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Englische Zusammenfassungen der in den Berichtsjahren 1985 und 1986 abgeschlossenen Dissertationen und Diplomarbeiten

Summaries of Ph D and Diploma Thesis

Dissertationen (Ph D Thesis)

EGLOFF Thomas. Auswirkungen und Beseitigung von Düngungseinflüssen auf Streuwiesen. Eutrophierungssimulation und Regenerations-experimente im nördlichen Schweizer Mittelland. Veröff.Geobot.Inst.ETH,Stiftung Rübel,Zürich **89**(1986). 183 S.

Effects and elimination of fertilization influences on litter meadows. Simulation of eutrophication and regeneration experiments in the northern Swiss midlands.

The study presented here, carried out in the northern part of the Swiss midlands, is a contribution to the solution of two problem complexes, with which nature conservationists working for the protection of litter meadows are confronted: A) avoidance of nutrient infiltration from the intensively used agricultural area ('buffer zone problem'); B) recovery of eutrophicated litter meadows and of nutrient rich meadows, which were once used as litter meadows, to an oligotrophic state (oligotrophication, regeneration, 'renaturation').

Litter meadows are unfertilized and therefore poor in nutrients. They are moist, and only cut once a year, in autumn, to gain bedding for the stables. The focus of the study is on the litter meadows dominated by *Molinia coerulea* (Molinion).

Problem complex A: eutrophication, 'buffer zone problem'

To simulate indirect fertilization (nutrient infiltration mainly by surface runoff and soil water) of the border zones of litter meadows, we fertilized the inner part of undisturbed areas. The aims were a list of species indicating fertilization influences (eutrophication indicators) and information about the importance of the main nutrients nitrogen, phosphorus, and potassium in the process of eutrophication.

In the fertilizer trial on mineral soil in the lower valley of the Reuss, nine plots of 100 m² were fertilized with PKN or PK mineral fertilizers for two years (1979, 1980); the vegetation was observed until

1983. The trial on fen peat in the airport area of Kloten, which based on the experiences of the first experiment, was carried out in 1982 and 1983, on plots with N, KN and PKN mineral fertilization covering an area of 135 m².

Problem complex B: oligotrophication, regeneration

For the oligotrophication of eutrophicated and/or former litter meadows, we carried out, besides the mowing in autumn, an additional one in early summer, which should accelerate the nutrient impoverishment and damage plant species which are not typical for litter meadows. Two periods of early mowing were tested: the first half of June and the middle of July. As third treatment, the effect of mowing only once, in autumn, was investigated.

Test plots were the former PKN-plots of 25 m² of the fertilizer trial in the valley of the Reuss and five plots of 75 m² on disturbed meadows in the airport area of Kloten.

The study presented here reports the effects of two years additional early mowing on vegetation and soil.

The results of fertilization and additional early mowing were investigated with relevés, counting of individuals, measurements of standing crops and analyses of plant minerals. Vegetation data were mainly analysed with correspondance analyses.

Results:

1. On the control plots, numbers of individuals (of certain plant species) and standing crops showed strong year-to-year fluctuations.
2. Problem complex A: **fertilizer tests**
 - a) The list of eutrophication indicators contains, besides widespread species (e.g. Calamagrostis epigeios) and ruderal plants (e.g. Solidago serotina), mainly typical species of the alliances Molinion (e.g. Cirsium palustre), Filipendulion (e.g. Carex acutiformis) and Calthion (e.g. Agrostis gigantea).
 - b) The wetter the plots the less the effects of fertilization.
 - c) On slightly alcalic mineral soil (valley of the Reuss) and also on slightly acid fen peat (Kloten) phosphorus proved to be the prime limiting nutrient for plant growth (see also EGLOFF 1983).
3. Problem complex B: **regeneration experiments**
 - a) Relative to nutrient deprivation, the treatment with mowings in July and autumn is a little more efficient than the treatment with mowings in June and autumn. The treatment with one mowing in the middle of September follows with a clear difference.
 - b) On mineral soil, the P-oligotrophication by mowings is much more difficult and more tedious than the impoverishment of nitrogen and potassium, due to the strong immobilisation of phosphorus: During the two years with two yearly mowings, the sites lost on average a fifth of the N- and K-quantities, but only a tenth of the P-quantity from fertilizers.
 - c) Relative to reaction of species to early mowing, on the one hand both treatments resulted in equal effects (e.g. Filipendula ulmaria, Cirsium arvense), while on the other, some species showed clearly different behaviour: Holcus lanatus and Rhinanthus alectorolophus for instance spread greatly on plots mown in July.
 - d) Calamagrostis epigeios, Cirsium arvense, Filipendula ulmaria and Solidago serotina, frequent species in disturbed litter meadows, cannot be combatted by mowing only in autumn.

Main conclusions:

1. When the litter meadow is wet, the eutrophication may only be recognized after intervention in the water balance or after dry summers.

- For this reason a yearly and methodically fine floristic surveillance is necessary.
2. On mineral soils, half-bogs, and fens, where the vegetation is dominated by the flying bent (Molinia coerulea), small sedges (Carex sp.) or small rushes (Schoenus sp.), phosphorus is on principal the prime limiting nutrient. On fen, potassium can be almost as limiting. When therefore fertilization restrictions are decided for the surroundings of protected litter meadows, then mainly the phosphorus infiltration must be prevented.
 3. For the floristic surveillance of litter vegetation in permanent plots, finer methods than the classic relevé must be employed (e.g. counting of individuals, phenological observations).
 4. When an oligotrophication is aimed at by additional mowing(s), one must conform to the actual vegetation (and the site). An analysis of the composition of the vegetation must precede the determination of the mowing treatment, in order to prevent undesired species from profiting by an early mowing carried out too late or too early. On wetter areas one can often forgo an additional mowing.
 5. If a meadow, which is to be oligotrophicated, is situated directly near an intact litter meadow, the aim need not be 'regeneration of a litter meadow', since nutrient impoverishment by mowings is extraordinarily tedious. Alternatives for the 'renaturation' of intensively utilized meadows can be for instance once or twice mown (unfertilized) hay meadows, which, except in the mountain regions, have also become extraordinarily rare.

GASSER Max. Genetic-ecological investigations in Biscutella laevigata L. Genetisch-ökologische Untersuchungen von Biscutella laevigata L.
Veröff.Geobot.Inst.ETH,Stiftung Rübel,Zürich 86(1986), 86 S.

Biscutella levigata from the alpine vegetation belt of Davos is predominantly allogamous and highly self-incompatible. However, neighbourhood size is apparently restricted by factors operating in the pollination phase, in seed development, and in seed dispersal. Clear adaptations to dolomite and serpentine were observed; germinating behaviour as well as mortality and development of young plants proved to be greatly dependent on substratum and origin in laboratory, greenhouse, and field trials.

B. levigata forms edaphic races on various alpine substrata. In addition, an (eco)clinal differentiation on dolomite was observed. The subpopulations occurring in dense dolomite grassland were small, had a very low density of ramets and seedlings were scarce. On the other hand, subpopulations inhabiting dolomite scree had a high density of ramets, and seedlings occurred frequently. The subpopulations of intermediate dolomite sites were intermediary. Contrary to the pattern found on dolomite, the demographic behaviour of B. levigata on serpentine was similar in all sites studied.

In conclusion, influence of neighbourhood size on microdifferentiation in plants is briefly discussed.

KUHN Urs. Bedeutung des Pflanzenwasserhaushaltes für Koexistenz und Artenreichtum von Trespen-Halbtrockenrasen (Mesobromion).
Veröff.Geobot.Inst.ETH,Stiftung Rübel,Zürich, 83 (1985).
118 S.

Influence of the water balance of the plants on the coexistence and the richness of plant species in semi-dry meadows (Mesobromion).

The present investigation deals with the influence of water balance and especially water deficiency on the coexistence and richness of plant species in semi-dry meadow ecosystems. The ecophysiological behaviour of six species (Bromus erectus, Dactylis glomerata, Salvia pratensis, Plantago lanceolata, Trifolium pratense and Taraxacum officinale) was investigated under different water conditions in the growth room and in the field.

1. Plants grown under dry conditions in the growth room showed very great intraspecific differences of leaf conductance. The highest values of leaf conductance differed from the lowest ones by a factor of 10 for D. glomerata and P. lanceolata, by a factor of 20 for B. erectus or even of 50 for S. pratensis.
2. The difference of the mean leaf conductance from species to species was larger under dry conditions in the field than under moist ones. Under dry conditions (in $\text{mmol} \cdot \text{m}^{-2} \cdot \text{s}^{-1}$) S. pratensis (100-670) and P. lanceolata (10-720) generally reached very high values, T. officinale (25-370) medium ones and T. pratense (10-460), B. erectus (15-230) and D. glomerata (6-320) low ones.
3. The species showed very different reactions to different weather conditions. The differences between the species are particularly distinct on warm and dry days; they concern the midday xylem water potential (D. glomerata and B. erectus very low values, S. pratensis very high ones), differences of leaf conductance between dry and wet treatment (B. erectus and D. glomerata pronounced differences, S. pratensis insignificant ones), midday depression of leaf conductance (D. glomerata very distinct, S. pratensis no midday depression).
4. In general, leaf conductance was higher after cutting than before. The values of D. glomerata, P. lanceolata and T. pratense, were much higher, those of B. erectus and T. officinale slightly higher, and those of S. pratensis insignificantly higher.
5. There was no recognizable relationship between high leaf conductance and high xylem water potential. In the moist species there was, however, a pronounced midday depression of leaf conductance when the xylem water potential fell below a certain specific threshold. This threshold was -2.75 MPa for D. glomerata, -2.2 MPa for P. lanceolata, -2.25 MPa for T. pratense and -2.0 MPa for T. officinale. B. erectus and S. pratensis showed no recognizable threshold.
6. The behaviour of the plants in relation to the water balance was estimated in combination with morphological data of the different plants. The adaptation to drought decreased in the following order: B. erectus, S. pratensis, D. glomerata, P. lanceolata, T. officinale, T. pratense. This sequence is much the same as that of the biomass of the different species in the meadows.
7. The water balance strategies of the different species were compared with those published by BORNKAMM (1958), STOCKER (1967), HICKMANN (1970) and PASSIOURA (1982). This led to some disagreement, especi-

ally concerning the strategies of the grasses. It is shown that the sensitive and efficient stomatal regulation of the grasses does not necessarily lead to a higher xylem water potential.

8. For the discussion of the water balance strategies data on water uptake, loss, utilization and adaptability to temporarily improved water supply were estimated. The results show that every species has its own water balance strategy, related to physiology and morphology.
9. Based on the sociobiological theory of the evolutionary stable strategy (ESS), a theoretical model of a successional stable combination of water balance strategies in semi-dry meadows has been developed. This model can explain the coexistence of species and richness of species for
 - absolutely homogenous environmental conditions,
 - species with synchronous phenological development
 - species that have their roots in the same horizon and
 - species with similar growth geometry.
10. Moderate water stress as it is typical in semi-dry meadows promotes coexistence of different plant species, is one of the reasons for their richness of plant species and thus nature conservation value.

PETERER Roger. Ertragskundliche Untersuchungen von gedüngten Mähwiesen der subalpinen Stufe bei Davos.
Veröff.Geobot.Inst.ETH,Stiftung Rübel,Zürich **84** (1985).
100 S.

A study of yield and nutritive value of fertilized meadows in the subalpine region near Davos (Switzerland).

Phytosociological and ecological aspects as well as productiveness of fertilized hay meadows (Phleo alpini-Trisetetum Dietl 82) in a subalpine zone near Davos (Grisons, Switzerland) were investigated. With different dates of mowing the development and optimal harvest-time of 14 trial plots (10 in the lower and 4 in the upper subalpine zone) could be detected. On plant material of mountain sorrel, snake-root knotgrass, common lady's-mantle, yellow oat, and cock's-foot (Rumex arifolius, Polygonum bistorta, Alchemilla xanthochlora, Trisetum flavescens, Dactylis glomerata) which was collected weekly from 3 trial plots with different ecological conditions we furthermore analysed the nutritive value of the most important herbs and grasses. The energy (Netto Energy Lactation, NEL), raw protein, raw fibre, phosphorus, potassium, magnesium, and calcium content were used to examine the nutritive value.

Results.

1. The arrangement of the vegetation data showed 5 sociological units of Phleo alpini-Trisetetum Dietl 82. These 5 units can be summarized in 4 ecological groups:
 - group I: Sloping meadows exposed to the south; warm, dry, and poor in nutrients (unit I).
 - group II: in the lower subalpine zone, meadows in locations with better supply of water and nutrients than group I; in the upper subalpine zone, meadows dry and poor in nutrients (unit II).
 - group III: meadows balanced in water and nutrient supply (unit III).

- group IV*: relatively wet meadows, rich in nutrients (unit IV and V).
2. In the lower subalpine zone (1520-1665 m a.s.l.) two harvests a year are possible. The meadows of the upper subalpine zone (1820-1910 m a.s.l.) can be mown once a year. Mown at the optimal date the yield of the 10 trial plots in the lower subalpine zone varied from 35.5 to 71.0 dtDM/ha, 21.8 to 45.3 GJ NEL/ha, and 5.0 to 11.2 dt raw protein/ha. Meadows of group III were the most productive and yielded an average of 61.5 dtDM/ha, 39.5 GJ NEL/ha, and 9.5 dt raw protein/ha. The yield of the meadows of the upper subalpine zone (1820-1910 m a.s.l.) ranged from 31.0 to 37.5 dtDM/ha, 18.5 to 23.6 GJ NEL/ha, and 3.6 to 4.7 dt raw protein/ha.
 3. During the first growth from June 20th to mid-July all meadows of the lower subalpine zone showed a quick change in energy, protein, and raw fibre content). In group III e.g. the energy content fell from 6.7 to 6.1 MJ NEL/kgDM, the raw protein content from 179 to 121 g/kgDM whereas the raw fibre content increased from 192 to 249 g/kgDM. During the second growth the changes in quality were less the later the harvest. High energy and protein content resp. optimal raw fibre content were only possible to obtain by an early harvest of the first growth. On the contrary an early harvest of the first growth often reduced the yield of dry matter, energy, and protein per hectare.
 4. Especially in June and July the 4 groups of Trisetum-meadows of the lower subalpine zone showed different yield and nutritive value. The highest productiveness and nutritive value was ascertained in group III. A harvest of the first growth at the moment of panicle pushing of yellow oat (Trisetum flavescens) group III reached 39 dt DM/ha with 6.45 MJ NEL/kgDM, 156 g raw protein/kgDM and 220 g raw fibre/kgDM; group I yielded in the same phenological stage of yellow oat 26 dt DM/ha with 6.3 MJ NEL/kgDM, 136 g raw protein/kgDM and 240 g raw fibre/kgDM.
 5. Mountain sorrel, snake-root knotgrass, and common lady's mantle (Rumex arifolius, Polygonum bistorta, Alchemilla xanthochlora) showed, in comparison with yellow oat (Trisetum flavescens), the higher energy, raw protein, phosphorus, magnesium, and calcium content. The energy and mineral content of cock's-foot (Dactylis glomerata) showed practically no difference to those of yellow oat; however the protein content was higher than that of Trisetum flavescens. Only snake-root knotgrass was richer in protein than cock's-foot. Yellow oat and cock's-foot contained more raw fibre than the herbs. The different conditions of temperature, radiation, water, and nutrient supply of the 3 trial plots ("Grüeni", "Seehöhi", "Chaiserren") led to differing energy and protein content in the same species. At the beginning of flowering snake-root knotgrass of "Seehöhi" was richer in energy and protein than those of "Grüeni" and "Chaiserren".

Diplomarbeiten (Diploma thesis)

LEONI Giorgio. Die Nahrungsmittel des Steinbockes auf alpinen Silikatrasen bei Davos mit Vergleich zur Gemse. 73 S. (Manuskript). (1985).

Food selection of the ibex (Capra ibex) in the alpine region of Davos, Switzerland, with comparison to the chamois (Rupicapra rupicapra).

RAILLARD Martin. Die Nahrungswahl der Gemse auf alpinen Silikatrasen bei Davos mit Vergleich zum Steinbock. 73 S. (Manuskript). (1985).

Food selection of the chamois (Rupicapra rupicapra) in the alpine region of Davos, Switzerland, with comparison to the ibex (Capra ibex).

The theses deal with food selection of chamois and ibex in the alpine region of Davos, Switzerland, in July and August 1985.

The freshly bitten plant and the total available plant set of plant species along the grazing path were recorded. The selectivity of the animal and its preference for each plant species relative to the available set was established using a specially developed method. This made the comparison of food selection habits of ibex and chamois possible.

The investigations indicate that the chamois graze more selectively than the ibex, the female ibex more selectively than the male, and the chamois more selectively in August than in July.

The preference of the chamois for 31 alpine plant species or groups of species and of the ibex for 26 plant species or groups of species is listed. The chamois grazes more dicots and monocots than the ibex. The relation between body weight and selectivity shows a negative correlation. It is assumed that the differences in selectivity between chamois and ibex is related to the differences of their respective locations in the winter. The relation between plants and ungulates in alpine grasslands can be interpreted by the predator/prey-model; this helps to describe various niches of plant species.

ROSSI Antonella. Einfluss des Verbisses freilebender Huftiere auf einzelne alpine Pflanzenarten. 88 S. (Manuskript). (1985).

The influence of grazing by free-living ungulates (Rupicapra rupicapra, Cervus elaphus) on some alpine plant species.

WALKER Gabriela. Aesungsverhalten freilebender Huftiere in der alpinen Stufe. 98. S. (Manuskript). (1985).

The feeding behaviour of free-living ungulates (Rupicapra rupicapra, Cervus elaphus) in the alpine vegetation belt.

The food selection of the chamois and the red deer in July and August 1986 was investigated in the alpine region of Val Roseg near Pontresina (Eastern Switzerland).

The freshly bitten plants and the local available set of plant species within 10 cm of every bite were recorded. The preference of the animals for each plant species relative to the available set was calculated. Obvious distinctions between the various classes of animals (deer - bull, cow, and calf as well as chamois - buck and goat) are described. The chamois utilize 28 plant families, the deer only 17. The main component of the food of deer are monocots (84%); of chamois dicots (69%). Plant genera favoured by chamois are Astragalus, Silene, Trifolium, Primula, Campanula, Hieracium, Leontodon, Solidago, and Phleum; by deer Silene and Primula.

Possible reasons for seasonal variation of herbivore damage are: modification of the physiological state of the plant, variation of the conditions of the habitat of the plant and of the needs of the animals.

The average selectivity of deer (0.15) is significantly lower than that of chamois (0.30): the chamois utilizes the vegetation in a more "balanced" way. Still there is a pronounced grazing overlap in respect to some favourite plant species, habitat, and temporal niche. The results can be 1) danger of extermination of the most favoured plant species and 2) expansion of disliked plant species and impoverishment of the available plant set. This can lead to a competitive dominance of the deer.

MERZ Bernard. Vegetationszusammensetzung von Trespen-Halbtrockenrasen nach 10-jähriger Brache, Mahd- und Brandbewirtschaftung bei Merishausen (Kt. Schaffhausen). 114 S. (Manuskript). (1986).

The vegetation of semi-dry Bromus grasslands (Mesobromion) after ten years mowing, burning and lying fallow, at Merishausen (Canton Schaffhausen).

Since 1977 the effects of different methods of management (mowing every 1, 2, or 5 years in June, mowing every year in October, burning in March, allowing to lie fallow) are being studied in Northern Switzerland (Merishausen, Canton Schaffhausen). The aim of the present work is to show the changes in the differently managed plots over the past ten years and to judge them in view of nature conservation. For this purpose the vegetation and synthetic colour spectra were recorded and the phenology of flowering of selected plant species was investigated.

1. Mowing in June on the one hand prevented the flowering of plants that grow late in the year, such as Bupthalmum salicifolium, Anthericum ramosum, Aster amellus and Prunella grandiflora; on the other hand the intensity of flowering of Primula veris, Salvia pratensis, and Sanguisorba minor was diminished. This allows the conclusion that mowing should be undertaken earliest in June.
2. Lack of mowing in summer (burning, lying fallow, mowing in October) allowed an increase in coverage and intensity of flowering of the late-flowering species. If mowing was omitted also in October, the coverage of Brachypodium pinnatum increased and this was connected with a reduction of the total number of species. According to the

experiences made so far, mowing in October seems to be a good method of management, also because the flower colour spectra viewed over the whole year showed the greatest diversity.

3. After ten years the plots lying fallow are a thick layer of litter, small bushes and trees, large anthills, and a great coverage of Brachypodium pinnatum. Mowing every five years could cancel these tendencies of succession.
4. Controlled burning destroys all mosses. It also causes a decrease of Primula veris s.l., particularly of its flowering. On the whole, burning caused the largest changes of the vegetation.
5. The observations of phenology of flowering corresponded in general to the mid-term prognosis of KRUESI (1981). However, the changes in the coverage of some species are, contrary to his observations, clearly management specific and correspond largely to the phenology of flowering.
6. Under all managements except early mowing in June the inhomogeneity of the stands in the plots increased. An explanation of this observation has been attempted with a model of "random succession".
7. The chosen method of evaluation (by principal components analysis without transformation of the value of coverage) can only partly show the differences between the different managements. Possible reasons are discussed and alternatives suggested.
8. The influence of all managements on flora and fauna is presented with a view to nature protection. Alternating managements dealt with in the literature are compared and discussed as to their usefulness for the meadows investigated.
