Algae and their classification

The term algae (or seaweeds) is a practical term to use in everyday language, even if it has lost all clear meaning in the new phylogenetic classification of living organisms!

Algae could be defined as **plant organisms** capable of **photosynthesis** using chlorophylls, but **which have not acquired the advanced reproduction of** higher plants (Embryophytes or Archegoniates: mosses, ferns, conifers, Angiosperms). This definition remains vague and does not allow us to show that in fact there are more genetic distances between the various groups of algae than between higher fungi and multicellular animals! We cannot even use their living environments in this definition. While most of them live in aquatic environments, there are aerial algae and others that form a symbiosis with fungi to produce lichens.

The distinctive criteria of the various groups or lineage of algae are numerous and often difficult for neophytes to understand:

- Nature of **pigments** in addition to chlorophylls and carotene: xanthophylls for green algae, fucoxanthins for some brown algae and phycoeryhtrin and phycocyanin for reds (and blues). The colour of the thalli is what is best seen in the field and that is why these three large groups have been defined as quite practical, at least for algae visible to the naked eye;
- Other **biochemical criteria**, such as the nature of the reserve substances;
- **Cellular criteria:** no nucleus for blue algae **(Cyanobacteria**) which are Procaryotes and therefore particular bacteria; disappearance of cell motority in red and some green algae; organization of plasters; presence of a siliceous exoskeleton in Diatoms....;
- **Organization of the thallus**, from microscopic unicellular forms (Diatoms, Desmidiae) to large complex algae (Fucals and Laminarials);
- **Reproductive cycles and organs;** it can be said with certainty that there is more diversity in the reproduction of all algae than in all other living organisms! This ranges from a very simple cycle (*Fucus* has a cycle similar to that of animals), to a very complex cycle in which three generations of individuals of sometimes very different shapes (some red algae) follow one another;
- **Diversity of environments and lifestyles**.

Excluding the blue algae which are bacteria and simplifying a lot, we can distinguish several sets of eukaryotic algae (with a differentiated cell nucleus):

- first of all, the algae of the **green lineage** (Figure A). At the base of this evolutionary line are red algae **(Rhodobiontes** or **Rhodophyceae**) which are only aquatic and rather marine. Then come, in the **Chlorobionta**, the green algae divided into two parallel lineages: **Chlorophyte** lineage with, among others, **Ulvophyceae** - most of the green algae on our coasts - and **Chlorophyceae**, more freshwater or terrestrial; **Streptophyte** lineage which includes mainly **Zygophyceae** (spirogyres and Desmidiae) and **Charophyceae**, non-marine aquatic groups, and also Embryophytes (terrestrial plants), which are therefore the cousins of Charophyceae;
- then, the **brown lineage** quite far from the previous one (Figure A). It is only a convergence of the lifestyle (autotrophy for carbon) between the two sets and it has been shown that the appearance of photosynthesis is due to two totally distinct symbiosis events between non-chlorophyllous eukaryotic cells and chlorophyllous prokaryotic cells ! In this brown lineage, there are also several branches: towards the base, the **Haptophytes**, unicellular and marine, the **Pheophyceae** or brown algae in the strict sense, sometimes very large and especially marine, the **Diatoms**, aquatic and microscopic..
- other groups of algae, usually single-celled, are scattered in the classification (Figure A); they havemixed animal and plant characteristics. **Euglenobiontes** and **Dinophytes** are, for example, two constituent groups of plankton, such as many Diatoms, Desmidiae and some Chlorophyceae (*Chlorella* or *Volvox*).

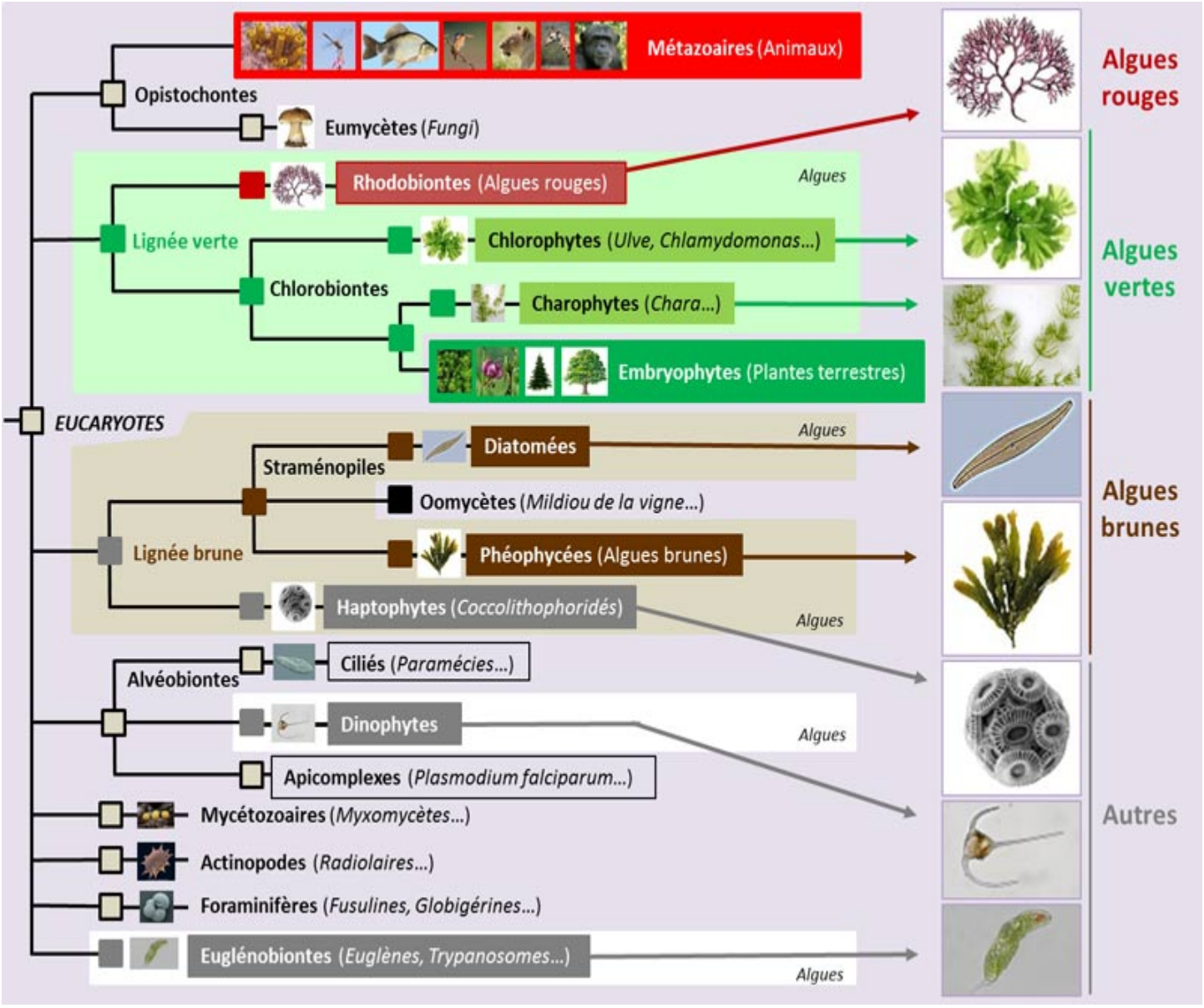

Figure 1. Distribution of the various groups of eukaryotic algae, in the broad sense, in the phylogenetic tree [Source: inspired by Lecointre, 2004]

References and notes

- Lecointre, 2004. *Comprendre et enseigner la classification du vivant*. BELIN, 312 p.
- De Reviers, 2002. *Biologie et phylogénie des algues*, 2 tomes. BELIN, 500 p.
- http://application.sb-roscoff.fr/download/fr2424/enseignement/stageete/flore/C.Destombe/2011%20la%20classification%20des%
