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ROLE OF PLANT DOMINANTS ON ABANDONED TAILINGS CONTAINMENT FROM MANGANESE-ORE MAINING IN CHVALETICE, EASTERN BOHEMIA, CZECH REPUBLIC (OVERVIEW OF LONG-TERM CASE STUDIES)

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ABSTRACT

During long-term research (almost forty years) of tailings containment in Chvaletice (Eastern Bohemia) were also carried out studies on the role of each plant dominants in succession. This review presents the most interesting results of these studies.

Keywords: tailings containment, substrate toxicity, plant dominants, vegetation succession, colonization, lichens, bryophytes, annuals, grasses, pioneer tree species, species diversity

INTRODUCTION

Tailings pond containment* from manganese-ore maining in Chvaletice (Eastern Bohemia, Czech Republic) is a long-term target of studies on the succession of vegetation, but also the other biological processes and phenomena in extreme environmental conditions (high content of heavy metals and salts in the substrate, extreme fluctuations of surface temperatures, unfavourable water conditions). Studies of the systems of three sedimentation basins (working between 1952–1973) are underway with varying intensity, since the beginning of the phasing out the operation of the last tailings pond in 1973. Between 1986 and 2002 the research at this locality has been quite intensive (Kovář, 2004). First data concerning the local flora and vegetation after abandonment of the ore-waste deposits were published in the late 1970s (Kovář, 1977; 1979).

Two reclaimed tailings (1975–1978) demonstrate differences to the third one neighboring them. This unreclaimed abandoned waste body was left to spontaneous natural succession, that has been influenced only in places by anthropogenic activities (like deposition of construction wastes, motorcycling etc.). This enabled exposure to a number of experimental and monitoring studies, including those that were focused on the role of dominant plant species in primary succession, and contributed to some generalisations within the context of restoration ecology (e.g. Kovář, 1994; 1999; 2000; 2003; 2006; 2007; Prach & Hobbs, 2008; Prach *et al*., 2008).

* Terminological variations in literature could be found: abandoned (derelict) sedimentation basin, slime pit deposit, ore-washery setting pit, mining waste disposal, orewaste sulphate reservoir.

MOSSES AND LICHENS

The initial vegetational cover of the substrate is characterised by the dominance of lichens of the genus *Cladonia*, mainly *Cladonia coniocraea* and *C. rei*, and also *Peltigera didactylus*. Besides lichens, the mosses that occur there include *Bryum caespiticium* and especially *Ceratodon purpureus* (Palice & Soldán, 2004; Soldán, 2009). After the fire episode (triggered by the extremely warm and dry summer in 1994), *Funaria hygrometrica* was increasingly abundant, but later its coverage decreased. Coverage of afore-mentioned species of lichens and mosses facilitate higher survival of clonal sprouts of dominant grasses (*Calamagrostis epigejos* and *Phragmites australis*), but it is unfavorable for long-term survival of seedlings. That is due to the microclimatic conditions (particularly soil humidity), which are suitable for seed germination, but not for further growth and attachment of seedlings. 75% of the seedlings of *Calamagrostis epigejos* in stands of mosses or lichens died within four months (Pohlová, 2004). Higher seedling establisment of this grass with prolonged success started after mulching of its own biomass (Štefánek *et al*., 2012). As well as the terricolous species, some primary epiphytic lichens can sometimes grow on soil within the biological soil crust. In well-developed moss-lichen crust near the access road to the Chvaletice sedimentation basin, a prosperous thallus of *Evernia prunastri* was observed (Peksa, 2009). Much more preferable for the attachment of seedlings are crevices in stands of mosses, which extend deeper into the soil (see Hroudová & Zákravský, 2004). A similar role is also played by dynamic vegetation of mosses in dispersal facilitation of other plant dominants, which are able to disperse by seeds (f.e. *Betula pendula*). In Contrast, lichens are not suitable for attachment of seedlings (both genus *Cladonia* and species *Peltigera didactylus*). Rather surprisingly, the largest number of seedlings was observed on bare soil.

ANNUAL PLANTS

Annual plant species (especially the vetches of the genus *Vicia* - *Vicia hirsuta* and *Vicia tetrasperma*) have appeared mainly in the younger stages of succession. Their proliferation and maximum abundance occurred within a relatively short period after the fire, which impacted a considerable area of the sedimentation basin in 1994. The sudden release of a high concentration of nutrients (and space) resulted in breaking the dormancy of seeds (Štefánek, 2004). A significant supporting factor of their dispersal was found in myrmecochory - dispersal of seeds by ants (Kovář *et al*., 2013). The role of annual *Vicia* species was in enrichment of the soil with nitrogen through root-nodule bacteria.

GRASSES

The main herb dominants in the middle successional stages are grasses - wood-small reed (*Calamagrostis epigejos*) within dry successional series and common reed (*Phragmites australis*) within wet successional series. Competitively strong and stress-tolerant *Calamagrostis epigejo*s produces a positive effect in extreme environmental conditions, because it favorably affects seedling establishment of other plants due to its litter. The litter layer of *Calamagrostis epigejos* has a positive effect on the microclimate of the soil surface. Similarly, although to a lesser extent, common reed (*Calamagrostis epigejos*) may grow in wet places (in terrain depressions). Simultaneously, litter of *Calamagrostis epigejos* is, surprisingly, most easily subjected to decomposition (in comparison with other dominants – namely birch and aspen) (Štefánek *et al.*, 2012). Another comparative study of two types of

substrates deposited in sedimentation basins (ash deposits and ore-washery deposits) show noteworthy plasticity of this grass in its growth strategy (Bryndová & Kovář, 2004). It consists in different ways of dispersal and generative production of clones and their selection by the site conditions (Kovář *et al.*, 2004). Seed persistence in harsh environment on ecotoxicologically strong substrate is another supporting factor of vitality of *Calamagrostis epigeios* (Dostál & Kovář, 2013). The other grasses follow the stressed microsite conditions with their tolerance to extremes - e.g., *Puccinellia distans, Agrostis stolonifera, Festuca brevipila* etc. (Vaňková & Kovář, 2004).

TREES

The dominant tree species are pioneer trees like birch (*Betula pendula*) and common aspen (*Populus tremula*), each of them with a different dispersal strategy. Birch spreads generative with small, anemochory seeds, while aspen is capable of clonal growth (but it is also possible to spread generatively with seed). Accordingly, they are also able to respond to different stresses and disturbances, such as sulphuric compounds (Rauch, 2004), or fire (Štefánek, 2004, Kovář *et al.*, 2011, Štefánek *et al.*, 2012). Effect upon leaf litter of these tree species is inconsiderable (with a similar effect as above-mentioned grasses), and it appears that leaf litter decay of both species occurs approximately at the same rate (Štefánek, 2004).

CONCLUSIONS

Studies of different types of industrial waste in abandoned sedimenation deposits within the landscape, shows that extremely high concentrations of sulphuric compounds and heavy metals represent enviromental conditions implying relatively low diversity of plants, and dominance of stress-tolerant and disturbance resistant plants (Vaňková & Kovář, 2004; Štefánek, 2004; Prach *et al.*, 2008). Described conditions are comparable with analogical environments throughout the world (such as volcanic substrates on high mountains) where some dominants are the same (e.g. bryophytes) regardless of latitude or longitude (Kovář, 2001). Anemochory and zoochory are the main types of plant diaspore distribution during plant colonisation of the substrate deposits, and they are the main factor of increasing biodiversity during spontaneous vegetational succession, when enrichment by humus and nutrients from decomposition processes of sufficient dead biomass is ensured (Kovář *et al.*, 2011; Štefánek *et al.*, 2012).

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