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OPTIMAL WOODLAND DEVELOPMENT ON SANDY SOILS IN THE NETHERLANDS*·**

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Introduction

Little is left from the extensive forests that covered our country at the beginning of this era. By cutting, burning, grazing by cattle and by reclamation man has virtually extirpated our virginal forests. Only small fragments, the so called 'Malebossen' have been maintained in a nearly natural state, mainly because of hunting.

It was not before the middle of the 19th century that man became concerned about the need for timber and ever since he proceeded in planting trees. In the beginning planters thought in short term rotation in order to harvest by life. As a matter of fact this meant 'murder in childhood'; it was a policy still based on agricultural thinking. In 1899 the State Forest Service in the Netherlands was founded and during its development the idea gained ground that forestry is something quite different from agriculture and that the forest has other purposes than just timber production, e.g. recreation nature-study and nature-conservation.

In the middle of this century the idea of 'multiple use became generally accepted. One realised that the forest had to be subserviant to different purposes. This finally resulted in the aim formulated recently by the Kampfraath-Committee: 'The maintenance and development of a natural environment, as varied as possible, in which biocoenoses of plants and animals can survive and through which a contribution to the material and spiritual fulfilment of human needs is realised'. How correctly this aim may have been formulated, one has to realise that carrying it into effect is a long term undertaking. It does not only take much time, but we have hardly experience with it. The nearly 80 years old State Forest Service is, in terms of rotation of a tree or development of an ecosystem, only a child under age or even an infant!

The forest as an ecosystem

In our forest there is a cycle of organic matter, produced by the trees, shrubs, herbs and mosses. Part of it gets into the soil directly through dying roots. The major part of it accumulates on the surface of the soil as so-called 'raw humus' (Auflagehumus). This humus layer – the A_0 or litter – is intensively penetrated by roots. The dying off of the fine hair roots is a continuous process. A considerable part of the organic matter in the A_0-layer comes from these roots. The mosses are dying off continuously as well. According to Damman (1971) litter only partly contributes to the A_0, whilst the contribution of dying roots and mosses is not neglectible at all. The proportion may change strongly depending on the type of vegetation. Especially our, needle-leaf woods are rich in mosses and ferns. In hardwood forests the annual fall of leaves covers the mosses and brings them to die (Ellenberg 1963). Only where leaves are blown away mosses have a chance.

Concerning the ferns: they are negatively influenced by the alternation of sunshine/shadow and changes in relative humidity occurring in deciduous woodlands but they are well adapted to the moderate and more constant climate of our coniferous woodlands.

The litter and the raw humus decay during the years. Thereby fauna and especially microfauna (insects, gacteria and fungi) play an important role. In most of the forest-types an equilibrium is established in the course of time,

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** Nomenclature follows Heukels-van Ooststroom, Flora van Nederland, 18e druk, 1975, Wolters-Noordhoff, Groningen.

where supply and decay are in balance. This equilibrium depends on the composition of the raw humus and therefore on the vegetation-type.

The Netherlands have a humid climate. Precipitation surpasses evaporation and thus there is a precipitation surplus, that disappears in the soil. The humus acids dissolved from the A_0 cause a stratification in the soil profile. There is a zone of leaching - the A-horizon - and a zone of infiltration - the B-horizon. The B-horizon in a forest-soil is still intensively penetrated by roots. The minerals precipitated in it are dissolved by these roots, assimulated by the trees and added back to the A_0 by way of litter. And so the cycle is closed.

In heathland, as compared with woodland, the soil is less deeply penetrated by roots. The moisture balance is different as well. As a result there is a strong podsolisation. Whilst we find a humus iron-podsol or 'holtpodsol' under woodland, under heathland we observe a humus podsol or 'haarpodsol', which is much poorer in nutrients. The heathland *(Genisto-Callunetum)* is a semi-natural ecosystem, developed from the wood through interference of man (burning, grazing by sheep and sodding). By overgrazing the soil can be completely denudated and wind may cause shifting of sand until large inland dunes arise, which may be stablished again by a *Spergulo-Corynephoretum*. There we have a 'vague' profile or even no profile at all ('vaaggronden').

When man withdraws, the wood returns. At first there is a *Pinus-Betula* phase in which the flamish jay sews his acorns. From this stade an oak phase develops with a gradualy growing humus-layer, in which shrubs like *Sorbus aucuparia*, *Frangula alnus* and recently also *Prunus serotina* establish. As a result of the changed conditions the heather disappears and shade-standing grasses *(Deschampsia flexuosa)* and dwarf shrubs *(Vaccinium myrtillus* and *V. vitis-idaea)* appear. Also *Fagus silvatica* returns and as a shade standing tree it reaches dominance after all.

Forestry and pioneer forests

This natural succession takes several hunderds of years. The forestry officer can accelerate this succession by planting trees. But he is bound to the laws of nature. In the beginning he has to use pioneer species. On the poor sandy soils in our country these are white birch *(Betula pendula)*, aspen *(Populus tremula)* and scotch pine *(Pinus silvestris)*, all species who show a better growth in a more continental climate (Ellenberg 1963, p. 68). From the possible coniferous trees *Pinus silvestris* has the preference as can be judged from the fact that 80% of the first generation of our planted woodlands consist of *Pinus silvestris*. Scotch pine – originally an indigenous species (Wolterson 1973) has been exterminated in our country by excessive cultivation. We should bear in mind that even *Fagus silvatica* almost disappeared from our landscape through exploitation as a coppice because of its low stooling capacity. It is also comprehensible that a coniferous tree like scotch pine disappeared long before. For afforestation we had to import seeds.

The proveniences of *Pinus silvestris* imported from elsewhere were not adapted to our climate and suffered much from diseases (e.g. *Lophoderminum pinastri*). In the more pronounced atlantic parts of our country (West-Frisian Islands and Drente) the culture even failed almost completely. Thus we had to look out for other tree-species and as such we adopted Corsican pine *(Pinus nigra* v. *corsicana)* in the southern parts of our country and in our dunes. For the northern part (Drente) *Larix leptolepis* has been a lucky hit. Nevertheless, Japanese larch grows only on soils with sufficient water-holding capacity, i.e. on loamy soils or on soils with ground-water in reach. For zonal soils we cannot use it so much.

Second generation

In the second tree-generation, after a woodland microclimate was created and a first layer of litter and raw humus was formed, so-called 'more demanding species' can be used. In addition to the indigenous hardwood species: pedunculate and sessil oak *(Quercus robur* and *Q. petraea)* and common beech *(Fagus silvatica)* on economic considerations also coniferous trees like Norway spruce *(Picea exelsa)*, sitka spruce *(P. sitchensis)* douglas fir *(Pseudotsuga taxifolia)* and grand fir *(Abies grandis)* were used. It was especially the two last-mentioned species, which are native on the atlantic coast of North-America, that have proved their usefulness in our country. The production of timber was considerably higher than that of our native deciduous trees like *Quercus* and *Fagus* and even more than twice that of *Pinus silvestris*. Also the penetration of the roots in the soil-profile (Groszkopf 1954), as well as the decay were much more pronounced.

The minerals, brought into circulation, and the humification of the litter of *Pseudotsusa taxifolia* leads to an ecosystem, that seems to be richer than that of other conifers *(Pinus* and *Picea)* or even those of our indegenous hardwood-species *(Quercus* and *Fagus)*. This finds its expression in an understorey rich in ferns and mesotrophic mosses. Nevertheless, the climate of the West coast of

North-America – as a result of the NNW-SSE-coursing chains of mountains like Rocky Mountains and Cascades, who catch off the east winds – is considerably more oceanic than ours. In Europe where the chains of mountains run in E.W.-direction, the atlantic character of the climate is strongly weakened, especially in the latter part of the winter and spring, when dry east winds blow, with an attendant cloudless sky that *Pseudotsuga* madly endures. It is for this reason that *Pseudotsuga* – having a pioneer character in its native country – is a more demanding species here which must be planted in the shelter of older trees.

Succession

If we consider the 'Malebossen' *(Ilici-Fagetum)* as the climax-association, there is a great number of derivated 'substitute communities' (Ersatz-Gesellschaften) who can be considered as associations and also are described like this. In a scheme of break down and building up we can represent this as follows *(Figure 1)*. Braun-Blanquet 1951, p. 468) distinguished an 'Optimum-community' (Optimal Gesellschaft) besides the climax. This optimum-community is defined as the association that produces the greatest

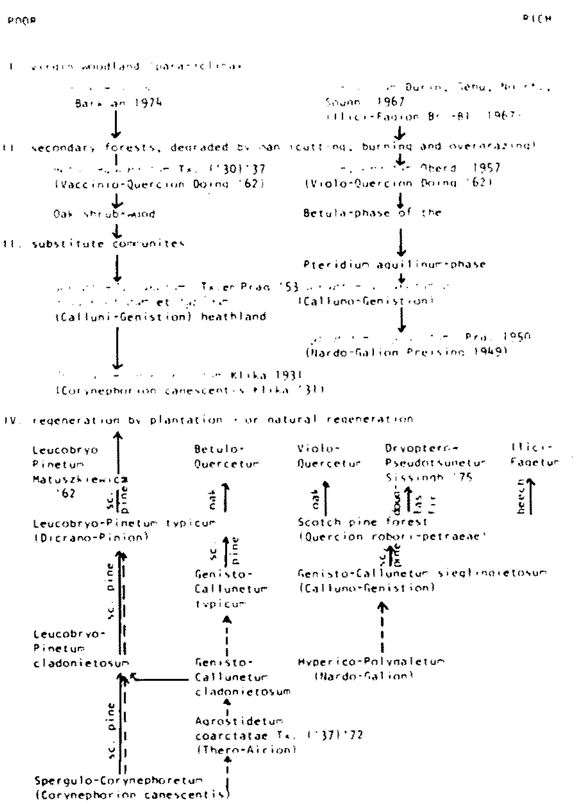

Fig. 1

biomass. It may coincide with the climax but it need not. In the scheme presented above such is surely not the case. Whereas the *Ilici-Fagetum* is the climax, the coppice of sessile oak *(Violo-Quercetum petraeae)* is the secondary forest and the coppice of pedunculate oak *(Betulo-Quercetum roboris)* is a man-made substitute association (Ersatz-Gesellschaft). The equally man-made pine forest *(Leucobryo-Pinetum, Dicrano-Pinion)* is a pioneer forest and the douglas fir-forest *(Dryoptero-Pseudotsugetum)* approximates the optimum-community. This process is still going on. The *Dryoptero-Pseudotsugetum* is an association in statu nacendi. In the second generation its timber-production is already considerably greater than in the first generation (van Goor 1974). The floristic composition in this fern-douglas-fir-forest is in development as well (Sissingh 1976).

As a rule this development goes faster on soil rich in minerals (loamy soils or soils with a previous agricultural history) than on poor soils arisen from heathland-reclamation.

Development of the optimal forest

Most of our cultivated douglas-fir-forests are still even-aged pure stands. Therefore these stands – as a rule with horizontal density of canopy – are not stable and especially sensitive to winds and gales. According to the transformation of into uneven-aged stands by natural regeneration and their mixing with storm-proof species, stability will be built up. For instance we can give a structure to the forest by *Pinus silvestris* reserved from a preceeding generation, by coniferous species with a tap root as *Abies grandis* or shade-bearing hardwood species with a rapid youth-growth as common beech *(Fagus silvatica)* and American oak *(Quercus borealis)*.

Finally the durability has to be guaranteed by a form of group felling (Femelschlag). Regeneration over large areas has to be avoided because not only the micro-climate – a condition for douglas-fir – would be disturbed, but also the destruction of humus is strongly stimulated by access of light. A clearance plant-community like the *Corydalo-Epilobietum* appears and the development process to the optimal forest has been turned back. Removal of forest litter, which for some years was thought to be sufficiently compensated by adding an equal amount of minerals and organic matter, e.g. some tons of V.A.M.-compost, is now considered very unwise. Not only because it results in the destruction of an important part of the hair roots of the stand, but also because it obstructs the development of the ecosystem in the direction of the optimal forest.

Evaluation

The State Forest Service in the Netherlands consists of three divisions, each of which approaches the forest from its own point of view. Whilst the division of forestry considers the forest from the viewpoint of timber-production, the division of nature conservancy aims primarily at forest-protection and the division of landscape-architecture takes care of the scenery. We can show this clearly by representing the wood as an equilateral triangle, in which the three divisions operate from a different angular point (*Figure 2*).

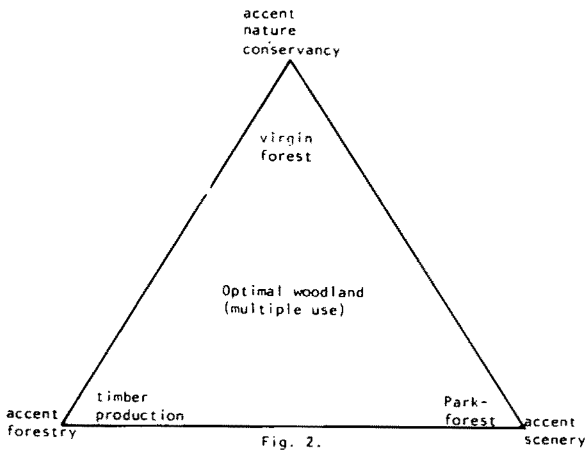

Fig. 2.

In the centre of the triangle we situate the optimal wood (the multiple use forest) where timber production, forest protection and scenery are balanced. It is an ecosystem of different tree-species (not entirely natives but also exotic species) from different ages and dimensions. It is a forest which not only has a high production of timber but is also sound, stable, durable and multilateral. From the point of view of vegetation science it is a 'substitute-community' since the climax, which just like other substitute-communities like heathland (*Genisto-Callunetum*) and semi-natural grass-communities (*Violion caninae*, *Cirsio-Molinietum* etc.) can regenerate naturally by purposive intervention of man and can be maintained permanently through rejuvenation. Provided it has the right composition of trees and is well managed, it also can deliver continously a much higher production than the virginal forest.

In our effort to establish the optimum forest we have to realise that time plays an important role. Our present day forests are hardly grown out of the stage of youth. They are still composed by pioneer species like *Pinus silvestris* or *Larix leptolepis*. These monotonous forests are not in balance. They can be affected by insects, burned to death by fire or blown down by gales. In that case we have to take the consequences and start at the beginning.

To fortify our forests we have to mix them with other species and therefore bring in some so called 'more demanding' trees, i.e., trees that need a micro-climate and a litter-layer for good growth. We bring them in by planting three or four years old plants. It will take a generation of trees – that is to say more generations of man – before they are fertile, produce cones and seeds and rejuvenate. Meanwhile we have to learn about composition and management of this future forest, how to make it sound and stable. How does the mixture of tree-species behave in competition? Which blending makes our forest stable for gales? In which proportions do we have to plant or rejuvenate our tree-species? How do we have to tend thinnnings? What will our cutting- and rejuvenate-system be?

Of course we also have to avoid the mistakes we made in the past, like plundering the litter-layer or clear cutting on large scale. Even the setting in of heavy earning-machines, who invent the soil and wound the roots can nullificate much of the achievement. So we still have a lot to learn. But the ultimate aim – the optimum forest – is worth the trouble.

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