UTILIZATION OF WETLANDS AND SOME ASPECTS OF AQUEOUS CONDITIONS

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Areas exist associated with coal-mining in which seepage is highly acidic and contains dangerously high levels of iron, manganese, and other metals. Little if any readily noticeable plant growth is normally present at such sites. However, very often certain algae and bryophytes will colonize, tolerate, and even thrive under these extreme circumstances when flowering plants will not establish. Some species of algae and bryophytes are important and highly relevant in the use of wetlands to treat acid mine drainage because they are known to take up metals much more readily than flowering plants, in part because they are exposed and often free-floating (Whitton 1984). Another characteristic of some species of algae is their ability to form genetically distinct races that are uniquely adapted to the local environment (for example, tolerant of low pH and high iron levels; Moore and Ramamoorthy 1984). These races are morphologically indistinguishable from other races that are not adapted to such harsh conditions.

We are presently involved in compiling a list of algae and bryophytes that (1) occur in these highly contaminated areas; (2) grow through the winter months; and (3) occur in sizeable populations (i.e., not as traces among other plants). Included in this report is a preliminary list of plants together with their pH minima, iron maxima, and manganese maxima, collected in the winter of 1985-1986. The results are organized and alphabetized by plant genus, with the species given when known (Table 1). At times it is impossible to determine a collection to species because of an absence of reproductive material; in many cases the plants will have to be recollected at another time of year. The collection areas include sites from the following counties: Greene, Indiana, Jefferson, Vanango (Pennsylvania); Garrett (Maryland); and Coshocton (Ohio).

The pH, iron, and manganese values of Table I should be regarded as preliminary findings and based on only a few specimens. Nevertheless, several genera tend to recur in acid seeps, and it is evident that only a handful of species can grow to a marked degree under such harsh conditions. We have found five genera of algae in particular that tend to recur in these sites and which remain alive during the winter: Mougeotia, Euglena, Ulothrix, Eunotia, and Frustulia. All have been reported as tolerant of pH's below 3.0 (Round 1981). Two of these genera (Ulothrix and Mougeotia) are multicellular filamentous Green Algae, whereas Euglena is a unicellular alga in its own division that forms aggregate populations and can at times be the only plant in a mine seep. Eunotia can be quite abundant, whereas Frustulia seldom forms

dense populations. Most algae die off over the winter, persisting only as dormant spores. For this reason they are of little use in water reclamation (at least during the winter months). However, the fact that some species can not only survive at temperatures below freezing but also tolerate the low pH and high metal concentrations in the water is significant. It is possible that such algae are, in part, responsible for the diminution of soluble iron and manganese observed at several of the collection sites. Of the species reported in Table 1, those of the genera Ulothrix, Eunotia, and Frustulia are noted by Bennett (1969) as indicator algae of -mine waters. He found these genera to be common over a period of several months at a variety of sites.

Table 1. Genera of algae and bryophytes found inhabiting acid mine drainage sites; based on 43 specimens, many of which containing more than one species.

GENUS (COMMON NAME/DIVISION)	NO. OF OCCURRENCES	PH MINIMUM	FE MAXIMUM (MG/L)	MN MAXIMUM (MG/L)
BRYUM (MOSS)	2	2.5	100	43
DICRANELLA (MOSS; D. heteromalla)	3	3.2	100	43
EUGLENA (EUGLENOID ALGA; E. mutabilis)	5	2.5	5000	91
EUNOTIA (DIATOM)	17	2.7	140	60
FRUSTULIA (DIATOM)	8	3.2	65	55
LOPHOCOLEA (LIVERWORT; L. heterophylla)	1	2.5	--	--
MOUGEOTIA (GREEN ALGA)	20	2.5	5000	70
OSCILLATORIA (BLUE-GREEN ALGA; O. aghardhii)	1	4.0	30	24
POHLIA (MOSS; P. wahlenbergii)	1	2.5	--	--
POLYTRICHUM (MOSS; P. commune)	5	3.2	100	43
SPHAGNUM (MOSS; S. cuspidatum, S. fimbriatum, S. imbricatum)	5	2.7	140	60
ULOTHRIX (GREEN ALGA; U. subconstricta, U. subtilissima, U. tenerrima, U. variabilis)	9	3.2	5000	83
ZYGOGONIUM (GREEN ALGA)	2	4.0	65	30

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In several instances, collections were found to consist of the living plants of one species, and the dead plants of another species. For example, diatoms associated and/or epiphytic on filaments of Mougeotia; and Mougeotia growing over dead moss plants of Dicranella. In one instance, Polytrichum plants (mosses) were coated with living populations of Mougeotia. Perhaps the most common association between two living species included the co-occurrence of species in the genera Ulothrix and Mougeotia.

We are also involved in identifying and maintaining races of algae that are adapted to

extreme conditions of acidity and high metal concentrations. Currently we are maintaining a culture of Euglena mutabilis at Pennsylvania State University, and are investigating possibilities to culture other tolerant strains of algae inhabiting mine drainage waters. We are also testing the viability of these algae when dried down for purposes of storage and transport. Possible uses of these kinds of plants in mine waters include a winter treatment, transplantation in wetlands for enhancement, and as a preliminary biological treatment of particularly toxic drainage. Clearly, before such uses can be assessed more research is called for to investigate the role of aquatic or subaquatic algae and bryophytes in volunteer and man-made acidic wetlands. In addition, the role of vascular plants in providing a matrix for the growth of lower plants, as well as functioning in a direct manner, needs to be addressed. Webster (1985) found higher than expected metal levels in living tissues of the moss Pohlia nutans. Future studies will enlist other species, botanically characterize the seeps, include non-photosynthetic microorganisms, and determine which species, or species combinations, play an active role.

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REFERENCES

Bennett, H. D. 1969. Algae in relation to mine water. Castanea 34: 306-328.

Moore, J. W. and S. Ramamoorthy. 1984. Heavy Metals in Natural Waters. Springer-Verlag, New York.

Round, F. E. 1981. The Ecology of Algae. Cambridge University Press, London.

Webster, H. J. 1985. Elemental analyses of Pohlia nutans growing on coal seeps in Pennsylvania. J. Hattori Bot. Lab. 58: 207-224.

Whitton, B. A. 1984. Algae as monitors of heavy metals in freshwaters, pp. 257-280 in L. E. Shubert (ed.), "Algae as Ecological Indicators." Academic Press, London.