CHAPTER 3

PROKARYOTIC AND BOTANIC DIVERSITY

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1. INTRODUCTION

Botanic diversity is used in its classical sense, excluding the prokaryotes. The latter are integrated as a separate paragraph in this chapter for completeness. Besides the prokaryotes, the chapter provides information on algae (with the exception of the prokaryotic blue-green algae), green plants and fungi.

Most of the information was obtained by sending out a questionnaire, based on the model for zoologists developed by Marc PEETERS and Jackie VAN GOETHEM (RBINS), to targeted experts. The answers of the completed forms were 'translated' into a summary text by the first author, under the supervision of the second author. The correspondents are acknowledged in the text.

In addition to the answers gathered via the questionnaires, information was collected by directly contacting additional researchers, or by searching Belgian or other West European literature, in some cases also grey literature. The latter category tends to become more and more important, since several main sources of information, often related to short time research, do not reach the public literature. For a number of groups, no questionnaire was returned despite further contacts. This was especially the case for algae with marine planktonic taxa and for many microfungi in general, especially plant pathogens. In these cases, we tried to estimate or describe the diversity on the basis of the literature mentioned above. Occasionally, the questionnaires were returned with data that could not directly be synthetised (e.g. amalgamated information on several taxa, former classification concepts). If the task of bringing together the information with the help of the available literature could not be done within a realistic time frame, we opted not to join any summary of knowledge on the respective taxa.

We selected basic reference texts for inclusion in the reference list. If dedicated literature on the identification or status of a taxon in Belgium was not readily available, we included the references of literature covering other (western) European countries or of a recent general textbook. References used for the description (Belgian or worldwide situation) of several taxa are grouped at the end of the chapter under 'general references and further reading'.

The authors have tried to follow present-day insights in phylogeny and systematics as much as possible, but the delimitation of the many taxonomic subdivisions presented in this chapter has also been dictated by other factors such as common scientific practice and specific Belgian expertise. This explains why flowering plants and chlorophytes are not subdivised any further. For the latter, Belgian researchers are generally specialised either as marine or continental experts. On the other hand, some groups, such as for example the taxon Laboulbeniales, which is a highly specialised group of ascomycetes relatively

well known in Belgium, is treated separately. This may seem an eclectic point of view, but it offers the opportunity to illustrate the highly diverse degrees of knowledge in the matter.

In one particular case, we opted not to follow the formal hierarchic ranks and their appropriate suffixes imposed by systematics and the International Code of Botanical Nomenclature. For all groups of land plants (embryophytes), we consequently kept the suffix '-ophyta' at all distinguished levels. One would end up with too many intermediate levels (with badly known suffixes) before arriving at the angiosperms. Moreover, this choice is supported by other authors such as RAVEN *et al*. (1999). The order in which the summaries on embryophytes are placed nevertheless reflect current views on their phylogeny.

This is the first time since the beginning of the 19th century (see DE WILDEMAN & DURAND 1898-1907 with three volumes of the 'Prodrome de la flore belge') that a compilation like this is achieved in Belgium. We have brought information together on botanic biodiversity and produced a summary for all taxa on a 'best professional judgement' basis. We are pretty confident that the experts answered the questionnaires to the best of their knowledge. However, it is inevitable that this synthesis is incomplete. We would very much appreciate any comments, corrections and additions.

2. PROKARYOTIC DIVERSITY

PROKARYOTA, partim EUBACTERIA (excl. CYANOBACTERIA) and ARCHAEA (syn. ARCHAEBACTERIA) - TRUE BACTERIA and ARCHEBACTERIA

(BACTERIËN en ARCHAEBACTERIËN - BACTÉRIES et ARCHÉBACTÉRIES - BAKTERIEN und ARCHEBAKTERIEN)

Ancient life forms; simple cell structure, with few organelles: no nucleus (but DNA and RNA present), no chloroplasts (but pigments and thylakoids can be present), no mitochondria, small ribosomes for protein synthesis; bacterial cell walls contain peptidoglycan or murein; most known Archaea have a protein coat, although some do have pseudomurein; unicellular, eventually forming aggregates; Archaea originally mainly known from extreme habitats (extreme thermophiles in hot springs, extreme halophiles in hypersaline conditions, etc.), but recently proven to be more widespread; methane production in nature is the work of Archaea (methanogens); asexual reproduction.

Prokaryotes occur everywhere, sometimes in very extreme habitats, in marine, freshwater and terrestrial environment, in other organisms, as useful symbionts or parasites (pathogens), in anaerobic or aerobic conditions; anoxygenic photosynthesis by bacteria is at the basis of many food webs.

At present, approx. 6,000 species known worldwide; this number represents only 1% of the actual diversity as based on estimations in various ecosystems; a species concept in prokaryotes is not well defined, partly because a biological species definition as in Eukarya is not possible and also because of the important impact of lateral gene transfer on the composition and the organisation of the prokaryotic genome.

The questionnaire has been completed by Paul DE VOS and Anne WILLEMS (Ghent University).

Knowledge is insufficient. An estimation of the diversity in Belgium is not available and not relevant as most species are ubiquitous. The Belgian diversity will be similar to the diversity in other regions of the world with comparable conditions. A downward trend may be caused by habitat loss and an upward one by the continuous creation of new xenobiotic compounds that are targeted via a reshuffling of the bacterial genome and/or the introduction of external genomic elements. Reference literature are the globally acknowledged handbooks: 'Bergey's Manual of Systematic Bacteriology', the second edition of which is currently been undertaken, and the on-line third edition of 'The Prokaryotes' (DWORKIN 1999-2002). Belgian expertise in bacterial taxonomy is recognised worldwide. Important collections are kept in the Belgian Co-ordinated Collections of Micro-organisms, Bacteria Collection (BCCM^{TM}/LMG, http://www.belspo.be/bccm/lmg.htm).

References and further reading

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DWORKIN, M. (ed.), 1999-2002. The Prokaryotes. Third Edition. An evolving electronic resource for the microbiological community. Springer-Verlag, New York: link.springer-ny.com/link/service/books/10125/index.htm

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PROKARYOTA, partim CYANOBACTERIA, (syn. CYANOPROKARYOTA, CYANOPHYTA) - BLUE-GREEN ALGAE, CYANOPHYTES, CYANOBACTERIA

(BLAUWWIEREN, CYANOBACTERIËN - ALGUES BLEUES, CYANOPHYCÉES, CYANOBACTÉRIES - BLAUALGEN, CYANOBAKTERIEN)

Oxygen-producing photoautotrophic prokaryotic organisms with a unicellular, colonial or filamentous organisation; specialised (asexual) reproductive cells absent or present in the form of exospores, endospores or akinetes; occur virtually everywhere, in marine, freshwater and terrestrial environments, sometimes in very extreme habitats (hotsprings), also epiphytic and endophytic; two taxonomic approaches are presently coexisting: a 'botanical' one based on the morphological features (e.g. KOMAREK & ANAGNOSTIDIS 1999) and a 'bacteriological' one based on molecular characters and gene sequences (e.g. CASTENHOLZ 2001); approx. 1,700 (1,400-2,000) species worldwide.

The questionnaire has been completed by Pierre COMPÈRE (National Botanic Garden of Belgium). Additional information was received from Annick WILMOTTE (University of Liège) and Lucien HOFFMANN (Luxembourg University Centre, Grand Duchy of Luxembourg).

Approx. 300 species are known from Belgium, but this is an incomplete estimation. Knowledge is insufficient and supported by very few people. Some 15 endemics of unclear taxonomic status are described. The main geographical regions and habitats are the North Sea and estuaries, wet soils and rocks, eutrophic and polluted standing waters (but this may merely reflect the existing research). Caves and 'tufs' are especially vulnerable habitats (SYMOENS *et al*. 1951, GARBACKI *et al*. 1999). Blue-green algae have been observed to cause toxic blooms in standing waters (VAN HOOF *et al*. 1994, WIRSING *et al*. 1998, WILLAME & HOFFMANN 1999). MOLLENHAUER *et al*. (1999) warn that cyanobacteria and algae may be endangered, mainly due to human influences. However, the extinction risk of microbial taxa is problematic to assess. Two partial checklists and identification keys are available: COMPÈRE (1986) for the freshwater and terrestrial habitats and COPPEJANS (1995, 1998) for the hard substrates within the littoral marine environment. Other marine habitats have hardly been sampled for Cyanobacteria.

References and further reading

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3. SYNOPSIS OF THE BELGIAN FLORA

EUKARYOTA, partim PROTOCTISTA

The photoautotrophic representatives of the Protoctista or Protists are the so-called Algae, studied by phycologists (who also often study the photoautotrophic prokaryotic Cyanobacteria). Heterotrophic Protoctista comprise taxa formerly classified with fungi (and often still being studied by mycologists) or animals.

MYXOMYCOTA (syn. MYXOMYCETES, MYXOGASTRIA, MYCETOZOA) - TRUE SLIME MOULDS
[(PLASMODIALE) SLIJMZWAMMEN - MYXOMYCÈTES PLASMODIAUX - MYXOMYCETEN, SCHLEIMPILZE]

Heterotrophic protoctists, formerly classified with Fungi (or with animals); also known as plasmodial slime moulds or acellular slime moulds; exhibiting different life cycle stages: uninucleate cells (some biflagellate), somatic moving multinucleate plasmodium, resistant sclerotium and reproductive phase with the formation of stationary sporophores; true slime moulds are essentially terrestrial organisms, generally avoiding dry habitats, although 'blooms' have been observed in deserts after rainfall; saprobic on decaying (wooden or leavy) organic material (with among others nivicolous, corticolous and coprophilous specialists), fungivorous, bacteriovorous or in symbiosis with bacteria; no marine representatives; some 900 species worldwide.

The questionnaire has been completed by Myriam DE HAAN (independent expert, Kalmthout).

Some 300 (200-500) species are estimated to occur in Belgium. The group is moderately well known (better in the northern part of the country, i.e. Flanders), but knowledge is supported by too few specialists. A relatively recent checklist and identification keys for Flanders are available (VANDEVEN *et al*. 1996, VERMEULEN 1999). Knowledge on trends does not exist. Important collections (among others Nannenga-Bremekamp) are kept in the National Botanic Garden of Belgium.

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ACRASIOMYCOTA and DICTYOSTELIOMYCOTA - LOBOPODIAN CELLULAR SLIME MOULDS or ACRASIDS and FILOPODIAN CELLULAR SLIME MOULDS or DICTYOSTELIDS
[(CELLULAIRE) SLIJMZWAMMEN - MYXOMYCÈTES CELLULAIRES - ZELLIGE SCHLEIMPILZE]

The latter used to be seen as a class of the former, but both groups are now considered as separate phyla, probably not even closely related. They are treated together for convenience.
Acrasids are found on dead plants, tree bark, dung and soil, whereas dictyostelids are typical soil organisms; both are small taxa, with 12 acrasid and 46 dictyostelid species worldwide.

No questionnaire has been returned. DE WILDEMAN & DURAND (1898-1907) mention no acrasids and two species of *Dictyostelium*. The actual status of both groups in Belgium is unclear.

Further reading

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KESSIN, R.H., 2001. Dictyostelium - Evolution, Cell Biology, and the Development of Multicellularity. Cambridge University Press, Cambridge: 308 pp.

GLAUCOPHYTA (syn. GLAUCOCYSTOPHYTA)

Unicellular and colonial flagellates, with a primary endosymbiosis (cyanelles); main environment is fresh water, especially soft water habitats such as bogs; only 13 species are known worldwide.

One species has been recorded in Belgium (e.g. VAN MEEL 1944). A second species, common in well-defined habitats in the British Isles, may be found elsewhere in temperate regions, Belgium included (JOHN *et al*. 2002).

Reference

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CHLORARACHNIOPHYTA

Unicellular green-pigmented algae, derived from filose amoebae with a secondary endosymbiosis (green alga); so far, only species from temperate and tropical marine waters have been described; only 5 species are known worldwide; environmental sampling in the North Sea near Helgoland has shown the occurrence of chlorarachniophytes.

Nothing is known about the occurrence in Belgium.

Further reading

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EUGLENOPHYTA (syn. EUGLENIDA) - EUGLENOPHYTES, EUGLENIDS, EUGLENOIDS, EUGLENOID FLAGELLATES

(GESELWIEREN, OOGWIERTJES - EUGLÉNIENS, EUGLÉNOÏDES - AUGENTIERCHEN)

Mainly unicellular green-pigmented flagellated algae (but also a number of non-pigmented -with colourless plastids or lacking plastids- heterotrophic taxa), originating from an ancient divergence of protists, with a secondary endosymbiosis occurring much later (green alga); chlorophyll a and b are thus the photosynthetic pigments; chloroplasts enveloped by triple membrane; pellicula has subsurface proteinaceous (usually), spirally arranged bands ('striped' pattern); typical eyespot; usually elongated form, but very plastic; asexual reproduction by closed mitosis; no sexual reproduction; lives predominantly planktonic in freshwater habitats (swamps, ditches, lakes, bogs, etc.), but also benthic and in nearshore marine or brackish mud or sand, or in marine plankton; approx. 930 species worldwide.

The questionnaire has been completed by Pierre COMPÈRE (National Botanic Garden of Belgium).

So far, 405 species are known, but knowledge is insufficient and supported by very few people. Some 50 species of doubtful taxonomic status are described as endemics. Main geographical regions and habitats are standing, or slow running, waters in the lowlands of Belgium: Pleistocene sandy region, loam plateaus, polders (but this may reflect the habitats in which phycologists were active). Nothing is known about possible trends. A partial checklist and identification key for the inland waters is available (COMPÈRE 1989).

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TOMAS, C.R. (ed.), 1993. Marine phytoplankton: a guide to naked flagellates and coccolithophorids. Academic Press, London: 263 pp.

CRYPTOPHYTA (syn. CRYPTOMONADIDA) - CRYPTOPHYTES, CRYPTOMONADS

(CRYPTOWIEREN - CRYPTOPHYCÉES - SCHLUNDGEISSLER)

Small planktonic algae with a unicellular, rarely colonial or filamentous organisation, derived from a secondary endosymbiosis (red alga); phototrophic and heterotrophic species; showing a large spectrum of pigments: chlorophyll a and c_2, α- and β-carotenes, phycoerythrin or phycocyanin; chloroplasts surrounded by four membranes; asymmetrical cell shape, with furrow/gullet or depression; asexual reproduction by semi-closed mitosis, no sexual reproduction; occur mainly in marine and fresh water of temperate and Boreal regions; approx. 200 species worldwide.

The questionnaire has been completed by Pierre COMPÈRE, amended for the marine environment by Guido RAPPÉ (both National Botanic Garden of Belgium).

Some 50 inland species are known, with an additional estimated number of less than 10 for the purely marine environment. Knowledge is insufficient, especially as far as marine species are concerned, and is supported by very few people. From Belgium, 23 species have been described, many of doubtful taxonomic status and with a badly known distribution. Main geographical regions and habitats in Belgium are estuaries, creeks and other inland waters in the coastal zone (but this may reflect the habitats in which phycologists were active). Nothing is known about possible trends. A partial checklist and identification key for the inland waters is available (COMPÈRE 1989).

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HAPTOPHYTA (syn. PRYMNESIOPHYTA) - HAPTOPHYTES, HAPTOMONADS, COCCOLITHOPHORIDS

(HAPTOWIEREN - HAPTOPHYTES - KALKALGEN)

Unicellular (sometimes colonial), mainly nannoplanktonic, biflagellated algae, derived from a secondary endosymbiosis (red alga); pigments common to all haptophytes are chlorophyll a, c_1 and c_2, β-carotene, diatoxanthin and diadinoxanthin; chloroplasts typically surrounded by four membranes; cell shape is variable (round, flattened, elongated); scales or spines may be observed; asexual reproduction by closed, semi-closed or open mitosis, depending on the species; typical haptonema; most haptophytes are marine, being important members of the plankton and responsible for a major part of the oceanic primary production, nutrient cycles, DMS production and marine (chalky) deposits; benthic forms are insufficiently known; approx. 300 species worldwide.

No questionnaire has been returned. The text has been compiled by Guido RAPPÉ, with additional information from Pierre COMPÈRE (both National Botanic Garden of Belgium).

From inland waters and estuaries, 12 to 13 species have been mentioned in literature. A conservative estimation leads to 10 species for the area of the Belgian Continental Shelf, with another 10-15 to be expected. *Chrysochromulina* is the most diverse genus in marine waters, but identification at species level is difficult. No checklist is available. Belgian marine phytoplankton researchers mainly focus on ecology, production and nutrient cycles of the dominant bloom species. *Phaeocystis globosa* causes an important bloom in Belgian waters in spring and some years also in summer. These blooms have intensified in abundance and duration during the last decades. The ecology of *Phaeocystis* is very well studied in the Southern Bight and along the Belgian coast, among others by LANCELOT and colleagues (e.g. ROUSSEAU *et al*. 2000).

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RHODOPHYTA - RED ALGAE

(ROODWIEREN - ALGUES ROUGES - ROTALGEN)

Showing a variety of thallus organisations: unicellular, filamentous and foliose, often multibranched; derived from a primary endosymbiosis; most important photosynthetic pigments are chlorophyll a, phycoerythrin and phycocyanin; most filamentous species show typical connections between daughtercells, known as primary pit plugs; secondary pit plugs can be formed between non-sister cells or even red algae parasites and their hosts; sexual reproduction is oogamous, with coccoid (non-motile) gametes (lacking flagella); biphasic or triphasic, isomorphic or heteromorphic life history; occur mainly in a marine, much less in a freshwater environment; approx. 5,500 species worldwide.

The questionnaire has been completed by Henry ENGLEDOW (Ghent University) for the marine benthic species and amended by Guido RAPPÉ (National Botanic Garden of Belgium) to include the freshwater species.

In the marine tidal and subtidal coastal zone, 33 species are known, but a further 15 can be expected. In the non-marine environment, 20 species have been found. Knowledge is moderate to good. As most of the red algae in the temperate zone are benthic or epiphytic on other algae, the most important habitats are formed by a variety of artificial constructions in the coastal waters (harbours, groynes, piers, etc.). Many non-indigenous species can be found washed ashore on the beach. Nothing is known about possible trends, but alien species clearly are in progress, finding shelter in harbours and marinas (e.g. KERCKHOF & STEGENGA 2003). Two partial checklists and identification keys are available, COMPÈRE (1991) for the freshwater habitats and COPPEJANS (1995, 1998) for the (coastal) marine environment. Main collections are kept at the herbaria BR (National Botanic Garden of Belgium, Meise) and GENT (Ghent University).

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ALVEOLATA, partim PLASMODIOPHOROMYCETES - ENDOPARASITIC SLIME MOULDS

(PLASMODIOFOREN, PARASITAIRE SLIJMZWAMMEN - MYXOMYCÈTES PARASITAIRES - PARASITISCHE SCHLEIMPILZE)

These organisms have formerly been classified within the kingdom Fungi. Obligate endoparasites observed in vascular plants, in heterokont and streptophycean algae and in water moulds (Saprolegniales); producing multinucleate, unwalled protoplasts within the cells or hyphae of their hosts and forming biflagellate zoospores; asexual reproduction in the hostcells or hyphae; 47 known species worldwide.

No questionnaire has been returned. DE WILDEMAN & DURAND (1898-1907) mention two species, but no doubt more taxa occur in Belgium. Apparently, no synthesis of current knowledge on plasmodiophorids is available.

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ALVEOLATA, partim DINOFLAGELLATA (syn. DINOPHYTA, PYRRHOPHYTA p.p.) - DINOFLAGELLATES, DINOPHYTES

(PANTSERZWEEPHAARWIEREN, DINOFLAGELLATEN - DINOFLAGELLÉS, DINOFLAGELLATES - DINOFLAGELLATEN, PANZERGEISSLER)

Largely unicellular flagellates with two distinctive undulipodia (each of them often in a distinct furrow); autotrophic forms mainly derived from a tertiary endosymbiosis, from a variety of sources: green algae, cryptomonads, haptophytes, diatoms; a wide variety of pigments can thus be encountered (chlorophyll a and c_2, carotenes, xanthophylls, etc.), with one pigment typical for most autotrophic dinoflagellates: peridinin; chloroplasts usually surrounded by three membranes; many species with a theca, showing a multiple membrane complex forming plates, giving them an armoured appearance; some species have scales; different types of eyespots; characteristic reproductive cells are known as dinospores (zoospores) and asexual resting spores (hypnospores); vegetative cells are haploid; diploid motile zygotes (planozygotes) occur due to sexual reproduction; common in fresh and (predominantly) marine water, planktonic and benthic; symbiotic and parasitic lifestyle; approx. 4,000 species worldwide.

The questionnaire has been completed by Pierre COMPÈRE for the brackish and freshwater species, completed for the marine environment by Guido RAPPÉ (both National Botanic Garden of Belgium).

So far, 141 inland species have been recorded, with an additional estimated minimum of 60 for the purely marine environment. Knowledge is insufficient, especially as far as marine species are concerned. Forty species are described from Belgium (mainly from inland coastal waters), but were rarely seen after their original description. The most important habitats in Belgium are the marine and coastal waters: North Sea, estuaries, brackish polder creeks (e.g. CALJON 1984) and ditches, as well as the Pleistocene sandy regions (Flemish and Campine districts). Nothing is known about possible trends. A partial checklist and identification key for the inland waters is available (COMPÈRE 1989).

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HETEROKONTA (syn. STRAMENOPILES) - HETEROKONTS

(HETEROKONTEN - HÉTÉROKONTÉES - HETEROKONTEN)

Possessing two flagella that differ in length and ornamentation; group is very diverse, including oomycetes, diatoms, chrysophytes, brown algae, etc.

HETEROKONTA (syn. STRAMENOPILES), partim HETEROKONTIMYCOT(IN)A (syn. PSEUDOFUNGI)

This taxon encompasses the Oomycetes, Labyrinthulomycetes and Hyphochitriomycetes.

OOMYCETES - OOMYCETES or DOWNEY MILDEYS and WATER MOULDS

(o.a. WATERSCHIMMELS en VALSE MEELDAUWEN - OOMYCÈTES, CHAMPIGNONS AQUATIQUES p.p. - ALGENPILZE)

Include aquatic, both freshwater ('water moulds') and marine, terrestrial and parasitic, heterotrophic organisms, formerly classified within the Fungi; range from unicellular to highly branched coenocytic filamentous forms; main cell wall components are cellulose and cellulose-like polymers; asexual reproduction by biflagellated zoospores; sexual reproduction through conjugation; form thick-walled oospores; approx. 810 species worldwide.

LABYRINTHULOMYCETES - NET SLIME MOULDS

Living in marine and brackish habitats, nearshore and in estuaries, most often associated to marine angiosperms or benthic algae; at least one species is known as a parasite of bivalve molluscs; approx. 48 species worldwide.

HYPHOCHITRIOMYCETES

Occurring in marine, freshwater and terrestrial habitats; living saprobic and in soils, in nearshore waters and in estuaries; approx. 23 species worldwide.

One questionnaire comprising these three related groups has been completed by André FRAITURE (National Botanic Garden of Belgium).

Based on old literature (DE WILDEMAN & DURAND 1898-1907, VERPLANCKE 1940), approx. 100 (80-150) species, almost exclusively oomycetes, may occur. Knowledge of these groups in Belgium is poor. Some serious pathogens of important agricultural crops, e.g. the oomycete *Phytophthora*, are studied in depth. Nothing is known about trends or extinctions.

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HETEROKONTA (syn. STRAMENOPILES), partim HETEROKONTOPHYTA (syn. OCHROPHYTA, CHROMOPHYTA p.p.)

All autotrophic Heterokonta are the result of a secondary endosymbiosis (red alga); photosynthetic pigments: chlorophyll a and c (in one or more forms c_1, c_2 or c_3), β-carotene, fucoxanthin or vaucheriaxanthin; chloroplast surrounded by four membranes; many eyespots can be present.

HETEROKONTOPHYTA, partim CHRYSOPHYCEAE s.s. and *incertae sedis* - CHRYSOPHYCEANS, GOLDEN(-BROWN) ALGAE

(GOUDWIEREN - CHRYSOPHYCÉES - GOLDBRAUNE GEISSELALGEN, GOLDALGEN)

Chrysophytes used to be a large concept, including xanthophytes and diatoms, next to the chrysophyceans. The latter used to include haptophytes, synurids, silicoflagellates, etc., but has been narrowed down considerably the last two decades (KRISTIANSEN & PREISIG 2001). The chrysophyceans *sensu stricto* are small planktonic organisms, with a unicellular, colonial or filamentous thallus organisation; derived, like other phototrophic heterokonts, from a secondary endosymbiosis (red alga); major brown pigment is fucoxanthin; thallus consists of naked cells or cells covered with (sometimes silicified) scales; some species with a cellulose or chitin lorica; Chrysophyceae, like Synurophyceae, form silica-walled resting stages (stomatocysts) by (isogamous) sexual or asexual reproduction; cell shape often round or pyriform; mainly living in inland waters, approx. 890 species worldwide; to this number can be added, for reasons of convenience, another 100 chrysophyte species *incertae sedis*, but not Chrysophyceae s.s. following KRISTIANSEN & PREISIG (2001).

The questionnaire has been completed by Pierre COMPÈRE, amended for the marine environment and the new taxonomic concepts within chrysophytes and allies by Guido RAPPÉ (both National Botanic Garden of Belgium).

A total of 175 non-marine species are mentioned in the literature. For the marine environment, a species number of 10 is roughly estimated. Also mentioned here, for reasons of convenience, are 9 chrysophyte species *incertae sedis*, but not Chrysophyceae s.s. following KRISTIANSEN & PREISIG (2001). Several species have been described from Belgian inland waters, many of doubtful taxonomic status and with a badly known distribution. Knowledge is moderate to insufficient and supported by very few people, especially as far as marine species are concerned. Main geographical regions and habitats are the coastal zone and Lower Belgium. Nothing is known about possible trends. No checklist is available.

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TOMAS, C.R. (ed.), 1993. Marine phytoplankton: a guide to naked flagellates and coccolithophorids. Academic Press, London: 263 pp.

HETEROKONTOPHYTA, partim SYNUROPHYCEAE

Small planktonic organisms, with a unicellular thallus organisation, often forming globular or chain-like colonies; cells or colonies are covered with siliceous scales, sometimes bearing silica bristles; derived, like other phototrophic heterokonts, from a secondary endosymbiosis (red alga); main reasons to separate them from the chrysophyceans are their lack of chlorophyll c and differences in flagella root systems; Synurophyceae, like the Chrysophyceae, form silica-walled resting stages (stomatocysts) by (isogamous) sexual or asexual reproduction; almost entirely restricted to fresh water, with some species penetrating brackish water; 151 species are recognised worldwide, 121 of which are attributed to the genus *Mallomonas*.

No separate questionnaire was received. The text was compiled from information supplied by Pierre COMPÈRE and from the literature by Guido RAPPÉ (both National Botanic Garden of Belgium).

In Belgian literature, 63 species are mentioned, 11 of which belong to *Synura* and 50 to *Mallomonas*. No doubt several of these have to be synonymised. Some species have been described from Belgian waters and possess a doubtful taxonomic status and a badly known distribution. Knowledge is moderate to insufficient, supported by few people. Main geographical regions and habitats are primarily located in Lower Belgium, but this is possibly biased by the distribution of the sampling effort. Nothing is known about possible trends. No checklist is available.

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HETEROKONTOPHYTA, partim BACILLARIOPHYCEAE - DIATOMS

(DIATOMEEËN, KIEZELWIEREN - DIATOMÉES - DIATOMEEN, KIESELALGEN)

Unicellular, solitary or colonial organisms, with a characteristic two-valved silica skeleton (frustule); main xanthophyll is fucoxanthin; diploid vegetative cells, with gametes produced by meiosis; centric diatoms are oogamous, pinnate forms isogamous; zygote develops into a large auxospore; auxospore formation is also possible by autogamy or apogamy; environment very broad, encompassing marine, freshwater, brackish water, planktonic, benthic, epiphytic, epizoic habitats, etc.; approx. 12,000 species worldwide, but estimations vary (up to millions).

The questionnaire has been completed by Koen SABBE (Ghent University) and Pierre COMPÈRE (National Botanic Garden of Belgium), with additional information from Luc DENYS (Antwerp University).

Approx. 1,600 non-marine (reasonable estimation) and 1,000 marine (very rough estimation) species estimated from Belgium. Several were described from Belgian inland waters. Knowledge is moderate to insufficient, especially as far as marine species are concerned. Main geographical regions and habitats in Belgium are the North Sea and estuaries, brackish waters and oligotrophic to mesotrophic standing waters. The increasing number of species is due to recently intensified research. No recent checklist is available, the latest one is that of DE WILDEMAN & DURAND (1898-1907), but many partial checklists have been drawn from larger research projets (e.g. DENYS 1991, DENYS *et al*. 2000, DESCY 1983, FABRI & LECLERCQ 1984). Diatoms have been used in studies on the water quality of lotic systems (DESCY & EMPAIN 1981), applying the Diatom Biological Index (IBD, PRYGIEL & COSTE 2000), or as an instrument to typify lentic freshwater habitats (DENYS 1997). An identification key to freshwater genera is available on the Internet (COMPÈRE 2001). The famous collection VAN HEURCK will soon be transferred from the facilities of the Antwerp Zoo to BR (herbarium National Botanic Garden of Belgium, Meise). Many small but fine collections are managed by research groups of the universities of Antwerp, Ghent, Liège and Namur.

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HETEROKONTOPHYTA, partim PELAGOPHYCEAE

Small group of planktonic algae with unicellular (coccoid, monadoid or palmelloid) or filamentous thallus organisation; derived, like other heterokonts, from a secondary endosymbiosis (red alga); exclusively marine, possibly entering brackish estuaries; this class was only established in 1993; approx. 12 species have been described worldwide.

No questionnaire was returned. In the Belgian literature, one species is mentioned, with a further two expected. Knowledge is insufficient. The coastal habitats are the main geographical region. Nothing is known about possible trends.

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TOMAS, C.R. (ed.), 1993. Marine phytoplankton: a guide to naked flagellates and coccolithophorids. Academic Press, London: 263 pp.

HETEROKONTOPHYTA, partim DICTYOCHOPHYCEAE

Class includes silicoflagellates, pedinellids and rhizochromulinids; silicoflagellates are unicellular, planktonic and marine, living mostly in temperate surface waters and having a siliceous skeleton; pedinellids are unicellular, with the second undulipodium internally; main xanthophyll is fucoxanthin; occur in both marine and freshwater environments; *Rhizochromulina* is a marine amoeboid species; 25 to 27 species are recognised worldwide for the three groups together.

No separate questionnaire has been received. Text compiled by Guido RAPPÉ, based on information provided by Pierre COMPÈRE (both National Botanic Garden of Belgium) and on the situation elsewhere in the southern North Sea (NOVARINO *et al*. 1997, AQUASENSE 2000).

The literature mentions two silicoflagellates and five pedinellids, with one forma. One newly described pedinellid is doubtful. Very little is known about their status in Belgium. From the available data, brackish water seems to be the major habitat in Belgium. No knowledge on possible trends or threats exists, apart from the general situation of the mentioned habitat.

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HETEROKONTOPHYTA, partim RAPHIDOPHYCEAE (syn. CHLOROMONADIDA)

Relatively large (30-80 m) unicellular photoautotrophic flagellates; naked cells, no cell wall or skeletal elements; marine species with fucoxanthin and violaxanthin, freshwater species with vaucheriaxanthin instead of fucoxanthin; no photoreceptor system; no sexual reproduction known; occur in marine and freshwater environment; 28 species known worldwide.

No questionnaire was returned. Text compiled by Guido RAPPÉ (National Botanic Garden of Belgium).

Three non-marine species are mentioned from Belgium. In the southern North Sea, at least five species have been observed (e.g. AQUASENSE 2000, KOEMAN *et al*. 2002). These are expected to be present in the Belgian marine waters too. Main geographical regions and habitats probably are the North Sea, estuaries and inland standing (acid) waters. Knowledge is poor. Nothing is known about any trends in species composition or populations. A partial checklist and identification key for the inland waters are available (COMPÈRE 1989).

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TOMAS, C.R. (ed.), 1993. Marine phytoplankton: a guide to naked flagellates and coccolithophorids. Academic Press, London: 263 pp.

HETEROKONTOPHYTA, partim EUSTIGMATOPHYCEAE

Small unicellular, coccoid algae; derived, like other phototrophic heterokonts, from a secondary endosymbiosis (red alga); fucoxanthin and chlorophyll c are lacking; major brown pigments are violaxanthin and vaucheriaxanthin; show typical red body, which function is unknown; reproduction by the formation of autospores or sometimes by zoospores; cell shape often round or ovoid; mostly in fresh water or in soil, but marine forms exist; approx. 20 species worldwide.

No questionnaire was returned. The text was compiled by Guido RAPPÉ, on the basis of information from Pierre COMPÈRE (both National Botanic Garden of Belgium) and the literature.

Seven species are mentioned in the literature, of which possibly half have to be synonymised. Knowledge is insufficient and supported by very few people. Nothing is known about possible trends. No checklist is available.

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HETEROKONTOPHYTA, partim TRIBOPHYCEAE (syn. XANTHOPHYCEAE) - YELLOW-GREEN ALGAE, XANTHOPHYTES

(GEELGROENE WIEREN - XANTHOPHYCÉES - GELBGRÜNE ALGEN, GELBGRÜNALGEN)

Unicellular photoautotrophic flagellates, filamentous and siphonaceous coenocytic, rarely coccoid, palmelloid or amoeboid; greenish to greenish-yellow colour due to the lack of fucoxanthin, which is normally widely present among Heterokontophyta; instead, vaucheriaxanthin is the common xanthophyll; asexual reproduction by motile zoospore or non-motile aplanospore; sexual reproduction by oogamy only occurs in *Vaucheria*; xanthophytes primarily live in terrestrial habitats (wet soil) and in fresh and brackish water; approx. 600 species worldwide, many of which are rare.

The questionnaire has been completed by Pierre COMPÈRE and adapted to current taxonomic concepts within chrysophytes and allies by Guido RAPPÉ (both National Botanic Garden of Belgium).

Some 105 inland species are mentioned in literature. Knowledge is moderate. Some species have been newly described from Belgium, but they are often of doubtful taxonomic status. Most obvious species belong to the genus *Vaucheria*, forming green mats on regularly inundated muddy soils, inhabited and grazed by a typical community. The most important habitats in Belgium are the coastal inland fresh and brackish waters (polder creeks and ditches) and the estuarine part of lowland rivers. Vulnerable habitats are estuaries and other brackish waters. Nothing is known about possible trends. Identification and reference literature was only developed by foreign authors (SIMONS 1977, ETTL 1978, RIETH 1980, BOURELLY 1981, CHRISTENSEN 1987, JOHN *et al*. 2002). No checklist is available.

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HETEROKONTOPHYTA, partim PHAEOPHYCEAE (syn. FUCOPHYCEAE) - BROWN ALGAE

(BRUINWIEREN - ALGUES BRUNES - BRAUNALGEN)

Multicellular photoautotrophic benthic organisms; small filamentous to giant thalloid organisation; many have root-like holdfast systems, stem-like stipes and leaf-like blades; next to the green pigment chlorophyll a, the main xanthophyll (brown pigment) is fucoxanthin; sexual reproduction mostly by oogamy, but isogamy and anisogamy occur; also asexual zoospores; isomorphic or heteromorphic alteration of generations; occur almost exclusively in marine waters; approx. 1,700 species worldwide.

The questionnaire has been completed by Henry ENGLEDOW (Ghent University) for the marine species, with additional information received from Pierre COMPÈRE (National Botanic Garden of Belgium) on the freshwater species.

In the marine tidal and subtidal coastal zone, 28 species are known, but a further 12 could be expected. Only one species, *Pleurocladia lacustris*, is found in inland waters. Knowledge is moderate to good. The large brown algae need a hard substratum to attach to. Others live epiphytic on the larger species. Along the sandy coast of Belgium, the most important habitats are artificial, in the form of a variety of constructions in the coastal waters (harbours, groynes, piers, etc.). Non-indigenous species from rocky shores to the west (English Channel) can be found in huge quantities, washed ashore on the beach. Alien species are clearly in progress, finding shelter in harbours and marinas. Nothing is known about possible trends, but the most conspicuous species, the laminarian *Laminaria saccharina*, disappeared from its sole locality. A checklist and identification key are available (COPPEJANS 1995, 1998). Main collections are kept at the herbaria BR (National Botanic Garden of Belgium, Meise) and GENT (Ghent University).

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Halidrys siliquosa (Phaeophyta), a brown seaweed regularly washed ashore, but not a Belgian native species (© National Botanic Garden of Belgium, drawing by E. COPPEJANS).

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HETEROKONTOPHYTA, remaining classes

On the other -most often very recently described or recognised- classes of Heterokontophyta, i.e. the freshwater Phaeothamniophyceae (1998) and the marine Chrysomerophyceae (1995), Bolidophyceae (1999) and Pinguiophyceae (2002), no questionnaire has been received. The first three may be expected to occur in Belgium, while this is far less probable for the picoplanktonic and oceanic latter class. On the other hand, picoplanktonic exploration has hardly started. Bolidophyceans e.g. proved to be an important part of the diversity in environmental sampling in the North Sea near Helgoland, Germany (VALENTIN *et al.* 2001). It is very improbable that the group is absent in Belgian marine waters. Apparently, no synthesis of current knowledge on their status in Belgium exists.

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EUKARYOTA, partim CHLOROBIO(N)TA (syn. VIRIDIPLANTAE) - GREEN PLANTS

Only the green pigments chlorophyll a and b are present, derived from a primary endosymbiosis; storage of carbohydrates usually in the form of starch; two anterior whiplash flagella (sometimes modified or lost); two groups: chlorophytes and streptophytes.

CHLOROPHYTA - GREEN ALGAE, CHLOROPHYTES

(GROENWIEREN - ALGUES VERTES - GRÜNALGEN)

Include the classes Prasinophyceae, Chlorophyceae, Trebouxiophyceae and Ulvophyceae; photoautotrophic unicellular, colonial or multicellular organisms, derived from a primary endosymbiosis, with very diverse thallus organisation: monadoid, palmelloid, colonial, coccoid, sarcinoid, trichoid, thalloid and coenocytic forms; a phycoplast is formed during cell division; the spindle does not last during closed mitosis; sexual reproduction usually by flagellated gametes (iso-, aniso- and oogamy), asexual reproduction usually by zoospores; environment mainly fresh water, although Ulvophyceae are almost exclusively marine; also terrestrial, epiphytic and in association with lichens; approx. 12,000 species worldwide.

The questionnaire has been completed by Pierre COMPÈRE (National Botanic Garden of Belgium) for the freshwater species and by Henry ENGLEDOW (Ghent University) for the marine benthic macro-algae. Additional information on the marine plankton has been gathered by Guido RAPPÉ (National Botanic Garden of Belgium).

Approx. 860 non-marine species have been recorded, with numerous species and subspecies described from Belgium, whose taxonomic status is unclear nowadays. So far, 37 marine benthic species (mainly Ulvophyceae) were observed, with another 13 to be expected. Chlorophytes are uncommon in the marine plankton, with six species mentioned in recent Dutch monitoring reports (AQUASENSE 2000, KOEMAN *et al.* 2002). All of these belong to the Prasinophyceae. Knowledge is moderate, supported by very few people, and poor for the marine plankton. Nothing is known about possible trends. Main geographical regions and habitats are the coastal marine and inland waters, inland running and standing waters and, for the benthic marine species, artificial constructions. Oligotrophic and mesotrophic waters are the most vulnerable habitats. A partial checklist and identification keys for the marine benthic species are available (COPPEJANS 1995, 1998). At the National Botanic Garden of Belgium, an unpublished list is kept for the inland species. Published records are dispersed, sometimes presenting species lists for a particular area (e.g. SYMOENS 1960). Main collections are managed by the herbaria BR (National Botanic Garden of Belgium, Meise) and, especially for the marine species, GENT (Ghent University).

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STREPTOPHYTA

The Streptophyta include the land plants and the remainder of what was formerly called the 'green' algae. The streptophycean green algae are sometimes grouped together and referred to as 'Charophyta' (charophytes) in older literature, but this should be avoided because this term is also used in a narrowed sense to designate the stoneworts only. The terms 'charophycean green algae' or 'charophyceans' do not take away the confusion (GRAHAM & WILCOX 2000) and are only practical in a strictly phycological environment. Although professional botanists may be split up in an algal and a land plants clade (and a fungal clade for that matter), one should be aware that nature is not that simple and that land plants have algal ancestors more related to them then to other algae.

Algal representatives of the streptophytes are unicellular or multicellular; thallus organisation is mainly monadoid, coccoid, sarcinoid or trichoid; land plants have a more elaborate structure; cell division with formation of a phragmoplast; permanent spindle during open or halfopen mitosis.

STREPTOPHYTA, partim ZYGNEMATOPHYCEAE (syn. CONJUGATOPHYCEAE) - ZYGNEMATALEANS, ZYGNEMATOPHYCEANS

(JUKWIEREN, VOEGWIEREN - ZYGNÉMATOPHYCÉES - JOCHALGEN, KONJUGATEN)

Unicellular coccoid, colonial pseudofilamentous and multicellular unbranched filamentous forms; no flagellated cells; reproduction by 'conjugation' between two amoeboid gametes; half-open mitosis; exclusively non-marine species, very few in brackish water; approx. 4,600 species worldwide.

The questionnaire has been completed by Pierre COMPÈRE (National Botanic Garden of Belgium).

Approx. 740 species have been recorded, with numerous species and subspecies described from Belgium, whose taxonomic status is unclear nowadays. Desmids are the most important group. Knowledge is moderate, supported by few people. Main geographical regions are the Pleistocene sandy lowlands (Flemish and Campine district), the

Ardenne (particularly the Haute Ardenne) and the Gaume. Oligotrophic and mesotrophic standing waters (bogs, fens) and non-polluted brooks and brooklets are the main, and at the same time most vulnerable, habitats. An identification key for the desmids has been published (COMPÈRE 2001). Little is quantified about possible trends, but a decrease in diversity is suspected in the vulnerable habitats mentioned above. Main collections are kept at the herbaria BR (National Botanic Garden of Belgium, Meise).

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STREPTOPHYTA, partim CHAROPHYCEAE - CHAROPHYTES, CHARALEANS

(KRANSWIEREN - CHARACÉES - ARMLEUCHTERALGEN)

Highly developed multicellular thalloid forms, with a typical nodal and internodal organisation and whorled branching; asexual reproduction by adventitious development of new thalli from rizoids or nodal complexes, also by formation of bulbils; sexual reproduction by oogamy; their natural environment is fresh water, with very few species in brackish water and none in the marine environment; up to 450 species worldwide, though some authors consider many taxa conspecific.

The questionnaire has been completed by Pierre COMPÈRE (National Botanic Garden of Belgium).

Twenty-nine species are known from Belgium. Knowledge is sufficient to good, supported by a working group. Some species tend to become rare. The main geographical regions are the Pleistocene lowland sands (Flemish and Campine districts), the loamy plateau (Brabantine district), the coastal inland waters and the Meuse district. Oligotrophic and mesotrophic non-polluted waters are the most vulnerable habitats. A checklist, identification key and distribution maps are available (COMPÈRE 1992, BRUINSMA *et al*. 1998). Main collections are kept at the herbaria BR (National Botanic Garden of Belgium, Meise), GENT (Ghent University) and LG (University of Liège).

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STREPTOPHYTA, partim KLEBSORMIDIOPHYCEAE

Non-branching filamentous organisation, with cells in one row; asexual reproduction by formation of a single zoospore per cell; mainly in standing and running fresh water; also on banks, terrestrial and epiphytic; approx. 17 species worldwide.

No questionnaire was returned. Text compiled by Guido RAPPÉ, based on literature and additional information from Pierre COMPÈRE (both National Botanic Garden of Belgium).

Seven or eight species have been recorded in Belgium. Main geographical regions and habitats are the higher altitudes, but this may be merely a reflection of the distribution of explorations. Oligotrophic and mesotrophic waters are the most frequent habitats. Knowledge is poor to moderate, supported by very few people. Nothing is known about possible trends. A thorough study of the genus *Klebsormidium* in Europe was carried out by LOKHORST (1996), who also gives a key in SIMONS *et al*. (1999).

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STREPTOPHYTA, partim COLEOCHAETOPHYCEAE - COLEOCHAETALEANS

Branching filamentous organisation, forming a two-dimensional, disc-like (one cell thick) or three-dimensional thallus; typically sheated hairs; asexual reproduction by formation of a single zoospore per cell; sexual reproduction by a kind of oogamy; mainly epiphytic or epilithic in fresh water; also terrestrial and epiphytic on banks; approx. 19 species worldwide.

No questionnaire was returned. Text compiled by Guido RAPPÉ, based on literature and additional information from Pierre COMPÈRE (both National Botanic Garden of Belgium).

Six or seven species have been recorded in Belgium, five of which belong to the *Coleochaete* and one or two to the *Chaetosphaeridium* (probably synonymous). Main geographical regions and habitats are the lower altitudes, mainly on sandy substrates. Oligotrophic and mesotrophic waters are the most frequent habitats. Knowledge is poor to moderate, supported by very few people. Nothing is known about possible trends. An identification key for the Dutch species is given by SIMONS *et al*. (1999).

References and further reading

See under 'General references and further reading' at the end of the chapter.

STREPTOPHYTA, partim EMBRYOPHYT(IN)A - LAND PLANTS

(LANDPLANTEN - EMBRYOPHYTES - ECHTE LANDPFLANZEN)

The basal taxa of non-algal green plants are informally grouped together under the vernacular or paraphyletic name 'bryophytes' (mossen - bryophytes - Moospflanzen). They are usually divided in three subgroups: liverworts, hornworts and mosses. They are small flat or leafy plants, which most often, but not exclusively, grow in moist conditions in temperate and tropical environments.

In many respects, the 'bryophytes' are intermediate between streptophycean green algae and the vascular plants. Together with the latter, they form the embryophytes and share a number of characteristics that distinguish them from the other Streptophyta. They have male and female gametangia, called antheridia and archegonia respectively, with a protective, sterile 'jacket' layer. The zygote and the developing multicellular embryo (or young sporophyte) are retained within the archegonium or the female gametophyte. The multicellular diploid sporophyte allows an increased number of meioses and thus the production of an increased number of spores. The thick wall of the spores contains sporopollenin, which resists decay and drying. The epidermal cells are coated with a waxy protective layer: the cuticle. All these are adaptations to life on land.

Bryophytes lack the true vascular tissues xylem and phloem of the vascular plants. Their cell walls are never lignified. Bryophytes and vascular plants both exhibit alternating heteromorphic, gametophytic and sporophytic generations.

In bryophytes, the gametophyte is dominant and free-living, with the unbranched sporophyte being small and bearing only a single sporangium. It is attached to, and nutritionally dependent upon, the gametophyte.

HEPATOPHYTA (syn. MARCHANTIOPHYTA) - LIVERWORTS

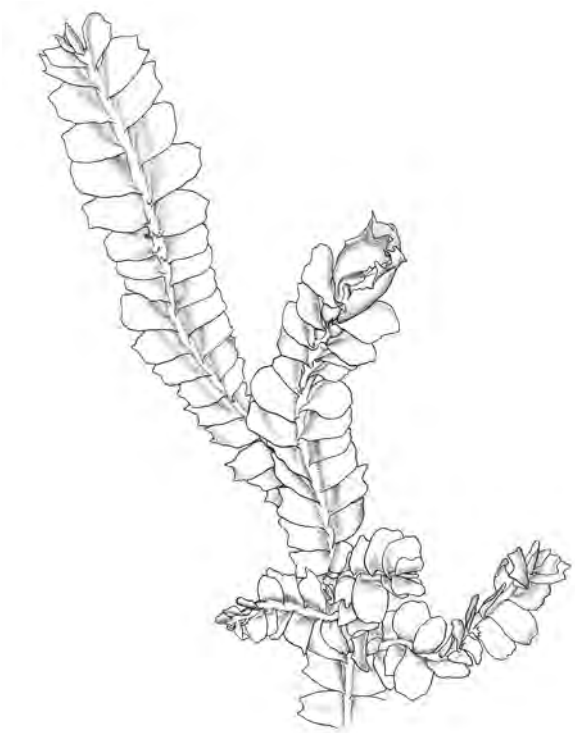
(LEVERMOSSEN - HÉPATIQUES - LEBERMOOSE)

Usually divided into thalloid and leafy species; gametophyte is dominant and free-living; possessing unicellular rhizoids; most cells have numerous chloroplasts; many produce gemmae; some have a protonema stage; most species store lipids in a special organelle, the oil body; growth from an apical meristem; sporophyte lacks stomata; spores (and gemmae) for dispersal; approx. 5,500 (5,000-6,000) species worldwide.

The questionnaire has been completed by Herman STIEPERAERE and André SOTIAUX (National Botanic Garden of Belgium).

The Belgian list comprises 171 species. Most important geographical regions are the Ardenne, the Meuse district and the Gaume. Main threat is habitat loss. Knowledge is good. The total species number is more or less constant since vanishing species are compensated by new discoveries. In the near future, nine species are threatened with disappearance. VANDEN BERGHEN (1979, 1981) has published an identification key to the inland species. SCHUMACKER (1985) has edited a national distribution atlas. VANDERPOORTEN (1997) and SOTIAUX & VANDERPOORTEN (2001) have published regional distribution data, offering a view on the dynamics of the bryoflora in a limited area. A recent checklist is available (SOTIAUX & VANDERPOORTEN 2002), with an even more recent

addition (SOTIAUX *et al*. 2003). Main collections are kept at the herbaria BR (National Botanic Garden of Belgium, Meise), LG (University of Liège) and CMV (Centre Marie-Victorin, Vierves-sur-Viroin).



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Lophocolea heterophylla (Hepatophyta), a common liverwort on decaying trees (© National Botanic Garden of Belgium, drawing by O. VAN DE KERCKHOVE).

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ANTHOCEROPHYTA - HORNWORTS

(HAUWMOSSEN - ANTHOCÉROTES - HORNMOOSE)

Dominant and free-living gametophyte; thalloid of many species looking rosette-like; elongated sporophyte splits in mature stage; unicellular rhizoids; most cells have a single chloroplast; sporophyte with stomata; no specialised conducting tissues; spores for dispersal; small group with approx. 120 (100-150) species worldwide.

The questionnaire has been completed by Herman STIEPERAERE and André SOTIAUX (National Botanic Garden of Belgium).

Five species have been recorded. Most important geographical region is the Pleistocene sandy lowland (Flemish and Campine district). Habitat loss forms the main threat. The species have a preference for bear moist soils, where they act as pioneers; for example, several new discoveries have been made in abandoned agricultural fields under nature management. A fifth species has recently been recognised as new to the Belgian flora (HEYLEN *et al*. 2001). Knowledge is good. VANDEN BERGHEN (1979, 1981) published an identification key for inland species. SCHUMACKER (1985) has edited a national distribution

atlas, while VANDERPOORTEN (1997) and SOTIAUX & VANDERPOORTEN (2001) published regional distribution data. A recent checklist is available (SOTIAUX & VANDERPOORTEN 2002). Main collections are kept at the herbaria BR (National Botanic Garden of Belgium, Meise), LG (University of Liège) and CMV (Centre Marie-Victorin, Vierves-sur-Viroin).

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BRYOPHYTA - MOSSES

(BLADMOSSEN - MOUSSES - LAUBMOOSE)

*A huge number of organisms have been called '**mosses**', but the organisms in the present group are the '**common**' mosses. Subdivision is subject to discussion, but three classes are generally accepted: the Sphagnidae or peat mosses, the Andreaeidae or granite mosses and the Bryidae or 'true' mosses.*

Dominant and free-living gametophyte; rhizoids are multicellular; most cells have numerous chloroplasts; several species produce gemmae; growth from an apical meristem in the Bryidae; protonema stage grows by a marginal meristem followed by growth from an apical meristem in the Sphagnidae; some species have non-lignified conductive tissue for water transport; sporophyte has stomata, forming spores (and gemmae) for dispersal; terrestrial, epiphytic and a few aquatic species; approx. 9,500 (7,500-12,500) species worldwide.

The questionnaire has been completed by Herman STIEPERAERE and André SOTIAUX (National Botanic Garden of Belgium).

So far, 557 species have been recorded. Another 20 are expected. The total number increased with 10% since 1985, due to dedicated research. The real trend is probably the reverse, as a result of habitat loss, drainage, intensive agriculture and atmospheric deposition. The most important geographical regions are the higher altitudes [Ardenne (incl. Haute Ardenne), Meuse district], followed by the Gaume and Middle (Brabantine district), and Lower Belgium (the Pleistocene sandy region). Rocks, rocky outcrops and calcareous fen are very important habitats for the survival of special taxa. Knowledge is good. Some alien species are rapidly spreading (STIEPERAERE 1994, STIE-

PERAERE & JACQUES 1996). The exploration of the urban environment has yielded interesting discoveries during the last decade (STIEPERAERE & HOFFMANN 1993, ZWAENEPOEL *et al*. 1994, VANDERPOORTEN 1997, DURWAEL & LOCK 2000). The bio-indicating role of bryophytes for the water quality in Belgian rivers has been studied by EMPAIN (1973, 1974) and, more recently, VANDERPOORTEN & EMPAIN (1999). Regional distribution atlases have been published by VANDERPOORTEN (1997) and SOTIAUX & VANDERPOORTEN (2001), the latter offering an illustration of the dynamics (disappearance, expansion) of the bryoflora on a local scale. A recent checklist is available (SOTIAUX & VANDERPOORTEN 2002). Main collections are kept at the herbaria BR (National Botanic Garden of Belgium, Meise), LG (University of Liège) and CMV (Centre Marie-Victorin, Vierves-sur-Viroin).

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Campylopus introflexus (Bryophyta), an established alien moss (© National Botanic Garden of Belgium, drawing by O. VAN DE KERCKHOVE).

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EUTRACHEOPHYTA - VASCULAR PLANTS

(VAATPLANTEN - PLANTES VASCULAIRES - GEFÄSSPFLANZEN)

In vascular plants, the sporophyte is the dominant generation and the gametophyte greatly reduced: the sporophyte is free-living, branched and bearing many sporangia; include a number of seedless vascular plant groups and the seed plants; habitus differentiated in roots, stems and leaves; vascular tissues present; secondary growth confined to the seed plants; spores or seeds for dispersal.

'PTERIDOPHYTA' - SEEDLESS VASCULAR PLANTS

(VARENPLANTEN - PTERIDOPHYTES - FARNPLANZEN)

A vernacular (paraphyletic) name for the following groups of non seed-forming vascular plants.

LYCOPHYTA - LYCOPHYTES

(LYCOFIETEN - LYCOPHYTES)

Some species are more or less dichotomously branched; stem of most species protostele or modified protostele; leaves microphylls; sporangia on or in the axills of sporophylls; Lycopodiaceae (clubmosses - wolfsklauwen - lycopodes - Bärlappe) homosporous, Selaginellaceae (lesser clubmoss - mosvarens - sélaginelles - Moosfarne) and Isoetaceae (quillworts - biesvarens - isoètes - Brachsenkraut) heterosporous; spores for dispersal; terrestrial and aquatic species; approx. 1,000 species worldwide.

The questionnaire has been completed by Ronald VIANE (Ghent University).

A total of 11 (nine according to some authors who consider *Diphasiastrum issleri* and *D. zeilleri* as hybrids) species have been recorded, with another one to be expected and one non-native. Of these, nine species (or seven, see above) belong to the Lycopodiaceae, one to the Selaginellaceae and one to the Isoetaceae. *Isoetes lacustris* occurs

near the Belgian border. Numbers have decreased since 1905, mainly due to habitat loss. Most important geographical regions are the higher altitudes (Haute Ardenne, Ardenne) and the Pleistocene sandy region (Flemish and Campine district). The Hautes Fagnes was the sole region where *Selaginella helvetica* (single observation), and the now extinct *Diphasiastrum issleri* and *Diphasiastrum complanatum*, were found. The other *Diphasiastrum* species, except *D. tristachyum*, have disappeared too. *Selaginella kraussiana* is known as an escape that can overwinter. Isoetaceae only occur in oligotrophic standing waters of the Pleistocene sandy region, which are not used for recreation. Some Lycopodiaceae are under pressure due to *Picea* and *Pinus* plantations. All habitats suffer from atmospheric deposition. Knowledge is good. An identification key is available in the flora of Belgium and neighbouring regions (LAMBINON *et al.* 1998, 2003). The Plant Atlas (VAN ROMPAEY & DELVOSALLE 1979) gives distribution maps for all species. Main collections are kept at the herbaria BR (National Botanic Garden of Belgium, Meise), BM (Natural History Museum, London) and LG (University of Liège).

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SPHENOPHYTA - HORSETAILS

(PAARDESTAARTEN - PRÊLES - SCHACHTELHALME)

Only one recent genus: *Equisetum*; not dichotomously branched; stems eustele-like siphonostele; leaves scale-like macrophylls/megaphylls; sporangia on sporophores in strobili at the apex of the stem; homosporous; dispersal by formation of spores; terrestrial and semi-aquatic species; only 15 species worldwide.

The questionnaire has been completed by Ronald VIANE (Ghent University).

Seven species have been recorded, with an additional one to be expected. Species number remains constant, but wetland species show some decline. *Equisetum variegatum*, primarily found in dune slacks, has shown a strong decline. For the group as a whole, all geographical regions are important, with the coastal dunes especially important for *E. variegatum* and the loam plateau and Gaume for *E. telmateia*. Knowledge is good. An identification key is available in the flora of Belgium and neighbouring regions (LAMBINON *et al.* 1998, 2003). The Plant Atlas (VAN ROMPAEY & DELVOSALLE 1979) gives distribution maps for all species. Main collections are kept at the herbaria BR (National Botanic Garden of Belgium, Meise), GENT (Ghent University) and LG (University of Liège).

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PTEROPHYTA - FERNS

(VARENS - FOUGÈRES - FARNE)

Not dichotomously branched; stems in some a protostele, in others siphonostele or more complex types; leaves megaphylls; sporangia on sporophylls, sometimes clustered in sori; all homosporous, except the heterosporous 'waterferns' Marsileales and Salviniales; spores for dispersal; terrestrial, rarely aquatic species; approx. 11,000 species worldwide.

The questionnaire has been completed by Ronald VIANE (Ghent University).

So far, 42 species have been recorded, although some doubt exists on the true native status of *Botrychium simplex* (possible, but maybe erroneous herbarium label), *Matteuccia struthiopteris* (almost certainly native), *Salvinia natans* (doubtful) and *Azolla filiculoides* (extinct and re-established). Another four species could be expected. *Asplenium* is the most numerous genus with eight species. Numbers have decreased since 1950 with 10% to 12%, or four or five species, mainly due to habitat loss. The most important geographical regions are the higher altitudes (Ardenne, Meuse district), followed by the Gaume and Middle (Brabantine district) and Lower Belgium (the Pleistocene sandy region). In Lower Belgium, old walls, quays and graveyards in historic cities are important habitats for ferns (JADEM 1975, LAN LANDUYT & HEYNEMAN 1999). Knowledge is good. An identification key is available in the flora of Belgium and neighbouring regions (LAMBINON *et al*. 1998, 2003). The Plant Atlas (VAN ROMPAEY & DELVOSALLE 1979) gives distribution maps for almost all species. Main collections are kept at the herbaria BR (National Botanic Garden of Belgium, Meise), GENT (Ghent University) and LG (University of Liège).

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Botrychium lunaria (Pterophyta), a threatened fern of nutrient-poor soils (© National Botanic Garden of Belgium, drawing by A. CLEUTER).

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SPERMATOPHYTA - SEED PLANTS

(ZAADPLANTEN - SPERMATOPHYTES - SAMENPFLANZEN)

Seed plants form seeds for dispersal; a seed consists of a seed coat (integuments), an embryo and stored food; it develops from an ovule that consists of the megasporangium, the single retained megaspore in it and one or two integuments; male gametophytes develop inside pollen grains; antheridia are lacking; five divisions with living representatives, two of which occur in Belgium: the Pinophyta (syn. Coniferophyta) or conifers and the Angiospermae (syn. Anthophyta) or flowering plants.

PINOPHYTA (syn. CONIFEROPHYTA) - CONIFERS

(NAALDBOMEN, CONIFEREN - CONIFÈRES - NADELHÖLZER, GABELNERVIGE NACKTSAMER)

Together with the three divisions lacking in Belgium commonly grouped as gymnosperms; ovules exposed on the surface of megasporophylls; fertilisation of egg cell by one sperm of male gametophyte; stored food in seed is provided by female gametophyte; approx. 630 species worldwide.

Only two species are considered indigenous: *Juniperus communis* and *Taxus baccata*, with conflicting opinions on the true nature of a few stands of *Pinus sylvestris*. The latter is often planted in sylviculture, as other *Pinus* species are and, primarily, *Picea abies* (for the former coal mining industry and for wood production). Many individual localities of *Taxus baccata* and *Pinus sylvestri*s are debated on their indigenous status. A lot of species are also used in horticulture, with as a result some garden escapes rarely found in the wild. Knowledge is good. An identification key is available in the flora of Belgium and neighbouring regions (LAMBINON *et al*. 1998, 2003). The Plant Atlas (VAN ROMPAEY & DELVOSALLE 1979) gives distribution maps for the species, except for *Pinus sylvestris*. Main collections are kept at the herbaria BR (National Botanic Garden of Belgium, Meise), GENT (Ghent University) and LG (University of Liège).

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ANGIOSPERMAE (syn. ANTHOPHYTA) - FLOWERING PLANTS

(BLOEMPLANTEN, ANGIOSPERMEN - ANGIOSPERMES, PLANTES À FLEURS - BEDECKTSAMER, BLÜTENPFLANZEN)

Flowerlike reproductive structures; ovules enclosed by carpels often differentiated to form an ovary; stamens derived from microphylls, with anthers bearing two pairs of pollensacs; fertilisation of egg cell by one sperm of male gametophyte; stored food in seed provided by the second fertilisation between second sperm and polar nuclei (double fertilisation); fruits contain mature ovaries, with mature seeds; approx. 230,000 (222,700-258,700) known species worldwide.

Questionnaire completed by Leo VANHECKE (National Botanic Garden of Belgium).

Approx. 1,350 (1,250-1,430) species are considered 'indigenous' (including some species naturalised since a long time). This figure also varies with the taxonomic status given to the taxa in apomictic genera such as *Taraxacum, Hieracium, Rubus, Alchemilla*, etc. One taxon on the level of variety is endemic: *Sempervivum funckii* var. *aqualiense* (but some authors consider it to be a triple hybrid). Another taxon, *Bromus bromoideus*, almost exclusively restricted to Belgium, has not been seen since 1935 (TOURNAY 1968). The territory is divided in a number of geographical regions, called plant districts, each of them with its own characteristic flora. VAN LANDUYT *et al*. (2000) published a report on the botanic quality of habitats, based on combinations of vascular plant indicator species. Main reason for important decline is habitat loss. Remainders of the habitats suffer from fragmentation, overdressing, drainage, atmospheric nutrient deposition, eutrophication and pollution in general. Nutrient-poor soils and waters are not adequately protected. Heaths, bogs, fens (including calcareous fens), chalky grasslands and weed communities, and coastal habitats such as strandlines (trampling and beach cleaning), salt marshes, dune slacks and grasslands, are among the most vulnerable.

This is by far the best known group in the plant kingdom and Belgium is no exception to this statement. New species added to the flora during the last quarter of the 20th century are mainly the result of dedicated research in difficult groups such as bramble, some genera of orchids (BOURNÉRIAS 1998, TYTECA 2003) or neglected groups like thalassochorous species (RAPPÉ 1996) and indigenous trees and shrubs (MAES 1997, 2002). An important trend is the rapid spread of alien species due to increased human transport activity or deliberate introduction (LAMBINON 1997). In some spectacular cases, existing communities are invaded, dominated or completely replaced by naturalised -or naturalising- species (e.g. HOSTE & VERLOOVE 2001), probably causing irreversible changes in our wild flora at a speed never seen before. Another human-induced phenomenon is the inland spread of certain coastal species, due to the use of deicing agents on the main traffic axes in winter (RAPPÉ 2000). A recent report on the subject of alien species in the wild in Flanders presents a checklist of taxa almost as long as the indigenous list (VERLOOVE 2002).

A (now dated) checklist has been published by STIEPERAERE & FRANSEN (1982). DELVOSALLE *et al*. (1969) and VANHECKE (1985) have drawn a list of threatened species. An identification key is available in the flora of Belgium and neighbouring regions (LAMBINON *et al*. 1998, 2003). The Plant Atlas (VAN ROMPAEY & DELVOSALLE 1979) gives distribution maps for the indigenous species. For the northern part of the country, Flanders, a red list of

endangered species has recently been published as an appendix to VAN LANDUYT *et al*. (1999). A synthesis of trends and threats at province level is presented by BERTEN & GORA (2002). Also in Flanders, a register with ecological indicator values for the inland vascular flora is available on cd-rom (BIESBROUCK *et al*. 2001). A document established through a similar approach, but restricted to woodland plants, is published for the southern part of the country (DULIÈRE *et al*. 1996). Main collections are kept at the herbaria BR (National Botanic Garden of Belgium, Meise), GENT (Ghent University) and LG (University of Liège).

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Viscum album (Angiospermae), a flowering half-parasite (© National Botanic Garden of Belgium, drawing by G. VAN ASSCHE).

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EUMYCOTA - TRUE FUNGI

[(ECHTE) ZWAMMEN - CHAMPIGNONS - ECHTE PILZE]

The true fungi are mostly terrestrial, heterotrophic organisms; cells have a cell wall containing chitin; although unicellular forms exist (= yeasts), most are filamentous; fungal filaments are called hyphae, the whole packing and network of hyphae being called a mycelium; hyphae with (septate) or without crosswalls (aseptate, coenocytic); densely packed hyphae (mycelium) in many cases form the 'fruiting' bodies called mushrooms, toadstools, puffballs, etc.

'CHYTRIDIOMYCOTA' (syn. ARCHEMYCOTA) - CHYTRIDS

(- CHYTRIDES - FLAGELLATENPILZE)

Recently, strong evidence has been put forward that this is a paraphyletic group (BARR 2001, SCHÜSSLER *et al*. 2001). Aseptate or coenocytic hyphae; reproduce asexually by forming zoospores; sexual reproduction is unknown or doubtful in most species; oogamous reproduction (oospores) is however known in the Monoblepharidales; inhabitants of soil, fresh water and estuaries; most live saprobic, but pathogens of plants (*Synchytrium*, *Olpidium*, vector of plant pathogenic viruses), other fungi and animals are known; approx. 914 species worldwide, e.g. many 'water moulds', Allomyces, etc.

The questionnaire has been completed by André FRAITURE (National Botanic Garden of Belgium).

A list with 57 species has been published at the end of the 19th century (DE WILDEMAN & DURAND 1898-1907). This group is poorly known in Belgium.

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'ZYGOMYCOTA' (incl. GLOMEROMYCOTA) - ZYGOMYCETES

(JUKZWAMMEN, WIERZWAMMEN - ZYGOMYCÈTES - JOCHPILZE)

The ecologically and economically important arbuscular mycorrhizal (AM) fungi, crucial in the ecology and physiology of land plants, together with Geosiphon pyriformis, an endocytobiotic fungus, have recently been separated from the Zygomycota and put in a phylum of their own: the Glomeromycota (SCHÜSSLER *et al*. 2001). *As the major part of the latter used to be classified within the class Zygomycetes, both phyla are still treated together here. Moreover, there is strong evidence that the remainder of the Zygomycota, i.e. excluding the Glomeromycota, is in fact a paraphyletic group* (SCHÜSSLER *et al*., op.cit.).

Aseptate or coenocytic hyphae; reproduce asexually by forming non-motile spores or sexually by the zygospore formed in the zygosporangium; most are commonly known as moulds (schimmels - moisissures - Verschimmeln) but this is a general term that designates any fungus without a fruiting body; species of the class Zygomycetes live on a variety of substrates: soil, dung, plants, mushrooms, animals (including man and his food), as saprobes or parasites; some are mycorrhizal; species of the class Trichomycetes (about 230 species worldwide) are obligate symbionts, mostly commensals, but a few are parasites within the digestive tract of arthropods; approx. 1,090 species worldwide.

No questionnaire has been returned.

VANDEVEN *et al*. (1996) mention only 15 species, but this figure is irrelevant, merely being the number of taxa observed during fieldwork focused on macrofungi. THOEN (1988) mentions four species of *Endogone* (now in Glomeromycota). Apparently, no synthesis of knowledge on Zygomycota and Glomeromycota is available in Belgium. Important collections of economically or medically important species and strains are kept in the Belgian Co-ordinated Collections of Micro-organisms, (Agro-)industrial Fungi & Yeasts Collection (BCCM™/MUCL, http://www.belspo.be/bccm/mucl.htm) and Biomedical Fungi & Yeasts Collection (BCCM™/IHEM, http://www.belspo.be/bccm/ihem.htm).

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ASCOMYCOTA (excl. LABOULBENIALES and LICHENISED ASCOMYCETES) - ASCOMYCETES

(ZAKJESZWAMMEN - ASCOMYCÈTES - SCHLAUCHPILZE)

Septate hyphae; sexual spores (ascospores) are formed in a typical ascus (sac fungi); ascocarp present or absent; diversity of forms and life strategies is large: e.g. powdery mildew, Dutch elm disease, morels, truffles, beer yeast; many species exhibit an additional asexual reproduction process by the formation of conidia (see Deuteromycetes) or by having a yeast phase (mostly unicellular); occur on a large variety of substrates

as saprobes, parasites and predators: soil, dung, in bark, wood, leaves, associated to algae in lichens (treated separately lower), even in marine habitats; many are associated with particular plant species; Ascomycetes all in: approx. 32,800 species worldwide; excluding the groups mentioned in the above title (they are treated separately below): approx. 17,400 species.

The questionnaire, restricted to the Pezizales, Elaphomycetales, Helotiales, Rhytismatales, Ostropales, Erysiphales, Taphrinales, Sphaeriales, Clavicipitales, Diaporthales, Hypocreales, Sordariales, Xylariales and Dothideales, has been completed by Bernard DECLERCQ (independent expert, Wachtebeke).

Approx. 2,000 (between 1,800-2,200) species are known from Belgium, but this estimation is not complete since some taxa are not taken into consideration, including among others the yeast *Dekkera bruxellensis* (involved in the spontaneous fermentation that yields the lambic and gueuze beers, typical for the vicinity of Brussels). In fact, this figure should be compared with an adjusted worldwide total, restricted to the orders mentioned above, i.e. 8,500 species. Knowledge is fairly good, but supported by very few people. Roughly estimated, some hundreds additional species are to be expected on the territory, based on the situation in neighbouring countries. The highest diversity is found in the southern part of the country: Ardenne (incl. Haute Ardenne), Gaume, river Meuse valley and tributaries.

Saprobic species on endangered plants and hydrophilic species (water quality) are especially vulnerable. A partial checklist is available (VANDEVEN *et al*. 1996). A Red List of some macrofungal taxa, including information on a number of trends, is available for the northern part of the country (WALLEYN & VERBEKEN 1999). Two sets of distribution maps of macrofungi (incl. Basidiomycota) have been published (HEINEMANN & THOEN 1981, FRAITURE *et al*. 1995). The herbaria at the National Botanic Garden of Belgium (BR), Ghent University (GENT) and University of Liège (LG) harbour the largest collections. Important collections of economically or medically important species and strains are managed by the Belgian Co-ordinated Collections of Micro-organisms, (Agro-)industrial Fungi & Yeasts Collection (BCCM^{TM}/MUCL, http://www.belspo.be/bccm/mucl.htm) and Biomedical Fungi & Yeasts Collection (BCCM^{TM}/IHEM, http://www.belspo.be/bccm/ihem.htm).

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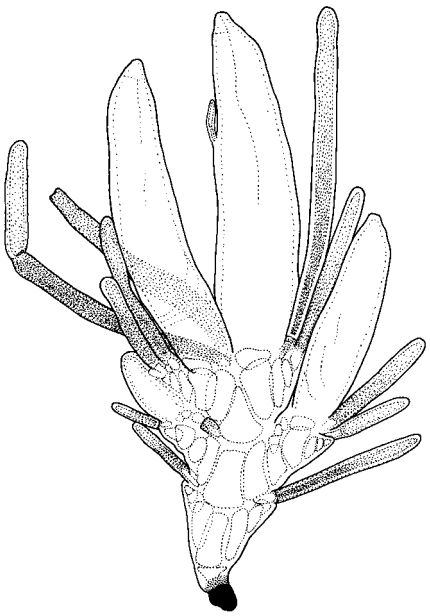
ASCOMYCOTA, partim LABOULBENIALES

Group of highly specialised ascomycetes, forming obligate associations with arthropods (insects, mites, few millipedes); mycelium is lacking in many species, the thallus being derived from enlargement and subsequent cell divisions of the two-celled ascospore; approx. 1,900 species worldwide.

The questionnaire has been completed by André DE KESEL (National Botanic Garden of Belgium).

So far, 100 species have been recorded in Belgium, almost exclusively on beetles (Insecta, Coleoptera). Half of these species belong to the genus *Laboulbenia* (DE KESEL 1998). The group is poorly studied, but relatively well known in Belgium. Another 100 species can be expected, on other arthropods. Two recently described species are, for the time being, only known from Belgium: *Phaulomyces simplocariae* and *Laboulbenia hyalopoda*. A checklist (DE KESEL & RAMMELOO 1992) and (unpublished) flora (DE KESEL 1997) exist. Partial results of the latter (identification keys for the genera *Laboulbenia* and *Rhachomyces* and for the species on cockroaches) have been published (DE KESEL 1998, 2001, 2002).



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Peyritschiella heinemanniana (Laboulbeniales), a staphylinid beetle parasite newly described from Belgium (© National Botanic Garden of Belgium, drawing by O. VAN DE KERCKHOVE).

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'LICHENES' - LICHENS

(KORSTMOSSEN - LICHENS - FLECHTEN)

A lichen is a mutualistic symbiotic association between a fungal partner (the mycobiont) and an algal partner (the phycobiont or photobiont); alga can be filamentous, unicellular eukaryotic or prokaryotic (Cyanobacteria); lichens are named after the fungus, which is, however, never occurring as a free-living organism (in contradiction to the alga); most of the lichen-forming fungi belong to the Ascomycota, a minority to the Basidiomycota or anamorphic fungi; approx. 13,500 species worldwide. *Included here are some other fungi that are usually studied by lichenologists*.

No questionnaire has been returned. The following information has been compiled from the literature by Guido RAPPÉ (National Botanic Garden of Belgium).

This element of the flora is reasonably well known. A total of 977 taxa are concerned: 832 lichens, 19 lichenicolous lichens, 109 lichenicolous fungi, 4 doubtfully lichenised fungi and 13 non-lichenised fungi. Some 200 dubious taxa have been mentioned for the country, but not accepted. Twenty-five taxa have been originally described from Belgium, of which only 16 are accepted (11 lichens, five lichenicolous fungi). Forty-eight lichens and one lichenicolous fungus are considered extinct. The majority of these were only known from one locality. Local lichen deserts occur in areas of major air pollution (big cities, harbours with associated heavy industry, etc.). Because the quality of the air (SO_2 load) is recently evolving in the good direction, some species clearly show recovery. Nitrophilous species also are doing well during the last decades, due to atmospheric deposition. The urban environment can harbour interesting species on stone artifacts, such as in old graveyards, with their variety in used materials (e.g. ZWAENEPOEL *et al*. 1994). A checklist for Belgium, Luxembourg and northern France has recently been published (DIEDERICH & SÉRUSIAUX 2000). Recent identification literature is of foreign origin: POELT & VEZDA (1977, 1981), PURVIS *et al*. (1992), WIRTH (1987), APTROOT & VAN HERK (1994). A key to the Belgian macrolichens is in preparation.

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BASIDIOMYCOTA

Basidiomycota have dikaryotic, septate hyphae, often with a dolipore (no pore in some Ustilaginomycetes); hyphae form clamp connections (associated with mitosis); multilayered cell wall; sexual basidiospores formed on a basidium; asexual reproduction by conidial formation (fragmentation, budding), some species also having a yeast phase; sexually or asexually formed ballistospores; three classes: Basidiomycetes s.s., Urediniomycetes (mainly the rusts) and Ustilaginomycetes (mainly the smuts).

BASIDIOMYCOTA, partim BASIDIOMYCETES s.s. (syn. HYMENOMYCETES s.l.) - BASIDIOMYCETES

(BUISJESZWAMMEN - BASIDIOMYCÈTES - STÄNDERPILZE)

Basidia are arranged on a distinct exposed fertile layer, the hymenium, in the 'Hymenomycetes s.s.' (mushrooms, coral fungi, polypores, chantarelles, etc.), and formed in a gleba inside the basidiocarp in the 'Gasteromycetes' (puffbals, earth stars, stinkhorns, etc.); traditional classification is being reshuffled by detailed microscopic studies and molecular evidence, redefining or leaving concepts like Hymenomycetes, Gasteromycetes, Aphyllophorales, Agaricales, etc.; other groups are Tremellomycetidae, 'jelly fungi', etc.; the class Basidiomycetes roughly corresponds to the 'macrofungi' in the phylum Basidiomycota; Basidiomycetes are mainly terrestrial organisms; many are important ectomycorrhizal species; approx. 20,400 species worldwide.

A questionnaire for the macrospecies has been completed by André FRAITURE (National Botanic Garden of Belgium).

The species number of the basidiomycete macrofungi in Belgium is estimated at 2,910 (2570-3350) with another 300 to be expected. Most numerous taxa are Agaricales s.l. (approx. 2,100, including Boletales, Russulales, Cantharellales) and 'Aphyllophorales' (approx. 600). Outdated checklist in DE WILDEMAN & DURAND (1898-1907), incomplete checklist in VANDEVEN *et al*. (1996). Declining in numbers. Basidiomycetes are present in all natural regions, with the highest diversity in the southern part of the country, the lowest on the Holocene deposits. Mycosociology has a strong tradition in the south and has been studied extensively in the forests (HEINEMANN & DARIMONT 1956, DARIMONT 1975, THOEN 1977, FRAITURE 2003). Information on trends is included in a Red List discussing the status of some macrofungal taxa in the northern part of the country (WALLEYN & VERBEKEN 1999). Two sets of distribution maps of macrofungi (including Ascomycota) have been published (HEINEMANN & THOEN 1981, FRAITURE *et al*. 1995). The herbaria at the National Botanic Garden of Belgium (BR), Ghent University (GENT) and University of Liège (LG) harbour the largest collections.

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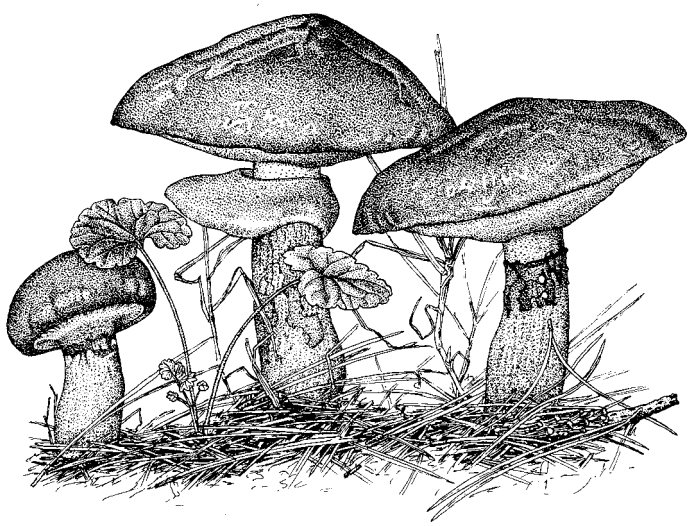

7

Suillus luteus (Basidiomycota), a mushroom (© National Botanic Garden of Belgium, drawing by O. VAN DE KERCKHOVE).

BASIDIOMYCOTA, partim UREDINIOMYCETES - RUSTS

(ROESTZWAMMEN - ROUILLES, URÉDINÉES - ROSTPILZE)

Mycelia generally intercellular; complex life cycle, with up to five spore states; a vast majority of species are obligate parasites on seed plants and ferns, frequently causing major diseases; 8,057 species worldwide, 6,929 of which belong to the order Uredinales.

Data collated from the literature by Guido RAPPÉ (National Botanic Garden of Belgium).

DE WILDEMAN & DURAND (1898-1907) mention 189 species. VANDEVEN *et al.* (1996) include 126 taxa, many with the rank of forma or varietas, of which 44 to 75 are not in the previous list. This leads to a provisional total ranging between 233 and 264 species. The actual status of this group in Belgium is unclear.

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BASIDIOMYCOTA, partim USTILAGINOMYCETES - SMUTS

(BRANDZWAMMEN - CHARBONS, USTILAGINÉES - BRANDPILZE)

Thick-walled probasidia (ustilospores); non-septate or transversely septate promycelia; septa with or without pores; life cycle with a saprobic haploid phase and a parasitic dikaryophase; host-specific endophytes, parasitic on flowering plants (mainly Poaceae and Cyperaceae); important diseases of cereal crops; 1,464 species worldwide, at least half of which belong to the order Ustilaginales.

Data collated from the literature by Guido RAPPÉ (National Botanic Garden of Belgium).

DE WILDEMAN & DURAND (1898-1907) mention 48 species. VANDEVEN *et al.* (1996) include 17 species, of which 7 to 8 are not in the previous list, bringing the provisional total to 55-56. Apparently, no recent synthesis of knowledge on this 'microfungi' group in Belgium is available.

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'DEUTEROMYCETES' (syn. DEUTEROMYCOTINA, FUNGI IMPERFECTI) - DEUTEROMYCETES, ANAMORPHIC FUNGI

(DEUTEROMYCETEN - DEUTÉROMYCÈTES, CHAMPIGNONS IMPARFAITS - DEUTEROMYCETEN)

Artificial gathering of fungi without known sexual cycle (hence 'anamorphic fungi' or 'asexual fungi'); most of them belong to the ascomycetes, with others allied to the basidiomycetes or zygomycetes; lichenicolous Deuteromycetes are considered under 'Lichenes' (see before); molecular methods can help solve their taxonomic positions; some are common medically important species; as mycological knowledge advances (discovery of sexual stages), this list of asexual forms tends to get shorter, compensated however by discoveries of new deuteromycetes; in the case of separately named sexual and asexual morphs, the name of the sexual morph is preserved; approx. 16,200 species worldwide.

In the list of VANDEVEN *et al*. (1996), 268 species are included. To 46 of these, a teleomorph is attributed, in fact expelling them from this gathering of anamorphic fungi. Apparently, no synthesis of knowledge is available for the Belgian species. The herbarium at the Mycothèque de l'Université de Louvain (MUCL) houses a large collection. Important collections of economically or medically important species and strains are kept in the Belgian Co-ordinated Collections of Micro-organisms, (Agro-)industrial Fungi & Yeasts Collection (BCCM^{TM}/MUCL, http://www.belspo.be/bccm/mucl.htm) and Biomedical Fungi & Yeasts Collection (BCCM^{TM}/IHEM, http://www.belspo.be/bccm/ihem.htm).

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4. CONCLUSIONS

A little more than 13,500 species of fungi, algae and plants have so far been recorded in our country. Between 3,500 and 5,200 additional species are expected, which means that not less than 19% to 28% of our flora is still unknown.

Only the vascular plants (flora and distribution atlas) and, to a lesser extent, the bryophytes (checklist and regional distribution atlases) and lichens (checklist, identification key in preparation) can be considered as well known taxonomic groups. All other groups are moderately to badly known, some are even poorly or not studied at all. This is particularly the case for micro-organisms from soil and marine environments, as well as for parasitic and pathogenic agents of non-commercial hosts: bacteria, archea, marine phytoplankton,

Table 1. Overview of the Prokaryotic and botanic biodiversity in Belgium and the world. For Belgium, recorded and expected (= recorded + additional expected species) species numbers are given. The last column indicates the worldwide number of described species per taxon. [+: present; +?: probably present; xx ?: rough estimate; ?: not known (more precisely)]

Taxon/Group	Recorded	Expected	Described
Prokaryotes:			
– Eubacteria (excl. Cyanobacteria) and Archaea	< 6,000	< 6,000	6,000
– Cyanobacteria	300	400 ?	1,700
Eukaryotes:			
– Myxomycota	300	400	900
– Acrasiomycota	?	?	12
– Dictyosteliomycota	2	> 2	46
– Glaucophyta	1	2	13
– Chlorarachniophyta	0	+?	5
– Euglenophyta	< 405	400	930
– Cryptophyta	< 60	60 ?	200
– Haptophyta	22	40	300
– Rhodophyta	53	68	5,500
– Alveolata:			
– Plasmodiophoromycetes	2	> 2	47
– Dinoflagellata	200 ?	250	4,000
– Heterokonta:			
– Oomycetes			810
– Labyrinthulomycetes			48
– Hyphochitriomycetes			23
The above three groups together	100 ?	150	880
– Chrysophyceae	185	185	890
– Heterokontophyta *incertae sedis*	9	9	100
– Synurophyceae	< 63	60	151
– Bolidophyceae	0	+?	2
– Bacillariophyceae	1,600	2,600	12,000
– Pelagophyceae	1	3	12
– Dictyochophyceae	7	9	25-27
– Chrysomerophyceae	0	+?	7-8
– Pinguiophyceae	0	0	5
– Raphidophyceae	3	8	28
– Eustigmatophyceae	< 7	7	20
– Tribophyceae	105	110	600
– Phaeophyceae	29	41	1,700
– Phaeothamniophyceae	0	+?	26
– Chlorophyta	< 900	950	12,000
– Streptophyta:			
– Zygnematophyceae	< 740	750	4,600
– Charophyceae	29	30	< 450
– Klebsormidiophyceae	7	8	17
– Coleochaetophyceae	6	7	19
– Embryophyta:			
– Hepatophyta	171	185	5,500
– Anthocerophyta	5	5	120
– Bryophyta	557	577	9,500
– Lycophyta	11	12	1,000
– Sphenophyta	7	8	15
– Pterophyta	42	46	11,000
– Pinophyta	2	2-3	630
– Angiospermae	1,350	> 1,350 ?	230,000
– Eumycota:			
– 'Chytridiomycota'	57	150 ?	914
– 'Zygomycota' and Glomeromycota	+	200-400 ?	1,090
– Ascomycota:			
– Ascomycota (excl. Laboulbeniales and lichenised ascomycetes)	> 2,000	2,500	17,400
– Laboulbeniales	100	200	1,900
– Lichenised and lichenicolous fungi	977	1,000	13,500
– Basidiomycota:			29,950
– Basidiomycetes (macrofungi only)	2,910	3,200	20,400

zygomycetes, glomeromycetes and other microfungi or pseudofungi (slime moulds, alveolates, heterokonts). In many cases, the knowledge is out of date, going back a century or more. This leads to the conclusion that the knowledge of the Belgian botanic diversity is fragmentary and that many taxa have an uncertain taxonomic status.

Taxonomic research is thus far from achieved. On the one hand, there is the lack of knowledge on an important part of the Belgian flora. On the other hand, the few existing overview papers, even the recent ones, need to be updated with the most recent information. For example, a flora on the marine benthic macro-algae exists, but a recent survey of groynes and other hard substrates on the Belgian coast revealed many additions to the list (pers. comm. H. ENGLEDOW).

Another point of concern is the fast spread and the important number of alien botanic species. For example, the list of alien flowering plants observed in the wild in Flanders is almost as long as the indigenous list! Because the ecological consequences of this phenomenon are unknown and probably mainly unpredictable, monitoring and early warning systems become of crucial importance.

Tackling the lack of knowledge, keeping track of the settling of alien species, making information easily available, and this by the preparation of checklists, reference works and reviews, and by the follow up of the literature, are clearly important as well as huge tasks for botanic researchers. In many cases, this work is supported by accomplished naturalists. Strengthening taxonomy as an important basic scientific discipline should be the subject of an urgent and dedicated initiative by the federal and community governments.

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