AUTOCHTHONOUS TREES AND SHRUBS IN THE NETHERLANDS

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Introduction

Trees have been bred, selected, planted, traded and transported over vast distances for centuries. What, then, can we say about the autochthonous character of our forests and wooded banks? In this paper we look into the research on indigenous trees and shrubs in the Netherlands (Fig. 1). This paper presents a method of tracing indigenous trees and shrubs in the field, which was developed by the author. After the most recent Ice Age, which ended some 15,000 years ago, trees and shrubs re-colonized Northern Europe. The succession in vegetation is known through studies of fossil pollen and macrofossils (Glimeroth 1995; Lang 1994).

The geomorphology and the landscape of the Netherlands

The ice of the penultimate Ice Age together with the melting water and strong winds along the ice front formed important elements in the Dutch landscape. This has led to several types of moraines, boulder clay plateaux (tills), melting water valleys and aeolian sand deposits. The ice from the last, or Weichselian, Ice Age did not reach the Netherlands. After the last Ice Age four major elements of the Dutch landscape became apparent, viz. the coastal area characterised by low-lying clay and peat soils, the river area in the lower reaches of the Rhine, the Meuse and the Scheldt, the more elevated sandy soils in the south and east with their brook valleys and finally the marl and loess area in the utmost south-eastern part of the country. Coastal regions and strips along the rivers constituted a dynamic area where floods, peat accumulation, dune formation and sand and clay deposition occurred. The dynamic character of the area has been substantially suppressed by centuries of dyke-building, which began about 1100 AD.

Human influence during Prehistoric Times

Man has influenced his surroundings from an early stage of the Holocene vegetation development. It has been shown that hunting and burning of vegetation took place in Palaeolithic times. Human influence became a major factor during the Atlantic period when forest was cleared to advance agriculture.

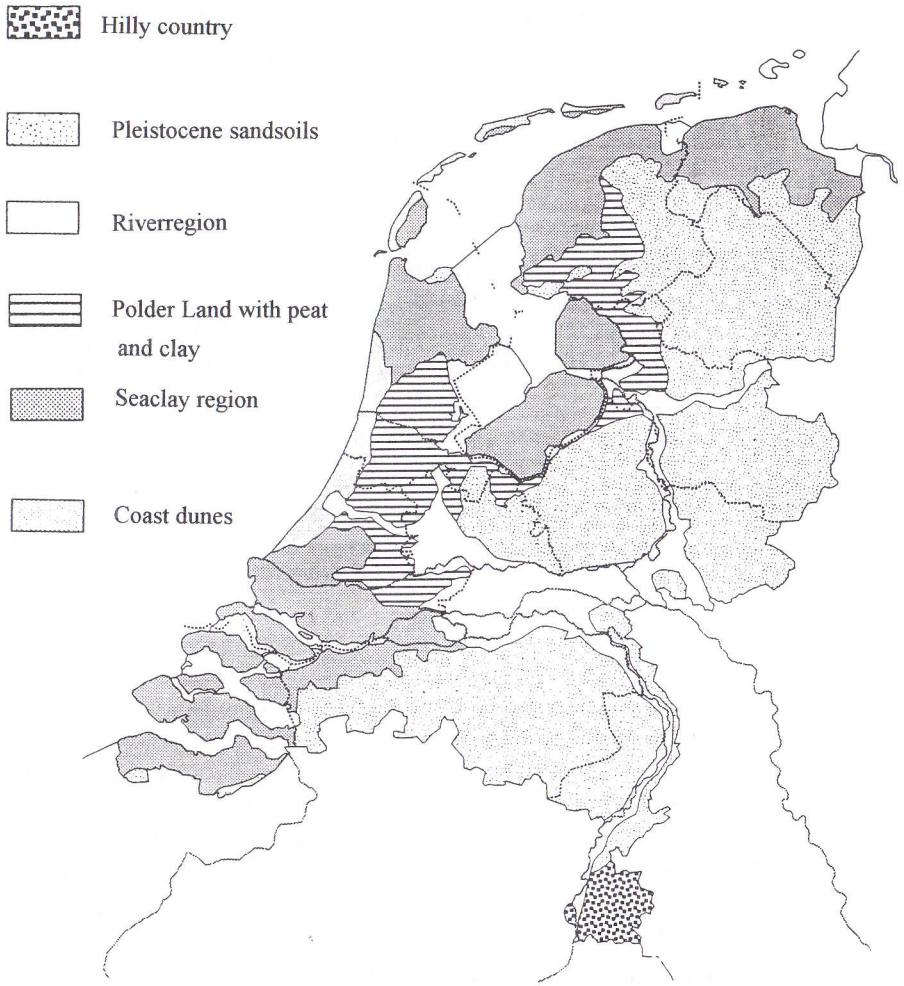

Fig. Map of the Netherland. Geographic regions (from: Natuurbeleidsplan, 1970)

In the Netherlands this happened from 7200 BP on. In the west of the country traces of agriculture and cattle breeding have been shown to date from 5000 BP on. Of course, it only occurred where the dynamics of the environment allowed that. Once agriculture and cattle breeding had started the forest became more open in its character. This trend was even stronger during the much later Iron Age and the mediaeval times. This type of forest developed under the pressure of man, relatively shortly after the Atlantic primeval forest had established itself. The main factor in the process was the influence of natural succession. A number of researchers feel that the primeval forests of the north-western European lowlands had an open character, but sufficient arguments can also be found to prove the opposite (Vera 1997; Stortelder et al 1998).

Five thousand years before the arrival of the Romans (7000 BP) the human population was engaged in agriculture, thereby greatly influencing the Atlantic primeval forest. A considerable number of photophilous trees and shrubs, such as oak (*Quercus robur*), durmast (*Q. petraea*) and many rosaceae, including crab apple (*Malus sylvestris*), forest pear (*Pyrus pyraster*), hawthorn (*Crataegus monogyna*, *C. laevigata* and *C. rhipidophylla*), sloe (*Prunus spinosa*) and sweet cherry (*P. avium* subsp. *avium*) as well as various species of rose (*Rosa* sp.), has benefited from this influence. These light-loving species were probably present in forest edges and copses as well as lining the meandering rivers and brooks. Due to their thorny nature they offer shelter to other species of trees and shrubs, mainly the oak species, which are able to germinate and prosper because large grazing animals are kept out (Vera 1997).

During and after Roman Times

In many places, the Romans found well-ordered agricultural societies and trade routes on their way to conquer Central and Northern Europe. The exchange and transport of all sorts of woody plants was already well established on a regional basis. This especially concerned useful species like fruit trees (Zeven et al 1997). In their turn, the Romans brought with them several new crops, starting from edible fruits like walnut (*Juglans regia*), chestnut (*Castanea sativa*) and sweet cherry (*Prunus avium*). Later, trees were planted near homes, e.g. near the villa at Heerlen, the Roman Coriovallum, in the south of our country. But we must not overestimate the number of species that were able to survive after the Romans left. A number of Mediterranean species are unable to live through our winters, and even if they can be bred it is difficult for them to propagate spontaneously. In any case, there are few or no indications that the woody species introduced by the Romans have established

themselves as a natural component of our forests and wood banks. Possible exceptions are medlar (*Mespilus germanica*) and chestnut (*Castanea sativa*). In England, stubs of Chestnut apparently dating back to the first millennium AD have been preserved; however, in the Netherlands these ancient specimens are unknown. Moreover, there are no indications of very old sites. Spontaneously growing medlars in the south and east of the Netherlands are more likely the descendants of specimens introduced in the Middle Ages. Written sources tell us that several species of trees and shrubs were introduced from Asia Minor and southern Europe in mediaeval times. Examples are peach (*Prunus persica*), black mulberry (*Morus nigra*), oriental plane (*Platanus orientalis*), sour cherry (*Prunus cerasus*), plum (*Prunus domestica*), chestnut (*Castanea sativa*) and medlar (*Mespilus germanica*). These species were more widely used in the southern areas of our country as well as in southern England where the climate is warmer and the soil is richer in lime. Only a small area in the south of the Netherlands is somewhat comparable with these areas.

Monasteries, castles and armies spread the valuable fruit tree species. Archaeological research has shown that the following species were present in the Netherlands in the Merovingian and Carolingian periods (6th to 9th century AD): apple (*Malus domestica*), damson (*Prunus insititia*), walnut (*Juglans regia*), medlar (*Mespilus germanica*), sloe (*Prunus spinosa*) and elderberry (*Sambucus nigra*) (Bakels 1991; Zeven et al 1997). Apparently the large fruited and selected sweet cherry was introduced from Italy and Asia Minor at an early date (Scholz and Scholz 1994). It is known that Charlemagne issued guidelines (*Capitulare de villis*) on growing vegetables, fruit trees and medicinal herbs. Tradition has it that he also encouraged lime trees to be planted; however, this is not supported by solid evidence. In particular the monasteries were a source of knowledge and plant propagation. Archaeological research has established that the following species date from the 10th, 11th and 12th centuries: apple (*Malus domestica*), damson (*Prunus insititia*), pear (*Pyrus communis*), walnut (*Juglans regia*), medlar (*Mespilus germanica*), hazel (*Corylus avellana*), hawthorn (*Crataegus* spp.) and elderberry (*Sambucus nigra*) (Bakels 1991; Zeven et al 1997).

Besides the species mentioned above the following species are known from the 13th, 14th and 15th centuries: peach (*Prunus persica*), sweet cherry (*Prunus avium*), sour cherry (*Prunus cerasus*), cherry plum (*Prunus cerasifera*), black mulberry (*Morus nigra*) and juniper (*Juniperus communis*) (Körber-Grohne 1996; Zeven et al 1997). From this period we also find red currant (*Ribes rubrum*) at Cologne, Germany (Knörzer 1989). The archaeological findings corroborate the botanical writings of the mediaeval herbalists like Hildegard von Bingen (1099–

1179), Albertus Magnus (ca. 1235–1280) and Pier de Crescenzi (about 1235–1320) (Louis 1977). The species they mentioned are largely forest trees, fruit trees and southern European species that are quite hardy. Most of the species mentioned by them exhibit little or no capability of spontaneous propagation in forests and wood banks. For example, cultivated peaches and walnuts seldom revert to their wild form. Cultivated sweet cherry (*Prunus avium* subsp. *juliana*) hardly propagates itself, unlike its wild counterpart (*Prunus avium* subsp. *avium*). Since the 16th century the already well known species, such as oriental plane (*Platanus orientalis*) and horse chestnut (*Aesculus hippocastanum*), were introduced to northern Europe from the Mediterranean and the Balkans as ornamental trees (Boom 1982). During the 16th and 17th centuries universities and botanical gardens started to play a major role in the acquisition of knowledge on forestry and the introduction of exotic species. The Netherlands led the way in northern Europe. After the Italian examples of Florence, Padua and Pisa botanical gardens were set up at Leiden in 1587 (Karstens en Kleibrink 1982). In the 17th century the cities of Amsterdam, Utrecht, Harderwijk and Franeker followed suit. Originally these gardens were primarily pharmaceutical in nature; however, rarities and curios were much in demand. It is estimated that the old laburnum (*Laburnum anagyroides*) in the Hortus at Leiden dates from 1601 or even from an earlier, 16th-century collection.

Rembert Dodoens gave the first scientific review of trees, shrubs and herbs in the middle of the 16th century (Louis 1977). During the 17th century more estates and country mansions were set gradually up, spurred on by increasing prosperity. The new owners were always looking out for something extraordinary. Voyages to Asia and particularly to Central and North America to discover new lands and products provided them with the means required for that. In 1576 *Plantarum Historia* by M. de Lobel was published. It first mentioned a number of American trees and shrubs that had by then become known in the Netherlands.

Species like Robinia (*Robinia pseudacacia*), tulip tree (*Liriodendron tulipifera*), American cherry (*Prunus serotina*), swamp cypress (*Taxodium distichum*), feathery maple (*Acer negundo*) *and* black walnut (*Juglans nigra*) were introduced from America. During the 17th and 18th centuries a whole array of other species were introduced, viz. American red gum (*Liquidambar styraciflua*), staghorn sumac (*Rhus typhina*), honey locust (*Gleditsia triacanthos*), horse chestnut (*Aesculus pavia* and *A. octandra*), southern catalpa (*Catalpa bignonioides*), American oak (*Q. rubra*), western balm poplar (*Populus trichocarpa*), sugar maple (*Acer saccharum*) and sugar maple (*A. saccharinum*). These are all species we expect to find in our woods, parks, avenues and streets. Some introductions dating from the second half of the eighteenth century are *Pterocarya fraxinifolia* and a species of pear (*Pyrus*

salicifolia) from Asia Minor. The Douglas fir (*Pseudotsuga menziesii*), one of the major wood producing species, was only introduced from North America in 1836.

Most of the exotic woody species from China and Japan were not introduced until the 19th and 20th centuries, except for maidenhair tree (*Ginkgo biloba*) originating from China, which was imported as early as in the 18th century. Although many exotic species have been introduced to the Netherlands since the 16th century the number of species that have been capable of establishing themselves in our forests and wood banks is strikingly few. Some species that propagate themselves easily through generation or new shoots tend to behave like pests, viz. Robinia (*Robinia pseudacacia*), the Douglas fir (*Pseudotsuga menziesii*), American oak (*Quercus rubra*), American cherry (*Prunus serotina*), feathery maple (*Acer negundo*) and *Pterocarya fraxinifolia.*

Tree cultivation and trade

In our country, the Netherlands, the history of tree cultivation can be traced back only to the 15th and 16th centuries. In this period, thousands of trees, such as alders, beeches, oaks, limes, elms, maples and white and black poplars (Buis 1985; Temminck 1984; Oldenburg-Ebbers 1993; van der Groen 1669, 1687, 1721), were sold and planted in the west of our country.

During the 16th and 17th centuries, a specialisation took place from general breeding to breeding for trade. In particular, there was a substantial rise in the demand for ornamental trees to be used in avenues and realties due to the establishment of country estates. Partly, fruits and spontaneously growing stands were harvested in the forests to cater for the breeders; however, selection breeding was carried out on a large scale and experiments were held with grafting material and artificial crossbreeds. Thousands of hybrid clones of Dutch lime (*Tilia* × *europaea*) were grown during the 17th and 18th centuries and exported to England (C.D. Pigott; pers. comm.), Scandinavia (R. Bengtsson, Alnarp, Denmark; pers. comm.; Christensen 1981), Germany, Estonia (H. Sander, Tallinn; pers. comm.) and Russia.

In these countries Dutch limes dating from this period have been preserved (Maes 1996), even to a more extent than in the Netherlands itself. Particularly in southern Sweden one finds hundreds of avenues lined with *Tilia* × *europaea* dating from the 17th and 18th centuries. The Swedish researcher R. Bengtsson used DNA analysis to discover that the plant material consisted of a range of different Dutch lime clones (PhD thesis, in preparation).

A written source from 1618 found with a Dutch trader aptly named Erik van der Linde [the surname literally means of the "Lime tree"] shows that limes were planted in

Sweden; however, other tree and shrub species were sold there as well. In more rural areas the cultivated products were hardly sold and used at all; the local plant material was used instead. A later development, especially since 1950, is large-scale transport of non-autochthonous (but indigenous) plants from other floristic regions in Europe to be used in ornamental stands of trees, in lining the roads and, more recently, to repair small elements of landscape.

Changes in the landscape

Apart from the introduction of foreign species over the past millennia the composition of our tree and shrub flora has been strongly influenced by changes in the human population and the way in which mankind has made use of the landscape. Immediately after the Roman era part of the Low Countries was depopulated. This led to an increase in the area covered by natural forests. During the Middle Ages the area used for agriculture steadily increased, leading to a reduction in forested areas. As early as the late Middle Ages, around 1500, it had become impossible to locally provide the wood required by large parts of the Netherlands (Buis 1985; Spek 1998). Regulations and measures failed to stem the tide. Many of the remaining woods, coppiced woods and woodbanks consisted of autochthonous plant material, especially copses and pollards. The copse management, however, was targeted at a limited range of tree species, particularly oak and durmast (*Quercus robur* and *Quercus petraea*), ash (*Fraxinus excelsior*) and alder (*Alnus glutinosa*). To a lesser degree, other species like small-leaved lime (*Tilia cordata*), the elm species (*Ulmus spp.*), hornbeam (*Carpinus betulus*) and field maple (*Acer campestre*) were also used in copses.

In particular, oaks were immensely valuable for their acorns used as pig fodder as well as a source of wood for burning, building and making charcoal, inner bark for fibre production and outer bark for leather tanning (Buis 1985; Dirx 1998; Vera 1997). In some cases rules were laid down to provide for the conservation of thorny shrubs like sloe (*Prunus spinosa*), because they laid a protective cover over the young oak sprouts (Vera 1997).

In woodbanks selection was less important, which resulted in the number of autochthonous woody species being much larger. This holds true for the shrub layer as well. Genuine attempts to set up new forests were launched as late as toward the end of the 18th and in the 19th century, mainly through the afforestation of heath and dune areas. Hybrid poplar clones (*Populus* × *canadensis*) were planted on the moist soils of brook valleys. Several non-indigenous willow clones and hybrid willows were also planted in brook valleys as well as alongside rivers to provide willow-wands for basket making. These new plantings are sure to have made inroads into the already weakened

natural stands of black poplar (*Populus nigra*) and the indigenous sallow species of the river softwoods.

These new woods have made little (or even no) contribution to the conservation of indigenous tree and shrub genes. Moreover, new woods were established in areas that had previously been deforested. During the 20th century the economical importance of copses and pollards diminished, which led to the clearing of at least three quarters of the existing old tree stands and woodbanks.

The original gene material of trees and shrubs is mainly to be found in the remaining ancient woodlands, old woodbanks, dune shrub landscape and alongside brooks that have been left intact. Only the shrub areas in the dunes have increased in area after the cessation of grazing over the 20th century (Maes 1995).

In general, autochthonous woody plants are now rare in the Netherlands, and their continued existence is highly endangered.

The concepts of *indigenous* and *autochthonous*

There arises an additional problem when we discuss the meaning of the word "indigenous". This term refers to a species capable of growing within a particular area, which constitutes the distribution range of the species. Populations from other areas, which may differ genetically, are also called indigenous. To distinguish between the two we use the term "autochthonous". It has been sufficiently proved that plant populations from different regions may vary extensively as far as genetics are concerned. Autochthonous populations result from millennia-long genetic selection and are fully adapted to the local environment. This development is the basis of natural biodiversity. H.M. Heybroek (1992) defines the term "autochthonous" as follows: "plant material which has exclusively propagated itself spontaneously since the Ice Age, or which has been artificially propagated using only local original material". In principle, autochthonous plants have established themselves naturally in a certain region.

A method to establish the autochthonous nature of trees and shrubs

We cannot apply the definition given above without further consideration. The problem is that we must distinguish between imported and autochthonous plant material in the field. To establish whether the character of a plant is autochthonous by using the above method we should start by considering a number of criteria related to taxonomy, forest history and breeding history. In short, the method initially employs criteria that

are linked both with the tree itself and its site (Maes, Vuure en Prins 1991).

1. Criteria linked with the tree or shrub itself

- The tree or shrub belongs to a wild, indigenous variety; it is not a cultivated form.
- It is an apparently old specimen, a (former) old stub or grown tree in a bank.
- The tree or shrub appears to have spontaneously sprouted rather than planted.
- DNA research points to the autochthonous character of the tree or shrub.

2. Criteria linked with the site

- The landscape element containing the tree or shrub is part of a topographical map dating from 1850 or earlier (scale 1:25,000 or 1: 50,000).
- The landscape element is shown only on more recent maps; however, there are clear indications that the tree arrived there by seeding from the older landscape elements nearby.
- The site is within the limits of the natural distribution range of the species concerned.
- The species occurs in the natural or potential vegetation form.
- The landscape element looks natural and undisturbed in the field.
- The soil type and the site characteristics comply more or less with the natural niche of the species.
- The soil is undisturbed.
- Species indicating ancient woodlands or old woodbanks are present in the tree, shrub or herb layer.
- The same species occurs in the neighbourhood under comparable circumstances.

3. Other criteria

- Archives show that the site is old, or there are other indications to corroborate that.
- Local people can attest to the old age of the site or can provide information indicating such an old age.
- Palaeobotanical or archaeological research shows that an autochthonous character is likely.

In practice, all these criteria seldom appear simultaneously. In degraded areas indicative herbs may be lacking, and old trees or copses are not consistently present. Tracing typical garden varieties is possible, but doing so with typical wild varieties is more difficult. Therefore the criteria are to be used in combination.

In general, autochthonous trees and shrubs can be found in old tree stands, old copses and stands of grown trees in a copse as well as in undegraded parts of coastal and river dune areas, fallow land, farmland copses, wood banks, polder quays, cattle barriers, dry ditches, old drainage courses and steep inclines and alongside intact meandering brooks.

It is hard to verify the autochthonous character of trees and shrubs directly. Some species are known to have been bred and planted very rarely or never, such as crab apple (*Malus sylvestris*), flottering elm (*Ulmus laevis*), needle furze (*Genista anglica*) and small-leaved sweet briar (*Rosa agrestis*). A number of species found in old wooded banks or tree stands are almost certainly autochthonous, e.g., juniper (*Juniperus communis*), durmast (*Quercus petraea*), small-leaved lime (*Tilia cordata*), flottering elm (*Ulmus laevis*) and red woodbine (*Lonicera xylosteum*). Some authors even feel that several species indicate an old age of the forest they grow in, such as red dogwood (*Cornus sanguineus*), field maple (*Acer campestre*), two-styled hawthorn (*Crataegus laevigata*), *Sorbus torminalis*, which does not grow in the Netherlands, blueberry (*Vaccinium myrtillis*), field rose (*Rosa arvensis*), mistletoe (*Viscum album*), furze (*Ulex europaeus*), ling (*Calluna vulgaris*), crab apple (*Malus sylvestris*), wild pear (*Pyrus pyraster*) and mezereon (*Daphne mezereum*) (Tack and Hermy 1997).

The origin of another group of species that carry berries or fruits easily spread by birds, e.g. holly (*Ilex aquifolium*) and various species of rose (*Rosa* ssp.), is less clear. This is even more true for anemochorous species. In genera like *Ribes* and *Prunus*, there may be confusion about cultivated material that is closely associated in morphological terms. Refer to "Taxonomy" for details.

The main problems, however, arise from species that have been cultivated for a long time for commercial reasons, such as beech (*Fagus sylvatica*), oak (*Quercus robur*), ash (*Fraxinus excelsior*), alder (*Alnus glutinosa*), sallows and willows (*Salix spp.*), elms (*Ulmus* spp.), lime species (*Tilia* spp.) and hornbeam (*Carpinus betulus*) (Maes 1998; Bremer 1998).

Autochthonous specimens of these species have survived the ages thanks to the specific ways of forest management. The most important ways are coppicing and the system of singling coppices. In our country, beeches are seldom coppiced. As an autochthonous tree, beech can sporadically be found in the central moraine area of the Veluwe, the eastern corner of the country (Achterhoek) and perhaps the utmost south-

east area (Limburg). Both common oak and durmast oak have been preserved in old copses spread all over the country. In view of the circumference of the stubs, which is sometimes over 32 and even 48 feet (10 and 15 metres, respectively), these trees must be very old, dating at least from mediaeval times. On the Kempens Plateau in Flanders just across the border the oak stubs have been reported to have a circumference of over 65 feet (20 metres). The stubs include a tree-ring that is usually rotten or covered by soil in the middle. It is remarkable that hybrid groves of common oak and durmast oak (*Quercus robur* and *Quercus petraea*) as well as their various transitional forms (*Quercus* × *rosacea*) often occur in natural stands. It has been shown that common oak is dominant in crossbreeding. Pure durmast oak is a rarity that can occasionally be found in the south and north of our country and along the coast (Prins, Maes en Smit 1993).

It is interesting to note here a recent study on the DNA in Dutch oak trees satisfying the criteria for autochthonous material (van Dam en de Vries 1998). The countries from which these trees arrived shortly after the Ice Age can still be traced by the DNA properties. It was found that the oaks in the middle of the country originate from Italy while those in the east came from Spain. It is possible that the oak populations in the south-western part of the Netherlands reached the country along migration routes from the Balkans. Populations stemming from the Balkans have been found even on the Atlantic coast of France. Old stools of hornbeam (*Carpinus betulus*), ash (*Fraxinus excelsior*) and alder (*Alnus glutinosa*) can still be regularly met on the Pleistocene soils of the brook valleys. Old copses consisting of elm and lime species are less common (Maes 1990). Surprisingly, extremely old ash stools have been found in the western peat meadow area. The original genetic material of extensive marsh forests that were in existence before their exploitation started about 1200 has with a high degree of probability been preserved in dykes and old farmland copses (Maes en Rövekamp 1995).

Finally, we have to point out the existence of hybrids in which one of the ancestors is non-indigenous. This is the case with grey poplar (*Populus* × *canescens*), which is a crossbreed between aspen (*Populus tremula*) and white poplar (*Populus alba*). Some scholars consider grey poplar to be a bona fide species. The white poplar occurs naturally in southern and central Europe. The hybrid, which is also considered a natural plant, is likely to occur more northwards than white poplar. This view has been drawn, among other facts, from the existence of various poplar toponyms in Flanders and the province of Noord-Brabant (Tack, van den Bremt en Hermy 1993; van der Werf 1996). However, sites of grey poplar that look natural can very seldom be found. The same phenomenon may occur in *Prunus* × *fruticans*, a natural hybrid of Bullace (*Prunus domestica* subsp. *insititia*) and sloe (*Prunus spinosa*).

The Importance of autochthonous gene sources

Of course, in principle there can be no objections to the use of exotic and non-autochthonous plant material, particularly in forestry, cultivating ornamental trees, planting recreational grounds, etc. The importance of autochthonous plants lies foremost in their rarity and the dangers they face. The use and preservation of autochthonous trees and shrubs is of major importance to gene preservation, biodiversity, and nature management and development. The natural selection and adaptation of trees and shrubs during the regeneration process following the last Ice Age should be seen as a vast ecological and genetic investment by nature. This process, which has continued through centuries and in some cases even millennia, cannot be matched in any laboratory.

Undoubtedly, the low vitality of imported woody plants partly stems from the region of their origin. There are indications that autochthonous trees and shrubs, such as hawthorn species (*Crataegus ssp.*), are less susceptible to bacterial infections. More research into the subject would be interesting. There is an elm species, viz. flotterelm (*Ulmus laevis*), which is seldom attacked by the Dutch elm disease. The reason probably lies in the properties of its bark, which is not eaten by the beetle *Eccoptogastrus geoffroyi*, the carrier of the fungi that cause the disease. This is by itself a sufficient factor to protect this rare species. It may be assumed that the plant material introduced from other floral regions and climate zones will be less well adapted to the local circumstances. It is known that hawthorn, sloe and yellow dogwood imported from southern countries will start to blossom several weeks earlier than autochthonous specimens. This may be lethal to those invertebrates whose phenological evolution coincided with that of autochthonous specimens. In the Netherlands, juniper (*Juniperus communis*) is the only woody plant protected by law. The number of woody species on the preliminary Red List is very small and is not correlated at all with the real number of endangered species and their rarity. The plans to protect endangered autochthonous tree and shrub species ought to be given a higher priority than is currently the case.

Although increasing emphasis has been laid on autochthonous trees and shrubs in the Netherlands over the last few years the intensive introduction of new trees and shrubs is continuing unabated. They are planted on a large scale in tree stands, recreation grounds, new wooded banks and farmyards as well as along roads. Despite the unknown origin of these plants, they are even used to repair valuable landscapes. In particular, species carrying berries and hips will form new gene pools that compete with the already scarce wild populations. This is in fact a form of floristic contamination.

Sole use must be made of reliable, autochthonous plant materials at least in the vicinity of nature reserves and valuable landscapes. Considering the fact that over 90% of our forests and wildlife elements have in fact been planted the use of autochthonous

material can hardly arouse any objections.

Most forests, including the old ones, are poor in woody species and suffer from unnatural composition. A number of species cannot be expected to establish themselves spontaneously, even in the long run. The natural seeding sources of these species are too far away and germination is hardly or not at all possible. Many forests have an unbalanced composition of leaf mould and show a considerable layer of organic material that does not decompose. A more natural composition of forest, including species that yield easily decaying mould, would lead to better development of the forest soil in which the herbs and the soil fauna that belong there could establish themselves.

When planting indigenous trees and shrubs it is advisable to use autochthonous plant material from similar regions. This material is becoming increasingly available for sale. In addition, far-reaching plans are now being prepared to set up gene banks and lists of races and varieties of autochthonous trees and shrubs (Rövekamp, Maes en Ketelaar 1997).

Taxonomy

The identification of indigenous tree and shrub species is not free of problems. It is complicated by extensive morphological variation and the frequent occurrence of hybrids and cultivated counterparts. In genera such as *Rosa*, *Crataegus*, *Quercus* and *Salix* the intraspecific variation is high and hybrids are usually formed. In the case of *Rosa*, and probably *Crataegus*, these hybrids and parent crossbreeds can maintain themselves in a region for a long time by means of apomixis. In most brambles hybrids often do not form yet variation is extreme.

The number of bramble species in this country is estimated to be 150, of which some are endemic, such as *Rubus baroni* (in the south-west of the Netherlands) and *Rubus drenthicus* (in the north). In a number of species, primarily those that belong to the *Rosaceae* family, both wild and cultivated subspecies and varieties are present, and both are used for planting (Bakels 1991; Zeven et al 1997).

Several fruit trees have been selected for yielding larger or better tasting fruit for centuries. It is nearly impossible to distinguish the cultivated sweet cherry (*Prunus avium* subsp. *juliana*) from its wild counterpart, wild sweet cherry (*Prunus avium* subsp. *avium*), by vegetative properties. However, the size of the pip and the fruit around it are the unmistakable criteria (Körber-Grohne 1996; Scholz and Scholz 1994). Contrary to the wild form, the cultivated sweet cherry seldom propagates itself spontaneously.

Although the medlar (*Mespilus germanica*) originally came from Asia Minor we can distinguish its wild, spontaneous form that appears in ancient woodland and woodbanks. Medlar is even considered to indicate an advanced age of a forest (Tack en

Hermy 1997). Apart from this wild form, which has small fruits, a large-fruited variety, *Mespilus germanica* var. *macrocarpa*, is often cultivated in gardens (Boom 1982). Bullace (*Prunus insititia*), cherry plum (*P. cerasifera*) and the edible chestnut (*Castanea sativa*) can be considered less extreme archeophyta among woody plants. These species, however, only seldom appear naturally in old forests.

The same problem that haunts sweet cherry and medlar also occurs in the species of *Ribes*, including red currant (*Ribes rubrum*), gooseberry (*Ribes uva-crispi*), black currant (*Ribes nigrum*) and possibly *Ribes spicatum* that occurs in the northern provinces. There are no macrofossils of this species from prehistoric times. In general, fossil pollen of the *Ribes* (and of many *Rosaceae*) species can seldom be found. This fact is causing a degree of uncertainty concerning the occurrence in prehistoric forests of species belonging to these families. It seems obvious that species carrying edible fruits have had an advantage since the introduction of agriculture in prehistoric times. In any case it holds true for sloe (*Prunus spinosa*), hazel (*Corylus avellana*) and crab apple (*Malus sylvestris*).

Crab apple is easy to distinguish from its cultivated forms by its small fruits. Another distinction between them, as far as vegetative properties are concerned, is that the latter have pubescent leaves. Even hybrid forms can be easily traced. The overwhelming majority of crab apple occurrences have to be ascribed to escaping through the throwing away of the cores of cultivated apples (*Malus domesticus*), from which new trees have grown. Wild pear (*Pyrus pyraster*) is less easy to be distinguished from its cultivated varieties (*Pyrus communis*). The leaves of wild pear are often bald and rather small; however, some old cultivated pear varieties have similar leaves. In the Netherlands wild pear is seldom seen to fruit. The fruits are unmistakably small and lack the characteristic pear shape! Part of the rare wild pears may have originated from sprouting rootstocks of cultivated varieties.

Distribution range limits

Some tree and shrub species reach the northern, western or southern border of their distribution range in the Netherlands. In some cases they have accidentally profited from cultural measures. Yellow dogwood (*Cornus mas*), of which just about 10 specimens have remained in southern Limburg, has spread toward the north over a long period of time, possibly because of marl and gravel quarrying activities. A species of elderberry, *Sambucus racemosa*, originally belonged to central and southern Europe. It occurred in southern Limburg as late as around the middle of the nineteenth century. Currently it grows everywhere in the Netherlands due to planting and escaping. This species must be considered as a neophyte in all parts of the country except the original region (Weeda et

al 1988). It benefits from the various ways in which the forests are being disturbed. It has not been unambiguously authenticated whether wild pear, which reaches its northern limit here, exists in a truly wild state in the Netherlands; however, this is not unlikely. White alder (*Alnus incana*) is an example of a species reaching its western limit in our country. Although there are sites, especially on seepage soils in the middle and eastern parts of the country, that have a natural aspect (Maes 1993; Rövekamp, Maes and Ketelaar 1997) there is no certainty about the autochthonous character of the local trees and shrubs.

White alder has been used in forestry for undergrowth, and it may seed from there. The bay willow (*Salix pentandra*), which attains its western limit in the north of the Netherlands (Drenthe province) is considered a positively autochthonous species. Bay willow is seldom planted. Other species growing at the limits of their natural distribution range are red woodbine (*Lonicera xylosteum*), wooly snowball (*Viburnum lantana*), mezerean (*Daphne mezereum*), berberry (*Berberis vulgaris*), red bell heather (*Erica carnea*), *Crataegus* × *macrocarpa*, a hybrid of the two-styled hawthorn (*Crataegus laevigata*) and coral hawthorn (*Crataegus rhipidophylla*) (Maes en Rövekamp 1997), and crowberry (*Empetrum nigrum*). Some species growing in our country, like durmast (*Quercus petraea*), are near, but not exactly at, one of their distribution limits. Species growing at the limit of their natural distribution range always form a vulnerable and rare population. From the perspective of biodiversity and gene conservation they are especially important, because the limits are the focal point of adaptation, genetic selection and evolution.

Research and policy

The necessity of preserving the genetic potential of forest trees has been laid down in resolutions passed on the protection of European forests by ministerial conferences held at Strasbourg in 1990 and more recently at Lisbon in 1998. The Netherlands are one of the signatories to these resolutions. In more general terms, the Rio de Janeiro conference on biodiversity in 1992 has had a major influence.

In 1992 the Ministry of Agriculture, the Nature Management and the Fisheries of the Netherlands launched a project named Genetische Kwaliteit (Genetic Quality), which dovetails with the Natuurbeleidsplan (Nature Policy Plan) and the Bosbeleidsplan of 1990 (Forest Policy Plan). This project is aimed at gaining an insight into the existence of autochthonous tree and shrub species as well as their decline, protection possibilities, harvest and use. Within the framework of this project the above mentioned method was developed by the author in order to recognise and take stock of original tree and shrub species. First from 1988 surveys were carried out by the author in several

regions of the Netherlands, Flanders and the adjacent part of Germany (the Bundesland of Nordrhein-Westfalen), and from1994 in co-operation with the Stichting Bronnen (Sources Foundation).

This study has demonstrated how cramped the conditions have become for our originally indigenous woody species. A number of species have disappeared on a national or regional scale; undoubtedly, the same holds true for other European countries. In the Netherlands there are some 100 originally indigenous woody plant taxa (without considering the approximately 150 species of bramble). Of these, over three quarters are now rare, endangered, or both. On the other hand, this detailed survey has shown that taxa previously unknown in the Netherlands are present in the country, such as *Rosa elliptica* (sweet briar rose), *Rosa pseudoscabriuscula* (felt rose), *Rosa canina* var. *scabrata* (dog rose), *Rosa dumalis* var. *transiens*, *Rosa rubiginosa* var. *jenensis* (Egelantine rose), *Crataegus* × *subsphaericea* (*C. monogyna* × *C. rhipidophylla*), *Ribes spicatum* and *Salix* × *ambigua* (*Salix repens* × *Salix aurita*).

A review and the incidence of Dutch autochthonous tree and shrub taxa

The following survey presents the taxa of autochthonous woody plants and their incidence, excluding brambles, brooms, heathers and their varieties. The nomenclature is based on van der Meijden (1996), Biobase (1997) and the *Standardliste der Farn-und Blütenpflanzen Deutschlands* (Wisskirchen und Haeupker 1998).

Apparently extinct species (2 taxa, 2%)

Scots pine (*Pinus sylvestris*) and coral hawthorn (*Crataegus rhipidophylla*).

Extremely rare species (29 taxa; 29%)

Maple (*Acer pseudoplatanus*), beech (*Fagus sylvatica*), white alder (*Alnus incana*), Carpathian birch (*Betula pubescens* subsp. *carpatica*), yellow dogwood (*Cornus mas*), *Crataegus* × *subsphaericea* (*C. monogyna* × *C. rhipidophylla*), *C.* × *macrocarpa* (*C. laevigata* × *C. rhipidophylla*), mezerean (*Daphne mezereum*), wild privet (*Ligustrum vulgare*; common in the coastal dunes and south Limburg), beech (*Fagus sylvatica*), black poplar (*Populus nigra*), *Salix* × *ambigua* (*S. repens* x *S. aurita*), (*Ribes spicatum*), small-leaved sweet briar (*Rosa agrestis*), hairy northern dog-rose (*R. caesia*), glaucus northern dog-rose (*R. dumalis*; including *R. dumalis* var. *transiens*), small flowered sweet briar (*R. micrantha*), Egelantine (*R. rubiginosa*; including var. *jenensis*; common

in coastal dune areas), *R. pseudoscabriuscula*, *R. sherardii*, *R. tomentosa*, *R. elliptica*, *R. subcollina*, *R. subcanina*, *R. canina* var. *scabrata*, *Red Currant* (*Ribes rubrum*), yew (*Taxus baccata*), grey poplar (*Populus* × *canescens*), wooly snowball (*Viburnum lantana*).

Very rare species (17 taxa; 18%)

Field maple (*Acer campestre;* common in south Limburg), berberry (*Berberis vulgaris*; common in the coastal dunes south of Bergen), crab apple (*Malus sylvestris*), buckthorn (*Rhamnus cathartica*; common in the coastal dunes and south Limburg), eared willow (*Salix aurita*), rusty willow (*S. cinerea* subsp. *oleifolia*), small-leaved lime and large-leaved lime *Tilia cordata and T. platyphyllos*, the elm species *Ulmus laevis*, rough elm (*U. glabra*; common in south Limburg), slippery elm (*U. minor*), wood rose (*Rosa arvensis*; common in south Limburg), *R. tomentella*, *R. canina* var. *andegavensis*, mistletoe (*Viscum album*; common in south Limburg, purple willow (*Salix purpurea*), crack willow (*S. fragilis*).

Rare species (23 taxa; 24%)

Hornbeam (*Carpinus betulus*), *Betula* × *aurata* (*B. pendula* × *B. pubescens*), old man's beard (*Clematis vitalba*; except in south Limburg), two-styled hawthorn (*Crataegus laevigata*), red dogwood (*Cornus sanguineus*; except in south Limburg), wild spindle tree (*Euonymus europaeus*; common in the coastal dunes and south Limburg), ash (*Fraxinus excelsior*; common in the Utrecht-Holland peat meadow area), durmast (*Quercus petraea*; fairly common in Veluwe area), *Q.* × *rosacea* (*Q. robur* × *Q. petraea*; fairly common in Veluwe area), aspen (*Populus tremula*), sweet cherry (*Prunus avium* subsp. *avium*; except in south Limburg), bird cherry (*P. padus*; fairly common in the brook valleys of Brabant), sloe (*P. spinosa*; common in south Limburg and the Subcentreuroop district-one of the floristic regions distinguished by the "official" Dutch flora), *P.* × *fruticans*, black currant (*Ribes nigrum*), gooseberry (*R. uva-crispi*; common in South Limburg), almond willow (*Salix triandra* subsp. *triandra*), *S.* × *reichardtii* (*S. cinerea* × *S. caprea*), *S.* × *holosericea* (*S. cinerea* × *S. viminalis*), katwilg (*S. viminalis*), needle furze (*Genista anglica*), juniper (*Juniperus communis*), buckthorn (*Hippophae rhamnoides;* common in the coastal areas).

Fairly rare species (13 taxa; 14%)

Rough birch (*Betula pendula*), *Crataegus* × *media* (*C. monogyna* × *C. laevigata*), hazel (*Corylus avellana*), hedge rose (*Rosa corymbifera*), dog rose (*Rosa canina* var. *canina* and *Rosa canina* var. *dumalis*), dune rose (*Rosa spinosissima*; in coastal dunes only), guelder rose (*Viburnum opulus*), creeping willow (*Salix repens* subsp. *repens* and *S. repens* subsp. *argentea;* common in the coastal dunes), white willow (*S. alba*), (*S.* × *rubens*, *S. alba* × *S. fragilis*), red-berried elder (*Sambucus racemosa*; it is extending its range).

Fairly common and common taxa (12 taxa; 13%)

Alder (*Alnus glutinosa*), smooth birch (*Betula pubescens*), oak (*Quercus robur*), alder buckthorn (*Rhamnus frangula*), one-styled hawthorn (*Crataegus monogyna*), ivy (*Hedera helix*), wild woodbine (*Lonicera periclymenum*), goat willow (*Salix caprea*), grey sallow (*S. cinea* subsp. *cinerea*), *S.* × *multinervis* (*S. cinerea* × *S. aurita*), wild rowan (*Sorbus aucuparia*), woody nightshade (*Solanum dulcamara*).

It should be clear from the lists above that about three quarters of the autochthonous tree and shrub species are rare or endangered in the Netherlands. Thus there is reason to pay more attention to this group of plants, all the more because it is represented so widely in our ecosystems.

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