

5 Life, ecology and nature

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5.1 Natural History

Biodiversity

There are about 1.7 million known species and new species are being discovered every day.²⁰⁶ It is estimated that one successful new form is created each year, while, under the present conditions, approx. 500 species per year become extinct. Some biologists estimate the real number of existing species as being 10 million, others as many as 80 million, Zoest (1998) reports. Distinguishing species from subspecies (taxonomy) is a constant on-going task. For example, the authoritative Dutch work: *Heukels' Flora* edited by Meijden (1996) has recently been drastically amended to accommodate the new international insights into the organisation, differentiation and nomenclature of the plant kingdom. Viewed from this angle, we live on an unknown planet with a rapidly diminishing biodiversity. Nevertheless, the existing species represent an enormous genetic richness, of which we are hardly aware.

A risk cover for life

Within any one species there are as many variations as there are specimens, and just to make the problems of ecological generalisation even greater, all these specimens live in different contexts and micro environments. To question the meaning of this enormous diversity at the species, genetical and habitat level is typically human, but it is not an ecological question in the scientific sense. All we can do as Pianka (1994) does, is to observe that this biodiversity has arisen due to evolution and that, in the past, when sudden environmental changes took place, it was this that ensured the continuation of life up to the present time. Life has survived all manner of catastrophes because there was always a species, or a specimen of a species, that could survive in the new environment. The extinction of the dinosaurs about 65 million years ago in the darkness, of a kind of nuclear winter, following a meteoric collision with Earth, gave an advantage to night animals, and among them, mammals like ourselves. Biodiversity acts, therefore, as the the risk coverage of life itself suggests Londo (1998).²⁰⁷

Plants first

Plant life, which transforms carbon dioxide into food and oxygen for the animal kingdom, is the foundation of this diversity. This forms the basis of the local food chain, down to the smallest scale on the surface of the Earth. Thus, in urban ecology, if one does want to begin with the basement and not the ridge tiles, when reconstructing our *oikos*^a although for many this is the most interesting (caressible) part of the housekeeping, attention should first be given to botanical diversity.

Dutch plants

Approximately 1,500 of the 250,000 known plant species, worldwide, 3,500 of the 100,000 toadstools and 500 of the 23,000 mosses are found in the Netherlands, in the wild. The science of dividing plants into classes, orders, families and species is known as taxonomy.²⁰⁸ Taxonomy is based on kinships that can be deduced from evolution. Against that background, plants can be given a name.

Heukels' Flora provides the scientific access to approximately 1,500 Dutch plant species.

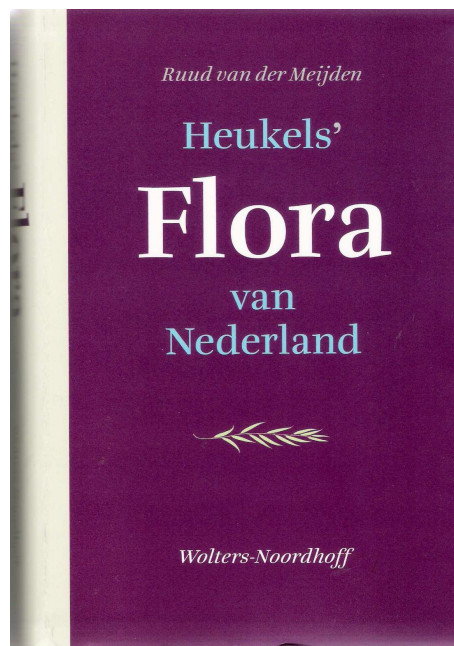


Fig. 674 *Heukels' flora*^b

^a *Oikos* is Greek for 'house'.

^b Meijden (2005)

Insects are the largest group

To find one's way in this flora, some insight is needed into the genesis of life (see para. 5.1.6). Insects often cooperate closely in the reproduction of higher plants, and of the 1,100,000 known species of insect, approximately 20,000 can be found in the Netherlands. Compared to those, the other groups of creatures are almost negligible: approx. 500 of the 50,000 known vertebrates (30 reptiles, 300 species of birds, 100 mammals).²⁰⁹

Counting species or genetic complexity?

The question that comes to the fore here is whether one can compare one-celled life forms with multiple-celled forms that undergo cell differentiation. Although they live independently, their diversity among themselves can be likened to the internal cell diversity of multiple-celled forms. Should we use the number of species as the criterion for biodiversity? The disappointing discovery that human beings do not have very many more genes than species that, so far, have been considered to be much simpler, leads to a similar question, even though it indicates exactly the opposite. As far as the criterion for choosing the number of species is concerned, for the time being, we adhere here to the present mid-way scientific position.

5.1.1 Long-term biotic changes

This history is excellently documented on the bottom floor of the Naturalis Museum.^a This museum was designed by Fons Verheijen. The design process is described in 'Ways to study and research', Jong and Voordt (2002) and is thus worth a visit.

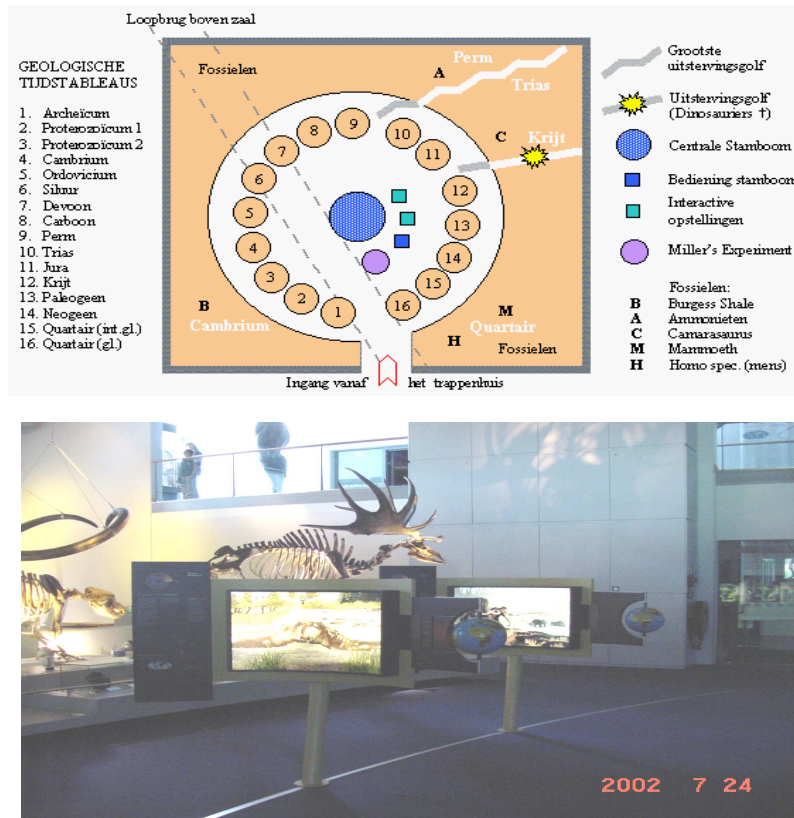


Fig. 675 Eras at Naturalis

The oldest forms of life

The oldest forms of life are single-celled marine organisms that later formed themselves into threads of algae. They have produced oxygen from carbon dioxide for more than a billion years.²¹⁰ This form of life stagnated when carbon dioxide gases became depleted after the excessive growth that took place during the Carboniferous and Permian eras and carbon ceased to oxidate spontaneously. Fauna took over part of this oxidation process. Carbon dioxide fertilization is still a constant feature of horticulture to cause profuse growth. The increasing amount of CO₂ in the atmosphere, not only leads to a greenhouse-effect, but also to more profuse growth and increased agricultural production. Ecologically, from the point of view of biodiversity, this is not an advantage.

^a See <http://website.leidenuniv.nl/~siebersam/>

Revolutions during the last billion years

During the last billion years there have been four important revolutions:²¹¹

- 600 million years ago: Fauna began to adopt chalky skeletons, so that suddenly their historical development can be read in the sediments.
- 400 million years ago: Life established a foothold beyond the sea. Mosses and liverworts (*Bryophyta*) brought a green colour to the wet parts of the land (5.1.2).
- 230 million years ago: Many animal and plant species suddenly became extinct, marking the end of the Palaeozoic. This made way for the Mesozoic, the Saurian Age. Seed-bearing plants started to develop, which had a completely diploid life cycle. These plants fertilised each other and dispersed diploid seeds (5.1.3).
- 65 million years ago: The Cenozoic began with the extinction of the saurians and the advance of mammals (5.1.4).

5.1.2 400 000 000 years ago

Life gained a foothold beyond the sea. Where the land was wet, it became green with mosses and liverworts (*Bryophyta*). These plants can not establish themselves on drier areas because their structures are not sufficiently developed to take in water and store it to use during drought; they have no roots. In addition, they are dependent for reproduction on male gametes that swim. Early in their development, mosses did not halve their genetic material by means of sex cells, but sometimes duplicated themselves on a part of the female plant. Only then was the duplicated (diploid) genetic material divided and dispersed as single spores that germinated as haploid organisms with a single set of genetic material. Mosses are predominantly haploid. They are not included in *Heukels' Flora*.

The earliest vascular plants

The next step was the appearance of the first staghorn and club-mosses, the horsetails and the ferns (*Pteridophyta*, the first 15 families in *Heukels' Flora*). These were the earliest vascular plants, capable of transporting water internally. They can thus grow higher than the mosses. However, although fully grown ferns can withstand dry conditions because of their vascular system, they still need water to reproduce sexually.²¹² This is why the existing *Pteridophyta* are usually to be found in moist, shadowy places and/or why they often reproduce themselves vegetatively.

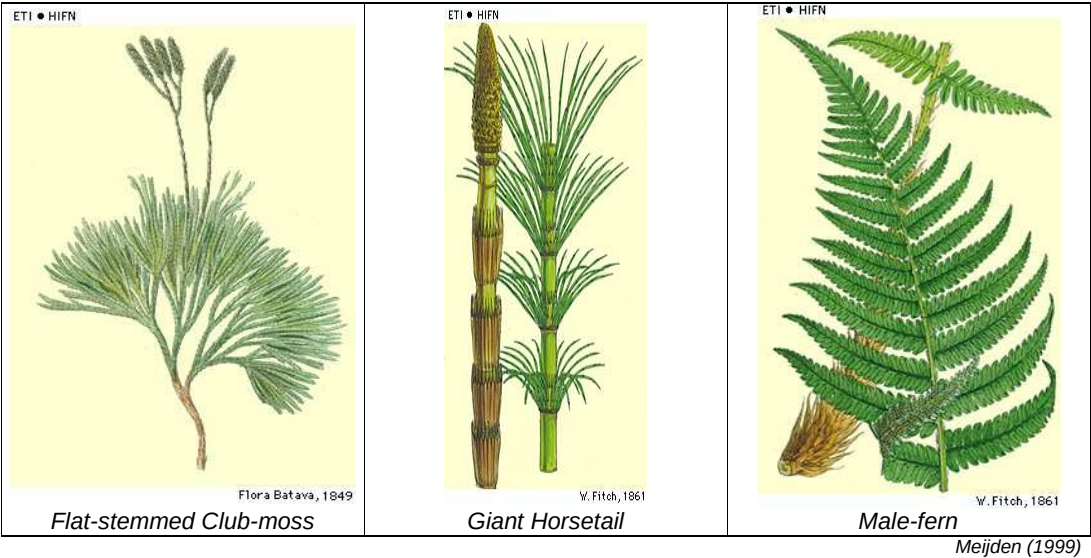


Fig. 676 *Pteridophyta*^a

Although small haploid forms do exist, the predominant forms on which all higher plants are modelled are diploid.

^a Meijden (1999)

5.1.3 230 000 000 years ago

A family tree

Many plant and animal species suddenly became extinct, marking the end of the Palaeozoic. They gave way to the Saurian Age, the Mesozoic. Seed plants began to develop, with a completely diploid life cycle. They fertilised each other and dispersed diploid seeds.

The following appeared, successively:

gymnosperms (families 16-18 in *Heukels' Flora 1996*: the conifers),

angiosperms (families 19-119 in *Heukels' Flora 1996*: most of the flowering plants)

monocotyledons (families 120 to 140, to which lilies and grasses belong)

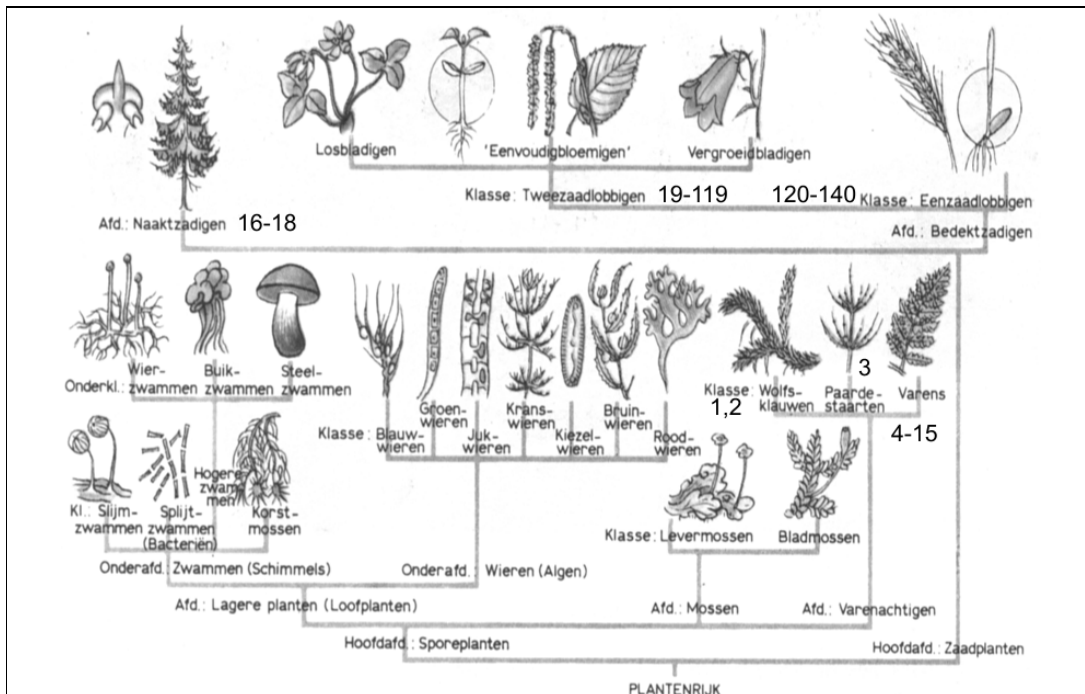


Fig. 677 Division of the Plant Kingdom^a

This scheme gives a didactically simpler division into subclasses than the currently accepted scientific one shown in *Heukels' Flora 1996*. In the mean time DNA-research changed the supposed tree of life again, so the arrangement and name giving of the *Heukels' Flora 2005* has changed again substantially.

^a Garms (1977) page 2

CD-ROMs

This species specificity is thus focused on the recognisability of these reproductive organs. Species are primarily identified on the basis of these organs. This process is currently simplified by using interactive CD-ROMs (Fig. 678 and Fig. 679). Knowledge of species gives insight into the constitution of the soils, climatic conditions and growth possibilities. It is probably an important basis to give urban architects a feeling of the *genius loci*.

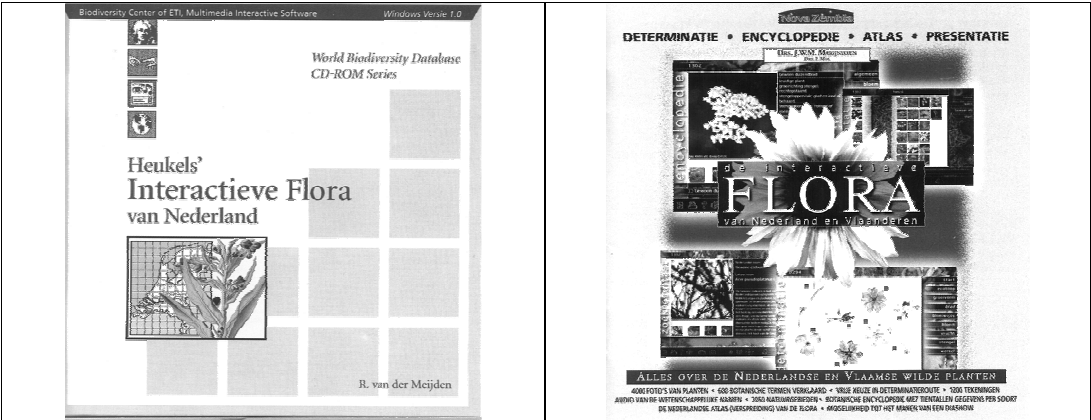


Fig. 678 An interactive CD-ROM of Heukels' Flora^a

Fig. 679 CD-ROM Marijnissen^b

These CD-ROMs give a good picture of different ecological approaches in the Netherlands. The Nijmegen approach (Marijnissen) is less orthodox taxonomically and more accessible for lay people. Another electronic source is CBSs Biobase (see Fig. 807), elaborated on <http://team.bk.tudelft.nl> > Publications 2007 > Life.xls (see 5.1.6).

Taxonomy of plants

According to recent evolutionary insights, plant taxonomy is built up as follows:

Class -da	Subclass -dae	Super order -florae	Order -ales	Family -ceae	Genus -ida, ids
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Fig. 680 The taxonomy of Dutch plant families

According to accepted interpretations of evolution, the lowest subclass, the *liliidae* (monocotyledons, such as lilies, grasses and orchids), were the most recent to come into existence. However, taxonomy is not a static science; there is still no agreement on the sequence of evolution and subdivision. The families in Heukels' Flora of 1990 were still not classified according to the present international standard. In 1996 and 2005 drastic changes were made to the classification system and thereby to the nomenclature, much to the sadness of many.

5.1.4 65 000 000 years ago

The great extinction

The Cenozoic began with the extinction of the saurians and the advance of the mammals. A meteoric impact in the region of the Caribbean caused so much dust to enter the atmosphere that, in the prolonged darkness that followed, plant growth stagnated and the large plant-eaters died out. It was mainly night animals, mammals, for example, that survived.

^a Meijden (1999)
^b Marijnissen and Mol (1998)

5.1.5 Pleistocene

The last 2 million years (the Quaternary or Pleistocene) has been occupied by ice ages (glacials) and warmer interglacials (see page 51).²¹³ The two most recent glacial periods, the Saalian (Fig. 681) and the Weichselian (Fig. 682), were interrupted by the Eemian interglacial period.²¹⁴

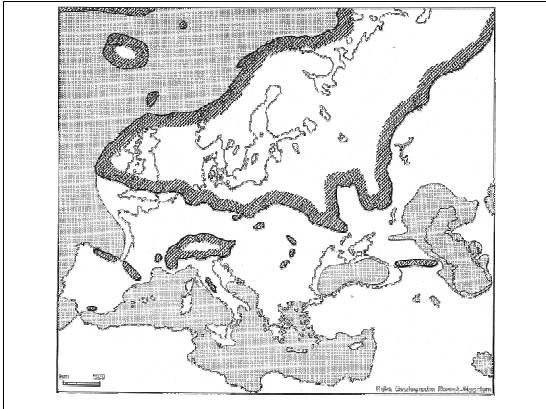


Fig. 681 Saalian



Fig. 682 Weichselian

Ice ages in The Netherlands

The higher parts of the Netherlands were formed in particular during the Saalian.²¹⁵ The Weichselian did not reach the Dutch area.

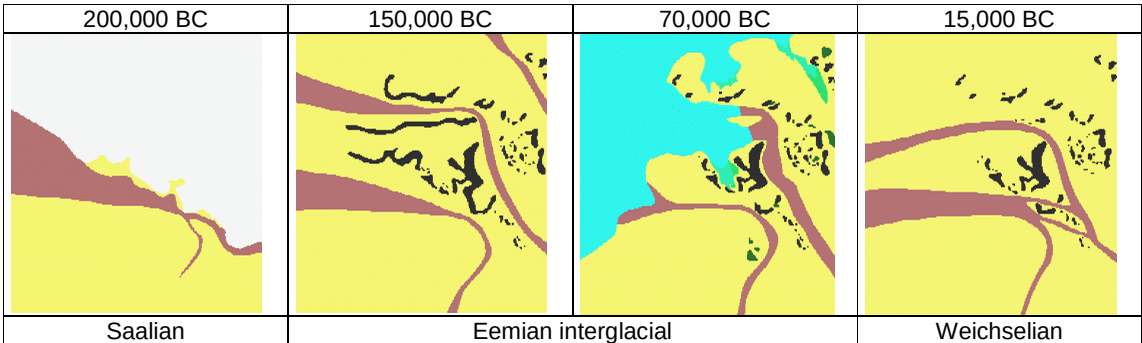
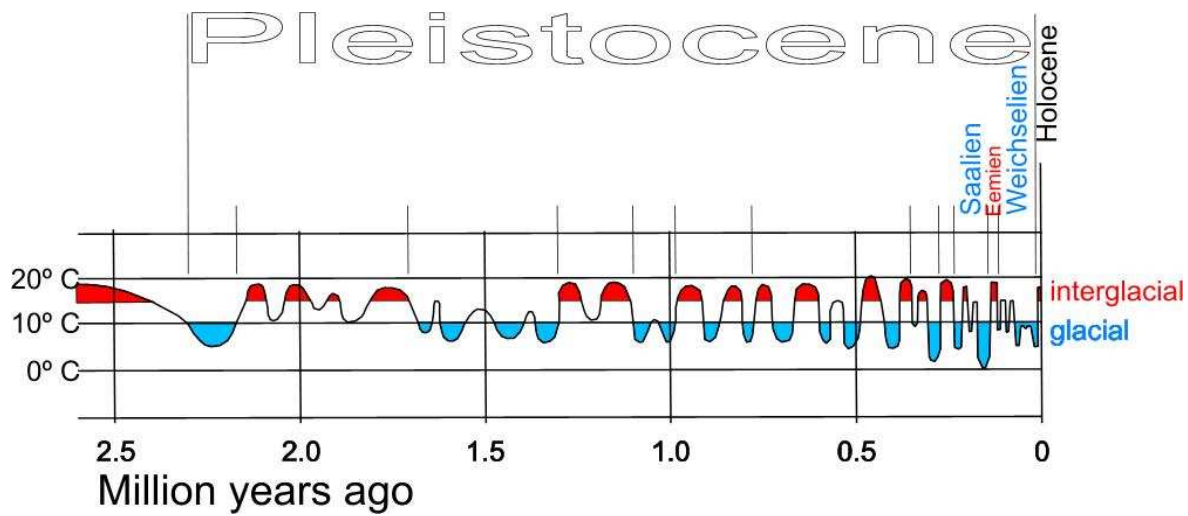


Fig. 683 The two most recent ice ages

The forming of the Veluwe massif and the Gelderse Poort are clearly visible.

Holocene

The lower areas of the Netherlands were shaped from 10,000 BC onwards (Fig. 684).



See Fig. 73^a

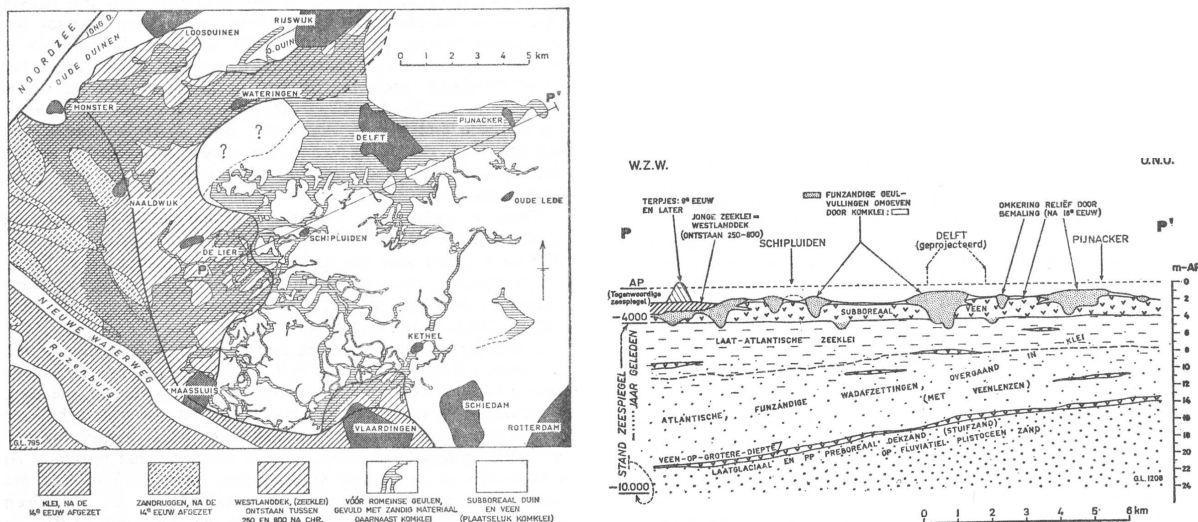


Fig. 684 Temperature changes and deposits^b

For instance, deposits under Delft to a depth of 18 metres beneath New Amsterdam Level (NAP) is Holocene²¹⁶; the Pleistocene extends to a depth of 400 metres²¹⁷

^a Sticht.Wetensch.Atlas_v.Nederland (1985) page 13

^b Faber (1966)

Vegetation changes by temperature

Fig. 685 shows how climatic changes greatly influence the vegetation.

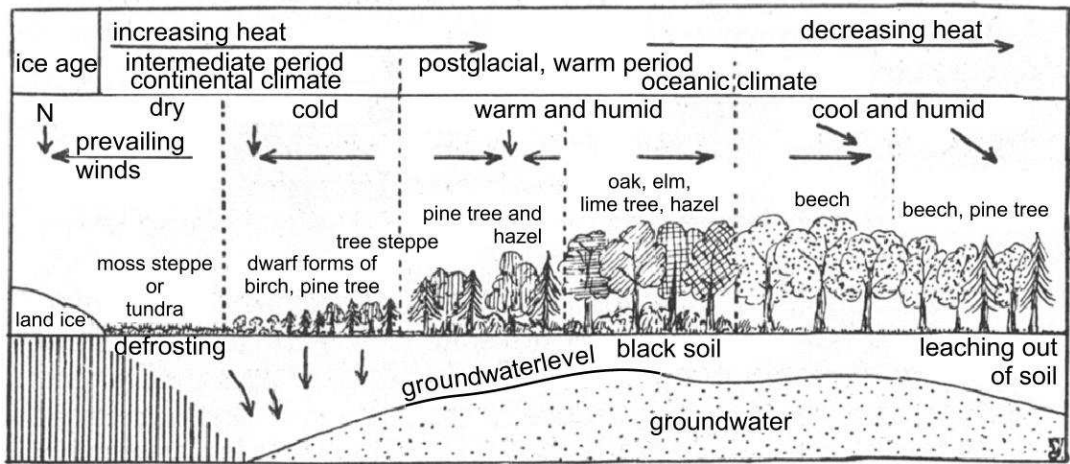


Fig. 685 The influence of climatic changes on vegetation^a

The picture that emerges from pollen dating is one of changing landscapes and habitation (Fig. 686).

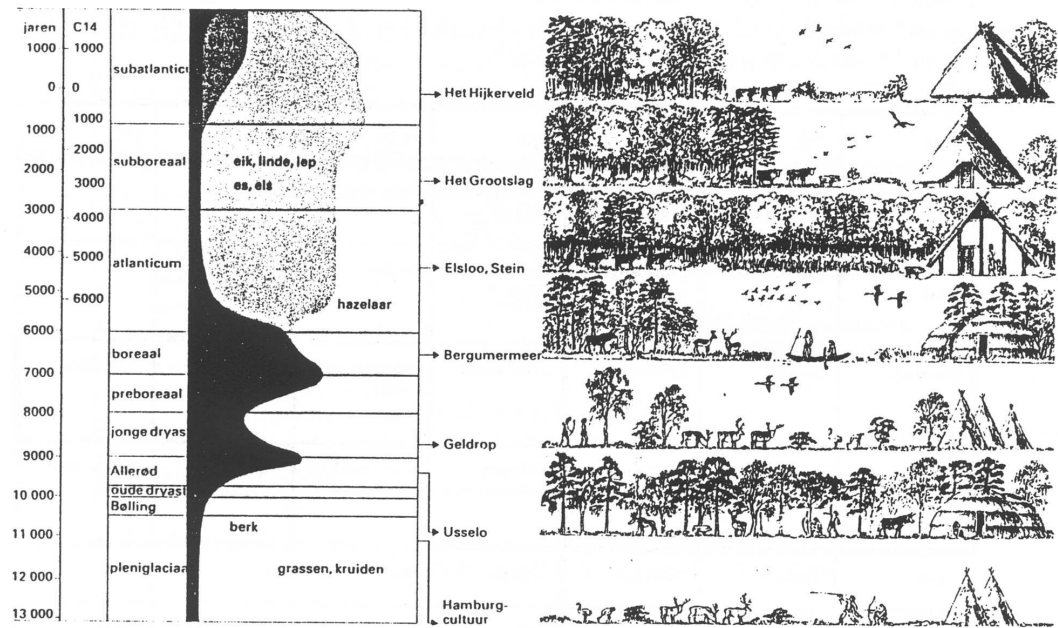


Fig. 686 Landscape changes since the last ice age^b

Paragraph 1.3.1 from page 51 on gives a closer picture of this.

^a Visscher (1949)

^b Bloemers, Kooijmans et al. (1981) page 32

5.1.6 Identifying plants species

Naming

Identifying plants informing you about a biological genius loci (history, soil, water level) of the location and its rarity is a difficult job for laymen. However, on <http://team.bk.tudelft.nl> > Publications 2007 > Life.xls you will find an extract from Duuren (1997) CBS Biobase containing all wild plants of The Netherlands with many characteristics. You can sort this Excel sheet on any characteristic. Fig. 687 shows the first four columns. The sheet is currently sorted on occurrence of urban wild species in the urban area of Zoetermeer. Wild parsnip occurs in nearly any km² of the town.

Species number	Scientific name	English name	Dutch name
000922	Pastinaca sativa	Wild Parsnip	Gewone pastinaak
000101	Artemisia vulgaris	Mugwort	Bijvoet
000135	Bellis perennis	Daisy	Madeliefje
000188	Calystegia sepium	Hedge Bindweed	Haagwinde

Fig. 687 First columns of Biobase extract on Excel sheet

Primary identification criteria

By next 17 (yellow or grey headed) columns (Fig. 688) you can make your own rough selection to identify plant species quickly. Suppose you find a herb (Growth form = kr) without prickles growing up to your middle flowering in august. Wild parsnip (000922) will appear somewhere in your selection.

Species number	Growth form	Prickles	Until knee (<50cm, low)	Up to middle (<100 cm)	Above middle (>1m, high)	January	February	March	April	May	June	July	August	September	October	November	December
000922	kr			1								1	1	1			
000101	kr			1	1							1	1	1			
000135	kr		1						1	1	1	1	1	1			
000188	lk				1						1	1	1	1	1	1	1

Fig. 688 First identifying characteristics of Biobase extract on Excel sheet with rows of Fig. 687

If you like to identify a tree you should choose 'bo' as growth form. You also can choose grass like (gr); bush or shrub (st); dwarf shrub (dw); woody liana (lh); herby liana (lk) and epiphyte, which is a plant growing on other plants (ep).

Secondary identification criteria

If your selection is still too large you can select further on leaf form and flower colour (Fig. 689).

Leaf season	Leaf form	Calyx / kelkbladen	Petals / kroonbladen	Flower colour	Second flower colour	Pistils / stampers / stijlen	stamens / meeldraden	Sex / geslacht bloem	pollination / bestuiving	Seed form	Fruit type / vruchttype	Fruit colour / vruchtkleur	Light minimal	Light maximal	Moist minimal	Moist maximal
Z	5		5	F		2	5	C	IC	9	41	o	LS	VL	3	3
Z	6			F	B	1	5	D	IH	1	32	o	LS	VL	3	4
W	3			A	F	1	5	D	Il	1	32	o	LS	VL	3	3
Z	4			A	R			C	IH	1	43	o	HS	L	2	3

Fig. 689 Second identifying characteristics of *Biobase extract* on Excel sheet with rows of Fig. 687

Some plants keep their leaves in winter (W), most have leaves in summer only (Z). You can not rely fully on leaf form or flower colour because one plant may have different leaf forms or colours simultaneously. If you doubt you can select two characteristics simultaneously choosing 'or'. Fig. 690 shows used codes for leaf form with proportion of length (L) and width (W), colour, required light and moist.

leaf form	colour	sex	light	moist
1 line L>10W	A = white	A = monoecious	VL = full sun	1 = aquatic
2 lancet	B = brown	B = dioecious	L = light	2 = wet
3W<L<10W	C = blue	C = hermaphrodite	LS = light shadow	3 = moist
3 elongated	F = yellow	D = polygamous	HS = half shadow	4 = dry
2W<L<3W	G = grey	E = spore plant	S = shadow	
4 (nearly) round	H = colourless		VS = full shadow	
B<L<2B	M = multicoloured			
5 hand (compound or not)	N = back			
6 feather	O = without flower			
7 compound feather	P = purple, violet, lila			
	R = red, rose			
	U = orange			
	V = green			

Fig. 690 Codes used in second identifying characteristics from Fig. 689

The orange or dark grey heads of columns in Fig. 689 are not very useful for identification, they give characteristics to check your selection.

Environmental information derived from plant species

After identifying plant species next 16 columns give interesting information about the environment (Fig. 691). The last row of Fig. 691 shows community type according to Westhoff and Den Held from Fig. 724. The ecotope columns show the code from Fig. 726 *Ecological groups*. Inbetween these columns their classes of tolerance discussed in paragraph 5.2.9 are shown. The last columns show additional characteristics summed up in Fig. 693.

Food minimal	Food maximal	Acidity	Salt minimal	Salt maximal	Zinc	Groundwater	Root depth	Root depth 2	Flow maximum	Flow minimum	Ecotope 1	Ecotope 2	Ecotope 3	Ecotope tolerance	Community Westhoff
2	3	x				7	3	4	9	9	G47	G48		1	25Ba01
3	3	x				7			9	9	P48	P68	R48	2	17Aa01
2	3	x				9	1	1	9	9	G47	G48		1	25Ba
2	3	x				5	4	4	9	9	R27	R28	R47	2	17B

Fig. 691 Environmental information derived from plant species

nutrients	acidity	salinity	dependency ground water	root depth	water flow
1 = poor 2 = moderate 3 = nutritious x = indifferent	1 = acid 2 = moderate 3 = alkaline x = indifferent	0 = fresh 1 = between 2 = brackish 3 = between 4 = salt	1 = hydrofyt 2 = wet freatofyt (obligatory) 3 = moisty freatofyt (obl.) 4 = moisty freatofyt (fac.) 5 = local freatofyt 6 = lime afreatofyt 7 = afreatofyt 8 = salt plant 9 = dune freatofyt	1 = < 10 cm 2 = < 20 cm 3 = < 50 cm 4 = < 100 cm 5 = > 100 cm	0 = unknown 1 = stagnant 2 = slow 3 = streaming 4 = fast 5 = very fast 9 = no sense

Fig. 692 Codes used for environmental information in columns of Fig. 691

Additional characteristics per plant species

Column head	description
Height belt / hoogtegordel	typical height belt of species
Areal position / areaaligging	position in European dispersion
Use 1 / gebruik 1	agricultural or herbal use
Germinating time / kiemtijd	month when growth starts
Life span / levensduur	1, 2, 3 or more years
Family Heukels' flora	page number in authoritative Dutch flora of Fig. 674 and Fig. 680
Genus Heukels' flora	subdivision of preceding family
Species / soort Heukels' flora	subdivision of preceding genus
UFK_1940	occurrence in The Netherlands in 1940 per 5x5km ²
UFK_1990	occurrence in The Netherlands in 1990 per 5x5km ²
Protection rode lijst	member of Dutch list of rare and declining plant species
Protection Natuurbeschermingswet	protected by Dutch law
Protection EHS doelsoort	target species in Dutch ecological policy (see paragraph 5.5.1)
Protection Bern Convention Protection	protected by European law
European blue list	member of European list of rare and declining plant species
Change in the Netherlands since 1950	Difference between UFK_1940 and UFK_1990
Abundance per 25km ² 1980	Number of 5x5km ² squares species was found in The Netherlands 1980
Abundance per km ² Zoetermeer	Number of 1x1km ² squares species was found in the urban area of Zoetermeer 2000
Buytenwegh 2002 305723/24	found in the urban area of a 2x1km ² district of Zoetermeer 2000

Fig. 693 *Additional characteristics per plant species*

For example Fig. 770 used columns Abundance per 25km² 1980 and Abundance per km² Zoetermeer to compare national and local rarity in a graph.

5.2 Diversity, scale and dispersion

Biodiversity

There are many estimates on biodiversity described much better than I can do by Zoest (1998). We know some 1.7 million well-described species but much more are unknown while some 100 000 species are lost since Linnaeus. The extinction rate is estimated 1000 per year now; the growth in evolution as 1 successful species per year. Though we now know the genome of some, we still do not know how they work let alone we know their mutual relations. Even how our own species works is nearly completely unknown to us, though we already studied 3000 years on this topic. Having some success by medicine, we seldom understand exactly why. Compared with the combinatory explosion of unanswered questions we understand almost nothing, otherwise we could invent species. Possible principals punish researchers admitting that honestly and modestly. Mythmakers win the competition. However, myths may be useful for survival.

Responsability

Every state bears its own responsibility in this multitude of species like a modern Noah. Though The Netherlands occupies less than 0.01% of the earth's surface it entails approximately 35 000 (2%) of the earth's number of known species. Our responsibility is proportional to their global, continental (blue list), national (red list) or local rarity.

The concept of rarity and thus responsibility is scale-sensitive.

Health

Depending on the definition of health^a I estimate that roughly 80% of the human population is not healthy. There are positive and negative relations between human health and biodiversity. The impact of biodiversity on human health is unknown. Perhaps a small organism in some square kilometres of the remaining rainforests on the long term appears to be a necessary condition for our life by producing tiny quantities of chemical compounds conditioning processes in our body and mind as catalysts. But we do not know. How to calculate the risk of losing them?

The reverse impact of human health and growth on biodiversity is better known but not certain.

WORLD POPULATION

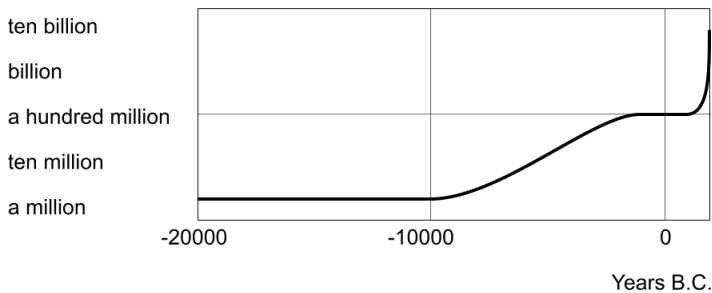


Fig. 694 Estimated growth of world population

Health is a scale dependent concept in time. Though world population is not healthy on an individual level, in the long term we are a healthy species growing in numbers exponentially ousting other species, living twice as long as some centuries ago. And we are not only expanding in number. Per person we need more and more living space in our homes and neighbourhoods. In a wider context we reduced the space we need for

agriculture reducing biodiversity in rural areas at the same time.

Intensity of use

However, some 20 years ago Jong (1985) found the *intensity* of urban use in The Netherlands was highest in shops (135 hours/m²year). After shops came offices, social-cultural facilities, schools, home and garden (48 hours/m²year).²¹⁸ The other hours of the year (counting 8760 hours) in the urban surface may be available for other species depending on the conditions we leave them by design and use (distinguished by time scale). Some species accept or even welcome our presence like that in

^a Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity. Preamble to the Constitution of the World Health Organization as adopted by the International Health Conference, New York, 19-22 June 1946; signed on 22 July 1946 by the representatives of 61 States (Official Records of the World Health Organization, no. 2, p. 100) and entered into force on 7 April 1948. The Definition has not been amended since 1948. See <http://www.who.int/about/definition/en/>

step vegetation (for example greater plantain, rats, mosquito's, sparrows). Could we welcome more rare species in our towns by creating ecotope cities or as Tjallingii (1996) stresses ecological conditions? How does it interfere with our health?

5.2.1 The importance of diversity for life

Risk-cover for life

Londo (1997) considered diversity as a *risk-cover for life*. In the diversity of life there was always a species to survive or within a species a specimen that survived. Survival of the fittest presupposes diversity from which can be 'chosen' in changed circumstances. Diminishing biodiversity means undermining the resistance against catastrophes. From the 1.7 million species we know, we probably lost some 100 000. So, we not only introduce ecological disasters, but we also undermine the resistance of life against these disasters.

Ecological tolerance

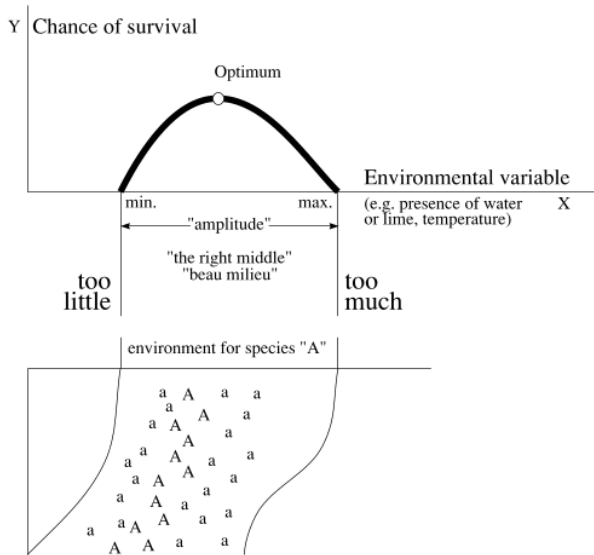


Fig. 695 *Ecological tolerance in theory and reality.*

The curve of *ecological tolerance*²¹⁹ relates the chance of survival of a species or ecosystem to any environmental variable, for instance the presence of water. In that special case survival runs between drying out and drowning (Fig. 695).

Imagine the bottom picture as a slope from high and dry to low and wet. Species A will survive best in its optimum. Therefore we see flourishing specimens on the optimum line of moisture (A). Higher or lower there are marginally growing specimens (a). The marginal specimens however are important for survival of the species as a whole.

Suppose for instance long-lasting showers: the lower, too wet standing marginal specimens die, the flourishing specimens become marginal, but the high and dry standing specimens start to flourish! Long-lasting dry weather results in the same in a reversed sense. Levelling the surface and water-supply for agricultural purposes in favour of one useful species means loss of other species and increased risk for the remaining.

But there is a less friendly ecological lesson hidden within this scheme. Marginal specimens are important for survival of the species as a whole. A reservoir of unhealthy specimens favours species. Death regulates life. Health is also spatially scale-sensitive.

5.2.2 The importance of diversity for human living

A realm of exceptions

Biodiversity in mankind is a crucial value in our quality of life. As we are here we are all different and the very last comfort you can give a depressed person is 'But you are unique'. Reading Philp (2001) you should conclude that medicine hardly discovered that uniqueness in the evaluation of medicines. It hinders generalizing science using concepts as average and standard deviation. Dieckmann, Law et

al. (2000), Riemsdijk and NOBO (1999) and Jong and Voordt (2002) are aware of that difficulty in ecology, organization theory and design study. Evolutionary ecology (see Pianka, 1994) is only comprehensible considering exceptions outside the limits of a normal test population (3-standard deviation) as Philp (2001) described.

Diversity is also a precondition for trade and communication. If production and consumption would be the same everywhere, there would be no economic life. If we would have all the same perceptions and ideas, there would be no communication. It is an important misconception to believe that communication only helps *bridging* differences. Communication also *produces* diversity by compensating each other and coordinating behaviour by specialization. Diversity is a precondition of freedom of choice, a fundamental right of any human.

Possibilities of choice

The World committee environment and development (1990) of chairwoman Brundtland²²⁰ summarized the environmental challenge by stating sustainability as leaving next generations at least as much possibilities as we found ourselves^{a, 221}. But what are possibilities? 'Possibilities' is not the same as economic supply. If our parents would have left us the same supplies as they found in their childhood, we would be far from satisfied. 'Possibilities' has to do with freedom of choice and thus variety. Our converging Schumpeter-economy as Krupp (1995) described and converging culture of Fukuyama (1992) leaves no choice. In our search for the alternative we find everywhere in the world the same hotels, the same dinners, the same language. This century, the last 'primitive' cultures are lost and with them an experience of life that no western language can express. After looking at their dancers in the afternoon on our rain forest holiday we find them back in the disco in the evening.

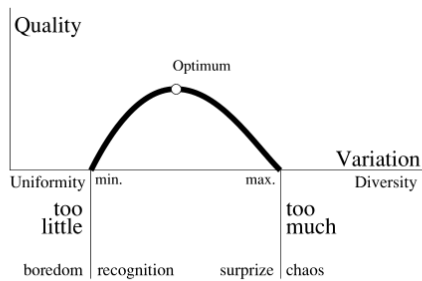
A world without difference

The most extreme consequence of this levelling out would be a world without economy and even communication. If there were no longer any differences in production factors, exchanging goods and services would no longer be necessary. If total worldwide distribution of knowledge and consensus would be the result of our communication age, there would no longer be anything worthwhile to communicate. These thought experiments show clearly that 'difference' is also a hidden presupposition in communication and economy. The question remains on what level of scale self-sufficiency is desired: global, continental, national, local like Steekelenburg (2001) illustrates beautifully in his scenarios.

Quality

Quality can be measured in terms of possibilities of use, experience and expectation for future generations. The way design can sustain a sustainable development in the sense of Brundtland is to produce more 'choices' for man, animal and plant. If there were one best solution for all problems of architecture and urban planning, it would be the worst in the sense of choices for future generations! This paradox pleads more for diversity than for uniform solutions. Moreover, if there were a uniform solution, the designer would have no task. Quality is always a function of variation.

^a By this committee 'sustainable development' was defined as an economic development meeting the needs of the present generation, without endangering next generations in meeting their needs.

Fig. 696 $Quality = f(Variation)$

Quality of possible experience moves between diversity and uniformity, surprise and recognition. One step too far into both sides brings us in the area of boredom or confusion.

This is a simple conception, already recognized by Birkhoff (1933) and Bense (1954), but why did it not succeed, why is quality always posed as an unsolvable question? Because the concept of diversity is scale sensitive and so is our experience.

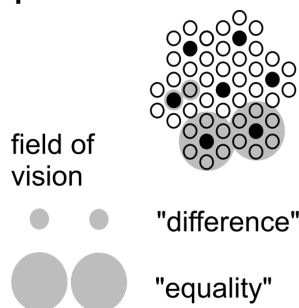
When on one level of scale we experience chaos, in the same time on an other level of scale we could experience boredom.

5.2.3 Scale-sensitive concepts

Confusion of scale

As mentioned in the introduction, rarity, responsibility for rare species and even health are scale sensitive concepts. So is quality. But any discussion on variety and thus variables can fall prey to confusion of scale. That means that even logic and science as forms of communication could be prey to a scale paradox. The paradox of *Achilles and the turtle* is a beautiful example of a scale-paradox in time. The turtle says: 'Achilles cannot outrun me when I get a head start, because when he is where I was at the moment he started I'm already further, when he reaches that point I am again further and so on!' This conclusion is only incorrect by changing the time-scale during the reasoning. Russell (1919) finds something similar on set theory. Russell bans sets containing themselves and reflexive judgements²²² such as 'I lie'. This sentence is not only an object statement, but in the same time a meta-linguistic statement about itself producing a paradox. When I lie I speak the truth and the reverse.

Scale paradox

Fig. 697 *The scale paradox*

The *scale paradox*²²³ means an important scientific ban on applying conclusions drawn on one level of scale to another without any concern. The picture shows the possibility of changing conclusions on a change of scale by a factor 3. There are 7 decimals between a grain of sand and the earth. That gives approximately 15 possibilities of turning conclusions. In the scale distance between a molecule and a grain of sand applies the same. This ban is violated so many times, that this should be an important criterion on the validity of scientific judgements.

If the scale-paradox influences the concept of diversity, it influences any class stating a difference with the rest.

An example of turning conceptions into their opposite by scale is the duality of aim and means. For the government subsidizing a municipality the subsidy is a means, for the municipality it is an aim. So the conception of means changes in a conception of aim by crossing levels of scale. The turning of 'Zweckbegriff' into 'Systemrationalität' discussed by Luhmann (1973) may be a turning conception of the same scale-sensitive character. In growing organizations *integration* on the level of the organization as a whole means often *disintegration* of the subsystems and perhaps a new form of integration in the sub-sub-systems. This scale articulated process is called '*differentiation*'!

Avoiding confusion of scale

In Fig. 697 confusion of scale is already possible by a linear factor 3 difference in level of scale. That is why in spatial planning we articulate orders of size by a factor of approximately 3.

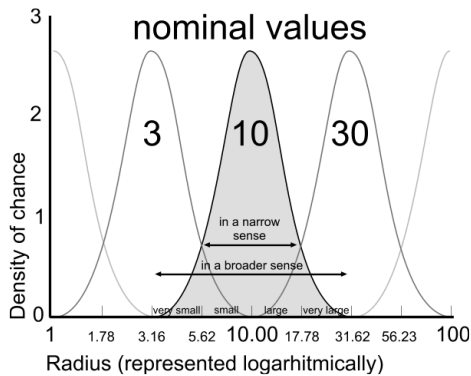


Fig. 698 Names and boundaries of urban categories

An element from the nearly logarithmical series {1, 3, 10, 30, 100 ...} is the name (nominal value)²²⁴ of an 'elastic' urban category ranging until those of the nearest categories (scale range). The name giving 'nominal' radius $r=10$ then is the median of a chance density distribution of the logarithm of radiuses between (rounded off) $r=3$ and $r=30$, with a standard deviation of 0.15. We chose a series of radiuses (and not diameters) because an area with a radius of {0.3, 1, 3, 10km} fits well with {neighbourhood, district, quarter, conurbation} or loose {hamlet, village, town, conurbation} in every day parlance.

Then also the system of dry and wet connections could be named in this semi logarithmical sequence according to average mesh widths.

5.2.4 Spatial state of dispersion as a condition of diversity

State of dispersion

Form as a primary object of design supposes state of dispersion.

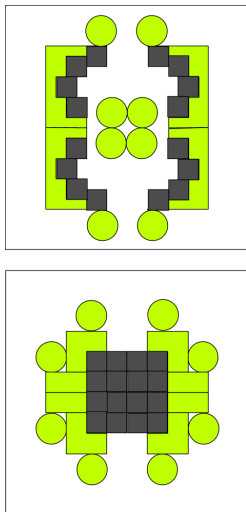


Fig. 699 States of dispersion $r=100m$

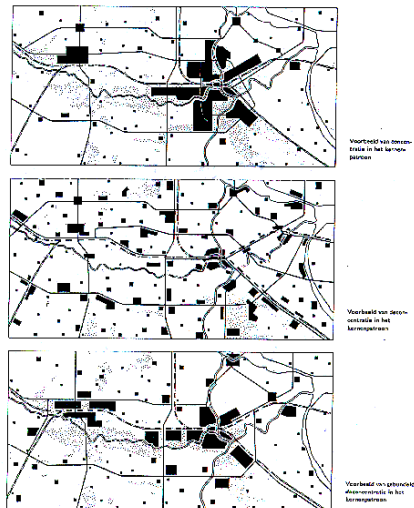


Fig. 700 Accumulation, Sprawl, Bundled Deconcentration $r=30km^a$

Scale articulation of dispersed states

Scale articulation is especially important distinguishing states of dispersion. State of dispersion is not the same as density. Considering the same density different states of dispersion are possible (Fig. 701) and that is the case on every level of scale again (Fig. 702).

^a RPD (1966)

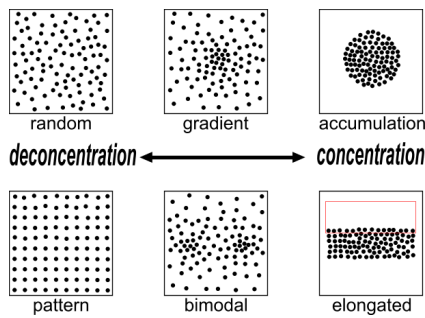


Fig. 701 States of dispersion in the same density on one level of scale

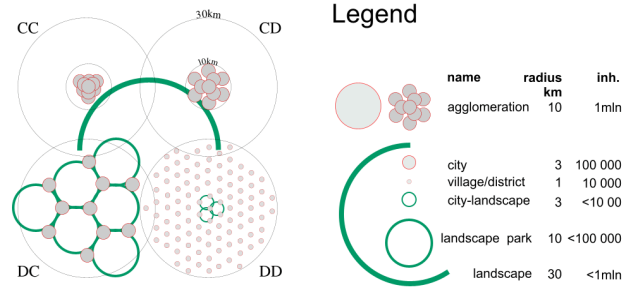


Fig. 702 One million people in two states of distribution on two levels of scale (accords CC, CD, DC and DD).

Fig. 701 shows the use of the words concentration (C) and deconcentration (D) for processes into states of more or less accumulation respectively. Applied on design strategies in different levels of scale we speak about 'accords' (Fig. 702).

In Fig. 702 the *regional density* is equal in all cases: approx. 300 inh./km^2 . However, in case CC the built-up area is concentrated on both levels ($C_{30\text{km}}C_{10\text{km}}$) in a high *conurbation density*: (approx. 6000 inh./km^2).²²⁵

In the case CD people are deconcentrated only within a radius of 10km ($C_{30\text{km}}D_{10\text{km}}$) into an average conurbation density of approx. 3000 inh./km^2 .

In the case $D_{30\text{km}}C_{10\text{km}}$ the inhabitants are concentrated in towns (concentrations of 3km radius within a radius of 10km), but deconcentrated over the region. This was called 'Bundeled deconcentration' in NRO2. The *urban density* remains approx. 3000 inh./km^2 .

In the case $D_{30\text{km}}D_{10\text{km}}$ they are dispersed on both levels.

Urban sprawl

Urban sprawl in a radius of 10km hardly influences the surrounding landscape when the inhabitants are concentrated in a radius of 30 (the two variants above in Fig. 702).

However, the urban sprawl in a radius of 30km breaks up the surrounding landscape in landscape parks. By that condition the sprawl within a radius of 10km is important again: the landscape parks are broken up further into town landscapes. In The Netherlands until 1983 DC was the national strategy ('Bundeled deconcentration', 'Gebundelde Deconcentratie' from NRO2, RPD (1966)), after NRO3, RPD (1983) the policy changed into CC (Compact town, 'Compacte Stad'), but turned out in practice as CD and even DD. The result of both strategies was disappointing.

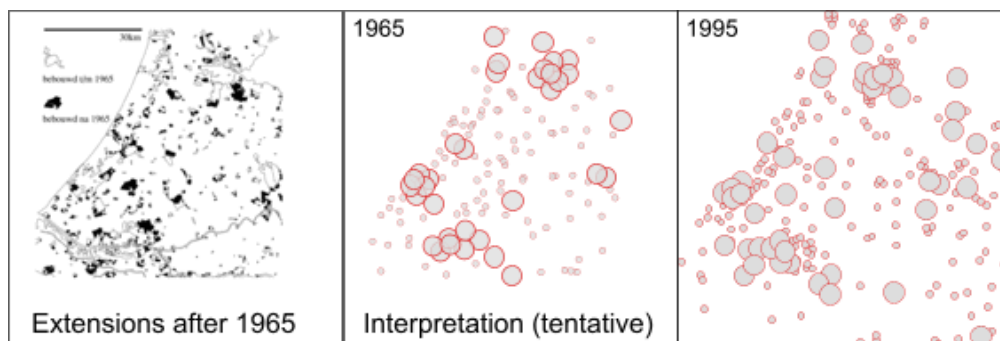


Fig. 703 Urban sprawl in Randstad, The Netherlands

Distribution and abundance of organisms

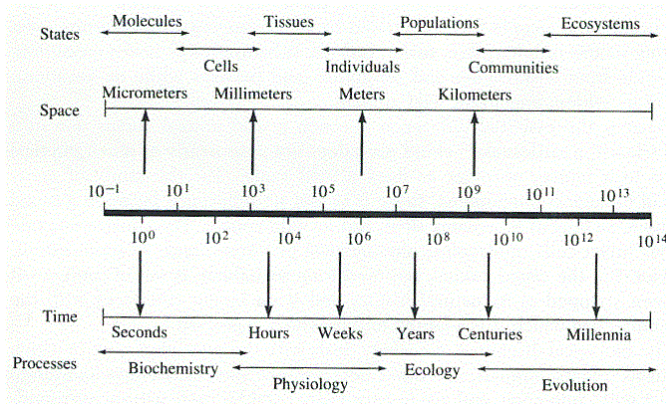
In prominent ecology textbooks there are several definitions of ecology emphasising dispersion or with an increasing awareness of scale (in that case we will speak about spatial distribution).²²⁶

Andrewartha (1961), cited by Krebs (1994): Ecology is the scientific study of the *distribution and abundance* of organisms.

- Krebs (1994): Ecology is the scientific study of the *interactions* that determine the distribution and abundance of organisms.
- Pianka (1994): Ecology is the study of the *relationships between organisms* and the totality of the *physical and biological factors* affecting them or influenced by them.
- Begon, Harper et al. (1996): Ecology is the scientific study of the interactions that determine the distribution and abundance of *organisms, populations and communities*.

Kolasa and Pickett (1991) seem to be the only ecologists fully aware of scale articulation consequences avoiding confusion of scale.

Time-space scaling



Pianka (1994) stresses relationships in a broader sense than spatial relationships. He adds a scheme stressing scale in space and time, but does not detect any paradox. 'Community and ecosystem phenomena occur over longer time spans and more vast areas than suborganismal and organismal-level process and entities. (after Anderson (1986) after Osmund et al.)'

Begon, Harper and Townsend (1996) distinguish organisms, populations and communities.

Fig. 704 Diagrammatic representation of the time-space scaling of various biological phenomena^a

That distinction looks like a distinction of scale, but is primarily a distinction between different kinds of ecology:²²⁷

- autecology concerning populations of one species at a time within their 'habitat' and
- synecology concerning the community of different species in the same 'biotope'.

On the level of organisms one could speak about 'ecological behaviour' as for instance Grime, Hodgson et al. (1988) elaborated as plant species bound 'strategies for survival' like 'competitors', 'ruderals' and 'stress tolerators' as rôles in a play concerned less predictable than communities reaching a well described 'climax'.²²⁸

^a Pianka (1994)

5.2.5 300km continental vegetation areas

Global and continental

Ecological typology is scale-sensitive. The subdivision of global life conditions in Fig. 705 distinguishes 'biomen'²²⁹ primarily by temperature and precipitation²³⁰. This variation is recognisable on a smaller level of scale vertically in mountains. The average temperature and precipitation in the Netherlands are near 10°C and 1000 mm. The natural vegetation in such conditions is moderate deciduous forest, but grassland is not far from these conditions.²³¹ However, in the low countries of the Netherlands the availability of water is much higher than to be expected from its average precipitation.

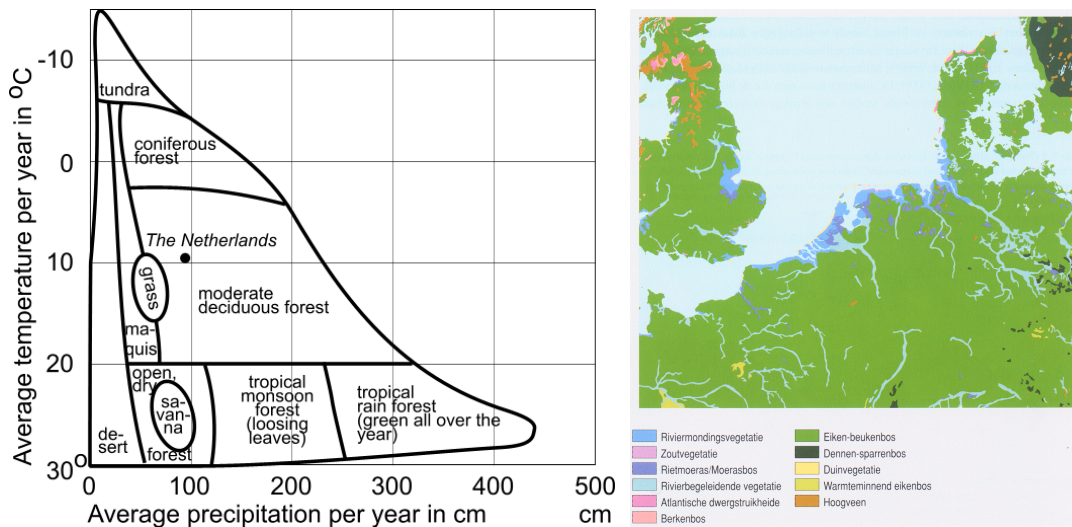


Fig. 705 Global and continental ecological typology^a

On a continental level ($r=3\,000\text{km}$) areas of vegetation like estuaries, salt vegetations, reed marsh, river accompanying, Atlantic heather, birch forest, oak-beach forest, pine-spruce forest, dunes, warm oak forest and high moor land are distinguished. On a map types in a typology appear like legend-units in a legend (see Fig. 705). In The Netherlands, Northern Germany and Southern Denmark, the distinction of Fig. 705 (right) corresponds with geological categories like Pleistocene (until 1 000 000 years old) and Holocene (until 10 000 years old).

European level

On a European level of scale different distinctions were made. Fig. 705 gave the most recent one based mainly on forest types and Fig. 706 an earlier one based on species²³².

^a Myers (1985); Bohn, Gollub et al. (2000); Bohn (2001)

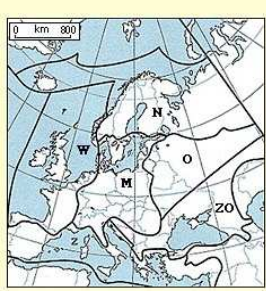
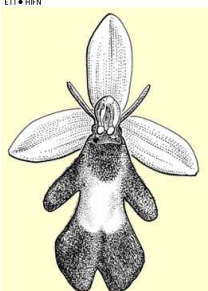
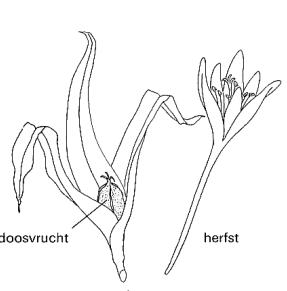
 L. van Duuren & J.H.J. Schaminée	 J. Vermeulen, 1990	 doosvrucht herfst voorjaar	 E. Hallier, 1886
Western (W), 'Northern' (N), Middle (M), 'Eastern' (O) and South-Eastern (ZO) European vegetation areas.	Vliegenorchis H43	Herfsttijloos	Kleine Kaardebol

Fig. 706 Plants, characteristic for Middle-European vegetation areas (M) in the Netherlands^a

Mainly West European vegetation in The Netherlands

In The Netherlands the distinction of Fig. 705 (right) corresponded with geological categories like Pleistocene (until 1 000 000 years old) and Holocene (until 10 000 years old).
Fig. 706 distinguishes grounds mainly older than 1 000 000 years in Limburg as 'Middle European vegetation area' (M). Pleistocene and older grounds in South Limburg are nearly fully covered by löss alternating with rock on surface, primarily consisting of chalk, marl and limestone sometimes turning up elsewhere in The Netherlands as well. The rest of The Netherlands as part of 'West European vegetation area' (W) is younger.²³³

^a Mennema, Quene-Boterbrood et al. (1980) , p. 16; Meijden (1999); Kelle and Sturm (1980); Meijden (1999)

5.2.6 30km national counties

Holocene and Pleistocene

On a national level in The Netherlands Holocene and Pleistocene are the most enclosing categories approximately separated by the 5m altitude²³⁴, roughly a distinction of clay (with peat and dunes) versus sand (intersected by river clay or locally filled by high moor land). The most urbanised Holocene estuary area, botanically indicated as 'lagoon county' is highly influenced by man and in the same time an internationally rare cultural-natural monument of polders. It is ecologically divided further in many ways representing its dynamic and unpredictable wet ecological diversity.

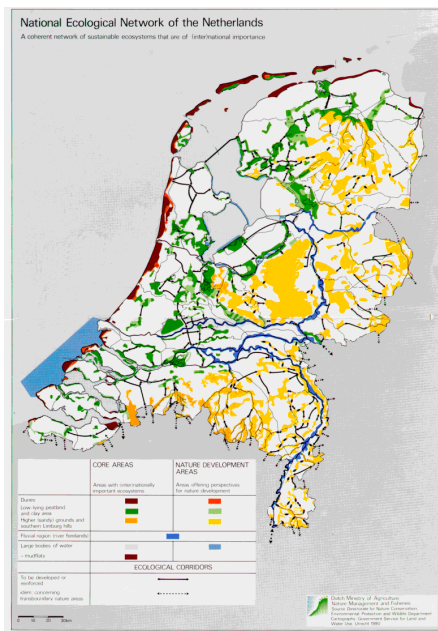


Fig. 707 Planning Ecological Infrastructure^a

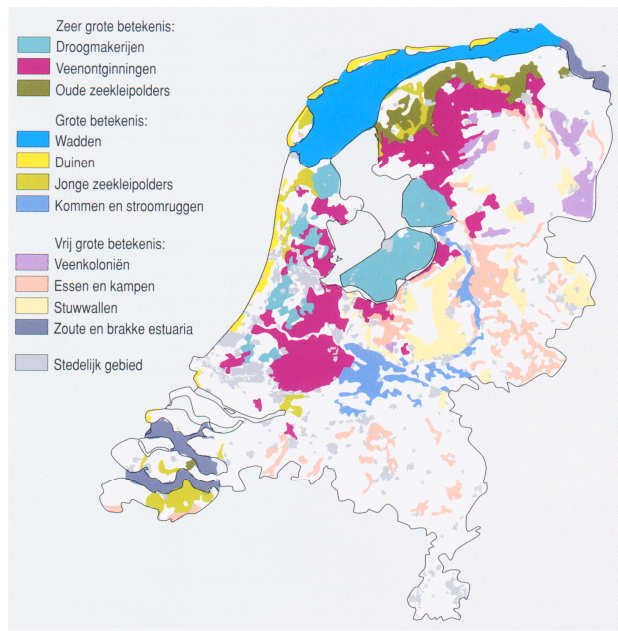


Fig. 708 International rarity of landscapes^b

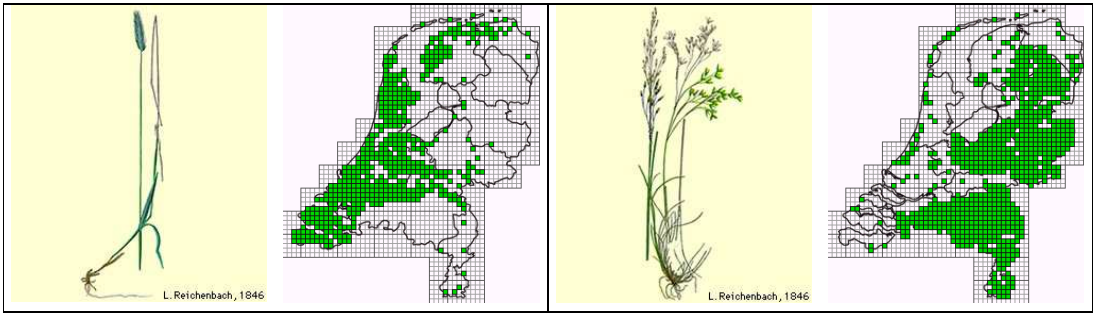
Based on the synecological typology of Westhoff and Held (1969) and Held (1991), Bal, Beijer et al. (1995); Bal, Beijer et al. (1995) defined 132²³⁵ (in Bal, Beijer et al. (2001) reduced into 92) nature target types of the national ecological infrastructure (EHS). However, Clausman and Held (1984) earlier had proved them to be inadequate for the Holocene Zuid-Holland area. Too many transitional stages between sand, clay and peat, influenced by a historical local diversity of cutting peat and water management produced a variety of nature types nearly equalling the number of grounds itself.

Different plants on Pleistocene and Holocene grounds

Apart from the sandy dunes, the lower Holocene with clay from sea and rivers and low (wet) and high (acid) peat has a very different vegetation compared with the higher and dryer pleistocene covered with coarser sand and gravel.²³⁶ The ecological difference between low Holocene and high Pleistocene is clearly illustrated by dispersion of two species: meadow barley (veldgerst, Fig. 709) and wavy hair-grass (bochtige smele, Fig. 710).

^a From an earlier version of LNV (2002)

^b RIVM (2001)



Different plants in dunes and rivers

Holocene is subdivided in dune and river county, illustrated by the dispersion of two other species, marram (helm, Fig. 711) and greater burdock (grote klis, Fig. 712). The remainder is called Haf county with sea clay and peat.²³⁷

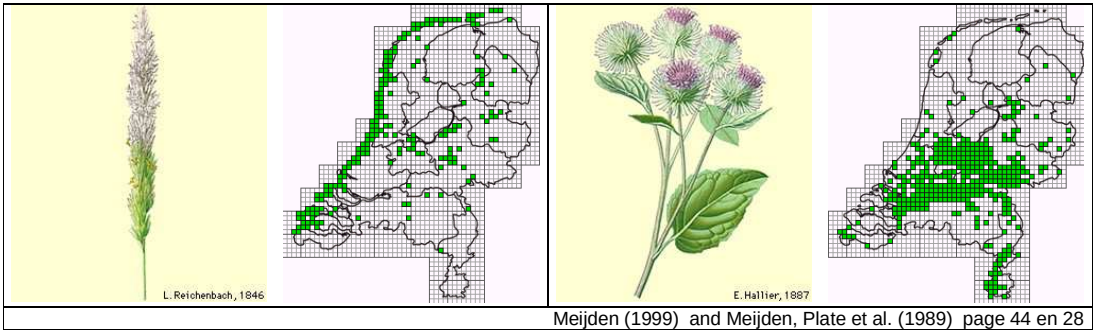


Fig. 711 Dispersion of marram (helm)

Fig. 712 Dispersion of greater burdock (grote klis)

^a Meijden (1999) and Meijden, Plate et al. (1989) page 84 en 58

General trees in The Netherlands

General trees in The Netherlands are alder (els), ash (es), sycamore (esdoorn), hawthorn (meidoorn), birch (berk), rowan or whitebeam (lijsterbes).²³⁸

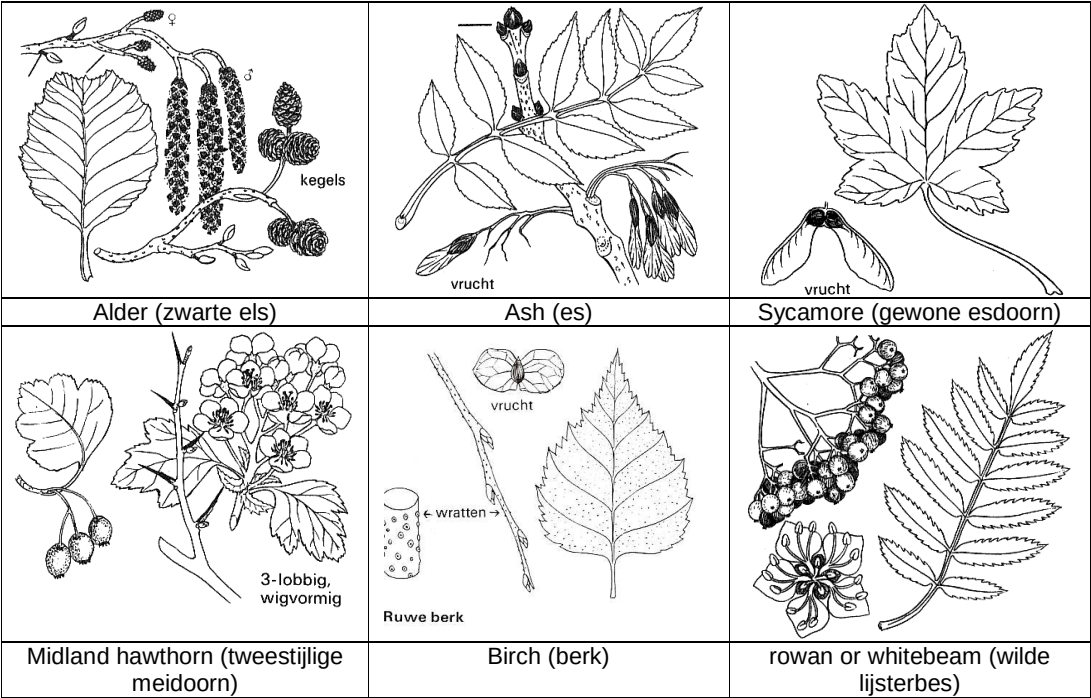


Fig. 713 General trees in The Netherlands^a

Trees specific for Holocene and river grounds

Holocene and rivers are characterised by black poplar (zwarte populier), willow (wilg), dogwood (rode kornoelje) (Fig. 714).²³⁹

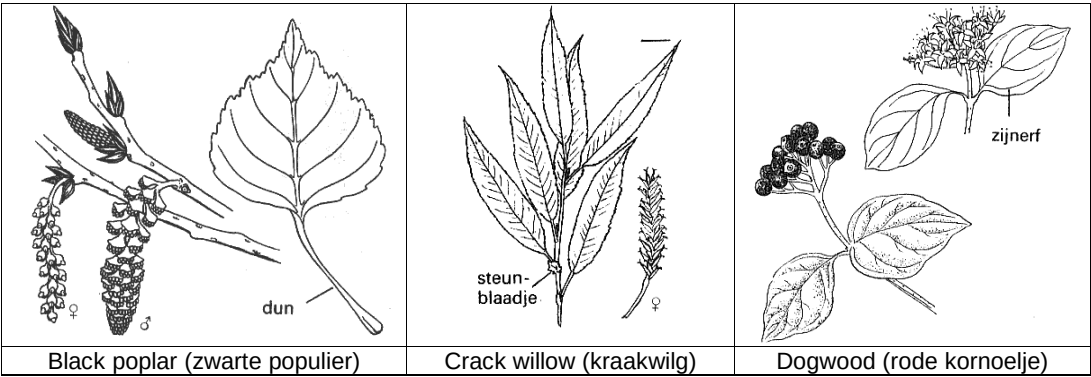


Fig. 714 Trees of Holocene and rivers in The Netherlands^b

^a Kelle and Sturm (1980)

^b Kelle and Sturm (1980)

Trees specific for Pleistocene and dunes

Pleistocene and dunes are characterised by scots pine (grove den), red oak (amerikaanse eik), beech (beuk), aspen (ratelpopulier), hazel (hazelaar), holly (hulst), locust tree (robinia pseudo-acacia) and rum cherry or black cherry (amerikaanse vogelkers).²⁴⁰

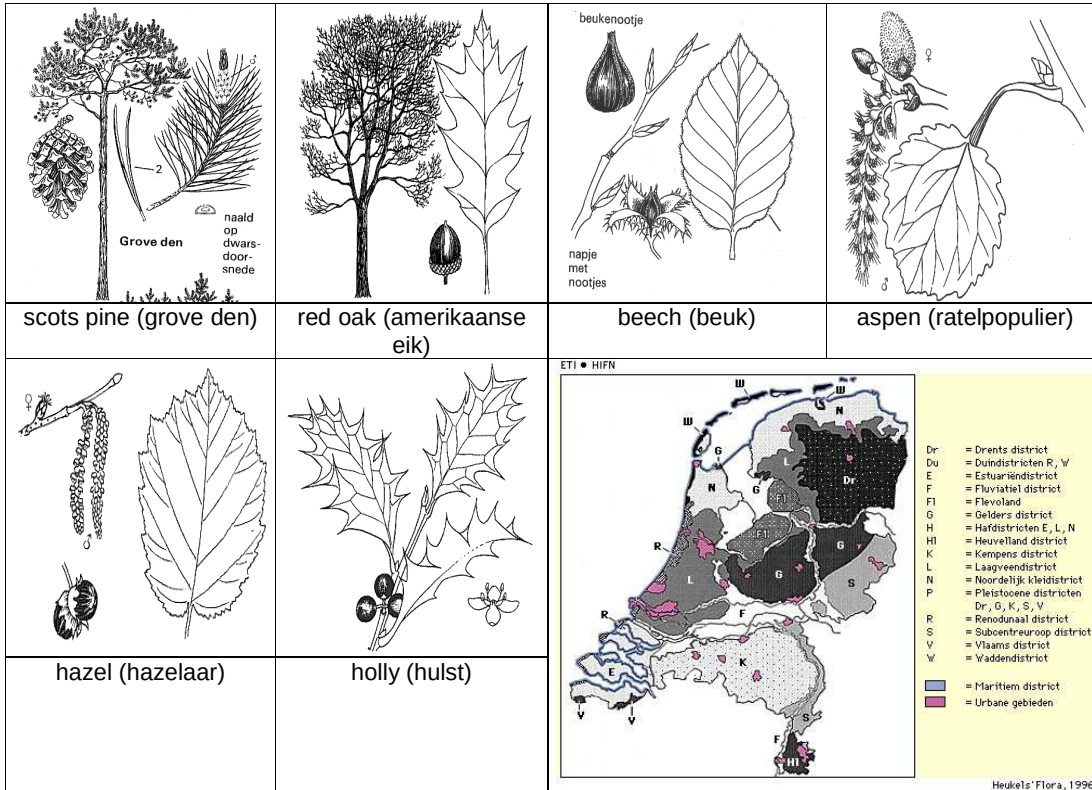


Fig. 715 Trees of Pleistocene and dunes in The Netherlands^a

Fig. 716 Flora districts according to Van Soest^b

Further elaboration of ecological counties (districten) (Fig. 716) is given by Van Soest (1929/32)²⁴¹

5.2.7 3km Landscape formations

Undisturbed 'definitive' vegetations

Obviously any region in The Netherlands that has got the time for succession of vegetation types gets a more or less 'definitive' vegetation. Coincidences of first establishments are filtered out.

This vegetation is not only dependent on soil, but also on climate, position in respect to sea and ground water level. For example, peat will only remain at high ground water level. In dry conditions it will settle, oxidate to CO₂ en H₂O and disappear leaving a lower mineral surface level.

In this paragraph we will discuss landscape formations and typical forest landscapes that would appear without impact of man at last. Agriculture and the use of fertilizers caused a homogeneous landscape. But the agricultural surface being reduced by economic conditions, an ecologically well-considered choice of vegetation and management could restore regionally characteristic forest, kept open partially by wild grazing cattle. You can consider this paragraph as a guide to planting, because trees occurring naturally in the region will grow better. You can obtain regional knowledge about soils from soil maps 1:50.000 with explanatory descriptions of landscapes.

^a Kelle and Sturm (1980)

^b Meijden (1999)

Natural forest types

Following descriptions are derived from Leeuwen and Kraft (1959). With regard to these elaborations Van Leeuwen's nomenclature is obsolete but simple, useful and clarifying for urbanists and not yet exceeded in that respect.

Forest	Natural	Reclaimed
Holocene		
salicion ²⁴²	Willow and poplar forests, often found on <i>nutricious flooded areas like river forelands</i> . As coppice wood and wickers, willows are planted on 'grienden'. Temporarily you will find these woods on other nutritious grounds as pioneer vegetation.	Grass land on river forelands and 'grienden'.
alnion incanae ²⁴³	Alder and ash forests with densely shrubs on <i>clay or sandy nutritious grounds with high and often somewhat changing ground water level or in the neighbourhood of streaming water</i> . These forests often contain some oaks and poplars as <i>well</i> .	Moisty grass land (meadows) sometimes with hedges (Rubion, alder), pollard willows or poplars.
ulmion ²⁴⁴	Oak, ash (sometimes elm or maple) forests on <i>moisty, nutritious sandy and not too heavy clay grounds with ground water level in reach of roots</i> .	Settlements, horticulture, orchards, fields, grass land, elm lanes, country estates and dune woods.
sambuco-berberidion ²⁴⁵	Hedges and thickets on <i>most limy grounds</i> of <i>Ulmion</i> .	
Pleistocene		
rubion ²⁴⁶	Hedges and thickets (hawthorn, sloe, roses, blackberries) on <i>nutricious, but not explicitly limy grounds</i> .	Settlements, orchards and fields on rather dry grounds; grass land on more moisty or very limy grounds.
carpinion ²⁴⁷	Oak, ash (sometimes maple or beech) forests on <i>nutricious, not too wet loam grounds</i> . In coppice wood thickets you will find hazel and hornbeam.	
carpino-berberidion ²⁴⁸	Hedges and thickets on <i>most limy grounds</i> of <i>Carpinion</i> .	
violeto-quercion ²⁴⁹	Oak (seldom birch or beech) forests or coppice wood on <i>acid but not extremely poor, often loam containing or somewhat moisty sandy grounds</i> .	Fields
vaccinio-quercion ²⁵⁰	Oak (sometimes birch or beech) forests or coppice wood on <i>acid extremely poor, sandy (sometimes loamy) grounds</i> .	Prehistoric (neolithic) settlements, heath often later planted with coniferous wood (drifting sand) or crops (if dry) or meadows (if wet).
Peat		
betulon pubescentis ²⁵¹	Rarefied birch forests on <i>somewhat dehydrated peat grounds</i> (very <i>rare</i>).	Digged out or drained and manured meadows sometimes planted as Alnion incanae.
sphagno-alnion ²⁵²	Birch (sometimes alder) forests with shrubs of alder buckthorn, willows, bog myrtle on <i>acid peat grounds</i> (rare).	Bluegrass lands, later usually drained and manured, sometimes planted as Alnion incanae.
irido-alnion ²⁵³	Alder or willow (mostly coppice wood) in <i>peat areas with very hing, stagnating not too poor ground water</i> , usually with rarefied <i>shrubs</i> .	Moisty grass land, digged out or drained and manured meadows mostly planted as Alnion incanae.

Fig. 717 Relation between original natural forest type and reclaimed landscape^a

^a Leeuwen and Kraft (1959)

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Zij komen voor in beekdalen, vochtige laagten in dekzandgebieden en oude duinlandschappen, laaggelegen rivier- en zeekelegronden, niet regelmatig overstromd buitendijks rivierlandschap, bemeste en iets ontwaterde veengronden.

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stroomruggronden in het rivierkele gebied, kreekkrug- en kwelderwalgronden in het zeekele gebied grensstroken tussen droge, zandige heuvels en vochtige dalen.

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Voor in de kalkrijke jonge duinen, ook in Zuid Limburg en hier en daar langs de rivieren, waar de grond kalkrijk is.

Comment [T.M. de12]: Pagina a: 468

op voedselrijke, maar niet uitgesproken kalkrijke gronden in het rivieren gebied op de leem- en losgronden in Limburg. Vroeger werden ze ook veel gevonden in de oudere zeekele gebieden zoals op Walcheren.

Comment [T.M. de13]: Pagina a: 468

in Oost Nederland, Zuid Limburg, Achterhoek, Twente, plaatselijk in het Nijmeegs heuvelland, Veluwezoom, Drenthe en Noord Brabant.

Comment [T.M. de14]: Pagina a: 468

Zij komen voor in Zuid-Limburg.

Comment [T.M. de15]: Pagina a: 468

Bovenste deel van hellingen in Zuid-Limburg, grensstrook tussen Ulmion en Vaccinio-Quercion in geaccidenteerde zandgebieden, hoogste gedeelte van de oude ... [1]

Comment [T.M. de16]: Pagina a: 468

Vlakke plateaus in Zuid Limburg, het grootste gedeelte van de pleistocene zandgebieden in Oost en ... [2]

Comment [T.M. de17]: Pagina a: 468

iets ontwaterde veenterreinen in Oost en West Nederland. Zeer zeldzaam.

Comment [T.M. de18]: Pagina a: 469

Laagste gedeelten met slecht waterafvoer in de pleistocene zandgebieden, voedselrijkere delen van de veengebied ... [3]

Ideal typical profiles

The situation of most important soils and corresponding vegetation is represented in ideal typical profiles Fig. 718 to Fig. 721 never appearing in reality. Corresponding forest types have been mostly disappeared since long and replaced by grass and crops. They illustrate mutual arrangements of Dutch original or natural landscapes. Soil maps give more detailed and realistic images.

The Northern coast formation of The Netherlands

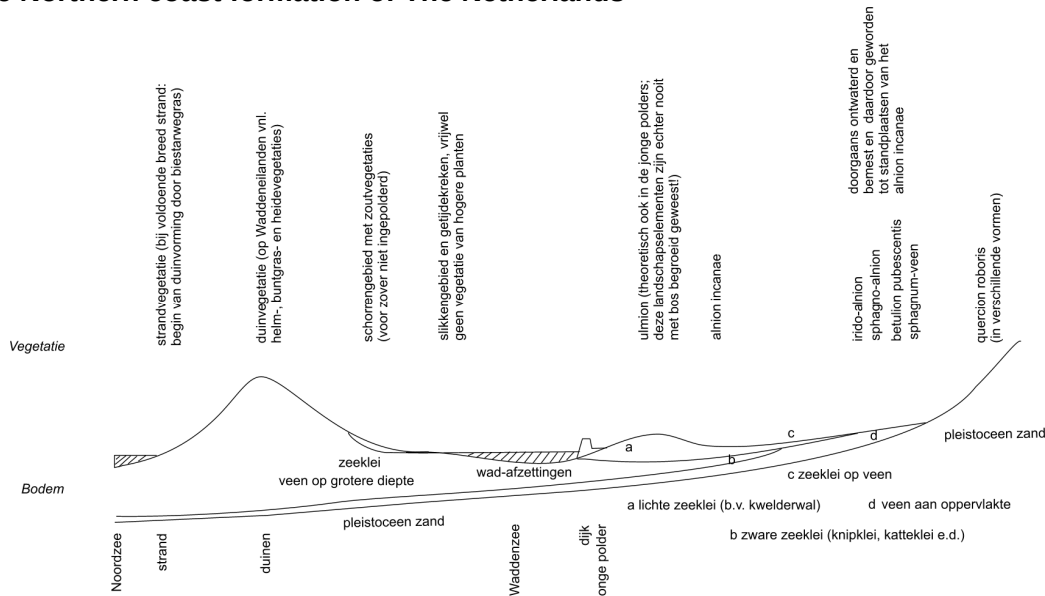


Fig. 718 Ideal typical coast formation in Northern part of The Netherlands^a

Mid-West cost formation of The Netherlands

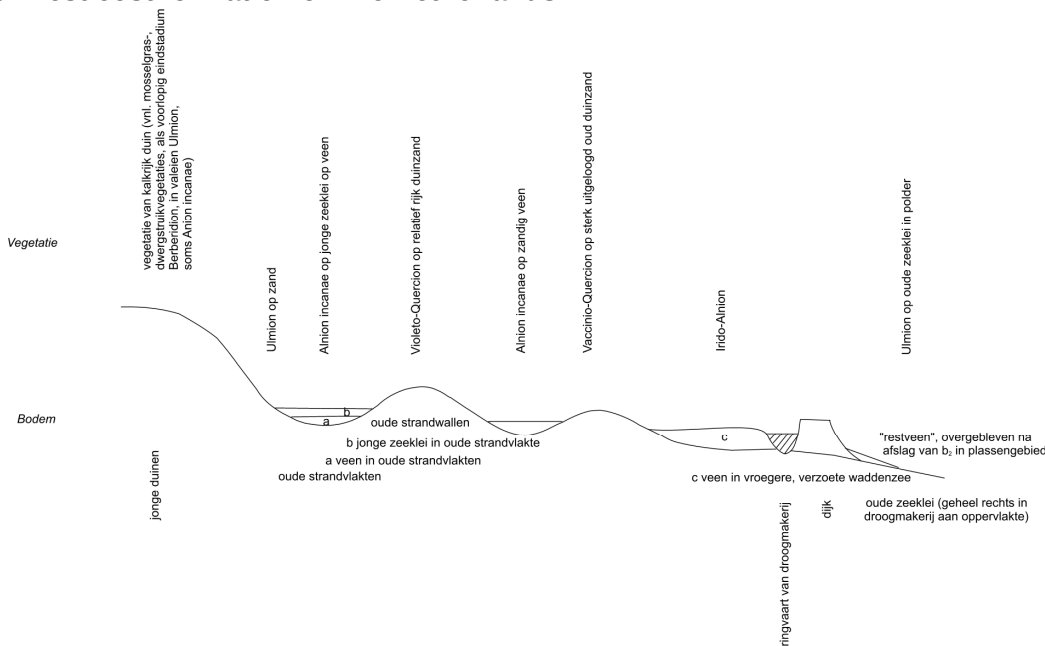


Fig. 719 Ideal typical coast formation in mid-West of The Netherlands^a

^a Leeuwen and Kraft (1959)

Peat, river and pleistocene sandy formations

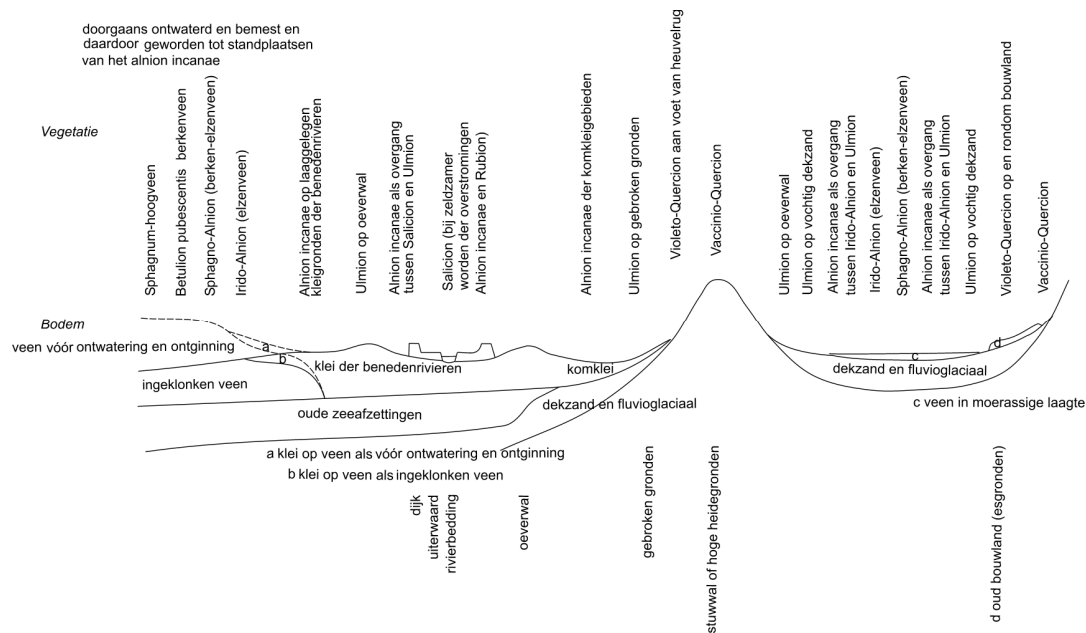


Fig. 720 *Ideal typical peat, river and pleistocene sandy formations^b*

Growing Peat

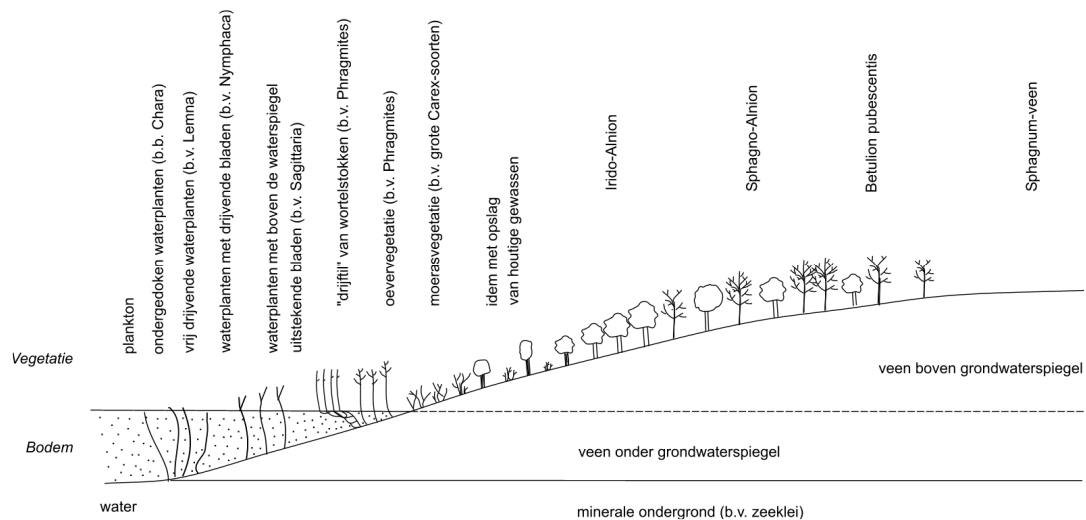


Fig. 721 *Ideal typical 'verlanding' in nutritious environments^c*

^a Leeuwen and Kraft (1959)
^b Leeuwen and Kraft (1959)
^c Leeuwen and Kraft (1959)

Clay

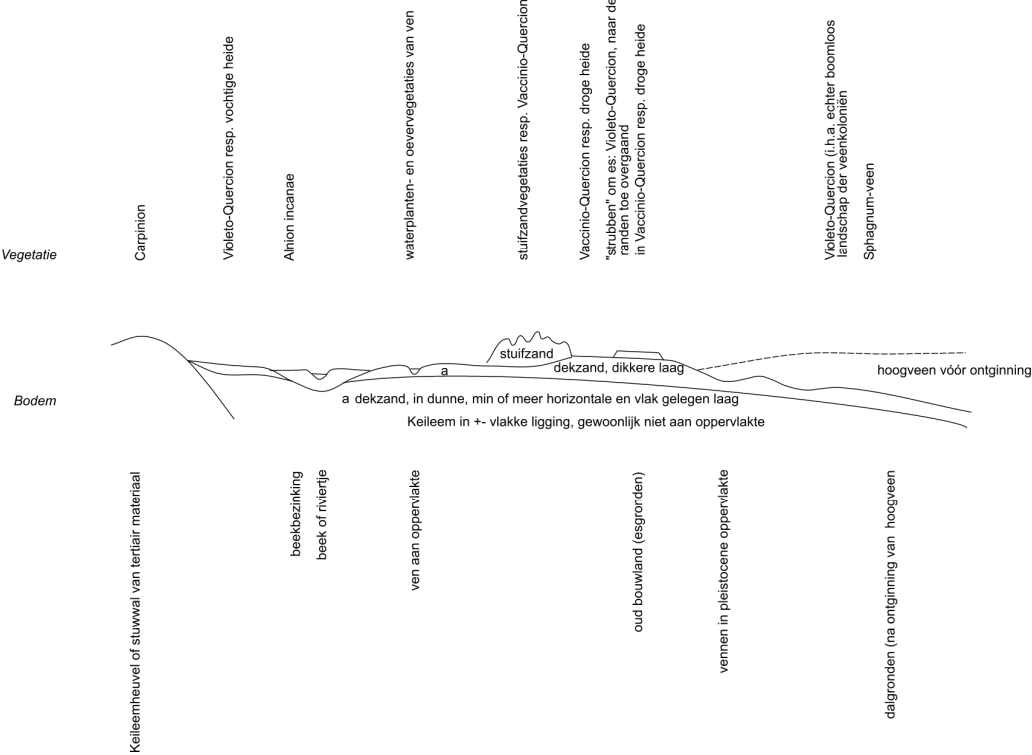


Fig. 722 *Ideal typical boulder clay formation*^a

South Limburg

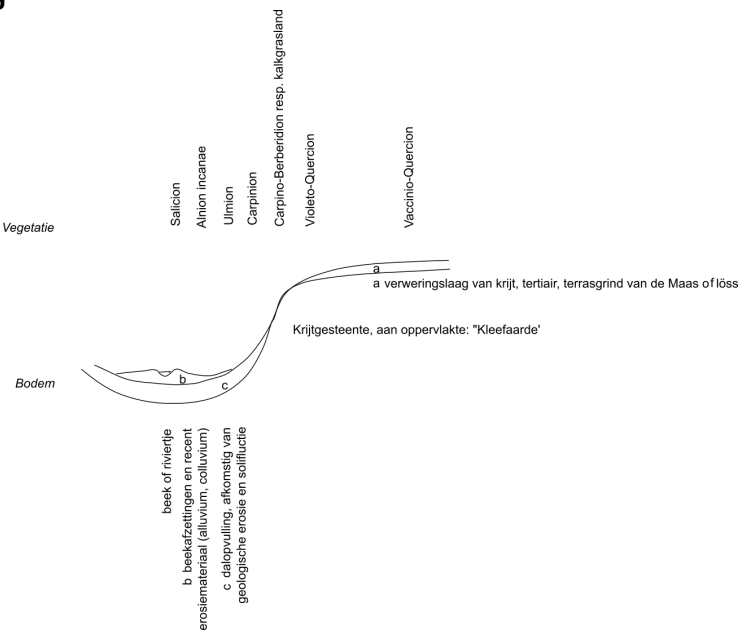


Fig. 723 *Ideal typical formation of South Limburg*^b

^a Leeuwen and Kraft (1959)

^b Leeuwen and Kraft (1959)

'Original landscape' is not the same as the 'natural landscape' appearing when human impact would stop, especially when agricultural measures were very radical.

5.2.8 300m local life communities

Succession

Organisms influence each other. In the beginning competition in fast growing homogeneous pioneer vegetation is dominant. In the next phase of succession different species alternate their use of sun, water and minerals over the year and differentiate them over the area in increasing specialisation. Primarily establishing plants cause a micro climate and soil structure creating conditions for other species. Under these conditions some newcomers get the opportunity to built up reserves and become more competitive than their fast growing predecessors. For example, they grow higher catching sunlight from their neighbours or grow deeper surviving dry periods better by their longer roots. In their shadow slow growing specialists settle.

Differentiation and regulation

The differentiating life community prevents large fluctuations of temperature and moist, retains water and nutrients attracting new animals. Specific insects pollinate specific plants and clear up plants weakened by competition in homogeneous vegetation. Birds control insect overloads, disperse seeds. Large grazing animals keep spaces open, predators keep their number limited. Reproductive cycles of every participating organism with its own consumptive, productive and reproductive periods are geared to one another and find for every phase the environmental circumstances they need, or die out. The rise of mutual relations into a climax stage (Fig. 732) requires coordination in space and synchronisation in time. In general it takes time.

Different communities in the same biotope

In the same type of biotope different life communities can develop, according to the history of their development. Different (weather) histories after all, change the biotope itself in different ways and select species differently. For example, if papilionaceous flowers with their specialised algae established in an early stage to combine nitrogen in the soil, an other series of succession would follow then when they established later or never. If not, vegetation is dependent on nitrogen manure from outside. And the reverse, if there is an external nitrogen source in the beginning, papilionaceous flowers would not survive competition.

Equal communities in different biotopes

On the other hand the same type of vegetation can disperse over different biotopes as well. So, there is not always a one-to-one relation between biotopes and life communities.

Especially man plants on his fields and gardens species he wants to, regardless the existing biotope accomodating it to his needs. He mostly reduces a mature system into its pioneer stage to get homogeneous highly competing productive crops. Then ecosystems do not reach their climax stage because human dynamic (grazing, mowing, burning and digging) prevents succession into more differentiated stages.

A first taxonomy of communities

Mutual relations between species produce recognizable plant communities listed in 38 synecological classes from Westhoff and Held (1975) summarised by Held (1991), subdivided in orders, unions and associations (partly elaborated in Fig. 724)²⁵⁴. Classes 32 to 38 elaborate forests more in detail than Fig. 717 did obsoletely but simply. Some scientific names like Salicion (32Aa and 33Aa), Alnion (35Aa) remain the same, other forest types named in paragraph 5.2.7 changed.

code	class 01-38 ~ea	order A-C ~alia	union a-d ~ion	association 1-99 ~tum	Dutch name class
01	Lemnetea				Eendekroos-klasse
02	Zosteretea				Zeegras-klasse
03	Ruppiaetea				Ruppia-klasse
04	Charetea				Kranswieren-klasse
05	Potametea				Fonteinkruiden-klasse
29	Oxycocco-Sphagnetea				Klasse der hoogveenbultgemeenschappen en vochtige heiden
30	Nardo-Callunetea				Klasse der heiden en borstelgrasanden
31	Trifolio-Geranietea sanguinei				Marjolein-klasse
32	Franguletea				Klasse der sporken-wilgenbroekstruwelen
32A	Salicetalia auritae				
32Aa	Salicion cinereae				
32Aa1	Myricetum gale				
32Aa2	Frangulo-Salicetum auritae				
32Aa3	Alno-Salicetum cinereae				
32Aa4	Salicetum pentandro-cinereae				
32Aa5	Salicetum pentandro-arenariae				
33	Salicetea purpureae				Klasse der wilgen-vloedstruwelen en bossen
33A	Salicetalia purpureae				
33Aa	Salicion albae				
33Aa1	Salicetum triandro-viminalis				
33Aa2	Salicetum arenario-purpureae				
33Aa3	Salicetum albo-fragilis				
34	Rhamno-Prunetea				Klasse der eurosiberische doornstruwelen
35	Alnetea glutinosae				Klasse der elzenbroekbossen
35A	Alnetalia glutinosae				
35Aa	Alnion glutinosae				
35Aa1	Carici elongatae-Alnetum				
35Aa2	Carici laevigatae-Alnetum				
36	Vaccinio-Piceetea				Klasse der naaldbossen
36A	Vaccinio-Piceetalia				
36Aa	Dicrano-Pinion				
36Aa1	Leucobryo-Pinetum				
36Aa2	Dicrano-Juniperetum				
36Ab	Betulion pubescentis				
36Ab1	Betuletum pubescentis				
37	Quercetea robori-petraeae				Eiken-klasse
37A	Quercetalia robori-petraeae				
37Aa	Quercion robori-petraeae				
37Aa1	Quercus roboris-Betuletum				
37Aa2	Fago-Quercetum				
37Aa3	Convallario-Quercetum dunense				
38	Quercus-Fagetea				Eiken-beuken-klasse
38A	Fagetalia sylvaticae				
38Aa	Alno-Padion				
38Aa1	arici remotae-Fraxinetum				
38Aa2	onsortium van Carex remota & Populus nigra				
38Aa3	runo-Fraxinetum				
38Aa4	acrophorbio-Alnetum				
38Aa5	iolio odoratae-Ulmetum				
38Aa6	raxino-Ulmetum				
38Aa7	nthriscio-Fraxinetum				
38Aa8	rataego-Betuletum				
38Aa98	Imion carpinifoliae				
38Aa99	ircaeo-Alnion				
38Ab	Carpinion betuli				
38Ab1	Stellario-Carpinetum				
code	klasse 01-38 ~ea	orde A- C ~alia	verbond a-d ~ion	associatie 1-99 ~tum	Nederlandse naam klasse

Fig. 724 Taxonomy of life communities according to Westhoff and Den Held.

The next taxonomy

However, that taxonomy was adapted again by Schaminee, Stortelder et al. (1995); Schaminee, Weeda et al. (1995); Schaminee, Stortelder et al. (1996); Schaminee, Weeda et al. (1998) . Fig. 725 gives an impression of the first classes only.

	class 01-11 ~ea	order A-C, DG, RG ~alia	union a-d ~ion	association 1-99 ~tum	subassociatiion a-b
01					<i>Lemnetea minoris</i>
02					<i>Ruppietea</i>
03					<i>Zosteretea</i>
04					<i>Charetea fragilis</i>
05					<i>Potametea</i>
06					<i>Littorelletea</i>
07					<i>Montio-Cardaminetea</i>
08					<i>Phragmitetea</i>
09					<i>Parvocaricetea</i>
10					<i>Scheuchzerietea</i>
11					<i>Oxycocco-Sphagnetea</i>
.....					
	klasse 01-11 ~ea	orde A-C, DG, RG ~alia	verbond a-d ~ion	associatie 1-99 ~tum	subassociatie a-b

Fig. 725 Taxonomy of life communities according to Schaminee.

This taxonomy at last was used in nature conservation, simplified in nature target types we will discuss in 5.5.1 more in detail.

5.2.9 30m ecological groups

Based on ideas of Van der Maarel (1971), Runhaar, Groen et al. (1987) divided Dutch plant species in ecological groups (Fig. 726), suitable for estimating impacts of technical measures and ecological potencies.

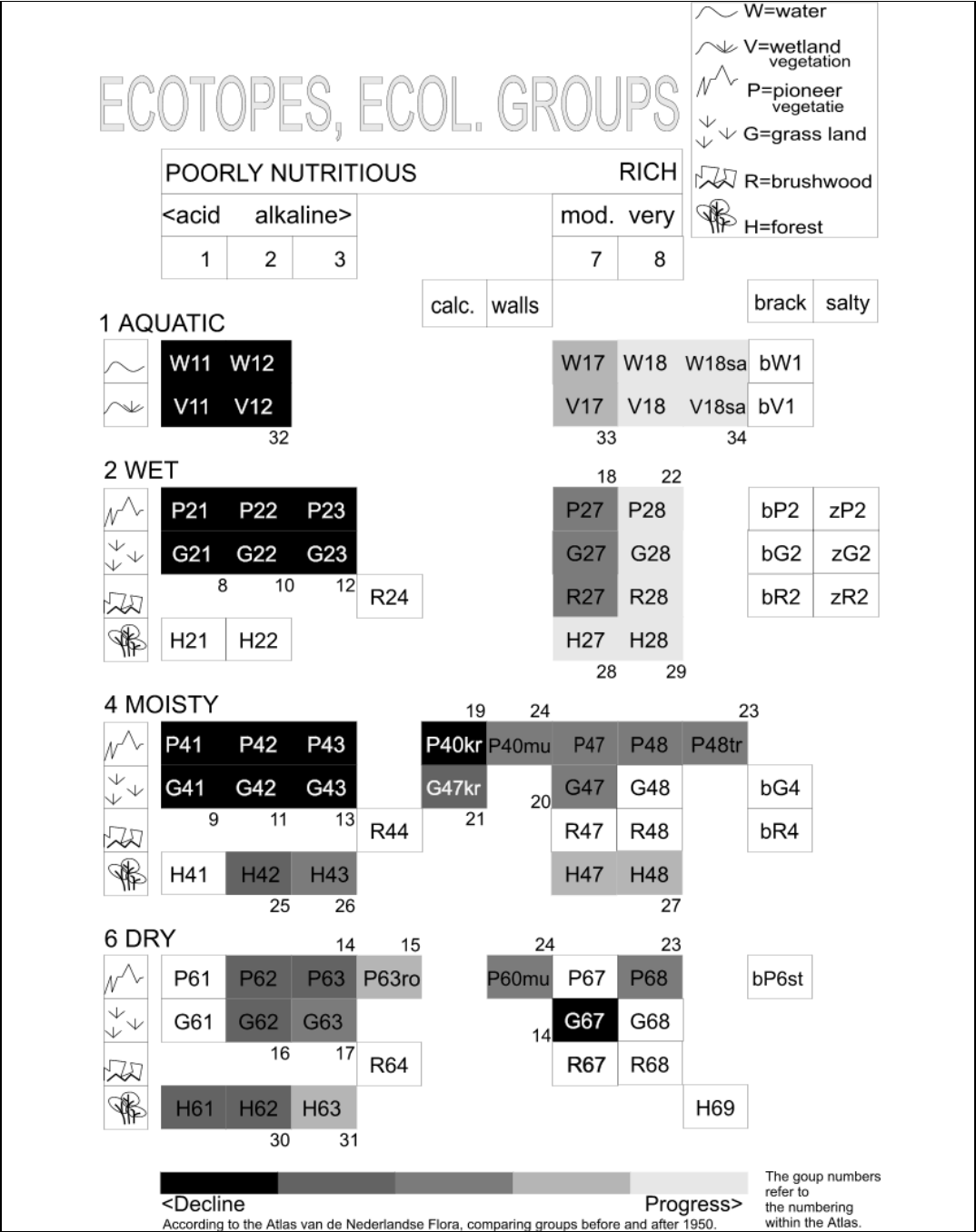


Fig. 726 Ecological groups^a

^a Runhaar, Groen et al. (1987)

Fig. 726 below shows which ecological groups made progress in the last century and which declined. It is clear that oligotrophe groups declined substantially²⁵⁵.

Ecological groups classified by directly working conditions

This subdivision restricts itself to conditions directly working on plants like sunlight, moist and acidity. It avoids taking into account underlying causes like soil type and water management complicating this classification. These are important factors estimating the impacts of technical interventions indeed, but they are originating in very different ways from higher levels of scale.²⁵⁶ For example, salty or brackish groups could not only be caused by surface water but also by seepage. Seepage on its turn can cause very different vegetations dependent on its chemical composition. Keeping classification as close as possible to the plant, the number of subdivisions and their presupposed explanation is limited. Moreover, the difference between ecotope and vegetation fades away and classification concerns both.

A hierarchy in classification

The used characteristics show a certain hierarchy by which a higher characteristic may not have to be subdivided further. For example within salty and brackish environments salt proportion (salinity) is so dominant that no further subdivisions into nutritiousness are necessary. On the other hand lower characteristics like soil spray (st) do not always have to be added to higher characteristics. Moreover, hierarchy could cause different definitions of lower characteristics depending on current higher characteristics. For example the degree of acidity in water depends strongly on its proportion of bicarbonate (HCO_3^- ions as buffer against acidification). On land other buffers are active. So, by distinguishing land and water vegetations first you can combine both buffer systems in the concept of acidity without losing their distinction but without explanation of causes²⁵⁷.

Main classification in water, wetland and land vegetations

This classification distinguishes primarily water (W), wetland (V) and land vegetations in freshwater (if heavily loaded by organic pollution marked by 'sa', brackish (b) and salty (z) environments). Land vegetations are subdivided further according to succession stages of pioneers (P), grass land (G), brushwood (R), and forest (H), all of them subdivided in wet (2), moisty (4) and dry (6). Then a distinction is made according to different degrees of nutritiousness from poor (oligotrophe) to rich (eutrophe). Within rich groups acidity does not make much sense, but within poor groups it is essential because it regulates the availability of present nutrients. In acid conditions existing organic material can not be digested by any organism (pickled gherkins, dead bodies in peat).

More specific indexed vegetations

Other subdivisions are indicated by indexes. Wall vegetations (Fig. 727) like procumbent pearlwort (*sagina procumbens*, *liggende vetmuur*), yellow corydalis (*pseudofumaria lutea*, *gele helmbloem*) or ivy-leaved toadflax (*cymbalaria muralis*, *muurleeuwebek*) get the index 'mu'. Within moderately nutritious environments pioneer and grass land vegetations can get the index 'kr' to indicate lime. Pioneer vegetations can get indexes like 'st', 'ro' and 'tr' to indicate soil spray, digged and treaded soil, often present in towns.

Some examples of coding ecological groups

For example treaded soil is densified and relatively unaccessible by water and air. Some plants are specialised to such conditions. So, on pathways you will find well known P48tr plants (Fig. 727) like plantain (*plantago maior*, grote weegbree), shepherd's-purse (*capsella bursa-pastoris*, gewoon herderstasje), knotgrass (*polygonum aviculare*, gewoon varkensgras), annual meadow-grass (*poa annua*, straatgras) or pineapple weed (*matricaria discoidea*, schijfkamille)²⁵⁸.

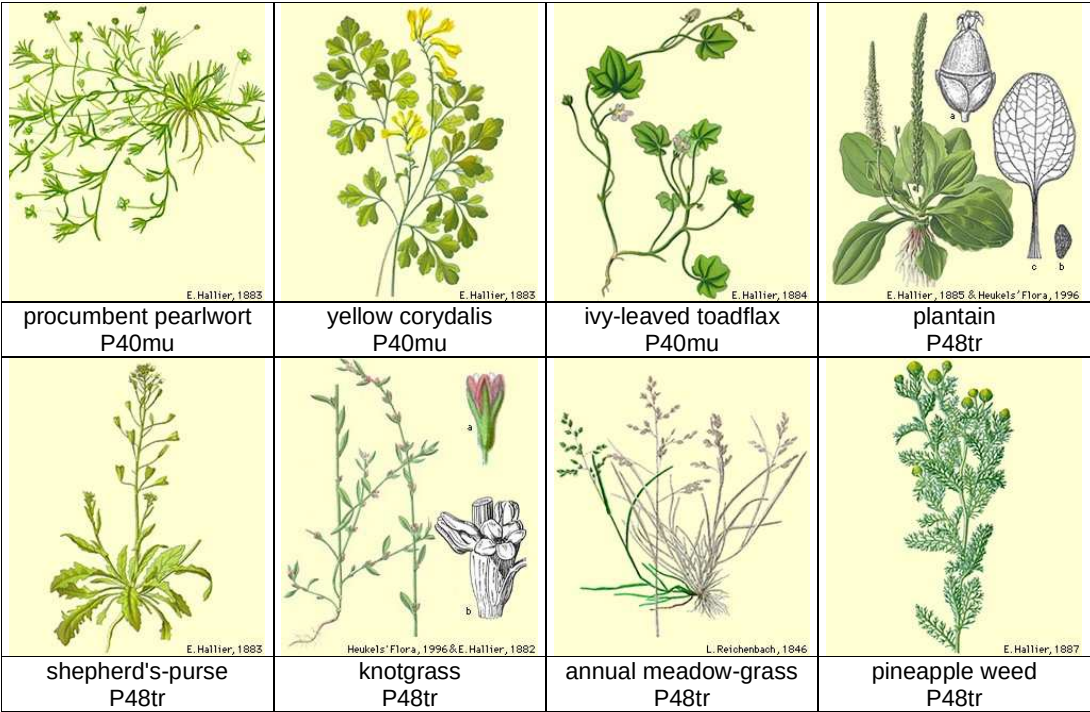


Fig. 727 Some wall and tread plants well known in urban areas^a

Plants indicating an ecological group

Most plant species appear in different ecological groups simultaneously. Plants appearing in many ecotopes can live in many conditions, they have a wide 'ecological tolerance' and are less appropriate as indicators of specific conditions. Runhaar, Groen et al. (1987) distinguish two classes of tolerance. Class 1 occurs in one or two very related ecotopes only; class 2 occurs in more types. Best indicators live in one ecotope only (class 1), but they are often rare and difficult to recognise by laymen. So, to recognise an ecotope you can best identify several species living together indicating the same ecotope. The wider the tolerance the more species you have to identify to be sure about the ecotope²⁵⁹. In the ecotope system a species is classified in as many ecological groups as necessary to explain 2/3 of its presence. If species would be classified to all accidental ecotopes they ever were found the classification would be little specific.

Less specific indicators

To filter out less specific ecological groups taking up a major part of The Netherlands the classification calculates all ecotope types back to the same surface. For example sweet vernal-grass (*anthoxanthum odoratum*, gewoon reukgras) appears optimally in poor grass lands (G22, G42), but in a lower abundance and coverage also in more nutritious grass lands (G27, G47). However, nutritious grass lands are very common in The Netherlands and poor grass lands are rare. The consequence is sweet vernal-grass occurs most in nutritious grass lands in spite of its preference for poor grass lands. By departing from relative occurrence per ecotope type commonness of nutritious grass lands plays no rôle in classification.

^a Meijden (1999)

5.2.10 3m symbiosis and competition

Dependencies

Most animal species are location bound by their dependency on specific plant species. That is why we primarily concentrate on plants. For example the large copper butterfly (*lycaena dispar*, grote vuurvliender) feeds only from june until half august on its host plant loosestrife (*lythrum purple*, kattestaart) and lays its eggs only on its breeding plant a water dock (*rumex hydrolapathum*, waterzuring) in weak condition (a healthy specimen defends itself against damage by insects). This typical combination is found in The Netherlands in peat counties between Friesland and Overijssel only. So, large copper butterfly is rare in The Netherlands.

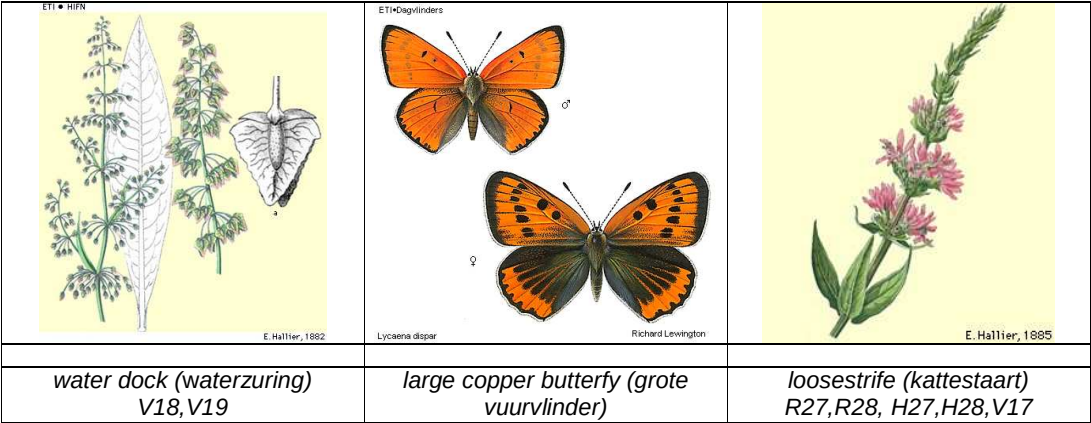


Fig. 728 Symbiosis of copper butterfly with breeding and host plant
Interactieve ETI CD-ROMs Heukels flora en vlinders^a

An other example of specific dependency is a common night butterfly *tyria jacobaeae* (jakobsvlinder, Fig. 729) laying its eggs on common ragwort (*senecio jacobaeae*, jakobskruiskruid).

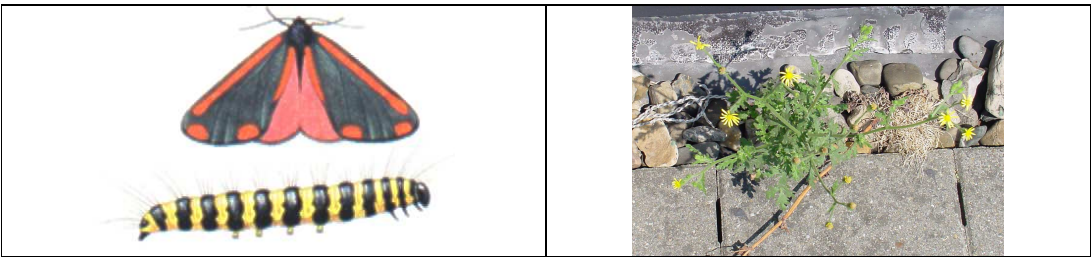


Fig. 729 *Tyria jacobaeae* and its breeding plant common ragwort on the roof of the faculty^b

Common ragwort is very poisonous except for *Tyria jacobaeae*'s caterpillar. It stores the poison. So, the caterpillar and the butterfly are poisonous for their enemies.

Rare plants on poor grounds

If presence or digestibility of minerals are a limiting factor, only rare specialists can survive. By manuring exactly these rare species loose competition of common and fast growing species. A nutrition poor environment not only selects rare species but also diminishes defence of plants. Weak plants are better digestible by herbivores and insects. One often recognises rare vegetation by a multitude of insects and their predators like birds. To avoid leakage of caught ions on poor grounds plants build cholesterol in their membranes instead of sitosterol. However, sitosterol makes cell walls stronger and plants less digestible by herbivores (from cow to caterpillar). Where less herbivores

^a Meijden (1999); Halder, Wynhoff et al. (2000); Meijden (1999)

^b Chinery (1988)

survive the ecosystem supports less species.²⁶⁰ Cows on a richly manured meadow bend as far as they can over the fence to eat grass from a neighbouring unmanured meadow, leaving the manured grass uneaten. A farmer gladly puts an ill cow on an unmanured meadow. Salt and acid diminish digestibility of minerals leaving space for specialist plants and peculiar ecosystems. Soured forests are rich in parasites. The abundance of great titmouses increased in soured forests though they suffered lack of calcium. Their eggshells became thin^a.

Plants and insects

The relation of every Dutch plant species with animals - particularly insects – is described in Weeda, Westra et al. (1985); Weeda, Westra et al. (1987); Weeda, Westra et al. (1988); Weeda, Westra et al. (1991); Weeda, Westra et al. (1994) . The authoritative Meijden (1996) (see Fig. 674) refers to this publication naming volume and page.

The question how animals recognise 'their' plants depends on perception of smell, colour and form. The recognisability of plants for their matchmakers, the insects, culminates in their reproduction organs, their flowers. The question how pistils recognise 'their' pollen is a vast area of microscopical research. Fertilisation requires coordination in space and synchronisation in time between plant and animal.

Small populations at risk

After the problem of fertilisation the problem of seed dispersion follows. These problems occur on different levels of scale. Topographic, demographic and genetic isolation of populations decreases genetic biodiversity and increases risk of dying out. On a minimum population area after 50 generations 10% of genetic material may be left, decreasing adaptability and probability of survival. Genetic deterioration becomes a big problem. A minimum population area is not sufficient for conservation of genetic variation and impels making gene banks of threatened species.

Connections between populations

This is an important subject for nature conservation and spatial planning. The Dutch Nature conservation plan LNV (1990) and its successors stimulate a main ecological infrastructure (EHS, see paragraph 5.5.1) to connect important natural areas by corridors for genetic exchange. This is more important for mammals and reptiles than for birds, insects and plants. However, for mammals and plants narrow corridors are very species-specific. Depending on their lay-out they work for one species and not for other ones. For plants - the basis of any food chain - isolation could even be preferable to avoid invasion of fast growing common species. Rare species often grow and disperse slowly. So, ecological infrastructure will have little favourable botanical impact and sometimes even negative²⁶¹. For vegetation local diversity is a better investment than connections.

5.2.11 30cm individual strategies for survival

According to Grime, Hodgson et al. (1988) plants have three different strategies for survival:²⁶²

- 1 growing fast, reproduce and evacuate ("ruderals" like chickweed, *stellaria media*, vogelmuur);
- 2 develop competition power, then reproduce ("competitors" like rosebay willowherb, chamierion angustifolium, wilgenroosje);
- 3 endure difficult circumstances other species avoid and reproduce when possible ("stress-tolerators" like cowslip, primula veris, gulden sleutelbloem)

Growing fast or slow

Chickweed can produce seed a fortnight after germination. It is record-holder of Dutch plants in that respect. The rosebay willowherb goes up fast to compete with other plants, but can weaken by shortage of minerals and fall down. The cowslip is a specialist surviving in circumstances other plants do not.

^a "Koolmees zwelgt in verzuurde bossen", Bio Nieuws nr. 5, 22 november 1991.