Distributions of vascular plants in the Czech Republic. Part 1

Rozšíření cévnatých rostlin v České republice. Část 1

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Despite a long history of botanical research on the Czech flora and the large amount of data on plant distribution that has been collected, there is still no comprehensive piece of work with distribution maps in this country and no distribution maps are available for more than a half of plant taxa. This paper is the first part of a series of publications prepared within the PLADIAS project, intended as the first step towards a complete atlas of the distribution of both native and alien vascular plants in the Czech Republic. It contains grid distribution maps of 75 taxa of the genera *Achillea*, *Aegilops*, *Aira*, *Alopecurus*, *Avena*, *Bolboschoenus*, *Carex*, *Cladium*, *Elatine*, *Eleocharis*, *Eriophorum*, *Glyceria*, *Polypogon*, *Sclerochloa*, *Scheuchzeria*, *Sparganium*, *Tofieldia*, *Tragus* and *Viola*. The maps are based on all available herbarium, literature and field records, which were stored at the CzechDistrib database, checked geographically and evaluated taxonomically, and shown in maps using the Central European mapping grid template derived from quadrants of 5 × 3 arc minutes (corresponding to approximately 5.5 × 5.9 km). Many of these maps resulted from detailed revisions carried out during the work on the Flora of the Czech Republic. Maps of taxonomically difficult groups are based solely or mainly on herbarium specimens revised by taxonomic experts. If useful, recent versus old records, native versus alien occurrences, or records based on revised herbarium specimens versus all other records are distinguished using different symbols. Records used for producing maps are listed in electronic appendices. The maps are accompanied by texts that include an outline of general distribution, information on habitats and specific details on the distribution in the country. Where appropriate, comments on taxonomy, biology or spatial and temporal dynamics in distribution are given.

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, phytogeography, plant record, vascular plants

Introduction

Botanical research in the territory of the current Czech Republic (Fig. 1), which includes the historical territories and later crown lands of Bohemia, Moravia and the Czech (once Austrian) part of Silesia, has a long tradition, which dates back to the second half of the 18th century (Skalický et al. 1988, Kirschner et al. 2007, Kaplan 2012, Krahulec 2012). The first attempts to produce a flora for Bohemia occurred at the turn of the 18th and 19th centuries, such as those of Schmidt (1793–1794) and Pohl (1809, 1814). Unfortunately, these efforts remained, for various reasons, unpublished or incomplete. The first complete flora of Bohemia was published by the Presl brothers (Presl & Presl 1819). For the eastern part of the country, Moravia and Austrian Silesia, the first flora appeared 16 years later (Rohrer & Mayer 1835). This separate development stems from the fact that the Kingdom of Bohemia and the Margraviate of Moravia (at that time administratively connected with the Duchy of Silesia), formerly parts of the medieval Czech state, were included in the Habsburg monarchy and later the Austrian Empire as autonomous provinces without any formal administrative connection to each other. Both provinces had their provincial legislative bodies (diets), administrative, educational and cultural institutions, and, consequently, also the natural history research followed somewhat different paths until the early 20th century.

Since the early 19th century, a great number of floras covering various regions have appeared. The most notable milestones of the late 19th century were Prodromus of the Bohemian flora by Čelakovský (1867–1881) and two floras covering Moravia and adjacent Silesia by Oborny (1886) and Formánek (1887–1897). The most influential floras of the 20th century include that of Polívka (1900–1904), covering already both Bohemia and Moravia, as well as Polívka et al. (1928), Dostál et al. (1948–1950) and Dostál (1954, 1958, 1989), covering the former Czechoslovakia. Eight of the ten planned volumes of a modern multiauthored Flora of the Czech Republic have been published (Hejný et al. 1988, 1990, 1992, Slavík et al. 1995, 1997, 2000, 2004, Štěpánková et al. 2010). The last outline of the Czech flora was presented in the field guide Key to the flora of the Czech Republic (Kubát et al. 2002) and in the checklist of vascular plants of the Czech Republic (Danihelka et al. 2012), which incorporated well-founded recent changes in the systematics. Comprehensive reviews have recently been published on the flora and phytogeography of the Czech Republic (Kaplan 2012), its vegetation (Chytrý 2007–2013, 2012) and alien plants (Pyšek et al. 2012). In addition, studies on different taxa of vascular plants (e.g. Bureš et al. 2010, Kaplan 2010, Koutecký et al. 2012, Kúr et al. 2012, Letz et al. 2012, Follak et al. 2013, Hoták et al. 2013, Kaplan et al. 2013, 2014, Krahulcová et al. 2013a, b, Lepší et al. 2013a, b, 2015, Kabátová et al. 2014, Krahulec et al. 2014, Otisková et al. 2014, Prančl et al. 2014, Řepka et al. 2014, Vít et al. 2014, Kolář et al. 2015) resulted in new discoveries and provided novel information on taxonomy and distribution of vascular plants. The history of the botanical research in the Czech Republic was reviewed by Krahulec (2012), and its specific issues were discussed by Chytrý et al. (2012), Danihelka et al. (2012), Kaplan (2012) and Pyšek et al. (2012, 2014).

Plant distribution records are indispensable for understanding patterns in species diversity and provide important information for nature conservation authorities. Robust data sets of georeferenced records stored in databases can be used for large-scale biogeographical or macroecological analyses. One of the most efficient ways of collecting data

for such databases in a standardized procedure is grid-based mapping, which is a method developed by the Botanical Society of the British Isles for the BSBI Maps Scheme launched in 1954. As described by Preston (2013), this project aimed at collecting records in 10 × 10-km squares of the British Ordnance Survey National Grid of military maps with comprehensive coverage "including all species and covering all grid squares". In order to achieve these goals, the scheme relied on help from voluntary recorders, including hobby botanists, of Natural History Societies and schools. The records were processed and maps produced using innovative technology, such as punched cards and a tabulator for plotting maps, developed by a private company specialized in machinery for accountancy. The Atlas of the British flora (Perring & Walters 1962), an extraordinary achievement even from today's perspective, shaped methods of biogeographical research in Europe and, to a large extent, also in other parts of the World.

In central Europe, like in the British Isles, there is a long tradition of floristic mapping (Haeupler 2005), and the wealth of floristic information has been summarized in numerous national or regional grid atlases (e.g. Haeupler & Schönfelder 1988, Schönfelder & Bresinski 1990, Hartl et al. 1992, Benkert et al. 1996, Hardtke & Ihl 2000, Jogan 2001, Korsch et al. 2002, Zając & Zając 2002, Haeupler et al. 2003, Garve 2007, Netzwerk Phytodiversität Deutschland & Bundesamt für Naturschutz 2013). However, despite the long history of botanical research on the Czech flora outlined above and the large body of taxonomic knowledge and data on distribution that has been collected, there is still no complete atlas of the distributions of Czech vascular plants based on data evaluated by taxonomic experts. Four volumes of a grid-based atlas with a grid template of 10 × 6 arc minutes (i.e. approximately 11.1 × 11.8 km) were published under the serial title Phytocartographical syntheses of the Czech Republic (Slavík 1986, 1990, 1998, Štěpánková 2012). Distribution maps of some plants appeared in the introductory chapters of the respective volumes of the Flora of the Czech Republic (Slavík 1988, 1995, 1997, 2000, 2004), while maps of rare and endangered plants of the former Czechoslovakia were published in the Red Data Book of the Czech and Slovak Republics (Čeřovský et al. 1999). Many additional maps (mostly dot maps) were published separately in studies that focus on taxonomy and distribution of various taxa (e.g. Trávníček 2000, 2001, Danihelka 2001a, b, Hroudová et al. 2004, Trávníček & Zázvorka 2005, Ducháček et al. 2006, 2007, Krahulec et al. 2006, Duchoslav et al. 2007a, b, Bureš et al. 2008, Ekrt 2008, Danihelka et al. 2009, Duchoslav & Krahulec 2009, Lepší et al. 2009, 2015, Kaplan 2010, 2012, Zázvorka 2010, Chlumský & Štech 2011, Letz et al. 2012, Prančl 2012, 2013, Moltašová et al. 2014, Řepka & Grulich 2014). In spite of these achievements, there are still enormous gaps in our knowledge about the distribution of vascular plants and for more than half the plant taxa, no distribution maps are available (Kaplan 2012).

The existing databases already contain a lot of records. However, most of them have never been checked geographically and, as a rule, they have never been evaluated with respect to correct identification and taxonomic delimitation nor sorted according to their reliability, accuracy and origin status. Maps generated from these records are nothing more than visualizations of the records on a topographic background. The aim of the present paper is to provide the first set of grid distribution maps that are produced by taxonomic experts and based on critically evaluated and sorted records. Data for many of these maps resulted from detailed revisions carried out during the work on the Flora of the Czech Republic. These records were transfered to the CzechDistrib database and the

maps produced within the PLADIAS project (www.pladias.org). Publication of this paper is considered a first step towards a complete atlas of the distribution of vascular plants in the Czech Republic.

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, in exceptional cases also 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 mapping. Nomenclature, taxonomic concepts and delimitation of species aggregates mostly follows 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 preferably printed.

Data sources

All relevant floristic data sources are used. Major national herbaria and some local collections were consulted, incl. BRNL, BRNM, BRNU, CB, CBFS, CHOM, FMM, GM, HOMP, HR, LIM, LIT, MJ, MMI, MP, MZ, NJM, OL, OLM, OP, OSM, OVMB, PL, PR, PRA, PRC, ROZ, SOB, SOKO, SUM, VM and ZMT (acronyms follow Thiers 2015), as the main source of taxonomically revised records. Most records for maps of common and taxonomically unproblematic taxa come from a recently developed CzechDistrib database (hosted at the Institute of Botany, Průhonice), which has integrated all available records on distribution of 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 CzechDistrib database by the authors of maps or regional contributors were also considered. Details on the structure and data coverage of the CzechDistrib database will be published in a separate paper.

Procedure of mapping

All records used for mapping are entered into the CzechDistrib 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 CzechDistrib database. Because maps of taxonomically critical groups are often highly inaccurate in distribution atlases (Gregor 2009), maps of such taxa 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 1–75. 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 of an accompanying text; authors of maps are indicated in the figure captions, and they also took major part in preparing the first drafts of the respective texts. Maps are displayed using spherical Mercator projection (EPSG:3857) where meridians and paralles are perpendicular, and the mapping CEBA grids are thus nicely displayed. The backround 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 the same time, 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. 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 counting. The accompanying text includes the accepted scientific name, a brief outline of the total distribution, information on habitats occupied by the species and description of its distribution in the Czech Republic. Where appropriate, comments on taxonomy, biology and details on spatial and temporal dynamics in distribution are given.

Distribution maps and comments

Achillea asplenifolia (Fig. 2)

Achillea asplenifolia is a diploid member of the *A. millefolium* group (Ehrendorfer 1953). This polyploid complex includes seven species in central Europe, of which six are present in the flora of the Czech Republic (Danihelka & Rotreklová 2001). *Achillea asplenifolia* is almost endemic to the Pannonian Basin: it occurs in the Czech Republic, eastern Austria, southern Slovakia, Hungary, Romania (Transylvania), northern Croatia, northern

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

Serbia and possibly also in the westernmost Ukraine (Meusel & Jäger 1992, Danihelka 2003). It was recently found also in western Bulgaria (Saukel et al. 2003). In the Czech Republic it is confined to southern Moravia, i. e. the south-eastern part of the country, and its occurrence roughly coincides with the former distribution of the halophilous flora. Records from other parts of the country are erroneous and are mainly based on misidentifications of the tetraploid *A. pratensis*. *Achillea asplenifolia* is found in the planar and colline vegetation belts, with an altitudinal maximum at about 350 m in the Větrníky National Nature Reserve south of the town of Vyškov. Most of the finds are from saline pastures, saline or fen meadows and wet habitats such as ditches along roads and railways. Though formerly documented from several dozens of sites, most of the populations were destroyed by drainage, conversion to arable land, or they disappeared in the course of succession after abandonment. This happened mainly during the 1950s and 1960s, and since 2000 the presence of *A. asplenifolia* has been confirmed at about 10 sites, with most of the populations consisting of small number of individuals. Consequently, its classification as critically threatened by Grulich (2012) is justified.

Achillea pannonica (Fig. 3)

Achillea pannonica is an octoploid member of the *Achillea millefolium* group (Ehrendorfer 1953) and one of the six yarrows of this group occurring in the Czech Republic (Danihelka & Rotreklová 2001). It is a European species found in central, eastern and south-eastern Europe, with an extension to northern Anatolia. Its northernmost localities are in central Germany and northern Poland, the southernmost in northern Greece. The westernmost occurrences are in Bavaria, while the eastern limit of its distribution range runs through south-western Russia. The Czech Republic is therefore situated close to the north-western limit of species' general distribution range (Meusel & Jäger 1992, Danihelka 2001, Hofmann et al. 2013). *Achillea pannonica* is a heliophilous to heliosciophilous species of different types of dry grasslands, both primary and secondary, forest fringe communities and thermophilous oak forests. It is sometimes found also in strips of ruderalized dry grassland along field margins, among vineyards or in settlements. It prefers calcareous or other base-rich substrates such as limestone and loess (Danihelka 2001a) but exceptions are not

Fig. 1. – Topographic map and position of historical lands of the Czech Republic. Adopted from Kaplan (2012) and slightly modified.

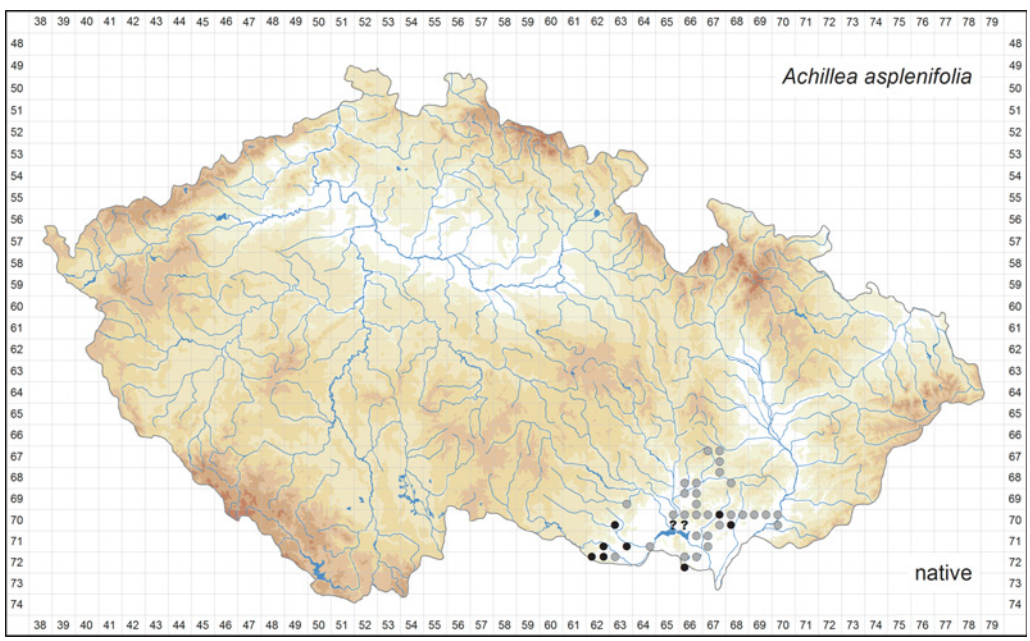

Fig. 2. – Distribution of *Achillea asplenifolia* in the Czech Republic: ● at least one record in 2000–2015 (8 quadrants), ◍ pre 2000 records only (29 quadrants). Prepared by Jiří Danihelka.

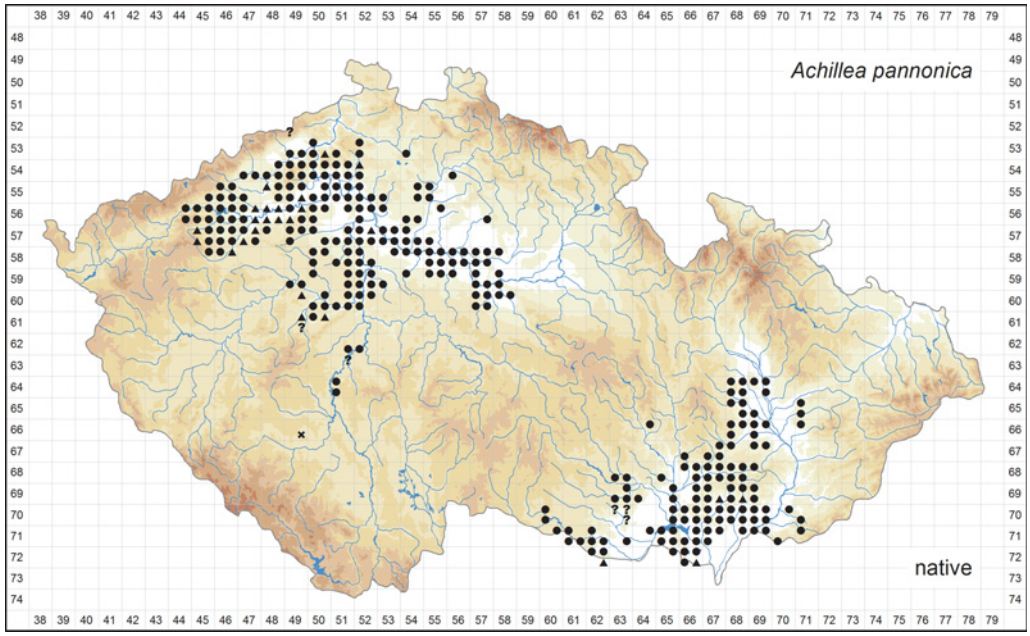

Fig. 3. – Distribution of *Achillea pannonica* in the Czech Republic: ● occurrence documented by herbarium specimens (284 quadrants), ▲ occurrence based on other records (25 quadrants), × alien (1 quadrant). Prepared by Jiří Danihelka.

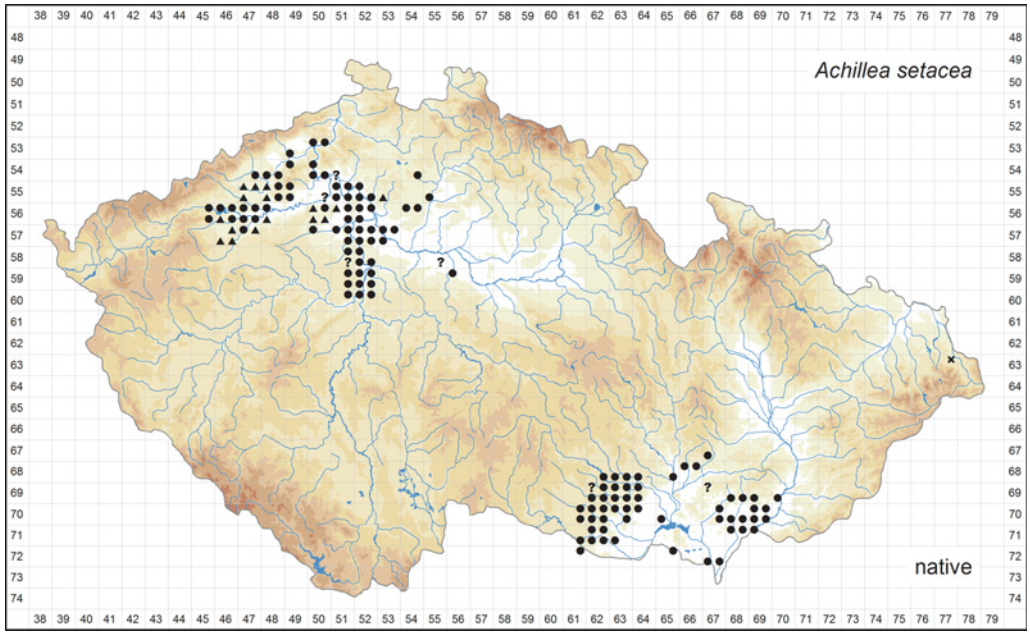

Fig. 4. – Distribution of *Achillea setacea* in the Czech Republic: ● occurrence documented by herbarium specimens (120 quadrants), ▲ occurrence based on other records (16 quadrants), × alien (1 quadrant). Prepared by Jiří Danihelka.

rare. In the Czech Republic *A. pannonica* is distributed in the relatively dry and warm parts of the country, forming two almost compact patches, one in north-western and central Bohemia, and the other in central and southern Moravia. The isolated occurrence in southern Bohemia north of the town of Strakonice is secondary, probably due to an introduction with grain used for feeding carp. Some of the records not supported by herbarium specimens may be erroneous, based on misidentification of other yarrows. Most localities are situated in the colline vegetation belt, with altitudinal maxima at 600–700 m being reached in northern Bohemia in Mt Milešovka in the České středohoří Mts and in Humnický vrch hill in the Doupovské hory Mts. *Achillea pannonica* may have slightly declined since World War II due to the destruction of some of its former sites, which is the reason for classifying it as vulnerable (Grulich 2012).

Achillea setacea (Fig. 4)

Achillea setacea is another diploid member of the *Achillea millefolium* group (Ehrendorfer 1953) and one of the six yarrows of this polyploid complex occurring in the Czech Republic (Danihelka & Rotreklová 2001). It is distributed mainly in eastern and south-eastern Europe and in Anatolia (Meusel & Jäger 1992, Danihelka 2001b). The eastern distribution limit has not been established yet with certainty due to unclarified taxonomy: records from the eastern Ukraine, Crimea, south-western Russia and the Tian Shan Mts in Central Asia may refer to other diploid and tetraploid taxa, such as *A. asiatica* and *A. stepposa* (Sytnik 1984) respectively. In addition, the plants from the southern Alps and the Balkan Peninsula are morphologically slightly different and flower later than those from central Europe. The populations in central Germany are situated at the north-western distribution limit of the species and are separated, as are those in Bohemia, from the more continuous distribution in the Pannonian Basin and adjacent areas. *Achillea setacea* is a heliophilous species of shallow and permeable, stony, gravelly or sandy soils that are usually poor in calcium and nitrogen. It is found in different types of dry grasslands or, in southern Moravia, continental heathland, formerly often used as pastures (Danihelka 2001b). In the Czech Republic *A. setacea* inhabits its driest and warmest parts, i. e. north-western Bohemia and southern Moravia, while local distribution patterns are shaped by the presence of shallow, permeable (often sandy) and nutrient-poor soils. It occurs in the planar and colline vegetation belts, with altitudinal maxima at 500 m in the České středohoří Mts. The 19th-century record from the vicinity of Český Těšín in the northeast of the country goes back to an introduction with grains or hay. Some of the undocumented records accepted here may be wrong, based on misidentifications of *A. pannonica*. *Achillea setacea* is slightly declining due to succession following abandonment of former pastures; it is therefore classified as vulnerable (Grulich 2012).

Aegilops cylindrica (Fig. 5)

Aegilops cylindrica is native to southern and south-eastern Europe, the Caucasus and western and central Asia. It has been introduced into central Europe (Slovakia, the Czech Republic, Poland and Germany) and to the south-western part of the Mediterranean area. Outside of Europe it has been recorded as casual, naturalized or invasive alien in most of the USA and Mexico (van Slageren 1994, Eliáš et al. 2013). In the Czech Republic *A. cylindrica* has been primarily spread by the railway transport. It occurs mostly along

railway tracks and their embankments, in railway stations, rarely in yards of warehouses and iron ore deposits, usually on sandy or gravel soils (Eliáš et al. 2013). Currently it is known from about 10 localities. However, the application of herbicides along railway lines considerably reduced its populations. *Aegilops cylindrica* is the only species of the genus overwintering in central Europe.

Aira caryophyllea (Fig. 6)

Aira caryophyllea is distributed particularly in western, central and southern Europe; it reaches Scandinavia in southern Norway and southern Sweden and has eastern limits of distribution in Poland, western Slovakia, western Hungary, the Balkan Peninsula and Crete (Frey 1997). Outside of Europe it has been recorded in north-eastern Iran and southern Azerbaijan, on the northern coast of Africa and in the mountains of tropical Africa, and it has been introduced to North America, South America, Australia and New Zealand (Meusel et al. 1965, Hultén & Fries 1986, Conert 1998). In the Czech Republic *A. caryophyllea* grows in open nutrient-poor habitats on sandy or sandy-loamy soils such as open dry grasslands, pastures, anthills, fallows, edges of sandy tracks and pine forests, rocky slopes, abandoned quarries and sandy river banks. It was most frequent in south-western Bohemia, and it used to be scattered also in southern, central, northern and eastern Bohemia. It tends to be rare or absent towards mountainous areas along the state borders and towards the east. It is rare in Moravia and Silesia, being absent from most of the area and only locally frequent in the north-east and also north-west of Brno. Since World War II it has declined considerably as a result of habitat destruction, eutrophication and changes in landscape management. It has disappeared from the great majority of phytogeographical districts where it had previously occurred. It is currently classified as critically threatened (Grulich 2012).

Aira praecox (Fig. 7)

Aira praecox occurs mainly in western Europe; towards the east it reaches southern Sweden, Poland, the Czech Republic, Switzerland and north-western Italy. Outside Europe it has been recorded as introduced in north-western Turkey, southern Africa, North America, South America, Australia and New Zealand (Meusel et al. 1965, Hultén & Fries 1986). In the Czech Republic it grows on disturbed nutrient-poor sandy habitats such as sand pits, open dry grasslands, edges of sandy tracks, open pine forests and sandstone rock outcrops. It only occurs in Bohemia, where it reaches the eastern limit of its local distribution. *Aira praecox* occurs only locally, with the highest concentration of localities in relatively small sandy areas in northern, eastern and southern Bohemia. It has vanished from a majority of its former sites and with an exception of a single small population it is extinct in the whole of western Bohemia. It is therefore classified as endangered (Grulich 2012). On the other hand, it has recently successfully colonized new open disturbed sands around recently opened sand pits and in camping sites on sandy soils in open pine forests (Kaplan 2013). These habitats seem to provide an optimal combination of a disturbance regime, surrounding vegetation, physical soil structure and microclimatic conditions (Černý et al. 2007). Campers unintentionally serve as dispersal vectors, transporting seeds to new camping sites, as they often travel among similar habitats throughout the country or even abroad, carrying diaspores on tents and other camping equipment

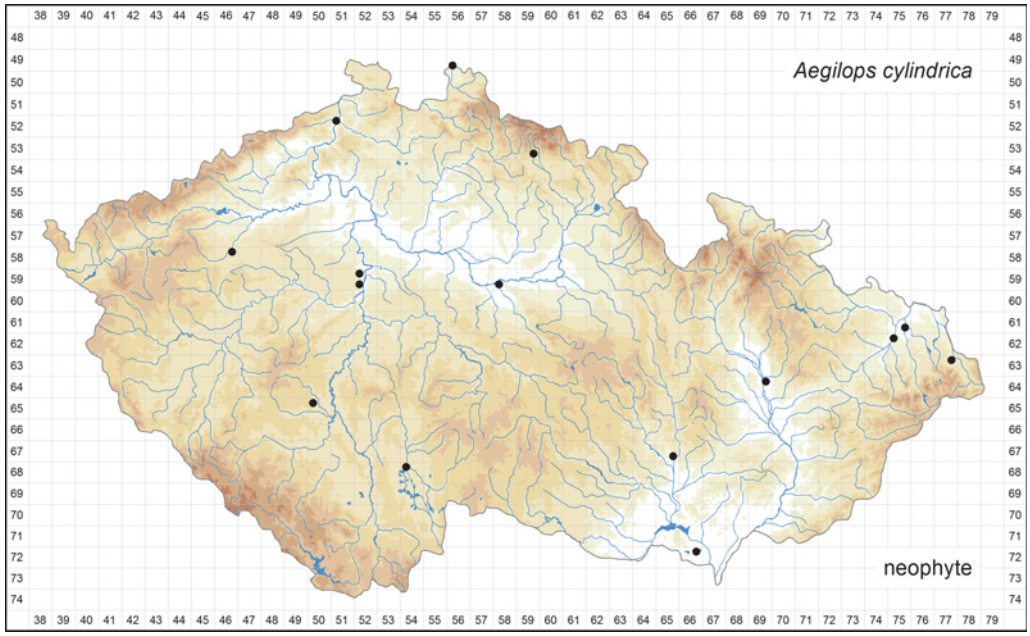

Fig. 5. – Distribution of *Aegilops cylindrica* in the Czech Republic (15 occupied quadrants). Prepared by Jiří Zázvorka.

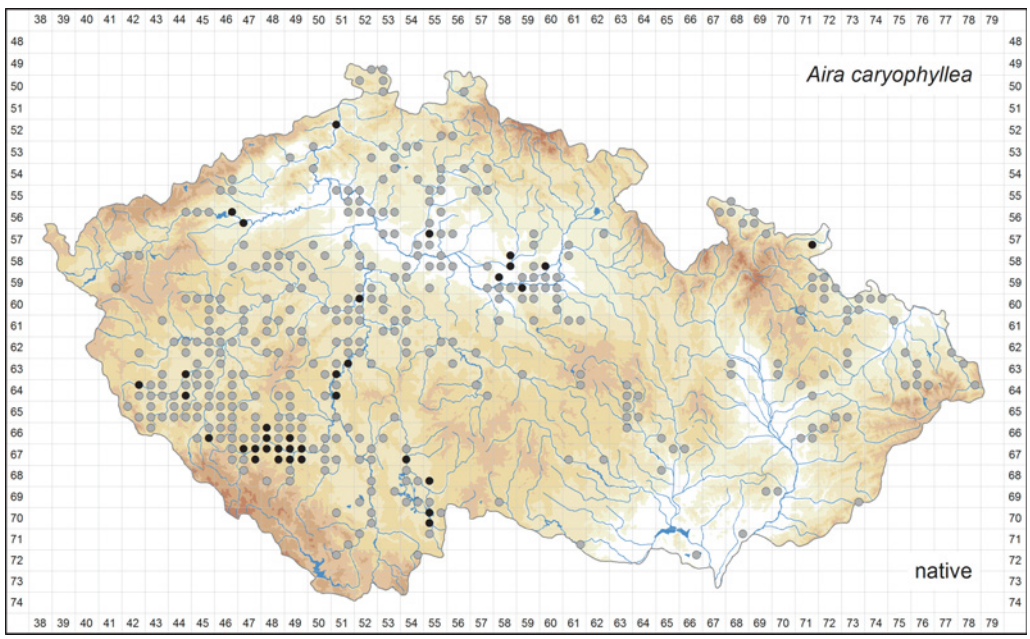

Fig. 6. – Distribution of *Aira caryophyllea* in the Czech Republic: ● at least one record in 2000–2015 (35 quadrants), ● pre 2000 records only and/or extirpated occurrences (352 quadrants). Prepared by Zdeněk Kaplan.

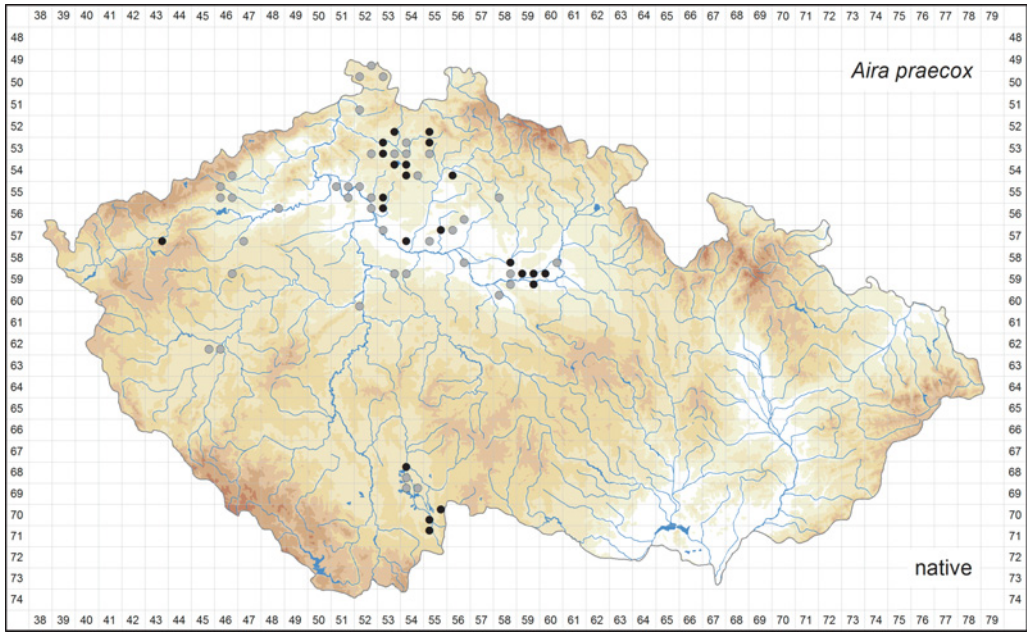

Fig. 7. – Distribution of *Aira praecox* in the Czech Republic: ● at least one record in 2000–2015 (23 quadrants), ◍ pre 2000 records only and/or extirpated occurrences (41 quadrants). Prepared by Zdeněk Kaplan.

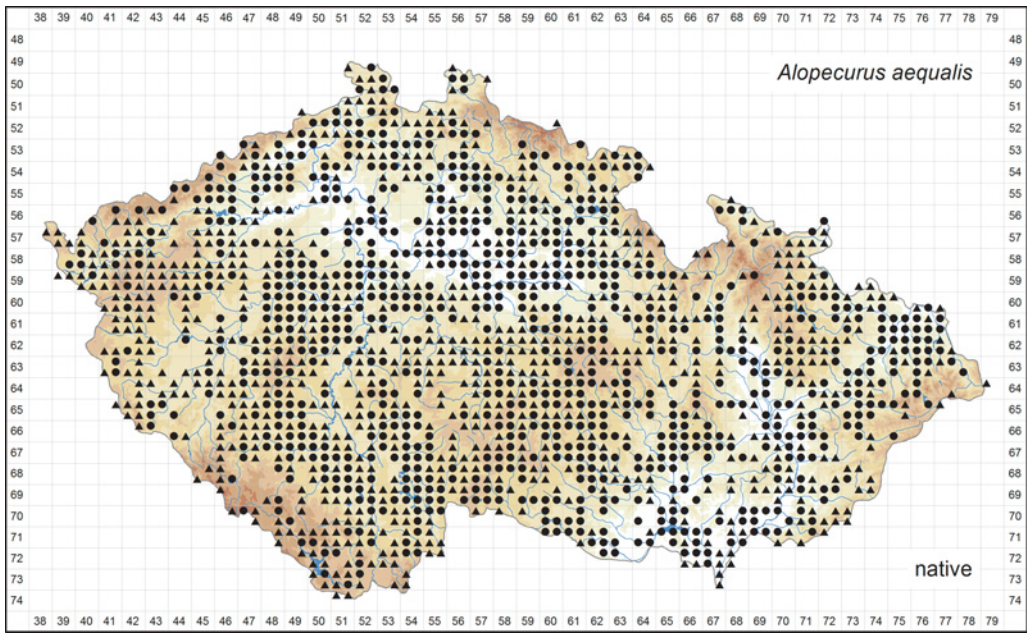

Fig. 8. – Distribution of *Alopecurus aequalis* in the Czech Republic: ● occurrence documented by herbarium specimens (865 quadrants), ▲ occurrence based on other records (784 quadrants). Prepared by Petr Bureš & Jiří Danihelka.

(Kaplan 2013). Although the species only has about two dozens of localities in the Czech Republic, its populations are often rich in individuals.

Alopecurus aequalis (Fig. 8)

Alopecurus aequalis is native to temperate zones of the Northern Hemisphere. In Europe it is more or less absent from its Mediterranean part, the strongly oceanic north of the British Isles and the western coast of Scandinavia (Hultén & Fries 1986). It has been introduced to the Southern Hemisphere, including New South Wales in Australia (Simon & Alfonso 2011), New Zealand (Edgar & Connor 2000) and some areas of South America (Soreng et al. 2003). It is a noxious weed of winter wheat, oilseed rape and rice fields in south-eastern Asia, frequently developing resistance to different types of herbicides (Guo et al. 2015). In the Czech Republic it occurs from the lowlands to middle altitudes but it was found as a casual at altitudes over 1000 m (including one record in the Hrubý Jeseník Mts at 1310 m a.s.l.). *Alopecurus aequalis* grows in various types of wet or moist habitats, such as banks of lowland rivers, shores of fishponds and other artificial water reservoirs (sometimes even forming small floating mats), on exposed mud in drained lakes and ponds, wet depressions in arable fields and meadows, and in wet places on unpaved forest roads. It is almost equally common all over the country but probably absent or rare from its driest parts: the gaps in north-central Bohemia and southern Moravia may indicate true absences rather than under-recording. In contrast, the gaps in western Bohemia may be due to under-recording. A few records not documented by herbarium specimens may be wrong, based on misidentifications of *A. geniculatus*. In contrast to *A. geniculatus*, this species has probably spread slightly in the last decades (Bureš et al. 2008).

Alopecurus geniculatus (Fig. 9)

Alopecurus geniculatus is native to most of Europe, being absent only from the southern parts of the Iberian Peninsula and of the Balkan Peninsula, as well as from north-eastern European Russia (Hultén & Fries 1986), while the status of the populations in north-western North America is still in dispute (Crins 2007). It has been naturalized in large parts of North America, South America (Soreng et al. 2003), Australia (Simon & Alfonso 2011), and New Zealand (Edgar & Connor 2000). In the Czech Republic it occurs from the lowlands to middle altitudes, with two records over 1000 m a.s.l. in the Krušné hory Mts and Šumava Mts. *Alopecurus geniculatus* prefers open wetland vegetation along water streams, ditches and around water reservoirs, wet meadows and pastures. It is also found on the exposed bottoms of drained water reservoirs but it is less frequent there than *A. aequalis* as its seeds do not survive in strongly anoxic conditions of organic mud (K. Šumberová, in verb.). It is absent from or rare in the driest parts of the Czech Republic. Some records not documented by herbarium specimens may be wrong, based on misidentifications of *A. aequalis*. The species is probably declining (Bureš et al. 2008), and from some quadrants only pre-1950 records exist.

Alopecurus myosuroides (Fig. 10)

Alopecurus myosuroides is native probably to the most of south-western and southern Europe, and western Asia (Hultén & Fries 1986). It is naturalized in other parts of the

World, including North America and South America (Soreng et al. 2003), and Australia and Tasmania (Simon & Alfonso 2011), at some places becoming a noxious weed of winter cereals, mainly on wet soils in humid climates. In the Czech Republic *A. myosuroides* was first recorded in the late 18th century as weed of cereals but it is assumed that it arrived much earlier (Jehlík 1998); it has been therefore classified as an archaeophyte (Pyšek et al. 2012). The records are scattered throughout the country, representing both casual occurrences in railway stations and around grain silos or fishponds, and naturalized populations on moist arable land, mainly in winter cereals but also in other crops. Some of the latter persist for decades, such as those in southern Bohemia north of České Budějovice or in southern Moravia west of Znojmo. The number of records has been slightly growing since 2000.

Alopecurus pratensis (Fig. 11)

Alopecurus pratensis is probably native to most of Europe and western Siberia, in Europe now being absent only from the southern part of the Iberian Peninsula and Greece (Hultén & Fries 1986). As a pasture and forage grass or by chance, it has been introduced to other parts of the World with a temperate climate. It is now naturalized in North America (including Greenland) and South America (Soreng et al. 2003), China and Japan (Conert 1998), and Australia (Simon & Alfonso 2011). In the Czech Republic all specimens examined critically corresponded to the type subspecies. *Alopecurus pratensis* occurs from the lowlands to the mountains, with an altitudinal maximum at 1580 m in Mt Sněžka in the Krkonoše Mts. The occurrences in the highest parts of the Krkonoše Mts and other mountain ranges are likely to represent recent introductions. The species may also have become more widespread at lower altitudes due to cultivation. It prefers humid meadows and pastures, often in floodplains, but it is found in a broad spectrum of other types of grassland and tall-forb communities, in ditches, field margins and on road verges, usually indicating humid soils rich in nutrients. *Alopecurus pratensis* is widespread throughout the country, but probably with different frequencies; most of the gaps in the map are due to under-recording rather than true absences of the species.

Avena fatua (Fig. 12)

Avena fatua is distributed in temperate and subtropical zones of Europe and Asia from the British Isles and Iberian Peninsula eastwards to the Sakhalin Peninsula and Japan, in the south it reaches northern Africa, Saudi Arabia, Iraq, Iran, India, Nepal and China. It has been introduced to Canada, the USA, Argentina, South Africa, Australia and New Zealand. It is probably native to the mountains and foothills of south-western Asia (Thomas & Jones 1976, Thurston & Phillipson 1976, Baum 1977, Hultén & Fries 1986). Currently, its distribution covers most of agricultural regions of the World. In the Czech Republic *A. fatua* is a noxious and widely distributed weed in fields of oats (*Avena sativa*), barley (*Hordeum vulgare*), as well as of other cereals and further crops on arable land. It spreads outside the fields to disturbed grounds, becoming a component of various ruderal vegetation. It mainly occurs in warm areas at altitudes of 200–550 m. As a casual it is found also at higher altitudes but it is absent from mountains (Kropáč 1980). It prefers base-rich soils and avoids acidic soils on silicate bedrock. The present-day distribution of

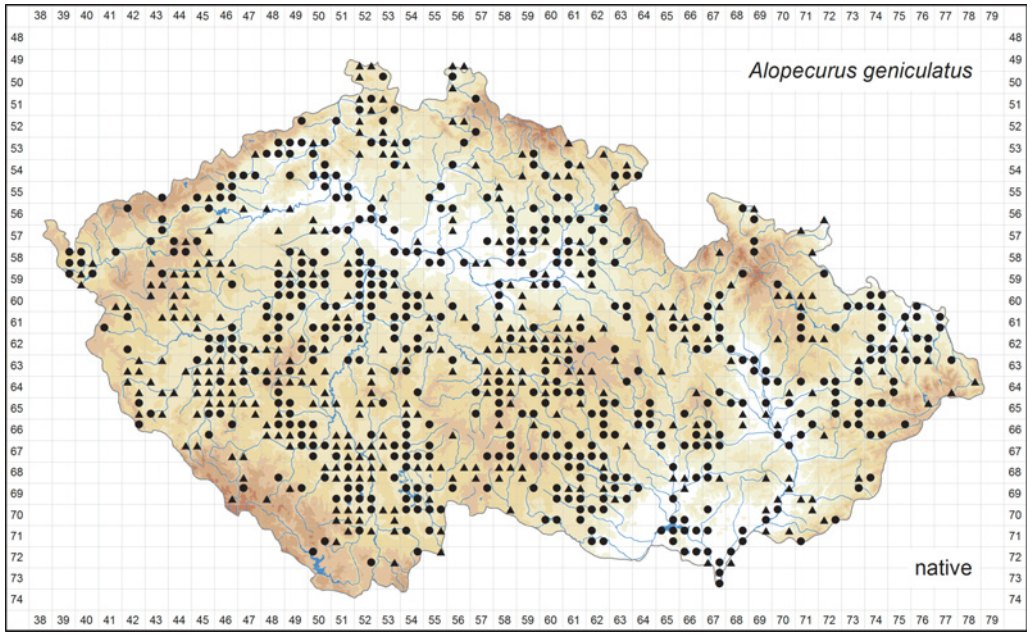

Fig. 9. – Distribution of *Alopecurus geniculatus* in the Czech Republic: ● occurrence documented by herbarium specimens (482 quadrants), ▲ occurrence based on other records (352 quadrants). Prepared by Petr Bureš & Jiří Danihelka.

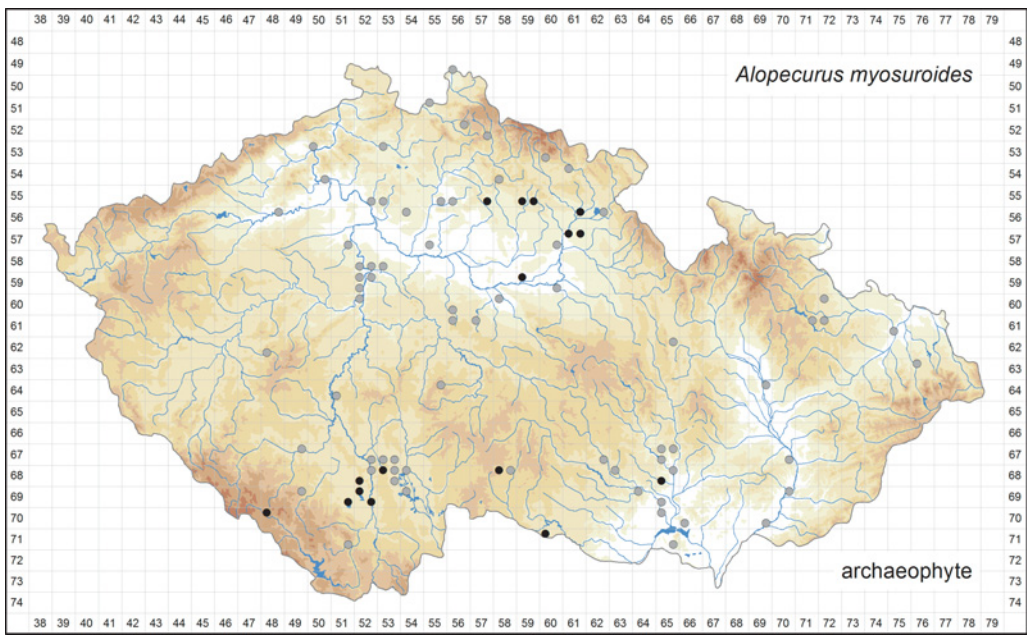

Fig. 10. – Distribution of *Alopecurus myosuroides* in the Czech Republic: ● at least one record in 2000–2015 (16 quadrants), ◍ pre 2000 records only (68 quadrants). Prepared by Petr Bureš & Jiří Danihelka.

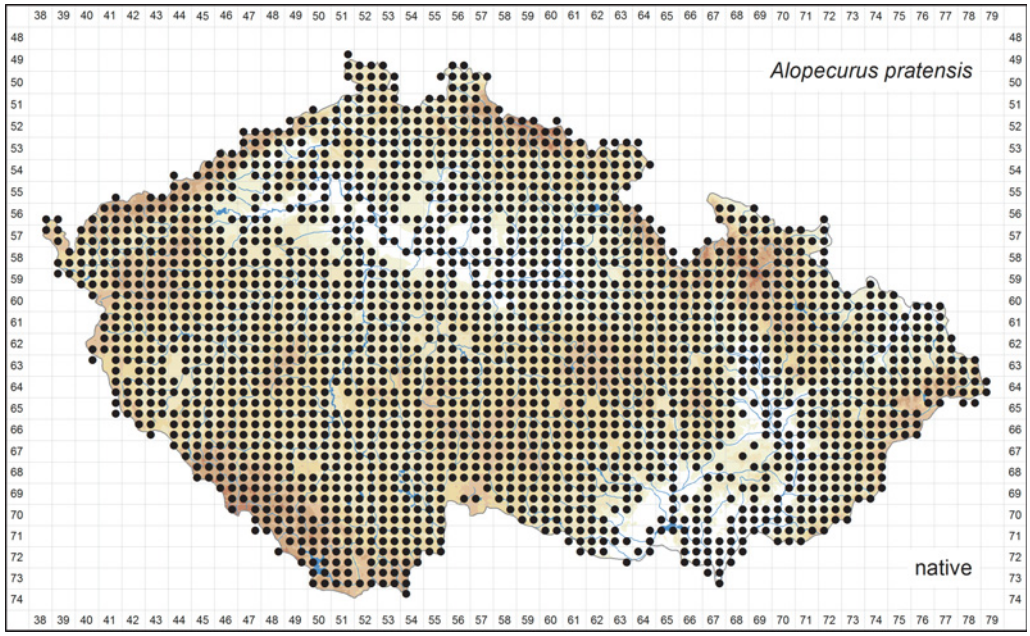

Fig. 11. – Distribution of *Alopecurus pratensis* in the Czech Republic (2257 occupied quadrants). Prepared by Petr Bureš & Jiří Danihelka.

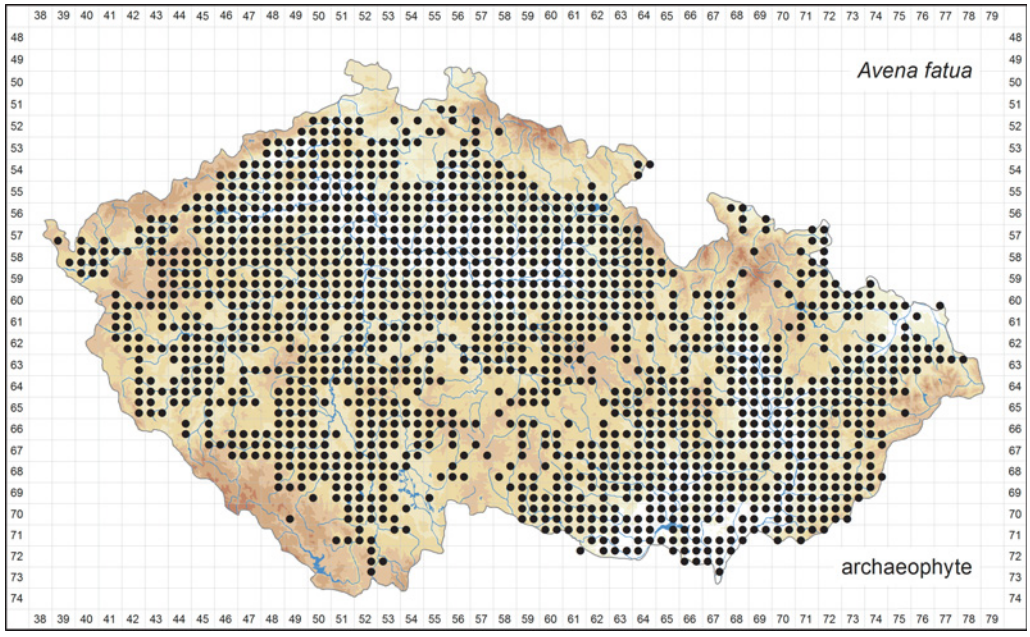

Fig. 12. – Distribution of *Avena fatua* in the Czech Republic (1591 occupied quadrants). Prepared by Jiří Zázvorka.

A. fatua is controlled by climatic, orographic and soil factors, as well as agricultural techniques, including application of herbicides.

Avena sterilis (Figs 13–14)

Avena sterilis occurs in the Mediterranean area and western Asia, extending eastwards to Afghanistan. Furthermore, it has been introduced worldwide to warm areas as a casual or naturalized alien and agricultural weed. It can be invasive in cultivated and disturbed ground and has invaded many regions of the world, predominantly where cereals are grown (Thomas & Jones 1976, Thurston & Phillipson 1976, Baum 1977). It spreads outside fields and occasionally occurs in various types of ruderal or seminatural vegetation. It seldom spreads beyond the limits of Mediterranean flora, being only rarely introduced to central Europe. The species comprises several infraspecific taxa, which most of the current authors (e.g. Conert 1998) assign to two subspecies, i.e. subsp. *sterilis* and subsp. *ludoviciana*, a concept that is also adopted here. The distribution of the subspecies is imperfectly known but some authors (e.g. Thurston & Phillipson 1976) suggest that the prevailing taxon on arable land in the Mediterranean area is subsp. *ludoviciana* rather than subsp. *sterilis*.

Only two herbarium specimens of *Avena sterilis* subsp. *ludoviciana* have been found from the Czech Republic (Fig. 13): one from Prague's city district of Liboc (1968) and the other from the village of Malý Budíkov near the town of Humpolec in south-eastern Bohemia (1965).

There are only three reliable records of *Avena sterilis* subsp. *sterilis* from the Czech Republic (Fig. 14): two for Prague (in city districts of Zlíchov and Michle, in 1922 and 1923, respectively) and one for the town of Litomyšl in eastern Bohemia (dated 1910). It was rarely cultivated in botanical and ornamental gardens in the past.

Avena strigosa (Fig. 15)

Avena strigosa is a species of uncertain origin (Rocha Afonso 1980), sometimes reported to occur naturally in the European Mediterranean area, northern Africa, on the Canary Islands and Crimea (Conert 1998). It used to be cultivated as cereals and fodder crop, and has become naturalized mainly in the Atlantic western, north-western and northern Europe. Only rarely it was introduced in the recent past also into the countries of central and eastern Europe, including the Czech Republic, Slovakia, Austria, Hungary, Ukraine, Belarus, Lithuania, Latvia and Russia, and sometimes cultivated as fodder crop (Baum 1977, Hultén & Fries 1986, Conert 1998). In these countries it is currently rare or extinct. Into the Czech Republic *A. strigosa* was introduced presumably as cereal from western Europe as early as in the Bronze Age and evidently grown before oats (*A. sativa*) started to be cultivated (Kropáč 1981). *Avena strigosa*, as an undemanding species, thrived even in acidic soils poor in nutrients in climatically hard conditions through the Middle Ages up to the half of 19th century. Since then *A. strigosa* was gradually replaced by more profitable oats *A. sativa* but persisted for almost a century as a rare weed. The common cultivation of *A. strigosa* was documented in the historical records from 15th to 19th century (Kropáč 1981). Herbarium specimens were collected within the period 1834–1946. The last record comes from the Radhošťské Beskydy Mts in eastern Moravia. It occurred mainly at altitudes between 500 and 800 m.

Bolboschoenus maritimus agg. (Fig. 16)

The map of the *Bolboschoenus maritimus* agg. includes records of *B. maritimus*, *B. planiculmis*, *B. laticarpus*, *B. yagara* and *B. glaucus* (these maps were based only on herbarium specimens or our own field records), and also records of plants which could not be identified to species level (specimens without well developed fruits) and earlier field records of "*B. maritimus*". This species aggregate corresponds to the broadly circumscribed *B. maritimus* (Casper & Krausch 1980), *Scirpus maritimus* (Schultze-Motel 1980b) and *S. maritimus* subsp. *maritimus* (DeFilipps 1980). The species of the *B. maritimus* group are distributed mainly in Europe: they occur in coastal areas from the Baltic and North Sea along the Atlantic coast to the Mediterranean region, and also in inland saline and freshwater habitats, concentrated in the lowlands and the floodplains of large rivers (Hroudová et al. 2007). Outside Europe, species of the *B. maritimus* agg. are found in northern Asia eastwards to the Russian Far East and Japan, and also in western and central Asia, Pakistan and India (Tatanov 2004), in Africa (Browning et al. 1998a, b), and probably as introduced in North America (*B. maritimus* subsp. *maritimus* and *B. glaucus*; Smith 2002). The *Bolboschoenus maritimus* group is distributed in wetlands over the whole of the Czech Republic, predominantly in lower altitudes. Comparison of the maps of the individual species of this aggregate reveals differences in their distribution, stemming from their different ecology.

Bolboschoenus glaucus (Fig. 17)

Bolboschoenus glaucus is a thermophilous species, in Europe found mainly in its Mediterranean part; northwards it reaches Hungary and Romania, with an isolated occurrence in the city of Prague in the Czech Republic (Hroudová et al. 2007). Most of its distribution range is outside Europe: in Africa (mainly sub-Saharan Africa; Browning et al. 1998a) and Asia (in the belt from the Middle East south of the Himalaya Mts to India and around the Caspian Sea; Browning & Gordon-Gray 2000). It has been introduced to North America (Smith 2002). It is found in freshwater wetlands, frequently as a weed in rice fields, but it sometimes occurs in brackish wetlands in river mouths. The only locality of *B. glaucus* in the Czech Republic is in a former brick-clay pit in the Prague city district of Košíře, where it inhabits a flooded depression (Ducháček et al. 2006). The species was first collected there in 1925 and the population still exists; it was certainly unintentionally introduced to the site but it has not spread since then. Its survival there has been probably enabled by a seepage spring, which protects it from drought during the summer and from damage by frost during the winter.

Bolboschoenus laticarpus (Fig. 18)

Bolboschoenus laticarpus is a taxon of hybrid origin, with assumed parentage of *B. yagara* and *B. planiculmis* (Marhold et al. 2004). It is a freshwater plant found mainly in central Europe, reaching the sea coast only along some large rivers such as the Wisła, Odra and Elbe (Hroudová et al. 2007). Outside Europe it has been found in central Asia, Russia (rarely in Siberia and the Russian Far East), China (Tatanov 2007) and Japan (Hayasaka & Ohashi 2002 as *B. fluviatilis* subsp. *yagara* with type B achenes). Typical habitats of *B. laticarpus* are along river shores and in floodplains, fishponds and other reservoirs,

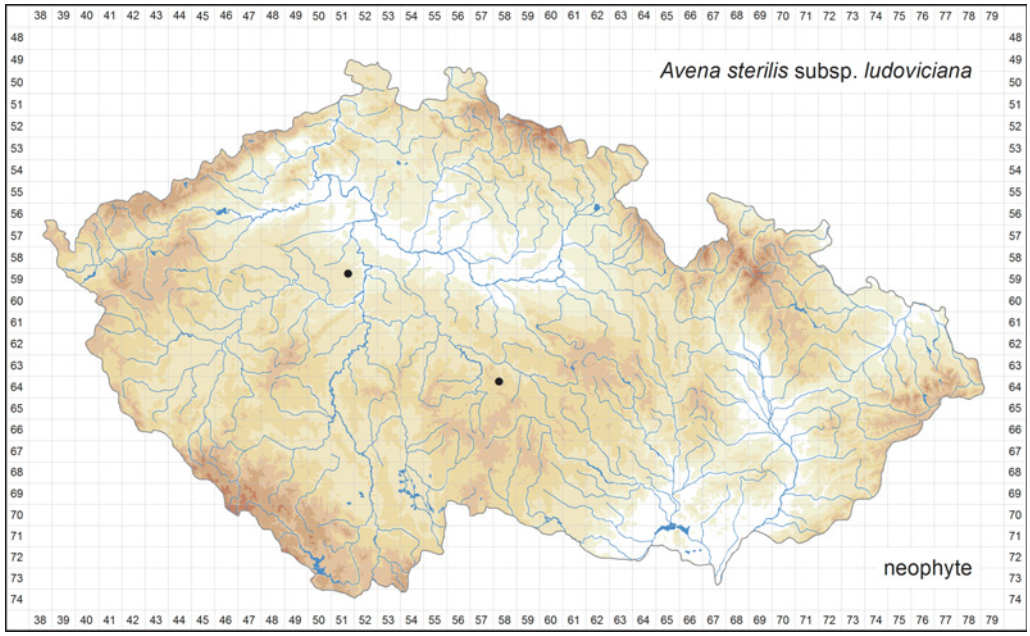

Fig. 13. – Distribution of *Avena sterilis* subsp. *ludoviciana* in the Czech Republic (2 occupied quadrants). Prepared by Jiří Zázvorka.

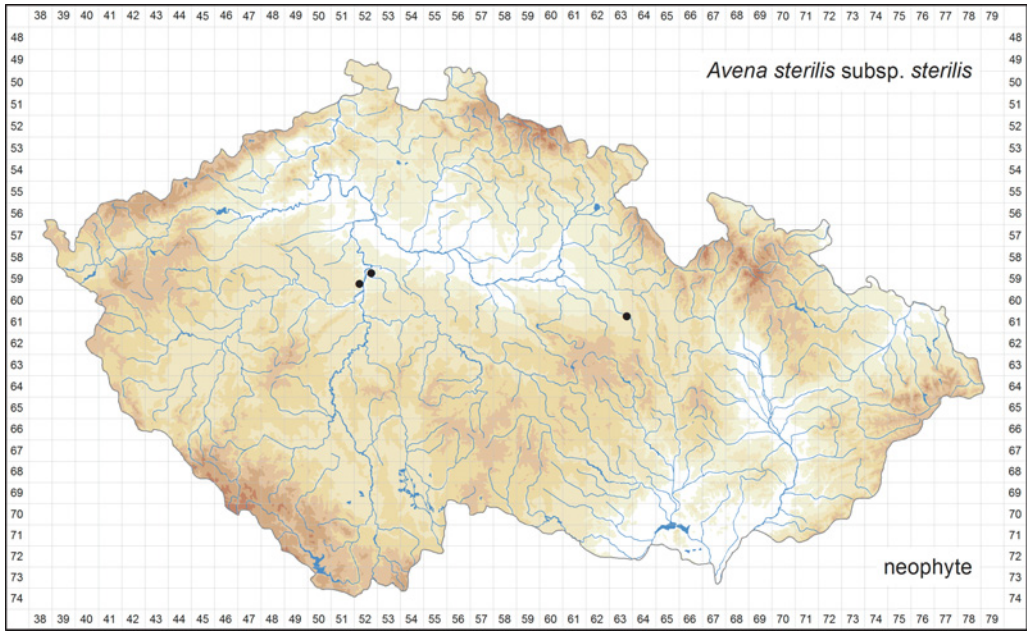

Fig. 14. – Distribution of *Avena sterilis* subsp. *sterilis* in the Czech Republic (3 occupied quadrants). Prepared by Jiří Zázvorka.

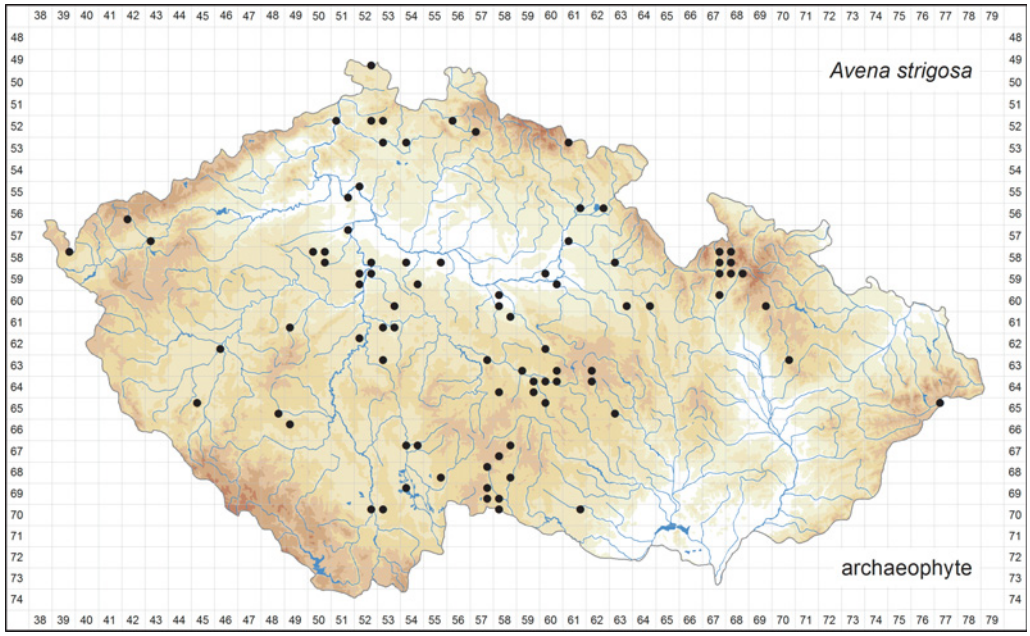

Fig. 15. – Distribution of *Avena strigosa* in the Czech Republic (85 occupied quadrants). Prepared by Jiří Zázvorka.

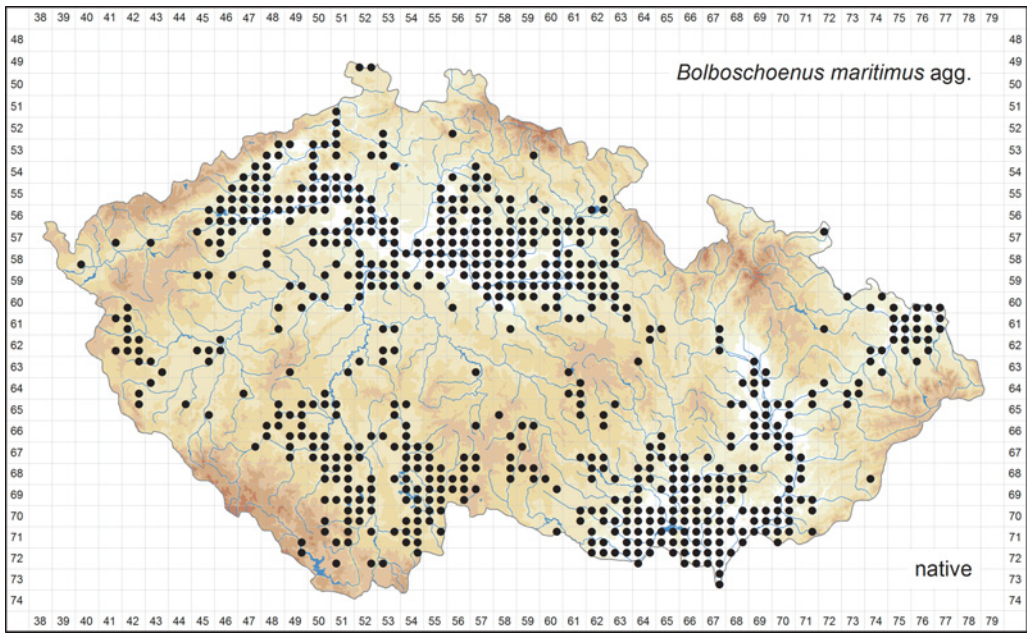

Fig. 16. – Distribution of *Bolboschoenus maritimus* agg. in the Czech Republic (663 occupied quadrants). Prepared by Zdenka Hroudová & Michal Ducháček.

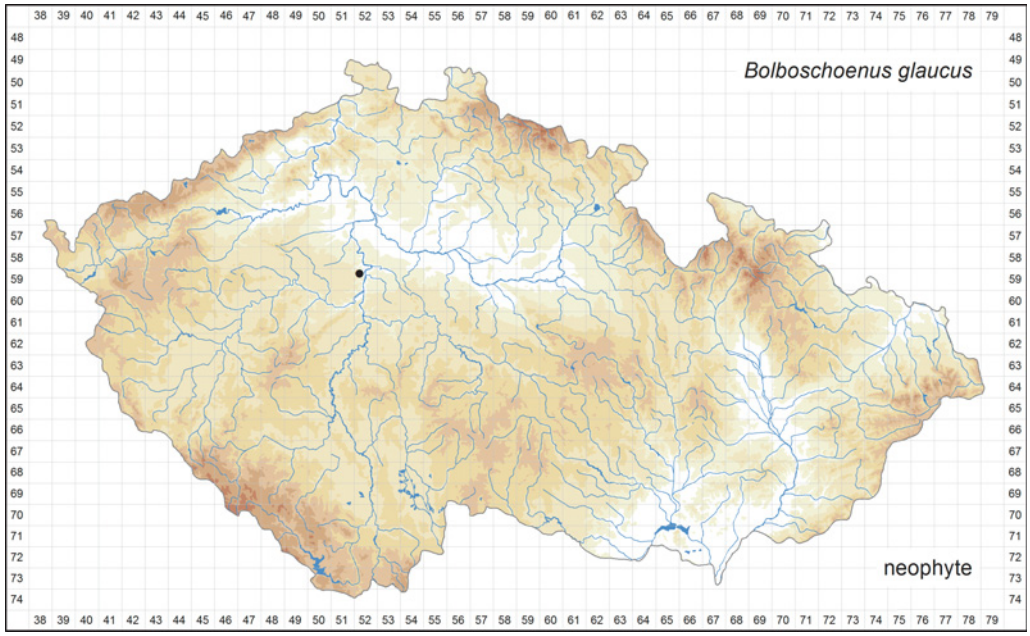

Fig. 17. – Distribution of *Bolboschoenus glaucus* in the Czech Republic (1 occupied quadrant). Prepared by Zdenka Hroudová & Michal Ducháček.

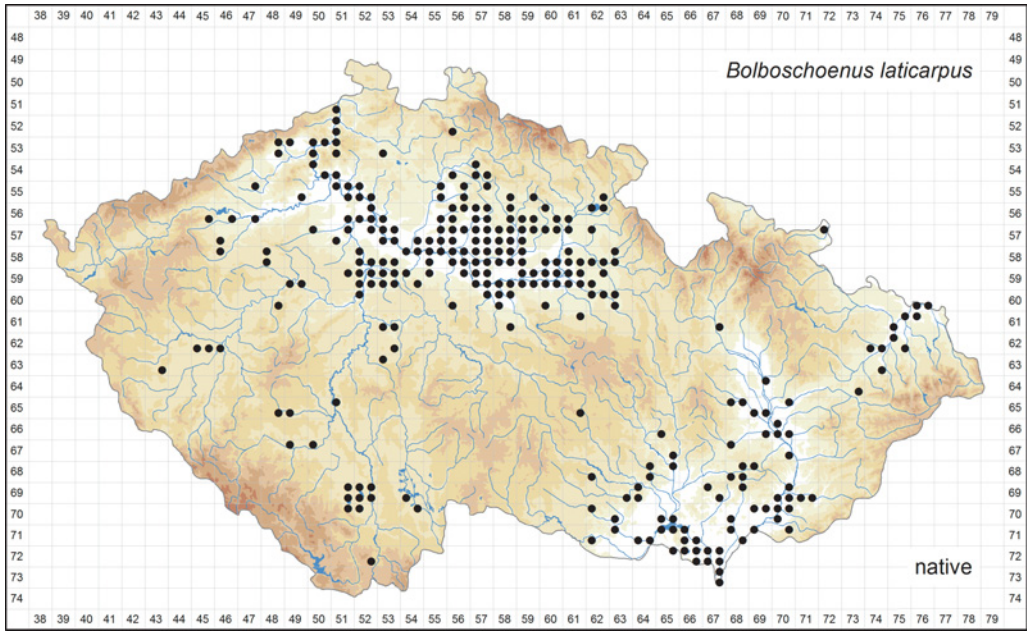

Fig. 18. – Distribution of *Bolboschoenus laticarpus* in the Czech Republic (281 occupied quadrants). Prepared by Zdenka Hroudová & Michal Ducháček.

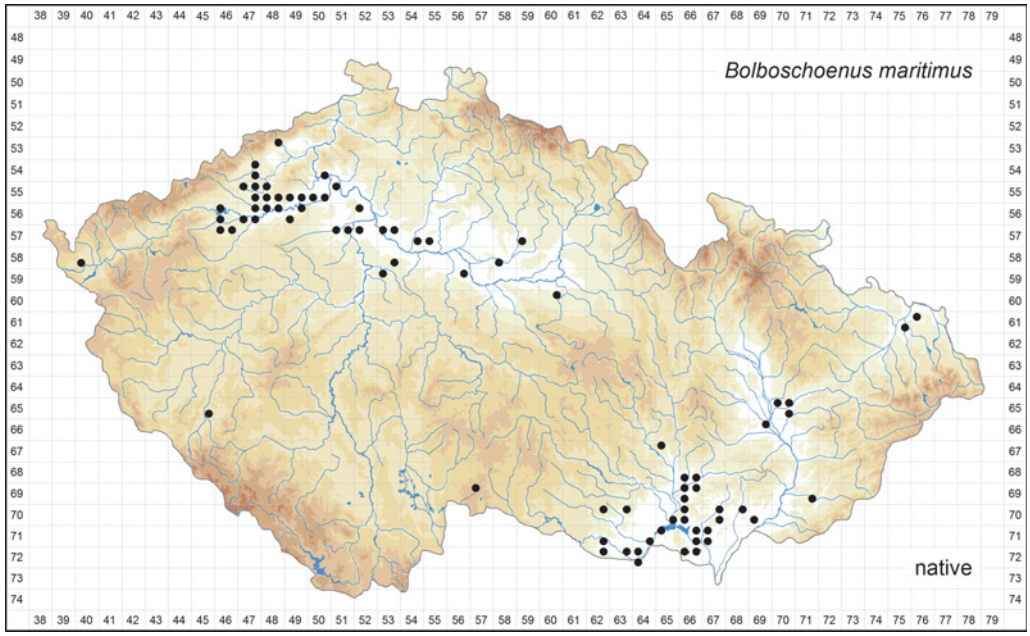

Fig. 19. – Distribution of *Bolboschoenus maritimus* in the Czech Republic (78 occupied quadrants). Prepared by Zdenka Hroudová & Michal Ducháček.

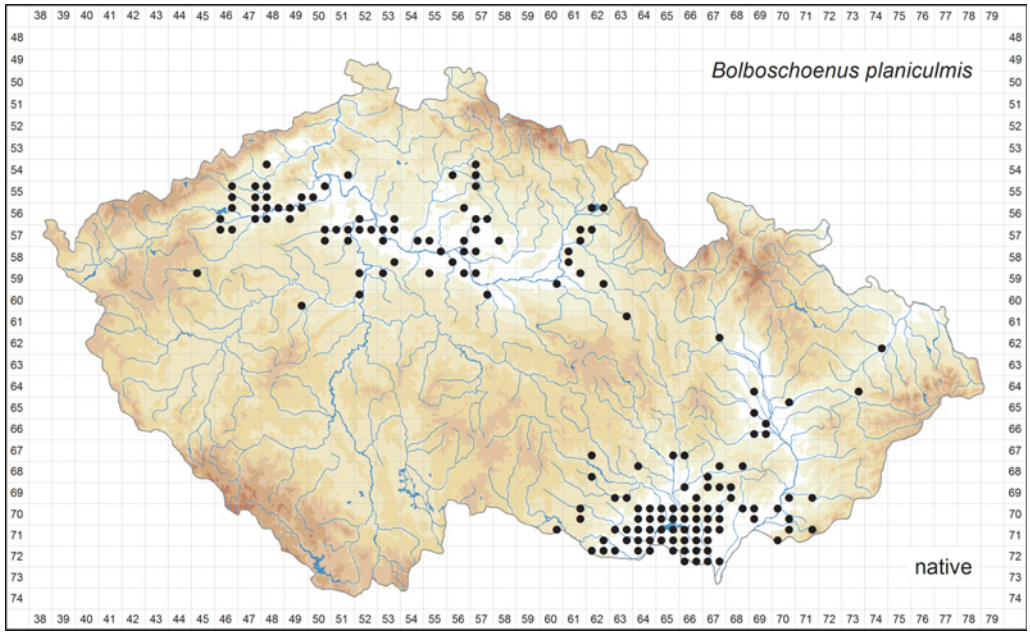

Fig. 20. – Distribution of *Bolboschoenus planiculmis* in the Czech Republic (158 occupied quadrants). Prepared by Zdenka Hroudová & Michal Ducháček.

temporarily flooded field depressions in wet meadows, fields or wet ruderal sites. Due its wide ecological amplitude *B. laticarpus* is the most frequent species of the genus in the Czech Republic. It is found in lowlands in warmer parts of the country, mainly in the Labe river basin, central Bohemia and southern Moravia, and scattered also over the rest of the country (Ducháček et al. 2007). *Bolboschoenus laticarpus* is well adapted to mineral-rich grounds, but in the field habitats on slightly saline substrates in southern Moravia and elsewhere may be replaced by *B. planiculmis*. Due to changes in agricultural techniques it has become a noxious weed of arable land, mainly of maize fields (Mikulka & Zákravský 2007). *Bolboschoenus laticarpus* is best able to utilize the increasing nutrient input, which gives it an advantage over other members of the genus in fertilized arable land (Hroudová et al. 2014).

Bolboschoenus maritimus (Fig. 19)

Bolboschoenus maritimus occurs mainly in Europe. It is a halophytic species, inhabiting salt marshes along the European coast from Scandinavia to the Mediterranean region, and also inland saline habitats (Hroudová et al. 2007). Outside Europe it has been found in Asia (from western Asia to central Asia and in Siberia; Tatanov 2007) and in southern Africa (Browning & Gordon-Gray 2000) and introduced to North America (Smith 2002). In the Czech Republic it is found on mineral-rich soils mainly in north-western Bohemia and southern Moravia, where it occurs in remnants of former salt-marshes, in wet meadows and wet field depressions (Ducháček et al. 2006). It is also found at a single locality in western Bohemia (salt marsh Soos), while the records in the town of Klatovy in south-western Bohemia and from the vicinity of the town of Nová Bystřice, both from secondary habitats, represent recent introductions or colonizations. As a facultative halophyte, *B. maritimus* can also survive in non-saline habitats, for instance at some sites in the Labe river basin and in the city of Ostrava in north-western Moravia. However, this species is not able to utilize nutrients as well as freshwater plants, and thus may be suppressed there by stronger freshwater competitors (Hroudová et al. 2014). Another possible explanation of the occurrence of *B. maritimus* in non-saline habitats may be hybridization between *B. maritimus* and *B. planiculmis* in the regions where they co-occur. Morphologically intermediate individuals are found in the populations, and the individuals of hybrid origin may also differ in their ecological requirements. *Bolboschoenus maritimus* is endangered by the destruction of natural habitats, and is therefore classified as endangered (Grulich 2012).

Bolboschoenus planiculmis (Fig. 20)

Bolboschoenus planiculmis is distributed in Eurasia, from central Europe eastwards through eastern Europe, central Asia and Siberia between 40°N and 60°N reaching the Russian Far East; it occurs also in China, Japan and in the Korean Peninsula (Egorova & Tatanov 2003). The overall distribution range of *B. planiculmis* overlaps with that of *B. yagara*; however, the distribution of *B. planiculmis* is more continuous. *Bolboschoenus planiculmis* is an ecological vicariant of *B. yagara*: while *B. yagara* is typical of littorals of standing waters on mineral-poor grounds, *B. planiculmis* inhabits mostly temporarily flooded field depressions in the steppe zone and wet mineral-rich to saline habitats around lakes. In Europe *B. planiculmis* is generally an inland species, being absent from

the sea coast (Hroudová et al. 2007). In the Czech Republic it reaches the western border of its continuous distribution range. It inhabits mainly secondary habitats, including temporarily flooded depressions in arable fields, wet fallow land, depressions in ruderal sites, shores of fishponds and other reservoirs used for fishing or swimming. Like *B. laticarpus*, *B. planiculmis* also occurs as a weed of arable land. However, the latter prefers mineral-rich grounds, and also inhabits some saline wetlands (Hroudová et al. 1999). This is clearly reflected in its distribution, which overlaps to some extent with that of *B. maritimus*: *B. planiculmis* is also concentrated to southern Moravia and north-western Bohemia (with mineral-rich grounds), but more frequently occurs as a weed in the Labe river basin and central Bohemia, together with *B. laticarpus* (Ducháček et al. 2006). The destruction of saline habitats and their conversion to arable land in southern Moravia caused the decline of *B. maritimus*, which was gradually replaced by *B. planiculmis*, well adapted to disturbances. At present, *B. planiculmis* prevails in southern Moravia also in saline habitats.

Bolboschoenus yagara (Fig. 21)

In Europe *Bolboschoenus yagara* is distributed mainly in its central part, particularly in fishpond basins, e.g. in southern Bohemia in the Czech Republic, in Upper Lusatia and Thuringia in Germany, in Lower Silesia in Poland, as well as in Styria (near the city of Graz) and Carinthia (near the city of Klagenfurt) in Austria. With scattered localities it reaches France in the west, southern Sweden in the north and southern Austria in the south (Hroudová et al. 2007). It is found in Ukraine and European Russia, and with scattered occurrences between 40°N and 60°N in Siberia reaching the Russian Far East (Tatanov 2003); it also occurs in Japan (Hayasaka & Ohashi 2002) and China (Wu et al. 2012). In central Europe *B. yagara* grows mainly in fishponds and other reservoirs, only exceptionally in other types of wetland, including flooded depressions on restored spoil tips. Littoral habitats with fluctuating water levels on sandy or acidic substrates are the most suitable habitats for *B. yagara* (Hroudová et al. 1999). In the Czech Republic it is found mainly in the South Bohemian fishpond basins, where it is particularly abundant, in western Bohemia and north-eastern Moravia and Silesia (Hroudová et al. 2005, Ducháček et al. 2007). It is rare in areas with warm climates, and almost absent from warm areas with nutrient-rich substrates, such as north-western Bohemia and southern Moravia, as it avoids mineral-rich grounds (Hroudová et al. 1999). It is endangered by intensification of fishpond management and thus it is classified as vulnerable (Grulich 2012).

Carex davalliana (Fig. 22)

Carex davalliana has rather a small distribution range including mainly central Europe. Its western distributional limit runs through France, the northern one through northern Germany. In Eastern Europe it occurs in Poland, the Baltic countries and Russia in the vicinity of Saint Petersburg. The eastern limit of its distribution runs through Belarus, Ukraine and eastern Romania, while southernmost localities are situated in central Italy, Albania and northern Greece (Meusel et al. 1965, Hultén & Fries 1986, Koopman 2011). It occurs also in central Anatolia (Nilsson 1985). Typical habitats of *C. davalliana* are calcareous fens and acidic moss-rich fens with calcium-tolerant peat mosses, e.g. *Sphagnum warnstorfii* and *S. teres* (Hájek & Hájková 2011b); it grows more rarely in various types of hygrophilous grasslands, such as intermittently wet *Molinia* meadows (Řezníčková

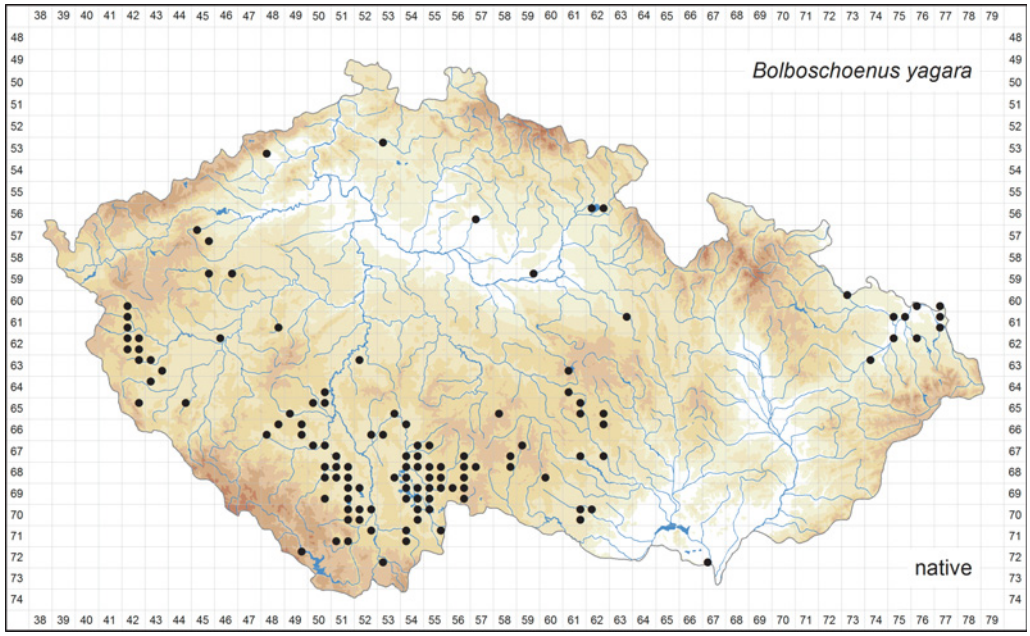

Fig. 21. – Distribution of *Bolboschoenus yagara* in the Czech Republic (121 occupied quadrants). Prepared by Zdenka Hroudová & Michal Ducháček.

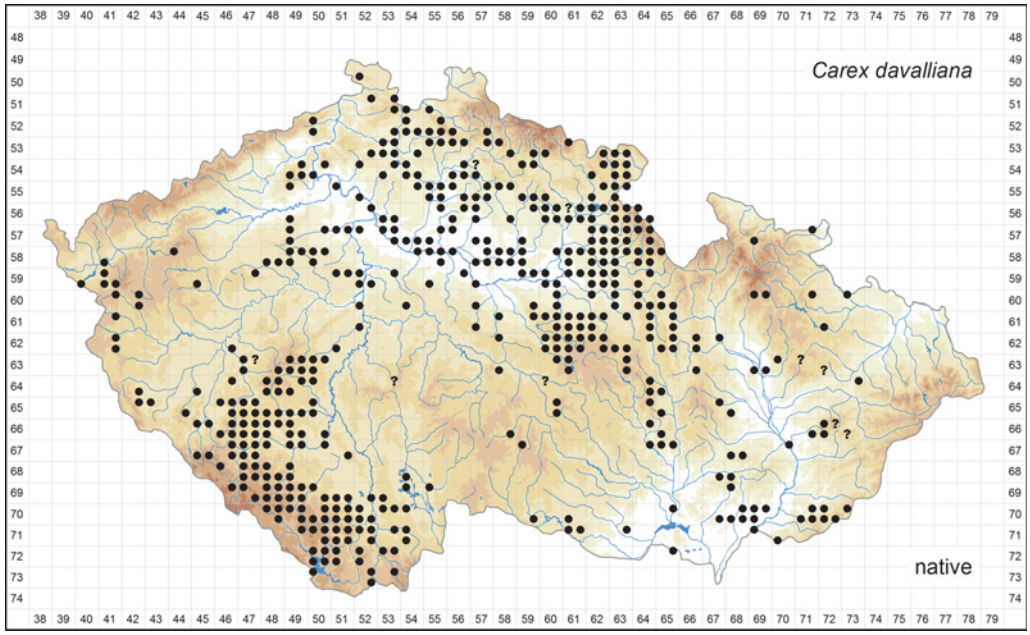

Fig. 22. – Distribution of *Carex davalliana* in the Czech Republic (479 occupied quadrants). Prepared by Vít Grulich & Radomír Řepka.

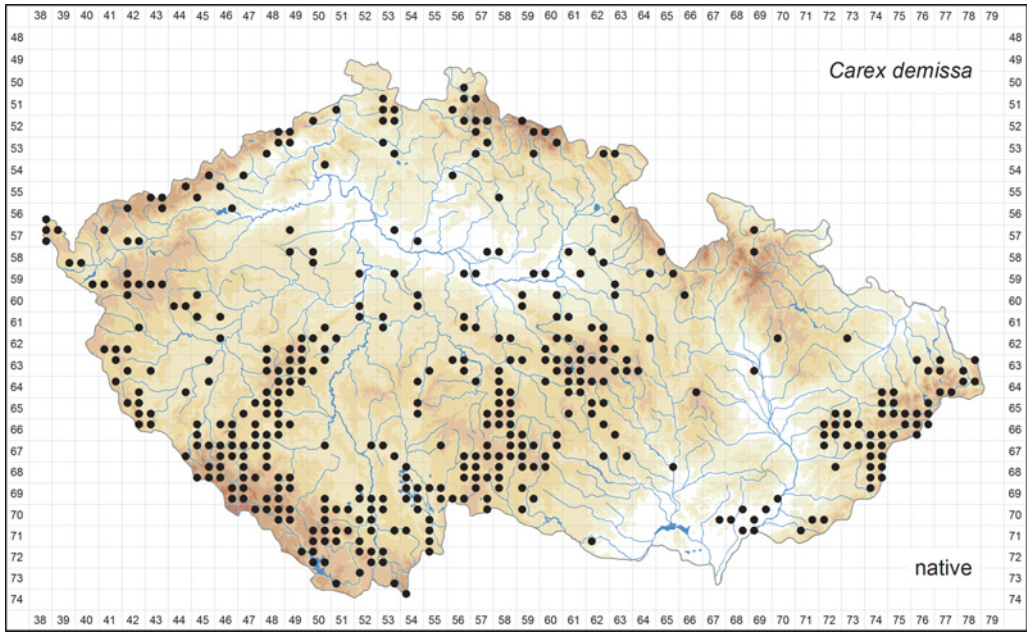

Fig. 23. – Distribution of *Carex demissa* in the Czech Republic (420 occupied quadrants). Prepared by Jitka Štěpánková

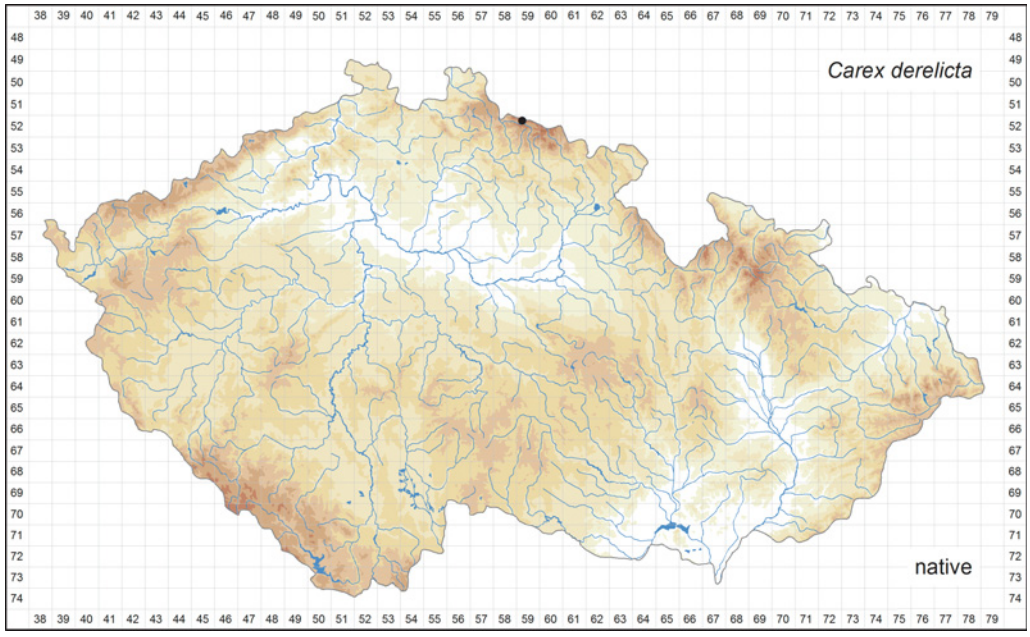

Fig. 24. – Distribution of *Carex derelicta* in the Czech Republic (1 occupied quadrant). Prepared by Jitka Štěpánková.

2007). In the past it was rather common in south-western Bohemia, northern and eastern Bohemia, while being rare in western Bohemia, the Českomoravská vrchovina highlands and the whole of Moravia. *Carex davalliana* is very sensitive to drainage, eutrophication and abandonment. It has vanished from a majority of its former localities, therefore it is classified as endangered (Grulich 2012).

Carex demissa (Fig. 23)

Carex demissa is distributed mainly in Europe, being reported from most of European countries (Meusel et al. 1965, Hultén & Fries 1986, Hynda & Danylyk 1994, Egorova 1999). It rarely occurs along the eastern coast of North America, where it has probably been introduced (Crins & Ball 1989), as well as in New Zealand (Healy & Edgar 1980). In the Czech Republic it mainly occurs in humid basins and mountains that are rich in bogs, where it is found in habitats permanently saturated with water and poor to moderately rich in minerals. It grows in managed fen meadows, bogs at fishpond margins and subalpine springs, developed on non-calcareous bedrock, and only rarely on calcareous fens. It often occupies poorer clay-sandy soils of moist tracks and ditches in disturbed pastures (Havlíčková 1983). *Carex demissa* is also able to spread quickly on denuded soils of disturbed moist habitats. It is mainly found in colline and montane vegetation belts of central and southern Bohemia, in the mountains along the country's borders in northern and western Bohemia, in the Českomoravská vrchovina highlands and in the mountains of eastern Moravia. It is rare in warm lowland regions of central Bohemia and southern Moravia. It occurs at altitudes from about 190 m to 1200 m. Owing to its wide ecological amplitude and ability to colonize new habitats, *C. demissa* seems to be the least threatened species of the *C. flava* group. Only revised herbarium specimens were accepted, therefore the map is incomplete.

Carex derelicta (Fig. 24)

Carex derelicta is considered endemic to the Krkonoše Mts (Holub 1999, Štěpánková 2008). It grows in two nearby sites in the Velká Kotelní jáma glacial cirque. The type locality is a small subalpine spring in the upper part of the Velká Kotelní jáma (at altitudes about 1230–1380 m) near the crest separating two glacial circles, Velká Kotelní jáma and Malá Kotelní jáma. *Carex derelicta* grows there on moist flats consisting of muscovitic albitic mica-schist, located under an outcrop of base-rich rocks such as crystalline limestone and erlan, apparently leaching Ca^{2+} ions. Another population, occupying a smaller area and poorer in individuals, was discovered below the Harrachovy plotny flats (at about 1240–1280 m a.s.l.) as late as in 2010. *Carex derelicta* is classified as critically threatened because of its rarity (Grulich 2012). Both its sites are protected, being included in the first zone of the Krkonoše National Park. Possible threats include the low number of individuals, which are confined to a small area, and potential hybridization with related species native to the Krkonoše Mts.

Carex dioica (Fig. 25)

Carex dioica is a boreal species: in Europe it is distributed mainly in its western, northern and central parts; the southern limits of its distribution run through central Spain, northern

Italy, Slovenia and central Romania. Outside Europe it has been recorded throughout Siberia as far as the Lena river (Hultén & Fries 1986, Egorova 1999, Koopman 2011). In other parts of northern Asia and North America it is replaced by the closely related *C. gynocrates* (Egorova 1999, Ball & Reznicek 2002). In the Czech Republic *C. dioica* prefers acidic moss-rich fens with calcicolous species and calcium-tolerant peat mosses and some *Sphagnum* species, such as *S. warnstorfii* (Hájek & Hájková 2011b). It occurs mainly in south-western Bohemia and in the Žďárské vrchy and Jihlavské vrchy hills; scattered localities are known from western, central and northern Bohemia. It is very rare in Moravia, only isolated localities lie near the Bohemian border and in Silesia along the border to Poland. This species has strongly declined as a result of habitat destruction, eutrophication and changes in management. It has disappeared from many phytogeographical districts where it had previously occurred and today it is known at about 30 sites. It is classified as critically threatened (Grulich 2012).

Carex distans (Fig. 26)

Carex distans is a European-temperate species, reaching southern Scandinavia in the north, northern Africa in the south and south-western Asia in the east. It is also reported from North America, where it has probably been only introduced (Meusel et 1965, Hultén & Fries 1986). It grows in open calcareous fens or in periodically flooded depressions in various degradation stages of fens, in moderately saline grasslands, bottoms of fishponds on mineral-rich to slightly saline soils and on calcareous tufa springs, which occur in warm areas with calcium-rich bedrock (Hájek & Hájková 2011a). In the Czech Republic *C. distans* is mainly found in the warm lowlands of northern, central and eastern Bohemia and in southern Moravia. A few isolated localities are also known from middle altitudes in western and south-western Bohemia, eastern Moravia and Silesia. It occurs mainly at altitudes of 160–700 m. It is classified as vulnerable (Grulich 2012).

Carex flava (Fig. 27)

Carex flava is a circumpolar species, widespread in Europe and northern Africa, western Asia and western and eastern parts of North America (Meusel et al. 1965, Hultén & Fries 1986). Its distribution range exhibits a large gap (or a lack of data) in central and eastern Asia. In Europe it is widely distributed from the Iberian Peninsula and the British Isles (Davies 1955) in the west to the European part of Russia in the east (Egorova 1999). It is scattered in southern Europe, being confined to mountains, whereas in northern Europe it reaches the Arctic Circle (Palmgren 1959). In western Asia it is reported from the Caucasus, western Siberia, Turkey and Iran (Meusel et al. 1965, Egorova 1999). *Carex flava* is the most frequent member of the *C. flava* group in the Czech Republic. It mainly occurs in various types of fens and bogs. It grows on mineral-rich, neutral to basic soils with a high ground-water level. On the silicate substrates it occurs in springs, moderately rich in nutrients (Havlíčková 1983). It is distributed almost throughout the country, but with varying frequencies. It is most common on the cretaceous sediments in eastern Bohemia and on flysch in the Western Carpathians in eastern Moravia, and is also found in the forested areas of central and southern Bohemia, where small fens or slope springs are preserved. It is almost absent from dry areas of north-western Bohemia and southern Moravia. Generally, throughout the country it is considerably less frequent in the areas

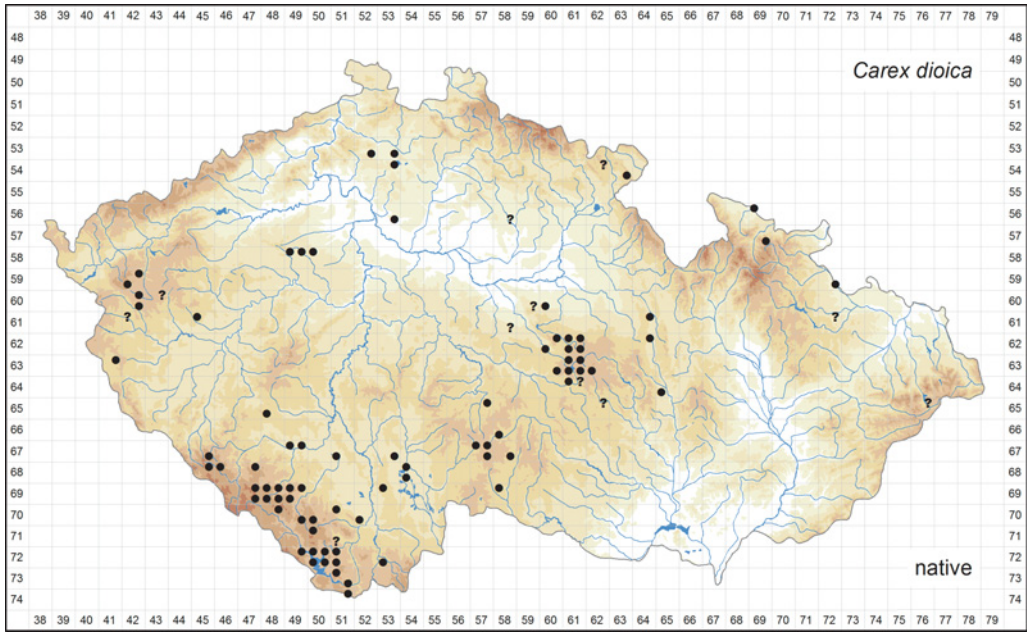

Fig. 25. – Distribution of *Carex dioica* in the Czech Republic (79 occupied quadrants). Prepared by Vít Grulich & Radomír Řepka.

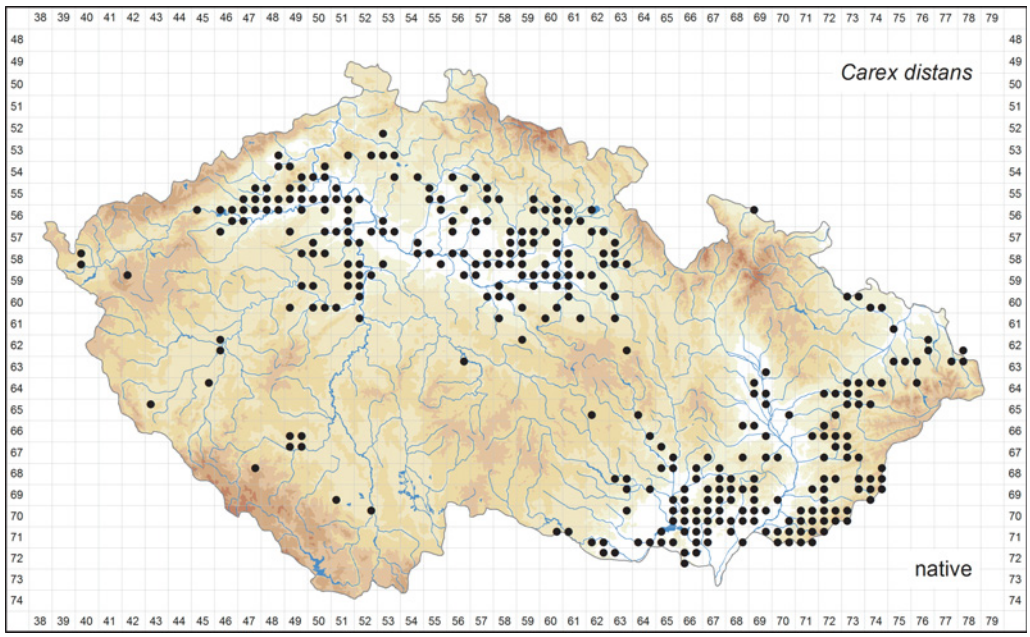

Fig. 26. – Distribution of *Carex distans* in the Czech Republic (329 occupied quadrants). Prepared by Jitka Štěpánková.

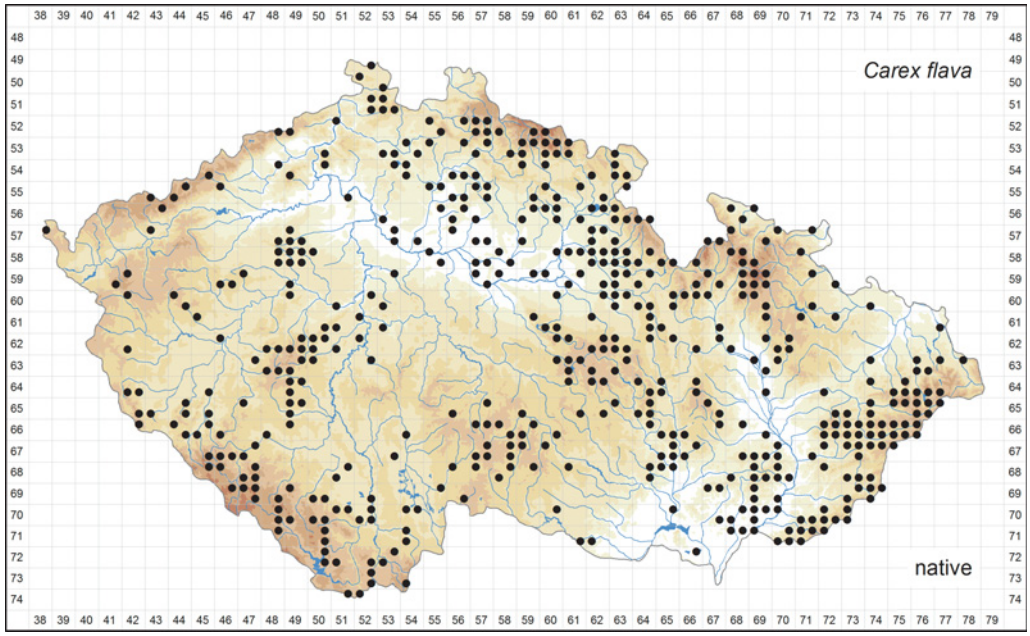

Fig. 27. – Distribution of *Carex flava* in the Czech Republic (511 occupied quadrants). Prepared by Jitka Štěpánková.

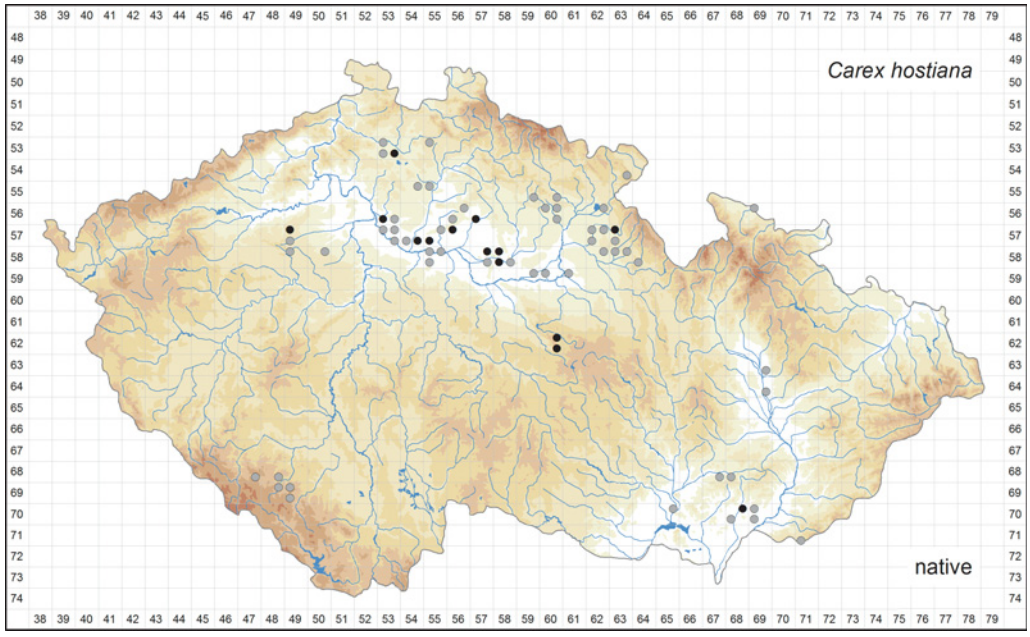

Fig. 28. – Distribution of *Carex hostiana* in the Czech Republic: ● at least one record in 2000–2015 (14 quadrants), ● pre 2000 records only and/or extirpated occurrences (54 quadrants). Prepared by Jitka Štěpánková.

with prevailing cultivated land where its suitable habitats have been destroyed. It occurs at altitudes from about 180 m to 1400 m. The distribution map is based mainly on revised herbarium specimens because of frequent misidentifications.

Carex hostiana (Fig. 28)

Carex hostiana exhibits an amphi-atlantic distribution pattern. In Europe it is relatively widespread in lowlands, occurring from the British Isles in the west to southern Scandinavia in the north and to Baltic regions and western Ukraine in the east (Egorova 1999). It is rare in southern Europe, extending from the French Pyrenees to the Balkan Peninsula (Meusel et al. 1965), having several localities also in western Asia (Fagerström 1967). In North America it is restricted to western Newfoundland and several adjacent isles (Crins & Ball 1989). It grows in open calcareous fens and small spring wetlands on mineral-rich substrates. In the Czech Republic *C. hostiana* is found mainly in central and eastern Bohemia, particularly in the middle and eastern parts of the Labe river basin and in the adjacent hills. In Moravia, it is confined to a small area in its south-eastern part; isolated localities in central and northern Moravia, as well as those in south-western Bohemia, have vanished. It occurs at altitudes from about 180 m to 800 m. *Carex hostiana* has dramatically declined since the 19th century due to drainage and conversion of fens into arable land. Nowadays, *C. hostiana* is extinct in southern Bohemia (Štěpánková et al. 2013) and nearly so in Moravia. Currently it is classified as endangered (Grulich 2012).

Carex lepidocarpa (Fig. 29)

Carex lepidocarpa is distributed mainly in the Atlantic regions of Europe (Davies 1955), from the British Isles to central Europe, and sparsely as far as the European part of Russia (Egorova 1999). In southern Europe it occurs in the mountains between the Iberian Peninsula in the west and the Balkan Peninsula in the east (Davies 1955), in northern Europe it reaches southern Norway, Sweden and Finland (Hedrén 2003). It also occurs in northern Africa, western Asia and western North America (Palmgren 1959, Meusel et al. 1965, Hultén & Fries 1986). In the Czech Republic *C. lepidocarpa* mostly grows on calcareous rich fens, fen grasslands or small springs on calcium-rich bedrock in warm lowlands and very rarely in subalpine springs. Most of its localities are situated in the middle Labe river basin in central Bohemia and in warm lowland regions of eastern Bohemia. It is very rare in Moravia. It occurs at altitudes from about 180 m to 1400 m. It has disappeared from many of its sites particularly in warm lowlands and is therefore classified as endangered (Grulich 2012).

Carex obtusata (Fig. 30)

Carex obtusata is a holarctic species with a large circumboreal distribution range including Siberia and Pacific western North America (Meusel et al. 1965, Hultén & Fries 1986, Ball & Reznicek 2002). In Europe it is a relict species from the late glacial or early postglacial periods. It is known only from scattered localities in eastern and central parts of this continent in central Russia, Belarus, western Ukraine, north-eastern Germany and southern Sweden (Schultze-Motel 1980a, Koopman 2011). It was discovered in the Czech Republic as late as in 2004 (Řepka 2005, 2008); the first specimen was collected

about a decade earlier but was misidentified as *C. supina*. Nowadays *C. obtusata* is known from three sites situated west of the town of Prostějov in central Moravia (Řepka & Grulich 2014). It is found there in small islands of dry grassland and scrub surrounded by arable land. It is classified as critically threatened because of its rarity (Grulich 2012).

Carex oederi (Fig. 31)

Carex oederi is a circumpolar species (Meusel et al. 1965, Hultén & Fries 1986). It occurs in most countries of Europe and from western Asia through Iran and Afghanistan as far as eastern Siberia. It is also found in northern Africa (Davies 1955, Egorova 1999), northern and eastern North America (Crins & Ball 1989) and in several isolated occurrences in the Southern Hemisphere (Meusel et al. 1965). Of the three currently recognized varieties (Hedrén 2003), only *C. oederi* var. *oederi* is found in the Czech Republic. It occurs on shores of fishponds and flooded sand pits and in calcium-rich fens. It even tolerates a moderate salt content and can therefore pass into subhalophilous meadows (Havlíčková 1983). It mainly occurs in eastern and middle Labe river basin in eastern and central Bohemia, in the Doksy region in northern Bohemia, the Třeboňská pánev basin in southern Bohemia, the Českomoravská vrchovina highlands and south-eastern Moravia. It occurs at altitudes from about 180 m to 700 m. It has considerably declined in many parts of the country, particularly in warm lowland regions of central and eastern Bohemia, due to drainage and conversion to arable land, and is therefore classified as endangered (Grulich 2012).

Carex pauciflora (Fig. 32)

Carex pauciflora is a holarctic species with a circumboreal distribution. In Europe it is found mainly in Scandinavia and northern Russia, being confined in central and southern Europe to the high mountains (Meusel et al. 1965, Hultén & Fries 1986, Koopman 2011). A similar distribution pattern is known from North America (Ball & Reznicek 2002). In the Czech Republic it is usually found in mountain bog vegetation (Hájková et al. 2011). It is rather frequent in the Šumava Mts, Krušné hory Mts, Jizerské hory Mts, Krkonoše Mts and Hrubý Jeseník Mts. It rarely occurs in other mountain ranges, including the Novohradské hory Mts, Orlické hory Mts and Králický Sněžník Mts. Only old records are known from the Český les Mts (last record in 1908), the Třeboňská pánev basin (last record in 1948), central Bohemia near Čáslav (collected before 1850), the Žďárské vrchy hills (last record in 1988) and the Moravskoslezské Beskydy Mts (the site was flooded in the Šance water reservoir before 1970).

Carex pulicaris (Fig. 33)

Carex pulicaris is a European sub-Atlantic species, distributed mainly in western and central Europe, reaching Slovenia, western Hungary and Slovakia in the east (Hultén & Fries 1986). Typical habitats of this species are acidic moss-rich fens (Hájek & Hájková 2011b). In the Czech Republic it was formerly common in south-western Bohemia, the Českomoravská vrchovina highlands and the Žďárské vrchy hills, while being rather rare in other parts of Bohemia and almost absent from Moravia. *Carex pulicaris* is very sensitive to drainage, eutrophication and vegetation succession, being overgrown by more competitive species. In consequence, it is a strongly declining species and is classified as endangered (Grulich 2012).

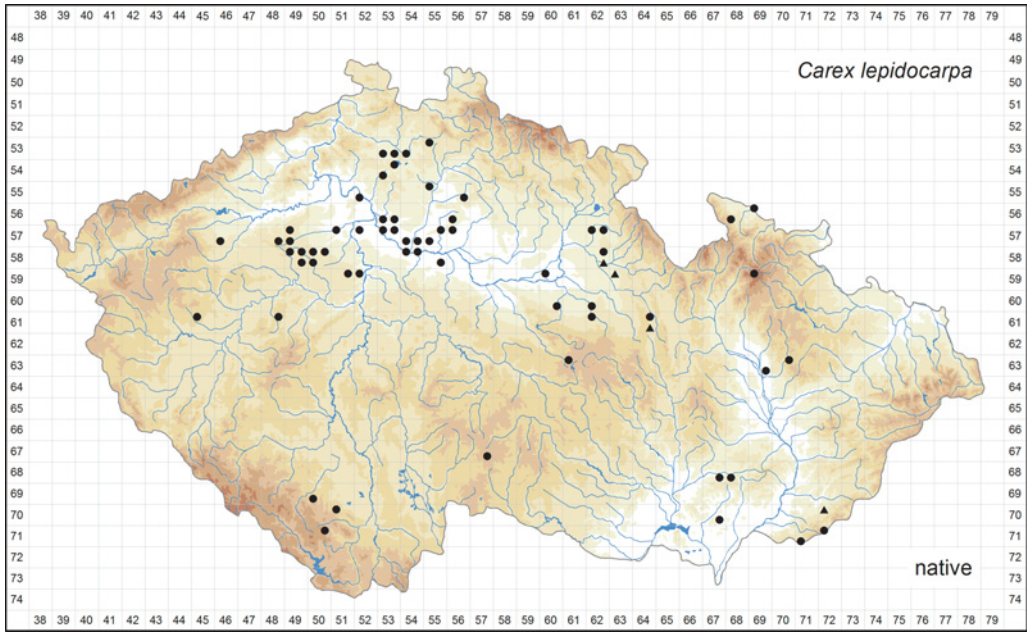

Fig. 29. – Distribution of *Carex lepidocarpa* in the Czech Republic: ● occurrence documented by herbarium specimens (61 quadrants), ▲ occurrence based on other records (4 quadrants). Prepared by Jitka Štěpánková.

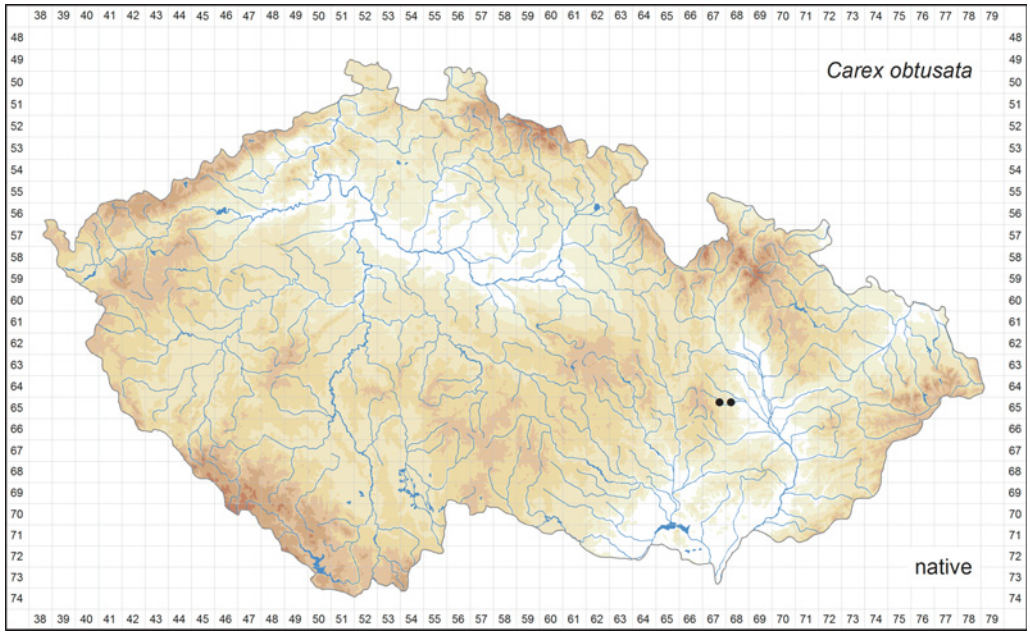

Fig. 30. – Distribution of *Carex obtusata* in the Czech Republic (2 occupied quadrants). Prepared by Vít Grulich & Radomír Řepka.

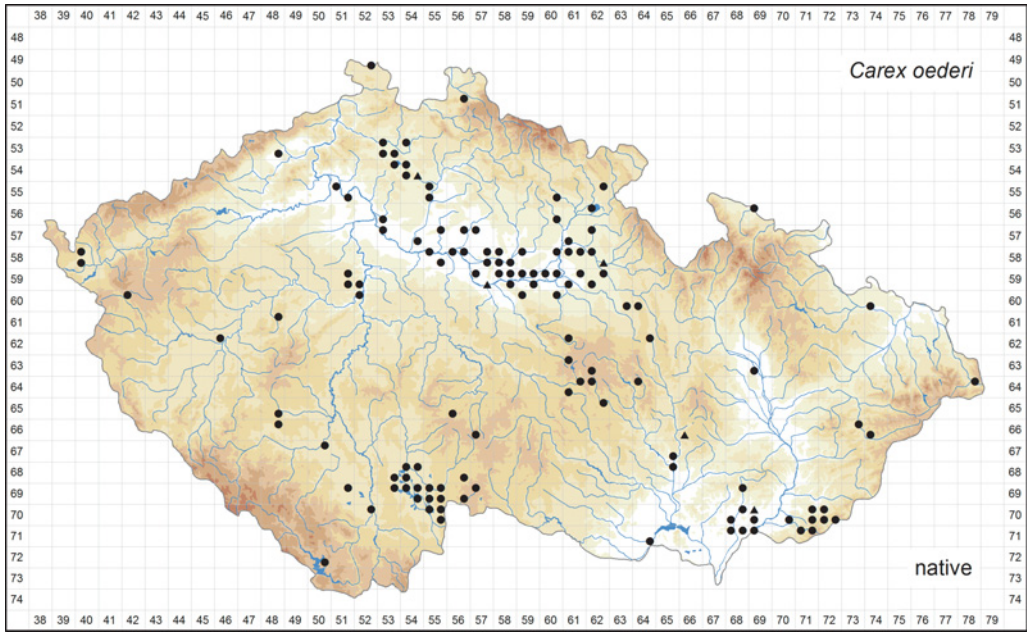

Fig. 31. – Distribution of *Carex oederi* in the Czech Republic: ● occurrence documented by herbarium specimens (125 quadrants), ▲ occurrence based on other records (5 quadrants). Prepared by Jitka Štěpánková.

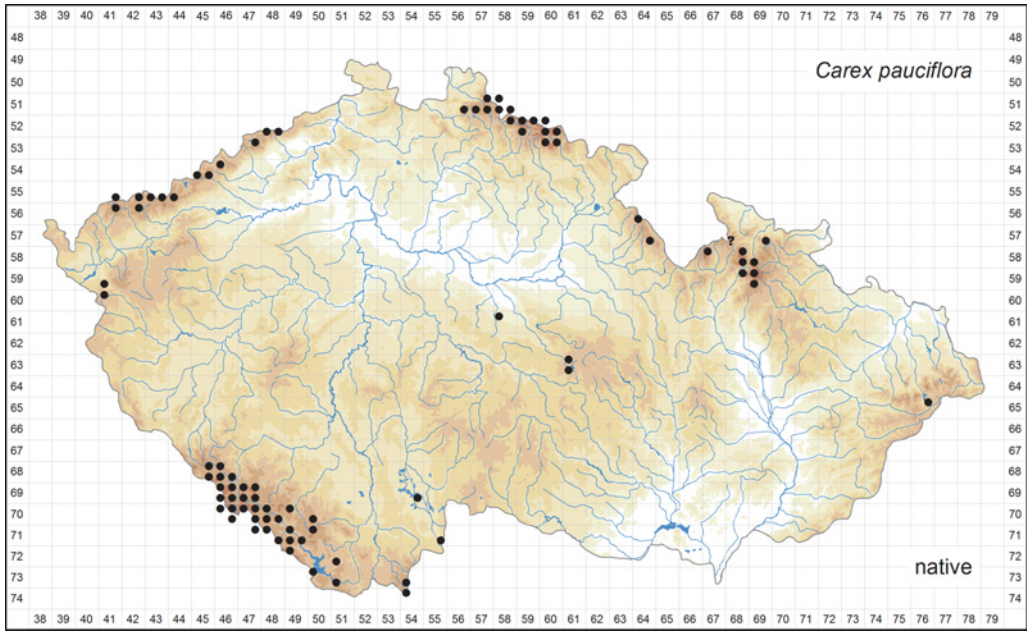

Fig. 32. – Distribution of *Carex pauciflora* in the Czech Republic (84 occupied quadrants). Prepared by Vít Grulich & Radomír Řepka.

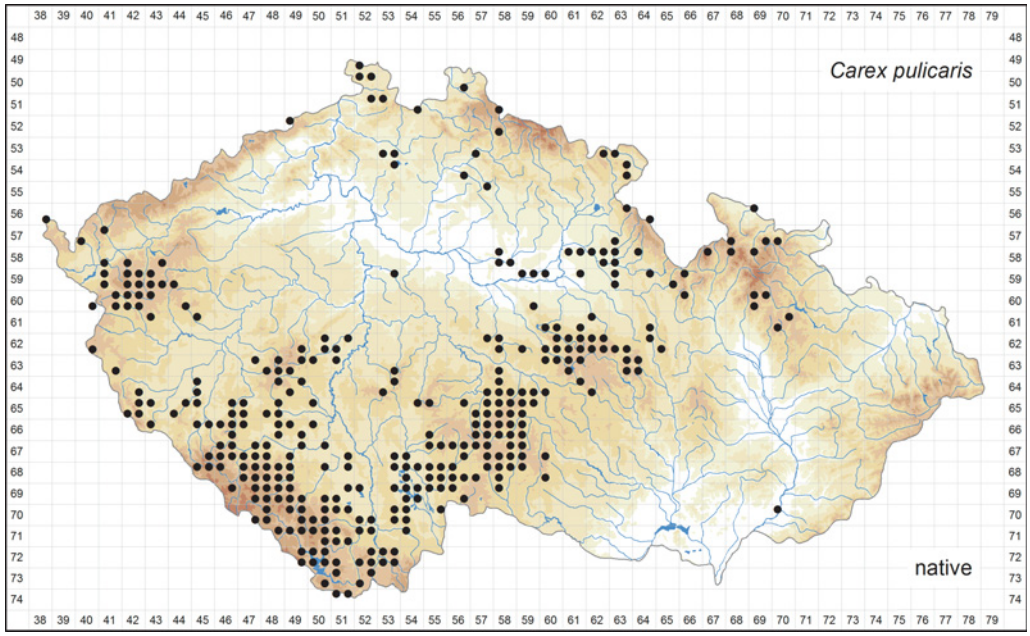

Fig. 33. – Distribution of *Carex pulicaris* in the Czech Republic (341 occupied quadrants). Prepared by Vít Grulich & Radomír Řepka.

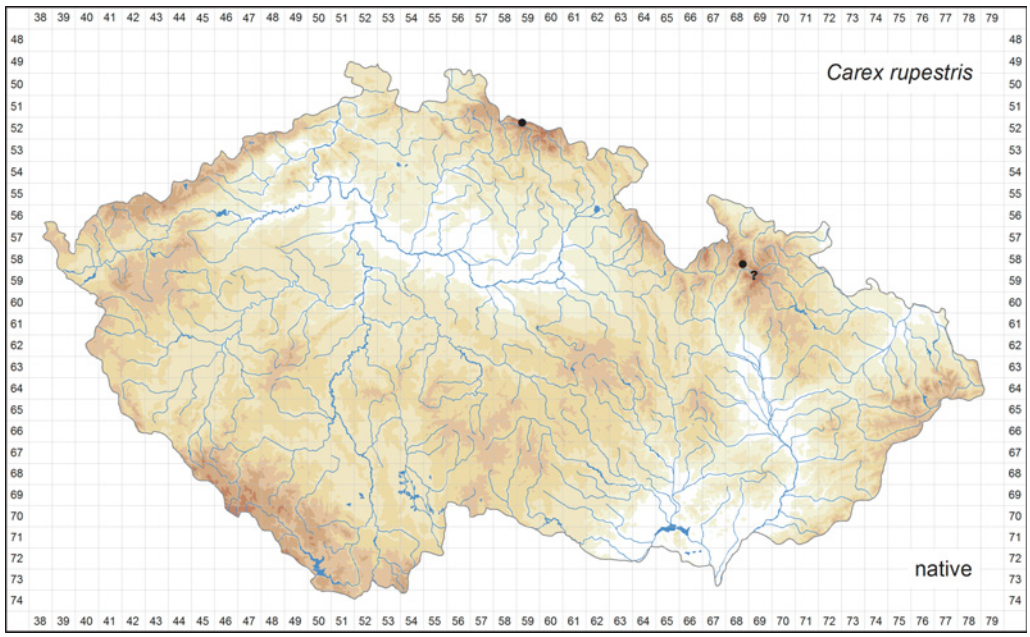

Fig. 34. – Distribution of *Carex rupestris* in the Czech Republic (2 occupied quadrants). Prepared by Vít Grulich & Radomír Řepka.

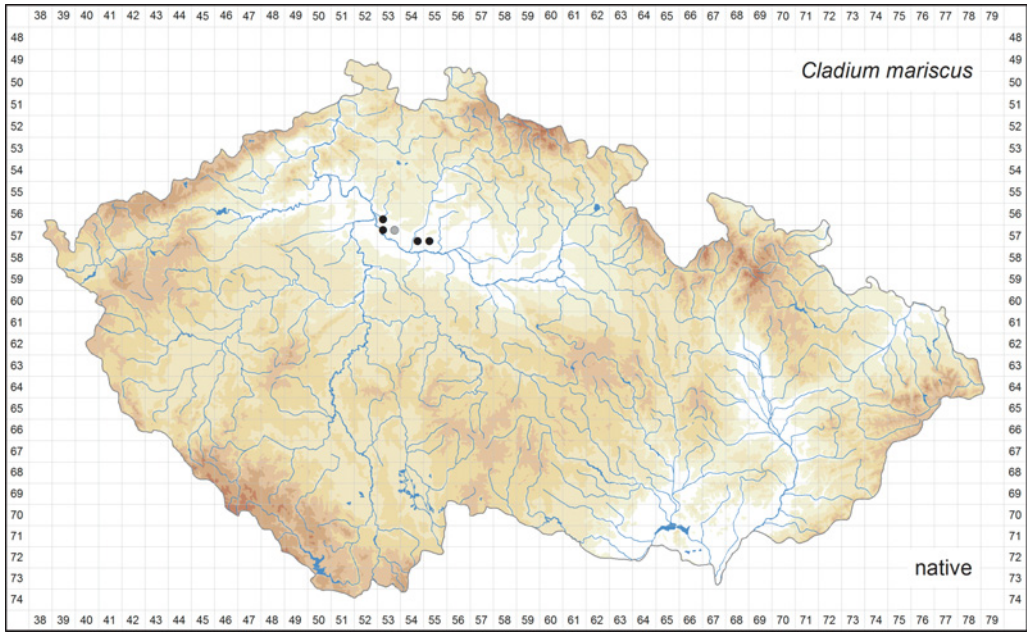

Fig. 35. – Distribution of *Cladium mariscus* in the Czech Republic: ● at least one record in 2000–2015 (4 quadrants), ● occurrences extirpated after 2000 (1 quadrant). Prepared by Zdeněk Kaplan.

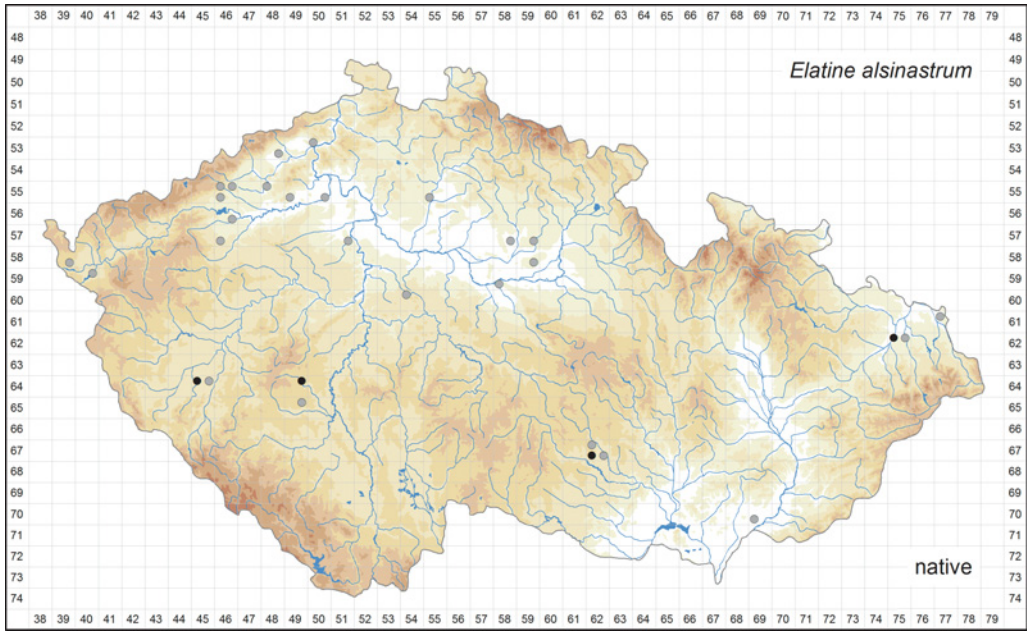

Fig. 36. – Distribution of *Elatine alsinastrum* in the Czech Republic: ● at least one record in 2000–2015 (4 quadrants), ● pre 2000 records only and/or extirpated occurrences (26 quadrants). Prepared by Jan Prančl, Kateřina Šumberová & Zdeněk Kaplan.

Carex rupestris (Fig. 34)

Carex rupestris is a holarctic species with a circumboreal distribution in northern parts of Europe, Asia and North America and in higher mountains of the temperate zone (Meusel et al. 1965, Hultén & Fries 1986, Ball & Reznicek 2002). It grows in rock crevices and prefers bedrock with neutral and alkaline pH (Schultze-Motel 1980a). In the Czech Republic *C. rupestris* is considered a glacial relict and is known only from two localities. Its occurrence in the Hrubý Jeseník Mts has been known since the early 19th century (Bureš 2013) and all records from these mountains may refer to a single locality (Grulich & Zmrhalová 1988). In the Krkonoše Mts, *C. rupestris* was discovered as late as in 1964 (Hempel & Büttner 1965). Both populations are very small, and the species is therefore classified as critically threatened (Grulich 2012).

Cladium mariscus (Fig. 35)

Cladium mariscus has a cosmopolitan distribution. In Europe it is represented only by the type subspecies, *C. mariscus* subsp. *mariscus*, which is most frequent in western and central Europe and along the western-Mediterranean coast, extending northwards into southern Scandinavia and eastwards to the Baltic countries, Poland, Bulgaria and Turkey. It also occurs in northern Africa and south-western Asia (von Post 1925, Meusel et al. 1965, Hultén & Fries 1986). In central Europe, it is considered to be a relict from earlier periods of the Holocene (Pokorný et al. 2010, Hájková et al. 2013). In the Czech Republic *C. mariscus* occurs in calcareous fens in an advanced stage of terrestrialization and is confined to the middle Labe river basin in central Bohemia. Since the 19th century it has been recorded at about eight sites between Mělník and Nymburk, but currently it is found at only four of them. It occurs in a species-poor type of marsh vegetation, which used to be more common in lowland fens in the early Holocene but has retreated due to filling-in process and drainage and conversion of fens into arable land (Sádlo 2011). At present it does not seem to be imminently threatened at its remaining sites but because of its rarity it is classified as critically threatened (Grulich 2012).

Elatine alsinastrum (Fig. 36)

Elatine alsinastrum occurs in continental Europe, south-western Asia, western Siberia and northern Africa. In Europe it is distributed from the Mediterranean area northwards to northern Germany, Denmark, northern Poland and Russia (not reaching 60°N there), with an outpost in southern Finland (Uotila 2010, Popiela et al. 2013). It is scattered throughout Europe, and its localities are often isolated, forming larger clusters in central France, north-eastern Germany, western Poland and in the Pannonian Basin. Currently, it is very rare and declining in the whole of Europe. It grows mainly in periodically flooded habitats, at margins of shallow standing waters, in wet depressions (often in arable fields), drainage ditches (in warmer regions outside the Czech Republic also in rice fields), mostly in full sun habitats on clayey soils, without competition of other plants. In the Czech Republic *E. alsinastrum* has always been a rare species. It has been recorded at about 35 localities in lower altitudes (up to 500 m a.s.l.), especially in the lowlands of north-western, central and eastern Bohemia (now vanished) and at a few sites elsewhere. Most of the Czech records are from the exposed bottoms of fishponds or from ponds

reflooded after a temporary drainage, on mineral-rich but calcium-poor substrates; in north-western Bohemia it is also found on saline wet soils. Due to the changes in fishpond management (in particular fertilizing and elimination of summer drainage), overall intensification of agriculture, destruction, eutrophication and drainage of wetlands, *E. alsinastrum* is currently close to extinction in the Czech Republic, and it has therefore been classified as critically threatened (Grulich 2012). It has been observed at only four sites since 2000.

Elatine hexandra (Fig. 37)

Elatine hexandra is almost an exclusively European species with a pronounced sub-Atlantic distribution. It is found mainly in western Europe and in the parts of central Europe with sub-Atlantic climate. Northwards it is distributed to the Faroe Islands and southern Scandinavia, in southern Europe it is more common on the Iberian Peninsula but very rare in the middle Mediterranean area. Eastwards it is reported to reach Poland, Slovakia, Hungary and Romania (Uotila 2009a, Popiela et al. 2011) but it would be desirable to revise its distribution in this area. For instance, its presence in Slovakia is reported only in the literature but not documented by herbarium specimens (Ťavoda & Goliašová 2008). Also the occurrence in Hungary has not been confirmed (Molnár 2009). Outside Europe, it is known only from Morocco and the Azores (Uotila 2010, Popiela et al. 2011). In the Czech Republic *E. hexandra* grows mainly on periodically exposed wet or shallow-flooded bottoms and margins of fishponds, also in fish storage ponds, and rarely in similar habitats in floodplains. It occurs on sandy or muddy, calcium-poor substrates; in contrast to *E. hydropiper* and *E. triandra*, it avoids strongly eutrophic habitats with a thick layer of sapropelic mud, and prefers nutrient-poorer substrates, e.g. in forest fishponds or fishponds constructed on deep peat layers (Šumberová 2013a). In the Czech Republic it occurs mainly in the South Bohemian fishpond basins, especially in the Třeboňská pánev basin, where the species was quite common in the past. In other parts of Bohemia *E. hexandra* was always very rare. Despite some literature reports (e.g. Křísa 1990, Popiela et al. 2011), it has never been reliably documented to occur in Moravia and Silesia; it is even possible that it reaches its regional eastern edge of distribution in Bohemia. *Elatine hexandra* has markedly declined since World War II as a result of intensification of fish farming, especially the absence of regular summer drainage in many fishponds and high amount of fertilizers causing eutrophication. Currently it is classified as endangered (Grulich 2012). On the other hand, the seeds of the species persist for a very long time in the soil seed bank, and they can also spread easily to new sites, e.g. on the tools used in fishpond harvesting (Šumberová 2013a). Because of frequent misidentifications of *Elatine* species, the distribution map was based solely on revised herbarium specimens and our own field records.

Elatine hydropiper (Fig. 38)

Elatine hydropiper is a Euro-Siberian species, widespread from Northern Ireland to Eastern Siberia. It occurs across most of Europe but is absent from or rare in the Mediterranean area, Iceland and the most oceanic regions, northwards reaching northernmost Scandinavia. The highest concentration of localities is in the central European lowlands (Germany, Poland), the south-western part of the Czech Republic and southern Scandinavia (Uotila

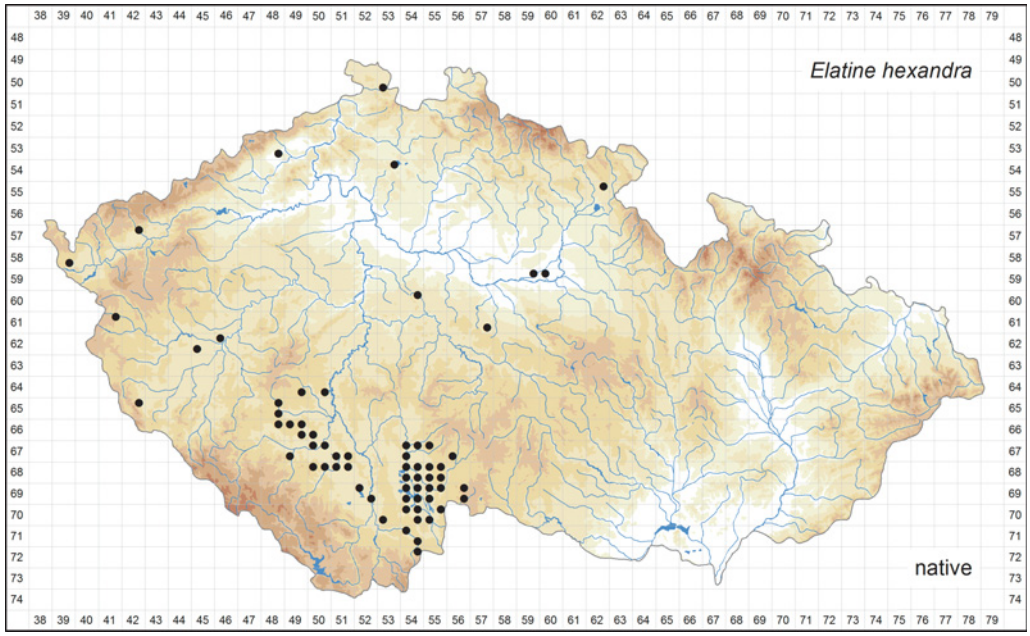

Fig. 37. – Distribution of *Elatine hexandra* in the Czech Republic (65 occupied quadrants). Prepared by Jan Prančl, Kateřina Šumberová & Zdeněk Kaplan.

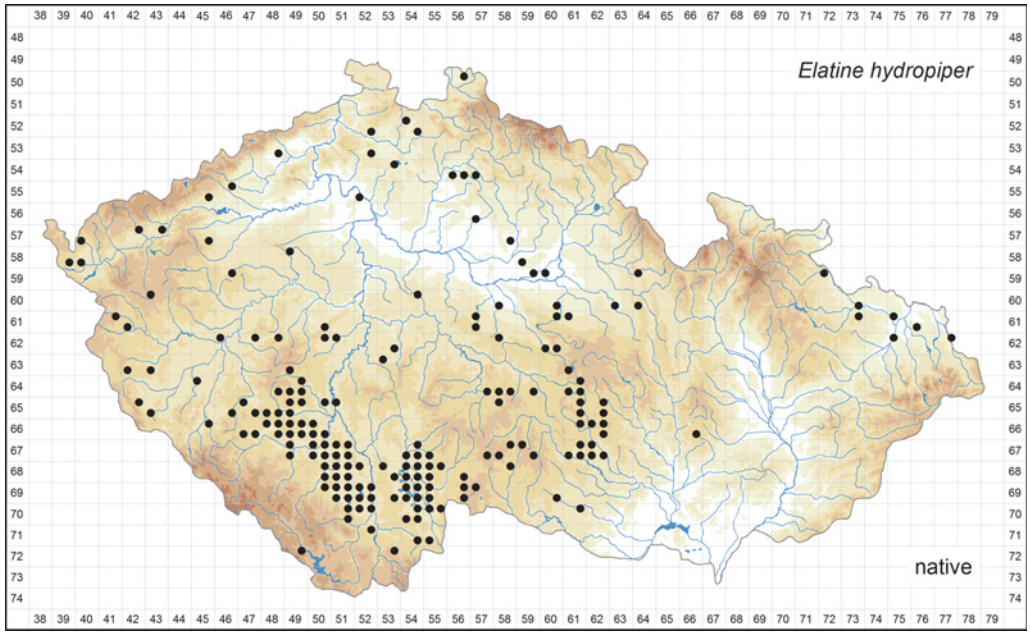

Fig. 38. – Distribution of *Elatine hydropiper* in the Czech Republic (186 occupied quadrants). Prepared by Jan Prančl, Kateřina Šumberová & Zdeněk Kaplan.

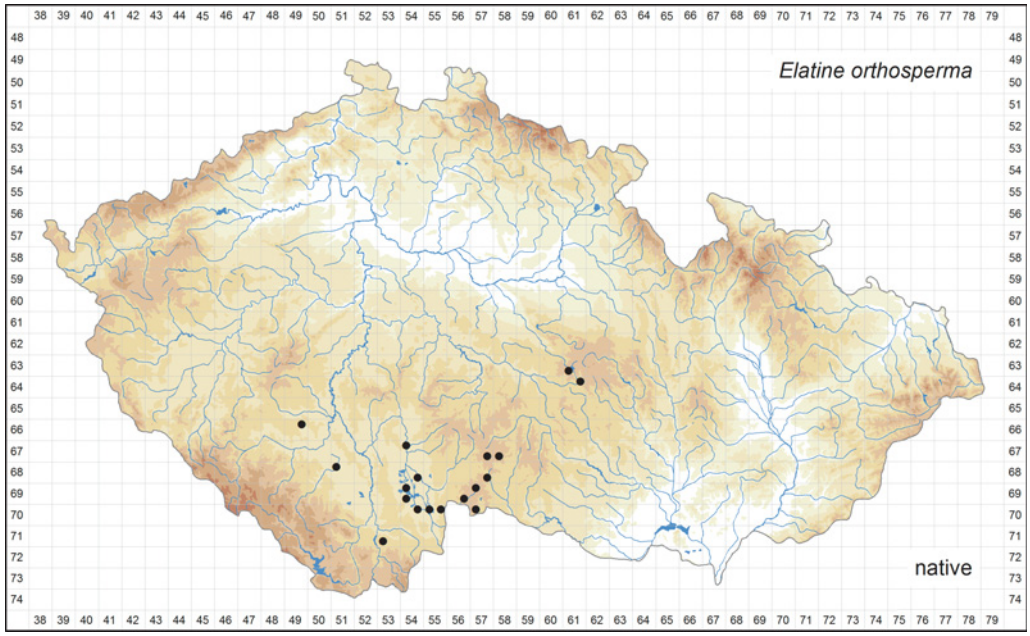

Fig. 39. – Distribution of *Elatine orthosperma* in the Czech Republic (18 occupied quadrants). Prepared by Jan Prančl, Kateřina Šumberová & Zdeněk Kaplan.

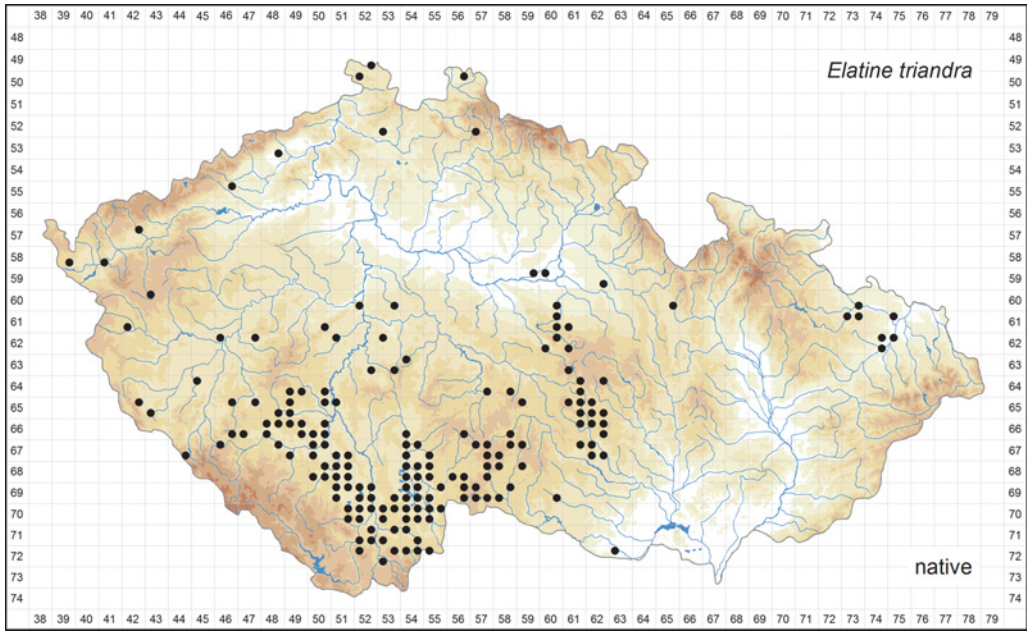

Fig. 40. – Distribution of *Elatine triandra* in the Czech Republic (177 occupied quadrants). Prepared by Jan Prančl, Kateřina Šumberová & Zdeněk Kaplan.

2010, Popiela et al. 2012). As with all the other species of the genus, it is confined to the habitats with strongly fluctuating water levels. In the Czech Republic it grows mainly in shallow margins and exposed bottoms of fishponds, in fish storage ponds and rarely in similar habitats in floodplains. Among all of our *Elatine* species, *E. hydropiper* is probably most capable of tolerating strong eutrophication, grows in the largest pH range and on various substrates; only on deep sapropelic mud it is usually replaced by *E. triandra* (Šumberová 2013b). As in other *Elatine* species, sufficient substrate moisture during the whole life cycle is essential for successful reproduction; too quick drying out of the substrate is probably the most important factor eliminating the species from the regions with dry summers. In the Czech Republic it is most widespread in the South Bohemian fishpond basins and in the Českomoravská vrchovina highlands in south-western Moravia. It is scattered (although probably under-recorded) in other parts of the country, being rare in the Bohemian lowlands and absent from most of Moravia. *Elatine hydropiper* may have spread in recent decades. However, the apparent spread may also be an artifact caused by the growing interest in aquatic plants. Currently, *E. hydropiper* is the most common species of the genus in the Czech Republic. It is therefore classified only as vulnerable (Grulich 2012). Because of frequent misidentifications of *Elatine* species, the distribution map was based solely on revised herbarium specimens and our own field records.

Elatine orthosperma (Fig. 39)

The overall distribution of *Elatine orthosperma* is poorly known because botanists have often failed to distinguish it from the similar and closely related *E. hydropiper*. It occurs throughout Scandinavia, where its distribution was mapped by Uotila (1974). Further reliably documented localities are known from the adjacent part of Russia (Karelia, surroundings of St. Petersburg) and Germany (Schleswig-Holstein, Bavaria; Uotila 2010). The species is also reported to occur in Belarus, Lithuania, Ukraine and some other parts of Russia, eastwards reaching as far as the Kamchatka Peninsula (Gortskova 1949, Prokudin 1987), but these records require revision. Until recently, *E. orthosperma* was almost unknown in the Czech Republic. The Flora of the Czech Republic (Křísa 1990) reported it only from two localities but one of the records was erroneous (Prančl & Šumberová 2015). We found herbarium specimens of this species from 20 sites in the South Bohemian fishpond basins (most of them in the Třeboňská pánev basin), the adjacent area of the Českomoravská vrchovina highlands and in the Žďárské vrchy hills; four of these specimens were collected after 2000. Most of the records come from forest fishponds or clear fishponds with sandy shores. *Elatine orthosperma* is probably much more sensitive to eutrophication than *E. hydropiper* and *E. triandra*, and is confined to periodically exposed, sandy or muddy substrates in areas with acidic bedrock and a colder and wetter climate (Prančl & Šumberová 2015). Because such habitats are suitable also for other *Elatine* species, *E. orthosperma* is probably accompanied by more common congeners in most of its sites, and therefore may often remain unnoticed. This corresponds to the fact that a significant proportion of revised herbarium specimens were mixed collections. The species is currently classified as critically threatened (Grulich 2012). Because of frequent misidentifications of *Elatine* species, the distribution map was based solely on revised herbarium specimens.

Elatine triandra (Fig. 40)

Elatine triandra is mainly a European species, with most localities found in France, central Europe (Germany, Czech Republic and Poland), Scandinavia and the adjacent Russian Karelia; it is absent from the British Isles and Iceland, very rare in the Mediterranean area and scattered in the central part of European Russia (Uotila 2010, Popiela et al. 2015). It is also reported from Siberia, East Asia, North America, South America and southern Africa (e.g. Hultén & Fries 1986, Deil et al. 2011), but at least some of these records probably refer to other taxa (Uotila 2010). In the Czech Republic *E. trianda* grows mainly on shallow margins and exposed bottoms of fishponds, less often in fish storage ponds and in similar habitats in floodplains. It prefers deep muddy substrates that dry out slowly, and often occurs also on nutrient-rich sapropelic mud (Šumberová 2013c). It is fairly common in the South Bohemian fishpond basins, the Českomoravská vrchovina highlands and the Železné hory hills. In contrast, it is rare in other parts of the country, being almost absent from the Bohemian lowlands and most of Moravia. Although until recently *E. trianda* was considered to be rare and declining, the growing number of records in the last decades suggests the opposite, and in many regions it is nowadays as frequent as *E. hydropiper*. This may be due to silting of fishponds with mud and eutrophication of formerly nutrient-poor substrates. Easy dispersal on the tools used in fishpond harvesting may ensure the recolonization of apparently lost localities or even the colonization of new ones (Šumberová 2013c). However, *E. triandra* was also frequently overlooked in the past and confused with the other *Elatine* species. It is currently classified as vulnerable (Grulich 2012). Because of frequent misidentifications of *Elatine* species, the distribution map was based solely on revised herbarium specimens and our own field records.

Eleocharis acicularis (Fig. 41)

Eleocharis acicularis is a circumboreal species. It is widespread across the whole of Europe, including Scandinavia and Iceland; however, it is less common towards the north, particularly above the Arctic Circle. Towards the east it is distributed through European Russia to Siberia, except its northern part. It is also found in Mongolia, northern China, the Kamchatka Peninsula, Sakhalin, the Kuril Islands, the Korean Peninsula and Japan; based on morphological differences, the East Asian populations are sometimes separated as *E. yokoskensis* (Lunkai & Strong 2010). Southwards it extends to Turkey, the Caucasus Mts, Iran, Afghanistan, Taiwan, the Philippines and Sumatra (Govaerts & Simpson 2007). In Africa it is restricted to the Atlas Mts. In North America it is widely distributed from Alaska and the Hudson Bay in the north towards Mexico in the south; it occurs also on the western coast of Greenland. It grows also in Central America and north-eastern South America as far south as Bolivia (Smith et al. 2002, Govaerts & Simpson 2007). To Australia it has probably been introduced (Smith et al. 2002). *Eleocharis acicularis* is widespread in the Czech Republic, particularly at middle elevations, becoming less frequent in areas with varied geomorphology, such as eastern Moravia. Most frequently it grows on exposed fishpond and fish storage pond bottoms, forming large and dense, usually monodominant carpets. Less frequently it is found in shallow oligotrophic to eutrophic water along shores of fishponds, water reservoirs, oxbow lakes or slow-moving large rivers (Šumberová et al. 2011). In periodically-flooded habitats, it

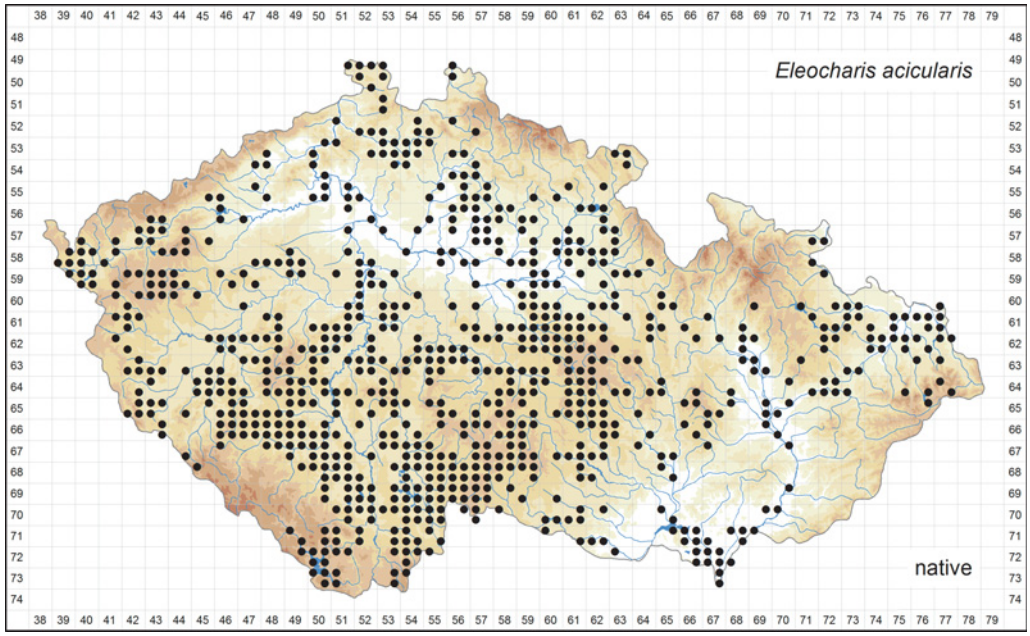

Fig. 41. – Distribution of *Eleocharis acicularis* in the Czech Republic (795 occupied quadrants). Prepared by Petr Bureš.

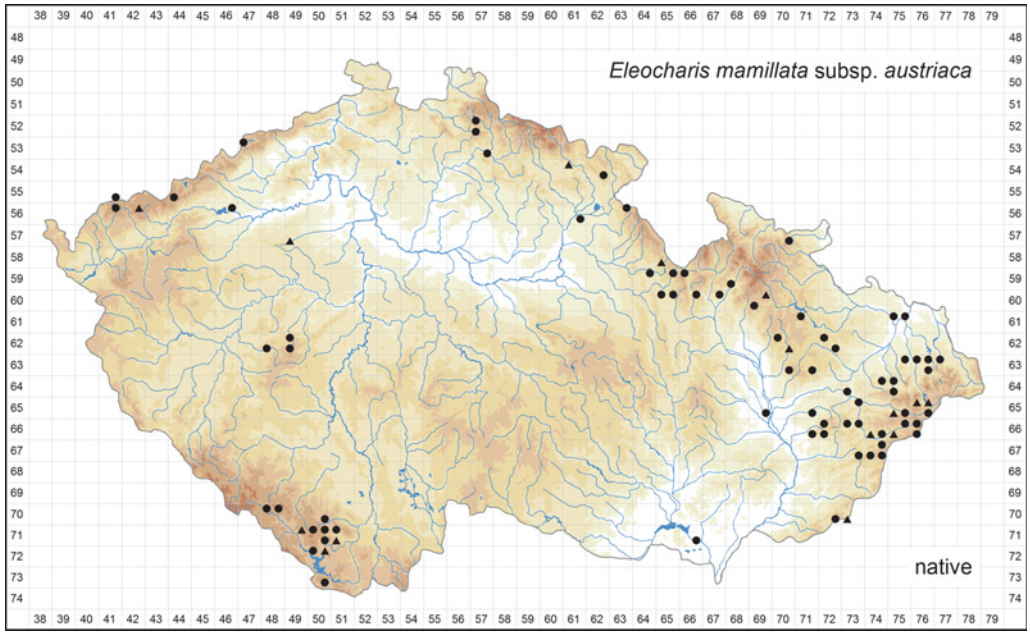

Fig. 42. – Distribution of *Eleocharis mamillata* subsp. *austriaca* in the Czech Republic: ● occurrence documented by herbarium specimens (70 quadrants), ▲ occurrence based on other records (15 quadrants). Prepared by Petr Bureš.

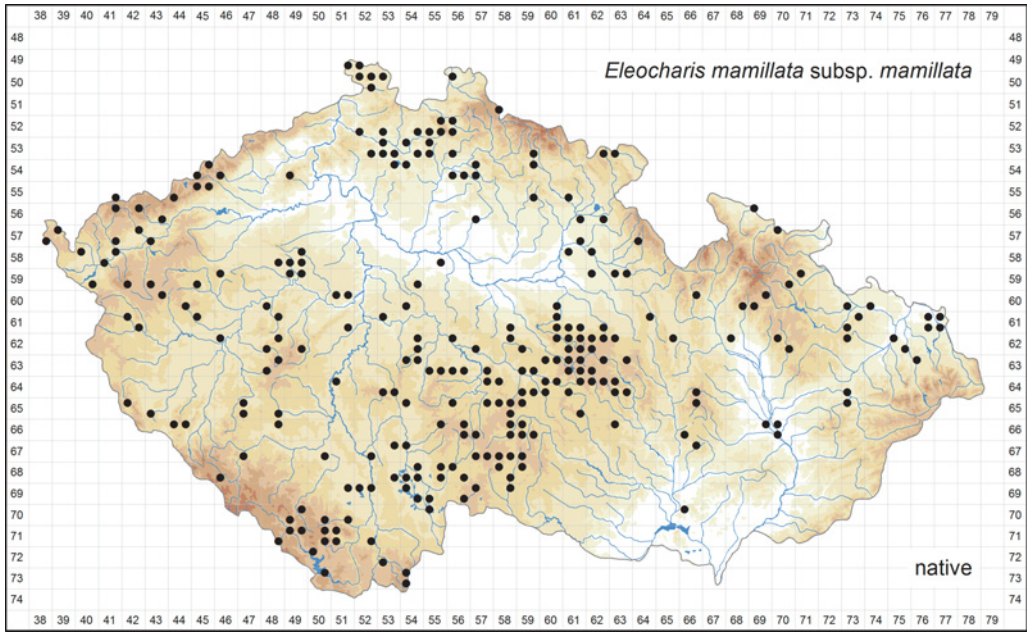

Fig. 43. – Distribution of *Eleocharis mamillata* subsp. *mamillata* in the Czech Republic (264 occupied quadrants). Prepared by Petr Bureš.

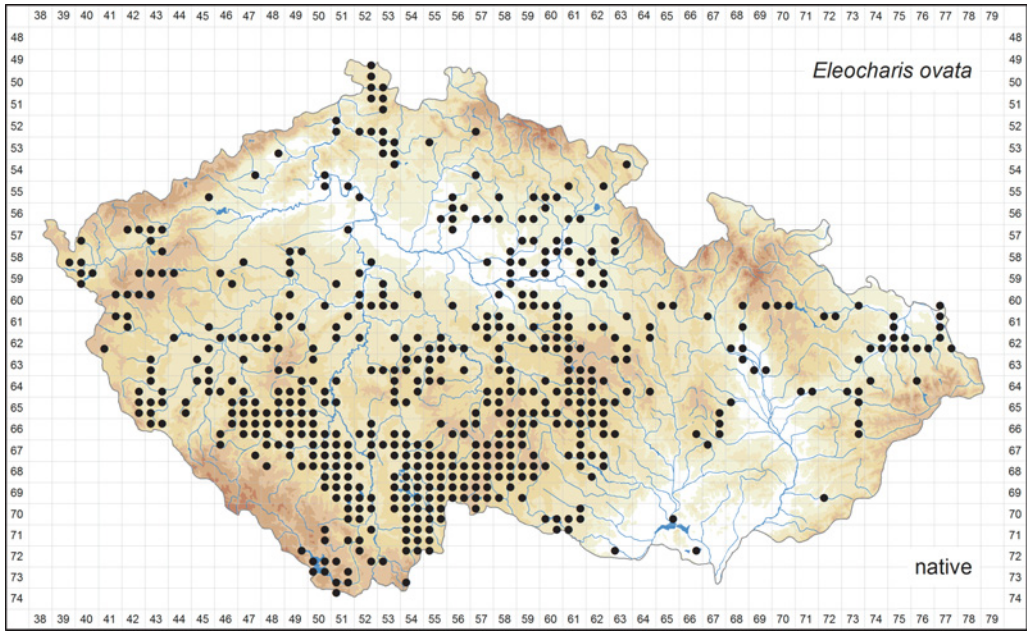

Fig. 44. – Distribution of *Eleocharis ovata* in the Czech Republic (547 occupied quadrants). Prepared by Petr Bureš.

is capable of tolerating long periods of submersion. It can occur on various substrates, avoiding only those with a high proportion of organic litter.

Eleocharis mamillata subsp. *austriaca* (Fig. 42)

The two subspecies of *Eleocharis mamillata* occurring in the Czech Republic can only be distinguished on the basis of ripe fruits with perianth bristles and persistent style bases (stylopodia), therefore their distribution maps are based mainly on revised herbarium specimens. *Eleocharis mamillata* subsp. *austriaca* is distributed mainly in calcareous mountainous areas of Europe, including the Pyrenees, the Alps and surrounding mountain areas of Germany, Switzerland, Austria and Czech Republic, and in the Carpathians; sparsely it occurs also in the British Isles, central Norway, in the Massif Central in France, in the Dinarids of Croatia, western Serbia, Bosnia and Herzegovina, and Montenegro, and in the Rhodope and Pirin Mts in Bulgaria; towards the east it occurs in the Caucasus and Ural Mts, in the Altai and Kuznetskii Alatau Mts, in some other parts of southern Siberia and the Amur river basin (Hultén & Fries 1986, Gregor 2003). In the Czech Republic it is found in similar habitats as the type subspecies (see below) but more rarely. It is distributed mainly in the mountain ranges surrounding the country and in the Brdy Mts, becoming more abundant in its eastern (Carpathian) part. Isolated occurrences in the lowlands may be of secondary origin.

Eleocharis mamillata subsp. *mamillata* (Fig. 43)

Eleocharis mamillata subsp. *mamillata* has a circumboreal distribution range. It occurs particularly at middle and higher elevations in the areas with a rather humid and cool climate. In Europe it is distributed mainly from eastern France through Switzerland, Germany, Austria and the Czech Republic as far as Poland and Slovakia; it is probably rare in Hungary, south-eastern Serbia, northern Bulgaria, Romania and Ukraine; in northern Europe it reaches central Scandinavia, Finland, the Baltic countries and the Russian part of Karelia. In Asia it is scattered across southern Siberia, Mongolia, China as far as the Korean Peninsula, the Russian Far East, Sakhalin, the Kuril Islands and Japan (Gregor 2003). In North America it is locally common in its boreal part and along the northern Pacific coast (frequent in Alaska and British Columbia) but rare in the rest of Canada and adjacent territories of the northern United States (Smith & Gregor 2014). In the Czech Republic it occurs in the cooler areas with annual precipitation above 650 mm, particularly in higher altitudes. In contrast to *E. mamillata* subsp. *austriaca* it seems to be less abundant in the eastern (Carpathian) part. It occurs in non-shaded shallow water along the shores of fishponds and other water reservoirs, abandoned sand pits, in depressions and disturbed places of floodplain meadows and in shallow depressions in mountain pastures.

Eleocharis ovata (Fig. 44)

Eleocharis ovata is distributed across Europe, Asia, and North America; however, its wide circumpolar distribution range is fragmented into many rather small areas. In Europe it occurs mainly in its central part, including southern and eastern Germany, the Czech Republic, Austria, southern Poland and Slovakia. It is absent from the British Isles and most of Scandinavia, and is rare in the Kaliningrad Region of Russia, in Lithuania,

Latvia, Estonia and Russian Karelia. It rarely occurs in eastern France, the Benelux states and Switzerland; in eastern Europe, it is found in north-western parts of Hungary and Romania, in the Dnepr river basin in Ukraine, between the Volga and Ural rivers in European Russia; in southern Europe, it is found only in northern Italy, eastern Slovenia, Croatia and Albania (Hultén & Fries 1986). In Asia it occurs in Iran, Kazakhstan, eastern Siberia, China, the Russian Far East and Japan (Hultén & Fries 1986, Govaerts & Simpson 2007). In North America it occurs in the north-eastern part of the United States and Canada (Smith et al. 2002). In the Czech Republic *E. ovata* grows in vegetation composed of low-growing annual graminoids, particularly on exposed bottoms of fishponds and fish storage ponds; less frequently it also occurs on sediments along rivers and on exposed banks of oxbow lakes and shores of water reservoirs (Šumberová 2011). It prefers muddy or sandy substrates with acidic to slightly basic pH. It is most frequent at middle elevations in areas with numerous fishponds such as in the South Bohemian basins or in the Českomoravská vrchovina highlands. In Moravia, particularly in the east, it is much rarer than in Bohemia. The species used to be more common in the past when summer drainage of fishponds was regularly undertaken in 2–5-year intervals.

Eleocharis palustris subsp. *palustris* (Fig. 45)

Since two subspecies of *Eleocharis palustris* occurring in the Czech Republic can only be distinguished on the basis of ripe fruits and stomatal length, their distribution maps include only revised herbarium specimens. The type subspecies has an almost cosmopolitan distribution, being absent only from extremely dry areas without water bodies and from high mountains. In western Europe it is almost replaced by *E. palustris* subsp. *waltersii*. In the Czech Republic it is most abundant in the lowlands with warmer climates (annual average temperature more than 7 °C and annual precipitation below 650 mm); in middle altitudes, it prefers basic substrates, particularly in eastern Moravia. It grows in non-shaded shallow water along the shores of ponds and other water reservoirs, oxbows or lower courses of large rivers as well as in wet depressions of floodplain meadows; it tolerates higher salinity and longer periods of drought.

Eleocharis palustris subsp. *waltersii* (Fig. 46)

Until recently, this subspecies was recognized under the name *Eleocharis palustris* subsp. *vulgaris* by Walters (1949) and others. However, a replacement name, *E. palustris* subsp. *waltersii*, had to be proposed because of homonymy of the former (Bureš & Danihelka 2008). *Eleocharis palustris* subsp. *waltersii* is widespread in western and central Europe, in the areas with an Oceanic climate, where it almost replaces the type subspecies. It is found in the British Isles, the Iberian Peninsula, France, the Benelux countries, Denmark, Germany, Austria, Poland and the Czech Republic; towards the north it reaches Iceland, the Faroe Islands, southern Scandinavia, Finland, Estonia and Lithuania (Strandhede 1966, Strandhede & Dahlgren 1968, Bureš et al. 2004). In eastern Europe it is rare or replaced by the type subspecies while its presence in countries of south-eastern Europe, reported by Govaerts & Simpson (2007), is uncertain. In the Czech Republic it is more frequent in the western part of the country where it co-occurs with the type subspecies at lower altitudes, while it prevails at middle elevations, particularly in areas with numerous fishponds. It prefers similar habitats to the type subspecies but it is less tolerant

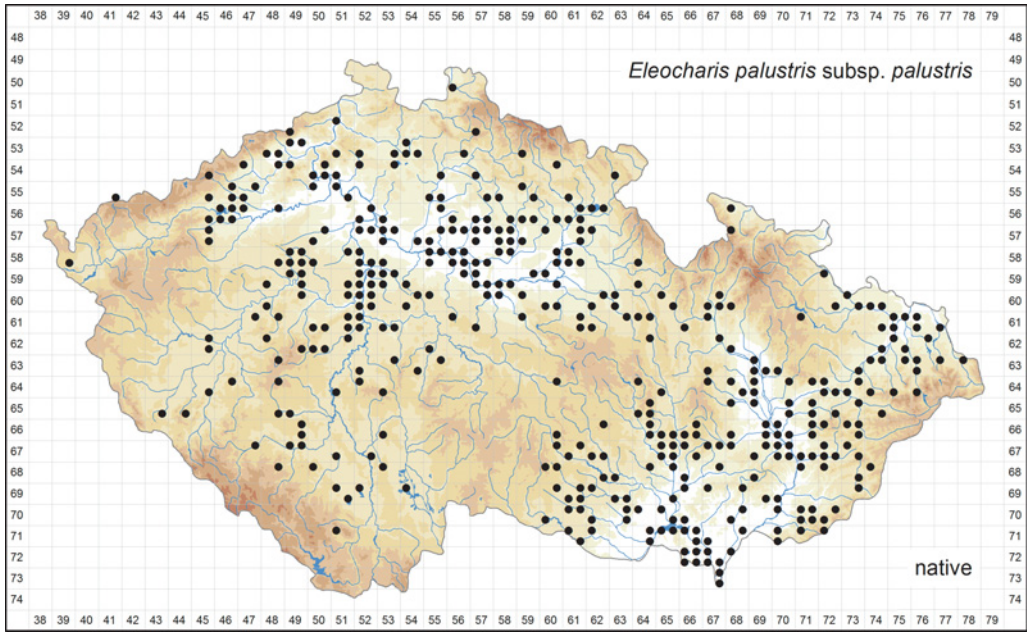

Fig. 45. – Distribution of *Eleocharis palustris* subsp. *palustris* in the Czech Republic (418 occupied quadrants). Prepared by Petr Bureš.

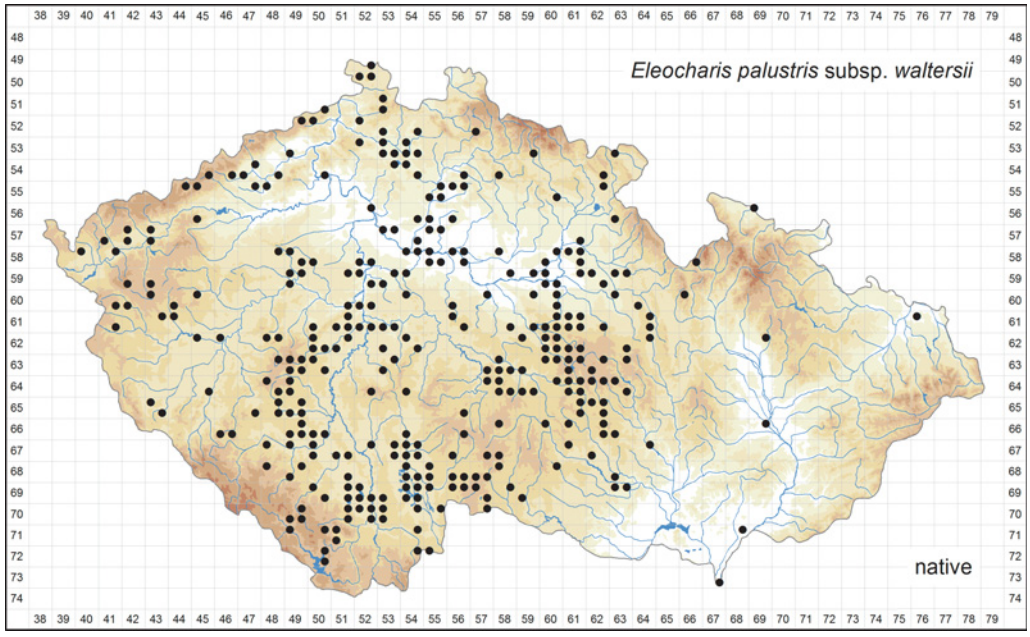

Fig. 46. – Distribution of *Eleocharis palustris* subsp. *waltersii* in the Czech Republic (326 occupied quadrants). Prepared by Petr Bureš.

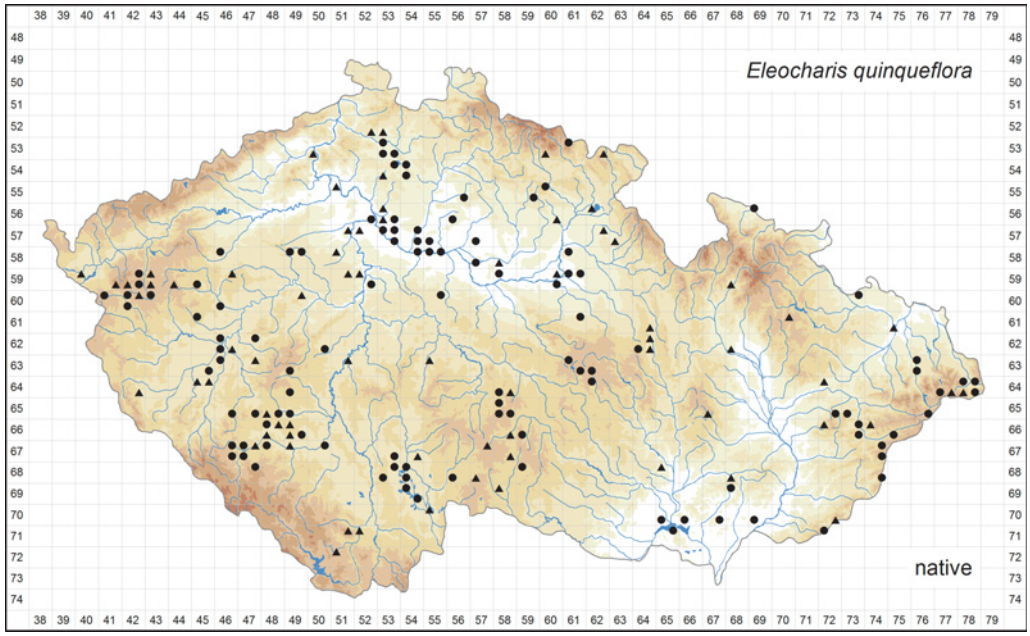

Fig. 47. – Distribution of *Eleocharis quinqueflora* in the Czech Republic: ● occurrence documented by herbarium specimens (108 quadrants), ▲ occurrence based on other records (70 quadrants). Prepared by Petr Bureš.

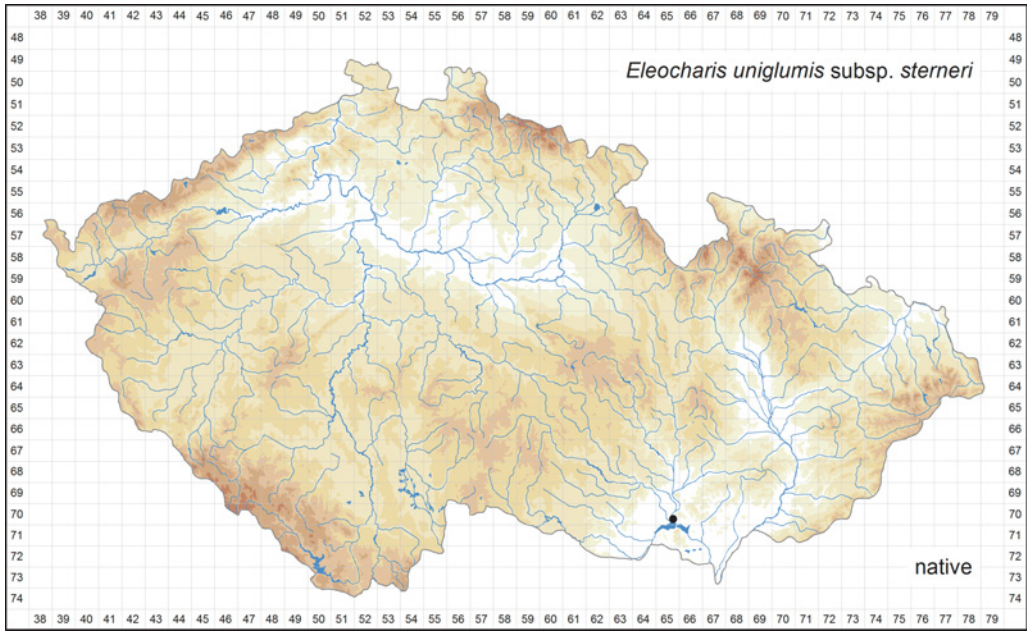

Fig. 48. – Distribution of *Eleocharis uniglumis* subsp. *sterneri* in the Czech Republic (1 occupied quadrant). Prepared by Petr Bureš.

to longer periods of drought and to salinity in the soil. It is also more competitive in taller and denser littoral vegetation than the type subspecies.

Eleocharis quinqueflora (Fig. 47)

Eleocharis quinqueflora has a circumboreal distribution range. It occurs in most of Eurasia from Iceland, the Faroe Islands, northern Scandinavia and the Kola Peninsula in the north, through most of European Russia and Siberia reaching as far as the Kamchatka Peninsula, in the south reaching northern parts of the Iberian, Apennine and Balkan Peninsulas, the Caucasus, Iran, Afghanistan, Pakistan, Central Asia, Nepal, northern China and Mongolia. It is also found in northern Africa (Morocco and Egypt) and South America (Argentina, Bolivia, Chile, Ecuador; Meusel et al. 1965, Hultén & Fries 1986). In North America it is distributed in Alaska, Canada and Greenland, southwards as far as the southern United States (Smith et al. 2002). In the Czech Republic it occurs in the vegetation of short sedges and mosses in mineral-rich calcareous fens and springs, particularly in the initial succession stage on water-saturated and disturbed patches of calcareous fens (Hájek & Hájková 2011b), in the past rarely also in salt marshes. While in the Czech Republic such habitats usually occur at low and middle elevations, in the Alps and the Carpathians *E. quinqueflora* is found also in mountain calcareous springs and fens at higher altitudes. Since it has been lost from many sites, particularly due to their drainage and abandonment (it requires grazing and minor disturbances), and only about 30 or fewer populations remain, it is classified as critically threatened (Grulich 2012).

Eleocharis uniglumis subsp. *sterneri* (Fig. 48)

Two subspecies of *Eleocharis uniglumis* occur in the Czech Republic, and measurements of stomata are necessary for their reliable identification. The distribution maps of both subspecies are therefore based solely on revised herbarium specimens. *Eleocharis uniglumis* subsp. *sterneri*, initially described as endemic to the Baltic Islands of Öland and Gotland, differs from the type subspecies in its higher and unstable chromosomal number (Strandhede 1966, Bureš 1998, Pikner & Bureš 2002), larger genome (Zedek et al. 2010) and in corresponding micromorphological characters such as stomatal and pollen size (Strandhede 1966, Bureš 1998, 2002). The geographic distribution of this subspecies is still poorly known. Outside Scandinavia it occurs in two separated areas: (i) in the northern Pannonian part of Europe in the south-eastern Czech Republic, southern Slovakia, north-western Hungary and north-eastern Austria, and (ii) in the Adriatic islands of Krk and Pag and in the adjacent parts of the Dalmatian coast in Croatia (Bureš 1998, 2002, Pikner & Bureš 2002). This peculiar distribution pattern may be explained by long-distance dispersal by migratory birds. *Eleocharis uniglumis* subsp. *sterneri* grows in wet shallow depressions of saline or fen meadows. In the Czech Republic it was found only near the village Strachotín in southern Moravia at two sites that were later flooded by the Nové Mlýny Reservoirs (Bureš 2002); therefore, it is classified as missing (Grulich 2012).

Eleocharis uniglumis subsp. *uniglumis* (Fig. 49)

Eleocharis uniglumis subsp. *uniglumis* is widely distributed from boreal to temperate areas of Europe, Asia and North America; southwards it reaches north-western Africa, the Arabian Peninsula, Iran, Pakistan, China, the Russian Far East, as well as Nevada, New Mexico and North Carolina in the United States (Hultén & Fries 1986, Smith et al. 2002, Govaerts & Simpson 2007). In the Czech Republic *E. uniglumis* subsp. *uniglumis* occurs in the vegetation of short sedges and mosses in mineral-rich calcareous fens on basic or slightly salinized soils. It is found at low and middle elevations, particularly in areas with sediments of the Bohemian Cretaceous Basin and in the Bílé Karpaty Mts, and also in saline areas of southern Moravia and northern Bohemia. Currently, it is classified as endangered because of its scarcity combined with decline (Grulich 2012).

Eriophorum angustifolium (Fig. 50)

Eriophorum angustifolium has a circumboreal distribution range mainly between 40°N and 60°N. In Europe it is distributed northwards to Iceland and to the Arctic Circle in Scandinavia, southwards to northern Portugal, northern Italy and the Balkan Peninsula, and eastwards through European Russia, Siberia as far as the Kamchatka Peninsula, the Korean Peninsula and Manchuria. In North America it is found from the Arctic Circle in the north and to the southern USA in the south (Phillips 1954, Meusel et al. 1956, Hultén & Fries 1986). *Eriophorum angustifolium* usually occurs on acidic peat substrates but is calcium tolerant and occurs also in fens. Its habitats include shallow bog pools and bog hollows with mesotrophic to dystrophic water, abandoned peat extraction hollows and the littoral zones of mesotrophic to oligotrophic fishponds (Navrátilová 2011). It also occupies fen meadows and fens at fishpond shores. It is widespread in the Czech Republic, particularly in the higher-rainfall areas of the colline to montane vegetations belts. It is nearly absent in the dry lowlands of north-western Bohemia and southern Moravia and scattered in lowlands of central Bohemia. It occurs at altitudes from about 180 m to 1350 m. Many of its lowland sites have been lost due to habitat destruction.

Eriophorum gracile (Fig. 51)

Eriophorum gracile has a circumboreal distribution range. In Europe it is widely but sparsely distributed from Ireland and Great Britain to Sweden and Finland (northwards to the Arctic Circle there), in the south it reaches its distribution limit along a line extending from the Pyrenees through northern Italy to southern Bulgaria. It is also found throughout northern Asia as far east as the Kamchatka Peninsula and northern Japan; however, it appears to be rather rare in central Asia. In North America it is found north of approximately 45°N (Hultén & Fries 1986). Its habitats include marshes along the shores of fishponds, bog hollows and spring fens on both acidic peat soils and mineral-rich fens. In the Czech Republic *E. gracile* is considered a glacial relict. It used to be found in the Třeboňská pánev basin in southern Bohemia, very locally in northern, western and eastern Bohemia, and even more rarely in Moravia and Silesia at altitudes from about 300 m to 900 m. Because of drainage, eutrophication and changes in landscape management, *E. gracile* has markedly declined. Of the 39 populations recorded, only seven exist to the present day. It is therefore classified as critically threatened (Grulich 2012).

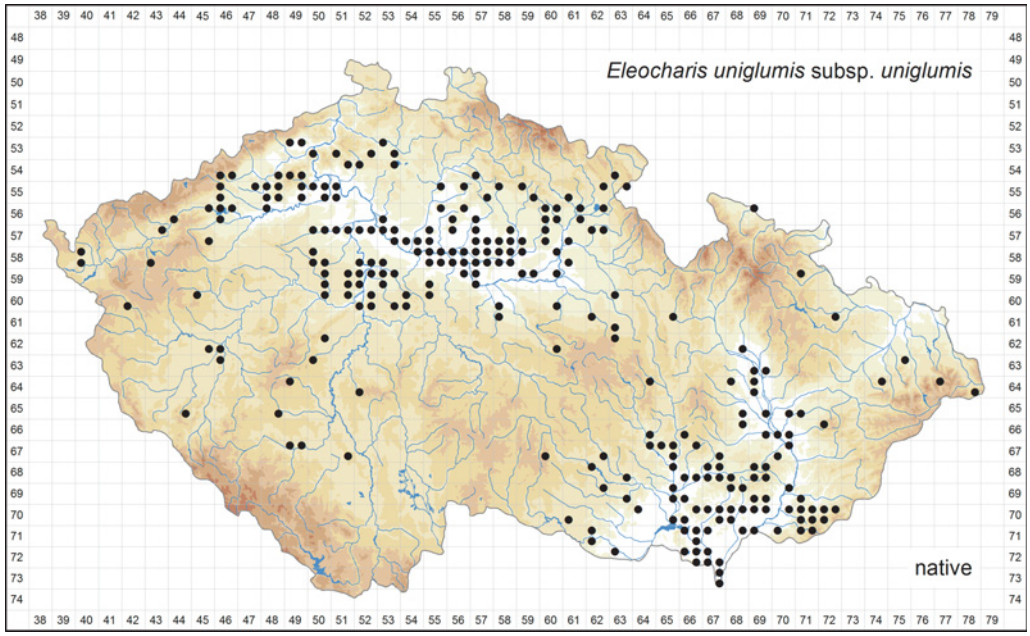

Fig. 49. – Distribution of *Eleocharis uniglumis* subsp. *uniglumis* in the Czech Republic (265 occupied quadrants). Prepared by Petr Bureš.

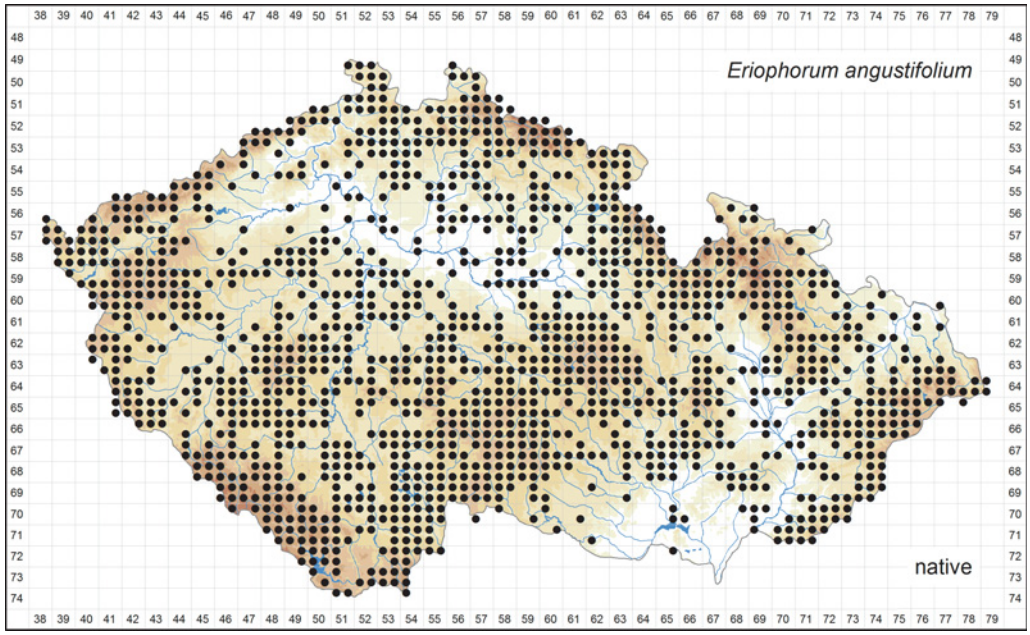

Fig. 50. – Distribution of *Eriophorum angustifolium* in the Czech Republic (1417 occupied quadrants). Prepared by Jitka Štěpánková.

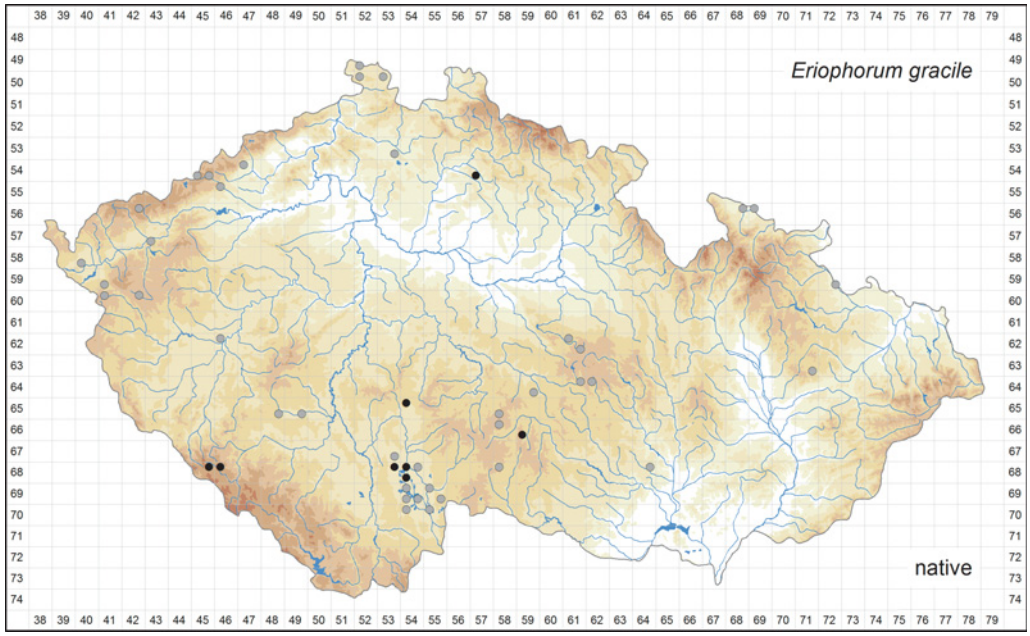

Fig. 51. – Distribution of *Eriophorum gracile* in the Czech Republic: ● at least one record in 2000–2015 (8 quadrants), ● pre 2000 records only and/or extirpated occurrences (39 quadrants). Prepared by Jitka Štěpánková.

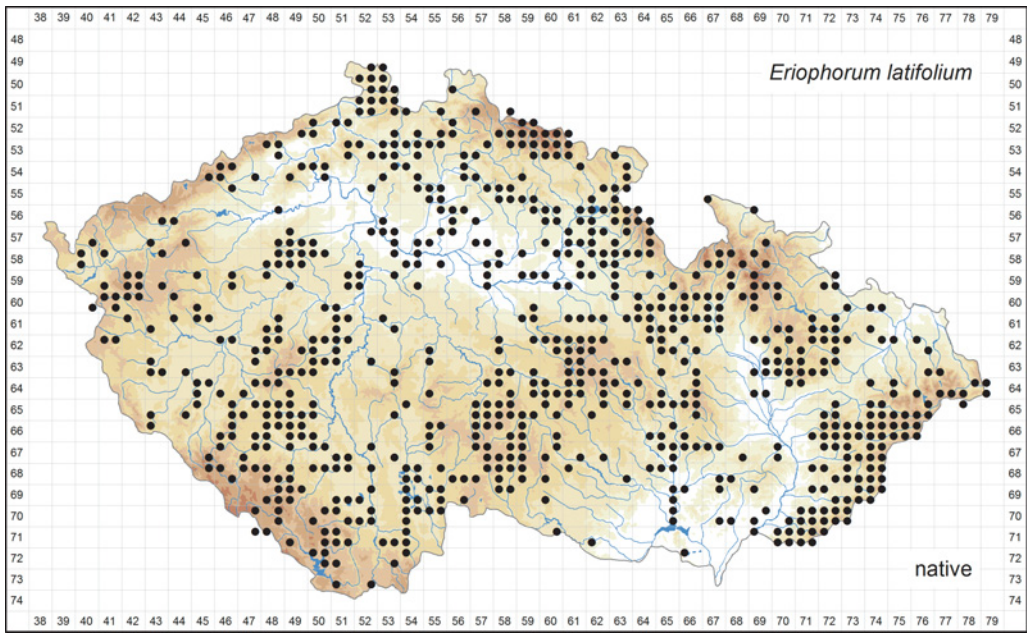

Fig. 52. – Distribution of *Eriophorum latifolium* in the Czech Republic (749 occupied quadrants). Prepared by Jitka Štěpánková.

Eriophorum latifolium (Fig. 52)

Eriophorum latifolium is widespread in Eurasia. It is scattered throughout most of Europe. It reaches the Arctic Circle in the north, in southern Europe it extends from the Pyrenees eastwards to the Balkan Peninsula. It is widespread in northern Asia from western Siberia to the Russian Far East and Mongolia (Meusel et al. 1965, Hultén & Fries 1986). *Eriophorum latifolium* is found on calcareous fens and springs in areas with base-rich soils. It is distributed throughout the Czech Republic, being frequent only locally. It used to be frequent on calcareous fens in the lowlands of Bohemia, but most sites disappeared due to habitat destruction. At present it is very rare there and occurs more frequently only on Cretaceous sediments in eastern and central Bohemia. It is absent from dry regions of north-western Bohemia and southern Moravia and from areas with silicate bedrocks in south-western and central Bohemia. In mountains it is more frequent in northern Bohemia and the Českomoravská vrchovina highlands and on flysch in the Western Carpathians in eastern Moravia. It occurs at altitudes from about 180 m to 1300 m. A lot of sites of *E. latifolium* have been destroyed, particularly by agriculture and building human settlements. Consequently, it is classified as endangered (Grulich 2012).

Eriophorum vaginatum (Fig. 53)

Eriophorum vaginatum has a circumboreal distribution range, mainly between 40°N and 60°N. In Europe it occurs mainly in the northern half, southwards reaching the Pyrenees, the Alps and the Carpathians, and eastwards through European Russia and Siberia as far as the Korean Peninsula, Japan, the Sakhalin Peninsula and the Kuril Islands. In North America it is widespread in Canada and the northern USA, and also occurs in Greenland (Meusel et al. 1965, Wein 1973, Hultén & Fries 1986). It grows on ombrotrophic bogs, in dystrophic bog hollows and at margins of bog laggs, where the water is acidic and mineral-poor. In the Czech Republic *E. vaginatum* mainly occurs in higher altitudes of the Bohemian Massif (particularly in the mountains along the country's borders, in the Brdy Mts, the Jihlavské vrchy and Žďárské vrchy hills and in Moravia in the Moravskoslezské Beskydy Mts. At lower altitudes it is mainly found in the basins near the towns of Třeboň and Doksy, and in several other isolated peat bogs. It occurs at altitudes from about 230 m to 1300 m.

Glyceria declinata (Fig. 54)

Glyceria declinata is distributed mainly in north-western and central Europe, reaching southern Scandinavia in the north, the Iberian Peninsula in the southwest and western Ukraine in the east (Holub 1960, Conert 1998). It occurs also in Morocco (Molina Abril 2001) and in northern Macaronesia, where it is considered native in Madeira (Borges et al. 2008), but alien in the Canary Islands (Izquierdo et al. 2004) and Azores (Silva et al. 2010). It has been introduced to North America (Barkworth & Anderton 2007), Australia (Randall 2007) and New Zealand (Howell 2008). In the Czech Republic it occurs in open wet or waterlogged places especially in rain-inundated shallow depressions of forest and meadow tracks, wet pastures, ditches, shores of fishponds, springs, marshes, shallow periodical pools and abandoned quarries. It is distributed throughout the country, with majority of the records from middle elevations. It avoids or only rarely occurs in dry

lowlands. Only revised herbarium specimens and our own field records were accepted in the distribution map since the species is frequently misidentified and other records are unreliable. Sometimes it remains unnoticed in the field and is collected only by chance together with another species of *Glyceria*. As a result, it is certainly more widespread than indicated by the map.

Glyceria fluitans (Fig. 55)

Glyceria fluitans is distributed throughout Europe. It is rare in or missing from the Arctic, most of the Mediterranean islands and the Pontic region of south-eastern Europe. In Asia it is found in the Caucasus, Anatolia and Lebanon (Meusel et al. 1965, Hultén & Fries 1986). It is native also to the northern coasts of Africa and it has been introduced to western and eastern Siberia, North America, South America (Conert 1998), Australia (Randall 2007) and New Zealand (Howell 2008). In the Czech Republic it inhabits banks of rivers and streams, shores of water reservoirs, periodically inundated gravel beds of fast-flowing rivers, shallow ditches and pools, springs, marshes, wet forest tracks, alder carrs and alluvial forests. It is common throughout the country, being rare in or locally missing only from the driest lowlands where it is usually confined to river basins. As *G. fluitans* is often misidentified, only revised herbarium specimens and our own field records were accepted in the distribution map. Therefore, the species may be more widespread than indicated by the map.

Glyceria maxima (Fig. 56)

Glyceria maxima is distributed across Europe and northern Asia from the British Isles to south-western Siberia. In Europe it is missing in the Arctic, Iceland, the Azores, Portugal, Corsica and southern Greece. Isolated occurrences are in the Caucasus and Anatolia (Meusel et al. 1965, Hultén & Fries 1986). It has been introduced to North America (Barkworth & Anderton 2007), Australia (Randall 2007) and New Zealand (Howell 2008). In the Czech Republic it grows along banks or shores of still or slowly running waters, in ponds, marshes, ditches, shallow inundated depressions, reed vegetation, alder carrs and alluvial forests. It is distributed throughout the country, being most frequent in the areas with fishponds and lowland rivers. It is less frequent in dry areas and is absent from higher elevations where suitable habitats are rare or missing.

Glyceria nemoralis (Fig. 57)

Glyceria nemoralis is distributed mainly in the eastern part of central Europe. Westwards it reaches northern Germany, northwards Lithuania, eastwards the Kostroma and Novgorod regions of the Russian Federation, southwards northern Greece, Anatolia, the Caucasus and north-eastern Iran. It is very rare in or absent from the Pontic region of south-eastern Europe (Conert 1998, Tsvelev 2006). In the Czech Republic it grows in forest springs, along banks and in inundated gravel beds of forest streams and in alder carrs. It reaches its south-western distribution limit in the Czech Republic where it is generally rare and occurs only in the north-eastern half of the country. It is common only in the Bílé Karpaty Mts and Chřiby hills and quite common also in some other forested parts of southern and eastern Moravia (e.g. Hostýnské vrchy hills, Javorníky Mts and the surroundings of Brno).

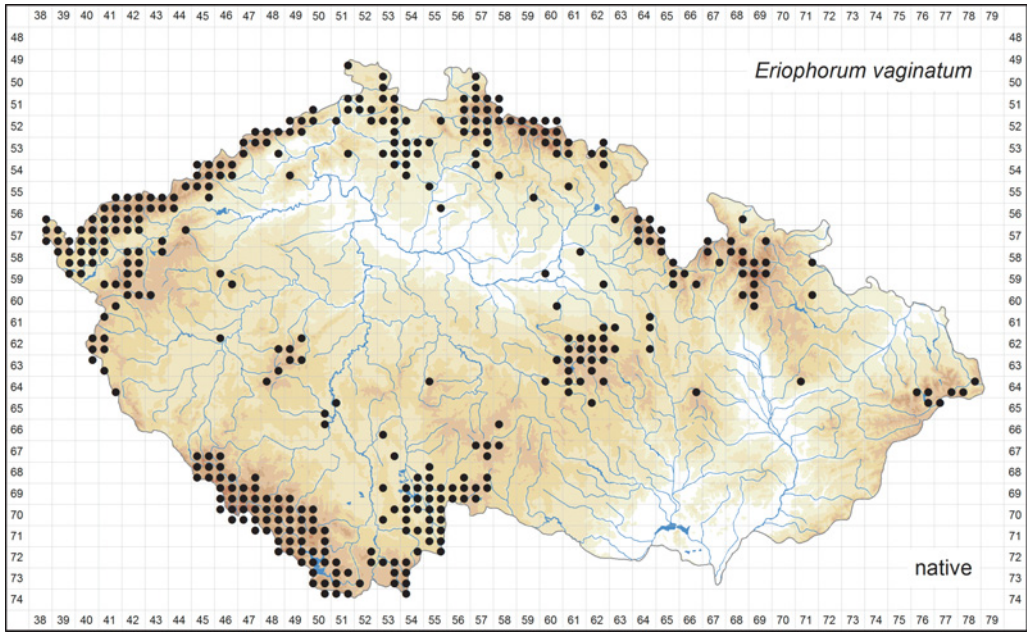

Fig. 53. – Distribution of *Eriophorum vaginatum* in the Czech Republic (380 occupied quadrants). Prepared by Jitka Štěpánková.

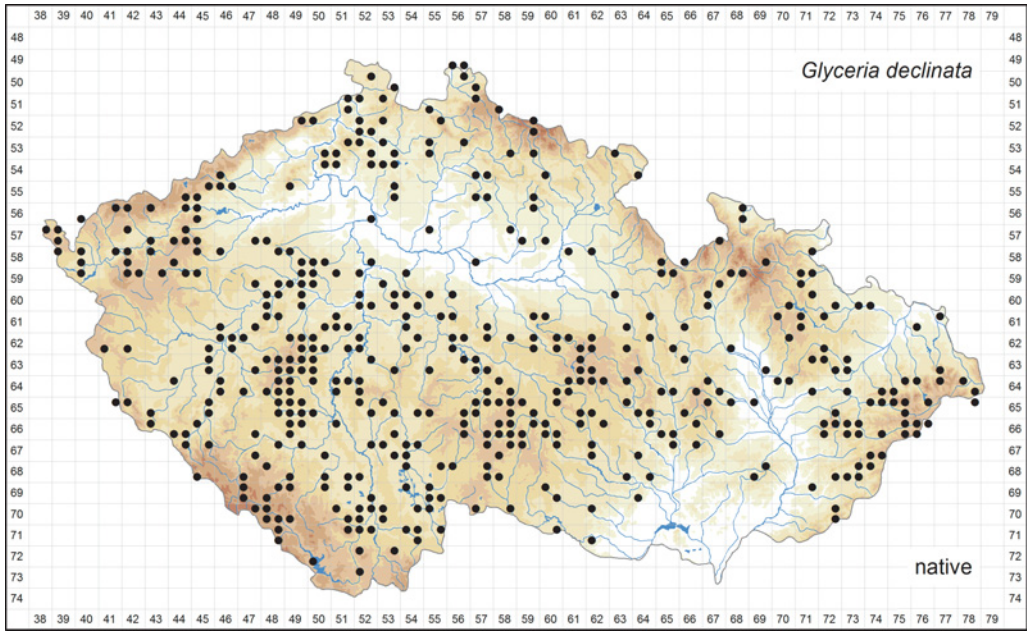

Fig. 54. – Distribution of *Glyceria declinata* in the Czech Republic (469 occupied quadrants). Prepared by Martin Dančák & Bohumil Trávníček.

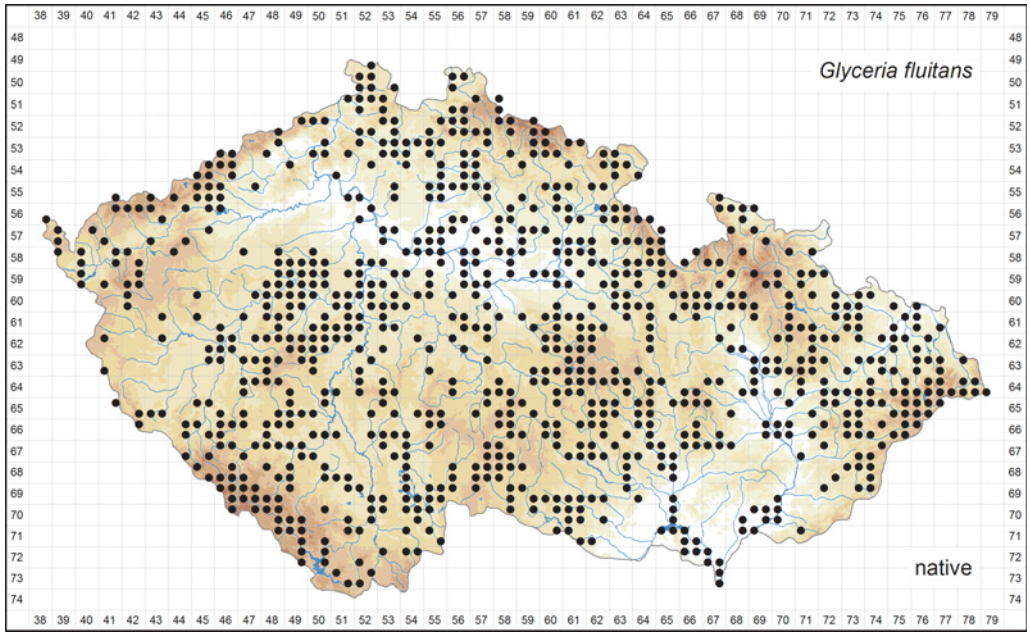

Fig. 55. – Distribution of *Glyceria fluitans* in the Czech Republic (908 occupied quadrants). Prepared by Martin Dančák & Bohumil Trávníček.

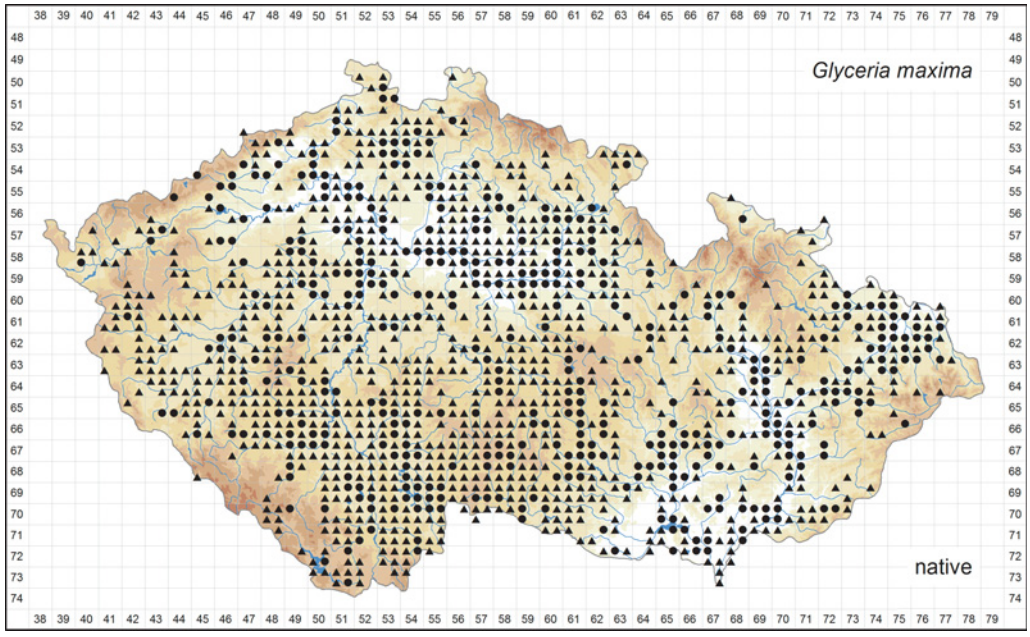

Fig. 56. – Distribution of *Glyceria maxima* in the Czech Republic: ● occurrence documented by herbarium specimens (415 quadrants), ▲ occurrence based on other records (914 quadrants). Prepared by Martin Dančák & Bohumil Trávníček.

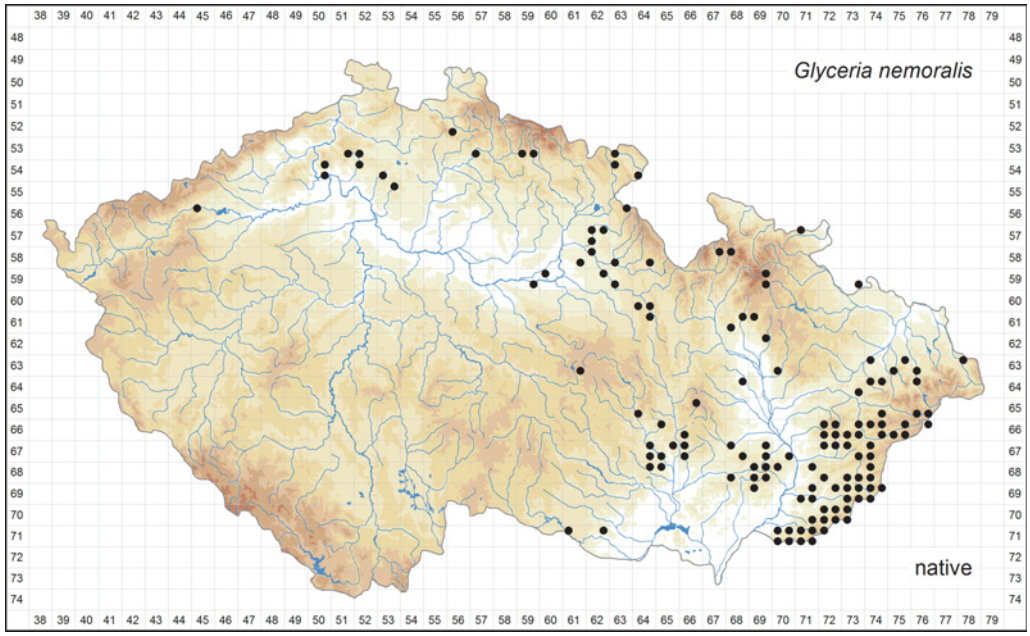

Fig. 57. – Distribution of *Glyceria nemoralis* in the Czech Republic (134 occupied quadrants). Prepared by Martin Dančák & Bohumil Trávníček.

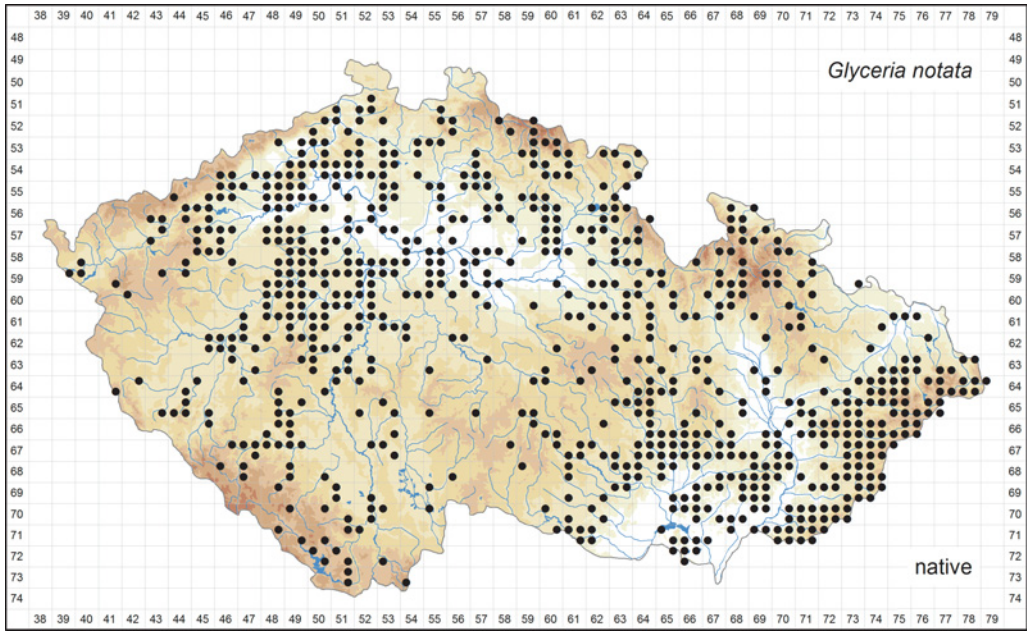

Fig. 58. – Distribution of *Glyceria notata* in the Czech Republic (764 occupied quadrants). Prepared by Martin Dančák & Bohumil Trávníček.

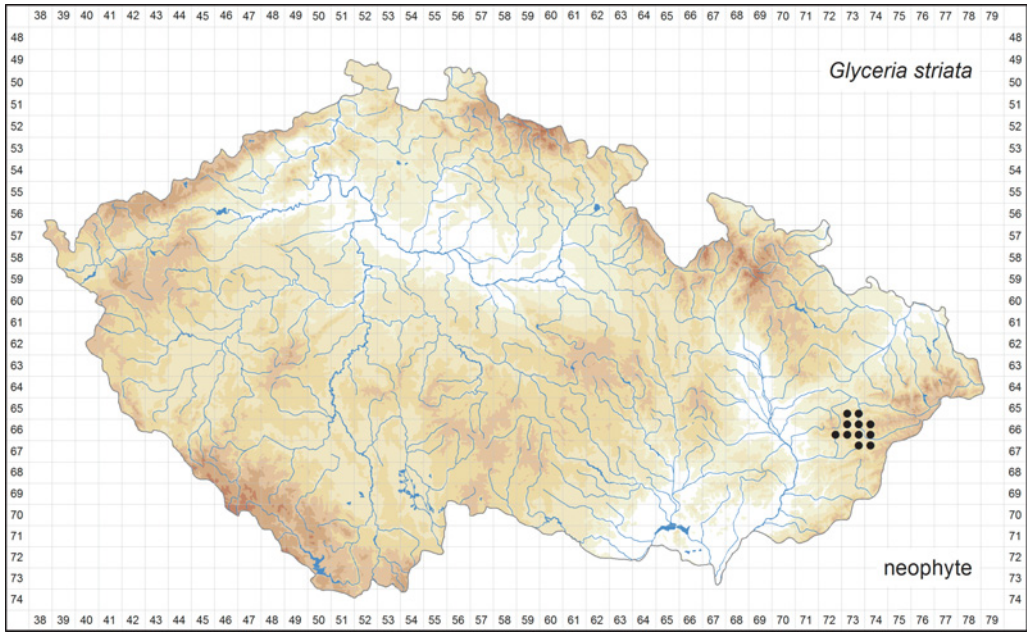

Fig. 59. – Distribution of *Glyceria striata* in the Czech Republic (11 occupied quadrants). Prepared by Martin Dančák & Bohumil Trávníček.

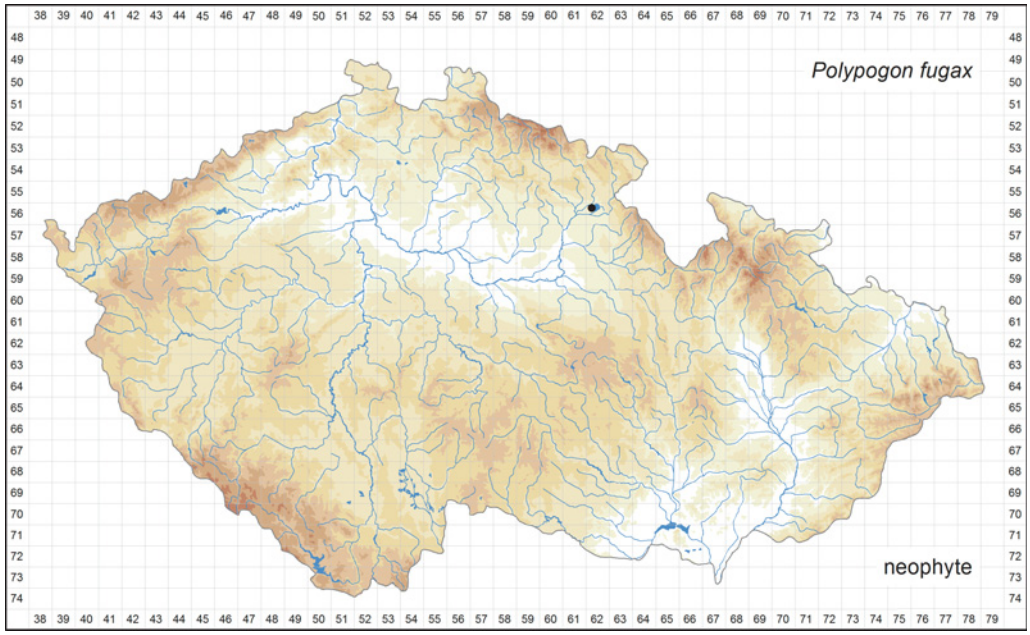

Fig. 60. – Distribution of *Polypogon fugax* in the Czech Republic (1 occupied quadrant). Prepared by Jiří Zázvorka.

Through northern Moravia and eastern Bohemia, it reaches north and north-western Bohemia, being only scattered or rare there. It is currently classified as vulnerable (Grulich 2012). As the species is frequently misidentified, only revised herbarium specimens and our own field records were accepted in the distribution map. The resulting map may be incomplete, but we believe it reasonably represents the species' distribution pattern in the country.

Glyceria notata (Fig. 58)

Glyceria notata is distributed in most parts of Europe, excluding the Arctic, Iceland, the Faeroe Islands, Azores and some Mediterranean islands. It is very rare in or absent from the Pontic region of south-eastern Europe. It is native also to northern Africa and in Asia from Anatolia in the west as far as western China in the east (Meusel et al. 1965, Hultén & Fries 1986, Tsvelev 2006). It has been introduced to the Russian Far East, North, Central and South America, Australia and New Zealand (Conert 1998, Howell & Sawyer 2006, Randall 2007). In the Czech Republic it inhabits banks and shores of still or running waters, periodically inundated gravel beds of fast-flowing rivers, springs, shallow ditches and pools, marshes, wet forest tracks and alder carrs. It is common throughout the country, being rare only in regions with poor acidic soils. Only records based on revised herbarium specimens and our own field records were accepted in the distribution map because *G. notata* is frequently misidentified. It may therefore be somewhat more widespread than indicated by the map.

Glyceria striata (Fig. 59)

Glyceria striata is native to Central and North America, from Guatemala in the south to Canada and Alaska in the north (Soreng et al. 2003). It has been introduced to continental Europe and New Zealand (Howell & Sawyer 2006, Tsvelev 2006). In the Czech Republic it grows in wet forest tracks and clearings, forest springs and marshes, ash-alder alluvial forests, on stream banks, in ditches, pools and ponds, usually in disturbed places with water seepage. It is currently known only from lower stretches of the Vsetínská Bečva river valley and its tributaries in eastern Moravia, particularly around Vsetín town. The species has probably spread somewhat since its discovery in the Czech Republic (Dančák 2002, 2003), but this spreading seems to be rather slow and only over a short distance. It is classified as a naturalized alien (Pyšek et al. 2012).

Polypogon fugax (Fig. 60)

Polypogon fugax occurs in temperate, subtropical to tropical Asia and in tropical Africa. It is found as agricultural weed, naturalized or as casual alien in warm areas of many countries of the world (e.g. Björkman 1960, Bor 1960, 1968, Tsvelev 1976, Lu & Phillips 2006). For central Europe there is a single record of *P. fugax*, which was introduced with cotton to the Czech Republic: a single plant was found in the yard of a cotton mill in the town of Česká Skalice in eastern Bohemia in 1964 (Conert 1998, Jehlík 1998).

Polypogon monspeliensis (Fig. 61)

Polypogon monspeliensis is probably native only to the Mediterranean area, northern and central Africa and south-western Asia. It has been widely naturalized, often as a weed, in Atlantic western Europe and Macaronesia, Crimea, the Caucasus, Central Asia and south-western, southern and eastern Asia. Further it has been introduced worldwide into temperate to tropical areas, e.g. southern Africa, Australia and New Zealand, the Americas, central Europe and the Baltic countries (Björkman 1960, Tsvelev 1976, Tutin 1980, Conert 1998), sometimes behaving as invasive (Weber 2003). *Polypogon monspeliensis* was rarely introduced to the Czech Republic in the past. It was recorded in ruderal places, railway stations, yards of warehouses, iron ore deposits, woollen and cotton mills and their vicinity. It used to be recorded particularly in the 1960s as introduced mostly with Australian wool (Jehlík 1998). The last time it was recorded was in the town of Liberec in northern Bohemia in 1967.

Sclerochloa dura (Fig. 62)

Sclerochloa dura is distributed particularly in the central part of southern Europe (Italy and south-eastern France), the southern part of central Europe and south-western Asia, from where it extends to central Asia and northern Africa. It is also scattered through south-western and south-eastern Europe; northwards it reaches central Germany, northern Bohemia, south-eastern Poland and Slovakia (more northwards being only sporadically introduced). From the eastern-Mediterranean area it extends almost continuously through temperate Asia to the Tian Shan Mts and north-western India and also occurs in northern Africa. It has been introduced into North America (now considered invasive in the USA), Argentina and Australia (Zając 1987, Conert 1998). *Sclerochloa dura* is a thermophilous species requiring open, sunny habitats on loamy or clayey trampled soils. It grows on loam tracks among fields, on open places in vineyards, in slightly saline pastures, on trampled soils near buildings and in abandoned quarries, at altitudes of 155–450 m. In the Czech Republic *S. dura* has two main areas of distribution, one in north-western Bohemia (particularly between the towns of Kadaň, Podbořany, Žatec and Louny) and the other in southern Moravia (mainly south of the line connecting the towns of Znojmo, Brno and Uherský Brod); elsewhere being rarely introduced as a casual.

Scheuchzeria palustris (Fig. 63)

Scheuchzeria palustris has a circumboreal distribution range approximately between 40°N and 60°N. It occurs mainly in the northern half of Europe, in western Siberia and western North America (Sledge 1949, Meusel et al. 1965, Hultén & Fries 1986). It grows in bog hollows or bog laggs in rain-fed bogs permanently saturated with water, poor in minerals and nutrients and with a low pH. In the Czech Republic it occurs only locally and is mainly found in higher mountains of the Bohemian Massif along the country's borders. It has also been reported from up to 10 sites in the Třeboňská pánev basin, and fossil records exist from another handful of sites; however, the latest record from that area dates back to 1976 (Koutecký 2013a). In Moravia, *S. palustris* is extremely rare, being confined to several isolated sites. Currently, it occurs there only at two sites in the Hrubý Jeseník Mts, while two other populations have vanished. It occurs at altitudes from about 430 m to 1300 m. It is classified as critically threatened (Grulich 2012).

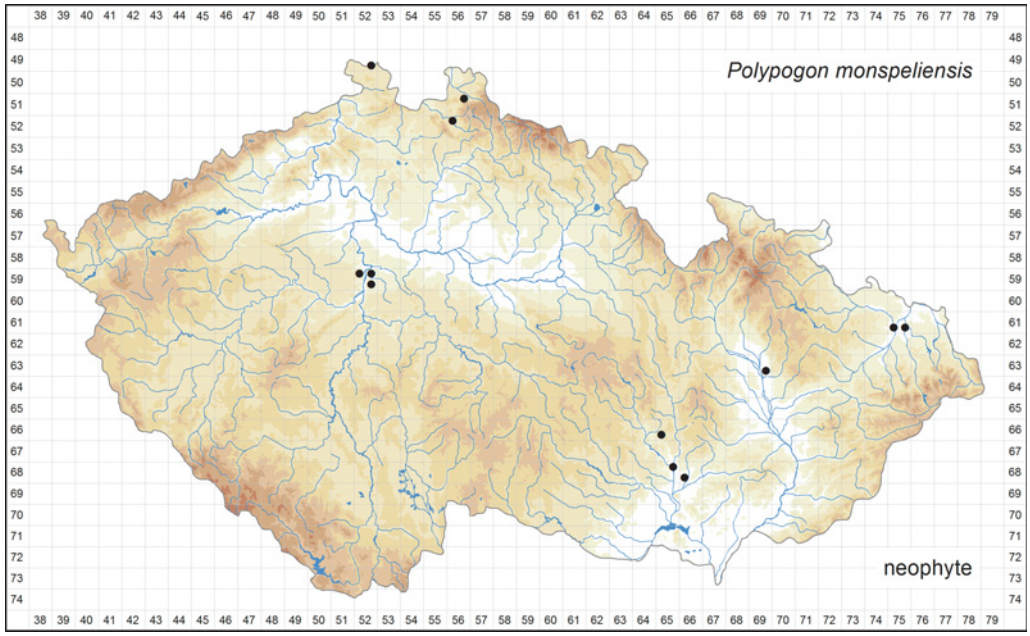

Fig. 61. – Distribution of *Polypogon monspeliensis* in the Czech Republic (12 occupied quadrants). Prepared by Jiří Zázvorka.

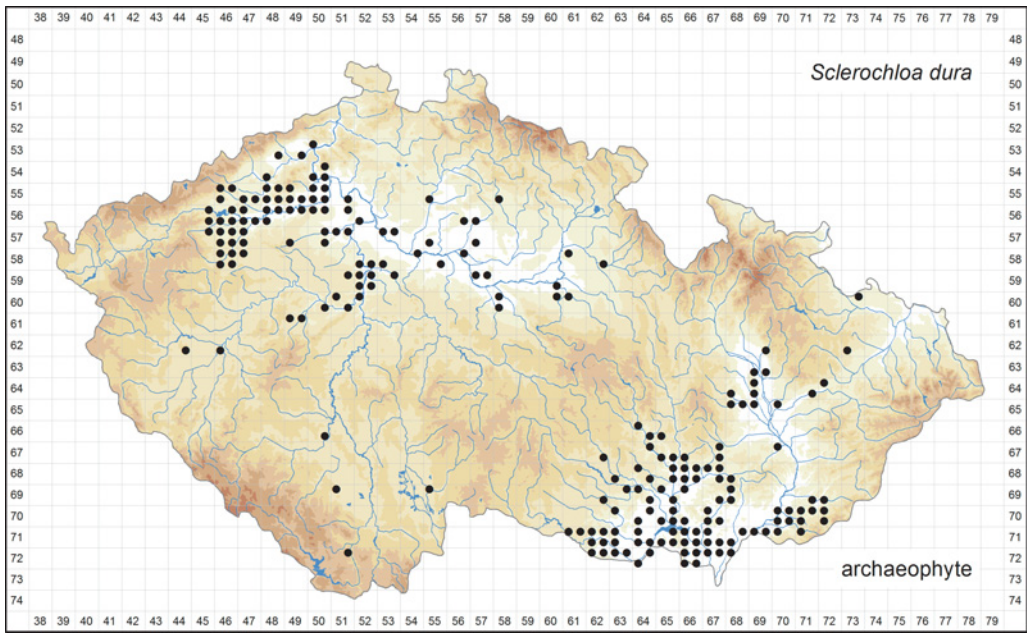

Fig. 62. – Distribution of *Sclerochloa dura* in the Czech Republic (208 occupied quadrants). Prepared by Jiří Zázvorka.

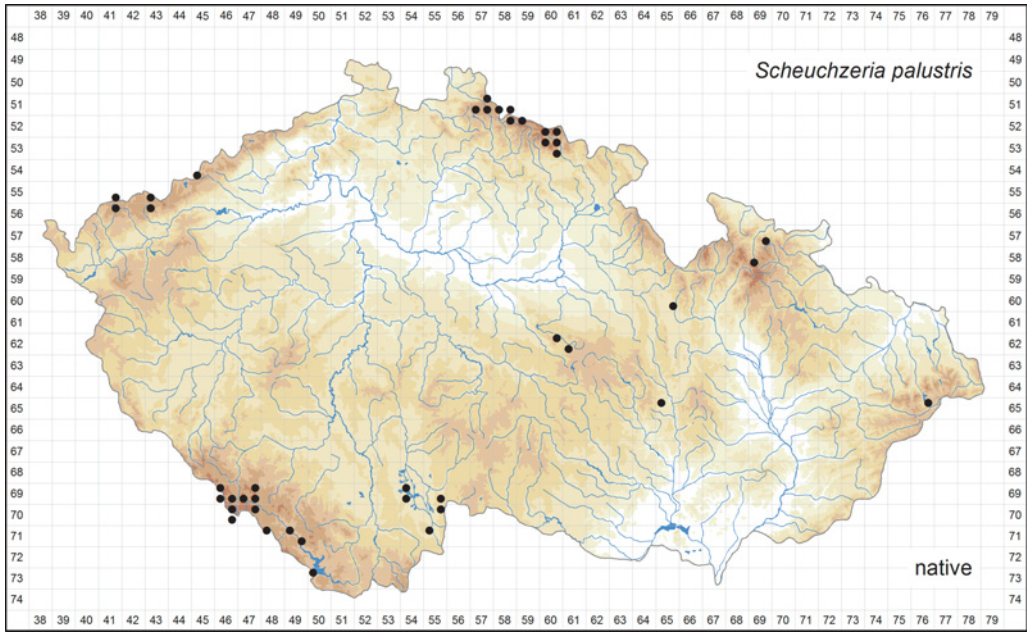

Fig. 63. – Distribution of *Scheuchzeria palustris* in the Czech Republic (42 occupied quadrants). Prepared by Jitka Štěpánková.

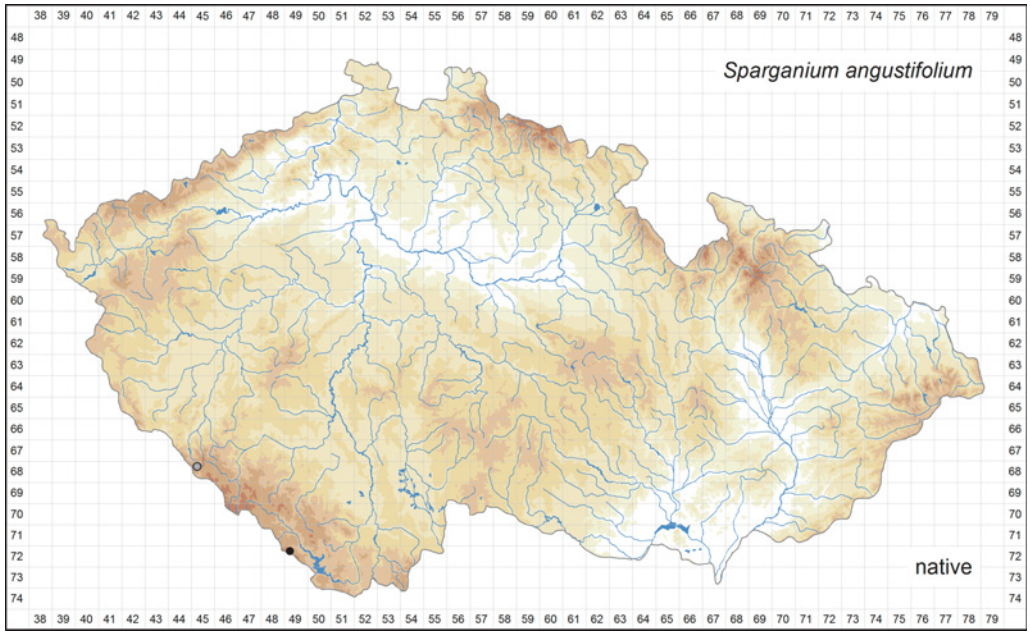

Fig. 64. – Distribution of *Sparganium angustifolium* in the Czech Republic: ● at least one record in 2000–2015 (1 quadrant), ◍ pre 2000 records only and/or extirpated occurrences (1 quadrant). Prepared by Zdeněk Kaplan.

Sparganium angustifolium (Fig. 64)

Sparganium angustifolium is a holarctic species with a circumboreal distribution. It shows an arctic-alpine distribution pattern in Europe and North America. In Europe it is widespread in the north, whereas in central and southern Europe it is confined to high mountains (Cook & Nicholls 1986). In the Czech Republic it has occurred only in two oligotrophic lakes (Černé jezero and Plešné jezero lakes) in the Šumava Mts in south-western Bohemia. *Sparganium angustifolium* was repeatedly recorded there particularly in the 1870s–1890s but both populations vanished later: it was last recorded in Plešné jezero in 1892 and in Černé jezero in 1956. Water acidification is considered as a probable cause of extirpation (Procházka 1998). However, the water quality in the lakes has improved recently and the population in Plešné jezero is being restored from the soil seed bank (M. Čtvrtlíková unpubl., cited by Koutecký 2013b).

Sparganium emersum (Fig. 65)

Sparganium emersum has a holarctic distribution range with the main occurrence in the temperate zone. It is found throughout Europe from about the Arctic Circle to the submeridional zone. In Asia it extends through Siberia eastwards to Japan, southwards to Turkey, Kashmir and eastern China, and in North America from the west to the east coast (Cook & Nicholls 1986). *Sparganium emersum* grows in shallow zones of fishponds or on their seasonally exposed bottoms, along banks in lowland rivers and in adjacent oxbow lakes. In the Czech Republic it is most frequent in fishpond basins of southern Bohemia, in the Labe river basin and adjacent regions of eastern Bohemia and in the Českomoravská vrchovina highlands. In contrast, it is markedly less frequent in or absent from dry areas of north-western Bohemia, most of Moravia and the mountains where suitable habitats are missing.

Sparganium erectum (Fig. 66)

Sparganium erectum occurs in Europe from the Arctic Circle southwards to northern Africa and extends through temperate Asia southwards to the western Himalaya and eastwards through Japan into north-western North America, and also occurs in south-eastern Australia where it may have been introduced (Cook & Nicholls 1987). The species includes five subspecies, of which four are present in Europe (Cook & Nicholls 1987), and all these also occur in the Czech Republic (Kaplan 2002). *Sparganium erectum* grows usually in shallow water in fishponds, along banks in lowland rivers, in adjacent oxbow lakes, in canals, ditches, pools in wetlands and along shores of lakes in abandoned sand pits. It is distributed throughout the Czech Republic, being particularly common in fishpond regions and along lowland rivers. It is less frequent in dry areas particularly in north-western Bohemia and southern Moravia and is absent from the mountains where suitable habitats are missing. As its subspecies can only be determined with ripe fruits, a great majority of herbarium specimens, which are mostly in flower or with only unripe fruits, cannot be identified to the subspecies level. Most undocumented field records are unreliable because the precise taxonomic concept of the subspecies has been developed only in a recent monograph (Cook & Nicholls 1987) and the subspecies are often identified incorrectly. For these reasons, all four distribution maps of subspecies (Figs 67–70) are based solely on revised herbarium specimens with ripe fruits, which is

only about 13% of all available records. The resulting maps are inevitably incomplete and may serve as basis for a future more detailed study of the distribution of the subspecies. All available records, i.e. records from herbaria, literature, databases and field observations, are included in the distribution map of the species (Fig. 66).

Sparganium erectum subsp. *erectum* (Fig. 67)

Sparganium erectum subsp. *erectum* is found mainly in central and southern Europe, extending northwards to southern Scandinavia, eastwards to the Caucasus and southwards to Turkey (Cook & Nicholls 1987); it also occurs in south-western and southern Siberia (Kashina 1988). The majority of available records of this subspecies in the Czech Republic come from the Labe river basin in central and eastern Bohemia. Other records indicate that it is rather frequent also in fishpond regions in southern and south-western Bohemia and in basins along lowland rivers in southern and north-eastern Moravia.

Sparganium erectum subsp. *microcarpum* (Fig. 68)

Sparganium erectum subsp. *microcarpum* is found in most of Europe, being particularly common in its northern part (Cook & Nicholls 1987), but is apparently absent from some southern regions (Uotila 2009b). It also occurs in the Caucasus and in Turkey (Cook & Nicholls 1987, Uotila 2009b) and may even extend to south-western Siberia (Kashina 1988). This is the most frequent and most widespread of all four subspecies of *S. erectum* occurring in the Czech Republic. Although the knowledge of its distribution is incomplete, it was documented from all areas where the species occurs, and it is the only subspecies in the Czech Republic found in the mountains.

Sparganium erectum subsp. *neglectum* (Fig. 69)

Sparganium erectum subsp. *neglectum* occurs throughout much of Europe, extending northwards to southern Sweden and southwards to the northern coast of Africa, Greece and Turkey (Cook & Nicholls 1987). This is the rarest of the subspecies in the Czech Republic, known from about 20 localities in the middle Labe river basin in central Bohemia and from about the same number of localities in southern and eastern Bohemia and in Moravia.

Sparganium erectum subsp. *oocarpum* (Fig. 70)

Sparganium erectum subsp. *oocarpum* occurs scattered in western, central and south-eastern Europe and from Turkey and Iraq (Cook & Nicholls 1987). In the Czech Republic it is found most frequently in the Labe river basin in central and eastern Bohemia, while being less frequent in south-western Bohemia and in south-western, southern and north-eastern Moravia.

Sparganium natans (Fig. 71)

Sparganium natans is found in Eurasia and North America. It occurs in most of Europe except the extreme north and dry and warm Mediterranean areas (Meusel et al. 1965, Cook & Nicholls 1986, Hultén & Fries 1986). In the Czech Republic it is mostly found at

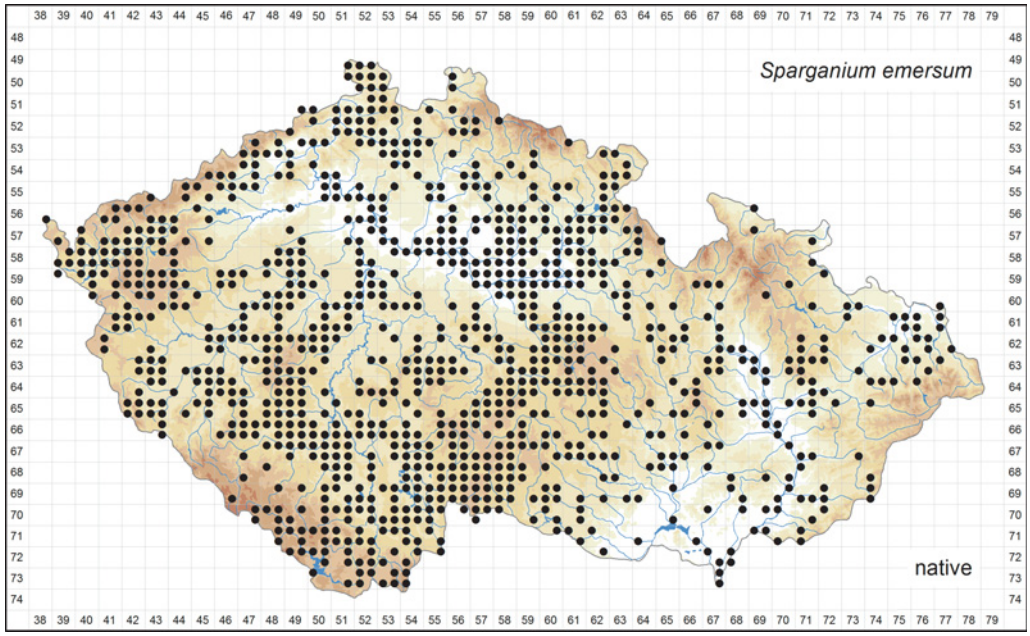

Fig. 65. – Distribution of *Sparganium emersum* in the Czech Republic (1026 occupied quadrants). Prepared by Zdeněk Kaplan.

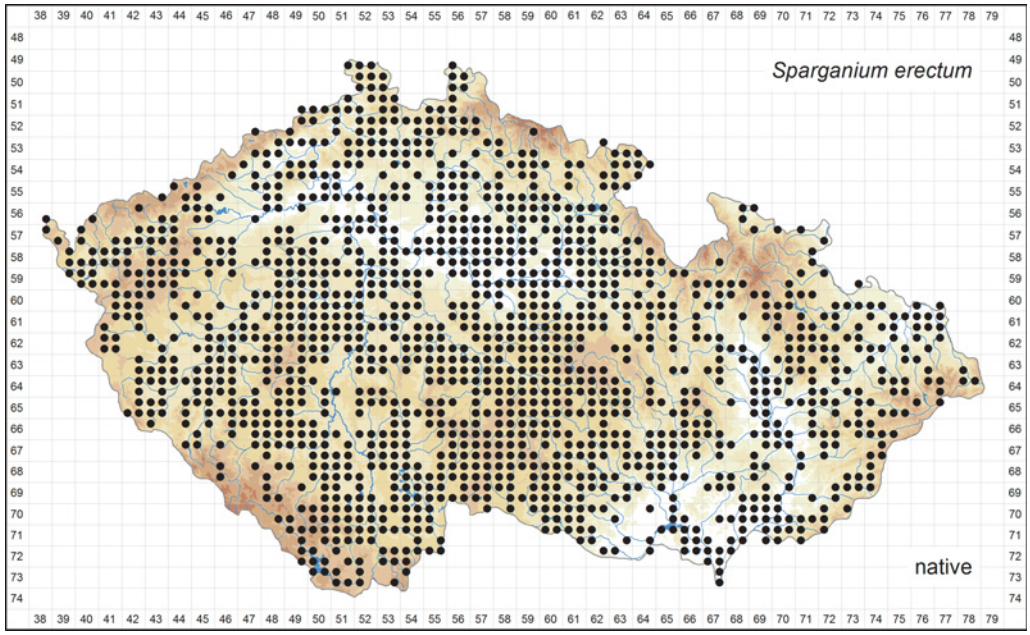

Fig. 66. – Distribution of *Sparganium erectum* in the Czech Republic (1462 occupied quadrants). Prepared by Zdeněk Kaplan.

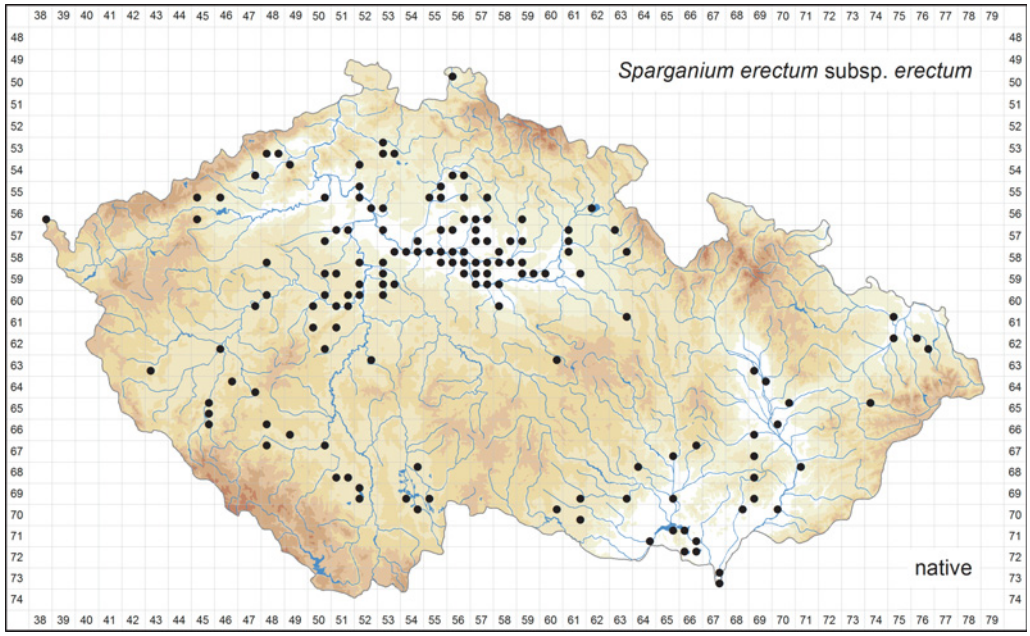

Fig. 67. – Distribution of *Sparganium erectum* subsp. *erectum* in the Czech Republic (149 occupied quadrants). Prepared by Zdeněk Kaplan.

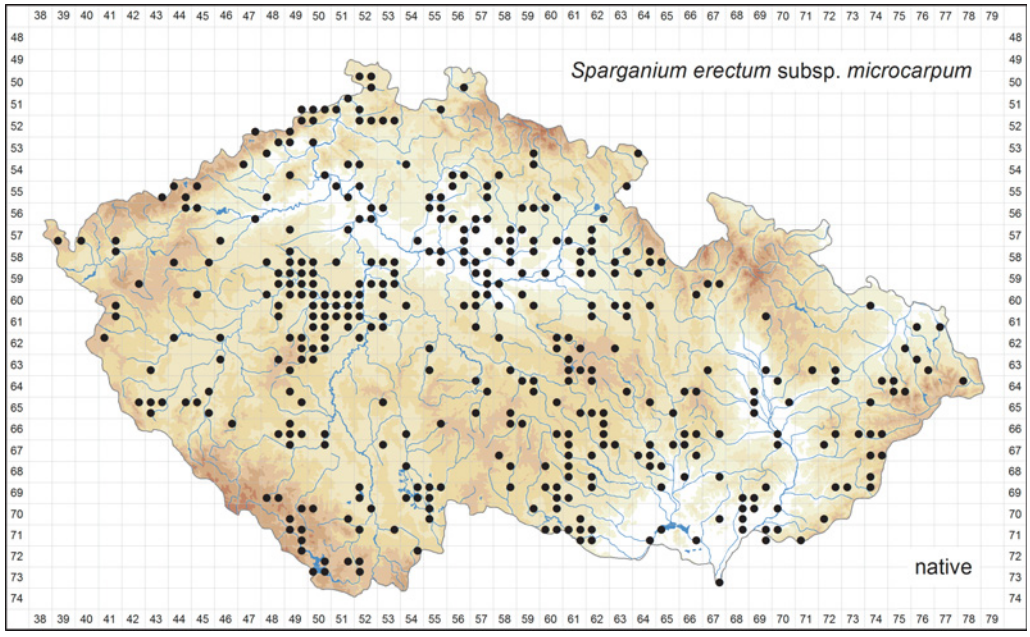

Fig. 68. – Distribution of *Sparganium erectum* subsp. *microcarpum* in the Czech Republic (389 occupied quadrants). Prepared by Zdeněk Kaplan.

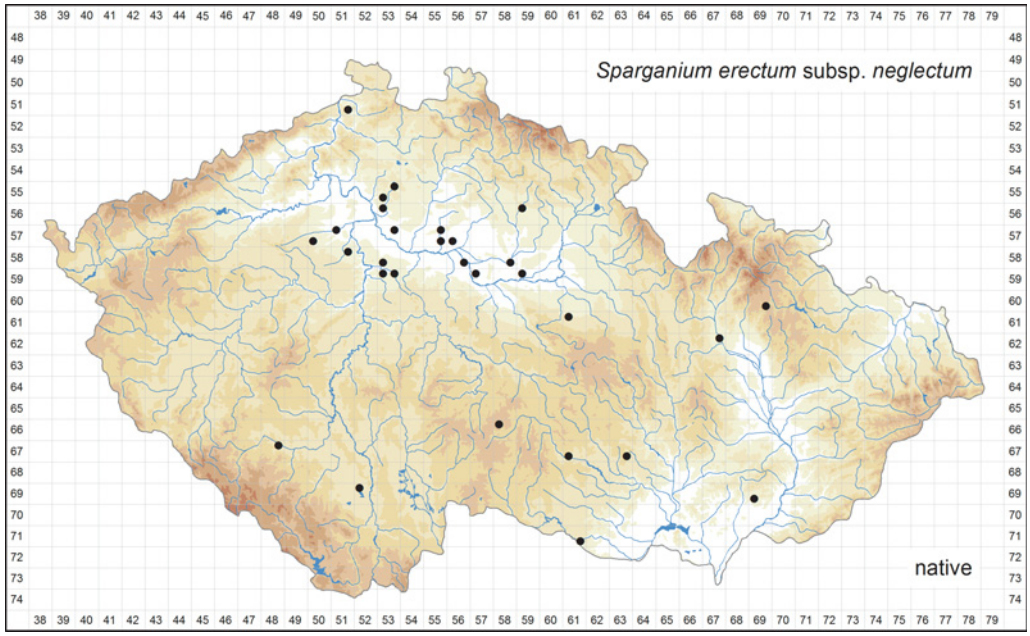

Fig. 69. – Distribution of *Sparganium erectum* subsp. *neglectum* in the Czech Republic (29 occupied quadrants). Prepared by Zdeněk Kaplan.

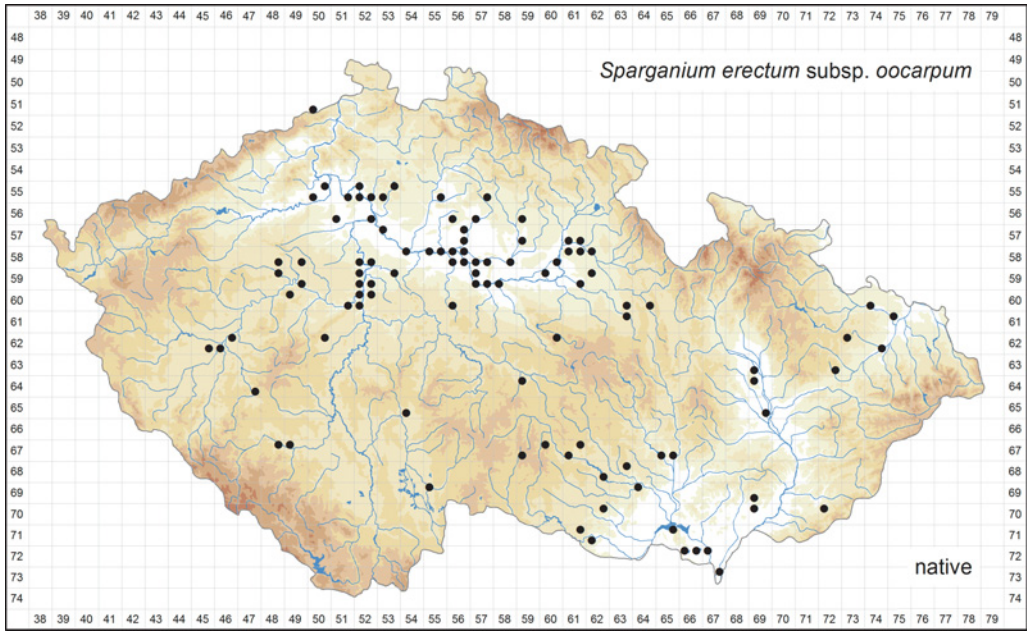

Fig. 70. – Distribution of *Sparganium erectum* subsp. *oocarpum* in the Czech Republic (101 occupied quadrants). Prepared by Zdeněk Kaplan.

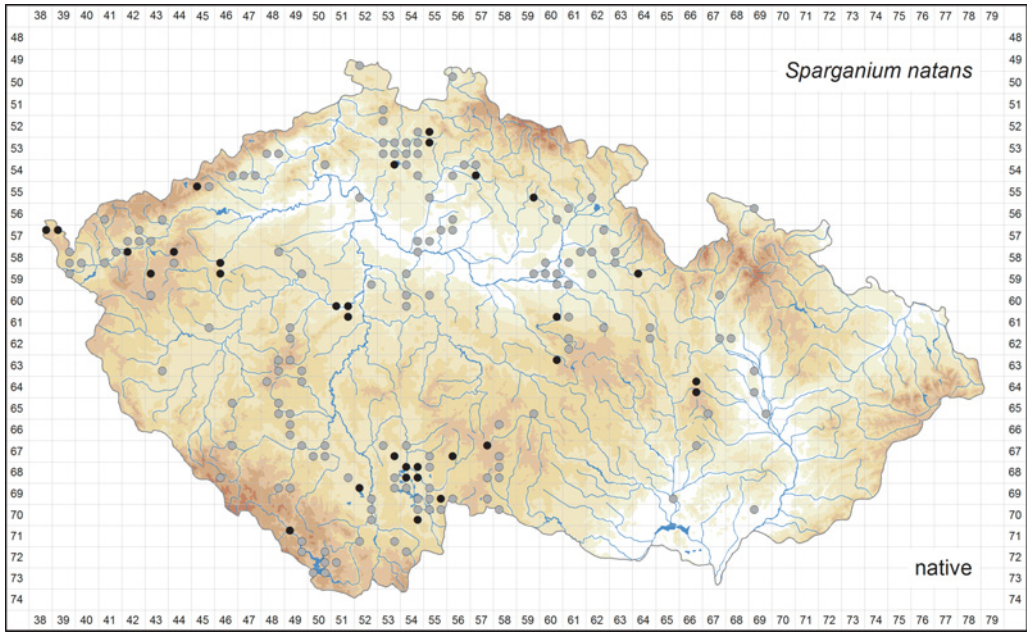

Fig. 71. – Distribution of *Sparganium natans* in the Czech Republic: ● at least one record in 2000–2015 (32 quadrants), ◍ pre 2000 records only and/or extirpated occurrences (147 quadrants). Prepared by Zdeněk Kaplan.

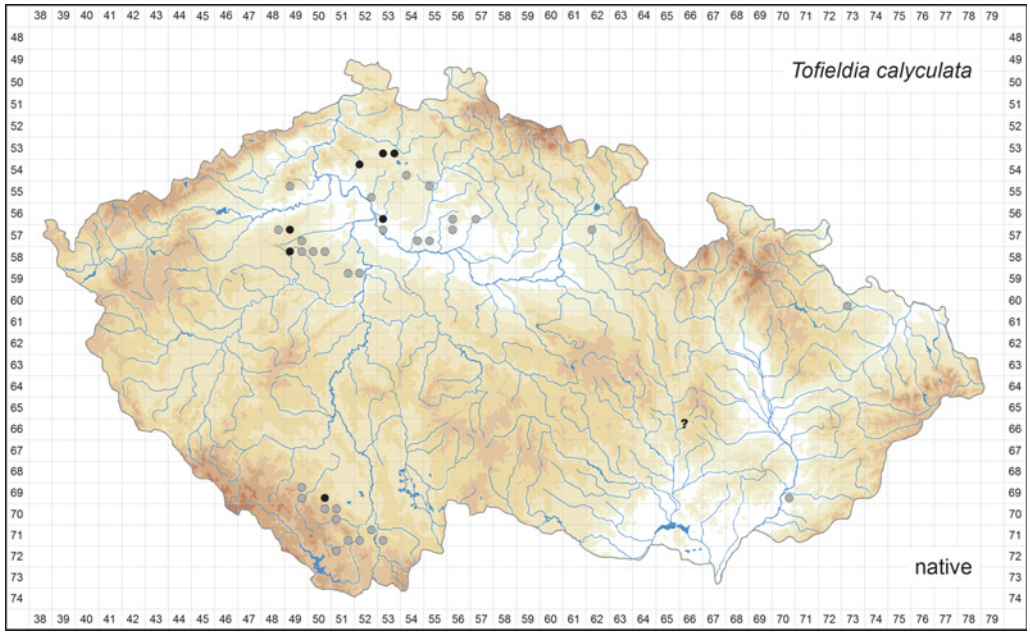

Fig. 72. – Distribution of *Tofieldia calyculata* in the Czech Republic: ● at least one record in 2000–2015 (7 quadrants), ◍ pre 2000 records only and/or extirpated occurrences (30 quadrants). Prepared by Jitka Štěpánková.

the edges of dystrophic ponds and in shallow pools, mostly on peat substrates. It is scattered throughout the country, being locally more frequent in fishpond basins of southern Bohemia, in westernmost Bohemia, in the Doksy region in northern Bohemia, and in eastern Bohemia. It is very rare in Moravia, being absent from most of its area. Because of the drainage of wetlands and eutrophication of fishponds it has vanished from a majority of its former localities. It is classified as endangered (Grulich 2012).

Tofieldia calyculata (Fig. 72)

Tofieldia calyculata is distributed mainly in central and eastern Europe, including the Alps, the Carpathians and the lowlands areas of Ukraine, with some outposts in the Pyrenees, the Baltic states and the Dinarids (Hultén & Fries 1986). In the Czech Republic it occurs in calcareous fens, calcareous tufa springs or small springs on a mineral-rich substrate, rarely also on wet places in pinewoods ravines. Outside the Czech Republic it is more common on small subalpine springs and moist flats on limestones in mountains. In the past, *T. calyculata* was a typical element of the vegetation of calcareous fens located mainly in northern and central Bohemia and of the plant communities of fen springs in the foothills of the Šumava Mts in southern Bohemia. A few isolated populations occurred in eastern Bohemia, southern Moravia and in Silesia. Due to the habitat destruction, it disappeared from most of its former sites and currently survives at only seven of them: near the town of Doksy in northern Bohemia, near Úštek, Bílichov, Třtice and Mělnická Vrutice in central Bohemia and near Kralovice in southern Bohemia. It occurred at altitudes from about 180 m to 600 m. It is classified as critically threatened (Grulich 2012).

Tragus racemosus (Fig. 73)

The native distribution range of *Tragus racemosus* is unclear but it probably comprises south-western and southern Europe from where it extends through the Rhineland to the northern foothills of the Alps and through the Balkan Peninsula and the Danube river basin to Hungary, Lower Austria and southernmost Slovakia. At present the species is found in both African and European Mediterranean areas, the Middle East, southern Ukraine, the Caucasus and Central Asia. It has been introduced worldwide to subtropical and tropical zones of both hemispheres. In addition it sometimes appears as a casual in the temperate zone of Europe but mostly it does not spread beyond the limits of the Mediterranean flora (Tsvelev 1976, Anton 1981, Conert 1998). *Tragus racemosus* is usually found on sandy and skeletal, acid or calcareous, dry and nutrient-poor soils. Its diaspores used to be introduced into the Czech Republic with wool into local woollen mills, and with wool waste it spread to their vicinities. Most records come from southern Moravia, predominantly from the vicinities of the towns of Znojmo, Moravský Krumlov and Brno, where it was repeatedly documented between 1825 and 1919 (Jehlík 1998). After the abandonment of local woollen mills in southern Moravia at the beginning of the 20th century the species soon vanished from the majority of its localities, with the last record from the town of Olomouc in central Moravia dating back to 1943.

Viola elatior (Fig. 74)

Viola elatior, described from the Swedish island of Öland at the northwestern limit of its distribution range, is a Eurasian species with rather a continuous distribution in eastern and south-eastern Europe. The Asian part of the distribution range is discontinuous: the species occurs scattered through southern Siberia, almost reaching Lake Baikal in the east; it is also found in the Altai and Tian Shan Mts. The central- and western-European part of its range is fragmented, with the westernmost occurrences in central France and the southernmost ones in northern Italy (Meusel et al. 1978, Eckstein et al. 2006). *Viola elatior* behaves as a river corridor plant in most of central Europe (Burkart 2001). Most frequently, it grows in alluvial forests, usually in canopy openings, along forest roads, in clearings and nitrophilous forest fringes. Less frequently it occurs also in alluvial and fen meadows, usually in their parts adjacent to alluvial forests or scrub. It prefers base-rich soils. The species builds up a persistent soil seed bank and may appear in forest clearings at its former sites after logging and other soil disturbances. Most of the records are from the planar vegetation belt and only a few from the colline belt, with an altitudinal maximum at 350 m in the Bílé Karpaty Mts in the National Nature Reserve Čertoryje south of Kněždub. In the Czech Republic *V. elatior* occurs in eastern, central and north-western Bohemia, mainly along the Labe river, while the southern-Moravian populations follow the lower stretches of the Svratka, Dyje and Morava rivers (Danihelka et al. 2009). The most remarkable exception to this pattern are the occurrences near the towns of Podbořany and Kladno in Bohemia and in the Bílé Karpaty Mts in Moravia, all situated far from floodplains, which resembles the situation in the more eastern part of the distribution range. *Viola elatior* strongly declined during the last century, and after 1980 its occurrence was confirmed only in about 30% of grid cells compared to all records (Danihelka et al. 2009); the size of many populations also diminished. The species is therefore classified as critically threatened (Grulich 2012).

Viola pumila (Fig. 75)

Viola pumila is a Eurasian species with rather a continuous distribution range in eastern Europe and the Pannonian Basin. The Asian part of its range is poorly known but most of the records in the regional literature of *V. stagnina* may refer to *V. pumila*; the easternmost occurrences are known from the northern part of the Irkutsk Oblast' in Russia. It is also known from Kazakhstan and Uzbekistan (Hultén & Fries 1986, Eckstein et al. 2006). The western- and central-European part of the distribution range is fragmented, with the westernmost occurrences in the Western Alps in France, the southernmost ones in northern Italy, and the northernmost ones in southern Sweden. *Viola pumila* is a heliophilous species and occurs on base-rich soils mainly in alluvial and fen meadows, preferring drier places. However, it was also found in dry meadows and steppic grasslands, usually on heavy soils in places that are intermittently wet in the spring but dry out during the summer. It is distributed in the planar and colline vegetation belts, with altitudinal maxima at about 350 m in central Bohemia near Bílichov and in the Bílé Karpaty Mts in the National Nature Reserve Čertoryje south of Kněždub. The Czech Republic is situated near the north-western limit of the species'distribution range, and *V. pumila* has there a distribution pattern similar to that of other river corridor plants, including the related *V. elatior* (Burkart 2001). However, the affinity to the corridors of large rivers is less pronounced

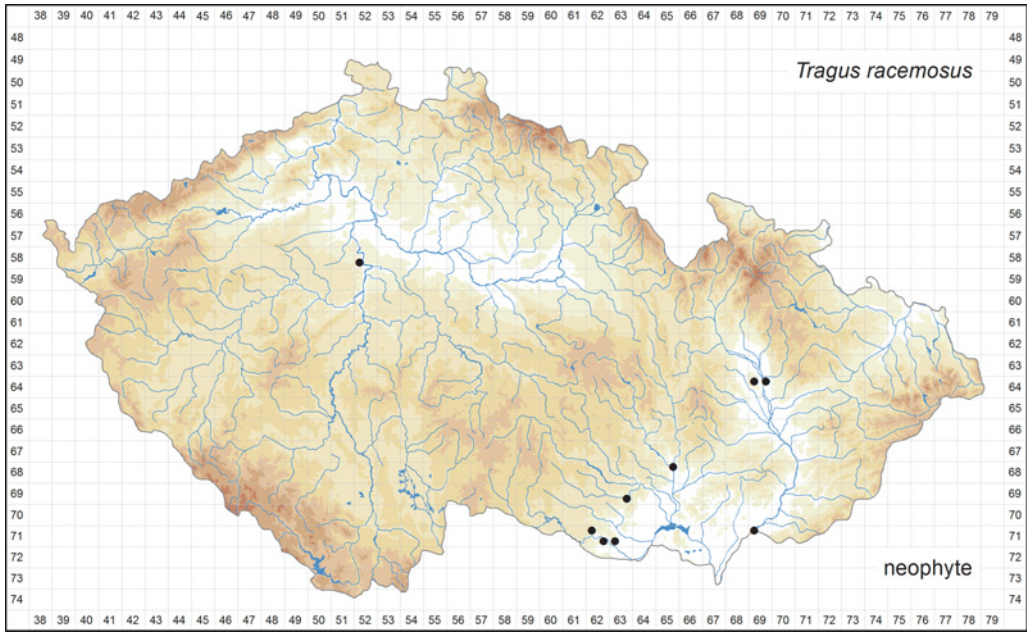

Fig. 73. – Distribution of *Tragus racemosus* in the Czech Republic (9 occupied quadrants). Prepared by Jiří Zázvorka.

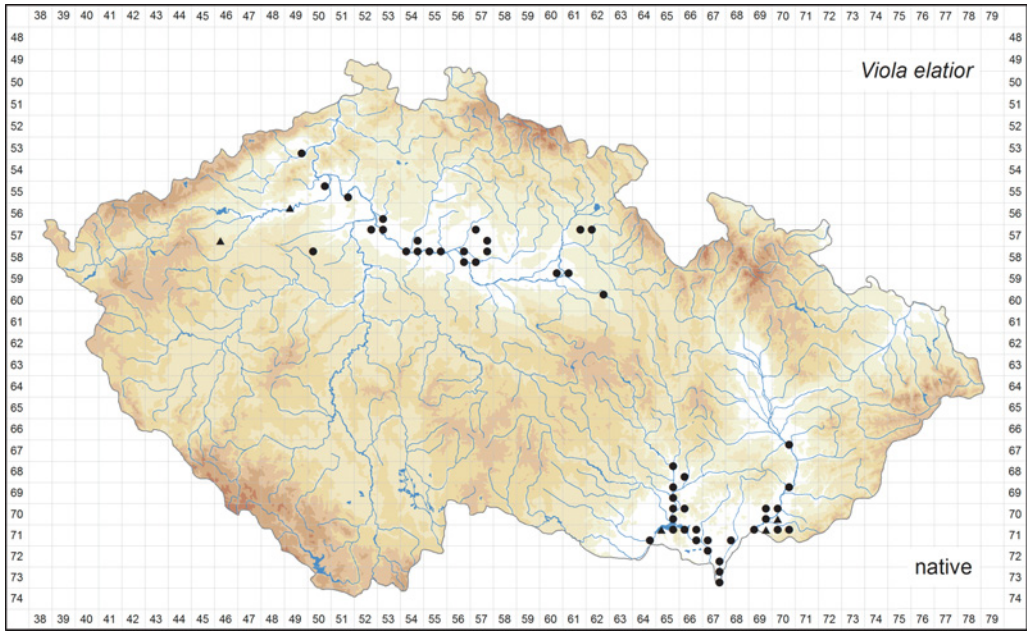

Fig. 74. – Distribution of *Viola elatior* in the Czech Republic: ● occurrence documented by herbarium specimens (49 quadrants), ▲ occurrence based on other records (5 quadrants). Prepared by Jiří Danihelka.

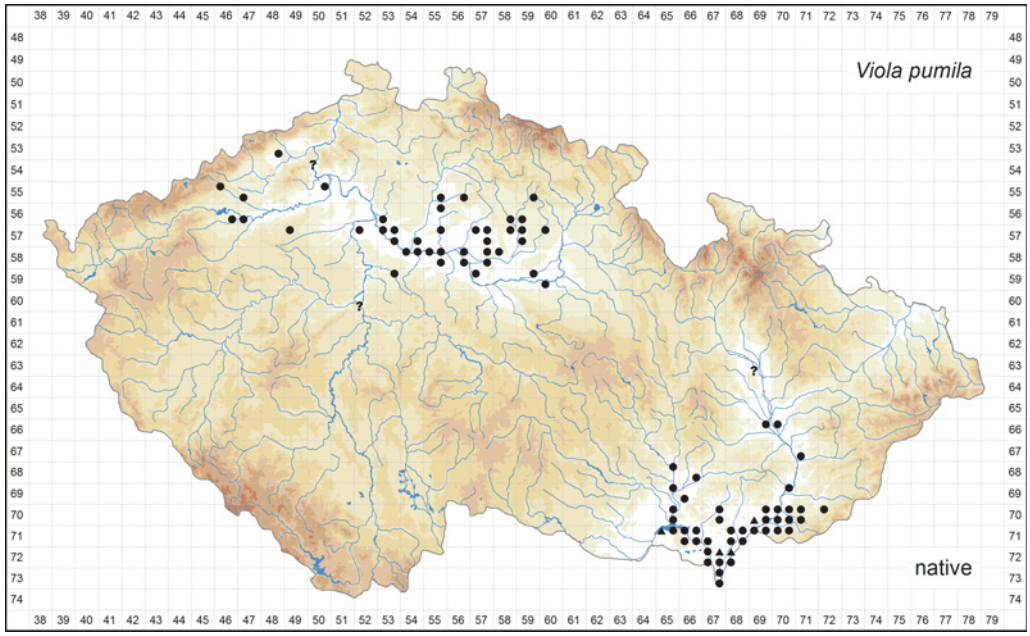

Fig. 75. – Distribution of *Viola pumila* in the Czech Republic: ● occurrence documented by herbarium specimens (82 quadrants), ▲ occurrence based on other records (4 quadrants). Prepared by Jiří Danihelka.

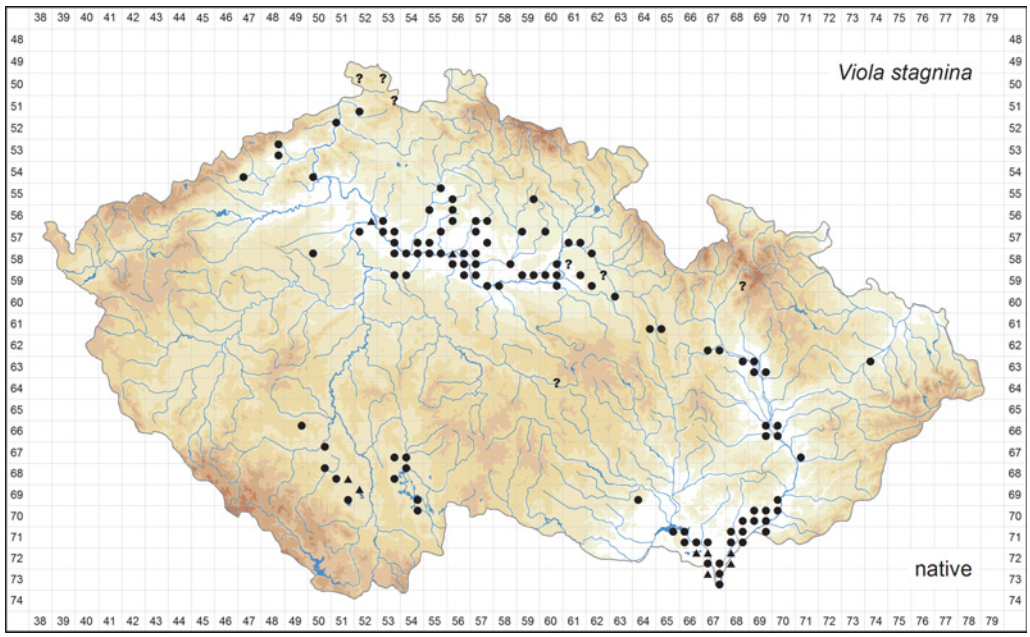

Fig. 76. – Distribution of *Viola stagnina* in the Czech Republic: ● occurrence documented by herbarium specimens (103 quadrants), ▲ occurrence based on other records (9 quadrants). Prepared by Jiří Danihelka.

than in *V. elatior*, and many localities of *V. pumila* are situated far from such rivers, including those in the Bohemian Cretaceous Basin in central and eastern Bohemia and in the Bílé Karpaty Mts and elsewhere in southern Moravia. *Viola pumila* is a rare and declining species: after 1980 its occurrence was confirmed in about 32% of grid cells compared to all records (Danihelka et al. 2009). Still, occupying about twice as many quadrants as *V. elatior*, it is classified only as endangered (Grulich 2012).

Viola stagnina (Fig. 76)

Viola stagnina is a European species with a distribution range overlapping to northern Kazakhstan and south-western Siberia. However, the eastern distribution limit is uncertain due to the confusion with *V. pumila* in the Russian literature. Its distribution range in central and western Europe is less fragmented than that of the related *V. elatior* and *V. pumila*, and it is shifted towards the areas with Oceanic climate, including the British Isles and the southern part of Scandinavia. The species is absent from the Iberian, Apennine and Balkan Peninsulas (Hultén & Fries 1986, Eckstein et al. 2006). Compared to the other two violets dealt with here, its affinity to lowland rivers is the weakest, though it is also considered a river corridor plant in central Europe (Burkart 2001). *Viola stagnina* is a heliophilous plant. Like *V. pumila*, it is found in alluvial meadows, preferring their wettest parts, such as shallow depressions and surroundings of temporary pools. It grows also in different types of fen and other wet meadows, often together with species indicating acidic soils (Hölzel 2003), which may help explaining its presence in southern Bohemia. This violet builds up a persistent soil seed bank. Its populations may recover after strong disturbances, including ploughing, and the species may even "return" to some sites after decades of putative absence (Eckstein et al. 2006). Most of the records are from the planar, colline and supracolline vegetation belts, with an altitudinal maximum at 435 m near Třeboň. In the Czech Republic *V. stagnina* occurs along the Labe river and in the Bohemian Cretaceous Basin in central and eastern Bohemia, in the South Bohemian basins, as well as along the Dyje and Morava rivers in central and southern Moravia. However, it was also recorded scattered in other parts of the country (Danihelka et al. 2009). Though the most widespread of the three species treated here, it is a declining species. After 1980 its occurrence was confirmed in about 33% of grid cells compared to all records (Danihelka et al. 2009); it is therefore classified as endangered (Grulich 2012).

See www.preslia.cz for Electronic Appendices 1–75

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Souhrn

Přestože botanický výzkum na území dnešní České republiky má dlouholetou tradici a floristický průzkum přinesl obrovské množství údajů o rozšíření rostlin, dosud není k dispozici žádné souborné dílo s mapami rozšíření českých rostlin a více než polovina druhů dosud nebyla vymapována vůbec. Tímto článkem otevíráme sérii publikací připravenou v rámci projektu Pladias, které představují první krok k atlasu rozšíření cévnatých rostlin v České republice. Článek obsahuje síťové mapy a doprovodné texty k 75 druhům a subspeciím z rodů *Achillea*, *Aegilops*, *Aira*, *Alopecurus*, *Avena*, *Bolboschoenus*, *Carex*, *Cladium*, *Elatine*, *Eleocharis*, *Eriophorum*, *Glyceria*, *Polypogon*, *Sclerochloa*, *Scheuchzeria*, *Sparganium*, *Tofieldia*, *Tragus* a *Viola*. Pro přípravu map byly využity téměř všechny dostupné floristické údaje. Základem jsou většinou údaje získané excerpcí herbářů a literatury a vlastní terénní zápisy, dále byly využity terénní nálezy dostupné v databázích. Všechny tyto údaje byly začleněny do centrální floristické databáze CzechDistrib, kde je prostřednictvím mapovacího modulu po geografické a taxonomické stránce prověřili autoři map, roztřídili je podle věrohodnosti a následně postoupili k veřejné recenzi regionálním floristům. Mnoho z předložených map vzniklo jako jeden z výsledků revize rodů pro osmý a devátý svazek Květeny České republiky. Mapy taxonomicky kritických skupin jsou založeny výhradně nebo převážně na herbářových dokladech, které revidovali taxonomičtí experti, zpravidla autoři příslušných map. Ve vybraných mapách jsou odlišnými symboly rozlišeny současné (existující) výskyty od starších (a často pravděpodobně zaniklých), původní výskyty od nepůvodních nebo výskyty založené na revidovaných herbářových dokladech od výskytů podle všech ostatních údajů. Floristické údaje použité pro přípravu map jsou obsaženy v elektronických přílohách. Každou mapu doprovází textový komentář, který obsahuje nástin celkového rozšíření, výčet nejčastějších stanovišť a stručnou charakteristiku rozšíření v České republice. Je-li to potřebné, jsou uvedeny i doplňující informace k taxonomii, biologii, změnám v rozšíření a míře ohrožení.

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