Biodiversity.
Abiotic an biotic ecological conditions.

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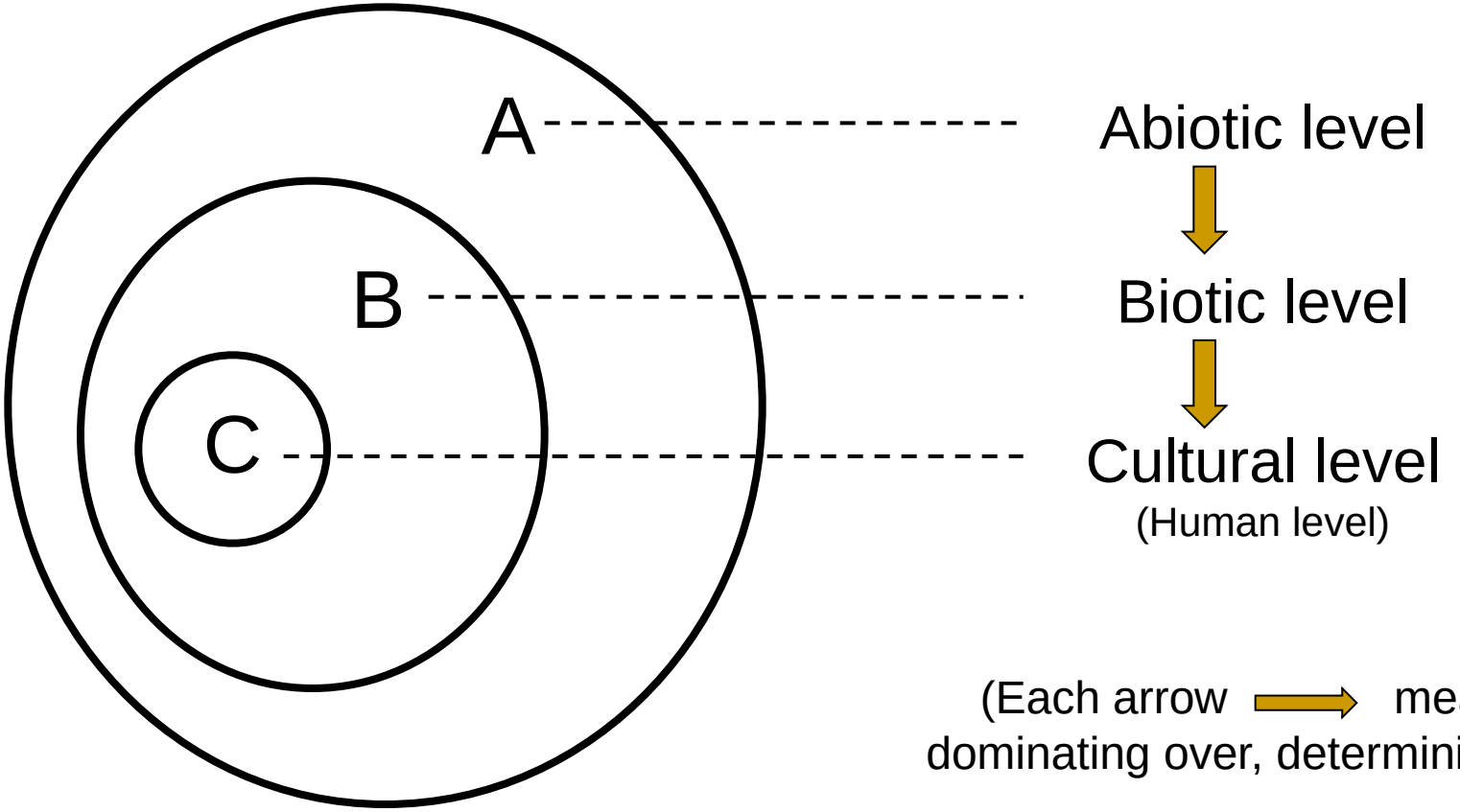
International Master in Architecture.

Course Environmental Sustainability. Theme 2

HUMAN ACTIVITIES DEPEND ON AN INTACT BIOTIC AND ABIOTIC LEVEL.

VAN LEEUWEN (1979) EN SCHROEVERS (1982)



(Each arrow ⟹ means: dominating over, determining for)

Cosmosphere (A) ⟹ *atmosphere (A)* ⟹ *hydrosphere(A)* ⟹ *lithosphere (A)* ⟹ *biosphere (B)* ⟹ *noosphere (C)*

HUMAN ACTIVITIES DEPEND ON AN INTACT BIOTIC AND ABIOTIC LEVEL.

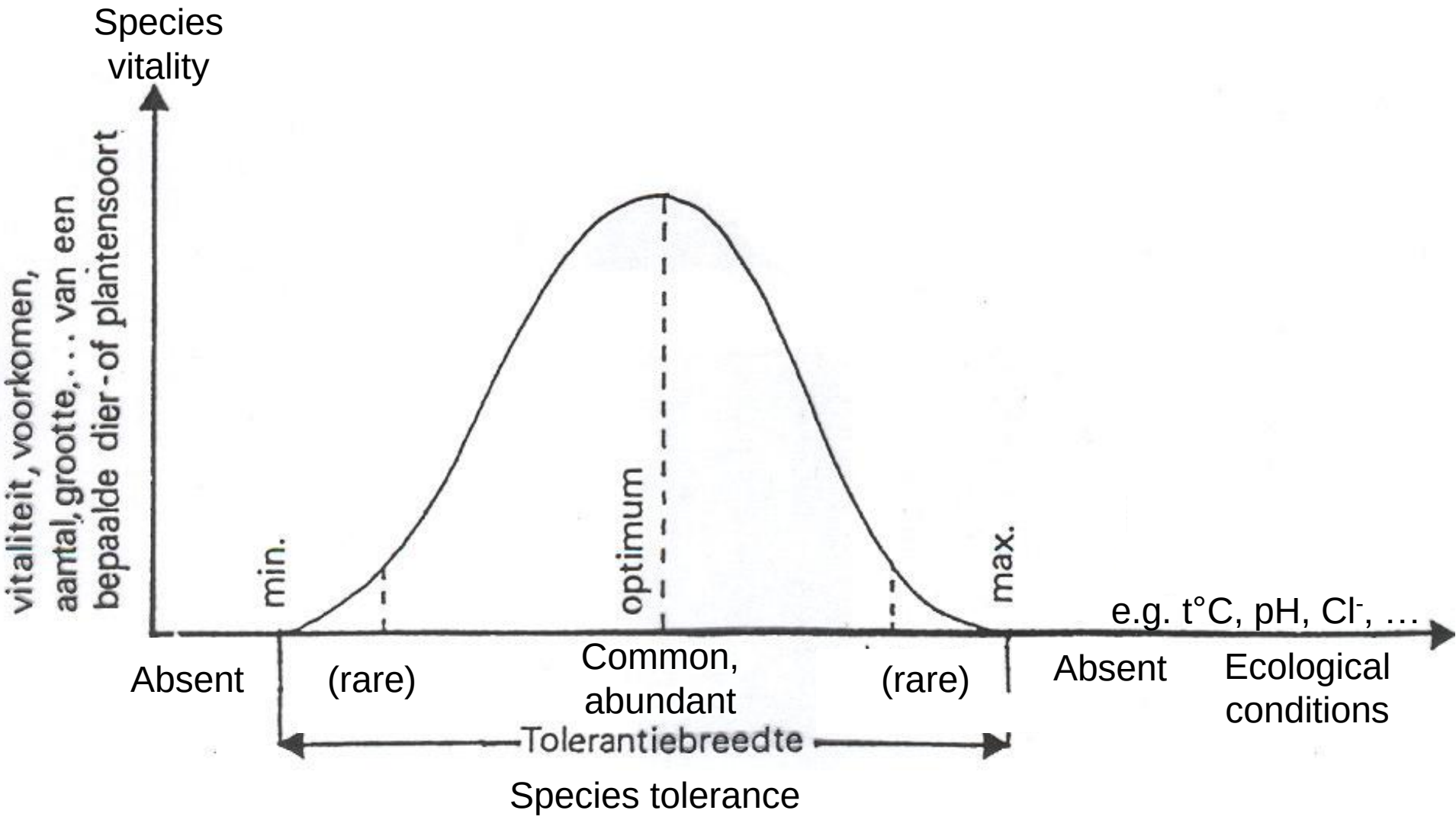
VAN LEEUWEN (1979) AND SCHROEVERS (1982)

SOME CONSEQUENCES:

1. When species disappear (or occur), an exploration of possible causal changes in the abiotic conditions is desirable.

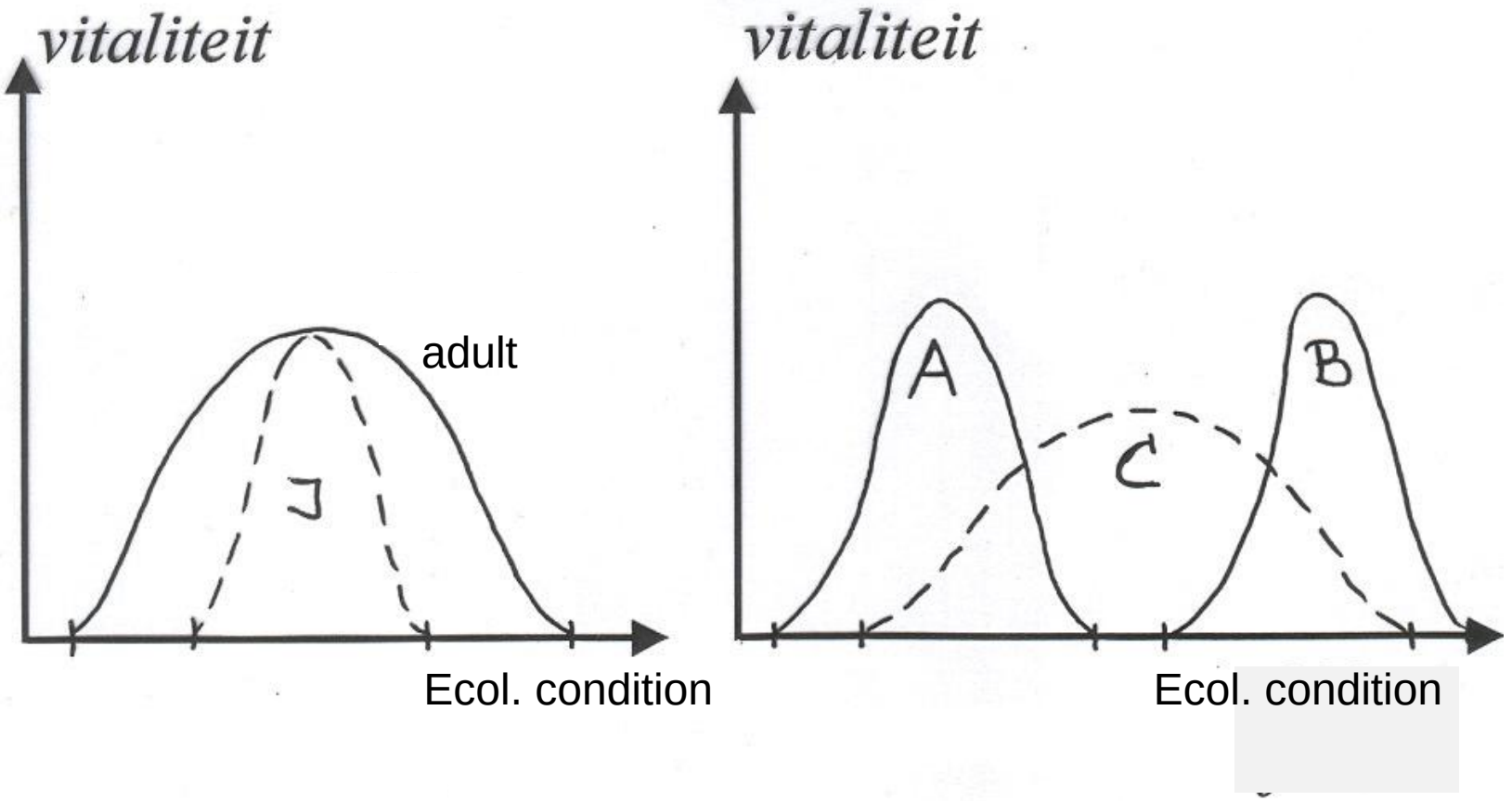
2. When we want to avoid species to extinct or if we want species to be introduced, then steering (managing) of the abiotic conditions is most efficient.

The Law of Tolerance (Shelford,1911)



A certain species can occur when the ecological conditions vary between a *species- specific* **minimum** and a **maximum**.

Some consequences of the law of Tolerance:



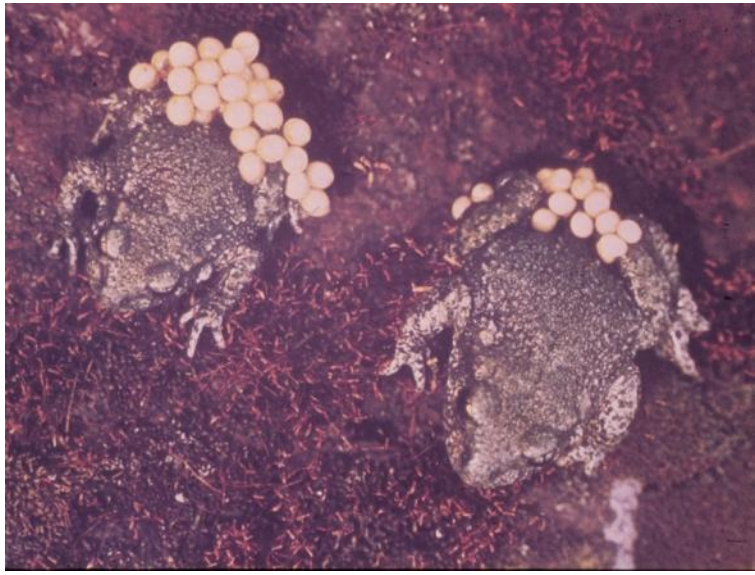
tolerantie
volw > jong

tol. A ≠ tol. B
areaal A ≠ areaal B

The tolerance of adults is broader than the juvenile tolerance

Many species have difficulties with our (Belgian) climate , because of low winter temperatures.

Reptiles, such as the **Sand Lizard**

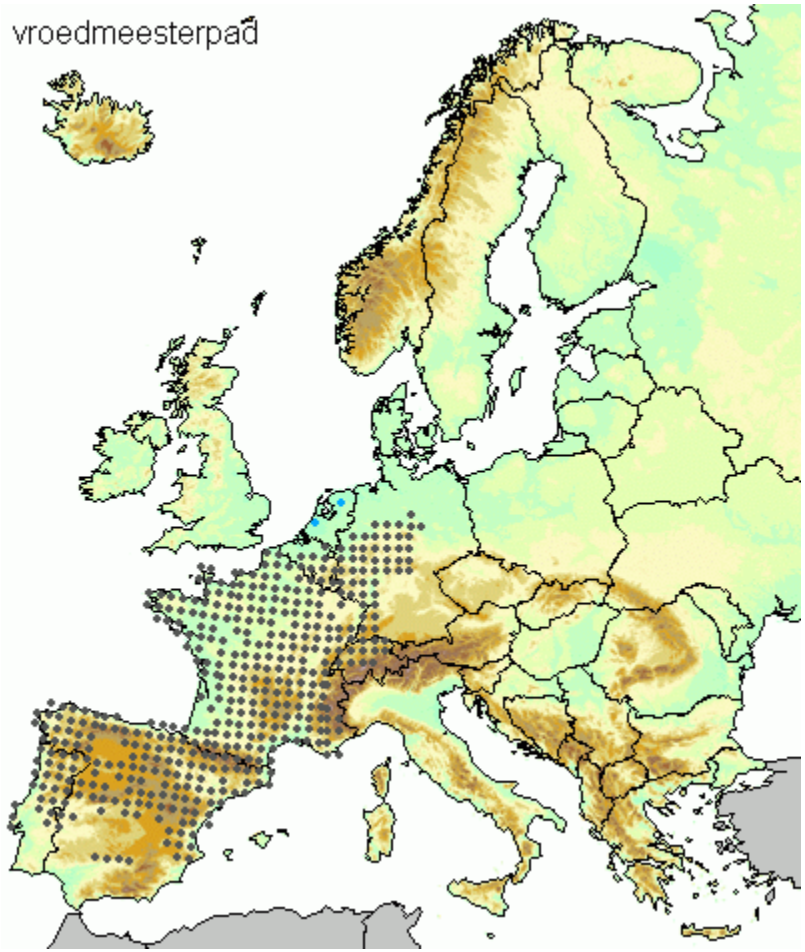


Amphibians, such as **Midwife Toad** *Alytes obstetricans*

So most reptile and amphibian species show (sub)tropical distribution patterns

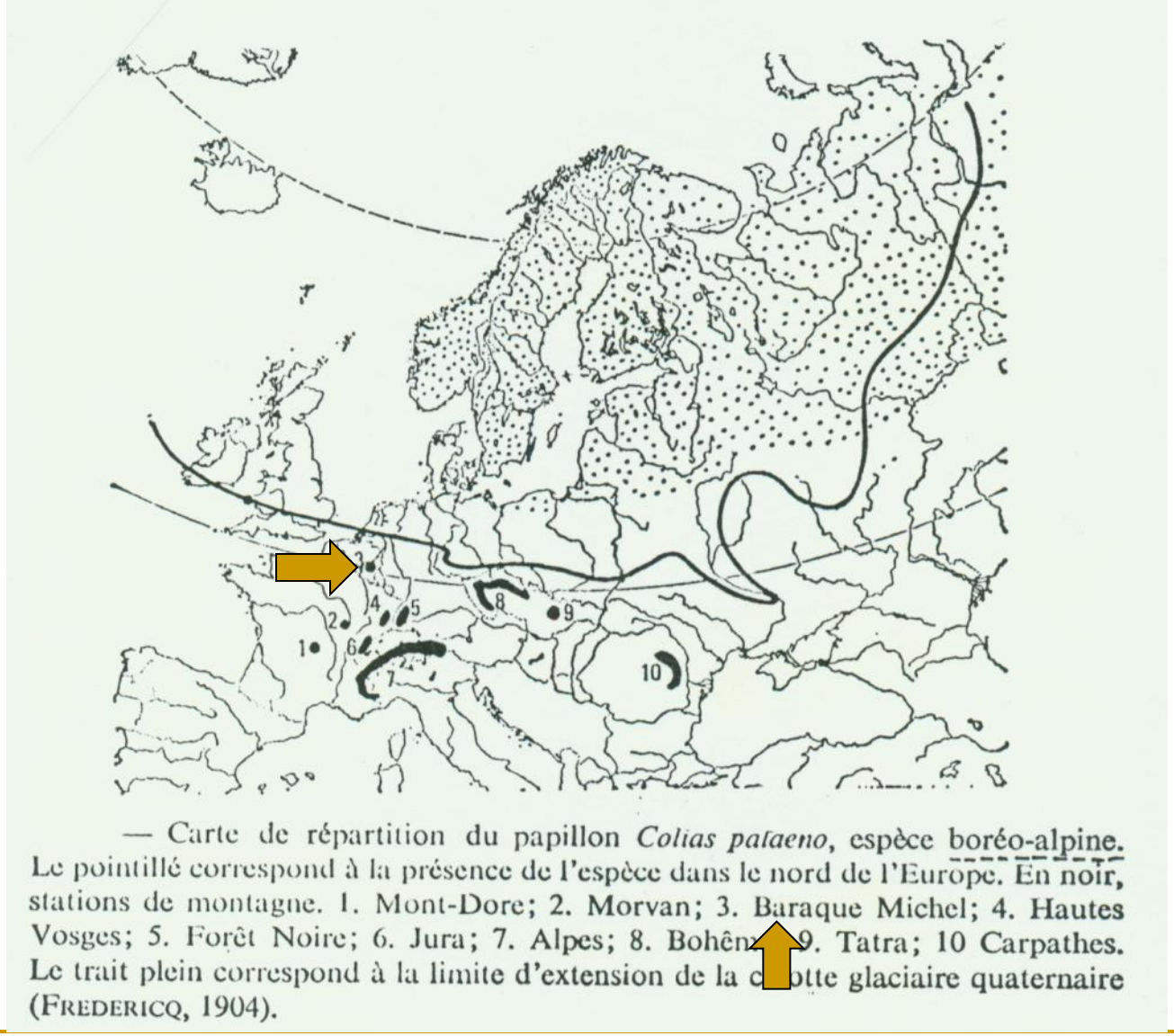
Kingfisher, Ijsvogel (needs ice-free water for food)

De **Midwife Toad,Vroedmeesterpad** (*Alytes obstetricans*).
SW-European area



www.ravon.nl

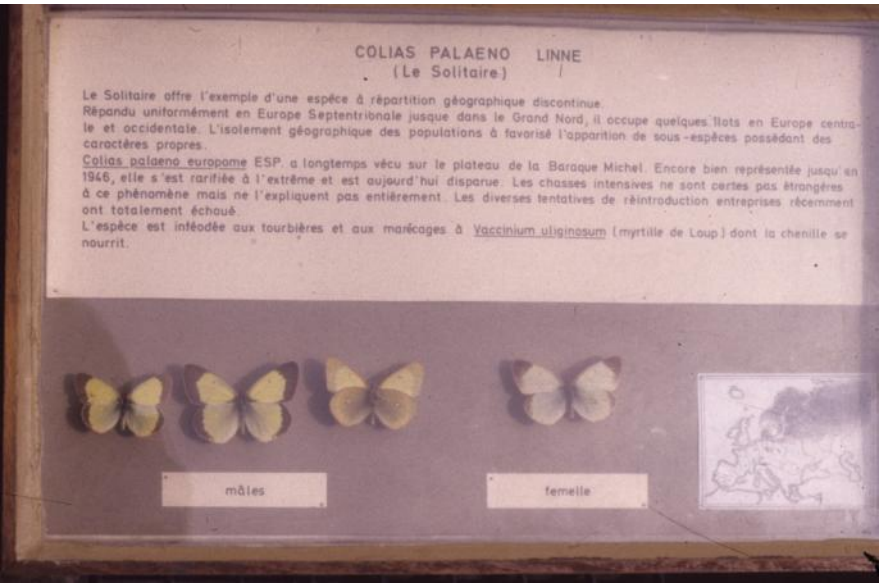
TEMPERATURE as an abiotic ecological condition.



— Carte de répartition du papillon *Colias palaeno*, espèce boréo-alpine. Le pointillé correspond à la présence de l'espèce dans le nord de l'Europe. En noir, stations de montagne. 1. Mont-Dore; 2. Morvan; 3. Baraque Michel; 4. Hautes Vosges; 5. Forêt Noire; 6. Jura; 7. Alpes; 8. Bohê[illegible]9. Tatra; 10 Carpathes. Le trait plein correspond à la limite d'extension de la c[illegible]otte glaciaire quaternaire (FREDERICQ, 1904).

Area of *Colias palaeno* (**breedband luzernevlinder)** (DAJOZ,1975)

Such a disjunct Boreo-alpine area is determined by historical climate change (global warming) after the last glacial period Würm glaciaal).

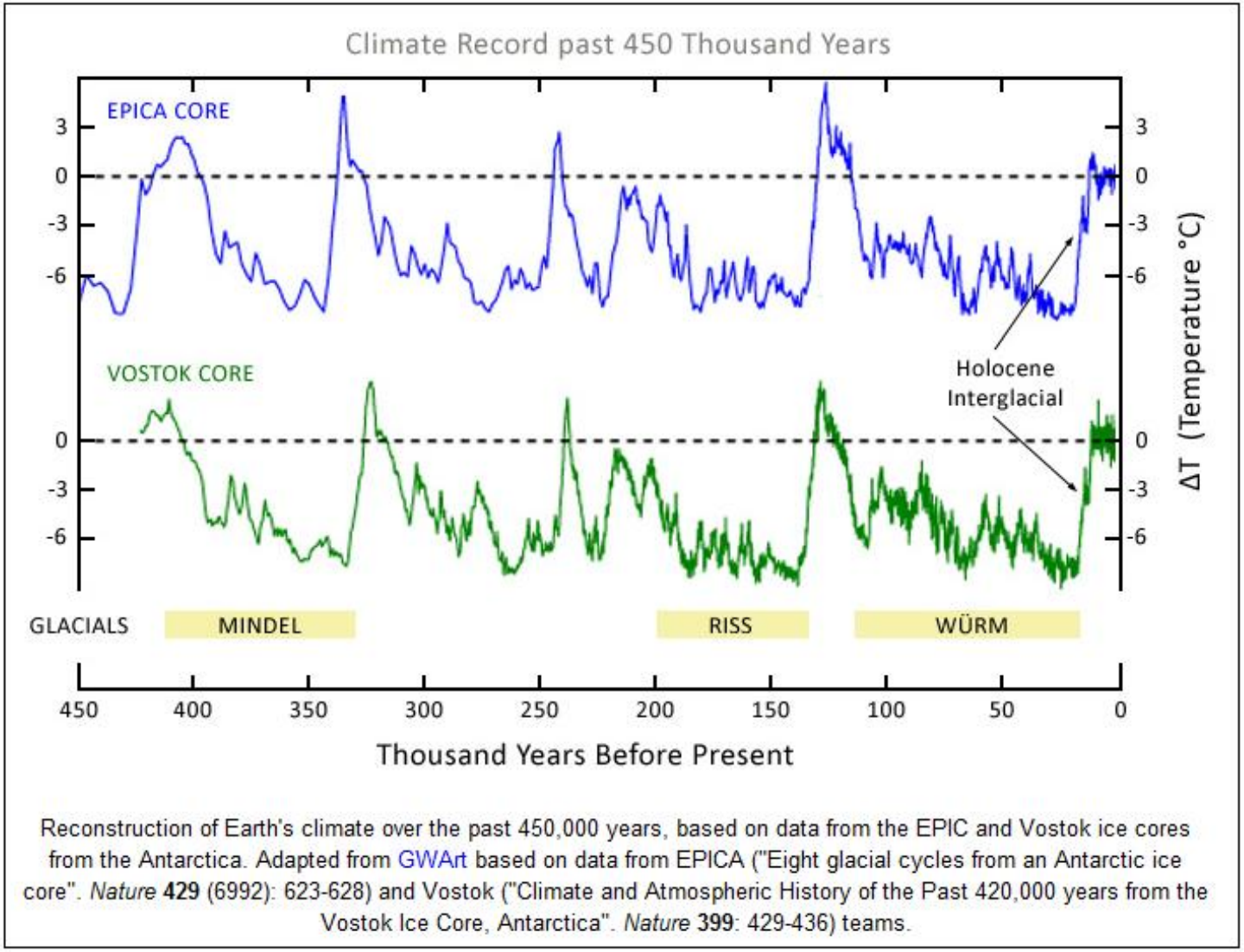


The butterfly larvae are monophagous on **Odon**, **Rijsbes** (*Vaccinium uliginosum*)

Reintroduction in the nature reserve 'the High Fens' failed: artificial acidification

http://www.lepidoptera.pl/show.php?ID=17&country=XX

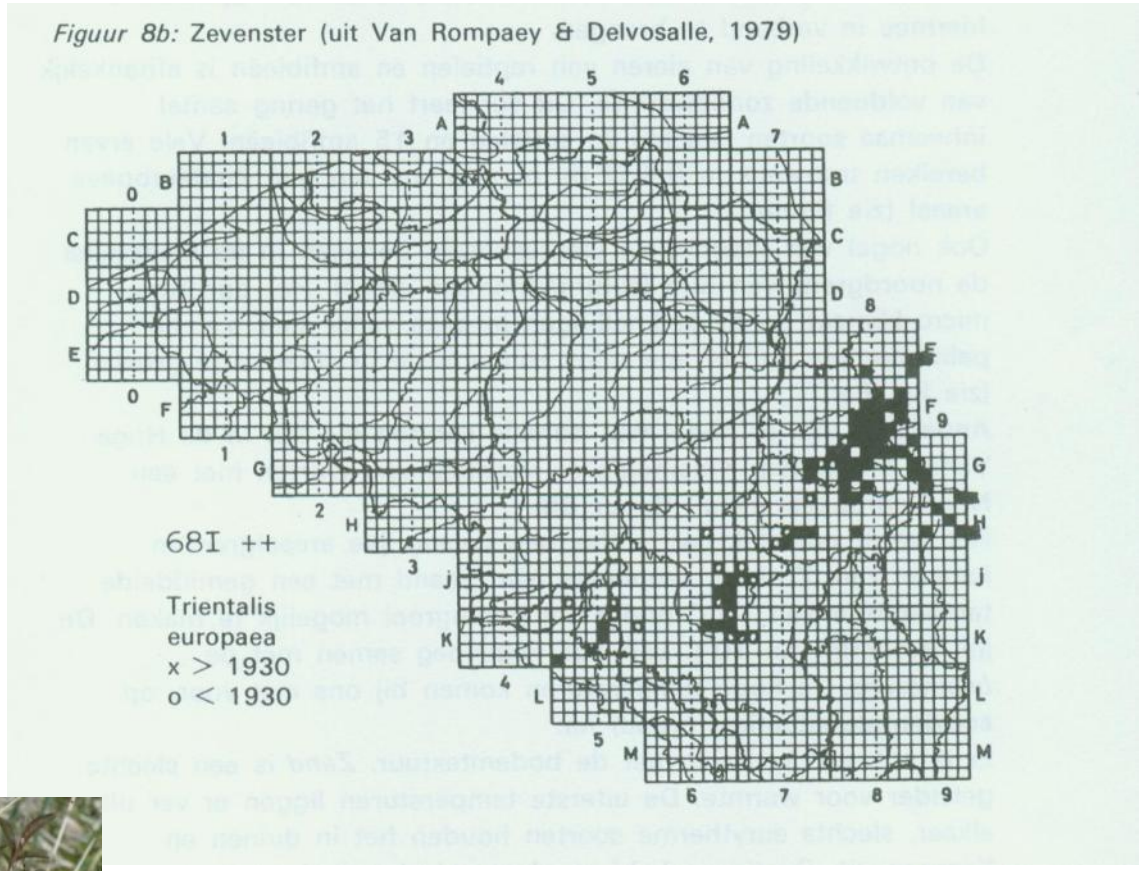
Climate record over the past 450000 years.



Reconstruction of Earth's climate over the past 450,000 years, based on data from the EPIC and Vostok ice cores from the Antarctica. Adapted from GWArt based on data from EPICA ("Eight glacial cycles from an Antarctic ice core". *Nature* **429** (6992): 623-628) and Vostok ("Climate and Atmospheric History of the Past 420,000 years from the Vostok Ice Core, Antarctica". *Nature* **399**: 429-436) teams.

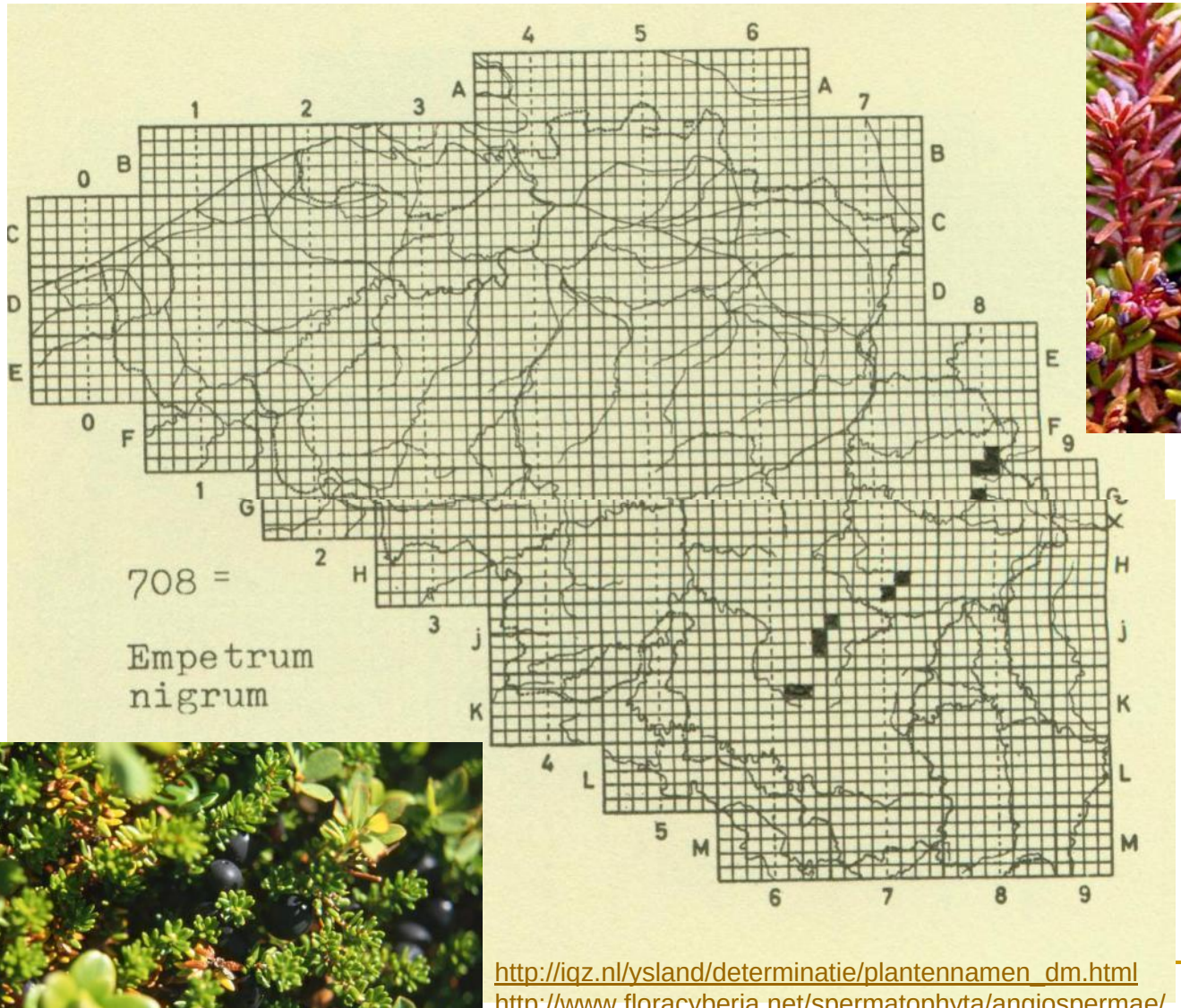
Source: essayweb.net/.../images/450%20thousand.jpg

Area of the **Chickweed Wintergreen, Zevenster** (*Trientalis europaea*).



Trientalis europaea is a glacial relict. It is chosen as the emblem of the nature reserve '*De High Moorlands (B)*'

Also the **Crowberry, kraaiheide** (*Empetrum nigrum*) is a glacial relict.



http://iqz.nl/ysland/determinatie/plantennamen_dm.html
http://www.floracyberia.net/spermatophyta/angiospermae/dicotyledoneae/empetraceae/empetrum_nigrum_hermaphroditum.html

Even within the limited Belgian scale, the abiotic ecological conditions very diverse

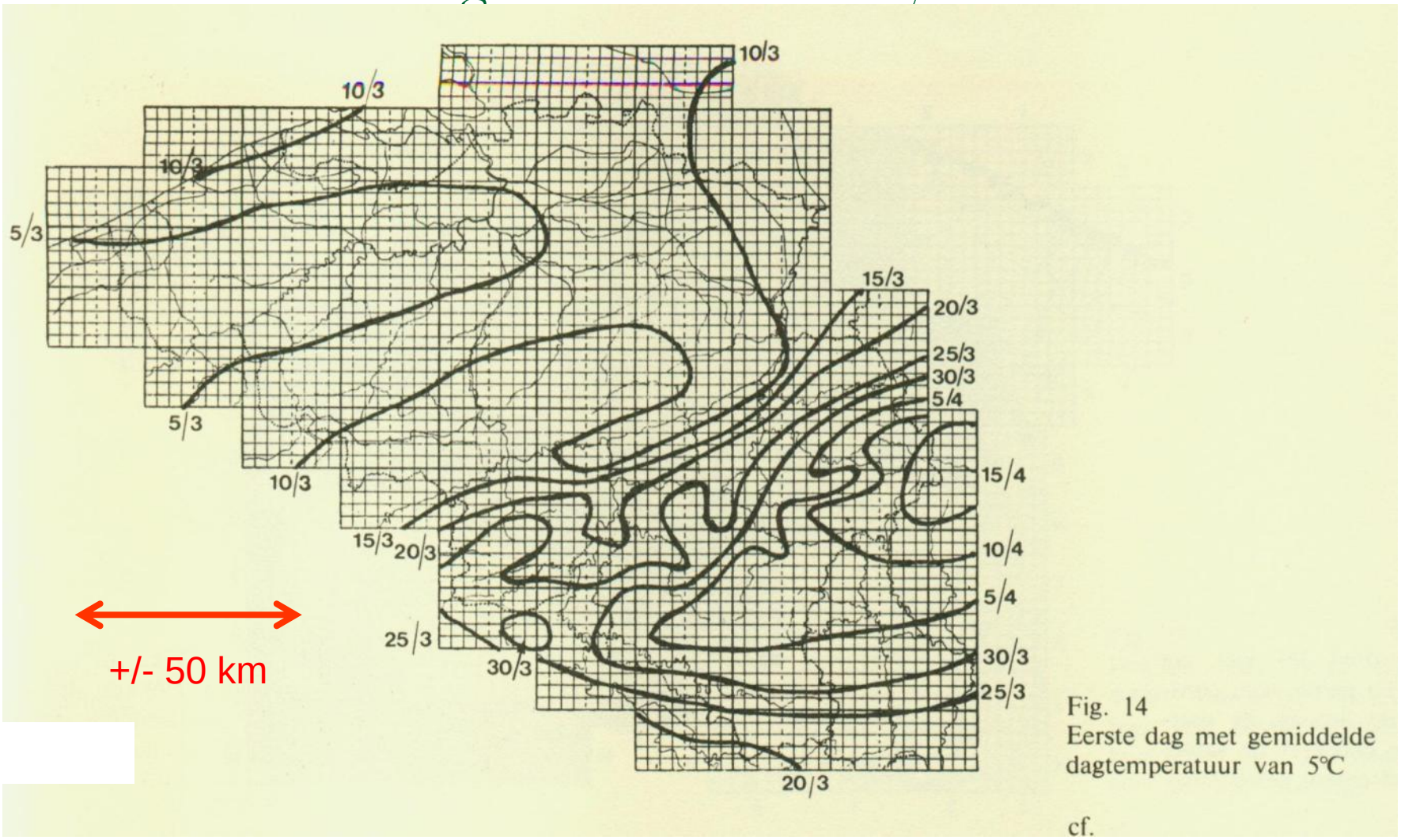
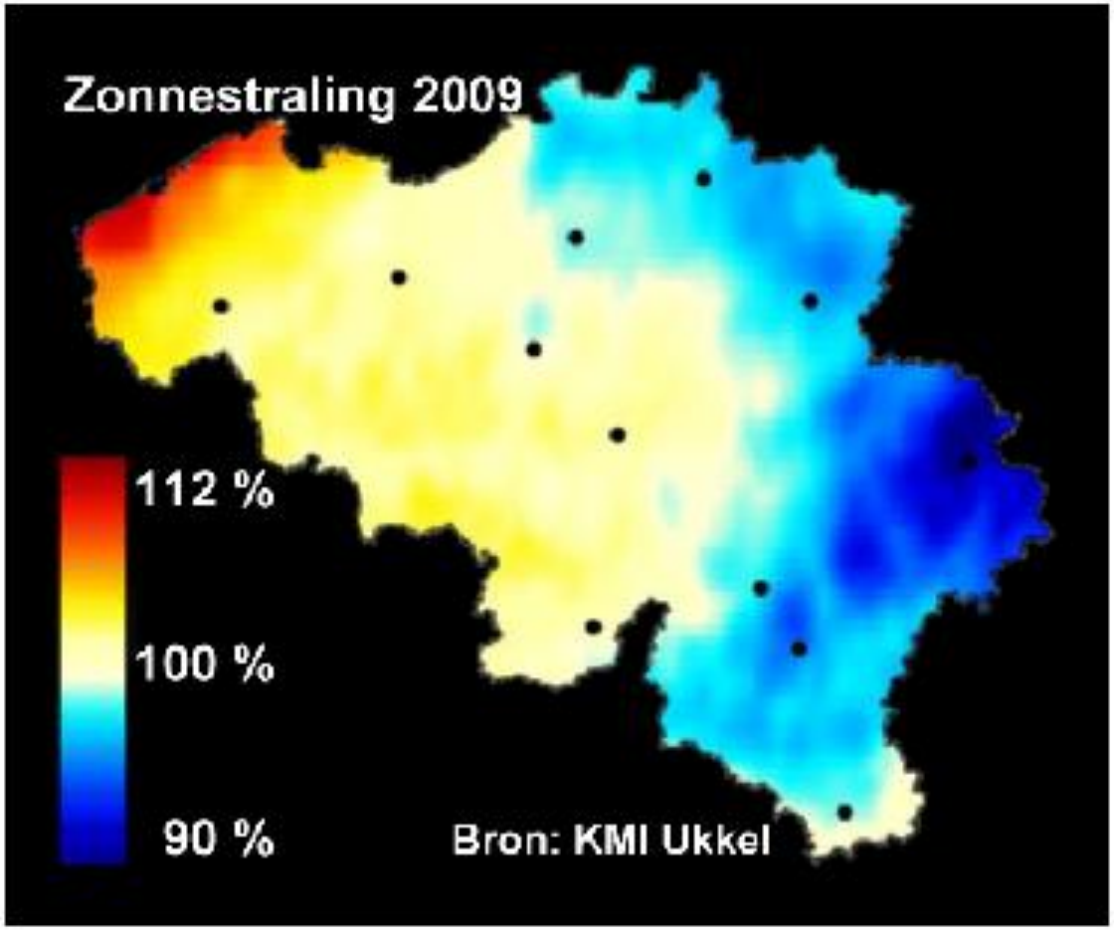


Fig. 14
Eerste dag met gemiddelde dagtemperatuur van 5°C

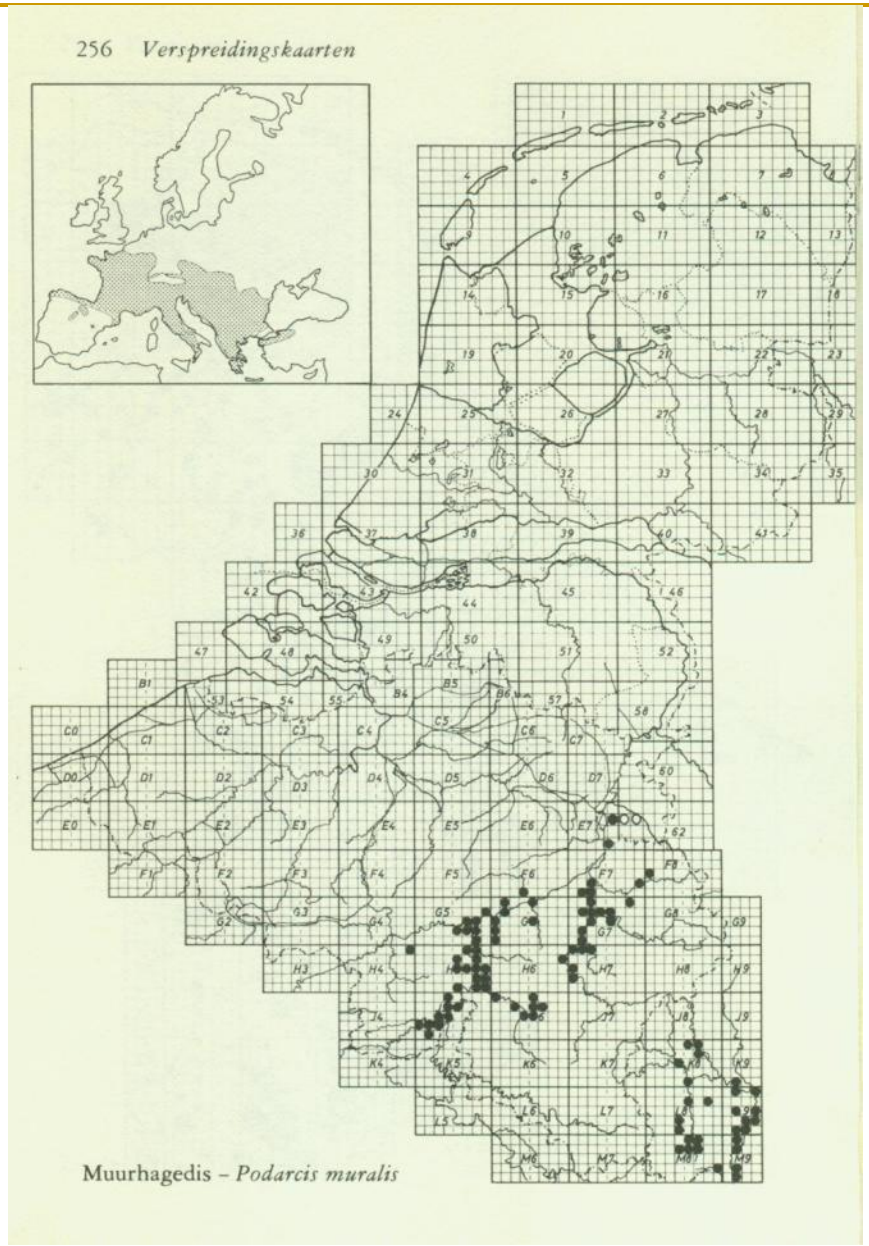
cf.

First day in spring with an average temperature of 5°C

Even within the limited Belgian scale, the abiotic ecological conditions very diverse.



Solar radiation input in Belgium



Area of the **Common Wall Lizard, Muurhagedis** (*Podarcis muralis*)

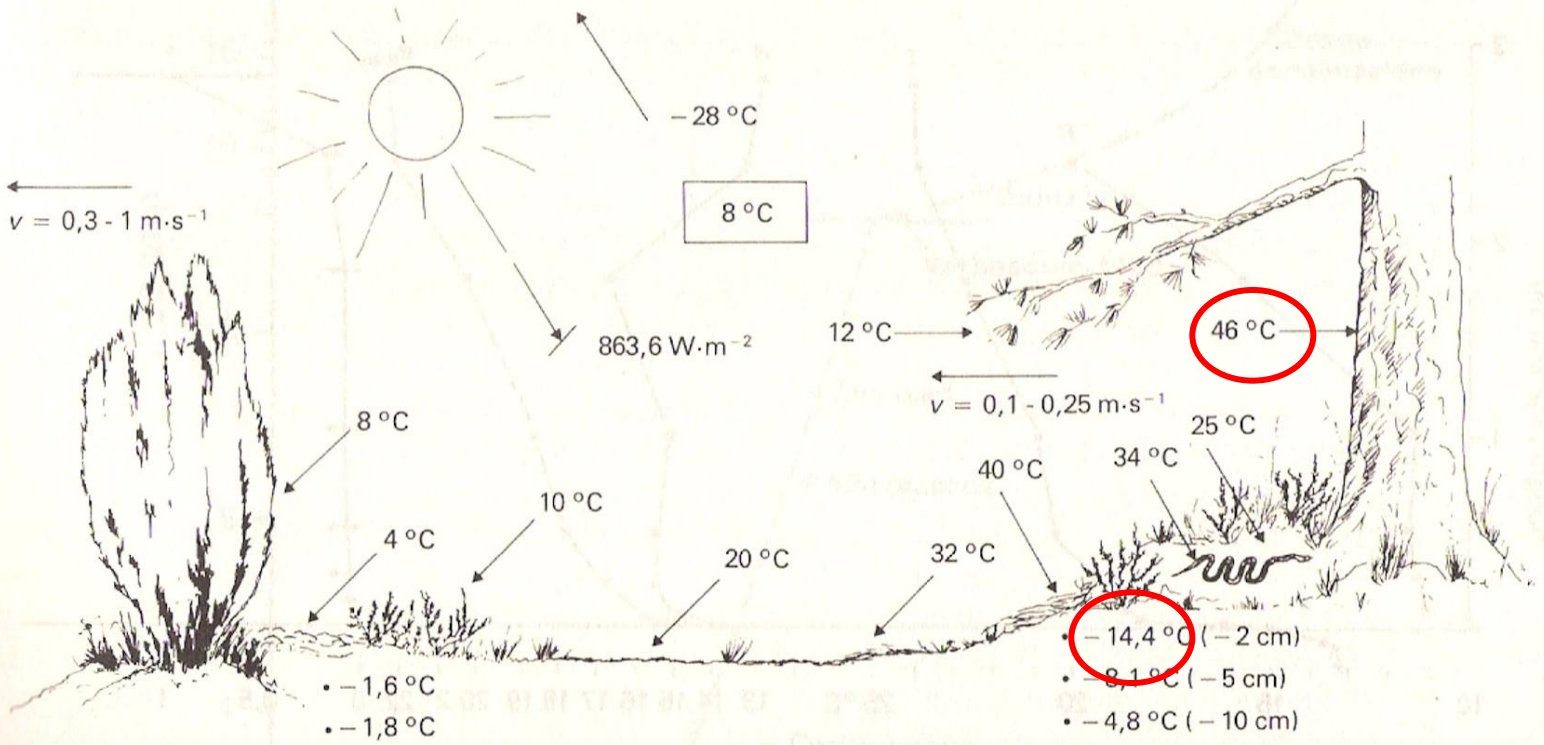
The area of thermophilic species

The center of their distribution is often located in the Meuse valley (limestone slopes to the south: microclimate is warm). Many Mediterranean species reach the northern boundary of their area.

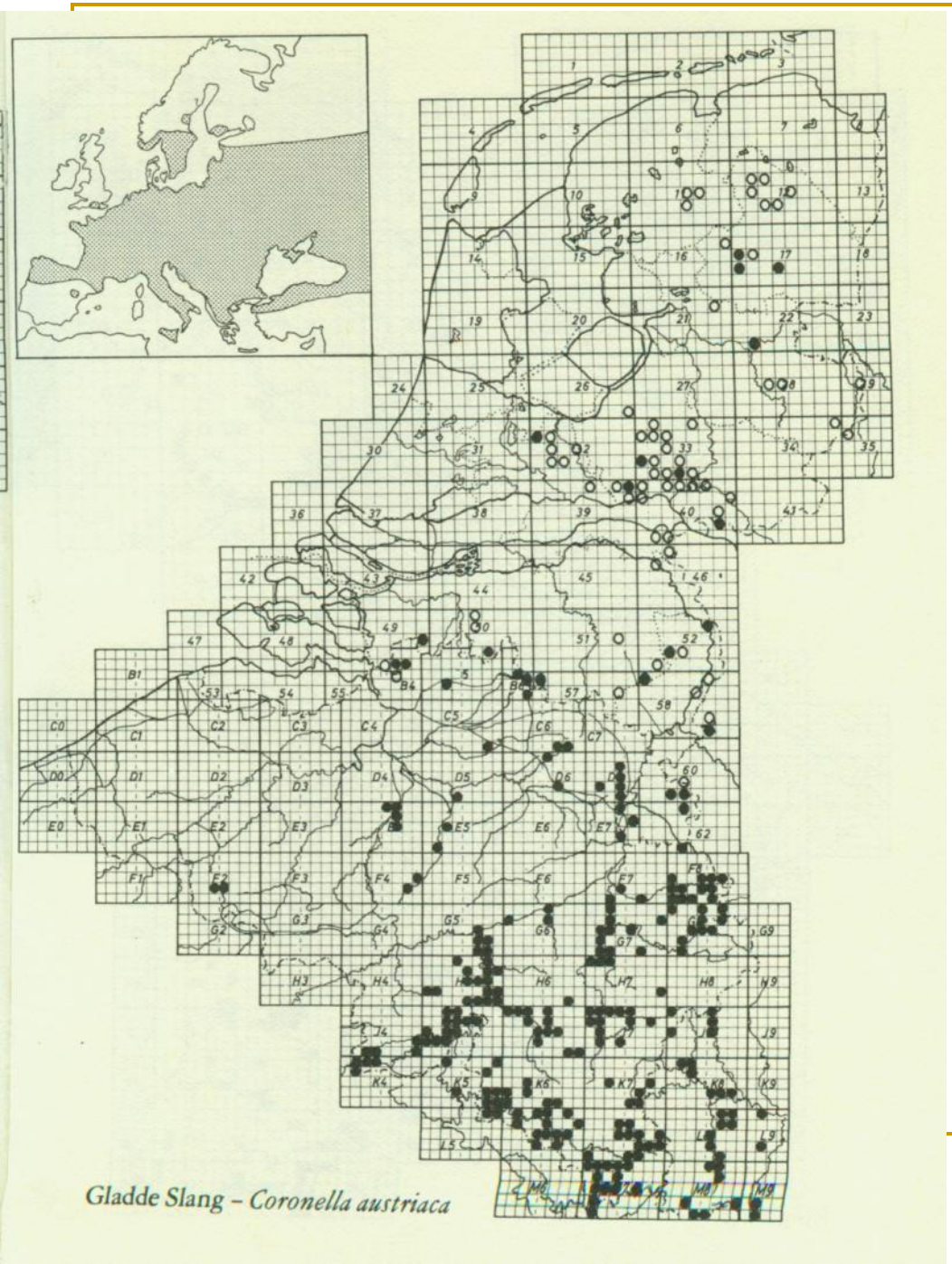
http://www.david.element.ukgateway.net/amphibiansandreptiles6lizards.htm

The concept of a '**microclimate**' illustrated at the edge of a pine forest, on a day end of February, at noon.

(from BAKKER, et al. , 1985)



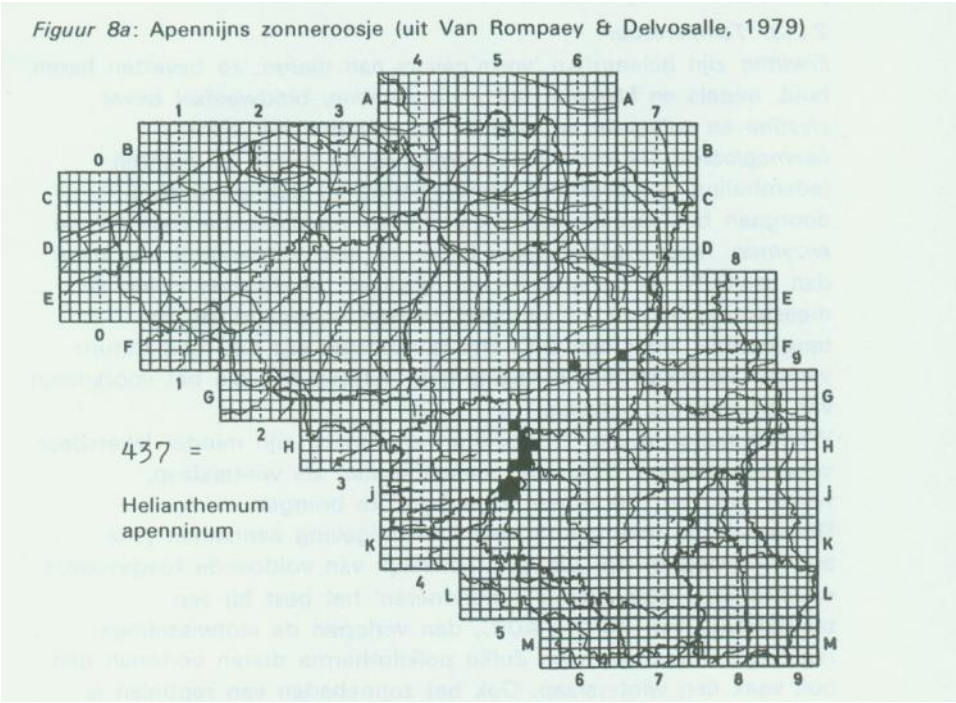
Afbeelding 2-22
Schematische doorsnede van de zuidrand van een dennenbos, waarin de microklimatologische toestand midden op een zonnige dag aan het eind van februari wordt weergegeven. De windsnelheid is met *v* aangegeven. De effectieve stralingstemperatuur van de lucht is –28 °C. De intensiteit van de zonnestraling in een vlak loodrecht op de stralenbundel is 0,79 W·cm⁻². De temperatuur van de lucht is 8 °C. (Uit: Stoutjesdijk, 1966, *Verh. Kon. Ned. Akad. Wetensch., Afd. Natuurk.* 2e Reeks 67.)



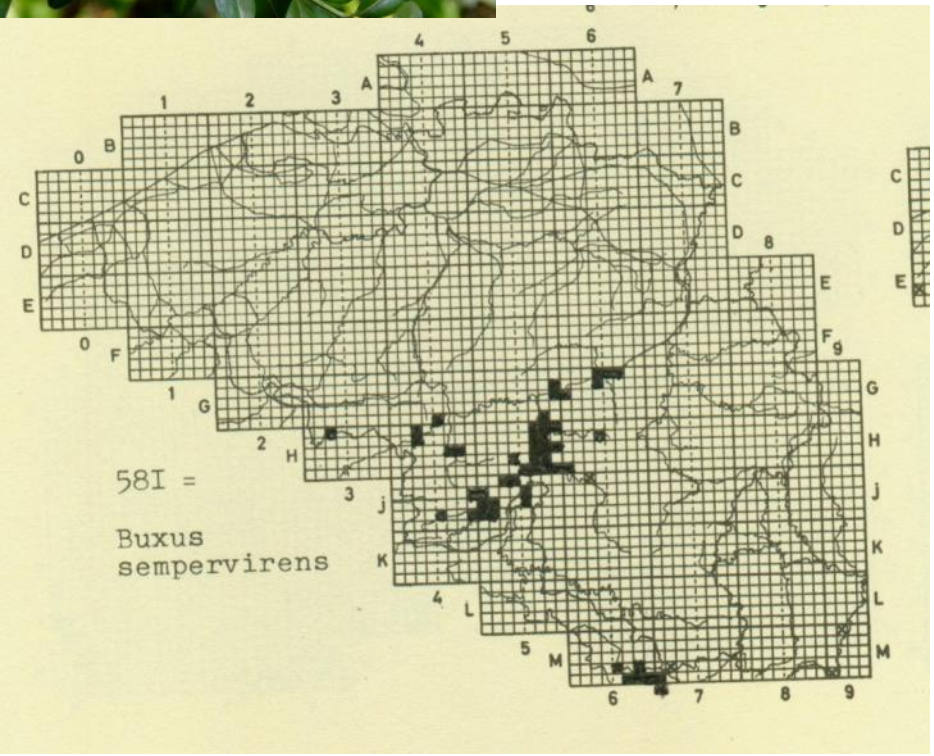
Compare with this area of the **Smooth Snake**, **gladde slang** (*Coronella austriaca*) and explain.

Htt www.herpet.mysites.nl/mypages/herpet/365311.html

The area of the **White Rock Rose, Apennijns Zonneroosje** (*Helianthemum apenninum*) is limited to the so-called thermophilic river-Meuse Triangle (thermofiele Maasdriehoek)



…as the area of the **Box Hedging, Palmboompje** (*Buxus sempervirens*) is.



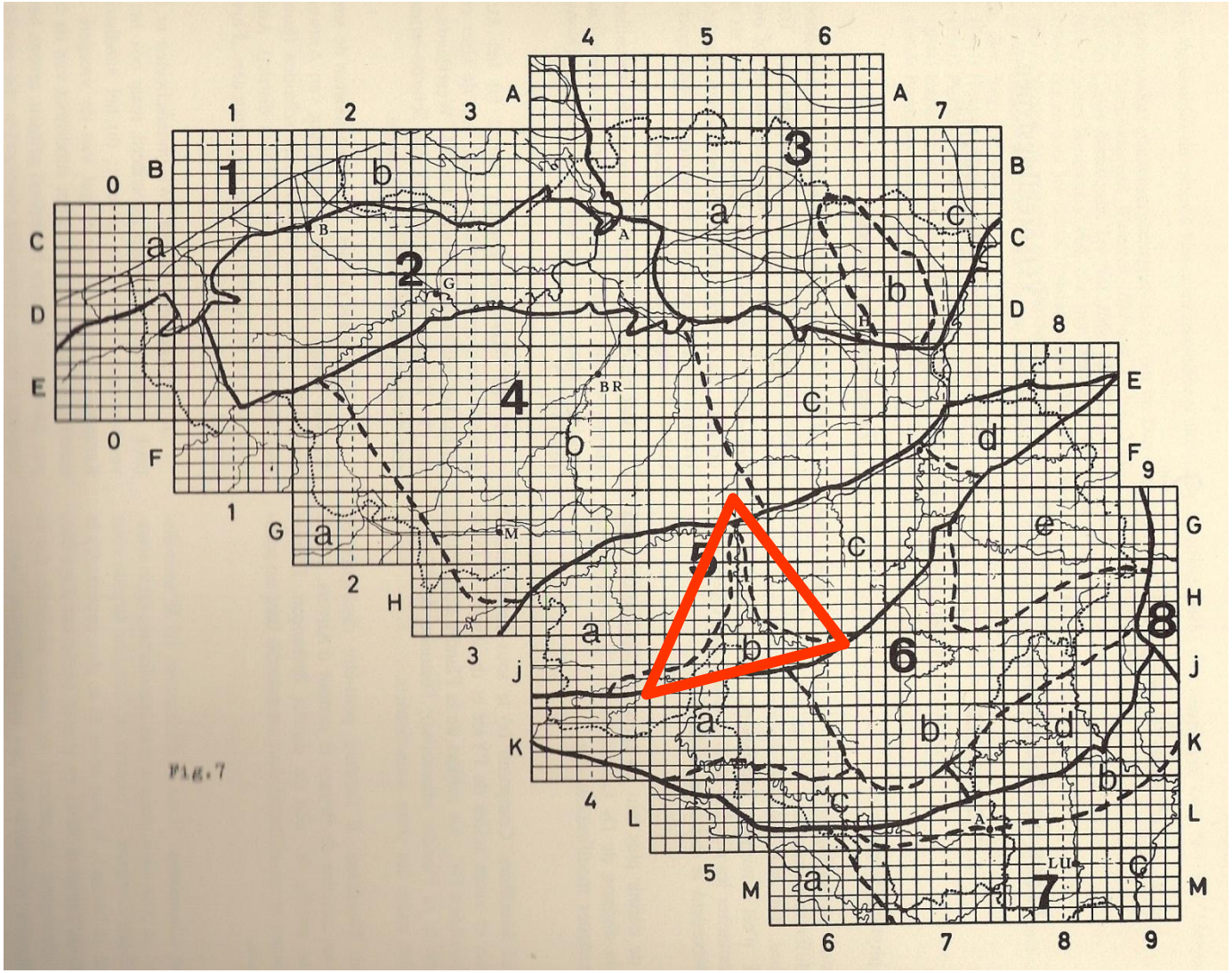
http://www.aphotoflora.com/DevonandCornwall/Buxus%20sempervirens19-09-04.jpg

Subdistricts 'High Ardennes' and 'Thermophilic river-Meuse Triangle'.

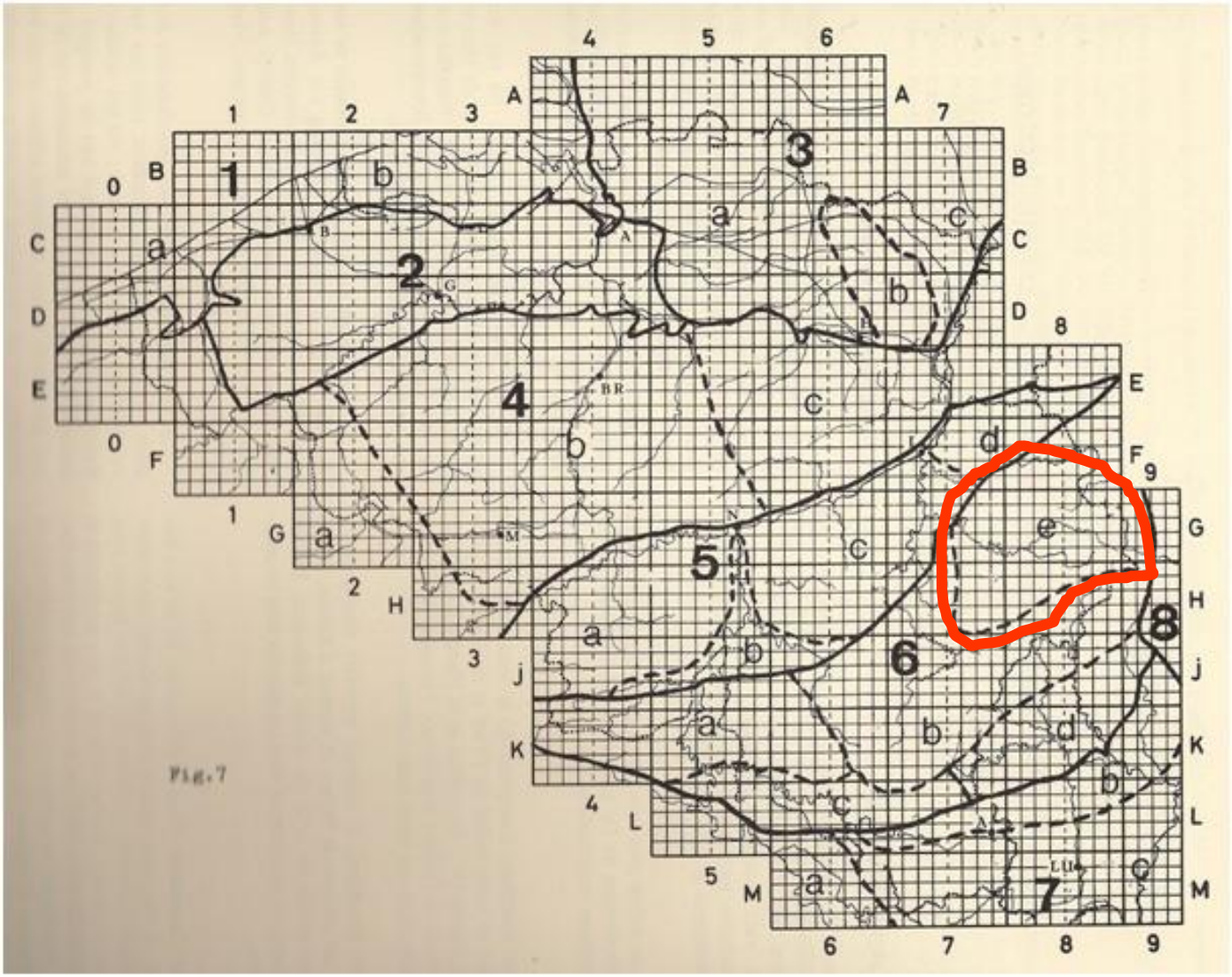
- The biocoenosis 'High Ardennes' contains many northern European species (relicts of the glacial period).
- While in the thermophilic River-Meuse triangle (cities of Dinant-Namen) a lot of southern European species reach the northern border of their area.

Biocoenosis: concept introduced by Karl Möbius in 1877, describes all the interacting organisms living together in a specific habitat or biotope.

Subdistrict the thermophilic ‘river-Meuse Triangle’



Subdistrict ‘the high Ardennes’



LIGHT as an abiotic ecological condition.

A storm destroyed a pine plantation, there is sunlight reaching the soil again.
In the soil a lot of ‘sleeping’ seeds of **heather** (*Calluna vulgaris*), are germinating.

- De Maten (Genk, B.).

  Heather areas are often grazed (goats, sheep, ….) to stop the natural succession (see theme 8) towards woodland (oak-birch wood).

  The presence of **heather** (*Calluna vulgaris*) is linked with the abiotic conditions:

- Light
- Dry
- Sandy
- No lime (acid)
- Few minerals
- ….

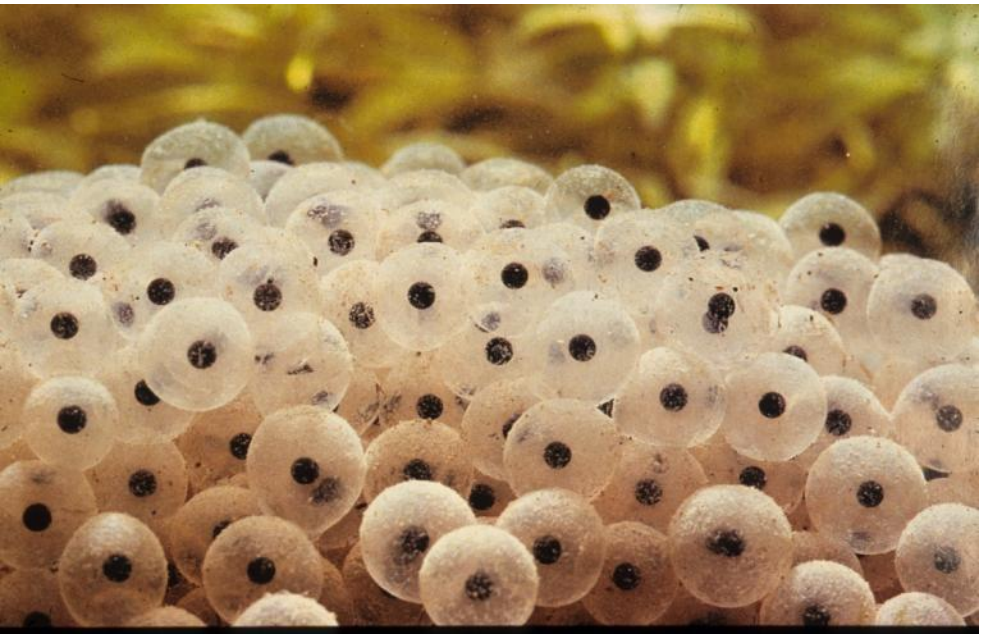
WATER as an abiotic ecological condition.

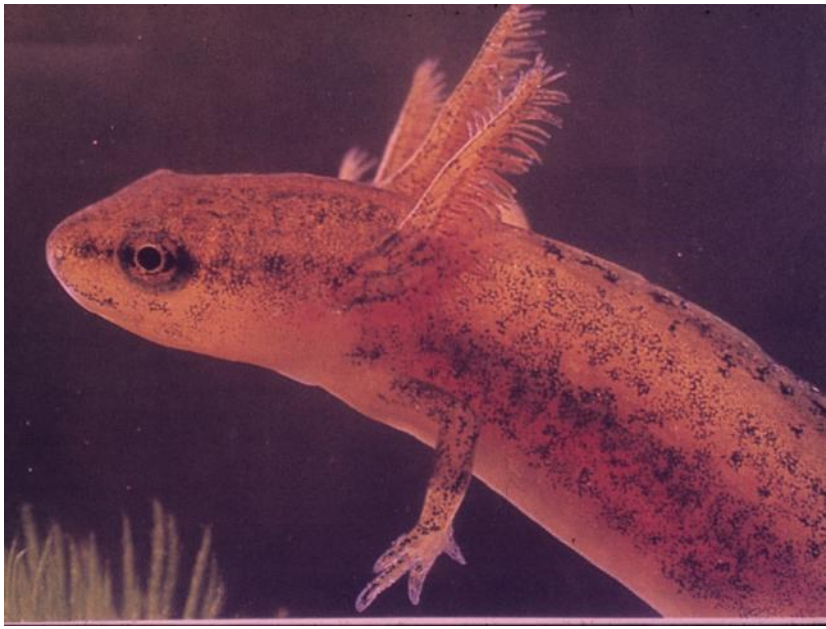
High levels of water, well into the summer are very important to preserve marsh conditions, on which a lot of marsh species depend.
e.g. **Flowering Rush**, **Zwanebloem** (*Butomus umbellatus*).
Kleine Blankaart (Woumen, B.)

Amphibians have no real skin, but a skin mucosa. As a consequence they are so highly dependent on wet conditions.

Amplexus, **the common toad, gewone pad** (*Bufo bufo*)

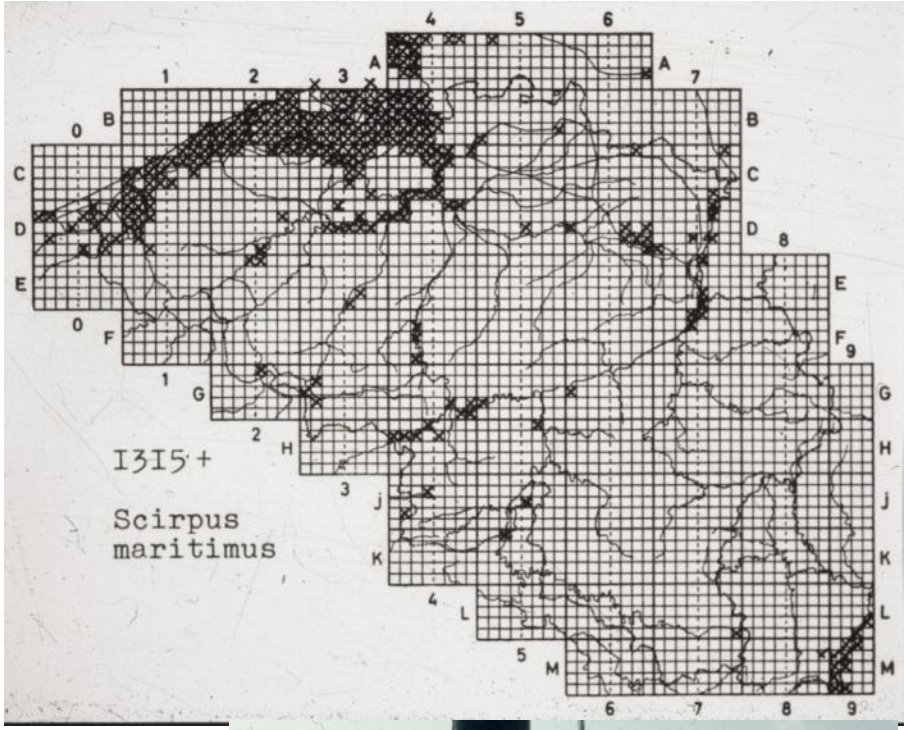
Also what the reproduction is concerned, **amphibians** depend heavily on water: eggs have no shell and the larvae have gills (dehydration!)





Larva of a salamander, with behind the head, the gills.

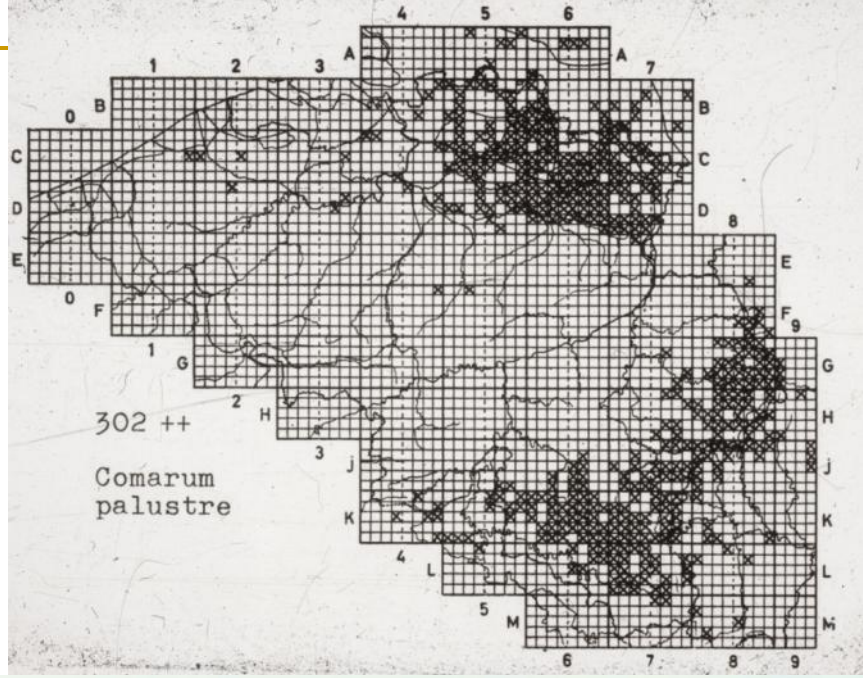
Water **quality** is also important. SALT



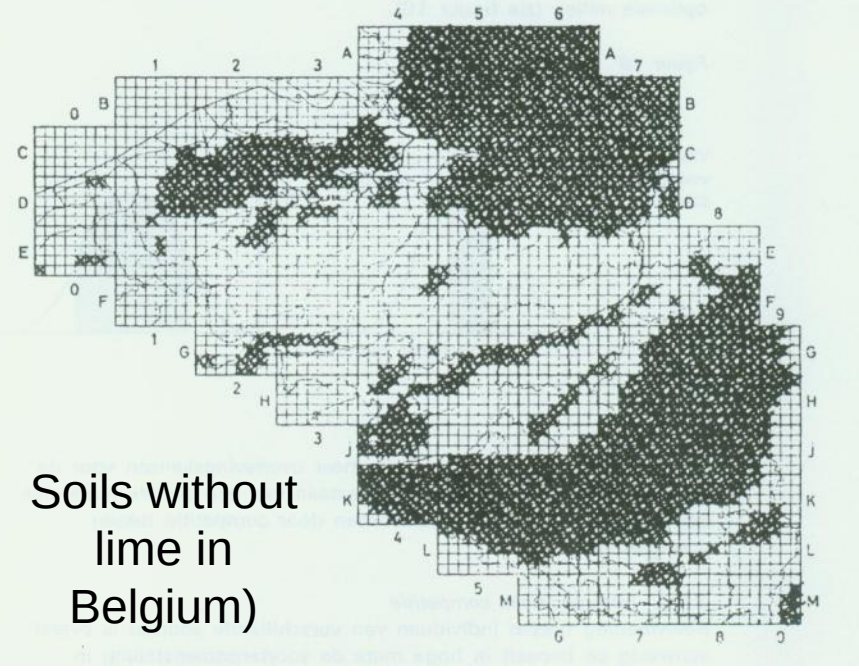
Sea Clubrush, Zeebies (*Scirpus maritimus*)

Water **quality** is also important.
ACID (no lime)

Marsh fivefinger, Wateraardbei
(*Comarum palustre*)

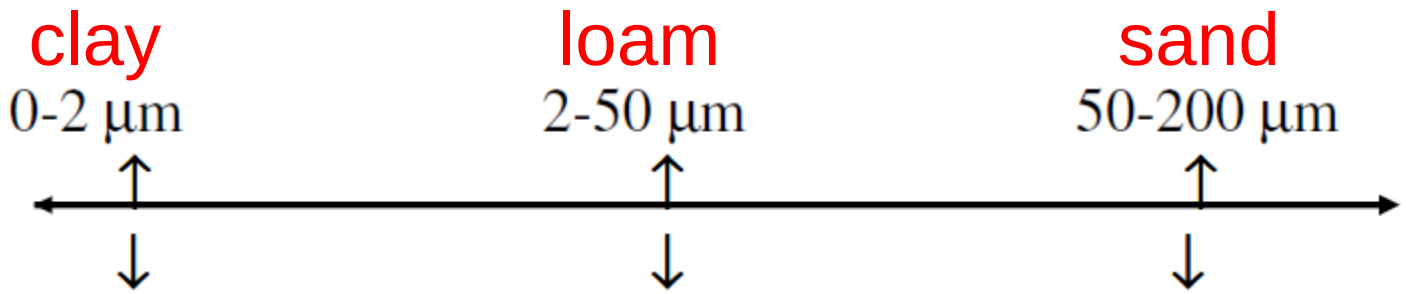


Figuur 9: Hokken die tenminste gedeeltelijk op zure zanden of zure klei gelegen zijn (uit Van Rompaey en Delvosalle)



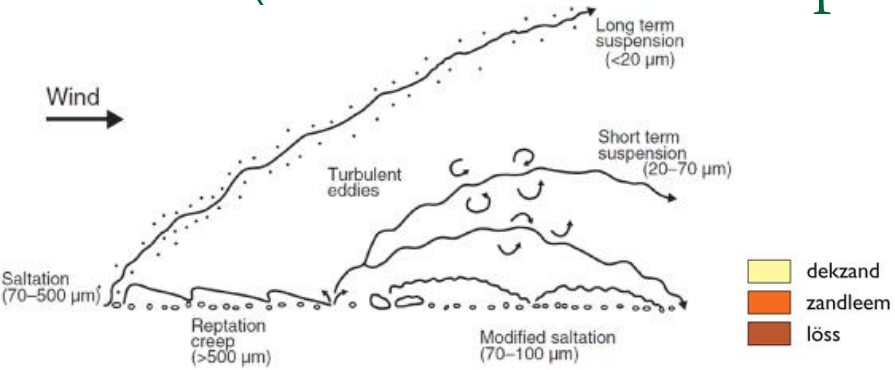
Soils without lime in Belgium)

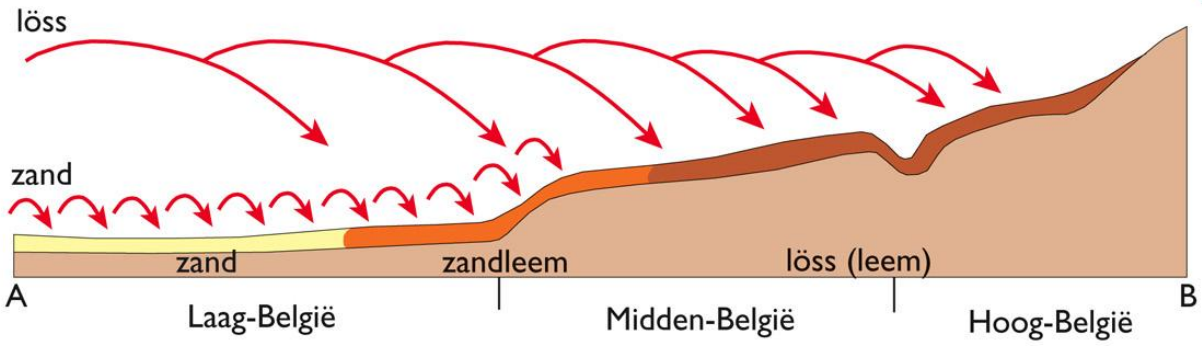
Some consequences of soil texture for some abiotic ecological conditions

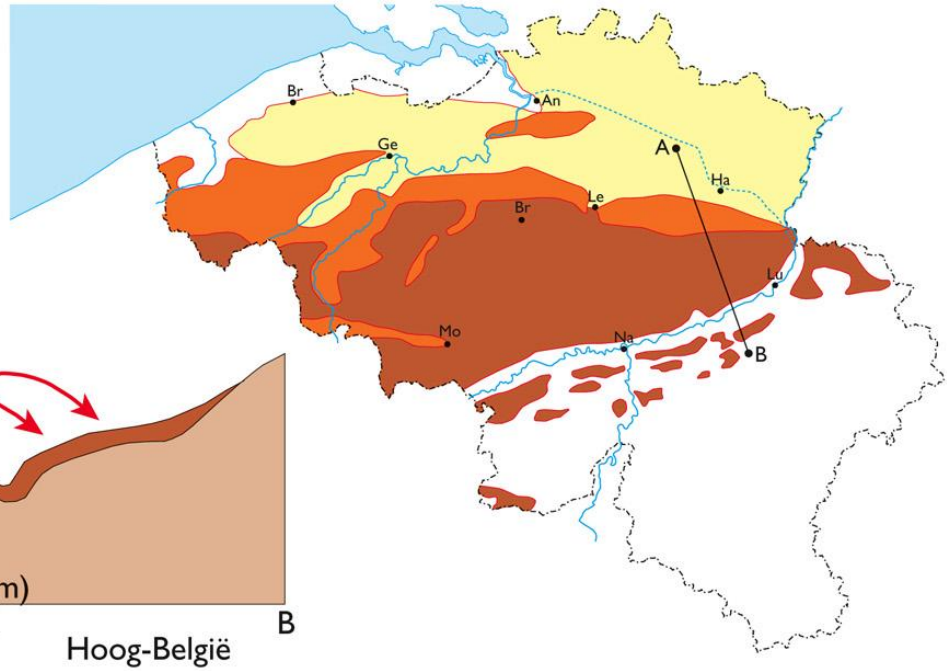


poorly permeable to water: WET	intermediate position	highly permeable to water: DRY
mineral-rich, calcareous and alkaline: pH > 7 **(NO_3^-, PO_4^{3-})**	intermediate position	mineral-poor, lime-poor, acid: pH < 7
good conductor of heat	intermediate position	bad conductor of heat (temperature extremes)

The soils in Lower and Middle Belgium landed during the last Würm ice age (niveo-aeolian transport from the dry North Sea).

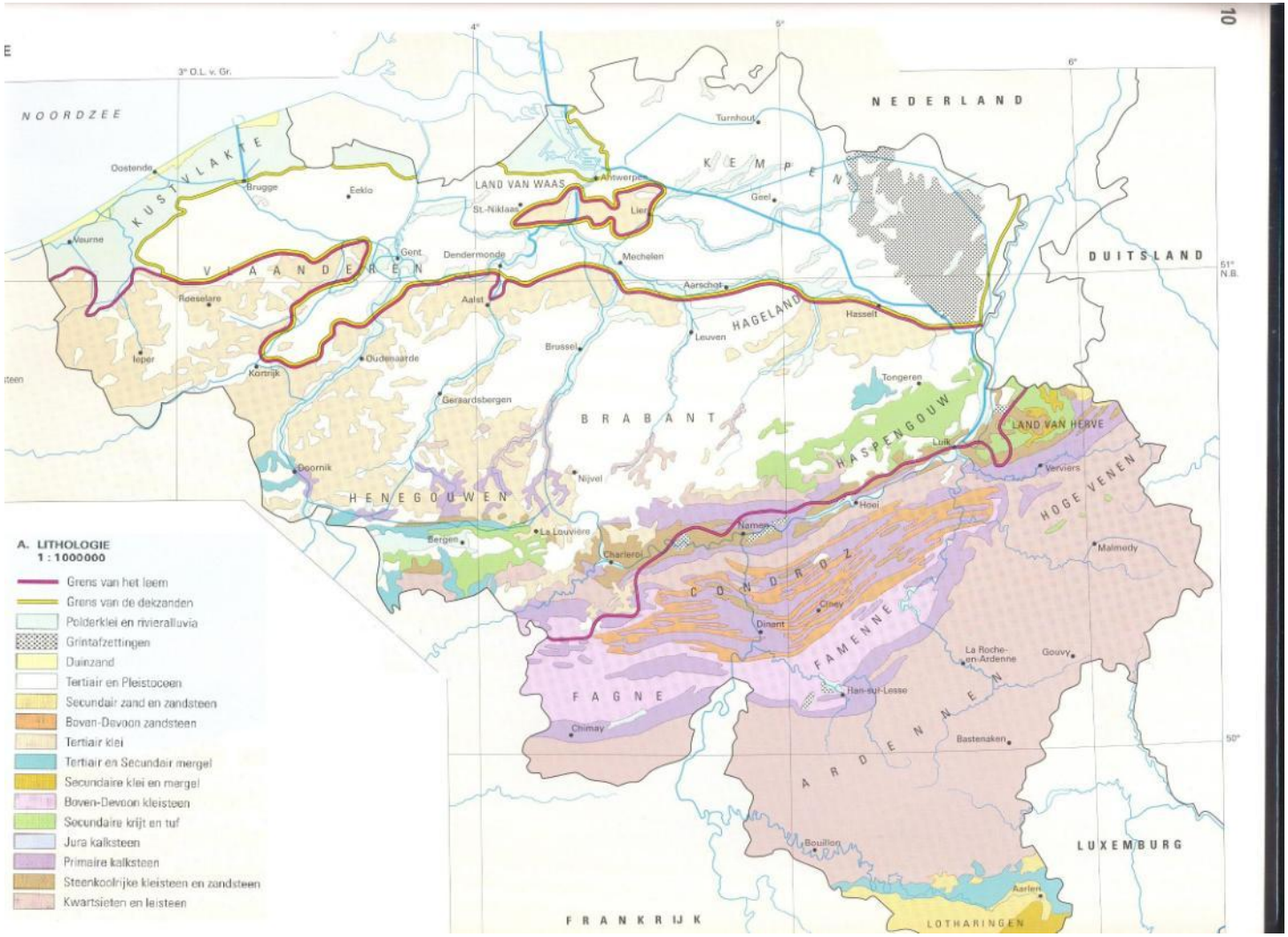






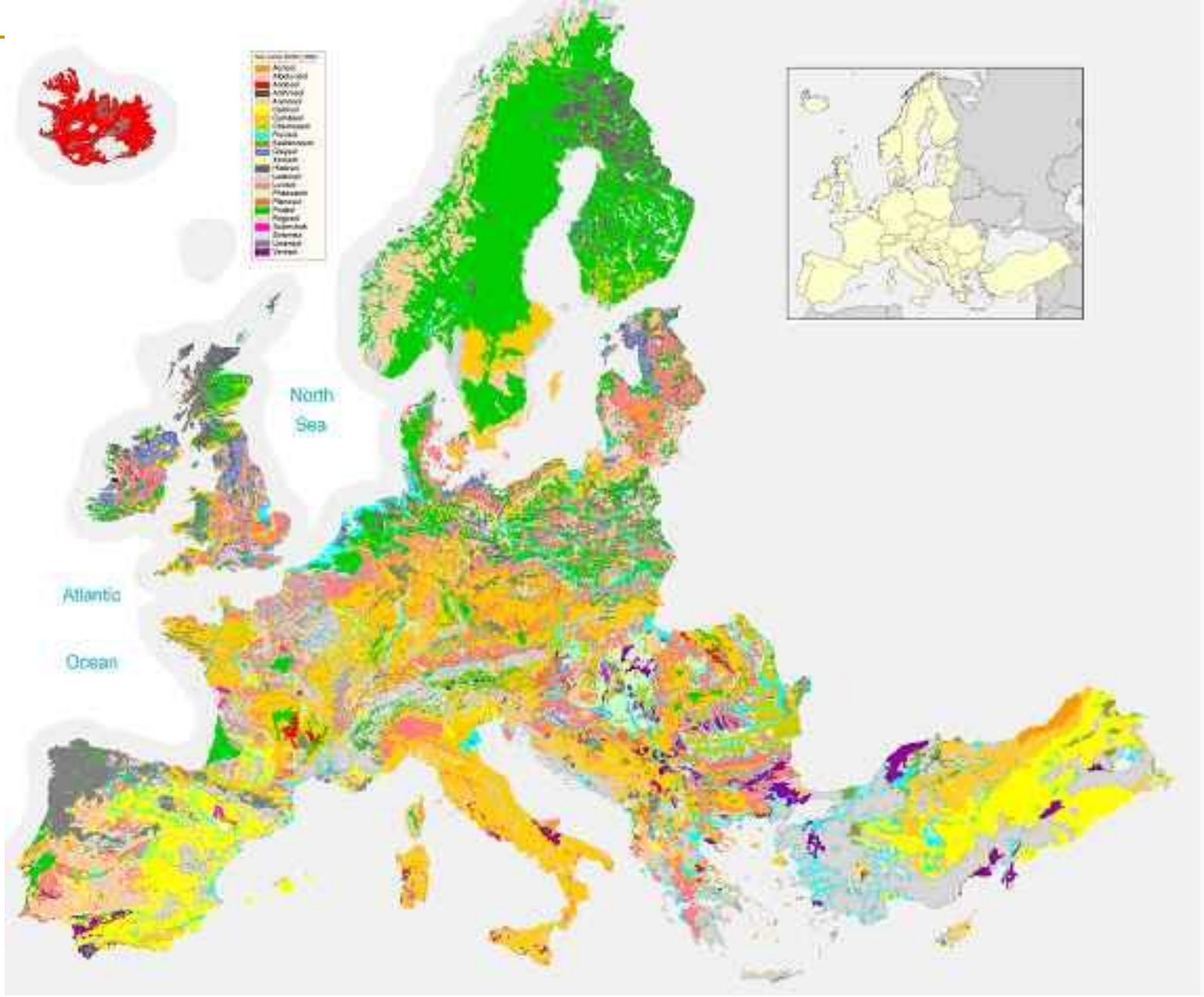
The lighter clay particles were transported further inland than the heavier sand grains.

The soils in Lower and Middle Belgium landed during the last ice age (niveo-aeolian transport from the dry North Sea).



The lighter loam particles were transported further inland than the heavier sand grains.

European soils map



http://eusoils.jrc.ec.europa.eu/projects/soil_atlas/Atlas_Contents.html

Presence of zinc ore (or waste) in soils is shown by plants bio-indicators or 'alarm plants'.

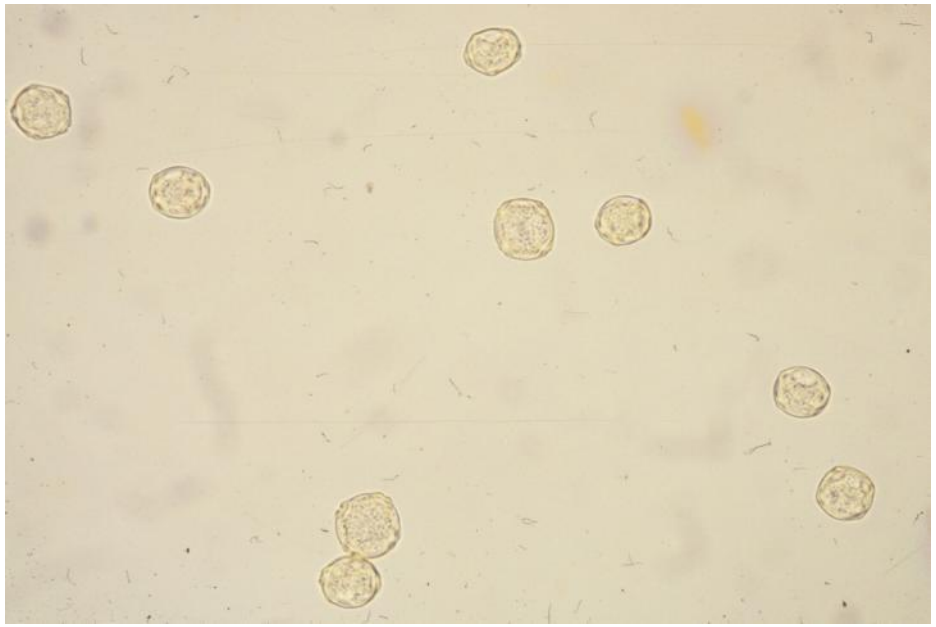
Bladder Campion, Blaassilene (*Silene vulgaris*)

Zinc Pansy, Zinkviooltje (*Viola calaminaria*)

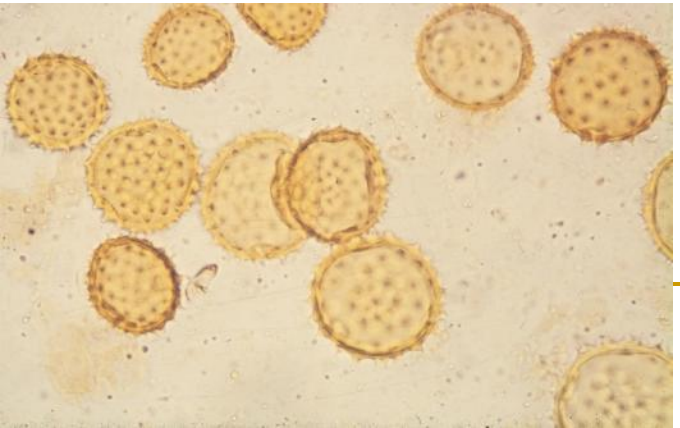
WIND as abiotic ecological condition.

Ambleteuse (Fr.): Dunes are formed by a combination of wind, sand and vegetation. Shifting sands caused by irrational recreation.

Wind pollination in the **hazel, hazelaar** (*Corylus avellana*)



Flowers and <u>smooth</u> pollen from **hazel**.



Compare with <u>prickly</u> pollen from a insect pollinator as **coltsfoot, klein hoefblad** (*Tussilago farfara*) .

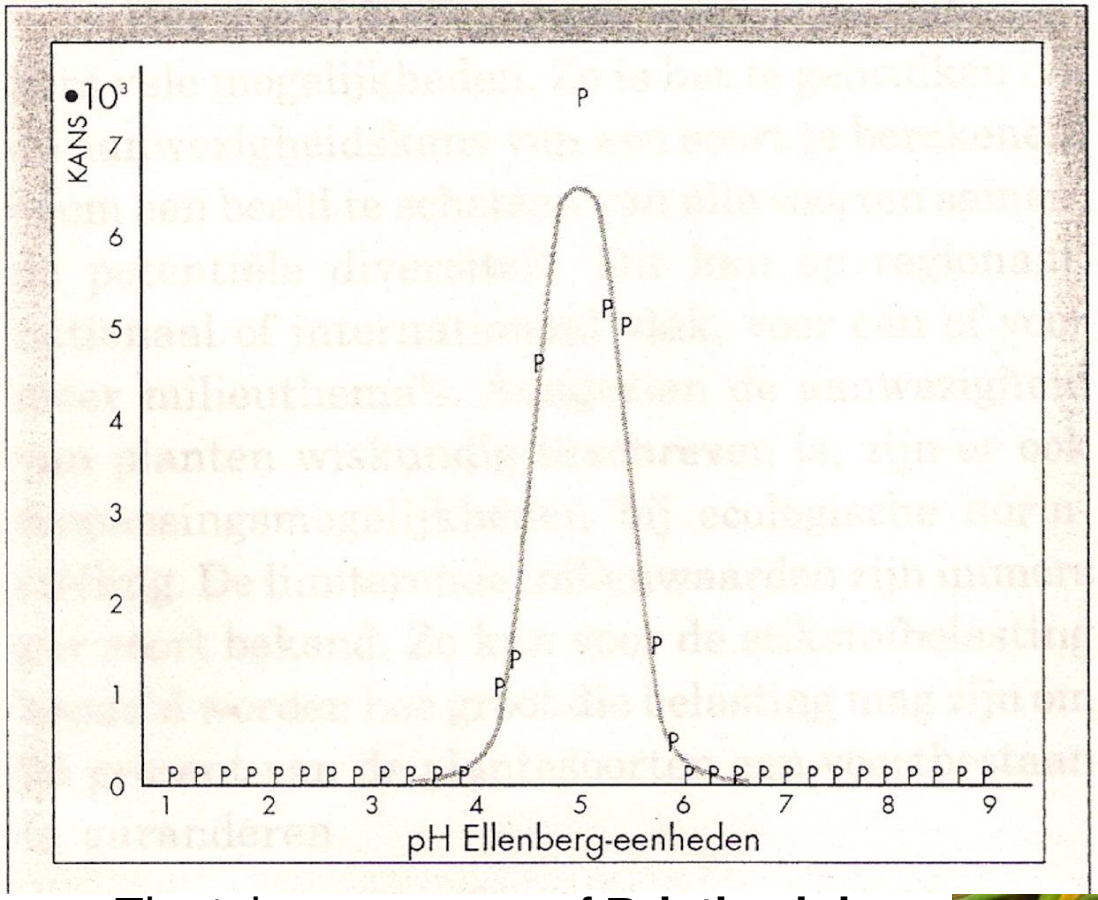
Spreading the fruits by the wind

Lichens are **bio-indicators** for air quality.

Clean air: rich lichen vegetation (Scotland)

Yellow stone lichen *(Xanthoria parietina)* points to dirty air

Bio-indicators.

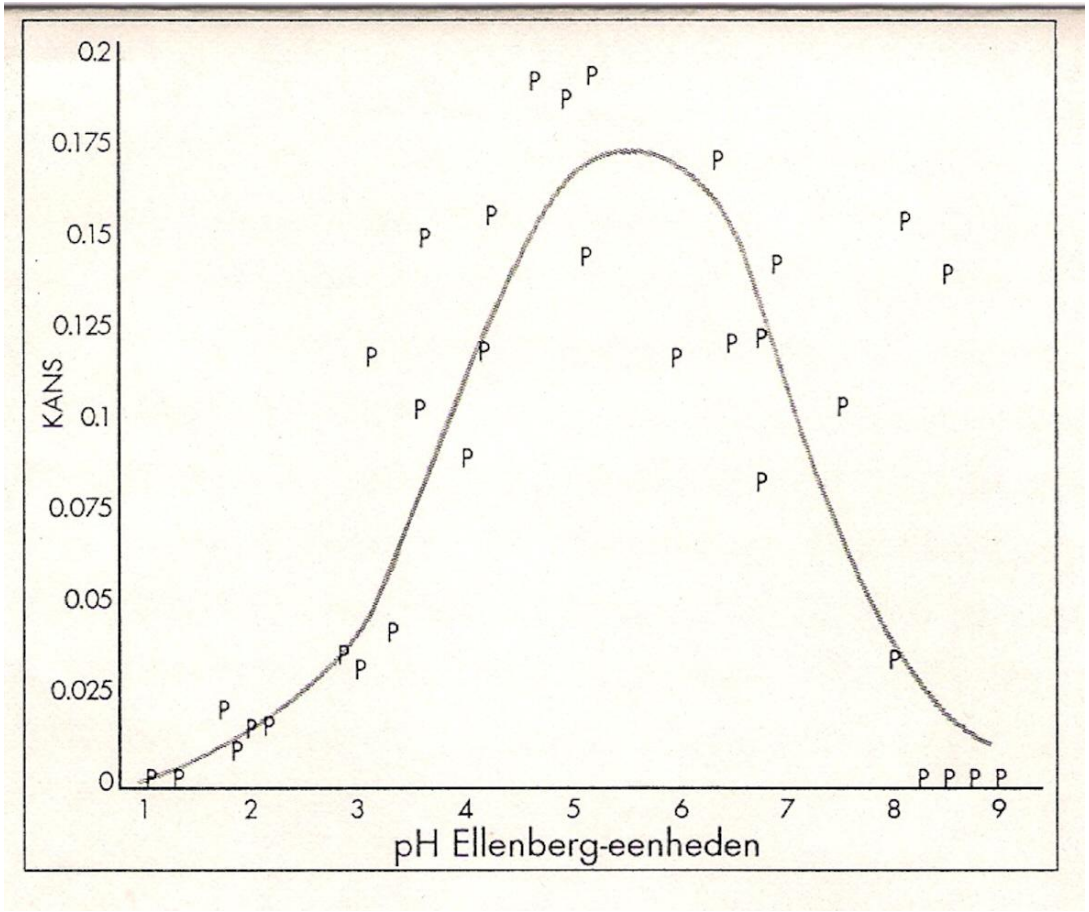


www.wilde-planten.nl/borstelbies.htm

The tolerance curve of **Bristle club-rush, borstelbies** *(Isolepis setacea)* is narrow, so this plant has a great information value.

Bron: Boomblad, sep. 1993

Foto: Phil Smith, www.british-wild-flowers.co.uk



The tolerance curve of **Creeping Bentgrass Fioringras** (*Agrostis stolonifera*) is broad. This grass has little information value about the surroundings.

Bron: Boomblad, sep. 1993

http://scheldeschorren.be/cms/index.php?page=fioringras---agrostis-stolonifera

Indicator values in literature (see lecture for explanation).

Doorgedreven onderzoek maakte het mogelijk de optima van planten ten aanzien van diverse abiotische oecologische factoren te omschrijven. Londo (1975) en Ellenberg (1974, 1979) maakten daarbij geen gebruik van absolute cijfergegevens maar van rangwaarden (rank) die slechts vergelijkend kunnen gebruikt worden.

Ellenberg (1974, 1979) geeft voor de Middeneuropese vaatplanten indicatorwaarden aan voor diverse abiotische factoren:

L Lichtgetal (schaduwplant → lichtplant. L: 1 → 9)
T Temperatuurgetal (weinig thermofiel → sterk thermofiel. T: 1 → 9)
K Kontinentaliteitsgetal (oceanisch → kontinentaal. K: 1 → 9)
F Vochtigheidsgetal (xerofiel → waterplant. F: 1 → 12)
R Bodemreactie (pH) (zuurminnend → kalkminnend. R: 1 → 9)
N Stikstofgetal (stikstofmijdend → nitrofiel. N: 1 → 9)
CL Zoutgetal (zoutmijdend → zoutminnend. I → III)

Londo (1975) beperkte zich tot het aangeven van de tolerantie van planten t.o.v. het grondwater in een 7-tal groepen opgesplitst.

Stieperaere en Fransen (1982) berekenden voor de inheemse Belgische flora zeldzaamheidswaarden. Ze baseerden zich daarbij op de Atlas van de Belgische en Luxemburgse flora (Van Rompaey & Delvosalle, 1979) en verdeelden de soorten over uurhokfrequentieklassen. Deze werden als indicatie van hun zeldzaamheid beschouwd.

Examples out of the Ellenberg (1974, 1979) list.

Name	Ökologisches Verhalten L	T	K	F	R	N	sonst.
Alchemilla							
alpina agg	9	2	2	5	2	2	–
fissa	8	1	4	6	2	3	–
hoppeana	9	2	4	5	9	2	–
vulgaris agg	6	4	3	6	×	6	–
Alisma							
plantago-aqu., +agg	7	×	×	10	×	8	–
Alliaria							
petiolata	5	6	3	5	7	9	–
Allium							
angulosum	8	6	7	8	~ 8	2	–
montanum	9	6	5	2	7	2	–
sphaerocephalon	9	8	5	3	8	2	–
suaveolens	9	6	5	8	~ 9	2	–
ursinum	2	×	2	6	7	8	–
vineale	5	7	3	4	×	7	–
Agrostis							
alpina	8	1	2	5	6	6	–
canina, +agg	9	×	5	9	3	2	–
rupestris	7	1	2	4	2	1	–
stolonifera, +agg	8	×	×	6	~ ×	5	1
– gigantea	7	×	3	8	7	6	–
tenuis	7	×	3	×	3	3	–
Aira							
caryophyllea	9	×	2	3	3	1	–
praecox	9	7	2	3	2	1	–

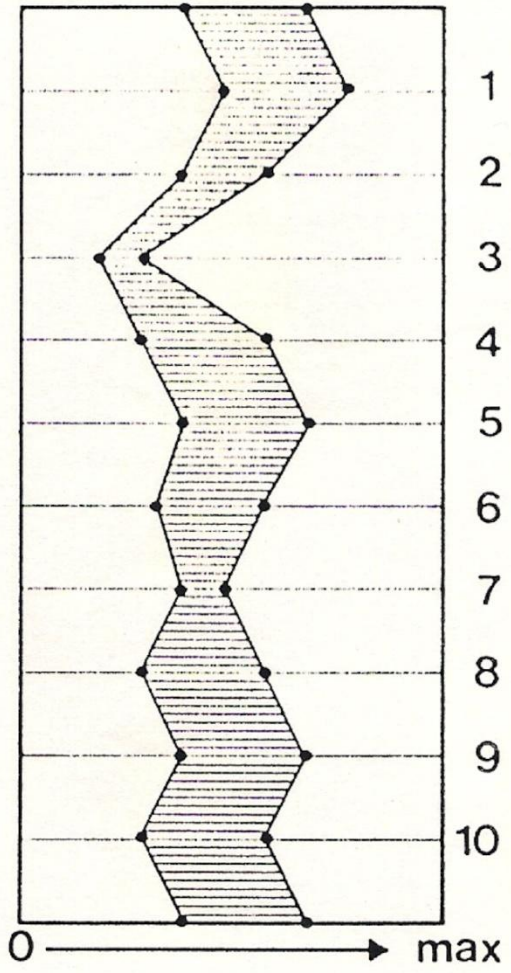
Waterweegbree is a water plant

Daslook is a forest plant

Moerasstruisgras grows in light marshes.

Such indicator lists can also be used in landscaping and gardening, they can prevent wrong choices in sowing or planting.

The environment of a species.



Amount of lime

pH

wind

Amount of loam

Grazing pressure

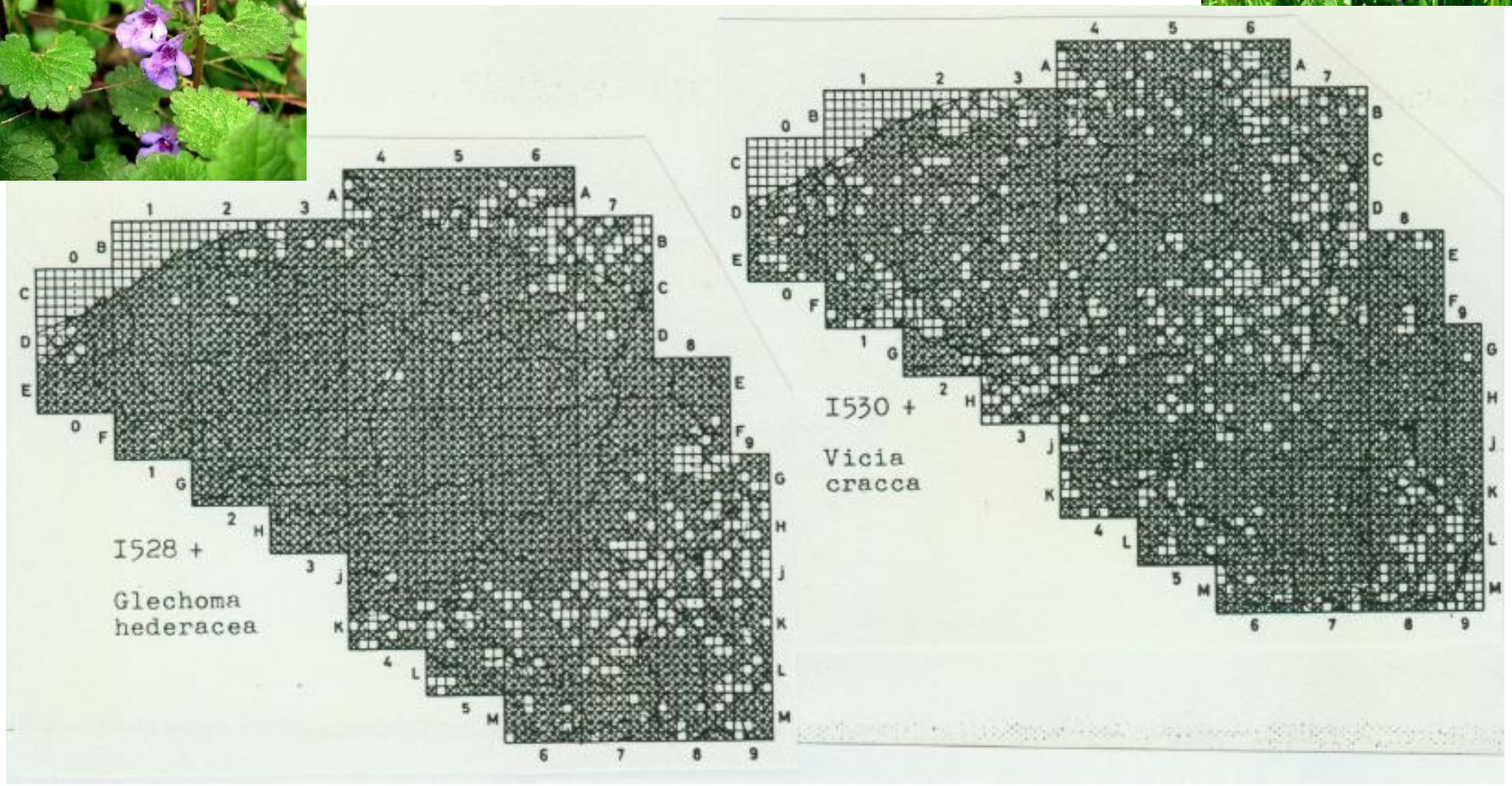
mowing frequency

Etc….

The environment of a species is favorable, when *all* environmental conditions (both abiotic and biotic) are in order, that means within the tolerance width of the species. (in this case the shaded area of the diagram, left).

from SCHROEVERS, 1982

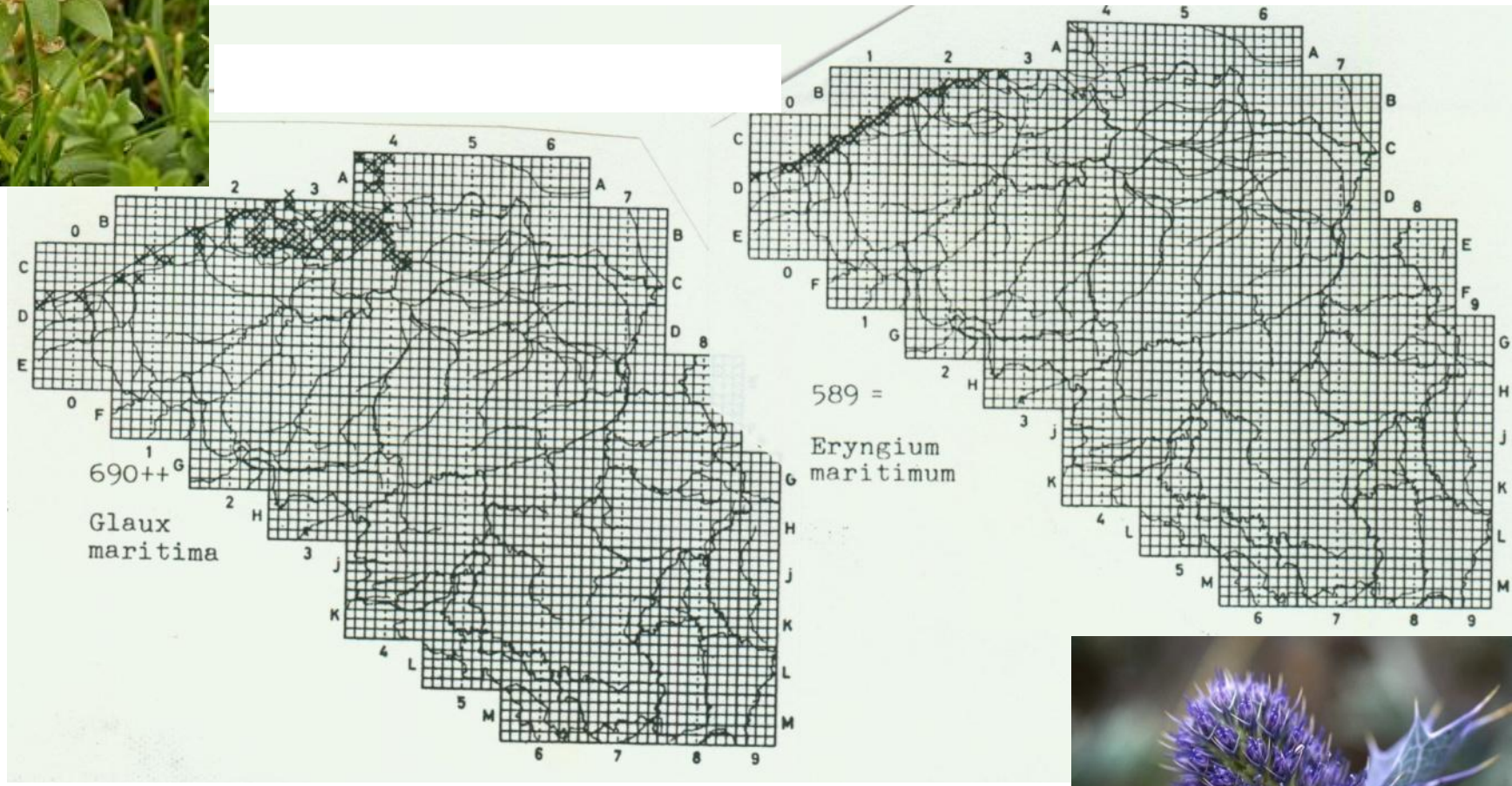
Some species have a very large area



Ground Ivy, Hondsdraf (l.) and **Cow Vetch, Vogelwikke** (r.) have a wide tolerance for many environmental conditions and are very common in the whole country.

http://www.de-natuur.be/temp/es_page_sections_img_thumb_5892_.jpg

Other species are very rare because the necessary abiotic ecological conditions are rare, on a Belgian scale

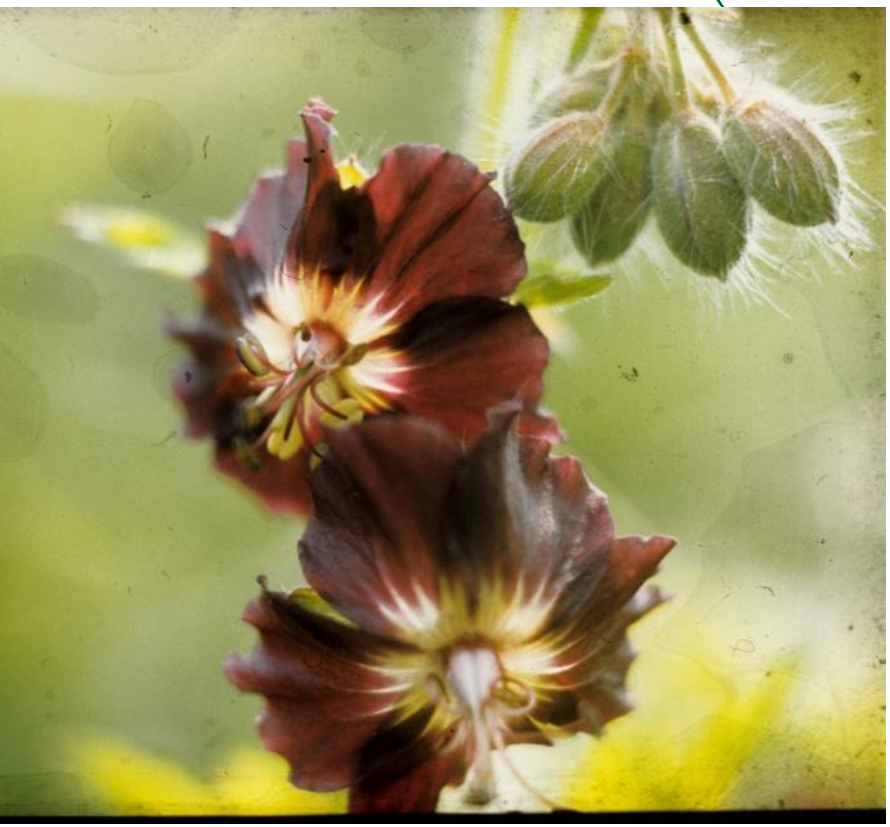


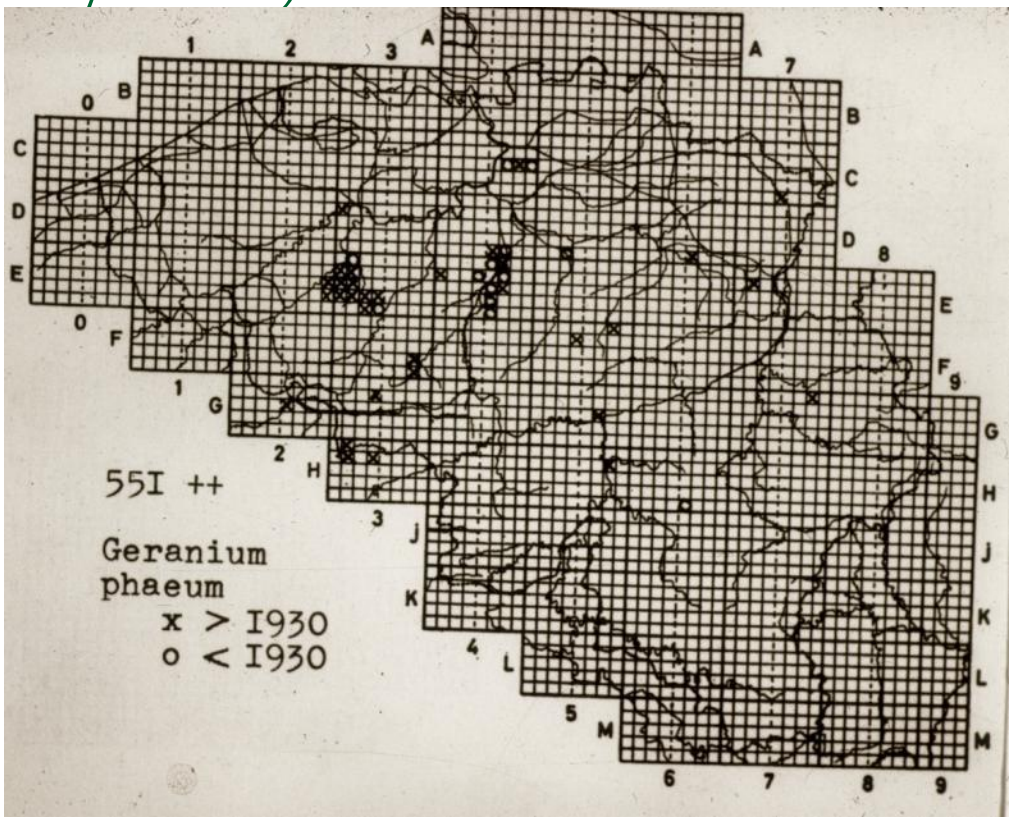
Sea Milkwort, Melkkruid (l.) en **Sea Holly**, **zeedistel** (r.) are maritime species http://www.nlnatuur.nl ; http://www.floralimages.co.uk/pglauxmarit.htm

Sometimes the cause of limited area still unclear

E.g. **Mourning widow, _donkere ooievaarsbek**

(*Geranium phaeum*)



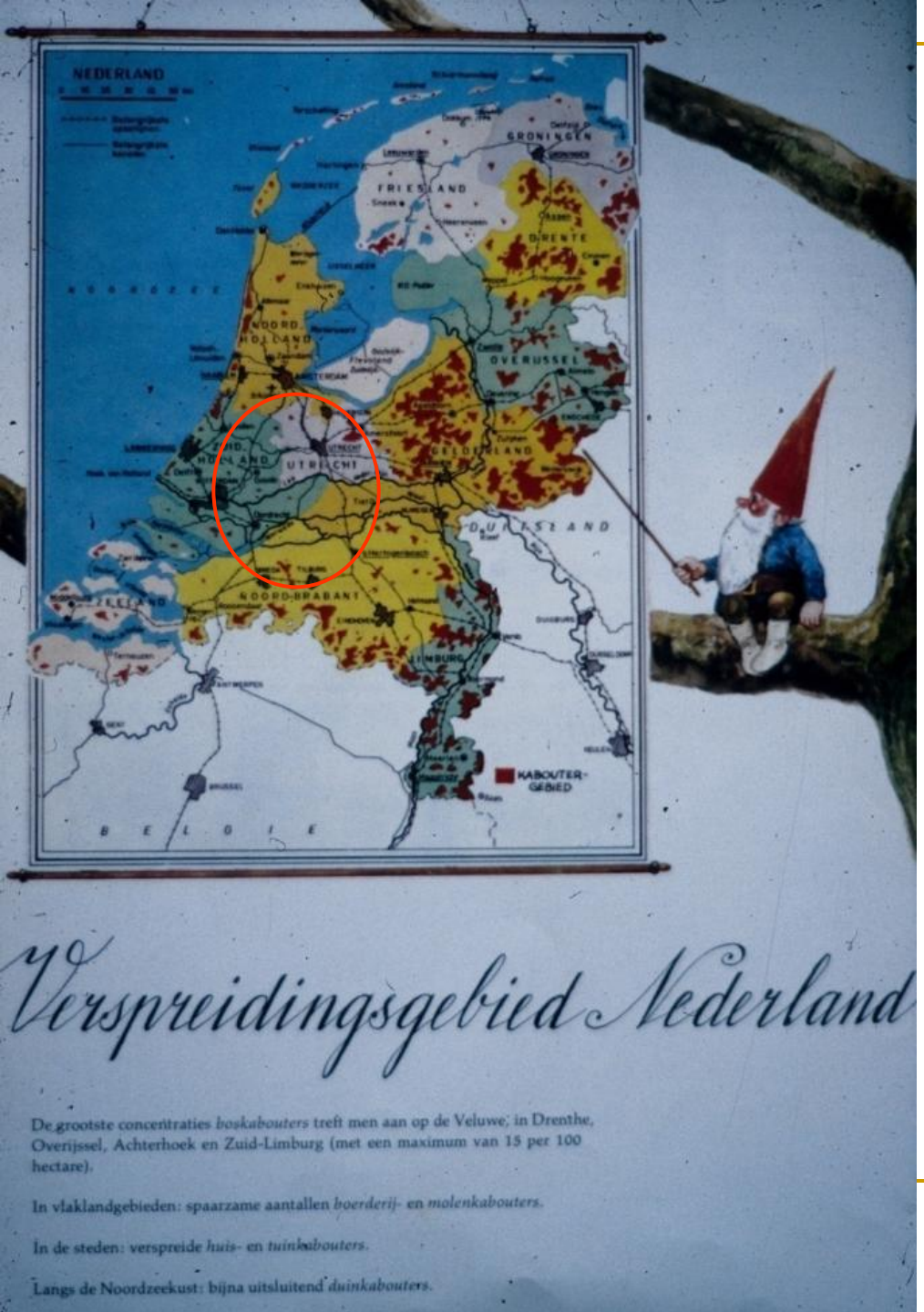


Sometimes humans plays a clear role

E.g. **'Purple toothwort', paarse schubwortel (*Lathraea clandestina*).**

This aromatic parasitic plant is common in the ‘Flemish Ardennes’ This species grows often parasitic on fruit trees and poplars.

May have been imported from southern France with poplar wood needed for the ‘matches industry’ near the municipality of Geraardsbergen



Area Map of the **Gnome** in the Netherlands (source : Rien Poortvliet)

This area map corresponds well with the map of the great natural areas in the Netherlands. The species avoids urban areas (Amsterdam, Rotterdam, Randstad)

This is the area of **"human imagination"** which coincides with the area of the Dutch nature reserves.

See lesson for further interpretation

A link is suspected with the **Fly agaric, vliegenzwam** (*Amanita muscaria*) ….

Gnomes might use them as their dwelling …..

BIOTIC ECOLOGICAL FACTORS.

Intra-specific factors (relationships between conspecific organisms)

- Group effect : positive effects of a minimum group size:

Elephants: 25 ex.

Reindeer: 300 à 400 ex.

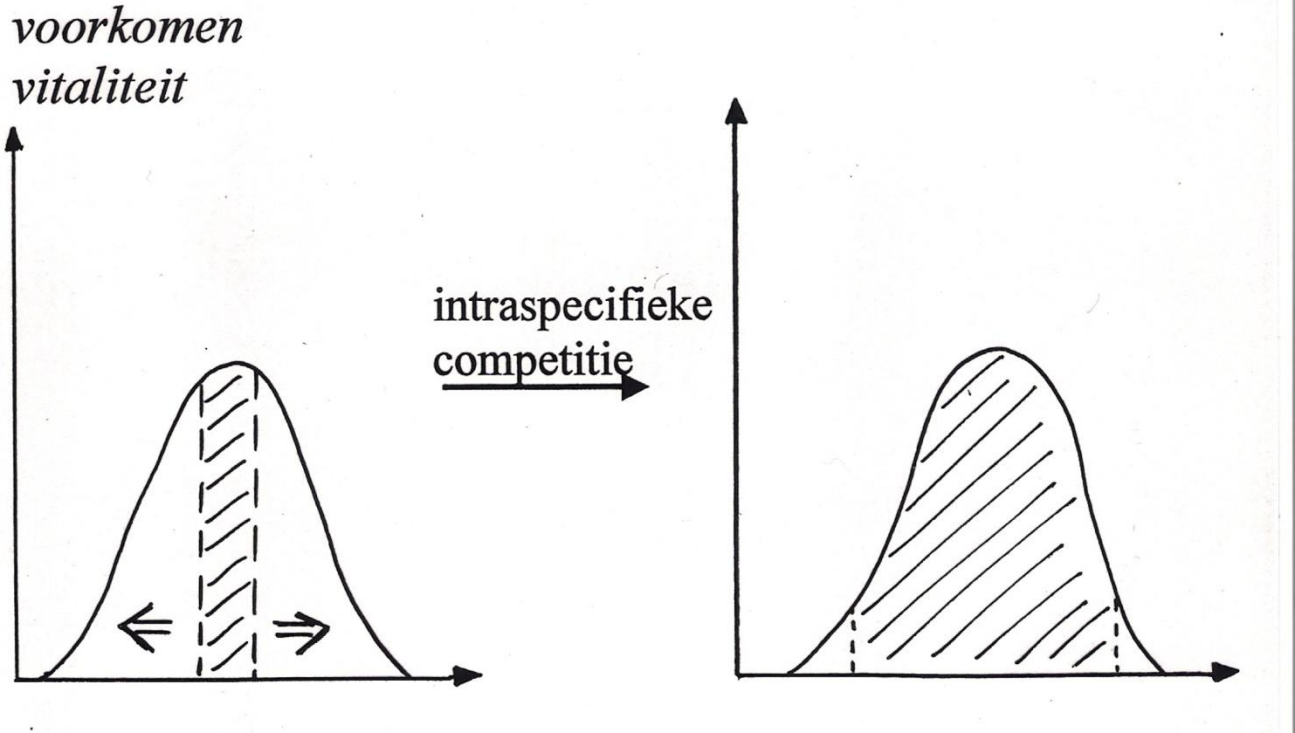
…

- Intra-specific Competition : negative for individuals, positive for the species with following consequences:

territorial behaviour

social hierarchies

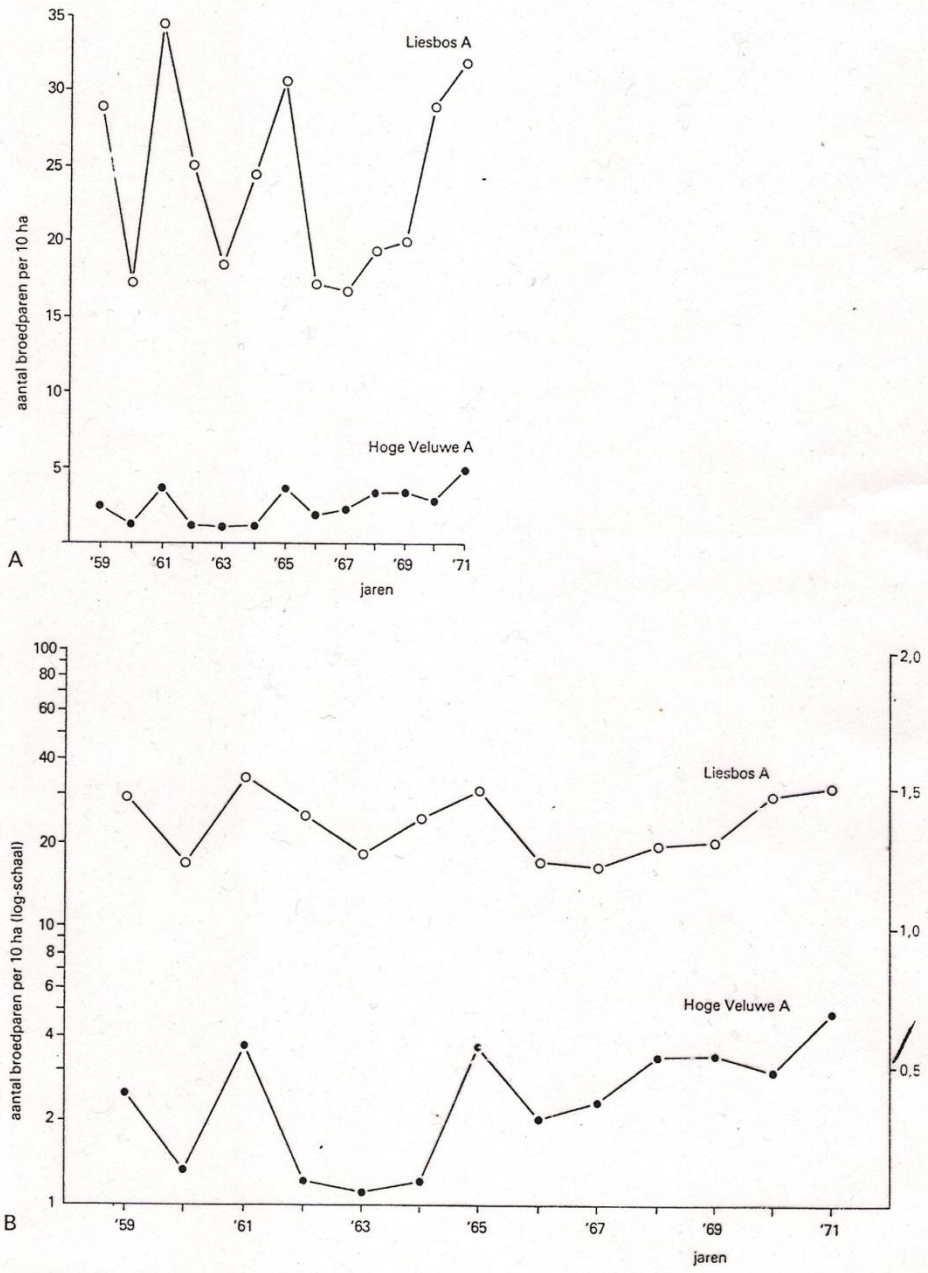
<u>enlargement area :</u>



An example:
great tit, koolmees
(*Parus major*)

Great tits have a preference for deciduous forests, but if the population gets too big, some will be forced by competition to suboptimal coniferous forest. One advantage for the entire population is risk diversification

http://www.bio.davidson.edu



Afbeelding 8-1
Aantal broedparen van de Koolmees in een loofbos (Liesbos A) en een dennenbos (Hoge Veluwe A) over de 1959-1971. A ordinaat lineaire schaal; B ordinaat logaritmische schaal. (Naar: Van Balen, 1973, *Ardea 61*, en persoonlijke mededelingen.)

The principle of the competitive exclusion (GAUSE ,1934)

Inter-specific factors (relations between different species):

When two different species are asking exactly the same conditions from their environment (the same *resources, food, nesting place,* …), the strongest species will ultimately supplant the weaker.

This is the **principle of the competitive exclusion (GAUSE, 1934)**

E.g.

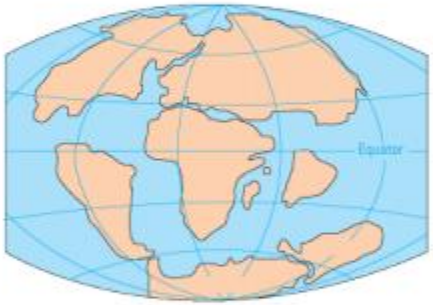
- Cuckoo's Nest
- gray squirrel (N.Am.) expels brown squirrel.
- muskrat expels black and brown rat.
- Pests such as: **Canadian Waterweed, waterpest** (*Elodea canadensis)* Europa ca. 1835) ; **black cherry, Amerikaanse vogelkers** (*Prunus serotina)*
- Australia: rabbit (mammal) versus marsupials. (see oral course)

Continental drift theorie (Wegener, 1911)

PERMIAN
225 million years ago

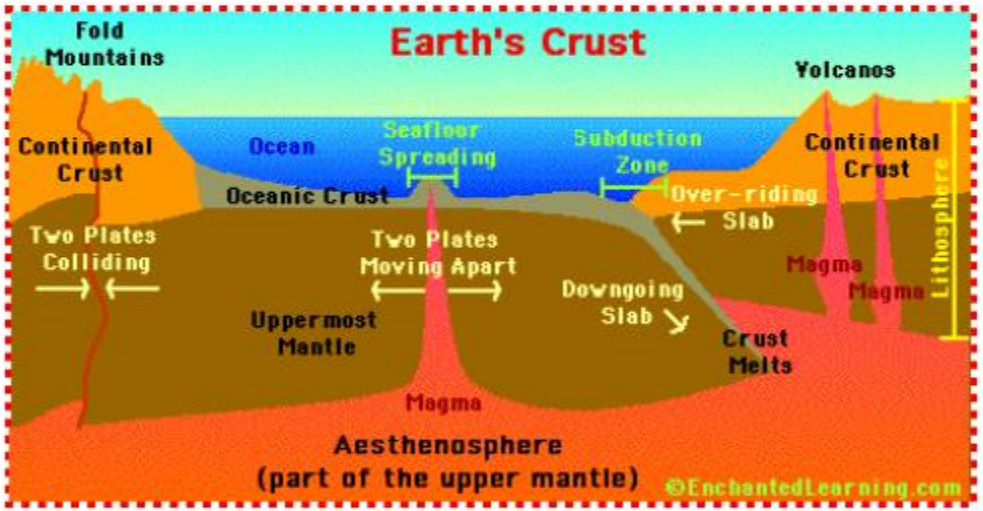
TRIASSIC
200 million years ago

JURASSIC
150 million years ago



CRETACEOUS
65 million years ago

PRESENT DAY



https://www.boundless.com/biology/evolution-of-early-life/rates-of-emergence-and-extinction/explanation-of-tectonic-plates-and-continental-drift/

http://www.enchantedlearning.com/subjects/dinosaurs/glossary/Contdrift.shtml

Evolutionaire stamboom (gebaseerd op theorie Darwin, 1859)

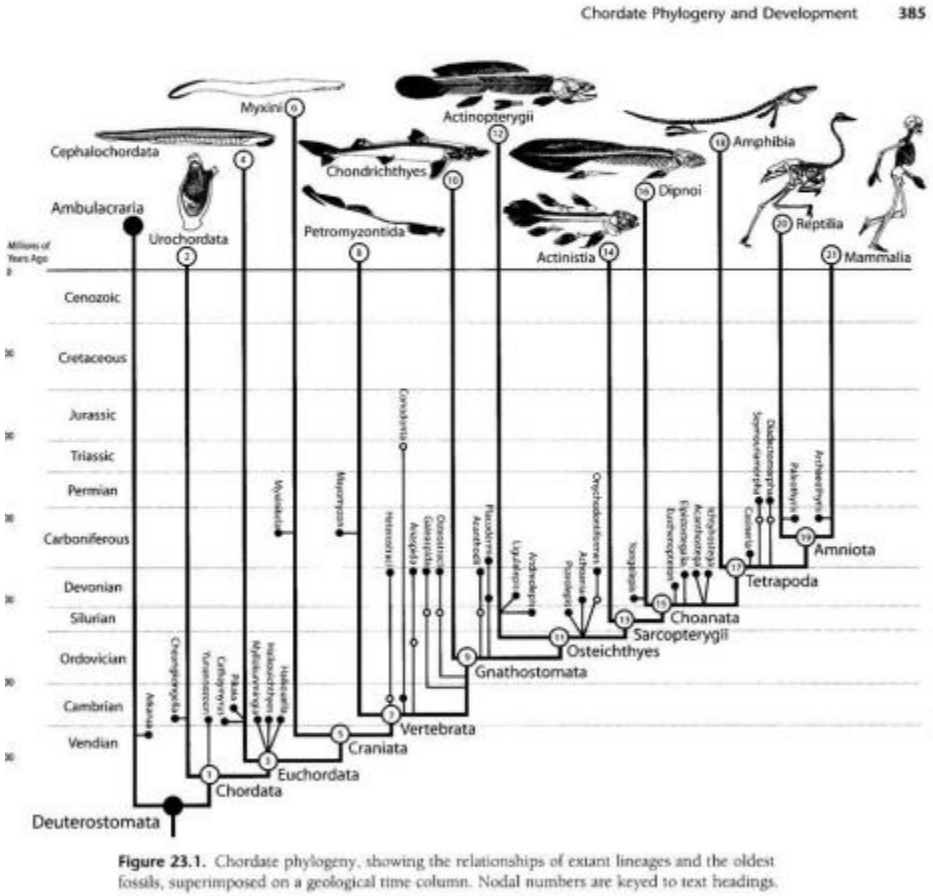
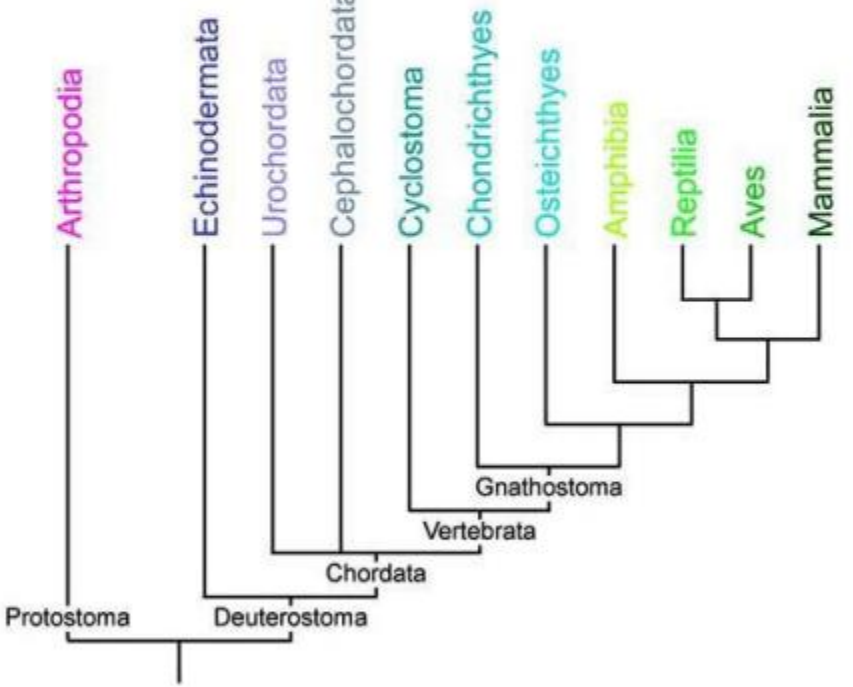


Figure 23.1. Chordate phylogeny, showing the relationships of extant lineages and the oldest fossils, superimposed on a geological time column. Nodal numbers are keyed to text headings.

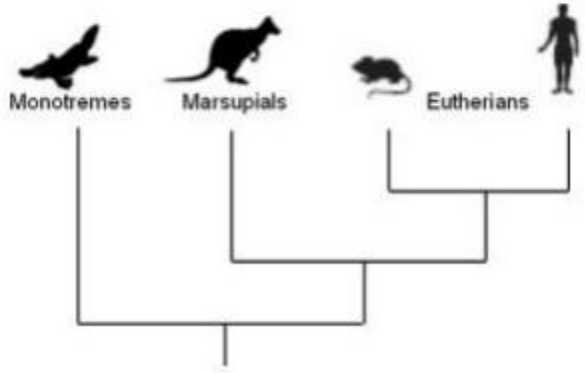


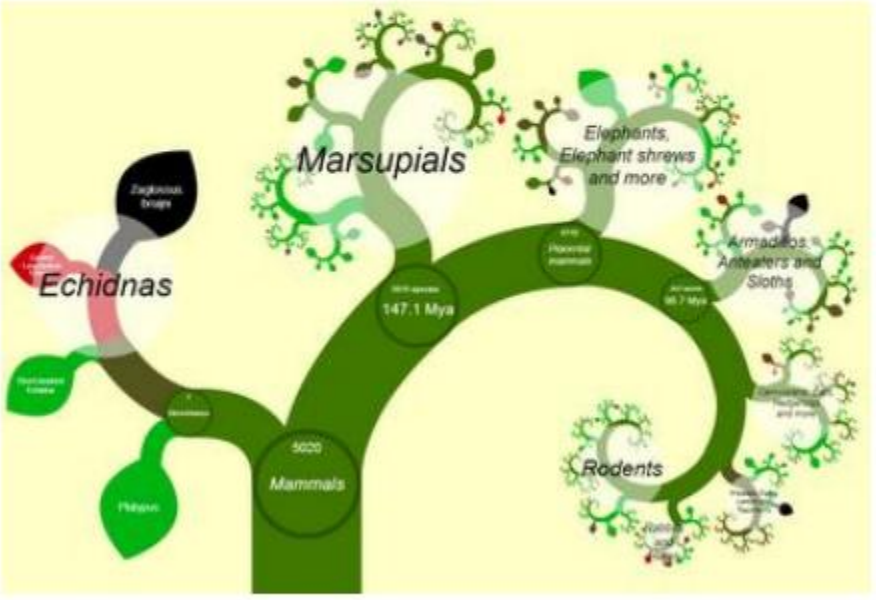
Evolutionary tree - Kingdom Animalia

http://www.utexas.edu/features/2008/03/03/tree/
http://evolutionaos.wikispaces.com/5a.+Conservation+of+Genes

Fylogenie van de zoogdieren. Monotremes (vogelbekdier ; Echidnas, mierenegel) zijn eierleggende zoogdieren ; Marsupials zijn buideldieren ; Eutherians zijn echte zoogdieren met placenta.

http://www.creationscience.com/onlinebook/LifeSciences13.html





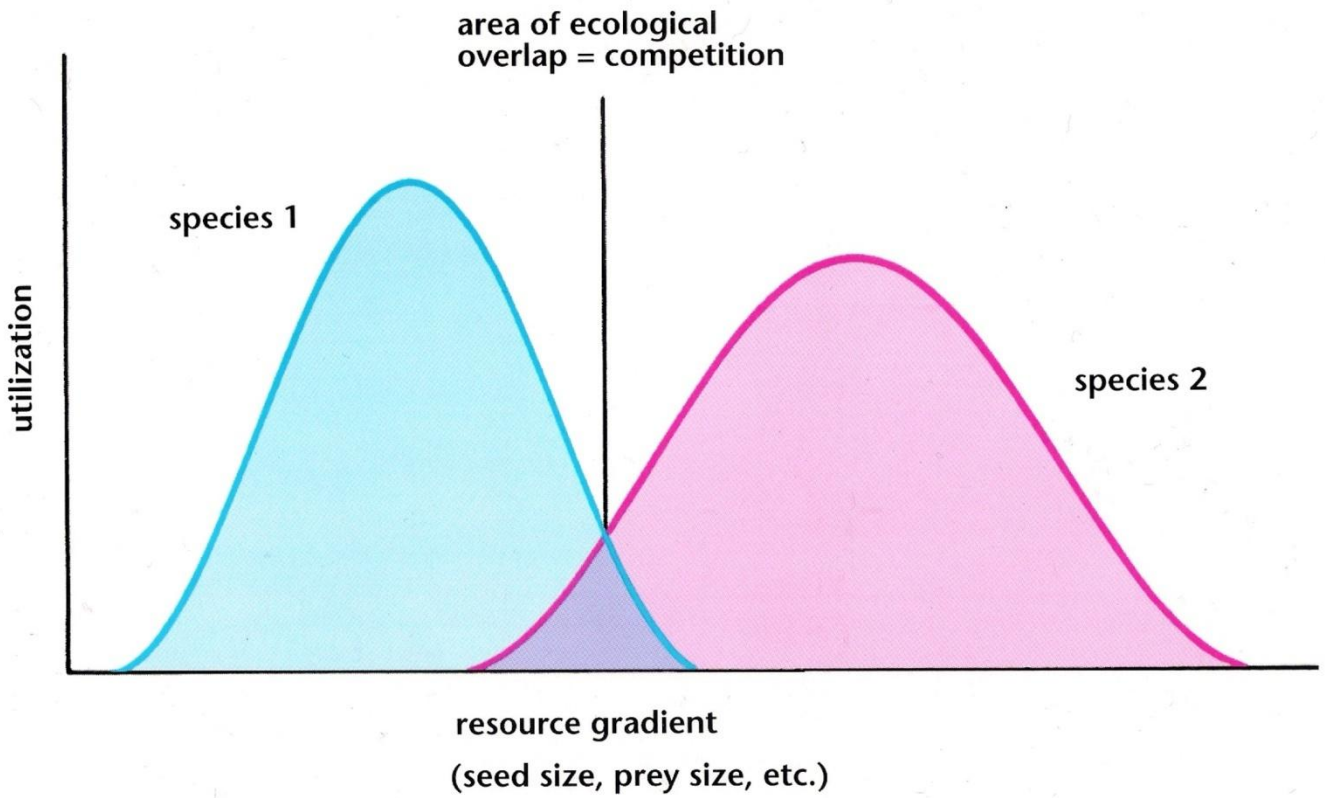
http://palaeo.gly.bris.ac.uk/palaeofiles/marsupials/Index.htm

http://cabbagesofdoom.blogspot.be/2012/12/zooming-round-tree-of-life.html

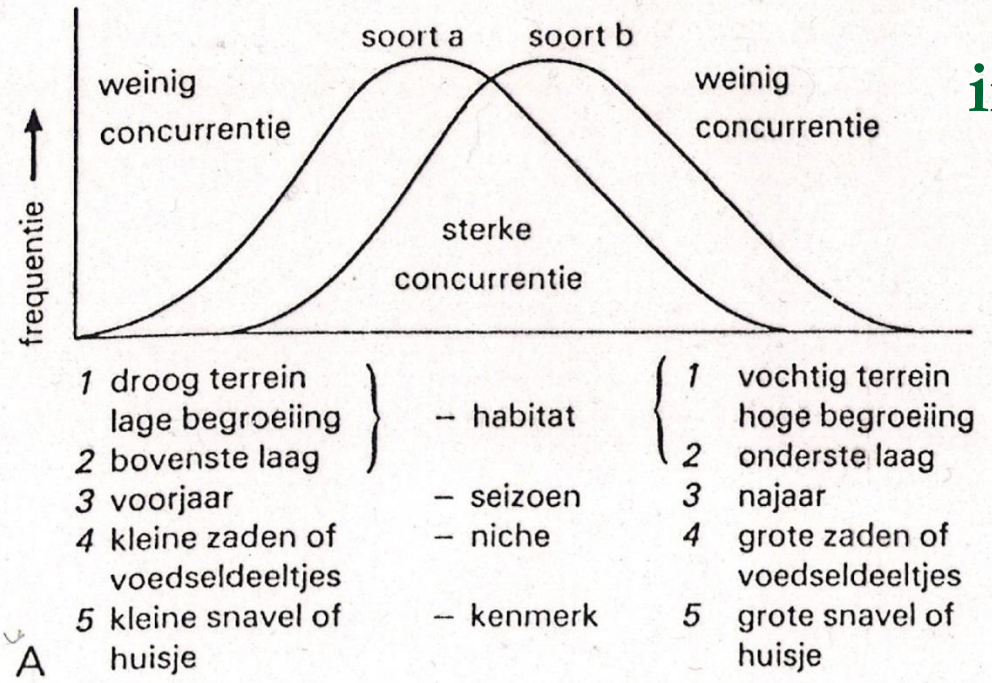
Conclusion

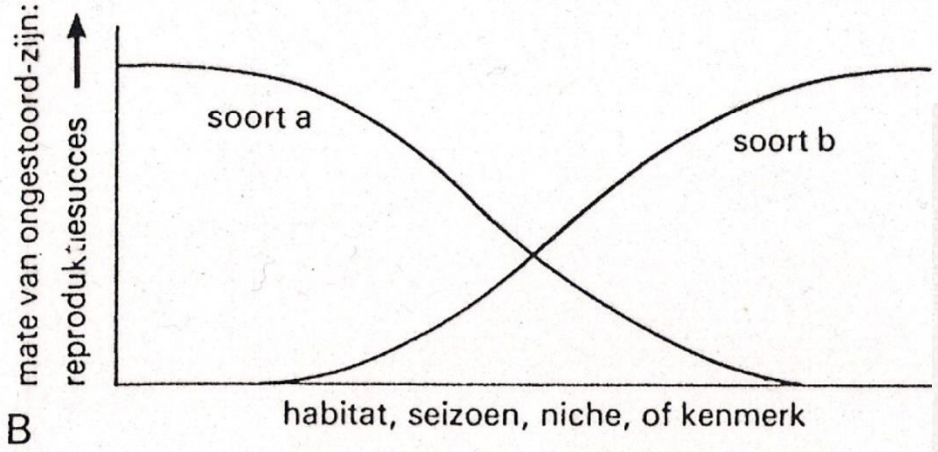
- 1. Both theories: Continental drift (Wegener, 1911) and the evolution theory (Darwin, 1859) reinforce each other and prove each other.
- 2. Also shifting ecological conditions from the past (climate, drifting continents, …) are important to understand actual biodiversity on earth.

Competition Principle:



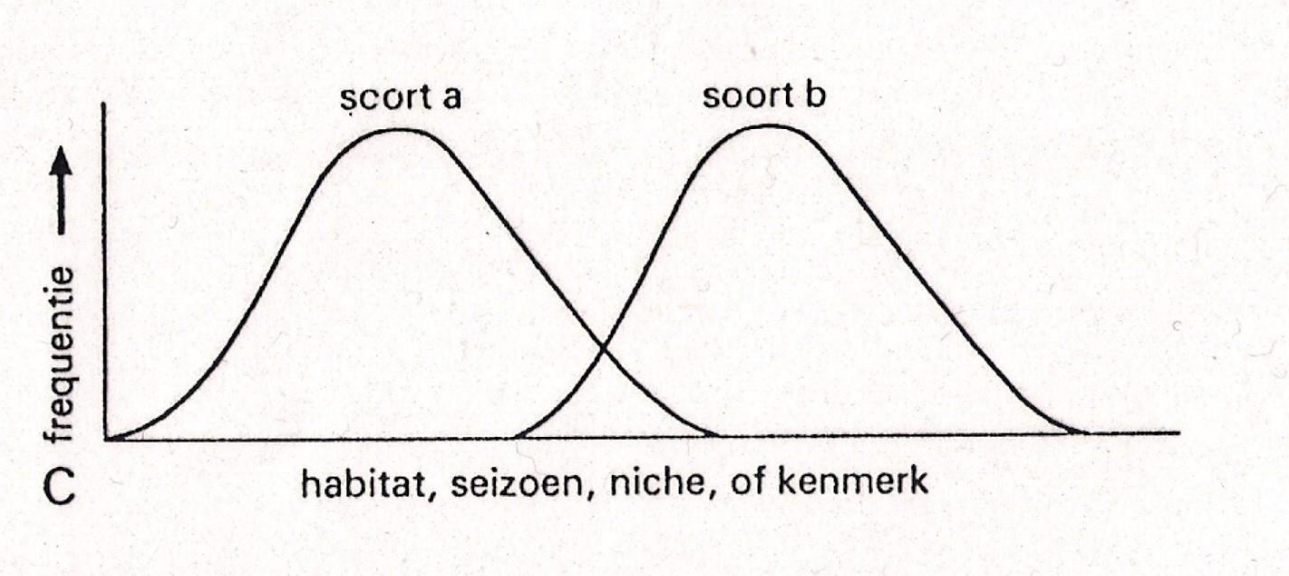
Consequences of interspecific competition





A De veelal veronderstelde uitgangssituatie bij twee soorten a en b, sterk overeenkomend wat betreft hun habitatkeuze (1, 2), het seizoen waarin ze optreden (3), de niche die ze bezetten (4) en hun morfologische kenmerken (5), leidt tot sterke concurrentie in de gebieden waar ze te zamen voorkomen.

B De mate van hinder die eventueel genetisch verschillende individuen van de soorten a en b van elkaar ondervinden door de concurrentie en het mogelijk gevolg hiervan op het succes van de reproduktie van deze verschillende individuen.



C

c De verdeling van de individuen van de soorten a en b in het gebied waar ze te zamen voorkomen als gevolg van selectie door interspecifieke concurrentie: ze bezetten een verschillende habitat, leven in een verschillend seizoen, gebruiken verschillende hulpbronnen (niches), en verschillen ook morfologisch. Indien situatie c optreedt en bovendien de individuen van beide soorten ook erfelijk verschillen van de situatie waarbij de soorten gescheiden voorkomen, is sprake van kenmerkverschuiving.

Finally: a definition of a community (biocoenose)

A community (biocoenose) is a collection of organisms with more or less the same tolerance width (**Shelford, 1911**) but never exactly the same, because then they exclude each other through competition over time ('survival of the fittest' **Gause,1934 ; Darwin, 1859**)