

A CONTRIBUTION TO THE INVESTIGATION OF THE HOLOCENE HISTORY OF THE BEECH IN THE EASTERN NETHERLANDS

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ABSTRACT

To study the immigration and spreading of the beech (*Fagus sylvatica* L.) in the Netherlands during the young Holocene, three peat bogs were palynologically investigated in the eastern Netherlands and in the adjacent German area. For this purpose peat samples have been collected in the Korenburgerveen near Winterswijk, in a peat bog near Burlo (Germany) and in the Aamsveen south-east of Enschede. The analysis of the peat-samples proved, that extensive beech-forests existed in subatlantic times in the subcentroeuropean flora district of the Netherlands. This is shown in the comparatively high *Fagus*-percentages in the pollen-diagrams.

GEOGRAPHY

The recent area of *Fagus sylvatica* stretches from South-Sweden and Norway into northern Spain and towards the east into the Balkans. In the west, the beech is (perhaps) only spontaneous in the south-east of England as far as Dorset, Brecon and Cambridge. In Ireland the beech is absent. In Scandinavia the most northern locality where *Fagus* still occurs is near Bergen (Norway). This area, however, is separated from the main area and it remains to be seen whether *Fagus* has arrived here by natural way (FAEGRI, 1954). In Norway the beech is also present along the coast between Oslo and Kristiansand and along the east coast of the Oslofjord. In Sweden it occurs along the west coast and in the south Swedish lowland south of the 59th degree of latitude. In Denmark the beech is present in the whole country except on Bornholm. Here the beech has been indigenous according to MIKKELSEN (1963), with a maximum from subboreal till historical times, when it was extirpated almost completely. Along the Baltic the beech reaches till Gdansk (Danzig). From here the border of the area goes in south-eastern direction to the River Dnjestr. On the Crimea and in the Caucasus, too, *Fagus sylvatica* is found; further in north Iran in the provinces of Gilan and Mazandaran and in the northern part of Asia Minor. In the Balkans it reaches till Thracia, Macedonia and Thessalia, but it is absent on the Peloponnesos. In Italy the beech occurs in the Alps, the Apennines and on the Etna. Also in Corsica the beech is found in the mountains. It is the same in northern and central Spain (Pyrenees, Castilia and Galicia). In France the beech is rare in the lowland of the southwest and in the lowest parts of the Mediterranean area, further it

is common. In Central Europe *Fagus* is by no means equally distributed (RUBNER, 1925). It was and is still dominating in the south German Alps and the moraine area, in the Württemberg-Bavarian Jura area, in the Paltish-Lotharingian mountains, in the west German mountains between Zeits-Harz-Deistermountains-Teutoburger-forest and Spessart-Odenwald, in the fringe area of the western Baltic with the Pommern Plain, eastern Sleswick and eastern Jutland. The beech is rather rare in northern Germany south of the line Havel-Spree. In South Central-Europe the beech is found in the Erz mountains, Riesenmountains, Fichtelmountains, further in the Bavarian forest, Bavarian Alps, Tiroler Alps, Oetstaler Alps, Vosges, Black Forest, in the Berner Alps and in the eastern Central Alps. In the Netherlands and Belgium the beech is not spontaneous now in the polder area, but it has been planted there to a large extent. In the east of the Netherlands and South-Limburg there are yet remnants of rather luxuriant deciduous forests, in which the beech takes up an important place too. Pollendiagrams of peatbogs from these areas show clearly, that the Netherlands too, at least in these areas, have had rather extensive beech forests.

For the first time *Fagus sylvatica* was common in Europe in the Pliocene (JONKER, 1963). In the older pleistocene flora of western and central Europe *Fagus* is usually not present. Apart from some sporadic finds during interstadial phases of the last glaciation, *Fagus* reappeared again during the Holocene, also in the Netherlands. On account of this behaviour of the beech Jonker supposes that the species had a refuge during the Ice-age and from this *Fagus* spread again. This refuge may be localized somewhere in the Balkans as is generally accepted at present. Jonker reports data, from which it may be concluded that the refuge was situated around the Adriatic.

ECOLOGY

The beech occurs both in the mountains and in the lowlands. South of the Alps we find it only in the mountains, north of the Alps in the lowlands too, but there preferably in hilly districts. In the north the beech occurs on lower levels than in the south: Etna 2000 m, Apennines 1800 m–1900 m, Alps till \pm 1500 m, Erzmountains \pm 850 m, Harz 250 m on an average, the Baltic coast 0 m. In the mountains the beech zone develops only above the oak forests. Especially in the Mediterranean and western European mountains the beech forests often form the timberline. Therefore we must consider the beech, according to its present area of distribution, a Central European tree and also a Mediterranean mountain tree, of the temperate mountain climate (FIRBAS, 1949). With the increase of the altitude of the mountain ridges the circumstances become more continental. This mostly implies extreme climatological conditions, against which the beech is less resistant than fir and spruce for example, so that we perceive that the timberline of these trees comes higher (RUBNER, 1934).

The beech is present especially on rich soil. The *Fagetalia* here occur; *Acereto-Fagetalia* (in the mountains) and *Querceto-Fagetalia* (in the lowland). But on less rich soil too, the *Fagus* associations can form a climax; *Luzulo-Fagetum* (in the mountains) and the *Fageto-Quercetum* (*Querceto-Betuletum*). The associations in the Netherlands, in which the beech can take an important part, are: the *Fraxino-Ulmetum*, the *Querceto-Carpinetum* and the *Querceto-Betuletum* (*Fageto-Quercetum*). The *Fraxino-Ulmetum* occurs on limy, moist sandy soil. It is a rare association in the Netherlands. The beech does not establish easily in it on account of the undergrowth. Because the tree takes root only superficially, it falls over rather soon. DOING (1962) calls the *Querceto-Carpinetum* (*Querceto-Carpinetum*) a forest association of rich soil with well developed profile ("Gray-brown podzolic" of Rendzina). The association is absent on the holocene soil, so in the west of the Netherlands. The forest in the east of the Netherlands, in which the peat bogs examined by us, lie, can be classed in the *Querceto-Carpinetum*. The *Carpinion* is very rich floristically, but the Dutch *Querceto-Carpinetum* is an association relatively poor in species. In the *Q.-C.* the oak mostly dominates, but the beech too can take an important place in it, though in the Netherlands this is not the case anymore (DOING, 1962). That the oak dominates here, is probably a result of secondary factors, such as human influence. If one leaves the *Querceto-Carpinetum* alone, there is not much rejuvenation of *Quercus*.

Then the beech nearly always wins in competition with the oak. Yet the beech is at a disadvantage in the present circumstances, because it does not bud very well and cannot stand any pruning. Besides *Fagus* only gives viable seeds when it is 60–80 years old. These and other circumstances are the cause, that also on otherwise good soil only few beeches occur. Originally it was supposed that *Fagus* was not present in the *Querceto-Betuletum*, but as it appeared in Westphalia, the beech can be important here too. Though in the Netherlands, the *Querceto-Betuletum* was replaced by *Calluna* heath almost everywhere, it yet covers the largest area of all the forest-associations (DOING, 1962). When the climax situation appears, *Calluna*, *Betula* and other tree species disappear. Then *Quercus* and *Fagus* will dominate (*Fageto-Quercetum*).

DISCUSSION OF THE POLLENDIAGRAMS

I. The Korenburgerveen

The Korenburgerveen is situated near Winterswijk in the south-east of the province of Gelderland. The peatbog owns its name from a "Koolburg", derived from "Kolenbranden" (= charcoalburning) (JONKER, 1963). It is property of "de Vereniging tot Behoud van Natuurmonumenten in Nederland" (Society for the preservation of nature reserves in the Netherlands), which gave us kind permission to take samples. The peat was already palynologically investigated by TEN HOUTEN (1935).

Pollenanalytical investigation (diagram 1)

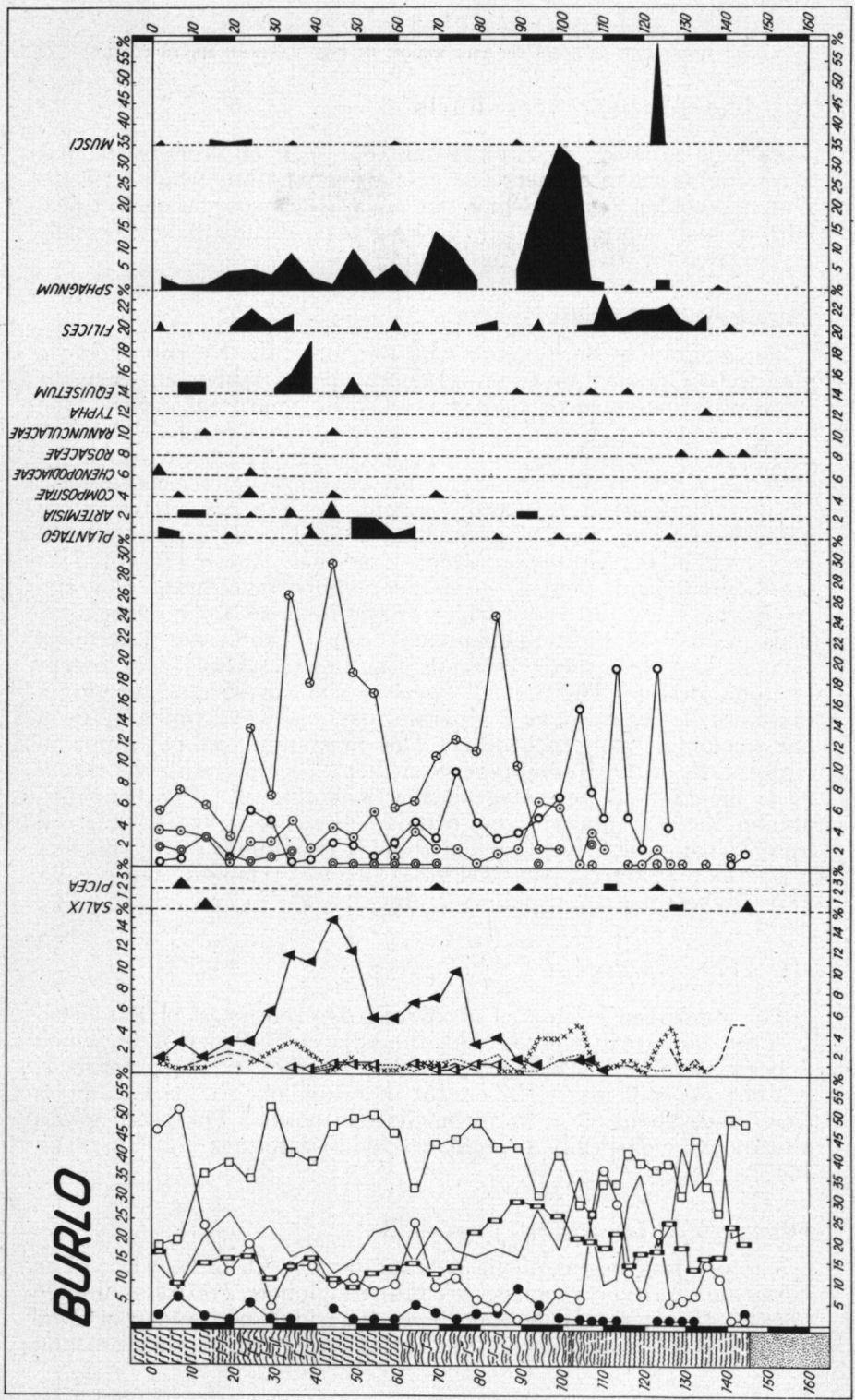
In the history of the forest of the Korenburgerveen environment 5 periods are to be recognized with the help of the diagram:

1. A *Pinus*-*Betula* period (340 cm–325 cm). *Pinus* and *Betula* reach values of $\pm 60\%$ here. This means, according to the zonation according to Overbeck and Schneider that this is the Praeboreal (V). *Corylus* is present already, but in low percentages.
2. A *Pinus* period (325 cm–297 cm). *Pinus* dominates (60 %). *Betula* decreases sharply. *Corylus* increases. *Ulmus* and *Quercus* appear, but *Tilia* is still absent. This is the beginning of the Boreal (O. & S. VI). Zone VII of O. & S., which is characterized by a maximum of *Corylus*, is not present here. Towards the end of the Boreal, *Pinus* decreases, while *Alnus* sharply increases. The Atlanticum begins, where the *Pinus* and *Alnus* curves meet in the diagram (290 cm).
3. During the Atlanticum (290 cm–237 cm) the percentage of *Alnus* is very high (till 92.5 %). First *Pinus* is high too, but it goes back towards the end of this period. *Betula* drops below 5 %. Further the high percentage of *Tilia* is striking.
4. Subboreal (IX) 237 cm–165 cm. *Corylus* increases, *Alnus* decreases but remains relatively high. After *Corylus* *Quercus* occurs most: i.e. mixed oak forests. *Tilia* and *Ulmus* decrease. *Fagus* appears and even shows a continuous curve at the end of this period. In the diagram *Fraxinus* appears here for the first time.
5. At 140 cm *Fagus* is on the increase. *Corylus* has had his maximum and decreases. This is the beginning of the Subatlanticum (O. & S. X, XI and XII). *Tilia* does not show a continuous curve anymore.

Fagus

The increase of the percentage of *Fagus* starts at a depth of 140 cm. After this the value increases gradually up to 25 %. The remarkable thing in the *Fagus* curve is, that clear maxima and minima are to be noticed. PERSCH (1950) had something like it in his diagram of the Hohe Venn. He distinguished even 4 maxima in the *Fagus* curve (F_1 , F_2 , F_3 and F_4). SLOTBOOM (1963) too has 3 or 4 *Fagus* maxima in some diagrams of peatbogs in Luxemburg. In the Korenburgerveen 3 *Fagus* maxima are to be observed in the Subatlanticum, viz. F_1 127 cm, F_2 90 cm and F_3 18 cm. It is true there are striking peaks in the curve at 138 cm and 115 cm, but these are based on one spectrum, at least the one at 138 cm, while the one at 115 cm may perhaps be reckoned under one maximum together with F_2 . It is also striking, that no or only a single *Carpinus* pollen grain is present at F_1 , F_2 shows a continuous *Carpinus* curve, while F_3 clearly has a *Carpinus* maximum. PERSCH (1950) and SLOTBOOM (1963) also notice this. The Aamsveen shows this picture too.

BURLO



II. The peatbog near Burlo

Burlo is situated at about 10 km south-east of Winterswijk, just across the German border. The peatbog formed one whole with the Dutch Wooldse Veen of which not much is left now because of peat cutting and cultivation. The peatbog was already palynologically investigated by H. KOCH in 1930.

Palynological investigation (diagram 2)

The diagram of Burlo agrees with the one of the Korenburgerveen very well. The diagram begins (145 cm) in the Subboreal, when the forest was dominated by *Quercus* and *Corylus* (mixed oakforests). First the percentage of *Quercus* is much higher than that of *Corylus*, but at 100 m *Corylus* is going to dominate *Quercus*. The high percentage of *Betula* is remarkable here. Probably this must be ascribed to local circumstances. *Fagus* is already present, but the percentage is not high. *Fraxinus* reaches a percentage of 5 %. The *Tilia* percentage is only high in the beginning, which is normal. Above 130 cm *Tilia* is only sporadically present. *Ulmus* is of no importance in this diagram. At 75 cm *Corylus* decreases sharply, *Fagus* increases for the first time. This means that the Subatlanticum begins. The *Corylus* percentage remains low, *Alnus* increases again. *Fagus* increases till 15 %, except for some decline. The 2 small *Fagus* maxima at 75 cm and 45 cm must not be regarded as 2 separate maxima. They probably form one maximum with each other. This maximum can be compared with the F₁ of the Korenburgerveen then. Together with the rise of *Fagus* the *Ericaceae* percentage increases enormously. This happened also in the Korenburgerveen. Human influence is to be observed from 70 cm, where the Cerealia show a continuous curve. Further it is clear that a great part of this peatbog was removed. The greater part of the subatlantic period is absent.

III. The Aamsveen

The Aamsveen is situated at about 5 km south-east of Enschede. It forms one great peatbog with the adjacent German part, which is being reclaimed. This does not alter the fact that large parts of peatbog are still intact. In one of these undamaged parts samples were taken about 50 m from the German border. The peatbog was already palynologically investigated by FLORSCHÜTZ (in HIJSZELER 1947).

Pollenanalytical investigation (diagram 3).

The diagram begins in the Atlantic period (O. & S. VIII). The *Ulmus* and *Quercus* percentages are rather high here. *Fraxinus* is already present. *Corylus* dominates the forest. The high percentage of *Tilia* is remarkable here. When *Tilia* and *Ulmus* begin to decrease and

Corylus has had its last maximum (300 cm), the Subboreal begins (IX). Here the *Corylus* curve decreases gradually while *Alnus* reaches higher values. *Fagus* appears too. Towards the end of the Subboreal *Fagus* shows a continuous curve (from 245 cm). At ± 205 cm *Corylus* decreases definitely. At the same time *Fagus* increases. This means that the subatlantic period (X) begins here.

Fagus

In this diagram too, the *Fagus* curve does not go gradually to its highest maximum at 33 cm. Just like in the Korenburgerveen we clearly distinguish some maxima. F_1 at 200 cm, F_2 at 105 cm, F_3 at 75 cm and F_4 at 33 cm. In this peatbog also there is no *Carpinus* at F_1 , F_2 shows a continuous *Carpinus* curve and F_3 has a *Carpinus* maximum in addition. At the last *Fagus* maximum *Carpinus* decreases.

DISCUSSION

When studying pollendiagrams it is important to observe, according to FIRBAS (1949), that the number of pollen grains of *Fagus* is generally comparatively smaller than the number of pollen grains of most other trees. This on account of the following reasons:

1. A flowering beech produces a relatively small number of pollen-grains.
2. The number of years in which a beech blooms is few.
3. The pollen of the beech is not so much represented in the higher layers of air, because the greater part of it sinks on the spot.

All the three peatbogs, which were investigated, show high percentages of *Fagus*. The maxima amount to: the Korenburgerveen 25 %, the Burlo peatbog 15 % and the Aamsveen even 35 %. This indicates that this part of the eastern Netherlands was covered with extensive beech forests during a part of the subatlantic period. This is also evident from diagrams of TEN HOUTEN (1935) and FLORSCHÜTZ (1944). Not published diagrams of the Haaksbergerveen (OVER) and Vragenderveen also show high percentages of *Fagus*: 43 % and 32,5 % respectively. Further the Korenburgerveen and the Aamsveen show clearly how the percentage of *Fagus* increases, after the beginning of the Subatlantic period, to a maximum, that must be in the beginning of our era (JONKER, 1963). After that the *Fagus* percentage decreases a few percents, where upon a second maximum arises and so on. In that way 3 *Fagus* maxima can be distinguished in the Korenburgerveen and even 4 in the Aamsveen. PERSCH (1950) also distinguished 4 maxima in a diagram of the Hohe Venn, just like SLOTBOOM, who investigated some peatbogs in Luxemburg and a "vivier" in the Hohe Venn (1963). OVERBECK and SCHNEIDER (1938) also found 4 *Fagus* peaks in Germany. JANSSEN (1960) found 2 *Fagus* maxima in Southern Limburg, just like HUMMEL (1949) in the Eiffel. JANSSEN

supposes that F_3 and F_4 are absent. How can we explain this conduct of the *Fagus* curve?

In the diagrams of the Aamsveen, Haaksbergerveen, Vragenderveen and more or less in the Korenburgerveen, the course of the *Alnus* curve is remarkable. It is striking, especially in the Aamsveen, that where *Fagus* has a maximum, *Alnus* shows a minimum and the reverse. Perhaps this is accidental, for it is normal, that when the percentage of one tree species increases, this must be at the cost of other species. But here it is only *Alnus* that decreases when *Fagus* increases. The percentages of the other trees do not change. Some trees, like *Quercus*, even increase. If *Alnus* should be left out of the treepollen sum a continuously increasing *Fagus* curve with only one peak will arise. The question is, however, if *Alnus* may be removed from the treepollen sum (JANSSEN, 1959), because here is no local occurrence of *Alnus*. In the environment *Alnus* is present too. In diagrams of peatbogs in a hilly district, in which *Alnus* is not present, except in the bog itself, a wrong picture can certainly arise and then it is advisable to leave *Alnus* out of the treepollen sum. So if we accept that in this case *Alnus* is no "disturbing factor", what can the explanation of the *Fagus* maxima be?

Some investigators are inclined to ascribe the various maxima and minima to human influence. If this supposition is correct, man would have intervened in Germany, the Netherlands, Belgium as well as in Luxemburg in the same way, so that the same picture arose. This is not probable. In the Aamsveen a continuous curve of the Cerealia begins only between F_3 and F_4 , while only after F_4 human influence becomes more clear, witness the remnants of a peatbog-fire at 13 cm, together with 14 % *Fagopyrum* and high percentages of *Rumex* (40 %). In the Korenburgerveen the Cerealia already show a continuous curve before the third *Fagus* maximum is reached. PERSCH (1950) and SLOTBOOM (1963) too found a continuous Cerealia curve during F_3 . OVERBECK and SCHNEIDER (1938) already found Cerealia pollen-grains after F_2 . JANSSEN (1960) supposes that the lack of F_3 and F_4 in South-Limburg and in the Eiffel is on account of man. It is not probable and certainly not in the Korenburgerveen and the Aamsveen, that the *Fagus* maxima and minima must be ascribed to human influence. The diagrams of these peatbogs do not point to that direction.

JANSSEN (1960) also gives the natural life time of a beech forest as one of the possible causes of the maxima and minima.

Another explanation for the development of the 4 *Fagus* peaks SLOTBOOM (1963) suggests. His pollendiagram of the peatbog of the Birkbach (Luxemburg) can be compared with PERSCH's diagram of Neu-Hattlich in the Hohe Venn (1950) on many points. Both the diagrams show 4 *Fagus* maxima, the first maximum of which has the highest percentage of *Fagus* (± 60 %), while at F_2 , F_3 and F_4 the percentage gradually decreases. Also the behaviour of *Carpinus*, *Tilia* and the appearance of Cerealia is in both cases all but the same. PERSCH arrives with the help of C 14 datings of some comparable

diagrams in the Eiffel and the Rhön, at the following absolute datings:

| | |
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| F_1 = about the beginning of our era | F_3 = C. 1200 A.D. |
| F_2 = C. 700 A.D. | F_4 = C. 1600 A.D. |

The striking thing is, according to SLOTBOOM, that the *Fagus maxima* always fall between the transgression phases, which BAKKER, BENNEMA, and others distinguish in the Dutch coastal region. SLOTBOOM (1963) says: "It is plausible that there is a connection between these two phenomena, the four peaks of *Fagus* occurring in a large area". During the regression phases the climate would be more continental, which would benefit the beech. Even now *Fagus* still has its largest range in continental Central-Europe. In the Netherlands too, high percentages of beech are to be found where, in comparison with the rest of the Netherlands, the conditions are more continental, namely in Southern Limburg (calcareous district and loess district), and the Achterhoek and Southern Twente (subcentreuropean district).

So the beech would be at a disadvantage particularly in the extreme oceanic areas, like the west of the Netherlands. This idea seems to be in conflict with the opinion defended a.o. by VAN ZEIST (1959), that the spreading of the beech is connected with the increase of oceanic conditions.

The question remains, however, to what extent the *Fagus* peaks are synchronous in the Netherlands, Belgium, Luxemburg and Germany. Therefore it will be advisable always to perform accurate C-14 datingtests in further investigations.

In the pollendiagrams the usual peat- and pollen symbols are used (see also JANSSEN, 1960, p. 113). The first of the three subdiagrams of the composite type contains the percentages of *Alnus*, *Betula*, *Corylus*, *Pinus* and *Quercus*. In the second one the percentages of *Carpinus*, *Fagus*, *Fraxinus*, *Tilia* and *Ulmus* are given and in the third one those of *Cyperacae*, *Gramineae*, *Ericaceae* and *Cerealía*.

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