Burges N. A., Chater A. O., Edmondson J. R., Heywood V. H., Moore D. M., Valentine D. H., Walters S. M. & Webb D. A. (eds), Flora Europaea, ed. 2, 1: 164–175, Cambridge University Press, Cambridge.

Jeßen S. (1995): *Asplenium trichomanes* L. subsp. *hastatum*, stat. nov.: eine neue Unterart des Braunstiel-Streifenfarnes in Europa und vier neue intraspezifische Hybriden (*Aspleniaceae*: *Pteridophyta*). – Ber. Bayer. Bot. Ges. 65: 107–132.

Jogan N., Bačič T., Frajman B., Leskovar I., Naglič D., Podobnik A., Rozman B., Strgulc-Krajšek S. & Trčak B. (eds) (2001): Gradivo za atlas flore Slovenije [Materials for the atlas of flora of Slovenia]. – Center za kartografijo favne in flore, Miklavž na Dravskem polju.

Jonsell B., Brysting A. & Karlsson T. (2001): *Cerastium* L. – In: Jonsell B. (ed.), Flora Nordica 2: 135–159, Bergius Foundation, RSAS, Stockholm.

Kaplan Z. (1999): *Lemna turionifera* – nový druh pro květenu České republiky [*Lemna turionifera* – a new species for the Czech Republic]. – Zpr. Čes. Bot. Společ. 34: 135–141.

Kaplan Z. (2002): *Araceae* Juss. – árónovité. – In: Kubát K., Hrouda L., Chrtek J. jun., Kaplan Z., Kirschner J. & Štěpánek J. (eds), Klíč ke květeně České republiky [Key to the flora of the Czech Republic], p. 874–875, Academia, Praha.

Kaplan Z. (2009): *Pontederia cordata* L. – In: Hadinec J. & Lustyk P. (eds), Additamenta ad floram Reipublicae Bohemicae. VIII [Additions to the flora of the Czech Republic. VIII], Zpr. Čes. Bot. Společ. 44: 294–295.

Kaplan Z. (2010): *Lemnaceae* S. F. Gray – okřehkovité. – In: Štěpánková J., Chrtek J. jun. & Kaplan Z. (eds), Květena České republiky [Flora of the Czech Republic] 8: 283–293, Academia, Praha.

Kaplan Z. (2012): Flora and phytogeography of the Czech Republic. – Preslia 84: 505–573.

Kaplan Z., Danihelka J., Štěpánková J., Bureš P., Zázvorka J., Hroudová Z., Ducháček M., Grulich V., Řepka R., Dančák M., Prančl J., Šumberová K., Wild J. & Trávníček B. (2015): Distributions of vascular plants in the Czech Republic. Part 1. – Preslia 87: 417–500.

Kaplan Z., Danihelka J., Štěpánková J., Ekrt L., Chrtek J. Jr., Zázvorka J., Grulich V., Řepka R., Prančl J., Ducháček M., Kúr P., Šumberová K. & Brůna J. (2016): Distributions of vascular plants in the Czech Republic. Part 2. – Preslia 88: 229–322.

Kárpáti Z. (1960): Die *Sorbus*-Arten Ungarns und der angrenzenden Gebiete. – Feddes Repert. 62: 71–331.

Kirschner J., Kirschnerová L. & Štěpánek J. (2007): Generally accepted plant names based on material from the Czech Republic and published in 1753–1820. – Preslia 79: 323–365.

Kobrlová L., Hroneš M., Koutecký P., Štech M. & Trávníček B. (2016): *Symphytum tuberosum* complex in central Europe: cytogeography, morphology, ecology and taxonomy. – Preslia 88: 77–112.

Kovanda M. (1992): *Sorbus* L. – jeřáb. – In: Hejný S., Slavík B., Kirschner J. & Křísa B. (eds), Květena České republiky [Flora of the Czech Republic] 3: 474–484, Academia, Praha.

Kovanda M. (1996): Observations on *Sorbus* in Southwest Moravia (Czech Republic) and adjacent Austria I. – Verh. Zool.-Bot. Ges. Österr. 133: 347–369.

Kovanda M. (1997a): A remarkable range extension for *Sorbus austriaca*. – Acta Mus. Morav., Sci. Natur. 81: 193–204.

Kovanda M. (1997b): Jeřáb prostřední (*Sorbus intermedia*) v Krkonoších [*Sorbus intermedia* in the Krkonoše Mts]. – Opera Corcontica 34: 175–178.

Kovanda M. (1998): *Sorbus sudetica* in the Karkonosze Mts (Poland). – Thaiszia 8: 137–140.

Kovanda M. (2002): *Sorbus* L. – jeřáb. – In: Kubát K., Hrouda L., Chrtek J. jun., Kaplan Z., Kirschner J. & Štěpánek J. (eds), Klíč ke květeně České republiky [Key to the flora of the Czech Republic], p. 383–386, Academia, Praha.

Kubíková J. & Manych J. (1979): Současná květena státní přírodní rezervace Prokopské údolí v Praze [Recent flora of the Prokopské údolí State Nature Reserve in Prague]. – Zpr. Čs. Bot. Společ. 14: 37–58.

Kurtto A. (1982): Taxonomy of the *Symphytum asperum* aggregate (*Boraginaceae*), especially in Turkey. – Ann. Bot. Fenn. 19: 177–192.

Kurtto A. (2009): *Rosaceae* (pro parte majore). – In: Euro+Med PlantBase – the information resource for Euro-Mediterranean plant diversity, URL: http://ww2.bgbm.org/EuroPlusMed/ (accessed April 2016).

Kutzelnigg H. (1995): *Sorbus* L. – In: Conert H. J., Hamann U., Schultze-Motel W. & Wagenitz G. (eds), Gustav Hegi, Illustrierte Flora von Mitteleuropa, ed. 2, 4/2B: 328–385, Blackwell Wissenschafts-Verlag, Berlin & Wien.

Landolt E. (1986): The family of *Lemnaceae* – a monographic study. Vol. 1: Morphology, karyology, ecology, geographic distribution, systematic position, nomenclature, descriptions. – Veröff. Geobot. Inst. Eidg. Techn. Hochsch. Stift. Rübel Zürich 71: 1–566.

Landolt E. (1994): Taxonomy and ecology of the section *Wolffia* of the genus *Wolffia* (*Lemnaceae*). – Ber. Geobot. Inst. Eidg. Techn. Hochsch. Stift. Rübel 60: 137–151.

Lepší M., Lepší P., Koutecký P., Bílá J. & Vít P. (2015): Taxonomic revision of *Sorbus* subgenus *Aria* occurring in the Czech Republic. – Preslia 87: 109–162.

Lepší M., Lepší P., Sádlo J., Koutecký P., Vít P. & Petřík P. (2013a): *Sorbus pauca* species nova, the first endemic species of the *Sorbus hybrida* group for the Czech Republic. – Preslia 85: 63–80.

Lepší M., Lepší P. & Vít P. (2013b): *Sorbus quernea*: taxonomic confusion caused by the naturalization of an alien species, *Sorbus mougeotii*. – Preslia 85: 159–178.

Lepší M., Vít P., Lepší P., Boublík K. & Kolář F. (2009): *Sorbus portae-bohemicae* and *Sorbus albensis*, two new endemic apomictic species recognized based on a revision of *Sorbus bohemica*. – Preslia 81: 63–89.
Lepší M., Vít P., Lepší P., Boublík K. & Suda J. (2008): *Sorbus milensis*, a new hybridogenous species from northwestern Bohemia. – Preslia 80: 229–244.
Lepší P. & Lepší M. (2008): Adventivní výskyt muchovníků (*Amelanchier*) v České republice [Alien species of the genus *Amelanchier* in the Czech Republic]. – Zpr. Čes. Bot. Společ. 43: 209–230.
Letz D. R., Dančák M., Danihelka J. & Šarhanová P. (2012): Taxonomy and distribution of *Cerastium pumilum* and *C. glutinosum* in Central Europe. – Preslia 84: 33–69.
Lovis J. D. (1964): The taxonomy of *Asplenium trichomanes* in Europe. – Brit. Fern Gaz. 9: 147–160.
Lovis J. D. & Reichstein T. (1985): *Asplenium trichomanes* subsp. *pachyrachis* (*Aspleniaceae*, *Pteridophyta*), and a note on the typification of *A. trichomanes*. – Willdenowia 15: 187– 201.
Lowden R. M. (1973): A revision of the genus *Pontederia* L. – Rhodora 75: 426–487.
Májovský J. & Hegedüšová Z. (1993): *Symphytum* L. – In: Bertová L. & Goliašová K. (eds), Flóra Slovenska [Flora of Slovakia] 5/2: 76–97, Veda, Bratislava.
Marchant C. J. (1973): Chromosome variation in *Araceae*: V. *Acoreae* to *Lasieae.* – Kew Bull. 28: 199–210.
Marhold K. (2011): *Caryophyllaceae*. – In: Euro+Med Plantbase – the information resource for Euro-Mediterranean plant diversity, URL: http://ww2.bgbm.org/EuroPlusMed (accessed 11 Aug 2016).
Marhold K. & Hindák F. (1998): Checklist of non-vascular and vascular plants of Slovakia. – Veda, Bratislava.
Matthiolus P. A. (1562): Herbarž, ginak bylinarž… [Herbarium alias plant book…]. – Staré Miesto Pražské.
McAllister H. A. (2005): The genus *Sorbus*: mountain ash and other rowans. – The Royal Botanic Gardens, Kew.
Meusel H. & Jäger E. J. (eds) (1992): Vergleichende Chorologie der zentraleuropäischen Flora. Vol. 3. – Gustav Fischer, Jena, Stuttgart & New York.
Meusel H., Jäger E., Rauschert S. & Weinert E. (1978): Vergleichende Chorologie der zentraleuropäischen Flora. Vol. 2. – Gustav Fischer, Jena.
Meusel H., Jäger E. & Weinert E. (1965): Vergleichende Chorologie der zentraleuropäischen Flora. Vol. 1. – Gustav Fischer, Jena.
Morton J. K. (2005): *Cerastium* L. – In: Flora of North America Editorial Committee (eds), Flora of North America 5: 74–93, Oxford University Press, New York & Oxford.
Murín A. & Májovský J. (1982): Die Bedeutung der Polyploidie in der Entwicklung der in der Slowakei wachsenden Arten der Gattung *Symphytum* L. – Acta Fac. Rerum Nat. Univ. Comen., Bot. 29: 1–25.
Němec R., Dřevojan P. & Šumberová K. (2014): Polní mokřady Znojemska jako refugium významných a vzácných druhů cévnatých rostlin [Wetlands on arable land in Znojmo region as a refuge of important and rare vascular plants]. – Thayensia 11: 3–76.
Niklfeld H. (1999): Mapping the flora of Austria and the Eastern Alps. – Rev. Valdôtaine Hist. Nat. 51, Suppl. 51: 53–62.
Novák F. A. (1960): Fylogenese serpentinových typů [Phylogeny of serpentine forms]. – Preslia 32: 1–8.
Ogra R. K., Mohanpuria P., Sharma U. K., Sharma M., Sinha A. K. & Ahuja P. S. (2009): Indian calamus (*Acorus calamus* L.): not a tetraploid. – Curr. Sci. 97: 1644–1647.
Owens C. S. & Madsen J. D. (1995): Low temperature limits of waterhyacinth. – J. Aquat. Plant Manage. 33: 63–68.
Pawłowski B. (1972): *Symphytum* L. – In: Tutin T. G., Heywood V. H., Burges N. A., Moore D. M., Valentine D. H., Walters S. M. & Webb D. A. (eds), Flora Europaea 3: 103–105, Cambridge University Press, Cambridge.
Petersen G. (1989). Cytology and systematics of *Araceae*. – Nord. J. Bot. 9: 119–166.
Pieterse A. H., de Lange L. & Verhagen L. (1981): A study on certain aspects of seed germination and growth of *Pistia stratiotes* L. – Acta Bot. Neerl. 30: 47–57.
Preston C. D. & Croft J. M. (1997): Aquatic plants in Britain and Ireland. – Harley Books, Colchester.
Pyšek P., Danihelka J., Sádlo J., Chrtek J. Jr., Chytrý M., Jarošík V., Kaplan Z., Krahulec F., Moravcová L., Pergl J., Štajerová K. & Tichý L. (2012): Catalogue of alien plants of the Czech Republic (2nd edition): checklist update, taxonomic diversity and invasion patterns. – Preslia 84: 155–255.
Rai D. N. & Datta Mushi J. (1978): The influence of thick floating vegetation (water hyacinth: *Eichhornia crassipes*) on the physicochemical environment of a fresh water wetland. – Hydrobiologia 62: 65–69.
Reichstein T. (1984): *Aspleniaceae* L. – In: Kramer K. U. (ed.), Gustav Hegi, Illustrierte Flora von Mitteleuropa, ed. 3, 1/1: 211–273, Verlag Paul Parey, Berlin & Hamburg.
Rich T. C. G., Green D., Houston L., Lepší M., Ludwig S. & Pellicer J. (2014): British *Sorbus* (*Rosaceae*): six new species, two hybrids and a new subgenus. – New J. Bot. 4: 2–12.

Rich T. C. G., Houston L., Robertson A. & Proctor M. C. F. (2010): Whitebeams, rowans and service trees of Britain and Ireland: a monograph of British and Irish *Sorbus* L. – BSBI Handbook 14: 1–223, Botanical Society of the British Isles, London.

Rickard M. H. (1989): Two spleenworts new to Britain – *Asplenium trichomanes* subsp. *pachyrachis* and *Asplenium trichomanes* nothosubsp. *staufferi*. – Pteridologist 1: 244–248.

Rojas-Sandoval J. & Acevedo-Rodríguez P. (2013): *Eichhornia crassipes* (water hyacinth). – In: Invasive Species Compendium, Centre for Agriculture and Biosciences International, Wallingford, URL: http://www.cabi.org/isc/datasheet/20544 (accessed 16 August 2016).

Rojas-Sandoval J., Acevedo-Rodríguez P. & Mikulyuk A. (2013): *Pistia stratiotes* (water lettuce). – In: Invasive Species Compendium, Centre for Agriculture and Biosciences International, Wallingford, URL: http://www.cabi.org/isc/datasheet/41496 (accessed 17 August 2016).

Röst L. C. M. (1978): Biosystematic investigations with *Acorus* L. (*Araceae*). 1. Communication. Cytotaxonomy. – Proc. Koninkl. Nederl. Akad. Wetensch., ser. C, 81: 428–441.

Rotach P. (2003): EUFORGEN Technical Guidelines for genetic conservation and use for service tree (*Sorbus domestica*). – International Plant Genetic Resources Institute, Rome, Italy.

Rydlo J. (1999): Vodní vegetace [Aquatic vegetation]. – In: Kolbek J., Blažková D., Břízová E., Kučera T., Ložek V., Rybníček K., Rybníčková E. & Rydlo J., Vegetace Chráněné krajinné oblasti a Biosférické rezervace Křivoklátsko 1. Vývoj krajiny a vegetace, vodní, pobřežní a luční společenstva [Vegetation of the Křivoklátsko Protected Landscape Area and Biosphere Reserve 1. Development of the landscape and vegetation, aquatic, riparian and meadow communities], p. 35–111, Agentura ochrany přírody a krajiny & Botanický ústav AV ČR, Praha.

Rydlo J. (2006): Vodní makrofyta ve stojatých vodách v oblasti soutoku Labe a Vltavy [Aquatic macrophytes in standing waters in the area near the confleunce of the Labe and Vltava rivers]. – Muz. Současn., ser. natur., 21: 25–70.

Schroeder F.-G. (1995): *Amelanchier*. – In: Conert H. J., Hamann U., Schultze-Motel W. & Wagenitz G. (eds), Gustav Hegi, Illustrierte Flora von Mitteleuropa, ed. 2, 4/2B: 385–404, Blackwell Wissenschafts-Verlag, Berlin & Wien.

Smejkal M. (1978): Rod *Symphytum* L. v Československu [The genus *Symphytum* L. in Czechoslovakia]. – Zpr. Čs. Bot. Společ. 13: 145–161.

Stace C. (2010): New flora of the British Isles. Ed. 3. – Cambridge Univ. Press, Cambridge.

Štěpán V. J. (1925): K umělému rozšíření rostlin [On the artificial spread of plants]. – Věda Přír. 6: 114.

Šumberová K. (2011a): *Acoretum calami* Dagys 1932. Rákosiny s puškvorcem obecným [*Acoretum calami* Dagys 1932. Stands of *Acorus calamus*]. – In: Chytrý M. (ed.), Vegetace České republiky 3. Vodní a mokřadní vegetace [Vegetation of the Czech Republic 3. Aquatic and wetland vegetation], p. 417–419, Academia, Praha.

Šumberová K. (2011b): *Calletum palustris* Vanden Berghen 1952. Mokřadní vegetace s ďáblíkem bahenním [*Calletum palustris* Vanden Berghen 1952. Wetlands dominated by *Calla palustris*]. – In: Chytrý M. (ed.), Vegetace České republiky 3. Vodní a mokřadní vegetace [Vegetation of the Czech Republic 3. Aquatic and wetland vegetation], p. 523–526, Academia, Praha.

Šumberová K. (2011c): *Ceratophylletum demersi* Corillion 1957. Vegetace mělkých eutrofních vod s růžkatcem ostnitým [*Ceratophylletum demersi* Corillion 1957. Vegetation of shallow eutrophic water bodies dominated by *Ceratophyllum demersum*]. – In: Chytrý M. (ed.), Vegetace České republiky 3. Vodní a mokřadní vegetace [Vegetation of the Czech Republic 3. Aquatic and wetland vegetation], p. 93–96, Academia, Praha.

Šumberová K. (2011d): *Eleocharito palustris-Hippuridetum vulgaris* Passarge 1964. Vegetace mělkých vod s prustkou obecnou [*Eleocharito palustris-Hippuridetum vulgaris* Passarge 1964. Sallow-water vegetation dominated by *Hippuris vulgaris*]. – In: Chytrý M. (ed.), Vegetace České republiky 3. Vodní a mokřadní vegetace [Vegetation of the Czech Republic 3. Aquatic and wetland vegetation], p. 456–462, Academia, Praha.

Šumberová K. (2011e): *Potamo-Ceratophylletum submersi* Pop 1962. Vegetace mělkých vod s růžkatcem bradavčitým [*Potamo-Ceratophylletum submersi* Pop 1962. Vegetation of shallow water bodies dominated by *Ceratophyllum submersum*]. – In: Chytrý M. (ed.), Vegetace České republiky 3. Vodní a mokřadní vegetace [Vegetation of the Czech Republic 3. Aquatic and wetland vegetation], p. 96–99, Academia, Praha.

Šumberová K. (2011f): *Trapetum natantis* Kárpáti 1963. Vegetace mělkých eutrofních vod teplých oblastí s kotvicí plovoucí [*Trapetum natantis* Kárpáti 1963. Vegetation of shallow eutrophic water of warm areas dominated by *Trapa natans*]. – In: Chytrý M. (ed.), Vegetace České republiky 3. Vodní a mokřadní vegetace [Vegetation of the Czech Republic 3. Aquatic and wetland vegetation], p. 121–124, Academia, Praha.

Šumberová K. (2011g): Vegetace volně plovoucích vodních rostlin (*Lemnetea*) [Vegetation of free-floating aquatic plants (*Lemnetea*)]. – In: Chytrý M. (ed.), Vegetace České republiky 3. Vodní a mokřadní vegetace [Vegetation of the Czech Republic 3. Aquatic and wetland vegetation], p. 43–99, Academia, Praha.

Šumberová K. (2013): *Limosella aquatica* L. – blatěnka vodní. – In: Lepší P., Lepší M., Boublík K., Štech M. & Hans V. (eds), Červená kniha květeny jižní části Čech [Red Data Book of the flora of southern part of Bohemia], p. 247–248, Jihočeské muzeum v Českých Budějovicích, České Budějovice.

Szeląg Z. (2004): Taxonomic and nomenclatural notes on *Hieracium silesiacum* (*Asteraceae*). – Polish Bot. J. 49: 15–20.

Szeląg Z. & Wójcik G. (2014): *Hieracium sudetotubulosum* (*Asteraceae*) rediscovered outside the Karkonosze Mts. – Polish Bot. J. 59: 117–119.

Téllez T. R., de Rodrigo López E. M., Granado G. L., Pérez E. A., López R. M. & Guzmán J. M. S. (2008): The water hyacinth, *Eichhornia crassipes*: an invasive plant in the Guadiana River Basin (Spain). – Aquat. Invas. 3: 42–53.

Thiers B. (2016): Index Herbariorum: a global directory of public herbaria and associated staff. – New York Botanical Garden's Virtual Herbarium, URL: http://sciweb.nybg.org/science2/IndexHerbariorum.asp (accessed August 2016).

Tomšovic P. & Kubát K. (1981): Poznámky k výskytu kyvoru lékařského (*Ceterach officinarum* DC.) v Čechách [Notes on the occurrence of *Ceterach officinarum* in Bohemia]. – Zpr. Čs. Bot. Společ. 15: 87–90.

Uechtritz R. (1876): Floristische Bemerkungen. – Oesterr. Bot. Z. 26: 177–181.

Uotila P. (2010): *Ceratophyllaceae*. – In: Euro+Med Plantbase – the information resource for Euro-Mediterranean plant diversity, URL: http://ww2.bgbm.org/EuroPlusMed (accessed 18 July 2016).

USDA, NRCS (2016): The Plants Database. – United States Department of Agriculture, URL: http://plants.usda.gov (accessed 13 July 2016).

Velebil J. (2012): *Sorbus omissa*, a new endemic hybridogenous species from the lower Vltava river valley. – Preslia 84: 375–390.

Verloove F. (2016a): *Lemna turionifera*. – In: Manual of the alien plants of Belgium, Botanic Garden of Meise, Belgium, URL: alienplantsbelgium.be (accessed 18 August 2016).

Verloove F. (2016b): *Pontederia cordata*. – In: Manual of the alien plants of Belgium, Botanic Garden of Meise, Belgium, URL: alienplantsbelgium.be (accessed 18 August 2016).

Vít P., Lepší M. & Lepší P. (2012): There is no diploid apomict among Czech *Sorbus* species: a biosystematic revision of *S. eximia* and discovery of *S. barrandienica*. – Preslia 84: 71–96.

Vít P., Wolfová K., Urfus T., Tájek P. & Suda J. (2014): Interspecific hybridization between rare and common plant congeners inferred from genome size data: assessing the threat to the Czech serpentine endemic *Cerastium alsinifolium*. – Preslia 86: 95–117.

Wallentinus I. (2002): Introduced marine algae and vascular plants in European aquatic environments. – In: Leppäkoski E., Gollasch S. & Olenin S. (eds), Invasive aquatic species of Europe. Distribution, impacts and management, p. 27–52, Kluwer Academic Publishers, Dordrecht.

Wang H., Li W.-L., Gu Z.-J. & Chen Y.-Y. (2001): Cytological study on *Acorus* L. in southwestern China, with some cytogeographical notes on *A. calamus*. – Acta Bot. Sin. 43: 354–358.

Webb C. J., Sykes W. R. & Garnock-Jones P. J. (1988): Flora of New Zealand. Vol. 4. Naturalised Pteridophytes, Gymnosperms, Dicotyledons. – Botany Division DSIR, Christchurch.

Wickens G. E. (1978): *Symphytum* L. – In.: Davis P. H. (ed.), Flora Turkey and the East Aegean Islands 6: 378–386, Edinburgh University Press, Edinburgh.

Wolff P. & Bruinsma J. (2005): Knopkroos (*Lemna turionifera* Landolt) nieuw voor Nederland [*Lemna turionifera* Landolt new to the Netherlands]. – Gorteria 31: 18–26.

Wolff P. & Landolt E. (1994): Spread of *Lemna turionifera* (*Lemnaceae*), the red duckweed, in Poland. – Fragm. Flor. Geobot. 39: 439–451.

Wolff P. & Orschiedt O. (1993): *Lemna turionifera* Landolt – eine neue Wasserlinse für Süddeutschland, mit den Erstnachweisen für Europa. – Carolinea 51: 9–26.

Xie Y., Li Z.-Y., Gregg W. P. & Li D. (2001): Invasive species in China – an overview. – Biodivers. Conserv. 10: 1317–1341.

Zhu G. L., Riedl H. & Kamelin R. (1995): *Boraginaceae*. – In: Wu C. Y., Raven P. H. & Hong D. Y. (eds), Flora of China 16: 329–427, Science Press, Beijing & Missouri Botanical Garden Press, St. Louis.

Zieliński J. & Vladimirov V. (2013): *Sorbus ×latifolia* s. l. (*Rosaceae*) in the Balkan Peninsula and SW Asia. – Phytol. Balcanica 19: 39–46.

Received 9 September 2016
Revision received 11 November 2016
Accepted 13 November 2016