



Bryophyte vegetation of forests in relationship to forest management types

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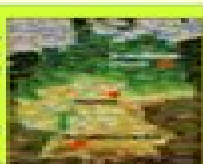


BIODIVERSITY EXPLORATORIES

Introduction:

Three research sites were established for large-scale and long-term functional biodiversity research. These Exploratories are situated in geographically different regions of Germany (see map).

The main objectives of this project are to:
- compare bryophyte diversities of different forest management types on landscape scale
- analyze the main factors promoting high bryophyte diversity in forests



Methods

- bryophyte vegetation relevés on 998 plots (size: 400 m²)
- species were recorded according to their stratum: corticolous (epiphytic and on tree bark), lignicolous (on dead wood), terricolous (on ground) and saxicolous (on rocks)
- coverage estimation of the bare soil, bedrock and litter
- forest inventory recorded: forest type, management type, tree data (species, height, BHD), forest structure and deadwood volume and their decay stage and type.

Results

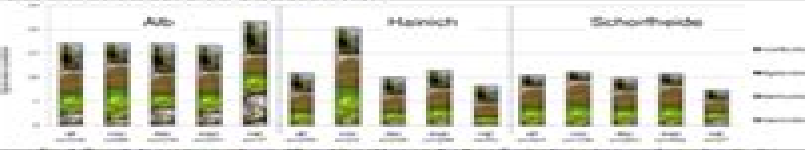
1. Species numbers

Differences concerning species composition existed between the Exploratories regarding total species number (Tab. 1).

Tab. 1: Total species number of Exploratories and number of species that were found only in the Exploratory

| Exploratory | Species |
|-------------------|------------|
| all Exploratories | 1480 |
| Swabian Alb | 144 (10%) |
| Hainich | 112 (7.6%) |
| Schorfheide | 84 (5.7%) |

Forests of the Swabian Alb showed the highest bryophyte diversity (Fig. 1), due to high numbers of corticolous and saxicolous species. We counted significant higher species numbers in coniferous plantations than in deciduous forests for all plots in the Hainich and Schorfheide-Exploratory, but not on sites of the Swabian Alb.



Developmental stage of age class forests revealed an effect on bryophyte diversity only in the Alb-Exploratory (Fig. 2). Young and old timber stands showed higher species numbers than thickets, pole wood and bare land, but we observed in uneven aged forests (mainly unmanaged) the highest species densities.

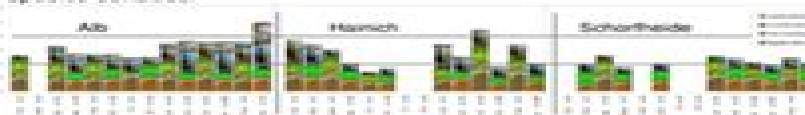


Fig. 2: Bryophyte species density per plot in coniferous (C) and deciduous (D) forests for three forest age classes (pole wood, P; Thicket, T; Thicket stage, TS) in young timber (Y), old timber (O), and uneven aged (U).

2. Qualitative bryophyte vegetation analyses

The species compositions in the Exploratories differed in ecological requirements (Fig. 3, 4). So the most hygrophilous and basophilic communities grew in the Swabian Alb, whereas the communities of the Schorfheide were dominated by acidophilic species.



Fig. 3: Mean indicator values for humidity for all plots of each Exploratory



Fig. 4: Mean indicator values for reaction for all coniferous (C) or deciduous (D) forest plots of each Exploratory

Factors promoting bryophyte diversity:



Corticolous species

Mean breast height diameter (BHD) of several tree species was often positively correlated with species numbers of corticolous bryophytes (Tab. 2). Moreover correlations were also positive with highest BHD, mean tree height and number of individuals of several tree species.

Tab. 2: Bivariate tests of interactions between mean BHD of tree species and corticolous bryophyte diversity ($r = 1$ = significant positive, -1 = significant negative) in each Exploratory

| Exploratory | Species | r |
|-------------------|-------------|------|
| all Exploratories | all species | 0.12 |
| Swabian Alb | all species | 0.12 |
| Hainich | all species | 0.12 |
| Schorfheide | all species | 0.12 |
| all Exploratories | deciduous | 0.12 |
| Swabian Alb | deciduous | 0.12 |
| Hainich | deciduous | 0.12 |
| Schorfheide | deciduous | 0.12 |
| all Exploratories | coniferous | 0.12 |
| Swabian Alb | coniferous | 0.12 |
| Hainich | coniferous | 0.12 |
| Schorfheide | coniferous | 0.12 |



Lignicolous species

We could detect decay stages of dead wood and their type as factors, that benefit high diversities of lignicolous species. The most important was dead wood originating from coniferous trees (Tab. 3).

Tab. 3: Bivariate tests of interactions between types of deadwood (conifer and deciduous) and lignicolous sp. ($r = 1$ = significant positive, -1 = significant negative) in each Exploratory

| Exploratory | Species | r |
|-------------------|-------------|------|
| all Exploratories | all species | 0.12 |
| Swabian Alb | all species | 0.12 |
| Hainich | all species | 0.12 |
| Schorfheide | all species | 0.12 |
| all Exploratories | deciduous | 0.12 |
| Swabian Alb | deciduous | 0.12 |
| Hainich | deciduous | 0.12 |
| Schorfheide | deciduous | 0.12 |
| all Exploratories | coniferous | 0.12 |
| Swabian Alb | coniferous | 0.12 |
| Hainich | coniferous | 0.12 |
| Schorfheide | coniferous | 0.12 |



Terricolous species

Soil disturbances, caused by human activities or windbreak had positive influence on species densities in deciduous as well as in coniferous forests (Fig. 5). Moreover species numbers were negatively correlated to litter cover [%] and positively to bare soil cover [%] and bryophyte cover [%].



Fig. 5: Species numbers of terricolous bryophytes in coniferous (C) and deciduous (D) forests with and without human or natural disturbances



Saxicolous species

Diversity of saxicolous species is significant influenced by abundance of rocks (C).

Discussion

The observed differences between the Exploratories depend on differences in landscape characteristics e.g. precipitation, altitude, pollution, soil and bedrock attributes.

But the impact of forest management on bryophyte diversity is also present. Plantations of coniferous trees have the most evident and promoting effect of forest management on bryophyte diversity because these forests are characterized by relatively good light conditions and sparse litter. Further bryophyte diversity promoting factors were forest stand age, existence of deadwood and soil disturbances. But these factors are not directly correlated with forest management types.

Unmanaged forests did not reveal higher bryophyte diversity than managed forests in all Exploratories. The reason for that observation could be that these forests are only since few decades out of any land use. Typical attributes of real natural forests like high amount of dead wood and high tree species diversity are still missing.

Conclusion

Forest management has an impact on bryophyte diversity mostly by plantation of coniferous trees. Further effects are indirect and complex and not directly correlated with forest management types.

Management Recommendations For Bryophyte

David Kirk



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