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# *Calamagrostis purpurea* (Poaceae) – A long neglected boreal element, new for the flora of Austria

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Abstract: *Calamagrostis purpurea*, a presumably relict boreal wetland grass with a wide distribution in Eurasia, is presented here as new for the flora of Austria. The currently known distribution of this species in Central Europe and its ecological preferences are summarized. After revision of herbarium vouchers, *C. purpurea* has to be excluded from the flora of Hungary, as the single known population on a ski slope in the Börzsöny Mts. turned out to be the single currently known population of *C. villosa* in Hungary. Putative occurrences of *C. purpurea* (published under *C. phragmitoides*) from the Waldviertel (Lower Austria), documented in phytosociological relevés that were overlooked in the floristic literature, are erroneous. Herbarium vouchers of Austrian material of *C. purpurea* exist from Piburger See (Ötztal, North Tyrol) and Lunzer Obersee (Ybbstaler Alpen, Lower Austria), where the species was confirmed during field work in 2016 and 2017. Whereas the 1975 collection from Piburger See was correctly identified during a herbarium revision in 2012, the occurrence at Lunzer Obersee was already suspected during a floristic mapping excursion in 1992. A misidentified voucher was collected at Lunzer Obersee in 1907, thus being the oldest record of *C. purpurea* for Austria. All revised specimens from both localities are enumerated and discussed in the context of published floristic and vegetation ecological data. The population size and ecological conditions of the two Austrian populations, as well as the possibility of a relict status vs. postglacial migration, are discussed. The category "endangered" (EN) is suggested for the future Austrian Red Data Book. An identification key for the three most frequently misidentified species of Austrian *Calamagrostis* (*C. purpurea*, *C. canescens* and *C. villosa*) is presented as an Appendix.

Key words: Flora of Austria, Flora of Hungary, *Calamagrostis phragmitoides*, *Calamagrostis villosa*, Poaceae, Tyrol, Lower Austria, grass, relict, boreal element, Alps, Börzsöny Mts., floristics

Zusammenfassung: ***Calamagrostis purpurea* – ein lange übersehenes boreales Element, neu für die Flora von Österreich**
*Calamagrostis purpurea*, ein mutmaßlich reliktäres boreales Gras von Feuchtgebieten und weiter Verbreitung in Eurasien, wird hier als neu für die Flora Österreichs präsentiert. Die derzeit bekannte Verbreitung dieser Art in Mitteleuropa und ihre ökologischen Vorlieben werden zusammengefasst. Die Revision von Herbarbelegen zeigte, dass *C. purpurea* für die Flora Ungarns gestrichen werden muss. Die einzige bekannte vermeintliche Population, auf einer Schipiste im Börzsöny (Pilsengebirge), stellte sich als die derzeit einzige bekannte ungarische Population von *C. villosa* heraus.

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Für Österreich sind alle bisherigen, in vegetationsökologischer Literatur publizierten Angaben von *C. purpurea* (publiziert als *C. phragmitoides*) aus dem Waldviertel in Niederösterreich, die ohnehin in der floristischen Literatur übersehen worden waren, als irrig zu betrachten. Bei Herbarrevisionen wurden Belege von *C. purpurea* vom Piburger See (Ötztal, Nordtirol) und vom Lunzer Obersee (Niederösterreich) gefunden. Das rezente Vorkommen an beiden Seen wurde 2016 und 2017 bei Freilandarbeiten bestätigt. Während die Aufsammlung von 1975 vom Piburger See seit einer Herbarrevision im Jahre 2012 bekannt ist, wurde das Vorkommen am Lunzer Obersee schon 1992 bei einer Kartierungsexkursion vermutet. Ein 1907 am Lunzer Obersee gesammelter, aber ursprünglich falsch bestimmter Herbarbeleg stellt die älteste Aufsammlung von *C. purpurea* für Österreich dar. Alle revidierten Belege beider Lokalitäten werden aufgezählt und im Kontext von publizierter floristischer und vegetationsökologischer Literatur diskutiert. Populationsgröße und Ökologie der beiden österreichischen Populationen sowie die Frage des reliktären Status gegenüber postglazialer Einwanderung werden diskutiert. Die Gefährdungskategorie „stark gefährdet" wird für die zukünftige Rote Liste Österreichs vorgeschlagen. Abschließend wird in einem Appendix ein Bestimmungsschlüssel für die drei, oft verwechselten *Calamagrostis*-Arten *C. purpurea*, *C. canescens* und *C. villosa* präsentiert.

## 1. Introduction

### 1.1 The *Calamagrostis canadensis* aggregate

*Calamagrostis purpurea* belongs to a taxonomically intricate group called *C. canadensis* agg. or *C. purpurea–langsdorffii–canadensis* complex. This species complex has a circumpolar distribution (Tateoka 1974, Hultén & Fries 1986). It includes several wetland taxa, shows great morphological variation caused by phenotypic plasticity in diverse habitats and regions, and has several chromosome numbers related to supposed facultative apomixis (Nygren 1949, 1951, 1954, Tzvelev 1965, 1976, Mitchell 1968, Tateoka 1974). Hybridization and hybrid evolution may also be important in some cases (Nygren 1962). Taxonomic treatment of the group differs among individual authors. North American plants of the complex are usually classified as *C. canadensis* (Mitchell 1968, Barkworth & al. 2007), whereas Siberian plants are often recognized as *C. purpurea* (Tzvelev 1965, 1976). Another taxon, *C. langsdorffii*, was described on the basis of plants cultivated in the Botanical Garden in Berlin (Link 1821), probably originating from the Aleutian Islands (Tzvelev 1976). This taxon mainly occurs in Asia and North America and has been treated as an infraspecific taxon of *C. canadensis* (Mitchel 1968, Hultén & Fries 1986, Barkworth & al. 2007) or as an infraspecific taxon of *C. purpurea* (Tzvelev 1965, Clarke 1980, Valdés & Scholz 2009). Conspecifity of *C. canadensis* and *C. purpurea* has been suggested by some authors (Marr & al. 2007). European plants of the complex were described as *C. phragmitoides* from Lapland (Hartman 1832). Based on morphology and hybridization experiments, they are often regarded as a product of hybridization between either *C. langsdorffii* and *C. canescens* (Scholz 1964, Tzvelev 1965) or of *C. canescens* (= *C. lanceolata*) and *C. epigejos* (Nygren 1948, Scholz 1971), species that do not belong to the *C. canadensis* complex. In Europe, *C. canescens* is tetraploid, *C. epigejos* is usually tetraploid or hexa-

ploid, *C. purpurea* is predominantly octoploid and *C. villosa*, which is morphologically similar and frequently misidentified as *C. purpurea*, is dodecaploid (Schaabová 2015, Schaabová & al. unpub.). In contrast to the classical hypotheses, recent studies employing molecular markers imply a biosystematically isolated position of *C. purpurea* among other Central European species. A general similarity to plants of *C. purpurea* from Siberia has been shown, and the hypothesized hybrid origin seems unlikely (Schaabová 2015, Schaabová & al. unpub.). When treating *C. purpurea* and *C. phragmitoides* as conspecific, the older name *C. purpurea* (Trin.) Trin. (Gram. Unifl. Sesquifl.: 219, 1824) has priority over *C. phragmitoides* Hartm. (Handb. Skand. Fl., ed. 2: 20, 1832). In this paper, the European plants are classified as *C. purpurea* following the treatment of the genus *Calamagrostis* in the recent edition of the Key to the Flora of the Czech Republic by the first author (Štech 2019). The broad species concept is also accepted in recent European and world plant databases (Valdés & Scholz 2009, WFO 2019). Nevertheless, Russian taxonomists retain a very narrow species concept and consider 11 species in the *C. purpurea* complex in the flora of Russia (Tzvelev & Probatova 2019).

### 1.2 *Calamagrostis purpurea* in Central Europe

*Calamagrostis purpurea* is common throughout Scandinavia but is rather rare in southern and eastern parts of Europe (Conert 1998). Its occurrence in Central Europe has been known for a long time from Mt. Hoher Meißner in Hesse in Germany (Hackel 1883); however, most of the localities have been overlooked until recently. Until the 1970s, it was considered to be a very rare species in Central Europe (Scholz 1964, Meinunger 1977). Since then, it has been discovered in a number of Mittelgebirge ranges throughout Central Europe and adjacent regions. The occurrence of *C. purpurea* has been confirmed in the majority of Central European countries. The species is known from the Massif Central and the Vosges Mts. in France (Phillipi 1970, Tison & Foucault 2014), the Hautes Fagnes in Belgium (Scholz 1964, de Langhe & Delvosalle 1973) and from several regions in Germany (Bettinger & al. 2013): the Harz, where it is locally common (Dersch & Mast 2000), the Rhön and Vogelsberg Mts., the Rothaar and Westerwald Mts. (Ludwig 1991), the Erzgebirge/Krušné hory Mts. and the Frankenwald (Meinunger 1977), as well as the Black Forest (Schwarzwald) (Phillipi 1970). In the Czech Republic, *C. purpurea* was found as late as in 1974 (Smejkal 1976); however, it is present in more than 20 known localities (Schaabová 2015, Schaabová & al. unpub., Štech unpub.), mostly in the Bohemian-Moravian Highlands (Růžička 2005) and the Erzgebirge/Krušné hory Mts. (Ondráček 2011), as well as the north-eastern part of the country and the south-eastern part of the Bohemian Forest (Šumava, Böhmerwald) close to the Austrian border (Štech 2013, PLADIAS 2019, Štech unpub.). In Slovakia, the species was found in the Low Tatras (Nízké Tatry) as late as 2015 (Koutecký & al. unpub.). In Romania, *C. purpurea* was collected in 1942, but historic herbarium vouchers from the Eastern Carpathians were hidden among *C. canescens*, *C. villosa* and even *C. pseudo-*

*phragmites* until now (Pachschwöll & al. unpub.). The occurrence of *C. purpurea* on a ski slope in the Börzsöny Mts. in Hungary was reported by Tatár (1995). This has been the only accepted population in Hungary until now (Penksza 2009, Valdés & Scholz 2009, Bartha & Király 2015). Although the presence of *C. purpurea* in Poland appears likely, no credible records are known (Mirek & al. 2002).

Despite the numerous sites in Mittelgebirge ranges across Central Europe, *C. purpurea* has been scarcely reported from the Alps. In France, the species is mentioned for the "Alpes du Nord" (Tison & Foucault 2014). Doubtful records exist from the tourist path to Demoiselles Coiffées de Pontis (Hautes-Alpes) and from Saint-Martin-de-Belleville (Savoie) (https://www.tela-botanica.org, http://www.pifh.fr). In Switzerland, *C. purpurea* has been known since the report by Scholz (1971), who revised a herbarium voucher collected by H. Seitter in 1966 in a moist meadow of a riverine forest in the Rhine valley near Sennwald in the canton of Sankt Gallen (Becherer 1972). This occurrence was confirmed in 2016 by Brülisauer (2019). In Switzerland, two additional records are known from the canton of Valais: an unconfirmed record from Les Bouveret at the mouth of the Rhône into Lake Geneva and one confirmed record from Lac de Champex in Val Ferret, Valais Alps (Desfayes 2008, Lauber & al. 2018, Brülisauer 2019). There are two other unconfirmed localities at the southern edge of Lake Constance and the Upper Inn river valley near Pontresina (www.infoflora.ch). Only one locality is known from the "Moränengürtel" (moraine belt) in Bavaria (Scheuerer & Ahlmer 2003, www.bayernflora.de). In the Allgäu Prealps, *C. purpurea* occurs in a rich population in the mire Lindenberger Moos, a Natura 2000 site near Lindenberg, where it was discovered in 1977 (Dörr 1979, Dörr & Lippert 2004). The latter site is the only one in the Eastern Alps, as the Rhine is traditionally considered the border between the Eastern and the Western Alps. As the Swiss population near Sennwald, the Bavarian population near Lindenberg is only approximately 3 km from the Austrian territory.

### 1.3 Ecology

*Calamagrostis purpurea* grows in Central Europe usually at 500 to 1000 msm (Scholz 1971). Typical habitats include forest springs, open alder and birch forests, willow scrub, stream banks, ditches, wet meadows and littorals of ponds and lakes (Conert 1998, Dersch & Mast 2000, Štech unpub.). Locations at elevations above 1000 msm are known from the Massif Central, Vosges Mts., Black Forest, Valais Alps and the Low Tatras, where this species mostly occurs in upper montane deciduous shrub, tall-forb or lakeshore vegetation (Phillipi 1970, Desfayes 2008, Koutecký & al. unpub.). Overall, *C. purpurea* prefers wet to muddy, nutrient-poor to moderately nutrient-rich sites with moderate acidity (PLADIAS 2019). Although the species is generally rare, and its occurrence is restricted to regions with relict wetland vegetation, it can colonize abandoned meadows and may become dominant at such sites (Dersch & Mast 2000, Ondráček 2011).

### 1.4 Research questions

Due to recently reported unconfirmed records of *Calamagrostis purpurea* in Austria, the aims of this study were: (a) confirmation of the occurrence of *C. purpurea* in Austria based on herbarium specimen revision and (b) revision of current occurrences in places where a historical occurrence was documented by herbarium specimens. An additional objective of this study was the revision of specimens of *C. purpurea* from Hungary.

## 2. Material and Methods

A revision of *Calamagrostis* herbarium specimens was carried out at BP, BRNM, CB, CBFS, GJO, GZU, KL, LI, PR, PRC, SZU, W, WHB and WU. The presence of the species at sites documented by herbarium specimens was checked during field excursions in 2016 and 2017.

Apart from *C. purpurea*, the taxonomy and nomenclature in this article follow Fischer & al. (2008). The herbarium abbreviations are in accordance with the Index Herbariorum (New York Botanical Garden Herbarium, http://sweetgum.nybg.org/science/ih/). If not indicated on the herbarium label, the quadrant of the floristic mapping scheme for Central Europe (Niklfeld 1971) was added in square brackets.

Microphotographs were obtained with a Zeiss Stemi 2000-C stereo microscope equipped with an AxioCam ERc 5s camera.

## 3. Results

### 3.1 Erroneous records of *Calamagrostis purpurea* in Austria

In Austria, the occurrence of *C. purpurea* was first reported by Czech botanists during ecological studies along the Lainsitz River between Fischbach and Steinbach (7354/4) (Prach & al. 1990, 1996). However, Austrian botanists were not aware of these reports, and, therefore, *C. purpurea* is not mentioned in the Austrian excursion flora (Fischer & al. 2008). The herbarium voucher for one of these records turned out to be *C. canescens*: [Lower Austria], Karlstift, Fischbach, pravobřežní niva Lužnice [right-side alluvium of the Lainsitz River]; 15 July 1987: Stanislav Kučera (CB 2311), rev. M. Štech, 2009. No *C. purpurea* was found in this area during a joint excursion of Austrian and Czech botanists (C. Pachschwöll, L. Schratt-Ehrendorfer, F. Ehrendorfer, P. Koutecký and M. Štech) on August 1st, 2016. Therefore, it is likely that robust plants of *C. canescens* and *C. villosa* were mistaken for *C. purpurea* by Prach & al. (1990, 1996). Similarly, in the southern parts of the Czech Republic bordering Austria, earlier records from the Třeboň basin and the Novohradské hory Mts. foothills (Chán & al. 1999) have not been confirmed and are based on misidentification (Štech 2013). However, the species

occurs in the south-eastern part of the Bohemian Forest (Šumava Mts.) near Černá v Pošumaví and in the central part of the Bohemian-Moravian Highlands in the vicinity of Jihlava (PLADIAS 2019, Štech unpub.).

### 3.2 Erroneous records of *Calamagrostis purpurea* in Hungary

Tatár (1995) reported *C. purpurea* as new for Hungary in a forest clearing on a ski slope at Mt. Nagy-Hideg-Hegy in the Börzsöny Mountains (8079/4). Taking into account the reported environmental characteristics of the site, the presence of *C. purpurea* appears to be unlikely. The numerous herbarium vouchers from this locality collected from 1994 to 2013 and deposited in BP turned out to be mostly *C. villosa* (*C. epigejos* in one case). This is interesting as *C. villosa* is currently treated as extinct in Hungary (Király 2015). The only known historical gathering is from 1953, from the "Nyíres-tó" lake in the Tisza valley near Csaroda, eastern Hungary (Király 2015). *Calamagrostis villosa* is well known from the catchment area of the upper Tisza River in the Romanian and Ukrainian Carpathians (Meusel & Jäger 1965–1992, Sârbu & al. 2013, Chopyk & Fedoronchuk 2015). We therefore interpret the eastern Hungarian occurrence as a likely extinct drift population outside of its main distribution. Our revision could confirm *C. villosa* for Hungary, naturalized on a ski slope where it grows on a clearing in a population of c. 50–60 m$^2$ (Nagy 2007). As this is the only recently confirmed Hungarian population (Bartha & Király 2015, Király 2015), a human-induced origin is very likely. *Calamagrostis villosa* is a common forest species that regularly occurs in the Alps and Carpathians at the margins of lower- to middle-altitude ski slopes (Conert 1998, Fischer & al. 2008, Hedl & al. 2012, Sârbu & al. 2013, Chopyk & Fedoronchuk 2015, Müller & al. 2017).

**Herbarium vouchers of *C. villosa* from Hungary, originally determined as *C. purpurea*:**
Mt. Börzsöny, in decl. borealis montis Nagy-hideghegy "sípálya" pro praed. Királyrét [8079/4]; 27 June 1994: T. Simon & D. Tatár (BP 651523), see Fig. 1; – Comit. Pest (olim Hont). Mt. Börzsöny. In declivibus septentrionalis montis "Nagy-hideg-hegy" (északi sípálya) supra pag. Perőcsény [8079/4], UTM: CU41; 30 June 1995: Dóra Tatár (BP 412944); – Comit. Pest (olim Hont). Mt. Börzsöny. In declivibus septentrionalis montis "Nagy-hideg-hegy" (északi sípálya) supra pag. Perőcsény [8079/4], UTM: CU41; 18 July 1995: Dóra Tatár (BP 473237); – Pest megye, Börzsöny, Perőcsény: Nagy-hideghegy, a nagy É-i sípályán [8079/4]; 21 July 2013: Lajos Somlyay & József Nagy (BP 729600, BP 729601).

Most of the vouchers were revised as *C. villosa* by C. Pachschwöll and M. Štech in 2020; one voucher (BP 599514) was revised as *C. epigejos*: Pest m., Börzsöny-hegység, [8079/4]; 700 msm; Az északi nagy sípályán; 18 July 1996: József Nagy (BP 599514).

**Fig. 1:** Herbarium voucher of *C. villosa* from the Börzsöny Mts. (Hungary) stored in BP; originally determined and thus published as *C. purpurea* by Tatár (1995). Photo: Clemens Pachschwöll, 31 January 2020. — **Abb. 1:** Herbarbeleg von *C. villosa* aus dem Pilsengebirge (Ungarn), aufbewahrt in BP; ursprünglich als *C. purpurea* bestimmt und von Tatár (1995) so veröffentlicht. Foto: Clemens Pachschwöll, 31. Jänner 2020.

### 3.3 The occurrence of *Calamagrostis purpurea* in Austria

During the revision of herbarium specimens, vouchers of *C. purpurea* from two Austrian sites were discovered. The presence of the species at both sites was confirmed during field excursions in 2016 and 2017. Furthermore, discussions with colleagues revealed that the occurrence of *C. purpurea* in Austria has been suspected since 1992 but has never been published and is therefore lacking in Fischer & al. (2008).

### 3.3.1 The mountain lake Piburger See in North Tyrol

*Calamagrostis purpurea* was first collected at Piburger See (Ötztal, North Tyrol) as *Calamagrostis* sp. in 1975 by Adolf Polatschek (1932–2015), the author of the "Flora von Nordtirol, Osttirol und Vorarlberg" (Fischer 2016). Helmut Melzer (1922–2011), one of the leading Austrian florists at that time (Zernig 2010), with an interest in *Calamagrostis*, saw this specimen and left the following note with the herbarium voucher (translation in square brackets by C. Pachschwöll): "Schade, daß von dieser Pflanze so wenig vorliegt, die unteren Teile fehlen. M.E. [Meines Erachtens] eine Hybride, denn die 5 Nerven der Deckspelze führen auf *C. lanceolata* [= *C. canescens*] oder *villosa*, es käme aber nur erstere in Frage. Dafür ist aber die Granne zu lang und die Blätter viel zu breit, die ganze Pflanze zu derb. Vorerst würde ich an *C. epigeios* × *lanceolata* denken. Es wäre gut, bei Geleg[e]nheit mehr Material zu sammeln." [It is a pity that there is so little material present; the lower parts are missing. In my opinion, a hybrid because the 5 nerves lead to *C. lanceolata* or *villosa*, but only the former is possible. For this, however, the awn is too long and the leaves are too wide, and the whole plant is too rough. For the time being, I would think of *C. epigeios* × *lanceolata*. It would be good to collect more material on occasion.] The label bears another comment by [K.] Fitz from 1980, who considered the specimen to be the hybrid *C. pseudophragmites* × *C. lanceolata*. As the specimen was never determined unambiguously, the record is lacking in the "Flora von Nordtirol, Osttirol und Vorarlberg" (Maier & al. 2001). The correct determination as *C. phragmitoides* by B. Paszko in January 2012 came too late to be considered for the supplementary volume (Polatschek & Neuner 2013).

Hundreds of flowering shoots were found during field work at Piburger See by the first author on July 22nd, 2016. A photo of a stand of several plants is depicted on the cover of this issue of NEILREICHIA. At Piburger See, most of the plants were concentrated in the south-eastern corner of the lake in small wet places near the shore. For geomorphological reasons, only small sites of shore vegetation exist at Piburger See (Holländer & Bischof 2010). Due to its conservation biology problems and the fact that this lake has served as a "model lake" for limnologists for decades (e.g., Tolotti & al. 2005), its flora and vegetation were studied by Rott (1982) and Holländer & Bischof (2010). The species lists in these publications contain *C. epigejos* from the nearby forest but no other *Calamagrostis*. Notably, *C. canescens* is lacking at Piburger See (M. Štech, pers. obs. 2016).

**Herbarium vouchers:**
Nordtirol, Ötztal: Piburg, am S-Ende des Piburgersee bei Ötz [8831/1]; 915 msm; gemeinsam mit *Phragmites*; 6.–19. Juli 1975: A. Polatschek (W 1976-14536), rev. as *C. phragmitoides* by B. Paszko, 2012; originally determined as *Calamagrostis* sp.; – Austria, Ötztal, Piburg: the SW lakeshore of the Piburger See Lake [8831/1]; 930 msm [recte: 914 msm]; 22 July 2016: Milan Štech (CBFS 7753, WU 0088941).

### 3.3.2 The mountain lake Lunzer Obersee in Lower Austria

A co-author of this study, L. Schratt-Ehrendorfer, had seen the closely related *C. langsdorffii* in Greenland, where it is frequent (Böcher & al. 1978), shortly before the occurrence of *C. phragmitoides* at Lunzer Obersee (Ybbstaler Alpen, Lower Austria) was first suspected by her and A. Tribsch at a joint floristic mapping excursion on June 1st, 1992 after consulting the scanty key in "Flora Europaea" (Clarke 1980). However, the final determination of the herbarium voucher collected in 1992 was made with certainty as late as 2010 by A. Tribsch, who meanwhile knew *C. purpurea* from Scandinavia, using German and Norwegian excursion floras (Lid & al. 1994, Jäger & Werner 2005). The revision of the population in the field was done on July 14th, 2017 by C. Pachschwöll and M. Štech. Hundreds of flowering shoots of *C. purpurea* were found in the fen and the wet upper montane tall-forb meadow on the north-eastern lakeshore (Fig. 2–5). Besides *C. purpurea*, *C. canescens* also occurs at this site (CBFS 7755, W 2019-09982, WU 0107991), especially in the wet parts close to the lake. During herbarium revisions

**Fig. 2:** Wet meadow habitat with *Calamagrostis purpurea* and *C. canescens* at the NE lakeshore of Lunzer Obersee (Lower Austria). Photo: Clemens Pachschwöll, 14 July 2017. — **Abb. 2:** Feuchtwiesenhabitat mit *Calamagrostis purpurea* und *C. canescens* am NO-Ufer des Lunzer Obersees (Niederösterreich). Foto: Clemens Pachschwöll, 14. Juli 2017.

in LI and W, the first and the last authors found three herbarium vouchers of *C. purpurea* from Lunzer Obersee that were collected in 1907, 1920 and 1955, respectively. Although no detailed information is given for the first two, the voucher collected by Hans Metlesics in 1955 bears some interesting information about plant localization and accompanying species. He collected *C. purpurea* as *C. lanceolata* (= *C. canescens*) on the south-western shore, and on the same day, he collected *C. canescens* (as *C. lanceolata*) on the eastern shore of Lunzer Obersee (LI 380349).

Lunzer Obersee is a mountain lake in a glacial depression at an elevation of 1100 msm. At around 0.14 km² it is approximately the same size as Piburger See but bears a broad belt of shore vegetation in contrast to the latter. The quagmire ("Schwingrasen") covers 45% of the area (Englmaier 1985) and is well studied. In general, the finding of a new species at Lunzer Obersee is quite astonishing as this lake has been a "model lake" for limnology and ecology since 1906, when the "Biologische Station Lunz" (now "WasserCluster Lunz") was founded (Schiemer 2014). It is obvious that *C. purpurea* was

**Fig. 3:** *Calamagrostis purpurea* together with *Filipendula ulmaria*, *Cirsium oleraceum*, *Deschampsia cespitosa* and *Carex* spp. at the NE lakeshore of Lunzer Obersee (Lower Austria). Photo: Clemens Pachschwöll, 14 July 2017. — **Abb. 3:** *Calamagrostis purpurea* gemeinsam with *Filipendula ulmaria*, *Cirsium oleraceum*, *Deschampsia cespitosa* und *Carex* spp. am NO-Ufer des Lunzer Obersees (Niederösterreich). Foto: Clemens Pachschwöll, 14. Juli 2017.

**Fig. 4:** Close-up of *Calamagrostis purpurea* showing the conspicuously long ligula (arrow) and the bluish-green and dull leaves. NE lakeshore of Lunzer Obersee (Lower Austria). Photo: Clemens Pachschwöll, 14 July 2017. — **Abb. 4:** Nahaufnahme von *Calamagrostis purpurea*, die unübersehbare lange Ligula (Pfeil) und die bläulich-grünen und matten Blättern zeigend. NO-Ufer des Lunzer Obersees (Niederösterreich). Foto: Clemens Pachschwöll, 14. Juli 2017.

**Fig. 5:** The long, fringed and hairy ligula of *Calamagrostis purpurea*. NE lakeshore of Lunzer Obersee (Lower Austria). Photo: Clemens Pachschwöll, 14 July 2017. — **Abb. 5:** Die lange, ausgefranste und behaarte Ligula von *Calamagrostis purpurea*. NO-Ufer des Lunzer Obersees (Niederösterreich). Foto: Clemens Pachschwöll, 14. Juli 2017.

not distinguished from *C. canescens* in the subsequent publications. Brehm & Ruttner (1926: 338) reported "*Deschampsia caespitosa* und *Calamagrostis lanceolata*" as common grasses of the lakeshore growing together with different species of *Carex* as well as *Calamagrostis canescens* (as *C. lanceolata*) growing in the famous quagmire (Brehm & Ruttner (1926: 348). *Calamagrostis canescens* (as *C. lanceolata*) was also mentioned by Gams (1928: 325), building a "*Calamagrostis lanceolata-Sphagnum teres* Assoziation" in the quagmire. From the shore meadows of Lunzer Obersee, Wendelberger (2000) reported a preliminary "*Calamagrostis canescens*-Fazies" of the Potentilletum palustris (Kłosowski & al. 1995), situated in the catena between the "*Carex juncella*-Fazies der Feuchtwiesen" and the Potentilletum palustris. However, the complete plant sociological treatment by the late G. Wendelberger remains unpublished (W. Willner, pers. comm.).

**Herbarium vouchers:**
Oberer Lunzer See [8156/3]; General J. Schneider: 2 September 1907 (W 1942-0000118), rev. C. Pachschwöll, 2019; originally determined as *C. villosa*; – Niederösterreich: Moorsümpfe um den Obersee bei Lunz [8156/3]; 1113 msm; 16 July 1920: Friedrich [Karl Max] Vierhapper (LI 104374), rev. M. Štech, 2019; originally determined as *C. lanceolata* (= *C. canescens*); this voucher is from the former herbarium of "Tierärztliche Hochschule Wien, Lehrkanzel für Botanik"; – Nördl. Kalkalpen (östl. der Enns), Ober-See bei Lunz [8156/3]; 1117 msm; Schwingrasen am Südwestufer nahe dem Uferwald, mit *Deschampsia cespitosa*, *Carex diandra*, *C. limosa*, *Viola palustris*, *Potentilla palustris*, *Menyanthes trifoliata*; 18 August 1955: Hans Metlesics (LI 380337), rev. C. Pachschwöll, 2019; originally determined as *C. lanceolata* (= *C. canescens*); – Österreich, Niederösterreich, Nordöstliche Kalkalpen, Lunzer Obersee, SE-Ufer [8156/3]; 1113 msm; Verlandungsmoor; 1 June 1992: Andreas Tribsch no. 740 (SZU 15007), det. as *C. phragmitoides*, A. Tribsch, 2010 (Krit. Rothmaler, Lid's Flora); – Lower Austria (Niederösterreich), Ybbstaler Alpen: NE lakeshore of Lunzer Obersee ca. 7 km SE of Lunz am See (Scheibbs District), 15°04′42.9″E 47°48′19.4″N (8156/3); 1113 msm; terrestrialisation mire, wet meadow, together with *Calamagrostis canescens*, *Deschampsia cespitosa*, *Filipendula ulmaria*, *Potentilla palustris*, *Cirsium oleraceum*, *Carex nigra*, *C. rostrata* and others; 14 July 2017: Clemens Pachschwöll & Milan Štech CP1102 (CBFS 7745, WU 0107992, WU 0107993, W 2019-09981).

## 4. Discussion

*Calamagrostis purpurea* is generally a rare species in the Alps, but it can be assumed that additional populations will be detected in Austria. Shores of small lakes and wet montane to subalpine tall-forb meadows in glacial cirques in the northern part of the Alps at elevations up to 1500 msm seem to be the most promising habitats for such new discoveries. In addition, the species may be expected in the Austrian part of the Bohemian Massif, especially in the northern part of the Mühlviertel.

Ideas about the last glacial environmental conditions and vegetation of Central Europe have changed during the recent decades (Willis & al. 2000, Barron & Pollard 2002, Willis & Van Andel 2004, Birks & Willis 2008, Tzedakis & al. 2013). The current environmental conditions and vegetation of southern Siberia seem to be the most similar modern analogues of the situation in eastern Central Europe during the last glacial period (Chytrý & al. 2008, Kuneš & al. 2008). The scattered occurrences of the mainly boreal *C. purpurea* in the Alps are well in line with the disjunct distribution of other rare boreal taxa, such as *Linnaea borealis*, *Pedicularis sceptrum-carolinum* or *Polemonium caeruleum* (Kulczynski 1924, Meusel & Jäger 1965–1992, Fischer & al. 2008, Wróblewska 2013a,b). The presence of these taxa was often explained by the periglacial survival during the Ice Ages and a relict character (Gams 1933). A recently published model of the European distribution of vegetation types at the Last Glacial Maximum (Janská & al. 2017) supposed a wide distribution of peatland forests potentially appropriate for *C. purpurea* in the area between the continental and alpine ice sheets. After postglacial climate warming and subsequent vegetation changes, populations from the distribution area north of the Alps likely successfully spread northwards as well as southwards and upwards. Rarely, populations might have spread to a few ecologically appropriate areas within the formerly glaciated areas of the Eastern Alps (Van Husen 1987, Tribsch & Schönswetter 2003). Under this scenario, it remains open why *C. purpurea*, which is quite widespread and common in northern Europe and Siberia, has not been able to colonize larger areas in the Alps as other species with similar habitat requirements have. Therefore, the alternative hypothesis of a recent, even post-glacial, repeated and independent immigration from northern (Scandinavia) or north-eastern (boreal Russia) populations cannot be refuted. The fact that the seeds of the *C. canadensis* agg. are morphologically perfectly suited for long-distance dispersal by wind (Lieffers & al. 1993) would support the recent dispersal hypothesis. On the other hand, the newly known localities in the Carpathians seem to support "the relict hypothesis". Comprehensive and range-wide phylogeographical data of the *C. canadensis* agg. is needed to test those two hypotheses.

As in Switzerland, two populations of *C. purpurea* have been confirmed in Austria. Following Bornand & al. (2016), we suggest treating *C. purpurea* as "endangered" (EN) in the forthcoming Austrian Red Data Book. Due to its general rarity, *C. purpurea* has been considered "endangered" (EN) in Bavaria and the Czech Republic, although more populations are known there (Scheuerer & Ahlmer 2003, Grulich 2012).

## Appendix 1: Identification key for *C. purpurea* and similar species in Austria

*Calamagrostis purpurea*, *C. canescens* and *C. villosa* form a group characterized by the presence of a slender awn that is not very different from the callus hairs in the flower. In contrast, other Central European *Calamagrostis* species have thicker awns that are clearly distinct from the callus hairs (Conert 1998, Müller & al. 2017, Štech 2019).

For the identification of the three morphologically similar *Calamagrostis* species, we present the following key with photographs of relevant characters (Plate 1), following point 5 in the key in Fischer & al. (2008). Although the variation in important diagnostic characters is large, their combination usually allows for a correct identification.

1a Ligule of upper stem leaves 5–15 mm long (Plate 1, A1), with erect long (>50 µm) hairs (Plate 1, A2); fresh leaf blade usually greyish or bluish green and rather dull on both sides; anthers usually with aborted pollen.....*C. purpurea*
b Ligule of upper stem leaves shorter than 6 mm (Plate 1, B1), with erecto-patent or appressed short (<50 µm) hairs (Plate 1, B2), rarely glabrous; fresh leaf blade ± fresh green, usually ± shiny on the lower side; anthers with viable pollen.....2
2a Culms with 5–8 nodes, frequently branched; leaves usually without a hair bundle at the junction of lamina and sheath (Plate 1, B2); awn apical, up to 1 mm long, inserted between the apical teeth of the lemma, rarely subapical (Plate 1, B3) ...*C. canescens*
b Culms with 3–5 nodes, rarely branched; leaves often with a hair bundle at the junction of lamina and sheath (Plate 1, C2); awn dorsal, up to 3.5 mm long, frequently inserted below, occasionally above the middle of the lemma, rarely missing (Plate 1, C3)..... *C. villosa*

Variation in awn length and awn insertion point on the lemma is large, but the general characteristics seem to be stable. *Calamagrostis canescens* has very slender and short awns (up to 1.5 mm, i.e., the shortest of the three species), inserted close to the apex of the lemma (Plate 1, B3), which is often deeply notched. *Calamagrostis purpurea* and *C. villosa* have longer awns, up to 3.5 mm long. The awn of *C. purpurea* is frequently inserted above the middle of the lemma, occasionally below, and is rarely missing (Plate 1, A3). *Calamagrostis villosa* frequently has the awn below the middle of the lemma, occasionally above it, or is rarely missing the awn (Plate 1, C3).

Regarding growth form, *C. canescens*, *C. purpurea* and *C. villosa* are quite similar, generally laxly caespitose, with long rhizomes. *Calamagrostis canescens* often forms dense stands, whereas *C. purpurea* grows usually solitarily or in sparse stands, but dense stands very similar to *C. canescens* are also possible. Both species usually have

**Plate 1:** Comparison of microscopic traits of the ligules and awns of Austrian collections of *Calamagrostis purpurea*, *C. canescens* and *C. villosa*. A: *Calamagrostis purpurea*, Lower Austria, Lunzer Obersee (CBFS 7754). B: *Calamagrostis canescens*, Lower Austria, Lunzer Obersee (CBFS 7755). C: *Calamagrostis villosa*, East Tyrol, Virgental, Pebellalm (CBFS 7756). 1: ligules. 2: details of ligules: hairiness. 3: awns. Scale bars in the first row are 5 mm, those in the second and third rows are 1 mm (Photos: Milan Štech). — **Tafel 1:** Vergleich mikroskopischer Merkmale der Blatthäutchen und Grannen bei österreichischen Aufsammlungen von *Calamagrostis purpurea*, *C. canescens* und *C. villosa*. A: *Calamagrostis purpurea*, Niederösterreich, Lunzer Obersee (CBFS 7754). B: *Calamagrostis canescens*, Niederösterreich, Lunzer Obersee (CBFS 7755). C: *Calamagrostis villosa*, Osttirol, Virgental, Pebellalm (CBFS 7756). 1: Blatthäutchen. 2: Blatthäutchendetail: Behaarung. 3: Grannen. Maßstab: erste Reihe: 5 mm; zweite und dritte Reihe: 1 mm (Fotos: Milan Štech).

A1
B1
C1
A2
B2
C2
A3
B3
C3

branched stems, whereas *C. villosa* is usually unbranched, although it may occasionally be branched, especially towards the end of the vegetation period. Whereas *C. canescens* and *C. villosa* are well distinguished in the field due to the different habit, they are difficult to distinguish in herbarium material. In contrast, *C. purpurea* is often confused with robust plants of *C. villosa* in the field (Conert 1998, Müller & al. 2017, Štech 2019, Štech pers. obs.).

In addition to morphology, flow cytometry has proven to be a useful tool to confirm species identification in *Calamagrostis* (Schaabová 2015). Both Austrian populations of *C. purpurea* are DNA-octoploid (Schaabová & al. unpub.).

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