A CONTRIBUTION TO OUR KNOWLEDGE OF THE ORIGIN OF THE BRITISH FLORA

by

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A lecture delivered lately by Dr. W. G. N. van der Sleen at a meeting of the Royal Dutch Geographical Society on the so-called Cromer Forest Bed has revived in this country the interest in an old theory, advocated by Prestwitch, Harmer and others, according to which many thousands of years ago, in an age when the North Sea was still land, the Rhine took its course through the east part of England, entering it near Walton on the coast of the county of Essex, to the south of Harwich, and leaving England again after passing in a northerly direction through Essex, Suffolk and Norfolk at Cromer on the north-coast of the last-named county. With regard to this I have asked myself, whether it would not be possible to find in the distribution of certain species of plants in England and on the Continent some arguments in favour of the above-mentioned theory, upheld energetically by Van der Sleen. Any Dutch botanist of experience knows, that the valleys of our big rivers Meuse and Rhine are characterized by certain species of plants, which strictly follow the beds of these rivers, rarely-if ever-occur in other places and the distribution of which is obviously dependent on them. If it could be proved, that these species occur all or partially in England too, and this strictly locally in the counties of Essex,

Suffolk and Norfolk, in the vicinity of the hypothetical former river-bed, then doubtless an important argument, if not definite evidence would be hit upon. The reader may judge for himself the value of what I as a botanist have to say hereunder on the problem, which interests us here, basing myself amongst others specially on the information, which Prof. A. G. Tansley of Cambridge, Englands wellknown plant-geographer, has been so kind as to furnish me.

In order to make the following quite clear, I intend first of all to say a few words about the geological aspect of the problem. Harmer has found between Walton and Cromer, in a soil which in other respects does not show much variety, a broad and winding strip of river-clay and in its neighbourhood a peculiar kind of small white pebbles, such as are found also in the southern parts of our country. In this way he became an advocate of the idea, that the Rhine might at one time have flowed through the eastern counties of England. Van der Sleen finds back the river-bed near Walton as well as near Cromer. According to him, its position is fairly high near Walton, which is possible, as the soil may have raised itself in course of time, and it is based on an underground, which, as appears from the fossils it contains, is evidently of late tertiary, late pliocen origin. Near Cromer its position is lower and here especially it is buried under the deposits of the ice-age. Van der Sleen concluded, that doubtless during the transition-period from the tertiary to the ice-age the Rhine took its course through England, being enabled to do so by the circumstance, that the North Sea, which formerly already extended more to the south, was then dry till far to the north.

Let it be borne in mind, that it will be difficult to find botanical arguments in favour of the Rhine having taken its course through England during the period mentioned

by Van der Sleen. For afterwards came the ice-age, which of course entirely expelled the original tertiary flora from the south part of England, which was the only part left uncovered by the ice. Many articles have been written already about the flora, which existed south of the ice-border at that time. Much depends here upon the question, whether a sea- or a land-climate prevailed. In the south of England and in our country the climatic snow-line was situated, according to Penck and Brückner, at an altitude of about 800 meters. In the case of a sea-climate having prevailed, it is possible that there still existed a fairly rich flora. With a pronounced sea-climate, the tree-limit may even surpass the snow-line, as I have been able to see myself in the region of Mt. Rainier in the United States, whilst it usually remains more than 800 meters below it. As a rule, however, the climate is considered to have been rather continental. The big ice-deposits must have caused an area of high pressure and a prevalence of eastern winds on the southside of the ice-border. But in this case the flora can not possibly have been much more than a tundra-flora, very poor in species. The well-known peat-soil explorer Weber, in absolute conformity with this, found in peat-soil of the ice-age only remainders of a few species of mosses and *Carex*. We may conclude, that practically the whole actual British flora must have come into England after the ice-age, and this chiefly from the south-east. And in connection herewith we can only ask, whether there is a possibility of the Rhine having flowed through a certain portion of England even after the ice-age, and further, whether there may exist in England species of plants, the presence of which can only be accounted for by this circumstance.

The first part of this question may be answered in the affirmative. It seems to be considered a fact, that the North Sea during the ice-age was dry up to a point far north.

This is proved by the remains of Mammoths found in the peat-soil of Doggersbank. It is true that some believe that sometimes the water temporarily covered these regions, e.g. in the first interglacial period, during which the so-called Eem-Sea should have extended at least as far as the present isle of Goeree. But on the other hand the Dutch soil must have been sloping to the south during the ice-age, according to discoveries of northern stones found far to the south, sothat the big rivers will probably have had a more southern course. It is therefore quite possible, that during the ice-age the Rhine took its course through England. In addition to this the following should not be forgotten. If at the beginning of the ice-age the Rhine flowed through England, it may be conceived that, the ice-age having once properly begun, its further course would have been towards the west, under compulsion from the ice. It is therefore quite possible, that soon after the ice-age this was the actual state of affairs. And such plants, as were introduced eventually by the Rhine into England, may be expected a priori somewhere to the south-west of Cromer.

The question, at what time river-plants had a last chance to penetrate into England, is an important one. This must have been the case in the so-called oak-period, which is a fact of very great importance. With regard to this a word will have to be said about the periods, which may be distinguished after the ice-age. There is in the first place the so-called *Dryas*-period. The Tundra gave way to a vegetation of arctic-alpine dwarf-shrubs, amongst which the well-known rosaceous species *Dryas octopetala L.* with its eight white petals, different species of dwarf-willows, etc. This period brought us such plants as the *Empetrum nigrum L.*, the *Arnica montana L.* etc., which have since continued to grow here. The *Dryas*-period was followed by a period of birches and Conifers, and

together with these came a number of plants, which draw at present specially the attention in our country. I allude to such species as *Trientalis europaea, L., Cornus suecica L., Linnaea borealis L., Chimaphila umbellata Nutt.* and perhaps other species of *Pyrola, Rubus saxatilis L., Goodyera repens R. Br.* and *Corallorhiza, Monotropa,* which are all typical representatives of the undergrowth of coniferous wood, growing in moist and relatively warm regions, and which in our country are mostly found only in very few places. Have we got to do here always with relic-stations? I should think it very likely in the case of such a place as the well-known *Trientalis*-station near Denekamp e.g., but in other cases it seems to me at least doubtful. Am I well informed, then young Conifers are often imported straight from the north and with them the seeds might have been introduced. I think an enquiry into the character and the history of the stations of our postglacial coniferous wood-plants would be very desirable. In this case the real relic-stations ought to be raised at once to the dignity of national monuments! As a matter of fact, the coniferous wood also had to yield to a new vegetation. Whether this was entirely the case in our country, it is difficult to say. It is often supposed to be so, but I ask myself, whether a bad soil could not hinder the development of a vegetation, which owing to a changed climate might have come? On the other hand it is also true, that in course of time a coniferous vegetation improves the soil, sothat with the same climate a more luxuriant vegetation can arise. I have seen a very remarkable proof of this in the dunes surrounding lake Michigan, where, coming from the lake-side, we find first a zone of recently formed dunes, behind them a zone of dunes with coniferous wood, then dunes with a vegetation of oaks and last of all the old inner dunes, covered with the typical beech-wood of the Eastern States, hardly, if at all differing from such a

wood growing on a fertile clayey soil. Therefore it is quite possible, that the whole coniferous wood has disappeared, if only there was time enough available, before in our country mankind began to affect nature. Those readers, who know the Alps and have seen, in descending a mountain, how a coniferous zone preceded a zone of beeches, will now only expect, that the coniferous wood has given way to the actual deciduous forest of Central Europe, with the beech as its principal representative. This, however, did not happen. After the age of Conifers came a period of oaks, as with the dunes of Michigan, and in this period a dry and warm climate prevailed. The general conditions in our regions must have been about the same then as those found actually in Galicia, where there is to this very day a zone of oak-woods between the Central European wood of beeches in the west and the steppes in the east. Somewhere about the middle of this oak-period began the definitive sinking of the soil, which led to the North Sea breaking through the Pas de Calais. The results were in our country, first a climate much like the actual one, then the appearance of the so-called atlantic and mediterranean-atlantic plants, i. e. plants from the atlantic and mediterranean regions which, owing to the mild climate on the west-coast of Europe, could by this way reach our country; finally a destruction of the oak-woods by heath and moors, and — although sporadic owing to edaphic factors — the appearance of beeches. In any case — and this is the principal point of interest to us — during the oak-period there was for the last time the possibility of an introduction of typical river-plants into England.

Let us now treat the botanical side of our problem! In order to do so, I have in the first place read the articles of Van Eeden concerning a supposed former course of the Rhine past Harlem to the north in old volumes of

the periodical: "Het album der natuur" (The album of nature), which unfortunately has ceased to appear. At present many persons, especially botanists, believe in such a course, but in the times of Van Eeden the idea was new. I have not become any the wiser by it. Van Eeden records as typical Rhine-plants of the environs of Harlem *Epilobium hirsutum L., Plantago media L., Euphorbia Cyparissias L. var. β esuloides D. C., Sedum purpurascens Koch*, further *Adoxa Moschatellina L., Aristolochia Clematitis L.*, finally two plants of the ruins of Brederode, namely *Cheiranthus Cheiri L.* and *Parietaria erecta M. et K.* All these plants are found growing wild in Switzerland, the last three not often. In Belgium the first five are widely spread, though chiefly in the east part; the last three are considered to have been introduced and in our country also have perhaps only escaped from castle- and cloister-gardens; the last two only grow on walls, like in our country. In Germany also the first five of the above-mentioned species are widely spread; the *Aristolochia* grows wild in a part of it (perhaps in Alsatia and Baden?), but is considered elsewhere to be naturalized, like the *Parietaria* and the *Cheiranthus*; the latter seems to be confined to the west part (the river-basin of the Rhine?). It will not be possible to prove much by means of all these plants. They may have a local importance, but to our problem they are not of any great value. There are, however, a few points, which struck me particularly when reading the works of Van Eeden. This was the case in the first place with the distribution of a very remarkable mushroom, the *Geaster coliformis Dicks.* It was discovered in England by Sowerby and in this country only occurs in grassland on sandy soil of Norfolk and Suffolk. In 1865 it was found for the first time in our country (by Hugo de Vries, near Katwijk on the Rhine). Lateron some other localities have been discovered: all are situated on the

inner side of our dunes, in places where an ancient river-bed of the Rhine may have existed. Further I only know from a station near Darmstadt (on the Rhine!) and one or two other places. Could this *Geaster* therefore perhaps be a link of our argumentation in favour of Prestwitch c. s.? Another point, which struck me with Van Eeden, is that speaking about the presence of Rhine-plants near Harlem he also refers to a connection with England, without knowing however anything about the view of Prestwitch, Harmer etc. On the well-known country-seat Duin en Kruidberg to the north of Harlem *Viburnum Lantana L.* is found growing wild. In our country this plant is further only found in the south of Limburg. In Belgium it occurs in the east part only, in Germany not in the northern districts, Saxonia and Silesia, but not even rarely in the centre and the south-west. Reasons enough to suppose, that we have got to do here with a true river-plant, and to consider its presence north of Harlem as an argument in support of the theory, that once the Rhine has passed here. This opinion is shared indeed by Van Eeden, who at the same time mentions, that this species also occurs on the opposite coast-regions of England, which according to him points to a connection between England and Holland. It is only to be regretted, that our *Viburnum* may by suspected to have been spread by birds! But perhaps in the times of Van Eeden it was not yet so intensively cultivated, that it was necessary to think of this possibility? *Primula acaulis Jcq.* also is mentioned by Van Eeden as a plant, which, being common on the inner side of our dunes and on the opposite side of the North Sea, as well as in Germany and Switzerland, whilst in Belgium it only occurs naturalized in a few places, may point to an ancient river-bed of the Rhine; but unfortunately this species also is suspected to be in our country only as the result of former cultures.

If we only had at our disposal the data mentioned by Van Eeden, we would not be able to bring the problem, which interests us here, much nearer to its solution. Fortunately, however, there are other plants to be mentioned, many of which are much more typical as companions of our rivers and give us much more evidence too in favour of an ancient Rhine-bed past Harlem to the north, such as those mentioned by Van Eeden, and which are of greater value to us for the solution of the problem. In connection herewith it must be pointed out, that it is generally accepted, that during the oak-age there has been a period of special dryness and warmth. Big ranges of wood should have perished in those times and a distribution of plants set in from the coast of the Black Sea in the direction from south-east to north-west to our regions, and specially so through the valleys of the Danube, Main and Rhine, as the steep slopes of these river-valleys offered favorable passages, which were free from woods. Actually these plants, representatives of the so-called pontic-pannonic plantcommunities, are only found here in very warm places and as a rule they give unmistakable indications concerning the course of the big rivers. The examples which are best known are the following:

Silene Otites Smith; in our country this species only grows on the inner side of the dunes, further near Huizen (mouth of the river Vecht) and finally in one place corresponding to the German stations, namely on the isle of Schiermonnikoog; it is not found in Belgium;

Artemisia campestris L., growing in our country strictly along the big rivers and in the environs of Harlem near the ancient Rhine-bed of Van Eeden; in Belgium this plant is only found in a few places in the vicinity of the Meuse;

Eryngium campestre L., occurring e. g. on the Kyffhäuser

on very hot soil together with the previous species, follows in our country remarkably the big rivers, the river-mouths of the province of Zeeland, the ancient Rhine-bed of Van Eeden and the river Vecht; in Belgium it is rare and nearly confined to the valley of the Meuse;

Erucastrum Pollichii Sch. et Sp. is a common species along our big rivers, also along the ancient river-beds of the Rhine, but besides it also has been found on railway-embankments, which may be after all easily understood; in Belgium it is extremely rare and has only been recorded from a few places as an alien;

Dianthus deltoides L., specially common along the river-beds of the Ysel and the river Vecht in the province of Overijsel, has however also been recorded from the south of Limburg, the valley of the river Eem and the neighbourhood of the ancient Rhine-mouth near Katwijk; further from the east of the province of Groningen (near the Eems!), the isle of Walcheren and a few other places; in Belgium it is chiefly confined to the regions of the Meuse and there still it is rare;

Galium verum L., the least important species to our purpose, may be said to grow chiefly along our big rivers, but is also found in many places far away from them, on railway-embankments e.g. and along the whole coast; it is widely spread in Belgium.

Knowing that it was just the oak-age, which offered a last chance to the typical plants of the river-valleys to penetrate into England, we are now of course anxious to know, which is the distribution of the above-named species in England. My communications are based here on the data, which Prof. Tansley has been kind enough to give me. *Galium verum* is as common in England as it is in our country and Belgium; therefore it is of no further importance to our purpose. *Dianthus deltoides* too is widely spread in Great Britain, with the exception of

Ireland, and can 't therefore give us neither any indication with regard to an ancient course of the Rhine. *Erucastrum Pollichii* and *Eryngium campestre*, which are both extremely rare in England, are of more importance already. Prof. Tansley says about the first one, that it is sometimes found as an alien in England, as is the case in our country, but that there is one place in Essex, consequently near our Rhine-bed, where it may be regarded as naturalized; about *Eryngium campestre*, that it is reported as native in two places on the Kent and Suffolk coasts, consequently at any rate opposite the mouths of our big rivers, which have distributed it in a north-western direction. I was however greatly surprised by the information of Prof. Tansley with regard to the two first-named species, *Silene Otites* and *Artemisia campestris*. Those who have been present at the above-mentioned meeting will perhaps remember, that immediately after the lecture of Dr. Van der Sleen the word escaped me, that, if it could be shown that a species as e. g. *Artemisia campestris* in England only grows in the neighbourhood of the Cromer Forest Bed, direct evidence, that this is an ancient Rhine-bed, would be hit upon. In this paper we concluded, that one has the greatest chance to meet Rhine-plants somewhere to the south-west of the Cromer Forest Bed. Now, Prof. Tansley literally informs me as follows concerning *Silene Otites* and *Artemisia campestris:* "Norfolk and Suffolk only: in "Breckland", i. e. a sandy area (probably old post-glacial blown sand, some think loess-like sand) in west Norfolk and Suffolk". We must represent ourselves this area on the map to the north and to the south of the frontier between Norfolk and Suffolk and situated against the west frontier of Norfolk and Suffolk, consequently indeed to the west of the Cromer Forest Bed! Should this still be a mere chance?

It goes without saying, that from the very moment I felt greatly interested in the "Breckland-sands". Let us

also pay attention to the opinion, that we should have got to do here with a loess-like material. Has not v. Cappelle in 1900 defended the theory, that loess is a deposit of rivers, and argued, that there is in our country a distinct connection between the distribution of the loess and the course of the IJsel, Rhine and Meuse? Now I know very well, that others consider loess to be a deposit of the wind, but I should like to ask as non-expert on this subject, whether not here also truth lies midway. Here again the botanist knows, that at present still such things as deposits made by the wind, being washed away by the water, happen in the Alps. The wellknown "Schneetälchenflora" is e. g. a result of it. Would it not be possible, that what we see take place at present has also happened in the past and that it is of importance to understand the loess-deposits? Still another important point mentioned by Prof. Tansley was, that the "Breckland-area" contains a series of further species, which are not found elsewhere in England or which are nearly confined to it. At my request, the names were kindly given to me and in this way I have had the opportunity to work in inverse direction, which has given me additional evidence.

Strictly confined to the "Breckland-sands" are according to Prof. Tansley still the following plants: *Medicago falcata L.*, *Veronica verna L.*, *Veronica spicata L.*, *Carex ericetorum Poll.* and *Ornithogalum umbellatum L.* The Dutch botanist recognizes the first of these species at once as a river-plant. In our country it only occurs along the big rivers Meuse, Waal, Rhine, IJsel and also along the old Rhine-bed of Van Eeden. In Belgium it is very rare in the south-east corner, rare within the range of the Meuse and in the central part, but in the latter, according to Crépin, perhaps only an alien. It certainly is therefore of importance to our purpose. In Germany it is

widely spread, although very rare in the west part of the north German lowlands. *Veronica verna* has in our country only been found in one single place, sothat it is difficult to say, whether we have got to do here with a river-plant or not. In Belgium it is rare and occurs in the east part only. In Germany it is on the whole not rare, but it is not found in north-west Germany, which is worth noting with regard to the distribution of the former species. At any rate it is a remarkable fact, that the only statement in our country, which is thought reliable, refers to Loosduinen, consequently to a sandy soil in the neighbourhood of the big rivers and as near as possible to England. The presence of *Veronica spicata*, a plant of sunny hills and dry deciduous forests, in our country is doubted in our Prodromus. Nevertheless it is typical, that two of the three localities, which have been mentioned, are situated near the place, where the Rhine enters into our country. In Belgium this species is totally missing, in Germany it is not found in the north-west German lowlands. I consider it to be of positive interest to our problem. This is not so much the case with *Carex ericetorum*, because of the great rareness of this species. In our country it has been recorded from Asselt on the Veluwe, but concerning this locality too there is some doubt. After Crépin in Belgium also only one station is known, situated in the Ardennes, immediately south of our province of Limburg. As to Germany, Garcke mentions Trier and Bonn in the Rhine-province and further certain places in Alsatia, Baden, Wurtemberg and Bavaria. I have the impression, that we have got to do here with a mountain-species, which in our country is a relic from very old times, probably from the *Dryas*-period, if not from the ice-age. As to the *Ornithogalum umbellatum* at last, we have got to do here again with a widely spread species, which is common in Germany, in Belgium, here, it is true, chiefly

in the central part, and also in our country. Let me therefore only say about this species, that I myself always had the impression, that we have got to do here with a river-plant. Most of the localities are situated along our big rivers and we must not forget, that a species like this one is likely to obtain an unnatural distribution through human influence.

The species, which Prof. Tansley has recorded to me as nearly confined to the "Breckland-area", that is to say, only growing there and in some places quite near to the south-west and the west of it, consequently in the counties of Essex, Middlesex, Hertfordshire, Bedfordshire, Lincolnshire etc. are: *Herniaria glabra L. (var. vera Babingt.), Scleranthus perennis L., Holosteum umbellatum L., Silene conica L., Veronica triphyllos L., Phleum Boehmeri Wib.* and *Muscari racemosum Mill.* We will treat them again the one after the other. *Herniaria glabra*, common in Germany, rare in Belgium and there confined to the east part, gives us entirely the impression to be a river-plant. It comes in along the Meuse and the rivers coming from Germany and it penetrates far to the west, as far as Vianen, Gorkum etc. It is therefore not impossible, that the English stations depend upon this. About *Scleranthus perennis* literally the same may be said as about *Herniaria glabra*. The only difference is, that this species seems to have a somewhat greater spreading-power as the former. It has namely also been found in the neighbourhood of Naarden-Bussum (mouth of the river Vecht) and along the old Rhine-bed of Van Eeden (Heemskerk, Breesaap, Hillegom, etc.) In conformity with this in England also it has advanced somewhat farther from the "Breckland-sands" and has namely also been recorded from Radnorshire, whilst the *Herniaria* does not go any farther than Lincolnshire and Middlesex. *Holosteum umbellatum* is doubtless a river-plant and this species again

shows exactly the same distribution as the *Scleranthus*. Only in very few places it has been found, which are not situated near the present or former river-beds of the Rhine and Meuse. In Belgium it is less rare than the two former species and particularly in the central part it has been found several times. Yet it seems admissible to bring its presence in the "Breckland-sands" (and in Surrey) in connection with a former vicinity of the Rhine. *Silene conica* is a noteworthy plant. If we only study its distribution in Germany and in our country, we get entirely the impression of having before us a river-plant. Garcke records the following stations in Germany: the region of the Rhine, specially the "Mainzerbecken", further the region of the Nahe and the Moselle, and the Palatinate. In Holland this species has been found on the Meuse, Waal, Rhine, IJsel and the mouth of the Vecht (Naarden) and in the dunes between Beverwijk and Terheiden. So there seems to be no doubt concerning its character as a river-plant! Yet we have to be careful. In Belgium it occurs namely particularly along the coast, which explains at the same time a station near Kadzand in our country, and the flora of Schinz and Keller for Switzerland considers it to have been introduced from the mediterranean regions. Have we got to do here therefore with a typical atlantic species? It is not impossible, but its distribution along the Rhine and our big rivers, as well as the big chasm between the stations Kadzand and Terheiden are at any rate very striking phenomena. Are the Englisch stations in Sussex and Kent perhaps based on a distribution along the west-coast of Europe, those in Norfolk and Suffolk on a distribution along the Rhine? *Veronica triphyllos,* common in Germany, with the exception of the north-west part and Sleswick, fairly common also in the central part of Belgium, is found in our country chiefly along the rivers Meuse, Rhine, Ysel, Eem, Vecht and

the ancient Rhine-bed of *Van Eeden*. The importance of this species to our problem seems to me to be the same as the one of *Holosteum umbellatum*. Finally as to the last species, which have to be treated, *Phleum Boehmeri* and *Muscari racemosum*, I think them very valuable again. *Phleum Boehmeri* is a species of a barren hilly soil in Central Europe, not found in north-west Germany and Sleswick-Holstein; in Belgium it is rare and occurs in the east part only. In our country it has been found on the Meuse near Rotterdam, near Leiden and Harlem. It seems to me, that the stations in the "Breckland-area" and in the counties of Bedfordshire, Hertfordshire and Essex immediately to the south-west of it surely point to the Rhine as their cause. *Muscari racemosum* does not occur in Holland, neither in Belgium, but in south and central Germany it is a rather common species. Apparently the plants of the "Breckland-area" — in Great Britain the species has been recorded outside but not far outside Breckland proper on chalky grassland — form a far advanced outpost of the main mass in Central Europe. And as our *Muscari* is a species of a hot soil, quite as the *Artemisia campestris*, it might be assumed that it has come to England together with this plant and in the same way.

For the moment I must confine myself to these communications. I think however, that it was worth while to make them and that they may be said at any rate to form a contribution to the problem of the course of the Rhine through England as well as to our knowledge of the origin of the British flora. Perhaps one of the younger ones amongst us cares to work this subject further out! Finally a well-nigh superflous encouragement to all readers, to be as accurate as possible when recording stations in herbaria etc.! We have seen, which important problems may be brought nearer to their solution by many reliable floristical data!

Amsterdam, November 1923.