

The section *Ceratocystis* (*Carex*, Cyperaceae) in the Netherlands

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Key words

Carices
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Abstract – All the material of *Carex* section *Ceratocystis* kept in the herbarium of Naturalis Biodiversity Center in Leiden (L), to be precise 1412 sheets, has been revised in order to get a better understanding and more complete overview of the occurrence of the native species and hybrids within this section in the Netherlands. The hybrid material from the Hussenberg near Beek (Province of Limburg), which was known in literature as *C. ×luteola* [*C. distans* × *C. flava*] belongs in our opinion to *C. ×xanthocarpa* [*C. flava* × *C. hostiana*]. A key for determining all species and hybrids within the section *Ceratocystis* occurring in the Netherlands has been provided. Besides, this study shows that it is important to continue collecting material for Naturalis, Leiden.

Samenvatting – Al het materiaal van *Carex* sectie *Ceratocystis* in het herbarium van Naturalis Biodiversity Center te Leiden (L), in totaal 1412 vellen, is gerevideerd om zo een beter begrip en een completer beeld te krijgen van het voorkomen van de inheemse soorten en hybriden van deze sectie in Nederland. Het hybride-materiaal van de Hussenberg bij Beek (Limburg), dat te boek stond als *C. ×luteola* [*C. distans* × *C. flava*], behoort o.i. tot *C. ×xanthocarpa* [*C. flava* × *C. hostiana*]. Een sleutel ter determinatie van alle in Nederland voorkomende soorten en hybriden in de sectie *Ceratocystis* is toegevoegd. Deze studie laat bovendien zien dat het noodzakelijk is om materiaal te blijven verzamelen voor Naturalis, Leiden.

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INTRODUCTION

The section *Ceratocystis* Dumort. (*Carex* L., Cyperaceae) consists of eight species in Europe (Koopman 2015). Three of them do not occur in the Netherlands: *Carex durieui* Steud. ex Kunze is endemic to Portugal and Spain (Luceño 2007), *C. castroviejoii* Luceño & Jim.Mejías is found in Greece and Albania (Jiménez-Mejías & Luceño 2009), and *C. derelicta* Štěpánková is an endemic species, only known from the Czech Republic (Štěpánková 2008).

The other five species occur more widespread over Europe (Koopman 2015). *Carex lepidocarpa* Tausch and *C. flava* L. are rare in the Netherlands and mainly restricted to Zuid-Limburg (Van der Meijden 2005). Vonk (1979) was, erroneously, of the view that *C. lepidocarpa* does not occur in the Netherlands at all. The other three species, *C. demissa* Hornem., *C. hostiana* DC., and *C. oederi* Retz., are more widespread over the country.

They prefer more or less wet grasslands and other open places in dunes and heathlands (Van der Meijden 2005).

Van der Meijden (2005) treats *Carex demissa* and *C. oederi* as subspecies, resp. *C. oederi* Retz. subsp. *oedocarpa* (Andersson) Lange and *C. oederi* Retz. subsp. *oederi*. However, the correct citation of the former is *C. oederi* Retz. subsp. *oedocarpa* Andersson (Govaerts et al., continuously updated). Nowadays these two subspecies are generally treated at species level (e.g. Koopman 2015).

The distinction of the variable, similar and closely related species within section *Ceratocystis* gets even more blurred by the relatively frequent occurrence of hybrids (e.g. Więclaw & Koopman 2013, Więclaw & Wilhelm 2014). With five species occurring in the Netherlands there are $5 \times 4 / 2 = 10$ possible hybrids and they are all known to science (Table 1). Besides, there are another twelve hybrids known between members of the sections *Ceratocystis* and *Spirostachyae* (Drejer) L.H. Bailey (Koopman 2015).

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Table 1. The hybrids of *Carex* L. section *Ceratocystis* Dumort.; the hybrids occurring in the Netherlands are given in **bold** (Koopman 2015).

Hybrid name	Parental species
1 <i>C. ×alsatica</i>	<i>C. demissa</i> × <i>C. flava</i>
2 <i>C. ×fulva</i>	<i>C. demissa</i> × <i>C. hostiana</i>
3 <i>C. ×leutzii</i>	<i>C. hostiana</i> × <i>C. lepidocarpa</i>
4 <i>C. ×pauliana</i>	<i>C. hostiana</i> × <i>C. oederi</i>
5 <i>C. ×ruedtii</i>	<i>C. flava</i> × <i>C. lepidocarpa</i>
6 <i>C. ×schatzii</i>	<i>C. lepidocarpa</i> × <i>C. oederi</i>
7 <i>C. ×subviridula</i>	<i>C. flava</i> × <i>C. oederi</i>
8 <i>C. ×xanthocarpa</i>	<i>C. flava</i> × <i>C. hostiana</i>
9 –	<i>C. demissa</i> × <i>C. lepidocarpa</i>
10 –	<i>C. demissa</i> × <i>C. oederi</i>

MATERIAL AND METHODS

By means of a loan of all the available material of the section *Ceratocystis* in L., sent from Leiden (the Netherlands) to Szczecin University (Poland), we were able to study all the, initially, 1412 sheets. The label information has been put into a d-base for the overview and for working out the information. Of the 1412 records five concern *Carex extensa* L., erroneously kept for *C. demissa* or *C. oederi*, and two *C. rostrata* Stokes, kept for *C. hostiana*. They are not further included in this study. On the other hand, there are 21 sheets with more than one species or hybrid, so with a mixed collection. It brings the total number of collections at 1430. One of the collections cannot be identified due to the poor quality of the material.

The nomenclature of *Carex* taxa follows Koopman (2015); Hedrén (2002) is followed for the name *C. oederi*.

RESULTS

Carex demissa Hornem. — Fig. 1B

There are 521 sheets of *Carex demissa* in L (Table 2) – six of which with more than one species – representing 36% of the total number of 1430 collections. Therefore, *C. demissa* is in the Netherlands the most common species within the section *Ceratocystis*.

Carex demissa is distributed all over the country, with finds in all provinces except for the Province of the IJsselmeerpolders (Table 3). The species has mostly been collected in Gelderland. The distribution shows that *C. demissa* avoids the clay soils of the coastal provinces. For seven records the province of origin is unknown.

There are 53 sheets without a date or even a year of collecting, probably all of them were made in the nineteenth century when several botanists were generally reluctant providing their collections with label information. Sometimes only a name was given.

Table 2. Numbers of specimens in the herbarium of Naturalis Biodiversity Center in Leiden (L) and their corresponding percentages of all five *Carex* species of *Carex* L. section *Ceratocystis* Dumort., as well as of the six hybrids native to the Netherlands.

Species and hybrids	Number of specimens	Percentage of total number of specimens (%)	Number of correctly identified specimens	Percentage correctly identified specimens (%)
<i>Carex demissa</i>	521	36	386	74
<i>Carex flava</i>	101	7	90	89
<i>Carex hostiana</i>	326	23	292	90
<i>Carex lepidocarpa</i>	16	1	9	56
<i>Carex oederi</i>	342	24	303	89
<i>Carex ×alsatica</i>	59	4	21	36
<i>Carex ×fulva</i>	45	3	24	53
<i>Carex ×pauliana</i>	10	0.7	7	70
<i>Carex ×ruedtii</i>	1	0.1	0	0
<i>Carex ×xanthocarpa</i>	1	0.1	0	0
<i>Carex demissa</i> × <i>C. oederi</i>	7	0.5	2	29
Unknown	1	0.1		
Total	1430	100	1134	79

The oldest dated record of *Carex demissa* is a collection under the name of *C. distans* made by Vrijdag Zijnen in 1826 near Haren (Province of Groningen); the sheet contains two specimens, one belongs to *C. demissa*, the other to *C. hostiana*.

It is rather remarkable, that there is only a single collection of *Carex demissa* from the 21st century, which was made in 2004 by R. Beringen near Ede (Province of Gelderland).

Carex flava L. — Fig. 1A

Carex flava is represented in L by 101 sheets, eight of which concern collections with more than one taxon. There are 13 sheets with misidentified material, i.e. seven sheets are labeled as *Carex lepidocarpa*, two as *C. demissa*, two as *C. ×ruedtii* Kneuck. [*C. flava* × *C. lepidocarpa*], one as *C. ×alsatica* Zahn [*C. demissa* × *C. flava*], and one as *Carex* × ...?

Carex flava has been collected in five provinces (Table 3). The oldest collection of *Carex flava* was made in 1866 near Voerendaal (Province of Limburg), the most recent one in 2014 near Gameren (Province of Gelderland). Most collections come from the Province of Limburg, where the species was collected at ten sites, resulting in 73 sheets. Hitherto the richest site is Bunde, where 41 sheets of *C. flava* have been made during 1912–1960. There are eleven sheets with material from Ravensbosch, which were collected from this site between 1914 and 1961. *Carex flava* is still present at Ravensbosch (own observation). The species has been collected in the Kathagerbroek, near Vaesrade, six times, even in more recent years. The other sites in the Province of Limburg concern casual finds or the sites have gone lost.

The collections in the Province of Noord-Brabant were mainly made in the Labbeget near Sprang-Capelle (n = 10, 1955–1998) and in the Worp near Drimmelen (n = 7, 1913–1916). On the former site *Carex flava* is still present (own observation).

Carex hostiana DC. — Fig. 1A & 1B

Carex hostiana is represented in L by 326 sheets, eight of which have more than one taxon. Of these, 292 collections have been correctly identified (90%), i.e. as *C. hostiana*, its synonym *C. hornschuchiana* Hoppe, or as *C. fulva* Gooden., formerly supposed to be the correct name for *C. hostiana*. There are 19 sheets without a date and year of collecting. The oldest collection of *C. hostiana* was made in 1826 near Paterswolde (Province of Drenthe), labeled as *C. distans*.

Carex hostiana is distributed all over the country and known from all provinces except for the two provinces with mainly clay-soil, i.e. the Provinces of IJsselmeerpolders and Zeeland. Most collections were made in the Province of Gelderland. Of five collections the province of origin is unknown.

Carex lepidocarpa Tausch — Fig. 1A

There are five sheets in L with Dutch material named *Carex lepidocarpa*. In fact, this is the outcome of several previous revisions. However, in our opinion there are 16 sheets of *C. lepidocarpa* in L from the Netherlands, 1% of the total set of 1430 records of section *Ceratocystis* (Table 2). Nine of them were initially correctly named, four as *C. flava*, two as *C. oederi* subsp. *oedocarpa* (= *C. demissa*), and one as *C. flava* β *oederi*.

All the 15 collections (with 16 sheets) are treated in chronological order below. *Carex lepidocarpa* is a very rare and, therefore, poorly known species and the ambivalent determinations written on the labels of the collections and sheets clearly show the struggle of botanists with the identification of this species.

Without date [JK & HW: 18.]; Nijmegen (Gelderland); leg. *Perin*: *Carex flava* Wahlb.; on the sheet later written in pencil: "Perin, dus... vindplaats zeer twijfelachtig [Perin, so... location very doubtful]"; K. Wiinstedt 1949: *Carex flava* L. forma. 1830; near Paterswolde (Drenthe); the left specimen on the sheet belongs to *C. lepidocarpa*, although the location is very doubtful. The right specimen is *C. demissa*.

Table 3. Distribution of the taxa of *Carex* L. section *Ceratocystis* Dumort. in the Netherlands, represented as number of sheets per province. For each species and hybrid the highest number of sheets in a province is given in bold. The names of the species and hybrids are abbreviated to the first three letters of their epithet; see Table 2 for their full names.

Province	dem	fla	hos	lep	oed	×als	×ful	×pau	×rue	×xan	dem × oed
Groningen	24	1	6		3						
Fryslân	48		37		63		17				2
Drenthe	27		24	1?	9		1				
Overijssel	60		43	1?	49		8	5			1
IJsselmeerpolders		1			2						
Gelderland	129	6	80	1?	61	7	9	3			2
Utrecht	48		65		22		4	1			1
Noord-Holland	22		3		28						
Zuid-Holland	46		38	1	35		1				
Zeeland	2				15						
Noord-Brabant	51	20	20		42	9	4				
Limburg	57	73	5	12	8	43	1	1	1	1	1
Unknown	7		5		5						
Total	521	101	326	16	342	59	45	10	1	1	7



Fig. 1. The five species within *Carex* L. section *Ceratocystis* Dumort. that occur in the Netherlands (left to right): A. *Carex flava* L., *C. lepidocarpa* Tausch, and *C. hostiana* DC.; B. *Carex hostiana* DC., *C. demissa* Hornem., and *C. oederi* Retz.



Fig. 2. Three hybrids within *Carex* L. section *Ceratocystis* Dumort. (left to right): *Carex* × *fulva* Gooden., *C.* × *leutzii* Kneuck., and *C.* × *xanthocarpa* Degl. *Carex* × *leutzii* has not been found in the Netherlands.

10-6-1872; Hussenberg near Beek (Limburg); leg. *C. v.d. Sande Lacoste*: *Carex flava* L.; there are three specimens on this sheet; J. Kern 1943: "Nur das Ex. links oben scheint mir *C. flava* zu sein, die andern *C. lepidocarpa* Tausch" [Only the specimen on the left top seems to me to be *C. flava*, the others *C. lepidocarpa* Tausch]; J. Kern April 1944: "2 kan geen vorm van *C. flava* zijn m.i., maar *C. distans* × *flava* [2 cannot be a form of *C. flava* in my opinion, but *C. distans* × *flava*]; K. Wiinstedt 1949: "Omnia *Carex flava* L. *varia* (non *distans* × *flava*)"; in our opinion: 1: *Carex flava* L.; 2: *Carex lepidocarpa* Tausch; 3: *Carex x alsatica* [*C. distans* × *C. flava*]; see below.
12-7-1897; Entersch veen (Overijssel); leg. *J.W.C. Goethart*: *Carex flava*; written on a piece of paper by Goethart: "in het moeras. Geen *Oederi* gezien! [in the swamp. Not seen any *Oederi*!]; J. Kern revised the material in 1943 and wrote, in German, in correspondence with K. Wiinstedt from Denmark: "Wegen der Schlauchform wage ich es nicht, diese Exx. zu *C. lepidocarpa* zu bringen, es scheint mir jedoch even-sowenig *C. demissa*" [Because of the utricle form I dare not say that these specimens belong to *C. lepidocarpa*, although I think they do not belong to *C. demissa* either]; in 1944 Kern wrote in the margin of the same paper: "Toch *lepidocarpa*! [Indeed *lepidocarpa*!]; K. Wiinstedt revised the material between 1943–1949: *Carex lepidocarpa* Tausch;

R. van der Meijden & W.J. Holverda (Rijksherbarium, Leiden), January 2006: "*Carex oederi* subsp. *oedocarpa*"; although the location, in the Province of Overijssel, seems to be strange and doubtful, the material belongs in our opinion to *C. lepidocarpa*.
25-7-1912; Epe [JK & HW: should be: Epen!], forest (roestig zand [rusty sand]) near Eperheide (Limburg); leg. *A. de Wever*: *Carex lepidocarpa* Tausch; J. Kern 1943: "Das linke Exemplar scheint mir zu *C. lepidocarpa* zu gehören, das rechte eher *C. flava* zu sein [The left specimens seems to me to belong to *C. lepidocarpa*, the right one more to *C. flava*]; K. Wiinstedt 1943–1949: "1. Vielleicht [Maybe] *Carex flava* × *lepidocarpa*?; 2. *Carex flava* L.; J. Kern 1944: "1 lijkt me nog steeds eerder *lepid.*, dan *lep.* × *flava* [1 seems still to me to be rather *lepid.* than *lep.* × *flava*]; Th.J. Reichgelt 1954: "Is m.i. zeker *lepidocarpa*! [Is in my opinion certainly *lepidocarpa*!]; R. van der Meijden & W.J. Holverda, January 2006: left: *Carex lepidocarpa*; right: *Carex flava*. We agree with Van der Meijden and Holverda.
25-7-1912; Epen, Forest near Eperheide (Limburg); leg. *A. de Wever*: *Carex lepidocarpa* Tausch; there are four flowering stems mounted on this sheet; J. Kern: "2 *C. lepidocarpa* Tausch; 4 ook wel *C. lep.* [also *C. lep.*]; 1 en 3 misschien *flava* × *lepidocarpa*? [1 and 3 maybe *flava* × *lepidocarpa*?]; Th.J. Reichgelt wrote in 1952 in the margin



Fig. 3. Three hybrids within *Carex* L. section *Ceratocystis* Dumort. (left to right): *Carex* × *xanthocarpa* Degl., *C.* × *ruedtii* Kneuck., and *C.* × *alsatica* Zahn.

of Kern's note: "1 en 3 ook m.i. *flava* × *lepidocarpa* [1 and 3 in my opinion, too, *flava* × *lepidocarpa*]; K. Wiinstedt 1949: "1 + 3 *Carex flava* L. forma; 2 + 4 *Carex lepidocarpa*"; R. van der Meijden & W.J. Holverda, January 2006: "2-4: *Carex flava*; 1: sterile: *C. flava* × ? *demissa*"; in our opinion: 1 + 3: *Carex* × *ruedtii* [*C. flava* × *C. lepidocarpa*]; 2 + 4: *Carex lepidocarpa*".

10-6-1913; near Vaals (Limburg); leg. A. de Wever: *Carex lepidocarpa* Tausch?; K. Wiinstedt 1949: "1 + 2+ 3: *Carex flava* L.; 4: *Carex lepidocarpa* Tausch"; R. van der Meijden & W.J. Holverda, January 2006: 1, 2, 3: *Carex flava*; 4: *Carex demissa*; actually, there are five specimens, as the two flowering stems (1 and 2) are not connected to the most left specimen; in our opinion: 2: *Carex flava*; 1, 3, 4 and 5: *Carex lepidocarpa*.

31-5-1960; Ravensbos (Limburg); leg. Th. J. Reichgelt / R.I.V.O.N.-excursie; R. van der Meijden & W.J. Holverda, January 2006: *Carex flava*. In our opinion: *C. lepidocarpa*.

31-5-1960; Ravensbos, Valkenburg (Limburg); leg. unknown, but the comparison of handwriting and the collecting date with the next collection suggest that the specimen was collected by E.E. van der Voo; this material was initially named *Carex lepidocarpa*, which is in accordance with a revision by R. van der Meijden & W.J. Holverda in January 2006.

31-5-1960; Ravensbos, Valkenburg (Limburg); leg. E.E. van der Voo. 15-6-1993; Oostvoornse Meer (Zuid-Holland); leg. K. van Setten: *Carex oederi* Retz. ssp. *oedocarpa* (N.J. Andersson) Lange; a surprising find outside the Province of Limburg.

25-5-1994; Kathagerbeemden, Vaesrade (Limburg); leg. S. Keulen, J.H.J. Schaminée, E.J. Weeda; rev. R. van der Meijden & W.J. Holverda, January 2006: *Carex lepidocarpa*.

3-6-1997; Ravensbosch near Valkenburg (Limburg); leg. F. van Westreenen / PKN-excursion; det. R. van der Meijden / W.J. Holverda, January 2006.

3-6-1997; Ravensbosch near Valkenburg (Limburg); leg. F. van Westreenen / PKN-excursion; det. R. van der Meijden / W.J. Holverda: *Carex* cf. *flava*. Although, according to the attached maps with co-ordinates, the two collections made by Van Westreenen on June 3, 1997, come from the same site, Van der Meijden & Holverda regarded them to belong to different species.

To summarise, *Carex lepidocarpa* has been collected from nine sites in the Netherlands. Eleven of the 15 collections (12 sheets) were made at five sites in southern Limburg. The sites of the other four collections are located in provinces outside

the Province of Limburg, albeit that for three of them the site of origin is doubtful (Table 3). The collections from Limburg were made between 1872 and 1997.

***Carex oederi* Retz. — Fig. 1B**

There are 342 collections of *Carex oederi*, the smallest member within the section *Ceratocystis*, of which five consists of more taxa. There are 303 collections (89%) with the 'correct' name, i.e. correct according to the contemporary opinions: *Carex flava* (n = 36, 11%), *C. oederi* (n = 137, 40%), and *C. serotina* (n = 130, 38%). Ten collections were initially called *C. lepidocarpa* (3%), all were collected before 1950. The oldest collection of *C. oederi* dates from 1832 and was collected near Wassenaar (Province of Zuid-Holland), the most recent one was made by J. van Kasteel on Terschelling (Province of Fryslân) in 1998.

Carex oederi is the only species within the section *Ceratocystis* which has been collected in all twelve provinces. It occurs mainly on sandy soils of the Pleistocene and along the coast. It avoids clay soils. The largest number of records were made in the Province of Fryslân (n = 63), of which 22 were made by D. T. E. van der Ploeg between 1960 and 1990. The total number of collections (342) of *C. oederi* is comparable with that of *C. hostiana* (326), but the latter has significantly decreased in abundance in the Netherlands during the last 50 years.

***Carex* × *alsatica* Zahn [*C. demissa* × *C. flava*] — Fig. 3 & 4**

There are 59 sheets of *Carex* × *alsatica* in L, of which five also contain material of *C. flava* and one *C. flava* as well as *C. lepidocarpa*. There are 21 collections with the correct name (39%), 21 collections were named *C. flava*, ten *C. lepidocarpa*. These



Fig. 4. Three hybrids within *Carex* L. section *Ceratocystis* Dumort. (left to right): *Carex* × *alsatica* Zahn, *C.* × *schatzii* Kneuck., and *C.* × *subviridula* Fernald. *Carex* × *schatzii* Kneuck. and *C.* × *subviridula* Fernald have not been found in the Netherlands.

59 collections were made between 1872 and 1993 in the Provinces of Limburg (n = 43), Gelderland (n = 8) and Noord-Brabant (n = 8). In the Province of Limburg the species was found on five sites: Ravensbosch (n = 19, 1912–1961), Bunde (n = 11, 1912–1948), Hussenberg near Beek (n = 8, 1872; according to a revision note by Kern all these collections were made from a single plant), Kathagerbroek bij Hoensbroek (n = 4, 1912 and 1914), and Epen (n = 1, 1918). The oldest known collection in the Netherlands was made in 1872 by Van der Sande Lacoste on the Hussenberg near Beek (Province of Limburg). [Van der Meijden & Holverda \(2006\)](#) treated this material as *C. ×ruedtii*. We wonder whether *C. ×alsatica* still occurs in Limburg.

The seven collections in Gelderland were all made between 1957 and 1993 near Gameren; see below at *Carex ×ruedtii*. The nine collections from Noord-Brabant were made in Drimmelen (n = 3, 1914) and in the Labbegat near Sprang-Capelle (n = 6, 1960–1961). The hybrid still occurs on the last mentioned site (own observation).

***Carex ×fulva* Gooden. [*Carex demissa* × *C. hostiana*] — Fig. 2**

There are 45 collections of *Carex ×fulva* [*C. demissa* × *C. hostiana*] in L. Of these 45 collections, 25 have been correctly identified (56 %). On 15 sheets, the material was initially determined as *C. hostiana* or its older name in use, i.e. *C. hornschurchiana* Hoppe. The other five collections were treated as *C. ×xanthocarpa* Degl. [*C. flava* × *C. hostiana*]. *Carex demissa* and *C. hostiana* often grow together, especially in *Cirsio dissecti-Molinietum* vegetations, where *C. flava* and *C. lepidocarpa* are lacking. The hybrid *C. ×fulva* seems to be easily produced. The oldest collection was made in 1882 near Veenendaal (Province of Utrecht) by Kobus, who thought it to be *C. distans* L. This name was later (unknown when or by whom) crossed-out and replaced by *C. hornschurchiana*, a synonym of *C. hostiana*, which was incorrect too. Kern revised the material in 1946 and provided it with the correct hybrid name, which was confirmed by Wiinstedt's revision in 1949.



Fig. 5. Three hybrids within *Carex* L. section *Ceratocystis* Dumort. (left to right): *Carex ×schatzii* Kneuck., *C. ×subviridula* Fernald, and *C. ×pauliana* F.W. Schultz. *Carex ×schatzii* Kneuck. and *C. ×subviridula* Fernald have not been found in the Netherlands.



Fig. 6. Three hybrids within *Carex* L. section *Ceratocystis* Dumort. (left to right): *Carex* × *subviridula* Fernald, *C.* × *pauliana* F.W. Schultz, and *C.* *demissa* Hornem. × *C.* *oederi* Retz. *Carex* × *subviridula* Fernald has not been found in the Netherlands.

During the years 1882 to 1981, material of *Carex* × *fulva* was collected in eight provinces: Fryslân (17), Overijssel (8), Gelderland (9), Utrecht (4), Noord-Brabant (4), Drenthe (1), Zuid-Holland (1), and Limburg (1). Sixteen of the Frisian records were made by D. T. E. van der Ploeg and F. Rudolphy, who, according to their *C.* × *fulva* collections, were actively botanising from 1952 to 1981. It is remarkable that Kern & Reichgelt (1954) did not mention *C.* × *fulva* from Fryslân; they obviously overlooked or were unaware of the existence of Van der Ploeg's collection made in 1952.

***Carex* × *pauliana* F.W. Schultz [*C.* *hostiana* × *C.* *oederi*]**
— Fig. 5 & 6

This hybrid has been collected seven times, resulting in ten sheets, during 1885–1964. Nine collections were named correctly. Only one collection, from 1939 near Denekamp (Overijssel), was erroneously called *Carex flava* L. *eu-flava lepidocarpa*. Where both parents grow together, the hybrid is relatively easily formed. It has been collected in four provinces: Overijssel (5 sheets on 3 sites), Gelderland (3 sheets on 2 sites),

and a single collection was made in the Province of Utrecht as well as in the Province of Limburg. In the latter, the oldest collection was made in Epen in 1885. Several labels report that the hybrids grows together with the parents. Illustrative is this note: “*Carex* cf. *Pauliana* F.W. Schultz, met *Carex Hostiana* DC. en *Carex serotina* Mérat, waar zij in grooten getale tusschen groeide. *Molinietum*, rijk aan *Gymnadenia conopsea*, *Epipactis palustris*, *Orchis incarnatus*, *Eriophorum latifolium*, *Pinguicula vulgaris*, *Parnassia palustris*, *Pirola rotundifolia*, *Carex pulicaris*, *C. glauca*, *C. panicea*, *C. diandra*, *C. fusca*, *C. rostrata* enz. Lemseler Maten bij Weerseloo. Leg. V. Westhoff 26 Juli 1944.” [*Carex* cf. *Pauliana* F.W. Schultz, with *Carex Hostiana* DC. and *Carex serotina* Mérat, among which it grows in great numbers. *Molinietum*, with a lot of *Gymnadenia conopsea*, *Epipactis palustris*, *Orchis incarnatus*, *Eriophorum latifolium*, *Pinguicula vulgaris*, *Parnassia palustris*, *Pirola rotundifolia*, *Carex pulicaris*, *C. glauca*, *C. panicea*, *C. diandra*, *C. fusca*, *C. rostrata* etc. Lemseler Maten near Weerseloo. Leg. V. Westhoff 26 July 1944].

Carex ×ruedtii Kneuck. [**Carex flava** × **C. lepidocarpa**]

We could find only one collection in L with *C. ×ruedtii*, mixed with *C. lepidocarpa*:

25-7-1912; Epen, Forest near Eperheide (Limburg); leg. A. de Wever: *Carex lepidocarpa* Tausch; there are four flowering stems mounted on this sheet; J. Kern: "2 *C. lepidocarpa* Tausch; 4 ook wel *C. lep.* [also *C. lep.*]; 1 en 3 misschien *flava* × *lepidocarpa*? [1 and 3 maybe *flava* × *lepidocarpa*?]"; Th. J. Reichgelt wrote in 1952 in the margin of Kern's note: "1 en 3 ook m.i. *flava* × *lepidocarpa*" [1 and 3 in my opinion, too, *flava* × *lepidocarpa*]; K. Wiinstedt 1949: "1 + 3 *Carex flava* L. forma; 2 + 4 *Carex lepidocarpa*"; R. van der Meijden & W. J. Holverda, January 2006: "2-4: *Carex flava*; 1: sterile: *C. flava* × ? *demissa*; in our opinion: 1 + 3: *Carex ×ruedtii* [*C. flava* × *C. lepidocarpa*]; 2 + 4: *Carex lepidocarpa*."

Carex ×xanthocarpa Degl. [**C. flava** × **C. hostiana**] — Fig. 2 & 3

There is only a single collection of *C. ×xanthocarpa* in L, which was made by A. de Wever near Bunde (Limburg) in 1918. This hybrid has never been recorded before for the Netherlands; see Discussion.

Carex demissa × **C. oederi** — Fig. 6

There are seven collections of *C. demissa* × *C. oederi* in L, 1917–1973, of which three were provided with the correct hybrid formula:

6-6-1917; Hoevelaken bij Amersfoort (Utrecht); leg. *Jansen et Wachter, v.d. Houten, Sloff*: *Carex Oederi* Ehrh.; determ. K. Wiinstedt 1949: Maybe *Carex demissa* × *serotina* (f. *varia*)
20-5-1918; Roevender Peel near Weert (Limburg); leg. *Henrard, Jansen en Kloos*: *Carex flava* L. subsp. *oederi* Ehrh. *lepidocarpa*; determ. K. Wiinstedt 1943–1949: Maybe *Carex demissa* × *serotina* Mérat (v. *canaliculata* (Callmé))?
27-7-1951; Bennekomse Meent (Gelderland); leg. *H. Schimmel & Th. Reichgelt*: *C. demissa* Horn. × *C. serotina* Mérat
26-7-1961; Hasselt, Veerslootlanden (Overijssel); leg. *S. Segal*
8-6-1963; Hoomsterzwaag, Miedweg (Fryslân); leg. *J.F. Neve*; det. D. T. E. van der Ploeg: *Carex demissa* Hornem.; det. Th. J. Reichgelt, November 1963: *Carex demissa* Hornem. × *C. serotina* Mérat
25-7-1973; Bennekomse Meent (Gelderland); leg. *K. Boeve*; det. F. Adema: *Carex demissa* Hornem. × *C. serotina* Mérat
5-9-1985; Boornbergum Krite (Fryslân); leg. *D. T. E. van der Ploeg*

The oldest collection was made in 1917 in Hoevelaken (Province of Utrecht). This hybrid has been found in four provinces: twice in the Province of Gelderland, and once in each of the Provinces of Fryslân, Utrecht, and Limburg.

KEY TO THE IDENTIFICATION OF TAXA OF THE SECTION CERATOCYSTIS IN THE NETHERLANDS

The key takes into account all species and hybrids of section *Ceratocystis* recorded in the Netherlands. All members are small to medium-sized (loosely) tufted plants having an inflorescence with 2–4 erect female spikes with bracts in the basal part and one male spike at the top (rarely two in *Carex hostiana*). The female flower has 3 stigmas.

1. All utricles with mature fruits (on fully developed plants) 2
1. Utricles empty or only 10–20(–30) % of the utricles contain fully developed fruits; hybrids 6
2. Loosely tufted plants, with well-developed short rhizomes. All female spikes distant, narrowly ovoid to terete, lowest spike on peduncle of 10–50 mm long; lowest bract shorter than inflorescence, with a sheath of 10–40 mm in length; glumes dark brown, with white membranous margin; utricles beak with white membrane at apex *Carex hostiana*
2. Tufted plants. Female spikes close together, only lowest spike more or less distant from others, ovoid to spherical, usually on peduncle of up to 35 mm long; lowest bract slightly shorter to longer than inflorescence; bracts with short sheaths, uppermost bracts usually sheathless; glumes light brown to rusty brown, with white membranous margin; utricles beak without white membrane at apex 3
3. Utricles with curved beaks 4
3. Utricles with straight beaks 5
4. Utricles 4–6(–6.5) mm long, gradually narrowed into bifid beak, its outer surface usually scabrous (> 5 bristles on each tooth); beak ≥ 1.8 mm long (accounting for ½ of total utricles length). Male spike sessile or rarely on peduncle of up to 10(–15) mm in length; lowest female spike bract 2–5 times as long as inflorescence, usually 2–4(–5) mm wide. Basal leaves usually as long as culm, rarely longer or slightly shorter; ligule well-defined, usually > 3 mm long *Carex flava*
4. Utricles 3.5–4.5(–5) mm long, abruptly narrowed into beak, smooth or with several bristles (< 5 on each tooth); beak ≤ 1.8 mm long (accounting for ½ of total utricles length). Male spike on peduncle of 2–60 mm in length; lowest female spike bract usually as long or shorter than inflorescence, rarely up to 1.5 times as long as inflorescence, 1–2(–3) mm wide. Basal leaves usually up to ½ as long as culm, rarely as long or slightly longer than culm; ligule < 2.5 mm *Carex lepidocarpa*
5. Beak 0.9–1.8 mm long (accounting for 35–45 % of total utricles length); female spikes 2–4(–5), uppermost ones close together, lowest spike distant and often located below half the length of culm; male spike usually on peduncle of up to 21 mm in length; culm often slightly bent; leaves usually shorter than culm, rarely equally as long or longer than culm *Carex demissa*
5. Beak ≤ 1.5 mm long (accounting for 23–36 % of total utricles length); female spikes 2–6(–7), typically clustered below male spike, rarely distant; male spike sessile or rarely on peduncle of variable length; culm erect; leaves usually equally as long or longer than culm *Carex oederi*
6. Utricle beak with white membrane at apex; glumes with wide white membranous margin; *Carex hostiana* hybrids 7
6. Utricle beak without white membrane at apex; glumes with narrow white membranous margin 9
7. Stems 35–60(–70) cm. Female spike width 0.75–0.95 mm, lowest bract 0.20–0.35 cm wide; utricles length ≥ 4 mm *Carex ×xanthocarpa* [*Carex flava* × *C. hostiana*]
7. Stems 10–40(–55) cm. Female spike width ≤ 0.75 mm, lowest bract usually less than 0.20 cm wide; utricles length ≤ 4 mm 8

8. Stems 10–25 cm. Utricle beak less than 1 mm long
 *Carex* × *pauliana* [*Carex hostiana* × *C. oederi*]
8. Stems 18–55 cm. Utricle beak 1–1.6 mm long
 *Carex* × *fulva* [*Carex demissa* × *C. hostiana*]
9. Utricles usually 4–5 mm long; beak \geq 1.5 mm 10
9. Utricles \leq 4 mm long; beak \leq 1.2 mm long; female spikes
 5–7 mm wide; male spike on peduncle of up to 15 mm in
 length *Carex demissa* × *C. oederi*
10. Female spikes 1–3, usually close together; bract of lowest
 female spike usually ca. 2 mm wide; bract of second female
 spike usually ca. 1 mm wide
 *Carex* × *ruedtii* [*Carex flava* × *C. lepidocarpa*]
10. Female spikes 2–4, usually lowest distant from others; bract
 of lowest female spike usually 3 mm wide; bract of second
 female spike usually ca. 2 mm wide
 *Carex* × *alsatica* [*Carex demissa* × *C. flava*]

DISCUSSION

In the past, the identification of *Carex demissa* was often confusing due to nomenclatural and taxonomic problems (Palmgren 1959, Schmid 1983, Hedrén 2002). During the nineteenth century the taxon was generally called *C. flava* in a broader sense (s.l., 127 records) and as *C. flava* fo. or var. *oederi* (55 records). Remarkably, there are 83 records including the name *lepidocarpa*, most of them are from the first half of the twentieth century. This clearly shows that the botanists of those days hardly knew the real *C. lepidocarpa* nor its preference for a calcareous habitat. There are, e.g., 16 records with *C. lepidocarpa* by Kern & Reichgelt from the twenties of the twentieth century; however, later, in the forties, they corrected their own determinations into *C. demissa*. Kern wrote on a note at a herbarium sheet (L.3119741) with *C. demissa* in 1943: “*Carex demissa* Horn. Ist hier allgemein als *C. lepidocarpa* betrachtet!” [*Carex demissa* Horn. Has here commonly been treated as *C. lepidocarpa*!]. All by all, there are 199 records with the correct name *C. demissa*. If we also accept the broader name *C. flava* s.l. and *C. oederi* as being in use in those days, as well as *C. tumidocarpa* Andersson and *C. oederi* subsp. *oedocarpa*, then we can say that 386 records (74%) has been named correctly.

Among the six collections of *Carex flava* from the Province of Gelderland, the one made near Gameren, collected in 1958, is the most interesting one (see discussion at *C. ruedtii* below). According to Van der Meijden & Holverda (2006) *C. flava* did not occur there, but obviously they overlooked a collection of *C. flava* from 1958 made by Mooi. The taxon was also collected in 2013 and 2014 in De Lieskampen near Gameren, both specimens were initially identified as *C. lepidocarpa*. Recent finds in the Lauwersmeer (Province of Groningen, 1996), the most northern locality of *C. flava* in the Netherlands, and in Zuid-Flevoland (Province of IJsselmeerpolders, 2001) show that *C. flava* is not only limited in its distribution to the Provinces of Limburg and Noord-Brabant. Nature development projects on calcareous soils seem to have potential for *C. flava*.

The nomenclature of *Carex hostiana* has been confusing through history (Crins & Ball 1987). Goodenough (1794) described *C. fulva* as a species, which was later regarded as conspecific to *C. hornschurchiana*, described by Hoppe (1824). However, for a long time the name *C. hornschurchiana* was in common use, while *C. fulva* was regarded as being an ambiguous name (Schultz 1841). Much later *C. fulva* proved to be the hybrid of *C. demissa* and *C. hostiana*, while *C. hornschurchiana* was recognised as being identical to the older, validly described *C. hostiana*. The latter name has priority and is therefore now the accepted one (Govaerts et al., continuously updated).

The site of the collection of *Carex lepidocarpa* labeled to be made near Nijmegen in the Province of Gelderland is thought to be doubtful. A note in pencil, probably written by Kern / Reichgelt, clarifies that the collector, Perin, obviously had a bad reputation: “Perin, dus ... vindplaats zeer twijfelachtig” [Perin, so ... location very doubtful]. The sites in Drenthe and Overijssel are peculiar, but the material from both sites belongs without a doubt to *C. lepidocarpa*. The find from the Province of Zuid-Holland is from recent date (1993) and is the only one without any doubt coming from outside southern Limburg.

The nomenclature of *Carex* × *fulva* has always been rather confusing. Goodenough (1794) described *C. fulva* not as a hybrid, but as a species, which was closely related to, but different from *C. hornschurchiana* (= *C. hostiana*). Schultz (1841), however, regarded *C. fulva* as a sterile form of *C. hornschurchiana*, which he then called, respectively, *C. biformis* var. *sterilis* and *C. biformis* var. *fertilis*. Kern & Reichgelt (1954) used the name *Carex* × *fulva* as being the hybrid of *C. demissa* and *C. hostiana*, while Jermy et al. (1982) used it for the hybrid of *C. hostiana* and *C. lepidocarpa*. The latter hybrid is rather similar in appearance to *Carex* × *fulva* (see Więclaw & Koopman 2013), but does not occur in the Netherlands. Nowadays, this hybrid has as binomial name *Carex* × *leutzii* Kneuck. (e.g. Koopman 2015). For correct identification, it is important to verify in the field which potentially parental species occur nearby the hybrid plant that needs to be identified. Abroad *C. hostiana* often grows together with *C. lepidocarpa* and in the Netherlands often with *C. demissa*, but *C. lepidocarpa* and *C. demissa* are not often seen together, i.e. rarely abroad and never in the Netherlands.

Carex × *ruedtii* is extremely difficult to distinguish from *C. alsatica* (Więclaw 2014). Often *Carex* × *ruedtii* is more yellowish, has a longer stalked male top spike, and 2(–3) female spikes which resemble those of *C. lepidocarpa* in shape. The (2–)3 female spikes of *C. alsatica* are more oblong, like those of its parent *C. demissa*. Finally *C. alsatica* has, like *C. demissa*, often a distant lowest female spike, which is usually neither the case for *C. flava* nor for *C. lepidocarpa* nor for its hybrid *C. ruedtii*. However, all these features are not constant and rather subtle (see also Więclaw & Wilhelm 2014). It is therefore remarkable that Van der Meijden & Holverda (2006) assumed that the hybrid found in Gameren (Province of Gelderland) is *Carex* × *ruedtii*, although they admit that *C. lepidocarpa* has never been found outside Zuid-Limburg. Nevertheless, because of the big utricles of this hybrid, they supposed that *C. flava* is one of its parents and that *C. lepidocarpa* is the other, “omdat de hybride van *C. flava* en *C. oederi* subsp. *oedocarpa* [JK & HW: = *C. demissa*: *Carex* × *alsatica*] beduidend kleinere urntjes moeten (sic) hebben.” [“because the hybrid of *C. flava* and *C. oederi* subsp. *oedocarpa* should have much smaller utricles.”]. However, Więclaw (2014) gives for utricule sizes for *Carex* × *alsatica* and *Carex* × *ruedtii* resp. 3.6–5.3 × 1.1–1.8 mm and 4–4.9 × 1.1–1.9 mm. A collection of the hybrid occurring in Gameren made by Weeda in 1993 shows clearly two stems with a distant lowest female spike, a specific feature of *C. demissa*. Very important for unmasking hybrids is always to notice which potential parents are growing in their close surroundings. We do not know whether *C. demissa* occurs or occurred in Gameren, but we do know that *C. flava* occurs there and that *C. lepidocarpa* has never been found there. We have come to the conclusion, that “the *Carex* hybrid from Gameren” belongs to *C. alsatica* and not to *C. ruedtii*.

Carex material that was collected on June 10, 1872 deserves further attention. According to the collections in L, on that day Van der Sande Lacoste collected on the Hussenberg near Beek (Province of Limburg) material of *C. flava*, *C. lepidocarpa*, *C. alsatica*, and an unknown hybrid. It was Kern who thought the right specimen on sheet L.3122687 to be the hybrid of *C. distans*

× *flava*, as mentioned above at *C. lepidocarpa*. And although Wiinstedt wrote “non *distans* × *flava*”, Kern & Reichgelt (1954) ignored this annotation and called this material *C. distans* × *flava*. The three specimens on the aforementioned sheet were all collected as *C. flava*. All the seven collections made from the hybrid come from the same plant, as was mentioned by Kern on several sheets, so the plant must have been a rather big clump. The collections were distributed under the name *C. flava* by C.A.J.A. Oudemans in the exsiccata series ‘Herbarium van Nederlandsche Planten’. All later revisers had their own ideas about this material. In 1943, J. Kern thought it to be *C. lepidocarpa*, but one year later he regarded it as *Carex distans* × *C. flava*. In 1949, K. Wiinstedt considered the material to be closest to *C. flava*, but “non *C. distans* × *flava*”. In 2006, Van der Meijden & Holverda wrote “*Carex flava* × ? *lepidocarpa*” on a revision note attached to sheet L.3122614, where they wrote “*Carex flava* × ? *demissa*” on sheet L.3130142. Both collections come from the same site, the Hussenberg near Beek, and were made on June 10, 1872, as well. Based on the comparison of the hybrid material from the Hussenberg that was collected on June 10, 1872, with our own material of *C. alsatica* and *C. ruedtii* – see the previous paragraph for the differences between these two hybrids –, we have come to the conclusion that all the hybrid material from the Hussenberg belongs neither to *C. xuteola* [*C. distans* × *C. flava*] nor to *C. xruedtii*, but to *C. alsatica*.

In L there is another collection of a so-called *Carex distans* × *C. flava*, which is also mentioned by Kern & Reichgelt (1954). This collection was made by A. de Wever near Bunde (Province of Limburg) in 1918. He, or perhaps Jansen & Wachter, thought it to be *C. fulva* Good., by which in those days one had *C. hostiana* in mind. In 1946, Kern & Reichgelt wrote on a revision note about this material: “Ongetwijfeld een bastaard van *C. flava* L., zeer waarschijnlijk *C. distans* × *flava* L.” [Undoubtedly a hybrid of *C. flava* L., very probably *C. distans* × *flava* L.]. Finally, in 1949 K. Wiinstedt wrote on a piece of paper: “*Carex Hostiana* Bastard? (*C. Hostiana* × *lepidocarpa*?)”. De Wever’s material is different to the material from Hussenberg that was collected on June 10, 1872, which belongs to *C. alsatica* (see previous paragraph). De Wever’s material has an inflorescence of 15–20 cm long with 2(–3) remote female spikes and 1(–2) long stalked male spike(s). The female spikes are about 2–2.5 cm long. We have compared De Wever’s material with our own collections of *C. xanthocarpa* [*C. flava* × *C. hostiana*] and *C. xleutzii* [*C. hostiana* × *C. lepidocarpa*] from Poland and Switzerland and have come to the conclusion that De Wever’s material belongs to *C. xanthocarpa*. Hitherto it is the only collection of this hybrid ever made in the Netherlands.

Carex demissa × *C. oederi* is probably not a very rare hybrid – the parents often grow together – but it is possibly overlooked, because the parents, and therefore also the hybrid, are rather similar and have often been confused with each other by botanists. Apart from the above mentioned herbarium material, this hybrid is also known by the authors from the Province of Groningen and from a few other sites in the Province of Fryslân (Koopman et al. 2019).

CONCLUSIONS

Our revision confirms that section *Cerastocystis* is represented in the Netherlands by: *Carex demissa*, *C. flava*, *C. hostiana*, *C. lepidocarpa*, and *C. oederi*. Besides, there are six hybrids known: *C. alsatica* [*C. demissa* × *C. flava*], *C. fulva* [*C. demissa* × *C. hostiana*], *C. pauliana* [*C. hostiana* × *C. oederi*], *C. xruedtii* [*C. flava* × *C. lepidocarpa*], *C. xanthocarpa* [*C. flava* × *C. hostiana*], and *C. demissa* × *C. oederi*. The material of *C.*

xanthocarpa had hitherto been regarded as belonging to *C. xuteola* [*C. distans* × *C. flava*], which was initiated by Kern & Reichgelt on a note on sheet L.3127553. This implies that *C. xuteola* [*C. distans* × *C. flava*] has never been found in the Netherlands and has to be excluded from Koopman’s (2010) list of Dutch *Carex* hybrids, whereas *C. xanthocarpa* has to be added to this list.

The distribution of *Carex flava*, *C. lepidocarpa*, *C. alsatica*, *C. xruedtii*, and *C. xanthocarpa* in the Netherlands is (almost) restricted to the Province of Limburg. The other taxa of section *Cerastocystis* have a wider distribution in the Netherlands.

Hermans & Spreuwenberg (2015), who did not pay attention to *Carex* hybrids, report three current localities in Zuid-Limburg for *Carex lepidocarpa*: Ravensbosch, Kathagerbeemden, and a mire near Weustenrade in the valley of the Geleenbeek. The latter locality has been developed as a nature development project since 1992. There is no material from this locality in L, but the occurrence of *C. lepidocarpa* in the former two is supported by herbarium material in L.

The *Carex* hybrid from Gameren (Province of Gelderland), which was treated by Van der Meijden & Holverda (2006) as *C. xruedtii*, and the hybrid collected on the Hussenberg near Beek (Province of Limburg) in 1872 both belong to *C. alsatica*.

There is almost no chance that one of the other four *Cerastocystis* hybrids will ever be found in the Netherlands. On the one hand *Carex flava* and *C. lepidocarpa* are too rare in the Netherlands to produce those hybrids. In addition, *C. demissa* and *C. lepidocarpa* hardly ever grow together, and neither do *C. lepidocarpa* and *C. oederi*. *Carex xschatzii* Kneuck. [*C. lepidocarpa* × *C. oederi*] we know from Poland, as well as the hybrid of *C. flava* and *C. oederi* [*C. xsubviridula* Fernald]. The remaining *C. hostiana* hybrid, with *C. lepidocarpa*, *C. xleutzii*, we know from Graubünden, Switzerland, where it grows together with its parents on calcareous seepage slopes. We have also seen this hybrid in the east of Poland in 2015–2017, where it grows in wet meadows together with its parents and *C. xanthocarpa*.

In the period 2000–2015, only eight collections of the *Cerastocystis* material from L were made: *Carex flava* ($n = 7$) and *C. demissa* ($n = 1$). In the same time frame a century ago (i.e. 1900–1915), 129 collections of *Cerastocystis* taxa were made in the Netherlands! This indicates that nowadays only little *Carex* material is sent to L, which is partly due to the common use of digital cameras. However, for real evidence as well as a good check of the identification, especially from an extraordinarily difficult section as *Cerastocystis*, one needs to collect herbarium material, too. Photos can give supporting evidence for a correct identification, but are never decisive.

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