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How Long Will It Take? Regeneration of Vegetation and Soil after Clearing, Burning and Cultivation. The Forchtenberg-Experiment

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Drowned landscapes; Mesolithic; Rhine-Meuse delta; underwater excavation.

Introduction

Experiments are necessary to understand the principles of cultural landscape development, when natural or historical archives are unclear or even lacking. Such a project has been conducted since 1997 in south-western Germany near Forchtenberg/Kocher valley. It intends to test hypotheses of a model for southern Central Europe and to elucidate the 'Müller-Cycles.'[1] This project shall provide information on the importance of fire as an instrument of landscape management as well as on possible yields during that time on cultivated fields. The long duration of the project allows the first fire plots to be cleared again after a decade and regeneration types of vegetation and topsoil properties to be followed up in the long term.

Impact and Results: Two Mosaics

Forest clearing drastically changes the ecological conditions. Light and rainfall directly reach the soil surface. As interception and forest microclimate are no longer present, the organic cover layers dry out or are eroded. The cleared surface is rapidly colonised by mosses, grasses, herbs or bushes in a more or less accidental way. Finally there is a concurrence between grasses and bushes—mostly *Rubus fruticosus.* Cloning species such as *Holcus mollis* may conquer a great surface within weeks and dominate it for years,[2] whereas tussock grasses like *Deschampsia flexuosa* vary in their presence. High forbs like *Cirsium arvense, Epilobium angustifolium* or *Eupatorium cannabinum* become more and more important. Thus a complicated mosaic will develop during spring and summer. However, large surfaces may remain bare. Topsoil and soil surfaces react as rapidly as the plant cover creating their own mosaic. Bare surfaces with a mineral pellicular organisation interchange with algae-bacterial films and moss-settlements.

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1 Alternating periods of deforestation, fire use and cultivation as well as reforestation in the Neolithic, cf. Merkt and Müller 1995.

2 Cf. Schulz et al. 2012.

On this already established mosaic a part of the plot was burned. It created a new structure of a differentially destroyed surface, which was managed by sowing and, in part, by soil work and was exposed for a new colonisation. Depending on the temperature and the duration of the fire impact the over-burned topsoil/soil surfaces were differently transformed into a complicated pattern of bare surfaces, charcoal and ash layers as well as moss or grass plots with only minor damage.

Two Different Ways of Regeneration

During the first two years after cultivation the concurrence between grasses, herbs and bushes continued on the non-burned area with the development of a *Rubus*-layer. Tree seedlings are mostly repressed. On the burned surfaces, however, high forbs—especially *Eupatorium cannabinum* – predominate. Soil surfaces are largely characterised by grass felts. From the third year the forest dynamics reappeared. Re-growing trees with an early shedding of broad leafs such as *Tilia* and *Acer* created islands of an O_l and later on O_l/O_f layer under their growing crowns. Thus for the following years, the difference of plain (grass felts) and islands of O_l/O_f layers was the most prominent feature. Charcoal occurred either dispersed or, rarely, preserved in charcoal horizons.

Emerging trees characterised the following stages more and more. These were re-growing trees with growing crowns and pioneer trees (*Salix caprae, Betula pendula* but also *Acer pseudoplatanus, Fraxinus exelsior* or *Quercus petraea).* This situation developed to a dense tree cover, where *Betula* indicated the formerly burned areas. This succession followed more or less the lines given by Dierschke[3] in reaching the "preforest-stage," which he described from succession plots of beech forests in Central Germany.

From about the fifth year after the first clearing the regeneration of the plant cover changed to a long-lasting predominance of the high forbs, mostly *Cirsium arvense.* Re-growing trees developed from stumps, as was typical for the other fields. However, the seedlings of all other trees were impeded at least for four or five years. The dense standing of high forbs enabled a humid microclimate and supported the development of a short moss-/grass-/herb cover beneath them. Soil development was favoured by this microclimate and the annelid activity in the topsoil became important. This resulted in a well-developed Ah-horizon and grass felts as soil cover. It is interesting to mention that a ruderal development is quasi restricted to these high forbs. Even though the test site adjoins intensively cultivated fields only few ruderal herbs came from this area.

Conclusion

The Forchtenberg experiment showed two different succession pathways after severe intervention in the form of clearing, burning and cultivation.

Burning and cultivation disturb a first colonisation by vegetation on the cleared plots. During the months after clearing soil surfaces are rapidly modified from the original O_l/O_f layers to grass and herb felts, moss layers or bare surfaces. Burning creates a new mosaic due to differences in fire intensity. The following years showed the classical pathway of regeneration, which is one of "island and plain." Some trees re-grow from their stumps and create early spots of forest dynamics in a plain dominated by grasses, herbs or high forbs. *Betula* may colonise and suppress the *Rubus*-layers, in concurrence with other trees later on. Topsoil/ soil surfaces follow these developments by a first pellicular organisation being replaced by grass felts and O_l/O_f cover layers as an indicator of recommencing forest dynamics.

3 Dierschke 1988.

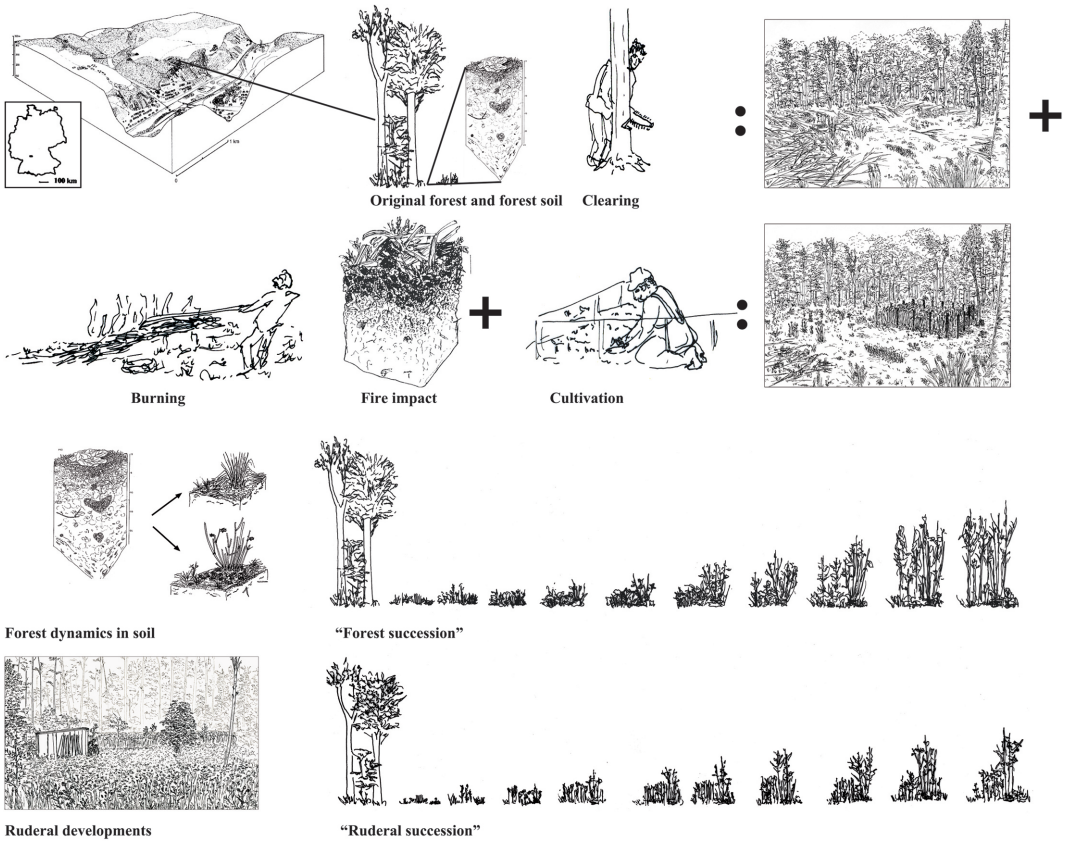

Fig. 1 | The Forchtenberg test site on the Hohenlohe Plain, the experiments and their results on the plots as well as the different pathways of regeneration (after Schulz et al. 2012, modified).

However, a second succession pathway became obvious. High forbs—especially *Cirsium arvense*—may rapidly colonise and form dense stands impeding the establishment of shrubs or tree-seedlings for half a decade. It is a monotypic ruderal formation. Topsoil/soil surface development follows the scheme of pellicular organisation leading to grass felts and O_l/O_f cover layers with intensive crumbling depending on the microclimate in these dense stands.

This type of ruderal development poses the question of the character of the early cultural landscapes.

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