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SPECIAL FEATURE

The role of vegetation succession in ecosystem restoration

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The 13 papers presented in this Special Feature result from an international conference "Spontaneous succession in ecosystem restoration" held in České Budějovice, Czech Republic, 7–10 September 1999.

Contents

The role of vegetation succession in ecosystem restoration: Introduction

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Background

The papers presented in this Special Feature result from an international workshop 'Spontaneous succession in ecosystem restoration' which was held from 7 to 10 September 1999 in České Budějovice, Czech Republic and organized by the University of České Budějovice, and the Institute of Botany, Academy of Sciences of the Czech Republic, Průhonice. Sixty-five participants from 11 countries attended the workshop and presented 20 lectures and 16 posters. We received 18 manuscripts based on these presentations of which 13 were accepted.

Primary succession

The issue starts with studies of primary succession. However, we point out that the distinction between primary and secondary successions is not always clear and of limited relevance for the course of succession (see also van Andel et al. 1993). Several papers deal with re-vegetation of extreme substrates of post-mining landscapes in different parts of Europe. *Wiegleb & Felinks* studied areas unaffected by reclamation measures and found a rather low level of predictability of early stages of primary succession. While mechanisms causing rapid changes are accessible to direct observation and experiment, investigation of slow changes is usually only possible in field studies using exploratory data analysis. Evaluation of the effectiveness of reclamation techniques cannot be done properly without comparison with vegetation developed without human intervention. This approach was repeatedly emphasized during the workshop. It was also adopted by *Kirmer & Mahn* who examined the colonization of unvegetated dry slopes in a lignite mining area in Germany, and compared the spontaneous vegetation development with plots treated by clippings from neighbouring grassland communities. No vegetation development was found on substrates with extremely low pH but at more hospitable sites a rather rapid vegetation development occurred; the application of fresh plant clippings from areas with similar habitat conditions appears to be a viable and relatively inexpensive alternative to traditional restoration methods. *Ninot et al.* evaluated different reclamation techniques on nutrient-poor lignite wastes in the montane and submontane belts of the eastern Pyrenees, where *Quercus* and *Pinus* forests and mesoxerophilous pastures are target communities for reclamation. After 7-8 yr, both reclaimed sites and spontaneously colonizing vegetation varied markedly in composition while it can be concluded that an appropriate choice of sown species and proximity to undisturbed vegetation accelerates succession (see also Zobel et al. 1998).

Secondary succession

Gergely et al. studied new terrestrial habitats originating on a recently exposed Danube riverbed (representing a transition between primary and secondary succession) and found a very rapid formation of *Salix* thickets. They pointed out that an elevation/moisture gradient was primarily responsible for the small-scale vegetation heterogeneity developed in the course of succession. From this paper, we move to secondary-succession processes, starting with old-fields, i.e. the habitat which has made a substantial contribution to present knowledge and understanding of vegetation succession in human-made sites (Osbornová et al. 1989). *Csecserits & Rédei* studied Hungarian old-fields to find out whether active intervention is needed to stimulate semi-natural vegetation to return to the site or whether secondary succession will suffice. They drew a conclusion from the restoration viewpoint: the main changes in species composition occurred in the first 10 yr after

abandonment, and species typical of natural vegetation appeared early in succession, attaining dominance. It is suggested that no intervention is needed, since spontaneous secondary succession leads to semi-natural vegetation. On a more detailed scale, *Pickett et al.* review some of the spatial and temporal dynamics during old-field succession at the Hutchinson Memorial Forest in New Jersey, which is perhaps the best long-term data base on old-field succession in the United States. The coarse-scale variation and long-term successional patterns are composed of the fine-scale contingencies and spatial effects across many spatial scales, and understanding how these contingencies structure the plant community can generate knowledge that can be used by practitioners. The effect of mammals on fine-scale patterns of succession is described by *Bartha*. His results suggest that gopher disturbance does not facilitate the colonization of native prairie species while diversity can be controlled through preventing litter accumulation. *Verhagen et al.* investigated the restoration success of low-production vegetation types on former agricultural soils after top soil removal. Many target species were still lacking from the developing vegetation in the permanent plots 9 yr after top soil removal, although most were present in the local species pool. This indicates that dispersal acts as one of the limiting factors.

Studies comparing successional seres in quantitative terms are informative but unfortunately rather rare (Prach et al. 1997). The study of *Prach et al.* concludes the section devoted to successions starting on bare ground. By summarizing information from a temporal scale of decades and a regional geographical scope, they distinguish two rather distinct pathways succession may take in the disturbed Central European landscape. Vegetation development in deeply human-altered, agricultural, industrial or urban landscapes is different from that in less impacted, mostly forested landscapes. The former type of succession starts with ruderal annuals, the latter usually by non-ruderal clonal perennials. The terms 'ruderal' and 'non-ruderal' succession, respectively, may be used to indicate these types.

Three papers explore the pattern of vegetation development and restoration possibilities in sites with vegetation cover not removed before the onset of succession. In the present European landscape, heathland, mountain meadows, and mires all represent valuable habitats seriously threatened by human activities. Hence knowledge of the course of spontaneous succession and its potential for reclamation, in concert either with traditional or new management techniques, is highly desirable.

Chytrý et al. investigated secondary succession following experimental disturbance in a species-rich dry heathland. Disturbance increased species richness, and the study demonstrated that restoration efforts must be taken with the specific situation borne in mind. In this kind of heathland where natural disturbances were part of community history, some kind of disturbance regime to maintain high species richness should be an integral part of present day management, practised by nature conservation authorities. *Krahulec et al.* explored sheep grazing as an alternative management in traditionally mown mountain meadows. Sheep grazing, if applied on its own, supports nitrophilous tall herbs and grasses; the best management leading to suppression of these species appears to be a combination of sheep grazing and mowing which minimizes the negative effects on species diversity. *Large* reports on a degradational successional change in two mire complexes in Scotland which has occurred despite management efforts. Analysis of vegetation succession provided a basis for recommendations made for management. Maintaining water tables at appropriate levels is a necessary condition to maximize the floristic diversity of active mires.

Conclusion

The rationale behind the workshop and this issue was to address the question: what do we know about spontaneous (i.e. not directed, accelerated or otherwise affected by direct human activities after site creation) successional processes and, how can this scientific information be used for solving practical questions of ecosystem restoration? This is reflected in the concluding paper by *Prach et al*. which was inspired by a stimulating discussion during the workshop. This paper attempts at evaluating the state of the art and suggesting future ways of diminishing the gap that still exists between academics and practitioners. It is evident that close cooperation is needed to make the most of the promising and effective role of spontaneous succession in ecological restoration.

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