CAREX AQUATILIS WAHLENB
A GLACIAL RELIC IN THE NETHERLANDS?

by

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Whether glacial relics occur in our country is a question as to which the opinions of botanists are still divergent. Although for a long period *Cornus suecica*, *Trientalis europaea* and *Linnaea borealis* had been called glacial relics, WEEVERS (15) in 1928 expressed his opinion that the occurrence of these plants was due to new settlement, their seeds being brought to our country by migratory birds which have eaten the fruits, and that in the Netherlands these plants were not genuine but only pseudo-relics. The comparatively short existence of pine-woods in which *Linnaea borealis* occurs and the recent spreading in Terschelling of *Trientalis europaea* are not considered corroborative to the theory which considers these species as relics. *Cornus suecica* is more than the other species proof against the objections raised, and a closer investigation will have to decide whether it is not really a glacial relic.

What requirements must a species fulfil to be a glacial relic? In the first place it must have a chiefly arctic- subarctic (and possibly alpine) distribution and a disjunct area, for in the places where the relics occur groups of individuals have remained behind, whereas the bulk of the species retreated along with the ice. In the second place it must have grown here in the pleistocene and since then have found continuously circumstances which enabled it to remain here. It is precisely the latter point which, in the case of glacial relics, is often called into question.

Now what does *Carex aquatilis* WAHLENB. show in this connection? In the Ned. Kruidk. Arch. of 1947, KERN and B. and TH. REICHGELT (9) called attention to this plant in an article in which they discussed the few specimens of this species present in the herbarium of the Kon. Ned. Botanische Vereniging and all of them coming from the province of Groningen.

SCHIPPER's specimen from Winschoten, 1922, is possibly of doubtful origin, since in an inexplicable way the label does not correspond with the plant; the other three discoveries, however, by SCHIPPER,

Onstwedde [1]), 1898, by DE BOER and KOOI, near Groningen, probably about 1900, and by VAN HALL, Haren (Groningen), 1845, are really authentic. The plants have been identified by the finders as *C. acuta* or *C. gracilis*; it was thought that *C. aquatilis* did not occur (any longer) in the Netherlands and consequently this species was, since OUDEMANS' Flora was published in 1874, not mentioned until, after the investigation by KERN and the two REICHGELT's, HEUKELS' flora of 1947 mentions the species again as indigenous.

However, the above-mentioned article also led to special attention being paid to the occurrence of *C. aquatilis* in our country, especially in the province of Groningen.

And indeed, in May 1948, miss H. D. SCHOTSMAN and the present writer found a few flowering specimens of *C. aquatilis* in Haren (Groningen) i.e. in the same village where VAN HALL found it in 1845. Whether the spot where it was found is also the same cannot be ascertained, no precise indication having been given by VAN HALL. We first found the plants in 'Sassenhein', H 7. 64. 33, an area of pools. In a peat pool, quite near the edge, but yet in the water, there grow some specimens among other *Carex* species (amongst them *C. disticha, gracilis, reticulosa*).

Carex aquatilis is conspicuous in the "field" by its stiff habit and long styles and is on closer inspection distinguished from *C. gracilis*, which it resembles most, amongst other things by a blunted-ged trilateral stalk (that of *C. gracilis* is sharp), further by the fact that the lowest bract rises higher above the inflorescence, and that the edges of the leaves, when drying, turn upwards (those of *C. gracilis* turn downwards); moreover, the utricle of *C. aquatilis* is pale green and nerveless. The identification was checked and confirmed by KERN and TH. REICHGELT.

The place where it was found at Sassenhein extends, to our present knowledge, only over a few metres and there grow only a few specimens. In the year 1949 we found some plants of *C. aquatilis* also in the so-called "Hemrik", J 7. 14. 11, a marshy piece of blue-grass land, which lies some hundreds of metres further south; they grow at the side of a ditch, again in the company of *C. gracilis*. The same year we found it also in a small pool along the road from Zuidlaren to Veendam, a little to the south-east of the Zuidlaren lake, about where the Hunze falls into it. This last spot, situated in the north of Drente and separated by the Hondsrug from the two first-mentioned, is, for the moment, the southernmost in our country

[1]) For a recent short description of this area see: J. M. DUIVEN, De Tichelberg bij Onstwedde. — Lev. Natuur 52 (1949) 231—236.

and, at the same time, the first outside the province of Groningen. In spite of the fact that this station was not known earlier, one is far from receiving the impression that the species has spread in the Netherlands in the last hundred years.

If we study the occurrence of *C. aquatilis* outside the Netherlands it becomes evident that it is, indeed, a species with an arctic-subarctic and circumpolar area, though it appears in the different parts of its area in somewhat various forms (KÜKENTHAL, 10).

The area of its distribution in Europe comprises Ireland, West and North England, Scotland, Iceland, Norway (to the south as far as near Oslo), Sweden (as far as a little south of Stockholm, where it becomes rarer), Finland, Esthonia (near Reval), North Russia (as far as Leningrad). South of this area there is a disjunction. In N.W. Germany and also in Denmark *C. aquatilis* is not known. The distance between the Dutch and the southernmost Scandinavian stations is about 700 kilometres. Now, disjunction is a relative idea, where details may be more or less considered, and for which a minimum in kilometres cannot be fixed. We may e.g. look upon the area Ireland, England, Scotland, Scandinavia as a whole in which, as a matter of course, the landplants do not occur in the sea but, on the other hand, we may look upon lakes in an area of landplants, or on mountain ranges in an area of lowland plants as just as many (small) disjunctions. However, the disjunction in the area of *C. aquatilis* is a striking one, not only on account of the great distance between the Netherlands and S. Scandinavia, but also because this distance is fairly completely bridged over by land (N.W. Germany and Denmark) where habitats suitable for the occurrence of *C. aquatilis* are doubtless to be found.

The situation of its area and the disjunction are certainly not in conflict with the view that in the Netherlands *C. aquatilis* is a glacial relic.

There remain two questions, first, did this species occur here as early as the pleistocene? Secondly, has it since that time been able to hold its own here?

Both questions will be rather difficult to answer, for the answers are dependent on fossil discoveries. However, there are as yet only few herbs which can be identified by palaeo-botanists as to the species; in the case of *Carex*, of which mostly the utricles or the "fruits" are found, they usually do not get beyond the identification of the section to which the species in question belongs. But there are some favourable exceptions and *C. aquatilis* seems to be one of them, for it is precisely *C. aquatilis* which, by the side of *Carex* spec. is separately mentioned in certain publications, with or without

some other species of the genus. (FLORSCHÜTZ and JONKER (3), JONKER (8), H. A. WEBER, (14)).

H. A. WEBER (14) as well as JESSEN and FARRINGTON (7) are of opinion that in attempting to recognise the fossil utricles there is considerable risk of confusing *C. aquatilis* WAHLENB. with *C. rigida* GOOD. Both have more or less plane-convex utricles without nerves; those of *C. rigida*, however, are a shade more arched. Moreover, the utricles of *C. aquatilis* have mostly purple granular spots over the whole surface, whereas *C. rigida* has these spots concentrated on the upper part of the utricle (see also KÜKENTHAL, 10). Therefore it may in some cases be possible to identify fossil utricles as belonging to *C. aquatilis* WAHLENB.

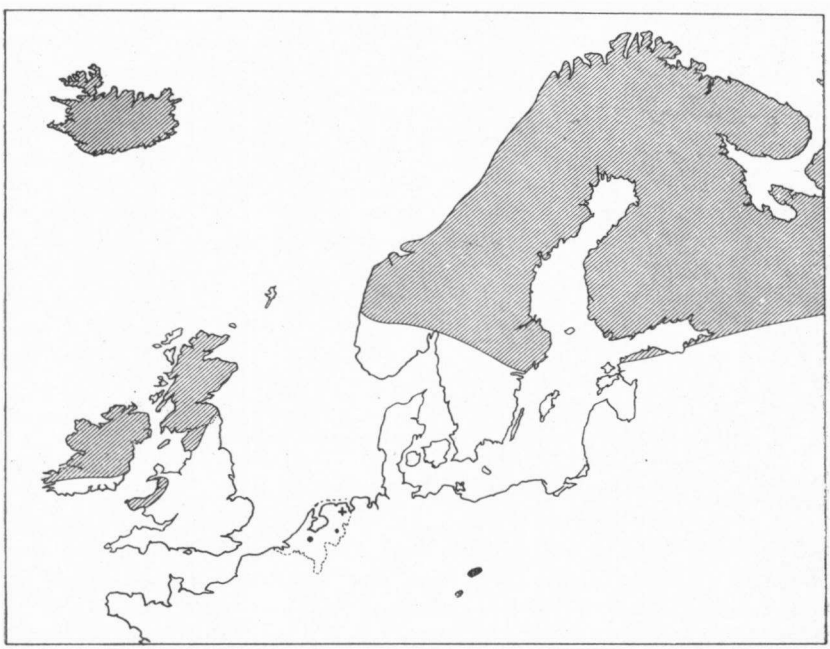
It has now been shown that in the Netherlands *C. aquatilis* really occurred in the glacial period. Fossil remains of this plant, together with those of *Dryas octopetala* and *Salix reticulata*, were found by FLORSCHÜTZ and V. D. VLERK near Hengelo (Overijssel) in layers belonging to the so called Frankfurt Stadium of the Würmglacial period [1]) FLORSCHÜTZ and JONKER (3) found it in a lock-chamber near Wijk bij Duurstede, in a layer of clay belonging to the late glacial period, at about 4 to 4½ metres below New Amsterdam watermark. This station lies considerably further south than the present ones which, in view of the then prevailing circumstances, is not inexplicable. In the company of *C. aquatilis* a number of (marsh)-plants were found, which still occur and which also in the habitats in Groningen grow in the closest vicinity of *C. aquatilis*. Of the plants mentioned by FLORSCHÜTZ and JONKER we find e.g. the genera *Betula*, *Salix*, *Alisma*, *Carex*, *Comarum*, *Eleocharis*, *Filipendula*, *Mentha*, *Menyanthes*, *Nymphaea*, *Oenanthe*, *Ranunculus* (incl. *Batrachium*), *Sparganium* and *Characeae*.

It has been pointed out that for a species being considered a glacial relic, it is necessary for it to have held its own also during the climatic changes since the glacial period. The boreal and especially the atlantic are, in this respect, the most critical periods. It is, of course, not necessary for the plant to have grown always in the same spot; there is no doubt that there may and probably will have been shiftings. Even if the plant occurs in a recently developed habitat this need not be an objection to the view that it is a glacial relic. In this connection it would be important to prove that suitable grounds were continually present, offering the plant possibilities of growth. NORDHAGEN (11) when studying vegetation in Norway came to

[1]) FLORSCHÜTZ, F. and J. M. VAN DER VLERK, The pleistocene human skull from Hengelo. — Proc. Kon. Ak. v. Wetensch., Amsterdam 39 (1936) 76-87.

the conclusion that *C. aquatilis* is more sensitive to conditions of humidity than e.g. to the degree of acid and the nutrient conditions of the environment.

The boreal period had a continental climate with low winter-temperatures; moreover, the results of palaeobotanic investigations (lit. 4) point to the fact that stagnant water, the chief requisite for an environment congenial to the plant, has been present on boulder clay in Drente ever since the end of the Pleistocene, and for this reason it is possible that *C. aquatilis* found a suitable environment in these pools. There is also a possibility that already at that early period the plant sought the river valleys. This latter view will probably have to be accepted in order to explain the tiding



Map of the distribution of *Carex aquatilis* WAHLENB. [1]).
Grey: the area known so far.
+ : the newly found stations in the Netherlands.
● : places where fossil remains of C. aquatilis were found.

[1]) After this article had gone to press I found in HULTÉN's atlas (lit. 6) some more stations of *Carex aquatilis* on the east and west coast of South Sweden.

over of the atlantic period, an era with a damp climate and a high water level, it is true, but, on the other hand, with fairly high temperatures and a development of *Sphagnum* peat which caused along with the open peat pools also a number of habitats suitable for *C. aquatilis* to disappear.

It is remarkable that the three stations of *C. aquatilis* known at present lie, indeed, in old river areas; Sassenhein and Hemrik in that of the Drentse Aa and the third in that of the Hunze.

Except for these present discoveries, however, there are, to my knowledge, as yet no proofs for the occurrence of *C. aquatilis* in the Netherlands after the glacial period. They may yet be discovered. It is also quite possible that among the remains found thus far there are some utricles of *C. aquatilis*, which, however, it has not been possible to identify as such.

In any case the post-glacial climatic conditions do not render the occurrence of this plant here impossible, and the data so far available are of such a nature that we may frame the hypothesis that *Carex aquatilis* WAHLENB. in the Netherlands is a glacial relic.

In England, according to a map of its distribution in the British Isles for which I am indebted to mr NELMES of Kew Herbarium, *Carex aquatilis* occurs in a limited area on the West coast of Wales (vice counties 45, 46, 48) and further from v.c. 69 to the north, i.e. from about the area where the river Tees has its source. Now, Upper Teesdale possesses a very interesting arctic-alpine flora of which, amongst others, HARRISON (5) assumes that it settled there in the late pleistocene and has since held its own.

In Ireland, which amongst other vegetation possesses an arctic flora element, neither *C. aquatilis* nor *C. rigida* are unusual phenomena; the latter, however, is more a plant of the mountains, whereas the former is found in the mountains as well as in the lowlands.

Both in England and Ireland *C. aquatilis* does not occur further south than about the 53rd degree of latitude, and such is the case in the Netherlands. Fossil *Carex* utricles found by JESSEN (JESSEN and FARRINGTON 7) in Ireland in late glacial layers in a bog of Ballybetagh, a little to the south of Dublin, could not be identified by him with certainty as those of *C. aquatilis*, and the same can be said of an inter-glacial bog in Jutland. However, the discovered utricles closely resemble the utricles of *C. aquatilis* from Niederlausitz, depicted by FIRBAS (2), who found this plant there in late glacial layers.

Also in other places in Europe this plant was found in pleistocene sediments.

Since H. A. WEBER (14) on the strength of only one utricle established near Lobstädt the occurrence of *C. aquatilis* in the glacial period in Central Europe, the discoveries of FIRBAS and GRAHMANN (1) in the young diluvial Marga bog in Niederlausitz are conspicuous by their numerousness; in almost all the layers of the profiles examined, which must have been formed when shallow water became land during an arctic and subarctic climate in a late glacial period, remains of this plant were found in the form of utricles, rhizomes and leaves. Therefore FIRBAS assumes that in those days *C. aquatilis* constituted an important part of the vegetation and occurred much further south than is the case at present.

In most layers he also found fruits of *Betula nana.*

Of the latter it has been proved that in some places in Germany it is a glacial relic. *Betula nana*, too, is arctic, sub-arctic and circumpolar. But its area, which for a considerable part coincides with that of *Carex aquatilis*, extends on the continent of Europe much further southwards and falls there asunder. Though in this case it is rather difficult to decide what belongs and what does not belong to the undivided area of distribution, yet the area of *Betula nana* is generally looked upon as disjunct.

Fossil discoveries of *Betula nana* in various parts in Germany comprise the late and post-glacial period down into the subatlantic. The Saar mountains in Moravia (Germany-Czechoslovakia) yielded an almost continuous series of discoveries of *Betula nana* from the *Pinus* period to the beginning of the *Fagus-Abies* period, which in itself furnished proof that this arctic and subarctic plant had survived there the whole warm(er) climatic period. This was a strong support for the opinion that in the German secondary mountains *Betula nana* is a glacial relic.

On account of the discoveries of OVERBECK and SCHNEIDER (12) the same may be said of the N. German lowland plain. For in the Melbeck bog, some kilometres south of Lüneburg they found *Betula nana* in a series from the pre-boreal period to far down into the atlantic. Evidently the plant also held its own here in the warmest period and must even have formed mass vegetation in the boreal as well as in the atlantic period. That, at present, it no longer grows in that place the writers attribute to the fact that *Betula nana* avoided the developing *Sphagnum* bog and therefore could at most be expected on the borders of this peat bog, which, however, have been so thoroughly cultivated that it is no longer possible for *Betula nana* to grow there, while a fairly recent occurrence cannot be established either, since in that region the layers in question have also been destroyed by cultivation. On an area map, however, we see that

at present *Betula nana* still grows in the vicinity of the above-mentioned bog in the N. German lowlands.

In the Erzgebirge fossil remains of *Betula nana* were found in late and post glacial layers. The series here runs on down into the subatlantic and links up with the recent occurrence of the plant there. Only such an uninterrupted series can prove that in a certain region a plant is a glacial relic, and therefore it is in this connection also required for *C. aquatilis* in the Netherlands. For, this proof lacking, the possibility must be kept in view that a plant from the pleistocene became extinct in the warmer climatic period and later settled again in the same area. In that case it would be a pseudorelic.

It will be difficult to ascertain whether it was possible for *Carex aquatilis* to show the same endurance as *Betula nana* in respect of the changing conditions after the glacial period. However, the series of discoveries of *Betula nana* in Germany prove, in any case, that there are arctic-subarctic plants which have been able to survive a warmer climatic period, even the atlantic. And such was the case, as far as the Melbeck peat bog is concerned, at a degree of latitude corresponding with that of the N. Netherlands, though it is about 270 kilometres E. of the present stations of *C. aquatilis* in our country.

For the time being, there is no reason to assume that *C. aquatilis* does occur in N.W. Germany and Denmark. However, if this might prove to be the case, the southern border of the then more or less unbroken area probably runs through the north of the Netherlands and not through the south of Norway and Sweden, as was so far thought. And, even then, the proof of the occurrence of this plant in the Netherlands since the pleistocene would be of importance. It is the task of palaeo-botanists when finding *Carex* utricles in glacial as well as in post-glacial formations, to pay special attention to *Carex aquatilis* WAHLENB.

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LITERATURE.

1. ESHUIS, H. J., Untersuchungen an niederländischen Mooren. — Rec. d. Trav. bot. néerl. 33 (1936), 688—704.
2. FIRBAS, F. und R. GRAHMANN, Ueber jungdiluviale und alluviale Torflager in der Grube Marga bei Senftenberg (Niederlausitz). — Abh. d. math.-phys. Klasse d. sächs. Ak. d. Wissensch. 40 (1929) No.4 (1928) 1—63.
3. FLORSCHÜTZ, F. and F. P. JONKER, A botanical Analysis of a late pleistocene

and holocene Profile in the Rhine-Delta. — Rec. d. Trav. bot. néerl. 36 (1939) 686—696.
4. HAMMEN, T. VAN DER, De Allerödoscillatie in Nederland. — Proc. Kon. Ned. Ak. v. Wetensch. LII (1949), 69—75, 169—176.
5. HARRISON, J. W. HESLOP, Chapt. "Flora" in: Scient. Survey of North-eastern England. — British Ass. Adv. Sci. 1949.
6. HULTÉN, E., Atlas över växternas utbredning i Norden. — Stockholm 1950.
7. JESSEN, KNUD and A. FARRINGTON, The Bogs at Ballybetagh, near Dublin, with remarks on late-glacial conditions in Ireland. — Proc. Roy. Irish Ac., vol. XLIV, section B No. 1 (1937) 205—260.
8. JONKER, F. P., De flora van Nederland tijdens het pleistoceen. — Vakbl. v. Biol. 28 (1948) 122—129.
9. KERN, J. ,REICHGELT, B. en TH., Caricologische Aantekeningen IV.— Ned. Kruidk. Arch. 54 (1947), vid. 248—252.
10. KÜKENTHAL, G., Cyperaceae — Caricoideae. — In: A. ENGLER, Das Pflanzenr. IV, 28, Hft. 38 (1909). Vid. p. 299—302, 309—311.
11. NORDHAGEN, R., Sikilsdalen og Norges Fjellbeiter. En plantesosiologisk Monografi. — Bergens Museums Skrifter No. 22 (1943). Vid. p. 448.
12. OVERBECK, F. und S. SCHNEIDER, Mooruntersuchungen bei Lüneburg und bei Bremen und die Reliktnatur von Betula nana L. in Nord-westdeutschland. — Ztschr. f. Bot. 33 (1939) 1—54.
13. PRAEGER, R. Ll., Report on Recent Additions to the Irish Fauna and Flora (Terrestrial and Freshwater). — Proc. Roy. Irish Ac., vol. XXXIX, section B No. 1 (1929) 1—94.
14. WEBER, H. A., Ueber spät- und postglaziale lakustrine und fluviatile Ablagerungen in der Wyhraniederung bei Lobstädt und Borna und die Chronologie der Postglazialzeit Mitteleuropas. — Abh. herausgeg. v. Naturwiss. Ver. z. Bremen XXIV (1926) 189—268.
15. WEEVERS, TH., Relikte oder Pseudorelikte. Betrachtungen über die Dünenheiden der Nordseeinseln. — Ned. Kruidk. Arch. (1928) 130—148.