4. Synanthropic biological soil crusts and the effect of disturbance; design of experiments

JIŘÍ NEUSTUPA & PAVEL ŠKALOUD

Mechanical disturbance is considered a key factor influencing ecological dynamics of biological soil crusts (Evans & Johansen 1999). Numerous studies demonstrated the vulnerability of crusts in semiarid ecosystems to disturbance. Johansen et al. (2001) described a significant negative correlation between autotrophic biomass and productivity of a crust and degree of disturbance. In heavily disturbed sites the autotrophic production almost ceased. In moderately disturbed localities, the negative effect on autotrophic microorganisms was still significant. Belnap (2002) revealed a conflicting response of biological soil crusts to mechanic disturbance with off-road vehicles. In her study, she detected a significant decrease of nitrogenase activity that indirectly measured biotic content and activity of *Nostoc*-bearing lichens in only about a half of her plots. Eldridge & Leys (2003) demonstrated the enhanced wind erosion on crusts after mechanic disturbance that leads to decreased productivity and total cover.

Apart from mechanic disturbance, several other potentially significant disturbing mechanisms were proposed and tested on crust localities of semiarid ecosystems. Considerable and long-term negative effects were demonstrated in studies investigating fire disturbance in semiarid crust localities (Johansen et al. 2001). The effect of grazing disturbance on crusts was tested in semiarid ecosystems of Utah, U.S.A. by Johansen & St. Clair (1986). Whereas the total cover and biomass of crusts was restored after 20 years, following disturbance, the authors revealed that a long-term negative effect of grazing on algal diversity remained even after a 20 year period of recovery. Negative effect of grazing on a diversity of algae in crusts was also ascertained by Hodgins & Rogers (1997) in the subtropical grasslands of Queensland, Australia.

In biological soil crusts of ore-sedimentation basins the disturbance effects were not previously investigated. However, off-road vehicles, motorbikes and other ways of mechanic disturbance evidently influence crust development and their physiognomy on most of our investigated sites. We investigated the effect of mechanic disturbance at two localities. Firstly, we chose Chvaletice ore-sedimentation basin as a typical surface crust site on toxic ore-rich substrate (50°2′28.577″N, 15°26′39.361″E, see Colour plates, Fig. 4.1). Secondly, we investigated the locality close to the Ralsko former military airport (50°37′17.538″N, 14°42′49.296″E, see Colour plates, Fig. 4.2).

The Chvaletice locality was located in an area of ore-sedimentation basin that was erected in 1952 in the vicinity of a pyrite mine. In 1975, mining activity ceased and in 1979, the ore-sedimentation basin was abandoned. In 1983, unsuccessful attempts to reforest the locality were conducted (Kovář 2004).

The Ralsko locality consists of sandstone-based tree-less habitats with well developed biological soil crust on a soil surface with low vascular plant cover. The sampling sites were situated in the immediate vicinity of a former Soviet military airport in the centre of a huge military area that ceased to exist after 1990. The area as a whole is heavily environmentally damaged. Contamination of soil and underground water by oil and other toxic substances in this area still represent one of the most significant environmental damages in the Czech Republic.

In total, we established seven experimental plots (Fig. 4.3), three in Ralsko site and four in Chvaletice ore-sedimentation basin. In each plot, we delimited four $1 m^2$ squares with different treatments: disturbed and undisturbed. Disturbance was done by mechanically scratching the surface crust layer (Figs. 4.1 d, 4.2 d) immediately after the first set of samples was completed on 17th November 2005. In 2006, we sampled both localities on 15th November. As the investigation of lichens species composition did not involve culturing experiments, in this group additional data were determined in October 2007 and used in subsequent analyses. For abiotic factors measured on individual plots and for methodics see chapter 3.2.

Firstly, we investigated the species composition of experimental plots and we asked whether there was any change in crust diversity and species composition in response to disturbance significantly different from annual change of undisturbed control plots. In other words, we looked for whether the biological soil crusts on both localities were stable enough to sustain intensive nonrecurring disturbance. Secondly, we asked for changes in abiotic and ecophysiological factors in response to disturbance. Thirdly, we investigated possible correlations of abiotic factors and biotic data both within and between sets of disturbed and undisturbed plots.

The floristic results are presented separately for different major organismal groups as their biodiversity, the patterns of variation in species composition and, presumably, their different responses to disturbance stress. Then, we present results and interpretations of patterns of change in diversity and in abiotic data in response to experimental disturbance.

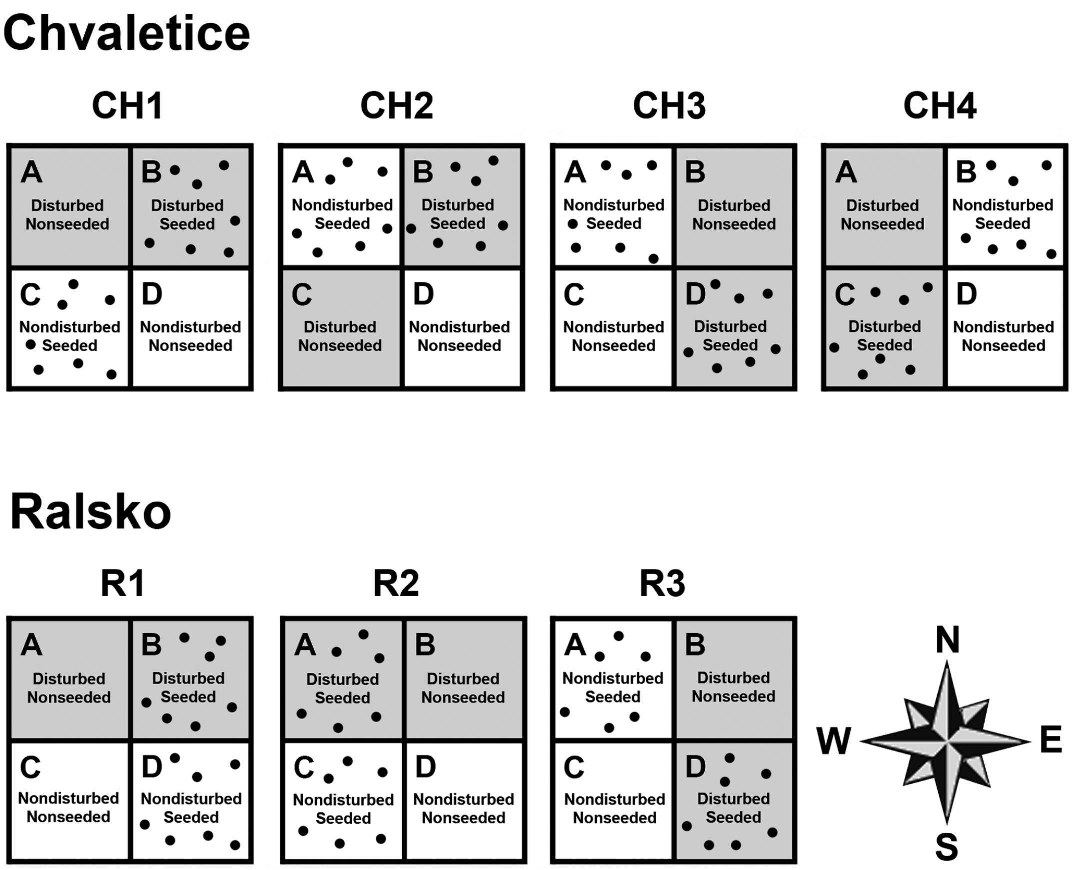

Fig. 4.3 Design of experimental plots. White – undisturbed, grey – disturbed.