ACTA BOTANICA NEERLANDICA, Vol. 5 (2), 1956

AIMS AND METHODS IN THE BOTANIC GARDEN "DE WOLF" OF THE STATE UNIVERSITY GRONINGEN (NETHERLANDS)

BY

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(*received May 11th, 1956*)

The State-University of Groningen, already in possession of a botanic garden since 1642, now owns two botanic gardens, each entirely different in character.

The old Botanic Garden,[2]) large more than 1.5 ha., is situated in the inner town behind the Botanical Laboratory. It is fitted up like the greater part of other botanic gardens, and complies with all demands usually made, viz.: having and tending a big and varied collection of plants. As a rule these are mostly seedplants: the Cryptogams are generally represented by ferns only.

The plants are grown in the usual manner. On the average they are arranged according to some system or other and provided with labels giving names and if need be further particulars. The arrangement may be in accordance with geography, aesthetics (groups of plants flowering simultaneously) or didactics (ornamental plants, utility plants, rare plants in connection with nature-conservancy) and is often of miscellaneous character in this respect.

The new botanic garden, called "de Wolf", in the village of Haren, however, was from the start and to a large extent established on quite different principles. The aim namely was, and is, dual:

I. the laying out and keeping of an arboretum, including a fruticetum; in this "de Wolf" only partially differs from other botanic gardens;

II. creating possibilities for development for as many plants possible, also for such as cannot, or only with great difficulty be grown in the ordinary way.

With which methods this aim was approached and in how far results have been attained in the botanic garden "de Wolf" in the ca. 25 years of its existence will be discussed in this paper.

Before passing on to that subject however, first some observations about the history and, roughly, about the division of the grounds, situated in Haren, a village 5 km to the south of Groningen.

Formerly it was a manorhouse, called "de Wolf", about 12.5 ha

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[2]) Further particulars about this garden in "Hortus Muntingiorum", by Che. H. Andreas. Scripta Academica Groningana 1953.

in size. In 1917 the State bought it and the idea was to have an arboretum laid out and a laboratory built for systematic botany, with a hothouse complex, that could catch a maximum of sunlight in the wide area. Later on, thoughts turned towards laying out of the garden and establishing a Biological Centre of the Groningen University there. Those plans could not be realised completely as yet.

In the winter of 1929-1930 the laying out of the garden was begun on a modest scale, to which we will return further on. The work had to be stopped during the war years 1940-1945; it was only later that it could be recommenced, to come to an end, for the moment being, in 1947.

Since 1942 the Genetical Institute, which had already for about 20 years had an experimental garden there, has been lodged in the former countryseat "de Wolf".

In 1953 the new Zoölogical Laboratory started work; it is surrounded by grounds with a.o. animal-lodgings for the use of ethological research. Further there is a small trial-plot for experimental botanical work. All this occupies about 1.5 ha. Another 1.5 ha was reserved for the future building of a Botanical Laboratory with hothouse complex and the laying out of a systematical garden for herbaceous plants and of experimental gardens. So 9.5 ha are at the disposal of the new botanic garden proper.

While considering the possibility of creating suitable conditions for growth in this botanic garden, for plants that cannot at all or only with great difficulty be grown in the usual way, such as e.g. *Pyrolaceae*, *Orchidaceae*, many alpine meadow-plants and Cryptogams like Myxomycetes, algae, scale- and leafmosses, lichens and fungi, there rose in the mind of the second author the idea of also trying to make certain types of vegetation develop.

In the laying out and fitting up of the garden, the ultimate aims were continually kept in consideration. For the aim mentioned sub II, creating possibilities for growth for as many kinds of plants possible, it was important to obtain a great variety of habitat conditions. The nature and site of the grounds made it possible to effect several differences in level, moisture status, composition and exposition of the soil.

The grounds lie on the eastern slope of the socalled Hondsrug, a glacial ridge, running from the town of Groningen, through the province of Drenthe, southeastwards. The difference in height between the western and the eastern sides of "de Wolf" consequently is about 2.75 m.

On account of the fact that the garden lies on this glacial ridge, there is a subsoil of boulderclay, on top of which is the layer for cultivation. This was heterogenously composed, which may be readily understood if one bears in mind that arable and pastural farming influenced it for many decads, probably even for some hundreds of years.

At the moment of buying, the situation of the grounds was as follows.

The manor "de Wolf", the vegetable-garden and the orchard

behind the house, and the flowergarden lying on the southside, were surrounded by a wide moat, lined with oaks, ashes, elms and limetrees; there was a subgrowth of hazel, hawthorn, guelderrose etc. Along the south- and east-sides of the wooded moat ran a ditch for drainage, to the south of which were pastures, bordered on the east-side by a ditch with willows.

For the benefit of the racehorses, formerly kept at "de Wolf", a course had been laid out along the eastern side of the grounds. Westward of this course the meadows again unfolded, surrounded and intersected by ditches, with or without willows.

On some of these pastures extra manure of moundearth was put by the former owner.

In general we may say that the cultivation-layer consisted of a very eutrophic, humous, sandy soil, with here and there great differences especially as to the humus content.

Now the fact that at "de Wolf" some difference in height and a layer of boulderclay occur, practically allowing no water to percolate, makes it possible to regulate the water effectively.

Rainwater penetrates only into the upper layers, as far as the boulderclay, and then flows down along the faint slope. If there are pits in the boulderclay or if those are purposely made, then the water remains. If these pools are continually fed artificially (vide below, pumpworks) then they retain the water all the year round; if, however, the pools only receive rainwater, then they will fall dry during the summer, entirely or partially. In the main one may say however, that even vegetations, requiring much water for their development, e.g. Shpagnum-vegetations, have sufficient water at their disposal, during summer as well. Dry spots however can also easily be effected, because the rainwater can speedily be drained off.

By building a soil-relief it was possible on the one hand to obtain layers of various thickness, pervious to water, on top of the boulderclay, and on the other hand a sufficiently thick loose culture-layer in which tree-roots could penetrate. In the deeper places the boulderclay forms the surface, in others it is loamy or humous sand which is at the surface. In some places yet another substrate is made, such as stones, stonechips, cinders and chalk.

On account of the natural conditions of the soil at "de Wolf" the differences in height caused, need not be great to be effective. The soil-relief is therefore nothing but a system of ridges and dams. The former, broad, long and sometimes flat, border the valleys; the dams are narrower and higher, and border the drainage-ditches. Some valleys have drainage, others do not. Sometimes they are pools, more or less deep, either receiving only rainwater, or principally fed by the more eutrophic, socalled depth-subsoilwater, pumped up from under the boulderclay.

The works for this purpose were erected in the highest part of the garden, by the side of the pond. This subsoilwater is brought up from 70 m depth, led into that pond and into a brook, running through nearly the whole of the Arboretum as well as through the more open

grounds. In the brook some dams have been built to prevent the uppercourse from falling dry; between the dams the current is slow, where they are lacking one can speak of a flowing stream. There plants like *Montia fontana* and species of *Callitriche*, specially dependant on flowing water, find suitable conditions. By a system of culverts as well the waterlevel desired can be maintained, while the eutrophic water is at the same time refreshed. Should the water in the pond rise too high, then it is drained off to some small pools in the promiscuous forest and from there past the meadows along a narrow bedding, finally emptying itself into above mentioned brooklet.

Owing to the great variety of conditions sketched above, combined with the methods of cultivation, yet to be described further on, many plants in many vegetations can find their place in "de Wolf". It is not only seedplants, forming part of them, to which attention is paid. Also Cryptogams like ferns, clubmosses, mosses, lichens, fungi and Myxomycetes occur in many species and in great numbers.

Among the vegetations there are such as develop without any human interference, while in other cases the human being interferes with the developing vegetation, so with the successionrange, in order to keep alive a certain vegetational type.

The arboretum is that part of "de Wolf" first laid out and planted; in 1930 it was started.

As the arboretum was also meant as a windscreen for the other part of the grounds and it must not obscure the sunlight too much, the greater part of the foliage trees-section is planted on the northside, while the pinetum forms the western border. On the eastside of the grounds a collection of shrubs (fruticetum) is now coming into existence.

About our tree- and shrubcollection as such we will not discourse further here. There are several arboreta in the Netherlands, differing little in principle, though they each have a character of their own.

It is, however, important that in the arboretum of "de Wolf" also the process of vegetation development is allowed to take place under various conditions, so that this arboretum serves a double purpose. For the dendrologist there are the trees and shrubs as such — among which there are some beautiful specimens especially in the pinetum; for the student of vegetations they are the components of the forest, where forestal vegetations develop.

The places where no trees grow, so the open spaces in the forest, are sometimes but small areas, but in other cases they are so large that the trees practically do not influence them. In such places there originate meadows, heaths and swamps.

Methods of cultivation

We have already indicated that, besides the naturally favourable soilconditions to be found at "de Wolf", it is the purposefully organised cultivation of the garden, that helps us to attain the end aimed at, and which also decides the entirely personal character of "de Wolf".

The method of cultivating is quite other than that in "ordinary" botanic gardens and so is quite different from that in the "old" hortus in Groningen also.

Spadework is only sporadically performed, and very locally, only for the benefit of the ruderal plants. The work consists principally of mowing, weeding, cutting, sodding and burning.

When deciding on the methods of cultivation two principally divergent final aims were at issue, roughly speaking.

a. On some grounds we allow a certain vegetation to originate, in this sense that the type, about to develop, has been decided on, e.g. a meadow for plants with a big production of litter, or one for plants with a small production of litter, but here no thought was given to the species which were to be the components of the vegetation.

b. In other areas cultivation is directed towards the development not only of a certain type, but thoughts have also been given as to which plants were to be the components of the vegetation, e.g. a moist heath with *Gentiana pneumonanthe*, *Lycopodium inundatum* etc., a poor meadow rich in orchids, a mossvegetation with *Sphagnum*, *Polytrichum*, *Pogonatum*, *Atrichum* a.o.

There are only two areas where human influence is completely barred. One is a very moist valley, excavated in 1933 down into the boulderclay. Here, via a series of succession stadia, a humid forest came into existence, the composition of which is still continually altering.

The other is a drier tableland, surrounded by a ditch, which was made as late as 1946. On this tableland a rich grassvegetation still dominates now, in 1956; the development into a forest has only just begun. This forest will of course come into existence via quite different successive stadia from that in the valley.

In all other vegetations there is more or less interference by one or more of the methods mentioned above.

This happens only slightly in the remaining forest where only the abundant woody shoots are thinned out. In the meadows which are not mown, only the sparse shoots of woody plants are taken away, while the swamps are saved from turning into swampforests by completely or partially cutting the woody shoots.

The hand of man exercices its influence to a growing extent on the composition of the meadows which are mown resp. once, twice or three times a year. In many of these meadows the moment for mowing is decided on by the vegetation itself; it namely takes place after the most important plants have shed their seeds.

The vegetation is influenced most in those plots for which the combination of species, so the flora, was chosen more or less in advance. Here we also weed, besides mowing or cutting, in places. Sometimes sodding is undertaken; this often occurs on only little trodden paths, and also on the bottom of ditches. Sometimes burning is done, or the substrate is influenced by sanding over. These last measures, just like intensive weeding, are aimed at continually creating new possibilities for the settling of plants with a small, to a very small, production of

litter. Pioneer vegetations or, if the successive series is broken off every year, ephemerous vegetations, are likely to originate here.

Just as was the case when forming the soilrelief, we aim at contrasts in these plots, — so where we interfere intensively — which, exactly as in the remaining part of "de Wolf" are divided into sections, by means of the cultivation-plan, which also makes comparison possible.

This is effected in several ways, viz.:

1. In the greater part of the grounds every section has its own treatment as a unit. Locally however, there often prevail different conditions within such a section. So per section we have to do with a similar method of cultivating, under conditions often greatly varying.
2. In a smaller area every section has its own treatment, while within each section the conditions are entirely or nearly the same.
3. There are a few sections, where, within each section, the conditions show little or no differences. They receive the same method of treatment. Relatively, however, they differ very much in conditions.
4. Somewhere else an area is divided into plots where the same treatment is given under identical conditions, but in each plot at a different time.

It may be advisable to point out that the "cultivationplan" is never deviated from, however great the temptation to do so may sometimes be. It namely happened now and then in the beginning, when competition was not yet great and every plant could settle practically anywhere, that a — let us say "spectacular" plant, e.g. a plant rare in our flora, — settled in an area where we knew it could not maintain itself under the cultivationplan decided on. Yet no other treatment was then undertaken for the benefit of this plant or plants in this special plot.

We may therefore, without any objection, consider human activity at "de Wolf" as a biotic factor.

To the various conditions already mentioned, may be reckoned: macro- and microclimate, proportion of light, moisture status and composition of the substrate. This extremely complicated unity of various methods of cultivation and varying conditions is also directed towards causing a greatest possible differentiation in the process of humification. The course of this process, — and for the pools that of putrefaction — is especially decisive for the development of vegetation at "de Wolf", as, ultimately, also the competition is dependent too on the method and degree of humification.

On: the flora of "de wolf"

Not all the flora of "de Wolf" is spontaneous. As for the woody plants: the trees and shrubs, forming the substance of the arboretum, were planted. A number of herbaceous species, among which also a few not found in our country, were sown or planted. This sowing or planting does not, however, take place anyhow, all over the grounds; certain localities have been destined for it and we use only small quantities and small amounts.

In general we may say that, as for the indigenous plants, all this

concerns species that occur only rarely nowadays, and, as for the exotic ones, species that are characteristic of certain vegetations e.g. alpine rockplants and plants from moist and drier alpine or mountaneous pastures.

When a plant has once been introduced into the garden, we no further interfere with the spreading; this takes place in the same way as for plants occurring quite spontaneously, they themselves "choose" the habitats that suit them best. In certain vegetations the settling of plants is therefore possible, originating from specimens introduced into the grounds in other localities. We call such plants, whether they be trees, shrubs or herbs, "subspontaneous". So their spreading is spontaneous; the term only indicates that the plant was introduced into the grounds by man, in another spot.

Spontaneous are: all Myxomycetes, algae, scalemosses, lichens and fungi; all leafmosses except a few species of *Sphagnum*, most ferns; *Triglochin palustris*, all *Juncaceae*, nearly all *Cyperaceae*, all *Gramineae*, except *Molinia coerulea*, both species of *Typha* (*angustifolia* and *latifolia*), *Potentilla sterilis*, *Achillea ptarmica*, *Cirsium dissectum*. In addition it may be observed that these plants were not introduced into the garden purposely by man; it will, however, always remain possible for them to have come as pollution of imported material.

In 1953 an investigation was made into the occurrence of *Desmidiaceae* in the pools of "de Wolf"; 78 species were determined. Besides these *Desmidiaceae* 23 other algae were determined. To the algae growing on the earth and on treetrunks etc. no attention was as yet given.

Of the scalemosses thus far 21 species were found, of leafmosses 61 species. The number of fungi, determined in the course of years, amounts to nearly 300 species, that of lichens to 36; the number of Myxomycetes is not exactly known, but it certainly amounts to some tens of species.

The remark has been made that it is a pity plants were introduced into "de Wolf" by human being, as "nature" was violated in this way. This point of view is a mistake, as it would not have been possible e.g. to let a heathervegetation originate, if we had not started by planting a few clumps of heather, in other words by forming a centre from where the scattering of seed over the grounds can take place.

Plants like *Gentiana pneumonanthe*, *Lycopodium inundatum* a.o. characteristic in our country of moist heaths, would in all probability never have settled, because they hardly occur in the near neighbourhood of Groningen. It was the intention to form a centre for distribution for all plants we introduced, nothing more.

Another critical remark that is sometimes made, concerns the fact that at "de Wolf" also exotic plants are found, e.g. alpine meadow- and rockplants. It must be kept in mind, however, that "de Wolf" is a botanic garden and that it never was the intention to have only indigenous plants. For the rest the number of these exotic plants, compared to the indigenous ones is very small, and they are only able to maintain themselves in those areas where we interfere inten-

sively. We need not be "afraid" that e.g. an alpine gentian will easily settle in a meadow mown once or even twice a year. Should this occur all the same, let it be so and it is in no wise contradictory to the aim of demonstrating vegetation development, to find out *which* plants can settle and *which* can stay alive for a longer or a shorter period. (This is ultimately the criterion for all vegetation development).

Nowhere at "de Wolf" is there any question about stabilisation, everywhere succession occurs; not only in the vegetation, also the substrate develops and here also one might speak of succession. Substrate and vegetation are everywhere "dynamic", in all sectors.

If it should prove that by the development of substrate and vegetation conditions have nevertheless somewhere become such, as to be favourable to the settling of e.g. an alpine gentian, then this stranger is heartily welcome there. In other words: the main point of work at "de Wolf" lies not on sociological but on ecological (s.s.) territory.

That we introduced a number of indigenous plant-species had yet another reason. They are often species which have become rare in our country, or are becoming so, on account of landreclaiming, ameliorated agricultural methods or for whatever other reason. It was in reality the intention to create a kind of refuge for those plants. And that we met with a certain amount of success may be proved by the fact that nowadays hundreds, if not thousands of plants of *Pinguicula vulgaris* occur, originating from some five specimens, planted in a certain section of the garden. And which scattered quite independantly over the grounds.

The same holds good for *Epipactis palustris*, occurring so overwhelmingly in some places that it assumes a "weed"-like behaviour. *Orchis majalis* and *Orchis maculata* show their manifold types in ample abundance, *Parnassia palustris* has become a "common" plant, *Lycopodium clavatum* covers great spaces.

Less overbearing and at first more or less successful, but now spreading, are: *Orchis morio*, *Orchis militaris*, *Orchis mascula*, *Orchis incarnata*, *Herminium monorchis*, *Platanthera bifolia*, *Listera ovata*, *Gentiana cruciata*, *Gentiana pneumonanthe*, *Narthecium ossifragum*, *Lycopodium inundatum* and *selago*, *Pyrola minor* and *rotundifolia*, *Ophioglossum vulgatum* etc.

It proved that for many of these plants the ecological amplitude is much greater than one would expect. *Pinguicula vulgaris* e.g. settled on peat-dust just as exuberantly as on sand; on loam it grows as easily as on coke-ashes and if there is but a minimal quantity of humus present, it develops as well on calcareous stone as on non-calcareous.

In this way it is made clear by all the plants at "de Wolf" mentioned that they are in no wise tied down to the conditions under which one is apt to find them in the field.

But we can also observe *how* easily most of these plants can be "ousted" and *how* difficult it is for them to conquer new territory. We see with our own eyes at "de Wolf" that only by acting rigorously, by continually causing calamities like the already earlier mentioned

Fig. 1. Herminium monorchis and Epipactis palustris in flower.

Fig . 2. Pool in heath. Part of pinetum on the background.

Fig. 3. View on alpine meadow (left), rocky wall and part of arboretum with foliage trees.

Fig. 4. Rich vegetation of Parnassia palustris.

sodding, burning, sanding over, etc. by which the vegetation extant is entirely or partially destroyed, it is possible to furnish these plants with not only new possibilities for settling, but also new possibilities for expansion. The same holds good, and perhaps even more so for the exotic plants with very small to small fitness for competition, than for the indigenous species mentioned.

And so it happens that in certain localities, after a calamity, beautiful pioneer communities originate, consisting of indigenous plants as well as exotic ones.

By way of example: part of a very damp meadow, bordered by a flowing brooklet, which continually keeps moist not only the meadow but also the lower part of the adjoining rocky wall (i.e. a wall built of sandstones) even in the driest periods.

On the meadows which have been sodded, algae immediately appear, scalemosses and leafmosses establish themselves, a.o. *Polytrichum commune* and bits of *Sphagnum*. Later on we see *Pinguicula vulgaris* appear and *Polygonum viviparum* (alpine), *Tofieldia calyculata* (id.), *Primula farinosa* (id.), *Primula luteola* (mountainplant from Central Asia); then *Gentiana pneumonanthe*, *Gentiana cruciata*, *Gentiana asclepiadea* (montane), *Parnassia palustris*, *Arnica montana*, *Lycopodium inundatum* and *selago* appear. *Orchis maculata* and *Epipactis palustris* put forth; *Pyrola minor*, *Drosera rotundifolia*, *Vaccinium vitis-idaea*, *Calluna vulgaris* and *Erica tetralix* settle. (We must immediately take measures against these last three species, as the meadow would otherwise become a „heath" within a few years).

It is more or less astonishing when it becomes apparent that a number of those plants has also settled in a place where one would not expect them, viz. in the crevices of the adjoining stonewall. It was not at all our "intention" that *Parnassia*, *Drosera*, *Gentiana* and *Lycopodium inundatum* would settle there.

The wall was intended for alpine rosette plants, on the drier parts *Sempervivum*, *Androsace* etc., in the more humid spots species of *Saxifraga*. These Saxifrages have found favourable conditions for their growth after lengthy wanderings. From the spots where a few rosettes were planted, they vanished long ago; there *Sempervivum* settled, which in its turn now fights a "struggle for existence" against oncoming lichens and mosses.

Amazing though this settling of *Parnassia*, *Drosera* etc. against the wall may have been, it can be understood. Seeds had been produced in abundance by the specimens along the brook; there was hardly any competition in the crevices between the stones; there was but little development of *algae*, just not too strong to prevent germination; the conditions of humidity and light apparently were exceptionally favourable and so we find besides the plants mentioned also a young plant of *Rhododendron hirsutum* (seed from the *Rhododendron* valley), seedlings of *Calluna* and *Erica* and even young plants of *Osmunda regalis* (spores from moist forest) and a few more species of ferns.

On the piece of sodded meadow described above we had occasion to ascertain that the spores and prothalliums of *Lycopodium inundatum*

indeed only need a short period for development. Already in the third summer after the sodding several plants were present.

It will hardly be necessary to remark that the development on other vegetation-free plots for which the conditions differ, will be entirely different.

We do not consider it necessary to treat all this in extenso. Once again: let us point out emphatically that all those processes enact on a relatively small part of "de Wolf", and that in the greater part of the garden human interference remains restricted to more or less intensive mowing.

Herewith we conclude this summary of what goes on at "de Wolf" and what biological processes are enacted.

One more final observation. At the beginning of this paper we simply stated: Aim II is the creating of possibilities for growth for as many plants as possible, Phanerogams as well as Cryptogams. However: what a fascinating idea; what possibilities lie hidden there.

To be able to give an idea, within a limited space, of the exceptionally complicated processes of humification under various conditions and the effect of it all on the vegetation; to be able to give an idea of succession; to put into practice the possibilities to guide this succession, to direct it towards an aim decided on in advance etc. etc.

One must realise what this infers, how many questions again and again come thronging, what hoard of observation may be gathered; observation, not only of botanical importance but possibly also essential in the practice of conservancy and eventually the establishment of nature-territories.

SUMMARY OF THE PRINCIPAL VEGETATIONS OCCURRING IN THE GROUNDS OF "DE WOLF"

A. Woodvegetations

1. Foliage trees, Conifers. Not mown. Herbs with great production of litter; hardly any mosses or fungi.
2. Foliage trees, Conifers, promiscuous forest. Mown once a year. Herbvegetation with less production of litter. In the last section rather more mosses and fungi than in the former two.
3. Foliage trees, Conifers, promiscuous forest. Mown twice a year. Herbs with little production of litter, mostly springflowering. In the promiscuous forest e.g. many *Anemone nemorosa*, *Ranunculus ficaria* and *auricomus*. Into the pinetum heath penetrates, especially in the lower parts and the open spaces.
4. Through the entire wooded area broad strips, also meant for paths, mown several times a year. Hardly any herbvegetation; abundant development of mosses and fungi.
5. In the entire wooded area spontaneous shoots of foliage trees. In certain sections no interference by man; here a "jungle" originates. In other places this development is checked by cutting.
6. In several places in the forest, where socalled trunk- and branch-manuring is practiced, abundant development of woodfungi, mosses and Myxomycetes, while gradually ferns settle on the decayed wood.

B. Dams

Partly unplanted, partly planted with foliage trees and with Conifers. Mown or not; in the former case mosses, lichens, fungi but little herbgrowth; in the latter rich development of herbs.

C. RUDERAL VEGETATIONS

1. Wide area in deciduous forest, where every year the wood — to be thinned out — of small proportions is burned. Here also plants characteristic of such habitats, such as the moss *Funaria hygrometrica* and the fungus *Flammula carbonaria.*
2. Sections outside the forest, dug up in spring and autumn. "Weeds".

D. MEADOWVEGETATIONS

There are meadows within the forest and without. In the first case the vegetation is influenced by leaf- or needle-litter and by other "forestal conditions".

1. Foliage-tree meadows and needletree meadows. Not mown. Herbvegetation with very great to great production of litter. No mosses or fungi.
2. Id. Mown once a year. Herbgrowth with less production of litter. Little development of mosses and fungi, in needletree meadows more than in foliage-tree meadows.
3. Id. Mown several times a year. Little herbvegetation. On the other hand many mosses and fungi.
4. Meadows outside the wood, so where the above mentioned influences of forestal conditions do not exist.
   a. Not mown. Herbvegetations with great litter production. Mosses nor fungi.
   b. Mown once a year. Herbvegetations with less production of litter. Mosses and fungi.
   c. Cut and weeded, so very intensive human influence. Herbs with very small production of litter. We also interfere in the mossvegetation; development of *Sphagnum* however is stimulated. After years the *Sphagnum* vegetation probably will become so dense that it starts to dominate; then interference will be necessary there too.

   One of these meadows might be described a little more in detail, viz. the orchid meadow.

After the moment at which the most important plants have shed their seeds, the meadow is mown and the refuse is immediately removed. The impovering gradually progresses and the meadow, in which grasses dominated, begins to adopt the character of the socalled "bluegrass meadow". *Carices* penetrate and a plant like *Cirsium dissectum* which is typical in such meadows, settles there quite spontaneously.

Early in spring plants like *Anemone nemorosa, Fritillaria meleagris, Primula elatior,* flower here. Somewhat later there appear *Lychnis flos-cuculi, Pedicularis palustris, Ajuga reptans, Rhinanthus glaber, Filipendula ulmaria, Molinea coerulea* and orchids: *Orchis majalis, Orchis maculata, Orchis morio, Orchis palustris, Listera ovata, Platanthera bifolia* and *Gymnadenia conopsea.* But also mosses like *Climacium dendroides* and fungi like *Sclerotinia tuberosa* and species of *Hygrophorus* occur.

Besides the above mentioned meadows there are at "de Wolf" also a number of meadowtypes in the making, where we will try to change only one factor at a time.

1. There are four meadows side by side under the same conditions of light and humidity, which also receive the same method of cultivation (mown a few times a year) on 4 greatly differing substrates, viz. a. on loamy sand, rich in humus; b. on calcareous seasand; c. on lime marl; d. on coalashes. The differences in overgrowth were extremely remarkable already in the first year; the further development can be studied.
2. Three meadows develop on loamy sand, rich in humus, and under the same conditions of light and cultivation (mown a few times a year) but under different conditions of humidity; a. moist; b. drier; c. dry.

For six meadows, on loamy soil, rich in humus and under similar conditions of light and moisture, the identical cultivation is practiced (mown once a year) viz. respectively on the 1st day of the months June to November inclusive.

E. HEATHS

The grass- and herbvegetation is either mown here, or cut or weeded. If necessary the development of mosses too is checked, that of *Ericaceae* and *Sphagnum* on the

contrary is stimulated. It is not the intention ever to interfere with the growth of *Sphagnum* in heaths.

1. *Myrica-* and *Vaccinium* heath. In a shallow dell, where water stagnates in a few places in winter only. As yet no *Sphagnum* development.
2. *Calluna-* and *Erica* heath. There are two large and a series of small dells in it. A great part of this heath is submersed all winter long.

   This heath, where *Empetrum nigrum* has been introduced, harbours plants we might expect on such soil in nature just as well; *Pedicularis sylvatica, Gentiana pneumonanthe, Arnica montana, Orchis maculata, Sphagnum* cushions; in deeper pits *Narthecium ossifragum, Eriophorum angustifolium,* or on a peaty soil *Andromeda polifolia* and *Oxycoccus quadripetalus*; in more bare places (sodded patches, mostly on paths) *Drosera rotundifolia, Pinguicula vulgaris* and *Lycopodium inundatum.*
3. *Pinus montana-* and *Rhododendron* heath. Principally alpine species.

F. Walls and stony meadows

Here human interference is very great on account of repeated weeding. Only herbs with a very slight production of litter, such as alpine herbs and rosetteplants are tolerated. On the stones many mosses and lichens.

G. Pools

As has been made clear in the part treating the water-provision, there are brooks and pools with eutrophic subsoil water and others with oligotrophic rainwater. The former type of water on the one side feeds a few small pools in the promiscuous forest and flows past mown pastures, where it makes it possible for *Sphagnum* to develop, while on the other side it flows through foliage tree-forest and part of the meadows where it provides water for a pool which is choking up, and for a few other pools of various depths. In, and bordering, these pools an abundant growth of water-, swamp- and shoreplants.

The oligotrophic rainwater is caught in the pinetum and on the heaths (vide eo loco) in more or less deep valleys without drainage. They have all been excavated in the boulderclay-soil so that no water is lost by percolation. Where the water stagnates very much, *Spaghnum* cushions develop, which have been evidently growing these last few years.

In the pinetum we sometimes tolerate leaftree-shoots in the dells, so that a swamp-forest may originate; in other places it is destroyed by cutting.

In the *Pinas montana-Rhododendron*-valley the rainwater stagnates in a small runnel. Along the sides development of *Spaghnum.*

Further there are four pits on the southborder of the grounds of various size and depth, excavated in the clay and bordered by claydams. The first, shallow, is without water for some time in dry summers; tree- and herbshoots are then taken away. This oligotrophic pool has a.o. already many remarkable micro-organisms.

On the dams of the second, deeper, pit, which never quite falls dry, a strong development of *Polytrichum commune* originated on the bare clay.

Of late we see it die down, while new growths do not appear. Along the shores of the pool much *Marchantia polymorpha, Pellia epiphylla*; in the pool algae, a.o. *Chara vulgaris.*

The 3rd and 4th pits are not bordered by dams; they are part of a valley which is submersed in winter.

Here a.o. magnificent growth of *Hypericum humifusum.*

The valleys and pits in this area are bordered by rows of Conifers and of leaftrees resp.

Further there are still a few other dells, lying in the leaftreeforest and in the meadows. Some have stagnating water in winter, others have not. There is, however, in all those valleys sufficient water to enable the growth of resp. a hygromorphous forest- and a hygromorphous meadow-vegetation.

Of course it is impossible, in this short survey, to describe everything that happens in the botanic garden "de Wolf", to discuss all the plants that occur there. A more explicit description of only a few sections was chosen, while the photo's reproduced here also give an impression of the grounds.

There is continuous vegetation in nearly all sections of the garden and most

plants have no fixed place, chosen by the gardeners, but they themselves "choose" there spot for development. The chance that they find habitats congenial to their growth is great because there are so many different conditions in "de Wolf".

We have tried to give an impression of the exceptional character of "de Wolf" in this paper and also of the great variety of vegetationtypes which have developed there in the course of about 25 years.