The Danish beech-forests

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By † *C. H. Ostenfeld*, Copenhagen.

There is not much wood-clad land in Denmark; we cannot count more than ca. 8 % of the surface as covered by forests; of this forest-area about 40 % is deciduous-forest, while most of the remainder is coniferous forest, mostly spruce-forest. All the coniferous forest is artificial and has been planted during the last two centuries.

Only two coniferous plants (Juniperus communis and Taxus baccata) are spontaneous in Denmark and neither is forest forming, the juniper is rather common in Jutland and Northeast-Sjælland, namely the shrub *Juniperus communis;* the yew has only been found wild in one place in Southern Jutland.

Amongst the deciduous trees the beech is by all means the commonest (33 %), and consequently nearly all the natural forest in Denmark is beech-forest. Nowadays the beech forest is almost pure, in older (historical) times, before it was so much influenced by man, the deciduous forest consisted of beech, oak, ash, red-alder, elm etc. The last tree to immigrate was the beech and its victory over the other trees is of very recent date and is partly due to man, partly to the deep shade in a beech forest preventing other trees from growing. Man's influence consisted mainly in the fact that owing to the higher value of the oak-wood as timber, the oaks were felled, especially the well grown trees, and used for timber, while the beeches were allowed to remain.

With exception of parts of western Jutland, where the climatic and edaphic conditions do not allow the growth of beech, and some smaller islands in the Baltic (Bornholm) an in the Cattegat (Læs etc.), to which the beech has not yet immigrated by natural means, beech forests occur scattered all over the country, the southern parts of the islands and the south-eastern parts of Jutland having the best developed beech forests.

As Denmark is a very flat country (the highest hill is only 172 m above the sea) no altitudinal limit for the beech forest occurs, nor are the exposure and the steepness of the slope of any noteworthy importance.

On the other hand another climatic factor, the wind, is of a very strong effect both directly and indirectly. That the western part of Jutland is destitute of beech is mostly due to the effect of the strong western winds which are prevailing there. The wind acts as a killing factor both by drying the young shoots before ripeness and also by its mechanical force.

As the soil of the surface in Denmark with few and small exceptions (Bornholm, Mens Klint) is a loose soil, the chemical variations of the surface are not so many as in a country with hard rocks. The differences are mainly due to a greater or smaller amount of lime and to the varying contents of water and air in the soil. On lime-rich, well drained and not too dry nor too wet soil we got the best development of the beech-forest. As regards the acidity, the sandy and poor soil is rather acid (p H = ca. 4), while the loamy and lime-rich good soil is much less acid (p H = ca. 6); the beech-forest can endure much more lime than the oak; while the oak stands wetness better than the beech. Consequently the amplitude with regard to content of water is larger for the oak than for the beech, while it is larger for the beech with regard to the content of lime, versus sand. We have beeches growing on nearly pure chalk, and beeches growing on nearly pure sand. Where the soil is very loamy and the height of the underground water is very high, e. g. on the low island Lolland, the beech forest is poor, in spite of the other conditions of life being favourable.

The highest and best developed beeches in Denmark reach a height of about 40 m and the girth of the trunk at about 1 m over the ground is ca. 6 m, but usually the good beech forests are not more than 25 to 30 m high and the poorer ones of course much lower, until the beech on very wind-exposed places is only a shrub of 1—2 m height. The ages of the older beech forests are not more than c. 250 years, although single trees are said to reach an age of 300—400 years. Usually the forests are exploited when the trees are between 80 and 150 years old, which seems to be the most profitable age.

A natural regeneration of beech trees takes place where the soil is good and fertile («muld», mild humus) and the other conditions of life are favourable, on the other hand where the soil is poor and acid («mor», raw humus) and the other conditions not favourable a natural regeneration does not occur. Then it is necessary to break up and remove the surface layers of the soil and then sow the fruits or plant the young trees. In this connection it is natural to mention that owing to the dense shade hardly any other trees are able to grow up under the roof of a beech-forest. When it is not too dense, we may find a few other individuals and then a growth of the young beeches themselves. Otherwise the light is not sufficient for the growth, in young beech plantations the light being not more than $^1/_{50}$ of the light outside the forest. For the same reason few shrubs live under the beeches, *Sambucus nigra* and *racemosa*, *Lonicera xylosteum* and a few others. There is a very marked contrast in this respect between the beech and the oak forest.

The ground-vegetation is very uniform in one locality and locally composed of few species, but owing to the differences in the soil we have a long series of plant communities, mostly in relation to the degree of acidity of the soil. The value of p H being low (6 to 5) the ground vegetation is composed of *Anemone nemorosa*, *Asperula odorata*, *Mercurialis perennis*, *Corydalis cava*, *Ficaria*, *Ranunculus auricomus*, *Primula elatior* etc., while on a somewhat poorer soil the five last are absent; in some places *Oxalis* and *Galeobdolon* replace them; still poorer is a pure or nearly pure community of *Anemone* and *Oxalis acetosella*. When the soil is raw humus *Trientalis*, *Majanthemum*, *Deschampsia flexuosa*, *Convallaria majalis* and in places *Vaccinium myrtillus* are the dominating species. According to recent investigations by dr. C. H. Bornebusch we may distinguish between «ground types» and «phenotypes» (Grundtyper og Tilstandstyper); the latter being the expression or result of the groundtype and the existing conditions of life (e. g. age and density of the beech trees, the effect of the wind etc.).

According to my opinion the types of the groundflora are so different that I feel inclined to consider the beech forests as consisting of several (or at least two) natural units.

The effect of the conditions of life on the growth of the beech trees is also seen in the degree and composition of the *epiphytic cryptogams* (lichens and mosses). The good beech forest with tall and slender trees on mild humus has only a slight cover of small crusty lichens and few and inconspicuous mosses, while the slow growing and low beech trees on poor and wind-exposed places have a rich covering on the stems of larger lichens and mosses. The flora of the higher F u n g i is also very different according to the conditions of the beech forest, Agarics are different in species in the good «muld» soil and on the raw humus. The beech trees have always mycorrhiza.

We have no species absolutety e x c l u s i v e t o t h e b e e c h forest. The few rare species which have only been found in beech forests e. g. some orchids, do not owe their exclusiveness to the beech, but rather to the rich amount of lime in the soil.

The exploitation of the forest is rather intensive and the culture has been brought up to a high standard both as regards the state-owned and the private forests. The wood of the beech is used partly as fuel and partly for making different kinds of tools. The result has, as mentioned above, been a much purer beech forest than under natural circumstances.

There is practically no g r a z i n g in the Danish beech-forests and practically n e v e r f i r e in them.

The usual attacks of different kinds due both to plant and animal parasites, mostly insects, are sometimes rather serious, and the purity of the beech-forest adds to the danger of the parasites.

As to s u c c e s s i o n the present day's pure beech forest is an artificial forest, which could not continue, if the forest was left to itself. It has developed by the influence of man from a mixed deciduous forest in which the beech was intermingled by oak, elm, ash, lime and other trees and where the shrub layer was much better developed. The foresters try nowadays to get that type of forest back again, as the pure beech covering has impoverished the forest soil so much that in many cases the forest is not able to regenerate as beech forest. It may become a spruce forest which is much more acid, or even heath.

There is a rather well known paleontological succession of the forest from the first forest which was forest after the late glacial heath and tundra until now. The beech immigrated at a rather late epoch, but not so late as was thought to be the case a few decades ago. I do not feel it the right place to go further into the consecutive order of the many postglacial phases of the forests of our country.
