

First record of a naturalized population of *Glyceria canadensis* (Poaceae), another potentially invasive New World grass species, in Switzerland

Filip Verloove & Wolfgang Bischoff

Summary: *Glyceria canadensis*, a New World weed, is reported from Switzerland for the first time. A naturalized population was discovered in a quite natural area (a protected raised bog area) in Wachseidorn (canton of Bern). The morphological differences between this species and the invasive weed *G. striata* are emphasized and their habitat is illustrated. Its ecology in the Swiss locality is outlined and an overview of the species' current distribution in Europe is provided. Taking into account the potentially invasive nature of the species and to prevent further spread, an attempt was made to eradicate already a part of the population.

Keywords: *Glyceria canadensis*, grasses, invasive, naturalization, Poaceae, Switzerland

Glyceria R.Br. is a relatively small genus that encloses ca. 35–40 species (or up to 55 if a narrower species concept is applied; see e.g. TSVELEV 2006). All species exclusively occur in wet habitats and most are confined to the northern hemisphere. The genus is particularly well-represented in North America (BARKWORTH & ANDERTON 2007) and Asia (TSVELEV 2006). In Europe, nine species and a widely distributed hybrid are native (HOLUB 1980). Only four are indigenous to Switzerland: *G. declinata* Bréb., *G. fluitans* (L.) R.Br., *G. maxima* (Hartm.) Holmberg and *G. notata* Chevall. (LAUBER et al. 2018). Most species of *Glyceria* are palatable to livestock and hence valuable pasture grasses. Some have strongly drooping inflorescences and thus also have some potential as ornamentals. However, some species tend to have weedy tendencies (HOLM et al. 1979; RANDALL 2017). For example, the Eurasian species *G. maxima* has become an invasive weed in North America and Australia (BARKWORTH & ANDERTON 2007; WEILLER & WALSH 2009). Conversely, the North American species *G. striata* (Lam.) A.S. Hitchc. has been much increasing lately in natural habitats in many parts of Europe and may have the potential to become an invasive species here (VERNIER 2015). The latter species is also known from Switzerland; it was in fact the second European country where this species was able to naturalize. According to PIWOWARSKI & BARTOSZEK (2012), it has been known from the Geneva area since 1953.

In June 2020, the second author recorded an unknown species of *Glyceria* in Wachseidorn (canton of Bern), just outside the 'Wachseidornmoos nature reserve', a protected raised bog area. The species grew in a dense stand, intermingled with *G. striata*. Although morphologically very similar, it clearly differed from the latter in having larger spikelets and wider leaves. On closer examination it was shown to be indeed a different species, *G. canadensis* (Michaux) Trin., a native of eastern North America that occurs elsewhere in the world as an introduced weed.

Since this species is obviously naturalized in Wachseidorn (it probably has been overlooked for quite a long time), moreover in a natural, vulnerable habitat, it seems appropriate to draw the attention to its presence in Switzerland. Its ecology and biology seem to be very similar or even identical with that of *G. striata*; the species thus may have the same potential to become an invasive weed.

In this paper the differences between *G. canadensis* and *G. striata* are emphasized and the former and its habitat are illustrated. The species' ecology in the Swiss locality is outlined and an overview of its current distribution in Europe is provided.

Materials and methods

Fieldwork was carried out by the second author in June 2020 in Wachseldorn (canton of Bern), within and in the immediate vicinity of the 'Wachseldornmoos nature reserve'. An unknown prolific grass species discovered on that occasion was identified by the first author using rather numerous relevant floras and papers, the most important being HOLUB (1980), TSVELEV (2006), BARKWORTH & ANDERTON (2007) and PORTAL (2014). Subsequently, the locality was revisited on several occasions and in the autumn of 2021 it was decided to eradicate the species in the most natural and vulnerable parts of the nature reserve.

Results and discussion

Morphology

Glyceria canadensis and *G. striata* are both representatives of section *Striatae* G.L. Church. In this section spikelets are clearly laterally compressed, oval in side view and not much longer than wide. The section includes seven or nine species and all are native to the New World (TSVELEV 2006; BARKWORTH & ANDERTON 2007).

Glyceria canadensis is in all respects a coarser species than *G. striata*: it usually grows taller (up to 150 cm or even more in height), with thicker culms, wider and longer flag leaves (up to 8 mm wide), longer and wider spikelets, etc. (Fig. 1A,B). In addition, lemmas are almost smooth or



Figure 1. *Glyceria canadensis* in Wachseldorn on 27 July 2021. A – The big inflorescence with drooping branches is quite characteristic; B – Details of the inflorescence. Photos: W. Bischoff.

Table 1. Measurements of the Swiss *Glyceria* compared with data for *G. canadensis* and *G. striata*, extracted from BARKWORTH & ANDERTON (2007).

	<i>Glyceria</i> Wachsedorn	<i>G. canadensis</i>	<i>G. striata</i>
Plant height (cm)	up to 100	60–150	20–80(–100)
Leaf width (mm)	up to 8	3–8	2–6
Spikelet length and width (mm)	up to 6.5 × 4	3–8 × (2.5–)3–5	1.8–4 × 1.2–2.9
Lemma surface	veins evident but not raised distally (only in lower half)	veins evident but not raised distally (only in lower half)	veins distinctly raised distally
Palea length and width	1.6× as long as wide	1.5–1.8× as long as wide	1.5–3× as long as wide

only have slightly prominent veins and paleas are less than twice as long as wide. In Table 1 measurements of the Swiss plants are compared with data for *G. canadensis* and *G. striata* extracted from BARKWORTH & ANDERTON (2007).

From the above, it soon became clear that the Wachsedorn plant indeed belongs to *G. canadensis*, a species not previously recorded from Switzerland.

Distribution, native and introduced

Glyceria canadensis is naturally restricted to eastern North America, ranging from eastern Saskatchewan and Newfoundland in Canada to Illinois and northeastern Tennessee in the United States (BARKWORTH & ANDERTON 2007). It has been introduced as a weed in cranberry farms in western North America, where it is established now. It is a high ‘priority weed’ according to SANDLER (2018).

In the Old World, *G. canadensis* was first reported from Germany (HOLUB 1980). It was collected in a military training area in the Lüneburger Heide in Lower Saxony by K. Lewejohann in 1973 (KOSSEL 1975; see also DUVIGNEAUD et al. 1996). However, this species has no longer been mentioned in contemporary German floras or checklists (e.g. CONERT 1998, JÄGER et al. 2017) and thus probably has disappeared from that area.

Since 1995, *G. canadensis* is also known from Belgium. It was first observed in the Hautes Fagnes Natural Park in Waimes near Malmedy (province of Liège; DUVIGNEAUD et al. 1996, SAINTENOY-SIMON 1997). Soon afterwards, in 1999, it was also found in Kessel (Nijlen; province of Antwerp), again in a quite natural area, the Steenbeemden nature reserve (DE BEER 2002).

The species has also been known from Finland, between Helsinki and Vantaa, since the 1990’s (KURTTI 1996). It was probably brought in with North American hay seed used for the grassing of the highway banks in the early 1970’s.

In the British Isles, *G. canadensis* has been known from a single locality in Scotland, also since the 1990’s (WATSON 1999). At present, it is well established in several clearings within damp woodland on both sides of the Burn river (MITCHELL 2007).

In 2020, *G. canadensis* was detected for the first time in a Swiss locality by the second author. Two populations were found in the municipality of Wachsedorn (canton of Bern), inside and in the immediate vicinity of the ‘Wachsedornmoos’, a nature reserve of 15.6 ha with peat

bog- and other bog vegetation [WGS 84 (lat/long) 46.82455/7.72535 or 46°49'28.369"N 7°43'31.266"E]. *G. canadensis* was detected, on the one hand, in the shore area of two ponds within the bog area, on the other hand, in a drainage ditch just outside the nature reserve. The occurrence of *G. canadensis* in the area is estimated to cover a total area of 350 m². The population in the drainage ditch consists of at least 800 shoots, the population in the shore area of the two ponds of more than 350 shoots.

Ecology

In its native North American area, *G. canadensis* is an obligate wetland species. It is usually found in open boggy areas and on damp or wet shores, additionally in moist woods, marshes, swamps, wet woods and along streams and lakes. In Europe, including the Swiss locality, it is found in comparable or even strikingly identical habitats.

The 'Wachseldornmoos' is located in a wooded area at 1000 m above sea level. The natural reserve comprises a secondary peat bog area, adjacent transitional peat bog areas, followed by typical fen vegetation types such as large sedge swamps, sedge reeds, tall-herb swamps, wet meadows and bog forests. The ponds, where *G. canadensis* was found, are located in the secondary peat bog and transitional peat bog areas of the nature reserve (Fig. 2). The water depth of the ponds is less than 30 cm. *G. canadensis* colonizes the exposed shore area of these ponds at several localities, but also reaches far out into the shallow water of the ponds. The conditions are characterized by a highly wet (stagnant water) and acid (peat bog) environment. The drainage ditch is also humid and acidic, but less extreme than in the ponds.



Figure 2. Peat bog area in Wachseldorn invaded by *Glyceria canadensis*. Photo: W. Bischoff.

Possible means of introduction

The origin of the Swiss population of *G. canadensis* remains obscure, although it is quite remarkable that in the same locality a congeneric North American species is also present, *G. striata*.

Earlier European occurrences have been associated with various introduction vectors. The prevailing assumption appears to be that the species was unintentionally introduced by American military troops during World War II. In both Belgian areas, where *G. canadensis* is found, it is believed to have been introduced this way (DUVIGNEAUD et al. 1996, SAINTENOY-SIMON 1997, DE BEER 2002) and the same applies to a former German occurrence (KOSSEL 1975), where the species was found in a military base that harbors a NATO shooting range in the southern part of the Lüneburger Heide; it is one of the largest military training areas in Europe with an area of 24,900 ha and an extension of 26 km in north-south direction and 18 km in east-west direction (comm. R. Otto, 01.2022). In Scandinavia, on the contrary, the species was apparently introduced with imported hay seed (KURTTO 1996).

Outlook

Glyceria canadensis is in many respects reminiscent of *G. striata*, not only morphologically. Both have similar ecological preferences and are found in the same types of habitats. They also seem to behave in identical ways. The latter is naturalized and spreading in numerous European countries (see for instance HOLUB 1980, but also HAEUPLER 1971; CARLSSON 1976; RAABE 1986; BABCZYŃSKA-SENDEK & SENDEK 1989; GANZERT & WALENTOWSKI 1989; MELZER & WAGNER 1991; GERSTBERGER 1994; KORNECK & SCHNITTNER 1994; STÖHR 2000; GEORGES 2002; DANČÁK 2002; KUMM 2002; FELZINES & LOISEAU 2002; BIZOT & PARENT 2005; KEIL 2005; PIWOWARSKI & BARTOSZEK 2012; PORTAL 2014; VERNIER 2015; WEYEMBERGH 2017; DUISTERMAAT 2020; WEYEMBERGH 2021; etc.). In the course of the 20th century it has almost completely invaded the European continent (Euro+Med Plantbase; <https://www.emplantbase.org/home.html>) although it remains rather rare in most countries. Although it is almost exclusively found in natural or near-natural habitats, it is rarely considered to be a noxious weed (e.g. WEBER & GUT 2004). Yet, the species inevitably takes the place of potentially vulnerable native species in native habitats.

A similar behavior of *G. canadensis* is most likely. Moreover, since both species are morphologically similar, the latter may well be more widespread, but not yet detected, resulting from confusion with *G. striata*. Therefore, all subplots covered with *G. canadensis* in the bog area in Wachsdorn were marked during the autumn of 2021, then excavated in January 2022 (when the bog-soil was frozen and covered by snow). The subplots in the two ponds, where the species is growing in the shallow water, could not be marked, but these plants can relatively easily be removed manually (the rhizomes are readily ripped out of the very swampy soil). The population in the drainage ditch along the raised bog is not currently being controlled.

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Addresses of the authors:

Filip Verloove (corresponding author)
 Meise Botanic Garden
 Nieuwelaan 38
 1860 Meise, Belgium
 E-mail: filip.verloove@botanicgardenmeise.be

Wolfgang Bischoff
 Naturschutzlösungen
 Klaraweg 2
 3006 Bern, Switzerland
 E-mail: mail@naturschutzloesungen.ch

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