Algal biodiversity on sandstone in Luxembourg

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Introduction

Aerophytic algae often inhabit stony substrates, especially light and porous stony outcrops to which belong sandstones. The colonization of natural sandstone outcrops by blue-green algae is well-studied in hot arid areas of Africa (Wessels & Büdel 1995; Weber *et al*. 1996), Asia (Friedmann & Galun 1974; Friedmann & Ocampo-Friedmann 1984), Australia (Büdel & Wessels 1991) and of the cold icy deserts of Antarctica (Friedmann 1982; Friedmann & Ocampo- Friedmann 1984; Friedmann *et al*. 1988; Broady 1996). So far, the algal communities thriving on natural sandstones are, however, very poorly known in the temperate regions of Europe. Few data are available on artificial sandstone walls under moderate oceanic climate in Ireland (Rindi & McGuiry 2003) as well as under Mediterranean climatic conditions in Spain (Ortega-Calvo *et al*. 1991).
The aim of this work was to investigate the species composition of algal communities colonizing the surface of sandstone outcrops in Luxembourg. To this end the biofilms growing in the hypogean artificial galleries of the 'casemates' in Luxembourg-town and exposed to artificial light were compared to the algal communities living on the shaded surfaces of the sandstone in the Müllerthal exposed to natural light.

Materials and Methods

The samples of algal biofilms on sandstone outcrops exposed to natural light were collected at 4 sites near Berdorf of the Müllerthal region, in spring 2003. In addition, the biofilms growing in the hypogean artificial sandstone galleries of the 'Bock and Pétrusse casemates' in Luxembourg-town and exposed to natural and artificial light were sampled in spring 2003. The samples were studied by direct microscopy of the field collections as well as by studying mixed and pure cultures. The material was grown on agarised Bold Basal medium (3 NBBM) (Bischoff & Bold 1963). *Cyanophyta* from enrichment cultures were inoculated on Drewes medium (Allen 1952).

Results and Discussion

61 algal species were recorded in the samples of the sandstone outcrops of the Müllerthal: 38 *Chlorophyta,* 15 *Cyanophyta*, 5 *Bacillariophyta*, 1 *Xanthophyta* and 2 *Eustigmatophyta*. The representatives of *Chlorophyta* dominated in the samples. The diversity of *Cyanophyta, Eustigmatophyta*, *Xanthophyta* was significantly lower than *Chlorophyta*. The most common algae were *Desmococcus olivaceus*, *Pseudendoclonium printzii*, *Gloeocapsa dermochroa*, *Chlorella ellpsoidea*. A number of rare species (e.g. *Podohedra falcata*, *Dyctiochloropsis reticulata*, *Stichococcus undulatus*, *Scotiellopsis terrestris)* mainly known from sandstone outcrops of the Alps were also observed. Besides, five strains which probably represent new taxa were isolated. On the sandstone outcrops of the Müllerthal, *Chlorophyta* are mainly represented by (1) filamentous types with package-like cell accumulations (species of the genera *Apatococcus*, *Desmococcus*, *Diplosphaera*), (2) unicellular and colonial autospore-forming types (species of *Chlorella*, *Elliptochloris*, *Pseudococcomyxa*, *Coccomyxa*, *Schizochlamydella*, *Neocystis*, *Gloeocystis*, *Coenocystis*), and (3) disintegrating filamentous forms (species of *Klebsormidium*, *Stichococcus*, *Geminella*, *Fottea*).
In the samples collected from the walls of the 'casemates' 59 algal species were found: 15 *Cyanophyta*, 31 *Chlorophyta*, 10 *Bacillariophyta*, and

2 *Eustigmatophyta*. *Chlorophyta* and *Cyanophyta* dominated the species composition, although *Bacillariophyta* were also present in a high diversity. The most common algae in this habitat were *Pseudendoclonium printzii*, *Chlorella ellpsoidea, Lobosphaera* sp. and *Diadesmis contenta*.

Green algae are largely dominating the algal communities on Luxembourg's sandstone. The dominance of representatives of *Chlorophyta* in the algal flora of stony substrates is characteristic of temperate zones, whereas in tropical areas blue-green algae generally dominate (Nienow 1996; Hoffmann 1989). The comparative analysis of the species composition of the sandstone under open conditions and the 'casemates' shows that the first habitat is characterized by a higher species diversity of *Chlorophyta* and by a rather low diversity of *Cyanophyta* and *Bacillariophyta*. The dominance of *Chlorophyta* in the open space is probably explained by the lack of light in the 'casemates', where the lighting is periodical and absent for several months.

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Résumé de la présentation

Biodiversité algale sur le grès au Luxembourg

Mots-clés: grès; algues lithophytiques; communautés algales; Chlorophytes; Cyanophytes

Les algues aérophytiques habitent souvent les substrats rocheux, en particulier les affleurements rocheux légers et poreux auxquels appartiennent les grès. A présent, les communautés d'algues prospérant sur les grès naturels sont très mal connues dans les régions tempérées de l'Europe. Le but de ce travail était d'étudier la composition floristique des communautés d'algues colonisant la surface des affleurements de grès au Luxembourg.

À cet effet, les biofilms croissant dans les galeries artificielles hypogées des «casemates» à Luxembourg-ville et exposés à la lumière artificielle ont été comparés aux communautés algales vivant sur les surfaces ombragées du grès dans le Müllerthal.

61 espèces d'algues ont été enregistrées dans les échantillons des affleurements de grès du Müllerthal: 38 *Chlorophyta*, 15 *Cyanophyta*, 5 *Bacillariophyta*, 1 *Xanthophyta* et 2 *Eustigmatophyta*. Les représentants des *Chlorophyta* ont dominé dans les échantillons. La diversité des *Cyanophyta, Eustigmatophyta, Xanthophyta* était sensiblement inférieure à celle des *Chlorophyta*. Les algues les plus communes étaient *Desmococcus olivaceus*, *Pseudendoclonium printzii*, *Gloeocapsa dermochroa*, *Chlorella ellpsoidea*. On a également observé un certain nombre d'espèces rares (par exemple *Podohedra falcata, Dyctiochloropsis reticulata, Stichococcus undulatus, Scotiellopsis terrestris*) principalement connues des affleurements de grès des Alpes. En outre, cinq souches qui représentent probablement de nouveaux taxa ont été isolées.

Dans les échantillons récoltés sur les murs en grès des «casemates», 59 espèces d'algues ont été trouvées: 15 *Cyanophyta*, 31 *Chlorophyta*, 10 *Bacillariophyta*, et 2 *Eustigmatophyta*. *Chlorophyta* et *Cyanophyta* ont dominé la composition en espèces, bien que les *Bacillariophyta* aient été également présents à une diversité élevée. Les algues les plus communes dans cet habitat sont *Pseudendoclonium printzii, Chlorella ellpsoidea, Lobosphaera* sp. et *Diadesmis contenta*.

L'analyse comparative de la composition d'espèces du grès dans les conditions naturelles du Müllerthal et dans les «casemates» a montré que le premier habitat est caractérisé par une diversité plus élevée d'espèces de *Chlorophyta* et par une diversité plutôt basse de *Cyanophyta* et de *Bacillariophyta*. Ce fait est probablement expliqué par le manque de lumière dans les «casemates», où l'éclairage est périodique, respectivement fait défaut pendant plusieurs mois.