Results of a taxonomic revision of *Sorbus* subg. *Aria* occurring in the Czech Republic are presented in a central-European context. Flow cytometry and multivariate morphological analyses were employed to assess the taxonomic diversity within the group. Diploid, triploid and tetraploid taxa were detected. Diploids are represented by a single species, *Sorbus aria*, which is morphologically very variable. This extensive variability is specific to this species and separates it, among other characters, from polyploid taxa. An epitype for *S. aria* is designated here. In the Czech Republic, *S. aria* has been recorded only in southern Moravia, and published records from Bohemia relate to other polyploid taxa of the subg. *Aria*. Native occurrences previously recorded for *S. austriaca* and *S. carpatica* in the Czech Republic are erroneous and relate to individuals of *S. aria* with lobed leaves. Three new triploid species are described: *S. cucullifera* M. Lepší et P. Lepší from the Podyjí and Thaytal National Parks between the towns of Znojmo and Vranov nad Dyjí, and *S. moravica* M. Lepší et P. Lepší from the Moravian Karst area near the city of Brno. Tetraploid taxa include *S. danubialis* and two newly distinguished taxa: *S. thayensis* M. Lepší et P. Lepší and *S. collina* M. Lepší, P. Lepší et N. Meyer. *Sorbus thayensis* is endemic to the Podyjí and Thayatal National Parks and in a similar manner as a triploid species varies very little morphologically, which indicates that these polyploid taxa reproduce apomictically. All these new species are assumed to have originated from interbreeding between *S. danubialis* and *S. aria*. Up until now, *Sorbus collina* has been referred to as *S. aria* in the Czech Republic, as *S. pannonica* in Germany and as *S. graeca* in Austria and Hungary. Records referring to *S. graeca* in southern Moravia (Czech Republic) do not belong to *S. collina*, but are untypical individuals of *S. danubialis*. In the Czech Republic, *S. collina* occurs in central and north-western Bohemia. *Sorbus danubialis* is confined to central and north-western Bohemia and southern Moravia, and is taxonomically uniform. Old records of the existence of diploid individuals of *S. danubialis* in Bohemia are incorrect. Detailed distribution maps for all stenoeendemics, photographs of the type specimens and line drawings of all polyploid species known from the Czech Republic are presented.

**Key words:** apomixis, DAPI flow cytometry, hybridization, multivariate morphometrics, *Rosaceae*, subg. *Aria*, taxonomy
Introduction

European members of the genus *Sorbus* are traditionally classified into five subgenera – *Aria*, *Chamaemespilus*, *Cormus*, *Sorbus* and *Torminaria* (Kutzelnigg 1995, Rich et al. 2010). The first subgenus includes the diploid amphimictic *Sorbus aria*, possibly also the diploid and amphimictic *S. umbellata* and an intricate complex of many transitional taxa between these two species, which are believed to be apomictic and polyploid. The remaining subgenera are monotypic in Europe and comprise diploid amphimictic species with the exception of subg. *Chamaemespilus* in which diploids, triploids and tetraploids are reported (Warburg & Kárpáti 1968, Meyer et al. 2005). Subgenus *Chamaemespilus* is represented by *S. chamaemespilus*, subg. *Cormus* by *S. domestica*, subg. *Sorbus* by *S. aucuparia* and subg. *Torminaria* by *S. torminalis*. All of these monotypic subgenera except for subg. *Cormus* hybridize relatively frequently with subg. *Aria* and produce polyploid intersubgeneric taxa that are largely viewed as separate apomictic species (Meyer et al. 2005, Cornier 2008, Rich et al. 2010, Grundt & Salvesen 2011, Németh 2012, Vit et al. 2012).

Despite relatively common intersubgeneric hybridization, modern phylogenetic studies indicate that at least some of the subgenera should be treated as independent genera. The substantial extent of crossbreeding is ascribed to weak barriers to hybridization rather than close evolutionary relationships (Robertson et al. 1991, Li et al. 2012). In other words, the traditional subgeneric division probably does not satisfactorily reflect the phylogeny of *Sorbus* within the *Pyrinae* (Robertson et al. 1991, Potter et al. 2007, Li et al. 2012, Lo & Donoghue 2012). It is already clear that pinnate-leaved (*Sorbus, Cormus*) and simple-leaved (*Aria, Torminaria* and *Chamaemespilus*) species form two distinct monophyletic groups (Potter et al. 2007, Lo & Donoghue 2012). However, the relationships within these two groups are not sufficiently understood and deserve further investigation. Therefore, the traditional broad delimitation of *Sorbus* in Europe still remains in use in systematics and taxonomy (Cornier 2008, Lepší et al. 2009, Németh 2012, Pellicer et al. 2012, Raimondo et al. 2012, Velebil 2012, Ludwig et al. 2013, Meyer et al. 2014, Rich et al. 2014) as well as in national and supranational botanical compendia and databases (e.g. Király 2009, Kurtto 2009, Rich et al. 2010, Grundt & Salvesen 2011, Jäger 2011, Danihelka et al. 2012), and is adopted in this study.

From the taxonomic and evolutionary perspective, the most challenging group of the genus *Sorbus* in Europe is subg. *Aria*. It is distinguished from other subgenera of the genus *Sorbus* in Europe by the following combination of characters: leaves simple, serrate or shallowly lobed, greenish-grey to snowy white tomentose on lower surface, with craspedodromous venation (with veins running directly from the midrib and ending at the leaf margin), flowers proterogynous; petals white to yellowish-white, patent; styles 2–3 connate or free and tomentose at base; ovary semi-inferior, tomentose; fruit medium-sized or large, orange, red to dark red, with lenticels and persistent sepals, with heterogeneous mesocarp and cartilaginous endocarp and without sclereids.

Velebil et al. 2012, Lepší et al. 2013a, Rich et al. 2014); however, some authors do not treat apomictic lineages as independent species and advocate broader species delimitations (cf. Aldasoro et al. 2004).

Members of the subg. *Aria* are classified into seven sections based mainly on morphological and anatomical characters (Aldaroso et al. 2004). All European species of the subg. *Aria* are assigned to the section *Aria*; the other sections occur in East Asia and adjacent regions (Aldaroso et al. 2004). Depending on the species delimitation, the section *Aria* includes 11 (Aldaroso et al. 2004) to 48 species (Phipps et al. 1990). In Europe, about 30 species are distinguished within this section when the narrow species concept is used, i.e. when apomictic species are accepted (Kurtto 2009).

Subg. *Aria* plays a crucial role in microspeciation within the genus, and due to the high diversity of its taxa and ongoing evolution, causes significant taxonomic problems in Europe. Hybridization with members of the subgenera *Torminaria*, *Sorbus* and *Chamaemelis* has produced numerous intersubgeneric apomictic taxa. However, even more taxonomic diversity has been generated by extensive hybridization within the subgenus. The weak reproductive barriers between its members have resulted in cases of great local diversity and complicated taxonomic situations (Feulner et al. 2013). It is therefore not surprising that, compared to other groups of the genus, subg. *Aria* is the least understood European group of the genus *Sorbus*.

It is hypothesized that most species distinguished within the subg. *Aria* in Europe stem from auto- or allopolyploidization of two basic species: the south-to-central-European species *S. aria* and the south-European and west-Asian species *S. umbellata* (Liljefors 1953, Kutzelnigg 1995). Polyploids originating from hybridization or polyploidization of these two basic species may have relatively large distribution areas, as is the case, for example, of the north-to-west-European endemic *S. rupicola*, known from Scandinavia and the British Islands. Other such polyploids can be confined to very small areas, such as *S. cheddarensis* L. Houston et Ashley Robertson, an endemic in the Cheddar Gorge in England (Rich et al. 2010). Local endemics are generally considered to be the results of hybridization between widely distributed polyploids and *S. aria* s. str. (Rich et al. 2010). For example, the above mentioned *S. cheddarensis* is supposed to have arisen from hybridization between *S. aria* and *S. porrigeniformis* E. F. Warb., a species with a scattered distribution in England and Wales (Rich et al. 2010).

A similar scenario is described for central Europe by the author of the fundamental *Sorbus* monograph of the region (Kárpáti 1960). He distinguished several basic (widely distributed) species connected by many morphologically transitional taxa. His concept influenced *Sorbus* taxonomy in central Europe for many years and is still at least partially accepted in many national compendia (Kovanda 1992, 2002, Májovský 1992, Fischer 2008, Király 2009, Jäger 2011). However, most of his taxonomic conclusions are based only on morphology, i.e. with little or no knowledge of the ploidy structure or genetic variability of delimited taxa. His treatments may therefore be to some extent burdened by subjectivity and therefore require revision using modern biosystematic methods.

The lack of the use of more objective methods in the taxonomy of subg. *Aria* also applies to the Czech Republic. Initially, only two species were reported from this country – *S. danubialis* and *S. aria* (Klika 1937, Kovanda 1961, 1992). Both were reported from Bohemia and Moravia, and both were regarded as species with relatively little variability (Kovanda 1992). Kovanda (1961) distinguished *S. danubialis* var. *apiculata*, a leaf
morphotype confined mainly to Bohemia, and assigned most plants of *S. aria* from Bohemia to var. *cyclophylla* Beck, stating that they differ from the Moravian population (Kovanda 1992). Later, Kovanda (1997a) reports, again based on leaf morphology only, *S. graeca* from Moravia. Finally, Šefl (2007) recognized triploid individuals transitional between *S. aria* and *S. danubialis* in Moravia. In 2009, we started a taxonomic revision of the group and revealed several taxonomic novelties and serious misinterpretations.

The goal of this paper is to clarify the taxonomy of subg. *Aria* within the Czech Republic based on a combination of classical taxonomic approaches and modern biosystematic methods and provide a basis for further modern biosystematic research of this challenging group in central Europe.

**Material and methods**

*Plant material and field work*

Samples for morphometric analyses, flow cytometry and herbarium specimens were collected between 2009 and 2014, following the recommendations of Meyer et al. (2005), Rich et al. (2010) and papers published by Lepší et al. (2008, 2009). Flowering and fructiferous parts were collected in mid-May and September, respectively, and stored in 70% ethanol.

A revision of relevant *Sorbus* material kept in the following herbarium collections was undertaken: BRNM, BRNL, BRNU, CB, CHEB, CHOM, Herbarium of the Museum of Ústí nad Labem, HOMP, HR, LIM, LIT, MP, OL, OLM, OP, PL, PR, PRA, PRC, ROZ, SOKO, ZMT. For abbreviations of public herbaria, see Holmgren et al. (1990). Species nomenclature was unified according to Danihelka et al. (2012) except for *Sorbus* names, which follow Kutzelnigg (1995); otherwise, authorities are provided. Phytosociological nomenclature follows Chytrý et al. (2001).

*Multivariate analyses*

Multivariate morphometric analyses were used to reveal the species-specific characters of all the species delimited. For numbers and localities of the individuals sampled, see Table 1. A set of 16 quantitative and 2 qualitative characters was chosen on the basis of published determination keys and floras (e.g. Kutzelnigg 1995, Meyer et al. 2005, Rich et al. 2010), including those used in our previous studies (Lepší et al. 2008, 2009, Vít et al. 2012). The characters are: AT – angle of the lamina top, AB – angle of the laminar base, AV – angle between the third lateral vein from the laminar base and the midrib, A3L – angle of the tooth in which the 3rd lateral vein terminates, FL – length of fruit, FW – width of fruit, INC – depth of the incision between the 2nd and the 3rd lateral vein from the laminar base, LL – length of lamina, LL/LW – lamina length/width ratio, LW – width of lamina, NL – number of lenticels per 25 mm² of fruit, NT3L – number of teeth between the 2nd and 3rd lateral vein, NV – number of lateral laminar veins, PET – length of petiole, PL – length of petals, PW – width of petals, WP – the distance along the main nerve from the laminar base to the widest laminar width, WP/LL – ratio of the distance along the main nerve from the laminar base to the widest laminar width/length of lamina. Only well developed, mature and intact leaves from the centre of short sterile shoots were
collected, flattened, dried and scanned at 300 dpi using Epson scan 1.11E software, and then measured using tpsDig software (Rohlf 2006). Reproductive organs (fruit, flowers) were analysed separately and used only for separating triploid species because characters of leaves overlapped considerably within this group. Flowers were measured manually using a stereo zoom microscope and fruit using a digital vernier calliper.

One measurement of each character per individual was recorded and used as the value for the individual in all morphometric analyses. Non-parametric Pearson correlation coefficients were calculated for pairs of characters of each species and for the whole dataset in order to reveal relationships among characters. Principal component analyses (PCA) were performed to provide an insight into the overall pattern of morphological variation and to reveal potential separation of the ploidy groups analysed. Prior to the PCA, the data were log-transformed and standardized to have a zero mean and unit standard deviation.

Linear discrimination analyses (LDA), which maximize differences between a priori defined groups (cytotypes and species characterized by SSR patterns, Vit et al., in prep.), were used to test the discriminating power of morphometric characters, following the methodology described by Lepš & Šmilauer (2003) using forward selection of characters with non-parametric Monte Carlo permutation tests (999 permutations; only axes with P-level < 0.05 were considered). A cross-validated classificatory linear discriminant analysis based on probabilities using only characters selected as discriminating variables by the previous analysis was performed in R version 2.12.2 (R Development Core Team 2011) using the “lda” function in the MASS package (Venables & Ripley 2002). PCA and LDA were carried out using CANOCO (Lepš & Šmilauer 2003). Univariate statistics

Table 1. – Locality details of populations of Sorbus subg. Aria included in morphometric analyses.

<table>
<thead>
<tr>
<th>Taxon</th>
<th>Locality</th>
<th>Geographic coordinates (WGS-84)</th>
<th>Altitude (m a.s.l.)</th>
<th>Number of individuals analysed</th>
</tr>
</thead>
<tbody>
<tr>
<td>S. aria</td>
<td>Czech Republic/Austria – Podyjí and Thayatal National Parks, Dyje/Thaya river valley around Hardegg</td>
<td>48°51'20&quot;N, 15°51'40&quot;E</td>
<td>330–540</td>
<td>20</td>
</tr>
<tr>
<td>S. collina</td>
<td>Czech Republic, Bohemian Karst, Beroun, SE of the town</td>
<td>49°55'40&quot;N, 14°07'40&quot;E</td>
<td>350–380</td>
<td>10</td>
</tr>
<tr>
<td>S. collina</td>
<td>Czech Republic, Horní Povltaví region, valley of Vltava and Sázava rivers around Stechovice</td>
<td>49°49'50&quot;N, 14°27'20&quot;E</td>
<td>250–400</td>
<td>10</td>
</tr>
<tr>
<td>S. cecullifera</td>
<td>Czech Republic/Austria – Podyjí and Thayatal National Parks, Dyje/Thaya river valley around Hardegg</td>
<td>48°51'20&quot;N, 15°51'40&quot;E</td>
<td>310–390</td>
<td>20</td>
</tr>
<tr>
<td>S. danubialis</td>
<td>Czech Republic, Moravian Karst, Blansko, E–NE of the town</td>
<td>49°21'60&quot;N, 16°42'50&quot;E</td>
<td>400–500</td>
<td>20</td>
</tr>
<tr>
<td>S. moravica</td>
<td>Czech Republic, Moravian Karst, Blansko, Suchý žleb gorge</td>
<td>49°21'40&quot;N, 16°42'50&quot;E</td>
<td>400–490</td>
<td>20</td>
</tr>
<tr>
<td>S. pontis-satani</td>
<td>Czech Republic, Moravian Karst, Blansko, Suchý žleb gorge</td>
<td>49°21'40&quot;N, 16°42'50&quot;E</td>
<td>410–470</td>
<td>17</td>
</tr>
<tr>
<td>S. thayensis</td>
<td>Czech Republic/Austria – Podyjí and Thayatal National Parks, Dyje/Thaya river valley around Hardegg</td>
<td>48°51'20&quot;N, 15°51'40&quot;E</td>
<td>310–440</td>
<td>20</td>
</tr>
</tbody>
</table>
(minimum, maximum, quartiles) of quantitative characters of all individuals were calculated and used in the description of the species.

**DNA ploidy level estimation**

DAPI flow cytometry was used to assess DNA ploidy levels (Suda et al. 2006) of members of the subg. *Aria*. Bulked samples from 207 individuals were analysed (i.e. up to four

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**Table 2.** Overall results of flow cytometric analyses of all taxa of *Sorbus* subg. *Aria* delimited in this study. *Bellis perennis* was used as the internal standard.

<table>
<thead>
<tr>
<th>Taxon</th>
<th><em>S. aria</em></th>
<th><em>S. cucullifera</em></th>
<th><em>S. moravica</em></th>
<th><em>S. pannonica</em></th>
<th><em>S. pontis-satani</em></th>
<th><em>S. collina</em></th>
<th><em>S. danubialis</em></th>
<th><em>S. thayensis</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of individuals analysed</td>
<td>53</td>
<td>26</td>
<td>8</td>
<td>5</td>
<td>6</td>
<td>45</td>
<td>51</td>
<td>13</td>
</tr>
<tr>
<td>Average sample:standard ratio</td>
<td>0.37</td>
<td>0.56</td>
<td>0.56</td>
<td>0.55</td>
<td>0.56</td>
<td>0.75</td>
<td>0.75</td>
<td>0.74</td>
</tr>
<tr>
<td>Average coefficient of variation of the sample</td>
<td>3.65</td>
<td>2.87</td>
<td>2.55</td>
<td>3.17</td>
<td>2.39</td>
<td>2.69</td>
<td>2.66</td>
<td>2.73</td>
</tr>
<tr>
<td>Average coefficient of variation of the standard</td>
<td>1.82</td>
<td>1.54</td>
<td>1.66</td>
<td>1.57</td>
<td>1.68</td>
<td>1.99</td>
<td>1.83</td>
<td>1.61</td>
</tr>
<tr>
<td>Estimated DNA ploidy level</td>
<td>2n−2x</td>
<td>2n−3x</td>
<td>2n−3x</td>
<td>2n−3x</td>
<td>2n−4x</td>
<td>2n−4x</td>
<td>2n−4x</td>
<td>2n−4x</td>
</tr>
</tbody>
</table>

---

*Fig. 1.* Map showing the distribution of the localities of members of *Sorbus* subg. *Aria* sampled for this study. ▲ *S. danubialis*, ● *S. aria*, ★ *S. collina*, ■ *S. pannonica*, → *S. cucullifera* and *S. thayensis*, ← *S. moravica* and *S. pontis-satani.*
Results

Based on extensive field observations and a detailed investigation of herbarium material, we delimited seven taxa within the subg. *Aria* in the Czech Republic. Results of flow cytometry and morphometric analyses are congruent with each other and support this taxonomic solution.

Ploidy level

The DAPI flow cytometry screening revealed that there are diploids, triploids and tetraploids in subg. *Aria* in the Czech Republic. The diploid level is represented by a single taxon, and triploids and tetraploids each comprise three taxa (see Table 2 for details). Null intraspecific variation was detected.

Morphometric analyses

No highly correlated characters (*r* > |0.95|) were found and all characters were used in the multivariate analyses. PCA of leaf characters indicated a certain level of morphological differentiation between diploids and polyploids. In addition, diploids turned out to be morphologically more variable than polyploids (Fig. 2). Tetraploids and triploids overlapped considerably when 36 individuals of 12 predominantly singular triploids, which we do not treat taxonomically here, were included in the analyses (data not shown). PCAs of individuals delimited here as species (i.e. without singular triploids) revealed that triploids and tetraploids are morphologically different (Fig. 2). The characters contributing most to the morphological distinctiveness of triploids and tetraploids (i.e. the most tightly correlated characters with the first component axis) were: angle of laminar base (AB), ratio length of lamina/width of lamina (LL/LW), angle between the third lateral vein from the laminar base and the midrib (AV), width of lamina (LW) and angle of lamina top (AT). The most strongly correlated characters with the second component axis, which separated diploids from polyploids, were: length of lamina (LL), number of lateral laminar veins (NV), number of teeth between the 2nd and 3rd lateral vein (NT3L) and width of lamina (LW). The subsequent LDA also showed these three groups to be morphologically distinct. No overlap of the canonical scores of diploids and triploids was detected. Both diploids and triploids overlapped slightly with tetraploids (Fig. 3). The forward selection procedure identified 8 characters with a significant conditional effect – length of lamina (LL), width of lamina (LW), angle between the third lateral vein from the laminar base and the midrib (AV), number of teeth between the 2nd and 3rd lateral vein (NT3L), number of lateral laminar veins (NV), length of petiole (PET), angle of laminar base (AB) and ratio of the distance along the main nerve from the laminar base to the widest laminar width/length of lamina (WP/LL); all characters had significant marginal effects.
The classificatory discriminant analysis resulted in an incorrect classification only in three out of a total of 140 cases (2.1%; Table 4). The LDA of the three triploid taxa showed that the two sympatrically occurring species, *S. moravica* and *S. pontis-satani*, are clearly separated along the first discriminant axes and that they can be distinguished primarily using the number of lateral laminar veins (NV), the angle of the tooth in which the 3rd lateral vein terminates (A3L) and the length of lamina (LL), characters that have higher values in *S. moravica*. The morphological separation of *S. cucullifera* from the remaining triploids is not so clear. This species falls between the other two species and overlaps somewhat with both of them (Fig. 4). However, *S. cucullifera* differs in fruit and flower morphology, as confirmed by a separate LDA (Table 3). This species has fewer lenticels on fruits (NL) and smaller petals (PL, PW).
Fig. 3. – Results of the linear discriminant analysis based on 8 morphological characters of leaves of the three ploidy groups of *Sorbus* subg. *Aria*. The characters were selected in a forward selection procedure, and only characters with significant discriminating power for separating the three ploidy groups were used. The first and second canonical axes are displayed, and explain 39.2% and 33.9% of the variation, respectively. The top diagram (A) shows the discriminating characters and centroids of classes and the bottom one (B) the canonical scores of individual plants on the first two discriminating axes. For abbreviation of characters, see the Material and methods.
Moreover, the range in the most distinctive character, the number of lenticels (NL) does not overlap with the ranges in either of the other two species, *S. moravica* or *S. pontis-satani* (see the descriptions of these species). The results of the classificatory discriminant analysis of all three triploid taxa were similar to those of the LDA: incorrect classification was detected in five out of a total of 60 cases (8.3%) in terms of leaf characters and in six out of a total of 45 (13.3%) cases in fruit and flower characters (Table 4).
Fig. 4. – Results of the linear discriminant analysis based on 6 morphological characters of leaves of the three triploid taxa of *Sorbus* subg. *Aria*. The characters were selected in a forward selection procedure, and only those that were significantly different and could be used to distinguish the three taxa were used. The first and second canonical axes are displayed, and explain 42.2% and 28.2% of the variation, respectively. The top diagram (A) shows the discriminating characters and centroids of classes and the bottom one (B) canonical scores of individual plants on the first two discriminating axes. For abbreviation of characters, see the Material and methods.
Fig. 5. – Results of the linear discriminant analysis based on 8 morphological characters of leaves of three tetraploid taxa of *Sorbus* subg. *Aria*. The characters were selected in a forward selection procedure, and only those that were significantly different and could be used to distinguish the three taxa were used. The first and second canonical axes are displayed, and explain 44.3% and 42.7% of the variation, respectively. The top diagram (A) shows the discriminating characters and centroids of classes and the bottom one (B) the canonical scores of individual plants on the first two discriminating axes. For abbreviation of characters, see the Material and methods.
The LDA of the three delimited tetraploid taxa (S. collina, S. danubialis, S. thayensis) confirmed their clear morphological separation. No overlap of the canonical scores of the species was detected (Fig. 5, Table 3). The classificatory discriminant analysis using these characters resulted in correct classification in all cases (Table 4).

Discussion and taxonomic treatment

Results of all biosystematic methods employed in this study are congruent with results of SSR analyses, which are part of a broader study on genetic variation in the genus Sorbus and will be published elsewhere (Vít et al., in prep.). With respect to the present study, all taxa described below possess different genotypes and are clearly separated.

Diploid species

Diploid members of the subg. Aria are relatively rare in the Czech Republic. We detected their occurrence only in three regions of Moravia (Fig. 1). They occur scattered in the Podyjí National Park between the towns of Znojmo and Vranov nad Dyjí, very rarely on the Moravian Karst near the city of Brno, and rarely in the Bílé Karpaty Mts near the villages of Javorník and Starý Hrozenkov. The populations analysed were both morphologically (Figs 2, 3) and genetically (Vít et al., in prep.) very diverse even at the same sites, and this feature combined with their ploidy level confirms the finding that these diploid plants belong to the amphimictic S. aria s. str.

This taxon is known to be an extremely variable and sexually reproducing diploid species (Liljefors 1953, 1955, Robertson et al. 2010, Feulner et al. 2013) distributed in central and southern Europe from Spain to the Balkans with outlying localities along the Black Sea coast and in northern Africa (Meusel et al. 1965). Sorbus aria is also cultivated for ornamental purposes and reported as a naturalized alien species in many European countries (Lepší et al. 2013b).

Sorbus aria s. str. has been reported as a native species in several areas of the Czech Republic with the alleged centre of its distribution in Bohemia (Kovanda 1992, 2002, Kutzelnigg 1995). Our results, however, do not support this claim. We show that all Bohemian members of the subg. Aria are tetraploids and that S. collina, a common species of warm and rocky areas of Bohemia (newly described below), has been mistaken for the diploid S. aria s. str. The only region where S. aria is native in the Czech Republic is Moravia. However, some other records from Moravia may also be dubious, such as the record from the valley of the river Jihlava (Kutzelnigg 1995), which probably actually refer to S. danubialis, the only member of the subg. Aria known to us in this area. Localities of S. aria in the Podyjí National Park and on the Moravský Karst appear as exsclaves – they are isolated from each other and from the continuous distribution areas in the Alpine and Carpathian regions, where the species is rather common. The localities in Bílé Karpaty Mts lie probably at the western border of a scattered distribution of this species in Slovakia. All Moravian populations are small except in the Podyjí National Park. It should be added that S. aria can occasionally be found in the wild in Bohemia, but they are plants that have escaped from cultivation (e.g. Liberec, Mladá Boleslav, Mcely, Klecany, Nové Hrady).
In the past, the exceptional variability of *S. aria* was overestimated or improperly understood. Many taxa were recognized at the specific and lower levels (Kárpáti 1960), but considering the continuous and reticulate morphological variation in the structure of these taxa, their delimitation is of little if any value. On the other hand, underestimating the range of morphological variation in these species has lead to several other misidentifications. For example, some individuals of *S. aria* from the Podyji National Park (Czech Republic) were mistakenly determined as *S. austriaca* and *S. carpatica* because of their lobed or conspicuously double serrate leaves (Kovanda 1996, 1997b, 2002). These two transitional taxa between the subg. *Aria* and subg. *Sorbus* were described from Austria and Slovakia, respectively, and do not, to our knowledge occur naturally in the Czech Republic. In addition, *S. austriaca* was recently found to be tetraploid (M. Lepší & P. Lepší, unpublished data).

In addition to their ploidy level, a conspicuous feature that distinguishes *S. aria* from polyploid members of the subgenus is the considerable variation in fruit and leaf morphology that is recorded in every population. Polyploids, by contrast, are morphologically uniform due to prevailing apomixis. There is no universal morphological character that would allow a clear separation of *S. aria* from polyploids within the whole of Europe, but its determination is mostly possible at the regional level. For example, Czech polyploids differ from the dominant morphotype of *S. aria* in having smaller and leathery leaves with fewer veins, while the common features of most individuals of *S. aria* in the Czech Republic are relatively large, thin and elliptic to longish leaves with many veins. However, there are rare individuals that do not fit this pattern and cannot be identified without establishing their ploidy levels (e.g. in the Podyji National Park). In addition to Moravia, we confirmed the occurrence of *S. aria* in France and Austria (Fig. 1, Appendix 1).

In some regions, the exceptional morphological variability of *S. aria* causes problems with distinguishing this species from polyploids, which in some cases is quite impossible without testing for polyploidy (see Rich et al. 2010), the Czech Republic being no exception (Figs 2, 3). This fact may have some bearing on the nomenclature of this species because its type specimen comes from a tree of unknown origin and ploidy level that was cultivated in G. Clifford’s garden in Holland in the 18th century. Despite the fact that the type specimen corresponds morphologically quite well to diploid morphotypes, which are recently uniformly called *S. aria* in Europe, we consider it advisable to select an interpretative epitype of known ploidy from a wild population. In this way, we hope to stabilize the nomenclature of this species in the future.

*Sorbus aria* (Linnaeus) Crantz, Stirp. Austr. 2: 46, 1763. (Fig. 6)


≡ *Pyrus aria* (L.) Ehrh., Beitr. Naturk. 4: 26, 1789.


≡ *Azarolus aria* (L.) Borkh., Handb. Forstbot. 2: 1229, 1803.

≡ *Aria nivea* Host, Fl. Austriac. 2: 8, 1831.


Epitype: Lower Austria, Hardegg, “pine forest I” on slopes of Dyje valley, ca 180 m SE of bridge over Dyje river, pine forest with *Sesleria*, 390 m a.s.l., 48°51’4.1”N, 15°51’52.16”E; scattered; tree ca 7 m high; 12. 9. 2011 leg. M. Lepší, P. Lepší; 2n – 2x – DNA ploidy level was determined using the flow cytometer Partec PA II

**Description:** Small tree or shrub up to 12 m high. Bark grey to dark grey, smooth when young, with fissures (particularly at the trunk base) when mature. Twigs thick, brownish-grey; young shoots brown, glabrous to sparsely tomentose when young, glabrous or glabrescent when mature, with pale brown to ochraceous lenticels. Buds turbinate or ovoid, pointed; scales green, glabrescent, with narrow brown sparsely tomentose margins. Leaves on short sterile shoots simple; lamina elliptical to broadly elliptical, oblong elliptical, ovate to oblong ovate, (9.6–) 11.5–12.7 (–15.6) cm long and (5.0–) 6.3–7.8 (–8.4) cm wide, (1.4–) 1.5–2.1 (–2.5) times as long as wide, widest at (43–) 49–54 (–64)% of the lamina length (from the base), with broadly acute, acute to acuminate apex with angle (70–) 85–115 (–135)°, cuneate to broadly cuneate and partly serrate at base, with angle of base (50–) 70–95 (–115)°, usually flat at margins, regularly finely to coarsely simply or double (to triple) serrate or dentate, or deeply serrate to shallowly lobed, with broadly acute, acute or acuminate teeth terminating the main veins (other teeth somewhat smaller), with (6–) 9–12 (–16) teeth between the 2nd and 3rd main veins from the base, with angle of the teeth terminating the 3rd main veins of (50–) 60–85 (–95)°, with incision between the 2nd and the 3rd main vein from the base of (0.7–) 1.6–3.0 (–5.6) mm, thin, more or less glossy, pale or dark green, sparsely tomentose when young, later glabrescent on upper surface, evenly greenish-grey-tomentose on lower surface, with (8–) 11–12 (–13) veins on each side, with the 3rd vein at an angle of (20–) 30–40 (–45)° to midrib; petioles (11–) 14–18 (–20) mm long, tomentose. Leaf laminae on short fertile shoots similar in shape and size. Inflorescences compact, convex, with tomentose branchlets. Sepals triangular, acute or acuminate, tomentose on both surfaces, patent or reclinato at flowering, erect, persistent and dry at fruiting. Petals (5.0–) 6.5–7.5 (–8.5) mm long and (3.8–) 5.0–6.0 (–6.5) mm wide, broadly elliptical to rotund, concave, white, patent, sparsely tomentose at base of upper surface, glabrous on lower surface, with a short claw. Stamens ca 20; anthers pale yellow. Ovary semi-inferior. Styles 2 (–3), free or connate and tomentose at base. Fruit ellipsoidoid to subglobose, (11.5–) 12.5–14.5 (–16.0) mm long and (9.0–) 11.5–13.5 (–15.0) mm wide, red to dark red, rarely orange-red when ripe, tomentose at top and base, otherwise glabrescent, glossy, with (1–) 4–9 (–23) lenticels per 25 mm²; mesocarp heterogeneous; endocarp cartilaginous. Seeds fuscous. DNA ploidy level: diploid (inferred using FCM). Reproduction sexual. Flowering V.

**Diagnostic characters:** Individuals in every population are very variable in their fruit and leaf morphology, with almost every individual morphologically unique. Common characters of most Czech plants of this species are relatively thin, large and elliptical to oblong elliptical leaves with relatively many veins on short sterile shoots.

**Triploid species**

Triploids occur in two Moravian regions in the Czech Republic (Fig. 1). We revealed three morphologically (Fig. 4) and genetically (Vit et al., in prep.) distinct lineages: one
Fig. 6. – Epitype of *Sorbus aria*.
in the Podyjí National Park and two on the Moravian Karst. Below, we describe each of these lineages as a separate species because they are morphologically and genetically uniform, and exhibit all the characteristics of apomictic species. In addition, we detected about 40 triploid individuals in the Podyjí National Park and four on the Moravian Karst associated with the three taxa delimited but clearly differing from them in their morphology and genetic structure (Vit et al., in prep.). Because these triploids occur usually as single or very rare individuals and do not form significant populations, we do not treat them as separate species. We suppose that they are products of hybridization between tetraploid *S. danubialis* and diploid *S. aria* or in the Podyjí National Park the tetraploid parent might be also *S. thayensis*. This hypothesis is probably valid at least in the case of the Podyjí National Park, where the supposed parental species are present. The situation on the Moravian Karst is not so clear, because *S. aria* does not occur in this area, and only tetraploid *S. danubialis* and two triploid species are found there. The four triploid individuals might either be the results of former hybridizations between *S. aria* and *S. danubialis* when *S. aria* occurred at this locality, or may be the descendants of crosses between *S. danubialis* and the two triploid species. The third, but less probable, option is that these taxa could have originated somewhere else and later spread by birds or other agents to this locality. A similar scenario applies to the origin of the two triploid species described below, *S. moravica* and *S. pontis-satani*. They could have either evolved at this locality as a result of hybridization between *S. aria* and *S. danubialis* in the past, or less likely, reached there by dispersal.

The first record of the occurrence of subg. *Aria* triploids in the Czech Republic is for the Podyjí National Park (Šefl 2007). The author assigned these plants to *S. subdanubialis* (Soó) Kárpáti, a transitional taxon between *S. aria* and *S. danubialis* described from Hungary. However, *S. subdanubialis* differs from the triploids in the Podyjí National Park in having longer triangular leaf apices, fewer teeth between the 2nd and 3rd main veins from the base and coarsely serrate leaf margins (cf. Kárpáti 1960, Király 2009).

*Sorbus cucullifera* M. Lepší et P. Lepší, **spec. nova** (Figs 7–8)

*Description:* Shrub or rarely small tree up to 12 m high. Bark grey or dark grey, smooth when young, with fissures (particularly at the trunk base) when mature. Twigs thick, brownish-grey; young shoots brown, tomentose when young, glabrescent when mature, with pale brown to ochraceous lenticels. Buds ovoid, pointed; scales green, glabrescent, with narrow brown sparsely tomentose margins. Leaves on short sterile shoots simple, when in the sun held more or less upright and overlapping each other; laminas more or less (broadly) elliptical to obovate, (7.2–) 8.4–8.9 (–10.5) cm long and (4.7–) 5.0–5.5 (–6.2) cm wide, (1.5–) 1.6–1.7 (–1.8) times as long as wide, widest at (51–) 54–60 (–65)% of the lamina length (from the base), with acuminate apex with an angle of 100–115 (–125)°, cuneate and partly serrate at base, with angle of base (65–) 70–80 (–85)°, usually flat to slightly undulate margins, regularly, finely, double to triple serrate, with acute teeth terminating the main veins (other teeth somewhat smaller), with (7–) 9–10 (–12) teeth between the 2nd and 3rd main veins from the base, with angle of the teeth terminating the 3rd main veins (40–) 45–65 (–75)°, with incision between the 2nd and the 3rd main vein from the base (1.5–) 2.0–3.0 (–4.0) mm long, leathery, more or less
Fig. 7. – Holotype of Sorbus cucullifera.
matt, pale green, sparsely tomentose when young, later glabrescent on upper surface, evenly greenish-grey-tomentose on lower surface, with (8–) 9–10 (–11) veins on each side, with the 3rd vein at an angle of (20–) 25–35° to midrib; petioles (12–) 14–16 (–17) mm long, tomentose. Leaf laminas on short fertile shoots relatively broader, broadly elliptical and more distinctively undulate at margin. Inflorescences compact, convex, with tomentose branchlets. Sepals triangular, acute or acuminate, tomentose on both surfaces, patent at flowering, erect, persistent and dry at fruiting. Petals (5.5–) 6.5–7.0 (–7.5) mm long and (4.2–) 5.0–5.5 (–6.2) mm wide, broadly ovate or broadly elliptical, concave, white, patent, sparsely tomentose at base of upper surface, glabrous on lower surface, with a short claw. Stamens ca 20; anthers pale yellow or pale rose. Ovary semi-inferior. Styles 2, connate and tomentose at base. Fruit ellipsoid to almost subglobose, (11.0–) 12.0–13.0 (–13.5) mm long and 10.5–12.0 (–13.5) mm wide, never wider than long, red when ripe, tomentose at top and base, otherwise glabrescent, matt, with (1–) 3–4 (–7) lenticels per 25 mm²; mesocarp heterogeneous; endocarp cartilaginous. Seeds fuscous. DNA ploidy level: triploid (inferred using FCM). Reproduction probably apomictic. Flowering V.

Holotype: southern Moravia, Čížov (distr. Znojmo), Dyje valley, Sloní hřbet ridge, ca 2.1 km SSE of chapel in village, on cliff; 340 m a.s.L., 48°51’39.53”N, 15°52’40.48”E; scattered; small trees ca 7 m high; 13. 6. 2011 leg. Martin Lepší, Petr Lepší; CB, No. 83095 (Fig. 7). – Isotypes: PR, 83095/a; PRA, 83095/b; W, 83095/c.

Name previously used for this taxon in the Czech Republic: Sorbus subdanubialis sensu Šefl, Thayensia 7: 139, 2007 p.p.
Diagnostic characters: Leaf laminae on short sterile shoots more or less (broadly) elliptical to obovate, relatively small, regularly, finely, double (to triple) serrate. Flowers relatively small. Fruit ellipsoid to almost subglobose, never wider than long, red, only with (1–) 3–4 (–7) lenticels per 25 mm². Leaves on short sterile shoots of individuals at sunny sites are held more or less upright and overlap each other and therefore resemble a cornet.

Etymology: The epithet “cucullifera” refers to the characteristic arrangement of leaves on short sterile shoots of individuals at sunny sites that resemble cornets (in Latin cucullus). We propose the name “kornoutolistý” for the Czech name.

Ecology: Sorbus cucullifera is a light-demanding species that prefers open habitats such as forest-steppes, rocky steppes, shrubs, open thermophilous oak forests and their fringes. Less often it occurs in other types of open forests and also on rocks and screes. The species grows mainly on calcareous soils on limestone, but frequently also on acid bedrocks such as gneisses and schists. In phytosociological terms, vegetation with common occurrence of S. cucullifera belongs to peri-Alpidic basophilous thermophilous oak forests (Quercion pubescenti-petraeae), central-European thermophilous oak forests (Quercion petraeae), tall xeric scrub (Berberidion), narrow-leaved continental dry grasslands (Festucion valesiacae) and vegetation of dry herbaceous forest fringes (Geranion sanguinei). Less often, this species is recorded in vegetation in oak-hornbeam forests (Carpinion), ravine forests (Tilio-Acerion), rock pine forests (Dicrano-Pinion), peri-Alpidic basophilous pine forests (Erico-Pinion), acidophilous oak forests (Genisto germanicae-Quercion), and low xeric scrub (Prunion spinosae).
Distribution and population size: *Sorbus cucullifera* was recorded at 28 localities in the wide surroundings of the town Hardegg, which is located on the border between Lower Austria and southern Moravia (Czech Republic). This species occurs in the valley of the river Dyje and that of its tributary, Fugnitz. Along with *S. aria* it is the most abundant species in the subg. *Aria* in this area. The distance between the two most remote localities, which are Umlaufberg hill (Austria) in the south and Pašerácká stezka trail (Czech Republic) in the north, is almost 5.4 km (Fig. 9). The total number of individuals is estimated to be around 150 in the Czech Republic and 300 in Austria. Some populations consist of about 40 or more individuals (localities 6, 7, 19, 26). *Sorbus cucullifera* is recorded in two quadrants (7161a and 7161c) of the central-European mapping grid (Ehrendorfer & Hamann 1965). All localities are situated in a moderately warm climatic region (Quitt 1971) with a mean annual temperature of about 8–9 °C and mean annual precipitation of 450–500 mm (Tolasz et al. 2007). Czech localities are in the supracolline vegetation belt (Chytrý 2012) in the phytogeographical district of Moravské podhůří Vysočiny (Skalický 1988). The altitudinal range of this species spans from 300 (near Pašerácká stezka trail, Czech Republic) to 420 m a.s.l. (Schwalbenfelsen cliff, Austria).

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Czech Republic, southern Moravia, 68. Moravské podhůří Vysočiny, 7161a: 1. Pašerácká stezka path: Čížov village, Dyje valley, Pašerácká stezka path, ca 1.7 km WNW of chapel in village, acidophilous oak forest, shrub ca 5 m high, 48°52'50.9''N, 15°51'00.4''E, 330 m a.s.l. (leg. ML et PL 8. 5. 2011, CB 79750). 2. Na Vyhlídce hill: Čížov village, slopes on left-hand bank of Dyje river, ca 400 m W of summit Na Vyhlídce hill, a gap in Pine wood, two juvenile plants, 48°52'29.0''N, 15°50'55.4''E, 400 m a.s.l. (leg. ML et PL 23. 7. 2010, CB 74000). – Čížov village, Dyje valley, NW slopes of Na Vyhlídce hill, a 1.8 km WSW of chapel in village, edge of scree and scree forest, rare, tree ca 2 m high, 48°52'30.1''N, 15°50'54.7''E, 380 m a.s.l. (leg. ML et PL 8. 5. 2011, CB 79762). – Čížov village, Dyje valley, NW slopes of Na Vyhlídce hill, ca 1.8 km WSW of chapel in village, rocky acidophilous oak forest, rare, tree ca 2 m high, 48°52'29.9''N, 15°50'56.0''E, 390 m a.s.l. (leg. ML et PL 8. 5. 2011, CB 79764). – Čížov village, Dyje valley, NW slopes of Na Vyhlídce hill, ca 1.8 km WSW of chapel in village, gap in acidophilous oak forest, rare, shrub ca 1.5 m high, 48°52'28.9''N, 15°50'55.3''E, 390 m a.s.l. (leg. ML et PL 8. 5. 2011, CB 79763). 3. Vinohrad hill I: Čížov village, Dyje valley, NW slopes of Vinohrad hill, ca 2 km SW of chapel in village, oak-hornbeam forest on steep slope, tree ca 4 m high, 48°51'59.1''N, 15°51'09.6''E, 360 (315) m a.s.l. (leg. ML et PL 8. 5. 2011, CB 79766). – Čížov village, Dyje valley, NW slopes of Vinohrad hill, ca 2.3 km SW of chapel in village, steep woody slope, ca 3 m high, 48°51'52.9''N, 15°51'00.8''E, 300 m a.s.l. (leg. ML et PL 8. 5. 2011, CB 79767). – Čížov village, slopes above Dyje river between Vinohrad hill and Ledové sluje chasm, oak forest, 48°51'54.4''N, 15°51'03.3''E, 350 (330) m a.s.l. (leg. ML et PL 5. 8. 2009, CB 73719). – Čížov village, slopes above Dyje river between Vinohrad hill and Ledové sluje chasm, oak forest, 48°51'56.3''N, 15°51'11.7''E, 360 m a.s.l. (leg. ML et PL 5. 8. 2009, CB 73744–73745). 4. Vinohrad hill II: Čížov village, Dyje valley, NW slopes of Vinohrad hill, ca 2.6 km SW of chapel in village, acidophilous oak forest with abundant *Pinus sylvestris*, only two individuals, ca 6 m high, 48°51'47.4''N, 15°50'46.0''E, 310 m a.s.l. (leg. ML et PL 8. 5. 2011, CB 79768). 5. Hardeggská vyhlídka outlook I: Čížov village, Dyje valley, ca 0.5 km SE of summit of Vinohrad hill, pine-oak forest, tree ca 5 m high, 48°51'33.5''N, 15°51'21.7''E, 330 m a.s.l. (leg. ML 21. 8. 2011, CB 79613). 6. Hardeggská vyhlídka outlook II: Čížov village, slopes with rocks and scree below Hardeggská vyhlídka outlook, ca 0.5 km NE of centre of Hardegg, 48°51'19.4''N, 15°51'41.0''E, 340 m a.s.l. (leg. ML et PL 6. 8. 2009, CB 73673). – Čížov village, slopes with rocks and scree below Hardeggská vyhlídka outlook, ca 0.5 km NE of centre of Hardegg, 48°51'24.9''N, 15°51'41.5''E, 390 m a.s.l. (leg. ML et PL 6. 8. 2009, CB 73672). – Čížov village, Hardeggská vyhlídka outlook, ca 260 m NNW of bridge over Dyje river, edge of oak forest and steppe, scattered, shrub ca 3 m high, 48°51'18.6''N, 15°51'42.1''E, 330 m a.s.l. (leg. ML et PL 7. 5. 2011, CB 79675). – Čížov village, Hardeggská vyhlídka outlook, ca 280 m NNW of bridge over Dyje river, forest-steppe, scattered, tree ca 3.5 m high, 48°51'18.9''N, 15°51'40.0''E, 310 m a.s.l. (leg. ML et PL 7. 5. 2011, CB 79693). – Čížov village,
Hardeggská vyhlídka outlook, ca 350 m NNW of bridge over Dyje river, limestone cliff, shrub ca 2 m high, 48°51’20.8”N, 15°51’37.4”E, 350 [315] m a.s.l. (leg. ML et PL 7. 5. 2011, CB 79687).

- Čížov village, Hardeggská vyhlídka outlook, ca 360 m NNW of bridge over Dyje river, scattered, 48°51’21.1”N, 15°51’38.2”E, 360 [340] m a.s.l. (leg. ML et PL 7. 5. 2011, CB 79692, CB 79846).

- Čížov village, Hardeggská vyhlídka outlook, ca 410 m NNW of bridge over Dyje river, rocky forest-steppe, scattered, shrub ca 4 m high, 48°51’22.8”N, 15°51’37.2”E, 340 m a.s.l. (leg. ML et PL 7. 5. 2011, CB 79689).

- Čížov village, Hardeggská vyhlídka outlook, ca 450 m NNW of bridge over Dyje river, scree, shrub ca 3 m high, 48°51’24.5”N, 15°51’39.7”E, 380 m a.s.l. (leg. ML et PL 14. 5. 2011, CB 79849).

- Čížov village, Hardeggská vyhlídka outlook, ca 470 m NNW of bridge over Dyje river, oak forest on cliff, shrub ca 3.5 m high, 48°51’25.3”N, 15°51’40.2”E, 400 m a.s.l. (leg. ML et PL 7. 5. 2011, CB 79683).

- Čížov village, Hardeggská vyhlídka outlook, ca 500 [600] m NNW of bridge over Dyje river, rocky forest-steppe, rare, shrub ca 2 m high, 48°51’27.1”N, 15°51’33.5”E, 380 m a.s.l. (leg. ML et PL 7. 5. 2011, CB 79678).

- Čížov village, Hardeggská vyhlídka outlook, ca 600 m NNW of bridge over Dyje river, pine forest on acidophilous rock, shrub ca 1 m high, 48°51’27.8”N, 15°51’31.5”E, 340 m a.s.l. (leg. ML et PL 7. 5. 2011, CB 79690).


- Čížov village, calcareous slopes above Dyje river ca 400 [560] m SE of the 417 m a.s.l. spot height with Hardeggská vyhlídka outlook, above road to Hardegg, edge of shrubs and steppe, 1 individual ca 2.5 m high, 48°51’17.8”N, 15°52’06.9”E, 350 m a.s.l. (leg. ML et PL 23. 7. 2010, CB 74004).

- Čížov village, calcareous slopes above Dyje river ca 500 [600] m SE of spot height of 417 m with Hardeggská vyhlídka outlook, above road to Hardegg, steppe, scaterred, 48°51’17.8”N, 15°52’08.5”E, 350 m a.s.l. (leg. ML et PL 23. 7. 2010, CB 74017).

- Čížov village, forest-steppe, scaterred, 48°51’17.8”N, 15°52’08.5”E, 350 m a.s.l. (leg. ML et PL 23. 7. 2010, CB 74018).

- Čížov village, slopes above Dyje river ca 0.5 to 0.9 km SE of Hardegg, open oak forests on southern slope, 48°51’15.3”N, 15°51’58.0”E, 340 m a.s.l. (leg. ML et PL 6. 8. 2009, CB 73682).

- Čížov village, Hardeggská stráň hillside, above road ca 300 m ENE of bridge over Dyje river, open forest, scattered, shrub ca 6 m high, 48°51’15.3”N, 15°51’57.6”E, 320 m a.s.l. (leg. ML et PL 7. 5. 2011, CB 79674).
lage, Hardeggská stráh hillside, ca 520 m ENE of bridge over Dyje river, forest-steppe, plentiful, shrub ca 4 m high, 48°51′17.6″N, 15°52′08.5″E, 350 m a.s.l. (leg. ML et PL 6. 5. 2011, CB 79649). – Čížov village, Hardeggská stráh hillside, ca 530 m ENE of bridge over Dyje river, forest-steppe, scattered, 48°51′17.6″N, 15°52′08.5″E, 350 m a.s.l. (leg. ML et PL 6. 5. 2011, CB 79722). – Čížov village, Hardeggská stráh hillside, ca 530 m ENE of bridge over Dyje river, forest-steppe, scattered, shrub ca 3.5 m high, 48°51′17.4″N, 15°52′09.1″E, 350 m a.s.l. (leg. ML et PL 6. 5. 2011, CB 79721). – Čížov village, Hardeggská stráh hillside, ca 550 m ENE of bridge over Dyje river, forest-steppe, plentiful, 48°51′17.4″N, 15°52′09.5″E, 350 m a.s.l. (leg. ML et PL 6. 5. 2011, CB 79647). – Čížov village, Hardeggská stráh hillside, ca 550 m ENE of bridge over Dyje river, forest-steppe, plentiful, shrub ca 4 m high, 48°51′17.6″N, 15°52′09.9″E, 350 m a.s.l. (leg. ML et PL 6. 5. 2011, CB 79650). – Čížov village, Hardeggská stráh hillside, ca 550 m ENE of bridge over Dyje river, forest-steppe, plentiful, shrub ca 3.5 m high, 48°51′17.7″N, 15°52′10.7″E, 350 m a.s.l. (leg. ML et PL 6. 5. 2011, CB 79651). – Čížov village, Hardeggská stráh hillside, ca 550 m ENE of bridge over Dyje river, forest-steppe, plentiful, shrub ca 4 m high, 48°51′17.6″N, 15°52′11.1″E, 350 m a.s.l. (leg. ML et PL 6. 5. 2011, CB 79652). – Čížov village, Hardeggská stráh hillside, ca 570 m ENE of bridge over Dyje river, forest-steppe, plentiful, shrub ca 4 m high, 48°51′18.0″N, 15°52′11.4″E, 360 m a.s.l. (leg. ML et PL 6. 5. 2011, CB 79655). – Čížov village, Hardeggská stráh hillside, ca 600 m ENE of bridge over Dyje river, forest-steppe, plentiful, shrub ca 5 m high, 48°51′17.9″N, 15°52′11.7″E, 350 m a.s.l. (leg. ML et PL 6. 5. 2011, CB 79654). – Čížov village, Hardeggská stráh hillside, ca 600 m ENE of bridge over Dyje river, forest-steppe, plentiful, shrub ca 3.5 m high, 48°51′17.6″N, 15°52′12.4″E, 350 m a.s.l. (leg. ML et PL 6. 5. 2011, CB 79655). – Čížov village, Hardeggská stráh hillside, ca 600 m ENE of bridge over Dyje river, open oak forest, plentiful, shrub ca 5.5 m high, 48°51′17.6″N, 15°52′13.0″E, 350 m a.s.l. (leg. ML et PL 6. 5. 2011, CB 79656). – Podyji region, slope above road from Hardegg to Čížov village, ca 400 m ENE of bridge over Dyje river, 48°51′16.2″N, 15°52′03.5″E (leg. J. Brabec 29. 5. 2012, CHEB). 8. Kozi stezky cliff I: Čížov village, Dyje valley, Kozi stezky slopes, ca 2 km SSW of chapel in village, open forest on rocky slopes, rare, 48°51′39.9″N, 15°52′15.8″E, 360 m a.s.l. (leg. ML 22. 5. 2011, CB 79792). 9. Kozi stezky cliff II: Čížov village, ca 2 km S of chapel in village, ridge between Dyje river and Klaperův potok brook, rocky oak forest, rare, shrub ca 5 m high, 48°51′40.5″N, 15°52′31.4″E, 350 m a.s.l. (leg. ML et PL 15. 6. 2012, CB 82893). 10. Mufloni kopce hill: Čížov village, ca 1.6 km S of chapel in village, Mufloni kopce hill, edge of scree, rare, shrub ca 6 m high, 48°51′58.1″N, 15°52′28.2″E, 410 (380) m a.s.l. (leg. ML et PL 15. 6. 2012, CB 82892). 11. Urbanova cesta road: Čížov village, ca 1.6 km SE of chapel in village, above Urbanova cesta road, oak-hornbeam forest, rare, tree ca 6 m high, 48°51′57.3″N, 15°52′19.9″E, 360 m a.s.l. (leg. ML et PL 15. 6. 2012, CB 82891). 12. Sloni hřbet hill: Čížov village, S slopes ca 0.4 km N of confluence of Klaperův potok brook (leg. B. Trávníček 3. 9. 1992, OL 26177). – Čížov village, Dyje valley, Sloni hřbet ridge, ca 2.1 km SSE of chapel in village, edge of pine and oak-hornbeam forest, three individuals, shrub ca 7 m high, 48°51′38.3″N, 15°52′53.7″E, 360 m a.s.l. (leg. ML 22. 5. 2011, CB 79796). – Čížov village, Dyje valley, Sloni hřbet ridge, ca 2.1 km SSE of chapel in village, forest-steppe, scattered, shrub ca 3.5 m high, 48°51′40.4″N, 15°52′49.5″E, 360 m a.s.l. (leg. ML 22. 5. 2011, CB 79795). – Čížov village, Sloni hřbet ridge, ca 2.2 km SSE of centre of village, forest-steppe, scattered, 48°51′39.3″N, 15°52′45.6″E, 330 m a.s.l. (leg. ML 3. 6. 2011, CB 79795). – Podyji region, Čížov village, Sloni hřbet ridge, ca 1.4 km NE of bridge over Dyje river in Hardegg, 48°51′39.8″N, 15°52′40.3″E (leg. J. Brabec 29. 5. 2012, CHEB, leg. D. Abazid 30. 5. 2011). – Čížov village, Hardeggská stráh hillside, ca 520 m ENE of bridge over Dyje river, scattered, 48°51′24.4″N, 15°52′56.5″E, 330 m a.s.l. (leg. ML 3. 6. 2011, CB 79593). – Čížov village, ca 2.8 km SSE of centre of village, western steep slopes of spur between Dyje river and Lukovský potok brook, by a rock in oak-hornbeam forest, scattered, 48°51′24.4″N, 15°52′56.5″E, 330 m a.s.l. (leg. ML 3. 6. 2011, CB 79593). – Čížov village, ca 2.8 km SSE of centre of village, western steep slopes of spur between Dyje river and Lukovský potok brook, edge of oak-hornbeam forest and open patch, scattered, tree ca 3 m high, 48°51′20.1″N, 15°52′54.8″E, 330 m a.s.l. (leg. ML 3. 6. 2011, CB 79592).
17. **Fugnitz brook I, 7161a**: Hardegg, W slopes of Fugnitz valley opposite Binderberg hill, ca 990 m W of bridge over Dyje river, edge of scree and Fagus and Carpinus forest, tree ca 3 m high, 48°51'08.6"N, 15°50'46.4"E, 400 m a.s.l. (leg. ML et PL 13. 9. 2011, CB 79632).

18. **Above swimming pool, 7161a**: Hardegg, S slopes of Maxplateau hill above swimming pool, ca 830 m WNW of bridge over Dyje river, rock steppe, scattered, shrub ca 4 m high, 48°51'14.9"N, 15°51'04.9"E, 360 m a.s.l. (leg. ML et PL 7. 5. 2011, CB 79770). – Hardegg, S slopes of Maxplateau hill above swimming pool, ca 830 m WNW of bridge over Dyje river, rocky forest-steppe, scattered, tree ca 3 m high, 48°51'14.8"N, 15°51'05.9"E, 360 m a.s.l. (leg. ML et PL 7. 5. 2011, CB 79700). – Hardegg, S slopes of Maxplateau hill, above swimming pool, ca 800 m WNW of bridge over Dyje river, rock steppe, scattered, shrub 4.5 m high, 48°51'15.1"N, 15°51'05.1"E, 360 m a.s.l. (leg. ML et PL 7. 5. 2011, CB 79763). – Hardegg, slopes of Fugnitz valley opposite Binderberg hill, ca 1 km SW of bridge over Dyje river, forest-steppe, scattered, shrub ca 3 m high, 48°50'56.0"N, 15°51'00.9"E, 400 m a.s.l. (leg. ML et PL 12. 6. 2011, CB 79730).

19. **Fugnitz brook II, 7161e**: Hardegg, slopes of Fugnitz valley opposite Binderberg hill, ca 1 km SW of bridge over Dyje river, forest-steppe, scattered, shrub ca 3 m high, 48°50'18.7"N, 15°51'02.9"E, 380 m a.s.l. (leg. ML et PL 9. 5. 2011, CB 79779).

20. **Fugnitz brook III, 7161e**: Hardegg, Kreuzmaiss, slopes above Fugnitz stream, ca 1.5 km SSW of bridge over Dyje river, shrubby edge of rock steppe, shrub ca 2.5 m high, 48°50'30.7"N, 15°50'58.7"E, 380 m a.s.l. (leg. ML et PL 9. 5. 2011, CB 79781). – Hardegg, slopes of Fugnitz valley ca 1.5 km SW of bridge over Dyje river, Bromion, tree ca 6 m high, 48°50'33.8"N, 15°51'00.1"E, 390 m a.s.l. (leg. ML et PL 9. 5. 2011, CB 79769). – Hardegg, slopes of Fugnitz valley, ca 1.8 km SSW of bridge over Dyje river, edge of cliff, shrub ca 1 m high, 48°50'18.7"N, 15°51'02.9"E, 380 m a.s.l. (leg. ML et PL 9. 5. 2011, CB 79779).

22. **Maxplateau hill, 7161a**: Hardegg, Maxplateau hill, ca 550 (600) m NW of bridge over Dyje river, oak-hornbeam forest, tree ca 3 m high, 48°51'20.3"N, 15°51'19.7"E, 360 m a.s.l. (leg. ML et PL 7. 5. 2011, CB 79639). – Hardegg, Maxplateau hill, ca 570 m NW of bridge over Dyje river, rocky forest-steppe, scattered, shrub ca 8 m high, 48°51'21.6"N, 15°51'22.1"E, 360 m a.s.l. (leg. ML et PL 7. 5. 2011, CB 79702). – Hardegg, Maxplateau hill, ca 570 m NW of bridge over Dyje river, rock, tree ca 5 m high, 48°51'21.5"N, 15°51'22.8"E, 360 m a.s.l. (leg. ML et PL 7. 5. 2011, CB 79701).

23. **Hardegg East, 7161a**: Hardegg, S slopes of Maxplateau hill above swimming pool, ca 800 m SW of bridge over Dyje river, small rock above road, shrub ca 3 m high, 48°51'07.1"N, 15°51'32.3"E, 320 m a.s.l. (leg. ML et PL 7. 5. 2011, CB 79644). – Hardegg, “pine forest I” on slopes of Dyje valley, ca 180 m SE of bridge over Dyje river, pine forest with *Sesleria*, scattered, shrub ca 3 m high, 48°51'06.2"N, 15°51'49.4"E, 350 m a.s.l. (leg. ML et PL 15. 5. 2011, CB 79789). – Hardegg, “pine forest I” on slopes of Dyje valley, ca 180 (230) m SE of bridge over Dyje river, pine forest with *Sesleria*, scattered, shrub ca 7 m high, 48°51'04.5"N, 15°51'51.9"E, 380 m a.s.l. (leg. ML et PL 15. 5. 2011, CB 79858). – Hardegg, “pine forest I” on slopes of Dyje valley, ca 180 [250] m SE of bridge over Dyje river, pine forest with *Sesleria calcaria*, tree ca 5 m high, 48°51'04.1"N, 15°51'52.2"E, 390 m a.s.l. (leg. ML et PL 12. 9. 2011, CB 79813). – Hardegg, “pine forest II” on slopes of Dyje valley, ca 300 m SE of bridge over Dyje river, pine forest with *Sesleria*, scattered, shrub ca 6 m high, 48°51'04.6"N, 15°51'56.3"E, 400 m a.s.l. (leg. ML et PL 15. 5. 2011, CB 79860). – Hardegg, ca 250 m SSE of bridge over Dyje river, pine forest with *Anthericum*, tree ca 10 m high, 48°51'02.7"N, 15°51'46.9"E, 400 m a.s.l. (leg. ML 29. 5. 2012, CB 82833). – Hardegg, slopes above Dyje river, ca 320 m ESE of bridge over Dyje river, on rock in forest, tree ca 5 m high, 48°51'08.6"N, 15°52'00.6"E, 300 m a.s.l. (leg. ML et PL 12. 9. 2011, CB 79808).

26. **Thayatalweg path, 7161a**: Hardegg, slopes above Dyje river ca 0.87 km E of bridge over Dyje river, cliff with dom. *Sesleria*, shrub ca 6 m high, 48°51'12.5"N, 15°52'27.6"E, 350 m a.s.l. (leg. ML 29. 5. 2012, CB 82841). – Hardegg, slopes above Dyje river ca 0.9 km ENE of bridge over Dyje river, oak-hornbeam forest, shrub ca 4 m high, 48°51'14.2"N, 15°52'29.7"E, 340 m a.s.l. (leg. ML 29. 5. 2012, CB 82840). – Hardegg, slopes above Dyje river ca 1 km ENE of bridge over Dyje river, cliff with dom. *Anthericum*, sapling ca 2 m high, 48°51'17.7"N, 15°52'33.5"E, 340 m a.s.l. (leg. ML 29. 5. 2012, CB 82838). – Hardegg, slopes above Dyje river ca 1.1 km ENE of bridge over Dyje river, edge of forest and rocky steppe, tree ca 5 m high, 48°51'19.7"N, 15°52'34.2"E, 320 m a.s.l. (leg. ML 29. 5. 2012, CB 82837). – Hardegg, slopes above Dyje river ca 1.1 km ENE of bridge over Dyje river, foot of cliff in oak-hornbeam forest, tree ca 8 m high, 48°51'23.4"N, 15°52'33.8"E, 330 m a.s.l. (leg. ML 29. 5. 2012, CB 82836). – Hardegg, slopes above Dyje river ca 1.1 km ENE of bridge over Dyje river, cliff with *Sesleria*, tree ca 5 m high, 48°51'24.7"N, 15°52'33.9"E, 330 m a.s.l. (leg. ML 29. 5. 2012, CB 82835). – Hardegg, slopes above Dyje river, ca 0.9 km ENE of bridge over Dyje river, cliff in forest, scattered, tree ca 7 m high, 48°51'14.6"N, 15°52'31.4"E, 360 m a.s.l. (leg. ML et PL 9. 5. 2011, CB 79773).
Dyje river, oak-hornbeam forest, scattered, tree ca 5 m high, 48°51’14.9’’N, 15°52’32.4’’E, 360 m a.s.l. (leg. ML et PL 9. 5. 2011, CB 79774). – Hardegg, slopes above Dyje river, ca 1 km NE of bridge over Dyje river, oak-hornbeam forest, tree ca 4 m high, 48°51’15.1’’N, 15°52’32.8’’E, 360 m a.s.l. (leg. ML et PL 15. 5. 2011, CB 79835). 27. Einsiedler, 7161a: Hardegg, open woodland on right-hand bank of Dyje river (near tourist footpath), ca 1.5 km E of town (leg. B. Trávníček 25. 5. 1990, OL 26164). – Hardegg, slopes above Dyje river, on rock, scattered, shrub ca 3.5 m high, 48°51’31.9’’N, 15°52’23.5’’E, 310 m a.s.l. (leg. ML et PL 15. 5. 2011, CB 79852).

28. Umlaufberg hill, 7161c: Hardegg, Umlaufberg hill, acid rock, Cotoneasteretum, rarely, shrub ca 1.5 m high, 48°50’31.1’’N, 15°53’25.9’’E, 340 m a.s.l. (leg. ML 30. 5. 2012, CB 82846). – Hardegg, Umlaufberg hill, on cliff in oak forest, 48°50’33.8’’N, 15°53’27.4’’E, 320 m a.s.l. (leg. ML 30. 5. 2012, CB 82845).

Sorbus moravica M. Lepší et P. Lepší, spec. nova (Figs 10–11)

Description: Shrub or small tree up to 12 m high. Bark grey or dark grey, smooth when young, with fissures (particularly at the trunk base) when mature. Twigs thick, brownish-grey; young shoots brown, tomentose when young, glabrescent when mature, with pale brown to ochraceous lenticels. Buds ovoid, pointed; scales green, glabrescent, with narrow brown sparsely tomentose margins. Leaves on short sterile shoots simple; laminas elliptical to oblong elliptical, (7.0–) 8.1–9.2 (–10.4) cm long and (3.9–) 4.7–5.6 (–6.2) cm wide, (1.5–) 1.7–1.8 (–1.9) times as long as wide, widest at (50–) 53–56 (–59)% of the lamina length (from the base), with acute to acuminate apex with an angle of (75–) 100–110 (–125)°, cuneate and partly serrate at base, with angle at base (65–) 70–85 (–90)°, usually flat at margins, regularly, double to triple serrate, with acute teeth terminating the main veins (other teeth also acute but somewhat smaller), with (5–) 6–8 (–11) teeth between the 2nd and 3rd main veins from the base, with angle of the teeth terminating the 3rd main veins (60–) 70–90 (–100)°, with incision between the 2nd and the 3rd main vein from the base (1.4–) 1.9–2.6 (–3.3) mm long, leathery, more or less glossy, green, sparsely tomentose when young, later glabrescent on upper surface, evenly greenish-grey-tomentose on lower surface, with (8–) 9 (–10) veins on each side, with the 3rd veins at an angle of (20–) 25–35° to midrib; petioles (9–) 12–15 (–17) mm long, tomentose. Leaf laminas on short fertile shoots more or less the same size and shape as leaf laminas on short sterile shoots. Inflorescences compact, convex, with tomentose branchlets. Sepals triangular, acute to acuminate, tomentose on both surfaces, patent or rarely bent to hypanthium at flowering, erect, persistent and dry at fruiting. Petals broadly ovate to broadly elliptical, (6.5–) 7.5–8.5 (–9.5) mm long and (5.0–) 6.0–6.5 (–7.0) mm wide, concave, white, patent, sparsely tomentose at base of upper surface, glabrous on lower surface, with a short claw. Stamens ca 20; anthers pale yellow. Ovary semi-inferior. Styles 2 (–3), free and tomentose at base. Fruit more or less subglobose, (10.5–) 11.5–12.5 (–13.5) mm long and (10.5–) 11.5–12.5 (–13.5) mm wide, slightly wider than long or slightly longer than wide, red at maturity, tomentose at top and base, otherwise glabrescent, matt, with (10–) 13–18 (–24) lenticels per 25 mm²; mesocarp cartilaginous; endocarp fuscous. Seeds fuscous. DNA ploidy level: triploid (inferred using FCM). Reproduction probably apomictic. Flowering V.

Holotype: southern Moravia, Lažánky (distr. Blansko), Suchý žleb gorge, S slopes, edge of forest and cliff; 440 m a.s.l., 49°21’46.55’’N, 16°43’11.11’’E; scattered; tree ca 8 m high; 22. 7. 2011 leg. Martin Lepší; CB, No. 79868 (Fig. 10). – Isotype: PR, 79868/a.

Fig. 10. – Holotype of *Sorbus moravica*. 

*Sorbus moravica* M. Legl. ex P. Legl. 

**HOLOTYPE**

Labiánky (district), Blansko, South Bohemian, slopes, edge of forest and cliff.

**Prepared by:** \[Signature\]

**Accession Number:** GD 144

**Prepared by:** \[Signature\]

**Photographic Details:** Moravský kraj

**Date:** 22.7.2011

**Collector:** \[Name\]

**Herbarium:** \[Herbarium Name\]
Diagnostic characters: Leaf laminas on short sterile shoots are elliptical to oblong elliptical, regularly, double (to triple) serrate, with (5–) 6–8 (–11) teeth between the 2nd and 3rd main veins from the base. Fruit are more or less subglobose, slightly wider than long or slightly longer than wide, red.

Etymology: The name “moravica” is derived from the Latin name of the Czech land Morava (Moravia), where the species occurs. We propose the epithet “moravský” for the Czech name.

Ecology: *Sorbus moravica* is a light-demanding species that prefers sunny or at least partly open habitats such as cliffs, scree beds, ravines and steep woody or shrubby slopes of canyons in karst areas. Besides semi-natural to relic vegetation, it also grows in *Picea abies* and *Pinus nigra* plantations or in their clearings. This species occurs on calcareous, dry and shallow soils developed on limestone, and inhabits slopes of all aspects (most individuals were found on slopes facing south, northeast or northwest). This species was mainly recorded in a mixture of communities associated with cliffs and rocky slopes, i.e. *Sesleria* grasslands (*Diantho lumnitzeri-Seslerion albicanis*), tall xeric scours (*Berberidion*), chasmophytic vegetation on calcareous cliffs and scree beds (*Cystopteridion*) and dry herbaceous fringes (*Geranion sanguinei*). It is also common in ravines, scree beds and rock forests (*Tilio-Acerion*) or in fringes and gaps in limestone beech forests (*Cephalanthero-Fagenion*). Rarely it was found in broad-leaved dry grasslands (*Bromion erecti*).
**Distribution and population size:** *Sorbus moravica* is a stenoendemic in the Suchý Žleb gorge by the village of Lažánky (distr. Blansko) on the Moravian Karst (quadrant 6666a of the central-European grid mapping, Ehrendorfer & Hamann 1965). About 200 trees and shrubs are known in the western part of the gorge and the adjacent valley of the Punkva River. A few individuals also occur on the plateau between the gorge and Lažánky (Fig. 12). Most individuals are confined to southern slopes in the Suchý žleb gorge between the settlement of Skalní Mlýn and Chobot hill. Despite being locally abundant, it was not found in adjacent areas such as the Pustý žleb, Lažáncký žleb and Veselý žleb gorges and Punkevní údolí valley. It is even absent in the northern part of the Suchý žleb gorge where there are many suitable habitats. The altitudinal range of this species spans from 360 to 490 m a.s.l. In terms of Czech phytogeography and climatology, the distribution area is in the supracolline vegetation belt (Chytrý 2012), the phytogeographical district Moravian Karst (Skalický 1988) and a moderately warm climatic region (Quitt 1971) with a mean annual temperature of about 7–8 °C and mean annual precipitation of 550–600 mm (Tolasz et al. 2007).

**Herbarium specimens**

Laminas broadly elliptical, (5.8–) 6.5–7.8 (–8.8) cm long and (3.8–) 4.4–5.1 (–6.1) cm wide, with pale brown to ochraceous lenticels. Buds ovoid, pointed; scales green, glabrescent, brownish-grey; young shoots brown, tomentose when young, glabrescent when mature, when young, with fissures (particularly at the trunk base) when mature. Twigs thick, D e s c r i p t i o n: Shrub or small tree up to 12 m high. Bark grey or dark grey, smooth and partly serrate at base, with angle at base of (70–) 75–85 (–95)°, usually undulate to (from the base), with acute to acuminate apex with angle (100–) 110–125 (–140)°, cuneate and partly serrate at base, with angle at base of (70–) 75–85 (–95)°, usually undulate to

Sorbus pontis-satani M. Lepší et P. Lepší, spec. nova (Figs 13–14)

D e s c r i p t i o n: Shrub or small tree up to 12 m high. Bark grey or dark grey, smooth when young, with fissures (particularly at the trunk base) when mature. Twigs thick, brownish-grey; young shoots brown, tomentose when young, glabrescent when mature, with pale brown to ochraceous lenticels. buds ovoid, pointed; scales green, glabrescent, with narrow brown sparingly tomentose margins. Leaves on short sterile shoots simple; laminas broadly elliptical, (5.8–) 6.5–7.8 (–8.8) cm long and (3.8–) 4.4–5.1 (–6.1) cm wide, (1.3–) 1.5–1.6 times as long as wide, widest at (50–) 54–57 (–61)\% of the lamina length (from the base), with acute to acuminate apex with angle (100–) 110–125 (–140)°, cuneate and partly serrate at base, with angle at base of (70–) 75–85 (–95)°, usually undulate to
Fig. 13. – Holotype of Sorbus pontis-satani.
crispate at margins apically, regularly, finely double to triple serrate, with acute teeth terminating the main veins (other teeth also acute but somewhat smaller), with (6–) 8–10 (–11) teeth between the 2nd and 3rd main veins from the base, with angle of the teeth terminating the 3rd main veins (35–) 45–55 (–65)°, with incision between the 2nd and the 3rd main vein from the base (2.1–) 2.7–3.5 (–5.0) mm long, leathery, more or less glossy, green, sparsely tomentose when young, later glabrescent on upper surface, evenly greenish-grey-tomentose on lower surface, with (7–) 8 (–9) veins on each side, with the 3rd veins at an angle of 25–30 (–35)° to midrib; petioles (9–) 10–14 (–17) mm long, tomentose. Leaf laminas on short fertile shoots relatively wider than leaf laminas on short sterile shoots. Inflorescences compact, convex, with tomentose branchlets. Sepals triangular, acuminate, tomentose on both surfaces, patent or rarely bent to hypanthium at flowering, erect, persistent and dry at fruiting. Petals broadly elliptical, (5.5–) 7.0–8.2 (–8.5) mm long and (5.0–) 5.5–6.0 (–6.5) mm wide, concave, white, patent, sparsely tomentose at base of upper surface, glabrous on lower surface, with a short claw. Stamens ca 20; anthers pale yellow. Ovary semi-inferior. Styles 2, free and tomentose at base. Fruit more or less subglobose, (7.0–) 11.0–12.5 (–13.5) mm long and (5.0–) 10.5–12.0 (–12.5) mm wide, slightly wider than long or slightly longer than wide, red when mature, tomentose at top and base, otherwise glabrescent, matt, with (2–) 7–10 (–16) lenticels per 25 mm²;
mesocarp heterogeneous; endocarp cartilaginous. Seeds fuscous. DNA ploidy level: triploid (inferred using FCM). Reproduction probably apomictic. Flowering V.

**Holotype:** southern Moravia, Lažánky (distr. Blansko), S slope of Suchý žleb gorge, above entrance of Kateřinská jeskyně cave; 390 m a.s.l., 49°21′38.8″N, 16°42′33.9″E; rarely; shrub ca 5 m high; 16. 8. 2013 leg. Martin Lepší; CB, No. 83096 (Fig. 13). – **Isotype:** PR, 83096/a.


**Diagnostic characters:** Leaf lamina on short sterile shoots broadly elliptical, usually undulate to crispate at margins apically, regularly and finely double (to triple) serrate. Fruit more or less subglobose, slightly wider than long or slightly longer than wide, red.

**Etymology:** The name “*pontis-satani*” relates to a natural bridge called Čertův most (Devil’s bridge) in whose surroundings the species occurs. We propose the epithet “čertův” for the Czech name.

**Ecology:** *Sorbus pontis-satani* appears to have very similar ecological demands as the sympatric species, *S. moravica*. It is a light-demanding, rupicolous and calcareous species that prefers semi-natural or relic vegetation on cliffs or their close surroundings, but rarely grows in open *Picea abies* plantations or man-made clearings. It was mostly recorded on south-facing and west-facing slopes, exceptionally also on slopes with a northern aspect. It occurs in vegetation consisting of tall xeric shrubs (*Berberidion*), *Sesleria* grasslands (*Diantholium albicantis*), ravine forests (*Tilio-Acerion*) and gaps in limestone beech forests and their fringes (*Cephalanthero-Fagenion*).

**Distribution and population size:** This species occurs in the Suchý žleb gorge by the village of Lažánky (distr. Blansko) on the Moravian Karst (quadrant 6666a; sensu Ehrendorfer & Hamann 1965). Most of the 30 known individuals of different ages occur mainly on south-facing slopes opposite the Čertův most natural bridge and are very rare on north-facing slopes (Fig. 12). The altitudinal range of this species spans from 380 to 450 m a.s.l. The phytogeographical and climatic data for the distribution of this species are the same as for *S. moravica*.

**Herbarium specimens**

*Czech Republic, southern Moravia, 70. Moravský kras, 6666a:* Lažánky village, N-facing slopes in Suchý žleb gorge, open *Picea abies* plantation, rare, tree ca 8 m high, 49°21′42.1″N, 16°43′14.2″E, 400 m a.s.l. (leg. ML 12. 5. 2012, CB 82959). – Lažánky village, N-facing slopes in Suchý žleb gorge, wooded rocky steep slopes, rare, 49°21′38.3″N, 16°43′09.6″E, 410 m a.s.l. (leg. ML 12. 5. 2012, CB 82956). – Lažánky village, N-facing slopes in Suchý žleb gorge, rocky slopes, rare, 49°21′33.7″N, 16°42′44.2″E, 440 m a.s.l. (leg. ML 12. 5. 2012, CB 82955). – Lažánky village, Suchý žleb gorge, N edge of gorge, cliff in clearing, tree ca 2 m high, 49°21′37.0″N, 16°43′03.8″E, 430 m a.s.l. (leg. ML et PL 26. 7. 2012, CB 82929). – Lažánky village, Suchý žleb gorge, S slopes, on cliff, scattered, tree ca 8 m high, 49°21′45.7″N, 16°43′05.9″E, 440 m a.s.l. (leg. ML 22. 7. 2011, CB 79869). – Lažánky village, Suchý žleb gorge, S slopes, shrub-steppe, 49°21′42.8″N, 16°42′52.4″E, 425 m a.s.l. (leg. ML et PL 26. 7. 2012, CB 82931). – Lažánky village, Suchý žleb gorge, S slopes, edge of forest and shrub, tree ca 4 m high, 49°21′43.5″N, 16°42′52.6″E, 425 m a.s.l. (leg. ML et PL 26. 7. 2012, CB 82930). – Lažánky village, Suchý žleb gorge, S slopes, forest-steppe, tree ca 6 m high, 49°21′43.6″N, 16°42′51.5″E, 460 m a.s.l. (leg. ML 22. 7. 2011, CB 79870). – Lažánky village, Suchý žleb gorge, S slopes, cliff, shrub ca 5 m high, 49°21′39.5″N, 16°42′36.3″E, 390 m a.s.l. (leg. ML et PL 27. 8. 2011, CB 79879). – Lažánky village, Suchý žleb gorge, S slopes, in beech forest, tree ca 3 m high, 49°21′41.2″N, 16°42′42.6″E, 420 m a.s.l. (leg. ML et PL 27. 8. 2011, CB 79887). – Lažánky village, Suchý žleb gorge, S slopes, thermophilous
shrubs, tree ca 5.5 m high, 49°21'41.1''N, 16°42'44.4''E, 440 m a.s.l. (leg. ML et PL 27. 8. 2011, CB 79888). – Lažánky village, Suchý žleb gorge, S slopes, on rock ridge, tree ca 6 m high, 49°21'43.3''N, 16°42'50.9''E, 470 m a.s.l. (leg. ML et PL 27. 8. 2011, CB 79892). – Lažánky village, Suchý žleb gorge, S slopes, edge of ravine forest, scattered, tree ca 5.5 m high, 49°21'43.6''N, 16°42'50.8''E, 470 m a.s.l. (leg. ML et PL 27. 8. 2011, CB 79893). – Lažánky village, Suchý žleb gorge, S slopes, edge of rocky forest-steppe, scattered, tree ca 7 m high, 49°21'43.8''N, 16°42'51.3''E, 470 m a.s.l. (leg. ML et PL 27. 8. 2011, CB 79895). – Lažánky village, Suchý žleb gorge, S slopes, gap in limestone beech forest, tree ca 5 m high, 49°21'43.5''N, 16°42'51.3''E, 470 m a.s.l. (leg. ML et PL 27. 8. 2011, CB 79896). – Lažánky village, Suchý žleb gorge, S slopes, rocky forest-steppe, scattered, shrub ca 8 m high, 49°21'42.9''N, 16°42'52.8''E, 450 m a.s.l. (leg. ML et PL 26. 7. 2012, CB 82918).

Tetraploid species

According to our investigation, the most common ploidy level in the subg. *Aria* in the Czech Republic is tetraploid (Fig. 1). They occur in two separate regions. The first and larger area is situated in central and north-western Bohemia, and the second in southern Moravia. Tetraploids are usually confined to climatically warm regions and inhabit relic habitats such as cliffs and rocky slopes with steppe vegetation. Their local abundance closely depends on the presence and range of these habitats. Tetraploids seem to have played a crucial role in speciation of the Czech *Sorbus* by hybridising with diploid members of other subgenera giving rise to apomictic microspecies. Up until now, there are 13 hybridogenous microspecies in the Czech Republic (Danihelka et al. 2012, Lepší et al. 2013a), and each of them probably have genes of a tetraploid of the subg. *Aria* (e.g. Challice & Kovanda 1978, 1986).

Based on the results of our field investigation and morphological analyses, we distinguished three taxa among Czech tetraploids – two widespread species, *S. danubialis* and *S. collina*, and one stenoendemic, *S. thayensis*. The latter two species are for the first time described below as new taxa. *Sorbus danubialis* is a traditionally recognized and widely accepted species in central Europe (Kovanda 1992, Májovský 1992, Kutzelnigg 1995, Meyer et al. 2005, Fisher 2008, Király 2009, Kurtto 2009, Jäger 2011). To verify the classification of Czech plants treated as *S. danubialis*, we analysed the ploidy levels and morphology of four individuals from the type locality (Sas-hegy hill, Budapest, Hungary; Kováts 1998). All of them turned out to be tetraploid, and morphologically similar to Czech plants in PCA (data not shown).

In the Czech Republic, *S. danubialis* is reported from Bohemia and Moravia (Kovanda 1992, 2002), and our findings are mostly in accordance with this general knowledge. However, there are some erroneous records, which deserve closer attention because they were accepted in national compendia such as determination keys or the Red List of the Flora of the Czech Republic (Holub & Procházká 2000, Kovanda 2002). All records of *S. graeca* in the Czech Republic (Podyji National Park and Moravian Karst) cited by Kovanda (1997a, 2002) apply in reality to untypical, round-leaved individuals of *S. danubialis*, and in a similar way, records of *S. austriaca* from the Moravian Karst (Kovanda 1997b) are partly based on misidentification of shaded individuals of *S. danubialis*. Other errors concern the ploidy level of the species. *Sorbus danubialis* is reported to be a diploid based on an analysis of plants from Hradišť hill in the Lounsko-Labské středohoří phytogeographical district (Jankun & Kovanda 1987, Kovanda 1992).
This region is located in Bohemia, where we did not find any diploid members of the subg. Aria (except several escaped plants of S. aria). We therefore conclude that S. danubialis is tetraploid and that Jankun’s and Kovanda’s records are incorrect. An erroneous ploidy level is reported by the same authors also for S. eximia (Vít et al. 2012).

Sorbus danubialis exhibits a certain level of morphological variation within the Czech Republic. Plants from the Moravian Karst and Bohemian Karst have more rounded leaf laminae compared to most plants from other regions. Individuals from the Dolní Povlatvá region and the České středohoří Mts are described as var. apiculata due to markedly rhombic leaves (Kovanda 1961), and some individuals from the České středohoří Mts are remarkable in having deeply serrate to shallowly lobed laminae, yet they occur sympatrically with the dominant typical morphotype. This variability can be explained either as a reaction of the species to diverse ecological conditions or a result of genetic variation caused by facultative sexuality or mutation. However, we have not observed any significant variability which would demand taxonomic classification, so we conclude that it is not essential to delimit infraspecific taxa within S. danubialis in the Czech Republic. In addition to the Czech Republic, we studied S. danubialis also in Bavaria, Lower Austria and Hungary (see Fig. 1 and Appendix 1).

Several different names were used for the second widespread tetraploid S. collina in the past. In the Czech Republic, this species was believed to be diploid S. aria, as is apparent not only from herbarium specimens, but also from descriptions of its distribution (Klika 1937, Kovanda 1961, 1992, 2002) and a drawing in the Flora of the Czech Republic (Kovanda 1992).

In Bavaria, this taxon was at first called S. graeca (Bornmüller 1918). Later, Bresinsky (1978) introduced the name S. pannonica following Düll’s evaluation of this taxon as a transitus and translating Düll’s name “S. aria ssp. (aria-cretica)” into Karpati’s nomenclatural system (Kárpáti 1960). This approach was finally adopted by recent authors (Meyer et al. 2005, Feulner et al. 2013). In fact, S. pannonica is the name for the transitional species between tetraploid S. graeca and diploid S. aria (Kárpáti 1960). We have analysed two populations of S. pannonica from Hungary and shown them to be triploid (Table 2, and Appendix 1), which supports the initially suggested origin (Kárpáti 1960). In Austria and Hungary, S. collina along with other similar taxa are classified as S. graeca (Király 2009, Jäger 2011).

Sorbus graeca is a widespread species distributed in central and southern Europe, Northern Africa and Asia Minor. It is a very variable complex of mutually similar tetraploid and also diploid taxa (cf. Gabrielian 1961, Kutzelnigg 1995, Kurtto 2009, Gabrielian & Balayan 2013). Central-European plants are all tetraploid and morphologically fit within the broadly delimited S. graeca. On the other hand, they are more or less morphologically uniform and well separated from S. graeca s. str., including several taxa that are regarded as taxonomic synonyms (for details, see Table 5). Based on our thorough comparative study of type material, protologues and other relevant sources on these related taxa, we conclude that the central-European populations represent a unique and well defined apomictic taxon, which deserves delimitation at the species level. To this end the new species Sorbus collina is described below. The species Sorbus danubialis was separated from the aggregate of S. graeca in a similar way (Kovanda 1992). Intraspecific variation within S. collina is insignificant in the Czech Republic, Bavaria and the regions of Austria sampled. Hungarian plants differ slightly from this main
Sorbus collina occurs very often with S. danubialis at the same localities, but no transitional plants were observed. This species occasionally hybridizes with S. aria, generating transitional morphotypes between the two species (Hungary, Bavaria).

For the sake of completeness, it should be pointed out that S. graeca is also reported from the Czech Republic. These records, however, do not relate to S. collina. The first reports of the occurrence of S. graeca in the Czech Republic were published by Kovanda (1997a). He reported the species from two regions in southern Moravia (the Moravian Karst and Podyji National Park) and soon these records were included in national compendia (Holub & Procházka 2000, Kovanda 2002). We revised all the herbarium specimens that this author collected (deposited in PRA) and subsequently carried out a detailed field survey of all reported localities, which indicate he mistakenly assigned some untypical individuals of S. danubialis to S. graeca. Incorrect information on the distribution of

<table>
<thead>
<tr>
<th>Species</th>
<th>Principal differences between taxa and S. collina</th>
<th>Characters of S. collina</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>S. graeca var. cuneifolia Zinserl.</td>
<td>fruit red with few lenticels located only at the base, petioles 3–15 mm long</td>
<td>fruit dark red with scattered and evenly distributed lenticels, petioles (13–) 16–20 (–22) mm long</td>
<td>protologue, Zinserling 1939, Gabrielian 1961</td>
</tr>
<tr>
<td>S. cretica (Lindley) Fritsch et Rech.</td>
<td>leaf lamina 4.2–6.2 cm long, coarsely serrate</td>
<td>leaf lamina (8.4–) 9.0–9.9 cm long, serrate to finaly serrate</td>
<td>lectotype in CGE, No. 06506</td>
</tr>
<tr>
<td>S. cyclophylla Gand.</td>
<td>leaf lamina 2–3 cm wide</td>
<td>leaf lamina (5.7–) 7.0–7.5 cm wide</td>
<td>protologue, Gandoger 1875</td>
</tr>
<tr>
<td>S. graco (Loddiges ex Spach) Loddiges ex Schauer</td>
<td>leaf lamina 5.0–6.6 cm long, elliptical subrhomboidal</td>
<td>leaf lamina 8.3–9.0 (–9.8) cm wide</td>
<td>lectotype in P, No. P00680357</td>
</tr>
<tr>
<td>S. greac var. orbiculata Gabr.</td>
<td>fruit red, petioles 3–15 mm long, leaf lamina base rounded to broadly cuneate, 2n = 34</td>
<td>leaf lamina 16–20 (–22) mm long, leaf lamina base cuneate to broadly cuneate, 2n = 68</td>
<td>protologue, Zinserling 1939, Gabrielian 1961, Gabrielian &amp; Balayan 2013</td>
</tr>
<tr>
<td>S. meridionalis Guss.</td>
<td>petioles 10–13 mm long, leaf lamina base narrowly cuneate</td>
<td>petioles 13–16–20 (–22) mm long, leaf lamina base cuneate to broadly cuneate, 2n = 68</td>
<td>comparison chart, Castellano et al. 2012</td>
</tr>
<tr>
<td>S. migarica Zinserl.</td>
<td>leaf lamina 4–5 cm long</td>
<td>leaf lamina (8.4–) 9.0–9.9 cm long</td>
<td>protologue, Zinserling 1939</td>
</tr>
<tr>
<td>S. obtusidentata Zinserl.</td>
<td>leaf lamina obovate, teeth more or less obtuse to crenate</td>
<td>leaf lamina 8.3–9.0 (–12.5) cm long, broadly elliptical to almost rotund, teeth acute</td>
<td>protologue, Zinserling 1939</td>
</tr>
<tr>
<td>S. schemachensis Zinserl.</td>
<td>leaf lamina with 7–9 pairs of veins</td>
<td>leaf lamina with 9–10 pairs of veins</td>
<td>protologue, Zinserling 1939</td>
</tr>
<tr>
<td>S. stankovii Juz.</td>
<td>leaf lamina lobate and crispate at margins</td>
<td>leaf lamina regularly simply or double (to triple) serrate, flat at margins</td>
<td>protologue, Juzepczuk 1950</td>
</tr>
</tbody>
</table>
S. graeca in the Czech Republic is presented also in the Flora of Central Europe (Flora von Mitteleuropa; Kutzelnigg 1995). It is obvious that this author did not distinguish S. danubialis correctly and reports S. graeca from localities where we were later able to confirm only S. danubialis occurs (e.g. all localities in Moravia).

The third tetraploid detected, S. thayensis, is an endemic species in the Podyji National Park and is described below.

Sorbus danubialis (Jávorka) Kárpatí, Borbásia Nova 25: 23, 1944. (Fig. 15)

≡ S. cretica subsp. danubialis (Jávorka) Javorka, Magyar flóra, 481, 1924.
≡ S. cretica var. danubialis (Jávorka) Soó, Tisza 2: 223, 1937.

Neotype: Budapest: in monte Sashegy. 5. 5. 1911 herbarium S. Jávorka; BP, No 562679 (Kováts 1998).


Description: Shrub or small tree up to 10 m high. Bark grey, smooth when young, with fissures (particularly at the trunk base) when mature. Twigs thick, brownish-grey; young shoots brown, tomentose when young, glabrescent when mature, with pale brown to ochraceous lenticels. Buds ovoid, pointed; scales green, glabrescent, with narrow brown sparsely tomentose margins. Leaves on short sterile shoots simple; laminas almost rotund less often broadly elliptical or rounded rhombic, (6.5–) 7.4–8.6 (–10.8) cm long and (5.2–) 5.8–6.6 (–7.9) cm wide, (1.1–) 1.2–1.3 (–1.5) times as long as wide, widest at (45–) 50–56 (–62)% of the lamina length (from the base), with broadly acute to obtuse apex with an angle of (95–) 110–130 (–145)°, broadly cuneate and partly serrate at base, with angle at base of (75–) 90–105 (–120)°, usually undulate at margins, coarsely and often deeply serrate or double (to triple) serrate (rarely shallowly lobed), with more or less acute teeth terminating the main veins (other teeth smaller), with (4–) 6–8 (–12) teeth between the 2nd and 3rd main veins from the base, with angle of the teeth terminating the 3rd main veins (55–) 65–80 (–95)°, with incision between the 2nd and the 3rd main vein from the base (1.7–) 2.7–3.4 (–4.5) mm, leathery, more or less glossy, dark green, sparsely tomentose when young, later glabrescent on upper surface, evenly greenish-grey-tomentose on lower surface, with (8–) 9–10 (–11) veins on each side, with the 3rd vein at an angle of (30–) 35–45 (–50)° to midrib; petioles (11–) 13–16 (–21) mm long, tomentose. Leaf laminas on short fertile shoots rounded rhombic, less often broadly elliptical to almost rotund, more distinctively undulate and more deeply serrate at margin. Inflorescences compact, convex, with tomentose branchlets. Sepals triangular, acute or acuminate, tomentose on both surfaces, patent at flowering, erect, persistent and dry at fruiting. Petals (7.0–) 7.5–8.2 (–8.8) mm long and (4.5–) 5.3–6.0 (–6.5) mm wide, broadly elliptical to almost rotund, concave, white, patent, sparsely tomentose at base of upper surface, glabrous on lower surface, with a short claw. Stamens ca 20; anthers pale
yellow or pale rose. Ovary semi-inferior. Styles 2, free or connate and tomentose at base. Fruit subglobose, (10.5–) 11.0–12.5 (–13.0) mm long and (12.0–) 12.5–14.0 (–15.0) mm wide, always wider than long, dark red at maturity, tomentose at top and base, otherwise glabrescent, matt, with (1–) 3–5 (–9) lenticels per 25 mm²; mesocarp heterogeneous; endocarp cartilaginous. Seeds fuscous. DNA ploidy level: tetraploid (inferred using FCM). Reproduction probably mostly apomictic. Flowering V.

Diagnostic characters: leaf lamina on short sterile shoots almost rotund, less often broadly elliptical or rounded rhombic, relatively small, with broadly acute to obtuse apex, undulate and coarsely and often deeply serrate or double (to triple) serrate (rarely shallowly lobed) at margins, with only (4–) 6–8 (–12) teeth between the 2nd and 3rd main veins from the base; leaf lamina on fertile short shoots often rounded rhombic with acute apex; fruit always wider than long, dark red when ripe.

Sorbus collina M. Lepší, P. Lepší et N. Meyer, spec. nova (Figs 16–17)

Description: Shrub or small tree up to 18 m high. Bark grey to dark grey, smooth when young, with fissures (particularly at the trunk base) when mature. Twigs thick, brownish-grey; young shoots brown, tomentose when young, glabrescent when mature, with pale brown to ochraceous lenticels. Buds ovoid, pointed; scales green, glabrescent, with narrow brown sparsely tomentose margins. Leaves on short sterile shoots simple; laminas broadly elliptical to almost rotund, (8.4–) 9.0–9.9 (–12.5) cm long and (5.7–) 7.0–7.5 (–9.8) cm wide, (1.2–) 1.3–1.4 (–1.5) times as long as wide, widest at (49–) 52–58 (–64)% of the lamina length (from the base), with obtuse, rounded or truncate apex with an angle of (130–) 140–160 (–170)°, cuneate to broadly cuneate and partly serrate at base, with angle at base of (85–) 90–105 (–120)°, flat at margins, regularly simply or double (to triple) serrate, with acute teeth terminating the main veins (other teeth smaller),
Fig. 16. – Holotype of *Sorbus collina*.
with (5–) 8–9 (–10) teeth between the 2nd and 3rd main veins from the base, with angle of the teeth terminating the 3rd main veins (60–) 65–85 (–100)°, with incision between the 2nd and the 3rd main vein from the base (1.3–) 1.8–2.8 (–3.7) mm, leathery, more or less glossy, dark green, sparsely tomentose when young, later glabrescent on upper surface, evenly greenish-grey-tomentose on lower surface, with 9–10 veins on each side, with the 3rd veins at an angle of 30–40 (–45)° to the midrib; petioles (13–) 16–20 (–22) mm long, tomentose. Leaf laminae on short fertile shoots almost rotund with acute to rounded acute apex. Inflorescences compact, convex, with tomentose branchlets. Sepals triangular, acute or acuminate, tomentose on both surfaces, patent at flowering, erect, persistent and dry at fruiting. Petals (6.0–) 6.5–7.5 (–8.0) mm long and (4.0–) 4.5–5.0 (–5.5) mm wide, broadly elliptical, concave, white, patent, sparsely tomentose at base of upper surface, glabrous on lower surface, with a short claw. Stamens ca 20; anthers pale yellow, pale rose or rose. Ovary semi-inferior. Styles 2, free or connate and tomentose at base. Fruit subglobose, (10–) 11–12 (–13) mm long and (10.5–) 12.5–13.5 (–14.5) mm wide, always wider than long, dark red when ripe, cobwebby tomentose at top and base, otherwise usually glabrescent, matt or glossy, with (3–) 5–11 (–15) lenticels per 25 mm²; mesocarp heterogeneous; endocarp cartilaginous. Seeds fuscous. DNA ploidy level: tetraploid (inferred using FCM). Reproduction probably mostly apomictic. Flowering V.

Holotype: Central Bohemia, Nažovické Podhájí (distr. Příbram), ca 130 m NNE of summit of Na Vyhlídce hill, edge of woodland; 39°43'30.9"N, 14°22'13.2"E; scattered; tree ca 7 m high; 7. 8. 2013 leg. Martin Lepší, Petr Lepší; CB, No. 83296 (Fig. 16). – Isotypes: BP, 83296/f; LI, 83296/e; M, 83296/g; PR, 83296/a; PRA, 83296/b; PRC, 83296/c; W, 83296/d.

Lepší et al.: Taxonomic revision of Sorbus subgenus Aria

Fig. 17. – Sorbus collina: short fructiferous shoot (left) and leaf from the middle part of a short sterile shoot (right). Scale bar 2 cm. Drawn by A. Skoumalová.

**Diagnostic characters:** Leaf lamina on short sterile shoots relatively large, broadly elliptical to almost rotund, resembling a tennis racket, with obtuse, rounded or truncate apex, uniserrate to biserrate (to triserrate), with flat margins; fruit wider than long, dark red.

**Etymology:** The Latin name refers to the dominant shape of the relief within the distribution area of the species. We propose the epithet “chlumní” for the Czech name.

**Ecology:** *Sorbus collina* prefers open or semi-open habitats such as cliffs, screes, steppes, rocky slopes, woodland and shrubby fringes, open woodlands and their gaps or clearings. It is recorded in a wide range of different types of vegetation in open mesophilous to thermophilous broadleaved and coniferous forests and shrubs, including contact or transitional vegetation in non-forest communities. It favours natural (often relic) or semi-natural habitats, but also grows in pine and spruce plantations. This species occurs on both acidic and base-rich bedrocks. The centre of its occurrence lies in hilly lands at medium altitudes, but exceptionally reaches the submontane vegetation belt. The altitudinal range of this species spans from 220 (river Kamp, Lower Austria) to 800 m a.s.l. (Milešovka mountain, northwestern Bohemia).

**Distribution and population size:** *Sorbus collina* is recorded in large areas of central, north-eastern, eastern, south-eastern Bavaria, central, western and north-western Bohemia, in the valleys of the rivers Kamp in Lower Austria and Salzach in Upper Austria, and in the north-western part of Hungary (Central Transdanubia; for individuals sampled, see Fig. 1 and Appendix 1). This species is also rarely cultivated for ornamental purposes in the Czech Republic (e.g. in Domažlice, Strakonice, Rojšín near Křemže, Třebíč, Kuřim). A comprehensive description of this species’ distribution in the Czech Republic, including a distribution map and list of herbarium specimens revised, will be published in a separate paper (Lepší et al. in prep.).

*Sorbus thayensis* M. Lepší et P. Lepší, **spec. nova** (Figs 18–19)

**Description:** Shrub or rarely a small tree up to 6 (–10) m high. Bark grey or dark grey, smooth when young, with fissures (particularly at the trunk base) when mature. Twigs thick, brownish-grey; young shoots brown, tomentose when young, glabrescent when mature, with pale brown to ochraceous lenticels. buds ovoid, pointed; scales green, glabrescent, with narrow brown sparsely tomentose margins. Leaves on short sterile shoots simple; laminae more or less broadly elliptical to almost rotund, (9.0–) 10.0–11.6 (–12.8) cm long and (6.3–) 7.1–8.3 (–9.5) cm wide, (1.2–) 1.3–1.5 times as long as wide, widest at (46–) 51–55 (–62)% of the lamina length (from the base), with broadly acute to obtuse apex with an angle of (100–) 110–125 (–140)°, cuneate to broadly cuneate and partly serrate at base, with angle at base (70–) 80–100 (–115)°, flat at margins, regularly, finely, sharply, double to triple serrate, with more or less acute teeth terminating the main veins (other teeth acute and somewhat smaller), with (6–) 8–11 (–15) teeth between the 2nd and 3rd main veins from the base, with angle of the teeth terminating the 3rd main
Fig. 18. – Holotype of *Sorbus thayensis*.
veins (30–) 45–65 (–75)°, with incision between the 2nd and the 3rd main vein from the base (2.2–) 3.0–4.4 (–6.5) mm long, leathery, more or less glossy, dark green, sparsely tomentose when young, later glabrescent on upper surface, evenly greenish-grey-tomentose on lower surface, with (8–) 9–10 (–11) veins on each side, with the 3rd vein at an angle of (25–) 30–35 (–40)° to the midrib; petioles (9–) 12–14 (–19) mm long, tomentose. Leaf lamina on short fertile shoots relatively broader, almost rotund, with broadly acute apex, undulate margins apically. Inflorescences compact, convex, with tomentose branchlets. Sepals triangular, acuminate to acute, tomentose on both surfaces, patent at flowering, erect, persistent and dry at fruiting. Petals broadly elliptical rarely almost rotund, (7.0–) 7.5–8.0 (–9.0) mm long and (5.0–) 5.5–6.0 (–6.5) mm wide, concave, white, patent, sparsely tomentose at base of upper surface, glabrous on lower surface, with a short claw. Stamens ca 20; anthers pale yellow. Ovary semi-inferior. Styles 2, free or connate and tomentose at base. Fruit ellipsoid to almost subglobose, (13.0–) 13.5–14.5 (–15.0) mm long and (11.0–) 12.5–14.0 (–14.5) mm wide, never wider than long, dark red when ripe, tomentose at top and base, otherwise glabrescent, matt, with (1–) 4–6 (–10) lenticels per 25 mm²; mesocarp heterogeneous; endocarp cartilaginous. Seeds fuscous. DNA ploidy level: tetraploid (inferred using FCM). Reproduction probably apomictic. Flowering V.

Holotype: southern Moravia, Čížov (distr. Znojmo), Hardeggská vyhlídka outlook, ca 630 m NNW of bridge over Dyje river, acid cliff; 350 m a.s.L, 48°51’28.69”N, 15°51’31.25”E; rare; shrub ca 4 m high; 15.6.2011 leg. Martin Lepší, Petr Lepší; CB, No. 83094 (Fig. 18). Isotypes: PR, 83094/a; PRA, 83094/b.

Fig. 19. – *Sorbus thayensis*: short fructiferous shoot (left) and leaf from the middle part of a short sterile shoot (right). Scale bar 2 cm. Drawn by A. Skoumalová.
Diagnostic characters: Leaf lamina on short sterile shoots broadly elliptical to almost rotund, relatively large, regularly finely, sharply, double (to triple) serrate. Flowers relatively large. Fruit large, ellipsoid to almost subglobose, never wider than long, dark red, only with (1–)4–6(–10) lenticels per 25 mm².

Etymology: The name “thayensis” refers to the Czech-Austrian border river whose German name is Thaya and Czech name is Dyje. This species is confined to the valley of this river. We propose the epithet “podyjský” for the Czech name.

Ecology: This species frequently occurs in open habitats such as fringes and steppes with cliffs; less often it grows in open thermophilous forests and on screes. It is mainly recorded in vegetation of low xeric shrubs on cliffs (Prunion spinosae), forest-steppe (mixture of Quercion pubescenti-petraeae, Geranion sanguine, Festucion valesiacae) and open oak-hornbeam forests (Carpinion). Occasionally it occurs in ravine forest communities (Tilio-Acerion), acidophilous oak forests (Genistro germanicae-Quercion) and on open screes (Asplenion septentrionalis). Sorbus thayensis is tolerant of a range of soils as it grows in both acidic (gneisses) and base-rich (limestone) soils. It is recorded on slopes of all aspects.

Distribution and population size: Sorbus thayensis appears to be confined to the valley of the river Dyje (= Thaya) in the surroundings of Hardegg (quadrant 7161a of the central-European grid mapping; Ehrendorfer & Hamann 1965). A total of 33 individuals of various ages were mapped at seven localities. Two of these localities are located in the Czech Republic and five in Austria. The northernmost locality by the Heimatkreuz outlook and the southernmost by the place called Einsiedler are 3.2 km apart, and both are in Austria (Fig. 9). The main population, consisting of about 20 individuals, is on Maxplateau hill (Austria). A smaller population of about 10 individuals occurs by the Hardeggská vyhlídka outlook (Czech Republic). At the remaining localities, one or two individuals are found. The phytogeographical and climatic data for the distribution of this species are the same as for S. cucullifera. The altitudinal range of this species spans from 310 (Einsiedler, Austria) to 440 m a.s.l. (Heimatkreuz, Austria).

Herbarium specimens

Czech Republic, southern Moravia, 68. Moravské podhůří Vysočiny, 7161a: 1. Hardeggská vyhlídka outlook: Čížov village, Hardeggská vyhlídka outlook, ca 450 m NNW of bridge over Dyje river, open scree, rare, shrub ca 2.5 m high, 48°51'25.0"N, 15°51'41.2"E, 390 m a.s.l. (leg. ML et PL 7. 5. 2011, CB 79681). – Čížov village, Hardeggská vyhlídka outlook, ca 450 m NNW of bridge over Dyje river, edge of scree, scattered, shrub ca 2.5 m high, 48°51'24.6"N, 15°51'39.2"E, 380 m a.s.l. (leg. ML et PL 7. 5. 2011, CB 79685). – Čížov village, Hardeggská vyhlídka outlook, ca 450 m NNW of bridge over Dyje river, oak-hornbeam forest, scattered, tree ca 1.5 m high, 48°51'23.7"N, 15°51'35.9"E, 320 m a.s.l. (leg. ML et PL 7. 5. 2011, CB 79686). – Čížov village, Hardeggská vyhlídka outlook, ca 460 m NNW of bridge over Dyje river, open scree, shrub ca 6 m high, 48°51'24.9"N, 15°51'41.2"E, 390 m a.s.l. (leg. ML et PL 7. 5. 2011, CB 79679, 12. 6. 2011, CB 79726). – Čížov village, Hardeggská vyhlídka outlook, ca 460 m NNW of bridge over Dyje river, oak-hornbeam forest, scattered, tree ca 1 m high, 48°51'25.1"N, 15°51'40.9"E, 400 m a.s.l. (leg. ML et PL 7. 5. 2011, CB 79682). – Čížov village, Hardeggská vyhlídka outlook, ca 470 m NNW of bridge over Dyje river, rocky oak forest, scattered, tree ca 3.5 m high, 48°51'25.3"N, 15°51'40.2"E, 390 m a.s.l. (leg. ML et PL 7. 5. 2011, CB 79684). – Čížov village, Hardeggská vyhlídka outlook, ca 630 m NNW of bridge over Dyje river, acidic rock, scattered, shrub ca 4 m high, 48°51'28.7"N, 15°51'31.3"E, 350 m a.s.l. (leg. ML et PL 7. 5. 2011, CB 79676). – Čížov village, Hardeggská vyhlídka outlook, ca 660 m NNW of bridge over Dyje river, oak-hornbeam forest, sapling ca 1.5 m high, 48°51'29.8"N, 15°51'30.7"E, 360 m a.s.l. (leg. ML et PL 7. 5. 2011, CB 79688). – Čížov village, Hardeggská vyhlídka outlook, ca 680 m NNW of bridge over Dyje river, oak forest, scattered, sapling ca 0.75 m high, 48°51'29.9"N, 15°51'28.6"E, 350 m a.s.l. (leg. ML et PL 7. 5. 2011, CB 79691). – Čížov village, slopes...
with cliffs and screes below Hardeggská vyhlídka outlook, ca 0.5 km SE of the centre of Hardeg, 48°51’24.9’’N, 15°51’17.9’’E, 390 m a.s.l. (leg. ML et PL 6. 8. 2009, CB 73679). – Podyj region, cliff close to Hardeggská vyhlídka outlook, ca 60 m SE of gazebo, 48°51’25.1’’N, 15°51’14.8’’E (leg. J. Brabec 29. 5. 2012, CHEB).

2. Hardeggská stráň hillside: Čížov village, Hardeggská stráň hillside, ca 420 m ENE of bridge over Dyje river, forest-steppe, a shrub ca 6 m high, 48°51’16.8’’N, 15°52’02.5’’E, 340 m a.s.l. (leg. ML et PL 11. 6. 2011, CB 79723).

Austria, Lower Austria, 7161a: 3. Heimatkreuz: Hardeg, Dyje valley by Heimatkreuz outlook, ca 2.7 km NNW [NW] of bridge over Dyje river, rocky oak forest, shrub ca 2 m high, 48°52’24.3’’N, 15°56’30.3’’E, 440 [400] m a.s.l. (leg. ML et PL 15. 6. 2011, CB 79606). 4. Below Hardegger Rundweg path: Hardeg, Maxplateau hill, ca 990 m WNW of bridge over Dyje river, acidophilous oak forest, tree ca 5 m high, 48°51’19.7’’N, 15°55’58.1’’E, 400 m a.s.l. (leg. ML et PL 12. 6. 2011, CB 79732).

5. Maxplateau hill: Hardeg, SE slopes of Maxplateau hill at W edge of town, edge of woody and rocky steppe, shrub ca 2.5 m high, rare, 48°51’20.3’’N, 15°51’21.9’’E, 360 m a.s.l. (leg. ML et PL 23. 7. 2010, CB 74020). – Hardeg, SE slopes of Maxplateau hill at W edge of town, rocky terraces, individual ca 5 m high, 48°51’20.0’’N, 15°51’22.2’’E, 350 m a.s.l. (leg. ML et PL 23. 7. 2010, CB 74019). – Hardeg, SE slopes of Maxplateau hill at W edge of town, on limestone cliff, shrub ca 5 m high, rare, 48°51’20.0’’N, 15°51’21.6’’E, 350 m a.s.l. (leg. ML et PL 23. 7. 2010, CB 74021). – Hardeg, SE slopes of Maxplateau hill at W edge of town, close to rocky spur with outlook, on shaded cliff, one individual ca 6 m high, 48°51’14.2’’N, 15°51’13.5’’E, 360 m a.s.l. (leg. ML et PL 23. 7. 2010, CB 74023). – Hardeg, Maxplateau hill, ca 550 m NW of bridge over Dyje river, edge of forest and rocky steppe, scattered, 48°51’20.8’’N, 15°51’22.7’’E, 360 [330] m a.s.l. (leg. ML et PL 7. 5. 2011, CB 79697). – Hardeg, Maxplateau hill, ca 550 m NW of bridge over Dyje river, edge of forest and rocky steppe, scattered, 48°51’20.8’’N, 15°51’23.0’’E, 350 m a.s.l. (leg. ML et PL 7. 5. 2011, CB 79696). – Hardeg, Maxplateau hill, ca 550 m NW of bridge over Dyje river, in Juniperus-Cotoneasteretum on rock, scattered, 48°51’20.1’’N, 15°51’22.3’’E, 350 m a.s.l. (leg. ML et PL 7. 5. 2011, CB 79638). – Hardeg, Maxplateau hill, ca 560 m NW of bridge over Dyje river, edge of forest and rocky steppe, scattered, shrub ca 3 m high, 48°51’20.4’’N, 15°51’22.0’’E, 350 m a.s.l. (leg. ML et PL 7. 5. 2011, CB 79695). – Hardeg, Maxplateau hill, ca 560 m NW of bridge over Dyje river, limestone cliff, scattered, shrub ca 4 m high, 48°51’19.9’’N, 15°51’21.4’’E, 360 [340] m a.s.l. (leg. ML et PL 7. 5. 2011, CB 79694). – Hardeg, Maxplateau hill, ca 570 m NW of bridge over Dyje river, edge of gap in oak-hornbeam forest, scattered, 48°51’21.4’’N, 15°51’22.4’’E, 360 [330] m a.s.l. (leg. ML et PL 7. 5. 2011, CB 79698–79699, CB 79817). – Hardeg, Maxplateau hill, ca 650 m NW of bridge over Dyje river, ravine forest, tree ca 15 m high, 70 cm DBH, 48°51’21.3’’N, 15°51’16.6’’E, 380 m a.s.l. (leg. ML et PL 7. 5. 2011, CB 79640). – Hardeg, Maxplateau hill, ca 650 m NW of bridge over Dyje river, ravine forest, shrub 6 m high, 48°51’22.3’’N, 15°51’15.3’’E, 370 m a.s.l. (leg. ML et PL 7. 5. 2011, CB 79641). – Hardeg, Maxplateau hill, ca 650 m NW of bridge over Dyje river, cliff, shrub ca 5 m high, 48°51’14.2’’N, 15°51’13.3’’E, 360 m a.s.l. (leg. ML et PL 14. 5. 2011, CB 79818). – Hardeg, Maxplateau hill, ca 700 m NW of bridge over Dyje river, on rock, shrub ca 4 m high, 48°51’19.9’’N, 15°51’13.0’’E, 420 [380] m a.s.l. (leg. ML et PL 7. 5. 2011, CB 79642). – Hardeg, E rocky slopes of Maxplateau hill, forest-steppe, 48°51’19.5’’N, 15°51’19.8’’E, 350 m a.s.l. (leg. ML et PL 6. 8. 2009, CB 73703–73704). 6. Reginafelsen: Hardeg, SE slopes of Maxplateau hill at W edge of town, below outlook on rocky spur, small cliff in wood, one shrub ca 3 m high, 48°51’08.7’’N, 15°51’17.7’’E, 320 m a.s.l. (leg. ML et PL 23. 7. 2010, CB 74025). – Hardeg, E rocky slopes of Maxplateau hill, forest-steppe, 48°51’08.9’’N, 15°51’17.9’’E, 320 m a.s.l. (leg. ML et PL 6. 8. 2009, CB 73705–73706).

7. Einsiedler: Hardeg, slopes above Dyje river, ca 1 km NE of bridge over Dyje river, oak forest, tree ca 8 m high, 48°51’31.8’’N, 15°52’23.7’’E, 310 m a.s.l. (leg. ML et PL 15. 5. 2011, CB 79815). – Hardeg, slopes above Dyje river, ca 1 km NE of bridge over Dyje river, edge of scree, sapling ca 1 m high, 48°51’31.0’’N, 15°52’25.4’’E, 310 m a.s.l. (leg. ML et PL 15. 5. 2011, CB 79816).

Conservation

All four stenoendemic species were found in protected areas, Sorbus cuscullifera and S. thayensis in the Podyjí and Thayatal National Parks, and S. moravica and S. pontis-satani in the Vývěry Punky National Nature Reserve, which is part of the Moravian Karst protected landscape area. Despite this, the protection of these species is insufficient because all of these protected areas are currently being left unmanaged and left to spontaneous succession. The species prefer open forests, which were previously provided by traditional management of woodlands. The shady conditions that prevail in recent woodlands...
are unfavourable for the long-term survival and regular reproduction of light-demanding Sorbus species. The general colonization of open (rocky and steppe) habitats by trees is another serious threat to these endemics. Moreover, populations of S. thayensis and S. pontis-satani are so sparse that they may be endangered even by a random event such as a rock or tree fall. The reproduction and establishment of these species should therefore be supported by restoration or simulation of traditional landscape management, at least at selected localities. All four species should be included among the critically endangered plants of the Czech flora (C1; sensu Grulich 2012) and critically endangered species (Table 6) according to the IUCN (2001). Sorbus cucullifera and S. thayensis should be added to the Red List of Austrian Flora among the most endangered species (Category 1 sensu Niklfeld & Schratt-Ehrendorfer 1999). The widely distributed S. collina meets the criteria for vulnerable species according to the IUCN (2001), and the same level of endangerment is applicable in the Czech Republic (C3; sensu Grulich 2012) and Germany (3; sensu Korneck et al. 1996). The level of threat faced by these species in other regions is unknown, due to the lack of distribution data.

Table 6. – Threatened categories assigned to the newly delimited taxa of Sorbus subg. Aria according to the IUCN (2001) and their degree of endangerment in the Czech Republic according to Grulich (2012).

<table>
<thead>
<tr>
<th>Taxon</th>
<th>IUCN 2001</th>
<th>Grulich 2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>S. collina</td>
<td>VU A4abce; C2a (i)</td>
<td>C3</td>
</tr>
<tr>
<td>S. cucullifera</td>
<td>CR B1b (i,iii)</td>
<td>C1b</td>
</tr>
<tr>
<td>S. moravica</td>
<td>CR B2ab (i,iii,iV); C2a (ii)</td>
<td>C1r</td>
</tr>
<tr>
<td>S. pontis-satani</td>
<td>CR B2b (i,iii,iV); D</td>
<td>C1r</td>
</tr>
<tr>
<td>S. thayensis</td>
<td>CR B2b (i,iii,iV); D</td>
<td>C1r</td>
</tr>
</tbody>
</table>

Key for identification of the species of Sorbus subg. Aria occurring in the Czech Republic.

For safe identification, it is essential to use mean values of 3–5 measurements of the same character from the same individuals. Leaves have to be from middle part of short sterile shoots unless stated otherwise.

1a Leaf lamina more or less thin, relatively large, (9.6–) 11.5–12.7 (–15.6) cm long, veins on each side (8–) 11–12 (–13) ................................................................. S. aria

1b Leaf lamina more or less stiff, smaller, (5.8–) 6.5–11.6 (–12.8) cm long, veins on each side (7–) 8–10 (–11) ................................................................. 2

2a Leaf lamina (3.8–) 4.4–5.6 (–6.2) cm wide, elliptical to broadly elliptical, oblong elliptical, ovate, obovate; fruit red, sometimes dark red ................................................................. 3

2b Leaf lamina (5.2–) 5.8–8.3 (–9.8) cm wide, broadly elliptical to almost rotund; fruit always dark red .......... 7

3a Leaf lamina undulate and coarsely and often deeply serrated or double (to triple) serrated (rarely shallowly lobed) at margins; leaf laminae from fertile short shoots often rounded rhombic with acute apex

3b Leaf lamina flat and finely or shallowly serrated at margins, if undulate then finely serrated; leaf laminae from fertile short shoots of different shape ................................................................. 4

4a Fruit with (2–) 7–18 (–24) lenticels per 25 mm², Moravský kras Karst only ........................................ 4

4b Fruit with (1–) 3–6 (–10) lenticels per 25 mm², Podyjí National Park only ........................................ 6

5a Leaf lamina broadly elliptical, regularly finely double (to triple) serrated, angle of tooth in which the 3rd lateral vein terminates (35–) 45–55 (–65)°, usually undulate to crispate at margins apically, with (6–) 8–10 (–11) teeth between the 2nd and 3rd main veins from the laminar base, incision between the 2nd and 3rd lateral vein from the laminar base (2.1–) 2.7–3.5 (–5.0) mm long ................................ S. pontis-satani
Acknowledgements

We are grateful to N. Meyer and J. Závorka for their valuable comments on earlier drafts of this manuscript. We thank M. Hohla, G. Mészáros and N. Meyer for helping us with the field work in Austria, Hungary and Germany, respectively, and Cs. Németh for valuable information on the distribution of Hungarian Sorbus taxa. We thank A. Hajrudinović and F. Bogunić, who provided samples from the type locality of Aria nivea. We could not have undertaken this study without the financial support of the Grant Agency of Charles University (project No. RVO67985939; PV) and the Czech Science Foundation (project No. 1584414; JB). Additional support was provided by the Academy of Science of the Czech Republic (project No. RVO67985939; PV) and the Czech Science Foundation (project No. 1584414; JB).

Souhrn

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Nově popsány endemické jeřáby z Moravy navrhujeme zařadit k jiným kriticky ohroženým taxonům *S. collina* a *S. danubialis*. Jeřáby z Podyjí a verouzápadní Čechy a jižní Moravy, v rámci studovaného území vykazují jistou morfologickou variabilitu, kde se vyskytují zástupci podrodu. Nově popsány endemické jeřáby z Moravy navrhujeme zařadit k jiným kriticky ohroženým taxonům *S. danubialis* a *S. collina* do kategorie C3 (podle Grulich 2012). Vzhledem jeřáby z podrodu *Aria* jsou v ČR ohroženy zarůstáním světlých lesů a lesostepních biotopů, které byly dříve udržovány tradičním obhospodařováním krajiny. K odlišení jednotlivých druhů na území ČR poslouží teoretická hodnocení *S. pontis-satani* (vzácně u mělce laločnatá); čepel listů fertilních brachyblastů je bronzy, zvlněná a vzdušně použitá průměrně hodnoty získané z 3–5 různých orgánů stejného jedince).

**Tabulka 1.**

| 1a | Čepel listu a tenká, velká, (9,6–) 11,5–12,7 (–15,6) cm dlouhá, žilek na každé straně (8–) 11–12 (–13) |................................. | 1 | S. aria |
| 2a | Čepel listu a tuhá, menší, (5,8–) 6,5–11,6 (–12,8) cm dlouhá, žilek na každé straně (8–) 9–10 (–11) |................................. | 2 | ................................. |
| 3a | Čepel listu široce eliptická, pravidelně jemně 2 (–3)× pilovitá, s vrcholovým zubem na konci třetí čepel listu, obzvláště v horní polovině, zprohýbaná a hrubě, často zastřihovaně 1–2 (–3)× pilovitá |................................. | 3 | ................................. |
| 4a | Lenticele na plodech v počtu (1–) 3–6 (–10) na 0,25 cm², Podyjí ................................................................ 6 |................................. | 4 | ................................. |
| 5a | Čepel listu ± tuhá, menší, (5,8–) 6,5–11,6 (–12,8) cm dlouhá, žilek na každé straně (8–) 9–10 (–11) |................................. | 5 | ................................. |
| 6a | Lenticele na plodech v počtu (1–) 3–6 (–10) na 0,25 cm², Podyjí ................................................................ 6 |................................. | 6 | ................................. |
| 7a | Čepel listu ± tuhá, menší, (5,8–) 6,5–11,6 (–12,8) cm dlouhá, žilek na každé straně (8–) 9–10 (–11) |................................. | 7 | ................................. |
| 8a | Lenticele na plodech v počtu (1–) 3–6 (–10) na 0,25 cm², Podyjí ................................................................ 6 |................................. | 8 | ................................. |
| 9a | Čepel listu ± tuhá, menší, (5,8–) 6,5–11,6 (–12,8) cm dlouhá, žilek na každé straně (8–) 9–10 (–11) |................................. | 9 | ................................. |
7b Čepel listu větší, (8,4–) 9,0–11,6 (–12,8) cm dlouhá, na okraji plochá, nikdy zastřihovaně pilovitá, čepel listů fertilních brachyblastů téměř okrouhlá, s tupě špičatým až zaokrouhleně špičatým vrcholem ............ 8

8a Čepel listu na okraji 1–2(–3)× pilovitá, se zářezem mezi 2. a 3. žilkou od báze (1,3–) 1,8–2,8 (–3,7) mm dlouhým, s hrotitým, zaokrouhleným nebo až uťatým vrcholem o úhlu (130–) 140–160 (–170)°; plody středně velké, (10–) 11–12 (–13) mm dlouhé, vždy širší než dlouhé, Čechy ..................................

S. collina

8b Čepel listu na okraji ostře (2–3)× pilovitá, se zářezem mezi 2. a 3. žilkou od báze (2,2–) 3,0–4,4 (–6,5) mm dlouhým, s tupě špičatým až hrotitým vrcholem o úhlu (100–)110–125 (–140)°; plody velké, (13,0–)13,5–14,5 (–15,0) mm dlouhé, nikdy širší než dlouhé, Podyjí ......................................

S. thayensis

References


Appendix 1. – List of localities of Sorbus aria, S. danubialis, S. collina and S. pannonica analysed using flow cytometry during this study. Localities are sorted according to taxa and subsequently according to countries. The localities from the Czech Republic are further sorted according to the regional-phytogeographical classification system (Skalicky 1988). The format of the data is: Town or village, localization, habitat, height of individual, abundance, quadrant of the Central-European mapping grid according Ehrendorfer & Hamann (1965), coordinates of WGS-84, altitude (collector, collection date); number of individuals analysed; in Sorbus collina accession number of specimens. The specimens of all analysed trees are deposited in herbarium CB. Abbreviations of collectors: ML – Martin Lepší, PL – Petr Lepší, GM – Gábor Mészáros, NM – Norbert Meyer.

**Sorbus aria**

**Austria.** Gmunden, Traunstein Mt., W base of mountain, rocky slopes, tree ca 10 m high, 8148b, 47°51'34.0''N, 13°48'58.8''E, 550 m a.s.l. (ML 7. 8. 2011); 1. – Gmunden, Traunstein Mt., W base of mountain, open forest, tree ca 3 m high, 8148b, 47°52'32.7''N, 13°48'50.8''E, 430–550 m a.s.l. (ML 7. 8. 2011); 2. – Gmunden, Traunstein Mt., W slopes of mountain, 8148b, 47°51'54.7''N, 13°49'22.2''E, 860–1140 m a.s.l. (ML 7. 8. 2011); 4. – Hainburg an der Donau, NW slopes of Hundsheimer Berg, 7867d, 48°00'37.8''N, 16°55'58.5''E, 350–380 m a.s.l. (ML, PL 16. 7. 2011); 3. – Hardegg, “pine forest I” on slopes of Dyje valley, ca 180 m SE of bridge over Dyje river, 7161a, 48°51'05.4''N, 15°51'49.6''E, 350–400 m a.s.l. (ML, PL 15. 5. 2011); 3. – Hardegg, “pine forest II” on slopes of Dyje valley, ca 300 m SE of bridge over Dyje river, tree ca 12 m high, 7161a, 48°51’04.9”N, 15°51’57.6”E, 400 m a.s.l. (ML, PL 15. 5. 2011); 1. – Hardegg, Dyje valley, ca 2 km NW of bridge over Dyje river, cliff in oak-hornbeam forest, tree ca 10 m high, 7161a, 48°51'16.6''N, 15°50'23.3''E, 420 m a.s.l. (ML, PL 25. 7. 2012); 1. – Hardegg, Dyje valley, ca 2.8–2.9 km NW of bridge over Dyje river, 7161a, 48°52'26.1''N, 15°50'26.5''E, 420–440 m a.s.l. (ML, PL 17. 6. 2012); 2. – Hardegg, Dyje valley, Schwabenfelsen ca 2.1 km NW of the bridge over Dyje river, on cliff, shrub ca 4 m high, 7161a, 48°51'54.8''N, 15°50’28.1”E, 390 m a.s.l. (ML, PL 15. 6. 2011); 1. – Hardegg, Kreuznass, slopes above Fugnitzi stream, ca 1.8 km WSW of bridge over Dyje river, edge of rock, tree ca 2.5 m high, 7161c, 48°50’18.4”N, 15°51’02.9”E, 370 m a.s.l. (ML, PL 9. 5. 2011); 1. – Hardegg, Maxplateau hill, ca 700 m WNW of bridge over Dyje river, on rock in forest, tree ca 7 m high, 7161a, 48°51’21.6”N, 15°51’06.9”E, 360 m a.s.l. (ML, PL 14. 5. 2011); 1. – Hardegg, slopes above Fugnitzi valley of Binderberg hill, ca 1 km SW of bridge over Dyje river, rocky forest-steppe, shrub ca 3.5 m high, 7161c, 48°50’55.5”N, 15°50’59.1”E, 380 m a.s.l. (ML, PL 12. 6. 2011); 1. – Hardegg, Umlaufberg hill, edge of scrce and acidophilous oak forest, tree ca 6 m high, 7161c, 48°50’41.4”N, 15°53’33.7”E, 330 m a.s.l. (ML, PL 30. 5. 2012); 1. – Heufurt, near quarry at W edge of village, shrub, tree ca 6 m high, 7160d, 48°49’08.8”N, 15°53’42.4”E, 390 m a.s.l. (ML, PL 15. 6. 2012); 1. – Heufurt, woody slopes above village, 7160d, 48°49’24.1”N, 15°49’34.3”E, 390–430 m a.s.l. (ML, PL 15. 6. 2012); 5. – Klosterneuburg, S slopes of Leopoldsberg hill, 7764a, 48°16’35.9”N, 16°20’56.9”E, 310–330 m a.s.l. (ML, PL 14. 7. 2011); 5. – Prein an der Rax, below the Preiner Wand cliff, in a growth of Pinus mugo, rarely a tree ca 4 m high, 8360a, 47°41’51.6”N, 15°44’26.1”E, 1470 m a.s.l. (ML, PL 19. 9. 2010); 1. – Prein an der Rax, close by the Waxriegelhaus, a Picea abies and Larix decidua forest, a tree ca 5 m high, 8360a, 47°41’17.1”N, 15°43’20.6”E, 1380 m a.s.l. (ML, PL 18. 9. 2010); 1. – Prein an der Rax, the N periphery of the village, along a road, scattered, 8360b, 47°40’49.8”N, 15°46’23.0”E, 730 m a.s.l. (ML, PL 18. 9. 2010); 1. – Semmering, in the southern part of the village, an edge of a forest, scattered, a tree ca 8 m high, 8360d, 47°38’22.0”N, 15°45’46.3”E, 940 m a.s.l. (ML, PL 19. 9. 2010); 1. – Schönberg am Kamp, in valley of Kamp river (right-hand bank), ca 600 m NE of summit of Kogelberg hill, rocky and shrubby slopes, rarely, 7466a, 48°30’17.9”N, 15°41’27.1”E, 260 m a.s.l. (ML, PL 14. 8. 2010); 1.

**Czech Republic.** 19. Bílé Karpaty stepni: Velká nad Veličkou, Javorník, shrubby slope near railway stop Javornik nad Veličkou, mosaic of shrubs and Broomion grasslands, 7171a, 48°51’43.4”N, 17°31’13.3”E, 345 m a.s.l. (PL 20. 5. 2013); 3. – 68. Moravské podhůří Vysočiny: Čížov, Dyje valley, NW slopes of Na Vyhliďce hill, ca 1.8 km WSW of chapel in village, 7161a, 48°52’29.3”N, 15°50’55.6”E, 370–410 m a.s.l. (ML, PL 15. 5. 2011); 4. – Čížov, Dyje valley, Pašerácká stezka path, ca 1.5 km W of chapel in village, 7161a, 48°52’49.3”N, 15°53’55.8”E, 380–470 m a.s.l. (ML, PL 11. 9. 2011); 4. – Čížov, Hradecinecký stráh hillside, below road, ca 560 m ENE of bridge over Dyje river, open oak forest, scattered, 7161a, 48°51’16.3”N, 15°52’10.7”E, 320 m a.s.l. (ML, PL 6. 5. 2011); 1. – Čížov, Hradecinecký vyhlídkova outlook, ca 280 m NW of bridge over Dyje river, 7161a, 48°51’19.2”N, 15°51’40.9”E, 320–330 m a.s.l. (ML, PL 7. 5. 2011); 3. – Čížov, calcareous left-hand bank slopes of Dyje river valley, ca 400–500 m SE of spot height of 417 m with Hardegg outlook, edge of shrub and steppe, a small tree, 7161a, 48°51’18.4”N, 15°52’08.6”E, 330–360 m a.s.l. (ML, PL 23. 7. 2010); 3. – Čížov,
near ridge in meander of Dyje river (left-hand bank), ca 250 m WSW of obelisk above Ledové sluje chasms, ravine forest, tree ca 6 m high, 7161a, 48°53‘04.9”N, 15°50‘36.6”E, 420 m a.s.l. (ML, PL 21. 7. 2010); 1. – Čížov, rocky slope on left-hand bank of Dyje river, ca 100 m WNW of obelisk above Ledové sluje chasms, rocky woodland with dominant lime tree, individual ca 9 m high, 7161a, 48°53‘04.9”N, 15°50‘36.6”E, 390 m a.s.l. (ML, PL 23. 7. 2010); 1. – Čížov, summit area of Býčí hora hill, edge of forest road, one individual ca 7 m high, 7161a, 48°52‘35.8”N, 15°50‘12.8”E, 540 m a.s.l. (ML, PL 23. 7. 2010); 1. – Vranov nad Dyjí, ca 550 m NNW of summit of Býčí hora hill, on cliff, one small tree, 7160b, 48°52‘45.8”N, 15°49‘57.6”E, 510 m a.s.l. (ML, PL 21. 7. 2010); 1. – Vranov nad Dyjí, right-hand bank slopes of Dyje river valley, opposite meander with place called Ledové sluje chasms, ca 0.7 km NNW of summit of Býčí hora hill, woodland on rocky slope, one small tree ca 2 m high, 7160b, 48°52‘51.7”N, 15°49‘56.4”E, 420 m a.s.l. (ML, PL 21. 7. 2010); 1. – Moravský kras: Horákov, ca 400 m SE of summit of Hornek hill, cliff in forest, ca 20 individuals, 6766c, 49°13‘43.8”N, 16°43‘11.1”E, 350–360 m a.s.l. (ML 13. 5. 2012); 7. – Moravský kras: Horákov, ca 400 m SE of summit of Hornek hill, upper edge of former quarry, shrub ca 1 m high, 6766c, 49°13‘51.9”N, 16°42‘56.2”E, 400 m a.s.l. (ML 13. 5. 2012); 1.

Sorbus danubialis

Austria. Lower Austria: Hainburg an der Donau, NW slopes of Hundsheimer Berg, 7867d, 48°08‘10.7”N, 16°04‘05.6”E, 370 m a.s.l. (ML, PL 16. 7. 2011); 1. – Hardegg, “pine forest I” on slopes of Dyje valley, ca 180 m SE of bridge over Dyje river, pine forest with Sesleria caerulea, shrub ca 4 m high, 7161a, 48°51‘53.8”N, 15°51‘00.2”E, 360 m a.s.l. (ML, PL 12. 9. 2011); 1. – Hardegg, “pine forest II” on slopes of Dyje valley, ca 300 m SE of bridge over Dyje river, pine forest with Sesleria, rarely tree ca 7 m high, 7161a, 48°51‘04.5”N, 15°51‘56.1”E, 400 m a.s.l. (ML, PL 15. 5. 2011); 1. – Pulkau, Pulkau valley, young forest of Carpinus and Quercus on left-hand bank of Pulkau river, ca 2.3 km NW of Pulkau town, rarely, tree ca 6 m high, 7260d, 48°42‘53.3”N, 15°49‘56.9”E, 370 m a.s.l. (ML, PL 26. 9. 2012); 1. – Pulkau, Pulkau valley, open forest of Quercus pubescens on left-hand bank of Pulkau river, ca 2.1 km WNW of Pulkau town, above Peschtamühle, rarely, tree ca 4 m high, 7261c, 48°42‘39.9”N, 15°50‘02.1”N, 17°51‘33.7”E, 390 m a.s.l. (ML, PL 24. 5. 2013); 2. – Starý Hrozenkov, Vyškovec village, between settlements Kykula and Vlčí, fringe of broadleaves forest, near road ca 800 m SE of bell tower (near sharp curve), trees with many trunks, 7073c, 48°55‘00.5”N, 16°56‘02.1”N, 17°51‘33.7”E, 390 m a.s.l. (ML, PL 24. 5. 2013); 2.

France. Barr, the close surroundings of the castle of Landsberg, a rock in an oak forest, rarely, 7510d, 48°25‘11.4”N, 07°25‘20.3”E, 580 m a.s.l. (ML, PL 28. 7. 2010); 1. – Gérardmer, in valley of Kamp river, ca 1.8 km W of castle in village, top of cliff, rarely, 7359d, 48°02‘02.0”N, 07°01‘42.4”E, 1180 m a.s.l. (ML, PL 29. 7. 2010); 1. – Gérardmer, the area between the summit of le Hohneck Mountain and le Petit Hohneck Mountain, subalpine open shrubs, rarely, a tree ca 10 m high, 7908c, 48°02‘02.0”N, 07°01‘42.4”E, 1180 m a.s.l. (ML, PL 29. 7. 2010); 1.
Velký Bezděz hill, SE slopes, on cliff, scattered, 545ac, 50°32'23.8''N, 14°43'17.7''E, 560–590 m a.s.l. (ML, PL 16. 5. 2011); 5. – Velký Bezděz hill, SW slopes, scattered, 545ac, 50°32'17.4''N, 14°43'03.5''E, 530–540 m a.s.l. (ML, PL 16. 5. 2011); 4. – Moravské podhůří Vysočiny: Čížov, Hardeggská stráň hill - side, above road, ca 550 m ENE of bridge over Dyje river, forest-steppe, rarely, shrub ca 2 m high, 7161a, 48°51'17.5''N, 15°52'08.9''E, 370 m a.s.l. (ML, PL 14. 5. 2011); 1. – Čížov, calcareous slopes above Dyje river (left-hand bank), ca 500 m SE of spot height of 417 m with Hardeggská vyhlídka outlook, above road to Hardegg, steppe, shrub ca 2 m high, rarely, 7161a, 48°51'17.6''N, 15°52'08.9''E, 350 m a.s.l. (ML, PL 23. 7. 2010); 1. – Moravský kras: Lažánky, near Blansek castle ruin, 6666a, 49°22'22.8''N, 16°43'12.4''E, 440–470 m a.s.l. (ML 23. 7. 2011); 3. – Lažánky, Suchý žleb gorge, 5454c, 50°32'17.4''N, 14°43'03.5''E, (left-hand bank), ca 500 m SE of spot height of 417 m with Hardeggská vyhlídka outlook, above road to Hardegg, steppe, shrub ca 2 m high, rarely, 7161a, 48°51'17.6''N, 15°52'08.9''E, 350 m a.s.l. (ML, PL 23. 7. 2010); 1. – Plank am Kamp, in valley of Kamp river (right-hand bank) ca 0.6 km NE of church in village Thürneustift, wooded cliff, tree ca 6 m high, 7465c, 48°32'47.2''N, 15°40'16.8''E, 250 m a.s.l. (ML, PL 23. 7. 2010); 3. – Veszprém, Márkó, Malom hegy, 8872d, 47°06'33.3''N, 17°49'43.0''E, 360 m a.s.l. (ML, PL, GM 20. 7. 2011); 1. – Veszprém, ca 3.8 km WSW of centre of town, 8774d, 46°52'21.7''N, 17°30'12.2''E, 340 m a.s.l. (ML, PL, GM 21. 7. 2011); 4. – Budapest, Tündér hegy, 8479d, 47°30'54.2''N, 18°59'13.2''E, 280 m a.s.l. (ML, PL, GM 17. 7. 2011); 1. – Budapest, Sas hegy, 8580a, 47°28'59.2''N, 18°59'36.7''E, 310 m a.s.l. (ML, PL, GM 17. 7. 2011); 3. – Budapest, Ördög oron, 8579b, 47°28'55.1''N, 18°59'13.2''E, 310 m a.s.l. (ML, PL, GM 17. 7. 2011).
tree ca 6 m high, scattered in the surroundings, 7460c, 48°30'00.4''N, 15°41'30.5''E, 220 m a.s.l. (ML, PL 13. 8. 2010, CB 74047); 1. – Schönberg am Kamp, in valley of Kamp river (right-hand bank), ca 600 m NE of summit of Kogelberg hill, rocky and shrubby slopes of valley, rarely, 7460c, 48°30'19.5''N, 15°41'25.9''E, 280 m a.s.l. (ML, PL 14. 8. 2010, CB 74050); 1.

**Czech Republic. 6. Dibín:** Třeskonice, ca 1.3 km S of village, on Výrov hill, scattered, 5747b, 50°15'23.8''N, 13°39'12.8''E, 510–520 m a.s.l. (ML, NL 30. 6. 2011, CB 82672–82674); 3. – **Českolipsko:** Koněprusy, rocky hill, scattered, 5742b, 50°10'49.2''N, 14°5'3.6''E, 350 m a.s.l. (ML 17. 5. 2011, CB 79942–79943); 1. – **Bohemian Forest:** Slánská tabule: Kladno, Vinařická hora nature reserve, ca 3 m high, 5850b, 50°10'49.2''N, 14°5'3.6''E, 350 m a.s.l. (ML 17. 5. 2011, CB 79944); 1. – **Kladno, Vinařická hora nature reserve,** ca 750 m NW–NNW of centre of village, marlstone slope, ca 30 individuals shrub 3 m high, 5850b, 50°10'49.2''N, 14°5'3.6''E, 350 m a.s.l. (ML, PL 14. 8. 2010, CB 82472, CB 82475); 4. – Veszprém, Márkó, 17°51'39.4''E, 260–270 m a.s.l. (ML, PL, GM 20. 7. 2011, CB 82449); 1.

**Sorbus pannonica**

**Hungary.** Csíkovár, Vértes Mts, Nagy-Vasak hegy (NW of village), 8576c, 49°25'44.799''N 18°25'11.713''E, 380–410 m a.s.l. (ML, PL, GM 18. 7. 2011, CB 82513–82514, CB 82448, CB 82450, CB 82453, CB 82455); 7. – **Křivoklátsko:** Broumov, Berounka valley, cliffs above town, scattered, 5949c, 50°01'15.8''N, 13°50'49.9''E, 250–270 m a.s.l. (ML, PL 14. 8. 2010, CB 82472, CB 82475); 1. – Schönberg am Kamp, in valley of Kamp river (right-hand bank), ca 600 m NE of summit of Kogelberg hill, rocky and shrubby slopes of valley, rarely, 7460c, 48°30'19.5''N, 15°41'25.9''E, 280 m a.s.l. (ML, PL 14. 8. 2010, CB 74050); 1.

**Czech Republic. 6. Dibín:** Třeskonice, ca 1.3 km S of village, on Výrov hill, scattered, 5747b, 50°15'23.8''N, 13°39'12.8''E, 510–520 m a.s.l. (ML, NL 30. 6. 2011, CB 82672–82674); 3. – **Českolipsko:** Koněprusy, rocky hill, scattered, 5742b, 50°10'49.2''N, 14°5'3.6''E, 350 m a.s.l. (ML 17. 5. 2011, CB 79942–79943); 1. – **Bohemian Forest:** Slánská tabule: Kladno, Vinařická hora nature reserve, ca 3 m high, 5850b, 50°10'49.2''N, 14°5'3.6''E, 350 m a.s.l. (ML 17. 5. 2011, CB 79944); 1. – **Kladno, Vinařická hora nature reserve,** ca 750 m NW–NNW of centre of village, marlstone slope, ca 30 individuals shrub 3 m high, 5850b, 50°10'49.2''N, 14°5'3.6''E, 350 m a.s.l. (ML, PL 14. 8. 2010, CB 82472, CB 82475); 4. – Veszprém, Márkó, 17°51'39.4''E, 260–270 m a.s.l. (ML, PL, GM 20. 7. 2011, CB 82449); 1.

**Sorbus pannonica**

**Hungary.** Csíkovár, Vértes Mts, Fejér megye, Köhányás, Németh-völgy, 8576c, 49°25'44.799''N 18°25'11.713''E, 380–410 m a.s.l. (ML, PL, GM 19. 7. 2011, CB 82517–82519); 3. – **Várpalota, Bakony Mts, N of town,** 8774d, 47°15'06.1''N, 18°06'43.2''E, 280 m a.s.l. (ML, PL 19. 7. 2011); 2.