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## 7. ENGLISCHE ZUSAMMENFASSUNGEN DER IM BERICHTS-JAHR 1993 ABGESCHLOSSENEN DISSERTATIONEN (Summaries of Ph. D. Theses)

SAUTER Peter Richard. Kryokonservierung von *Lemnaceae*. Veröff. Geobot. Inst. ETH, Stiftung Rübel, Zürich 112, 134 S.  
*Cryopreservation of Lemnaceae.*

The aim of the present work was to develop a cryopreservation method for *Lemnaceae* (duckweeds), so that whole collections can be stored without great expense of time and work in the future. Of the 34 world-wide known species, 24 were involved in these investigations. Generally vegetative plants of one to several fronds were tested. In addition a few experiments were conducted with turions of *Spirodela polyrrhiza* and seed of *Lemna aequinoctialis*. Unless stated otherwise, the present observations belong always to whole plants.

After thawing living specimens were obtained by all 16 species of the genera *Spirodela* and *Lemna*, which could be cultivated further on and multiplied. But with *Spirodela polyrrhiza* only one pre-experiment was successful, and since then this result was irreproducible. The freezing resistance of each species is very different. This establishment applies also to clones of one species. There is no noticeable correlation of geographical origin of the plants and survival rate.

Fronds, roots, and parts of daughter fronds, which are outside of the pouches, are killed by the addition of the cryoprotectant or by its removal. The pouches seem to play a very important role to the *Lemnaceae* cryopreservation by keeping those parts of tissue, which are inside the pouches, from osmotic shock, supposedly due to the slow penetration of the fluid added into these pouches. Thus buds and young daughter fronds are exclusively available for the actual cryopreservation, but regeneration to new individuals requires no special culture conditions for *Lemnaceae*, in contrast to most other flowering plants. The findings of this study with *Lemnaceae* are in good agreement with cryobiological experiments, where until now almost, exclusively young tissue of meristematic origin with cells fit for segmentation was successfully cryopreserved. Buds surviving cryopreservation are sometimes also damaged and not all of them grow out after thawing. Also callus formation and succulent plants can be recognized, which are in many cases not useable for a further cultivation. Specimens of certain species which are slightly damaged tend to produce anthocyanins. A comparatively late recovery after thawing suggests that many buds need a time period for regeneration.

It is assumed that for the successful cryopreservation of *Lemnaceae* the plants were dehydrated by the cryoprotectant before freezing and the cryosolution vitrifies during cooling. During thawing a slight crystal growth can be tolerated in some cases. Glycerol in a concentration of about 50 v/v% is the only one of all cryoprotectants tested which comes up to these demands and is comparatively nontoxic at least for *Lemnoideae* species. Though the minimal cooling rate has to be -3°C/min and the samples must be rapidly thawed in a 30°C water bath. *Lemna minor*, by a wide margin the most freeze-resistant species can be cryopreserved very easily in the presence of 50 v/v% glycerol, and a distinct increase of the survival rate seems hardly to be possible. It is recommendable for all other *Lemnoideae* species to avoid any crystal growth even during thawing. This aim can be achieved either by an ultra-rapid cooling and thawing of a 50 v/v% glycerol drop con-

taining the plants or by increasing the glycerol concentration to 60 v/v%, while simultaneously shortening the incubation time for dehydration. Whether protection by glycerol against freezing injuries is only external or if this agent has the ability to penetrate into the cells could not be established.

The kind of cultivation before and after cryopreservation is also important for the survival rate. Plants grown on an agar nutrient medium are especially fitted for a storage in liquid nitrogen. The increase of freezing resistance by a food sources rich in nitrate suggests that many species produce proteins, which offer a protection against freezing damage, probably by inhibiting intracellular nucleation and/or by stabilisation of membranes. After thawing sugar (sucrose), which is important for recovery of the buds, should be available for the plants. Importantly, buds of plants with a low freezing resistance do not regenerate when growing on a sugar-free nutrient solution and die after a certain time. Also the age of culture influences the survival rate. Plants from young or very old cultures show a reduced freezing resistance.

Seed of *Lemnaceae* contains much water and the seeds of *Lemna aequinoctialis* studied could survive cryopreservation only following previous air-drying. The concentration of the cryoprotectant needed was remarkably lower than is necessary for whole plants, and the solution crystallised during cooling. In freezing experiments with turions of *Spirodela polyrrhiza* there was no success.

Cryopreservation is basically suitable as storage method for the subfamily *Lemnoideae*. The following mentioned eight species can be stored in liquid nitrogen without hesitation: *Spirodela punctata*, *Lemna gibba*, *Lemna disperma*, *Lemna minor*, *Lemna japonica*, *Lemna obscura*, *Lemna ecuadorensis* and *Lemna turionifera*. Storage in liquid nitrogen is also possible for the residual *Lemnoideae* species, with exception of *Spirodela polyrrhiza*, as far as the sample size of frozen fronds is big enough. First of all each clone of these species should to be tested for existence of low freezing resistance. It can be concluded from the successful cryopreservation of *Lemna minor* over a period of 21 months that there is no fear of lost of viability during a long-term storage. The cryopreservation method developed in this work is not applicable for *Wolffia* and *Wolffiella* species, which respond very sensitively to osmotical changes.

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Die Zusammenfassungen der weiteren im Berichtsjahr abgeschlossenen Dissertationen (Brigitte EGGER, René GILGEN, Marianne JEKER, Andreas KEEL, Barbara LEUTHOLD, Karin MARTI, Roland MARTI, Dieter RAMSEIER) folgen im nächsten Bericht.

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**8. ENGLISCHE ZUSAMMENFASSUNGEN DER IM BERICHTS-JAHR 1993 ABGESCHLOSSENEN DIPLOMARBEITEN**  
(Summaries of Diploma Theses)

FREY Daniel. Flora und Vegetation auf Bahnarealen in der Stadt Zürich. 49 S. + 17 S. Anh. (Polykopie).

*Flora and Vegetation on Railway Stations in Zürich.*

In this study 95 ruderal sites with an average surface area of 120 m<sup>2</sup>, which had been chosen by habitat specific criteria, were investigated with respect to flora and substrate. These sites on 8 railway stations in Zurich consisted of 57 intertrack, 12 interrail, 8 storage area, 7 railway embankment plots, and 11 plots on the surroundings of storehouses and railway stations.

A total of 330 vascular plants species mainly belonging to the families of *Compositae* (16%), *Gramineae* (14%), *Rosaceae* (7%), *Papilionaceae* (7%), *Cruciferae* (6%), *Scrophulariaceae* (5%), and *Caryophyllaceae* (5%) were found. Only one fifth of the species had a frequency of more than 20%.

On railway embankments and surroundings of storehouses and railway stations more hemicryptophytes and geophytes and less therophytes and therophyte-hemikryptophytes were found than on intertrack, interrail and storage area plots.

Of the 643 species counted on railway plots in Zürich by NÄGELI and THELLUNG in 1905, 224 were rediscovered during this investigation in 1993. Some of these species were more abundant than in 1905 (*Solidago canadensis*, *S. serotina*, *Lepidium virginicum*, *Poa compressa*). However, most of the 643 species found earlier have become rare or were not found at all any more (*Lepidium ruderale*, *Bromus commutatus*, *B. secalinus*, *Echium vulgare*, *Linaria elatine*, *Plantago indica* and many others).

Of the species found in 1993, 12 were listed in the red list of endangered vascular plants of Switzerland and 39 were listed in the regional red list of the eastern Midlands of Switzerland. The plant community, *Cerastium pumili* Oberd. et Müller, with its 6 endangered species, has been found to be especially valuable for Zurich.

It is recommended to monitor and control the reestablishment of rare and valuable plant communities after construction projects. The aspect of limited spread, due to isolation effects, was found to be important for further investigations.

From a technical point of view the application of completely degradable herbicides should be considered in order to maintain and provide open areas for the protection of endangered and valuable pioneer plant communities.

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DOMENIG Claudia. Bodenfaktoren und Vegetation an Mikrostandorten verschiedener Höhenlagen am Kunkelspann (GR). 68 S. + 7. S. Anh.

*Soil factors and vegetation on microsites at different elevations on Kunkelspann (GR).*

In the present paper, the influence of the habitat on vegetation and soil located on 20-50 cm high mounds and in 20-50 cm deep depressions has been researched. In this context, the following questions have been dealt with: How do the soil and the vegetation vary depending on their position on mounds or in depressions and the altitude? What differences are there between forest and clearing habitats? The Grossalpwald at Kunkelspass (GR) at an altitude of 1300 to 1700 m was used for this study.

At 3 different levels of altitude, 2 transects were installed, one in the forest and one in the clearing. On each transect, 6 mappings of the vegetation, 2 of the soil, 3 of the mounds, and 1 of a depression were realized. Physical parameters, pH value, the carbonate content, soil color and rhizoming were studied in the soil profile.

Six units of vegetation were described in the research area: *Carici albae - Fagetum* with indications of *Carici albae - Abietetum*, *Adenostylo - Abietetum* in the formation of *Lastrea dryopteris*, *Adenostylo - Abietetum* in the formation of *Polygala chamaebuxus*, *Adenostylo - Abietetum* in the typical formation, *Adenostylo - Abietetum* in the formation of *Saxifraga rotundifolia* and *Carici - Abietetum* with indications of *Carici - Fagetum*. No obvious influence was found of habitat position on forest societies and their variants within the research area. The main factors which effect forest society type are the altitude, continentality, light factor (and, in consequence to these two factors, the temperature), as well as the nutrient content and soil moisture.

The soil profiles are "Rendzinas, Braunerde-Rendzinas" and "Kalkbraunerden". The micro-relief influences the soil, because the layer of organic material in the depressions is deeper and better decomposed than on the mounds. The pH value on the mounds is higher or at least equal to that in the depressions. The microrelief does not influence the total soil depth, rhizomes, kind of soil structure, distribution of grain size, skeleton content, carbonate content, nor the soil color.

Only "Kalkbraunerden" were found in the forest, but in the clearings, 2/3 of the soil profiles are "Rendzinas" or "Braunerde-Rendzinas", and 1/3 of them are "Kalkbraunerden" in the high montane zone. In the clearings, the Bw - horizons show a higher color intensity than those of the forest. Typical mull (as organic material) is only found in the clearings and never in the forests. Between the forests and the clearings, there is no visible difference in soil depth, rhizomes, kind of soil structure, distribution of grain size, skeleton content, carbonate content, nor pH value.

The soil depth increases with increasing altitude, and the pH values decrease. The layers of organic material, rhizomes, kind of soil structure, distribution of grain size, skeleton content, carbonate content and soil color do not change with the different altitudes.

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GABRIEL Alexander. Möglichkeiten für Renaturierungen im Gebiet der Nussbaumer Seen. 100 S. (Polykopie).

*Possibilities of restoring three small lakes and surrounding wetlands in the valley, Seebachtal, in Switzerland.*

In the nineteenth century the valley, Seebachtal, was characterized by three scenic lakes surrounded by diverse wetlands. Only a small number of trees managed to grow there. In 1943 the area was drained for agricultural use. The water level of the lakes was lowered by two meters. Today the lakes are surrounded by a narrow strip of woods. Only small pieces of wetlands remain along the shores. Some fen woods have developed. They are the most natural vegetation left in the region. Where wetlands used to be, there are now agricultural

fields. The creeks have been rerouted into artificial beds. The peat-soils are sinking and the agricultural fields are becoming more and more wet. The water of the lakes and the aquifer is polluted with nutrients. Plans are being made to improve the situation.

One possibility is to renaturalize the lakes and the peat-soils. The study shows where wetlands can be regenerated. The water level of the lakes should be raised by 30-50 cm. Most nutrients should be eliminated from the soil. Then specially developed mixtures of seeds should be used to attain the desired plant communities. Maintenance and organization methods are proposed. The presumable development of areas managed according to the proposals is discussed. Effects on farms are pointed out. An attempt is made to estimate the acceptance of the concept to local lobbys.

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GÜSEWELL Sabine. Landschaftswahrnehmung und Landschaftsbewertung: Instrumente des Naturschutzes? Am Beispiel der Skipisten am Crap Sogn Gion. 105 S. (Polykopie).

*Ecological and aesthetic assessment of ski runs in the region of Flims (Grisons).*

Ausgeführt an der Eidg. Forschungsanstalt für Wald, Schnee und Landschaft (WSL), Birmensdorf und an der EAWAG, Dübendorf.

*The Basic Question.* Biologically diverse landscapes can only be preserved in the long term if their value is appreciated by the general public and certain changes are recognized as negative. It is difficult, however, to assess the overall value of a landscape when the traditional scientific methods are used separately. A landscape is an ensemble of material and immaterial aspects, natural processes and human impacts. Furthermor, every human being perceives a landscape in a very subjective way. Among other factors, individual life history, social and cultural background determine the way one looks at things. Consequently, it could be expected that the evaluation of a landscape by traditional scientific methods differs somewhat from its perception by the general public. The skiing area of Crap Sogn Gion was chosen to serve as an example in attempt to answer the following question: Do the parts of a ski run that are ecologically in comparatively good condition look more beautiful in the eye of the general public than ecologically poor sections?

*Ecological-aesthetic relevés and interviews.* At four different altitudes, between 1200 and 2200 m a.s.l., plots were chosen on which skiing has differing degrees of impact. On 15 plots of 100 sqm each, both ecological and aesthetic data were collected using standard scientific procedures. The ski runs proved to be distinctly poorer in both respects than the areas not affected by skiing. Levelled-out ski runs came out worst ecologically and aesthetically, whereas untampered ski slopes very often showed hardly any negative effects.

In addition, 40 qualitative interviews were conducted with locals, tourists and people totally unrelated to the place. Some of the interviews were held outdoors in the study area and the rest indoors on the basis of color photographs. The interviews confirmed that alterations in a landscape for the benefit of skiing reduced the visual quality of the affected area in the eye of the general public; bare spots, pylons, cables, and buildings being noted most often. A majority of the interviewees disliked the disruption of the scenery caused by the man-made structures, but only a few pointed out the resulting ecological damage. Many of those interviewed spontaneously demanded that such alterations of the landscape should only be permitted to a certain extent and intensity. However, they also thought that some

changes were necessary and justified.

*Scientific assessment vs. perception by the general public.* Both approaches, the ecological-aesthetic relevés and the interviews of the general public, lead basically to the same results: Levelled-out ski runs are generally harmful to the landscape. The ecological-aesthetic approach consisted of a number of individual surveys, conducted as objectively as possible, which were aggregated into an overall value. The interviewed non-professionals perceived the landscape as a unity, mostly on subjective levels, using terms such as pristine, natural, lively, healthy, wholesome, peaceful, disturbed, disruptive, scarred etc. On one hand, these criteria apply to characteristics of the landscape, on the other, they convey the subjective feelings of the interviewee. Thus they are more subjective and possibly more comprehensive than the ecological-aesthetic criteria such as vegetation cover, species richness, abundance of flowers etc.

*Comprehensive approach.* It is concluded that in the future both ecological-aesthetic criteria and aspects reflecting the perception of the general public should be taken into account when assessing the impact of a project on nature and landscape. This is of particular importance when it is likely that the two approaches will not lead to similar conclusions. As regards methodology in the present study, no special procedure seemed necessary for a comprehensive assessment of a landscape. However, this was obviously primarily due to the fact that all the different studies were carried out by the same person who continuously integrated the quantitative scientific results and the more qualitative subjective and emotional aspects. Thus, reasons for possible conflicts between the public opinion and professional judgements were immediately recognized, e.g. why some of the interviewed people did not see any particular beauty in a plot of special ecological value. On the other hand, it was possible to objectify some immaterial values of a landscape, such as peacefulness, wholesomeness, harmony, which initially were considered to be merely subjective notions. In conclusion, a comprehensive approach, taking into account both material and immaterial criteria, definitely leads to a more complete and meaningful assessment of the landscape, corresponding more closely to the needs of todays practice than an assessment based on traditional scientific criteria alone.

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KREMER Marie-Paule. Untersuchung von Parkrasen der Stadt Zürich: Botanische und sozialwissenschaftliche Aspekte. 83 S. + Anh. (Polykopie).

*Investigations on lawns in the city of Zurich: Botanical and sociological aspects.*

The management of lawns depends on professional know-how as well as general value judgements.

This diploma-thesis treats the aspect and the functions of public lawns in the city of Zürich.

- a) Floristical-phenological part: Studies of the development of the lawns by relevés and weekly assessment of the lawn structure and the intensity of flowering.
- b) Sociological part: Standardized interviews with 182 persons (13 managers and 169 users). The questionnaire contains 8 questions with 40 subdivisions. The persons were questioned about their impressions of the investigated lawns, the appearance and function and about the different ways of keeping lawns.

The investigation period was from March to July 1993. The investigation sites were chosen in collaboration with the Landscape Department (Gartenbauamt) of the City of Zürich

in three city parks (Rieterpark, Belvoirpark and Seeanlage Mythenquai). At each site, one part of a lawn was not mown and an adjacent part was managed as usual.

*Results:*

1. The persons interviewed were very cooperative and showed interest in the planning and management of their environment. About 3/4 of the passers-by, which were asked to participate as volunteers, agreed spontaneously. In their descriptions of the presented lawns, they perceived the differences in structure and flowering intensity of the lawns.
2. During the investigations, the unmown lawns showed a 2.5-11 times higher percentage of flowering intensity as the mown lawns. Compared to the mown lawns, average height of the unmown lawns was about two times higher and the maximal height about 3 times higher at the end of the investigations.
3. The unmown lawns were evaluated more positively at all 3 investigation sites. A well-groomed, carpet-like appearance was not appreciated for lawns rich in forbs.
4. When asked how they would like to change the appearance of the sites, the majority (59%) of the persons interviewed preferred an unmown lawn. About 1/6 of the people had alternative wishes, mostly meadows of different types.
5. Lawns rich in forbs are highly accepted. Ninety % of the interviewed persons accept forbs in the lawn. Flowering forbs are even more popular.
6. The preferences and requirements of the interviewed persons concerning the investigated areas (cf. points 3. and 4.) and general preferences (cf. point 5.) correspond with the answers given about a schematic representation of different types of lawns. Of the 5 types to choose from, about half of the interviewed persons preferred an irregularly mown forb-rich lawn and one third preferred a well-mown forb rich lawn in public areas.
7. The interviewed persons evaluated the extensively mown lawns as less monotonous. Unexpectedly, 5-10% of the interviewed persons decided for more than only one type of lawn for one localisation (cf. point 6.), depending on its function. This shows a trend away from the usual standard greens.
8. The descriptions of the lawns by visitors and managers were comparable, except concerning special technical aspects, such as the proportions of forbs - often related to as weeds and mosses.
9. Generally, there is a lack of information concerning different ways of keeping lawns and meadows and about the relations to biological diversity.
10. The preferences of the interviewed persons are related to the function and to the location of lawns. For the extensified management of park areas, intensity and type of use must be considered.

Differentiated lawn management can increase both naturalness and variety of park areas. Further investigation of the possibilities of extensifying the management of lawns and about adequate mowing methods at reduced frequency appears to be necessary.

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KURZ Isabelle. Kompatibilität von *Epichloë* und *Acremonium* Endophyten mit Waldgräsern. Methoden zur Anzucht endophytenfreier Keimlinge und künstlicher Infektionen. 53 S. (in Englisch).

*Compatibility of Epichloë and Acremonium endophytes with woodland grasses. Methods of obtaining endophyte-free seedlings and artificial inoculations.*

Grass endophytes live intercellularly in the living tissue of their grass hosts. They are classified in the tribe *Balansieae* (*Clavicipitaceae*, *Ascomycetes*). All endophytes in this study belong either to the genus *Epichloë*, which comprises sexual states, or to the form-genus *Acremonium*, which accommodates asexual states. Species of these genera mainly live in symbiosis with pooid grasses. Endophytes may render their hosts more resistant to biotic and abiotic environmental stress, and many grass-endophyte associations are therefore believed to be mutualistic.

Methods of obtaining endophyte-free seedlings of woodland grasses were empirically developed.

Seeds of *Brachypodium silvaticum*, *Bromus benekenii*, *Bromus ramosus*, *Elymus europaeus* and *Festuca gigantea* were subjected to heat treatments. Best results were obtained when the awns were removed from the seeds, the seeds then surface-sterilized, soaked with water, laid out on agar, and incubated at 37°C for 21 days.

In addition, host ranges and host specificity of *Epichloë* and *Acremonium* endophytes isolated from woodland grasses were investigated.

Seeds of *B. silvaticum*, *B. benekenii*, *E. europaeus* and *F. gigantea* were collected from infected plants growing sympatrically at the same site, or seeds of *B. ramosus* from greenhouse grown plants. *Acremonium* endophytes were isolated from seeds of all species and an *Epichloë* endophyte was isolated from stroma on *B. silvaticum*. Additionally, *Epichloë* was isolated from stroma on greenhouse grown *Dactylis glomerata*. The number of inoculations which could be carried out, depended on the availability of endophyte-free seedlings. The *Acremonium* isolate of *B. benekenii* could infect *E. europaeus* seedlings and perhaps *B. silvaticum* seedlings. *Epichloë* from *D. glomerata* infected *B. silvaticum* seedlings, but *Epichloë* from *B. silvaticum* did not infect *E. europaeus* seedlings. *B. silvaticum* and *E. europaeus* are classified in the grass tribe *Triticeae*, *B. benekenii* in the tribe *Bromeae*, and *D. glomerata* in the tribe *Poae*. This data suggests that *Epichloë* from *D. glomerata* and *Acremonium* from *B. benekenii* are not restricted to a single host and may have a wide host range. Long-term persistence of the new associations has not been monitored and requires further investigation.

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MAAG Bettina und HÄUSELMANN Stefan. Untersuchung in Feuchtgebieten des Ökoton Schutt-Sägel, Goldauer Bergsturzgebiet: Effekte der räumlichen Vielfalt auf die Zusammensetzung der Vegetation. 70 S. + Anhang. (Polykopie).

*Investigation of wetlands in the ecotone Schutt-Sägel in the debris of the landslide of Goldau: Effects of the spatial diversity upon the vegetation.*

The study area, here called "ecotone Schutt-Sägel", was formed by the landslide of Goldau on the 2nd of September, 1806. The ecotone lies between the woodlands of Goldau and the fen of Sägel near the lake of Lauerz. The relief is still characterized by the rocks and boulders from the landslide. A rich vegetation with a remarkable mosaik character has developed on this heterogenous ground.

Nowadays, this area is part of a natural reserve and the landscape is a natural protectorate (BLN No. 1604). It is used as litter meadow by farmers and by tourists and local people for recreation. The vegetation has already been described and classed as associations by WILDI (1976) and LEUPI (1986).

This study aimed to describe the remarkable variety in the mosaic vegetation patterns of the ecotone. The effects of the great variation of the meso-relief on the composition of the

plant communities are discussed. Phytosociological and selected pedological investigations were carried out in three characteristic biotopes of the ecotone: A strata with a complex of humps and troughs, a succession zone of an oligotrophic pond with an island, as well as a flood plain in the same region which was not severely influenced by the landslide.

Further information was gained by talking to local farmers, nature conservationists and tourists. This helped in understanding the differing interests of the groups in this area.

The results show that species richness of the vegetation differs along the various structures of the landscape and that succession still continues. The succession is partly slowed down by human impact such as annual cut. On the other hand it is influenced by fertilizer applications on neighbouring land and the atmospheric fertilization.

Differences in soil structure and thickness were related with the heterogenous meso-relief. In general, the vegetation is characterized by a strong moisture gradient from the top of the boulders and humps down to the swampy troughs. On the other side, there is a remarkably small scale variation in the structures and character of the soil (thickness and contents of clay and lime) which leads to a complex of plant associations composed by species of different ecological amplitudes.

The more dry areas on the boulders and humps of the fens are dominated by a variant of *Saturejo-Molinietum*, which is particularly rich in species. The periodically wet areas inbetween and the immediate surroundings can be described as a transition into the associations *Scorpidio-Caricietum hostianae* and *Caricion davallianae*, which do not have as many species.

The flood plains are relatively homogenous and belong to *Ranunculo-Caricetum hostianae*, *Caricion davallianae*. Here, the variability is determined by the input of nutrients and not of relief patterns.

The pond shows all formations of succession. An extended belt of *Nymphaeion* and *Potamogetonion* covers the open water area. A broad, high sedge fen with willow shrubs and alders inbetween surrounds the woody parts of the embankments (*Carici elongatae-Alnetum glutinosae*).

The open lakeside is characterized by homogenous reed belts, rushes and sedges. Behind it lies a narrow *Caricetum elatae typicum* disturbed by trampling. The island also has all kinds of bank formations as well as plant community formations on rocky sites. All zones near the pond are less rich in species. The formation can generally be described as small fragments of typical banks.

It must be mentioned that the ecotone of the study area is not only characterized by rare species and a vast plant diversity. The numerous sites of pioneer vegetation on rocks or extremely moist areas have only few species. The main value of this area must be considered in the total spectrum of the ecological aspects of its structural diversity caused by the landslide and its great spectrum of niches. The most impressing phytosociological aspect of this area is the unique mosaic or patchwork character of the plant cover and a very high diversity of the region as a whole. As transition between the open fens and the forest cover on the boulders, the area also plays an important role in linking different landscapes.

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RÖMER Neria. Oekologie und Systematik alpiner Arten der Gattung *Galerina*  
Earle. 79 S. (Polykopie).

*Ecology and systematics of alpine species of the genus Galerina.*

In order to collect alpine material of *Galerina*, several excursions have been undertaken to the region of Flüelapass (Valley of Radönt, GR, Switzerland) were undertaken in the

summer of 1992 (mid-August till mid-September). Twenty-seven collections were made, representing three different species of *Galerina* viz. *G. antheliae*, *G. chionophila*, *G. vittaeformis*. *G. antheliae* represents the first record from the Alps.

Based on bibliographical data, a determination key was drawn up which includes the arcto-alpine taxa recorded thus far from France, Switzerland, and Austria.

To determine the important characters of this complex and inhomogenous group of species in this genus, various macro- and microscopic features were examined and employed by four multivariate methods, viz. cluster analysis, principal component analysis, correspondence analysis, and discrimination analysis. The best result was obtained by correspondence analysis. Two previously incorrectly identified collections were recognized and singled out. In addition, it was demonstrated that the species pairs, *G. antheliae*-*G. tundrae* and *G. heterocystis*-*G. clavata*, can not be distinguished from each other and therefore should be regarded as synonyms. Furthermore, the relationships between the taxa belonging to the *vittaeformis* complex (*atkinsoniana*, *muricellospora*, *rubiginosa* and *vittaeformis*) was confirmed. In the correspondence analysis, the length of the spores turned out to be the most important of the examined characters to distinguish the species involved.

In general, the surface structures of the spores were found to be one of the most important characters for the separation of the taxa. Characters like warts, plage, perispore and germination pore can hardly be interpreted under the light microscope, if at all. Therefore, the species with these critical features were also examined with the help of the scanning electron microscope (SEM). It became clear, that the spores of *G. arctica* actually do not have a completely smooth surface (as was supposed under the light microscope) but are slightly roughened. The same is true for the spores of *G. tundrae* and *G. antheliae*, whereas the spore ornamentation in these two species is more distinctive. In addition, they do have a distinctive plage.

In the field, the occurrence of *Galerina* fruit bodies on certain species of mosses (direct contact with branchlets) was assessed and accordingly, the ecological relationships of *Galerina*-species with various mosses as substrate were confirmed.

Relying on data published in pertinent literature, the geographical distribution of arcto-alpine species of *Galerina* was worked out, and some distribution maps are presented.

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SCHMOCKER Bernhard. Gräben im Moor von Rothenthurm. 56 S. (Polykopie).

*Ditches in the Rothenthurm Mire.*

Ausgeführt an der Eidg. Forschungsanstalt für Wald, Schnee und Landschaft (WSL), Birmensdorf und an der EAWAG, Dübendorf.

One of Switzerland's last great bog landscapes (Object 303 of the Federal Inventory of the Raised and Transitional Bogs of National Importance) lies between Biberbrugg und Rothenthurm.

The location of this study is a slope in the 'Schlänggli' area where, in 1989, drainage ditches were illegally dug right down to the mineral soil. The excavated mineral soil material was deposited along the downhill side of the ditches.

In this study the drainage effect of these ditches on the surrounding bog area was investigated.

Fifteen years ago, in the area now under the effect of these ditches, WILDI (1977) conducted several rlevés and determined the soil parameters. This data provides an opportunity

to ascertain the changes that have occurred since then.

New relevés were made based on the samples of WILDI (1977). Additional sampling units were set in an adjacent land parcel which is still in use and in close range of the ditch. For all sample units, the soil was analysed and the pH value established. The water table was measured in three transects in a right angle to the ditch.

The vegetation data were processed by multivariate statistical analysis and by indicator analysis.

The study shows that the ditches have had a very small drainage effect on the uphill parts towards the center of the bog. On the downhill side of the ditch, however, the water table has clearly sunk. This change in hydrology is also reflected in the vegetation. A few plants that indicate dry conditions, such as *Calluna vulgaris*, have become quite widespread. Humidity averages show a trend towards dry conditions.

The fact that farming activities ceased in 1987 has had obvious consequences, bushes and trees have been able to grow. Growth is slow, however, so bushes will not dominate yet for a long time. The indicator analysis shows a decrease in the average light conditions values. A few species which prefer light have been substantially diminished.

No evidence of the assumed increase in nutrients brought in through the air and by the decomposition of peat could be found. Reasons are discussed in this study for the absence of signs in the vegetation of the expected increase in nutrients.

A comparision of the pH value measurements with those of WILDI (1977) revealed a general acidification of the area. As the acidity gradient heavily influences the vegetation, the acidification has had quite an effect on the spectrum of species in the studied area. A massive increase in the pH values was found where the excavated mineral soil had been deposited.

As reinforcing and counteracting factors are coinciding, any statement about simple cause and effect relations must remain hypothetical. These different factors must all be considered together and carefully balanced against each other.

The results of this study lead to the conclusion that the excavated mineral soil should be put back into the ditches. The peat that was also dug out has since decomposed. It is therefore recommended to cover the refilled excavation material with the peat mosses, currently growing in the ditches. This method will ensure a complete regeneration in the long run.

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SIEGMANN Bernhard. Offene Wasserflächen in der Moorebene von Rothenthurm: historische Entwicklung, Istzustand, Neuschaffung. 57 S. (Polykopie).

*Open water surfaces in the mire landscape of Rothenthurm: historical development, present situation, establishment of new pools.*

Ausgeführt an der Eidg. Forschungsanstalt für Wald, Schnee und Landschaft (WSL), Birmensdorf.

*Historical development.* Aerial photographs covering the time period 1932 to 1992 provide valuable information on the development of area covered by mire vegetation and the number and distribution of the larger bodies of open water in the study area. However, they do not allow any reliable assessment of the situation of the comparatively small and shallow hollows typical for raised bog communities.

During the last 60 years, intensively exploited agricultural areas have encroached considerably on the mire vegetation, resulting in a decrease of the mire surface by at least 60%.

Moreover, the aerial photographs show a continuous increase in number and density of drainage ditches. It is therefore safe to assume that the number of small natural bodies of water, mostly water filled hollows in raised bog vegetation, has decreased at the very least by the same order of magnitude, i.e. 60%.

As regards the secondary, man-made bodies of open water, the aerial photographs clearly show the black areas stripped of vegetation where peat was cut. Because peat cutting pits often fill with water, the aerial photos provide a valuable source for estimating the abundance of secondary water bodies for that period of time. Since the end of World War II, peat cutting has continually decreased, and at present peat is no longer cut in the Rothenthurm region. Consequently, most of the former peat cutting pits have undergone secondary succession and are today completely covered with vegetation.

In conclusion, in the mire landscape of Rothenthurm, the numbers of both the natural peat bog hollows and the man-made pools originating from peat cutting have decreased substantially during the past 60 years, whereas the surface area of open water in drainage ditches has increased.

*Present situation.* A map (scale 1: 5'000) was drawn showing the current distribution of open bodies of water in the mire landscape of Rothenthurm. On the whole, more than 250 objects were inventoried and described in detail. An object may consist of an individual body of open water, as well as of a peat bog area which encompasses a large number of comparatively small and shallow water-filled hollows. The map shows four areas which are of particular interest with regard to open water surfaces; (i) the banks of the river "Biber", (ii) the hollow-hammock-complex of raised bog vegetation in the "Schlänggli" area, and man-made pools in the former peat cutting areas of (iii) "Unter Bann" and (iv) "Allmigforen/Falzbrunnen". The map and descriptions show that the long term existence of some of the objects is endangered.

*Desirable situation.* First, the measures necessary to ensure the long term preservation of the existing open water surface are discussed in detail. Second, the advantages and disadvantages of creating new bodies of open water in the mire landscape of Rothenthurm are discussed, and locations particularly suitable for such developments are proposed.

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SOMMER Markus und STADLER David. Ökologische Aufwertung und Bewertung von Waldrändern. 90 S. (Polykopie).

*Ecological upgrading and assessment of forest edges.*

Ausgeführt an der Eidg. Forschungsanstalt für Wald, Schnee und Landschaft (WSL), Birmensdorf.

Conservationists frequently demand that ecologically uninteresting forest edges should be upgraded. Particularly on the Swiss Central Plateau, with its intensive agriculture and forestry, there are many forest edges that appear to have little ecological value. Upgrading such sites could improve considerably the habitat conditions for many plant and animal species. Forest edges can play a significant role as corridors between otherwise isolated habitats. Data on the effectiveness of upgrading treatments are scarce because, as yet, most experiments have not been accompanied by scientific studies. Therefore, several studies dealing with "forest edges" were begun in 1992 at the Institute for Forest, Snow and Landscape Research. The central issues are:

- a) To develop a key for assessing the ecological value of forest edge habitats in an objective, reproducible and easily applicable way.

b) To monitor the effects of different upgrading treatments on the flora, using permanent plots.

The present study is part of this long-term project.

*Objectives.*

The objectives of the present study were as follows:

1. To test the evaluation key developed by KRUG (1992) in a new area and to modify it if required.
2. To assess several forest edges in the Argovian Jura Mountains in order to find out whether there is a difference between the ecological value of forest edges inside and outside of nature reserves. The effect of exposition, inclination and protective status of the forest on the ecological value was also examined.
3. To repeat the phytosociological relevés in each permanent plot in the canton of Solothurn in order to monitor the effects of the upgrading treatments carried out during the winter of 1992/93.

*Modification of the evaluation key.*

The forest edges were assessed ecologically using three different keys

1. The evaluation key developed by KRUG (1992)
2. An extended version of the key developed by KRUG with the addition of the three structural criteria, "outline of the forest edge", "character of the forest-field-transition zone", "character type of the shrub belt" and the diversity criterium, "floristic diversity of the herbe fringe", thus totalling 15 criteria. In addition, the genus *Rubus* was also integrated in the category, "number of spiny and thorny shrubs".
3. Assessment of forest edges with a key encompassing 23 criteria including small structures, such as dead wood, rocks etc., and the ecological quality of the immediate surroundings of the forest edge.

Although the assessment with the 23 criteria, which is quite time-consuming, came closest to the subjectively estimated value of the forest edges, the key by KRUG (1992) is probably more efficient, in terms of costs and benefits.

The results presented in this study were obtained by means of the extended key including 15 criteria.

*Condition of forest edges in the Argovian Jura Mountains.*

The condition of the 54 forest edges examined turned out to be fair on average. Although none of them qualified as an "ideal forest edge" (overall depth ca. 30 m), 25 per cent of the forest edges were nevertheless in good condition, 30 per cent in fair condition, 30 per cent of intermediate ecological value, and 15 per cent were evaluated as poor.

*Effects of nature reserves.*

Forest edges within nature reserves (semi-dry meadows) were rated higher (70 points, on average, of a maximum of 84 points) than those outside (55 points, on average). However, this is mainly due to the size of the herb fringe which includes, by definition, all types of poor soil grassland. If the herbe fringe is not taken into account, forest edges, both within and outside of nature reserves, received basically the same score (52 vs. 49). Thus, the condition of the forest edge in a narrow sense, i.e. the structure and diversity of the woodland mantle and shrub belt, accounted very little for the differences found.

Whether or not a forest was listed in the inventory of protected forest sites had no noticeable effect on the quality of the forest edges.

*Effects of exposition and slope.*

Southern exposed forest edges as well as those located on steep slopes generally tend to have a somewhat better developed shrub belt (averaging 64 points) than those with other expositions or in flat locations (averaging 60 points).

*Upgrading forest edges.*

As expected, there was an average increase of 20 per cent in species richness within the herbaceous layer on plots which were upgraded during the winter of 1992/93. In the species poor forest edge in Küttigkofen, the number of species increased by 33 per cent, in the richer forest edges in Messen by 14 and in Lostorf by 10 per cent.

Unfortunately, the upgrading treatments were not carried out exactly as planned, i.e. on each location, an untreated plot, one with moderate treatment and one with intensive treatment. In fact there were only two untreated sections, but four sections with moderate treat-

ment. On average, the number of species remained basically unchanged on the two plots which were not upgraded at all (-4 per cent), but increased on the four plots with moderate treatment and on the three plots with intensive treatment (+33 and +46 per cent, respectively).

In Lostorf and Messen, the locations of the permanent plots, both towards the interior of the forest and directly on the forest edge, had no effect on the number of species found. In Küttigkofen, however, the number of plant species trebled on plots situated towards the interior of the forest, whereas it increased only by 50 per cent on plots situated immediately on the forest edge.

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UTELLI Anna-Barbara. Untersuchungen zur Systematik und Ökologie von *Erigeron*-Arten (Asteraceae) der Alpen: Nachweis von Genintrogressionen mittels multivariater Analysen morphologischer Merkmale. 69 S. (Polykopie). *Systematic and ecological investigations on Erigeron species (Asteraceae) of the Alps: evidence of gene introgression by multivariate analysis of morphological characters.*

*Erigeron* populations belonging to *E. alpinus*, *E. neglectus*, *E. glabratus* and *E. uniflorus* from nine plots of three regions (Melchsee-Frutt, Pizol and Celerina) of the Swiss Alps were examined for gene introgressions. Twelve morphological characters of 20 plants per plot were analysed and evaluated by multivariate statistics.

In addition, 67 plants of *E. alpinus*, *E. neglectus* and *E. uniflorus* were grown under identical conditions in the greenhouse for one year, and morphological characters were recorded before and after transplantation to assess the genetic basis of characters.

A phytosociological relevé was made and several soil parameters were investigated in the plots.

1. The multivariate analysis confirmed the presumption that introgressions occur between *Erigeron* species in the Alps. Not all species are likewise involved in the gene flow.
2. *E. alpinus* was highly variable. At both sites (Pizol and Celerina) gene flow seemed to occur between *E. alpinus* and *E. neglectus*.
3. The high variability of *E. neglectus* may be caused by hybridization and gene introgressions between *E. alpinus* and *E. uniflorus*.
4. An intermediate population between *E. alpinus* and *E. neglectus* persisted in the absence of one of the supposed parental species (*E. neglectus*) at the Pizol mountain site.
5. No gene flow could be shown from or towards *E. glabratus*. However, variability and possible hybridization of this species could not be estimated from the little material available.
6. *E. uniflorus* did not behave uniformly. At two sites (Pizol and Celerina), the variability of the species was small and only few presumed hybrids between *E. neglectus* were found. At the third site (Melchsee-Frutt), the variability was higher, and the species was not clearly separated from *E. neglectus*. Gene introgressions seemed to be frequent here.
7. The greenhouse experiment showed that all investigated characters were strongly influenced by environmental conditions. The variation of only two characters (height of the plants, length of the involcure) have a good genetic base in all three species.
8. The standard deviations of the investigated characters became generally smaller in culture.

9. *E. uniflorus* was the most constant species relative to the taxonomically important characters such as pubescence of the basal leaves, monocephalousness and absence of filiform flowers.
10. The absence or presence of filiform flowers depended partially on environmental conditions and should not be regarded as systematically very important. A split off of the genus *Trimorpha* from *Erigeron* is not justified.
11. The four analyzed species and their hybrids demonstrated very similar ecological behavior in all three regions. A positive correlation between heterogeneity, the degree of habitat cover, and the presence of intermediates was demonstrated in Celerina.

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WEBER Urs. Regeneration von Trespen-Halbtrockenrasen und lichten Föhrenwäldern durch Entbuschung (mit Hinweisen zur Heuschreckenfauna). 79 S. (Polykopie).

*Regeneration of limestone grasslands and open pine woodlands by shrub-clearing (with annotations on the grasshopper fauna).*

In summer 1993, the vegetation of different areas near Merishausen (Kanton Schaffhausen, northern Switzerland) was described in order to study the effect of shrub-clearing. Plots of the following types of vegetation were investigated; limestone grasslands, shrubby areas on former grasslands, shrub-cleared areas, open shrub-cleared pine woodlands, as well as areas described for a study on grasshoppers in shrub-clearings (GERLOFF 1993). All shrubs on the cleared areas had been cut back a year and a half before the study, and some again a year later, 6 months before the study began.

1. The annual regrowth of the shrubs – defined as the sum of all stump sprout lengths greater than 40 cm – was 2.4 to 9.8 m per m<sup>2</sup>, after the first and the second shrub-clearing.
2. In the second year, regrowth in nutrient-poor plots was 30-45% smaller than in the first year. This indicates a weakening of the shrubs due to the first clearing. In plots with more humus, the regrowth in the second year was 27-86% larger than in the first. This is probably due to more favorable nutrient conditions in the soil.
3. Compared with sites which had been cleared only once, shrub regrowth was greater on sites with a second cut. This is probably due to a larger mobilization of nutrient reserves from the roots. Repeated clearing probably weakens the shrubs successfully within a few years.
4. On all the shrub-cleared plots investigated, the frequency of many limestone grassland species was smaller than in traditionally mown grasslands. Only in plots that were never totally covered with shrubs (max. 70% of the area) was a large number of such species found.
5. The occurrence of 19 different ruderal species on shrub-cleared plots agrees with the results of other investigations. Species of other ecological groups are of only subordinate importance.
6. The chances of regeneration of limestone grasslands are discussed on the basis of literature and observations. They are better in the medium term if the encroachment of the shrubs has occurred only recently, if the shrubs have not covered the whole area yet, and if the site borders directly on limestone grasslands. According to other authors, shrub undergrowth can be successfully deterred by cutting it in June and August for several years and, as for small shrubs, by goat browsing.

7. On eleven plots, a high linear correlation between the number of grasshopper species and the number of grass and forb species was found ( $r = 0.75$ ), probably because of the corresponding reactions of grasshoppers and herbaceous plants to the intensity of management. Vegetation structure – described by means of the stratified clipping method – could not contribute to the explanation for the distribution of grasshopper species.

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