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Summaries of diploma and PhD theses (2002)

Diploma theses (15)

Patterns of grasshopper diversity and abundance on a former cattle ranch in the coastal savannah of Tanzania

Muster der Heuschrecken-Diversität und -Abundanz auf einer ehemaligen Rinderfarm in der tansanischen Küstensavanne; 64 pp.

CHRISTIAN BOHR

1 Mkwaja North was a cattle ranch in humid savannah of Tanzania during the last 50 years and has recently been abandoned. It has now become part of the new Sadaani National Park. To understand which ecosystem changes have resulted from the former grazing pressure, we studied spatial patterns of grasshopper (Orthoptera: Acridoidea) diversity and abundance within former paddocks and their surroundings.

2 Three paddocks and two transects through the surrounding savannah were sampled with a sweep net. The distribution of grasshoppers was related to the vegetation composition as well as physical and chemical properties of common grass species and the occurrence of predators. Three vegetation types were distinguished: paddock centre, paddock edge and undisturbed savannah.

3 Grasshopper distribution and composition differed strongly among the three vegetation types, with the largest numbers of individuals and species in the paddock centres with

dense, species-poor but nutrient-rich vegetation. In these areas, few grasshopper species made up the largest part of all individuals (e.g. *Aiolopus thalassinus*, *Morphacris fasciata*).

4 The species-rich paddock edge vegetation was inhabited by fewer grasshopper individuals than the centre but had a high relative diversity. The dry, nutrient-poor, long grasses of the undisturbed savannah supported the lowest numbers of grasshopper species and individuals.

5 Species with elongated bodies (*Acrida* cf. *Sulphuripennis*) were more frequent at paddock edges or in the savannah (*Leptacris monteroi*, *Cannula gracilis*) than in the paddock centre, whereas the centre was dominated by small species and many nymphs. A few species occurred in all plots (*Minihippus keyi*, *Orthochta dasycnemis*), indicating that they are widespread over the whole area.

6 The study demonstrates that cattle ranching and its impact on the vegetation have also strongly affected grasshopper diversity and abundance.

Vegetational succession on abandoned terraced land in the Vallée de la Roya (Alpes-Maritimes, France) and its perception by local people

La succession végétale sur les cultures en terrasses de la Vallée de la Roya (Alpes-Maritimes, France) et sa perception par la population locale; 100 pp. + App.

SÉBASTIEN BOILLAT

1 The aim of the study was to assess ecological and socio-cultural values as well as scenarios

on the future of terraced land in three villages of the middle Roya valley (Alpes Maritimes).

2 Forty-five Braun-Blanquet vegetation relevés were made on terraced land between 300 and 700 m, allowing 14 vegetation types to be identified. These can be grouped into four successional stages: regularly cut grasslands, abandoned grasslands, scrublands (maquis) and forests. At the beginning of the succession, a floristic difference was identified between olive-planted terraced land and former cereal-cultivated terraces without trees. In the shrub and forest stages, the floristic differences became more mesoclimate-dependent, drawing a contrast between the meso- and the supramediterranean zones and between north and south slopes. A succession model could be elaborated, showing a possible evolution of the vegetation on terraced land. The terminal stages of the succession were compared with the potential natural vegetation.

3 A vegetation map (with 14 vegetation units) was elaborated for an area of 10 km², showing large differences connected with land abandonment around the villages, the most popu-

lated and best accessible village of Breil-sur-Roya having the largest area of well-maintained terraces.

4 Interviews with 21 local people gave information regarding their perception and evaluation of land abandonment as well as their future visions for the valley. Four opinion groups could be identified: two groups among the neo-rural population who have come to the village with the ideal of restoring traditional agriculture, one group including native farmers, and one group including both native and non-native persons. The opinion spectrum ranged from ecologist philosophy rejecting modern technology to purely economist thinking among some village people who see no future for agriculture in the valley and industrial and tourism development as the only realistic alternative.

5 Based on the ecological and the socio-cultural results, scenarios are developed and discussed for the future of the valley's terraced land.

***Pholidoptera griseoptera* in the fragmented agricultural landscape of lowland Switzerland**

Pholidoptera griseoptera in der fragmentierten Agrarlandschaft des Schweizer Mittellandes; 45 pp.

DANIELA CSENCICS

1 Most of the area in Central Europe is used for agricultural or silvicultural purposes. Intensive agriculture is essential for food production but contributes to the destruction or fragmentation of habitats of many plant and animal species. As part of current efforts to combine efficient agriculture with biodiversity conservation, the "Greenveins" project studies how biodiversity in the agricultural landscape is influenced by landscape structure and land-use intensity. The aim of this thesis was to explore how the bush cricket *Ph. griseoptera* responds to the spatial struc-

ture of an intensely used agricultural landscape.

2 Based on the methods of metapopulation theory, the occupancy of suitable habitat patches by *Ph. griseoptera* was mapped in two differently structured agricultural areas (Reusstal, Seebachtal). A capture-recapture experiment revealed the movement patterns of larvae and imagos.

3 *Pholidoptera griseoptera* was found in almost every suitable habitat patch in both areas. Recapture rates were lower for larvae than for imagos but dispersal abilities of lar-

vae and imagos were comparable. Two male imagos moved extremely far away. Small agricultural roads were not complete barriers but were crossed only from time to time.

4 Because of its good dispersal ability *Ph. griseoptera* is able to find and colonize even small, distant patches of suitable habitat. Apparently rather vagile and rather sessile indi-

viduals occur in the same population. Among other reasons the fact that almost 100% of all suitable habitat patches were inhabited leads to the conclusion that there is no metapopulation but a spatially structured population. As *Ph. griseoptera* is still a common species, it is not yet endangered by the present fragmentation of the agricultural landscape.

Response of six *Carex* species to a simulated vertical light gradient

Reaktion von sechs Carex-Arten auf einen simulierten vertikalen Lichtgradienten; 54 pp.

PATRICIA EGLI

1 Plants can be exposed to two types of shading at their growth sites: shading of the entire plant by much taller plants (e.g. forest understory) or shading mainly of the lower parts by neighbours of similar size (e.g. grassland). The present thesis investigated whether plants of the genus *Carex*, whose meristems are located at the shoot basis, respond differently to these two types of shading.

2 Six common *Carex* species (*C. acutiformis*, *davalliana*, *flacca*, *flava*, *panicea*, *pilosa*) were subjected to four shade treatments at two nutrient levels in a pot experiment. Shade treatments were full light (L, control), shading (77%) above the plants (S_A), shading (91%) at approximately 50% of the plant's height (S_M), and a combination of S_A and S_M (S_{AM}). The two nutrient levels consisted in either simple or fourfold supply of the same complete nutrient solution. From May to September 2001, plant shoots were counted regularly, and leaf turnover was recorded. At harvest the above-ground biomass was subdivided into an upper and a lower layer at the height of the shading S_M .

3 The shoot biomass, total leaf area and mean leaf length increased in the rank order $L < S_A < S_M < S_{AM}$, whereas root biomass and the root:shoot ratio decreased. The more

basal plant parts were shaded, the higher was the proportion of shoot biomass and leaf area allocated to the upper layer. The turnover of whole leaves was generally not affected by shade or nutrient treatments, but shading caused a more rapid senescence of leaf tips. The shoot number at harvest was higher with the fourfold nutrient supply but unaffected by shading. The specific leaf area was enhanced by shading, particularly S_M , but independent of nutrient levels. The N concentration was generally higher in the upper than in the lower half of leaves, and the ratio of N concentration in the upper half to N concentration in the lower half of leaves increased with increasing shading of the basal plant parts.

4 Results show that shading of the basal meristems of *Carex* plants causes plastic responses of biomass, nitrogen distribution and specific leaf area even for plant parts situated above the shading. This may be an advantage in stands of plants of similar size. Leaf turnover and shoot production seem to depend primarily on other factors than shading.

5 The morphological responses of the six *Carex* species to shading and nutrient supply were rather uniform, whereas leaf turnover and shoot production responded differently

among species. As in other studies of the genus *Carex*, no consistent differences were found between fast- and slow-growing species.

Distribution of the warthog (*Phacochoerus africanus*) within a cattle-impacted coastal savanna in Tanzania

Die Verteilung von Warzenschweinen in einer durch Viehbeweidung modifizierten Küstensavanne Tansanias; 77 pp.

STEPHANIE ANNE HALSDORF

1 The ranch of Amboni Mkwaja is a large area of coastal savanna that was exploited from 1954 until 2000, when cattle grazing was given up. The aim of the research was to study the distribution of warthogs (*Phacochoerus africanus*) in vegetation types more or less modified by the former grazing pressure. We distinguished a strongly modified paddock region (PG) with three different strata (PC, paddock centre; PM, paddock margin; ACA, Acacia forest), and an unmodified region (UG). Moreover, we carried out direct observations in the nearby Saadani Game Reserve, which we used for comparison purposes.

2 Records of tracks and signs on 267 transects (50 m x 6 m) confirmed that warthogs preferentially stayed in the paddock region. Warthog presence was highest in the PC stratum, whereas the highest activity took place in the PM and ACA strata. The PC stratum is mainly used for grazing, and the two other strata for digging.

3 A survey of the habitat factors and vegetation composition of the transects showed that warthogs prefer habitats with a good visibility, low shrub cover and low vegetation. Their presence was related to the grass species *Cynodon dactylon* and *Paspalum dilatatum*, and their activity mainly to *Digitaria milanijana*, *Eragrostis superba* and *Fimbristylis triflora*.

4 Digging did not occur only in the dry season (in response to the lack of water or nutri-

ents) but during the whole period of data collection. High shrub and herb cover, soft soil composition as well as good visibility were identified as important factors for digging activity. Plant species associated with high digging activity were *Aristida adscensionis*, *D. milanijana*, *E. superba*, *F. triflora*, *Panicum infestum* and *Agathisanthemum bojeri*.

5 Of several investigated plant species, *P. dilatatum* and the spikes of *C. dactylon* had the highest feeding quality, while low values were measured in *F. triflora*. These measures explain the preference of warthogs for grazing in the PC stratum. However, the low feeding value of *F. triflora* shows simultaneously that this value is not the only parameter to describe warthog preference.

Do populations of the same species from dry and wet sites respond differently to drought and flooding?

Reagieren Populationen derselben Art von trockenen und feuchten Standorten unterschiedlich auf Trockenheit und Überflutung? 49 pp.

SILVIA HAUG

1 Dry and wet sites make different demands on plants. If populations of the same species grow at both types of sites, it is possible that ecotypes evolve which are specifically adapted to the predominant conditions. This study compared plant populations from dry and wet sites to test whether they are better competitors when growing under conditions similar to their site of origin.

2 Three experiments were carried out with *Briza media*, *Bromus erectus*, *Chrysanthemum leucanthemum*, *Hypericum perforatum* and *Scabiosa columbaria*. Plants of each species were grown from seeds collected at dry and wet sites. Two competition experiments were carried out with different water availability and various substrates. The third experiment examined whether root length differs between plants of different origins.

3 *Scabiosa columbaria* grew better when the conditions were similar to those of its origin, and its roots grew longer at the dry site than at the wet. *Briza media* originating from a dry site was a strong competitor, especially under wet conditions. *Chrysanthemum leucanthemum* and *Hypericum perforatum* showed clear differences in the onset of flowering according to their origins. *Chrysanthemum leucanthemum* flowered earlier at the dry site and *Hypericum perforatum* at the wet site.

4 The plants of distinct species and various origins grew very differently but were not always stronger competitors under conditions similar to their origin. The results show a differentiation among populations of the same species and the same region. However, they do not support the recommendation that wildflower seeds should originate from a site with similar conditions.

Ecological Value of the Fond Ferdinand, Praslin, Seychelles, and possible connection between Fond Ferdinand and Praslin National Park

Ökologischer Wert von Fond Ferdinand, Praslin, Seychelles, und dessen Verbindung mit dem Praslin National Park; 59 pp.

PAULINE HÉRITIER

1 The Fond Ferdinand is an area situated outside the Praslin National Park, harbouring a large population of the famous red list palm *Lodoicea maldivica*. Since an extension of the National Park is planned to protect this rare species, the vegetation and the ecological value of this important biodiversity site needed to be known. A suitable link between

the Fond Ferdinand and the Praslin National Park needed to be found, which should represent most components of the vegetation of the Seychelles.

2 The species composition and ecological value of the Fond Ferdinand were assessed using the trail-transecting method to determine the prominence value of the main tree

species, the protection value of the study area, species diversity and singularity, and tree rejuvenation. The results obtained with trail-transecting were compared to those obtained with the point centred quarter method to support their validity. With the data obtained by trail-transecting, the vegetation was classified into six forest types. Tree density as well as future development were also surveyed.

3 The most prominent species of the study area were three endemic trees: *Paragenipa wrightii*, *Phoenicophorium borsigianum* and *Deckenia nobilis*. Over 70% of the tree species

were native, and less than 30% were alien species such as *Cinnamomum verum*, *Chryso-balanus icaco* and *Tabebuia pallida*. The high protection value of the whole study area means that the Fond Ferdinand is ecologically very valuable.

4 Based on the results of this survey, recommendations are given for the management of the Fond Ferdinand. These include a better monitoring and, if possible, removal of invaders, the protection against soil erosion and the management of the post fire succession of plants.

Do plant populations from dry and wet sites respond differently to stress?

Reagieren Populationen von trockenen und feuchten Standorten unterschiedlich auf Stressfaktoren?
39 pp.

THERESE KOHLER

1 Plant populations that are exposed to different environmental factors may evolve genetic differences. Such ecotypes can vary in morphology and physiology, especially in their response to different stress factors.

2 In four experiments *Briza media*, *Bromus erectus* ssp. *erectus*, *Hypericum perforatum* and *Leucanthemum vulgare* were studied to test whether their resistance to drought, flooding and frost differs between populations from dry and wet sites. Seedlings of each population were subjected to the stress factors, and their mortality was recorded. Germination rates of seeds were determined on soils of varying moisture.

3 *Leucanthemum vulgare* plants from the wet site died more rapidly under dry conditions but survived longer under flooded conditions than plants from the dry site. *L. vulgare* seeds from the dry site germinated faster than seeds from the wet site regardless of soil moisture during germination.

4 *Briza media*, *Bromus erectus* and *Hypericum perforatum* showed no ecotypic differences in their reaction to the tested stress factors. On the basis of these results, only populations of *L. vulgare* can be regarded as ecotypes. These results indicate that in some cases meadow restoration may be more successful if the site of the donor population is similar to the site where restoration takes place.

Tritrophic interactions of transgenic Cry1Ab maize, transgenic Cry3B eggplant, *Tetranychus urticae* (Arachnida: Prostigmata), and its specialized predator *Stethorus punctillum* (Coleoptera: Coccinellidae)

Tritrophische Interaktionen zwischen transgenem Cry1Ab-Mais, transgener Cry3B-Aubergine, Tetranychus urticae (Arachnida: Prostigmata) und deren spezialisiertem Prädator Stethorus punctillum (Coleoptera: Coccinellidae); 31 pp.

CALOGERO L'ABATE

1 Transgenic plants expressing specific insecticidal toxins from the bacterium *Bacillus thuringiensis* Berliner (Bt) have become of increasing interest for agricultural pest management. However, laboratory experiments have shown that non-target insects, e.g. generalist predators, can be affected by toxins from Bt transgenes via the food chain. In this study, possible prey-mediated effects of transgenic Bt plants on a specialist predator, the lady beetle *Stethorus punctillum* (Weise) (Coleoptera: Coccinellidae) were investigated.

2 Maize expressing the lepidopterocidal Bt toxin Cry1Ab (variety 'Mon810', MON-SANTO) and eggplant expressing the coleopterocidal Bt toxin Cry3Bb (variety '9-8') with their respective isogenic control lines were grown in the greenhouse. To test the biological activity of the toxins in the leaf tissue, bioassays were conducted with the target organisms of the respective plants in addition to an immunological test for toxin expression.

3 Tritrophic level experiments were performed in leaf cages attached to whole living plants under constant environmental conditions. In separate treatments of either plant variety, larvae of *S. punctillum* were fed with herbivorous spider mites (*Tetranychus urticae* (Koch) (Arachnida: Prostigmata)), their principal model prey species, which were allowed to feed on the leaf tissue for at least 24 h. Mortality and developmental stage of the larvae were recorded every second day.

4 The biological activity of the toxins was verified for both Cry1Ab maize and Cry3Bb eggplant. Between the treatments of Bt and non-Bt maize and eggplant, no significant differences were found in the total mortality of *S. punctillum* immature stages and the total immature developmental time.

5 Especially in eggplant, relatively high control mortality was experienced, which might have masked differences in the studied life history parameters.

Fire and Vegetation on Praslin and in the Fond Ferdinand, Seychelles

Feuer und Vegetation auf Praslin und im Fond Ferdinand, Seychelles; 55 pp.

CYRILL MÉDARD MEUWLY

1 Fire is considered to be a major hazard for the endemic vegetation in the Inner Seychelles because it creates vegetation gaps that are prone to the establishment of invasive species. Firebreaks have therefore been made to protect ecologically valuable areas. However, vigorous resprouting of endemics has

been observed after fire in the Fond Ferdinand. This suggests some fire adaptation of the endemic flora and raises the question who actually profits most from fire: the introduced or the native species?

2 This study investigated four fire-disturbed sites on the island of Praslin (burned in 2001,

1999, 1989 and around 1987), plus one undisturbed site as a control. The vegetation density and diversity were surveyed at each site to assess vegetation recovery after fire. The prominence (PV) and the regeneration of introduced and native species were determined to evaluate whether fire causes a shift in the ratio of native to introduced species. Soil samples were taken at three of the sites (in the Fond Ferdinand) to examine how fire influences soil fertility.

3 Vegetation density generally increased after fire, but the extent of this response varied among sites. Species diversity dropped after fire. The study site burned in 1989 had a vegetation density and diversity similar to those of the control site, indicating that the vegetation had recovered 13 years after the fire.

4 The total nitrogen and phosphorus contents of the soil decreased in the first few years after a fire, probably due to erosion. Soil nitrogen and phosphorus contents at the site burned in 1989 were similar to those of the control site,

indicating a recovery also in terms of soil fertility.

5 According to the prominence values of native versus introduced species, the effect of fire on invasion is variable and depends on site characteristics such as the species composition of pre-fire vegetation or surrounding vegetation. However, an increased prominence of introduced species among juveniles after fire indicated the spread of introduced species into gaps caused by fire.

6 Resprouting percentages revealed that the regeneration of native species is promoted by fire more than the regeneration of introduced species, but this probably holds only for low intensity fires. Native species may therefore be seen as fire resisting strategists, and introduced species as fire avoiding strategists.

7 Whether native or introduced species gain after fire therefore depends on fire intensity, genetic traits of the species present in the pre-fire vegetation, and propagule pressure from the vicinity of the burned site.

Comparative ecology of invasive and non-invasive goldenrods (*Solidago* spp.)

Vergleichende Ökologie invasiver und nicht invasiver Goldruten; 44 pp.

NICOLE MÜLLER

1 There are four wild species of goldenrods in Switzerland. *Solidago virgaurea* is native, whereas *S. altissima*, *S. gigantea* and *S. graminifolia* have been introduced from North America as ornamental plants. *S. altissima* and *S. gigantea* are invasive species which spread in open, abandoned areas and threaten native species. *S. graminifolia* and *S. virgaurea* do not build dense populations nor do they show any negative effects on other species. The present study investigates whether invasive and non invasive goldenrods differ with respect to growth characters.

2 In a garden experiment the four goldenrod species were grown under different nutrient and light treatments (with fertilizer, without fertilizer, natural light and shade); their growth characteristics and morphological traits were measured in order to determine interspecific differences and the phenotypic plasticity of each species. Populations of the three species *S. altissima*, *S. gigantea* and *S. graminifolia* were also examined at their natural sites.

3 The invasive species *S. altissima* and *S. gigantea* formed on average more vigorous shoots than *S. graminifolia* and *S. virgaurea*.

In the nutrient rich and high light environment *S. altissima* was most successful, but *S. gigantea* was more tolerant to shade. The plasticity of the species ranked differently for the various examined traits. Plasticity did not differ consistently between invasive and non-invasive species.

4 The investigations of the natural populations show that *S. altissima* and *S. gigantea* build dense populations, and that these goldenrods crowd out the native plants. *S. graminifolia* builds the highest shoot density

but does not crowd out other plants because of its small growth habit.

5 These results show that in some characteristics the invasive goldenrods are very different from the non-invasive goldenrods. These differences are related mainly to growth characteristics, which may indicate a higher competitive ability of the invasive goldenrods. The present study also illustrates that a prediction of invasive species is difficult because interspecific differences depend on the environment and the characters investigated.

Interactions between transgenic insect-resistant (*Brassica napus* x *Brassica rapa*) hybrids and the diamondback moth *Plutella xylostella*

Wechselwirkungen zwischen transgenen insektenresistenten (Brassica napus x Brassica rapa) Hybriden und der Kohlschabe Plutella xylostella; 29 pp.

ROMAN MYLONAS

1 Hybridization is a possible escape route for transgenes from transgenic crops to related species. Oilseed rape (*Brassica napus*) is known to cross easily with *Brassica rapa*, and they both co-occur in agroecosystems. In this study the interactions between transgenic *Bacillus thuringiensis* (Bt), *B. napus* x *B. rapa* hybrids, non-transgenic *B. napus* x *B. rapa* hybrids, and the diamondback moth *Plutella xylostella* were examined.

2 The adult females of *P. xylostella* did not show a significant preference for transgenic or non-transgenic hybrids for oviposition. However, in two of the three runs always more eggs were laid on non-transgenic hybrids. In the third run almost equal numbers of eggs were found on transgenic and non-transgenic hybrids.

3 On the transgenic hybrids most larvae died a few days after hatching. Therefore, the foliar damage caused on the transgenic hybrids by the herbivores was minimal. In contrast, the foliar damage caused by herbivores on the

non-transgenic hybrids was high, resulting in a significant smaller leaf area.

4 The damage caused by the larvae on the non-transgenic hybrids had also a significant influence on the development of buds and flowers. This effect was stronger when plants in an early leaf stage were used in the experiment. These results suggest a greater fitness of transgenic hybrids.

Distribution and migration patterns of butterflies in agricultural landscapes

Verteilung und Migrationsverhalten von Schmetterlingen in der Agrarlandschaft; 70 pp.

ISABELLA SEDIVY

1 The spatial structure and dynamics of local populations of the three butterfly species *A. cardamines*, *A. hyperantus* and *P. aegeria* was studied in three Swiss agricultural landscapes with differing degrees of land-use intensity and fragmentation. The aim was to investigate if the species show a metapopulation structure and how population structures are affected by habitat and species attributes.

2 A presence-absence mapping for the three species showed that *A. cardamines* generally appeared at low densities with most detected individuals at site 2, with patchily distributed woods and different wood-edge structures. Females were able to use most patches of suitable host plants. *A. hyperantus* was widely distributed along the well connected canal embankments at site 1 and 3, but inhabited only small segments of the wood edges at site 2. *P. aegeria* was abundant at site 2 but restricted to isolated patches of woody structures at sites 1 and 3.

3 A capture-release-recapture was done for *A. cardamines* and *A. hyperantus*. It confirmed that *A. cardamines* has an open population

structure. Of a total of eight recaptured individuals only one was re-captured in the patch where it was previously marked. In contrast, population structures of *A. hyperantus* and *P. aegeria* were considered to be metapopulations.

4 Patch occupancy and migration patterns of *A. hyperantus* differed strongly between study sites. Only three movements between patches were detected at site 2, and some patches seemed to be totally isolated from the rest. In contrast, the well connected canal system at site 1 permitted a continuous interchange of individuals. Habitat quality and segment size affected both migration rates and species abundance. *A. hyperantus* appears to depend on well connected habitat systems.

5 The role of edge effects was investigated for *A. cardamines* in patches of its host plant *Alliaria petiolata*. Small and isolated patches had the highest egg per plant per patch ratio, which concurs with results of earlier studies. The effect seems to be caused by a searching behaviour of females that is adapted to a low density of host plants in disturbed habitats.

Territoriality, nest site selection and breeding success of Skylarks (*Alauda arvensis*) in territories with different crop composition

Der Einfluss von Alternativkulturen auf das Revierverhalten und die Brutbiologie der Feldlerche (Alauda arvensis) im schweizerischen Klettgau; 45 pp. + App.

SIBYLLE STÖCKLI

1 The ground-nesting Skylark (*Alauda arvensis*) used to be common in farmland, dunes and moorland but populations considerably decreased during the last decades, mainly due to changes associated with the intensification

of agriculture. In the Klettgau region of northern Switzerland, habitat quality for farmland birds was recently increased through the creation of compensation areas, i.e. set-asides, low-intensity meadows and hedges.

2 This study examines the importance of different alternative vegetation types as territory and breeding habitat compared to conventional winter-sown wheat in two areas of the Klettgau. The specific questions were: (1) Are territories including a high proportion of alternative habitat structures suitable for a longer time within the breeding season than territories including a high proportion of conventional wheat? (2) Do different alternative vegetation types influence the breeding success? (3) Does a high variety of alternative habitat structures influence territory size and shift during the breeding season? (4) Do micro-habitat structures influence nest site selection?

3 Average breeding pair (BP) density was 2.87 BP per 10 ha in the Langfeld area and 3.77 BP per 10 ha in the Widen area. Territory size was 1.81 ± 0.25 ha (mean \pm sd) in the Langfeld area and 1.47 ± 0.36 ha in the Widen area. In April and July territories were significantly smaller than in May and June. Territory size decreased with increasing number of neighbours, with decreasing field size, with increasing number of set-asides or low-intensity meadows, and partly with increasing number of vegetation types.

4 Winter-sown cereals, compensation areas (set-asides and low intensity meadows) and grassy farm tracks were highly used as habitat

throughout the season, whereas intensively managed meadows, hedges and villages were avoided. The importance of oil-rape, sunflowers, maize, potatoes, peas, soya and sugar beets increased from April to July. Emmer and spring sown wheat showed a relatively low preference which decreased during the season.

5 The average breeding success during the nestling stage was 39% (Mayfield method), and the number of nestlings per nest was 3.4 ± 0.54 . Breeding success was low in set-asides (predation) and clover (mowing) but high in cereals, sugar beets and winter sown wheat. To increase breeding success, sunflower and maize fields should be extensified to provide more ground cover, and mowing intensity in grasslands has to be reduced.

6 Microhabitat structures were important for nest site selection. Generally, vegetation height and cover at the nest site was significantly lower in comparison to the surrounding field; this difference was most pronounced in set-asides. There are several possibilities to promote the important microhabitat structures within the vegetation for breeding Skylarks: for example the suitability of winter-sown cereals could be enhanced through unsown areas within the field or small areas that are less densely sown and not treated with pesticides.

Hydrological and botanical assessment of a bog restoration project

Hydrologische und vegetationskundliche Abklärungen im Rahmen einer Hochmoorregeneration; 37 pp.

NORA ZUBERBÜHLER

1 Structural measures for bog regeneration were realised in spring 2002 in four bogs of the canton of Zurich, either to stop the penetration of mineral-rich water or to obtain a higher water level within the bog. This study

assessed the effects of these measures on the water level and on the electric conductivity of peat water and ditch water. Measurements were taken approximately weekly from early February until mid August 2002. A decrease

in electric conductivity would indicate that measures were successful.

2 In the bog Chrutzelenmoos positive changes were observed after the realisation of the structural measures: the water level rose, and in most cases the electric conductivity decreased or remained at a low level.

3 The measures were largely successful at the bog Torfried: the electric conductivity of the water in a dammed and partially filled ditch decreased. The effect of a newly dug ditch was not so clear but the input of mineral ions into the bog seemed to be reduced as well.

4 At Schwändiried the structural measures succeeded only partly. The discharge of a new

ditch did not work properly, so that the electric conductivity was only reduced in the upper part of the ditch. The structural measures at Spitzenmoos did not cause any ascertainable changes.

5 The vegetation was surveyed at Schwändiried and Spitzenmoos with the point-quadrat method. Schwändiried was in an intermediate state between fen and bog. Accordingly its vegetation contained many plant species that are not typical for bogs. Differences in the vegetation are probably due to the regular mowing of half of the surveyed area. At Spitzenmoos the species composition indicated that conditions were too dry.

Ph.D. theses (7)

Indigenous Knowledge of Storage Pest Management in Nepal

Lokales Wissen in der Vorratshaltung in Nepal; 226 pp.

ASTRID BJÖRNSEN GURUNG

1 This interdisciplinary research investigated on-farm storage management in marginal areas of Nepal. It examined the impact of farmers' perceptions and concepts, their knowledge and religious beliefs on their decision-making and practices.

2 The ethnoentomological research showed that the Nepalese folk-classification lumps insects together with arthropods and non-arthropods that interact with humans. Although insect morphology is important in local nomenclature, the insects' physical appearance is almost irrelevant for identification. The concept of pests and beneficials is virtually absent in traditional farming systems.

3 This documentation of farmers' knowledge of storage management demonstrated that farmers are aware of the degree of losses and the expected damage, and that their knowledge on storage protection is more complex

than generally assumed. The high losses in on-farm storage result from the lagging adaptation of traditional knowledge to the modern development.

4 A set of on-farm experiments was undertaken to evaluate farmers' knowledge and selected storage practices prior to and during storage. Sun drying of wheat controlled natural insect infestation insufficiently. The monitoring of nocturnal insect activity with sticky traps during grain cooling showed vast inter-household differences in terms of infestation risk. By skipping the cooling process and putting the warm grain directly into the storage container, this risk can be avoided, as initial temperature differences disappear within 3 days. Grain storage between two sand layers protects the grain for 7 months. The traditional sun-baked mud bin has no advantages against gunny bags in terms of microclimate and the build-up of

insect population. In both bins and bags, the grain moisture content doubled by the end of the 7 months' storage period, while the inoculated *Sitophilus oryzae* population multiplied nine-fold. Mixing oil cake powder (*Brassica campestris* var. *toria*) with wheat reduced *S. oryzae* population growth by half.

5 Storage related beliefs have an impact on the occurrence of storage pests and food storability. The research investigating spiritual aspects of storage management revealed how technical, social and psychological aspects of storage-related practices are influenced by the farmer's belief system.

Impact of cattle grazing upon the vegetation of an Alpine pasture

Auswirkungen der Beweidung auf die Vegetation einer Alpweide; 117 pp.

PETER LLOYD JEWELL

1 The effects of cattle grazing upon ecosystem structure and function of a subalpine pasture were investigated on Alp Nisciora in the southernmost Alpine region of Switzerland. Following a progressive decline in grazing intensity during the 20th century, a herd of Scottish highland cattle was introduced on the alp in 1994. This thesis examined how the spatial and temporal patterns of cattle activity are related to vegetation patterns and how they influence soil processes.

2 A vegetation survey was carried out in 1998 to describe the current state of the vegetation on Alp Nisciora. Vegetation dominated by *Nardus stricta* covered most of the alp; heathland vegetation with *Calluna vulgaris* and *N. stricta* as co-dominants occurred mainly in the higher and steeper parts of the site. The soil under both these vegetation types had a high organic matter content and a low P content. Vegetation with *Carex leporina*, *N. stricta* and various grasses occurred on nutrient-enriched soils associated with small flatter areas throughout the alp. Vegetation with little or no *N. stricta* mostly occurred at the bottom of the alp; it was dominated by various species including *Trifolium repens* (wet sites), *Agrostis capillaris*, nitrophilous forbs (especially around old cattle stalls) and *Pteridium aquilinum* (near woodland).

3 A GIS model was developed that simulates the spatial transfer of phosphorus by cattle within the alp. Data on cattle activity were collected in 1996 and in 1998 by observing the positions of grazing cattle and mapping the distribution of dung pats at the end of each grazing period. These data were extrapolated to produce density distribution maps of grazing animals and of dung. The four vegetation types were used in strongly contrasting ways by the cattle. Both grazing pressure and dung deposition were lowest in the *Nardus*-dominated and heathland vegetation types. Grazing pressure was highest on *Trifolium repens*- or *Agrostis capillaris*-dominated swards, while dung deposition was highest on vegetation dominated either by *Carex leporina* or by nitrophilous forbs.

4 The phosphorus transfers caused by the spatially heterogeneous activity of cattle were modelled by calculating rates of P offtake and P return for each point of the pasture. Approximately one half of the alp is scarcely used by cattle and there is no net loss of phosphorus due to grazing; a further quarter of the area has a loss of more than 0.5 kg P ha⁻¹ a⁻¹. About 2% of the area shows a gain of more than 5 kg P ha⁻¹ a⁻¹. The P content of the pasture soil was positively correlated with the modelled P transfers. A simple temporal extrapolation of

the model suggests that the highest current soil P contents could have been reached after approximately 200 years of grazing at the present rates of P accumulation. It is proposed that after this period most of the P transferred to heavily used parts is lost from the system through leaching or run-off.

5 The effect of nutrient enrichment by cattle on nutrient turnover in the soil was investigated in summer 1999 along transects from the centres of three enriched patches to the surrounding *Nardus*-dominated vegetation. The decomposition of plant material from both vegetation types was studied using litterbags buried under the soil surface, and nitrogen availability was assessed using ion exchange resins. Nitrogen availability was slightly higher in the *Agrostis* than in the *Nardus*

vegetation. By contrast, neither the decomposition of the *Agrostis* nor that of the *Nardus* substrate changed consistently along the transects, and decomposition rate was not correlated with nitrogen availability. However, the *Agrostis* substrate decomposed much faster than the *Nardus* substrate (81% vs. 30% dry weight loss after 100 days) and was more intensively colonised by plant roots, which suggests that it acted as a source of nutrients. The root response was not correlated with nitrogen availability in soil. This leads to the conclusion that the indirect effects of cattle on nutrient availability in soil (through changes in decomposition processes) are less important than direct effects of cattle on nutrient availability and the resulting nutrient losses from Alp Nisciora.

Effects of grassland management and species composition upon ecosystem-level processes

Auswirkungen der Bewirtschaftung und Artenzusammensetzung auf Ökosystemprozesse in Wiesen; 96 pp.

BETTINA R. KAHLERT

1 The removal of plant biomass due to agricultural management leads to the export of nutrients and carbon from the system. The time and frequency of biomass removal also influence the species composition of vegetation. The aim of the present study was to investigate to what extent the shift in species composition in response to management mediates the direct effect of biomass removal, i.e. whether the characteristics of dominant species under a certain management regime help to minimize the losses from the system.

2 A long-term management experiment in nutrient-poor limestone grasslands in the Schaffhauser Randen of Northern Switzerland was used for this study. For the past 22 years, permanent plots have been subject to

annual mowing in July, annual mowing in October, annual burning in February/March or no biomass removal. The principal hypothesis was that species composition in the plots has progressively adjusted to each management regime so as to minimise the losses of biomass and nutrients from the grassland ecosystem.

3 Seasonal variations in biomass and nutrient content of aboveground vegetation was investigated to determine how the timing of biomass removal influences nutrient losses from the system. Differences in species composition among management types led to differences in the seasonal dynamics of N and P stocks of the vegetation; these indirect effects of management could be larger than the di-

rect effects of nutrient removal. Plots mown in July had the lowest maximum standing crop, the lowest nutrient concentrations at the time of mowing, and a low seasonal dynamics of nutrient concentrations compared to the other treatments. Burnt plots had the lowest amount of living biomass and a large amount of nutrient-poor litter at the time of burning. Plots mown in October showed a sharper decline in nutrient contents in autumn than plots mown in July, and the unmown plots accumulated large amounts of nutrients in the litter. These contrasting seasonal patterns in the aboveground nutrient capital indicate that vegetation responds to the time and method of biomass removal so as to minimise nutrient losses.

4 Leaf phenology of the dominant species – *Brachypodium pinnatum*, *Bromus erectus*, *Salvia pratensis* – was studied to test whether it matches the mowing regimes. Both *B. pinnatum* and *B. erectus* produced similar numbers of leaves but the seasonal dynamics was different: *B. erectus* produced a high number of leaves after mowing in July, which may explain its tolerance to this mowing regime. *B. pinnatum* has long-lived leaves and no leaf production in winter, which is of advantage both on plots without disturbance and on plots burnt in winter. *S. pratensis* has long-lived leaves, but all of them senesce rapidly in autumn before mowing in October, the management promoting this species. Thus, differences in the phenology of the dominant species are consistent with the hypothesis that species composition has adjusted under management so as to minimise the losses of biomass and nutrients.

5 A pot experiment further tested the hypothesis that the turnover of nutrients and biomass in these three species preadapts them to differing management regimes. It showed that the timing of growth varies be-

tween the three species: *B. erectus* and *S. pratensis* grew early in the season whereas *B. pinnatum* was much later. For all species the uptake of P occurred earlier in the season than that of N. However, there are important differences between species in their seasonal patterns of nutrient uptake and loss relative to growth. The results demonstrate that internal nutrient cycling of the plant species is closely associated with the timing of biomass removal.

6 The dependence of *B. erectus* and *B. pinnatum* on arbuscular mycorrhiza fungi (AMF) and the importance of this symbiosis for the ability of plants to recover after mowing were investigated in a greenhouse experiment. The regrowth of the two grasses following defoliation was measured in treatments with or without AMF and with low or high P supply. Contrary to expectation, there was a positive effect of AMF on plant growth and P uptake of defoliated plants of *B. pinnatum*, which can hardly recover after mowing without AMF. The effects were more pronounced at low P supply. In contrast, *B. erectus* was mostly influenced negatively by AMF. Nevertheless, this negative influence was less pronounced after defoliation. The results demonstrate the particular importance of AMF when plants growing under conditions of low P availability are also subjected to losses due to defoliation.

Tree regeneration on the flood plain of an Alpine river*Regeneration von Gehölzen in der aktiven Aue eines Alpenen Flusses*; 143 pp.

SOPHIE KARRENBURG VAN DER NAT

1 River regulation has led to a strong decline of braided channel systems and associated pioneer ecosystems world-wide. To develop appropriate restoration strategies an understanding of the natural functioning of such systems is necessary. This thesis provides such information focusing on pioneer trees in the flood plain of the near-natural river Tagliamento, NE-Italy.

2 Along the Tagliamento, we examined patterns of woody pioneer vegetation. *Alnus incana* dominated the upper reaches of the river, whereas *Populus nigra* and *Salix* species were more abundant in the lower reaches. Woody vegetation was generally very young (mean < 9 years). In correspondence analyses, species composition was mainly related to climatic changes along the river but was also significantly impacted by small-scale variables, such as patch age, distance from the nearest channel and elevation above the water level. However; only 38% of the variation in species composition was explained. Thus, additional processes might be important, e.g. specifics of plant regeneration.

3 Life history traits that allow Salicaceae to occur in active flood plains include the production of abundant seeds that are dispersed by wind and water and the ability to regenerate vegetatively. These traits may also lead to high genetic variability and predispose these species to hybridisation. Therefore, we propose a feedback of adaptive traits on the evolutionary process. This hypothesis is evaluated in a literature review on the life history of riparian Salicaceae and used as starting point for three case studies on specific aspects of tree regeneration in flood plains.

4 Most plants need pollen vectors to produce seeds. We studied pollen vectors and inflorescence morphology in the floodplain species *Salix alba*, *S. eleagnos*, *S. daphnoides* and *S. triandra*. Seed set in all species was mainly due to insect visitation but some seed set occurred when wind was the only pollen vector (5–30% of natural seed set). Relative success of wind pollination differed between species and was positively related to ovule number per catkin. A dual pollination system as observed here may act as a reproductive assurance.

5 The co-existence of the various floodplain Salicaceae may be mediated by differences in their seed reproduction. We investigated seed production and seed longevity in six species of floodplain Salicaceae (*P. nigra*, *S. alba*, *S. daphnoides*, *S. eleagnos*, *S. purpurea* and *S. triandra*). Seed release periods in spring were staggered with some overlap. Seed mass ranged from 0.02–0.82 mg and was species specific; it was negatively related to seed number. In a laboratory experiment, half-viability periods, i.e. the time until 50% of the seeds are no longer viable, was very short (species means: 6–23 days) and positively related to seed mass. Thus, a phenotypic trade-off between seed size and seed number is accentuated by the short life span of small seeds.

6 During establishment of saplings and regenerating fragments on flood plains, root-anchoring ability is crucial for survival because of disturbance by floods. We examined uprooting resistance of saplings of *A. incana*, *P. nigra*, and *S. eleagnos* and of cuttings of *S. eleagnos* and *P. nigra*, planted at a field site

and in a common garden. Uprooting resistance of saplings was lowest in *A. incana*, intermediate in *P. nigra* and highest in *S. eleagnos*. For cuttings, differences in uprooting resistance between species were only evident under field conditions, where *P. nigra* was superior due to its better growth performance. The superior root anchorage of *S. eleagnos* saplings corresponds to its distribution across the flood plain, where it is most abundant on the margins of vegetated island whereas *P. nigra* dominated only in less flood prone areas.

7 The results of this thesis emphasise the importance of disturbance and chance processes for the regeneration of pioneer vegetation on flood plains. Due to their rapid and effective regeneration, woody pioneer vegetation would probably develop fast in restoration sites provided that appropriate hydrological conditions, i.e. seasonal water fluctuations and severe floods, are present. Hydro-engineering measures that develop flow regimes close to natural conditions are strongly recommended for restoration of woody pioneer vegetation and associated biota along regulated rivers.

Non-target effects of mass releasing *Trichogramma brassicae* (Hym.: Trichogrammatidae) against the European corn borer

Risiken für Nicht-Zielorganismen bei der Massenfrelassung von Trichogramma brassicae (Hym.: Trichogrammatidae) gegen den Maiszünsler; 72 pp.

STEFAN KUSKE

1 Inundative releases of *Trichogramma brassicae* against the European corn borer (ECB) in maize in southern Switzerland were evaluated for potential detrimental effects on the native non-target arthropod fauna. Dispersal from release fields into wildflower strips and stands of common reed was assessed using sticky traps. It was found that a considerable number of *T. brassicae* move out of the crop following releases, which leads to a transient inundation of non-target habitats.

2 Extensive field surveys using sentinel egg-cards and sticky traps demonstrated that these parasitoids can overwinter in southern Switzerland and persist in non-target habitats, even though they were introduced more than ten years ago without the intention of establishing resident populations.

3 Laboratory no-choice experiments concerning the host acceptance and suitability of the native common reed stalk borers *Archanara geminipuncta* and *Chilo phragmitellus* indicated

that there is virtually no risk for these two non-target species by *T. brassicae* because their eggs were either not accessible or not attractive for *T. brassicae* females. Field experiments carried out in natural wetlands near to maize fields with *T. brassicae* releases confirmed these findings; none of the eggs of the two common reed stalk borers were parasitised.

4 No harmful effects were found either for the indigenous parasitic fly *Lydella thompsoni*, which is an important natural enemy of the ECB throughout southern Europe. In southern Switzerland, this larval parasitoid relies upon the presence of the two common reed stalk borers for its first annual generation.

5 Parasitism of the ECB by *L. thompsoni* was assessed in maize fields throughout the study area. We found a strong correlation between ECB control by *L. thompsoni* in a maize field and the proximity between this field and natural common reed stands with alternative hosts of the parasitoid.

6 Our results imply that the pest control potential of *L. thompsoni* has been largely underestimated and can be enhanced if the number of habitats with alternative hosts of this parasitoid is increased and if a favourable spatial arrangement of these habitats in the agroecosystem is implemented.

7 Landscape management that favours *L. thompsoni* combined with inundative releases of *T. brassicae* is considered a highly effective and environmentally sound strategy for the biological control of the ECB and may further reduce the need for pesticides against this important pest.

Effects of site and management on the vegetation of Alpine pasture and implications for their sustainable use

Einfluss von Standort und Nutzung auf die Alpweidevegetation und ihre Bedeutung für die nachhaltige Alpnutzung; 142 pp. + App.

PRISKA MÜLLER

1 This study was part of a European research project on sustainable land use in alpine mountain regions. It focused on the region Glarner Hinterland-Sernftal in eastern Switzerland and dealt with the following questions: (1) How is the present vegetation of alpine farms influenced by site conditions, agricultural land use and land use history? (2) Which site factors and which aspects of management determine plant species richness on alpine pastures? (3) How can ecological knowledge be integrated into planning and contribute to a sustainable land use on alpine pastures?

2 The vegetation of 55 alpine farms was mapped in summer 1999 to show the distribution of 13 types of vegetation structure with a further distinction of 12 types of pastures. The distribution of these vegetation types was related to 33 potential explanatory variables describing the natural setting, land use, and land use history. Both the vegetation structure and the pasture composition were most closely related to the altitude, type of bedrock, animal stocking rate and pasturing system of the farms. Land-use variables (mainly stocking rate and pasturing system) influenced the pasture composition more than the

vegetation structure, whereas the latter was mainly influenced by the natural setting (altitude, bedrock). The former land use and land-use change since 1900 had even more influence on the present vegetation than current land use or site conditions.

3 Overuse of the pastures was not a major problem in the region: only a small part of the area was covered by intensively fertilised, species-poor lawns or by stands of unpalatable tall forbs. By contrast, underuse has turned large areas into species-poor pasture of low food value. The fraction of a farm's area classified as underused mainly depended on access; low-elevation farms that can be reached rapidly by car were less affected by underuse than remote, high-elevation farms. To maintain the economic value of the alpine pastures, the whole area needs to be used more homogeneously.

4 Plant species richness and soil chemistry were surveyed in 200 plots (each 1 m²). Between 3 and 32 vascular plant species were recorded per plot. The number of plant species per plot decreased with increasing P-content in soil (0.04–5.0 mg g⁻¹) and increased with increasing pH. There were unimodal relationships between species richness and soil

N-content (2.3–21.3 mg g⁻¹), soil C-content (26.1–277 mg g⁻¹) as well as the average nutrient indicator value of the vegetation. However, there was always a considerable scatter of individual values. Out of the 164 plant species recorded in the survey, five were most common in species-poor plots, while 36 were most common in species rich plots. In general, the species richness was related more closely to the occurrence of these indicator species than to the recorded site factors.

5 The last part of the thesis analyses how ecological knowledge can be integrated into planning in order to ensure a sustainable land use. Examples of cases where this integration has already occurred show that both changes in socio-economic conditions and increased scientific knowledge or new methods contrib-

uted to it. A major methodological issue is related to the small spatial scale at which ecological research often works, while planning is usually concerned with larger areas. In heterogeneous areas such as alpine pasture, the current planning zones should be subdivided into smaller zones according to ecological criteria, so that suitable forms of land use, possible land-use restrictions or an assessment of ecological quality is valid for the whole zone. A more detailed subdivision of the pastures into zones that are suited for specific forms of management (e.g. a certain pasturing system, stocking density, type and amount of fertilisation) entails field research. Improving the regional coordination and the communication between sectors represents another important challenge for spatial planning in the future.

Evaluating the quality of ecological compensation sites: some methodological investigations

Beurteilung der Qualität von ökologischen Ausgleichsflächen: einige methodische Untersuchungen; 99 pp.

ANDREA SCHWAB WACHTER

1 Biological diversity is a major criterion in evaluating the effectiveness of measures to enhance the ecological quality of rural areas. Assessments of biodiversity including both plant and animal groups are very time-consuming and require a high level of expert knowledge. The use of bioindicators is based on the assumption that the diversity of selected groups of organisms (i.e. the indicator taxa) is correlated with biodiversity in general. This study investigates whether habitat parameters such as vegetation structure can be used as surrogates for direct measures of biodiversity in ecological compensation areas. The diversity of plants, spiders (Araneae) and true bugs (Heteroptera) was assessed in wildflower strips and differently used mead-

ows together with site-specific factors and parameters of the vegetation structure. The aim was to find easily measured parameters which reflect differences in species diversity of the different indicator groups between management types.

2 Wildflower strips were surveyed in the regions Rafzerfeld and Klettgau. A total of 144 plant species, 81 spider and 98 bug species were found in the 25 sites. Correlations between the numbers of vascular plant species and the numbers of spider and bug species were weak, suggesting that for this habitat type the number of vascular plant species is not a reliable surrogate for overall biodiversity. Various parameters of the vegetation structure correlated significantly with the numbers of spe-

cies of the three taxa investigated. Between 25 and 60% of the variance in species numbers between sites can be explained using multiple regression models and canonical correspondence analyses. Two measures of canopy density measured – photosynthetically active radiation and vertical plant biomass distribution – are important for all three indicator taxa. The results indicate that parameters describing the vegetation structure can contribute useful information about the biodiversity of sites, at least of the same habitat type.

3 Three types of grassland were surveyed in the Randen. The 18 sites varied widely in terms of species richness, diversity and abundance for all indicator groups. However, indicator species numbers were significantly correlated with each other. Several parameters of the vegetation canopy were significantly related to species numbers, and multiple regression models based on these parameters explained 25–60% of the variance in species richness and species composition. Canopy density, plant biomass distribution and plant height were the most important parameters for all indicator groups. Once again, it is concluded that parameters describing the structure of the vegetation provide useful information about the relative species richness of sites.

4 A randomised block experiment was carried out to investigate how management of wildflower strips affects biodiversity. In this experiment the density of the vegetation was manipulated in various ways. The treatments included spraying with herbicides to remove monocotyledonous plants, and spraying all plants, removing litter and putting in of wire fences. No significant influence of the treatments on the arthropod groups was found. Relative differences in species diversity and abundance, although not significant, are consistent with the hypothesis that the physical

structure of the vegetation influences the arthropod communities. We suggest that the lack of a treatment effect on species abundance and diversity is related to the fact that the experiment was influenced by the previous management of the site.

5 It is concluded that any evaluation of biodiversity must be in relation to the objectives of the ecological compensation scheme. In the studied types of vegetation the true bugs gave the best estimate of overall biodiversity. In contrast, flowering plants – although widely used in evaluations – proved to be a poor predictor of arthropod diversity, especially in wildflower strips; the zoological and botanical importance of a habitat are therefore not necessarily the same. Parameters describing the structure of vegetation can explain a high percentage of species variability and might be used to assess potential biodiversity. However, the use of vegetation structure for quality assessments should be restricted to sites of the same habitat type within a particular area.

Annual report of the Geobotanical Institute ETH (2002)

P. J. EDWARDS, A. GIGON, E. AESCHBACH & S. REBSTEIN

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1 Introduction

The Institute's activities in the year 2002 reflect the large diversity of fundamental and applied research projects in which it is involved. Several interdisciplinary collaborative projects with other Swiss institutes were completed, such as the Polyproject PRIMALP on sustainable primary production in the Alps as well as the project on biodiversity in the agricultural landscape of Northern Switzerland (part of the Swiss National Fund integrated project on biodiversity). The Institute continues to involve itself in nature conservation and environmental research, for example through the leadership of both the Swiss commission for wild plant conservation and the working group on invasive plants, through participation in the Biodiversity Forum, the international 'Guidelines' project (ecological risk assessment) and several projects on the management and restoration of wetlands. At the same time, there is a strong development of fundamental research in the fields of systematics and evolution, for which some of the most modern molecular and biochemical techniques have been implemented.

The Institute's publishing activity was further enhanced according to international standards. Thus, as from 2002, the journal *Perspectives in Plant Ecology, Evolution and Systematics* appears with four issues per year (instead of two) and is now abstracted by the ISI Web of Science. The *Bulletin of the Geobotanical Institute ETH* is published in both printed and electronic form; the latter is also available and searchable on the homepage of

Opulus Press, the publisher of *Journal of Vegetation Science*.

Teaching was provided as usual to undergraduate and graduate students from ETH as well as from the University of Zurich. The number of undergraduate students is currently exceptionally high, mainly because changes in the Swiss high school system cause more students to enter university at the same time.

Structural changes at ETH, already mentioned in previous annual reports, have continued to progress, and many Institute members are directly involved in the planning process. The new Europe-wide study system leading to a Bachelor or Master degree will be introduced by the Department of Environmental Sciences in October 2003. At the same time, undergraduate studies – especially the first year – will be to a large extent merged among the Departments of Environmental Sciences, Forestry, Agronomy and Earth Sciences. This major change implies the modification or withdrawal of many existing courses, while new courses need to be developed. For several years, the old and the new system will co-exist within ETH as the current students complete their studies according to the old system of diploma courses.

An improved research collaboration among the Departments of Environmental Sciences, Forestry, Agronomy and Earth Sciences within a new 'Centre for Environmental Sciences and Natural Resources' has also been decided. The Department of Forestry will

merge with that of Environmental Sciences at the beginning of 2004. Close collaboration between the Geobotanical Institute and other research groups within the Centre is planned, especially in the fields of ecological modelling and ecosystem management.

On 28 June 2002 an interesting excursion to the Seebachtal (TG) was organised for members of the Department of Environmental Sciences by Dr. Dieter Ramseier and Matthias Suter. They presented an ongoing wetland restoration project as well as a large scale field experiment on plant competition.

The annual Institute excursion (18 to 22 August 2002) took the participants to the River Tagliamento in northern Italy. The main organisers, Dr. Sophie Karrenberg van der Nat and Dr. Dimitri van der Nat, had carried out their postgraduate research in this area; there is also a continued research collaboration with EAWAG and British research groups. The excursion gave an excellent insight into the dynamics of one of the last unregulated river floodplains of Europe.

After having been the head of the Department of Environmental Sciences for two years, Prof. Peter Edwards left on 1 October 2002 for a six-months Sabbatical in Costa Rica; Prof. Andreas Gigon acted as Institute leader during this time.

2 Staff of the Institute

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Scientific visitors

Prof. Dr. Frank KLÖTZLI, Geobotanisches Institut ETHZ (1.1.–31.12.02)

Prof. Dr. Elias LANDOLT, Geobotanisches Institut ETHZ (1.1.–31.12.02)

2.3 STAFF CHANGES IN 2002

Prof. Dr. Barbara ROY, who was appointed as professor at the University of Oregon in 2001, definitely resigned from her position as ETH professor in autumn 2002. It is hoped that her position will be filled again by a new Professor of Plant Evolutionary Ecology or Plant Ecological Genetics.

Prof. Dr. Egon HORAK formally retired on 31 May 2002. However, he will continue to work at the Institute for some more time to ensure the continuity of his important work in the field of mycology, and especially the scientific direction of the mycological herbarium. Prof. Horak is recognised as one of the leading specialists in fungal systematics world-wide. He has had innumerable research collaborations with research institutes on all continents and still spends several months per year abroad to revise the taxonomy and systematics of certain fungal groups. He has been very active as author of scientific papers, monographs or book chapters and as scientific editor of mycological journals. In addition, he offered high-level mycological courses to students at ETH.

3 Research

3.1 OVERVIEW

The research of the Geobotanical Institute is focused on four main directions: plant ecology, plant evolution and systematics, mycology, and archaeobotany; the current research topics of the research groups are listed below.

3.2 RESEARCH FIELDS

SECTION PLANT ECOLOGY

Group 1: Community and Ecosystem Ecology

(Prof. Dr. P.J. Edwards, Dr. C. Abivardi, Dr. R. Billeter, Dr. H. Dietz, Dr. S. Güsewell, Dr. E. Weber)

- Ecosystem processes: nutrient budgets, herbivory and other biotic interactions
- Ecosystems on a landscape level and GIS
- Agroecology
- Physiological and ecological characters of plants; plasticity in response to light and nutrients
- Herb-chronology and its application to population ecology
- Ecology of invasive plants

Group 2: Plant Ecology and Conservation Biology

(Prof. Dr. A. Gigon, Dr. M. Di Giulio, Dr. D. Ramseier)

- Ecological stability: concepts and case studies
- Competition, positive biotic interactions, and coexistence of plants
- Assessment of biodiversity
- Management for nature conservation

Group 3: Risk Assessments of Genetically Modified Organisms

(Dr. A. Hilbeck)

- Transgenic plant – insect interactions
- Nontarget effects of transgenic host plant resistance
- Consequences of transgene flow on populations of plants and plant-associated organisms
- Development of international scientific guidelines for the assessment of environmental risks of GMO's

SECTION EVOLUTION AND SYSTEMATICS

Group 1: Plant Systematics and Evolution

(Dr. M. Baltisberger, Prof. Dr. E. Landolt, Dr. A. Widmer)

- Speciation and population genetics in *Draba*, *Ranunculus*, *Ophrys* and *Viscum*
- Microevolution and genetic adaptation in a changing environment
- Plant–pollinator interactions
- Taxonomic revision of the Lemnaceae
- Survey of the flora of Zürich

Group 2: Evolution

(Dr. F. Schiestl; vacant professor)

- Evolution of plant-pollinator interactions
- Sexual deception in Orchids

Section Mycology

(Prof. Dr. E. Horak, PD Dr. A. Leuchtman)

- Plants and fungi (ectomycorrhiza, saprophytes) in various habitats of the northern and southern hemisphere
- Monographic revision of several genera of the Agaricales (*Crepidotus*, *Galerina*) and Boletales (*Boletellus*)
- Evolution and ecology of symbiotic interactions between grasses and endophytes
- Dispersal and infection strategies of the endophyte *Epichloë*

3.3 NEW RESEARCH PROJECTS 2002

(Title. Source of funding; research assistant(s); project leader)

- Odor communication and the evolution of pollination syndromes in Orchids. ETHZ; C. Salzmann; F. Schiestl.
- Biosafety testing guidelines. DEZA; E. Underwood; A. Hilbeck.
- Invasions of woody plants into the Seychelles tropical forests. ETHZ; C. Küffer & E. Schumacher; H. Dietz, P.J. Edwards & K. Fleischmann.

4 List of publications 2002

4.1 PERSPECTIVES IN PLANT ECOLOGY, EVOLUTION AND SYSTEMATICS 5 (2002)

The fifth volume of the journal *Perspectives in Plant Ecology, Evolution and Systematics* appeared in four issues with a total length of 249 pages. The aims and scope of the journal are given under <http://www.urbanfischer.de/journals/ppees>

Issue 1/02

Kollmann, J., Dietz, H. & Edwards, P. J. Editorial – recent developments in the journal.

Aarssen, L. W. & Schamp, B. S. Predicting distributions of species richness and species size in regional floras: applying the species pool hypothesis to the habitat templet model.

Imbert, E. Ecological consequences and ontogeny of seed heteromorphism.

Güsewell, S. & Koerselman, W. Variation in nitrogen and phosphorus concentrations of wetland plants.

Leite, E. J. State-of-knowledge on *Astronium fraxinifolium* Schott (Anacardiaceae) for genetic conservation in Brazil.

Issue 2/02

Sabater, B., Martin, M., Schmitz-Linneweber, Ch. & Maier, R. M. Is clustering of plastid RNA editing sites a consequence of transitory loss of gene function? Implications for past environmental and evolutionary events in plants.

Lumbsch, H.T. How objective are genera in euascomycetes?

Stagegaard, J., Sørensen, M. & Kvist, L. P. Estimations of the importance of plant resources extracted by inhabitants of the Peruvian Amazon flood plains.

Lopez, F., Fungairino, S. G., Serrano, J. M., de las Heras, P. & Acosta, F. J. Analysing hierarchically-structured fitness and modular dynamics in plants: integration of concepts from population dynamics.

Dietz, H., Kollmann, J. & Edwards, P. J. Editorial comment – Forum section.

Looijen, R. C. & van Andel, J. A reply to Thomas Parker's critique of the CI community concept.

Parker, T. V. The concept of the ecological community and a clash of perspectives: A reply to Looijen and van Andel.

Issue 3/02

Ehrlén, J. Assessing the lifetime consequences of plant-animal interactions for the perennial herb *Lathyrus vernus* (Fabaceae).

Woitke, M. & Dietz, H. Shifts in dominance of native and invasive plants in experimental patches of vegetation.

Loreto, F. Distribution of isoprenoid emitters in the *Quercus* genus around the world: chemotaxonomical implications and evolutionary considerations based on the ecological function of the trait.

Leite, E. J. State-of-knowledge on *Myracrodruon urundeuva* Fr. Allemao (Anacardiaceae) for genetic conservation in Brazil.

Issue 4/02

Greogius, H.-R., Bergmann, F. & Wehenkel, C. Analysis of biodiversity across levels of biological organization: a problem of defining traits.

Rixen, C., Stöckli, V. & Ammann, W. Does artificial snow production affect soil and vegetation of ski pistes? A review.

Kaitaniemi, P. & Ruohomäki, K. Factors controlling resource allocation in mountain birch.

4.2 BULLETIN OF THE GEOBOTANICAL INSTITUTE ETH 68 (2002)

Articles

Von Arx, G., Bosshard, A. & Dietz, H. Land-use intensity and border structures as determinants of vegetation diversity in an agricultural area.

Poinar, G. O., Bonnicksen, R. & Hedlund, C. Reconstruction and climatic interpretation of a late Pleistocene peat deposit in northwestern Oregon.

Studer, S. & Edwards, P.J. Morphological variation of plant populations from differently managed grasslands.

Billeter, R., Schneller, J. & Diemer, M. Genetic diversity of *Carex davalliana* and *Succisa pratensis* in mown and abandoned fen meadows.

Research Projects and Notes

Schiestl, F.P. Odor communication and the evolution of pollination syndromes in orchids.

Schwienbacher, E. & Erschbamer, B. Longevity of

seeds in a glacier foreland of the Central Alps – a burial experiment.

Buschmann, H., Edwards, P.J. & Dietz, H. Does herbivory by slugs influence the invasiveness of perennial Brassicaceae?

Fischer, H.S. & Gilgen, H. DACHRad – Berechnung der direkten Sonneneinstrahlung in Deutschland, Österreich und der Schweiz.

Bratteler, M., Widmer, A., Baltisberger, M. & Edwards, P.J. Genetic architecture of traits associated with habitat adaptation in *Silene vulgaris* (Caryophyllaceae).

4.3 FURTHER PUBLICATIONS

A Publications in refereed journals or books

Baltisberger, M., Dähler, D. & Horat, S. (2002) Karyologische Untersuchungen an den schweizerischen Arten der Gattung *Polygonatum*. *Botanica Helvetica*, **112**, 91–101.

Berry, N.R., Büeler, T., Jewell, P.L., Sutter, F., & Kreuzer, M. (2001) The effect of supplementary feeding on composition and renneting properties of milk from cows rotationally grazed at high altitude. *Milchwissenschaft*, **56**, 123–126.

Berry, N.R., Jewell, P.L., Sutter, F., Edwards, P.J. & Kreuzer, M. (2002) Selection, intake and excretion of nutrients by Scottish Highland suckler beef cows and calves and Brown Swiss dairy cows in contrasting Alpine grazing systems. *Journal of Agricultural Science*, **139**, 437–453.

Brem, D. & Leuchtman, A. (2002) Interspecific competition of endophyte infected vs. uninfected plants of two woodland grass species. *Oikos*, **69**, 281–290.

Buschmann, H. (2002) Fecundity of yellow-bellied toads *Bombina variegata* under free-range conditions: an indication of risk-spreading strategy. *Amphibia-Reptilia*, **23**, 362–369.

Dietz, H. & Fattorini, M. (2002) Comparative analysis of growth rings in perennial forbs grown in an Alpine restoration experiment. *Annals of Botany*, **90**, 663–668.

Dietz, H., Köhler, A. & Ullmann, I. (2002) Regeneration growth of the invasive perennial forb *Rorippa austriaca* (Brassicaceae) in relation to fertilization and interspecific competition. *Plant Ecology*, **158**, 171–182.

Dietz, H. & Schweingruber, F.H. (2002) Annual rings in native and introduced forbs of lower Michigan, USA. *Canadian Journal of Botany*, **80**, 642–649.

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- B Publications in other scientific journals, book chapters and books**
- Baltisberger M. (2002) Cytological investigations on some Albanian plant species. *Candollea*, **56**, 245–259.
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