Scolochloa marchica Düvel, Ristow & H. Scholz – a German-Polish endemic species of the lowlands and the distribution of S. festucacea (Willd.) Lk. in Poland

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Abstract. In the current study, an extensive worldwide herbarium search, including over 1500 herbarium sheets of Scolochloa festucacea (Willd.) Lk., was performed to find specimens of S. marchica Düvel, Ristow & H. Scholz. The latter is a recently described new species, whose primary distribution was found to be limited to the Brandenburg region in Germany and the Wolin Island in Poland. As a result of the query, S. marchica was not identified in any regions other than those previously known. This indicates that it is a German-Polish endemic species, with a limited distribution range. Taking advantage of flow cytometry, we analysed for the first time the nuclear DNA content of both Scolochloa species and the obtained 2C values correlated exactly with their chromosome numbers. These data allowed us to put forward a hypothesis of evolution of S. marchica from S. festucacea. The new results, together with those previously published, confirmed that we deal with a distinct species. Taking into account recent records of this endemic species, it is currently known from 9 extant and 6 historical localities in Germany. Field search for the species in its only historical locality in Poland, on the Wolin Island, was unsuccessful. The critical revision of herbarium and literature records of S. festucacea from the territory of Poland allowed us to generate an updated distribution map of this declining species, which deserves special protection.

Key words: Scolochloa festucacea, Scolochloa marchica, endemic species, grasses, distribution, flow cytometry, Central Europe, Germany, Poland

1. Introduction

Scolochloa marchica Düvel, Ristow & H. Scholz, was described in 2001 as a new species of the formerly monotypic genus Scolochloa (Düvel et al. 2001), based on findings of atypical individuals of S. festucacea (Willd.) Lk. in 1998 at Großer Wentowsee located north of Berlin, Germany. The new taxon was originally identified in the field at 3 localities (Düvel et al. 2001), all in the federal state of Brandenburg, but since then, several new stands of this species have been found (Bettinger et al. 2013). Besides, the historical and isolated occurrence of S. marchica on the Wolin Island (Poland) is documented by a single herbarium sheet.

This recently described species grows in habitats similar to those of S. festucacea, i.e. on lake shores, along sluggish rivers, in swamps, sloughs and marshes, rarely in ditches and on wet meadows (Fig. 1), frequently together with other littoral reeds, like Phragmites australis, Glyceria maxima, and Phalaris arundinacea (Fischer & Kummer 1994; Conert 1998; Düvel et al. 2001).

Scolochloa marchica differs clearly from the other species in both morphological and cytogenetic characters (Table 1, Fig. 2) (Düvel et al. 2001). The most evident differences concern spikelet morphology. In contrast to S. festucacea, the former has glumes of even length and longer than lemmas, which are covered densely with hairs (Table 1, Fig. 2) (Düvel et al. 2001).

So far, S. marchica has been found only at the western limit of the European range of S. festucacea. The question arises if the new species occurs also in other parts
of the very wide distribution range of \textit{S. festucacea}. The herbarium specimens verified previously (Düvel et al. 2001) suggested that \textit{S. marchica} does not occur outside a very limited area in German and Polish lowlands. However, the number of verified specimens was low and did not cover the whole distribution range of \textit{S. festucacea}. Therefore, we decided to revise herbarium specimens of \textit{S. festucacea} from its whole distribution range, focusing especially on those from the Baltic region. Beside morphological characters, the most unequivocal evidence discriminating species and hybrids is their chromosome number or nuclear DNA content. That is why we provide here the results of nuclear DNA content analysis of both species and the updated information on the general distribution range of \textit{S. marchica}, as well as that of \textit{S. festucacea} in Poland.

2. Material and methods

For microscopic observations and micrographs of \textit{Scolochloa} spikelets, we used a Bresser Advance ICD 10x-160x microscope (Meade Instruments Europe GmbH & Co. KG, Germany).

Flow cytometry was applied for nuclear DNA content estimation. For the analysis, plants from the following locations were used: \textit{S. festucacea} – Brandenburg, Potsdam, E shore of Lake Wublitz, 0.4 km S of Nattwerder, 31 Aug 2023, leg. L. Bergmühl; and \textit{S. marchica} – Brandenburg, Potsdam Nuthetal, Silbergraben, S of Nuthedamm, 31 Aug 2023, leg. M. Ristow. Samples were prepared and analysed as previously described (Kalinowski et al. 2016). \textit{Secale cereale} cv. Dankowskie (2C=16.19 pg; Doležel et al. 1998) and \textit{Pisum sativum} cv. Set (2C=9.11 pg; Sliwinska et al. 2005) were used as internal standards for \textit{S. festucacea} and \textit{S. marchica}, respectively.

Four leaves of each species were individually analysed with a CyFlow Ploidy Analyser (Sysmex Partec GmbH, Görlitz, Germany) flow cytometer. For each sample, at least 5000 nuclei were used to determine nuclear DNA content. Histograms were analysed using CyView 1.6 software. Coefficient of variation (CV) of the \(G_0/G_1\) peak of the \textit{Scolochloa} samples ranged from 6.15\% to 6.74\%. Nuclear DNA content was calculated from the ratio of the target species and the internal standard 2C peak positions on the histogram of fluorescence intensities.

To investigate the potential distribution of \textit{S. marchica} in Poland, field research was conducted in 2022 and 2023 in the region of the Wolin Island and at other historical localities of \textit{S. festucacea}, shown in Fig. 3 (insert).

\begin{table}[h]
\centering
\caption{Morphological and cytogenetic differences between \textit{Scolochloa marchica} and \textit{S. festucacea} (based on Düvel et al. 2001 and own observations)}
\begin{tabular}{|l|l|l|}
\hline
\textbf{Trait} & \textbf{\textit{S. marchica}} & \textbf{\textit{S. festucacea}} \\
\hline
Glumes & ± even & uneven, upper longer than lower glume \\
Lemmas & shorter than glumes & longer than lower glume \\
& outer side densely hairy & outer side smooth or slightly scabrid \\
Florets & embedded between glumes & protruding from glumes \\
Callus hair length & relatively long, ca. 2 mm & relatively short, 1-1.5 mm \\
Leaves & leaf ribs (veins) flat & leaf ribs protruding \\
& upper surface slightly scabrid, spine-like hairs sparse & upper surface very scabrid, spine-like hairs abundant \\
Ploidy & hexaploid, \(2n = 42\) & tetraploid, \(2n = 28\) \\
\hline
\end{tabular}
\end{table}
Fig. 2. Spikelet morphology of: (1a, 1b) *S. marchica* from Neuruppin (KRA224249), (1c) *S. marchica* from Neuruppin (KRA224254), (2a, 2b) *S. festucacea* from Lake Gopło (GMP herbarium), (2c) *S. festucacea* from Lake Jeziorak (KRA77110), (3a-c) *S. marchica*, Dorpat in Tiefland (?), com. von Uechtritz (WRSL) (photo 3c by E. Lenard, all the others by J. Kruk)
Herbarium specimens of *S. festucacea* analysed in the search for *S. marchica* were from virtual herbaria (https://www.gbif.org/species/5289768, https://virtherbard.senckenberg.de, https://www.jacq.org/#database) or obtained from curators of other herbaria. In the case of virtual herbaria, only the number of specimens revised from a given herbarium is indicated. In the latter case, all the specimen data are provided in the Appendix 1. The following other herbaria were consulted for records of *S. festucacea* and *S. marchica*: B, BILAS, FR, GFW, JE, KRA, KRAM, LATV, LBL, M, OLS, RIG, TRN, WA, and WRSL (abbreviations follow Thiers 2016).

For the preparation of an updated distribution map of *S. festucacea* in Poland, a number of unpublished herbarium data and literature data were provided. In the case of older herbarium and literature data, the original, German description on the herbarium labels and geographic names were given, as well as the appropriate translation. Maps from the Archive Maps of Poland and
Central Europe (http://igrek.amzp.pl/) were used for the identification of historical places. In some cases, if both herbarium and literature data referred to the same location and similar dates, the literature data were omitted. Among the references cited by Frey (2005), the following publications were omitted: Ascherson & Graebner (1898-1899), Pfuhl (1896) and Szulczewski (1951), as the localities given in those works are very general and covered by other publications cited in the current article.

The distribution map on the ATPOL grid (10 km × 10 km squares) (Zając & Zając 2001) was generated using Gnomon 3.3 software (Desmodus, Poland).

3. Results

3.1. DNA content analysis

The chromosome number of both species was earlier investigated by Düvel et al. (2001) (Table 1), but genome size was not analysed previously for any of these species. Flow cytometry measurements of nuclear DNA content (2C values) revealed that the value for *S. marchica* is nearly 1.5 times higher than that for *S. festucacea* (Table 2). This corresponds perfectly to the ratio of chromosome numbers (42/28) for both species, and indicates evidently that we deal with 2 distinct *Scolochloa* species.

Table 2. Nuclear DNA content (pg/2C) of the investigated *Scolochloa* taxa. The values are means ± SD (*n* = 4). The leaves analysed originated from 4 different plants of each taxon collected at the locations indicated in section 2 (Material and methods)

<table>
<thead>
<tr>
<th>Taxon</th>
<th>DNA content (pg/2C)</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>S. festucacea</em></td>
<td>9.96 ± 0.13</td>
</tr>
<tr>
<td><em>S. marchica</em></td>
<td>14.88 ± 0.07</td>
</tr>
</tbody>
</table>

3.2. *Scolochloa marchica* – general distribution

*Scolochloa marchica* in Germany is currently known from 9 extant localities, i.e. Großer Wentowsee (N of Berlin), N of Oranienburg, Ketzin am Havel (W of Berlin – 2 populations), Potsdam (Drewitz and Schlaatz), and 3 populations south of Potsdam (Fig. 3 and subsection 3.3 – List of localities). Besides, the species is known from 5 historical sites represented by herbarium specimens, i.e. Neuruppin (NW of Berlin), Oranienburg and Pinnow (N of Berlin), and 2 in Berlin (Strahlau and Köpenick). The population at Neuruppin, nowadays extinct, was probably very abundant, as it is represented by numerous herbarium sheets, as compared to those from other places. Taken together, *S. marchica* is restricted in central Brandenburg to the river systems of Nuthe, Havel, and Spree in the wider surroundings of Berlin, whereas in northern Brandenburg the known distribution is confined to 2 lakes.

In Poland, *S. marchica* is known from only one historical stand at Wolin, represented by one herbarium specimen (Fig. 4). It is not certain if “Wollin” (in German) refers to the town of Wolin or the Island of Wolin. The label has no date, but taking into account the living period of H. Seehaus (1813-1891) and that of J. Winkelmann (1842-1921), it can be inferred that the specimen is from the late 19th century. Two other herbarium specimens preserved from Wolin and Szczecin (Stettin), stored in GFW herbarium, were revised as *S. festucacea*. The plants from the other localities in this region (see Fig. 3, insert), mentioned in the literature, i.e. Lebbin [Lubin] (Conert 1998), Schwankenheim [Kielpinica], Fürstenflagge [Bolesławice], Ihnazoll [Inica near Sowno] (Schmidt 1840, 1848; Müller 1898) could not be verified because of the lack of the corresponding herbarium materials. Moreover, among localities of *S. festucacea*
given by Müller in the third edition of Flora von Pommern (Müller 1911), but not in the previous editions (Müller 1898, 1904), we found Wollin (Kreis Randow, Germany). In that region, there are two closely situated small villages with the name Wollin: one near Randowtal and the other near Penkun. The origin of Seehaus and Winkelman’s herbarium specimen from these villages can be rather excluded, as the area of botanical interest of both botanists was Szczecin and the Wolin Island region. On the other hand, Conert (1998) mentions Lebbin [Lubin] as an example of the localities of S. festucacea on the Island of Wolin, suggesting that there were more of them. Unfortunately, the original source data for this note are unknown.

In 2022 and 2023, extensive field search for S. festucacea at the historical sites (besides Szczecin) was performed, as well as at other, selected sites with appropriate habitats on the Wolin Island, i.e. lake shores, bogs, along rivers, and the southern island coast. However, the species was not found there.

Scolochloa festucacea shows circumboreal distribution in the Northern Hemisphere (Fig. 5). In Eurasia it occurs from Germany and Baltic countries in the west, to Yakutsk region in the Far East, and to the Caucasus (Georgia) in the south. Two isolated stands of S. festucacea in Europe were found in the last few decades in Hungary (Király 2005) and Sweden, close to Uppsala (Johansson 1987). In North America it grows from Alaska to the Great Lakes region. Among the Baltic countries, S. festucacea is rare in Poland and particularly in Lithuania, where it is included in the Red Data Book (Rašomavičius 2021), but further north it is considerably more frequent, especially in Estonia and Finland. The latter countries are represented in various herbaria by a high number of collected S. festucacea plants, accounting for over 500 specimens that were available for the analysis (see Appendix 1). In this study, over 1500 herbarium specimens of S. festucacea were verified, from nearly the whole area of its distribution (Fig. 5), and among these specimens only 6 were identified as S. marchica: from the Brandenburg region and one specimen of doubtful origin, labelled “Dorpat in Tiefland”, com. von Uechtritz (WRSL). That specimen shows most of the characters of the florets typical for S. marchica (Fig. 2). The lemma is covered with hairs only in the upper part, in contrast to the typical S. marchica where the hairs are found on the entire surface of the lemma. As none of the very numerous herbarium specimens

Fig. 5. General distribution map of Scolochloa festucacea according to Hultén & Fries (1986, reproduced with permission). Verified herbarium specimens originated from areas highlighted in yellow.
investigated from Tartu (Dorpat) region showed characters of *S. marchica*, the locality "Dorpat" could be false, as most probably that specimen originated from the Brandenburg region.

### 3.3. *Scolochloa marchica* – list of localities

**Germany**


Neuruppin, Seeufer [lake shore], June 1876, leg. Warnsdorf (JE); Mark Brandenburg: nördlich [north of] Ruppin, jenseitiges Seeufer [on another side of lake], July 1867, leg. Warnstorff (B); Neu-Ruppin, See-Ufer, einzeln [individually], July 1878, leg. Granzow (B); Neuruppin, am Seeufer, July 1878, leg. J. Warnstorff (KRA224249); Neuruppin: auf Wiesen [on meadows], July 1882, leg. Joh. Warnstorff (H596270); Neu Ruppin, 688, leg. Warnstorff (KRA224254);

Schloßgarten bei [near] Oranienburg, (s.d., before 1850), leg. A. Dietrich (Hb. Dietrich, University of Potsdam); In einem Seitenarm der Havel bei [In a branch of Havel River near] Pinnow (s.d., before 1900) (JE); Friedrichsthal, Niederung nördlich des Malzer Kanals [lowland north of Malzer Canal], 2022, leg. J. Halfmann & Y. Rothe (Hb. Ristow);


N-Ende [N end of] Größensee zwischen [between] Tremsdorf und Mietgendorf, Röhrich am Feuchtwiesenrand, leichter Salzeinfluß [reeds on edges of a wet meadow, slight influence of salt], 8 July 2014, leg. W. Petrick & M. Ristow (Hb. Ristow); 0.75 km N of Lüowiedorf (b. Trebbin), E-See des Bruchs [E side of bog], with *Phragmites*, 1993 obs. A. Herrmann (as *Scolochloa sp.*), 8 July 2014, leg. W. Petrick & M. Ristow (Hb. Ristow); Glieniksee, 1 km NW of Dobbrkow, Seeröhricht, 10 Aug 2013, leg. M. Ristow & B. Groth (Hb. Ristow), location given by Hudziok (1974) for *S. festucaea*;

Strahlu, Berlin, 1843, leg. Anonymous (P03631289); Strahlu bei der Kirche [near church], July 1868, W. Vattke (scripsit) (JE);

Köpenick, 1873, leg. Becker (JE); Berlin: Köpenick, Aug 1890, leg. Lehmann (L.1266382); Cöpenick, Aug 1896, leg. Lehmann (B);

Allemagne Orientale: Brandenburg, July 1910(9), leg. Leonhard? (CLF148582).

**Poland**

Wollin, Herbarium Seehaus, com. Winkelmann (GFW17193).

**Other countries – location questionable**

Dorpat in Tiefland, com. von Uechtritz (WRSL).

### 3.4. *Scolochloa festucaea* in Poland

*Scolochloa festucaea* is declining and threatened in Poland (Frey 2010), so it was placed on the Red List and classified as VU (Kaźmierczakowa et al. 2016). In this study, a critical review of herbarium specimens and literature data on the species was performed and based on these data an updated distribution map in Poland was generated (Fig. 6). As compared to the previously published distribution map of *S. festucaea* (Frey 2005), several corrections and updates were included. Its localities in Poland are scattered mainly in the north of the country, reaching Warsaw, the Vistula River valley, and Lublin Highlands southwards (Fig. 6). Altogether, *S. festucaea* was reported from 22 localities represented by herbarium specimens and from about 40 localities described in the literature, the majority of which are historical data from the late 19th century and early 20th century. These records correspond to 32 ATPOL squares representing data from before 1941, 10 squares – from the period between 1941-1980, and 11 squares indicating data obtained after 1980 (Fig. 6). Among herbarium specimens listed previously by Frey (2005), two from OLS and one from LBL were currently not found in the corresponding herbaria, so these specimens were not available for the taxonomic revision. All the other herbarium specimens examined belonged to *S. festucaea*. The reports on the occurrence of *S. festucaea* in the south of Poland (Zajač & Zajač 2001) are incorrect (Frey 2005). The corresponding herbarium specimens, deposited in KRA, belong to *Festuca arundinacea*. 

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List of localities of *Scolochloa festucacea* in Poland

**Herbarium specimens**

**AB34** (ATPOL grid 10 km x 10 km) – auf der Plagge [island name] am 2 Strom [river] (?) bei Wollin, leg. A. Lehman (GFW060633); Wollin, 1868, leg. Lehmann (GFW060632);

**AB83** – Exemplar pomeranum [Pomeranian specimen], Stettin [Szczecin], June/July, leg. Anonymous (GFW060631);

**CC67** – An der Montwy unweit Ostrow [at Maťwy, not far from Ostrów], in Kreise Inowrazlaw [Inowrocław district], 4 July 1892, leg. Spribille (L.1266349); Montwy, 1889, leg. Spribille (POZ-V-0136083);

**CC98** – Przewóz, szuwary n/Gopłem [rushes by Lake Gopło], 13 June 1994, leg. J. Chmiel (Hb. of Gopło Millenium Park, GMP);

**DA80** – Danzig, Alter Mottlauarm bei Walddorf [Gdańsk, an old arm of Motława River near Olsynka], June 1906, leg. H. Preuss (TRN-B.S.1388); Danziger Niederung, Alter Mottlauarm bei Walddorf, June 1906, leg. H. Preuss (TRN-B.S.1420); Danziger Niederung [Gdańsk Lowland], Walddorf, June 1906, leg. H. Preuss (TRN-B.S.1428); Kr. Danzig, Alter Mottlauarm bei Walddorf, June 1906, leg. H. Preuss (TRN s.n.); Danzig, 16 June 1912, leg. H. Steffen (L.1266386);

**DB76** – Iława, Lake Jeziorka, 10 July 1971, leg. E. Nowak (TRN s.n.); Iława, Lake Jeziorka, 24 July 1974, leg. M. Rajewski et W. Gugnacka; (KRA77110, KRAM216297, LBL029511, TRN s.n., WA133172, H596267, AMD.122834, L.1334035);

**DB81** – Graudenz [Gruziądz], an dem nördlichen Teil des Rudnicker Sees [at N shore of Lake Rudnickie], 30 Aug 1874, comm. Caspary (TRN-B.S.972); Graudenz, Am See von Rudnick [by Lake Rudnik], 2 July 1879, leg. Scharlock (TRN-B.S.1057); Graudenz, Am Ufer bei grossen Sees von Rudnick [shore by large Lake Rudnik], 30 July 1874, leg. R. Caspary (TRN s.n.); Graudenz: Gestade des Sees von Rudnick [shore of Lake Rudnik], 2 July 1879, leg. Scharlock (US04035021); Graudenz: Rudnick, 2 July 1879, leg. Scharlock (UGDA-OLS0012433);

**DC11** – Mlewo, on meadows by a canal, 15 July 1901, leg. K. Stampska (POZ-V-0136082);

**EB49** – Nikolaiken [Mikołajki], Sumpfiger Seerand, ca. 1-2 m vom Ufer [swampy edge of a lake, ca. 1-2 m from its shore], 6 July 1908, leg. Fibelkorn (U.1511751);

**EB67** – Ortelsburg [Szczytno], Marxowöner [Marxöwer] See [Lake Marksoby], 13 July 1890, leg. Abromeit (TRN s.n.);

**ED26** – między Wola a Czystem pod Warszawą [between Wola and Czyste near Warsaw], (probably 19th century), leg. Anonymous (KRA223343);

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**Fig. 6.** Distribution map of *Scolochloa festucacea* in Poland on the ATPOL grid

Explanations: red symbols – records before 1941; yellow – between 1941 and 1980; green – after 1980; dots – only herbarium specimens; squares – both herbarium and literature data; triangles – literature and other data. If there are multiple records from the same square, the most recent is illustrated using an appropriate colour
ED36 – Warszawa-Dawidy, nad jeziorem [by a lake], 27 July 1979, leg. B. Sudnik-Wójcikowska (WA133173) (the species at this location was still extant in 2013 but not in 2015, Kalinowski pers. com.); Warszawa-Paluch, wilgotna ląka nad rowem melioracyjnym [wet meadow over a drainage ditch], 29 Aug 1980, leg. B. Sudnik-Wójcikowska (WA133174); ED37 – Warszawa (Moczydło), skraj Lasu Kabackiego [edge of Kabaty Woods], 1 Aug 1979, leg. B. Sudnik-Wójcikowska (WA133175); FA90 – Węgorzewo, 15 July 1958, leg. L. Olesiński (OLS); specimen not found in the herbarium, so verification of S. marchica/festucacea not possible; FB51 – Kwik pow. [district] Pisz, na brzegach rzeczki Wyszki łączącej jezioro Śniardwy z jeziorem Białoławki [on banks of Wyszki River connecting lakes Śniardwy and Białoławki], 14 Aug 1952, leg. J. Mądalski (KRAM469907); FB61 – Lake Pogubie Wielkie near Pisz, 4 Aug 1982, leg. J. Dziedzic (OLS); specimen not found in the herbarium, so verification not possible; Ostpreußen [East Prussia], Vorderer Pogauer See [Lake Pogubie Wielkie], bei Johannisburg [Pisz], 10 July 1986, leg. H.-J. Schweitzer (FR s.n.); FAE – Warszawa (Moczydło), skraj Lasu Kabackiego [edge of Kabaty Woods], 1 Aug 1979, leg. B. Sudnik-Wójcikowska (WA133175); FAE – Warszawa-Paluch, wilgotna łąka nad rowem melioracyjnym [wet meadow over a drainage ditch], 29 Aug 1980, leg. B. Sudnik-Wójcikowska (WA133174); FA90 – Węgorzewo, 15 July 1958, leg. L. Olesiński (OLS); specimen not found in the herbarium, so verification of S. marchica/festucacea not possible; FB51 – Kwik pow. [district] Pisz, na brzegach rzeczki Wyszki łączącej jezioro Śniardwy z jeziorem Białoławki [on banks of Wyszki River connecting lakes Śniardwy and Białoławki], 14 Aug 1952, leg. J. Mądalski (KRAM469907); FB61 – Lake Pogubie Wielkie near Pisz, 4 Aug 1982, leg. J. Dziedzic (OLS); specimen not found in the herbarium, so verification not possible; Ostpreußen [East Prussia], Vorderer Pogauer See [Lake Pogubie Wielkie], bei Johannisburg [Pisz], 10 July 1986, leg. H.-J. Schweitzer (FR s.n.);

Literature and other data

AB32 – Lebbin [Lubin] (Conert 1998); AB63 – Schwankenheim [Kielpinica] (Schmidt 1840, 1848; Müller 1898); AB64 – Fürstenflage [Bolesławice] (Schmidt 1840; Müller 1898); AB85 – Ihnazoll (Krug) [Inica near Sowno] (Schmidt 1840; Müller 1898); BB57 – Trzesieka (Rutkowski 1982); BC39 – Chodzież (Wodziczko et al. 1938); BD18 – Pulawy, dolina Wisły [Vistula valley], 5 July 1969, leg. D. Fijałkowski (LBL029510); BD39 – Śrem (Wodziczko et al. 1938); CB41 – zw. Konzungsee u. Platzig [between Lake Końskie and Płaszczycy]; Brahefl. b. Prechlau [Brda River near Przechlewo] (Abromeit 1898-1940); CB51 – Konzungsee b. Zieten [Lake Końskie near Szczytno]; NO-Ufer d. Kl. Ziethenses b. Zieten [NE shore of Lake Szczytno Male near Szczytno]; Ufer d. kl. Insel, die d. Ausfluß d. Brahe aus d. Gr. Ziethensees zunächst liegt [shore of a small island, close to outflow of Brda River from Lake Szczytno Wielkie] (Abromeit 1898-1940); CC23 – Josephowo [Józefkowo] (Bock 1908); CC35 – Netze-Wiesen [meadows by Noteć River] (Nutzhorst) (Bock 1908); CC66 – Trlong-See (Broniewitz) [Lake Pakowskie Południowe, Broniewice] (Bock 1908); CC67 – Montwy-Wiesen (Popowitz) [Mątwy meadows, Popowice] (Bock 1908); CC68 – Lojewo-See [Lake Łojewo = Lake Szarlej] (Bock 1908); CC78 – Goplosee (Kruschwitz) [Lake Gopło-Kruszwica] (Bock 1908); CC88 – Racice, Ruisinowo, Kicko, Ostrowo, Popowo, Bachorza, Rzeszynek, Tarnówko (Lake Gopło) (Chmiel 1997); CC98 – Nowe Połajewo, Łuszczewo, Przewóz (Lake Gopło) (Chmiel 1997); DB46 – Ewingsee [Lake Ewingi] (Abromeit 1898-1940); DB60 – N-Ufer d. Radsees b. Glodowo [N shore of Lake Radodzież near Głodowo] (Abromeit 1898-1940); DB66, DB67, DB76 – Lake Jeziorak (Bohr, Rejewski 1973); DB67 – Widlungsee [Widłągi gulf of Lake Jeziorak] (Abromeit 1898-1940); DB81 – Wäldchen an Rondzen (Sanio 1882); EB59 – Mündung d. Schwarzen Flusses in d. Gartensee [mouth of Schwarze River, i.e. Lake Malinówko near Lake Gardyńskie] (Abromeit 1898-1940); EB75 – N-Ufer d. Kl. Schobensees b. Materschobensee [NE shore of Lake Sasek Mały near Lake Sasek Wielki] (Abromeit 1898-1940); EB85 – Ufer d Sawitzfl. zw. Kutzburgmühle u. Jankowen [left riverbank of Sawica between Papiernia and Jankowo] (Abromeit 1898-1940); FB02 – Lake Żabinki (Grzybowski, Endler 2002); FB10 – Mauersee b. Gutten [Lake Mamry near Guty] (Abromeit 1898-1940); Angerburger See bei Lötzen (Sanio 1882); FB11 – Woysacksee [Lake Wojsak] (Abromeit 1898-1940); FB12 – Goldaparsee [Lake Goldopiwo] (Abromeit 1898-1940); FB40 – Zufluß in d. Spirdingsee aus dem Luknainer See an d. Brücke [tributary of Lake Śniardwy from Lake Łuknajno, near a bridge] (Abromeit 1898-1940); Spirdingsee b. Luknainen [Lake Śniardwy near Łuknajno] (Abromeit 1898-1940); FB41 – Tirklosee b. Eckersberg [Lake Tyrkło near Okartowo] (Abromeit 1898-1940); FB43 – Abluflgraben am Arysssee W. v. Werder [outflow of a drainage ditch at Lake Orzysz, W of Ostrów] (Abromeit 1898-1940); FB50 – Beldahsee b. Nikolaiken [Lake Beldan near Mikolałki] (Abromeit 1898-1940);
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During our extensive herbarium search, we analysed over 1500 specimens from the whole distribution range of *S. festucacea*, but we found only 6 herbarium sheets of *S. marchica*, all originating from the region of Brandenburg. Therefore, it can be concluded that we deal with an endemic species limited to a relatively small area of the state of Brandenburg and the Wolin Island. The only herbarium sheet corresponding to *S. marchica* from outside this area, was most probably wrongly labelled (Turku, Estonia), as discussed previously. The name appearing on the label of this sheet is "von Uechtritz" (as com.) but neither Rudolph nor his father Max visited Estonia or Russia. According to the WRSL curator (Dr E. Lenard), among over 800 herbarium sheets with the name "von Uechtritz", none is from Russia. Nevertheless, "com." (*communicavit, comissum?*) suggests that the collection of the specimen was only ordered by von Uechtritz but it was gathered by an unknown collector. Therefore, this issue cannot be resolved at the moment.

The chromosome number of *S. marchica* (*2n* = 42, hexaploid) determined previously (Düvel et al. 2001) was different from the known numbers found for *S. festucacea* (*2n* = 28, tetraploid) from different countries: Poland (Pogan et al. 1985), Sweden (Löve & Löve 1944), Canada (Löve 1981), and Russia (Takhtajan 1993). Moreover, the currently performed analysis of genome size of both species, revealed that the obtained values correlate perfectly with chromosome numbers, i.e. we do not observe any loss of DNA following polyploid formation (genome downsizing), which is found frequently in angiosperms (Leitch & Bennet 2004). These data shed light on the origin of *S. marchica*. First, it is hardly probable that *S. marchica* is a hybrid of *S. festucacea* and an unidentified species of a different genus, with a chromosome number of *2n* = 56. Another scenario is that *S. marchica* was formed first by polyploidization of *S. festucacea* to a taxon with *2n* = 56 (octoploid – unknown or extinct), followed by hybridization of *S. festucacea* with the octoploid to give chromosome number of *2n* = 42 in *S. marchica*. However, the most straightforward possibility is hybridization of the tetraploid *S. festucacea*, introducing an unreduced gamete (*n* = 28), with the tetraploid carrying a normal gamete (*n* = 14). As genome downsizing was found to correlate with increasing age of polyploids (Leitch et al. 2008), the lack of such an effect in *S. marchica* may indicate that this species has evolved relatively recently. Generally polyploidization is considered often as one reason of being more resilient to extreme environments (cf. e.g. Van de Peer et al. 2021). Thus *S. marchica* could have evolved around one of the last glaciations. Further research on the chromosomal and genetic variability might provide insight into the evolutionary relationship and history of both *Scolochloa* taxa.

The presented genetic data and the pronounced morphological differences between *S. festucacea* and *S. marchica*, together with a very limited distribution of the latter, suggest that *S. marchica* evidently deserves the rank of a separate species. Currently, however, it is treated as a synonym of *S. festucacea* in the Kew World Checklist (https://powo.science.kew.org) for unknown reasons.

*Scolochloa marchica* is represented only by 14 herbarium sheets among ca. 150 representing *S. festucacea* from the Berlin area and surrounding regions, collected in the late 19th and early 20th century (based on data in Appendix 1 and Düvel et al. 2001), indicating that *S. marchica* even in historical times was evidently less common than *S. festucacea* in this area. Even though new localities of *S. marchica* have been found in recent years, nowadays it is also considerably less frequent than *S. festucacea* in Germany and deserves special protection. In Poland, *S. marchica* is probably an extinct species, known from one historical location on the Wolin Island. Similarly, although *S. festucacea* was known from several historical localities in the Szczecin-Wolin...
region, it has not been recorded from this area for a long time. Nevertheless, it is puzzling why *S. festucacea* was not mentioned in the 2 monographs on the flora of the Wolin Island (Lucas 1860; Piotrowska 1966). Although none of the *Scolochloa* species were found in this region during current field studies, a rediscovery of at least *S. festucacea* in this area cannot be excluded.

As indicated in the distribution map (Fig. 6), *S. festucacea* is evidently a declining species in Poland, as the majority of the records come from the late 19th and early 20th century, and only 11 localities were confirmed after 1980. Unfortunately, the majority of localities from northern Poland, where the species was recorded relatively numerous, are historical. Currently, *S. festucacea* probably exists only in the regions where the most abundant stands were reported in the past, i.e. by lakes Gopło, Jeziorka, Masurian Lakes, and possibly also in the Augustów Forest. Besides, the recent record from the Biebrza National Park also suggests that the species might still exist there. Undoubtedly, it should be classified as EN (endangered) or even CR (critically endangered) both in the Polish Red Data Book of Plants and in the Polish Red List of Pteridophytes and Flowering Plants.

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**Author Contributions:**

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Critical revision of the article: J. Kruk, M. Ristow
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Bock W. 1908. Taschenflora von Bromberg (Das Netzegebiet), Mittler’sche Buchhandlung (A. Fromm Nachf.). Bromberg.


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Appendix 1. Herbarium specimens of *Scolochloa festucacea* verified for the presence of *S. marchica*. The numbers in brackets, following a country name, indicate the total number of herbarium sheets verified from each country. In older collections the species occurs under different synonyms, e.g. *Arundo festucacea* Willd., *Aira arundinacea* Lilj., *Donax borealis* Trin., *Festuca borealis* (Trin.) Mert. & K. or *Graphephorum arundinaceum* Asch. For further details see section 2. Further specimens of *S. festucacea* are cited in Düvel *et al.* (2001)

*Scolochloa marchica*

*Scolochloa festucacea*
**Germany** (148)

**Poland** (36)
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Estonia (174)

KRAM236136, Tartumaa, parish Rõngu, Lake Võrtsjärv, 15.7.1930, leg. K. Eichwald; RIG: Herb. Balticum 226, Livland, Kreis
Dorpat, 28.7-9.8.1902, leg. Winkler;

Finland (356)

Sweden (87)
KRA224251, Norrköping, 6.1867, leg. Fr. Emguist?; TU319742, Norrköping, Himmelstadlund, 7.1888, leg. P. Olsson;

Hungary (1)
BP654981, Győr-Moson-Sopron county, 2 km west from Földszigt settlement, in "Csíkos-éger", in swamps and planted Euramerican poplar forests, 47°39'56"N, 17°07'01"E, 113 m, CEU 8368.2, 6.9.2004, leg. G. Király.

Russia (433)

Kazakhstan (12)
WA135151 & WA135152, Akmolinskaja obl., Kuzmurunskaja wolost, 1909, leg. F. Sjelinsky;
MW – 9, US – 1

Georgia (3)
KRAM524799 & KRAM524800, Javakheti, Akhalkalaki District, environs of Lake Tabatskuri, ca. 1937 m, 10.8.2003, leg. M. Eristavi, T. Gvinashvili, L. Jinjolia, Ch. Gagua; B s.n., dito, 2.8.2004, T. Gvianashvili & L. Jinjolia

Canada and United States (165)

Collected at unknown location (12)
AMD.122836, H596264, K000913371, K000913373, K000913374, L.1266335, L.1266378, L.1334034, LY0653421, LY0653424, US947644