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The nomenclature of two hybrid taxa in *Carex* sect. *Vesicariae* (Cyperaceae) currently assigned as *Carex rostrata* var. *borealis* and *Carex stenolepis*

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Abstract

In a recent study of *Carex* sect. *Vesicariae* in northern Europe, two hybrid species were identified using microsatellite markers. Whereas both taxa already have names associated with them, we find that these names are not appropriate for use. In this study, the taxon previously described as *C. rostrata* var. *borealis* is raised to species level as the hybrid taxon *Carex* × *saamica* (from *C. rostrata* × *C. rotundata*). We furthermore show that the name *C. stenolepis*, after designation of a lectotype, becomes a synonym of *C. rostrata*, and hence accept *C. ×grahamii* as the priority name for the hybrid taxon (from *C. saxatilis* × *C. vesicaria*) previously denoted as *C. stenolepis*. Arguments for these choices are given. Four other species names that have been assigned to the two hybrid taxa are discussed. Types are identified or designated for the names *C. rostrata* var. *borealis*, *C. stenolepis*, and *C. ×grahamii*. A key to the hybrid taxa and their parents is given.

Key words: *C. ×anticostensis*, *C. ×ewingii*, *C. ×grahamii*, *C. ×mainensis*, *C. ×paludivagans*, *C. ×saamica*, hybrid taxa

Introduction

Species of *Carex* Linnaeus (1753: 972) section *Vesicariae* Heuffel (1844: 535) are known to play an important ecological role in the arctic and boreal wetlands (Egorova, 1999, Reznicek & Ford, 2002, among many others), but frequent hybridization and several clonally extensive hybrid taxa sometimes complicate the identification and delimitation of species. A recent study based on analyses of microsatellite data (Pedersen *et al.*, 2016) sought to clarify the origins and taxonomic status of two problematic taxa in section *Vesicariae*, namely *C. stenolepis* Lessing (1831: 301) and *C. rostrata* Stokes (in Withering, 1787: 1059) var. *borealis* (Hartman, 1820: 39) Kükenthal (1909: 723). Both taxa were shown to be of hybrid origin, with *C. stenolepis* having originated from *C. saxatilis* Linnaeus (1753: 976) × *C. vesicaria* Linnaeus (1753: 979), and *C. rostrata* var. *borealis* from *C. rostrata* × *C. rotundata* Wahlenberg (1803: 153). Whereas both hybrid taxa appeared to be results of multiple, recent hybridization events, their frequent and largely predictable occurrence in North European mires, often apart from and even outside the current ranges of their parent species, led to the conclusion that binomial names for both taxa are justified. However, none of the names in current use for these hybrid taxa are appropriate or correct: a hybrid species between *C. rostrata* and *C. rotundata* should not be named as a variety of one of its parents (*C. rostrata*), and the name *C. stenolepis* has to be discarded for the hybrid species in question after designation of a lectotype. Five other species names have been suggested to refer to one or the other of the hybrids considered: *C. anticostensis* (Fernald 1942: 329) Lepage (1956: 108), *C. ewingii* E.S. Marshall (1911: 197), *C. grahamii* Boott (1844: 215–216), *C. mainensis* Porter (in Britton 1901: 193), and *C. paludivagans* Drury (1956: 66). The aim of this study is to discuss and provide solutions to these nomenclatural problems.

A name for *Carex rostrata* var. *borealis* at species level.

Hartman (1820: 39) described the variety [β] *borealis* of *C. ampullacea* Goodenough (1794: 207). Hartman's protologue is short, here translated from Swedish: "β *borealis* : spikes oblong, not stalked, scales ovate, acute, shorter than the utricles... (β Jä[mtland]). β similar to the preceding" [probably referring to *C. rotundata* described immediately before

C. ampullacea in the text]. Even if several sources are cited for *C. ampullacea*, no source is cited for variety β , only the location in the province of Jämtland. One specimen only has been found in UPS, the herbarium where Hartman worked and where his main collections are deposited, connecting the name to Hartman and Jämtland. It may well be the holotype, but as it does not seem clear enough, we have designated it as a lectotype.

The name *C. ampullacea* was at Hartman's time generally applied to the species later (and currently) denoted as *C. rostrata* (see Molina *et al.* 2006: 532). Kükenthal (1909) recombined the variety as *C. rostrata* var. *borealis* (Hartm.) Kükenthal (1909: 723). The designated lectotype specimen (UPS) conforms to our concept of the taxon in question; Hartman's description is, however, insufficient and therefore extended by us below. Characters that distinguish *C. rostrata* var. *borealis* from *C. rostrata* are the involute leaves without whitish papillae, the short, dark and not acuminate pistillate scales, the indistinct veins and the short beaks of the utricles; from *C. rotundata* the involute but not filiform leaves, the much larger and more numerous spikes (pistillate and staminate), the longer scales, and the at least visible veins and distinctly bidentate beaks of the utricles.

The pollen, studied by Pedersen *et al.* (2016), is uniformly of quite low stainability: 3–37% in var. *borealis*, as compared with 93–99% in *C. rostrata* and 76–96% in *C. rotundata*. For this and other reasons (see Pedersen *et al.* 2016), we assume that little (if any) sexual reproduction takes part in *C. rostrata* var. *borealis*.

This hybrid is a recurrent constituent of nutrient-poor minerotrophic mires in the upper and northern forest belts (North Boreal) in Fennoscandia. Its frequency increases northeastwards from South–Central Norway to the Russian border in North Finland and Northeast Norway (Elven, Pedersen & Bjorå, pers. obs.). It is likely that var. *borealis* also occurs in northern European Russia, as Kreczetowicz (1935) reported a plant under the name *C. stenolepis* from the Karelia–Murman and the Dvina–Pechora areas, on both sides of the White Sea, but not from farther east. He synonymized “*C. stenolepis*” with *C. rostrata* var. *borealis* (and his description fits the latter). Egorova (1999) did not mention *C. rostrata* var. *borealis* in her synoptic treatment of *Carex* within the borders of the former USSR.

The parent species of var. *borealis*, *C. rostrata* and *C. rotundata*, have overlapping ranges also in North America (see the maps of Porsild & Cody, 1980, and Reznicek & Ford, 2002). The only plant suggested as a hybrid between them there is *C. paludivagans* Drury (1956: 66) from the Kuskokwim River area in southwestern Alaska. Ford *et al.* (1993), however, found that Drury's “*C. rostrata*” specimens in fact belonged to *C. utriculata* Boott (in Hooker, 1839: 221), and that *C. paludivagans* is the hybrid between *C. rotundata* and *C. utriculata*. The name *C. paludivagans* is therefore not available for our hybrid taxon.

We therefore coin the new name *C. \times saamica*, based on the type for *C. ampullacea* var. *borealis*. A new name (nomen novum) is chosen as the name *C. borealis* was already published by O. Lang (1843: 142), now considered a synonym of *C. aquatilis* Wahlenberg (1803: 165), and thus the epithet *borealis* at species rank is not available.

***Carex stenolepis* Lessing is a misapplied name.**

In recent decades the name *Carex stenolepis* has been almost uniformly assigned to a hybrid species between *C. saxatilis* and *C. vesicaria* (Hylander, 1966, Jakobsen, 1980, Egorova, 1999, Reznicek & Ford, 2002, Jermy *et al.*, 2007). Lessing (1831: 301) described *C. stenolepis* based on specimens sent to him by a Mr. Deutsch from “Torneå-Lappmark” in North Sweden and by M.N. Blytt from the “Umgegend von Trondhjem” in Trøndelag, Central Norway. Lessing's diagnosis is extensive, but not sufficient to discriminate among several alternative taxa; he compared his *C. stenolepis* with *C. pulla* Goodenough (1797: 78, now *C. saxatilis*) and with *C. rotundata*, but not with *C. rostrata* (or *C. rostrata* var. *borealis*).

Therefore, the assignment of the name *C. stenolepis* depends on identification or designation and study of type material. We have not been able to locate any of the material studied by Lessing. Lessing's collections were mainly deposited in the Herbarium of the Botanic Garden and Botanical Museum in Berlin–Dahlem (B), where much of the collection was lost during World War II (Schultze-Motel 1960, Hiepko 1987). Some duplicates from Lessing's herbarium were found in Leiden (L) but specimens of *C. stenolepis* were not among them (as also noted by Jakobsen, 1980).

As for the two collectors mentioned, the Mr. Deutsch collecting plants in Torneå lappmark in Sweden is unknown to us, and no specimens by this collector are present in Norwegian or Swedish herbaria (Jakobsen, 1980). It is unlikely that there exist any duplicates of his Swedish collection. Mathias N. Blytt collected the plant we until now have named as *C. stenolepis* several times, especially in the Dovrefjell mountains well south of the Trondheim area, but the only year he collected in the interior parts of Trøndelag (“Umgegend von Trondhjem”) was in 1824. The specimen(s) that

Lessing received must have originated from Blytt's expedition to interior Trøndelag (the Stjørdalen area) in 1824. Blytt's main collections are deposited in the Natural History Museum in Oslo (O) and are intact. He customarily sent duplicates of his collections to corresponding botanists throughout Europe. Among the collections in Oslo, we have found a single sheet which must be a duplicate of what Lessing received, an undated collection from "Stjørdalen: Skurdalsporten", annotated as "*C. vesicaria–alpigena* Fr." This is his only known collection of this species group from the area and year in question. Blytt's collections of other plants from the same locality are dated 24 Aug. 1824, and this is most probably the collection date for the *Carex* specimen. The specimen is morphologically in accordance with Lessing's description, and is with near certainty a duplicate of the collection Lessing had available, and is thereby an isosyntype according to ICBN Art. 9.3 (McNeill *et al.* 2012), stating that the original material "comprises ... (c) the isotypes or isosyntypes of the name irrespective of whether such specimens were seen by either the author of the validating description or diagnosis or the author of the name." It is accordingly syntype material within the definitions of the Code. It was proposed as the only available type specimen by Jakobsen (1980). There may, however, be specimens from the same collection trip and area in other herbaria. One candidate is the specimen V-176311 in UPS, annotated as "*Carex isolepis* [!] Lessing" in Blytt's handwriting (indicating that he had received a message back from Lessing albeit misspelling the name), but there is no locality or year given for this collection. It is morphologically nearly identical with the specimen in O and most probably from the same collection. On this background we here designate the specimen in O, with locality information in Blytt's handwriting, as lectotype for the name *C. stenolepis*.

Although Blytt's plant from "Stjørdalen", and also the collection V-176311 in UPS, are in accordance with Lessing's description, they are not hybrids between *C. saxatilis* and *C. vesicaria*. Neither do they correspond to Fries' *C. vesicaria* var. *alpigena* (Fries, 1843:142), a name belonging to the hybrid in question, as concluded by Jakobsen (1980) and confirmed by the type specimen (UPS!). Blytt's specimens have distinct whitish dots (papillae) on the leaves, a feature characteristic for *C. rostrata* but absent from *C. saxatilis* and *C. vesicaria* and also from the plants currently denoted as *C. stenolepis*. In addition, they have narrow, acute pistillate scales, and fairly large utricles gradually narrowed into a long, forked beak (Fig. 2c); both features shared with *C. rostrata* and *C. vesicaria* but neither with *C. saxatilis* nor with plants currently denoted *C. stenolepis*. We identify Blytt's plant as *C. rostrata*, albeit short-grown. Thus, following our type designation, the name *C. stenolepis* Lessing becomes a synonym of *C. rostrata* and unavailable for a hybrid taxon of a *C. saxatilis* × *C. vesicaria* origin.

The hybrid species, which Jakobsen (1980: 114) showed to have a wide range in Fennoscandia and Scotland and with a comparatively uniform morphology throughout this range, needs a binomial name. From Scotland this hybrid species is reported as *C. ×grahamii* Boott (1844: 215–216, see, e.g., Jermy *et al.*, 2007, Stace *et al.*, 2015). Jermy *et al.* (2007) and Stace *et al.* (2015) cited *C. stenolepis* auct., non Lessing, as a synonym of *C. ×grahamii*, thereby implying that the name *C. stenolepis* Lessing is inappropriate. We do not know the reasons for this assumption, but as our findings show, the assumption is confirmed. From European Russia the hybrid species in question was reported by Kreczetowicz (1935) from the Karelia–Murman area under the name *C. ×grahamii* and by Egorova (1999) from the Murman area and the northern Urals under the name *C. stenolepis*. There are also reports from North America (see below).

At rank of species, four names have been proposed for hybrids with the assumed parentage of *C. saxatilis* × *C. vesicaria*, namely: *C. ×grahamii*, *C. ×ewingii*, *C. ×mainensis*, and *C. ×anticostensis*. We discuss each of these names in the following.

***Carex ×grahamii* Boott (1844: 180, 215–216).**

This species was described from Glen Phee (by some collectors misnamed as Glen Dole), Clova, Scotland, based on collections made in July and August 1832 and also in 1840. The protologue describing it is extensive and the set of syntypes uniform. There is no doubt that this plant is of hybrid origin from *C. saxatilis* and *C. vesicaria* and that it conforms to what has been denoted as "*C. stenolepis*" in Fennoscandia in the last decades. *Carex ×grahamii* is the earliest validly published species name based on material of the hybrid between *C. saxatilis* and *C. vesicaria*. The original material was distributed in several herbaria. As Boott (1844) did not specify a collection date (he was merely informed by "Dr. Graham that this plant was [first] found by Dr. Wight. July 30, 1832") and also accepted specimens from Glen Dole (as "the station ... affixed to some species, being incorrect", see Boott, 1844: 215–216), we accept as syntypes specimens from E (E No. 00044786!, 00044787!, 00044788!, 00044792!, 00044798!, 00279305!, 00279306!), BM (BM No. 000597601!), and K (K No. 000960506!, 000960507!). Specimen K No. 000960506 includes three culms with spikes and was labeled as "Typus" for *C. grahamii* Boott by T.V. Egorova in 1973 (Fig. 3). We accept her choice and designate one of the culms as lectotype.



FIGURE 1. Lectotype of *Carex rostrata* var. *borealis* (Hartman) Kükenthal, from Sweden: Jämtland. From Uppsala Herbarium (UPS). Here referred to *C. ×saamica* T.M.Pedersen & Elven nom. nov. (= *C. rostrata* Stokes × *C. rotundata* Wahlenb.). A, habit; B, pistillate spike. © Museum of Evolution, Uppsala University (UPS).



FIGURE 2. Lectotype of *Carex stenolepis* Lessing, designated here, from Norway: Nord-Trøndelag, Meråker. From Oslo Herbarium (O). The plants belong to a short grown form of *C. rostrata*. A, habit; B, pistillate spike; C, utricle.



FIGURE 3. Lectotype of *Carex grahamii* Boott, designated here, from Great Britain: Scotland, Clova. From the Royal Botanic Gardens, Kew (K). The priority name for the hybrid species from *C. saxatilis* × *vesicaria*, © of the Board of Trustees of the Royal Botanic Gardens, Kew.

Other names misapplied to *C. ×grahamii* or *C. stenolepis*

Carex ×ewingii E.S.Marshall, J. Bot. 49: 197 (1911).

This taxon was considered by Ewing (1910) and Marshall (1911) to be a hybrid between *C. ×grahamii* and *C. saxatilis* (i.e., a back-cross product, as also suggested by Stace *et al.* 2015). Ford *et al.* (1993) found a pollen stainability of up to 36% in *C. ×grahamii*, and we therefore cannot exclude back-crossing towards *C. saxatilis* resulting in *C. ×ewingii*. Stace and collaborators assigned this name as a synonym of *C. ×grahamii* and discussed the case closer (see Stace *et al.* 2015: 388).

Carex ×mainensis Porter in Britton, Man. Fl. N. States: 193 (1901).

This taxon was described from northeastern North America: from Maine to Labrador. Ford *et al.* (1993) concluded that this name belongs to a hybrid between *C. saxatilis* and *C. vesicaria*. However, this conclusion was based on a collective concept of *C. saxatilis* (Ford *et al.*, 1991, Ford & Ball, 1992) that we now question (Pedersen *et al.*, in prep.). Our view is based on a study of *C. saxatilis* s. lat. in Greenland, where we find that Greenland (and northeastern North American) “*C. saxatilis*” actually consists of three “biological” species: *C. saxatilis* s. str., *C. miliaris* Michaux (1803: 174), and *C. rhomalea* (Fernald, 1901: 50) Mackenzie (1910: 246), separated by reproductive barriers resulting in hybrids that are mainly sterile. The same morphological pattern is seen in material from New England and East Canada. In our opinion, the species of the *C. saxatilis* group present in the areas from where *C. ×mainensis* was described is *C. miliaris*. We therefore consider the name *C. ×mainensis* to be irrelevant for the northern European *C. saxatilis* × *C. vesicaria* hybrid.

Carex ×anticostensis (Fernald) Lepage, Naturaliste Canad. 83: 108 (1956).

This taxon was described from Anticosti Island in the St. Lawrence Gulf, Quebec, Canada (Fernald, 1942). Ford *et al.* (1993) concluded that this name, too, refers to a hybrid *C. saxatilis* × *C. vesicaria*. We conclude, as above, that the “*C. saxatilis*” involved in such a hybridization event must be what we consider to be *C. miliaris*.

In conclusion, we find that the valid priority names of the two hybrid species resulting from the parental combinations *C. rostrata* × *C. rotundata* and *C. saxatilis* × *C. vesicaria*, are, respectively, *C. ×saamica* and *C. ×grahamii*.

Formal nomenclature and taxonomy

Carex ×saamica T.M.Pedersen & Elven, nomen novum

≡ *C. ampullacea* Goodenough var. *borealis* Hartman 1820, Handb. Skand. Fl.: 39. (nom. subs.)

≡ *Carex rostrata* Stokes var. *borealis* (Hartman) Kükenthal 1909, Pflanzenz. IV, 20(38): 723.

Type:—SWEDEN, Jämtland “Jämtland subalpinis”. Herb. Hartman (UPS!), lectotype (Fig. 1), designated here (or perhaps holotype).

Etymology:—The name “saamica” is chosen because the main range of this taxon seems to be within the Saami (Sápmi/Lapland) areas of Fennoscandia.

Plants develop long-creeping rhizomes and forms open, extensive swards or clones, often of 1000 m² or more (Elven, Pedersen & BJORÅ, pers. obs.). Withered leaf bases form dense, dark brownish grey sheaths around base of culms. Leaves mainly basal, 1–2 blades arising from sheaths on the culms, erect, as long as or longer than culms, involute, smooth except for being scabrous on margins; abaxial surface green, adaxial surface pale green (but not visible unless the leaf is rolled out), both surfaces without pale spots or papillae. Culms 20–40(50) cm, erect, obtusely trigonous, smooth. Inflorescence (1)2–3 lateral pistillate spikes, the proximal one usually the largest, and 1–2(3) terminal staminate spikes, the distal one the largest. Lowermost bract 10–18 cm, usually overtopping the inflorescence, narrow (1–3 mm), moderately canaliculate; adaxial surface green, abaxial surface pale green, without pale spots or papillae. Distal bracts much shorter and narrower than the lowermost one. Pistillate spikes 20–35 × 7–9 mm, cylindrical or oblong, erect (even when long-pedunculate); proximal spike on peduncle 10–30 mm, more distal spikes on much

shorter peduncles or subsessile. Pistillate scales lanceolate or ovate, 3.5–5.0 × 1.2–1.8 mm, acute or obtuse, shorter and narrower than utricles, reddish brown with a pale brown or green midvein, darker brown towards the margins but with a narrow hyaline border and tip. Staminate spikes very narrow, the distal one 25–35 × 1.8–2.3 mm. Staminate scales ovate, 3.0–4.5 × 1.5–1.8 mm, obtuse, brown with a pale brown or green midvein, with a broad hyaline margin and tip. Stigmas 3. Utricles 4.0–5.5 × 2.0–3.0 mm, smooth, shiny, yellowish green during anthesis and turning pale brown during maturation, with indistinct veins, narrowing gradually into a short beak 0.3–0.5 mm, distinctly bidentate. Utricles well-formed but usually (but not always) with undeveloped achenes. Stamens exerted and well developed; pollen variable, but usually looks well formed.

Carex stenolepis Lessing, Reise durch Norwegen nach den Loffoden durch Lappland und Schweden: 301. 1831.

Type:—NORWAY, Nord-Trøndelag, Meråker: “Stördalen: Skurdalsporten, *Carex vesicaria–alpigena*.” [1824], M.N. Blytt (O!), left side plant, Lectotype (designated here; Fig. 2). The name is concluded to be a synonym of *C. rostrata* Stokes.

Carex grahamii Boott, Proc. J. Linn. Soc. London 1: 180. 215–216, 1844.

Type:—SCOTLAND, “Clova Forfarshire. *Carex saxatilis* Linn. *Carex pulla* Good. 8th Augt. 1840.—On Wight’s original station. From Dr. Grahame.” K No. 00960506!, (left-hand shoot of three, lectotype, designated here, Fig. 3).

Identification key

The following identification key is provided to distinguish the hybrid taxa from their parental taxa.

1. Stigmas 2; achenes lenticular; fresh leaves green, broadly canaliculate or flat2.
- Stigmas 3; achenes triangular; fresh leaves greyish green or green, flat, canaliculate or involute3.
2. Utricles 2–3 mm, with scarcely visible veins, abruptly narrowing into the beak; beak short (0.2–0.3 mm), truncate or very indistinctly bidentate; leaves 2–4 mm wide, broadly canaliculate.....*Carex saxatilis*
- Utricles 4–5 mm, with distinct veins, narrowing more gradually to the beak; beak longer (0.3–0.5 mm), distinctly bidentate; leaves 3–5 mm wide, broadly canaliculate or flat *Carex ×grahamii*
3. Staminate spikes 3 or more; utricles 4–8 mm, with distinct veins, narrowing gradually to the beak; beak long bidentate; pistillate scales much narrower than utricles; leaves with or without whitish papillae4.
- Staminate spikes 1–2; utricles 2–5 mm, with distinct or indistinct veins, narrowing more abruptly to the beak; beak short bidentate; pistillate scales narrower than or as broad as utricles; leaves never with papillae.....5.
4. Leaves canaliculate, dull greyish green due to whitish papillae on the adaxial surface; utricles patent when mature *Carex rostrata*
- Leaves flat (or rather moderately plicate), shiny green, without any papillae; utricles erectopatent when mature ... *Carex vesicaria*
5. Leaves flat or broadly canaliculate, often slightly plicate; utricles erectopatent when mature..... *Carex ×grahamii*
- Leaves loosely involute (adaxial surface not visible) or filiform (tightly involute); utricles patent when mature6.
6. Staminate spikes 1(2); pistillate spikes 1–2, subsessile, globular or nearly so; pistillate scales ovate, obtuse, blackish brown; utricles (body, except for beak) subglobose; beak indistinctly bidentate; leaves filiform..... *Carex rotundata*
- Staminate spikes (1)2–3; pistillate spikes 2–3, shortly pedunculate, cylindrical or oblong; pistillate scales lanceolate or ovate, acute or obtuse, dark brown; utricles (body, except for beak) ovoid; beak distinctly bidentate; leaves narrowly canaliculate (but not filiform) *Carex ×saamica*

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